SCAEF-Third International Conference on

'Resilient Infrastructure for a Better Tomorrow'

18th-20th November, 2019

Hotel Radisson, Lazimpat, Kathmandu, Nepal

Proceeding

Organizers:

Society of Consulting Architectural & Engineering Firms (SCAEF)

National Reconstruction Authority (NRA)

Co-Organizers:

Federation of Contractors' Association Nepal

National Society for Earthquake Technology-Nepal

visit Nepal 2020 Lifetime Experiences

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Foreword

After successfully hosting two TCDPAP international conferences in 1998 and thereafter in 2009; this year; The Society of Consulting Architectural and Engineering Firms (SCAEF) has organized the 3rd International Conference on the title **Resilient Infrastructure for a Better Tomorrow**. Having effectively completed the same; SCAEF is now pleased to present the proceedings of this Conference to you.

We believe that this event has been instrumental to provide valuable feedback to the government, leaders and policy makers and all stakeholders of infrastructural development. The interactions, sharing knowledge and experience between the national and international delegates might have been of a very appreciable value to be used in the development processes. Through this conference, international firms were not only introduced about the business environment in Nepal; but also the understanding and the gap in technical knowledge and experiences between the national and international consultants has become more conducive to both. We believe this event was a vibrant gathering and in realizing the process of globalization in an equitable and a fruitful manner.

On behalf of organizing committee, we would like to extent our sincerest gratitude to all our valued well-wishers, knowledge partners and the member firms for supporting us to make this International Conference, a success. A conference of this magnitude could not be realized without the selfless and generous support of the sponsors who contributed to making it happen. We thank the main Keynote Speaker, Session Chairs, Session Keynote Speakers, Paper Presenters, Rapporteurs, Delegates and Participants for their active participation and look forward to see most of you the next FIDIC ASPAC Conference in in Nepal, in a couple of years..

Publication Committee
December 2019

Vice President

Office of the Vice President Lainchaur, Kathmandu, Nepal

Kathmandu, Nepal

MESSAGE

It gives me a great delight to know that ***Society of Consulting Architectural and Engineering Firms*** (**SCAEF**) is going to publish "***Post conference Proceedings***". The organization was successful to host a three day symposium with a theme of "Resilient Infrastructure for a better tomorrow which held from 18th to 20th November 2019. I would like to congratulate the ***Society of Consulting Architectural and Engineering Firms*** (**SCAEF**) for remaining consistent in serving the nation for more than two decades.

I anticipate that the "Post Conference Proceedings" will bring in light the core values and theme of the organization and conference respectively. Distribution of the publication will enable worldwide scholarship on architectural engineering to elicit mutually beneficial ideas and plans for further accumulation and integration of complex architectural and engineering expertise in a plain and easily perceptible manner.

My best wishes for the publication.

December 22, 2019

Nanda Bahadur Pun

KATHMANDU
NEPAL

The Prime Minister

Message

I am happy to know that Society of Consulting Architectural & Engineering Firms (SCAEF) has completed its 29 years of in the field of professional consulting services. My congratulations to the SCAEF for this accomplishment. It gives me and the Government of Nepal a great pleasure in extending warm greetings and best wishes to the 15th Executive Committee and all the members of the Firms in celebrating the occasion.

Nepal is facing the urgency of its capacity to be self-sufficient. It is high time that country should work for all-round development including the improvement in agricultural productivity, industrial development and, especially, the physical infrastructure development. SCAEF has an important role to play to contribute to plan and implement the development activities in these and other sectors too. I would like to ask SCAEF and its members to dedicate to re-building the nation through providing excellent and profound professional services.

I extend my best wishes to the special edition of the Proceedings of **SCAEF'S Third International Conference on "Resilient Infrastructure for a Better Tomorrow"** held in Kathmandu from 18 to 20 November 2019.

22 December 2019

K P Sharma Oli

Government of Nepal
Personal Secretsriat of
Minister Physical Infrasructure and Transport

Message

Development and construction has important role to play at the time when overall development process need to be accelerated through development of physical infrastructure. SCAEF, being an umbrella organization of all the consulting firms involved in technology, engineering and development has also very important role to play. Now Ministry of Physical Infrastructure and Transport has initiated various development activities. For the smooth implementation of the planned activities, development partners has to cooperate and provide their quality professional services.

SCAEF has to carry out various activities to enhance its capacity to be able to provide its meaningful contribution to the country. In this regards , I am confident that special edition of Proceeding of **SCAEF'S-Third International Conference** will definitely be instrumental in providing the information on state of the art technology and trend in the area of various development issues. I hope this publication will be very useful to all the stakeholders of development and construction industry - policy makers, engineers, bureaucrats, contractors.

I congratulate SCAEF, professionals and engineers to contribute to the development works through such technical conferences in international level. I urge all the professionals and engineers to contribute to the development works from whatever means available in the country.

Lastly, I would like to extend my best wishes to SCAEF for the successful completion of the SCAEF's-Third International Conference "Resilient Infrastructure for A Better Tomorrow" and also wish for the best contribution of SCAEF in the overall development of the country.

Mr. Basanta Kumar Nemwang

Minister

Minister
Physical Infrastucture and Transport

Ministry of Physical Infrastructure and Transport

December 20,2019

Government of Nepal

National Planning Commission

Singha Durbar, Kathmandu, Nepal

Prof. Puspa Raj Kadel, Ph.D
Vice-Chairman

Government of Nepal National Planning Commission Singh Durbar, Kathmandu

Ref.:-

MESSAGE

On behalf of the National Planning Commission, I would like to congratulate the Society of Consulting Architectural and Engineering Firms(SCAEF) Nepal for organizing **SCAEF's-Third International Conference on "Resilient Infrastructure for A Better Tomorrow"**. It is my great pleasure to state that SCAEF has admirable contribution in nation building process by providing skillful and professional services with the recognition from Government as a national body of the consulting sector.

The National Planning Commission has considerable effort in development of Nepal since six decades emphasizing infrastructure development, socio economic enhancement and poverty reduction. Nepal has signed the 2030 Sustainable Development Goals agreed by the members of the United Nation. The National Planning Commission as a National Platform is intended to enable tracking of Nepal's progress toward achieving SDGs by 2030. We believe, to achieve good result as set out by SDGs, the role of SCAEF is very important, for infrastructure development. Therefore, NPC has always the desire to work collaboratively with SCAEF in the nation building process.

It is obvious that SCAEF has to enhance its capacity in various aspects so that it can provide quality input in national development. In this regard, organizing international level conferences will definitely be instrumental in providing the information on state of the art technology and new trends in the area of various development issues. It is expected that this Conference will be very beneficial to all the concerned stakeholders of development such as policy makers, architects and engineers, bureaucrats, contractors.

Lastly, I would like to extend my best wishes to SCAEF for the successful completion of the **SCAEF's-Third International Conference "Resilient Infrastructure for A Better Tomorrow"** and also wish for the best contribution of SCAEF in the overall development of the country.

Dr. Puspa Raj Kadel
Vice-Chairman
National Planning Commission (NPC)
December 22, 2019

Government of Nepal
National Reconstruction Authority
Singh Durbar, Kathmandu
Phone: 01-4211103

Ref.No.

Date:

MESSAGE

It is a pleasure for us to organize the 3rd International Conference on "Resilient Infrastructure for A Better Tomorrow"Jointly by National Reconstruction Authority (NRA) and Society of Consulting Architectural and Engineering Firms(SCAEF) Nepal on 18-20 November 2019 . I would like to congratulate the organizing team for the publication of this"Post Conference Proceedings" which will be auseful document and reference material for the people who will be interested in disaster management, reconstruction and recovery.

The 2015 earthquake in Nepal had a huge scale of damage in human lives as well as in private housings and other social, cultural & economic infrastructures. The National Reconstruction Authority (NRA), which wasestablished in December 2015 as an apex entity for undertaking a very challenging task of reconstruction and recovery, is going to complete its four years of operation. Within this period, we have been able to complete almost eighty six percent of private houses out of almost 800,000 houses and also the progress in schools, health institutions, and heritage monuments has been encouraging.Nepal has demonstrated incredible strength and endurance throughout the past forty-eight months. Next year we will be focusing our effort to complete the remaining reconstruction works in one hand and on the other we will also work for the long term sustainability of our experiences and knowledge gained. For this we have already started to make documentation of our leanings and experiences which we will also be sharing to international communities. In this context, this international conference on resilient infrastructure for better tomorrow has been very much relevant and timely. The proceedings of this conference will add value for our effort in this direction

The NRA recognizes the importance of the continued technical and financial support provided by our friendly countries and the development partners. We would also like to thank to all the civil society organizations, all tiers of government and government entities, private sector, academia, consulting firms, engineering community, academia, media and different stakeholders who have been providing their valuable support to NRA for making this huge task happen and also wish to have their continued assistance in the future.

The role of (SCAEF) Nepal has always been very constructive for NRA and in the process of reconstruction and recovery. The strong consulting industry is the backbone for any nation for achieving the national goals of sustainable & resilient development and prosperity. I wish for the success of SCAEF Nepal in the days to come.

I thank the SCAEF Nepal and all the organizing team of NRA and SCAEF Nepal for the success of this very important international conference and also for the publication of this proceeding report. I hope this report will be very useful for the individuals and the entities that have been engaging in the reconstruction process.

Thank you.

Sushil Gyewali
Chief Executive Officer
National Reconstruction Authority
Government of Nepal

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Singhdurbar, Kathmandu, Nepal

Government of Nepal
Ministry of Physical Infrastructure and Transport

Ref.No. Date:

MESSAGE

I am pleased to know that the Society of Consulting Architectural and Engineering Firms (SCAEF) Nepal is going to organize the 3rd International Conference on the title **"Resilient Infrastructure for A Better Tomorrow"**. I would like to congratulate SCAEF for organizing such an incredible event which will enable Nepalese consulting firms to have international exposure.

The Ministry of Physical Infrastructure and Transport (MOPIT) has been continuously making earnest efforts to enhance the economic and social development of the country by establishing connectivity to all geographical and economic regions through the national strategic transport network and linking rural areas of country to enhance economic activities related to tourism, agriculture, energy, industry and other sectors. The Government of Nepal is facing challenges during project planning and implementation, especially related to the geography, land acquisition, timely completion, quality delivery and project sustainability. In order to resolve these challenges, the MOPIT has been always committed for playing pivotal role in formulating plan and inter alia coordination. In this front, the MOPIT has been playing vital role in formulation of policies and legislation.

I believe that, being an umbrella organization of Engineering consulting firms, SCAEF has a significant role in promoting and developing the consulting industry in Nepal. I appreciate that SCAEF has been playing an important role as a key stakeholder in the formulation of policies and implementation of programs for sustainable development of the consulting sector. The forthcoming international conference will certainly enable to enhance the capacity of national consulting firms. The MOPIT, as parental ministry, is always willing to extend support to SCAEF for its endeavor in the overall development of the consulting industry in the country.

On behalf of the MOPIT and on my own, I wish SCAEF for the success in organizing the conference and publishing the outcomes from the International Conference along with the summarized resolutions.

Devendra Karki
Secretary
Ministry of Physical Infrastructure and Transport
17 November 2019

सोसाइटी अफ कन्सल्टीङ्ग आर्किटेक्चरल एण्ड इन्जिनियरिङ्ग फर्मस्
SOCIETY OF CONSULTING ARCHITECTURAL AND ENGINEERING FIRMS, NEPAL (SCAEF)

(A National Body of Consulting Firms Recognized by Government of Nepal)

Message from the President

Dear Family of SCAEF

SCAEF, celebrates its 29th Anniversary on 20th November this year; and to commemorate the occasion, we have decided to host the 3rd International Conference on **Resilient Infrastructure for a Better Tomorrow** between the 18th to 20th November. The Conference takes place following the successful International Conferences in 1998 and then in 2009. My visit to the FIDIC ASPAC Conference hosted by CEAI in New Delhi in early July gave me an opportunity to meet the international delegates, some of whom accepted our invitation.

The topic selected was derived from an exercise amongst the member firms of SCAEF, and has been seen as very appropriate in the context of the construction industry and the rebuilding efforts after the Gorkha Earthquake, which became an eye opener to all of us; especially in constructing strong and durable (infra) structures. It is for this very reason that the National Reconstruction Authority of the Government of Nepal; was keen to be the host organizer alongside us, in this Conference. We are also immensely pleased that FCAN and NSET also found it appropriate to be the joint co-organizers here; alongside so many professional and development institutions who agreed with the theme.

It is with this reason that SCAEF is creating a platform to understand and address the issue together with sharing and learning from the cauldron of knowledge that will be provided. When the proceedings will be prepared and distributed; I am sure, we will all value it most.

However, SCAEF's 29th Anniversary proves our continuous commitment in the development of Nepal, through the quality professional services of our member firms; responsible for nearly 90% of the development budget and activities. I am confident that each year we will better our efforts and every such Conference will provide the opportunities for making an even Better Tomorrow.

Finally, I wish to thank each and everyone responsible in making this event happen and I pray for it's huge success.

Ar. Rajesh Thapa
President
Nov. 17th, 2019

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About the Conference

The Society of Consulting Architectural and Engineering Firms (SCAEF) organized the International Conference on the title "Resilient Infrastructure for a Better Tomorrow" with an objective of boosting Nepal's economy towards prosperity through the development of resilient and sustainable infrastructures. This Third International Conference organized by the SCAEF is founded on its experience of successful hosting of First International Conference in 1998 (on title Consultancy in the New Millennium) and Second International Conference in 2009 (on title Making Globalization Work: Role of Consultants). This third international conference relates to broad arena of resilient infrastructural development in the context of Disaster Risk Reduction and Climate Change adaptation initiatives inclusive of relevant aspects of the engineering and consulting profession. Besides sharing knowledge and experience between its member firms and international delegates, this conference became instrumental in providing valuable feedbacks to the government, political leaders, policy makers and multitude of project actors and stakeholders in the infrastructural development for resilient nation building.

The international conference provides a forum for building effective networking and fostering cooperation with international societies like earlier TCDPAP countries, societies of consulting firms and Asia-Pacific community (FIDIC/ASPAC) of The International Federation of Consulting Engineers (Federation Internationaledes Ingénieurs-Conseils - FIDIC). The conference also was aimed to develop a platform for Nepalese consulting firms to seek opportunities in international consulting market through business networking with international firms, partner organizations in ASPAC region, FIDIC members, International Financing Institutions and other countries.

The conference also intended to introduce international firms on the business environment in Nepal. At a time when the government is seeking more investments in infrastructure sector, the gap in technical knowledge and experiences between the Nepalese and international consultants must be minimized by creating an enabling environment for sharing of knowledge. Therefore, to initiate dialogue between international partners, Nepalese consulting sector and government bodies for creating an enabling environment, this conference deliberated an outlook of the business environment in the country and henceforth initiate reforms and changes required for attracting international investments and business opportunities to international firms.

The Third International Conference was held on the opportune moment of the 29th Anniversary of SCAEF from 18 to 20 November 2019. The conference was hosted in the capital city Kathmandu which was followed by optional field excursions to nearby projects outside Kathmandu Valley.

About Organizers

National Reconstruction Authority (NRA)

The National Reconstruction Authority was established with the main objective of rapid reconstruction and recovery of destruction caused by Gorkha Earthquakes of April 25 and May 12, 2015 and their aftershocks. Altogether, 8,979 people lost their lives and 22,309 were injured. It was estimated that approximately seven billion US dollars equivalent of properties were damaged.

Out of 776,916 total households who concluded agreement with NRA, more than 65% received the last tranche of grant. 7553 school buildings, 1197 health institutions, 753 government buildings, 753 heritage monuments, 895 Monasteries, 1051 km of road are either completed or in the last stage of completion. In addition, NRA has initiated a number of livelihood initiatives and other recovery interventions.

All infrastructures have been reconstructed with disaster resilient and cost effective construction approach. We envisage that this technology will be replicated nationwide within a few years which will minimize damage in the future natural disaster considerably. NRA is in a position to contribute its experience to the international community which may help similar reconstruction and recovery initiatives.

Society of Consulting Architectural and Engineering Firms Nepal (SCAEF)

The Society of Consulting Architectural and Engineering Firms Nepal (SCAEF) is a national body recognized by the Government and represents the Consulting services sector in Nepal. SCAEF was registered in 20th November 1990 as a non-government and non-for profit organization with a goal of developing consulting industry in Nepal by:

- Contributing to nation building through the provision of skillful professional services
- Safeguarding the professional right, interest, privilege and duties of the consulting profession

SCAEF has 220 registered member firms and is a member of FIDIC and ASPAC since 1996.

SCAEF's Objectives are:

- Encourage profession development of Nepalese consulting firms,
- Create a conducive atmosphere for healthy competition
- Create a scenario for wider and major participation by the Nepalese consulting sector in development project within and outside of the country
- Enable smaller firms to participate in larger projects through joint ventures
- Setup affiliation with international societies and associations

Since last twenty-nine years, SCAEF has continuously and effortlessly undertaken number of activities for professional development through trainings, seminars and conferences. SCAEF promotes ethical performance and best practices as laid out in the guidelines. We have become able partners to the government for the progress and improvement of the consulting and construction industry through the Construction Business Development Council headed by the Ministry of Physical Infrastructures & Transport.

Society of Consulting Architectural and Engineering Firms (SCAEF), Nepal

Third International Conference

Conference Title: "Resilient Infrastructures for a Better Tomorrow"
18-20 November 2019
Venue: Hotel Radisson, Lazimpat, Kathmandu

Pre-Conference Tour:
18 November, 11:00-14:00 hrs. – Patan Durbar Square Heritage Walk

Session 1: Inaugural Session

18 November, 16:00-21:00 hrs.
Day 1 Monday 18 November 2019

16:00 – 17:00	Arrival of Participants & Registration Arrival of Dignitaries & Guests Arrival of Chief Guest Tea Coffee Cookies Served
17:00	Conference called to Order
17:00 17:05	All to be seated in the Hall Dignitaries on front row • Inaugural Session Chair Joint Organizer Er. Sushil Gyawali, CEO, National Reconstruction Authority, Nepal • Inaugural Session Keynote Address Speaker Rt. Hon. Dr. Baburam Bhattarai, Former Prime Minister Federal Democratic Republic of Nepal • Conference Chair Joint Organizer Ar. Rajesh Thapa, President, SCAEF, Nepal • Conference Manager Er. Thakur Prasad Sharma • Conference Technical Session Chair Er. Tuk Lal Adhikari, Vice President, SCAEF, Nepal • Conference Secretary Er. Krishna Prasad Sapkota, General Secretary, SCAEF, Nepal

17:10 17:10 – 17:13	Arrival of Chief Guest in the Hall and escorted to the seat Rt. Hon. Nanda Bahadur Pun Vice President, Federal Democratic Republic of Nepal All rise for the National Anthem
17:13 – 17:18	Welcome Dance
17:18 – 17:25	Welcome Address by Conference Chair Ar. Rajesh Thapa, President, SCAEF, Nepal
17:25 – 17:30	Recognition and Felicitation of Dignitaries
17:30 – 17:36	Musical Recital
17:36 – 17:40	Inauguration of the Conference by Chief Guest Rt. Hon. Nanda Bahadur Pun, Vice President, Federal Democratic Republic of Nepal
17:40 – 17:50	Madal Beats
17:55 - 18:20	Conference Keynote Address by Rt. Hon. Dr. Baburam Bhattarai, Former Prime Minister Federal Democratic Republic of Nepal
18:20 – 18:30	Address by the Chief Guest Rt. Hon. Nanda Bahadur Pun, Vice President, Federal Democratic Republic of Nepal
18:30 -18:40	Concluding Address and vote of thanks of the Inaugural Session Chair Er. Sushil Gyawali, CEO, National Reconstruction Authority, Nepal
18:45 – 18:55	Handing over of Token of Appreciation to Dignitaries by Conference Chair and SCAEF President Ar. Rajesh Thapa • Chief Guest: Rt. Hon. Nanda Bahadur Pun, Vice President , Federal Democratic Republic of Nepal • Keynote Address Speaker Rt. Hon. Dr. Baburam Bhattarai, Former Prime Minister Republic of Nepal • Guest of Honour • Inaugural Session Chair Er. Sushil Gyawali, CEO, National Reconstruction Authority, Nepal
19:00 onwards	Cocktail Dinner

Technical Sessions

Day 2	**19 November**	
Technical Session 2 **Challenges in Infrastructure Development Sector in Nepal**		**Chair – Prof. Dr. Pushpa Raj Kandel, Vice Chairman, National Planning Commission, Nepal** Rapporteurs – Dr. Sanjiv Shah and Ganesh Dawadi
9:30	Keynote presentation	**Mr. K K Kapila,** Past President CEAI and President Emeritus, IRF, Former Board Member of FIDIC
9:55	Transport Infrastructure Development in Nepal: Challenges and Prospects	Dr. Surya Raj Acharya, Visiting Professor, Institute of Engineering, Tribhuvan University, Kathmandu
10:10	Challenges in Water Resources Development in Nepal	Mr. Keshab Dhoj Adhikari, Former Joint Secretary Government of Nepal Water and Energy Commission Secretariat, Currently International Hydropower Expert
10:25	Tea Break	
10:45	Business Presentation	
10:55	Public Safety for All in Nepal's Context	Mr. Ananta Ram Baidya, P.E., AB&H Engineering & Code Consulting Services, San Diego, CA, USA
11:10	Innovating Fair Play in Resilient Infrastructure Development	Er. Badan Lal Nyachhyon, Past President, SCAEF, Managing Director, Multi Disciplinary Consultants
11:25	Advanced Geotechnical Considerations in Deep Foundation scheme for Resilient Infrastructure Development	Dr. Upendra L. Karna, P.E President, American Society of Nepalese Engineering (ASNEngr) Lambertville, NJ, USA
11:40	Q&A	Written questions only
12:10	Concluding Remarks	By the Session Chair
12:20	Session Closing	Token of Appreciation from SCAEF President Session Photo
12:25	Lunch Break	

Day 2	**19 November**	
Technical Session 3 **Business Networking / Regional Best Practices in Resilience**		**Chair – Mr. Hari Bhakta Sharma, Immediate Past President of Confederation of Nepalese Industries (CNI)** Rapporteurs – Manohar Shrestha, Hydro-Consult Engineering and Ms. Anugya Sapkota
14:00	Keynote presentation	**Dr. Mahendra Subba, Former Director General of DUDBC**
14:25	Ensuring Disaster Resilience of Private Sector Businesses and Their Potential Contribution to Promote Disaster Resilience in Communities	Mr. Surya Bhakta Sangachhe , Dr. Surya Narayan Shrestha and Suman Pradhan, NSET Nepal
14:40	Construction of Railway Engineering Projects and Its Promotion to National Economy	Ms. Qin Xuezhen, China Railway First Survey & Design Institute Group Co., Ltd. (FSDI), China
14:55	Tea Break	
15:15	Business Presentation	

15:25	On-Site Visualization Help the Safety of Construction	Mitsugu Nomuna Dr. (Eng) CTIPE Engineering Co. Ltd. and Shinichi Akutagawa PhD, Kobe University, Japan
15:40	Bringing traditional buildings to earthquake safety in the modern era	Mr. Naresh Giri Senior Project Manager, ADB, NRM, Kathmandu, Nepal and Mr. Jitendra Bothara International Structural/ Earthquake Engineer, New Zealand
15:55	Investment for Resilient Infrastructure	Mr. Nigel Fischer, Consultant for the World Bank
16:10	Infrastructure Consultancy Development In Developing Countries	Mr. Amitabha Ghoshal, President of Consulting Engineers' Association of India
16:25	Q&A	Written questions only
16:40	Concluding Remarks	By the Session Chair
16:50	Session Closing	Token of Appreciation from SCAEF President Session Photo

Day 3	**20 November**	
Technical Session 4 **Indigenous / Innovative Technologies and Heritage Conservation**		**Chair – Dr. Sunil Babu Shrestha, Vice Chancellor, Nepal Academy of Science and Technology (NAST)** Rapporteurs – Kumar Dhamala and Asim Ghimire
9:30	Keynote presentation	**Prof. Dr. Sudarshan Raj Tiwari, Institute of Engineering, Pulchok**
9:55	Post-Earthquake Design Lessons Learned on Resilient Reconstruction of Public Infrastructure in Nepal	Mr. Arjun Koirala, CDM Smith International Inc., Kathmandu, Nepal
10:10	Pedestrianisation for Sustainable Urban Mobility for Better Tomorrow: A Vision for Harmonized Resilient Society	Dr. Er. Hare Ram Shrestha, Past President of SCAEF, Chairman of Advisory Council of NEA, Immediate Past President of NEA and Executive Director of SiDeF
10:25	Tea Break	
10:45	Business Presentation	
10:55	3D Panel Technology for Resilient Infrastructure & Sustainable Development	Mr. Gihan Jayathilake, Eng. (Cdr.), SLN QServe (PMU) Pvt. Ltd., Colombo, Sri Lanka
11:10	An Innovative Approach for Hospital Retrofitting in Nepal: a case study of Western Regional Hospital, Pokhara	Dr. Santosh Shrestha, Senior Earthquake Resilience Adviser, DFID-Nepal and Mr. Sunil Khadka Lead Adviser, DFID-Nepal, Health Sector Support Programme-III
11:25	Development of intelligent ultrasonic device for damage detection of metallic structure	Mr. Manish Man Shrestha, Mr. Shreeram Thakur, Mr. Bibek Ropakheti, Mr. Uddhav Bhattarai and Mr. Ajay Adhikari, Cosmos College of Management and Technology
11:40	Q&A	Written questions only
12:10	Concluding Remarks	By the Session Chair
12:20	Session Closing	Token of Appreciation by SCAEF Chair Session Photo
12:25	Lunch Break	

Day 3	**20 November**	
Technical Session 5 **Investment on and Implementation of Resilient Initiatives**		**Chair – Er. Sushil Gyawali, Chief Executive Officer, National Reconstruction Authority, Nepal** Rapporteurs – Bhupendra Man Shakya and Hari Dawadi
13:30	**Keynote presentation "Investment in Resilient Infrastructure Development for Future : Focusing on Quality, Technology, Climate Change and Innovative Financing"**	**Dr. Bindu Nath Lohani, Former Vice President, Asian Development Bank**
13:55	Financing in Resilient Infrastructure	Dr. Shankar Prasad Sharma, Former Vice Chairman of National Planning Commission and Former Nepalese Ambassador to USA
14:10	Investment opportunities in Nepal	Mr. Maha Prashad Adhikari, Chief Executive Officer, and Mr. Sunil Poudel, Senior Divisional Engineer, Investment Board of Nepal
14:25	Tea Break	
14:45	Business Presentation	
14:45	Recharging Groundwater through Rainwater Harvesting in Kathmandu Metropolitan City	Mr. Saroj Basnet, Vice Chairman/ Urban Planner and Ms. Jayshree Rajbhandary, Environmental Engineer, City Planning Commission, Kathmandu Metropolitan City
14:55	Resilient infrastructure development projects through technical and financial cooperation in Nepal and Asian region.	Ms. Yumiko Asakuma, Chief Representative, JICA Nepal Office, Nepal
15:10	How to develop disaster resilient settlements? A Case of Tadi Rural Municipality of Nuwakot District	Dr. Chandra Bahadur Shrestha, Executive Member, National Reconstruction Authority, Nepal
15:25	Q&A	Written questions only
15:55	Concluding Remarks	By the Session Chair
16:00	Session Closing	Token of Appreciation from SCAEF President Session Photo

Session 6: Conference Closing Session and

SCAEF 29th Anniversary Celebrations

20 November, 16:00-22:00 hrs.

Day 3 Wednesday 20 November 2019

16:00 – 16:30	Arrival of Participants & Registration Arrival of Dignitaries & Guests Arrival of Chief Guest Tea Coffee Cookies Served	
16:30	Session called to Order	Facilitator Ar. Surena Shrestha

16:30	All to be seated in the Hall Dignitaries on front row • Closing Session Chair Ar. Rajesh Thapa, Conference Chair & President SCAEF • Chief Guest Er. Shankar Nath Rimal Past President of Nepal Engineers' Association • Wrap up Summarization and Resolution Presentation Er. Mahendra Bahadur Gurung, Past President Nepal Engineers' Association and Former CEO Pancheswor Hydroelectric Project • KMA Award Trustee Mrs. Tara Amatya • Conference Manager Er. Thakur Prasad Sharma • Conference Secretary Er. Krishna Prasad Sapkota, General Secretary SCAFE, Nepal	
16:30-16:35	Welcome Entertainment	
16:35 – 17:00 16:35- 16:47 16:47- 17:00	MoU Signing CEAI & SCAEF Er. Amitabha Ghoshal President CEAI MoU Signing ASNEngr USA & SCAEF PE Dr. Upendra Lal Karna, President ASNEngr	
17:00 -17:05	Welcome and Address by Conference Manager, Er. Thakur Prasad Sharma	
17:05 – 17:10	Recognition and Felicitation of Dignitaries	
	Resolution Committee • Er. Bal Sundar Malla PP SCAEF, Coordinator • Ar. Kishor Thapa, Former Secretary, GoN • Er. Mahendra Bahadur Gurung, Past President of Nepal Engineers' Association and Former CEO OF Pancheshwor Hydropower Project • Er Prof. Dr. Tri Ratna Bajracharya, President Nepal Engineers' Association (NEA) • Er. Birendra Raj Pandey, Vice President Confederation of Nepalese Industries (CNI) • Ar. Anju Malla President Society of Nepalese Architects (SONA)	
17:10 – 17:25	Wrap up Summarization and Resolution Presentation Er. Mahendra Bahadur Gurung, Past President Nepal Engineers' Association and Former CEO Pancheswor Hydropower Project	

17:25 – 17:40	Third International Conference and SCAEF 29th Anniversary Recognitions Facilitated Jointly by Er. Shrawan Thapa Awards Committee Chair and Er. Krishna Sapkota General Secretary SCAEF • KMA Young Engineer Excellent Award Handed Over jointly by Chief Guest, Mrs Tara Amatya and President SCAEF • SCAEF Young Architect Excellent Award Handed Over jointly by Chief Guest, Mrs Tara Amatya and President SCAEF	
17:40 – 17:45	Address by Er. Gopal Sigdel, Joint Secretary, MoPIT and Chairman of CBDIC	
17:45 – 17:50	Address by Hon. Member of National Planning Commission Mr. Sushil Bhatta	
17:50 – 17:55	Address by the Chief Guest Er. Shankar Nath Rimal Past President of Nepal Engineers' Association	
17:55 – 18:00	Handing over of Token of Appreciation to Dignitaries by Conference Chair and SCAEF President Ar. Rajesh Thapa • Chief Guest Er. Shankar Nath Rimal Past President of Nepal Engineers' Association	
18:00 – 18:05	Entertainment	
18:05 – 18:20	Third International Conference and SCAEF 29th Anniversary Recognitions Facilitated by Er. Krishna Sapkota General Secretary SCAEF • SCAEF Member Firms 25 years in Consulting Service • SCAEF Member Firm Staff 20 years+ in continued service	
18:20 – 18:25	Address by KMA Trustee Mrs. Tara Amatya	
18:25 -18:32	Entertainment	
18:32 -18:45	Concluding Address by the Conference Chair Ar. Rajesh Thapa, President SCAEF and Conference Chair	
18:45 – 18:50	Entertainment	
18:50 – 19:55	Handing over of Token of Appreciation to Dignitaries by Conference Chair and SCAEF President Ar. Rajesh Thapa • Wrap up Summarization & Resolution Presentation Er. Mahendra Bahadur Gurung, Past President Nepal Engineers' Association and Former Chairman Pancheswor Hydroelectric Project • KMA Award Trustee Mrs. Tara Amatya	
18:55 – 19:00	Vote of Thanks Conference Secretary Er. Krishna Prasad Sapkota	
19:00 onwards	Entertainment Cocktail Dinner Dinner served 20:30	

Post-Conference Tour:

21 November, 08:00-12:00 hrs. – Chandragiri Hills

Introduction of Session Chairs and Keynote Presenters

Session- 2

Prof. Dr. Pushpa Raj Kandel

Honorable Vice Chairman of National Planning Commission

Prof. Kandel holds a PhD degree from Delhi School of Economics, Delhi University, India in 2001 on "Corporate Tax System and Investment Behavior in Nepal". Prior to that, he had completed Master's degree in Commerce from Shanker Dev Campus (TU) in 1984.

Previously, he was involved as Member in public policy-making in different government authorities such as National Development Council (2010), Revenue Advisory Board and Committee (2009-2011), Industrial and Foreign Investment Policies Committee (2008), Macro-Economic Management Advisory Committee (2003-04), and High Level Tax System Review Task Force (1994). He also served as Budget Expert to Ministry of Finance (2009) and Revenue Expert of Decentralization Execution and Monitoring Working Committee (2003-04). After retirement from the public sector, Prof. Kandel has remained active in high level consulting services for policy research and public economics.

Academically, Prof. Kandel was recognized as the Professor in the Faculty of Management on Public Economics and International Business (2009). Besides that, Prof. Kandel authored 10 books related to Public Economics and Political Economy.

Keynote Presenter - K.K. Kapila

Consulting Engineers Association of India (CEAI), Chairman of ICT and Past member of FIDIC

Mr. Kiran Kumar Kapila is the Chairman and Managing Director of Intercontinental Consultants and Technocrats Pvt Ltd. (ICT). and Past member of the Executive Committee of International Federation of Consulting Engineers (FIDIC).

Mr. K.K. Kapila is a Chartered Civil Engineer and holds Fellowships of the American Society of Civil Engineers, the Institution of Engineers of India, the International Association for Bridge & Structural Engineering and the New York Academy of Sciences. He is the first non-European serving Chairman, International Road Federation (IRF), Geneva Programme Centre since 2010. He is a Co-Chair of Federation of Indian Chambers of Commerce and Industry (FICCI) National Committee on Transport Infrastructure. He has also served the role of an "Engineer" as per FIDIC conditions of Contract for over 100 projects.

Session- 3

Chair- Mr. Hari Bhakta Sharma

Mr Sharma is the Immediate Past President of Confederation of Nepalese Industries (CNI). He also served as the Sr. Vice President of CNI before he was elected as the President in March 2016. Mr. Sharma is the Founder and Executive Director of one of leading pharmaceutical companies in Nepal, Deurali-Janata Pharmaceuticals Pvt. Ltd. He has been instrumental in promoting and managing the company to be one of the leading pharmaceutical manufacturing companies in Nepal with some of the best management practices in business. Mr. Sharma is primarily responsible for corporate planning, policy formulation and implementation of company projects and plans including planning, implementation and supervision of company programs. He has obtained a Master's degree in Social Studies from Tribhuvan University, Nepal.

Keynote Presenter- Dr. Mahendra Subba

Dr. Subba is highly experienced Urban Development Specialist, 30+ years with the Government of Nepal. Dr. Subba has also provided his specialist services for organizations like GIZ, Asian Development Bank as Urban Development Specialist also. He has served the GON in the capacity of Joint Secretary of Ministry of Urban Development and as Director General of Department of Urban Development. He has obtained Doctoral of Philosophy from Norwegian University of Science and Technology in Town Planning and Regional Planning.

Chair- Dr. Sunil Babu Shrestha

Vice Chancellor, Nepal Academy of Science and Technology (NAST)

Dr. Sunil Babu Shrestha is a Vice-Chancellor and an Acadamician of Nepal Academy of Science and Technology (NAST). Dr. Shrestha has served the nation two times(2009, 2015-2018) as a member of National Planning Commission, Government of Nepal with portfolio covering Housing and Urban Development, Water Supply and Sanitation, Science and Technology, Local Development and Federal Affairs and Public Private Partnership.

Dr. Shrestha had Bachelor Degree in Civil Engineering and Master of Science in Urban Planning from Institute of Engineering, Tribhuvan University, Nepal. He earned Doctor of Engineering in Environmental Development Engineering in 2004 from Osaka Sangyo University (OSU), Japan.

He had honored with many medals and awards like Science and Technology Youth Award (2011) from Nepal Academy of Science and Technology; Youth Talent Award (2010) from Government of Nepal, Ministry of Youth and Sports; Excellent Youth Award with Gold Medal (2009) from Nepal Jaycees; Youth Professional Award (2009) from Nepal Engineers Association etc. for his special contribution to the science and technology, engineering and environmental field.

Keynote Presenter - Prof. Dr. Sudarshan Raj Tiwari

Prof. Sudarshan Raj Tiwari studied architecture at School of Planning and Architecture, University of Delhi, India and earned his Bachelor in Architecture Degree with a gold medal in 1973. He went to University of Hawaii for graduate studies and was awarded the M. Arch. Degree in 1977. He started his academic career as a faculty member in the Department of Architecture at Institute of Engineering (IOE), TU in 1974 and continued on the academic career at Tribhuvan University progressively to be appointed Associate Professor in 1988. He served as Dean of the Institute of Engineering for a four year term

ending in 1992. He was appointed Professor of Architecture in 1993. Prof. Tiwari took up further research studies at Tribhuvan University's Faculty of Humanities and Social Sciences in 1992 and was awarded a Doctor of Philosophy degree in Nepalese Culture in 1995. He retired from regular teaching service on 2013 but continues on as visiting faculty at the Department of Architecture for special courses.

He has been actively involved in many research activities and published widely. His research has been focused on the History of Nepalese Architecture, Urbanism and Culture and has presented several papers in these and allied themes in national and international conferences. He has written several books including The Ancient Settlements of the Kathmandu Valley (2001), The Brick and the Bull (2002) and The temples of the Nepal Valley (2009).

During his tenure as Dean of the Institute of Engineering, he also directed Engineering Education Project that was charged with the development of Bachelor of Engineering study programs under Institute of Engineering. In 1992, he was appointed member of a government commission set up to review the performance of government projects undertaken between1990-1992. From 1992 onwards, he also occasionally consulted for the World Bank, UNDP and Asian Development Bank for project appraisal, planning, design, implementation and supervision particularly in health and education sectors. In 1994, he headed a team to prepare Urban Environment Management Program for the Environment Protection Council of Ministry of Housing and Physical Planning of the Government of Nepal. In 2000, Prof Tiwari headed another team to prepare the Strategy Plan for the development of Institute of Engineering as a regional center of Engineering Education.

In recognition of his performance and contribution to the country, he has been awarded Prince Dipendra Award in1989 (RONAST) and Mahendra Vidhya Bhusan Medal (Class- A) in 1995.

Session - 5

Chair- Mr. Sushil Gyawali

Chief Executive Officer, National Reconstruction Authority, Nepal

Mr. Gyawali is a civil engineer with over 20 years of experience at the local level from Butwal Municipality to Lumbini Development Trust. Prior to becoming the CEO of the National Reconstruction Authority, Mr. Gyawali was serving as the executive director of the Town Development Fund.

Keynote Presenter - Dr. Bindu Nath Lohani

Former Vice President, Asian Development Bank

Dr. Bindu N. Lohani is Former Vice-President of the Asian Development Bank (ADB) for Knowledge Management and Sustainable Development. He was responsible for the ADB's Economic Research and Regional Cooperation Department (Office of the Chief Economist), Sustainable Development and Climate Change Department, and Office of Information Systems and Technology. Dr. Lohani holds Doctoral degree in Environmental Engineering. Dr. Lohani has been conferred with several Honorary Doctoral Degrees including the Degree of Doctor of University by the Griffith University, Australia in recognition of his distinguished contributions to environment. He has also completed several management development programs, including the Executive Program conducted by the Business School of the University of Chicago, Management Development Program by Cornell University; and programs by Arthur D. Little School of Management, and Corporate Leadership program at Yale University.

Inaugural Ceremony

Address by the SCAEF President

A Warm Good Evening & Namaskar
Chairman of this Inaugural Session Er. Sushil Gyawali CEO NRA
Chief Guest Rt. Hon. Nanda Bahadur Pun, the VP of the Federal Republic of Nepal
Keynote Address Speaker Rt. Hon. Dr. Baburam Bhattarai , Former PM of the GoN
Past Presidents and the Members of 15th Executive Committee of SCAEF
Members of the Organizing Partners NRA
and Co-organizing Partners President and representatives of FCAN and NSET
President / Representatives of the various Knowledge Partners
CEAI President Er. Amitabha Ghoshal
Friends of SCAEF
Respected International Delegates, Participants & Guests
National Participants and Guests
The Press & Media
Friends, Ladies & Gentlemen

It is indeed a great pleasure for me to stand here in front of this august gathering and welcome you ALL on behalf of SCAEF, and the joint organizer NRA (National Reconstruction Authority), the Co-organizers FCAN (Federation of Contractors' Associations of Nepal) & NSET (National Society for Earthquake Technology-Nepal), besides All the Knowledge Partners and all the members/staff that are behind in making this important event, starting with the inauguration, this evening.

SCAEF is recognized by the Government of Nepal as a national body that represents the consulting services in the Nepal. Since its inception on 20th November 1990, SCAEF has been advocating on the development of the consulting services sector through dialogue, trainings, workshops, seminars and conferences. In the 29 years of existence we have experienced a number of challenging issues and events. We are now over 200 member firm strong, who have been assisting in the national development as professional services providers in architectural & engineering works. Our members have been responsible to the implementing of nearly 90% of the development budget of the country.

Our firms have been undertaking important projects in building of schools, hospitals, hydropower installations, airports, highways, irrigation, water supply electrical transmission and communications etc.. ; to name a few. In order to improve the subject knowledge and performances of this sector; SCAEF does work to enhance the capabilities of our member firms and their staff by regular programs in capacity building and state of the art technical presentations.

As members to the Construction Business Development Council (which is Chaired by the Minister of the Ministry of Physical Infrastructure & Transport, MoPIT) and the Construction Business Development Implementation Committee; we have been assisting the government in a number of policy requirements and where our pursuance in this direction is to enhance to arrive at achievable benchmarks.

In 1998 and then again in 2009, SCAEF as members of FIDIC (International Federation of Consulting Engineers) and then as members of Technical Consultancy Development Program of Asia and the Pacific (TDCPAP) which has now better known as the Asia and Pacific wing of FIDIC or FIDIC ASPAC; we had organized these two international events. Rt. Hon. Dr. Baburam Bhattarai as Minister of the Ministry of Finance then, was the keynote address speaker at the second international conference of SCAEF. We take pride in having him with us once again as a very valuable keynote speaker and who will initiate our program.

Following the devastating Gorkha Earthquake in 2015, where thousands of houses were destroyed across many districts of the country, with entire villages flattened, especially those near the epicenter. Several temples on the Durbar Squares (which are UNESCO World Heritage Sites collapsed as did the Dharahara tower, built in 1832; Infrastructure: bridges and roads besides others were affected too. Repair estimates are $160 million to restore 1,000 damaged and destroyed monasteries, temples, historic houses, and shrines across the country.

The UN declared SUSTAINABLE DEVELOPMENT GOAL 9 underlines the need to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. The theme of this Third International Conference of SCAEF has appropriately been titled as "**Resilient Infrastructure for A a Better Tomorrow".** The Technical Sessions of which are in 4 distinct parts but yet interrelated with one another. The Chairs, keynote addressees, speakers in these technical sessions are very knowledgeable and will provide umpteen opportunities for learning, and making substantial interactions.

As mentioned earlier, the closing of the technical session will combine with the celebrations of our 29th Anniversary. I am sure you will be a part of this celebration. The conference resolution will be proposed derived from the deliberations and the discussions of each session. We expect that the objectives for which this Conference is being held, will be made. On the last day we look forward to the MOU signing with the Consulting Engineers Association India and the American Society of Nepalese Engineers (USA). This will increase bonds for future ventures in both countries and around the world. In July this year, we had concluded a MOU with CNAEC (China). In the past we have had MOUs signed in 1998 and on 2009 with ACEP (Pakistan), VECAS (Vietnam), ISCE (Iran), KENKA (Korea), ACEM (Malaysia), CEAT (Thailand) and UACE (Uzbekistan), all FIDIC ASPAC member countries. There was some exchange visits, but we hope now that with SCAEF member firms being sufficiently capable and some working in Africa and Asia, we will create opportunities for better partnerships and the future. We hope that we will be able to gather valuable knowledge to improve the procurement

We also take pride in our CSR approaches. Since our 25th Anniversary a few years ago, we introduced the Awards for Excellence to Young Architects and Engineers each year. After the demise of our 6th President late Keshav Man Amatya, his family helped us initiate this Award. The Trustees of the family Award and SCAEF, together select the best of the top five students from Tribhuvan University, Purwanchal University, Pokhara Universty and Kathmandu University; and from whom we select the most deserving architect and engineer. Also, each year we recognize SCAEF member firms who have crossed 25 years of active service, and also the staff of the member firms who have crossed 20 years of continued service therein.

I am indebted to the Chief Guest VP Rt. Hon. Nanda Bahadur Pun for his valuable time to be here with us, Rt. Hon. Dr. Baburam Bhattarai to accept our request to be the keynote address speaker and initiate the proceedings of this Conference and to NRA CEO the Session Chair to be our joint organizer. Similarly, we

appreciate the joining of hands at this Conference by our Co-Organizers FCAN and NSET and ALL the knowledge partners.

I also thank all the representatives of institutions: government and local and international; to be attending the Conference.

All the participants I am sure will value the Conference and carry more information from the addresses made throughout by very learned individuals, However it is the active participation of all the attendees that will make the Conference a success.

Once again WELCOME to you all, Enjoy the Conference and be with us on the 20th evening to celebrate the 29th Anniversary, as well. Thank you.

Ar. Rajesh Thapa

18th November 2019

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Resilient Infrastructure for a Better Tomorrow

Keynote Speaker: **Dr. Baburam Bhattarai**

Former Prime Minister Federal Democratic Republic of Nepal

Distinguished Guests, Participants of the Conference, Ladies and Gentlemen

I am very pleased to be here with such eminent Architects and Engineers of Nepal and abroad to share my opinions on "Resilient Infrastructure for A Better Tomorrow", a very pertinent topic at this crucial juncture for Nepal.

1. Socio-economic Context of Nepal

1.2 Current Status

Even though Nepal has made progress in poverty reduction and human development in the last two decades, the absolute poverty is at 21.6%, the highest in the South Asia, and the country is at the bottom in middle human development status (NPC, 2017a). As per UNDP report 2015, Nepal's rank in HDI is 144 out of 188 countries of the world (UNDP, 2016). Nepal's per capita GDP (Gross Domestic Product) at current prices is estimated as Rs. 1,17,455 (US $ 1,034) in FY 2018/19 (MoF, 2019). Nepal stands in 197th rank among 217 countries in per capita GDP at constant 2010 US$ as per 2015 data reported by the World Bank (WB, 2018). All these figures show that current socio-economic status of the country is quite frustrating.

I looked at the per capita GDP of some of the Asian countries of 1960 and 2018 (**Table 1**) to see if historic information tells something about it and Nepal's infrastructure status to see why we could not catch the right development path in this period (**Table 2**).

1.3 Historical Background

In 1960 the per capita GDP of China was less than that of Nepal while it was almost same with India. South Korea's per capita GDP was 3.5 times that of Nepal (WB, 2018). After 60 years Nepal's GDP per capita increased from $ 269 to $812 (increased by $512). Whereas, during this period GDP of China, India, Korea and Malaysia increased by $7,500; $1,800; $25,800 and $10,700 respectively. The ratio of these figures with China, India, Korea and Malaysia jumped to 9.6, 2.6, 33 and 15 respectively. It is interesting to note from the per capita GDP data of China, Korea and Malaysia that when per capita GDP crosses somewhere $1,000, it starts to take speed up and after $2,000 it accelerates. Further the pace of economic progress has been speeded since late 80s or early 90s in these countries. Nepal missed it somehow, although historical data tells we were not far behind other Asian countries in the past.

Table 1: Comparison of Per Capita GDP of 1960 and 2018 of Some of the Asian Countries

Particulars	Year	Nepal	China	India	Korea	Malaysia
Per Capita GDP	1960	**267**	192	304	944	1409
(Constant US$ 2010)	2018	**812**	7,755	2,104	26,761	12,109
Increase Amount (US$)	1960-2018	**545**	**7563**	**1800**	**25817**	**10700**
Ratio with Nepal	1960	**1**	0.7	1.1	3.5	5.3
	2018	**1**	9.6	2.6	33.0	14.9

Source: www.worldbank.org

i) **Causes of Underdevelopment of Economic Sector**

There are many factors contributing for the underdevelopment of the country in general and economic sector in particular. For instance, regressive political system of the past and instability in the near past, single country trade dependency with huge trade deficit, low national saving, unprecedented labor out-migration, fragmented market, lack of functional institutional setup and above all insufficient and sub-standard economic infrastructures. As per the Global Competitiveness Report 2019, Nepal ranks 112th out of 141 countries of the world, with Global Infrastructure Score of 52/100. It may be noted that the Global Infrastructure Score is estimated using transport, energy, water supply and sanitation facilities and their quality (**Table 2**). This score is 78 for China and Malaysia, 68 for India and 92 for Korea. The global data clearly show that countries having higher infrastructure score are richer. It tells that economic progress can only be achieved through the development of sound economic infrastructures. It is because infrastructures, which refers to the facilities, activities and services, help in increasing the overall productivity of the economy. They play a vital role in facilitating the smooth running of all three sectors of the economy: primary, secondary and tertiary.

Table 2: Global Competitive Index and Infrastructure Index of Some of the Asian Countries

Particulars	Nepal	China	India	South Korea	Malaysia
Global Competitive Index (GCI)	**108**	28	68	13	27
GCI Score (out of 100)	**51.6**	73.9	61.4	79.6	74.6
Per Capita GDP (Constant US$ 2010)-Year 2018	**812**	7,755	2,104	26,761	12,109
Global Infrastructure Index (GII)	**112**	36	70	6	35
GII Score (out of 100)	**52**	78	68	92	78
Transport		10	72		
Road Connectivity	**101**	10	72	26	133
Quality of Road	**120**	45	48	4	19
Utility	**116**	65	103	22	51
Electricity Access	**101**	2	105	2	87
Electricity Supply Quality	**119**	18	108	7	38
Supply of Quality Water	**122**	74	106	26	63
Reliability of Water Supply	**125**	68	96	28	49
ICT	**109**	18	120	1	33

Note Total Countries: 141; Year: 2019

Source: http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

It should be noted here that the quality of infrastructure is as important as the quantity; any inadequate or poorly performing infrastructure may create obstacles for economies to meet their full growth potential. Results confirm that the quantity of infrastructure is important to enhance economic growth; however, having quality infrastructure benefits more in producing productive and efficient output, thus has greater impacts on sustainability in economic growth.

2. Significance of Infrastructures in Socio-economic Transformation

It is to be remembered that the link between infrastructure and development is not a once for all affair, the progress in national development has to be preceded, accompanied and followed by the progress in infrastructure. With this backdrop, the significance of infrastructure on socio-economic transformation of a developing country like Nepal can be summarized in the following points.

i) **Development of Production and Service Sectors (Agriculture, Industry and Tourism).** The development of agriculture, to a considerable extent, depends on the adequate expansion and development of irrigation, credit, transport, power, marketing, training and education. Industrial production requires not only machinery and equipment but also requires energy, water, skilled manpower, management, banking, insurance and transportation services. Infrastructure increases the productivity of workers. The infrastructures, thus, directly lead to the development of these sectors of the economy. Further, infrastructure development plays an important role in tourism development as many tourist spots have gone unnoticed due to lack of infrastructure facilities.

ii) **Promotion of Business, Trade and Investment.** - Infrastructure enables businesses to generate additional production capacity, reduce the cost of inputs in the production and transaction costs, increasing competitiveness of the production sector in global market. Quality transport services reduce the travel time. Empirical findings show that a 10% reduction in the time to export increases trade by 5%, while time to import increases trade by 4%. Further, infrastructure development is the pre-condition to get increasing economic investments. Our experience has, also, showed that areas with sound infrastructural base have succeeded in attracting more capital for investment. In the global scenario, too, foreign direct investment as well as portfolio investment flow to those countries where adequate infrastructure facilities are available.

iii) **Employment Generation.** Infrastructures development has an important role in creating employment opportunities, in the initial period of construction work: creating jobs in construction and in later period, existing infrastructures require maintenance; it further creates a number of jobs. Further, infrastructure induced larger investment and development of industry and agriculture create more employment opportunities.

iv) **Development of Underdeveloped Regions**. The lack of infrastructural facilities in the backward regions acts as a constraint on the development of those regions. The development of backward regions and the removal of regional imbalances is yet another significant contribution of infrastructural facilities. Infrastructure contributes to the accession of the poor and undeveloped areas to the core business activities, public communications, which can raise the value of their assets, and increase human capital.

v) **Improvement of Education, Health and Poverty Reduction**: The infrastructure has a positive impact on education and health. It empowers women by alleviating the constraint imposed on

their time allocation for fetching water and cooking. A better transportation system helps raise school attendance. Electricity allows more time to study and helps facilitating the use of electronic equipment and other devices that may enhance the learning process. Similarly, better transportation networks allow for easier access to health care. Access to electricity is essential for the functioning of hospitals and other health care facilities. Access to safe water and sanitation reduces infant mortality. It increases the productive capacity of the poor. Access to transport can contribute to higher and more stable incomes enabling the poor to manage risk. Transport infrastructure has been found to expand opportunities for non-farm employment in rural areas. Improved rural transport can also ease the introduction of improved farming practices by lowering the costs of modern inputs. In this way infrastructure development contributes to reduce the poverty. Infrastructure increases the employment opportunities which in turn increase the income level of the people. Increased income level will enhance the standard of living of the people. Thus, infrastructure development will change the total outlook of the society.

vi) **The Growth of GDP.** There exists a very close relationship between spending for infrastructure and GDP growth. Studies reveal that 1% growth in the stock of infrastructure often associates with 1% growth in per capita GDP.

3. Need for Infrastructures, Climate and Disaster Risks and Significance of Resilient Infrastructures

3.1 Lifeline Infrastructures for Nepal

Given the importance of infrastructures for the socio-economic transformation of the country, in my views, following ones should be developed as lifeline infrastructures of Nepal.

a) **Transport Infrastructure**

- North-South Highways connecting borders with China and India: 6

(Nepal should move forward as a land-linked country and strategically position itself as an economic corridor both within and beyond the borders).

- East-West Highways through Terai, Hill and Mountainous Regions: 3
- Kathmandu-Birganj, Kathmandu-Biratnagar, Kathmandu-Pokhara and Lumbini-Pokhara Highways
- Highways connecting all Provincial and District headquarters
- East-West Railway
- One International Airport in each Province including High Quality Nijgadh International Airport

b) **Energy Sector**

- Development of at least 5,000 MW of storage projects: West-Seti, Nalsinggadh, Budhigandaki, Dudhkoshi, Tamor
- High Voltage Transmission Lines: Basin wise and parallel to East-West and Mid-Hill Highways

c) **Development of Urban and Economic Centres**

Develop Provincial capital as an Administrative Centre and another city (at least one city) as an economic centre in each Province

In addition to the above, development of year-round irrigation system (including major river diversion projects) to increase the agricultural productivity, safe and affordable drinking water system as well as sanitation facility for all, quality ICT sector like upgrading the internet service to 5G (fifth generation) are some of the other areas we should give due priorities. Of course, modernization of agriculture sector, industrial development and improvement in service sectors are to be materialized simultaneously to achieve optimum utilization of and maximum benefits from these infrastructures.

3.2 Climate and Disaster Risks

As we all know that Nepal ranks 4th in terms of climate risk according to the Global Climate Risk Index which assesses the impacts of meteorological events in relation to economic losses and human fatalities. Also, the country ranks 11th in terms of global risk for earthquake occurrence and impact (MoHA 2015). The country is in top 20 of all the multi-hazard countries in the world[1].

The effects of the Gorkha Earthquake 2015 on economic sector is quite visible. In that year, the overall GDP growth dropped 1.5% from the estimated number (NPC, 2015). Most of the monsoon precipitation during June to September triggers regular flooding in the low-lying Terai Plains. In 2017, 80% of the Terai region and some surrounding districts suffered inundation triggered by monsoon rains, causing US$ 584.7 million in damages (NPC, 2017). Similarly, the social implication of hazards is also severe which causes loss of livelihoods and results in increased poverty (The World Bank, 2014); and the loss of agricultural crops rapidly turns into food insecurity. The effects are often felt most by the poorest and the so-called low-caste populations due to their marginalized status, limited resources and livelihood options. On top of it climate change is exacerbating extreme weather events from severe floods and storms to droughts and heatwaves-bringing huge social and economic costs.

3.3 Need of Resilient Infrastructures

Making infrastructures more resilient—that is, better able to deliver the services to people and firms need during and after natural shocks—is critical, not only to avoid costly damage but also to minimize the wide-ranging consequences of natural disasters for the livelihoods and well- being of people. Wide range of case studies, global empirical analyses, and modeling exercises showed that the lack of resilient infrastructure is harming people in terms of direct and indirect detrimental impacts disrupted infrastructure services and incurred coping cost (Table 3) in one hand and investing in more resilient infrastructure is robust, profitable, and urgent on the other hand[2]. In low income country like Nepal designs for more resilient assets in the power, water and sanitation, and transport sectors would need an incremental cost of around 3 percent compared with overall investment in infrastructure, which is less than 0.1 percent of GDP of the country. For Nepal, the investment required to deal with climate change that includes building resilience and adaptive capacity, reducing emissions through mitigation, strengthening climate data, M&E and climate-proofing technology for infrastructure is about 2 percent (Table 4). On the other hand, the net benefit of investing in more resilient infrastructure is estimated to be more than $4 for each one dollar invested (Hallegatte et al., 2019). It is because i) the benefit of more resilient infrastructure is that it reduces the life-cycle cost of assets. They are less costly to maintain and repair in later period. Ii) More resilient

1 UNDRR (2019). Disaster Risk Reduction in Nepal: Status Report 2019. Bangkok, Thailand, United Nations Office for Disaster Risk Reduction (UNDRR), Regional Office for Asia and the Pacific

2 Hallegatte Stéphane, Jun Rentschler, and Julie Rozenberg. 2019. Lifelines: The Resilient Infrastructure Opportunity. Sustainable Infrastructure Series. Washington, DC: World Bank

infrastructure provides more reliable services and iii) Eventually, what matters is the resilience of users. Infrastructure disruptions can be catastrophic. More resilient infrastructure reduces the total impact of natural hazards on people and economies.

We just discussed on the significance of infrastructure development for prosperous nation building which will be instrumental to meet the people's aspiration of achieving Middle Income Country status by 2030. Infrastructure development should, therefore, get a high priority in the years to come for Nepal. However, such infrastructures are to be climate and natural disaster resilient for better tomorrow. In this context, there is tremendous need for prioritizing, designing, executing, and scaling up investment in resilient infrastructures.

Table 3: Disrupted infrastructure services have multiple impacts on firms and households

Sector	Entity	Direct impacts	Coping costs	Indirect impacts
Power	Firm	• Reduced utilization rates • Sales loss	• Generator investment • Generator operation costs	• Higher barriers to market entry and lower investment • Diminished competitiveness in international markets
	Household	• Diminished well-being • Lower productivity of family members	• Generator investment • Generator operation costs	• Higher mortality and morbidity (lack of access to health care)
Transport	Firm	• Reduced utilization rates • Sales loss • Delayed supplies and deliveries	• Increased inventory • More expensive location choices, for example, in proximity to clients or ports	• Inability to provide on-demand services and goods
	Household	• Greater congestion and loss of time • Higher fuel costs	• Higher cost of alternative transport modes	• Constrained access to jobs, markets, services • People forced to live close to jobs, possibly on bad land • Air pollution and health impacts

Table 4: Estimated Investment Requirement in Different Infrastructure Sectors and CC

SN	Sectors	Annual Average Investment Requirement in billion Rs (2016-2030)	% of Total Infrastructure Investment
1	Water and Sanitation	76.7	6
2	Energy	260.4	20
3	Road	154.7	12
4	ICT	613.7	48
5	Urban Infrastructure/Housing and Reconstruction	168	13
6	Climate Change Cost	25.6	2

Source: NPC (2017): Needs Assessment, Costing and Financing Strategy for Nepal's Sustainable Development Goals

4. Challenges in Building Resilient Infrastructures

In my opinion the followings are the main challenges in developing resilient infrastructures in Nepal.

i) **Policy challenges**

It is generally very difficult for policy makers to understand the benefits of adding resilience to infrastructure because it requires identifying the crises that are avoided which is hard to do and even harder to communicate to the public. Policy makers' motivations to invest in more resilient infrastructure systems are, thus, weakened by the asymmetry in the visibility of the costs and benefits of such investments.

ii) **Poor design, operation, and maintenance of infrastructure systems**

Infrastructure disruptions are chronic events in our country: load shedding occurred every day a couple of years ago, water supply is intermittent, and traffic jam is a regular phenomenon. It is because the infrastructure systems are simply insufficient to meet demand. The first step is to make them reliable in normal conditions by ensuring appropriate design, operation, and maintenance.

iii) **Inadequate data and skilled manpower**

Data bottlenecks impair the design of more resilient infrastructure. For example, the high-resolution digital elevation model (DEM), a data set that provides the topography of a given area and long-term time series hydro-meteorological data. Such data are the basis to design infrastructures and hazard risk assessments. Enough numbers of manpower with adequate skills to assess the climate and disaster risks and design the resilient infrastructures is another challenge in our country.

iv) **Financial constraints**

Generally, making the infrastructure project more resilient will increase its design cost, construction cost, or maintenance cost, linking the challenge to financing.

5. Resilient Infrastructures for A Better Tomorrow

Development of climate and disaster resilient infrastructure involves a broad range of stakeholders: policy makers, planners, investors, industry representatives, designers, engineers, researchers, professionals, standards developers, beneficiaries, and community members. They are shaping the physical structures and services required to meet national and communities' needs for years to come. Let me mention some of the general principles and activities needed to address the challenges we discussed above.

General Principles:

i) **Be Aware:**

Without significant improvements in infrastructure resilience, annual economic losses, social sufferings and environmental degradations from natural disasters' damage will increase, and these losses will continue to grow. Realization of this fact by all stakeholders, from policy makers and planners to implementers and impacted communities, is of prime importance for the formulation of the relevant polices and their implementation.

ii) **Be Proactive:**

Quicker action today can help ensure that current investments are sound and will contribute to a more resilient future in terms of economic losses reduction, social safeguard and environmental conservation

from probable climate and nature-induced disasters. Let's start doing what we can do now for infrastructure resilience with both existing knowledge and foresight. Uncertainty should not preclude actions.

iii) **Be Just:**

We should consider the implications of decisions on infrastructure resilience for those who are particularly vulnerable economically, socially and for the environment.

iv) **Be Inclusive:**

All stakeholders mentioned above should be engaged in early and often throughout the entire process of building resilient infrastructure.

v) **Be Comprehensive:**

Full range of risks and means to address them through planning, financing, and engineering should be taken into account while building resilient infrastructures. Not only economic resilience but also social and ecological resilience are to be integrated into decisions wherever appropriate.

Required Activities for Building Resilient Infrastructures:

i) **Build understanding among all stakeholders**

Proper understanding of the significance of resilient infrastructures to reduce the loss of human lives and physical assets of the nation and the individuals, to keep social harmony intact and to protect the environment in the face of climate change and natural disaster for better tomorrow by stakeholders is helpful for the formulations of legal instruments, policies and implementation of projects. It can be done through seminars and workshops or dialogues in public forums or in TV/Radios.

ii) **Produce and retain skilled human resources**

To design and implement resilient infrastructure projects we require new skills and abilities in a diversity of fields. Formal education, as well as technical and vocational education and training, in this field creates a foundation. It requires the development of appropriate curricula and modules for training professionals. Learning by doing is important, given the need to both move forward and to develop better approaches to the challenges of addressing multiple hazards and the uncertainty associated with climate change. But it is also very important to learn from others, to avoid reinventing the wheel and to accelerate learning. Following institutes are to be established to produce such skilled technical professionals and carrying out advance researches.

- Nepal Technical Institutes like AIT (Thailand), IIT (India) in each Province
- CTVET (Council for Technical and Vocational Education and Training) in each Province
- An Engineering Staff College

iii) **Promote national firms/organizations**

I fully agree with the views of Christine Lagarde, currently serving as President of the European Central Bank and former Chair and Managing Director of the International Monetary Fund (IMF), at World Economic Forum (WEF) in Davos, Switzerland that poor countries must not contract global consultancy firms to write development strategies or codes and standards. Instead government should promote national companies, both consulting and construction, and non-profit research organizations. It can be done through

creating conducive environment to those firms/organizations to carry out their jobs, provide opportunities to work in bigger projects, offer incentives through awards or tax rebates etc. Strong companies are actually great assets to the country, as we can see it from other countries. Presence of large numbers of such companies/organizations can only retain quality manpower in the country.

iv) **Develop and update codes and standards for resilient infrastructure**

Most building codes and design standards do not account for a changing climate i.e., policy constraints to building resilience features into infrastructure projects. Engineering design standards, construction codes, etc. prepared based on historic events or historic weather extremes act as a barrier to future climate and disaster resilience. They should be developed, if not existing, or updated so that resilient features can be incorporated in future infrastructure projects.

v) **Provide financial incentives for service providers to promote resilient infrastructure services**

Rewards and penalties can motivate utilities to implement cost-effective solutions to improve resilience beyond the mandatory. Two options are particularly common in this regard: a) rewards and penalties for infrastructure service providers, pushing them to go beyond the code and capture further opportunities to build resilience, and b) payment for ecosystem service schemes to promote nature based solutions.

vi) **Ensure financing for building resilient infrastructure**

- Provide adequate funding to include risk assessments in master plans and early project design.
- Develop a government wide financial protection strategy and contingency plans for natural hazards.

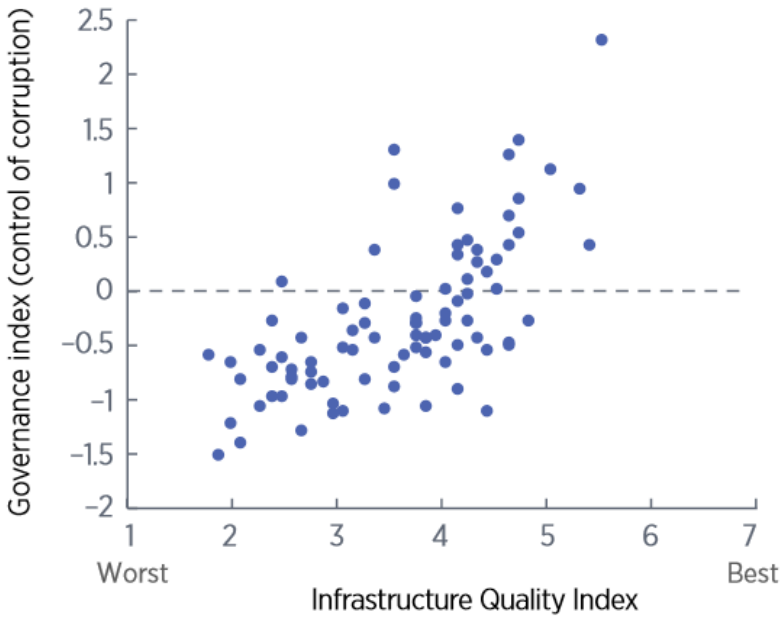
Financial Sources: A huge investment is needed in building resilient infrastructures and other development activities in the country to make better tomorrow. It comes around 40-45% of GDP. Government investment is one of the major sources for investment. Similarly, private sector investment is another source. Insurance could be crucial in unlocking major private sector funding to enhance resilience in infrastructure sector. An environment should be devised by the government so that common people develops a habit of saving and investing in productive sectors like hydropower. Conducive environment can attract Nepalis living abroad to invest in Nepal. The remittance can be a major financial source for investment as well. Still the amount will not be sufficient. For it Foreign Direct Investment (FDI) is needed. Bilateral Investment Promotion and Protection Agreement (BIPPA) can be instrumental in this regard.

vii) **Good Governance is a Must for Building Resilient Infrastructures in Nepal**

Issues of good governance and ethical conduct have always marred the political landscape of Nepal. Impunity and rampant corruption has fueled the public disenchantment with Nepal's democratic political parties. Instances of high-level corruption in all spheres are rampant. Even political parties are not exception in this matter.

Global data show that infrastructure quality correlates strongly with governance standards **(Figure 1)**. Government's ability to implement resilient building options depends on whether it has effective systems in place to implement, finance, manage, and maintain infrastructure assets. Strong institutions, clear assignment of responsibilities, and transparent and reliable financing mechanisms are all essential to ensuring good quality of infrastructures. Having an accountable and transparent government with ethical conduct is a must for building resilient infrastructures in Nepal.

Figure 1: Inter-relationship between the governance standard and infrastructure quality



Source: WEF (2019)

6. Concluding Remarks

Resilient infrastructure is the need of the day for the overall socio-economic development of Nepal. It is more for the households and communities for whom infrastructure is a lifeline to better health, better education, and a better livelihood. Actually it is for a better tomorrow of every citizen of this country as it is about making sure people will not lose their jobs because they cannot get to work, that they can get urgent medical care, and that their children can get to school. In essence Resilient infrastructure is not just about roads and bridges, power plants and water pipes but about unlocking economic opportunities for the people and for country to follow a safer, more secure, inclusive and prosperous future for all, as rightly pointed out by the World Bank Group President, David Malpass. As I mentioned above, cost of building resilient infrastructure is only about 3 percent of the overall investment in infrastructures. It is, therefore, not an issue of spending more. To function and meet users' needs during and after a natural hazard, it is better to spend on resilient infrastructure as One Rupee invested in resilience gives Rs. 4 equivalent of benefit. It, only, requires will power and strong commitment of the government. As a concluding point, I want to reiterate again "Invest in regulations and planning, in the early stages of project design to include resilience measures" which will considerably outweigh the costs of repairs and/or reconstruction after a disaster hits the system.

Thank you!

(November 18, 2019)

Chief Guest: Rt. Hon. Nanda Bahadur Pun

Vice President, Federal Democratic Republic of Nepal

Thank you, the master of ceremony.

Chairman of today's inaugural session of the highly important international conference, guest of honor, keynote speaker former Prime Minister, Rt. Honorable Baburam Bhattarai, special guests from various friendly countries, high level officials of the Government of Nepal, engineer friends, media friends and participating ladies and gentlemen,

Good evening and Namaskar to you all.

I have immense pleasure to be among the eminent engineer friends on the auspices of the inauguration ceremony of this international conference jointly organized by the Society of Consulting Architectural and Engineering Firms (SCAEF), an umbrella organization of consulting firms (SCAEF) and National Reconstruction Authority (NRA). First of all, I wish to express my best wishes for the success of this international conference on the theme "Resilient Infrastructure for A Better Tomorrow" jointly organized by the SCAEF and NRA with FCAN and NSET Nepal as co-organizers.

It is noted that engineer friends from many countries have arrieved to participate this international conference which is organized on the verge of Visit Nepal Year 2020. We have immense pleasure to welcome our foreign guests to this naturally endowed country, the land of the Lord Gautam Buddha and the land of the Mount Everest. We wish for your pleasant and comfortable stay in Nepal.

I also wish to congratulate the President, Executives and Members and all engineer friends affiliated to the Society of Consulting Architectural and Engineering Firms on the auspices on its 29th anniversary. I also wish for bright future for this Society.

Ladies and gentlemen, for decades, there was an aspiration or political engineering dream of the people and that political road map is now completed. On the other words, republic system is now established. At present, millions of political leaders and cadres have played a prominent role to translate the road map sketched by the Nepalese people. The achievements from the political process include federal democratic republic, secularism, proportional and inclusive governance with social justice etc. While institutionalizing these political accomplishments, the nation is moving forward towards political stability, lasting peace and sustainable development. The nation is presently moving forward with the political aspiration of "Prosperous Nepal and Happy Nepali", and the time is at our doorstep to sketch the road map of the national development. The responsibility of sketching a concrete road map for the national development is on the shoulders of you engineers present here. What shape of the country do we wish to hand over to our future generations? The responsibility of conceiving this road map also rests on your responsibility.

It is notable that engineer friends have accomplished many infrastructures which the nation can take pride or glorified. Many engineers have also been taking up the political leadership. The keynote speaker or special guest of this inaugural session Rt. Honorable Dr. Baburam Bhattarai is an adept architect by himself

and he has already presented his keynote paper. I believe that there are many important and necessary agenda for the country and the former Prime Minister Dr. Baburam Bhattarai had provided leadership from political front as well, and he is still very active in the politis. I also wish to express my great honor to engineer friends including Dr. Baburam Bhattarai at this moment.

It is also noted that engineer friends have also extended their contribution to the nation as planners, implementers, construction entrepreneurs and administrators apart from their role as engineers. In this occasion, I wish to thank for the contribution made by the engineers for the upliftment and development of the nation and people highly valuing their contribution. Nepalese engineers have demonstrated many exemplary engineering infrastructures. For example, projects such as Bheri-Babai Multipurpose Diversion Project, Mahakali Irrigation Project, Sikta Irrigation Project, Midhill Highway Project, East West Highway, Dodhara-Chandani Suspension Bridge, Upper Tamakoshi Hydroelectric Project, Kulekhani Hydroelectric Project, Kaligandaki A Hydroelectric Project, Chameliya Hydroelectric Project and road transport infrastructures of Kathmandu and outside were designed by Nepalese engineers. And the contribution of the engineers in these projects is highly commendable, on this occasion, I wish to express my high regards to the contribution of the engineers once again.

Ladies and gentlemen, apart from these positive contributions, sometimes negative news have also come to surface that the nation is suffering a huge loss due to incompetence or weakness of some engineers. From such negative news, the engineers are being criticized. Why some projects designed by the engineers get suspended later pointing to engineering mistakes? Why the completed projects become of inferior quality and end up in failure? Why the paved roads fail prematurely within a couple of days? Who is responsible for this? I feel that there are certain weaknesses and shortcomings in the part of engineers too. You must have felt the same. I wish to request that we should not take time to improve from such shortcomings. The reason for delay and substandard quality in projects, many not be solely due to the shortcomings or incompetency in the part of engineers alone.

The Federation of Contractors' Association of Nepal (FCAN), an umbrella organization of private sector construction entrepreneurs is also among the co-organizers. I believe construction entrepreneur friends might have self-assessed the extent role of the construction companies in project delays and substandard quality. Series of events hint that the shortcomings are also in the part of construction companies in project delays and sub-standard quality. What circumstance has compelled the construction entrepreneurs for such substandard performance? Is there no tradeoff in construction works targeted to make somebody happy? But the construction works should, in no case, be compromised. I feel that we should not compromise anywhere in matters of timely completion and quality standards. In this matter, what is the role of the government, what is their role of engineers and what is the role of the construction entrepreneurs, I feel that everbody should perform the respective roles. Because the development of the country is everybody's duty.

Civil servant engineers and construction entrepreneurs, firstly we are Nepalese and it is important to work by keeping the national prosperity as our motto. Engineers role is not only to build infrastructure, they must also ensure economic transformation of Nepalese people. The infrastructure we build should be able to change economic life and social life of the citizens.

Engineer friends, the infrastructure of our country must be based on geographical location and topographical context and our development model must be specific to Nepal. We need to learn from other countries and must do that but our development infrastructure should be of Nepalese model itself. We do have plains of the Terai, we do have hills of Churia, we do have high mountains, we do have high

Himalayas. We need to consider these geographic realities in building of our development infrastructure activities. We need to design and build the infrastructure with due consideration of Nepal's very geographical location, steep topography, geological complexity, primitive stage of development, erodible slopes and banks, vulnerable glacial lakes and earthquake hazard and risk etc. Not a long ago, we faced a disastrous major earthquake. Did we learn lessons from that disaster? The earthquake of 2015 taught us lessons. I ought to say in such a occasion that the initiative of reconstruction activities of infrastructures damaged by the earthquake are not at par with the target. It is an unpleasant fact that many of the affected people are still living in temporary sheds, our historical and archaeological heritage are still not reconstructed or retrofitted. In this occasion, I also wish to express my concern that we should reassess how appropriate or suitable is the donor agency's funding and its impact to the nation in respect of our historical, cultural and archeological heritage. I have my personal opinion on what type of infrastructure should we build. Our infrastructures should follow our indigenous practice, our infrastructure must be able to attract tourists, our hydropower projects, agricultural farms, our herbal centers, our industries should be pivoted to create touristic center in itself. The infrastructure in the rural area should be earthquake resistant, comfortable and technology friendly but at the same time, they need to be based on indigenous knowledge and practice of the village or, in other words, the originality or identity should be preserved. The infrastructure should be such that the tourists visiting Kathmandu also get attracted to visit the villages. And I wish to draw attention of engineer friends that engineers while designing one should feel that he/ she is designing infrastructure of his/her own country, and his/ her design should be made with high objective of standard quality and exemplary nature. The construction entrepreneurs should think high that he/ she is building the project for his/ her country and he/ she needs to complete timely with good quality and his/ her design should be an exemplary, not to maximize profit. If the projects targeted to complete in two years are completed in one and half year, the country moves fast forward and if the project gets delayed to six or seven years, the country moves backward by six or seven years. Project delays have become routine affairs so far and therefore we are backward and we are poor.

I feel that we all need to think of the impact to the nation by project delays. If projects are completed in time, the country can benefit from the project and moves to higher level of development. I feel that the concerned agencies need to be serious on this aspect. At the same time, we also need to consider environmental aspects and adopt measures to mitigate the adverse impacts of the projects and from natural disasters. I believe that this responsibility is also on the shoulders of the engineer present here.

I believe that the technical papers to be presented in this conference and the resolutions thereafter will give guidelines for appropriate design of projects in the context of Nepal and will also be a directive to the Government of Nepal too for the planning, design and implementation of the infrastructure projects.

I wish to thank the organizers for initiating interaction on issue of such serious nature. It is a commendable initiative and I believe the conclusions and resolutions from this conference will certainly contribute in the building of prosperous Nepal.

At the end, I wish to thank the organizers for inviting me in this august conference and also believe that the foreign guest delegates attending this program also get benefitted by visiting touristic destinations. With this, I wish to say good bye.

Thank you and Namaskar !

We Pledge to Dedicate our Professional Services to Nepal in the Following Fields:

PROJECT SERVICES:

- *Field reconnaissance, geo-technical & geological, topographical, and hydrological and soils surveys.*
- *Detail engineering design, project management, support in procurement of works, contract administration etc.*
- *Planning survey, feasibility study, socio-economic studies and environmental studies etc.*
- *Turnkey operation, start-up operation and project management services.*
- *Institutional strengthening, management advisory and training.*

PROJECT SECTORS:

Infrastructure Development: *Physical developments, rehabilitation, maintenance, improvement and upgrading, landscape and site development and formulation of plans.*

Energy: *Generation and distribution of hydropower, rural electrification, transmission line etc.*

Environment: *Environmental surveys and impact assessment protection measures. Geological and geophysical investigation and mitigation measures, seismic studies etc.*

Transportation: *Road Network, bridges, suspension bridges, ropeway and inland water transport.*

Water Resources: *Gravity and pumped irrigation schemes, exploitation of surface and ground water potentials for water supply, basin studies and water storage studies.*

Industrial: *Feasibility studies, equipment installation and production start-up.*

Construction Industry Development: *Construction management, capacity building, training and technology transfer.*

Agriculture: *Agricultural development planning, land use planning, farm management, operation and maintenance of irrigation systems.*

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Technical Session

2

Challenges In Infrastructure Development Sector In Nepal

Keynote Presenter: **K K Kapila**

Past President, CEAI and President Emeritus, IRF, Former Board Member of FIDIC

Good Morning. My co-speakers, delegates, members of the media, ladies and gentlemen,

At the outside, I thank the organizers SCAEF for inviting me in my capacity as a former President of Consulting Engineering Association of India, Executive Committee Member of the FIDIC and President Emeritus of the International Road Federation to deliver this keynote address on challenges in Infrastructure development in Nepal.

It's my pleasure to interact with you all through this important forum. As a professional deeply rooted in the activities pertaining to the development of infrastructure in over 46 countries of the world since last 5 decades, and with ample experience of working in Nepal, I like to share my perception on challenges being faced by the infrastructure sector in Nepal and ways to overcome the same. In a global economy, a country's focus is consistently on the overall development of infrastructure covering road, rails, airports, electricity, water, which when sustainable, becomes the backbone and economic driver of the country. Many developed economies stand testimony to this theme. In the context of Nepal, a country nestled amidst the mighty Himalayas, a trans-himalayan infrastructure development would open up enumerable opportunities in Nepal and also place it as an important bridge connecting the economies of neighboring countries India and China. From enhancing trade to tourism in the country, a well-planned infrastructure will pay consistently rich dividends.

This was also expressed by Dr. Baburam Bhattarai, former Prime Minister of Nepal, in his keynote address. The developing countries have an advantage of referring to or adopting global best practices and benchmark. Any massive development activities will do well and enjoy longevity with careful planning, allocation of resources, phased implementation and close monitoring. Customization to suit to the local requirements will enhance the returns on investment and must be adopted.

The pertinent issue facing infrastructure development in Nepal is the fragmented system of ownership and operation. Their multiple jurisdictions, so question of proper coordination within the elements: government agencies, central, state or local self- governance, prioritization, responsibilities sharing, transparency and efficient bureaucracy. Largely the infrastructure is generally owned by one of the wings of the government. Despite fragmented ownership, the infrastructure must function as seamless units so as to benefit the users, the citizens and the economy. With fragmented ownership, the decisions for construction and maintenance are also fragmented. Hence, immense responsibility rests on these agencies to optimize the resources to ensure quality infrastructure that provides safe and comfort, faster mobility by putting to good use the public funds and their appropriate maintenance.

There are three main sources of financing to start with. One is the budget which the government provides. Second is the support from the MDBs and friendly nations from their lending arms like the KFW, the Millennium funds, the Exim Banks, etc. And the third is the PPP, Public Private Partnership.

There is a need to compliment the efforts of the government in the infrastructure development, and therefore, presence of strong private sector institutions is imperative. The PPP or blended financing model needs to be encouraged by enacting regulations for institutional investors to find clever infrastructure projects in the country. This needs to be encouraged by enacting regulations for institutional investors to find favor in infrastructure projects in the country. This needs to be a very balanced document with clauses to protect the interest of the investor. The more protection you provide in the documentation itself will encourage more private investment. There are many lessons to be learnt in this regard. The worst fear that an investor has is that 'I am getting this work on PPP under this particular government. What happens if the next government stops my works and does not allow me to take returns anymore?' This problem we have faced in India, and that's why I am sharing in little more detail with you.

We need to have in the document itself that if this road section, the government decides that you cannot collect the toll anymore, then for every period that the government says don't do it, the government is liable to pay you an x amount which is predetermined and provided for in the agreement itself. We need to consider PPP as an excellent mode of getting financing, provided we are honest and fair in our dealings with the private investor. This is the lesson which we have to learn from many governments who have failed in their PPP missions because of bureaucratic hurdles, not wanting to provide the right kind of arrangements in the documentation, and thereafter, disputes which run, and the method fails. But PPP is an excellent method, its mechanism should be deployed to get funds. There are now with lot of, even UN, has come out with lot of documentation on ideal mechanism for PPP. From FIDIC also we have documents supporting PPP mechanism, and how they can be usefully utilized and deployed. Consultancy services is of paramount importance which presently are dependent to large extent on international consultants although the local consulting fraternity have developed, and there has been an excellent growth here. But the quality people tend to leave for foreign destination. They don't want to continue and work in the country itself. Perhaps the cause the remuneration or the remunerative nature of the consulting fraternity here is unable to support the best of them who choose to go to the west and earn much better returns thereby leaving a great void in the quality of manpower available with the local consultants, and therefore, more need for foreign consultants is felt.

We need to correct this situation, and try to see that the consultant get proper remuneration for their services so that the consulting firms can pay right wages to their staff to retain them here and use their knowledge which they have gained by studying here in institutions which have been financed by the government, and then if you don't get the benefit of those people, there needs to be an urgent correction in this regard.

The nation private sector, institutions of Nepal, construction industries can gain invaluable experience and maturity by including international contractors as part of joint venture consortiums or as associates by giving local partner a minimum of 25% to 30% stake holding particularly for bigger projects. This mechanism should particularly hold good in bigger projects. The extent of local participation can be determined by the authorities depending on the maturity of the local consulting industries in that particular area of infrastructure development.

Representatives to be stationed on project sites with defined output, the tender document should particularly specify the list of modern plants and equipment to be deployed by the contractor at site for the execution of the projects. Mostly if, the contracting team and consulting team works together, then national construction industry will definitely get strengthened and can mature. This is absolutely necessary if we want to strengthen the industry.

With the objective to build high quality infrastructure to begin with, there should be an established clarity for award of work and policies that govern it. What is the guiding factor, the Quality or the Cost? Even the developed economies of the world till today are faced with this dilemma. As the construction sector operates on low margins, they compete with each other to get the works, sometimes even at abnormally low rates. The developing world which enjoys the benefits of zero learning curve, in my opinion, are aspiring for robust and quality infrastructure and adopting a judicious mix of QCBS and QBS approaches for awarding consultancy works. I strongly recommend that for QCBS, we should go in for 90/10 as is done by the ADB however, the construction works are still awarded at the least cost. What do we do there? There is a need to bring about a change where the construction work is not awarded at least cost but is awarded at lowest workable rates. And that will end many of the problems which we in the developing world in particular face with poor quality of work being done because the contractors have quoted rates which are not workable and has still got away with the award of works. Ultimately, these works must take longer time that was stipulated in the contract and even the cost goes up because of various reasons.

There is a need to take a look at the FIDIC document which has come up in 2017 on engagement of contractors. I will be happy to leave a copy with the SCAEF here to take it with the government to look into this document which provides for many different methods for computing the lowest workable rates. You can adopt any method. All that you need is to transparently bring out in the RFP that this would be the method by which we will determine the award of work which will be on the basis of lowest workable rates and not the least cost. This single change will bring about a great opportunity for you to develop and grow as a nation. It is difficult but doable.

Benchmarking of infrastructure by star rating should be a function of quality, cost, robustness, safety, sustainability, etc., for construction industries should use more environment friendly green materials and adopt green technologies and processes. Orders of construction works at all stages towards enhancing safety of infrastructure and its users, vehicles and others is imperative. The loss on account of under provision of safety in the infrastructure can cause sizable loss to the economy. As per World Health Organization statistics, road accidents in developing countries account for loss of 2% to 5% of the respective country's GDP. This is besides the trauma which the accidents victims go through, and which the families of those killed in accidents go through. You lose 2% to 5% of the GDP only on road accidents. And in a country like Nepal where the roads have difficult geography because of the hilly mountains, curves and the geometrics need special care. We have a big challenge at hand.

The IRF, a signatory to the United Nations decade of action which envisages 50% reduction in road accident fatalities and injuries by 2020, is deeply involved with the four Es of road safety namely Engineering, Education, Emergency Care and Enforcement. Promoting forgiving roads, roads where if an accident takes place, the person would not die is called a forgiving road. So, we need to try and build forgiving road infrastructure. And for that we should be able to earmark 10% of the cost of work for road safety related items. You need to provide appropriate curves; where you can't, you must provide appropriate signages. You must provide calming measures near schools in particular, and near hospitals. There are various and a large number of them. I'm not going to enumerate each one of them. But the effect of the matter is that if we want sustainable road infrastructure, we must try and see that it is a forgiving infrastructure. We need to also take care of the cars. The engineering of vehicles is an important segment as well which is necessary to be taken care of if accidents have to be prevented.

Efforts are to be made to build safety culture in the road users, promote use of ITS technologies to get data for overall road management, to provide first-aid and trauma care training to bystanders on roads

stretches. The idea is to make infrastructure safe and sustainable. Bystander training is very important if the people on the road side who are having a Dhaba and eatery or school or a petrol pump there. If these people are trained in first-aid trauma care, there they will be able address the accident victim within the golden hours and save the lives.

We have also advocated allocation of 10% of budget towards road safety during construction and maintenance. Another aspect which I would like to touch upon is when you negotiate a loan with an international agency, please also negotiate in the same loan, a stretch of road which needs to be upgraded. So while you are trying to build safe infrastructure and reliable infrastructure further, you need to have a program of how to help the existing infrastructure also becomes resilient, and that can only happen if there is well laid out program. When you negotiate a loan with a multilateral development bank, you also will say I will build this 100 km of road, but I have this 300 km which I want to upgrade, and I need loan to cover this as well. And that's how a graded upgradation will take place and it is important to do that.

The developing countries lose precious infrastructure worth billions of dollars through deterioration of roads. Large road networks built at huge expense are under-maintained. More heavily used, abused than expected. With continuing neglect, the deterioration of roads gets accelerated. As old pavement crumble and the new ones outlive, the initial period during which the effects of neglect are barely perceptible. This is an aspect which was also highlighted yesterday by the chief guest Honorable Vice President as well as Dr. Bhattarai.

The cost of restoring these deteriorated roads is going to be 3 to 5 times greater than what it would have cost with timely maintenance. Added to this is the increased vehicle operating cost which will further impact the road repair cost. With roads going from good to fair to poor put together these costs are formidable obstacles to a growing economy. Then there is the issue of lack of skilled man power to develop appropriate infrastructure, audit them and maintain them and preserve them. There are trainings available which should form part of the funding of the projects enabling skill development.

One of the reasons why these trainings are not being properly undertaken is that the finance ministries of the developing world feel that this is a wasteful expenditure, and they do not subscribe to trainings as they should be.

The answer to my mind for this problem is that each training once imparted, there must be a test after the training has been done. To prove that the people who have undergone the training have learnt what they had come for because in developing world we often find the people do not seriously undertake these trainings, and that a few of them do not, have made this perception rather big in the minds of finance people that it is a wasteful expenditure, people don't take it seriously, and therefore, they do not like to approve any training programs at the cost of the government; only grant programs they are happy to support but no programs from the government funding. To that I would also like to bring out when you negotiate a loan, please try to tell the organization from which you are borrowing that please give us grant money for upgradation of human skills. It is very important that we develop the human skills in a very well thoughtful laid out program, and to my mind what you can do is, when a graduate engineer graduates, and before he joins the service, he must be deputed to a design training program attached to a design work going on in the country for at least six months, and similarly for another six months on a construction work which is going on. Only after one year of this training, he should be taken in the government service so that there is a better appreciation sitting in the government on the desk of what is happening around. He will be a better planner; he will be able to do and perform his duties much better if he has undergone this kind of training. Then at the end of 4-5 years, you need to again give them a training of about a fortnight each, at the end of which take an exam, and the next

increment should be dependent on the outcome of that exam so that there is a seriousness of developing the knowledge for which you have attended those training programs. By this mechanism, I believe you will be able to improve the human skills of the engineering fraternity.

The edge of doing business is another area which is necessary to address. This has been discussed in great details yesterday by Dr. Bhattarai. I will dwell on certain parts which this consulting fraternity is facing an issue which is rampantly faced with is in regard to Visa of International experts. The process of obtaining Visa for international experts is a long drawn and a complex one. Multiple government agencies are involved to obtain a limited one-year Visa, issuance of Visa to foreigners who are the main experts need to be simplified and made through a single window clearing system rather than multiple management. This is doable. There are concerns which the government has which can all be addressed by following one of the practices in the neighboring countries where single window is very popular and is being done. We don't need to reinvent the wheel; the processes are very clearly laid out. You can ask anyone of these countries and study the system and adopt it. But this is absolutely necessary to facilitate the working. The international investor also faces complexity in payment of taxes and labor laws. The labor laws of 2017 introduce a labor gratuity, medical insurance, accident insurance to be paid by the employer which places a large administrative burden on companies that already face considerable bureaucratic hurdles. For instance, double taxation avoidance treaty is in existence with India but remitting money overseas from Nepal is difficult and time-consuming process involving national bank, Nepal Rastra Bank, and the process really takes too long. Nepal ranks 158th for paying taxes in doing business out of 190 countries, and this is the lowest ranking among the 10 indicators. Besides taxation, Nepal also ranks low in other indicators in ease of doing business including enforcing contracts 154th, dealing with construction permits 148th and getting electricity 137th as per World Bank report of October 2018. This aspect was dealt within considerable detail by Dr. Bhattarai yesterday. This position needs urgent improvement as it is a big impediment in the growth of the nation. The political will on succession planning is important. The infrastructure development of one political regime should seamlessly be continued in the successive ones in the interest of the nation ably driven by legislators and policy directors. Continuous R&D for better construction materials, methodology and preservation of infrastructure need to be encouraged. Further, public education for their participation and support to protect the assets is mandatory. They must feel responsible for upkeep of the infrastructure as a national asset. It is important that every citizen realizes that the national asset has been built by his contribution as well as a tax payer, and he must try and protect it and use it and not abuse it.

Ladies and Gentlemen, any infrastructure development undertaken with judicious planning to cater to the country specifics will result in economic prosperity which returns on investment duly justified. This was dealt with in great detail by Dr. Bhattarai who indicated that the investment will give you 4 times the return if it is done that way.

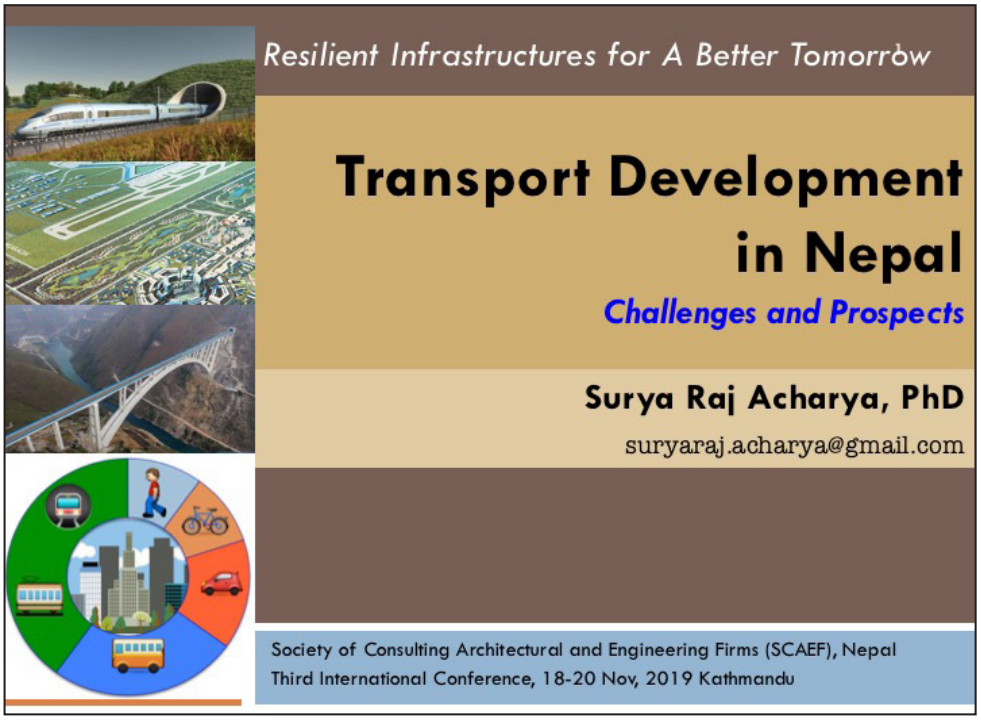
Before I close, I would like to congratulate SCAEF for putting together an impressive forum to take on pertinent issues of development of infrastructure in Nepal as well as to have an assessment of opportunities available to country to be made possible with association with the developing countries driven by the government.

I wish the deliberations of this conference all success and will keenly look forward to receiving outcomes of the proceeding.

Thank you once again ladies and gentlemen.

Transport Infrastructure Development in Nepal: Challenges and Prospects

Surya Raj Acharya, PhD[1]



Transport Network and Services in Nepal

Snapshot

2

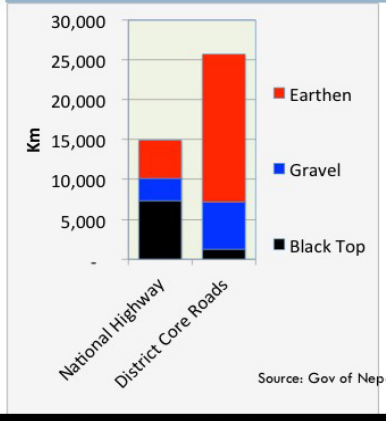
1. Main transport modes- Road and Air transport
2. Because of hill and mountain topography, road accessibility not available for all places
3. Car ownership is very low (250 % custom duty on car)- Nationwide 7 per 1000 pop; Kathmandu Valley 70 per 1000 pop
4. Congestion problem in Kathmandu
5. Plan for railway development
6. Road accident problems

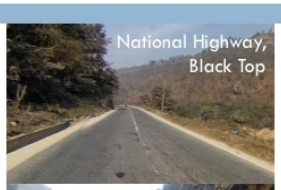
1 Freelance, Infrastructure Policy Expert, Email: suryaraj.acharya@gmail.com

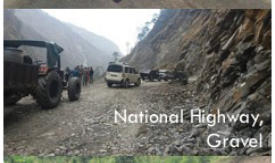
Road Network in Nepal

Length and Pavement Condition

3







Rural Road Network > 70,000 km, mostly Earthen.

Roads in Nepal 'Snapshots'

4

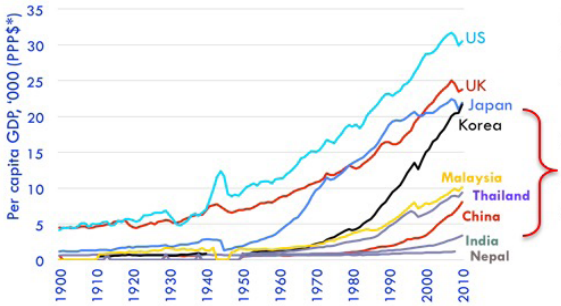
Road Sector National Highway access target
4 h walk: Hill
2 h walk: Terai

Experience of East Asian Countries

Infrastructure Driven Economic Development

5

GDP per capita in Selected Countries (1900-2010)



Rapid economic growth in the East Asia

Growth driven by infrastructure investment

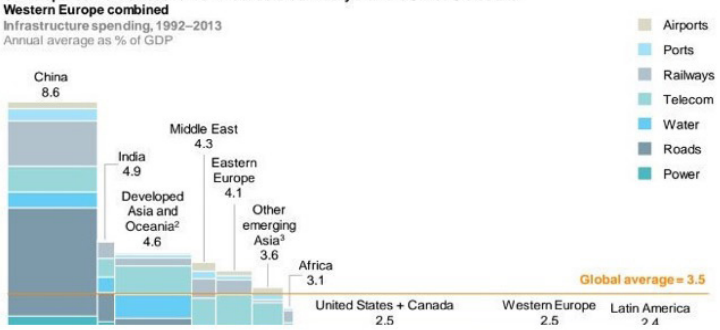
* (1990 Int. Geary-Khamis international $) Based on Bolt and Van Zanden (2013) New Madison project database (http://www.ggdc.net/maddison/maddison-project/home.htm)

Infrastructure Investment

6

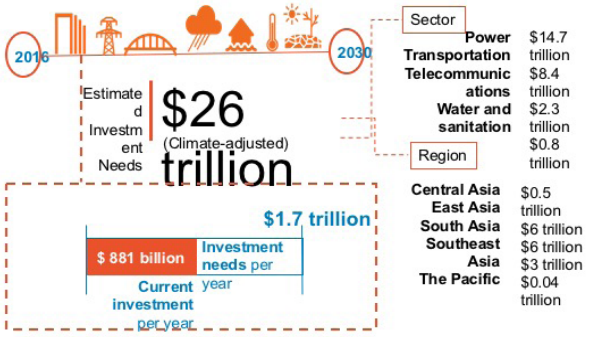
China spends more on economic infrastructure annually than the United States and Western Europe combined

Infrastructure spending, 1992–2013
Annual average as % of GDP



Source: McKinsey

The Asian Infrastructure Gap

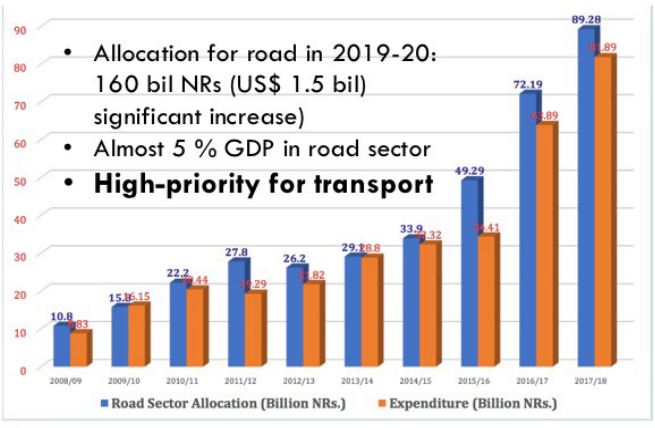


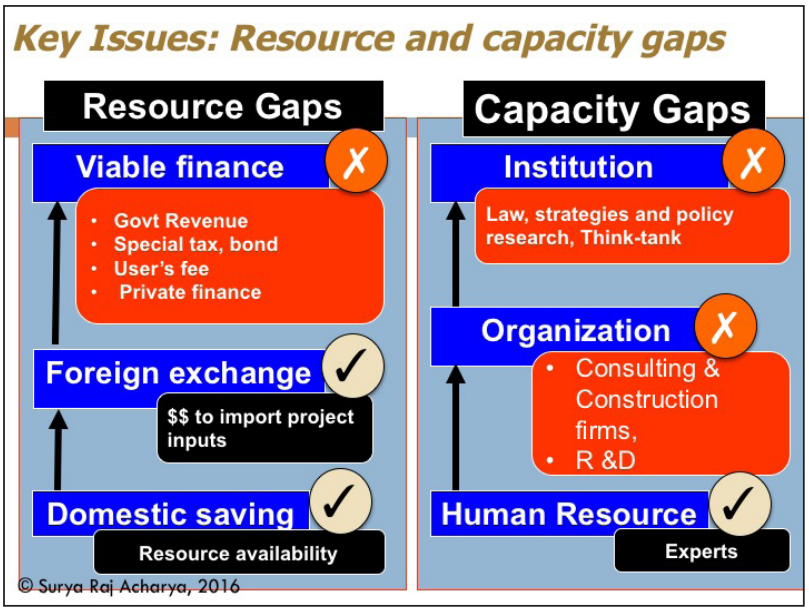
Sector	
Power	$14.7 trillion
Transportation	$8.4 trillion
Telecommunications	$2.3 trillion
Water and sanitation	$0.8 trillion
Region	
Central Asia	$0.5 trillion
East Asia	$6 trillion
South Asia	$6 trillion
Southeast Asia	$3 trillion
The Pacific	$0.04 trillion

ADB

Budget allocation and expenditure in road sector

- Allocation for road in 2019-20: 160 bil NRs (US$ 1.5 bil) significant increase)
- Almost 5 % GDP in road sector
- **High-priority for transport**




Key Issues: Resource and capacity gaps
Resource Gaps
Viable finance
Govt Revenue
Special tax, bond
User's fee
Private finance
Foreign exchange
$$ to import project inputs
Domestic saving
Resource availability
Capacity Gaps
Institution
Law, strategies and policy research, Think-tank
Organization
Consulting & Construction firms,
R &D
Human Resource
Experts
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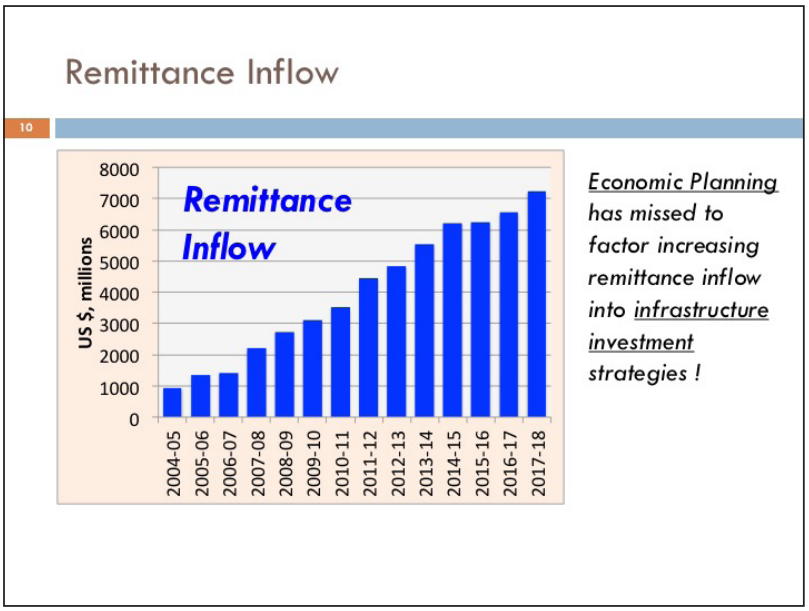
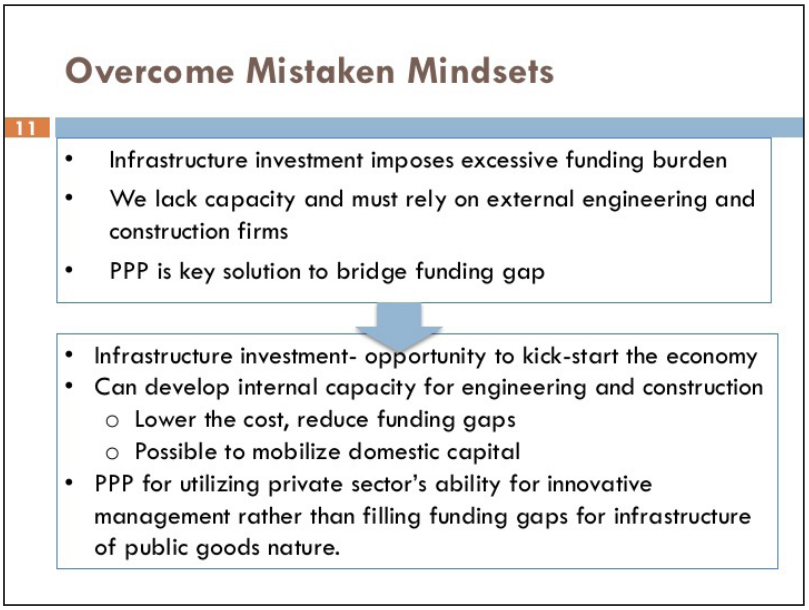

Remittance Inflow
10
Remittance Inflow
US $, millions
8000
7000
6000
5000
4000
3000
2000
1000
0
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
Economic Planning has missed to factor increasing remittance inflow into infrastructure investment strategies !


Overcome Mistaken Mindsets
11
Infrastructure investment imposes excessive funding burden
We lack capacity and must rely on external engineering and construction firms
PPP is key solution to bridge funding gap
Infrastructure investment- opportunity to kick-start the economy
Can develop internal capacity for engineering and construction
Lower the cost, reduce funding gaps
Possible to mobilize domestic capital
PPP for utilizing private sector's ability for innovative management rather than filling funding gaps for infrastructure of public goods nature.

Lack of spatial and settlement planning

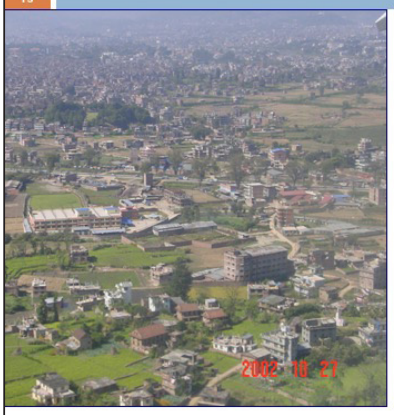
12

Scattered settlements in hilly areas, Nepal

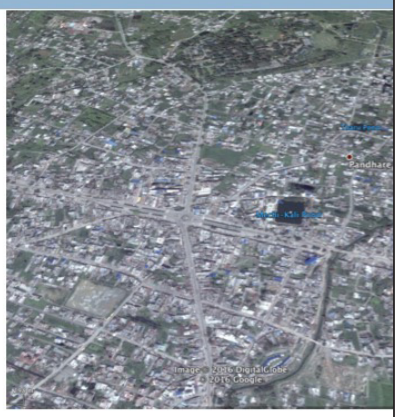
Land slide due to non-engineered hill road

Lack of spatial and settlement planning

13



Kathmandu Suburb (Haphazard dev)

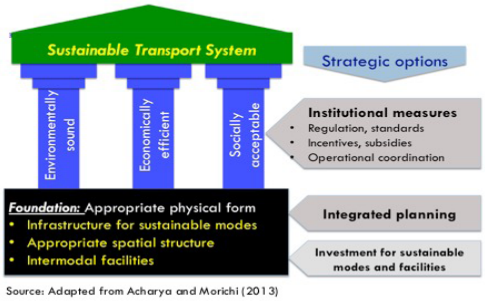


Itahari (Ribbon-type development)

Strategic Perspective for Resilient Transport System in Nepal

Overcoming Challenges and seizing Opportunities

14



Source: Adapted from Acharya and Morichi (2013)

1. Importance of both "hardware" and "software" solution
2. Achieve "synergy" rather than face "trade-off"
3. Resilient transport system: needs to be founded on robust domestic capacity

15

Thank you!

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Challenges in Water Resources Development in Nepal

Keshab Dhoj Adhikari[1]

Abstract

Nepal's water resources, despite its much commonly believed abundance and potential, is too far from development and utilization. Development of hydropower less than 2% of the potential, poor standard of water supply services both in terms of quantity and quality, limitations in irrigation services for various reasons and degrading environmental health of rivers indicate that we are way far from satisfactory conditions. In order to develop and manage water resources in an optimum and sustainable way we have several challenges, which can be broadly enumerated as - building a policy and legal regime that compels the concerned to formulate sector's integrated development and management plans and link them to the law-specified rights and responsibilities of various institutions of Governments at different levels; developing sustainable and quality infrastructure to address problems of adverse geological conditions, probable climate change, complex landform and uneven availability of water; building a consensus among various stakeholders, and particularly the stakeholders at decision-making level; garnering required capital for the development of the water resources sector; preserving water work sites from encroachment from other sectors; etc. This paper attempts to identify the issues in water sector of Nepal and put forth the challenges ahead to resolve those issues.

Keywords: *consensus building, optimum and sustainable development; site preservation; environmental health; legal regime building*

1. Introduction

Many of us have been carrying a notion that Nepal has tremendous amount of water and very high potential of hydropower generation. To a large extent, it is correct, too, however, given the spatial and temporal variation of availability of the natural resource compounded with disastrous landslide and flood events, the country has not been able to realize the benefits. These physical realities are always there; we cannot do away with them; and Nepal is not the only country having such adversities. Others in similar geophysical settings have developed and managed water sector in far better way with the application of proper technology and management, but in Nepal's case a comprehensive water policy, a coordinated sectoral institutional mechanism and a strong legal regime always remained absent. Not that water sector's comprehensive planning exercises were not carried out in the past; with the assistance of the Government of Japan, plans for Gandaki, Koshi and Karnali-Mahakali basins were prepared in the seventies, eighties and nineties, respectively. Likewise, irrigation master plans were prepared in late eighties and early nineties; and Water Resources Strategy and the National Water Plan were formulated in 2002 in 2005, respectively, but the governments that existed even up to now and their water institutions never had any compulsion to adhere to such plans.

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Lack of financial wherewithal has always remained a major constraint in Nepal because of which the country has always been relying mostly on external financial assistance in water sector. Anti-dam movement and excessive emphasis on water management at the cost of sustainable infrastructure, which gained momentum since the mid-eighties, also slowed down water sector's development in Nepal. The country had no choice but rely on external assistance geared towards such lop sided development endeavours. Nepal's water resources have a lot to do with international cooperation, particularly at bilateral level with India. Confidence building between these riparian neighbours is another major challenge.

Of late with the promulgation of the federal Constitution in 2015 a new challenge of defining rights and responsibilities of governments of different three levels - Centre, State and Local in water sector is standing stark in the country. These problems and challenges are dealt with in greater details in the following Sections.

2. Problems in Water Sector

There are multitudes of problems in Nepal's water sector. Identification and diagnosis of these only lead us to the challenges to meet, and overcoming these challenges only lead us to a developed and well managed water sector. The major problems identified are:

a. The **variability in water availability** in terms of location and time on account of the complex topography and monsoonal climate of the country is the single largest problem in the sector. Such variability causes a problem of 'too much or too less' water both in time and space. We have over 1.47 million ha of land under irrigation out of potential irrigable land of 2.27 million ha. However, area that gets round the year irrigation water is only one-third of the reported command area. Similarly, generation capacities of the hydropower plants also drop down in dry season, and we have been resorting to import of electricity. Water supply also drops down to severe deficit condition during dry season. Monsoonal flood problems are sometimes even more painful than the deficit water supply in dry season. Settlements and cultivated lands that are high up in the mountains are deprived of water even when there are close to rivers because of elevation difference.

b. **Minimal development of water related physical infrastructure** has taken place, and this has led to utilization of very small fraction of water in comparison to the abundance of the resource. In a country where the problem of variability in water availability as stated above exists, there should have been a number of storage dams. Unfortunately, there is not even a single storage dam in any of the major rivers in Nepal. Lack of infrastructure has, in fact, led to minimal use of water. Very low fraction of land with round the year irrigation facility and severe deficit of power in winter are all attributed to lack of or poorly planned and developed infrastructure. Although it is reported that almost 90% population is provided with some kind of basic water supply, but the service standard, which is also mainly attributed to infrastructure, is far from satisfactory. High-medium standard water supply is available only to 20% of the population. Wastewater treatment infrastructure in the country is next to non-existent because of which many of the rivers particularly that flow through the major cities and townships have degraded environmental health.

c. **Infrastructure for the collection, analysis and management of water resources related data** is inadequate. Hydro-meteorological data and information are crucial in planning, developing and managing water. Scientific evidence based approach could only lead to successful development and management of water. Inadequacy of hydro-meteorology related infrastructure has compelled the concerned to resort to empirical approach and adhockery.

d. **Institutional infrastructure** as required in the water resources sector is lacking. Most of the time, institutional restructuring in water sector is done with adhockery and randomness. Such approach has led to lack of coordination and integrated approach in sector's development and management. This problem seems even more serious when non-water institutions are also included in the picture. A totally different institutional arrangement in water sector might seem necessary, if we considered rights and responsibilities of State and Local Governments according to new Constitution.

e. **No clearly law-specified custodian for the protection of water bodies** such as - rivers, lakes, ponds and groundwater resources exists. This problem has led to degradation of river health, waterway encroachment, etc.

f. **Coordinated and integrated development and management** among the various use-specific sectors of water and other natural resources of the watershed such as land, forest, etc. is missing. Integrated Water Resource Management (IWRM) is a policy that is loosely adopted by Nepal. However, there is hardly any basin-wide integrated approach adopted practically encompassing other resources and stakeholders within a basin for achieving optimum benefit.

g. Efforts to **conserve adequately the sources and related ecology** for the sustainable development and management of water resources are inadequate. Conservation of water sources, particularly in the Climate Change condition, is very essential. However, efforts towards such conservation are not adequate.

h. **Encroachment upon potentially feasible water resources project areas and construction sites** is rampant. Construction of roads, new townships and other infrastructure in the river valleys without considering that the locations and areas are water work sites and reservoir areas for the identified potential major water resources projects inhibits development of the sector. BP highway and Khurkot-Ghurmi road, Khurkot town, and a host of other infrastructure built in the Sunkoshi valley conflict with Sun Koshi-2 Hydropower Project. There are countless such infrastructure and settlements, which have been built and are being built in dam and reservoir sites. Such disorganized development will - either inhibit the development of major storage projects, or impose prohibitive resettlement and rehabilitation cost. If Nepal is to take pride on its hydro potential, conservation of potential water work sites is already overdue.

i. **Inability to mitigate the risk and disasters for not being able to effectively manage floods, landslides and drought**. Every year, loss of life and property has occurred due to floods, landslides and drought. There is no sign of amelioration in flood and landslide situations despite spending of substantial amount of money by the Government. Drought situation is also not so dissimilar. Little has been done to mitigate the risk of water induced disaster both in terms of structural and non-structural measures.

j. Lack of adequate **access of the marginalized** people to water resources, and lack of **women's participation** in adequate manner

k. Increasing **pollution of surface and groundwater resources** and decrease in the level of the groundwater table owing to excessive extraction in certain areas

l. Lack of **human resources and organizational structure** of the desired capability within the country for the development and management of water resources. Institutional capacities, which are

primarily associated with the human resources, seem eroding particularly in government institutions in Nepal. Brain drain is believed to be a major reason for such erosion. Capacity to plan, design and implement large water works is lacking within the country on account of which the country has to rely on foreign consultants. Such reliance further prohibits capacity enhancement of domestic manpower. The country has trapped in such a vicious cycle.

m. Lack of **capital for large projects and consensus in modes of development**. Nepal lacks capital for the requisite expeditious development of water sector. The constraint has a lot to do with the limitation of the country in prioritizing and deciding on the modes of water sector development. It is even more so in the financing mechanism of large projects as demonstrated by the inconsistent decisions on 1200 MW Budhi Gandki Storage Power project. Absence of consensus at political level and inconsistency in policy decisions are very common in Nepal's water sector, and they have stalled progress in the development of large projects in great extent. Consensus across political parties is even rarest phenomenon when it comes to dealing with the riparian neighbour.

2. Challenges

Delving into the aforesaid problems in order to overcome them and chart a course to the development and management of water resources, a host of major works loom large and pose major challenges in the sector. Those challenges are described below.

i. **Policy formulation, law making and institution building:** It is quite unbelievable that Nepal has so far no water resources policy; it has disjointed use-specific sub-sectoral policies though for quite some time. Drafting of a water policy was attempted together with the formulation of National Water Plan and a couple of more times later, but to no avail. A draft of comprehensive water policy was prepared more than a year ago, which is still waiting for revision (?) and approval. The prevailing Water Resources Act, 1992 is very shallow in depth to cater the needs of today's water management, and more importantly, a comprehensive federal water legislation is in urgent need to address additional issues of defining rights and responsibilities of governments at different levels with respect to development and management of water sector. Institutional restructuring of the sector is also necessary not only for the sector's development and management but also for aligning the institutional arrangement with the federal structure. Experts and researchers alike suggest that the three works- policy drafting, legislation drafting and institutional restructuring exercise need to be done together involving redoing back and forth, because all the three need to maintain coherence. Once a comprehensive National Water Resources Policy and a Federal Water Resources Legislation are in place, province level water legislations need to be prepared maintaining consistency with that in the federal level. These works consistent with the Constitution need to be done urgently in order to streamline development and management of country's water resources. Delay in accomplishing these works will cause further chaos and give more rooms for adhockery and whimsical decisions.

ii. **Water planning and its legal backing:** Water planning is necessary for several reasons, which hardly need any elaboration. River basin plans encompassing all the water uses and use-specific master plans are normally fall under such plans. In Nepal, use-specific master plans are in existence for some time. Irrigation master plan has recently been updated and hydropower master plan is currently being updated. River basin plans are also being prepared under the World Bank

assistance. These plans will have no use as the National Water Plan was practically discarded, if they do not have legal backing. There must be provisions in the federal water legislation to make sure that development and management of water resources in the country are done in consistence with the river basin and other water plans. Previously such legal backing of water plans would have been necessary only to carry out systematic and optimal development of resources in basins, but apart from that it is all the more essential now to avoid conflicts between the Centre, States and municipalities as their political boundaries do not match with the hydrological ones.

iii. **Maintaining sufficient and sustainable availability of water**: Precipitation records of recent years suggest that despite having by and large constant annual rainfall there is increase in the frequency of flood extremes in Nepal, which is corroborated with the extremely high rainfall events of 2013 and 2014 in the Far-West and Mid-West respectively. Extreme drought events are also likely, according to the scientists. Storage of water in the form of snow, which makes our major rivers perennial, is also likely to decline. The only viable way to resilience against such climate change is storage of water behind dams until a time when technologies are developed that make recycling and low water requirement in every use. Whether we like or not it is very likely that dams will be necessary to regulate excess flow in order to address problems of floods and droughts or deficits whether they are due to climate change or otherwise. They will be necessary to increase - power generation, round the year irrigation, water supply services and rivers' adequate environmental flow in dry season. As Nepal's rivers have steep slopes and they flow through narrow valleys, there is limitation of storage volume, which is not enough to fully regulate monsoon flow in most of the cases. Reservoir sedimentation is another problem. In a country where there is only one sizable storage dam and no such dam has been constructed in past forty years, consideration of dams itself is a challenge.

iv. **Conservation of water work sites and irrigated areas**: As stated above, There is continuous encroachment upon the irrigated and other agricultural areas and potential dam and reservoir sites. Buildings are cropping up in place of agricultural crops. There was not even a landuse policy for long. From the financial perspective of an individual, converting irrigated field into a real state could be beneficial, however, its long term implication on national economy and food security is could be disastrous. Likewise, because of encroachment on the dam and reservoir sites from road construction, urbanization and other infrastructure development, we are already in a situation that potentials of many identified projects are to be foregone on account of prohibitive resettlement and rehabilitation costs.

v. **Garnering required capital for the development of the water resources sector:** Most of the water works are highly capital intensive. High quality sustainable physical infrastructures require even more capital investment. Garnering capital for public sector spending in water sector itself is a challenge, particularly in a poor country like Nepal. Domestic private sector is mostly limited to hydropower sector only, but not without its side effects. External financing is mostly attached with conditions that compromise country's priority and interests

vi. **Consensus building among various stakeholders, particularly at political level:** It is evidenced by the development of several projects that persistent efforts for several decades are necessary for realization of major water resources projects. Three Gorges project was realized after more than seven decades after it was conceived. It is about half-a-century since Karnali Chisapani Project

was identified, and we are not sure that the project will ever be realized. Planning, investigation and design of a project, mode of financing and decision making around implementation involve very lengthy debates that last several decades. Many times, these debates are emotional and futile having no quantitative and objective assessment. Lack of consensus among stakeholders at decision making level, particularly at political level, has been a constraint in water sector. Such lacking is even more stark when it comes to development of bilateral projects. Nepal-India joint investigation on Saptakoshi High Dam and Sun Koshi-Kamala Diversion Project is supposed to be completed within 30 months since 2004. It is already 15 years since then, and the investigation work is completely stalled midway. The story of Pancheshwar Project is also similar. Although lack of political consensus is not the only hindrance in the project.

vii. **Maintaining sustainable utilization, recharge and quality of groundwater resources:** Nepal has a good potential of groundwater resources in several parts of terai and inner terai regions. Groundwater can be a reliable source of water for irrigation, domestic, industrial and a host of other consumptive uses. However, systematic and sustainable utilization of the resource and maintenance of recharge and quality of aquifers is a challenge. The challenge is on account of absence of requisite law and its enforcement for the regulation of groundwater.

viii. **Other challenges:** Besides the above, there are several other challenges such as - adopting integrated water management approach involving participation and involvement of women and marginalized communities, preventing excessive bed sediment extraction, identifying institutions to work as custodians of water bodies, regulating water sector, etc. Since these challenges can be overcome by meeting the above first two challenges, they are not separately dealt with here.

3. Conclusion

Nepal has abundance of water, and it is country's main natural resource. However, the water sector is not developed as it should have been for want of systematic planning and implementation programs that are linked with requisite consistent policy & legislation and institutional arrangement. Such three elements of the sector are all the more necessary in the present federal State structure in which water is a concurrent subject in the Constitution. Clarity in vision is essential for the water sector's development. Equally important is that consensus building among the stakeholders, particularly those influencing decision making, needs to be done in order for the sector to develop expeditiously with the shared vision. The acts of adoption of a comprehensive national water policy and law making at federal and state level in harmony with the Constitution are already overdue.

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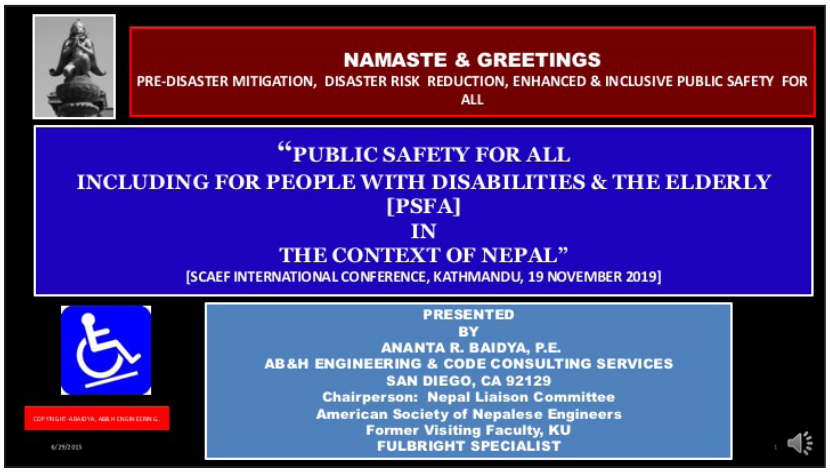
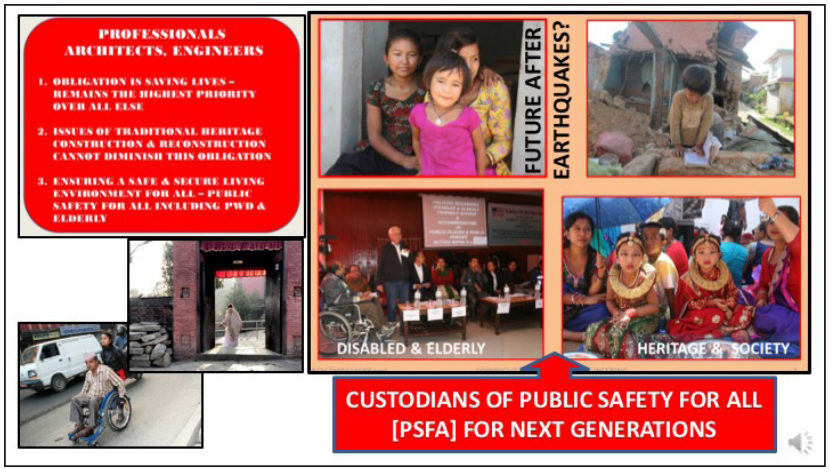
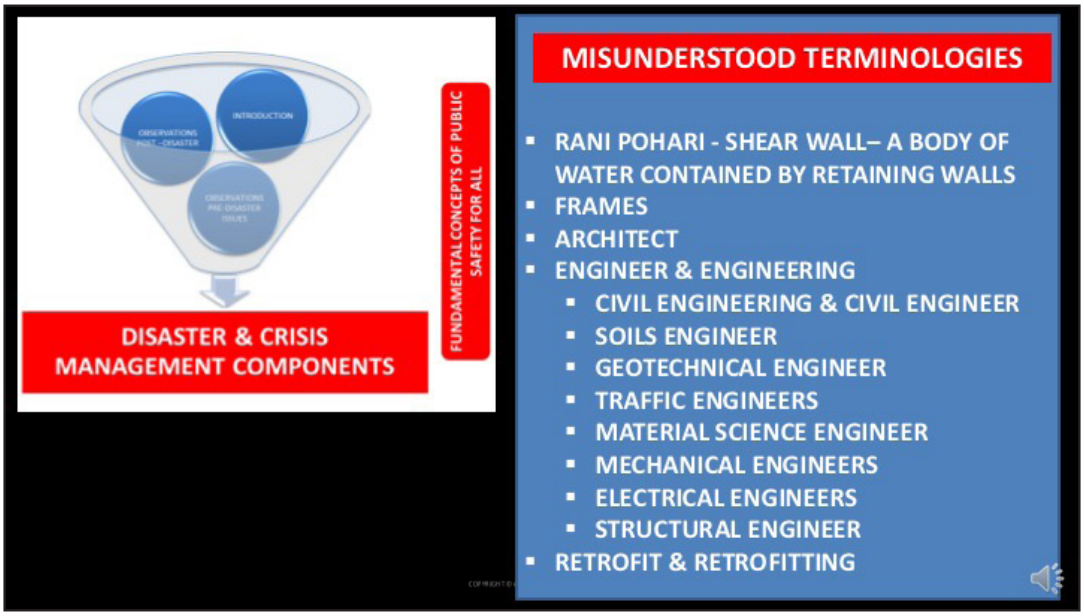


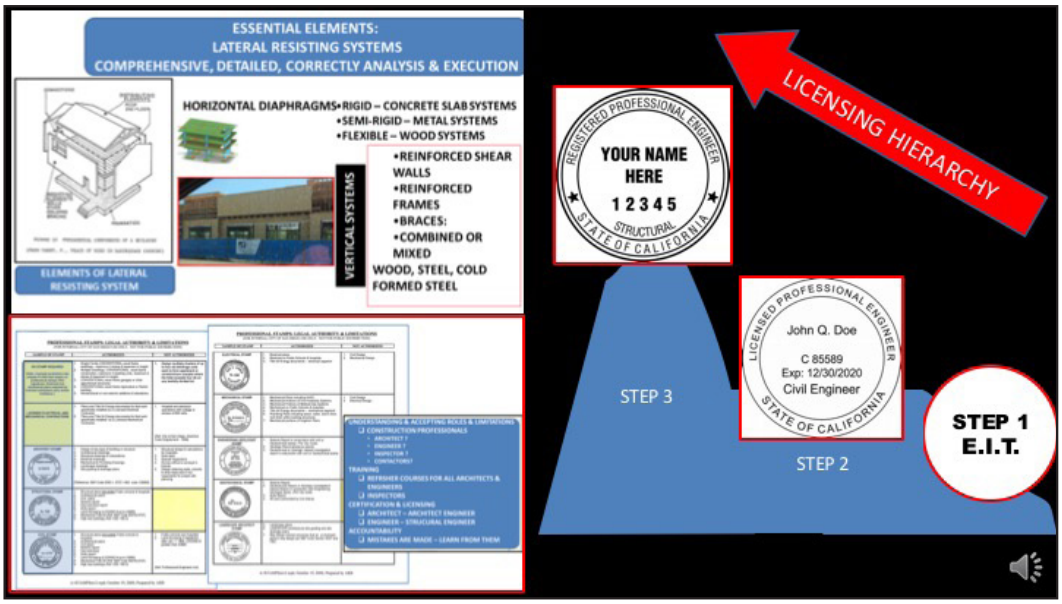


1 AB&H Engineering & Code Consulting Services, San Diego, CA, USA. Baidya.a.opposite@gmail.com

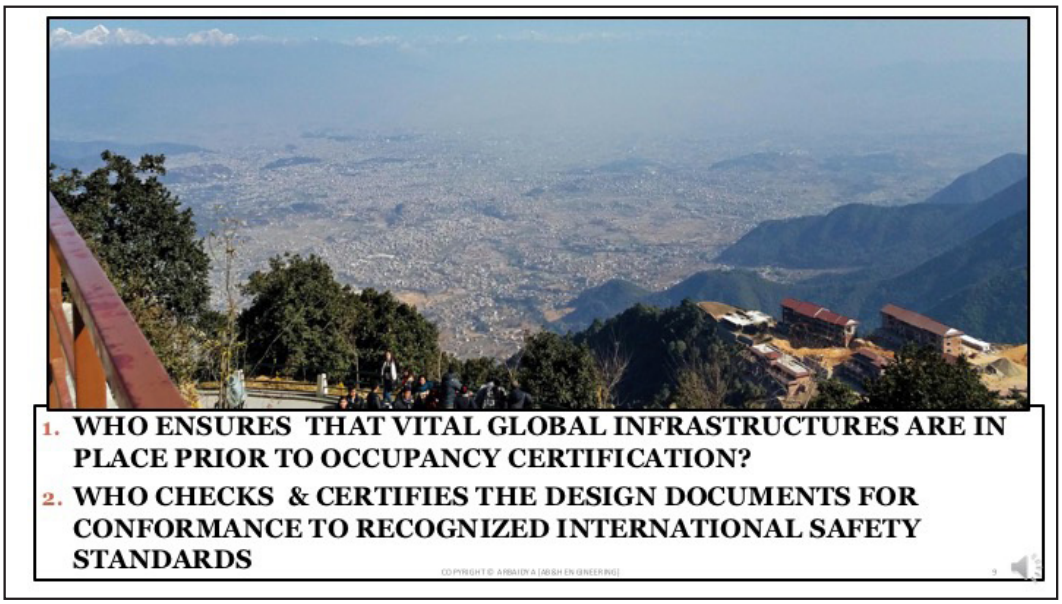

JAN 2018
SPRINKER SYSTEM INLET @ VISHWA JYOTI MALL
DEC. 2018
SPRINKER SYSTEM INLET @ VISHWA JYOTI MALL – INFORMED FIRE DEPT – NO CHANGE
26 OCTOBER 2019
SPRINKER SYSTEM INLET @ VISHWA JYOTI MALL ONE SET OF CONTROL VALVES ATTACHED – OTHER SET STILL MISSING PSFA? RIBT?
WILL SPRINKLER SYSTEM PROVIDE FULL FIRE PROTECTION WITH THIS APPROACH & SETUP? A PUBLIC SAFETY FOR ALL ISSUE?
PALTAN GHAR FIRE, 2013
EFFECT / CAUSE?
HAZARDS – RISKS
The Sun Koshi Experience
HAZARD
RISK
NATURAL EARTHQUAKES
MAN-MADE POOR INFRA-STRUCTURE
RISK TOLERANCE
HOW MANY EXPENDABLE?

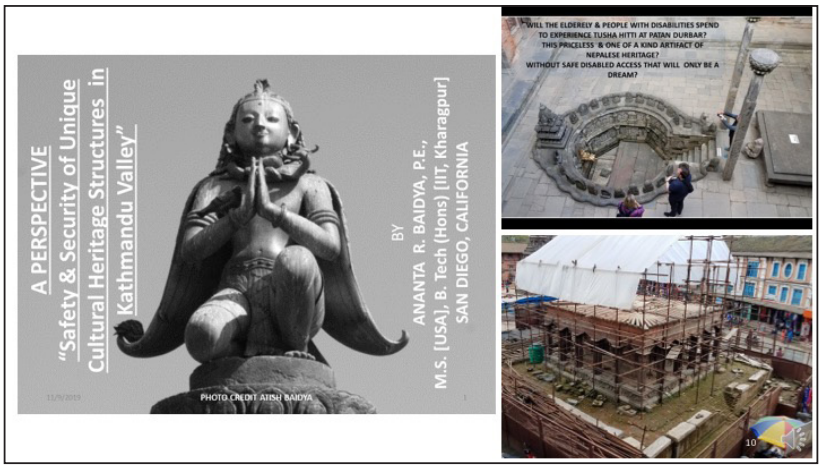

INTRODUCTION
DISASTER & CRISIS MANAGEMENT COMPONENTS
FUNDAMENTAL CONCEPTS OF PUBLIC SAFETY FOR ALL
MISUNDERSTOOD TERMINOLOGIES
RANI POHARI - SHEAR WALL– A BODY OF WATER CONTAINED BY RETAINING WALLS
FRAMES
ARCHITECT
ENGINEER & ENGINEERING
CIVIL ENGINEERING & CIVIL ENGINEER
SOILS ENGINEER
GEOTECHNICAL ENGINEER
TRAFFIC ENGINEERS
MATERIAL SCIENCE ENGINEER
MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS
STRUCTURAL ENGINEER
RETROFIT & RETROFITTING

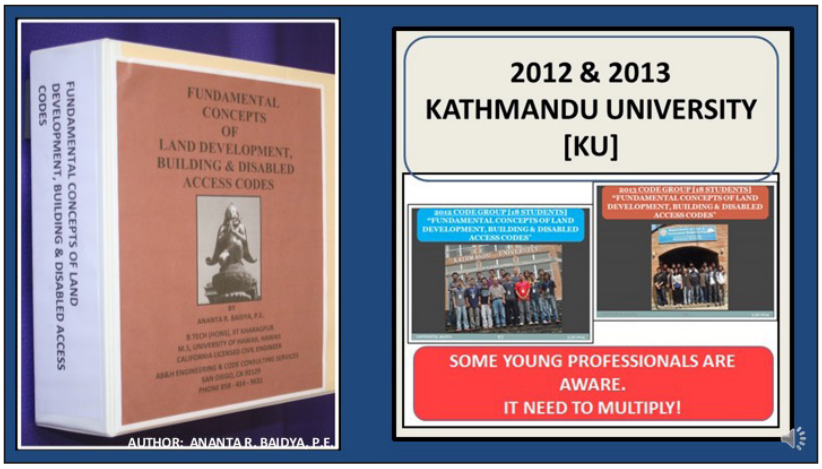

Minimum Design Loads for Buildings and Other Structures
ASCE
CALIFORNIA BUILDING CODE 2013
CALIFORNIA RESIDENTIAL CODE 2013
1997 UNIFORM CODE FOR BUILDING CONSERVATION
NEPAL NATIONAL BUILDING CODE
NBC 000 : 1994
REQUIREMENTS FOR STATE-OF-THE ART DESIGN AN INTRODUCTION
1/28/20
6

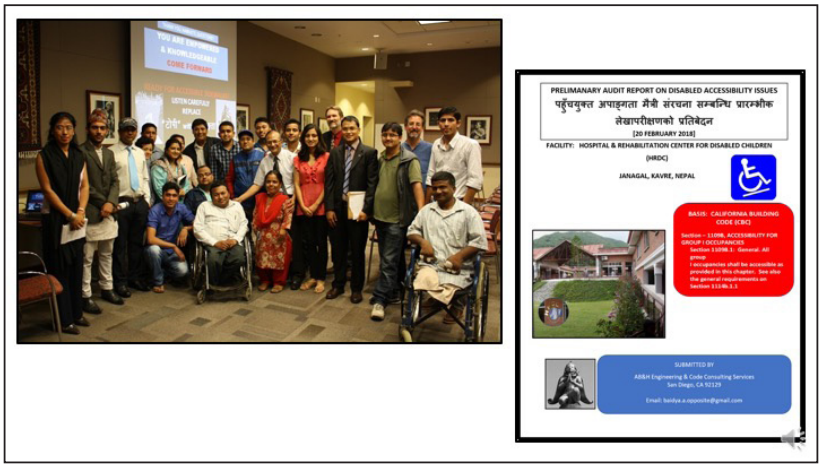

ESSENTIAL ELEMENTS:
LATERAL RESISTING SYSTEMS
COMPREHENSIVE, DETAILED, CORRECTLY ANALYSIS & EXECUTION
HORIZONTAL DIAPHRAGMS•RIGID – CONCRETE SLAB SYSTEMS
•SEMI-RIGID – METAL SYSTEMS
•FLEXIBLE – WOOD SYSTEMS
VERTICAL SYSTEMS
•REINFORCED SHEAR WALLS
•REINFORCED FRAMES
•BRACES:
•COMBINED OR MIXED
WOOD, STEEL, COLD FORMED STEEL
ELEMENTS OF LATERAL RESISTING SYSTEM
LICENSING HIERARCHY
REGISTERED PROFESSIONAL ENGINEER
YOUR NAME HERE
12345
STRUCTURAL
STATE OF CALIFORNIA
LICENSED PROFESSIONAL ENGINEER
John Q. Doe
C 85589
Exp: 12/30/2020
Civil Engineer
STATE OF CALIFORNIA
STEP 3
STEP 2
STEP 1
E.I.T.


NEPAL DELEGATION - CITY OF SAN DIEGO VISIT POST 2015 GORKHA NEPAL EARTHQUAKE
NEPAL DELEGATION
AT BUILDING DEPARTMENT, CITY OF SAN DIEGO
LISTENING TO PRESENTATION
NEPALI PROFESSIONALS EXPERIENCING GROWING PAINS


1. WHO ENSURES THAT VITAL GLOBAL INFRASTRUCTURES ARE IN PLACE PRIOR TO OCCUPANCY CERTIFICATION?
2. WHO CHECKS & CERTIFIES THE DESIGN DOCUMENTS FOR CONFORMANCE TO RECOGNIZED INTERNATIONAL SAFETY STANDARDS


A PERSPECTIVE
"Safety & Security of Unique Cultural Heritage Structures in Kathmandu Valley"
PHOTO CREDIT ATISH BAIDYA
BY
ANANTA R. BAIDYA, P.E.,
M.S. [USA], B. Tech (Hons) [IIT, Kharagpur]
SAN DIEGO, CALIFORNIA
WILL THE ELDERELY & PEOPLE WITH DISABILITIES SPEND TO EXPERIENCE TUSHA HITTI AT PATAN DURBAR? THIS PRICELESS & ONE OF A KIND ARTIFACT OF NEPALESE HERITAGE? WITHOUT SAFE DISABLED ACCESS THAT WILL ONLY BE A DREAM?


FUNDAMENTAL CONCEPTS OF LAND DEVELOPMENT, BUILDING & DISABLED ACCESS CODES
AUTHOR: ANANTA R. BAIDYA, P.E.
2012 & 2013
KATHMANDU UNIVERSITY
[KU]
SOME YOUNG PROFESSIONALS ARE AWARE.
IT NEED TO MULTIPLY!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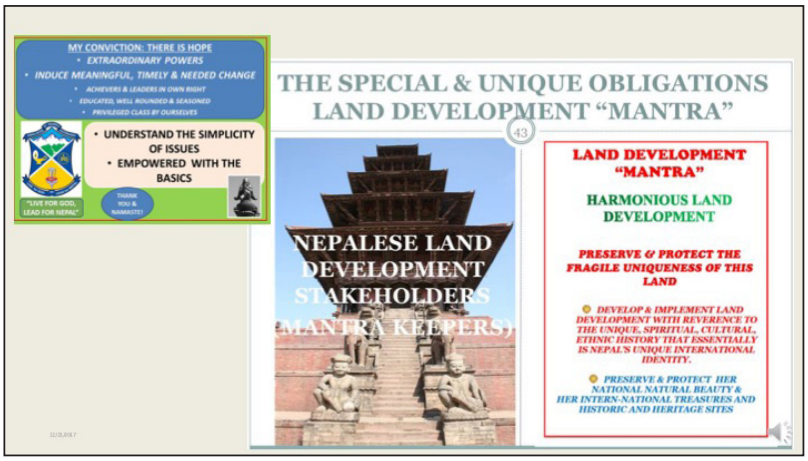
FACILITY: HOSPITAL & REHABILITATION CENTER FOR DISABLED CHILDREN (HRDC)
JANAGAL, KAVRE, NEPAL
BASIS: CALIFORNIA BUILDING CODE (CBC)


Fulbright Specialist Training Program (Project ID: FSP-P001980)
Training on Public Safety for All (PSFA), Earthquake Safety Engineering (ESE) and Heritage Conservation (HR)
Final Report
May 03, 2019
Submitted by the Host Institution:
Lalitpur Centre for Culture Conservation,
Ikhalakhu, Lalitpur Ward Nr. 19, Nepal


MY CONVICTION: THERE IS HOPE
• EXTRAORDINARY POWERS
• INDUCE MEANINGFUL, TIMELY & NEEDED CHANGE
• ACHIEVERS & LEADERS IN OWN RIGHT
• EDUCATED, WELL ROUNDED & SEASONED
• PRIVILEGED CLASS BY OURSELVES
• UNDERSTAND THE SIMPLICITY OF ISSUES
• EMPOWERED WITH THE BASICS
"LIVE FOR GOD, LEAD FOR NEPAL"
THANK YOU & NAMASTE!
THE SPECIAL & UNIQUE OBLIGATIONS
LAND DEVELOPMENT "MANTRA"
43
NEPALESE LAND DEVELOPMENT STAKEHOLDERS (MANTRA KEEPERS)
LAND DEVELOPMENT "MANTRA"
HARMONIOUS LAND DEVELOPMENT
PRESERVE & PROTECT THE FRAGILE UNIQUENESS OF THIS LAND
DEVELOP & IMPLEMENT LAND DEVELOPMENT WITH REVERENCE TO THE UNIQUE, SPIRITUAL, CULTURAL, ETHNIC HISTORY THAT ESSENTIALLY IS NEPAL'S UNIQUE INTERNATIONAL IDENTITY.
PRESERVE & PROTECT HER NATIONAL NATURAL BEAUTY & HER INTERN-NATIONAL TREASURES AND HISTORIC AND HERITAGE SITES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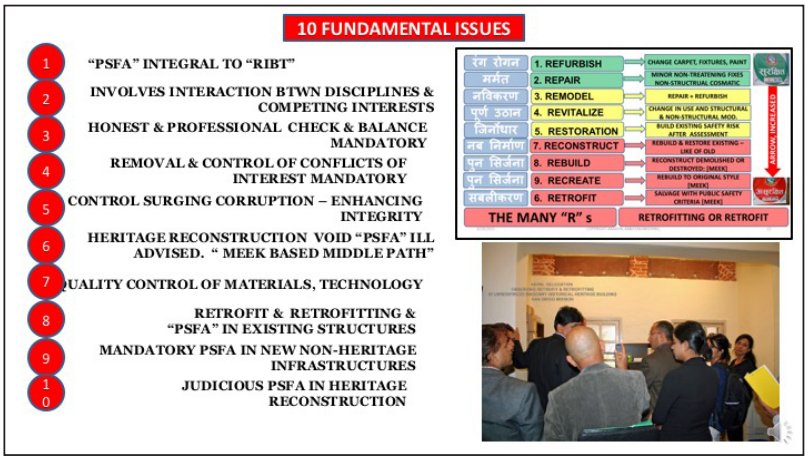
HINDERANCE TO FUTURE FOR ALL FUTURE GENERATIONS, HERITAGE & SOCIETY & TRADITIONS AT STAKE! NOT ANOTHER HAITI!
BRACED & UNSAFE STRUCTURES ON LIFE SUPPORT
TRADITIONAL HERITAGE RECONSTRUCTION NEPAL


LALITPUR CENTRE FOR CULTURE CONSERVATION (LCCC)
ललितपुर संस्कृति सम्वर्द्धन केन्द्र
FULBRIGHT
FULBRIGHT SPECIALIST TRAINING PROGRAM [FSP-P001980]
"Public Safety for All, Earthquake Safety Engineering & Heritage Reconstruction"
[A TRAINING FOR ALL STAKEHOLDERS - INCLUDING ARCHITECTS, ENGINEERS, REGULATORS & OTHERS]
Co-Organizers:
TU, Institute of Engineering, Pulchowk Campus (IOE)
Society of Consulting Architectural and Engineering Firms (SCAEF)
Nepal Engineers' Association (NEA)
Society of Nepalese Architects (SONA)
Contact: email: lalitpurculture@gmail.com, Cell: xxxxxxx
Sponsors: Himalaya Bank Ltd., Sunrise Bank Ltd., Venus Group, American Society of Nepalese Engineers (ASNEngr), USA
NAMASTE & GREETINGS
"FUNDAMENTAL CONCEPTS OF PUBLIC SAFETY FOR ALL [PSFA]"
FULBRIGHT SPECIALIST SERIES
WEEK 1, SERIES 1
FUNDAMENTAL CONCEPTS OF PUBLIC SAFETY FOR ALL
DISCUSSION SESSION
EXERCISE
02 22 2018


10 FUNDAMENTAL ISSUES
1 "PSFA" INTEGRAL TO "RIBT"
2 INVOLVES INTERACTION BTWN DISCIPLINES & COMPETING INTERESTS
3 HONEST & PROFESSIONAL CHECK & BALANCE MANDATORY
4 REMOVAL & CONTROL OF CONFLICTS OF INTEREST MANDATORY
5 CONTROL SURGING CORRUPTION – ENHANCING INTEGRITY
6 HERITAGE RECONSTRUCTION VOID "PSFA" ILL ADVISED. " MEEK BASED MIDDLE PATH"
7 QUALITY CONTROL OF MATERIALS, TECHNOLOGY
8 RETROFIT & RETROFITTING & "PSFA" IN EXISTING STRUCTURES
9 MANDATORY PSFA IN NEW NON-HERITAGE INFRASTRUCTURES
10 JUDICIOUS PSFA IN HERITAGE RECONSTRUCTION
रंग रोगन 1. REFURBISH
मर्मत 2. REPAIR
नविकरण 3. REMODEL
पूर्ण उठान 4. REVITALIZE
जिर्णोधार 5. RESTORATION
नब निर्माण 7. RECONSTRUCT
पुन सिर्जना 8. REBUILD
पुन सिर्जना 9. RECREATE
सबलीकरण 6. RETROFIT
THE MANY "R" s
CHANGE CARPET, FIXTURES, PAINT
MINOR NON-TREATENING FIXES
NON-STRUCTRUAL COSMATIC
REPAIR + REFURBISH
CHANGE IN USE AND STRUCTURAL & NON-STRUCTURAL MOD.
BUILD EXISTING SAFETY RISK AFTER ASSESSMENT
REBUILD & RESTORE EXISTING – LIKE OF OLD
RECONSTRUCT DEMOLISHED OR DESTROYED: [MEEK]
REBUILD TO ORIGINAL STYLE [MEEK]
SALVAGE WITH PUBLIC SAFETY CRITERIA [MEEK]
RETROFITTING OR RETROFIT
ARROW INDICATES

Innovating Fair Play in Resilient Infrastructure Development

Er. Badan Lal Nyachhyon[1]

Abstract

The recent news told us a big surprising story. Over 1,400 projects of Nepal are under termination and at least 2,200 are facing slow progress with budget expenditure of 16%. The mishap has attribute to huge corruption and collusion among officials and contractors based on the preference to selected ones and excluding the non-preferred ones. The efforts to elimination of the collusion syndrome will be the first step towards implementation of Fair Play games, PM KP Oli must be already planning.

Reversing these poor policies may require radical change in the performance of service providers by discarding the Lowest (Non-)evaluated (Non-)responsive Bids and QCBS (Quietly Collusion Based Selection) procedures, and demand for market based New Engineering Contracts. If the government allows Service Providers to deliver excellent services, it will not take much time to achieve the double-digit growth and the middle level economy. The need is to demonstrate "Fair Play" authenticated by "Third Umpire" and application of "Check and Balance" principles.

Key words: *Collusion, Resilience, Heritage, Environment, Institutionalisation*

1. Introduction

Infrastructure Development, being a part of Economic Opportunity, is subject to the Demand and Supply chain and innovates to deliver excellence in service products empowering the enterprises through demonstration of Fair Play.

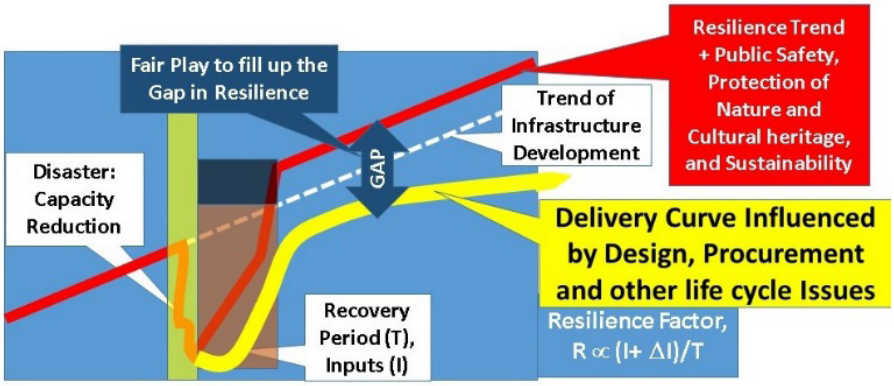


Figure 1: Resilience representation

1 Past President, Society of Consulting Architectural and Engineering Firms (SCAEF), Managing Director, Multi-Disciplinary Consultants (P) Ltd

The Infrastructure Development sectors in Nepal are moving in an unprecedented manner leaving behind many established and new firms from the fair competition resulting in vast inequality, fraud, corruption, preferences and most importantly facing low progress. The demand for "Resilience" has put the infrastructure development equation even in severe stringent condition. If fair play is not to apply it is for sure the economy will be yelling with very poor achievements.

The recent news told us a big surprising story. Over 1,400 projects of Nepal are under termination and at least 2,200 projects are facing slow progress and low quality of delivery with budget expenditure of 16% . The mishap has an attribute of huge corruption and collusion among officials, contractors and political leaders. The development efforts have bad effect on infrastructure development, and environment and heritage, the niche market of Nepal.

Apparently, the contemporary society has little clue how the situation of poor performance of service providers could be changed to assure the "Resilient Infrastructure for A Better Tomorrow". The scenario is quite dark without a visible light at the end of the tunnel. May be it is time for giving a trial for new ventures as Albert Einstein said; "We cannot solve the problems with the same thinking we used when created them".

Resilience of Infrastructure is understood as the ability of infrastructure systems "to function and meet users' needs during and after a natural hazard[2]. In Nepalese context, the resilience may have stringent conditions with the need to address the low quality, slow progress and stakeholders' collusion risks and their effect in due course of time (Figure 1).

In reality, there is a huge gap between what actually delivered and what is required for assuring the resilience. Adopting a Fair Play approach in delivery of Infrastructure Development may be the must to minimize the gap.

The problems created with LERB[3] and QCBS[4] contracts lead to the failure of Construction Industry in Nepal with slow progress, low quality of service delivery and works completion, collusion, cost and time overrun. This situation forced the government to change[5] the procurement regulations with great frequency without any visible change in the overall scenario. The provisions in the regulations are inherent with hidden Fraud and Corruption conditions in the name of open and free competition but accompanied with a vision to blacklisting the whole industry and ultimately paralysing the whole economy.

As the results indicate, LERB and QCBS contracts in Nepal are neither properly evaluated nor they are responsive. This is the reason why thousands of projects are in the verge of termination and the structure and institutional memory of the service industry were virtually destroyed. Winning a project needs full scale advanced Setting or Project fixing. This fact is proven with the evidence that several preferential and specific exclusion conditions are overloaded in each project instead of following generally acceptable criteria. The best and experienced experts are systematically driven away from the country.

The Service Providers' request to disclose the evaluation reports was discarded in the name of confidentiality meaning denial for transparency, and protecting Fraud and Corruption.

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2 The World Bank, Investing in resilient infrastructure in low- and middle-income countries (LMICs), 2019

3 Lowest Evaluated Responsive Bid (LERB) method of selection of Construction Contractors

4 Quality and Cost Based Selection (QCBS) method of selection of Consultants

5 Four times changes of Procurement Rules in 3 months period

Figure 2: PM Oli addressing National Development Action Committee

2. Eliminating Fraud and Corruption

Back in 1980s, the German Government sent a team to Nepal for investigating the possibility of Fraud and Corruption in a case where three projects were continuously awarded to a firm. However, in last ten years, review of contract a wards or performance of service providers or government agencies and learning lessons seldom occurred, which authenticate the fraud and corruption cases were practically mandated and the project setting has become frequent phenomena with most of the projects awarded based on specific preferential criteria. The LERB and QCBS are the basic source of project setting, a result of collusion between the contractors, the government officials and political leaders as PM KP Oli has referred this matter in his address to the 46th meeting of the National Development Action Commission of NPC[6], Sep 21, 2019 (Figure 2). The most beautiful fact is that PM KP Oli also made commitment to eliminate[7] all forms of Fraud and Corruption practices during his tenure. The people are disparately waiting for visibility of the change making indicators.

3. Project Setting or Fixing

The beginning of the Project fixing era escalated with introduction of QCBS 90:10 method of selection of consultants (Figure 3). The project is awarded to the preferred with deliberately given 12 or more higher marks is given so that other firms become out of competition. The thresh hold is used to play for exclusion or inclusion of a firm to derive benefit to the preferred one. This proof is in our front - just look at the list of Project winners.

Review QCBS: $S = St \times T\% + Sf \times P\%$

QCBS 90:10 is Project Setting or Fixing:
All winning contracts score high at least by 10

Example A 1: 10% reduced price

Case	St	ΔT	FP	Sf	S	Rank
1	750		95	95	684.47	III
2	899		90	100	819.10	I
3	900	0.9	100	90	819.00	II
Min			90			

Example A2: Keep Technical Score high by 12/1000

Case	St		FP	Sf	S	Rank
1	750		95	95	684.47	III
2	899		90	100	829.10	II
3	912	12	100	90	829.80	I
Min			90			

Proj. 1	TC	Remarks
Firm 1	860 (+10)	
Firm 2	867 (+17)	
Firm 3	850 (+-0)	
Firm 4	748	Excluded from Bid
Firm 5	894 (+24)	Preferred Bid

Proj. 2	Technical Score	Remarks
Firm 1	816.62 (+16)	Preferred bid
Firm 2	750.61	Keeping on bid

Figure 3: QCBS examples from two recent projects

An example from two international projects are demonstrated in Figure 1. In Case A1, when top scores are very close, the financial positon determines. In order to avoid this risk, the preferred one is given 12 marks more than the nearest competitor is so that the financial quote will have no influence on the final

6 National Planning commission

7 PM KP Oli during a foundation stone laying ceremony of NAMS, Bir Hospital, in Kathmandu, on Friday, March 9, 2018

position. In QCBS 90:10, the client can very easily play with the evaluation and select the preferred one following project setting theory.

Project setting or fixing is known as a process where the client and service providers agree beforehand how the contract could be awarded to the preferred and selected service providers by including exclusion and preferential criteria suitable to a preferred service provider or determined by a bargain before the projects are floated. This aspect has had claimed several lives. Similarly, several international companies do not prefer to be involved in Nepalese projects. This has damaged the national and sectoral image. This should be a matter of concern to the government and professional societies. It should be noted that no value added factors are deliverable with the Swine flu (H1N1[8]) model of QCBS (L1T1) but serves as a tool for exploiting the Engineering profession.

4. The Ghosts and The Collusion[9] of Client, Contractors and Donors

In many construction contracts in Nepal, the International Contractor acts as a ghost and does not take any responsibility. It never appears in the site and all responsibilities are transferred to the domestic partners. The contracts awarded with consideration of the international experience in contract management, provision for technology transfer and commitment to complete the works suffer with low quality, the time and cost overrun. Such contracts receive the "No objection" certificate from respective authorities. This is, in general, a breach of Contract and illegal. However, the Clients and the donors silently accept these cases and make no claims against the breach of contract. All the three parties blame the supervising consultant for the poor performance of the project. This is a live case of collusion between clients, donors and contractors and incur huge losses to the country.

5. Clients in Panic

One of the departments of GON recently issued a RFP, which included a very strange unnatural clause. It says, "Make necessary adjustments to ensure fitness of purpose without increase in time and cost of construction"[10]. This kind of statement never encountered before. To a query on this issue, the department very precisely wrote, "The experts responsibility is to ensure the project completion without increase in time and cost of construction". It sounded a dream and most preferable object. This is a project awaited from last 10 years and still not on board. Naturally, the service delivery in such a case does not practically warrant the health care and safety, and compliance to the environment protection. In such a case, the client acts in a panicky manner (Figure 4), puts all odd clauses over the consultants and the contractors without any possibility to expect Fair Play in the business. Naturally, cost and time abide no man. Over runs are natural.

Figure 4: The Panicky Key Words

8 L1T1 stands for Lowest First Technically First.

9 PM KP Oli in 46th meeting of the National Development Action Commission of NPC, Sep 21, 2019.

10 RFP No.: (DUDBC/CS/QCBS/07/075/76).

6. The Exclusion Theory and Preferences

The author has realized there are two categories of exclusion theory in procurement:

i. **Exclusion for Poor performance, Fraud and Corruption**

PPGFP[11], 2018 has made some new provisions for exclusion that allow contracting authorities to reject the service providers who have shown:

1) **poor performance or significant shortcomings** in previous public contracts,
2) **distortion in competition by practicing collusive tendering** with other service providers;
3) **misrepresentation of data and information**, and
4) **avoiding firms with huge workloads** or giving opportunity to firms with low workload.

The poor performance, collusion, fraud and corruption are not the criteria in PPA/PPR, WB, ADB Contracts. None of the contracts in Nepal in recent years was rejected on these grounds. On the contrary, they claim that the firm that cannot fix a project in advance will not get jobs so easily. There seems to be some truth since the jobs allocated are concentrated within very few companies. They advocate free competition based on the Darwin's theory of "Survival of the Fittest" and practicing "Do in Rome what Romans Do". The Don Quixote philosophy of "One for all. All for one" and peaceful co-existence is not in menu.

ii. **Exclusion of better competitors and supporting the preferred ones**

Few criteria used in this category of Exclusion Theory are referred herewith as examples:

- **Time restriction:**

Bids with restricted time of experience counting for firms and experts (7 years, 5 years, 4 years[12] without any rationale. It is difficult for majority of the service providers to meet the mandatory criteria since very few such works had been performed in last 7 years, and best works done were no more considered valid. The knowledge, skill and experience are not time bound and there should be no time restrictions. The technology and knowledge are not the product of 7 years but of many decades of experience.

- **Bidding over long holidays (Dashain, Tihar, Christmas[13] and New year)**

In several occasions, the bidding is carried over the long public holidays providing benefit to selected bidders who are informed in advance. This factor reduces the interest of the bidders and deprive them to devote adequate time for preparation of the bids since the staff are in holidays.

- **Short bidding period**

Number of times, the clients are encouraged to shorten the bidding period to a short period compared to the standard practice. This aspect reduces the competitiveness of the bid and demotivates the bidders to participate and providing advantage to the selected ones.

11 PUBLIC PROCUREMENT GUIDANCE FOR PRACTITIONERS , European Commission, Feb 2018

12 Fast Track Tunnel Road and Babai Irrigation Project for individual expert.

13 Urban Water Supply, 1991

- **Unfair Competitive Advantage:**

Several projects including unfair competitive advantages in favour of the preferred competitor and circulate their reports as mitigation measures to the unfair competitive advantage provided. This is a part of collusion game exercised. **Experience in upstream Projects:**

- **Restricting wide competition:**

This is one of the very popular aspect where wide competition is restricted by providing freedom allow the associates to take part in competition and associate with any number of competitors. This has restricted the wide competition providing equal opportunity to qualified firms and coverage to competition across the region and globe. The principles of "One Consultant one Proposal and One Consultant from one region" is neglected.[14]

- **Abnormal Project features**

In several cases, there are very unusual statements as "Any other staff deemed necessary to fulfil the consultant's obligations shall be provided by the Consultant at its own cost". This is a non-competitive clause and remain redundant. Such kind of clause is provided as a means of exploiting the consultants and fundamentally unfair.

- **Abnormal Qualification needs:**

There is a tendency for giving preference to Master's Degree and PhD without any rationale against making provision of Bachelor degree with adequate practical project experience. This aspect has deprived the fundamental right of Bachelor degree holders to provide services

- **Need for manipulating facts and figures:**

The need for manipulating the Project Data Sheets, experience, Curriculum Vitae15 of experts in order to match with the mandatory criteria and getting higher score for eliminating the best competitors. This factor has been matter of concern that has distorted the fair competition. The clients and donors frequently take action but admit that they have no capacity to check the authenticity.

7. Lack of Appropriate and Experienced Experts

Nepal has made all efforts to drive away the best practicing engineers and experts during last 10 years. The need for manipulating CV to get highest score, working for low fees, lack of dignity and respect, and continuity of job are the sufficient features for brain drain. Additionally, the lack of ability of the firms to retain best human resources because of "Swine Flu" contracts is the other important feature to drive away the productive and innovative personnel. Experts trained in Nepal are happily absorbed all over the world with better prestige, respect, dignity, working environment, job continuity and more importantly the higher remuneration that Nepal cannot offer.

Most of the experts are related to the free market. For this reason, the firms are not eager to invest in human resource development and training. Particular and selected project based training may be more wise carry out to enhance the capacity of selected consultants and the performance in the project.

14 Fast Track Tunnel Road

15 The example of manipulation of qualification of an international expert from BE to ME in an irrigation project was a classic example.

8. Hurdles of Development

The resilience of Infrastructure is number of times are affected by the hurdles encountered in the course of development practices. They are related with taxation (Double taxes, mis-posted and mismanaged items, over taxations, procedural complications), corporate taxation, profit repatriation, import duties, export facilitation, tax holidays, investment, capital gain, Visa, Foreign Currency conversion, Free Market Economy[16] Access to Resources, Right Person at Right Place, labor, and Policy, Development Focus and National Priorities.

9. Wrong Demand and Wrong Supply

At the beginning of the 21st century, it seems that fundamental principle of the general economy "Demand and Supply" was forgotten. Many projects demand something and expect something different It seems that the whole society has taken a different mode and demand profits at all cost irrespective of the productivity and investment. No actions practically move forward unless the personal interest of the decision makers are fulfilled. When the demand is for the compliance with personal interests, how the supply could be of best project outputs. Simply, very absurd situation. Er. Jean Tirole[17] concludes the Regulator, the Government in our case, and the Private Sector are in collusion or carteling and all prices and fees charged are at monopolistic manner as a product of unregulated Free Economy, a very bad thing for the society.

10. Fair Play Concept[18] in Infrastructure Development

Fair Play Concept in infrastructure development in Nepal may deal with the methods by creating decent new work culture and resilient development.

Coined by Shakespeare, "Fair Play" phrase was used in several of his plays and mean to providing properly conducted conditions for a game, giving all participants an equal chance preventing dishonest or treacherous behavior or violent conduct.

Fair play[19] in sports is a complex concept that comprises and embodies a number of fundamental values that are not only integral and relevant in everyday life. Fair competition, respect, friendship, team spirit, equality, sport without doping, respect for written and unwritten rules such as integrity, solidarity, tolerance, care, excellence and joy, are the building blocks of fair play that can be experienced and learnt both on and off the field. The whistle blowing for foul play in Football was introduced in 1881 whereas the Yellow and Red Card system was introduced in 1970 Mexico FIFA World Cup. It took over half a century for the Football to display "Fair Play" and introducing fair referee system through interference of the third referee.

Fair Play in Infrastructure Development demands several unique features to be adopted:

16 Er. Jean Tirole, the Nobel Prize 2014 laureate

17 The Nobel Prize 2014 laureate

18 Modification to the Fair Trade Concept developed by World Fair Trade Organization, a worldwide network of Fair Trade organisations.

19 http://www.fairplayinternational.org/what-is-fair-play-

i) Eliminating mistakes at every step by following Natural Law of Perfection:

Natural Law of Perfection

- No one is not Perfect;
- Making Mistake is natural and characteristic;
- Check and Balance is the Mantra for eliminating mistakes;
- Acknowledging Mistake is Sincerity and Honesty;
- Making correction is the Progress.

In Nepal, honest one is penalised and not allowed to make corrections whereas defaulters are unpunished. Naturally, we will not progress so easily unless we accept the "Natural Law of Perfection".

ii) Protecting Firms as National Assets

The Procurement Act of Nepal is founded on the concept of Black listing of Entities for whatever reasons irrespective of merits or demerits. The author considers this action is a case of violation of Natural Law. Entities are National assets created over several years of operation, accumulate a lot of knowledge and experience, dedicated several years for national development and provided employment. For these reasons, the entities should be immune from blacklisting since their employees are innocent. Natural Law of Justice says, "Let thousand criminals escape but the innocent one should not be penalized".

iii) Implementing Check and Balance

Implementing Check and Balance is a part of Fair Play that ensures:

a. Strengthening Judicious Decision Making, Rationale and Justification,
b. Eliminating mistakes and risks at every step,
c. Reducing Avoidable Cost, Taxes and Expenditures,
d. Strengthening Institutional Structure and Memory,
e. Strong monitoring through Review, verification, Authentication and Certification,
f. Public consultation and consensus building,
g. Strengthening Responsiveness and Liability,
h. Free Competition, Balanced Productivity, Fair Distribution of Benefits and Jobs for all[20],
i. Strengthening companies and protecting them as national assets, and
j. Supporting High Economic Growth and quality of Demand and Supply.

iv) Carry out Urgent Policy Reform

The Infrastructure Development in Nepal is sick with Collusion, rampant Fraud and Corruption due to low bids, lack of capacity to deliver Good Practice, lack of Check and Balance and independent third party audit and the need to support the political system, which has legal access to resources for its existence. This fact demands for a radical policy change from Low Bid to Market and Performance based Contracts, and deriving valid method of providing national support of political coexistence.

11. New Approach for A New Vision: Merits, Performance and Honesty

The Policy Reform demands a new vision and new approach based on Merits, Performance and Honesty (See Box 1) with Check and Balance at every step.

20 Dr. Chandramani Adhikari's Facebook wall.

EU has made a provision of checking the public procurement procedures by authorities.[21] Unfortunately, PPA/PPR has no such provisions that promote Fair Play assuring independent checking of reports and documents, TOR and evaluation reports for compliance with the good practice rules, delivering transparency, eliminating mistakes and errors, and avoiding conflict of interest, and fraud and corruption.

Box 1: Merits, Performance and Honesty (Abstract from Wikizero)

Meritocracy is a political system in which economic goods and/or political power are vested in individual people on the basis of talent, effort, and achievement, rather than wealth or social class. Advancement in such a system is based on **performance**, intelligence, credentials, and education as measured through examination or demonstrated achievement rather than ties to politicians or political affiliation (The Pendleton Civil Service Reform Act, USA, 1883; Confucius, the sixth century BC). Back in 200 B.C., the Han Dynasty adopted Confucianism as the basis of its political philosophy and structure, which included the revolutionary idea of replacing nobility of blood with one of virtue and **honesty**, and thereby calling for administrative appointments to be based solely on merit in order to prevent corruption and favoritism.

"Honesty is not just about telling the truth. It is about being real with yourself and others about who you are, what you want and what you need to live your most authentic life. Honesty promotes openness, empowers us and enables us to develop consistency in how we present the facts. Honesty sharpens our perception and allows us to observe everything around us with clarity" - Christopher D. Connors.

We plan bigger things for tomorrow in spite of zero knowledge of the future. In coming days, we may need to demonstrate New Vision for achieving:

1) Fair Play in delivery of all kinds of services,
2) Adopting Merit, Performance and Honesty delivery approach,
3) Zero Tolerance to Corruption,
4) Implementation of Check and Balance to avoid all kinds of procedural mistakes and
5) Establish a work culture instead of black listing, the leftover of the feudal system of capital punishment,
6) Resilience of Infrastructure Development, and
7) Prevent hijacking of resilience of cultural heritage infrastructure, the pride and image of Nepal.

12. Flying over clouds

Lastly but not the least, we, the service providers, consider ourselves very fortunate to have sweet dreams of flying over the clouds particularly over Pashupatinath and Guheswori. Possibly assuming that "the Truth, Fairness, Goodwill, Better Friendships and Benefits To All[22]" are what we had been advocating would gradually pass through the masses. It would be a profound confidence provided we identify a prince among ourselves, lend our strong hands for bringing rational reforms and changes and demonstrate the fair play as referred to a Nepali song (Box 2) and a hymn from Prayers to goddess "Guheswori" (Box 3).

Box 2: A Nepali song

"यो कथाको राजकुमार मै हुँ तिम्रो लागि, तिम्रो साथ पाएँ भने पुग्छु बादल माथि"

"I am the prince of this story. If you abide by me, we would be flying over the sky."

The ideology of the song may change the governance for Resilient Infrastructure development that requires strengthening the institutions, institutional memory and profession for a better tomorrow.

21 "authorities may also find the guidance useful when acting as public buyers or when conducting checks on public procurements" : PUBLIC PROCUREMENT GUIDANCE FOR PRACTITIONERS , European Commission, Feb 2018

22 Rotary International's 4 Way Test principles

It is understood the decision makers should listen and make all needful efforts to strengthen the industry for delivery of excellence and eliminate the environment that creates a need for collusion for a job acquisition. The provisions of fraud and corruption inherent in the policies, documents and practices need to be eliminated urgently, if the collusion among the client, contractor and politicians to be erased.

The decision makers just cannot escape by saying that it is your responsibility and we don't care a case of 19/20.

Box 3: A Devotional Hymn in Nepal bhasha to Mother Guheswori

"काली न। कृपा तय मालिई मतल धासा सेबक हाले मालिई ।"

Oh Mother God Kali! You need to bless us, yours faithful servants, with Mercy and Compassion otherwise nothing would be left than for agitating and making noise".

It is time for the service providers, the bhaktas, to declare "Zero Tolerance" and discard all Low Bid "LERB" and Swine Flu "L1T1" contracts and declare a strong campaign for practicing MPH principles followed by market based "New Engineering Contracts", where competition is limited to the management items within the command of the bidders.

It seems that it is the right time for implementation of the Fair Play. With so much of chaos, Nepal's current growth rate, tagged at 7.1%, together with Fair Play policy would be a strong instrument to achieve double digit growth and moving closure to delivery of Resilient Infrastructure for A Better Tomorrow, a strong indicator of Prosperous Nepal Happy Nepalese.

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Advanced Geotechnical Considerations in Deep Foundation scheme for Resilient Infrastructure Development

Dr. Upendra L. Karna, P.E[1]

Abstract

A deep foundation is a system that transfers the loads of any infrastructures to the earth down to a greater depth from the surface layer. Loads are either resisted by the mechanism of the mobilization of skin friction or by the end bearing or the combination of both. The mode of resisting force mobilization depends upon the type of subsurface conditions.

Primarily deep foundations are: piles, drilled shafts and caissons. Piles are most common used around the world for the foundation of any infrastructures. In the USA, American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), National Highway Institute (NHI) and Universities are working with Federal Highway Administration (FHWA) to develop the design and construction standards for a highly effective foundation system for transportation projects. These standards and guidelines have provided a defined framework that is required to be followed judiciously by a designer and has also assured owner of a quality product. American Society of Civil Engineers and Deep Foundation Institute have guided effectively to the infrastructure owners. The focuses have been to develop the design standards that would provide optimum confidence to all for the serviceability and reliability of the foundation systems. By using advanced geotechnical considerations in the foundation design, a structure could not be economical but also be resilient and sustainable in the long-term.

This presentation will discuss the current deep foundation practices (design and load testing) being employed for the bridge and approach in the United States. This will be demonstrated by few relevant projects where the uses of advanced technology in design and load testing have not only saved substantial foundation cost but also time of construction. This presentation will briefly present the type and constraints of subsurface soil conditions, environmental and public safety issues that were key parameters considered for these effective deep foundation design and construction. The findings of the real field data along with visual construction demonstration of these projects will be presented to elaborate the importance of advanced technology for a deep foundation design and construction. The presenter has been directly involved with these projects as design engineer and consultant for 30 years in the USA.

The presenter will explore the practices of deep foundation used in Nepal and will also discuss the type of deep foundation considered suitable for the subsurface conditions. The suitability and benefit of an effective deep foundation scheme utilizing advanced technology in the context of Nepal (including Kathmandu Valley) will be explored and discussed. The importance of standards and their effective enforcing mechanism to the design and construction practice will be explored. Coherent engineering understanding and deep foundation parameters that must be considered for the design of a resilient and sustainable infrastructure development will be explored and discussed. It will also be discussed how a deep foundation scheme would not only be an economical solution in general but also safer against liquefaction in the event of an earthquake.

Keywords: *Collusion, Resilience, Heritage, Environmental, Institution*

Please refer Presentation slides in Appendix for detail contents by the presenter.

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Technical Session

3

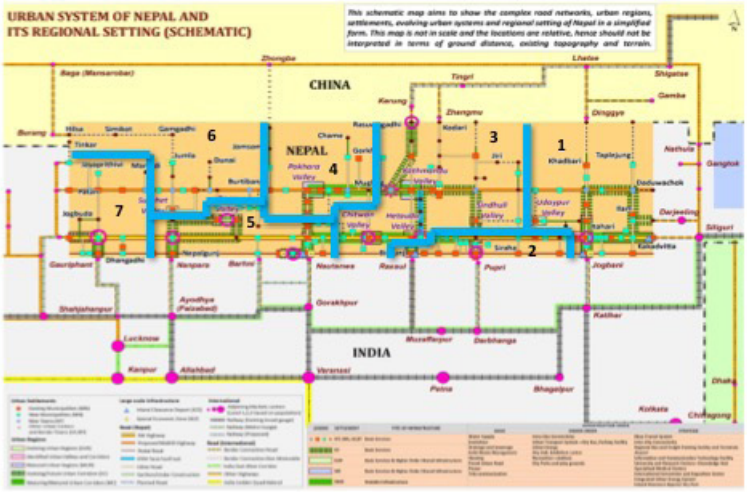
Business Networking / Regional Best Practices in Resilience

Keynote Presenter: Dr. Mahendra Subba

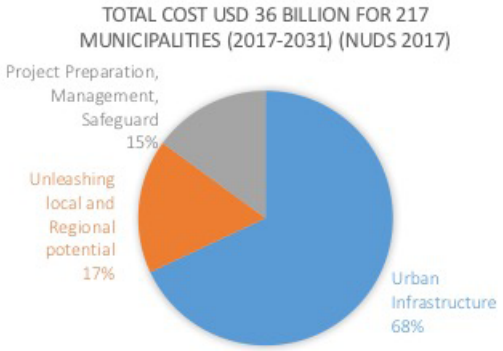
Former Director General, Department of Urban Development and Building Construction

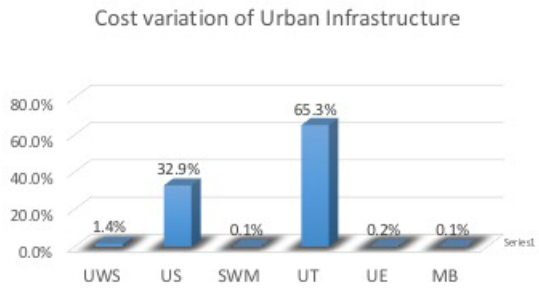
Nepal's urban system is emerging. Strengthened and balanced urban system is expected to lead to regional and national prosperity. Evolving NS growth corridor shall become pivotal to transform Nepal's land-locked regional context to become an opportunity.

- Network of NS and EW highways connecting hierarchies of growth centers form urban system of Nepal.
- Strengthened relations of these though exchanges of trade, services, people, investment, and technology is expected to enhance regional and national economy.
- North-South growth axes have potential to link industrial and commercial centers of India and China—enhancing Nepal's own export potential, while becoming future trade and transit corridors between these two nations



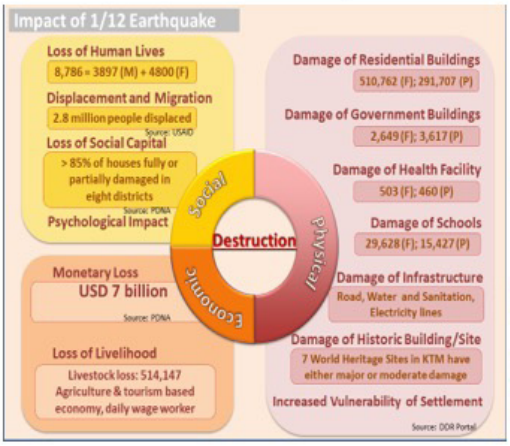
This demands concerted and sustained investment on infrastructure—specially to upgrade regional connectivity and improve livability. Nepal's urban infrastructure need alone is staggering.

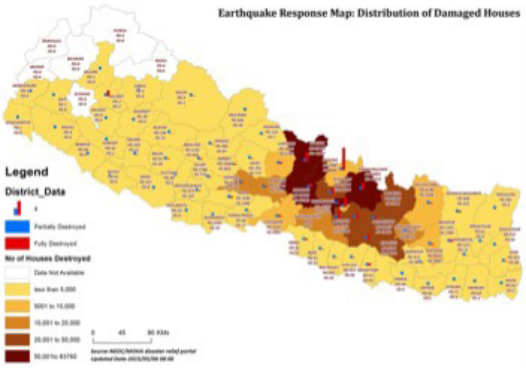




Its efforts are being constrained by its vulnerabilities against internal or external shocks and disasters. These could emanate from natural or man-made phenomenon—having high physical, environmental, social-psychological, economic cost.

Gorkha Earthquake, April 2015





Flooding in the Biratnagar Industrial Corridor, Eastern Region (Aug 2017)

According to the National Planning Commission (NPC) Assessment during August 2017, total damage caused by 2017 floods was USD 584.7 million. Over 1.7 millions people in 35 districts were affected. NPC has estimated recovery needs to be over USD 700 million. (Source: https://reliefweb.int)

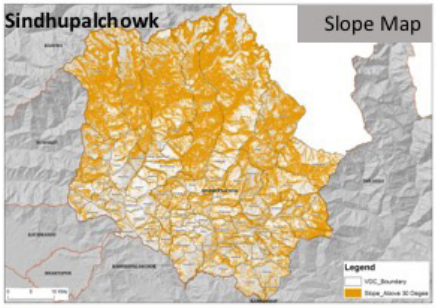
Biratnagar Airport

Nobel Hospital, Biratnagar

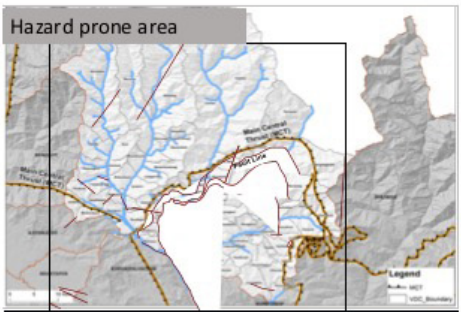
Vulnerabilities are resulting from the way that Nepal is urbanizing that may be characterized by weak implementation in spatial planning, growth management, and governance—increasing exposure to hazards.

Source: Reuters

Hazard assessment and mapping as an integral part of spatial planning enables to know habitable area and guides where to grow and where not to grow.



Areas with slope greater than 30 degree are deemed inhabitable



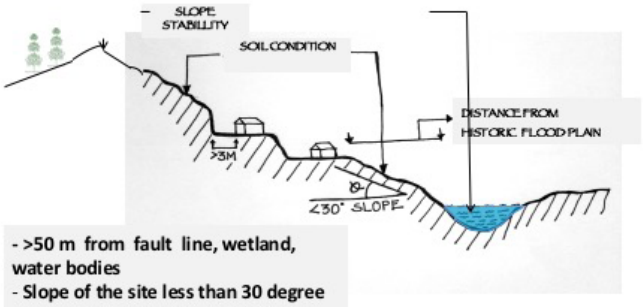
Buffer space of 50m is generally required from MCT line and river

Household	Population	Total Area (Ha)	Habitable Area (Ha)	% of Habitable Area
65,876	282,844	249,212	64,276	25.8%

Habitable Area

Spatial planning and growth management with multi-hazard view and coordinated strategies need emphasis for solutions leading to Safer Cities and Settlement.

Selected criteria for safer location selection



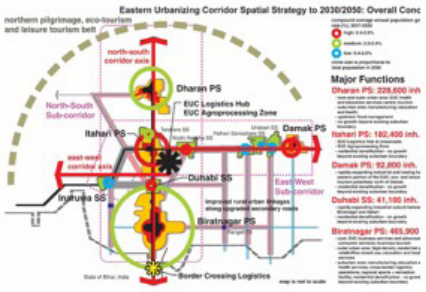
- >50 m from fault line, wetland, water bodies
- Slope of the site less than 30 degree
- Safe distance from uphill, downhill and retaining wall
- Slope stability between ridge and top

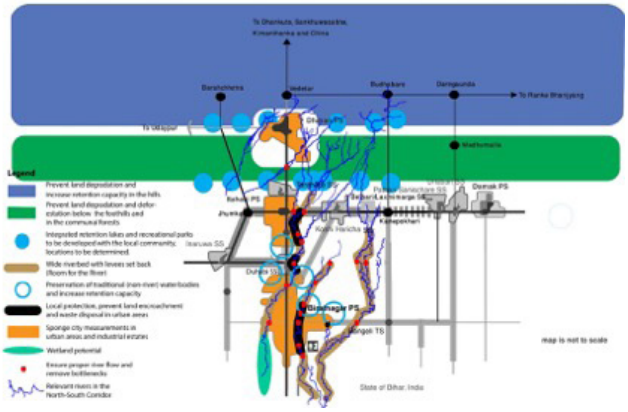
Multi-Hazard (Earthquake, Flood, Landslide) Assessment including Climate Change for selecting safer location.

- Integration of planning bye-laws, building regulation, national building code, and other environmental performance standards is basis for safer settlement

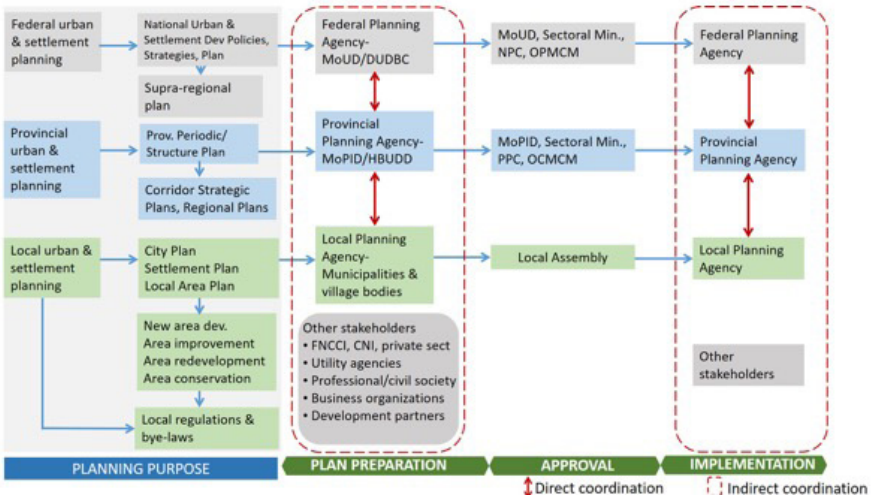
Resilient Spatial planning and Growth management needs regional perspective as demonstrated by nature of hazards—whose origin & effect is far reaching in terms of geographic extent—with location specific resilience measures in place.

Regional Flood Management Strategies (RFMS) devised for East Urban Corridor Region to ensure sustainability of future infrastructure investment—with **sponge city measures & green development** for individual urban centers.



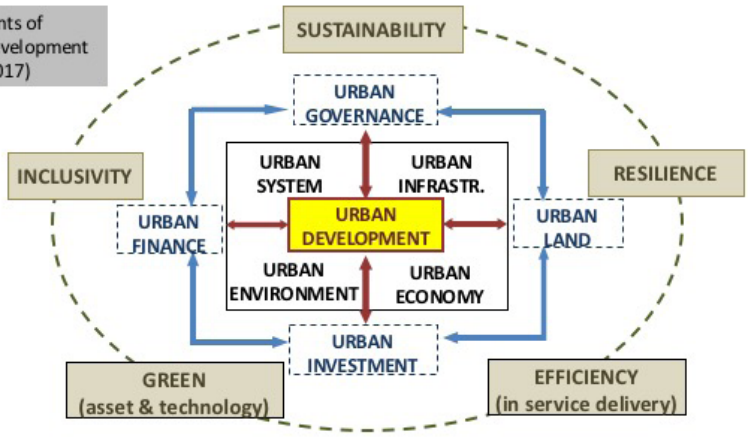


Coordination in process and in actions of planning agencies is required for resilient planning—along with building institutional capacity, social capital, and knowledge management



A national policy framework is critical to offer a coordinated and holistic guidance on resilient planning. NUDS is pivotal in this regard. Embracing and implementing such a framework at all layers of governance is a pre-condition for resilient outcome—for urban infrastructure investment and livability.

Conceptual elements of National Urban Development Strategy (NUDS, 2017)



"Ensuring disaster resilience of private sector businesses and their potential contribution to promote disaster resilience in communities"

Surya Bhakta Sangachhe[1], Surya Narayan Shrestha[2], Suman Pradhan[3]

Abstract

A recent initiative by NSET on public private partnership for earthquake risk management, the 2015 Gorkha earthquake and 2017 Tarai floods changed the perception of private sector towards Disaster Risk Management. The private sector today recognizes the need for disaster preparedness as a routine in-house job and DRM as an inevitable component of the whole industry / business investment. Private sector is motivated to embed earthquake safety measure as one of essential components of business / industrial plants, and they have greatly realized the disaster risk factors and moving positively with proper use of CSR fund for better preparedness for business resilience as well as making the community disaster resilient. We have realized that lack of proper guidelines on CSR fund utilisation and private sector's involvement has greatly hindered the DRR initiation of private sector in Nepal. NSET believes that the DRR initiation that private sector is leading will ultimately reach to every corner of the country ultimately become a community driven initiative. Recent enactment of Disaster Risk Reduction and Management Act is the realization of the need for Development of Disaster Risk Reduction and Management Plan as an inevitable component of infrastructure in government and business sectors can be taken as one of the major step in making Nepalese society disaster resilient.

Keywords: *DRM, Private sector, Earthquake, Resilience, CSR,*

1. Introduction

The participation of the private sector is essential, and should be a "matter of fact" perpetually in disaster risk reduction processes. With the view to enhance private sector engagement in DRR/ERR, NSET had implemented "Public Private Partnership in Earthquake Risk Management (3PERM)" program (2012-2016) funded by USAID/OFDA.

The role of private sector in disaster risk reduction beyond charity is being recognized and discussed in several recent disaster related events in Nepal. Many private institutions and group of companies and individuals such as manufacturers, Rotary Clubs have shown keen interest on implementing concrete initiative for disaster risk reduction in Nepal. Public Private Partnership (PPP) for Disaster Risk Management (DRM)

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is a new concept in Nepal. However, this approach promises to be one of the most effective approaches as it helps creating win-win situation by:

- Sharing by the public and private sectors the perceived roles in disaster risk management,
- Unleashing the local potentials by contributing towards fulfilling the roles expected by the society, not only as a responsibility but as "business as usual",
- Contributing to reduce disaster risks, protection of the environment, raising voice for a better governance including making cities safer by better enforcement of the building codes; enhancing both the government's and companies' ability to recover from earthquake losses.

NSET has been able to establish partnership and accomplish some ignition phase activities with both the production and service sector business communities; namely FNCCI, CNI, various DCCIs, HAN, NATTA, Bankers, Insurance, Consulting and Construction agencies, manufacturers and also with cooperatives. And efforts are on to engage more stakeholders mainly with the view to helping them develop their resiliency and seeking contribution of private sector in ERR/DRR. NSET is also piloting Urban Regeneration concept in the city core area of Kathmandu. Dolakha, Sankhu, Khokana, and Bungamati.

2. Program Overview

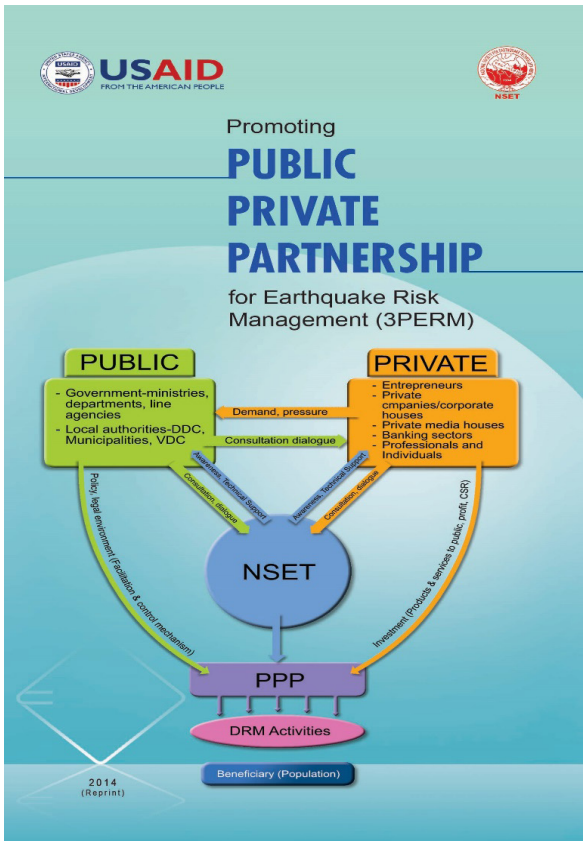
The program Promoting Public Private Partnership for Earthquake Risk Management (3PERM) focused on tapping vast potentials of private sector for contribution to earthquake risk reduction in Kathmandu Valley and Nepal. The original program includes three key activities namely i) massive awareness campaign on earthquake risk reduction, ii) enhancement of public private partnership for earthquake risk reduction, iii) feasibility study of urban regeneration in core city of Kathmandu. To provide support to the ongoing efforts of the government in the post-earthquake response after 2015 Gorkha Earthquake, it was envisioned to implement three new activities namely 1) feasibility of regeneration of earthquake devastated 3 historic settlements, 2) emergency shelter design, training and dissemination, 3) assessment of earthquake damage buildings.

The program has a) raised awareness of all stakeholders, especially the private sector and other stakeholders that closely relate with potential earthquake risk reduction activities to be led by the private sector, b) assessed the potential of the commitments and potential energy and leadership within the private sector and its potential capacity to exert pressure on the government to consider earthquake risk management as one of the priority areas for mainstreaming into development process, c) conducted a feasibility study of urban regeneration in core city of Kathmandu, implemented a detail study of the model PPP in historical building regeneration, conducted studies on feasibility of earthquake devastated historical settlements, d) completed two types of emergency shelter design, 2 pilot demonstration, and dissemination, and e) completed detail damage assessment of 170,767 buildings in 14 municipalities and 1 village Development Committee of earthquake devastated districts. 6.4 million People of Nepal and 16,610 people of historic settlements within urban areas of Kathmandu valley and some private businesses were benefitted by this program implementation.

The program Promoting Public Private Partnership for Earthquake Risk Management (3PERM) was a 5-year pilot program for developing a sound strategy for public private partnership in reducing earthquake risk in Nepal, and implement the strategy in earthquake- resistant urban regeneration, and in massive awareness raising for raising demand for earthquake safety, for putting up pressure on the

government and political process for improving policy and legal environment for earthquake safety and for providing synergy to the decade long initiatives on community based disaster risk management programs by government, non-government and private sectors in Nepal.

There were several cases of public private partnership in terms of raising public awareness for disaster risk reduction, and in terms of implementing DRR initiatives. However, such isolated cases of successes needed to be framed into a comprehensive concept and integrated implementation so as to generate maximum benefit and maximum outcomes. Hence, this program for promoting PPP has been prepared, obtained grant from USAID/OFDA and launched to comprehensively take forward the concepts and activities. The following figure presents a schematic diagram of roles and responsibilities and benefits to various stakeholders under this program.



The **overall goal** of the program was: **Improved earthquake disaster resilience of Nepal;**

The **objective** was: **Increase disaster awareness and promote public private partnership (PPP) for earthquake risk management in Nepal.**

3. Key Activities Implemented

Brief descriptions for the Program Activities under 3PERM implemented within the project period October 2011 - April 2016 are described in bullet form here-under.

- Weekly radio program produced and broadcasted, through 28 FM radios;
- Audio PSAs and Video PSAs produced and broadcasted through radios and TV channels , cable networks TV channels, video PSAs display in supermarkets, Video PSA displayed in Public Transport
- Handbooks and Guideline on Emergency Preparedness and Response Planning for business is published in collaboration with NBI
- Fully equipped Audio-Visual studio established.
- PPP Consultative Meetings with 69 Corporate Private sector and 12 government institutions held;
- Media Workshops and 2 Seminar (one with Nepal Banker's Association and another with Federation of Nepal Chamber Commerce and Industries) on BCP organized;
- Organized workshops on PPP in DRR; and Urban Regeneration;
- Conducted orientation programs and advocacy meetings on ERR/DRR with municipal officials, experts & residents on Urban Regeneration;
- MOU signed with 15 different agencies of government, local body, professional societies, manufacturing industries, media agencies, corporate bodies and Completed Media Training for journalists on ERM / DRM ;

- Conducted trainings for Private Sector Business (Hotel employees and Media persons) on Earthquake Preparedness; and conducted third party impact assessment of 3PERM

- 455 engineers volunteers trained and mobilized for buildings damage assessment, situation survey, data collection and analysis of 3historic settlements, mini workshops organized; Consultative Meetings and Consensus building advocacy meetings held with prime stakeholders; Urban Regeneration report of 3 historic settlements prepared

4. Key Achievements

3PERM program key achievements are:

- Knowledge, ideas, skills and practices on earthquake safety could be massively produced and propagated throughout the country most extensively and intensively for the first time in the history of Nepal. Engagement of local radios, television and print media remained tremendously impacting in disseminating the safety messages, educating people on disaster resilience and creating public concerns and discourses on disaster/earthquake issues.

- Massive media engagement in Earthquake Risk Management, local FM radios taking lead at local level and also sharing/contributing appreciable resources for the cause, collaboration made for television programs for education and policy advocacies.

- Many journalists could participate in workshops and interactions. Many got trained on disaster reporting and preparedness. The result that the accuracy and comprehensiveness of disaster reporting has been much enhanced. Most of the radios, televisions and print media have established disaster reporting desk.

- Central Bank of Nepal (Nepal Rastra Bank) has come up with the directives that guide to all commercial banks to use CSR fund and to disburse the housing loan to the clients based on the earthquake resistant design only. NRB directives have strictly been following by the Commercial banks in Nepal these days. This initiative has greatly influenced the bankers, house owners and builders to adhere to the building codes for earthquake resistant construction.

- Some private sector Telecom service providers, ISP providers have started taking initiatives in awareness raising as well as applying risk reduction activities such as structural and non-structural safety of the buildings. Review of DRR policies being prepared by Nepal Telecommunications Authority (NEA) is being done by NSET, Government's upcoming policy on telecommunications towers erection on safe buildings is ensured, NSET did structural vulnerability assessment of tower buildings of private sector telecommunications providers.

- Nepal Business Initiative (NBI) promoting Disaster Preparedness and Emergency response planning within private business circle

- Insurance Board (IB- Regulatory Body) has come up with the directives that guide to all Insurance companies to ensure mandatory earthquake insurance of a building while doing fire insurance

- Urban Regeneration in historic core city and settlements have been included in Kathmandu Valley Long-term Development Plan 2015-2035 Strategy

- Engineers and volunteers trained and mobilized for building damage assessment

5. Impact

- Public awareness on earthquake safety and overall disaster literacy enhanced. Policy makers, decision makers as well as implementers sensitized on issues of Disaster Risk Reduction.
- Participation and contribution of local FM Radio stations on promoting earthquake / disaster awareness enhanced. Engagement of policy makers, private sector and community people on Safer Construction and earthquake preparedness
- Commitment of policy-makers and decision makers towards better disaster risk management systems has increased (commitment letters signed)
- The private sector today recognizes the need for disaster preparedness as a routine in-house job and ERM as an inevitable component of the whole industry / business investment. And changed the perception of the private sector towards the ERM
- Private sector motivated to embed earthquake safety measure as one of essential components of business / industrial plants. They have greatly realized the disaster risk factors and moving positively for better preparedness for business resilience as well as making the community disaster resilient where they operate.
- Planting the concept of urban regeneration and producing a workable design (what was conceived in pre-April 25 earthquake turned out to be the reality in post-April 25 quake)
- Urban Regeneration in historic core city and settlements have been included in Kathmandu Valley Long-term Development Plan 2015-2035 Strategy, KMC incorporated Urban Regeneration program in its Annual program and Budget of 2016/2017
- Nepal Government's Reconstruction and Recovery Policy – 2015 states that the government can provide financial support for the regeneration of collapsed and risky old settlements in the urban area.
- Produced a scientifically reliable base for vulnerability-studies such as fragility curves and damage probability distributions.

6. Success Stories

The media campaign for making people aware of earthquake information and safety measures could be termed successful. The message has been communicated well through the Hoarding Board, print media, Radio and TV and other programs as well. The message has made people able to seek tools for safety, places of safety besides enabling them to use earthquake vocabulary. The private sector entrepreneurs have understood the concept of their engagement in ERR / ERM thanks to the 3PERM intervention. Immediately after Gorkha Earthquake, BBC World Service in Nepali shifted to NSET Office and used NSET Office facility for the uninterrupted operation for 45 days till their office facility got ready for the resumption of the services.

Realization of the need for Development of Earthquake Risk Management as an inevitable component of infrastructure in government and business sectors can be taken as one of the success part of the 3PERM project. NSET has realized that lack of proper guidelines on CSR fund utilisation and on private sector's involvement has greatly hindered the DRR initiation of private sector in Nepal. NSET believes that the DRR initiation that private sector is leading will ultimately reach to every corner of the country ultimately become a community driven initiative. The temporary shelter and damage assessment of buildings have both served the people effectively during the immediate after-shocks of Gorkha earthquake. Both are replicable.

7. Lessons Learned and Challenges

- Investing in community radios for awareness raising has yielded more worth in terms of generating/ ensuring more investment/contribution from radios, establishing closer connectivity with community people, Raising awareness on safety knowledge and skills, enhancing local actions on risk reduction and Contributing build local capacity, develop ownership and promote multi stakeholders' engagement
- Engagement of Private sector businesses in DRR enhanced, acceptability is there but yet more efforts required to make them take real actions. DRR is not yet considered to be an attractive & profitable business for them. Not only to disseminate the information about ERR but also to translate the learned information in the life of the people, for, as the third party impact study shows, substantial number of people know about ERR but do not use in reality
- Lack of proper guidelines on CSR fund utilisation and private sector's involvement has greatly hindered the DRR initiation of private sector in Nepal.
- For urban regeneration process, there is a need to have a Community discussion Forum. Local Authorities should plan to establish such forum. And a clear understanding of institutional responsibilities along with supportive legal provisions is crucial for the effective implementation of urban regeneration activities.
- Need to involve local authorities to facilitate the survey in Damage Assessment of Buildings and objective of survey should be disseminated to community through the municipality.
- Should develop quick reporting system of assessment result to central and local authorities and community.

Construction of Railway Engineering Projects and Its Promotion to National Economy

Qin Xuezhen[1]

Abstract

The paper describes China's railway development history and achievement along with railway features of large capacity, low energy consumption, high speed, safety, low pollution and land occupation demonstrated in the national comprehensive transportation system, and introduces the railway construction procedures. By taking two specific railway engineering projects undertook by the China Railway First Survey and Design Institute Group Co., Ltd. in Nepal, namely China-Nepal cross-border railway corridor and Mechi-Mahakali Electrified Railway, the author stresses the significant promotion role of railway development on Nepali economy and gives the reference to the railway construction and development in Nepal.

Keywords: *Railway, Comprehensive transportation system, Construction procedure, China-Nepal Cross-border Railway, Mechi-Mahakali Electrified Railway*

1. Overview

1.2. History and achievement of China Railway development

China's railway has developed for a century. Since the foundation of People's Republic of China, railway has achieved the same remarkable success as that of the other industries, especially the rapid development in the recent decade. China has accumulated rich experience in heavy haul railways, existing railways upgradation and reconstruction, HSRs and passenger station construction, ascending to the top positions worldwide with No.2 in the railway network scale and No.1 in the high-speed railway mileage, playing a significant role in promoting the railway development in the world. Particularly since 2004, China's railway development has embraced its golden period in history and obtained four major achievements as following:

Qinghai-Tibet Railway crossing the Roof of the World: Opened in July 2006, the world's highest and longest railway crosses plateau permafrost with the Golmud-Lhasa section of 1,142 km.

Upgrading of Datong-Qinhuangdao and Shuozhou Huanghuagang heavy haul railways: Opened in December 1992 with 652km total length□it is China's first double-track electrified line for coal transportation. In 2013, its freight volume reached to 445 million tons, largest annual freight volume in the world. In April 2014, a 30,000-ton heavy-haul train was tested for operation.

Successfully Sixth large-scale upgrading: The sixth large scale speed up gradations are conducted on existing lines as Beijing-Shanghai, Beijing-Guangzhou, Beijing-Kowloon, Beijing-Harbin, Lanzhou-Lianyungang, Shanghai-Kunming with 200km/h or above EMU.

China ranks first in the world by HSR operating mileage: Thanks to the large-scale construction for nearly a decade, over forty HSRs have been completed, such as Beijing-Shanghai, Beijing-Guangzhou, Harbin-Dalian, Zhengzhou-Xi'an, Lanzhou-Xinjiang and Shanghai-Kunming railways. By the end of 2018,

the CRH mileage reached 29,000 km. The HSR network of "four vertical and four horizontal lines" was basically completed, making China the largest country in term of network size

1.2. Characteristics of Railway Engineering Project

Railway is the important transportation mode and vital base for national economy development. It can accelerate the flow of capital, technology, human resources and other production factors, improve people's living standards, promote the national modernization and the optimization of national economic pattern and industrial layout, provide the basic guarantee for national economic and industrial upgrading, and then enhance the national economy competitiveness in the world.

1.2.1 Important Role of Railways in National Economy

Railway is the important transportation mode and vital base for national economy development. It can accelerate the flow of capital, technology, human resources and other production factors, improve people's living standards, promote the national modernization and the optimization of national economic pattern and industrial layout, provide the basic guarantee for national economic and industrial upgrading, and then enhance the national economy competitiveness in the world.

The economic stimulate effect of railway investment on related industries can reach to as high as 1:10. Hundreds of billions investment per year can produce trillions of economic driving effect. The facilitation of railway construction to economy development can be demonstrated in two aspects: firstly, railway construction investment itself can increase GDP and fuel economic growth; secondly, when in operation, as increased traffic volume, decreased cost, and less traveling time resulting from the improved transportation capacity and traffic conditions, direct economic benefits can be obtained. Meanwhile economic stimulate effect for other industry by breaking transportation bottlenecks and improving investment environment can also be achieved.

1.2.2 Important Role of Railways in National Comprehensive Transportation System

Unique advantages of railways in the national comprehensive transportation system are demonstrated as of large capacity, low energy consumption, high speed, safety, low pollution and land occupation. It has an absolute predominance in large-volume, medium/long-distance passenger & freight transportation. A dozen years of rapid development in railways has already set the pace for the national economy's progress.

1.2.3 Huge Investment, Long Period and Complicated Construction of Railways

Railway project has large investment, which is usually tens of billions or even hundreds of billions for trunk railway. The construction period is about 3 ~ 10 years. Its complicacy of construction and management can be found in the complex transaction and production, complex project organization, and complex project environment

1.3. Construction Process of Railway Project

1.3.1 Railway Project Stages

According to railway project features, the project period can be divided into five stages: investment decision-making stage, survey & design stage, implementation stage, completion acceptance stage, Operation and Post-Operation Evaluation stage.

1.3.1.1 Investment Decision-making Stage

(1) roject Proposal

Based on the National Railway Network Planning approved by the government, it is to demonstrate the necessity and feasibility of the project after relevant data collection, social & economic and transport

volume investigation and site reconnaissance. The pre-feasibility study shall be conducted, and project proposal shall be prepared and submitted to relevant government investment authority for approval. The Project Proposal is the basis to approve and initiate a project.

(2) Feasibility Study Report

According to the project proposal approved by the government investment authority, analysing the project feasibility in terms of technical feasible and economic feasible, environmental protection, soil and water conservation, energy saving and land utilization by taking the social , economy and transport volume investigation, transportation capacity, transportation quality, coordination of road network, and input-output benefit into account.

Feasibility study report is the basis for project decision. The project shall be submitted to corresponding investment authority for approval, review or filing based on project types.

(3) Works in Project Approval and Decision Stage

Investment authority will entrust related qualified appraisal agency to review and evaluate the Feasibility Study Report.

Main work: investment opportunity study, project proposal, feasibility study, project evaluation and decision, etc.

Main tasks: demonstrating the necessity, possibility, feasibility and rationality of the project, and major issues such as when to invest, where to build, and how to implement, and comparing various schemes.

The investment in this stage is relatively small, however it has a great impact on the project benefits. The mistakes in the early decision-making will often lead to major investment loss.

1.3.1.2 Survey and Design Stage

(1) Survey

Preliminary survey mainly identifies the landform, surface feature, regional geological conditions of the line area, and the geological conditions of the recommended scheme and the alternative schemes. Preliminary survey is the basis of feasibility study. Final survey mainly verifies the landform, surface feature, regional geological conditions of the line area to provide geological data for various buildings. Final survey results are the basis of preliminary design.

(2) Survey & Design

From project definition to construction, the design goes through four stages: project proposal, feasibility study, preliminary design and detailed design. In each design stage, surveys (site reconnaissance, preliminary survey, final survey and supplementary final survey) in addition to the four design stages shall be organized to obtain site data required for the design of landform, stratum structure and characteristics.

Preliminary design Report is the main basis for project construction. It shall be carried out according to approved feasibility study, planning and site selection report, environmental impact report, water and soil conservation plan, preliminary land review, geological hazard assessment and underlying mineral resources evaluation. Preliminary design unit is tendered together with the feasibility study preparation unit at the same time. The depth of Preliminary design shall meet the requirements for main equipment procurement, land acquisition and demolition/relocation and construction drawing design.

Construction drawing document (detailed design report) is the basis for project implementation and acceptance. It is based on approval opinions on the preliminary design, and is prepared with final survey and supplementary final survey data to provide the necessary drawings and instructions for construction. And the Cost Estimation is calculated based on the BOQ of construction drawings.

Survey and design stage reflect specific strategic decisions, and is the implementation of the feasibility study objectives. It determines whether the project will be a success and whether the expected objectives can be achieved efficiently.

Simplified work process of survey and design include: Approved Feasibility Study Report--Detailed Survey--Preliminary Design--Preliminary Design Review--Preliminary Design Approval--Supplementary Survey--detailed Design—detailed design Review—detailed design Submission.

1.3.1.3 Project Implementation Stage

The project legal entity has been established, and the detailed design needs to be reviewed and the safety, quality, environmental protection and social stability assessment shall be carried out. The main work includes the following four parts: project tendering, construction preparation, official commencement, construction and equipment installation.

Project tendering: After construction drawing design documents are examined and approved, the tendering shall be carried out.

Construction preparation: Land requisition and demolition, joint review of design drawings and design technical disclosure, preparation and review of construction organization and special construction scheme, quality, safety and environmental protection supervision formalities, temporary house construction, site leveling, connection of power, water supply and service roads, etc. shall be carried on. Preparations before commencement shall be done.

Official commencement: Commencement procedures and conditions are implemented. The project construction can only be commenced after the Project approved, project legal entity established, design documents, construction funds, construction participants are confirmed, EIA report, energy conservation evaluation and land requisition are completed.

Construction & equipment installation: Organize and dynamically adjust the construction according to approved construction scale, technical standards, construction period and investment, drawings and designed organization documents. This stage focuses on safety, quality, progress and investment control.

1.3.1.4 Project Acceptance

After the completion of all the railway engineering projects according to the approved documents, it shall organize the completion acceptance and handle the transfer of assets according to the regulations. Completion acceptance is divided into preliminary acceptance and formal acceptance.

(1) Preliminary Acceptance

The construction unit shall organize the contractors to rectify the problems found in the completion acceptance in time, and submit an application acceptance report after the railway project meets the preliminary acceptance conditions. The Acceptance Committee shall organize the preliminary acceptance of the project once it considers that the preliminary acceptance conditions are met.

After the preliminary acceptance and the operation safety assessment are qualified, the formal operation will be carried out. The construction unit shall organize static acceptance and dynamic acceptance

(joint commissioning and test, dynamic test and operation test), and organize safety assessment after the preliminary acceptance is qualified.

(2) Official Acceptance (National)

After more than 1 year of initial operation, the project approval authority organizes official acceptance. The Employer shall timely apply for State-owned Land Use Certificate and complete special acceptance of environmental protection, soil and water conservation and archives, etc. The Acceptance Committee shall organize official acceptance after official acceptance conditions are met.

The acceptance department will issue National Acceptance Certificate for railway projects that have passed official acceptance (national).

1.3.1.5 Operation and Post-Operation Evaluation

(1) Operation

The main operation body is the Employer, and the main work is completed by the Employer or a special project company. Main work: operation and maintenance.

(2) Post-project Evaluation

Post-project evaluation is to use scientific evaluation method and complete index system to analyse the project construction management and the actual results achieved after completion and operation for a certain period (2-3 years), so as to sum up experience and improve decision-making. Contents of Post-project evaluation include: Post-project evaluation, Project Implementation Evaluation, Project Operation Evaluation, Project Financial and Economic Benefits Evaluation, Project Operation Management Evaluation, Project Resource Environment Evaluation, Project Social Benefit Evaluation.

1.3.2 Summary of Construction Process of Railway

The processes are slightly different due to the difference in investment scale and subject, railway grade and function orientation. The approval of government authority or investment subject in each stage is the main basis for the next stage, and evaluation and approval by such authority shall be carried out at the end of each stage.

1.4. Major Cases of Nepal Railway Engineering Project Construction

1.4.1 Study on the China-Nepal Cross-border Railway Corridor

China and Nepal are friendly neighbours linked by mountains and rivers. The people of the two countries have a history of exchanges for thousands of years and the traditional friendship has a long history. It is the common mission of the Chinese and Nepalese people to push forward the implementation of major projects within the framework of "Belt and Road Initiative", strengthen connectivity, further strengthen land and air links, and improve the land transportation infrastructure between China and Nepal.

On December 17, 2014, the two countries signed *the Memorandum of Understanding between the Ministry of commerce of the People's Republic of China and the Ministry of Finance of the Nepali Government on Jointly Promoting the Construction of the "Silk Road Economic Belt" under the Framework of the China-Nepal Economic and Trade Joint Committee*. During the official visits to China by Nepalese Prime Minister Khadga Prasad Sharma Oli in March 2016 and June 2018, China and Nepal signed 10 cooperation agreements, including the extension of the Qinghai-Tibet Railway to the China-Nepal Railway.

At the invitation of Nepalese President Bidhya Dev Bhandari, President Xi Jinping of the People's Republic of China paid a state visit to Nepal from October 12 to 13, 2019. The two parties signed the "Joint Statement of the China and Nepal". Both parties agree to carry out the feasibility study of the cross-border railway project from Gyirong to Kathmandu in accordance with the Memorandum of Cooperation signed on October 13, 2019, so as to lay an important foundation for the start-up of the project construction. The two sides also reiterated their cooperation on the Kathmandu-Pokhra-Lumbini railway project.

The research work of China-Nepal Cross-border Railway Corridor is currently undertaken by China Railway First Survey & Design Institute Group Co., Ltd. in progress.

1.4.2 Design for Project of Nepal Mechi - Mahakali Electrified Railway Western Section Package 2 and Package 4

Nepal East-West Electrified Railway (hereinafter referred to as East-West Railway) is designed with a speed of 200 km/h, and mixed passenger and freight lines are jointly operated. The line runs roughly along the Nepal-India border (about 900km long from the east to the West). The technical standard of this line is single track railway for mixed passenger and freight transportation, with design speed of 200 km/h for passenger cars, 100 km/h for freight cars, track gauge of 1435mm, minimum curve radius of 2000m and maximum limit gradient of 10‰.

The main services include feasibility study report review, detailed investigation, environmental impact assessment, social impact assessment, detailed design and preparation of construction bidding documents. The service period is 15 months. The stage of the project is detailed survey and design, the depth is between the preliminary design and construction drawing design, and the Nepal government has its own funds.

On May 30, 2017, our institute, as the leading company, formed a JV with Pyunghwa Engineering Consultants Ltd. Korea (PEC), Dong Myeong Engineering Consultants & Architecture Co., Ltd. Korea (DMEC) and Nepal Silt Consultants (P). Ltd. (SILT), and signed the service contract for the package 2 and package 4 of the western section of the project with Nepal Railway Bureau. The consortium officially launched its work on July 1, 2017, and completed the project design by the end of October 2018.

1.4.2.1 Introduction to the Package 2 Undertaken by Our Institute

The package 2 is located in the middle of the west section of the East-West Railway. The line enters Kohalpur City of Terrain Plain, leads out from the station and then goes eastward to Rapty Valley Platform. After crossing the Rapti River four times, it enters the foothills on the south side of Nepal's Siwalik Mountains, connects with important towns such as Charpargauri along the line to Lamahi, the end point. The overall length of the main track is 99.3km.

Another consideration is that 10km to the south of Kohalpur city is the local important port city Nepalgunj, so package 2 section also is designed with a connecting line from Rangital to Nepalgunj port, with the overall length of 14.4km. The connecting line is designed according to 140 km/h standard. The package 2 section has an overall length of 115km and 7 stations. The total static investment of the project is NRs. 95.68 billion.

1.4.2.2 Introduction to the Package 4 Undertaken by Our Institute

The package 4 section is the westernmost section of the East-West railway. The line is routed along the south side of the local East-West Highway to the Terrain Plain in the north of the Ganges River Plain. The line leads out from Gaddachowki station, the starting point, and then runs eastward, and connects with

important towns such as Mahendranagar, Attariya and reaches Sukhkhad, the terminal of the bid section. The package 4 section has the overall length of 94km and 6 stations (5 reserved). The total static investment of the project is NRs. 72.43 billion.

2. Conclusion: Enlightenment and Experience of China's Railway Deve opment

2.1 Great Concern by the Central Government

Railway, as the main artery of national economy and important infrastructure, needs strong support from the government. In recent years, the central government has issued a number of policies to support railway development. It has promoted the reform of separating government administration from business management and the reform in the railway investment and financing system, accelerating the construction of railways.

2.2 Substantial Support from Local Governments

Chinese local governments actively solve the land acquisition work, which is a key and guarantee for railway construction, and ensures the smooth progress of the railway construction. Converting land requisition and demolition into shares and cash, the record of maximum investment ratio is more than 50%.

2.3 Scientific Industrial Development Plan

In January 2004, *the Medium and Long-term Railway Network Plan* was published, which is the first railway industrial development plan approved by the central government. It outlines the blueprint for the development of the railway network by 2020,and the target has been achieved five years ahead of schedule.

In 2016, the new version of the Plan was approved by the central government, the railway operating mileage will reach more than 175,000 km by 2025, including 38,000 km of HSRs.

2.4 Suitable Technological Development Path

According to the technical characteristics and the status quo of the technical level in different fields, we have studied and formulated the technological innovation path of "original innovation, integrated innovation, introduction, digestion, absorption and re-innovation". In the field of engineering construction, original innovation is adhered; In the field of high-speed train operation control, integrated innovation is insisted. In the high-speed train manufacturing field, further innovation on the basis of introduction and absorption is pursued.

2.5 Efficient Operation Management Mechanism

Railway construction projects are uniformly organized, managed and coordinated by the competent departments of railway, with the project as the platform to raise construction funds from multiple sources and break through the bottleneck of funds. The railway construction fund in China consists of equity fund and debt fund, respectively accounting for 36.8% and 63.2% of the total funds during the 12th Five-Year Plan.

2.6 Complete Talent Supporting System

Large-scale railway construction and operation management needs strong talent support. A team of talents covering many fields such as scientific research and design, industrial colleges and universities, construction industry, industrial manufacturing and railway transportation, becoming an important guarantee for the rapid development of China's railway.

3. FSDI Company Overview

China Railway First Survey and Design Institute Group Co., Ltd. (hereinafter referred to as "FSDI") was established in 1953, is one of the first batch of railway survey and design institution in China. Over the past 60 years, the institute has completed more than 460,000 kms of railway research and survey design, put into operation more than 30,000 kms. FSDI has scored new high for hundreds of times both home and abroad. FSDI contributed the China's first electrified railway, the first desert railway, the first Salt Lake railway, the world's first plateau frozen earth railway, the first high-speed railway built in the collapsible loess region in China, the world's first high-speed railway across the alpine region and the through the wind area.

The FSDI has undertaken subway planning, design, consulting, supervision, general contracting and comprehensive property development in more than 30 cities in China. As well as contracted more than 2,000 kms of consulting and design projects for railways, highways and subways in more than 40 countries around the world. FSDI also undertaken more than 6,000 kms of high-speed railway, passenger dedicated line and high-standard railway design tasks, is one of the leaders in the field of high-speed railway in China.

In the FIDIC centennial celebration in 2013, the Qinghai-Tibet railway and Qinling Tunnel Group projects designed by the FSDI were both awarded the "FIDIC Centenary Awards". In 2014, the Xi 'an Metro Line 2, which was turnkey contracted by FSDI, won the "FIDIC Outstanding Projects Award". So far, FSDI has 4,000 employees, more than 2,700 senior and intermediate professional and technical personnel, nearly 1,000 qualified personnel, 1 academician of Chinese Academy of Engineering, 7 National Masters of Engineering Survey and Design.

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On -Site Visualization Helps the Safety of Construction

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Abstract

On-Site Visualization (OSV) is a new concept of monitoring scheme for disaster reduction on the construction stage and natural slopes and tunnels. Usually monitoring system has 3 steps, sensoring the deformation or inclination, judgement of risk and alert. These steps need some minutes or hour. Sometimes alert does not send in time for the escape of workers in the construction site or citizens of residence under the dangerous slope. OSV can connect these 3 steps. Under using OSV, risk of collapse of structure or slope will be informed in time to the workers or citizens.

Keywords: *On-Site Visualization, safety of construction, monitoring, risk management*

1. Introduction

Today construction projects in Nepal are becoming dynamic and big. Small projects require small structures and small excavations, small slopes. There are small dangers and small risks. But Today's big highway projects in Nepal require high piers and long span bridges, deep excavation for the cut and cover structures, wide and long tunnels, big long slopes. Of course, structures for the Resilient Infrastructure require wide and high concrete walls, thick piers, big footings and long slopes.

On the construction stage of the big and high structures, deep excavations, tunnelling, the engineer must keep the safety of the neighbour citizens, workers and the stability of the neighbour structures, residents, and the buildings. Usually engineer takes monitoring system for this purpose, but sometimes engineer choices low performance system or makes a wrong choice of devices, judgement threshold setting and meaningless alert under his low experiences. The failure of the monitoring design leads the serious accident. But many serious accidents happen every day around the world. One of the most major reason for the failure is that the alert is not enough time for the outbreak of the hazard.

On-Site Visualization (OSV) is a new concept of monitoring scheme for disaster reduction on the construction stage and natural slopes and tunnels. Usually monitoring system has 3 steps, sensoring the deformation or inclination, judgement of risk and alert. Sometimes alert does not send in time for the escape of workers in the construction site or citizens of residence under the dangerous slope. OSV can connect these 3 steps directly. Under using OSV, risk of collapse of structure, excavation or slope will be informed in time to the workers or citizens.

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2. Concept of OSV

OSV (On Site Visualization) is a system concept for displaying observation results on site, by level of hazard, without a process of decision making which is usual output from the site. In a broad sense, it does not matter for this OSV what is observed and by what means. In other words, it is a new concept of handling and outputting the observation results. With an external display unit directly attached to an observation tool functioning as a deformation sensor, OSV aims to notify third parties, such as citizens and road users, of whether the deformation has reached the hazard level or has a margin to that level, on site without a process of decision making by the administrators. Figure 1 shows the flow of the OSV in comparison with the flow of the conventional method from observation to warning display to workers.

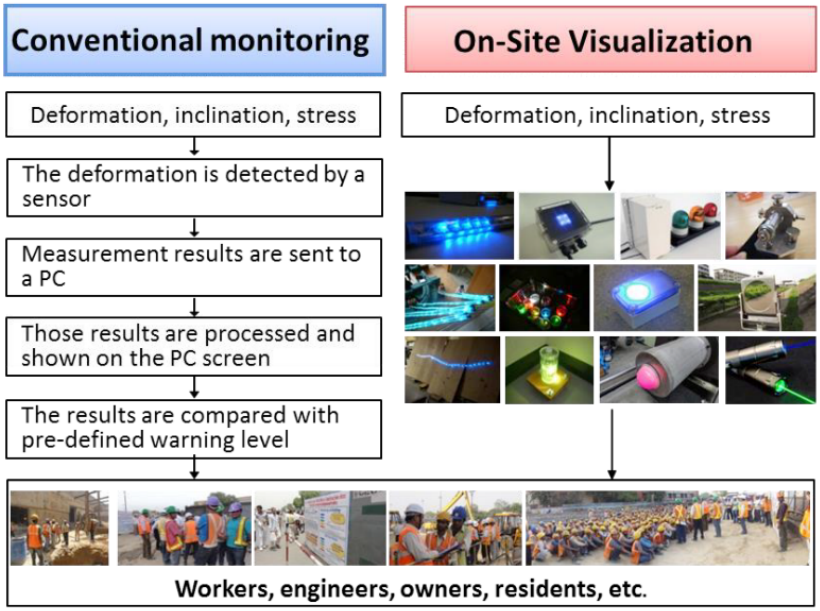


Fig. 1 Comparison of Conventional monitoring and OSV (C.IZUMI, 2015)

In the conventional method, data on deformation, stress, and strain measured with observation tools are transmitted to the site or to the observation hut that covers several sites through multicore cables etc. Normally, no administrator is stationed at the observation hut and data is transmitted to the operation room through telephone lines or fiber-optic network. In the operation room, various kinds of information including weather data and road network data are collected. The administrator makes most appropriate decisions in full consideration of such information.

Once a decision is made, emergency evacuation or road blocking information will be publicized to at-risk or similar areas by means of broadcasting, siren, TV, etc. and at the same time communicated to relevant administrative agencies which will take public assistance measures such as evacuation support. In contrast, the basic concept of OSV is to display observation results on site. Such display is provided with the functions to determine a level of danger that is predetermined or adjusted. These functions enable the notification of danger information to users without transfer of information or the administrator's impromptu decision making.

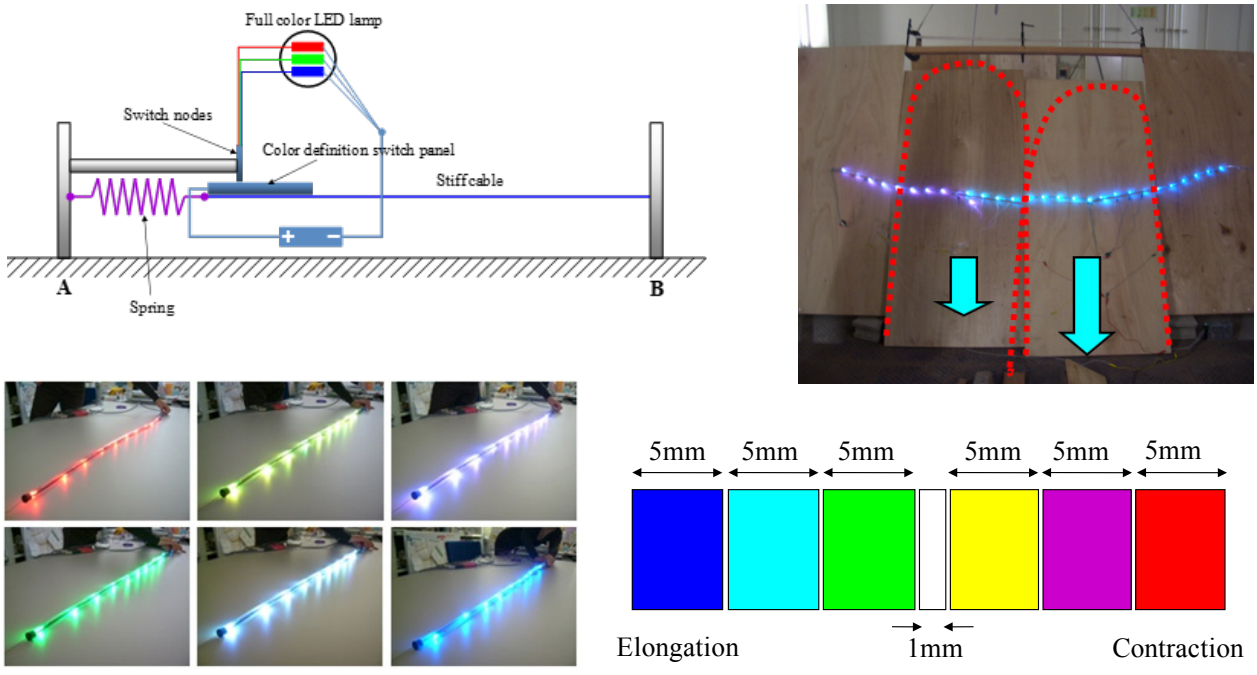
OSV displays a level of hazard on site and transmits signals to remote areas as required by the situation. Therefore, unlike the conventional display and notification methods, OSV communicates the warning information figuratively, i.e., using siren, illumination, color LED, etc. Of course, no understanding of what OSV intends to suggest will cause a failure in communicating information of emergency evacuation to local

residents. However, such a situation can be avoided mainly by using information that people feel dangerous in psychological terms and by accepting the fact that OSV is not designed to display as much information as broadcasting or TV can, and consequently, OSV is considered to serve sufficiently as a support tool for self-help actions and mutual aid.

3. Tools of OSV

3.1 LEDS

It is necessary to develop a device that is simple but highly expressive to realize OSV. For example, in the case of a landslide disaster, the part where deformation occurs at the initial stage of the disaster is generally located near the top of the collapsing block in at-risk areas, where direct reading of values of the deformation gauge and such will not be possible as it is too far from where local residents or tool users will stand. For this reason, it is necessary to communicate the presence of danger and the level of the danger to remote areas using some display devices. In such cases, light will serve as an effective display means because it is highly visible from a distance and it can use various expressions. Fig.2 shows this tool applied to a deformation gauge. Since this is a deformation sensor, these tools are collectively called LEDS (Light Emitting Deformation Sensor). For the purpose of providing more detailed information using this basic circuit, in the way that lighting patterns of the electric bulb will change according to deformation volumes, we developed a practical version of LEDS (Light Emitting Deformation Sensor) using a full-color LED (Light Emitting Diode).



(a) Color variation (b) Color scheme

Fig. 2 Structure of LEDS (M.NOMURA, 2015)

Fig. 3 Activity of LEDS (M.NOMURA, 2015)

3.2 LEIS

LEIS means Light Emitting Inclination Sensor. LEIS were manufactured by Akebono Brake Industry Co., Ltd(member of OSV Consortium). Outfitted with two internal acceleration sensors by MEMS Technology (Micro Electro Mechanical Systems), the LEIS precisely measures the inclination of a structure and displays the resultant data as colored light. Angular measurements with accuracy within 1/100 degree are achievable.

Fig. 4 Activity of LEIS (M.NOMURA, 2015)

3.3 LEIS/Pocket

Light Emitting Inclination Sensor / Pocket is a stand-alone and portable inclination sensor that uses a MEMS sensor, with its maximum resolution of 0.01 degree, to measure inclinations qx and qy to compute q=SQRT(qx2+qy2). q is then compared with two threshold values I1 and I2, such that green, yellow and red LED flashes to visualize inclination.

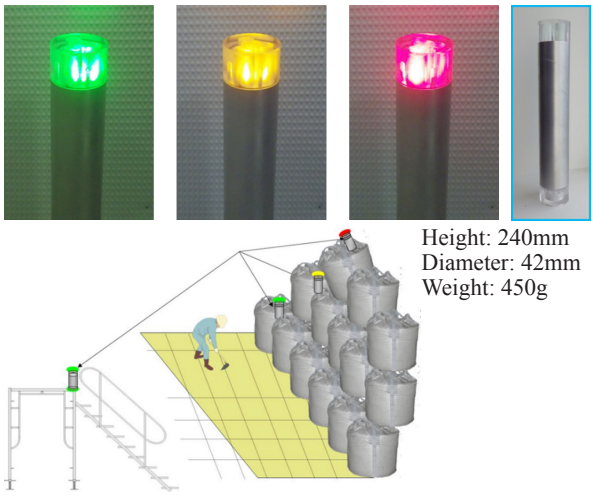


Fig. 5 Structure and Activity of LEIS/Pocket (M.NOMURA, 2015)

3.4 LEC

LEC is designed for connection to a variety of sensors (inclination, deformation, strain, stress, pressure, pH, temperature, humidity, etc.) for real-time data display as colored light. The LEC, that serves as a data logger as well, can be effectively used for a diverse range of on-site visualizations. An LEC, that can be powered by a solar cell, can be connected to multiple sensors for data collection and visualization of data while switching as instructed.

Fig. 6 Using LEC at excavation site (M.NOMURA, 2015)

4. OSV Application on JICA Projects

JICA and OSV Consortium held the SAPI (Special Assistance for Project Implementation) Program at Delhi Metro construction sites in 2010. This program had controlled by Oriental Consultants Global Co., Ltd. This program included OSV monitoring for the deformation of excavation wall of AIMS Station and others, inclination of the neighbour buildings and residents.

Fig. 7 Education Program of SAPI by OSV (C.IZUMI, 2010)

5. Method for Performance Evaluation of Monitoring System

5.1 Definition of function and performance of monitoring system

The function of monitoring system can be decomposed into the combination of the process of measurement, judgement and on-site data output, the internal communication in the system, the alarm output for the workers who are the final recipients and the related citizens, and the external communication by evacuation announcement. The scope of monitoring system is expanded to the cognition of final recipients, which could be considered as the generalized one. In the study, the performance of generalized monitoring system is defined. Because in slope construction the monitoring system and communication can be extracted as the independent function in many cases, it is thought the performance can be prescribed in each function and its value can be given as the evaluation. Furthermore, it should be considered that the performance of monitoring system is the comprehensive result of the performance of each process and communication. And the performance of monitoring system should be evaluated with its performance value. Here, the performance value P for monitoring system can be defined as follows,

$$P = P_1^{\alpha} \times P_2^{\beta} \times P_3^{\gamma} \qquad \text{(Eq. 1)}$$

where, P_1 is the performance value of monitoring tool and measurement, P_2 is the performance value of measuring value judgement, P_3 is the performance value of result expression in the field. α, β, γ are the factors determined by importance of each performance value. In (Eq.1), although P_1, P_2, and P_3 are independent processes, the monitoring system is thought to play the role when each process begins to work.

Performance value P_1 of monitoring tool and measurement can be defined as follows by the evaluation based on the performance of extraction of proper subjects, selection of proper measuring device, and measurement with proper intervals

$$P_1 = P_{1-1} \times P_{1-2} \times P_{1-3} \qquad \text{(Eq. 2)}$$

Performance value P_2 of measuring value judgement is defined as follows,

$$P_2 = P_{2-1} \qquad \text{(Eq. 3)}$$

Where, $P_{2\text{-}1}$ is the performance value determined by the method with the reasonable threshold value in terms of safety. Performance value P_3 of result expression after the process of measurement and judgement is the necessary performance for the final recipients of information to react to evacuation etc., or take necessary measures to strengthen and conduct traffic control in predetermined time, corresponding to the performance of generalized monitoring system. The performance value is defined as follows.

$$P_3 = P_{3-1} \times P_{3-2} \times P_{3-3} \qquad \text{(Eq. 4)}$$

Table 1 to 3 shows every performance contents under FMEA matrix. On this table, performance ratio is explained simple evaluation points by 4steps (1-4). After evaluating the performance of the slope monitoring system, administrator evaluate the total risk and estimate the cost of disaster response accurately.

Table 1 index of performance value of monitoring tool and measurement (P_1)

$P_{1\text{-}1}$	$P_{1\text{-}2}$	$P_{1\text{-}3}$	Performance comments	Point
All systems are kept under control including a critical unit	The precision appropriate to the demand, a durable instruments are chosen	For the measurement time appropriate to the demand, a measurement interval is realized	Perfect	1

Many critical units are grasped, but is difficult to all systems	The precision appropriate to the demand, a durable instruments are chosen,; but over specifications	It is shorter than the measurement interval appropriate to the demand	Passing	2
The critical unit is not grasped	It is an instrument of the precision appropriate to the demand, but is not certain about the durability	It is longer than the measurement time appropriate to the demand	Improvement required	3
No Monitoring system	The instrument that the precision appropriate to the demand, the durability are not met is chosen	A measurement interval is not considered	Failure	4

Table 2 index of performance of measuring value of judgement *(P_2)*

$P_{2\text{-}1}$	Performance comments	Point
The threshold by a technical standard or a positive law learned by experience is decided	Perfect	1
The threshold is suggested by the analytic examination that modelled the field or a law learned by experience	Passing	2
Some kind of threshold is determined	Improvement required	3
There is not a judgment logic only by state indication	Failure	4

Table 3 index of performance of result expression *(P_3)*

$P_{3\text{-}1}$	$P_{3\text{-}2}$	$P_{3\text{-}3}$	Performance comments	Point
Other than urgent refuge, time necessary for an action for damage minimization is secured	Information is transmitted definitely	A meaning of the information is completely recognized definitely by education and coping of the indication method	Perfect	1
Minimum time necessary for urgent refuge is secured	Information is transmitted approximately definitely	A meaning of the information is recognized approximately definitely by education and coping of the indication method	Passing	2
The information comes by occurrence of disaster, but urgent refuge is not guaranteed	Something including the heterology comes	It is recognized that something is abnormal	Improvement required	3
Information has less time by occurrence of disaster	Information is not transmitted	A meaning of the information does not come	Failure	4

6. Conclusion

OSV will help engineers for the designing of monitoring and judgement of their construction site's safety. Sometimes OSV seems simple and easy system, but legitimacy and reliability of system performance is very important because of workers and citizens will move under alert. If alert will send delay from attack by wrong design of monitoring, workers and citizens will be attacked by hazard. Because they believe alert signal. So, engineers who design OSV must be educated and pile up experience of monitoring.

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Bringing traditional buildings to earthquake safety in the modern era

Naresh Giri[1], Jitendra Bothara[2]

Abstract

Achieving earthquake safety for people in rural areas requires the utilization of building processes and materials that are accessible, affordable and sustainable. We have developed school building designs using stone and mud using innovative techniques that have proven to be earthquake-resilient by the most modern testing methods. These techniques can be replicated en masse around the world to save lives.

Keywords: Traditional Buildings, earthquake safety, innovative techniques, earthquake resilient

1. Background

The Mw 7.8 2015 Gorkha earthquake damaged or destroyed approximately 750,000 houses, 6,000 government buildings, and 30,000 school classrooms and resulted in 9,000 deaths (NRA, 2016). As evidenced by the 2015 Gorkha, the large majority of Nepalese building stock – traditional or modern, public or private, ordinary or important – is severely vulnerable to earthquake shaking. The 2015 earthquake also highlighted that the major source of human and economic losses was triggered by unsafe buildings, particularly in the rural areas where these are constructed of low strength masonries (LSM) such as stone or brick or adobe in mud mortar.

In the above context, improving the seismic resilience of building structures is the pre-requisite for achieving a comprehensive seismic safety for the protection of population and their properties. However, any information and construction materials required to implement the proposed earthquake-resilient technology should be physically accessible, it should be within financial means of the population and should not demand radical changes in construction technologies to make efforts sustainable. Only the maximum use of locally sourced construction materials such as stones, mud and timber in a combination with minimal use of imported construction materials could provide sustainable seismic safety in the long run, particularly in rural and areas inaccessible by motorable roads and little financial means. As the stone and mud are sourced locally with minimal production and transportation cost, these are affordable, suitable for the local economy (Bothara & Sharpe, 2003) and are environmentally sustainable as well.

As part of the earthquake reconstruction efforts, for future-proofing agaist earthquakes the Government of Nepal is constructing reinforced concrete (RC) frame type buildings for schools in vehicular accessible areas, but transporting industrialised construction materials such as cement, structural steel and rebars is generally a logistical challenging and financially not viable in the larger part of the inaccessible earthquake-

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affected areas. The only construction materials that are economically available in abundance in such inaccessible areas is stone and mud. The Government of Nepal hence commissioned an assignment under the Asian Development Bank's (ADB) Technical Grant Assistance to explore the suitability of using locally abundant materials for the construction of earthquake-resilient school buildings.

2. Design of School buildings

Under this assignment, four Type Designs (TD) of two-room and three-room one-story school buildings were developed using locally available materials with minimal use of imported materials in close collaboration with the Central Level Project Implementation Unit (CLPIU (Education)) under National Reconstruction Authority, Government of Nepal and the ADB. Figure 2 presents a sketch of the two-room prototype school building. The details of the Type Designs are as follows:

- Type Design 1 (SM_RC): Semi-dressed stone masonry in mud mortar with RC bands and galvanized iron (GI) containment mesh on wall surfaces,
- Type Design 2 (SM_Gabion): Semi-dressed stone masonry in mud mortar with GI gabion bands and containment mesh on wall surfaces
- Type Design 3 (CSEB_RC): Cement stabilized earth brick (CSEB) in cement stabilized mud mortar with reinforced concrete bands and vertical rebars.
- Type Design 4 (SM_Timber): Semi-dressed stone masonry in mud mortar with timber bands and GI containment mesh on wall surfaces.

As noted above, the developed Type Designs of stone buildings in mud mortar were provided with gabion, timber or reinforced concrete (RC) bands. To basket and thereby prevent disintegrity of the stone masonry walls, galvanized steel mesh was proposed on both surfaces of the walls, which were tied together by cross-links (crossties) passing through the walls. The CSEB walls in cement stabilised mud mortar have been proposed for the areas where dressable stones are not available.

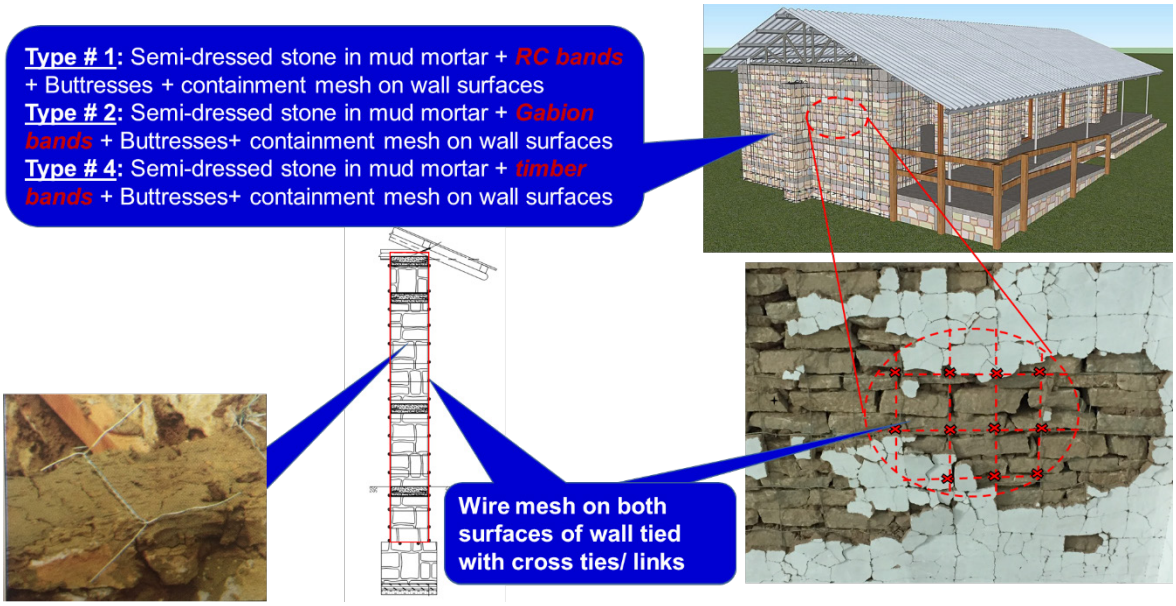


Figure 1. Prototype details of the proposed building (DT 1)

To date, no design standards are available and limited research is available on the design and construction of earthquake-resilient important facilities (such as schools) using LSM (Bothara, Ingham, & Dizhur, 2018). In the absence of established design standards for LSM buildings, the designs were based on available prescriptive guidelines and previous researches and observed and postulated failure modes of the LSM buildings and their consequences. The focus of the concept design was to maintain integrity between the masonry units and building components and prevent any loss of building volume. The structural design of the buildings was completed following classical mechanics and simplified engineering methods.

3. Testing the technology

The major challenge was to demonstrate that the proposed school building designs were adequate to meet seismic safety levels prescribed by the Nepal Building Code. This triggered an extensive experimental testing programme which included most modern testing methods. The testing programme included extensive basic tests on constituent materials, subassembly tests (prisms, wallettes and short piers) to define material parameters. In order to confirm compliance of the proposed Type Designs to the relevant seismic standards, state-of-the-art dynamic shake table (a table which could generate simulated earthquake shaking) tests were performed on linearly reduced four 1/3rd scale and another four 2/3rd scale model buildings representing each Type Designs. The 1/3rd and 2/3rd scale models were tested an 8-ton and 60-ton payload capacity shake tables, respectively. To acquire response of the model buildings to the shaking, multiple sensors were installed at strategic locations on the models.

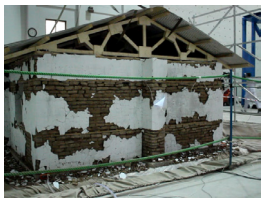
			
a) Diagonal test of stone masonry in mud mortar with containment mesh	b) Model building with truss timber band (DT 4) under construction	c) One of the 2/3rd scale model buildings (DT 4)	d) One of the 1/3rd scale model buildings (DT 1)

Figure 2: Testing of masonry and model buildings

The model buildings were subjected to progressively increasing intensity of shaking up to 1g (the earth applies 1 gravitational acceleration in the vertical direction, the same magnitude of shaking was applied to the models in the horizontal direction). The stone masonry models were also tested after partial and full removal of containment mesh and cross wires. The models were subjected to long-duration intense shaking; however, no significant degradation was observed and all stone masonry models (with at least partial containment wires) and CSEB models survived without triggering any unstable mode of failures, other than CSEB models that suffered damage to corner and buttresses, and dislodgement of a few masonry units. This established that the proposed Type Designs conformed to the requirements of relevant seismic standards.

4. Conclusion

The technology developed herein has the potential to be modified and adapted for buildings with other occupancies including residential buildings, and it could easily be adopted for seismic retrofitting of

the existing stone masonry buildings. It could straightforwardly be replicated in other seismically active countries around the world, particularly the developing countries, thereby save lives en masses.

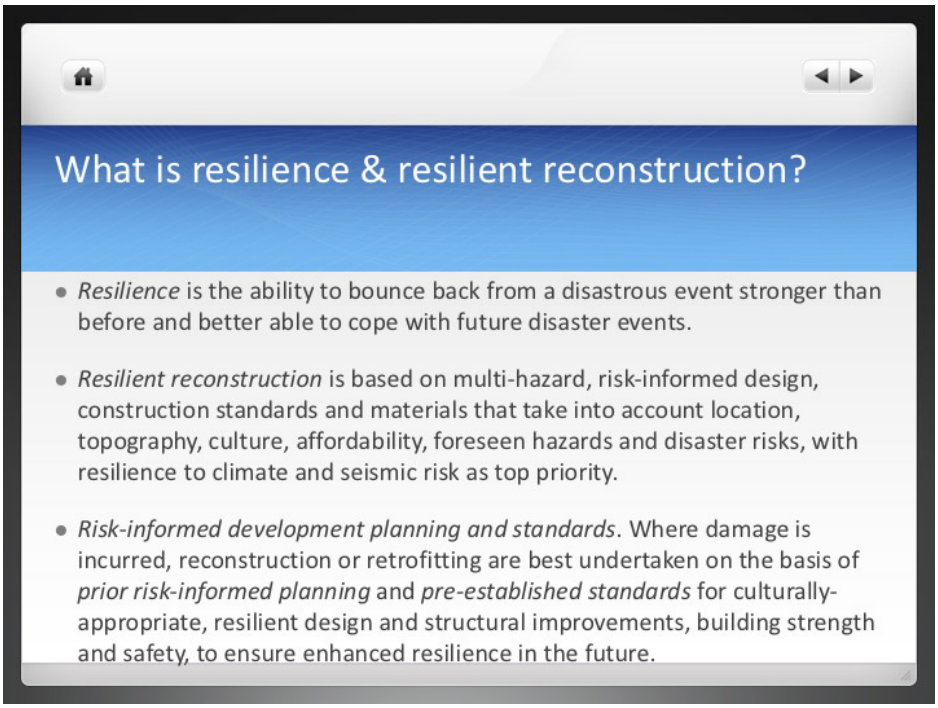
The results obtained from the experimental testing needs to be generalised for other shapes and sizes of buildings, particularly the stone masonry buildings. The investigation now needs to be extended to two storeys plus attic buildings with different combinations which are commonly found in hills and mountains of Nepal.

Acknowledgements

The study presented here was completed under the Asian Development Bank's (ADB) financial and technical assistance to the Government of Nepal under the Earthquake Emergency Assistance Project after the 2015 Gorkha earthquake. The support provided by CLPIU (Education) during the assignment is thankfully acknowledged. All the experimental testing work presented here were completed at the Earthquake Engineering Center of University of Engineering and Technology (UET), Peshawar, Pakistan under a contract between the ADB and the UET. Thanks to the UET research team. The technical advice and support of Professor Jason Ingham and Dr Dmytro Dizhur, both of the University of Auckland, Late Professor Anand and S Arya and others are gratefully acknowledged

Investment for resilient reconstruction

Nigel Fisher[1] and Chandra Bahadur Shrestha (Dr.)[2]



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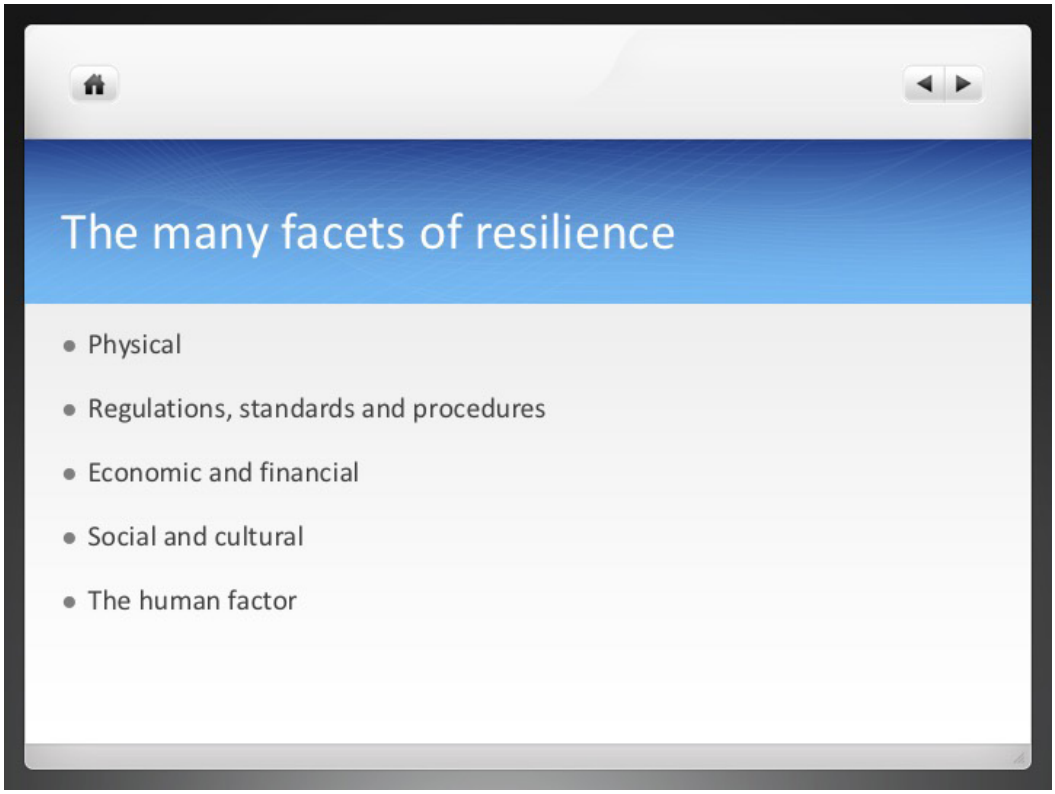
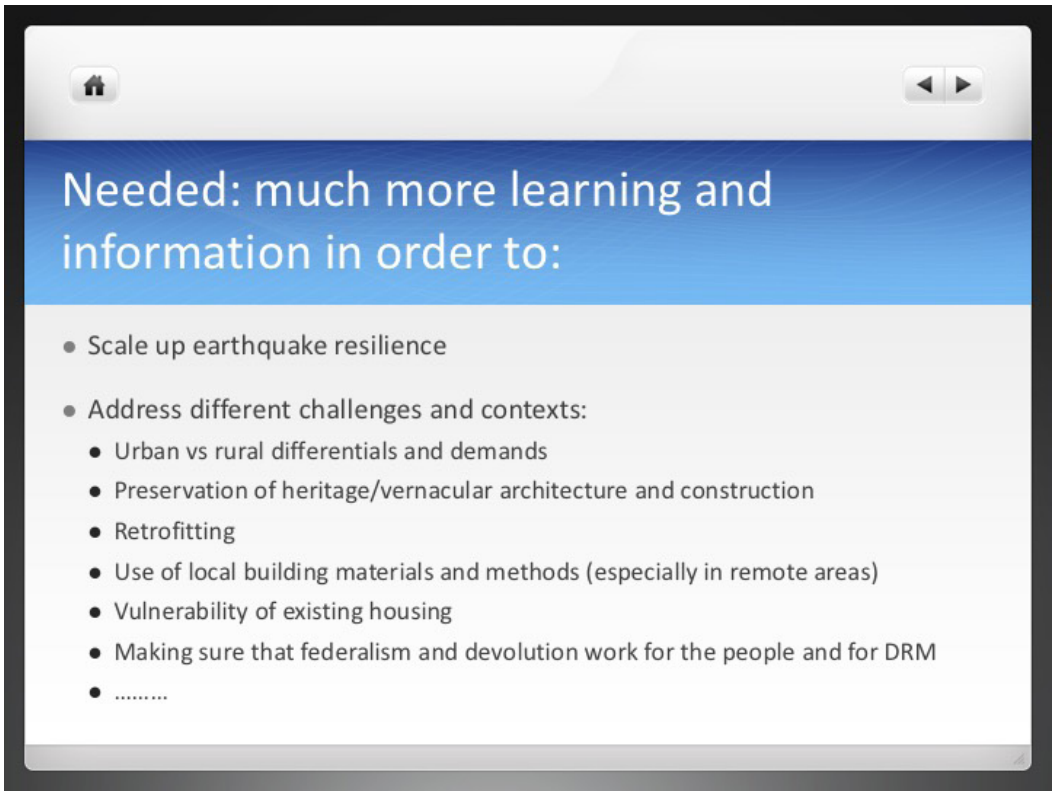
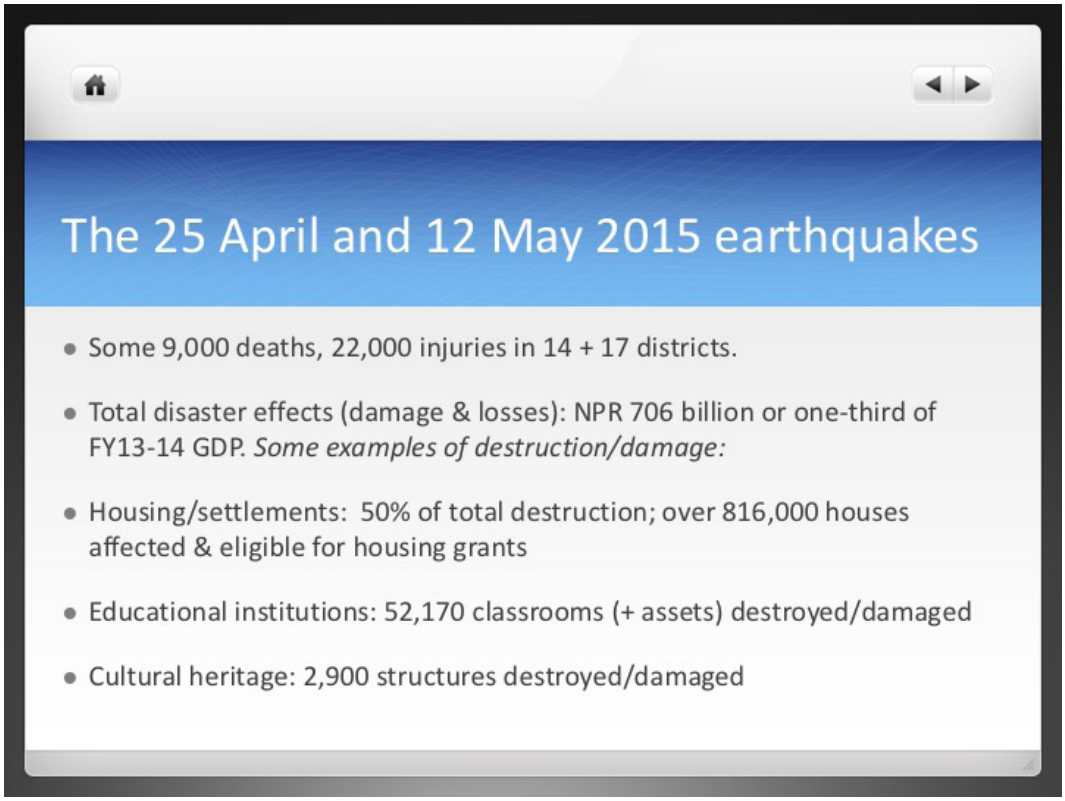
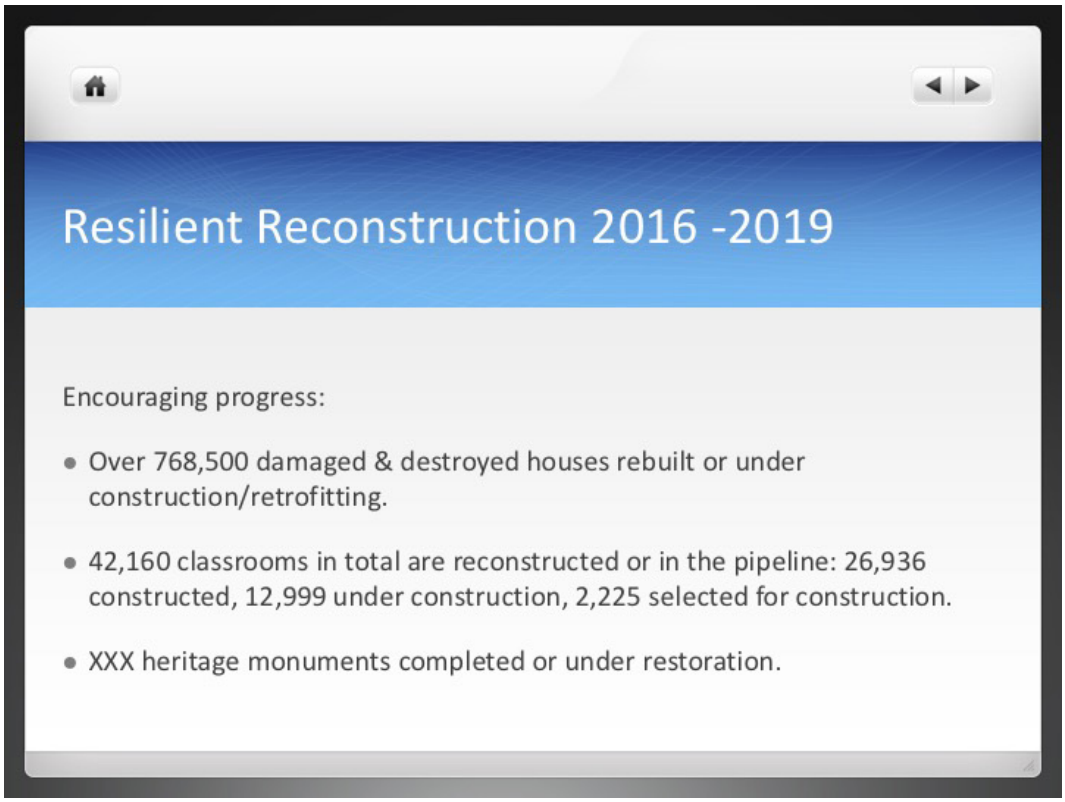
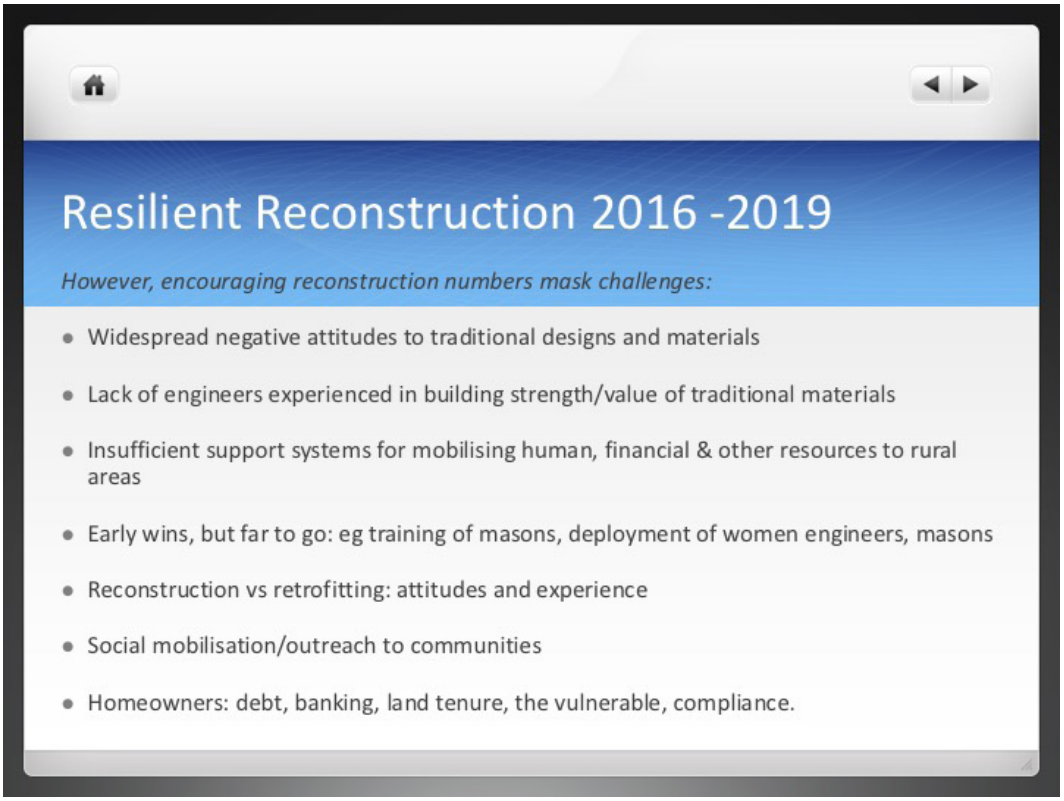
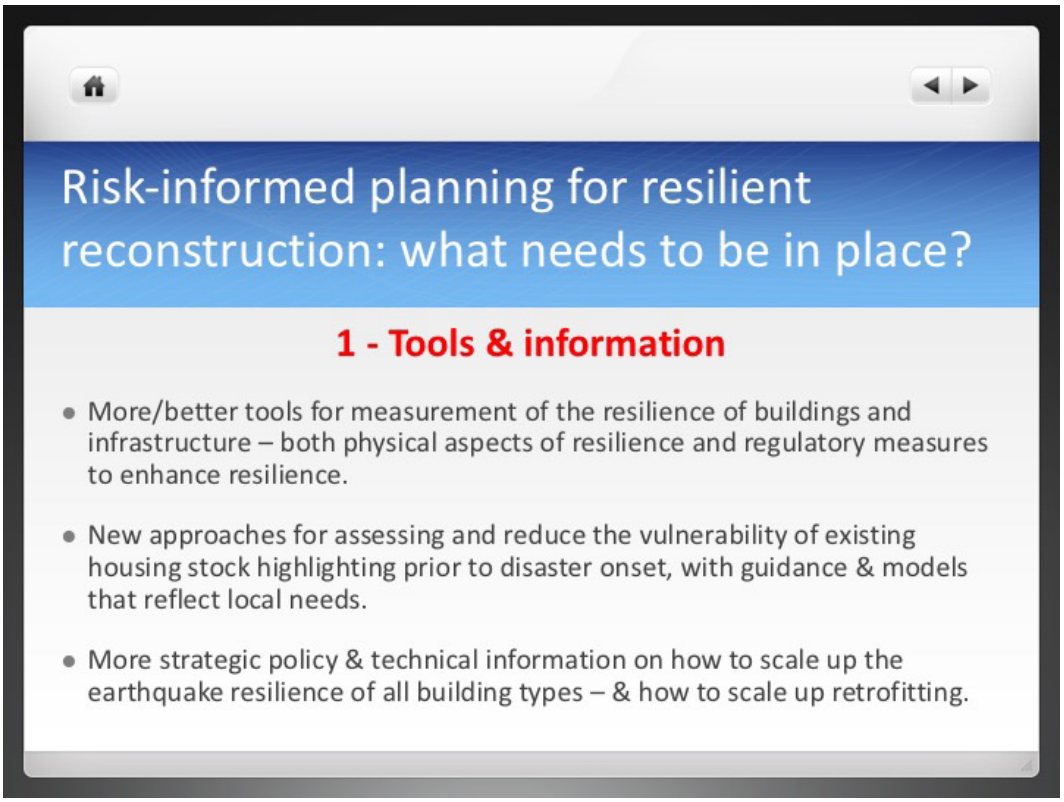

The many facets of resilience
Physical
Regulations, standards and procedures
Economic and financial
Social and cultural
The human factor


Needed: much more learning and information in order to:
Scale up earthquake resilience
Address different challenges and contexts:
Urban vs rural differentials and demands
Preservation of heritage/vernacular architecture and construction
Retrofitting
Use of local building materials and methods (especially in remote areas)
Vulnerability of existing housing
Making sure that federalism and devolution work for the people and for DRM
……


The 25 April and 12 May 2015 earthquakes
Some 9,000 deaths, 22,000 injuries in 14 + 17 districts.
Total disaster effects (damage & losses): NPR 706 billion or one-third of FY13-14 GDP. Some examples of destruction/damage:
Housing/settlements: 50% of total destruction; over 816,000 houses affected & eligible for housing grants
Educational institutions: 52,170 classrooms (+ assets) destroyed/damaged
Cultural heritage: 2,900 structures destroyed/damaged

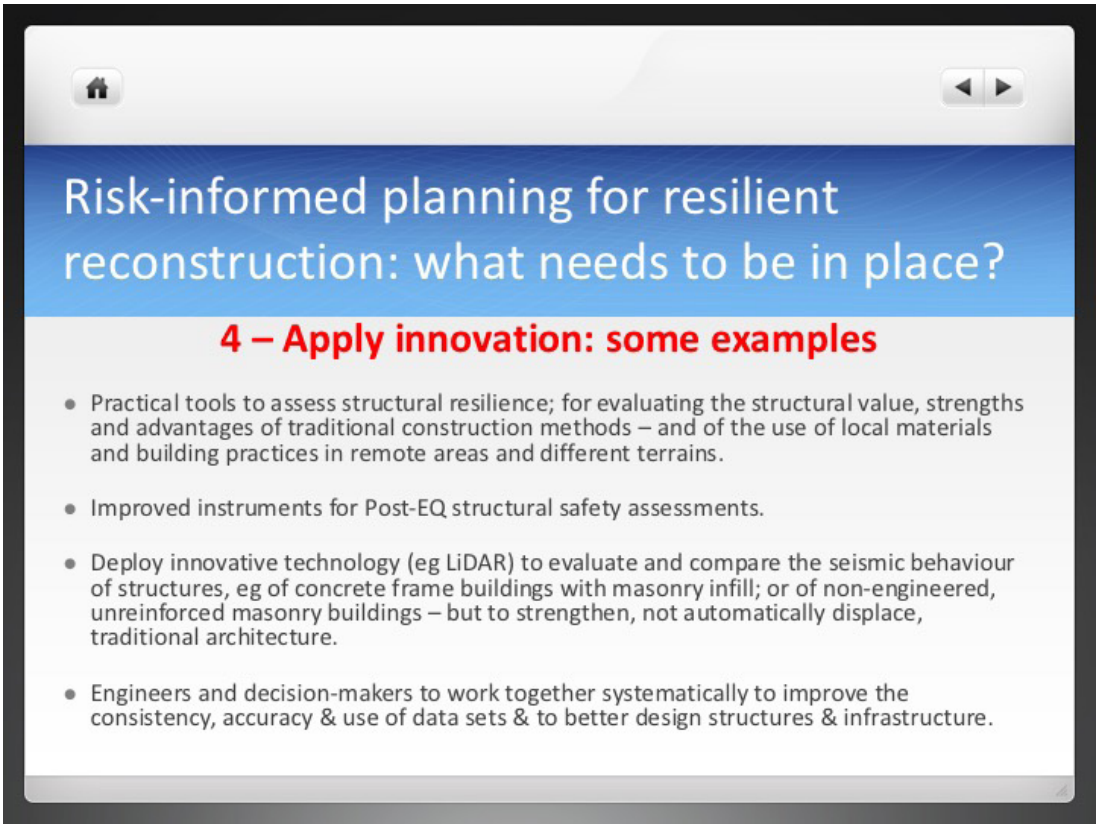

Resilient Reconstruction 2016 -2019
Encouraging progress:
Over 768,500 damaged & destroyed houses rebuilt or under construction/retrofitting.
42,160 classrooms in total are reconstructed or in the pipeline: 26,936 constructed, 12,999 under construction, 2,225 selected for construction.
XXX heritage monuments completed or under restoration.


Resilient Reconstruction 2016 -2019
However, encouraging reconstruction numbers mask challenges:
Widespread negative attitudes to traditional designs and materials
Lack of engineers experienced in building strength/value of traditional materials
Insufficient support systems for mobilising human, financial & other resources to rural areas
Early wins, but far to go: eg training of masons, deployment of women engineers, masons
Reconstruction vs retrofitting: attitudes and experience
Social mobilisation/outreach to communities
Homeowners: debt, banking, land tenure, the vulnerable, compliance.


Risk-informed planning for resilient reconstruction: what needs to be in place?
1 - Tools & information
More/better tools for measurement of the resilience of buildings and infrastructure – both physical aspects of resilience and regulatory measures to enhance resilience.
New approaches for assessing and reduce the vulnerability of existing housing stock highlighting prior to disaster onset, with guidance & models that reflect local needs.
More strategic policy & technical information on how to scale up the earthquake resilience of all building types – & how to scale up retrofitting.


Risk-informed planning for resilient reconstruction: what needs to be in place?
2 – Settlement planning
Much-improved integration of planning/development of service infrastructure & utilities with housing/ settlement planning – requiring dialogue & decision-making with local governments & communities to better meet their service needs.
Focus on settlement planning, not on individual housing support – especially important in heritage settlements, requiring technical support for reconstruction that promotes heritage building designs.


Risk-informed planning for resilient reconstruction: what needs to be in place?
3 – Address specific urban challenges
The significantly higher cost of urban – as compared to rural – reconstruction: small land plots, high land costs.
Community grants for settlement planning and local infrastructure.
Reconstruction of homes amidst terraced housing: address prejudices against traditional materials, risks of variable building value of materials in existing and newly-constructed buildings.
Practical guides to preservation of vernacular structures & construction and for scaling up rebuilding of vernacular architecture.


Risk-informed planning for resilient reconstruction: what needs to be in place?
4 – Apply innovation: some examples
Practical tools to assess structural resilience; for evaluating the structural value, strengths and advantages of traditional construction methods – and of the use of local materials and building practices in remote areas and different terrains.
Improved instruments for Post-EQ structural safety assessments.
Deploy innovative technology (eg LiDAR) to evaluate and compare the seismic behaviour of structures, eg of concrete frame buildings with masonry infill; or of non-engineered, unreinforced masonry buildings – but to strengthen, not automatically displace, traditional architecture.
Engineers and decision-makers to work together systematically to improve the consistency, accuracy & use of data sets & to better design structures & infrastructure.


Risk-informed planning for resilient reconstruction: what needs to be in place?
5 - Federalism/devolution
Government, private sector, engineering profession to collaborate to transfer learning to local governments, strengthen the capabilities of municipalities: regulatory, oversight, technical, financial capacities.
Help enable municipalities to fulfill their responsibilities under the Local Government Operation Act 2017 for integration of disaster preparedness, management and response into local level planning – and to ensure that householders build earthquake-resistant houses.

Risk-informed planning for resilient reconstruction: what needs to be in place?

6 – Improved regulatory frameworks: examples

- Join forces to improve/better apply the National Building Code (NBC) 1994 – eg to include technical updates on retrofitting, vernacular architecture.
- Streamline the laborious, multi-step process of obtaining Building Code permits: revise the Building Act 1998 and NBC.
- Revise the National Procurement Act (eg for heritage buildings/monuments – lowest bid not equivalent to best contract option).

Risk-informed planning for resilient reconstruction: what needs to be in place?

7 – Expand and improve training: examples

- Improve college curricula for engineering and technical programmes , to increase technical skills and awareness for DRM, seismology, earthquake engineering practice, earthquake codes and regulations.
- Producing manuals is not enough: ongoing reinforcement of technical skills is essential, eg prompt and repeated OJT training of engineers, DLPIU technical staff.
- Repeated orientation, training, skills upgrading and monitoring of masons, carpenters, labourers is necessary: once is not enough.

Resilient Reconstruction 2016 -2019

Conclusions

- Document experience; compile, analyse and use data.
- Compile lessons, but learn them and apply them.....

  ..... many "lessons learned" exercises miss out on the actual learning part.
- Join us!

Infrastructure Consultancy Development in Developing Countries

Amitabha Ghoshal[1]

Preamble

Development of Infrastructure is the backbone for growth and development of any country.Systematic growth of a country is entirely dependent on having a robust network of Transport, Communication, Energy production units, Irrigation, Planned Urban Centres, together with adequate provision of Health, Education, Disaster Mitigation, Safety and Security.

Countries in Asia and Africa are today striving to make up for the acute deficiency in Infrastructure, a condition thrust upon them by over two centuries of Colonization, from which they emerged starting from the second half of twentieth century. While most of the countries were directly subjugated as colonies, some others, like Nepal, suffered indirectly, even though they escaped the humiliation of being directly ruled from away countries.Colonial powers carried out selective development of infrastructure, only enough, to plunder the natural resources as could provide the raw material for their industries back home, and for supply of finished goods produced by their industries, at the cost of decimation of the produces in the colonized countries.

The situation started changing with the gradual collapse of the colonization, an indirect effect of the two World Wars, which themselves, were caused by the continuing exploitation by few countries.

1. Challenge For Newly Liberalized Countries

The newly liberalized countries faced the twin challenges of correcting the huge shortage of essential infrastructure on a fast track and the shortage of funds, and more so foreign exchange essential for bringing over technological support, and this included consultancy services.

There was no consultancy expertise available in these countries, the local technical talent having been utilized only for routine construction supervision and maintenance purposes by the colonial masters. This crisis situation encouraged the capable and enterprising engineering talents to set up their own design units, for meeting the immediate needs of the country, initially the less complicated demands that gradually developed into higher level of capability amongst the entrepreneurs. The capability was rapidly enhanced by sending the younger technocrats abroad, to work in engineering consultancy units in developed countries, and the war inflicted shortage of technocrats in countries in Europe helped in raising the demands of good students from developing countries.

It is this trained manpower that helped the consultancy units in developing countries to grow rapidly both in size and in technical prowess. Each country responded according to their own urgent needs, and

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developed by utilizing local available resources of materials, tools and equipments as also skill level among artisans. The areas of development varied depending on the compelling needs of the country and kept on changing with the development process. Thus, in India, while the thrust initially was on developing water resources for augmenting the standard of living of the huge agricultural population, the emphasis shifted to Industry and Defence needs soon afterwards.

The benefit was that, the technology growth was of appropriate nature and could address the needs of the country much faster. With the use of local materials, skill and manpower, the overall cost of development came down, allowing greater return from the limited resources that were deployed. Different brands of technological growth happened, that were perhaps less impressive than those adopted in developed world but suited the countries of origin much better. In their pursuit of growth, the technocrats in countries like China, India, Malaysia etc., reached the standard that allowed them to venture out of their own countries and engineering services were exported against hard competition from the developed world. Initially such services were availed by other developing countries, but gradually their tested strengths were availed by the developed countries as well. Other developing countries are joining this mode of development from within and today increasing number of developed country consultants are setting shop in the developing countries for their own survival and growth.

2. Challenges For Nepal

Infrastructure needs of any country depend on its topography, ecology, geological status, ambitions and perceived needs of its populace. Nepal is no exception.

With combination of hilly terrains and flat lands of the foothills there are variations of demands. Unstable geological conditions, causing high seismic threats and extreme climate condition in winter, makes development of infrastructure a dynamic issue. The ample scope for development of tourism from across the world, thanks to the attraction created by the Himalayas, provide an opportunity for faster economic growth.

The severe seismic event of the recent past, that set back the status of infrastructure in the country, has provided a bigger challenge and underlined the needs of rapid development of infrastructure in areas of Transport, Communication, Water resource management, Energy needs and distribution, and Tourism developments essential thrust areas apart from the priorities of health, education and disaster management.

Nepal has the advantage of its young hard-working population and good trained manpower who have links with the developed world. This resource needs to be mobilized for meeting the challenges. Sharing of experience and knowledge with other developing countries that have similar problems and have solved of their own, can be an effective help for rapid development.

This can be best effected by establishing close links with engineering societies of such countries. Some of the steps for such development can be by:

- Establishing strong bonds with Consulting Engineering associations and academic institutions, starting with purposeful MOUs.
- Exchange of information on relevant and identified projects undertaken successfully by others in a strategic manner.
- Arrangements for participation in skill development programmes organized by target developing countries.

- Exchange of Technocrats for hands on participation in selected projects for rapid transfer of technology, during execution stage.
- Interactions at high Technical level for monitoring and evaluation of effectivity of such exchange scheme.

It is hoped that such systematic interactions will cut down on effective time needs for the development of Infrastructure that needs to be in place on urgent basis.

3. Impact of Digital Revolution

The world is passing through a new Intervention in the way we live and work - the DIGITAL REVOLUTION. Just as the Industrial Revolution and the Electronic Revolution had changed the ways of the human existence, the present new intervention is going to change the way engineering will work and the way we function. Digital Revolution has brought in new paradigms like Artificial Intelligence (AI), Internet of Things (IOT), Big Data Analysis, Cloud Technology and every day new developments are taking place with changes in everything around us. Such developments are beneficial to developing countries like us, Nepal and India, as it gives us an opportunity to catch up with the developed countries in such areas. We have an opportunity to be on the same page so far as the new developments are concerned.

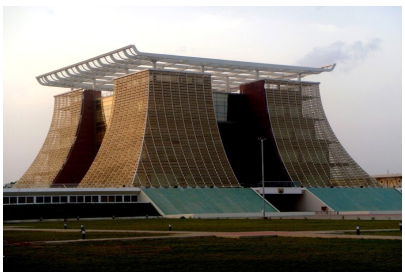
We can now use the benefits of the new developments e.g., use of drones for undertaking survey in difficult terrains at lightning speed, use of robotic equipment for accessing hitherto inaccessible areas, use of larger analytical programs for solutions to complex problems. We all need to take advantage of these developments on immediate basis, if necessary, by training a core team on priority, such that we can achieve a quantum jump in our capability and productivity.

4. Some Examples

Some examples of projects, where developing country partners have worked together and produced world class projects, are provided along with for understanding what benefits can accrue by bilateral interactions.

Dhaka-Chittagong Road 4-Laning

Nairobi-Tikka Super Highway, Kenya



Presidential complex, Ghana

Bhairab Bridge in Bangladesh

Trishuli Suspension Bridge at Nepal

Engineers, Managers,

Planners

and Development

Strategists

FBC

FULL BRIGHT CONSULTANCY (PVT.) LTD.

Key Sectors we work on are:

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- Industry, Trade, and Tourism
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Technical Session 4

Indigenous/Innovative Technologies and Heritage Conservation

Keynote Presenter: Prof. Dr. Sudarsan Raj Tiwari

Institute of Engineering , Pulchowk

Building great since Ancient times

- By 6th Cent. AD, we were already building WH Class – Temple, Chaitya and Irrigation and Water Supply system (Changunarayan, Chabel Chaitya and Satyanarayan)
- Kailashkut Bhawan, 598 AD, Kasthamandap, 7th Cent. AD
  - Plus amazing water works!
- 7th Century AD, Jokhang at Lhasa, and the Tang Chinese
- 13th Century AD, Anika, and the Yuan China
- Our Building technology was known across the Himalaya
  - Brick work, Wood work, Metal work, Gold plating…

Indigenous Technology Is Heritage!

- KVWHS recognized for its
  - architecture,
  - living civilization, and
  - tangible links to development of Hindu/Buddhist faiths
- What makes heritage architecture?
  - According to Vitruvius
    - Venustas, Firmitas and Utilitas
  - According to Mayamata
    - Dwellings constructed (vaastu) for the immortals and mortals primarily on the sites (vastu) on Earth
    - It is perfect, its strong and makes dwellings of the immortals and the mortals.
    - Many eastern analysts say Vitruvius got his definition from Vaastushastra only!

Indigenous Traditional Technology

- Need to know
  - Technology, Materials and Skill and (Knowledge?)
  - Understanding and recognizing traditional technology as technology!
  - Not just as a cultural heritage from the past alone
    - Karunakar Vaidya, Chabilal Gajurel, etc. & Madan Puraskar
- Need to Use
  - Traditional technologies as technology
  - Most are still relevant
  - Their relevance may get enhanced in future
- Research > Knowledge > Innovation > Technology

Traditional Technology for Future

- Study of Traditional Technology can lead to gains on
  - Epistemologies
  - Fundamentalisms in materials and methods
  - Regeneration
  - Practices
- 'Down to Earth' nature of indigenous and traditional technologies can show the pathway, for both of reconstruction and restoration of heritage as well as building future towns ecologically!
  - Excellent performance
  - High prospects of innovation
  - Great Ecological sense of Traditional Technologies
- Two-options of innovation
  - Innovate the modern with the traditional
  - Use the modern to innovate the traditional

Indigenous Technology is Sensitive

- Introduction of 'modern technology' has not been innovative but a disaster on heritage
  - The flooring of Kasthamandap in Telia brick in cement mortar (1968)
  - The brick layers inserted between the I-lohn and the timber post (1968)
  - Concrete 'yo-shi' for Boudda Stupa (1970)
  - Concrete pad as base for 'yo-shi' (2016)
  - The 'Chinese brick' skin on cement mortar on inside of 55W Palace (Gr. Fl. 1974)
  - Dachi skin in cement mortar
  - Piping water into Hiti conduit.
  - Tar-felting under Jhingati tiles – thinned under layer of mud (1978).
- On the 25th year of inscription of KVWHS, it was put on the List of Heritage in Danger (2003-2007)

Piping water into the Conduit

* destroys traditional channels, filter contraption, local pollution seal

…

Research and Experiences – Learning Fundamentals

- Research Build-up
  - Materials and methods
    - Foundations, Walls, Floors and Roofs
    - Process and Skills
  - Observation and Analysis of the action of 2015 earthquakes on restored and reconstructed works
- Experiencing Conservation
  - 55 W Palace (2003-2008)
  - Kasthamandap (2018- 2021)

Notable Indigenous Materials and Methods

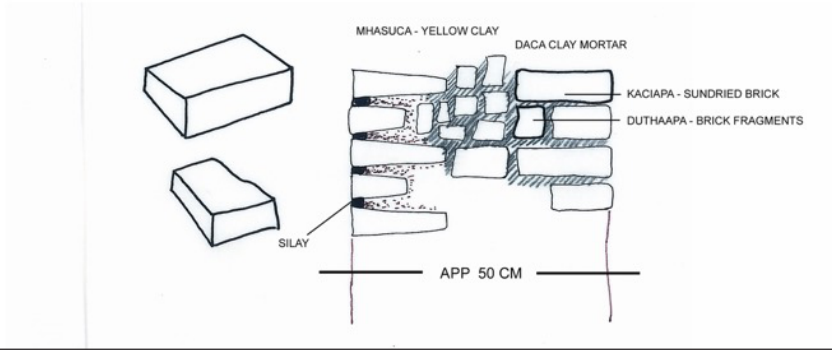
- Dealing with dampness: protecting wood
  - (Suspended Floor in circumambulatory)
    - I-Lohn, Lakasi and Tepu-Lohn
  - Dachi-appa
    - Wedge shaped and Yellow mortar > Gathicha/Mhasucha
  - Lintel and Mikhafusi bricks
- Traditional Roof – Why Copper roof could not be a norm? Why Jhingati was not glazed?
  - Protecting timber rafter – tar-felt disaster
  - saddle tiles
  - mud backing –controlled wetting and drying – the thermal advantage
- Lichchhavi tamralep on stone – Malla glaze on bricks!
  - Malla bricks – (9th Century) … Glazing of bricks
    - use of rain generated moss for rain protection

Tham with Lakasi & I-Lohn under – Suspended Floor (3rd & 4th Ring of Posts)

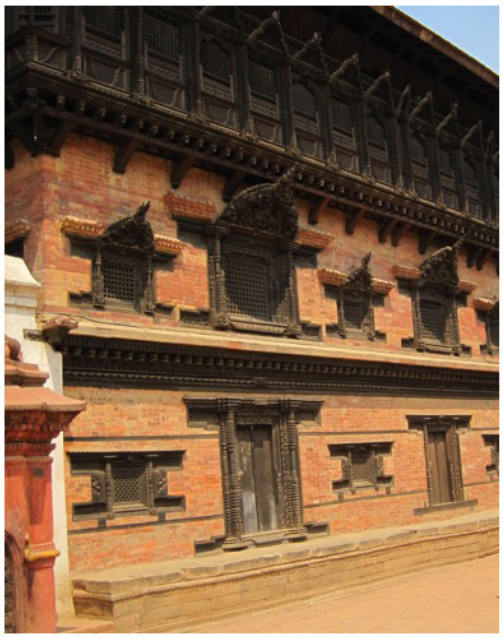
Up-rights (on I-Lohn) & Horizontal Ties for increased stiffness Of corner brick piers (2nd Ring)

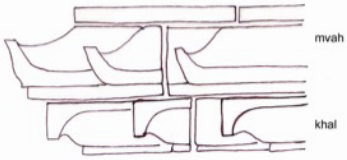
Tham with copper shoes – On Tepu-Lohn Over Brick Wall (2nd Ring)

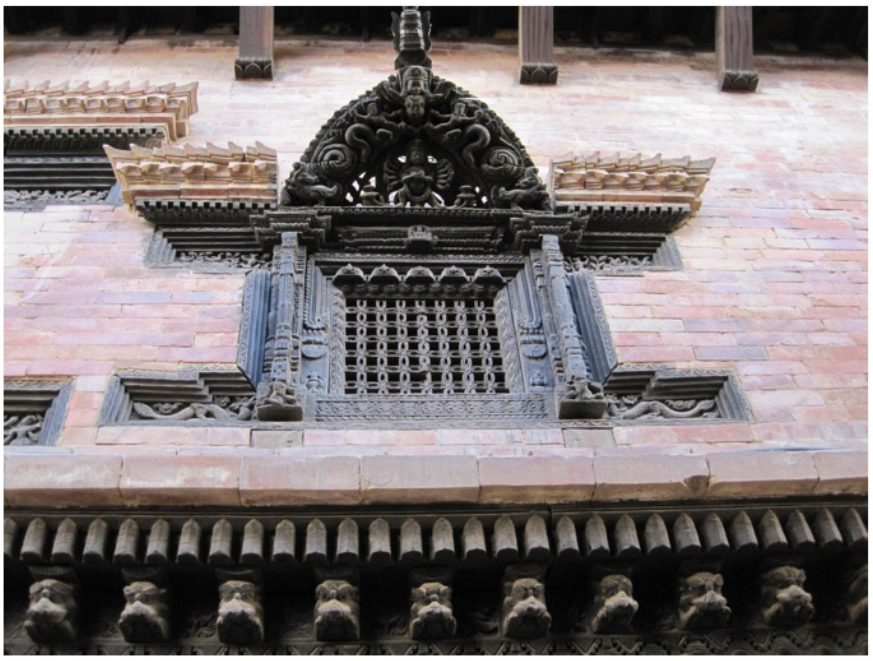
Dachi bricks – wedged and glazed

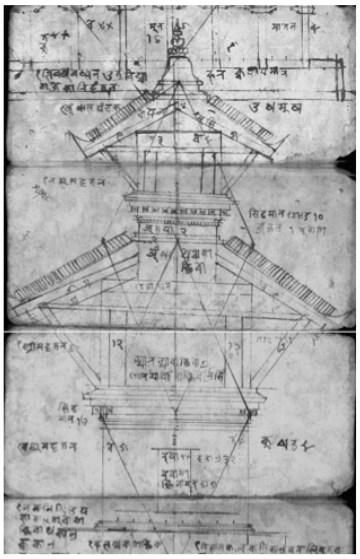


Mikhafusi bricks

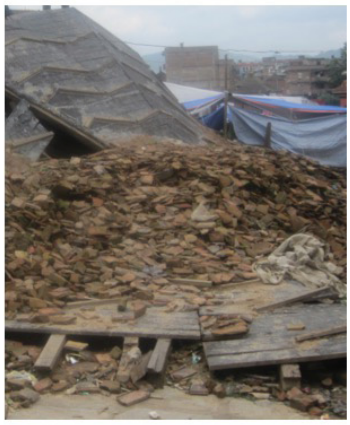








Varying thickness of mud sole (1"-12")



Making Dachi-apa – slip glazing

(from – Gutschow and Shresthacharya)

Brick making: second stage – trimming bricks

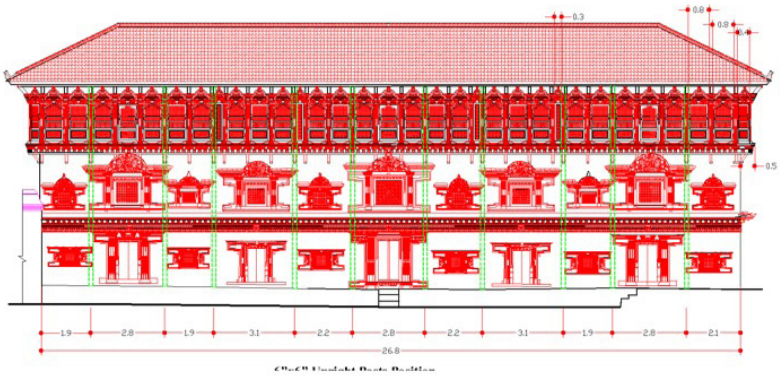
Brick making: third stage – slip glazing

Conservation of 55Window Palace

15 year debate over methods (1988-2003)

Traditional vs Modern

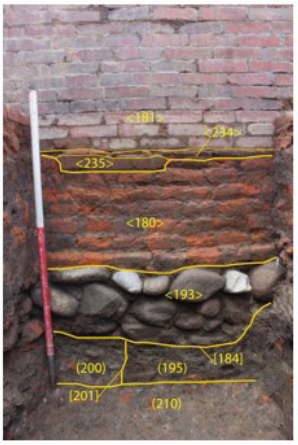
straightening and strengthening main wall with the mural



Back to the Indigenous materials and methods
with dyo-cha, tham, dachi-apa and ma-apa to the best of ability and understanding

A post-earthquake Learning on Innovative Indigenous Building Technology

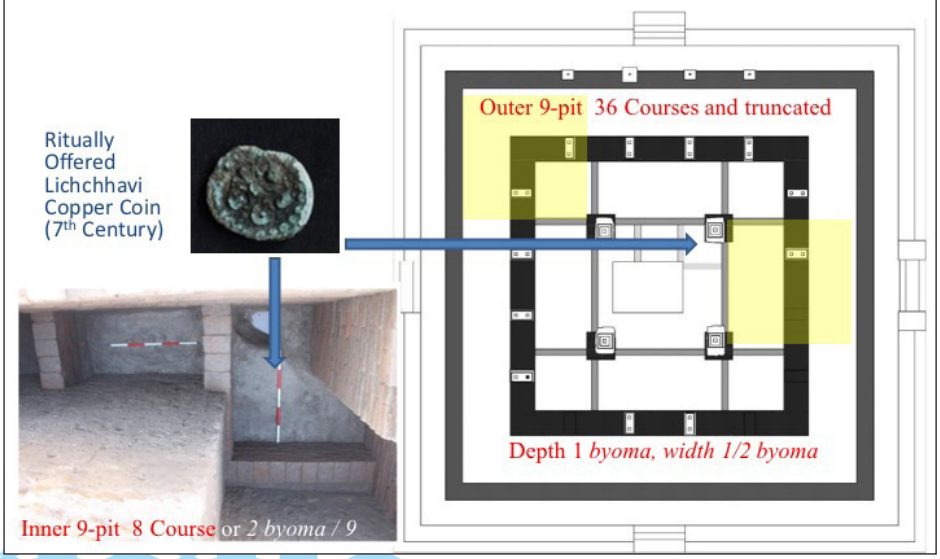
- Technology of Foundations
  - Round River Stone Padding of the Malla
  - Engineered Backfill, Dry brick Packing between walls
  - Mud Mortar in clay : silt : sand :: 1 : 2 : 3

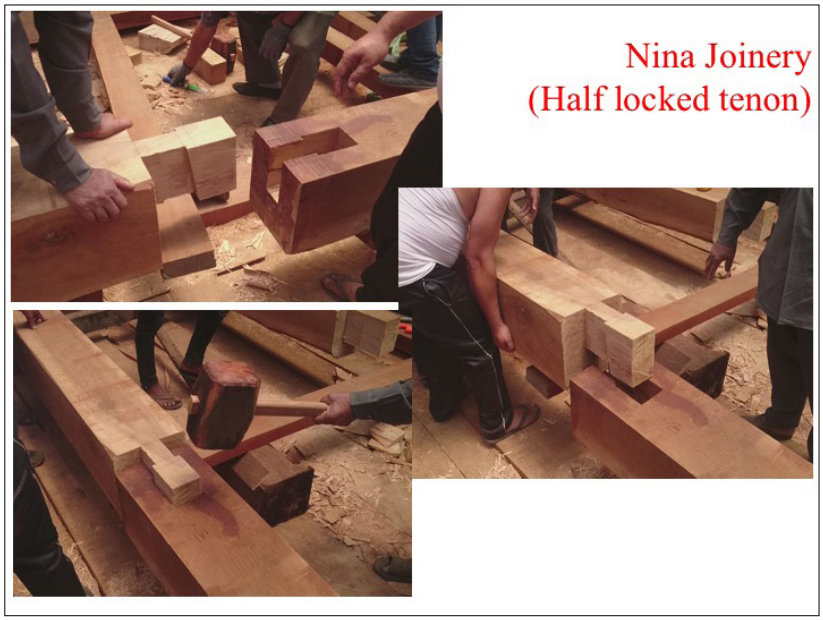


CHARNARAYAN – 16th Century AD construction

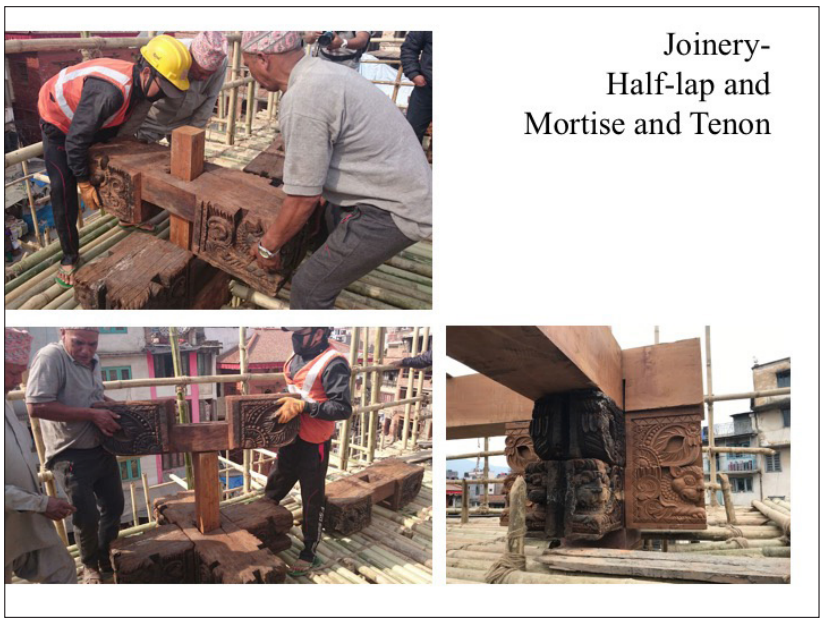
Notice: River Boulder Soling Strip at Bottom – a late Malla innovation

Kashthamandap Foundations




Nina Joinery
(Half locked tenon)


Joinery-
Mortise, Lap and Mitre


Joinery-
Half-lap and
Mortise and Tenon

Joinery – Mortise and Tenon

Conservation of the construction Process

Post-Earthquake Design Lessons Learned on Resilient Reconstruction of Public Infrastructure in Nepal

Arjun Koirala[1]

Abstract

USAID extends support to the Government of Nepal in its reconstruction efforts after the devastating earthquake of April 2015 through many of its programs. This paper highlights the lessons learned during the ongoing USAID's Nepal Reconstruction Engineering Services Project (NRES) that supports to "build back safer" health and educational facilities in the selected earthquake affected districts in Nepal in coordination with the National Reconstruction Authority (NRA), Ministry of Education, Science and Technology and the Ministry of Health and Population. Founding on the Nepal's Post Disaster Recovery Framework 2016 and various Nepalese design guidelines, the paper demonstrates the efforts and procedures adopted to building on earlier successes and investments; construct resilient structure by improving national building code; engage and thus strengthen community resiliency in Nepal's earthquake-impacted disadvantaged communities and build local capacity through effective partnerships and interventions with federal and local government entities, communities, and the construction sectors. The project records the lessons learned with progressive evidences, which can be utilized not only to benefit the larger population affected by the earthquake but also to build resilient community by improving and strengthening designs from seismic considerations; considerations for user friendliness, environment/climatic, disability, least maintenance, community engagement, etc. through stringent quality assurance mechanism.

Keywords: *Reconstruction, quality assurance, resilient community, lesson learned, design*

1. Introduction

The Nepal Reconstruction Engineering Services (NRES) Project supports United States Agency for International Development (USAID) in its efforts to assist the Government of Nepal (GON) to "build back safer" health and educational facilities in Nepal after the devastating earthquake of April 2015. To accomplish this objective, the NRES Project is being implemented through the identification, design, procurement support, and construction supervision of numerous construction Task Orders. USAID executed the NRES contract with CDM International Inc (CDM Smith) on April 24, 2017. CDM Smith is a US based global Engineering and Construction Company delivering integrated solutions across water, transportation, environment and energy & facilities.

NRES, in coordination with the National Reconstruction Authority (NRA), worked with the Ministry of Education, Science and Technology (MOEST) and the Ministry of Health and Population (MOHP) to determine the districts where infrastructure needs were still to be addressed by other government or donor programs. The educational and health facilities in the selected districts were selected based on

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socio-economic, technical and environmental criterion such as disadvantaged community ratio, male-female ratio, community commitment and technical viability, initial and rapid social, engineering and environmental analyses, etc. The selected districts and the facilities were ranked and altogether 18 sites were selected in Kathmandu, Bhaktapur, Makawanpur and Sindhuli districts for reconstruction under the NRES Project of USAID. NRES Project has completed design and all facilities are now in the construction stage.

1.1. Objectives of documenting design phase lessons learned

The documentation and dissemination of design phase lessons learned becomes pertinent as the USAID NRES Project in Nepal has embarked upon reconstructing disaster resilient, community engaged and sustainable health and education facilities. The objectives, therefore, are to document, share and make widely available the design principles and methods to Nepal government, donors, and practitioners that the USAID NRES Project adopted in designing the disaster resilient health and education facilities meeting the framework for reconstruction set out by Post Disaster Recovery Framework (PDRF) 2016.

1.2. Framework and references for design

The PDRF prepared under the leadership of NRA with the engagement of development partners, private sectors, international and national non-governmental organizations and other relevant stakeholders, provides systematic, structured and prioritized framework for implementing recovery and re-construction activities. NRES project has aligned its effort to incorporate the applicable guiding principles to the best possible extent in its scope of providing design and construction supervision services for the reconstruction of health and education facilities.

Various Nepalese design guidelines that outline structural, architectural, electrical, water supply and sanitation, waste management, equipment, furniture and other relevant requirements have also been the primary references for the design of facilities under NRES project. However, evaluation of the completeness and conformity with international minimum standards for seismic design, environmental conditions, disability, safety, etc. have been additions to a larger extent on the part of detailing, which have demonstrated the ways to translate the guidelines into a doable form. Thus, the NRES design process specifically for education and health facilities is relied on a design philosophy that achieves earthquake resistance; energy efficiency; improved natural lighting; accessibility for disabled people; safety; maintainability; constructability; cost effectiveness; and aesthetics. List of documents referred for design are appended in attachment 1.

Besides the above, NRES project adopted inputs from additional components: (i) Community Engagement Plan- as a critical factor throughout the life cycle of the project for the success of the reconstruction of the facilities by mobilizing communities to help prevent and solve problems that might affect construction and/or have negative consequences in the community; (ii) Environmental Mitigation and Monitoring Plan- for screening projects using the site-specific Environmental Review Form to determine the environmental risk of each project phase to determine environmental risk to be moderate.

Workshops for CDM Smith's design subcontractors (SILT Consultants, MRB and Associates, A-Not Architecture N Architects, and Innovative Createers) were organized to build common understanding by orienting them on the overall design process, deliverables, standards for software use and electronic file formats. CDM Smith quality management procedures and approval process of Nepal government and municipalities were also discussed in the workshop.

Early Basis of Design principles were also developed in the workshop which was later fine-tuned with additional inputs from the design subcontractors and CDM Smith team, including Lead Practitioner and Coffman Engineers, Inc from US.

2. Design phase lessons learned

This paper records the learnings gathered by CDM Smith while designing various health and educational facilities in Nepal. The lessons learned are presented hereunder in various headings with reference to the framework that GON elaborated in the PDRF. The framework principles are presented as the titles and the design features responding to the framework are elaborated.

2.1 Provide shelter on site; maintain and restore local livelihoods, culture & traditions

The School Management Committees (SMC), Health Facility Operation and Management Committees (HFOMC), and local community members were guided on the selection and setting up of temporary learning centers (TLC) and temporary health service centers (THSC). Some of the TLCs were adjusted within the existing compound of the facility whereas some were set up in the nearest locations. Three of the Primary Health Care Centers (PHCC) in Sindhuli were set up in nearby locations.

The NRES designs consider local customs to the possible extent. For example, clockwise staircase with odd number of steps; architectural form with courtyard, location and orientation of rooms, toilets, etc. in the directions preferred by the local community have been incorporated. The design respects local culture where Saraswati shrine were proposed in alternate accessible locations in consultation with local stakeholders. The architectural design is based on the traditional/dominant architectural consideration for the district and the building facades are proposed accordingly. This consideration has caused the technical specifications to emphasize more on the maximum utilization of local materials and labor.

Local residents, facility owning committee members, local representatives, municipal representatives, government agencies, and relevant stakeholders were engaged in performing ground-breaking (Bhumi Puja), foundation stone laying, etc. As a part of community contractor agreement, construction contractor is mandated to prioritize the use of local construction workers and local materials providing an opportunity to restore livelihood of earthquake affected communities.

2.2 Reconstruct social infrastructure in a disaster-resilient manner

NRES Project conducted rapid assessment of earthquake affected facilities from technical, social and environmental perspectives and avoided unsafe sites for reconstruction. The sites that were prone to flood, landslide, steep slope, etc. were either screened out or shifted to alternate locations in consultation with local communities.

The National Building Code (NBC) of Nepal was reviewed by CDM Smith's seismic expert, Coffman Engineering Inc, from the United States (US). The recommendation led to designs exceeding from NBC from seismic load perspective. Shear walls were added to cater for the lateral forces. To increase resiliency, designs also provisioned retaining walls, fire rated doors, multiple staircases at appropriate distance, doors opening outward, earthing for electrical lightning arrestors, surge protectors, voltage fluctuation control, leakage current control, fire extinguishers, wider passage, evacuation areas, two separate doors for rooms with occupancy of 50 students or more, etc.

Tender documents and construction supervision processes were designed in a way that caters for resilient construction where construction contractors are made responsible for developing and implementing quality

control plan and health & safety plan; conduct tool-box meetings to train labours on health & safety and deploy full time supervision staff. Towards the completion of construction, contractor would be responsible to provide Operations and Maintenance (O&M) plans, Warranty plans and As-Built Drawings. As a part of community engagement process O&M assessments were conducted and O&M budget were prepared. Written commitments for O&M budgets were received from all municipalities and SMCs and HFOMCs. After the construction is complete, evacuation drills in accordance with prepared evacuation plan and fire extinguisher use training will be conducted.

2.3 Promote use of local materials, furnishings and skills of Nepalese to restore the traditional architecture

Community Contractor Agreement requires prioritized use of local materials and labor. Materials proposed in the design were widely available in local market to ensure promotion of the local businesses. Furniture drawings were provided in order to ease on-site fabrication. The building façades matches with local architecture offering maximum opportunity for the use of local materials and skills.

2.4 Promote principles of build back better and owner-driven reconstruction

The reconstruction guidelines prepared by the MOEST and MOHP emphasize on better layout and enhanced structural requirements as contributors to build back better, in addition to owner driven approach to reconstruction. The NRES design offer complete operable facility – with the provision of equipment, furniture, utilities, landscape, etc. Respective community's buy-in is assured in the form of willingness and partnership agreements. Community engagement plan has been prepared to ensure community's role in design, construction, operation and maintenance of the facilities. The other indicators of build back better, such as child friendly, environmentally safe, energy efficiency, Gender and Social Inclusion (GESI), conducive learning environment, infection controlled clinical environment, efficient spatial planning, etc. have been considered in the design.

2.5 Promote collective settlement

Schools and health facilities, in general, have traditionally remained central in urban and rural settlements, where cities, towns and villages have grown around them. As far as possible, the locations/ sites were located at the same site where the original facility was before the earthquake. If the location had to be changed due to any hazard, then a good location in the middle of same settlement was identified with the support of the local community. This will help to promote communities to maintain their current development process and promote collective settlement.

2.6 Maintain national unity, harmony and resilience; enhance social cohesion

The community engagement plan under the project is a tool to foster enhanced social cohesion- grassroots level common consensus towards one single overarching goal of completing the project. In addition, the design aims at promoting GESI initiatives – particularly female and disadvantaged, inclusion of grass root level communities, and integration of all stakeholder to one goal- construction of resilient community.

2.7 Provide specialized assistance to people with special needs; enhance the coping mechanism of the most vulnerable

Site selection criteria had major socio-economic parameters. The findings were utilized in framing the facilities with inclusive design which resulted into separate girls' toilets, changing rooms, disability

friendly toilets. Being active member of SMCs and HOFMCs vulnerable parts of society gets a say in disaster risk reduction (DRR) and Disaster Risk Management (DRM) planning. Series of design feedback meetings conducted (from concept design to finalization) with the communities had helped incorporating and addressing the special needs of disadvantaged people.

2.8 Ensure access to settlement location & livelihood support

Reconstruction has been proposed at the same location except for the need to shift, maintaining the pre-existing collective settlement. Shift of site was required in some of the cases due to limited land and risk factor such as flood, steep slope, etc. Canteen was provisioned for those schools which had a canteen as one of the bases of income. In addition, canteens were also provisioned in the case of health facilities. These canteens can be rented out for generating funds for operation and maintenance and to meet other needs.

2.9 Develop national capacity and skills to ensure overall recovery

NRES Project also contributes to development of national capacity and skill through training to local staff, design sub-contractors, consultants, construction contractors, communities and laborers by holding lessons learned workshop; collaborating with NRA, Central Level Project Implementation Unit (CLPIU) and the Department of Urban Development and Building Construction (DUDBC) on the updating of NBC.

2.10 Ensure health, safety & wellbeing of the affected population; restore health facilities

The design incorporated elements for improving the educational and health conditions for the catchment area by providing completely operable facility -before/ after (site assessment/ proposed plan). Infection control is ensured by carefully designed clinical spaces, provision of infectious waste management facilities, provision of hygienic sanitary system, and clean drinking water. For the safety purpose, guard rails and fire safety were incorporated. The Adarsha Secondary School at Sanothimi had asbestos sheet on its roof. A safe disposal of debris including asbestos were devised and implemented. The design is in complete compliance with the environmental laws and US Government's environmental regulations for and offers environmental mitigation and monitoring plan, monitoring and reporting systems.

2.11 Address psychosocial and mental health needs of earthquake affected population

Gorkha earthquake left general population specially children in Trauma where they were afraid to use their houses and schools. By engaging them in the design process where architects and engineers explained the additional measures taken to make the new buildings safe. It is therefore expected to help mend the traumatic effects to some extent. After the final selection of the site, multidisciplinary team collected the requirements consulting the respective communities. Thus, community inputs were included in the design process to establish community trust on resiliency of reconstructed facilities. The communities were made aware of the structural considerations taken on the design to sustain the earthquake intensity comparing with that of Gorkha earthquake.

2.12 Strengthen and re-establish functional maternal, new-born and child health care

The design incorporates pre- and post-natal facilities, and birthing facilities. The facilities are more friendly to the women with aattached toilet for maternity ward, privacy for gynecological patients, with appropriate waiting areas and care-takers unit so that the patient party can stay linger in the case of need.

2.13 Provide children and youth with access to quality and safe learning environment

The following aspects were considered in the design: child friendly classrooms (appropriate furniture for students of different age), furniture and walls with round edges, writing boards below sill level for

primary students, hooks for displaying art work, interactive display boards, corner shelf, carpeted floors in the early child development classes, use of natural sunlight for heating rooms, attractive colors for kids, use of natural ventilation and insulated roof, safe (treated) drinking water, play grounds, segregated courtyards based on age group, provision of complete furniture and equipment for completely operable facility, support in the preparation of Education Quality Improvement Plan for schools and Health Service Quality Improvement Plan, infection free clinical spaces- separated OPD/ In-patient zones, boundary walls, and complete utilities (water supply, drainage, sanitation and electricity).

2.14 Strengthen the preparedness and risk reduction capacity of the education system

For each school evacuation plans were prepared. In addition, after handover activities such as earthquake drills, training on using fire extinguisher, etc. will also be provided. Measures for lightening arrestor, leakage of electric current, slope protection, etc. which help mitigating multi hazards were incorporated in the design to increase the capacity of the education system. A careful building planning for obtaining safe layout maximizing the available space had been considered in the design.

2.15 Mainstreaming Gender Equality and Social Inclusion throughout the recovery and reconstruction process

Out of the earthquake affected districts, Makawanpur and Sindhuli districts were ranked among top based on the population of disadvantaged groups. Within the districts, the number of girls and the students from disadvantaged communities and the number of disadvantaged populations served by respective health facility have been the primary criteria for the selection of the facility. A system has been devised to monitoring and report on the SMC and HFOMC meetings which takes the account of women and disadvantaged group's participation. There are sperate changing rooms, toilets (even with separated entrance) in the schools for the girls. The facilities are handicap accessible following the Americans with Disabilities Act (ADA). These designs to become future social norm- can be replicated in future designs by others, it has required level of details. In addition, the NRES Project also provided GESI advisory support to NRA to help sensitize, initiate and implement GESI activities.

2.16 Protect environment and forests in improving DRR and climate resilient sustainable development

Environmental requirements of both the Nepal and US governments have been followed in the design. The following considerations have been taken: EMMP, pesticide evaluation report and safer use action plan (PERSUAP), safe disposal of debris in the designated areas identified by local government. colour coded bins, infectious waste management, protecting natural habitat during site selection, clean drinking water, lead free paints, reinforced cement concrete buildings, hygienic sanitary network, energy efficient fixtures, high ceilings with ceiling fans to take advantage on natural environment, ground water recharge through storm pits, building plan and landscaping considering least cutting of tress and tree plantation in the case of tree-cut.

2.17 Promote innovate technologies and approaches for water, sanitation and hygiene facilities

The design has proposed use of separate drinking water supply loop connecting water points to reduce the cost of filtration adopting appropriate filtration methodologies. Water saving taps are proposed. Silt traps are proposed to protect silting in Ikha Pokhari (pond) in the premise of Kanya Mandir Secondary School.

2.18 Establish enabling environment for tourism

Considering project focused on reconstruction of education and health facilities hence, NRES did not worked on this component of PDRF.

2. Conclusion and way forward

The recovery framework is applicable for wide range of reconstruction activities, hence the NRES design scope focused only to health and education may not necessarily have opportunity to extensively incorporate all elements to the same depth. However, NRES Project has been successful in encompassing 17 framework conditions of the PDRF out of 18 (as one of them was not in the premise of scope of NRES Project). Review of NBC and recommendations to strengthen designs from seismic considerations; considerations for user friendliness, environment/climatic, disability, least maintenance, community engagement from the initial assessment stage to conceptual design and finalization, etc. have been key in the designs. The NRES design offers details that can be included while reviewing guidelines of the government. Engagement of local architectural and engineering firms as subs to CDM Smith has helped raise the competence of local firms. The design approval and building permitting process was duly respected and obtained for each of the facilities from both the central and local level authorities.

As next step, it would be beneficial if relevant Government agencies involved in preparing type designs, specifications, building codes, reconstruction, approval of designs, issuance permits; Professional societies of engineers and architects; Local design firms; and donor agencies particularly involved in/supporting reconstruction of health and education facilities could come together and make a joint effort to discuss improvements in currently implemented type designs and policy documents to meet the complete intent of PDRF.

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Pedestrianization for Sustainable Urban Mobility for Better Tomorrow: A Vision for Harmonized Resilient Society

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"God made us walking animals – pedestrians. As fish needs to swim, a bird to fly, a deer to run, we need to walk, not in order to survive but to be happy" - Enrique Penalosa, Former Mayor of Bogota, Colombia

Abstract

Majority of global population resides in urban area and urban population is increasing throughout the world. Nepal is one of the country with fastest growth of urban population. Cities are the engine of economy and the urban transport is the oil of engine. But urban life has become very hectic and isolated within the crowd of people. Various cities have adopted various modes of urban transportation modes to fulfill the mobility of urban dweller to meet the need of reaching from one place to the desired destinations.

Many cities have adopted the policies of sustainable urban transportation according to their preferences based on economy, environment and social system. European commission has issued a Green Paper on the pursuit of such a policy for European cities. Green paper focuses in five sustainable urban mobility (Stead 2007); - free flowing towns and cities, greener towns and cities, smarter urban transport, accessible urban transport and safe and secure urban transport. For mobility of people and freight combination of motorized and non-motorized transport modes are used. Preference of new world trend is seen for the non-motorized transport for the sustainability of the urban life which encompasses environment, economy and social aspect that felicitates resiliency and harmony in the urban society.

This paper highlight the importance of pedestrianization to achieve resilient urban mobility with sustainable and harmonized urban life. This will also bring the attempt and endeavor of cities on pedestrian focused urban transport elsewhere in the world.

Key words: *Pedestrianisation, urban sustainability, resilient mobility, walkable city, harmonized society, enhanced personal mobility.*

1. Global Trend of Urbanization

World Population now is at the range seven billion. Population will reach nine billion in 2050. Now 50% world population is urban and increasing every year. Urban population is more than 80% in developed countries and Nepal has only 20% urban population. Two third of world population will be urban in 2030

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reaching five billion people residing in the cities. Rural population will shift to urban area, this is global phenomenon, which is rapidly taking place in developing countries.

Now 90% of urban dwellers are breathing unsafe air, resulting in 4.2 million deaths due to ambient air pollution. More than half of global urban population exposed to air pollution levels more than 2.5 times higher than safety standard. Till the period car has been the focused consideration in design and planning of urban areas. Car is no longer a status symbol in developed countries. Many cities are giving priority for non-motorized transportation – cycle path and pedestrianization on environmental and social ground for sustainable urban mobility.

2. Walkability and Pedestranization

Walkability is a measure of how friendly an area is for walking. Factors influencing walkability include the presence or absence and quality of footpaths, sidewalks or other pedestrian rights-of-way, traffic and road conditions, land use patterns, building accessibility, and safety, among others. Walkable neighborhoods give residents and businesspeople greater opportunities to mingle while they work, shop and dine, enhancing their sense of community. In addition to traditional health benefits, increased social interaction can improve individuals' health and happiness. Walkability is the function of mobility, while pedestrianization is the means of walkability that considers during the planning and implementation providing favorable infrastructure. Walkability is the fundamental of sustainable of urban mobility. It has benefits to all the parameters of sustainability –social, environmental and economic benefits. Walkability **is** *an important factor in* **livability** *of cities, because it promotes active forms of transport. Increasingly physically inactive and sedentary lifestyles* are *a global health problem and that contribute to around 3.2 million preventable deaths a year.*

3. Urban Transportation Problems in South Asia

Density of urban population has its role in efficiency of mobility in urban area. Density of urban population is higher in LDCs – Bangladesh, Pakistan, India etc, 44400/sq. km, KTM 34th highest with density of 17800/sq.km. Cities of developed countries less dense at the range of 2000 – 4000/sq.km. Suffers most from traffic jams & congestion - cause of excess energy use. Vehicle cannot move in reasonable/desired speed. Urban expansion largely haphazard. Inadequate roads, unbalanced urban development, no adequate expansion outside. Government's inability to manage the cities in guided manner, more business complexes in core & central area, generates more traffic. Reckless road user behaviours, streets and vehicle often ill maintained.

For elderly visitors to Swayambhunath, even crossing the road is a hazard

Elderly worshippers, who visit Swayambhu every day for the kora, fear that expansion will only make the Ring Road section more dangerous.

Women cross a busy road in Swayambhu, Kathmandu.

The Kathmandu Post 15 Nov 2019

Facilities to pedestrians and cyclist is severely lacking. Existing infrastructures in South Asian cities are dangerous to pedestrians. Many pedestrian are killed. Public transports are not attractive, overcrowded & poor state of vehicle. Traffic system is chaotic, unreliable, dangerous and socially inequitable. Thus the urban life of average people is poor.

Pedestrian panicking in Kathmandu: The newspaper coverage is evident that pedestrians have panicking experience during the walk in the city. Crossing a road is a hazard. Pedestrians killing are the frequent news in Kathmandu and many other South Asian cities.

4. SDG and sustainable mobility

Enhancing walkability help in achieving SDGs also. Urban transportation is directly related with four sustainable development goals:

Goal 3: Good Health and Well Being: Walking helps in individual's health.

Goal9: Resilient Infrastructure. Transport infrastructure for walking is not a complex structure requiring very high cost, is thus a relatively resilient infrastructure.

Goal 11: Sustainable cities and communities. Walking is the sustainable mode of mobility and more friendly for community and neighborhood interaction.

Goal 13: Climate action. Walking reduces the use of vehicle, which in turn reduces the use of fossil and do not emit the greenhouse gas.

5. Benefits of Walkable Streets

Adele Peters (Adele 2016) wrote a report on "Fifty Reason Why Everyone Should Want More Walkable Streets" in series of World Changing Ideas. This idea give us the insight of making us live longer to making cities more resilient. Walkable city is sustainable and resilient. Fifty reasons are elaborated in the report which can be divided broadly in six categories of benefits;

Health Benefits: Walking help people live longer. Inactivity is fourth leading cause of mortality worldwide. Physical activity dropped 32% in last four decades in U.S., 45% in two decades in China. For people over 60, walking just 15 minutes a day can reduce the risk of dying by 22%. It helps people lose weight. A 30-minute walk can burn 100 calories. It reduces the risk of chronic disease. Regular walking reduces risk of diseases e.g. diabetes, heart disease, and colon cancer. It makes people happier. Researchers found that if someone shifts from a long commute to a walk, their happiness increases.

Safety Benefits: It improves traffic safety. More than 270,000 pedestrians are killed worldwide every year. Better pedestrian facility help reduce the risk of crashes. It brings back "eyes on the street". Encouraging more people to walk is a cheaper way of increasing surveillance and making streets feel safer. It reduces crime in other ways. Making streets more pleasant also has the added benefit of reducing crime. In Kansas City neighborhood, crime dropped 74% after some streets pedestrianized on weekends.

Social Benefits: It makes neighborhoods more vibrant. More walkable, safer and more attractive streets make people want to spend more time in them, bringing vibrancy back to neighborhoods. It enhances the "sense of place". Spending time walking through a neighborhood, helps people have a better sense and more likely to want to help take care of it. It's a driver for creativity. If a neighborhood is walkable, it's more likely to become home to public street activities - art and open-air events; conversely and cultural events. It's a universally accessible. Walking is universally accessible, do not need driving skill. It fosters social interaction. More likely to know their neighbors. It strengthens community identity. As people interact

more on streets, that also builds a sense of community. In Ireland, study found that people in walkable neighborhoods had 80% more "social capital". It connects people across generations. The elderly, young people, children all ages of people meet each other. It builds inclusiveness. Better design for walkability makes the whole city more accessible to everyone.

Economic Benefits: It boosts the economy. Pedestrians spend as much as 65% more than drivers. It boosts employment. In Dublin, pedestrian-friendly neighborhood led to a 300% increase in employment. Overall, biking and walking provide an estimated return on investment of $11.80 for every $1 invested. It helps local businesses. In Brooklyn, redesigning a parking lot into a pedestrian plaza boosted retail sales 172%.; In Portland, Oregon, drive 20% less saved more than $1 billion, and much of that goes back to local businesses. It helps make people more creative and productive. Research suggests that walking boosts creative output an average of 60%, more likely to be productive, improve memory, and make better decisions after exercise. It improves a city's brand and identity. Barcelona, which has worked on improving public spaces and walkability since the 1980s, has seen its number of annual visitors grow 335% over the last two decades. It increases tourism. In London, Trafalgar Square saw a 300% increase in visitors after pedestrianizing. It encourages more investment. The High Line in New York led to $2 billion in private investment in the neighborhood around the park. It attracts the creative class. Skilled professionals tend to migrate to walkable areas; the most walkable neighborhoods have much higher GDPs per capita, and more college graduates. It increases land and property values. Safer, more accessible, and more livable, property values rise. It shrinks the cost of traffic congestion. Less stuck in traffic on roads, benefits the economy. It saves money on construction and maintenance. Sidewalks are more affordable. Investing in sidewalks also brings health and air quality benefits worth twice as much as the cost of construction. It reduces health care costs. The U.S. spends $190 billion on obesity-related illnesses alone. It decreases dependency on nonrenewable resources. World only have 56 years' worth of oil left. Walking, by contrast, can generate energy by installing energy-harvesting sidewalk tiles.

Environmental Benefits: It minimizes land use. It enables people to easily live in denser neighborhoods. It reduces air pollution. On a single car-free day in 2015, Paris cut smog by 40% in parts of the city. It can improve health as the air grows cleaner and can help cut a city's carbon footprint. It cuts ambient noise. Lessens traffic noise. On Paris's fist car-free day, sound levels dropped three decibels. It helps improve urban microclimates. Prevents from vehicular emission. It can improve water management. Sidewalks designed with permeable surfaces can help recharge water during rain. It makes cities more beautiful. In Chicago, they make up 70% more landscape. It increases active use of space. In Copenhagen, as the city became more pedestrian-friendly over the last few decades, the number of people sitting in squares making use of city space tripled. It makes better use of space. Streets that are redesigned to become more walkable also tend to incorporate underutilized space next to roads. It encourages people to drive less. After Copenhagen pedestrianized its main street, foot traffic increased 35% in the first year.

Livability and Other Benefits: It also promotes public transit. If walkway is good from their home to station, it's more likely that they'll want to use public transit. It increases permeability. Walkability can also make cities more "permeable," or easier to move around, creating a walking network. It bridges barriers. Pedestrian infrastructure reconnects parts of the city that have been disconnected by older infrastructure. It makes cities more competitive. Walkability is directly connected to livability. When Melbourne redesigned its center for pedestrians, it saw an 830% increase in residents, and it was recognized as The Economist 's "world's most livable city". It builds political support. After the mayor of the Spanish city of Pontevedra decided to go car-free in 1999, the public loved him allowed him to continue for fifth term. It builds

engagement. People more likely to feel attached, and to engage in improving the city in general. Crowd funded public projects are growing in many cities. It encourages more stakeholders to participate. In L.A., the city is building more participation by helping neighbors transform underused roads into pedestrian spaces. It inspires civic responsibility. Walkability brings people together with other community members, which increases a sense of responsibility. Mexico Cities who defends pedestrians on city streets, helped build political support for the city's new commitment to zero traffic deaths. It promotes sustainable behaviors. In Canada, a study found that if people drove one less day a week, it could reduce 3.8 million tons of greenhouse gas emissions a year. It helps make cities more resilient. Walkability makes cities more resilient in disasters. It's a tool for urban regeneration. In Madrid, a walkable park along the river led to investment in new sports areas, plazas, cafes, and the renovation of historic landmarks. It allows for flexible micro-solutions. It supports cultural heritage. Pedestrianization around a cultural landmark help effort for preservation. As Beijing quickly modernized, the city pedestrianized several ancient, narrow streets–bringing new visitors and saving part of the city that otherwise might have disappeared.

6. Walkability Index

Various walkability index is prepared to measure the walkability of cities. Walkability index by GWI Method (Minhas et.at, 2017) has included nine parameters - 1. Carriageway modal conflict. 2. Walking path availability. 3. Crossings availability. 4. Safety of grade crossing. 5. Behavior motorists. 6. Amenities availability. 7. Disabled infrastructure. 8. Obstructions and barriers. 9. Safety against crime

Walkability Assessment in a Rapidly Urbanizing City and Its Relationship with Residential Estate Value (Zhang et.al 2019) classified cities with walkability index in four categories;

80–100: Walker's paradise: daily errands do not require a car

60–80: Very walkable: most errands can be accomplished on foot

30–60: Somewhat walkable: some facilities are within walking distance

20–30: Less walkable: a few facilities are within walking distance

0–20: Car-dependent: almost all errands require a car

The 10 Most Walkable Cities in the World according to the Helen Armitage's report on Culture Trip (www.thculture trip.com) on 10 July 2018 are – 1. Florence Italy. 2. New York USA. 3. Marrakesh, Morocco. 4. Paris, France 5. Vancouver, Canada. 6. Buenos Aires, Argentina. 7. Dubrovink, Croatia. 8. Melbourne, Australia. 9. Boston, USA and 10. Vientiane, Laos

Florence Italy New York, USA Marrakesh, Morocco Paris, France

Vancouver, Canada Buenos Aires, Argentina Dubrovink, Croatia


Melbourne, Australia


Boston, USA


Vientiane, Laos

Gulyangyu, Xiamen China is the pedestrian only city, annual tourist visit is 2 million. This town is very famous tourist attraction in Xiamen. There are many other cities converting the heritage area, tourist area, commercial market being converted to pedestrian only streets. Many cities are building dedicated walking lane and wider sidewalks more friendly to pedestrians.


Gulyangyu, Xiamen China


Khao San Street Bangkok


Doha Qatar


Orchard Road, Singapore


Bhaktpaur


Basantapur, Kathmandu

Previous studies and reports recommending pedestrianiazation in Kathmandu:

JICA 2012 report on Traffic Improvement in Kathmandu Valley (page 16-17) made the following recommendations:

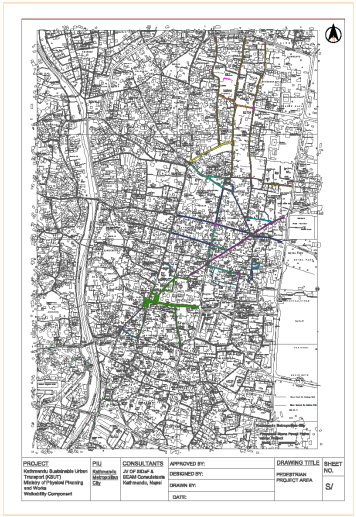
Pedestrian: 1) Pedestrian at central area: Separation from vehicles is crucial in the central commercial and heritage areas where walking is the most important travel mode. 2) Pedestrian network: Establishment of a pedestrian network plan as the most primary travel mode.

Bicycle: 1) The topography in Kathmandu Valley is generally gentle and the trip length of daily travel in Kathmandu Valley is adequate for bicycle use. 2) Therefore bicycle has potential to become citizens' means of daily transportation. The future M/P shall take into account of latent possibility of bicycle use in Kathmandu Valley.

Non-motorized Transport (NMT): 1) Promotion of walk and bicycle will not only contribute to decreasing the vehicles but also contribute to improve environment in air quality and noise and to decrease the energy consumption. 2) The future M/P shall contain establishment of network and facilities for Non-Motorized Transportation including pedestrian and bicycle by scrutinizing the strategy.

Kathmandu Walkability Study 2018 by Resource Centre for Primary Health Care (RECPHEC) found Kathmandu footpaths in very poor side in terms of width of footpaths. Less than 2 feet wide footpaths are 28%, 50% footpaths are 2-4 feet in width, 24% footpaths are 4 to 6 feet and footpaths more than 6 feet are less than 1%. It shows that walkability of Kathmandu is very poor.

Kathmandu Sustainable Urban Transport Project (KSUTP) had planned to improve the walkability in historic core of Kathmandu by improving the sidewalks and converting some core areas to pedestrian only streets. Sidewalks works royal palace, between of Singha Durbar and Bhadrakali, right bank of Bagmati River from Thapathali to Teku confluence and some are was implemented. But implementation of Thamel area, Ason area and Basantapur Durbar square area could not be implemented.



Conclusion

Pedestrianization is the basis of sustainability mobility. Walkability of cities is an important indicator to judge the quality of urban life. Pedestrinization is the tool to improve walkability in the cities. This helps in enhancing the harmony in the communities. This helps to improve neighborhood in the society. It improves social capital. It helps to minimize the isolation of senior and old age people, which is a important social concern worldwide. Many researches shows that it improves economic activities in the community and help in creating employment and earning. It improve health. It make environment freindly surrounding due to absence of motorized vehicles, reduces vehicle related emissions and traffic generated dust.

7. Recommendations

Walkability is the indicators of sustainability urban mobility, which can be measured and evaluated in incorporating various parameters. Cities are evaluated to what extent it is walkable friendly. Following are the recommendations for South Asian cities and particularly the cities in Nepal to adopt for the resilient urban mobility;

- Municipalities has to adopt the policy to enhance the walkability of cities.
- Pedestrianization facilities has to be given high priority to achieve sustainability of urban mobility.
- Pedestrian infrastructure should be an integral part of Municipal Transport Master Plan (MTMP).
- Walkability and pedestrian standard to be developed by each municipalities for building pedestrian infrastructures.

- Street specific plan is to be prepared in customized manner, particularly in already built up area.
- Some streets are to be made vehicle free zone making full pedestrianized streets.
- Existing sidewalks to be improved both in terms of width and surface quality.
- Side walk and full pedestrian streets are to be made differently able friendly and accessible to wheel chair and visually impaired.
- Some studies are made for Kathmandu valley, KMC should consider to implement these recommendation to improve the walkability.
- Strong institutional setup has to be established for taking up responsibility and accountability for its operational and maintenance mechanism for sustainability of the urban mobility.
- Newly set up human resource provision in *Palikas* are not adequate, need a strong, motivated and committed pools of technical HR supported by institutional and social team.

Let's enhance walkability for sustainable mobility to create resilient cities.
Let our future generation live in Harmonized society!

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3D Panel Technology for Resilient Infrastructure & Sustainable Development

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Abstract

Annually 3 billion metric tons of raw materials are consumed to manufacture building materials and products. The building industry is the second largest consumer of raw materials, after the food industry. Buildings and associated users are responsible for a large part of environmental load caused by humanity.

Many of the challenges facing humankind, such as climate change, water scarcity, inequality and hunger, caused due to impact on the environment & global warming can only be resolved at a global level and by promoting sustainable development.

The scarcity of natural raw materials, development of new technologies facilitating design of infrastructure resilient to natural disasters are the few challenges faced by the developing countries in their goal to economic development & sustainability.

In the above context, the 3D panel with Green Certification, a versatile product for walls, slabs, roofs, etc., which can replace the traditional brick or cement block, with the properties of heat insulation, sound proof & more importantly Tsunami & Earthquake Resistant, is an ideal solution. The light weight of the panel with less than 50% weight of a standard brick wall, reduces the size of foundation & structure, minimizes the use of natural resources especially sand & clay, resulting reduction in cost as well.

Keywords: *Building Industry, Sustainable Development, 3D Panel, Green Certification, Natural Resources*

1.0 Introduction

Many of the challenges facing humankind, such as climate change, water scarcity, inequality and hunger, caused due to impact on the environment & global warming can only be resolved at a global level and by promoting sustainable development: a commitment to social progress, environmental balance and economic growth.

Annually 3 billion metric tons of raw materials are consumed to manufacture building materials and products. The building industry is the second largest consumer of raw materials, after the food industry. Buildings and associated users are responsible for a large part of environmental load caused by humanity. The primary energy consumption during the production of building materials is estimated as 113 billion tones globally.

The scarcity of natural raw materials, scarcity of skilled labour & their costs, are the main challenges faced by the developing countries in their goal to economic development & sustainability.

In this context, it is vital to find sustainable solutions, which are low in cost and affordable, technically feasible and practical in implementation or construction, while preserving the nature and environment. There are number of new technologies developed by various countries and adopted in their construction industries, especially as a solution for housing, a basic need of human beings.

3D insulated panel technology, steel frame structure systems, insulated concrete forms, eco blocks, pre-cast element construction, slip form wall system, structural insulated sandwich panel, etc., are some of the new technologies developed in the world and being adopted for housing as well as for commercial building construction.

3D panel technology is one of the new technology developed, as a sustainable solution for building construction in providing housing and other needs.

The 3D panel technology enables a high production of low cost housing. This housing also encompasses residential, mid, and high class standing houses, as well as multi-story buildings. This system also allows the building of commercial and industrial housing.

3D panel, which is a versatile product for walls, slabs, roofs, etc., capable of molding to any shape with Green Certification, a product which can replace the traditional clay or engineering brick or cement block. The Construction System consists of panels with a layer of galvanized mesh on either side of an EPS core, welded together by galvanized steel diagonals (trusses) which penetrate through the EPS core. The panels are joined in the desired configuration on site and sprayed with concrete to form a sandwich type construction.

2.0 3D Panel

2.1 History of 3D panel

3D panel is a lightweight, precast, foam concrete building material invented in Sweden in the mid-1920s and widely used throughout Europe, the United States and around the world.

Later, research has been carried out in number of countries, USA, Austria, India, China, etc., and developed it as a light weight, versatile product capable of withstanding natural catastrophes such as tsunami, hurricanes, tornadoes, earthquakes, etc., and with heat insulation & sound proof properties.

2.2 3D Panel Profile Structure

The 3D Panel Construction System is a cost-effective construction system offering a well proven building method using high strength, load bearing modular panels. The Construction System consists of panels with a layer of galvanized mesh on either side of an EPS core, welded together by galvanized steel diagonals (trusses) which penetrate through the EPS core. The panels are joined in the desired configuration on site and sprayed with concrete to form a sandwich type construction.

3D panel (as Fig. 1) includes welded reinforcing meshes of high strength wire, diagonal wire and self-extinguishing expanded polystyrene uncoated concrete, manufactured in the factory. Shotcrete is applied to the panel assembled at the construction site, which gives the bearing capacity of the structure.

3D wire panel after shotcrete has the following five components (as Fig. 1):

a. The outer layer of shotcrete.

b. Welded reinforcing mesh of high wire.

c. The core of expanded polystyrene sheet.

d. Diagonal wire (stainless or galvanized wire).

e. The inner layer of shotcrete.

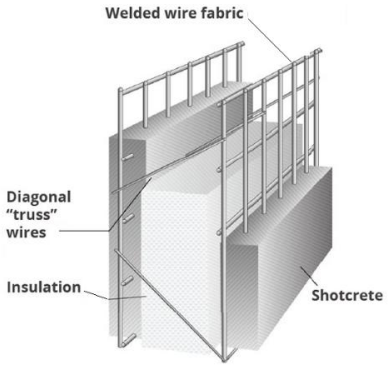

Fig. 1 – Schematic View of 3D Panel

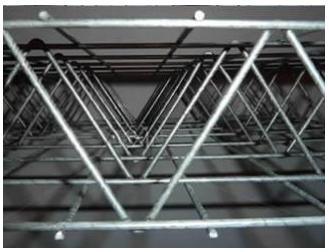

Fig. 2 – 3D Panel without EPS

Fig. 3 – 3D Panel with EPS

2.3 3D Panel Dimensions & Material Properties

The 3D panels are commonly produced and commercially available in the market in following sizes.

a. Length : 2m, 3m, 6m.
b. Width : 1.00m, 1.15m, 1.20m.
c. Thickness : 50mm (for internal non-load bearing walls), 100mm (for internal load-bearing walls), 120mm (for exterior wall).
d. Weight : 25kg (3 × 1.2m panel)

The reinforcing welded mesh of high-wire are of following properties and available in following sizes to cater for different load bearing requirements.

a. Materials : Low carbon grade, and galvanized wire.
b. Reinforcing mesh wire diameter : 3mm - 4.5mm.
c. Mesh size : 50 × 50mm, 50 × 100mm, 100 × 100mm.
d. Diagonal wire stainless steel or galvanized wire diameter : 3mm- 4mm.
e. Step laterally : 100 or 200mm.
f. Step longitudinally : 100mm or 200mm.
g. The distance between the mesh and Polystyrene : 16mm (for infill walls), 20mm (for load-bearing walls).
h. The number of diagonal bracing rods : 100 pieces per Sq. m.

Polystyrene is a polymer that is cheap and easy to process. Expandable polystyrene consists of micro-pellets or beads containing a blowing agent (usually pentane). The expanded or foamed polystyrene is thermally insulating, has high impact resistance and good process ability. The core of expanded polystyrene will be with following properties & thicknesses

a. Material Properties : Polystyrene foam P-25, P-35
b. Thickness : 50mm / 100mm /120mm / 150mm. (for exterior walls 120mm, / 150 mm, internal - 50mm / 100mm).

Expanded polystyrene is selected as the core because it is eco-friendly and durable material, supplying not only high thermal insulation, but also a good resistance to fire, and therefore fire safety. It increase the service life and durability as polystyrene foam is virtually inert and does not absorb moisture and resistant to decay.

The finished design, after the establishment of reinforced 3D panel at a construction site, it will be covered with 2 - 3 layers of concrete through shotcrete method using plaster station or hopper gun. The outer and inner layer of shotcrete shall be 50-60mm.

2.4 Advantages of 3D Panel

3D wire panels has the advantages in terms of energy consumption, thermal protection, thermal insulation, comfort, simplicity, speed and cost of construction, strength and durability.

Strength and rigidity of the panels result from the diagonal truss wires welded to the cover mesh layers on each side of the panel combined with the concrete layers, thus ensuring the effective transfer of the shear forces for a full composite behavior. Lateral forces are absorbed most effectively by the 3D panel shear walls. The 3D Building System provides a robust system that has a high resistance to hard and soft body impacts likely to be associated with normal residential and commercial use situations. The 3D Panel Construction System will remain durable and serviceable for at least 50 years.

All 3D panel components meet the requirements of the relevant building codes and International Standards. The main advantages of the 3D Panel Technology is indicated below.

a. Fast High Quality Construction

   50% faster than standard construction, saves money on capital turnover, reduces the need for heavy equipment on jobs saving worker costs.

b. Strength

   Greater structural integrity, maintenance-free wall system will not decay, monolithic design for superior strength.

c. Insect/Mold/Fungi Resistant

d. Pro-Environment and Energy Efficient

   Save 50-80% of utility costs on heating and cooling the structure.

e. Durability

   The 3D building system will remain durable and serviceable for 50 years

f. Fire-proof

The polystyrene is a non-flammable material as tested under ASTM E84 and with a smoke rating under 450 as a result of the same test. Under fire conditions, 3D panel has passed the 120 minutes fire proofing test.

g. Non-combustible structure.

h. Earthquake Resistant

Endures quakes with zero structural effects.

i. Compressive Test

A compressive test showed capacity to hold over 100,000 N. Bending capacity by resisting over 8,200 N.

j. Water Resistant

The ASTM test proved maximum water absorption of (2.5%) for (1lb density). The polystyrene will not rot and is highly resistant to mildew.

k. Sound-proof

Concrete panels also provide good sound insulation, improving the inner acoustic performance

l. Heat Preservation

3D offers strong thermal insulation properties. It keeps the heat or the cold out with significant energy savings from air conditioning or heating usage.

2.5 Versatility of 3D Panel

Any project can be adapted to the construction technology of 3D panels. It can create complex architectural shapes (round, square, sloping, segment), virtually any design. Rate the freedom to choose the architectural and design solutions due to the simplicity and flexibility of the technology with reinforced insulation boards. Bay windows, curved walls, wall fence, arches - all elements of the complex can be made without increase in the cost of construction and special architectural revisions.

Curved or radius walls can be built by cutting the wire of reinforcing welded mesh on one side of the panel. This will allow the panel to bend to the desired shape or radius. It is very important not to cut through the heavier truss wire so that wall strength and integrity remain intact.

3D panels are usually applied into;

a. In the construction of residential buildings, 3 - 5 storey residential buildings; 3D panels are made into all the basic building blocks of buildings, walls, floors, roof and stairs.
b. Public buildings, clubs, entertainment facilities, sports halls, farmhouses.
c. Commercial, industrial and administrative buildings.
d. Individual warm pools.
e. Sound-absorbing and protecting fences.
f. Warehouses and vegetable store.
g. Storage containers including tanks.
h. Architectural complex forms.
i. Barges and docks.

3D panels have the advantages construction in the following place:

a. Construction of facilities in areas where limited load on the ground: in marshy and sandy soils.
b. In earthquake-prone areas (buildings withstand an earthquake of 7 - 8 on the Richter scale).
c. Construction on the undeveloped and inaccessible areas for transport.
d. In the reconstruction and refurbishing of buildings in high-density urban areas - where it is impossible or cost-effective placement of cranes and heavy construction equipment.
e. When expanding the superstructure floors of existing buildings without increasing the foundations and walls with the available safety margin of an old design.

3.0 Design Aspects

3.1 Basic Design Principles

The calculation for flexural, shear and compression forces for 3D panel sections can be done in almost the same way as calculation for the reinforced concrete structural elements. Previous experience and application of the 3D panel system in different regions that were subjected to large earthquakes show that the 3D panel buildings are strong enough to resist large earthquakes.

The U.S. Army Corps of Engineers – Afghanistan Engineer District has been the main office for awarding and approving the design of plenty military bases built with 3D panels for the Afghan National Army and Police. Most of these bases are located in seismically active areas, which are experiencing tens of moderate and large earthquakes annually. There have been more than 50 military bases constructed with 3D panels in Afghanistan since 2004, (Mashal, 2011).

3.2 Design Manuals

Following design & application manuals published on the design of structural elements will provide the basic guidelines in designing of buildings for construction with 3D panel.

a. Technical Manual of Emmedue Construction System, Eastern Industrial Supplies, Administrative Offices, From ITR 2 C. east, 1/2 C. to the north. Managua, Nicaragua 2004
b. Technical Manual for Insulated, Load Bearing, Structural Panel Technology by Micro Constructions (Pte) Ltd., No 32, Wimala Vihara Rd, Sri Jayawardenepura Kotte, 11222 Sri Lanka, June 2006
c. Manual for Expanded Polystyrene (EPS) Core Panel System and its field Application of Ministry of Housing and Urban Poverty Alleviation, Government of India, published by CSIR – Central Building Research Institute Roorkee, June 2017

4.0 Installation

4.1 Tools

Tools required for installing the 3-D Panel System include a Pneumatic Fastener Tool, fastener rings or clips, reciprocating saw (with a minimum 8" metal cutting blade), a 7-1/4" circular saw with metal cutting blade, hot knife foam cutter, wire loop ties and hand twister tool, basic construction hand tools, screed material, concrete pump, finishing tools (trowels, sponges, darbys), air compressor and lumber braces.

4.2 Installation Procedure

String lines are used to establish wall lines. Construction begins by placing the slab with reinforcing rods sticking up vertically 12- to 18-inches at the edge. The 3D panels are placed so that the vertical rebar is positioned between the wire mesh and the foam core on one side of the panel. The first two panels are placed perpendicular to each other, forming a corner, and clamped together with the pneumatic fastening tool. The panels are then braced to align the tops. Strips of 2" X 2" cover mesh are pneumatically fastened to the panels to reinforce the seams. Pre-formed mesh with 90 degree bends are used for the corners. Panels can be cut for engineered openings. Window and door openings are located, the wire mesh and polystyrene core are cut away, around the opening. Electrical wiring and plumbing lines are installed behind the wire mesh. Pressure treated lumber is placed recessed into the panels or a prefabricated frame is hung in place to frame the openings. A strip of mesh is used to reinforce the corners and prevent the concrete from cracking. Utility wires and piping can be run in the space between the polystyrene and the wire mesh. Concrete is applied to the panel face either by shotcreting or poured into forms erected on both sides of the panel.

4.3 Utility & Services

The installation of electrical of plumbing is achieved by running conduit and piping in the walls behind the mesh. To fit the conduit in the allowable space, the polystyrene was melted back with a hot knife foam cutter or blow torch by about ½ inch. Electrical boxes were tied to the mesh and taped off to prevent their filling up with Shotcrete. Ductwork for the kitchen hood exhaust fan was run through an interior wall panel and vented outside.

5.0 Experience of 3D Panel Technology in Sri Lanka

Housing & commercial building projects have been carried out in Sri Lanka using 3D panel technology from year 2005 and some of the key projects completed are indicated below.

a. Construction of 242 houses for Tsunami affected children's village for SOS in Kayankerni, Batticaloa,
b. Hemas Hospital (Pvt) Ltd., No 10, Wakwella Road Galle, Galle
c. Northern Central Hospital, No. 342, Palali Road, Jaffna.
d. Sadaham Sevena, Meditation Centre Building, Rajagiriya
e. Wild Coast Tented Lodge, luxury hotel, Yala

6.0 Conclusion

Expanded Polystyrene (EPS) core 3D Panel system is a modern, efficient, safe and economic construction system for the construction of buildings. These panels can be used both as load bearing as well as non-load bearing elements. It has got the potential in catering housing requirements of all segments of people in solving the housing problems & achieving "Housing for all".

With the extensive research carried out in various countries, feedback received from the construction industry, EPS Core 3D panel system is considered to be

a. 3 times faster than conventional RCC construction
b. 12 – 14 % cheaper than conventional RCC construction
c. 3D panel buildings are strong enough to resist large earthquakes & other natural disasters.

d. Low carbon footprint, as the material used in the construction is sustainable in nature.
e. It's energy saving capabilities, reduction of construction material wastage, the technology facilitates LEEDs certification
f. Durable & solid construction technology which has been proved over a time span of 50 years in more than 35 countries including USA / Nicaragua / China / Mexico / Trinidad / Pakistan / India / Sri Lanka / Europe / Caribbean/ Hong Kong/ Venezuela etc.,

The 3D insulated panel system is a new construction system that could be a good alternative for the traditional masonry and wood construction.

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An Innovative Approach for Hospital Retrofitting in Nepal: a case study of Western Regional Hospital

Santosh Shrestha, PhD[1], and Sunil Khadka[2]

Abstract:

The retrofitting of a building means not only to increase structural safety but also to upgrade functional requirements as per current standards to make it more usable and effective in services. Besides it is also very important to improve building services water, energy and environmental performance of hospital as well as the improvement of comfort and indoor air quality of the hospital buildings. Recently an innovative approach of retrofitting is initiated in Nepal for hospital building retrofitting. The proposed approach has three-folds of retrofitting - structural, functional and green retrofitting of the existing buildings. This approach is adopted by DFID- Nepal Health Sector Support Programme-III in the retrofitting of two priority hospitals – Bhaktapur Hospital and Western Regional Hospital. This paper presents the proposed approach, methodology adopted for assessment and retrofitting and a case study of a priority hospital's retrofitting works. The case study results show that the proposed retrofitting approach is an innovative approach in retrofitting of building in Nepal which is more effective, efficient and sustainable retrofitting approach in hospital building retrofitting

Keywords: *Retrofitting, environmental performance, innovative approach*

1. Introduction

Nepal is one of the most disaster-prone countries in the world. Several factors such as its geographic structure, complex geology, frequent tectonic movements, and unfavourable climate conditions make this country vulnerable to a wide range of natural hazards. It is geo-physically location on the Alpine-Himalayan seismic belt, where approximately 17 percent of the world's largest earthquake occur (Ulak, 2015) makes Nepal the eleventh most earthquake-prone country in the world. Despite Nepal has a long history of earthquakes, the country has not learnt lessons from the earthquakes that it has been subjected to from time to time. After the destructive 1998 East Nepal earthquake of M6.8, the need for national building code was first realized. Consequently, the recent 2015 Gorkha earthquakes severely affected the health sector, along with the deaths of 8,702 persons and injuries to 22,303 individuals. According to Ministry of Home Affairs (MoHA), 2017, total of 446 public health facilities and 16 private facilities were completely destroyed and a total of 765 health facilities or administrative structures were partially damaged. The total

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monetary value of damages and losses due to the earthquakes in health sector is estimated to be NPR 7.5 billion. According to the Health Infrastructure Information System (HIIS) data, 191 facilities in the 14 most affected districts were extensively damaged or destroyed to the extent that they required replacing, while further 291 facilities required rehabilitation or retrofitting. In the rural area, significant number of unreinforced masonry buildings constructed of stone or brick in mud mortar exist throughout the country. These buildings are highly vulnerable to even moderate earthquake and require immediate attention based on the hazard and risk assessment conducted by Ministry of Health (MoH) and DFID's studies. Most of the existing big hospitals in cities are also vulnerable to seismic risks and recommended for seismic retrofitting as well as rebuild (Turner & Townsend, 2015).

A detailed damage assessment of health infrastructures conducted by Nepal Health Sector Support Programme (NHSSP) in 2016 -2017 shows that most of hospital and health facility buildings have serious functional problems which is affecting hospital services. For high priority structures like hospital buildings, the vulnerability of functional features including non-structural components of the buildings can lead to severe non-structural and functional damages and indirect losses after the events which may far exceed the loss caused by the structural damages. In addition, the recent report of Joint Assessment Review (MoH,2018) highlights that major hospitals and health facilities of both rural and urban area have issues in planning, designing and maintenance along with indoor air quality, water supply, waste management and energy system. More than 500 health facilities have lack of basic services especially water supply and electricity in Nepal. In this context, the recent studies highlight that there is a needs of retrofitting and rehabilitation of health infrastructures not only to increase seismic safety but also to upgrade functional requirements as per current standards. Besides it is also very important to improve water, energy and environmental performance of hospital as well as improve the comfort and indoor air quality of the hospital buildings.

To address the above mentioned needs of retrofitting and rehabilitation of hospital buildings, an innovative approach has initiated in the two priority hospital building retrofitting in Nepal. This approach includes three folds of retrofitting – seismic (structural and non-structural), functional and green retrofitting. This paper presents findings and proposed retrofitting approach for hospital retrofitting in Nepal based on a case study of Western Regional Hospital.

2. Retrofitting Approach

Retrofitting is not new and it is extensively available in public practices. Nevertheless, the question on what is retrofitting and what retrofitting should cover is still new for Hospital retrofitting in Nepal. In general practices and understanding, retrofitting of existing structures is the improvement of seismic performance of structural and non-structural components of the structures. For hospital retrofitting in Nepal, NHSSP has attempted to cover wider scope of retrofitting including functional, and green aspect along with the seismic aspect

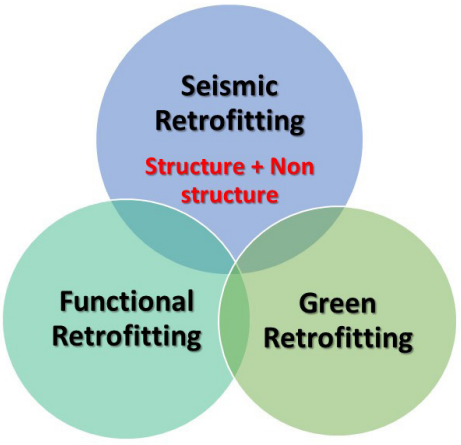

Figure 1: Proposed Retrofitting Approach

Thus, the proposed retrofitting approaches for Hospital Retrofitting in Nepal has three holds of retrofitting – Seismic retrofitting, Functional retrofitting and Green retrofitting. This approach of retrofitting is an initial for retrofitting of hospital buildings in Nepal and can be replicated in other buildings Seismic retrofitting

includes upgrading of existing building components to the level of the seismic strength requirements as per the present day codes and standards. It includes the seismic strengthening of both structural and non-structural components of buildings. In Nepal, general practices of retrofitting of the building has considered only this type of retrofitting of the structures.

Functional retrofitting is the upgrading of building functions in existing structures to make them more usable and effective in hospital services while Green retrofitting is the upgrading at an existing building to improve environmental and energy performance, to reduce water uses, and to improve the comfort and indoor air quality of the building.

3. Methodology

Undertaking retrofit works is far from being a single activity; rather, it is a feat of multitasking accomplishments, each of which is essential in order to achieve successful execution of a retrofit project. The proposed retrofitting procedure in hospital retrofitting program includes a net of activities as shown in Figure 2.

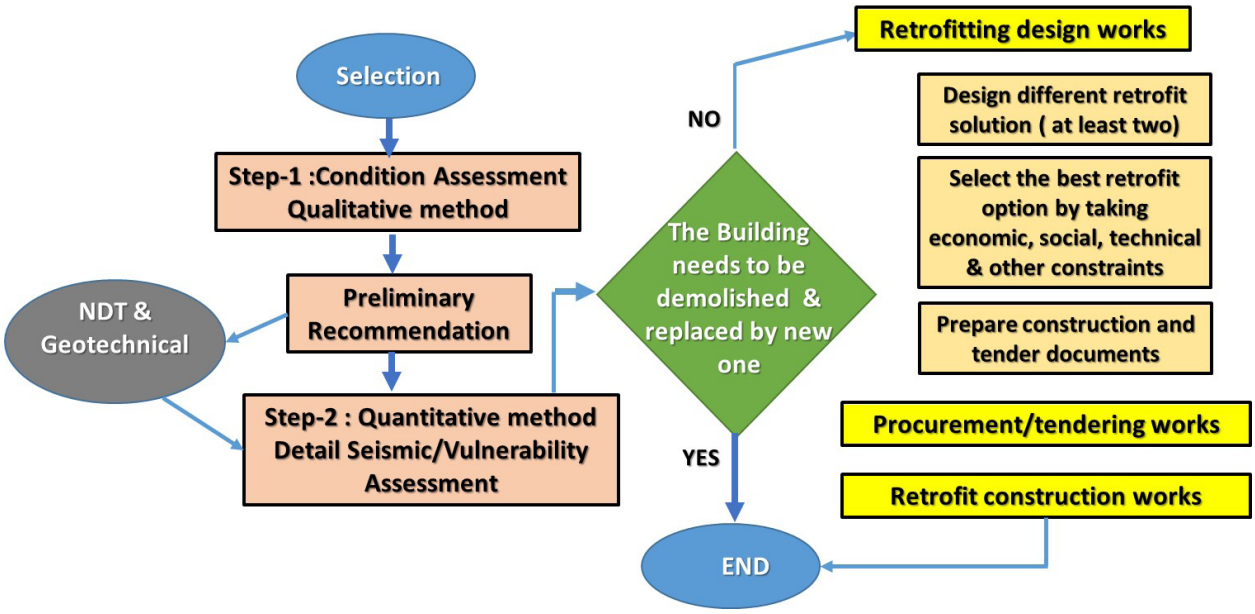

Figure 2: Assessment and Retrofitting Process in Hospital

A comprehensive hospital selection criterion is developed to priority hospitals for retrofitting works. It has a scoring system for the selection of the hospital. Key measures included existing knowledge from pre and post-earthquake studies, level of future earthquake risk based on geographical location, accessibility by general population, hub hospitals status for future emergencies, type and range of hospital services provided, utilisation rate based on MoHP statistics, and location and catchment area.

The condition assessment of the building is a preliminary assessment of existing building of the prioritized hospitals. This qualitative assessment of the buildings includes visual inspection from the expert team with on-site verification and desk review of the past studies documents and existing as-built drawings. From the qualitative assessment and based on the past studies results, a preliminary conclusion and recommendation are drawn for further retrofitting process. Prior to detailed quantitative assessment of the buildings, the on-site investigation - destructive and non-destructive testing was conducted to evaluate material parameters and condition for building materials. In addition, geotechnical investigation and

foundation exploration were also conducted to understand the geotechnical parameters of the hospital sites and foundation condition of the buildings.

The detailed seismic assessment (DAS) is performed to assess the seismic behavior of the buildings It is a qualitative assessment and more comprehensive assessment than the conditional assessment. In this process, the probable strength of the lateral load resisting system is determined and compared with expected seismic demand on the members. The DSA process is based on the Indian Standard Code of Practice and Nepal building codes (NBC)

4. Case Study: Western Regional Hospital Pokhara

Western Regional Hospital is located in Kaski District, Western Development Region, Nepal. The master plan (blown up) of the hospital are shown in 3. This Hospital consists of seventeen different blocks of two different building typology. The buildings vary considerably in size, usage requirements and age as well, some buildings being only ten years old while the oldest were constructed 34 years ago. The buildings are clustered together, and most blocks are connected by expansion joints, typically found at the ground floor but sometimes at upper floors as well

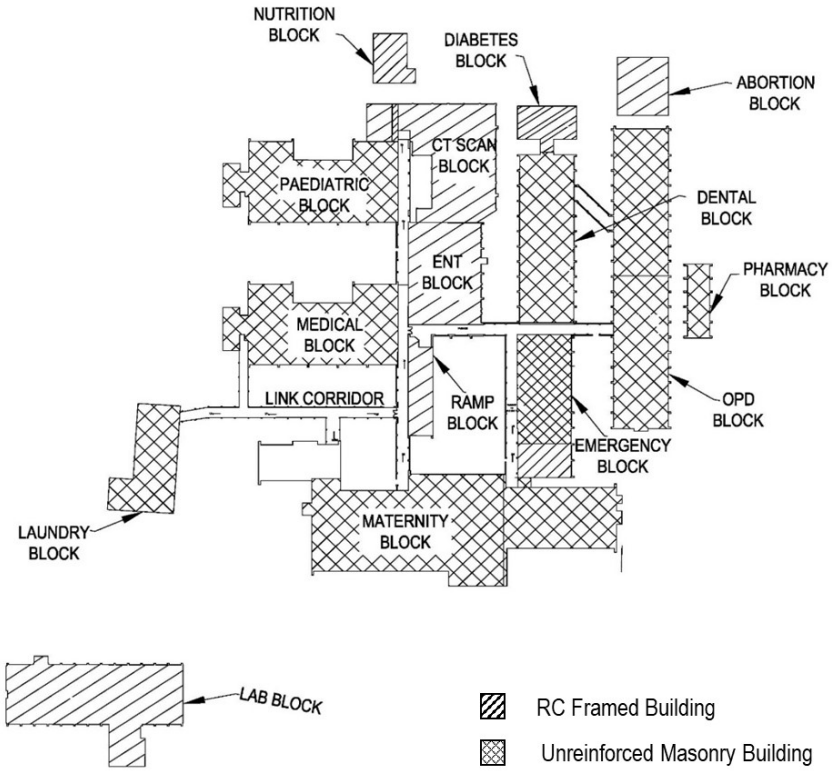

Figure 3: Building Typologies in Western Regional Hospital

5. Condition assessment

The hospital campus consists of sixteen building blocks from 10 – 34 years old. Of these, nine are unreinforced stone masonry buildings, while the remainder are RCC framed buildings with stone masonry and/or hollow/brick concrete blocks. A preliminary level of condition assessment (qualitative assessment) was performed through visual inspection by the expert team, with on-site verification and desk review of previous study documents and existing as-built drawings.

The major conclusions and recommendations based on these results are as follows:

- The impact of the 2015 Gorkha Earthquake appears to have been minor. Cracks are observed in the infill walls of CT scan building and ENT building (see photos).

Photos 1: Damages due to Gorkha Earthquake in CT Scan & ENT Blocks

- Repair and maintenance of the buildings appear to be inadequate, leading to degradation of the built fabric.

Photos: Serious seepage issues inside Emergency Block & Corrosion Cracks in the structure members

- The hospital buildings are present in a clustered form where the majority of the blocks are connected to each other with seismic /expansion joints. However, there are lacking of proper location and separation in most of the seismic gaps. The most of separation are covered by flooring finishing, and concrete as shown in the following photo.

- Upon investigation of the buildings within the hospital periphery, following deficiencies among non-structural components were found

  - Lack of appropriate anchorage and support of NSC

- Poor drainage and piping system
- Damages of flash ceiling
- Deterioration of flooring of the buildings including Operation Theater
- Poor electric wiring and HVSC system

- Most of the buildings are suitable for retrofitting, other than a few minor structures attached to the main blocks, if these buildings meet their intended functional requirements as per current standards, and also if the buildings meet their hospital's Master Plan requirements. However, the final decision shall be made only after the detailed seismic assessment with upgrading functional requirements of the building and economic considerations for retrofitting of these buildings

6. Structural Retrofitting:

6.1 Detailed Seismic Assessment - Quantitative Assessment

The detailed seismic assessment (DSA) was performed to determine the probable strength of the lateral load resisting system and to compare with expected seismic demand on the members. It is basically based on structural modeling and analysis using commercial structural analysis commercial structural analysis Finite element based ETABS software. Both static (linear static) and dynamic (response spectrum method) analysis were performed during numerical analysis based on Nepal's building code and Indian Standard (IS) codes. Non-structural components were assessed for position pretensions to prevent them from any potential falling hazards during seismic event.

Base on the above structural analysis results, the following findings are observed:

- The building complies with codal requirement for storey drift. But the seismic gap required between adjacent block is found insufficient. So, there is possibility of seismic pounding.
- The buildings do not have torsional irregularity, soft storey, mass irregularity, and eccentricity.
- The structural column members are not found safe for earthquake loading as per present relevant NBC and Indian Standard Codes.
- It is recommended that retrofitting solutions are required to strengthen the building addressing the above mentioned deficiencies as well as to upgrade the performance of the buildings reducing seismic risk

After the detailed seismic assessment and analysis, it was concluded that existing four RCC Framed buildings – Laboratory Block, Emergency– I, Mortuary, and Abortion Block – and a masonry building - Laboratory block are found to be safe and do not need any retrofitting/strengthening works for exiting condition without further changes to the civil works, although regular repair and maintenance will still be required. It is recommended that the Diabetes Block needs to be demolished and rebuilt. Deficiencies in the remaining building blocks noted during the detailed seismic assessment are summarized below:

Remaining RCC Framed Buildings:

- The remaining RCC buildings did not comply with the codes' requirements for storey drift. The seismic gap required between adjacent blocks, especially Computed Tomography (CT)-scan and Ear Nose Throat (ENT) Blocks, was found to be insufficient.

- Most structural members failed to meet checking the earthquake demand capacity ratio as required by the codes.
- Masonry Buildings:
- Most of the masonry buildings are safe in storey drift.
- The buildings are not safe in tensile and shear in both in-plane and out of plane earthquake loading while found to be safe in compression.

6.2 Retrofitting solutions

Two main retrofitting options were put forward to increase lateral stiffness of buildings: first, the use of Reinforced Cement Concrete (RCC) shear walls, and second, the application of the splint and bandage technique. After consultation meetings with the Department of Urban Development and Building Construction (DUDBC) in February 2018, it was agreed to apply RCC shear walls with column jacketing for use on RCC framed buildings. and the splint and bandage technique together with wall jacketing, will be used for masonry buildings.

To address the above mentioned deficiencies as well as functional requirements, the following retrofitting solutions for each block are recommended:

S.No.	Building Blocks	Proposed Retrofitting Solutions
Unreinforced Masonry Building Blocks		
1	Maternity	Separation of buildings introducing two seismic gaps, reduce opening, develop load path, splint and bandage with wall jacketing, introduce diaphragm at roof level, introduce steel frame at new atrium area and gable wall, brace parapet walls, and anchorage of slate at roof
2	Medical	Separation of buildings introducing a seismic gap, increase wall density, reduce opening, develop load path, and splint and bandage with wall jacketing
3	Pediatric	Separation of buildings introducing a seismic gaps, increase wall density, reduce opening, develop load path, and splint and bandage with wall jacketing
4	OPD	Splint and bandage with wall jacketing and steel bracing of parapet walls
5	Pharmacy	Splint and bandage with wall jacketing, increase wall density, reduce opening, and steel bracing of parapet walls
6	Dental	Splint and bandage with wall jacketing, shoe anchorage bracing of parapet walls, and introduce seismic gap
7	Emergency - II	Splint and bandage with wall jacketing, develop load path, demolish roof structure and walls at first floor and replace with light structures
8	Link corridor	Introduce seismic gaps, and steel stone column jacketing
RCC Framed Building Blocks		
1	CT-Scan	RCC shear wall with column jacketing & addition of a columns for load path
2	ENT	RCC shear wall with column jacketing
3	Ramp	Introduce new seismic gap, install steel framing up to slab level, replace RCC roof structure with light roofing
4	Nutrition	Steel column jacketing
5	Link corridor	Steel column jacketing with cross bracing
6	Mortuary	Steel column jacketing
7	Emergency - I	RCC column jacketing

7. Functional Retrofitting:

Functional Retrofitting includes upgrading of the hospital functional requirements as per standards specified in Nepal Health Infrastructure Development Standards (NHIDS), 2017. The followings are some of the retrofitting measures**:**

a) **Addition of missing functions -** List of missing functions as per the current standards and demand of hospital management were identified which were incorporated in design. MRI, Cathlab, CCU, Cardio OT, Neuro OT, Black room in emergency department, toilets, Library room, conference hall etc. were the functions that were added.

b) **Expansion of spaces -** Spaces and services were planned for expansion, which were identified inadequate. Space for emergency department, inpatient department, OPD, waiting area of OPD etc were expanded,

c) **Improvement for health safety -** Several interventions were planned for assuring the health safety of patient, health workers and visitors. Few example are: plan layouts were readjusted to accommodate dirty and clean routes; floor, wall and ceiling finishing were changed as per the hospital standards considering infection control; applied lead protection in x-ray rooms etc.

d) **Upgrading sanitary and electrical system:** Besides strengthening and readjustment for functional efficiency, replacement of total sanitary and electrical system has been planned. As current system is very old and deteriorated due to lack of maintenance. Furthermore, assessing the current demand and projecting the immediate future demand system were upgraded replacing transformer with higher capacity, addition of water storage tanks etc.

e) **Signage -** Proper Signage for all the spaces has been planned for ensuring efficient flow of people and communication.

8. Green Retrofitting

Green retrofits are new and recently available in public domain. So, the question on what is green retrofitting and what green retrofitting should cover is still debatable. Based on the triple bottom line structure of sustainable development or green development, green retrofitting of existing buildings is focus on economic, environmental and social advantages.

8.1 Economic

Retrofitting a building is often less expensive than to demolish and rebuild, or even to build new. Furthermore, since no demolition is undertaken or as the construction period is reduced, therefore the financing cost is reduced. The following chart shows the percentage of cost in different retrofitting and new construction works. Based on the cost comparison as per square meter cost, the retrofitting cost of all three retrofitting measures is less than half of the new building cost.

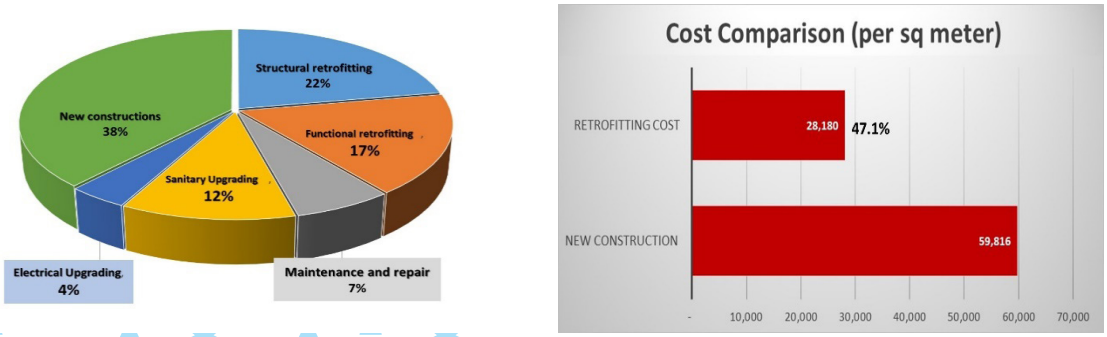

Figure 4: Retrofitting cost

8.2 Environmental

Green retrofitting involves improvement of environmental performance, energy efficient, reduce water use, and improve the comfort and indoor air quality. The followings works are included in this retrofitting**.**

- Upgrading of water supply and sanitary system of all the building for quality of water supply and reducing water use by replacing efficient appliances, installing water treatment and rainwater harvesting system, and new drainage system including waste water treatment system.
- Replacing old electrical system of all the building for quality and energy efficient with efficient appliances and efficient design as per current standards.
- Improving the comfort and indoor air quality by providing proper ventilation systems and improving building condition and functions. One of the major retrofitting in the Maternity Block which has five bays buildings is creating vertical ventilation by remodeling to accommodate inpatient ward functions (general ward and cabins with standardized staircase and fire escape route

Figure 5: Remodeling for improvement of Indoor Air Quality in Maternity Block

8.3. Social

Retrofitting preserves the societal and cultural assets embodied in existing built environment. The most of the building are stone masonry buildings (see photos), which has the social and cultural values of Pokhara. The retrofitting works preserves the social values without damaging their looks.

9. Conclusion:

This paper presents an innovative retrofitting approach that initiates in the hospital retrofitting in Nepal. It includes brief description of approached approach; methodology adopted for assessment and retrofitting design and construction and a case study. Based on the case study of the Western Regional

Hospital, a priority hospital for retrofitting, it discusses three retrofitting measures of the proposed approach – structural, functional and green retrofits. The results show that the proposed retrofitting approach is an innovative approach in retrofitting of building in Nepal which is more effective, efficient and sustainable retrofitting approach in hospital building retrofitting.

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Development of intelligent ultrasonic device for damage detection of metallic structure

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Abstract

In modern world, it has become essential to monitor structure for probable damages. If failed, it can cause structural catastrophe. Many researchers have worked on the low-power ultrasonic device to monitor the structures. In this paper, we present an intelligent ultrasonic device (IUD) to detect the damages on the structures. The device uses microcontroller, actuator interface circuit, sensor interface circuit and rf modem. The microcontroller has in-built high-speed analog-to-digital converter (ADC), digital-to-analog converter (DAC) and floating-point unit for single processing. The controller generates the tone-bust signal and send it to actuator interface circuit. The circuit, on receiving the signal, condition it and drives the PZT actuator. The actuator generates an ultrasonic wave in the structure. The wave is then sensed by PZT sensors. The sensor interface circuit selects the signal from desired sensor and send it to the microcontroller for further processing. The microcontroller computes the damage index and only if the damage is severe, it will send data wirelessly to the nearby PC. To test the device, iron specimen was prepared and, actuator and sensor was mounted in it. The artificial crack was then induced on the specimen. The device successfully detected the induced crack in the structure. The future work will be to use GSM modem so that the device can be monitored in the real time from the remote location.

Keywords: *Structure health monitoring, Tone-burst generator, Intelligent ultrasonic device, Wireless communication, Non-Destructive Evaluation*

1. Introduction

The metallic structures can adulterate with time due to ageing, fatigues, external loading and environmental influences. If structure is not monitored carefully, it can fail and may lead to serious incidents. To prevent such failures, it is necessary to provide highest level of quality and safety measures. In recent years, many researchers are doing research to utilize the wireless communication with ultrasonic wave for structure health monitoring of metallic structures. However, majority of the current devices are not intelligent and also have low data throughput with low amplitude of actuation signal. With this research, we present wireless intelligent ultrasonic device, which detects damage locally through wireless

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communication. The device generates high amplitude actuation signal and uses PZT sensor and actuator for precise measurement of the damages in the structure. The device can also compute the damage index of the structure in real time and only alert the PC if damage is severe.

2. Overview

Fig. 1 shows the overview of the intelligent ultrasonic device (IUD) system. The system consists of two main parts: IUD and ground PC. The IUD is placed on the desired metallic structure. The sensor and actuator are attached to it. The IUD first generates the tone-burst signal of amplitude 15 Vp-p, 6 cycle and 138 KHz frequency. It then actuates the PZT actuator. The PZT actuator in-turn generates the ultrasonic wave in the structure. The wave travel through the structure and reaches the PZT sensor. The sensor on receiving the wave, converts it into electrical signal and send it back to the IUD. IUD on receiving the signal, condition and digitize it. The digital signal is then processed by its controller to see if there is damage in the structure or not. If the device detects the damage, the damage index is sent to the PC via wireless communication. The PC can even request a raw data from the IUD for further analys is.

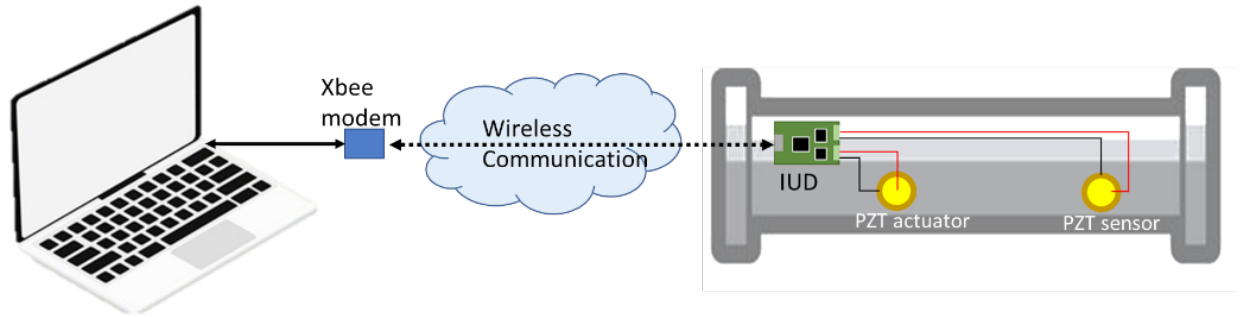

Fig.1. Overview of a wireless IUD system

3. Development of IUD system

Fig. 2 shows the development concept of IUD. The IUD board has actuator interface circuit, sensing interface circuit, microcontroller and wireless modem. Table 1 shows the specification of IUD.

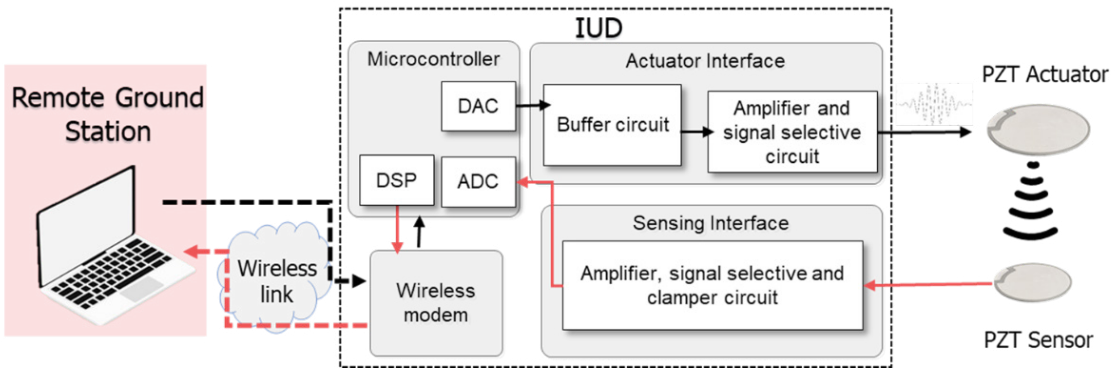

Fig. 1 Overview of a wireless IUD system

Table 1 IUD specification

Specification	Performance
Power supply	12 V
Microcontroller	168 MHz, ADC: 10 bit, 2.5 MSPS, FPU
Actuator signal	138 kHz, 15 Vp-p, 6 cycle
Communication	Wireless

3.1 Actuator interface circuit

Actuator interface circuit is designed so that the IUD can drive PZT with necessary amplitude and frequency. To drive the PZT, the actuation signal must be of sufficient amplitude and frequency. The design mainly consists of two parts: microcontroller and the circuit. The microcontroller has in-built DAC, which is used to generate analog signal pattern to drive the actuator. As the actuation signal is a sine wave with increasing and then decreasing amplitude, eq. (1) is developed. Using the equation, the firmware is written and signal is successfully generated. To increase the frequency of the signal, DMA controller is used.

$$\boldsymbol{lamb\ wave} = \begin{cases} \boldsymbol{e^{\frac{t12}{2}}.\cos(n.t1)} & \boldsymbol{for\ t1 < a} \\ \boldsymbol{\left[e^{\frac{t2}{2}}.\cos(n.t1)\right]^{-1}} & \boldsymbol{for\ t1 \geq a\ and\ t1 < t} \end{cases} \quad \text{(Eq. 1)}$$

The amplitude of the signal is of low amplitude and could drive PZT actuator properly, so the actuator circuit is developed. Fig. 2 shows the schematic of actuator circuit. The circuit consists of buffer amplifier, gain amplifier with compensation capacitor and resistor to drive PZT load and push-pull amplifier to increase the final amplitude.

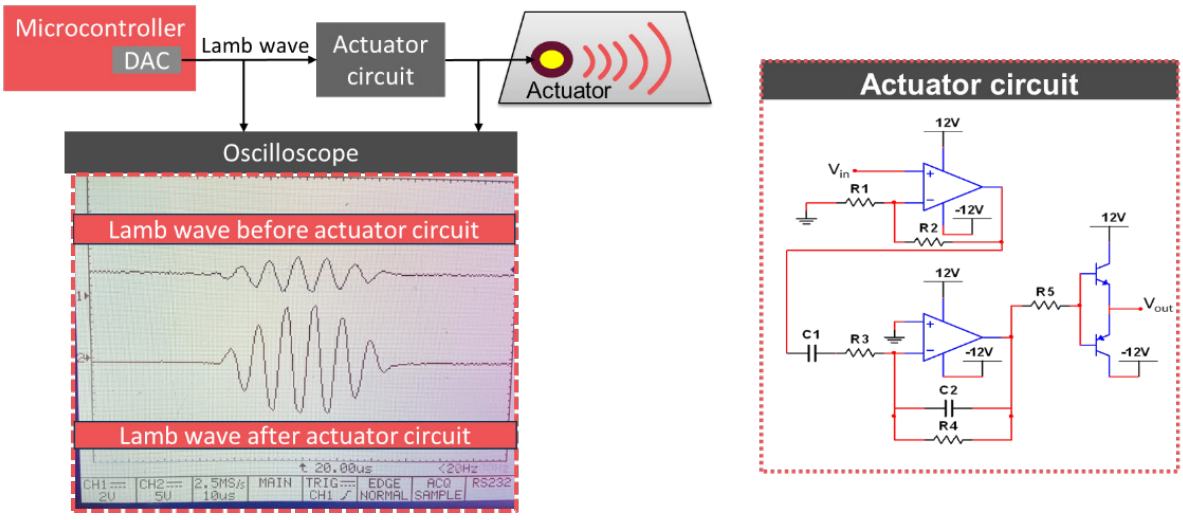

Fig. 2 Actuator circuit and actuator circuit testing

By using the circuit, the lamb wave of amplitude 15 Vp-p, 6 cycle and 138kHz frequency is successfully generated.

3.2 Sensing interface circuit

Sensor interface circuit is designed to process the signal from the PZT sensor. The microcontroller uses this signal to calculate damage index. The signal, however, is of very-low amplitude and have both positive and negative voltage. To make the signal suitable to process, the amplitude should be increased and voltage

level should be above zero. The circuit consist of charge amplifier, voltage level shifter, clipper circuit and ADC.

The gain of the amplifier is set to 100, voltage level shifter shifts the negative voltage to positive level, clipper circuit makes sure that the voltage doesn't cross upper limit of ADC and ADC digitized the analog data. The circuit uses the in-built ADC of the microcontroller. The sampling rate of the ADC is set to 2.5 MSPS. To get this sampling rate, DMA controller of the microcontroller is used. As PZT sensor store charge in accordance to the ultrasonic wave, the charge amplifier with high input impedance is designed.

Fig. 3 shows that the sensor interfacing circuit. The circuit has successfully detected the ultrasonic wave from the sensor. The oscilloscope shows the detected ultrasonic wave, captured through the sensor interface circuit.

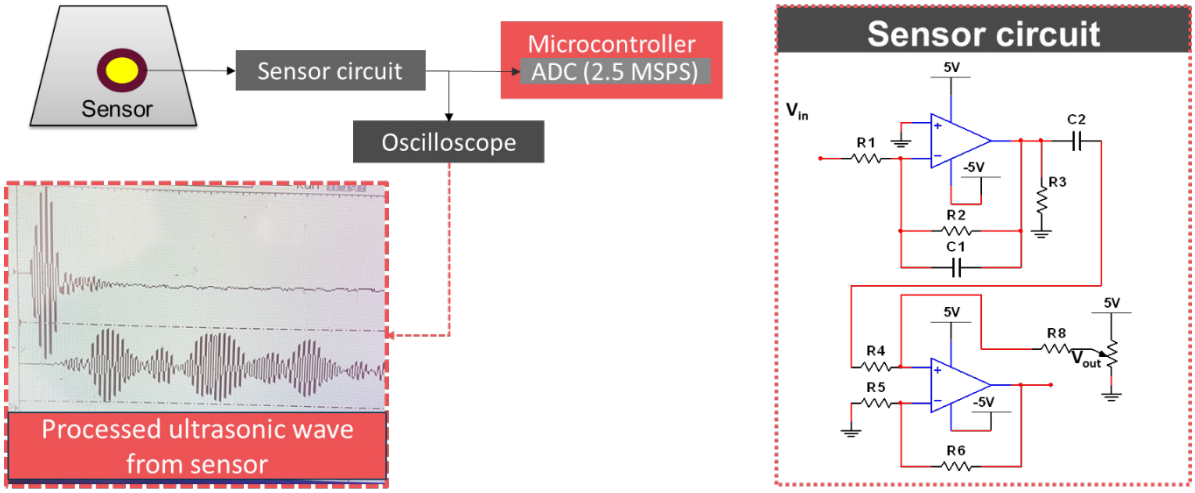

Fig. 3 Actuator circuit and actuator circuit testing

3.3 Digital signal processing

The damage index is calculated in the microcontroller. The microcontroller is chosen with the in-built floating-point unit (FPU) so that digitized signal can be processed more precisely. The digitized ultrasonic wave is first filtered with low pass filter with cut-off frequency of 300 kHz. The 6th order Butterworth filter is designed. The signal is then further processed to calculate damage index. Time domain – root mean square (TD-RMS) algorithm is used in the controller to calculate the damage index. TD-RMS algorithm is shown in the eq. (2).

$$\mathbf{DI_{TDRMS}} = \frac{\int_{t_1}^{t_2} |\mathbf{S_m(t) - S_b(t)}|^2 \mathbf{dt}}{\int_{t_1}^{t_2} |\mathbf{S_b(t)}|^2 \mathbf{dt}} \qquad \text{(Eq. 2)}$$

3.4 Wireless communication

The IUD uses wireless communication to communicate with the PC. The modem used is xBee modem and uses ZigBee protocol. The ZigBee is IEEE 802.15.4 standard, low power, low data transmitting wireless protocol. The architecture of ZigBee includes three parts namely co-ordinator, router and end device. The co-ordinator plays role of bridging and routing for the entire network and stores and handles the information. A router acts as intercessor device for two-way communication between router and other devices. It has four layers: physical layer, MAC layer, network layer and application layer

To initialize communication, first both xbee modems of transmitter and receiver is set up with same channel name, ID and baud rate (9600). The coordinator enable (CE) of transmitter is set to "coordinator" and CE of receiver is set to "End point". After this, the modems are joined to IUD and PC. The communication is done using UART.

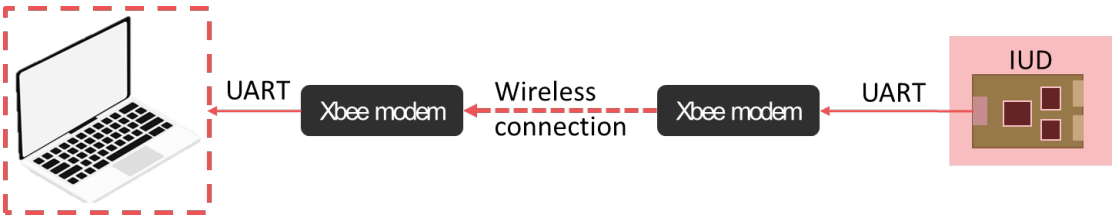

Fig. 4 Flowchart of IUD firmware

3.5 Firmware development

The firmware is developed on freeRTOS platform. The flowchart of the firmware is given below.

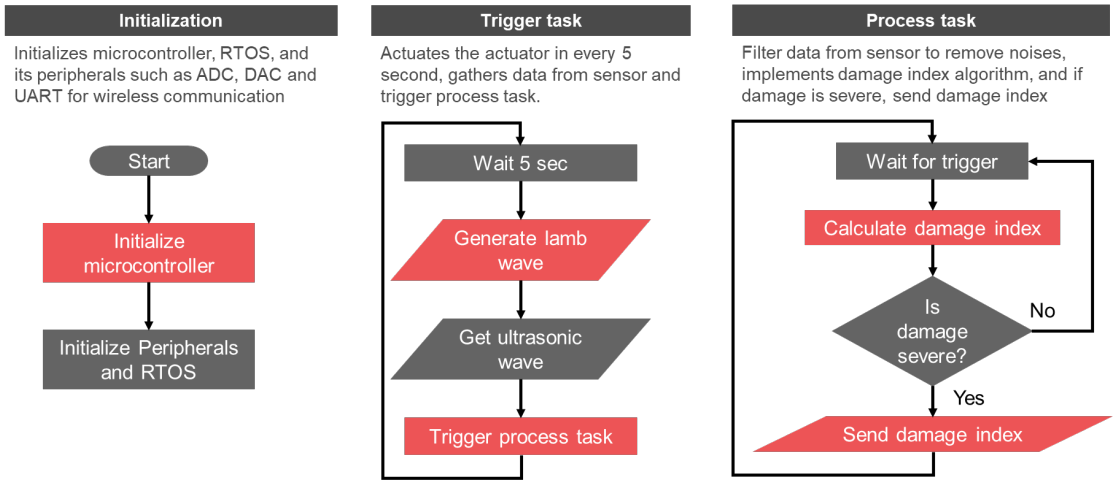

Fig. 5 Flowchart of IUD firmware

4. Testing of IUD

To evaluate the performance of IUD regarding damage detection, iron specimen is chosen. The PZT actuator and sensor is mounted on the structure as shown in fig. 6. The ultrasonic wave is first collected in intact condition of the specimen. Then the artificial crack is induced in it. The ultrasonic wave is again collected from the specimen. The wave from both conditions is compared and damage index is calculated.

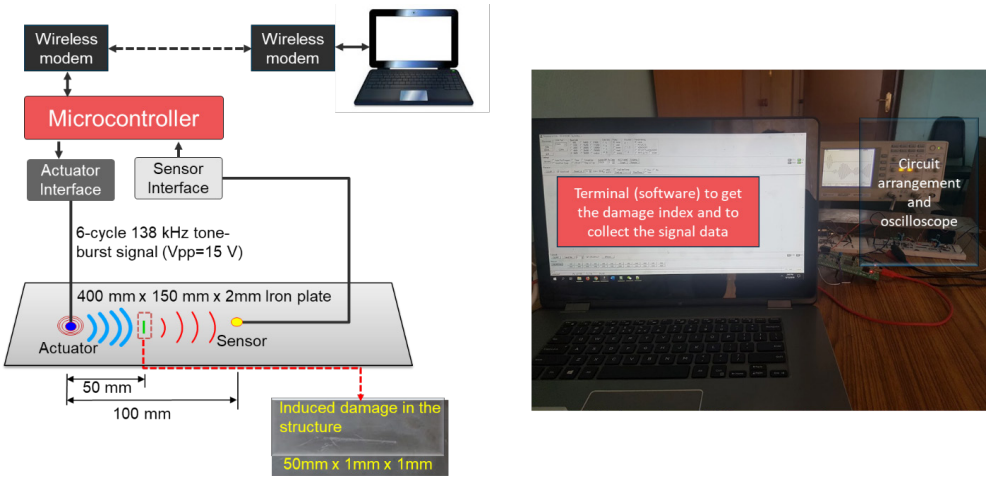

Fig. 6 IUD test setup

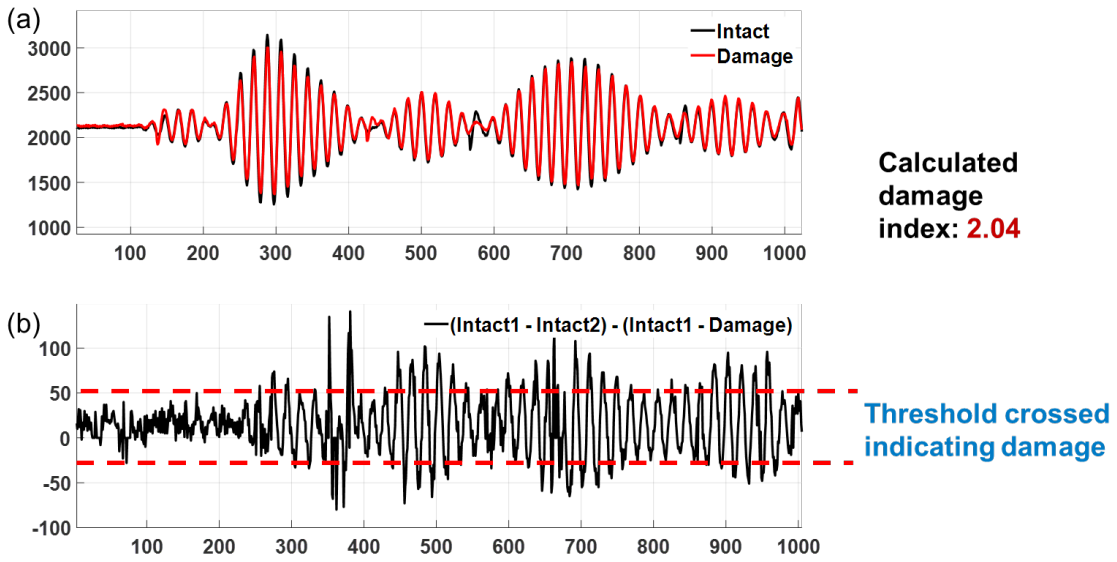

Fig. 7 Comparison of the signal before and after damage on the iron plate (a) amplitude comparison (b) amplitude difference

From fig. 7 it is clear that the damage has been successfully detected with damage index of 2.04.

5. Conclusion

From this research, we can conclude that it is possible to build an intelligent device that can detect damage by itself without any human intervention. The modern controllers are powerful enough to calculate the damage index by itself. The wireless communication is also reliable to send the damage index to the PC. With careful design and calibration, it is possible to both actuate and sense the PZT sensors. Further more PZT sensor are reliable to generate and detect the ultrasonic wave in the structure. With the use of high precision components, the obtained results are found to be highly corelated with the actual damages in the structure.

Acknowledgement

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Technical Session

5

Investment in Resilient Infrastructure Development for Future: Focusing on Quality, Technology, Climate Change and Innovative Financing

Keynote Presenter: **Dr. Bindhu Nath Lohani**[1]

Thank You, Good afternoon Ladies and Gentlemen.

Thank you for inviting me to say few words in this gathering. My presentation today will be on three topics:

The first point, I am going to talk about investment in an infrastructure development, what are some of the key economic and investment indicators, how the infrastructure in Nepal looks like does compared to the infrastructure in the region.

The second point, will be thinking building infrastructure differently, we have built building, how do we need to build this in future.

The third point, what are the financing investment needs in future. The first I want to start with the very motherhood statement which everybody knows infrastructure plays a critical role in economic development, I don't think anybody disputes with that but what is interesting and what its get deeper is infrastructure GDP per capita is closely associated with the level of infrastructure development when you look at the data for several countries in the region. You plot a graph, we all are technical people, will see that the GDP per capita has a very strong correlation that's also very easy to understand and most people know it. We also know the infrastructure reduces poverty provided if we look at the area properly provided, if we make infrastructure inclusively X factor not always and that is also well established. But the key determent of infrastructure quantity and quality is its investment. We know that but how do you see these investments. Investment in % of GDP, as I told you, is a good indicator but the question is, we know all of these concepts. We know is how much, how much what % of GDP should we invest. That needs research, that needs analysis, that need thinking and we don't know of that immediately and this is what I am going to talk as one of my first point.

One of the Asian development, where I spend about 30 years there, was a study looking at about 20 countries in 2011-2014, and we found that the infrastructure investment in Asia Pacific Region ranges from 2% of the GDP in some country and up to 7% of the GDP in countries like China. Two to seven, that's about

1 Former Vice President, Asian Development Bank.

20 countries almost 10 years of data. We also know that infrastructure stock is very important information, how much infrastructure stock do we have how do you measure that. The capital expenditure in Gross Fix Capital Formation (GFCF). This is what we use in infrastructure are very good proxies for investment in infrastructure. And then, we do a score. If we looked at the several countries and then found out that the infrastructure stock of Nepal is very low in a scale of 1-100 is 17. And countries like Bangladesh have 31.5 and countries like Thailand have 62%. All those data tell you one thing, we have to do more infrastructure, our infrastructure quality is low. investment is low and stock is low in the whole region. That's the baseline information that I want to tell. We need to, therefore, think these infrastructure development with a new thinking, I would like to say that the infrastructure even when I was working 50 years ago in Building Department, Road Department and Local Development Department. My mind as a civil engineer I used to think on infrastructure brick and mortar, cement and concrete plan and money and I know what to do with it. I think it's no longer brick and mortar, no longer concrete and steel, no longer plans and money only. The quality technical, highly technical information, technologically new opportunities that come in, are exceptionally important. It is often well understood but not executed. This is where I think we need to focus. Why we are not doing certain technologies so easily available. For example, take the water supply system. If the water supply system is leaking 30% in this 21st century, I think it's pathetic. You can use sensors which are able to say where it is leaking, how I can address etc. etc. and let me also tell you that today Artificial Intelligence (AI), computer manage traffic better. The way of managing traffic right hand is no longer demo-signification believe me and it cannot do that. And why we have not move to forward is a question to me. My observation, I may be wrong and I hope I am not wrong, is we need to adopt these technologies. We need to adopt and we need to live forward where it is required. And this is the missing link that I see in my short time here. The second thing is looking the infrastructure from demographic and special dimension. I said demographic because if 60% of people or 70% of Asian are going to live in the cities as one of our study says and in Nepal Shanker Jee said 62% in cities. If people are going to live in cities the urban infrastructure is going to be important as simple as that. Equally and that is too because the Asia data shows 60%, 70% of Asians will live in cities 70%, 60%, 70% of the GDP will be made in the cities and the employment will be in the cities, Greenhouse gas will be in the cities pollution, consumption of energy, water transfer in the cities. So, we need to have a special focus on demographic and spatial focus.

The second thing that we need in a country like ours is the regional infrastructure. The connectivity across the border we are already talking about the cross border and a cross border energy you know it. But It's very very important to be able to develop that from the perspective of national development.

The third dimension is the environment. It's not only doing environmental impact assessment we need to do more than that. We need to have the climate, the natural disaster etc. all those included in our infrastructure design. Something I needed to do that 50 years ago, realized probably did it in Singapore. You probably do it regularly but we need to do this climate screening should be mainly requirement of every infrastructure project. How can we build a hydro in Nepal without looking at what will be the impact of climate change on it. I don't see some of these things really done. Same thing will be for natural disaster. The reason I say, is the economic argument. In one report I have seen here says 1-3%, 1-2% of the GDP will be lost because the climate change. Just taking three sectors like agriculture, hydropower, water induced disaster. Our own study our meaning when I was in Delhi we did (2000-2001) scenario. Nepal could lose about 9-10% of GDP. That is a lot we don't grow that much. And same situation is in Bangladesh, about 9%, South East Asia 6.3%. It is very strong economic argument to include climate into a natural disaster as our

investor design. In the natural disaster, I think a lot of people are familiar here. I don't need to say much. I only see within one analysis to see the prevention everybody say prevention is the best solution we have and it is true. We did the cost benefit analysis of several of our prevention activity and you can have at least 1 to 2 return or sometime up to 20 times return. I mean the prevention is justifiable and very very economic and not only that is the important way to think.

The forth to me is the government issues. Every time you build the infrastructure don't think about connecting two points of the bridge or the road from a to b. we need to think about government structure who are the beneficiaries, the right benefiters you, who at what price at what cost, is there anything that we compromise the quality, the integrity, the cost. I think these are government issues we need to look at it. Can the private sector do it better than us if yes give it to them. If the private sector need to hold the hand of public sector do it together. All these government question need to be handled as a part of infrastructure development.

The final thing, is the financing and the investment side to which I have been asked to concern a little bit more. At first I want to give you a regional picture and I will give you the Nepal picture to the extent I know. I don't know as Shankar jee does, but I will leave all the question to him later because I have to go to airport after this. First Asian region, the region as a whole not only Nepal, has invested in infrastructure significantly in recent years and will invest quite a bit, but still not enough both in terms of quantity and quality. This is very very clear, If we look at our Asia wide data which we did back in 2015 – 17, Asia will spend about 26 trillion dollars in infrastructure, 26 trillion is very big which is about 1.7 trillion annually, because that amount is for until 2030. And out of that, almost about 3.4 trillion in for climate proofing the infrastructure the cost if climate proofing is about 10% to 15% and an average, we calculate which in the past had not been included but should be included. 26 trillion dollars and the largest that in terms of the GDP the South Asia, that's our region. Looking again from the region, it will spend about almost 8% to 9% of our GDP. Quite huge the Central Asia will spend about 7.8 and South East Asia about 5% to 7%. Again when you look at the regional data most of the investments are going to be on the energy sector and transport too. While I look at the Nepal data transport is number one. I am always looking at Shanker jee to verify that and energy as our number two. When I look at the fiscal data 2016/17 of the government in one of the report of CNI IIDS has prepared it, it's very nice report by the infrastructure investment needs in Nepal, I was partly involved. In transport sector the capital expenditure in 2016-17 in Nepal was about 3% of the GDP approximately. Energy was 3%, water supply sanitation was very low almost less than 1%. Sanitation you know that comes in very very small decimal point, so it shows that the approximately 2.6% of the GDP has been spent by Nepal so far in infrastructure, which is and clearly not adequate. Then we look at the various growth scenarios in the same report, what happens if the country want to grow 5% 7.5% 10%. We have all heard all these numbers all the time but of course if we have to grow that is also we need to increase our investment in infrastructure. We found out that it is 5% is we need about slightly more than about 8% 8.14% of the GDP and if it is 10% its 9.85%. Today we are talking about 6%-7 % 7.5% we are talking about 8.7% of GDP. So from 2.6% to 8.7%, we need to step up if we really want that growth and that's not enough to say, we would want to growth we need to do that. If we take the annual minimum investment need from 2009 to 2013, the calculation shows you need at least 2.63 billion dollar for the 5% growth scenario. Then we also look at after doing all this modeling, we will also look at what are the actual projects listed by the various ministries: energy, transport and urban. They are very huge, they go out of bounce that means we are listening a lot more project that we can do it than we can fund it and one project goes down is one billion

less. So there is this kind of the planning versus the actual list of the project. I don't know about the word to use mismatch or overestimate, which is there, but the conclusion is, we need these planning numbers.

We also need to look at the actual sectoral project which is listed by the government: by the various government officials to see whether those make sense against the money that you really have. And the next question we always say, is how much the money the government has can the private sector do. The standard question we all know the government has not enough money to do all these infrastructure. And then the question is: can private sector do it? we did a survey and found the private sector also doesn't have enough money. And these guys said in the CNI Review, we did will will invest 5 to 50 million dollars and will stay 3-7 years. That's not enough 50 million will not build you a big hydro or a big road sector or nothing, it's very small. And similarly if we stay 3-5 years, seven years your ability of the bank to stay on that's not enough. Infrastructure has a long life.

Hydropower has a 50 years life while the roads have much longer life. So, who is going to stay that longer for the infrastructure investment? Only public sector can do it or the public sector has limited, therefore you need to bring the FDIs, the multinational the public can stay longer. Without the multinational, without the FDI, I am of the opinion and I hope I am wrong that we will not have the enough money to build the infrastructure we want to do. And that leads me to the next question, how does it look like the private sector in the region. Look at Philippines, I lived 50 years in the Philippines. The private sector spends almost 50% of their money. But in Nepal, I think while I look at it how much private sector in this country has spent in infrastructure in the last 6 years – 0.66% of the GDP. Nothing so talking big just the local private sector in my opinion is very very limited, the bank have very very limited fund. So if you want the big thing, once again we need to bring money from outside that's what I am trying to say. How about at our FDI bringing about a lot. Of course the government has made many many rules and regulation to make them easier. The question there still asking is, if I bring money as FDI, what is my political risk. I want to do a power project. I have a PPA for 30 years. Can I trust this government for 30 years, Government you mean country? Next question, can I trust that the policy? Sometime it is take and pay sometime it take or pay. This is very huge difference in how do that policy and in a flip it just like that. Can I take the policy guarantee? Will this guy pay me in 30 years and how did who is going to guarantee my investment and what is my foreign exchange? Let it go because we don't have shop market and these are the questions the private sector are asking for big investment in infrastructure. I think these are fewer question, as far as I am concerned, but doable as long as we can do that.

And my last point is going to be that we do not have enough financial instruments. Besides the loan from the bank. Beside the liquidity, there is nothing. We don't know how to level it? We don't have the market here. We don't know how to do the project finance. We don't do it we don't securitize our asset. Like a good hydro which has a PPA for 30 years can be security you can leverage as that money today to do it. You can have a municipal bond, we don't have one. So, all kind of tools that are possible have not been developed. And this is also that we put in report in infrastructure report of CNI IIDA. I think country like this with a 28 million size same size as Malaysia. We don't even have a big private equity infrastructure fund. You go to India take a look, you go to Malaysia, you go to Singapore with 5 million to 6 million people where they really come from. This is the needed, you need to have the private equity fund, you need to have even public infrastructure fund if you need it. Or combined multinational government public sector together. All these instruments have been developed and used in the region, but somehow, we have

not been able to develop these new instruments. Then also countries which have gotten together and created a fund like Asian infrastructure fund, I think that the ADB help to put it together. Similarly, if we had a South Asia fund, I think in Friday we are talking about the power summit. If only South Asia had a power fund by all these countries involved then you have a stake. You need to be a stakeholder as a part of that investment and these are possible. Finally, building a finance we need to take advantage of, because climate requirement for Nepal infrastructure for the next 2019-2030. It's about two billion dollars. These kind of adaptation cause climate proofing cause can be in some cases obtained from global climate fund which will provide you fee which will provide you soft terms and you can blend it to make it cheaper and when I look at the GCA profile, I was there last month, two to three weeks ago, when I look at the GCA of the Nepalese project that has hardly any that means we haven't proposed any project may be we don't know how to develop but we are not taking advantage of bringing those money blending with the climate proof in our various infrastructure projects. So having said I am a engineer 50 years ago so I used to work in this country, I can't claim I still have some license here and license in the US. But I can tell you that looking at last 5-6 years going around my own city, my own just outside my house, I don't think our infrastructure needs to be this much this low. And some time people are telling me, you are the engineer you should improve it. We all should improve it. Somehow it will be nice with the conference like this will if we can uplift our image as a good quality engineer, good professional engineer, professional with integrity. Without that I think our profession does not seem to have been getting the kind of respect which we really deserve in my opinion.

Thank you very much.

Financing in Resilient Infrastructure

Dr. Shankar Prasad Sharma[1]

Presentation

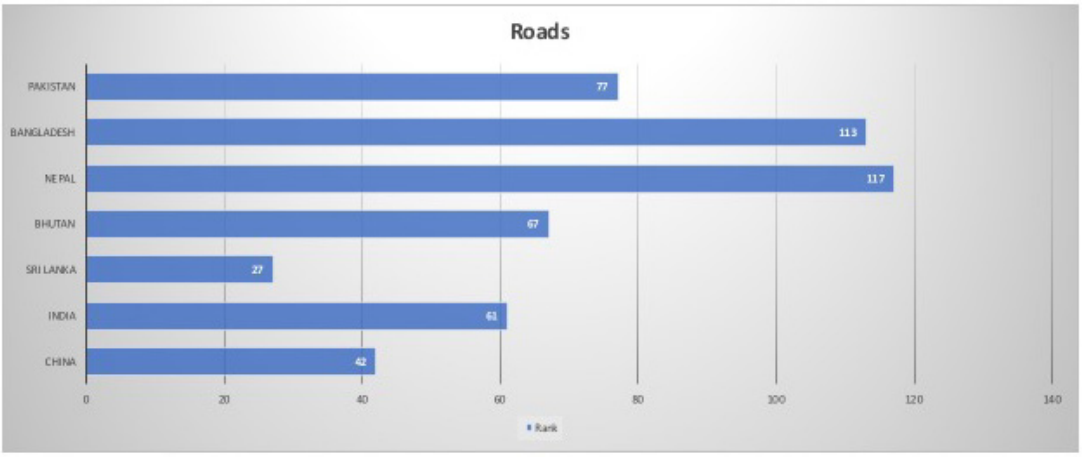
- Importance of Infrastructure Development
- Infrastructure gap and Financing Requirements
- Regional Connectivity for Higher Benefits
- Financing Options and Financing for Resilient Infrastructure Development

Infrastructure for Prosperity: *How infrastructure could affect SDGs and Economy*

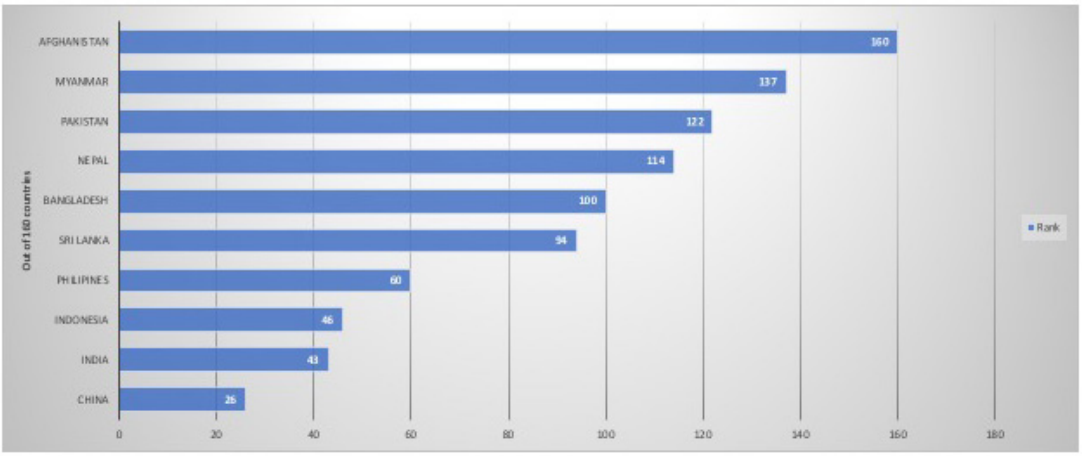
- Intermodal transport connectivity contribute to increase investment (2a) and will enhance international cooperation in infrastructure (2a, 6a; 7a;)
- Half the number of traffic deaths (3.6.1) by 2030
- Double the rate of energy efficiency (7.3)
- Facilitate sustainable infrastructure (7b; 9) by 2030
- Provide access to safe , affordable, accessible and sustainable transport systems for all (9)
- Contribute to poverty reduction that (Indonesia: 1% increase in road investment is associated with a 0.3% drop in poverty incidence in provinces)
- Can maintain the momentum of economic growth in the region (1% increase in infrastructure investment may lead to 0.01 to 0.39% economic growth)

1 Former Vice Chairman of National Planning Commission and Former Nepalese Ambassador to the United States of America, Mobile: 9851032970

Rank of Countries on Roads

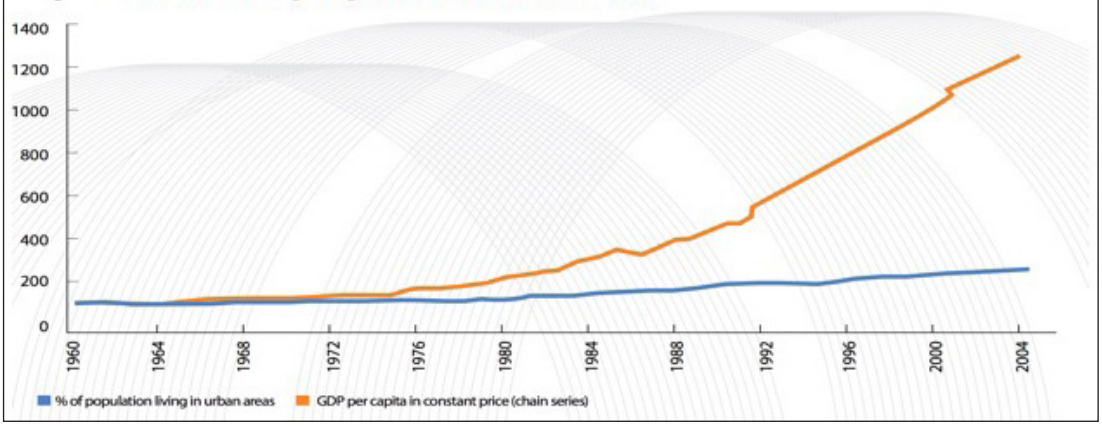


Logistic Performance Index 2018 (customs, infrastructure, international shipments, logistics competence, tracking, timeliness)

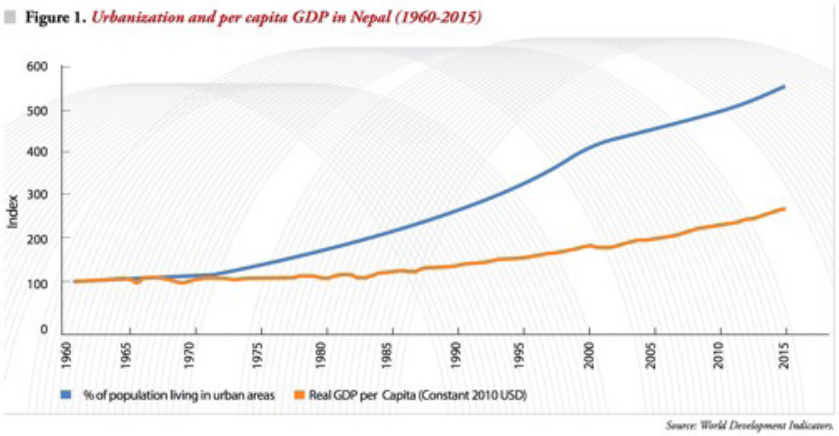


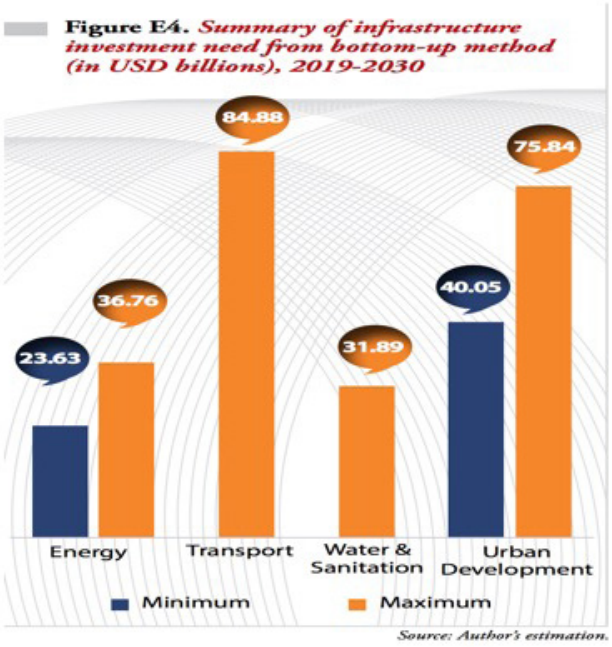
Urbanization and Per-capita income

Figure 2. ***Urbanization and per capita GDP in China (1960-2004)***



Urbanization and Per-capita income: Nepal





Infrastructure Financing Gap (2016-2030)- Nepal (US$ billion)

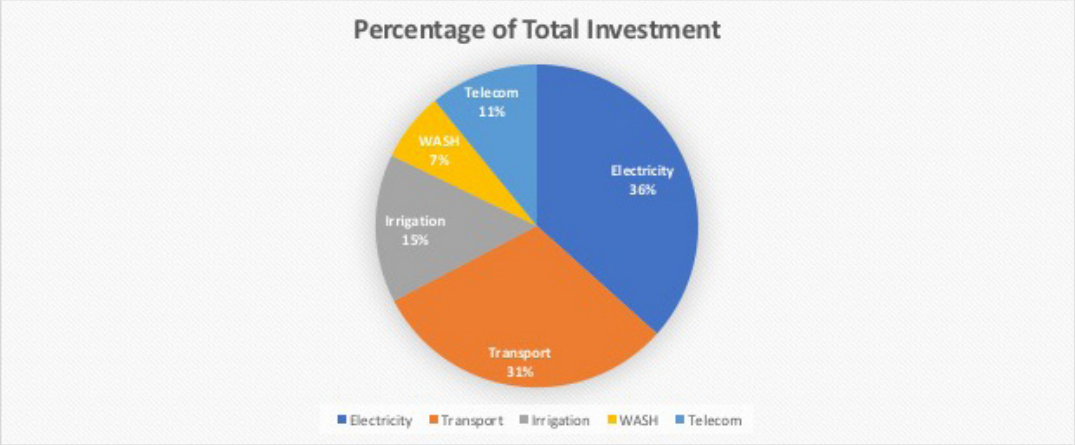
Total	Energy	Transport	Water and Sanitation	Urban Development	Total
BAU	24	36	20	25	105
Need	34	85	32	55	206
Gap	10	49	12	30	101

Estimated figures from CNI/IIDS study 2019

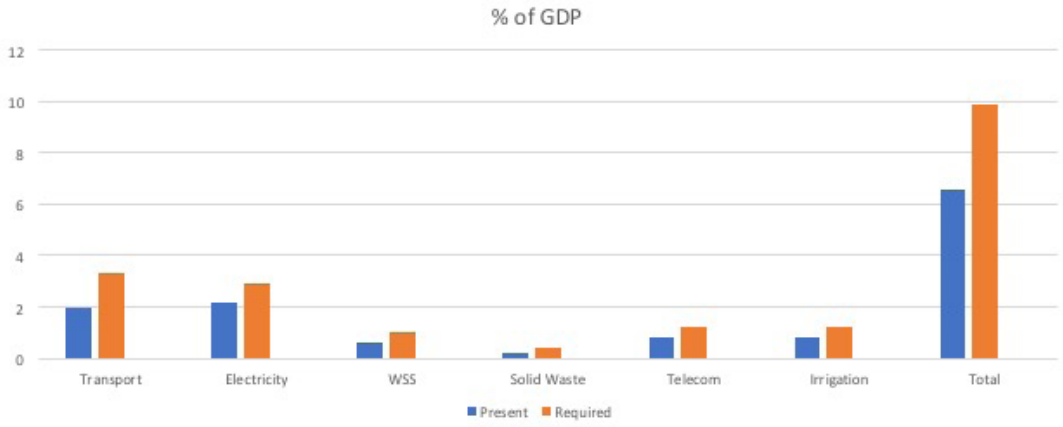
Issues:

- Infrastructural gap is still high and accessibility (road, energy, internet, sanitation etc.) is still low
- Quality of infrastructure is poor; not resilient to natural disaster
- Infrastructure development has to be linked with the private sector development and investment
- Infrastructure development must be complimented with other development e.g. customs, timeliness decisions, and other logistic support and so on
- Challenges are getting bigger and bigger in the urban areas, which are the major centers for growth

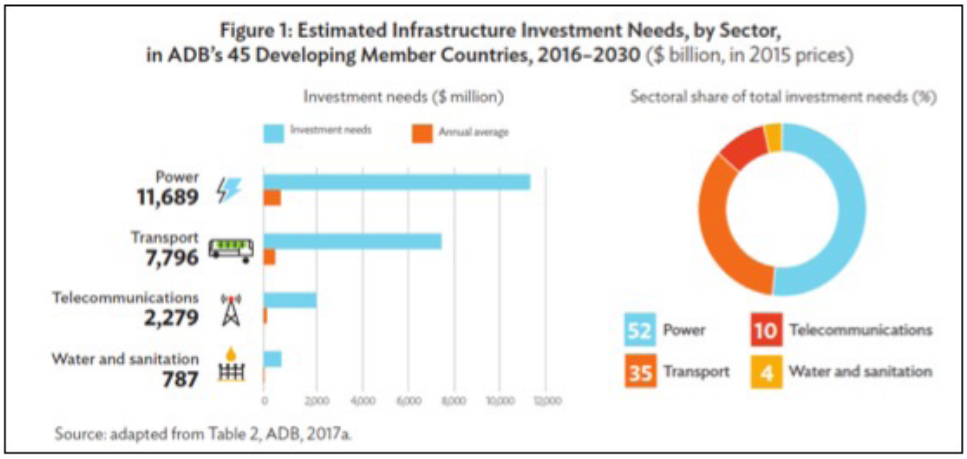
South Asian Investment in Infrastructure by Sector



Infrastructure Gap- South Asia (annual)



Estimated Infrastructure Investment Needs

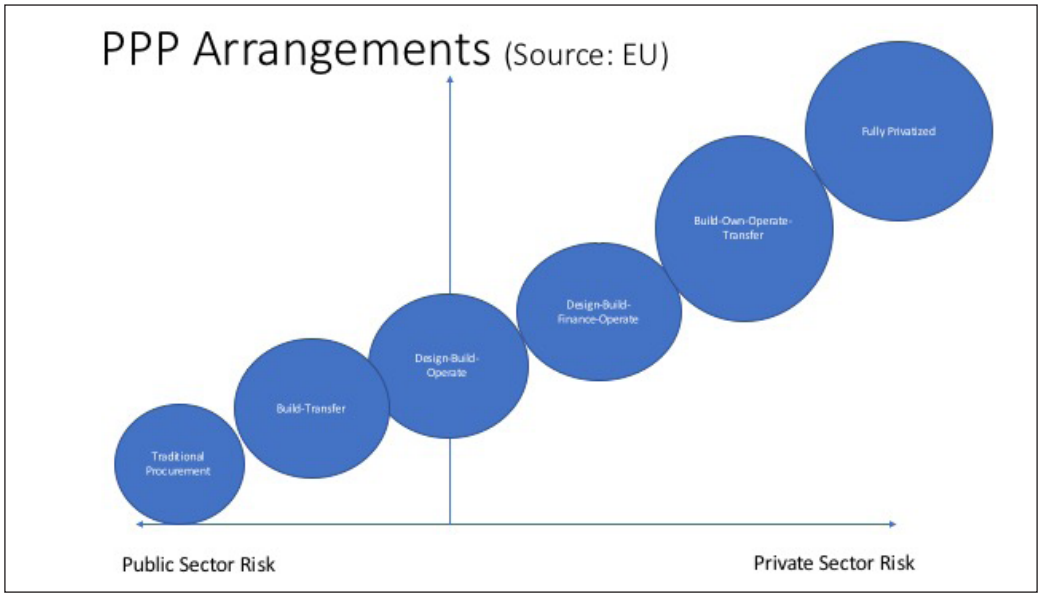


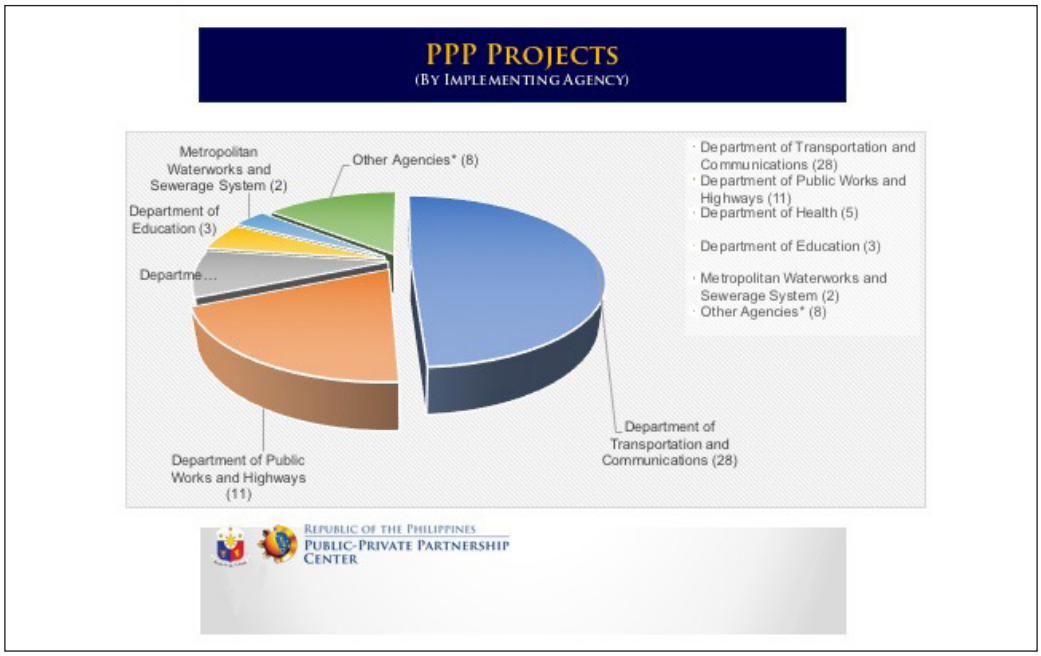
Financing (infrastructure development)

- Domestic resource mobilization (by increasing tax/GDP ratio)
- Increasing national, state and local budgets and harmonizing their investment plan
- Proper financial managements (on an average 30% lost on the process) and prioritization (targeting more to private sector development, trade, investment and growth)
- Increasing users fees

Financing (infrastructure development)

- Building resilient infrastructure- is "spending better and not spending more" (benefits of building more resilient infrastructure in low and middle income countries should be $4 benefit for every $ invested; saves expensive repair and maintenance, minimizes the consequences of natural disasters and increases productivity and quality of life;)
- Attracting private funding (Toll roads, internet services etc.)
- Expanding PPP models and financing (Rising budget deficit, improved capability of private sector and governments taking more and more market-driven approach are making PPP more acceptable)





Regional policies: Regional connectivity could have bigger multiplier effect (1)

- Strategies to strengthen regional connectivity should be considered not sector by sector but as part of a whole (as globalization continues)
- National governments must take the lead – in improving their national policies and participating in regional initiatives (Master Plan on ASEAN connectivity has been developed)
- To overcome differences and benefit more, countries should strive to adopt global and regional standards for both technical issues and procedures.

Regional policies: Regional connectivity could have bigger multiplier effect (2)

- Governments have to develop cross-sectoral policies on connectivity, at national, sub regional and regional levels.
- As the regional connectivity is inherently multifaceted, and benefits may be enhanced only by combining different other strategies like trade, tourism and investment
- The work can be effective only through collaboration and coordination with all of the relevant stakeholders.

Financing Resilient Infrastructure

- Publicly funded analysis of climate/disaster risks of important projects can be used to mobilize private finance for climate-resilient infrastructure.
- Support for project preparation (including to the private sector) can help to address capacity constraints relating to climate resilience.
- The use of tools for decision-making under uncertainty can reduce the need for costly retrofitting while reducing upfront costs.
- Nature-based, flexible or innovative approaches to climate-resilient infrastructure may even be cheaper than traditional approaches.

Financing Resilient Infrastructure (2)

- Public policies that promote resilience include public procurement processes that consider climate resilience when comparing competing bids, by accounting for costs over the asset lifetime under alternative scenarios.
- The choice of discount rate will affect the weight placed on potential future impacts relative to those in the near-term.
- For Public Private Partnership (PPP) contracts, it is important to clarify the allocation of responsibilities regarding climate related risks planning, management and response.
- Blended finance can be used to improve the risk-return profile of investments where appropriate

Investment Opportunities in Nepal

Mr. Maha Prasad Adhikari[1] Er.Sunil Poudel[2]

1. Country profile

Nepal, located between two of the world's economic giants, China and India, is a country with a GDP of approximately 30 Billion USD and per capita income of a little over USD 1000, has immense opportunities for investment. Spread across an area of 147,181 sq.km and a population of 29.49 million, the GDP of Nepal is approximately USD 30 Billion. The economy is growing at a rate of 6.81% and per capita income has reached USD 1034.The economy of the country is moving into the right direction and welcoming foreign investment.

Nepal aims to graduate to a middle-income country and achieve the SDG target by 2030. Which means that the country needs investment of approximately 20 billion USD every year especially in infrastructure development (in transport, energy, manufacturing etc.) to reach this target. We understand that this is not possible through domestic resources alone and therefore the government encourages FDI realizing the role and importance of FDI in terms of investment, technology transfer and skill transfer for the overall economic development of the country.

In addition to graduating to a middle-income country, the government has set some targets such as building around 2000 KM of rail network and paved roads, build 5 international airport and attract 5 million tourists in the next 10 years. Similarly, it also plans to generate 15000 MW of energy in that timeframe. This provides ample avenues for potential investors to explore investment opportunities in Nepal.

2. Why Invest in Nepal?

Strategically located between two of the world's fastest growing economies, Nepal can be referred to as a land linked country bringing unprecedented advantages and access to market of billions of people. With recent policy reforms and stable government there has been a significant improvement in business climate exhibited by improvement in doing business ranking. Nepal moved 16 places up in a year from 110 to 94 from 2019 to 2020.There is a provision of providing Non-Tourist Visa and Work permits upon the recommendation of the investment approving agencies. Residential visa is also granted if the investment is above USD 1 million. Foreign investment is allowed up to 100% in all the sectors except in the ones under the Negative list of FITTA. Land ownership is also allowed in the name of Companies. Foreign Companies are given National treatment and are treated at par with domestic companies. Repatriation after completing all the legal obligations is fully allowed. However, foreign employees can only repatriate up to 75% of their income.

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1 Chief Executive Officer, Office of Investment Board of Nepal

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Investment of any investor is protected in Nepal. If the project falls under the mandate of IBN, then there is also a provision of Project Development Agreement, PDA similar to concession agreement, for PPP projects and Project Investment Agreement, PIA for private investment projects. The agreement is developed as per the international best practices and spells out the obligation of both the government and private parties.

Nepal is very competitive in the region in terms of tax. Normal rate is 25% for entities but the priority sectors such as transport, energy, transmission lines, manufacturing have only 20% corporate tax. On the market access front, Nepal being a LDC country enjoys access to the global market through WTO membership. There is a special Treaty of Trade between Nepal and India and this allows for a duty-free market access to Nepali products (with 30% value addition) to India. Similarly, Nepal also enjoys duty free market access to China for over 8000 products. And through the Everything But Arms Arrangement we have access to the European market. In addition to that we also enjoy duty free market access for 10 years starting from 2016 for 66 items to the US market. In the nutshell, investment in Nepal will provide huge market access across the immediate borders and beyond. Nepal has also done BIPPA with 5 countries and DTAA with 11 countries and the government is preparing to sign more such agreements in future to make Nepal an attractive destination for investment.

On the policy front, The Constitution of Nepal promulgated in 2015 ensures the right to property and acknowledges the role of private investment for the development of the country and therefore encourages foreign investment, in resources and technology. Nepal has recently enacted and amended a lot of laws related to investment. One such case being the enactment of PPP and Investment Law. This law now gives a lot more clarity in terms of project procurement and implementation, both PPP and private investment projects. It also encourages competition and has provisions for Viability Gap Funding (VGF) in projects to make it financially viable. One Stop Services has been initiated at Department of Industry and IBN for efficient service delivery, investment protection through agreements are some of the other provisions that will ease the service delivery. Similarly, the amendment of FITTA and other Acts have made the entry, operation and exit of companies simpler. These initiatives all significantly contribute to achieve the government vision of "Prosperous Nepal, Happy Nepali."

3. Opportunities

Nepal is a land of opportunities. We are still at a very infant stage of development in many sectors. There are numerous areas of investment for potential investors to explore. Some sectors like Energy, Transport, Tourism, Manufacturing, Education and Health have high scope for development.

Nepal's economically feasible capacity for producing energy from hydropower projects is around 42,130 MW. The main river systems; Sapta Koshi river has potential of 10.86 GW, Sapta Gandaki river has 5.27 GW, Karnali and Mahakali river has 25.1 GW and Southern Rivers have 880 MW potential. However, current installed capacity is only 1044 MW of electricity. Nepal has huge possibilities of exporting excess power to neighboring countries via Power Trade Agreements and in regional market through SAARC Framework agreement on Energy Cooperation. Nepal needs a lot of investment in infrastructure development. Opportunities exist in road network development and expansion. Nepal is yet to have major railways, urban transport solutions (Metro, Sky rail, Subway) and water transport. There is

only one international airport till now and plans for building other international, regional airports are also underway.

Nepal's geography, topography, water resources, temporal conditions, and ample supply of labour gives a comparative advantage in agricultural production for various kinds of agro-based products, medicinal herbs and essential oils among others. The country also shares an open border with five adjoining Indian states comprising approximately 350 million people that pose as a huge, duty- free market for agricultural products.Tourism has always been one of the USP (Unique Selling Point) for Nepal. We have products to attract but need activities, infrastructure to reach such destinations and provide top class service which will prolong their stay as well as help fetch more spending.Nepal's ICT sector is one of the rapidly emerging sectors in the country, having huge potential for growth in future. Latest technology trends in Nepal exists in E-commerce; Internet Broadband; Digital Wallet; Online Ride Sharing; Electronic Gadgets; Online Business; Electric Vehicles; Robotics; Artificial Intelligence and gaming.

Nepal's health care sector has a huge potential to export services and establish itself as a hub for health services due to its comparative advantage in terms of skilled health manpower, climate and hospitable people. The demand for health care services is much more than the supply. Vast majority of Nepalese students go abroad every year in pursuit of better education and a foreign degree, establishing a quality educational institution is bound to attract a large number of students.The government is committed to supporting industrialization by promoting investment in the manufacturing sector. Industrial Districts and SEZs have been created to ensure a competitive and investment friendly environment and to simplify administrative procedures.

There exists a lot of opportunities in multiple sectors awaiting investment. The improvement in the investment climate and stable political status has generated a lot of interest from the international community. Hence this is the right time to invest in Nepal and take benefits from its growing economy.

Recharging Groundwater through Rainwater Harvesting in Kathmandu Metropolitan City

Saroj Basnet[1] Jayshree Rajbhandary[2]

Abstract

Kathmandu Metropolitan City (KMC) covers an area of 49.45 sq.km and groundwater is the major source of water supply. The relentless pressure due to competitive demands and increasing water needs, have resulted in over exploitation of groundwater. Rainwater being the major source of water, harvesting of excess monsoon runoff is the best option to provide sustainability to groundwater resources. Kathmandu Metropolitan City, realizing the necessity and urgency for groundwater recharge is forming a consortium comprising of relevant organization to serve as a planning and implementing body. The consortium will formulate technically viable design standards, guidelines and training manuals to implement a comprehensive and scientifically viable water conservation and rainwater harvesting program. It not only attempts to evaluate current state of the groundwater considering natural and social system together, but also to better understand the origin of stresses, their state, expected impact and responses made/needed to restore healthy groundwater resources. It is an effort to bring out detailed database/inventory of shallow/deep aquifers and various groundwater sources by immediate management intervention with institutional responsibility for groundwater development, regulation and knowledgebase management i.e. to facilitate collection, integration and dissemination of knowledge.

Keywords: *groundwater recharge; rainwater harvesting; consortium; institutional responsibility*

1. Introduction

Groundwater has now become a major natural resource contributing to the water supply system in Kathmandu Valley. Due to urbanization and increase in the impermeable ground, surface infiltration has been vastly reduced while consumption of groundwater is increasing every year. In addition, the over exploitation through excessive abstraction of groundwater (both shallow and deep) resource exceeding its replenishment capacity has resulted severe water stress in Nepal, particularly in Kathmandu (S. Shrestha et al., 2016).

The Valley's current water demand is about 375 million litres per day (MLD), but Kathmandu Upatyaka Khanepani Limited (KUKL) can only supply about 120 MLD (Rana and Shrestha, 2017). To meet the supply-demand gap, groundwater from both shallow and deep aquifers (more than 200 metres) is being heavily extracted by small- to large-scale users, including KUKL itself (R. R. Shrestha, 2009). This unregulated extraction is depleting the aquifers; especially the deep aquifers are not easily rechargeable due to the Valley's impermeable black clay (Pandey et al., 2012). The total annual abstraction in Kathmandu

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valley is estimated as 23.4 million cubic meters, which is much greater than the maximum recharge estimate of 14.5 million cubic meters (Shrestha, 2014). The overall groundwater extraction rate exceeds the natural recharge capacity by 6 times, resulting in a lowering of the groundwater table by approximately 2.5 metres per year (Shrestha, 2009). An immediate consequence of the depletion of shallow groundwater aquifers is that dug wells, hand pumps, and traditional stone spouts can no longer provide water as they once did. Depletion of water levels in aquifers and decline in design yield of wells due to excessive pumping in the absence of adequate knowledge on groundwater availability are becoming a major concern.

Rainfall is the major source of groundwater recharge. As the rainfall is unevenly distributed, the amount of groundwater withdrawal and situation of low rainfall are factors responsible for overall stress on groundwater. Groundwater resources development and related engineering activities have gained paramount importance as the risks from pollution to resource have increased year after year. Maintaining the water balance of extraction and recharge is vital for managing human impact on water and ecology. Management of groundwater resources, projecting the future development possibilities and socio-economic as well as environment impact assessment, can be achieved through effective implementation of water harvesting. The need of the hour therefore is a long-term planning for effective and efficient management of this precious resource as well as to bring in additionality to depleting water resources by adopting a holistic approach. Groundwater as common pool resource has been typically utilized in an open access framework, within which, resource ownership is according to a "rule of capture". But during the last decades decline of groundwater is seen prominently.

The average rainfall in the Kathmandu Valley is around 1900 mm: more than twice the world average. Approximately 1.2 billion cu.m/year or 3353 MLD of rainwater falls in the 640 sq.km Valley. This is about 12 times the present water demand (Gautam, 2017). Harvesting of rainwater and excess monsoon runoff which otherwise goes unutilized, to create additional groundwater storage is the most attractive and technically feasible option. Likewise, up-to-date information on well inventory, water extraction, water quality and overall situation of groundwater environment are not yet known in the absence of institutional responsibility in groundwater management.

Therefore this program attempts not only to evaluate current state of the groundwater environment considering natural and social system together but also to better understand origin of stresses, their state, expected impact and responses made/needed to restore healthy groundwater environment. Likewise, it also addresses the water issues and its resilience for better tomorrow. It therefore will be the immediate management intervention with institutional responsibility for groundwater development, regulation and knowledgebase management (i.e. to facilitate collection, integration and dissemination of knowledge) and use rainwater as one of the major source to recharge groundwater.

1.1. Existing condition and impacts on groundwater sources

Kathmandu Metropolitan City experiencing rapid urbanization has a total population of 9, 75,453 and 2, 45,292 household according to 2011 census. Among the total household 1, 63,339 household are connected with water supply pipeline and 10,890 household have private well/boring inside their house premises. Likewise there are 1,341 public wells and 4,830 stone taps inside metropolitan city. The KUKL is fully operational and supplies water to 72% of household (Pattanayak et al., 2005). Hence many people depend on stone spouts, public wells and public taps for their daily water usages and are important sources of water for urban poor. Likewise it also carries a vital aesthetic and traditional values and as an act of cultural heritage. According to the ESCAP strategy paper on "Improving Urban Water and Sanitation Services in

Kathmandu Valley, Nepal", rainwater harvesting was not in use and water reuse and conservation behaviour have not yet received any attention. Besides this most of the hotels, apartments, commercial buildings, governmental and non-governmental buildings, embassies, industries, nursing homes and schools depend on groundwater sources causes stress to the existing table. According to 2009 data, about 70 million cubic meter of water was extracted from ground water sources declining the water table by 2.5 m (Pandey et al., 2012). This decline in water table has also led to drying up of groundwater sources. It also stated that that 10% of the total population depends on stone spouts as an independent source of water (Rasul, 2014).

The 2015 catastrophic earthquake damaged the entire development infrastructure including water supplies sources. It was reported that water supply worth US $106 million was affected. The ground shaking affect lead to surface rupture to secondary hazards such as landslide, liquefaction, flooding, and changes in river and groundwater flow. There was a shift in the distribution line of the stone spouts which resulted in 41 sources to dry up among 382 in Kathmandu valley (Mostafavi et al., 2017).

1.1.1 Urban Flooding

Land use change i.e. conversion of agriculture and open land into concrete buildings and roads and encroachment of riverside public land have accelerated flood during the rainy seasons. Flood in Bagmati River and its tributaries is a common occurrence as the infiltration capacity of soil has declined, resulting in direct flow of large volumes of rainwater into river. In Kathmandu, storm water drainage has been constructed for normal rainfall and does not function to the desired level during rainy season. Intense rainfall in a short period has further damaged the drainage facilities and accelerated riverbank cutting. Furthermore, blockage of storm water drains has increases the road blockage due to inundation in urban roads. It is estimated that over 400 surface drains linked with sewerage are directly connected to the streams and rivers, which every year leads to flash flooding in Kathmandu (Tinh & Herath, 2005).

1.2. Groundwater recharge plan for KMC

The groundwater recharge plan for KMC is entrusted with exploration, study and monitoring of groundwater and its implementation plan. The plan argues that recharge on this massive scale suggested can help a) enhance the sustainability yield in areas where over development has depleted the groundwater; b) supports conservation and excess of surface and rain water for future requirements which often changes with season; c) improve the quality of existing groundwater; d) increase the groundwater table of which has decrease up to 2.5 m in last decade; e) rehabilitate the ponds and stone sprouts that has been drying up. The plan also argues that reusing excess monsoon run off will not only increase the availability of water to meet the growing demand but also help in controlling the urban flooding. The conceptual recharge plan rest mainly on a) formation of consortium for enhancement of performance of stakeholders b) research and development c) technical design and guideline.

1.2.1 Conceptual foundation for recharge plan

The conceptual foundation of the recharge plan is the formation of consortium. Realising the necessity and urgency to provide sustainability to groundwater resources in KMC, a consortium comprising of relevant organizations is planned be formed to prepare and implement the program. Harnessing of monsoon runoff through recharge techniques would be one of the thrust areas in coming years to manage groundwater resources. The formed consortium, would therefore serve as a planning and implementing body. It helps to formulate technically viable design standards, guidelines and training manuals to implement a comprehensive and scientifically viable water conservation and rainwater harvesting. The following figure shows the

general groundwater recharge plan of Kathmandu Metropolitan City from formation of a consortium as a conceptual foundation to the pathways to achieve the groundwater security and resilience in the city.

Figure. 1 :Groundwater Recharge Plan of Kathmandu Metropolitan City

1.2.2 Conceptual pathways for recharge plan

The key characteristic of a plan outlines the way of its implementation. The implementation pathways include a) mapping of open spaces, dug wells to develop an open inventory b) development of standard compendium for design standard and guidelines c) research and development for easy groundwater recharge systems d) Maintenance and rehabilitation of ponds e) addition of rainwater harvesting policies in building code f) awareness programs and documentation for success stories. These implementation plan also have defined specific roles to specific stakeholders, roles and responsibilities of different organization and resource channelization methods. Moreover, KMC is planning to add rainwater harvesting bylaws in the building bylaws. Different subsidy tariffs are planned to be provided for houses, hotels, restaurants and apartments that invest in rainwater harvesting, groundwater recharge and recognising good practices. Therefore, these conceptual pathways involves answering the questions like: Who will do what? What will be the roles of different organizations? How will resources be channelized? Who will be responsible for monitoring the progress?

1.3. Groundwater Recharge for Improved Resilience and Water Security

The need to ensure and improve resilience and water security have enhanced processes linked to the subsurface infiltration, purification, storage and environment flows through human intervention to enhance ecosystem function, water security, resilience and human development. The solutions span from simple rainfall and runoff harvesting and managed recharge schemes implemented at local government and communities to improve water availability especially in dry periods. Another approach of rehabilitating existing ponds to reduce flash urban flood, and regenerating groundwater as aquifers can provide sustainable, decentralised and cost effective solutions which also diversify water sources to increase community resilience. Retaining storm water during rainy season is an attractive urban wetlands method, stored either in pond or recharge pit which increases the chance of regenerating the aquifers and decreasing the risk of flash floods. The solutions include degrees of supportive grey infrastructure to enhance water storage underground for subsequent recovery and use.

It is becoming clear that international water and community must and is considering active components for sustainable water management solutions but there is still a long way to go. Proper management, regulation and rules are critical to ensure the intended outcomes are achieved and adverse consequences are minimised. These solutions discussed in terms of complementarity to existing traditional storage and treatment infrastructure solutions and how we can promote, improve and integrate the groundwater based ones for increased resilience and inclusive water security. Similarly, to protect groundwater table from further deterioration, the effective planning of policy and programs to fix the groundwater extraction within manageable limits can also increase resilience and water security.

Internationally, few concrete cases from Australia, Ethiopia, India, Japan and USA shows how water security is achieved by groundwater recharge sustainability. In Adelaide, Australia, the storm water during rainy season is retained as urban wetlands, injected and stored in brackish aquifers to be abstracted and used during summer for urban green spaces and peri-urban agriculture (Clark et al., 2015). Similarly, in Ethiopia, the initiative of Green Roads for Water aims at harnessing water runoff paved roads to recharge acquire and enhance roadside agriculture. Also, in India an innovative Underground Taming of Floods for Irrigation project in the Gangetic Plains has demonstrated the feasibility of collecting monsoon rains to recharge local acquires and decrease urban flooding (Reddy et al., 2017). Correspondingly, in Japan a payments for ecosystem service scheme in the municipality of Kumamoto seeks increased groundwater availability through payment from water utilities and water intensive industries to farmers for expanded rice growing has generated doubled recharge flows between year 2004 and 2018 (Shivakoti et al., 2018). Likewise, in Nebraska, USA the rehabilitation of irrigation canals and appropriate management of excess flows in rivers and canals have had positive impacts on groundwater recharge rates and natural or constructed wetlands (Roni, 2008). However, a not so successful case study in India of groundwater recharge schemes in textile producing areas, using poorly treated effluent from factories through infiltration pond induced risks and pitfalls of groundwater.

Nationally, one of the best practice is a joint initiative of Centre for Integrated Urban Development, Water Aid Nepal and Coca-Cola Foundation is the rainwater harvesting and ground water recharge at Ranibari Community Forest. The groundwater recharge and rainwater harvesting system was installed through cost-effective techniques like rain garden, recharge pits and bamboo check dams. It is one of the relentless approach to create a lasting positive impact on water efficiency, water conservation, water replenishment and integrated water resource management in Nepal. Similar approach has also been started at Gongabu land pooling area. These efforts have been a positive contributor to the availability of water in the aquifer by undertaking extensive ground water recharge works in Kathmandu.

2. Conclusion

Groundwater in Kathmandu had been under stress for long. Considering the consequences of excessive groundwater development in a form of reduced availability of groundwater resources, several responses aimed to reduce stress on groundwater resources have started. Recharging KMC developed is one of the major step forward in the local official thinking of the country. As, a country, Nepal relies on groundwater for most of its irrigated area. KMC investment priorities continues to favor the urgent need for groundwater recharge on a massive scale. By emphasizing this critical need, the KMC has made a significant contribution. The most important contribution of the KMC is its verifiable objective of raising post-monsoon groundwater levels throughout Kathmandu. Its implementation plan and a clear key roles of the stakeholders emphasizes

and responses the major enquiry on; will do what? ; What will be the role of government agencies, people, NGOs and civil society institutions? ; Who will construct the recharge structures? And how will they be maintained?

There is a long way to go to achieve the goal of groundwater sustainability. However, improvement in groundwater monitoring by increasing coverage, further research to enhance understanding of groundwater dynamics and recharge system, management of existing data/information/knowledge and its disseminations and policies and strategies for public participation in groundwater management and conservation activities is the immediate step in the direction of achieving groundwater sustainability. It is also expected that the groundwater and rainwater harvesting policy will play an important role in sustainable utilization and management of groundwater of Kathmandu Metropolitan City.

Copyright

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Resilient Infrastructure development projects through technical and financial co-operation in Nepal and Asian region

Ms. Yumiko Asakuma[1]

What is Japan International Cooperation Agency (JICA)?

JICA, in charge of administering Japan's ODA, is **one of the world's largest bilateral aid agencies.** JICA supports socioeconomic development in more than 150 countries through **flexible combination of various types of assistance** methods, such as Technical Cooperation, Finance and Investment Cooperation, and Grants.

President	Shinichi Kitaoka
Establishment	October 1, 2003
Capital	8 trillion 99.8 billion yen (end of fiscal 2017)
Full-time Staff	1,909 (end of fiscal 2017)
Objectives	Established as an Incorporated Administrative Agency under the Act of the Incorporated Administrative Agency - Japan International Cooperation Agency (Act No. 136, 2002), JICA aims to contribute to the promotion of international cooperation as well as the sound development of Japanese and global economy by supporting the socioeconomic development, recovery or economic stability of developing regions.

2

Our Vision

信頼で
世界をつなぐ
Leading the world
with trust

JICA, with its partners, will take the lead in forging bonds of trust across the world, aspiring for a free, peaceful and prosperous world where people can hope for a better future and explore their diverse potentials.

Our actions towards the vision

1. **Commitment:** Commit ourselves with pride and passion to achieving our mission and vision.
2. **Gemba:** Dive into the field ("gemba") and work together with the people.
3. **Strategy:** Think and act strategically with broad and long-term perspectives.
4. **Co-creation:** Bring together diverse wisdom and resources.
5. **Innovation:** Innovate to bring about unprecedented impacts.

3

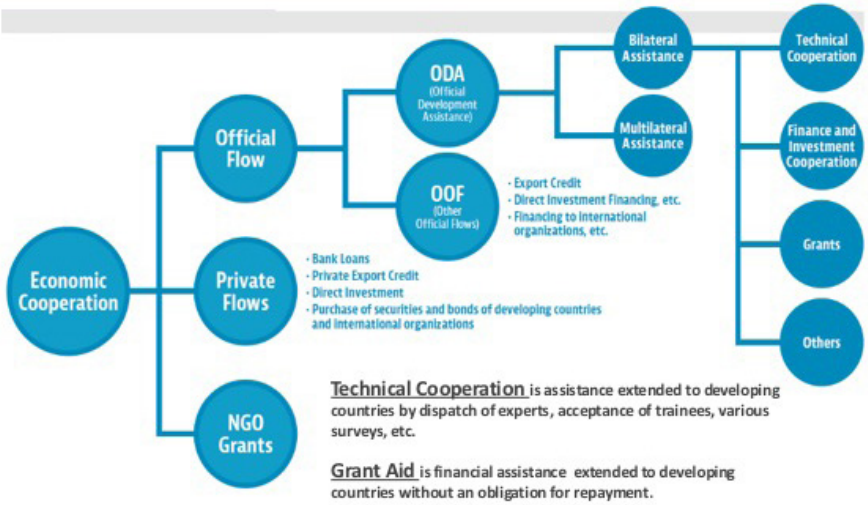
1 Chief Representative, JICA Nepal office

Overseas Office

- Around 100 offices are located worldwide to promote projects in response to local needs.

4

Economic Cooperation and JICA



Technical Cooperation is assistance extended to developing countries by dispatch of experts, acceptance of trainees, various surveys, etc.

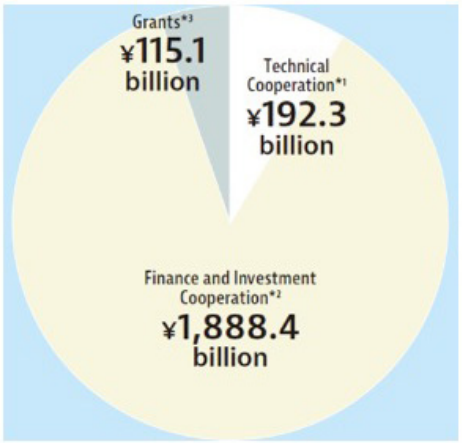
Grant Aid is financial assistance extended to developing countries without an obligation for repayment.

ODA Loans is concessionary loans provided to developing countries.

5

Types of Assistances

Our Scale of Operation (FY 2018)



Technical Cooperation

- By sharing Japan's technologies and expertise, technical cooperation aims to foster the human resources who will lead economic and social development in developing countries.

Assistance in agricultural production in Uganda

Finance and Investment
(ODA Loans and Private-sector Investment Finance)

- JICA provides ODA Loans with concessional conditions (similar to development finance provided by Multilateral Development Banks, etc.) for developing countries to finance investment for development.

Delhi Mass Rapid Transport System Project in India

Grant Aid

- Assistance in the form of grants with no repayment obligations to provide the goods and services necessary for economic and social development in developing countries.

Rural water supply in Ethiopia

6

Portfolio of South Asia Region

Afghanistan (billion yen)

	2015	2016	2017
Loans	NA	NA	NA
Grants	5.3	2.4	1.0
Technical Cooperation	3.8	3.5	2.2
SA Total	9.1	5.9	3.2

Bangladesh (billion yen)

	2015	2016	2017
Loans	133.3	173.5	182
Grants	2.5	2.2	1.5
Technical Cooperation	4.6	4.2	4.6
SA Total	140.4	179.9	188.1

Bhutan (billion yen)

	2015	2016	2017
Loans	NA	NA	NA
Grants	1.1	1.4	1.3
Technical Cooperation	1.0	1.5	1.0
SA Total	2.1	2.9	2.3

India (billion yen)

	2015	2016	2017
Loans	377.3	308.8	398.4
Grants	NA	NA	1.4
Technical Cooperation	4.8	16.0	9.0
SA Total	382.1	324.8	408.8

Maldives (billion yen)

	2015	2016	2017
Loans	NA	NA	NA
Grants	NA	NA	2.8
Technical Cooperation	0.4	0.3	0.1
SA Total	0.4	0.3	2.9

Nepal (billion yen)

	2015	2016	2017
Loans	26.0	16.6	NA
Grants	4.3	3.0	1.9
Technical Cooperation	3.5	3.3	2.4
SA Total	33.8	22.9	4.3

Pakistan (billion yen)

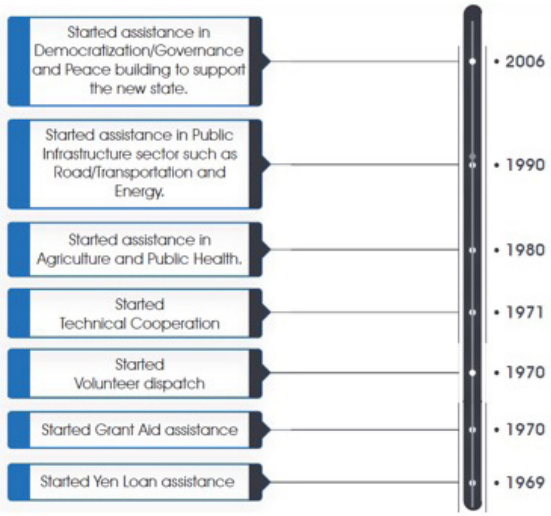
	2015	2016	2017
Loans	5.0	6.3	2.7
Grants	3.8	6.0	6.5
Technical Cooperation	2.4	2.5	1.7
SA Total	11.2	14.8	10.9

Sri Lanka (billion yen)

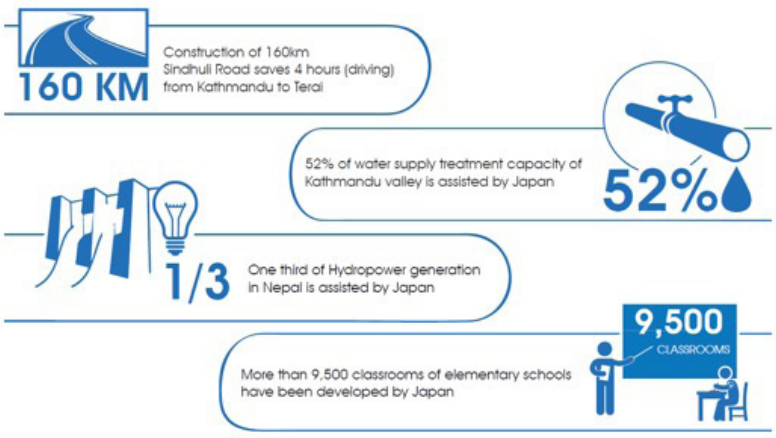
	2015	2016	2017
Loans	70.4	33.1	44.8
Grants	0.5	3.8	0.4
Technical Cooperation	2.1	2.9	2.4
SA Total	73.0	39.8	47.6

7

Our cooperation to Nepal

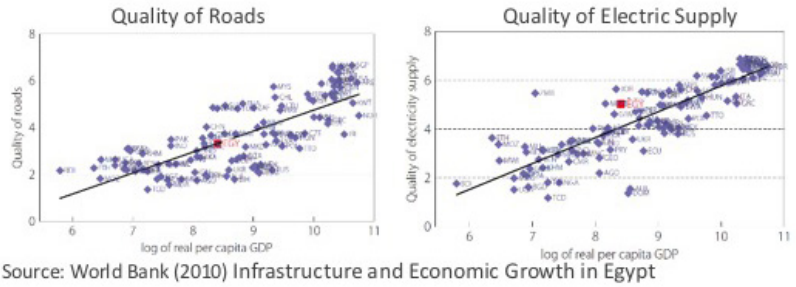


Examples of our past cooperation



Quality Infrastructure and economic development

- GDP per capita of Nepal broke the threshold of USD 1,000 in 2018.
- However, in order to maintain and accelerate economic development, more infrastructure is necessary.
- World Bank (2010) argues that there is a positive correlation between quality of infrastructure and economic growth



Source: World Bank (2010) Infrastructure and Economic Growth in Egypt

Examples of "Qualities" ODA loan projects

Delhi Metro

- Introduced the concept of "Safety First" in the construction site
- Technologies introduced in rolling stocks contributes to the reduction of electric consumption and CO2 emission

Railway Fly-over in Ulaanbaatar City in Mongolia

- Introduced an earthquake-resilient bridge
- Transferred related engineering technologies to Mongolian engineers and students through seminars and site visits.

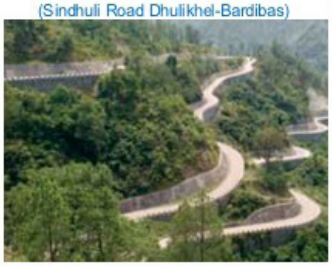
Nhat Tan Bridge in Hanoi, Vietnam

- Introduced suitable technologies for soft ground
- During the construction, Japanese engineers provided training to Vietnamese engineers on the technologies
- Now the construction method introduced to the bridge has been adopted as construction standards in Vietnam.

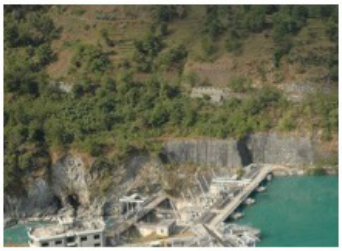
Examples of "Qualities" ODA projects in Nepal

Kathmandu - Bhakutapur Road

B.P. Highway
(Sindhuli Road Dhulikhel-Bardibas)



Kali Gandaki A Hydropower Plant



Other Key Infrastructure Developed by Japanese ODA.

Transport
- Gongabu Bus Terminal
- New Thapathali Bridge
- Nagdhunga Tunnel (ongoing)
- Tribhuvan Airport
- Airport and Enroute Surveillence Radars

Health
- National Tuberculosis Center
- Tribhuvan Univ. Teachnig Hospital
- Kanti Children's Hospital
- Bir and Paropakhar Hospital

Private Sector
- Udayapur Cement Factory

Energy
- Kulekhani I & II Hydropower Plant
- Tanahu Hydropower Plant (ongoing)
- Kathmandu Load Dispatch Center

Water Supply
- Melamchi Water Treatment Plant
- Manohara WTP
- Pokhara WTP (ongoing)

Challenges for the "Engineer" in Project Implementation in Nepal
Management of Construction Period

Causes of delay

1. The Employer's responsibility
- Land acquisition
- Disruption
- Delay in payment

2. Force Majeure
- Unforseenable geological condition
- Natural calamities
- General strikes and political unrest

3. The Contractor's responsibility
- Delay in procurement of material
- Lack of labor force
- Lack of literacy of contract conditions

Four major bridges in Dang completed before deadline

The construction company claimed it completed the construction of bridge eight months ahead of deadline. "The construction of bridge has been already completed. Just the wall on pavements of the bridge remains to be built. We plan to hand over the bridge to the authorities within three months,"

"Development projects can be completed on time if the company gives due priority and carries out the work sincerely," said manager of Rasuwa Construction

Kathmandu Post Nov 4, 2019

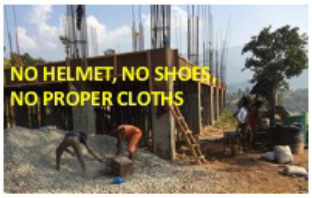
Management of Quality & Construction Safety

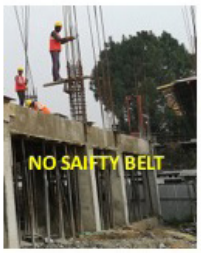
Contractors always try to

- Avoid material test
- Reduce amount of cement
- Hire cheap and not well qualified engineers

Contractors always try to

- Save expenses for safety measures, which sometime causes fatal incidents

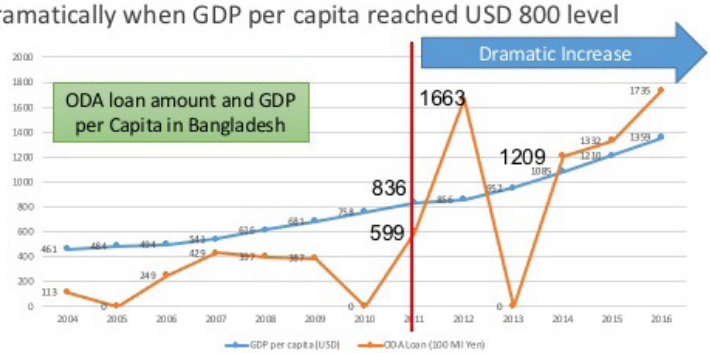


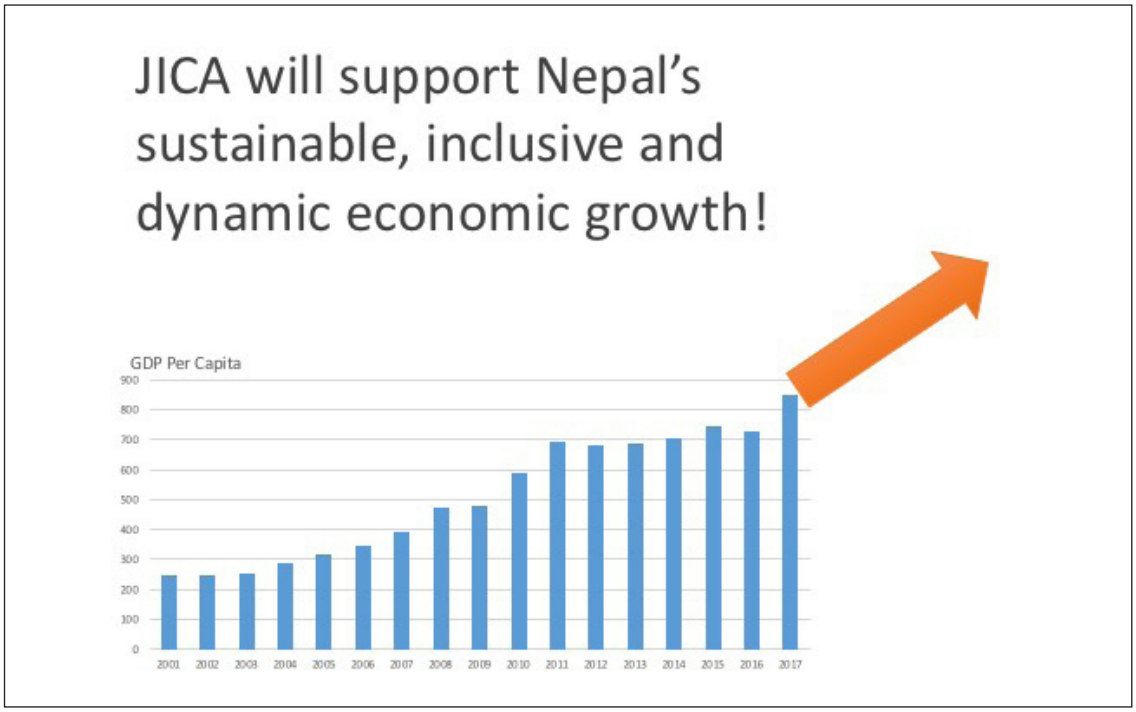


14

Where Nepal is right now and Nepal towards the future

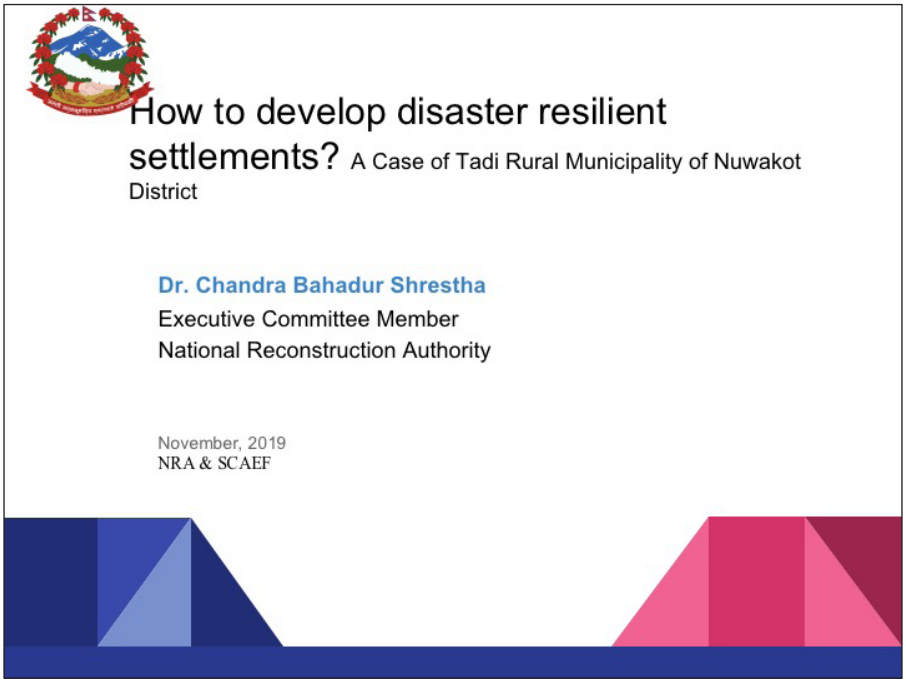
- With an economic growth and more growing need for infrastructure, JICA would like to utilize our loan facility to accelerate infrastructure development, with suitable quality.
- In case of Bangladesh, JICA increased the ODA loan amount dramatically when GDP per capita reached USD 800 level

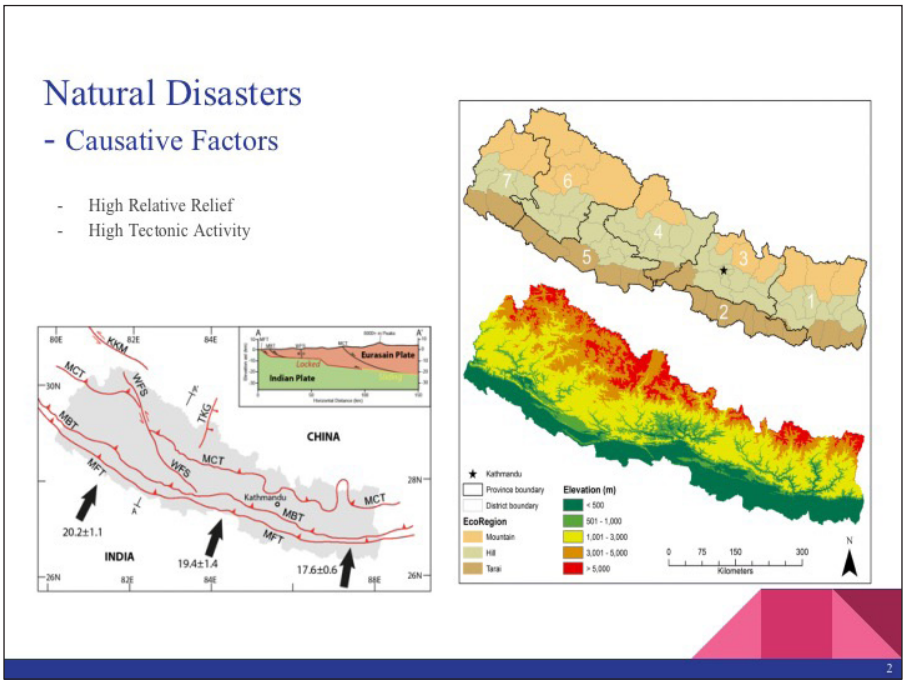



JICA will support Nepal's sustainable, inclusive and dynamic economic growth!
GDP Per Capita
900
800
700
600
500
400
300
200
100
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

How to develop disaster resilient settlements? A Case of Tadi Rural Municipality of Nuwakot District

Dr. Chandra Bahadur Shrestha[1]



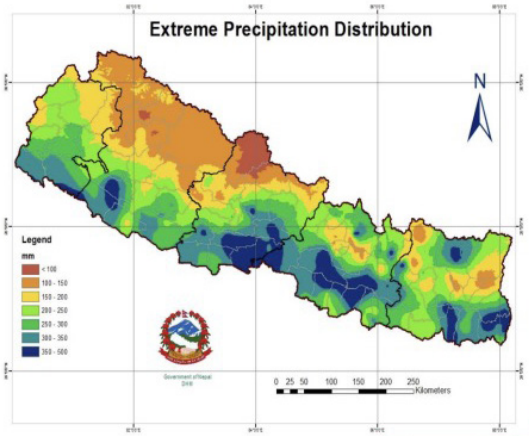


1 Executive Committee Member,National Reconstruction Authority.

Natural Disasters

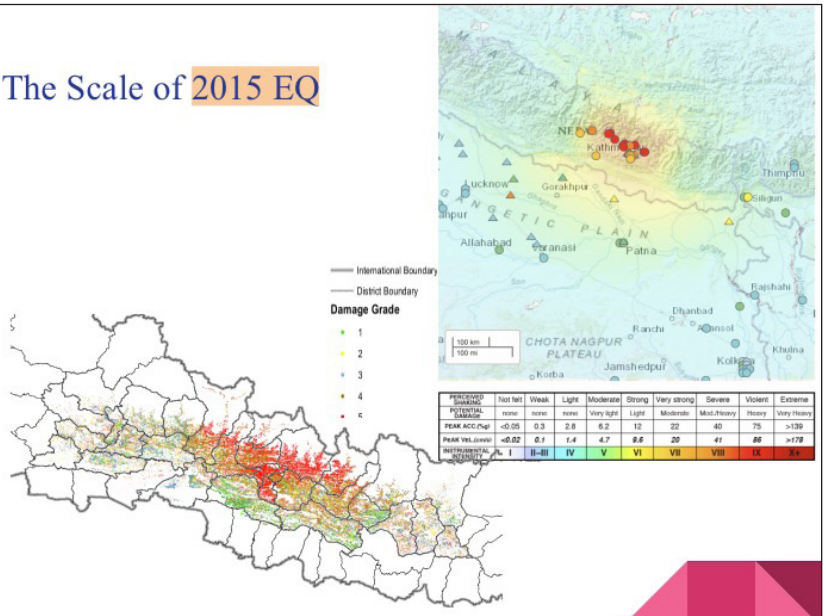
- Causative Factors

- Summer monsoon



3

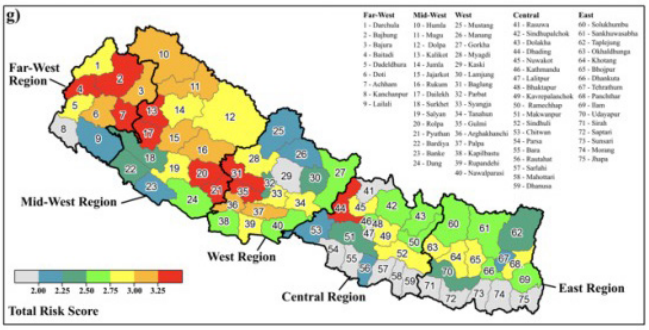
The Scale of 2015 EQ



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

4

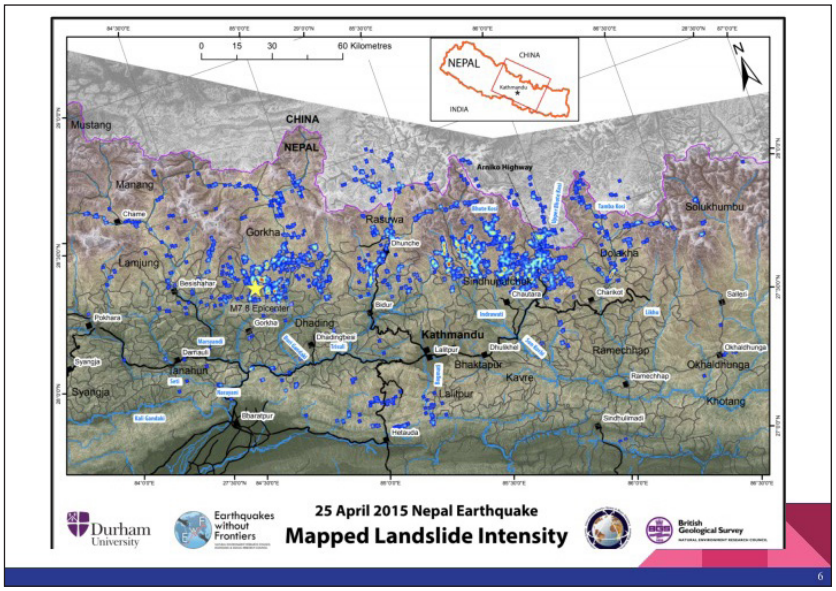
Earthquake Modelled Risk



Earthquake Risk

Durham University Research, 2018

5


0 15 30 60 Kilometres
NEPAL
CHINA
INDIA
Kathmandu
Mustang
Manang
Gorkha
Lamjung
Rasuwa
Arniko Highway
Solukhumbu
Dolakha
Sindhupalchok
Besishahar
M7.8 Epicenter
Dhading
Kathmandu
Bhaktapur
Kavre
Lalitpur
Ramechhap
Okhaldhunga
Khotang
Sindhulmadi
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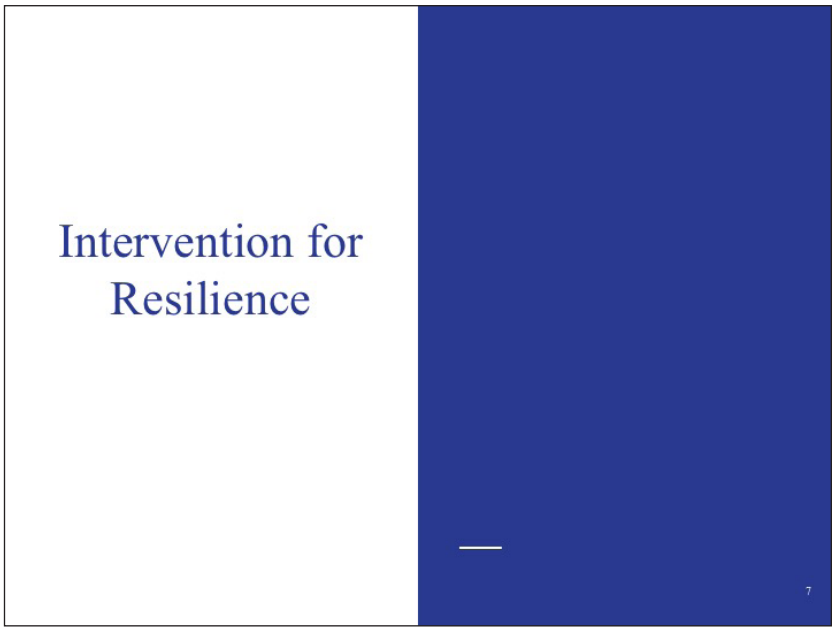
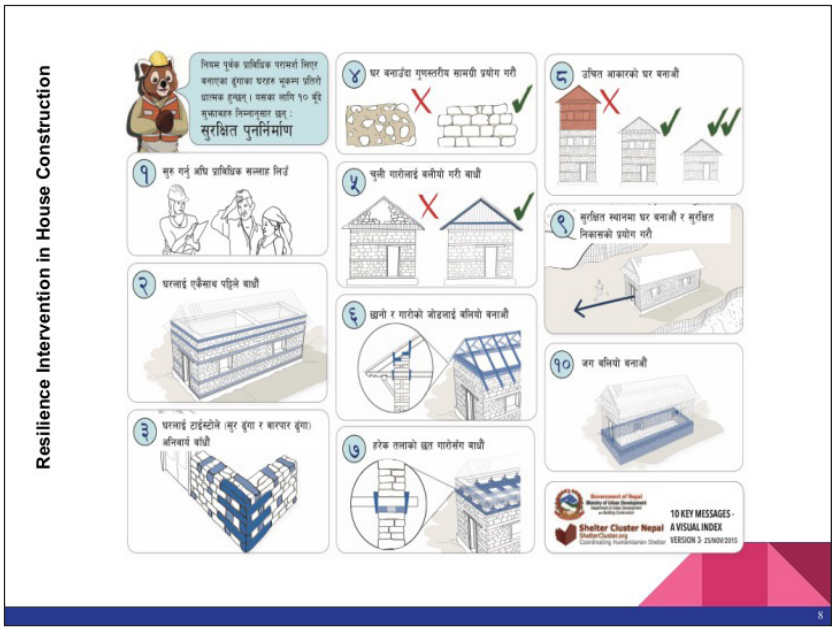
Bharatpur
Durham University
Earthquakes without Frontiers
25 April 2015 Nepal Earthquake
Mapped Landslide Intensity
British Geological Survey
6


Intervention for Resilience
7


Resilience Intervention in House Construction
नियम पूर्वक प्राविधिक परामर्श लिएर बनाएका ढुंगाका घरहरु भूकम्प प्रतिरोधात्मक हुन्छन् । यसका लागि १० बुँदे सुझावहरु निम्नानुसार छन् :
सुरक्षित पुनर्निर्माण
१ सुरु गर्नु अघि प्राविधिक सल्लाह लिउँ
२ घरलाई एकैसाथ पहिले बाँधौं
३ घरलाई टाईस्टोने (सुर ढुंगा र बारपार ढुंगा) अनिवार्य बाँधौं
४ घर बनाउँदा गुणस्तरीय सामग्री प्रयोग गरौं
४ चुली गारोलाई बलीयो गरी बाँधौं
६ छानो र गारोको जोडलाई बलियो बनाऔं
७ हरेक तलाको छत गारोसँग बाँधौं
५ उचित आकारको घर बनाऔं
९ सुरक्षित स्थानमा घर बनाऔं र सुरक्षित निकासको प्रयोग गरौं
१० जग बलियो बनाऔं
Shelter Cluster Nepal
10 KEY MESSAGES - A VISUAL INDEX
VERSION 3- 25/NOV/2015
8

Retrofitting… Catching up

Intervention in the road construction

Categories of geo-hazard survey

Cat 1: Safe to construct house

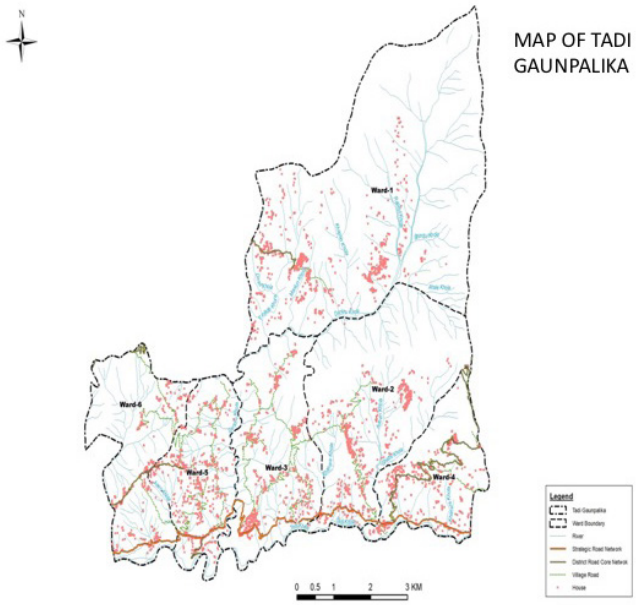
Cat 2: Requires some additional interventions

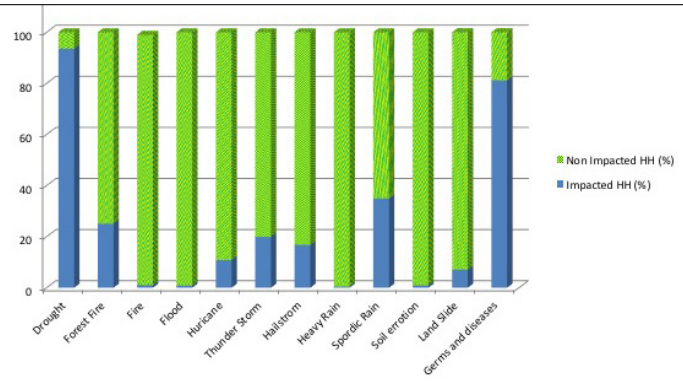
Cat 3: Need to shift to another safe location. Not safe to continue living.

A Model of Dhungetar Settlement, Bidur

12

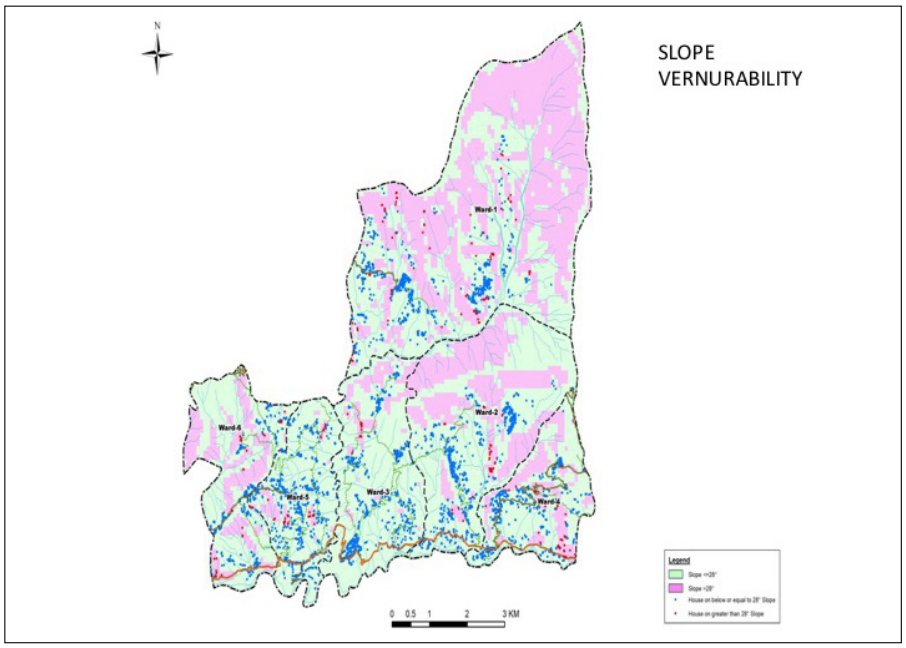
A Case of Tadi Rural Municipality

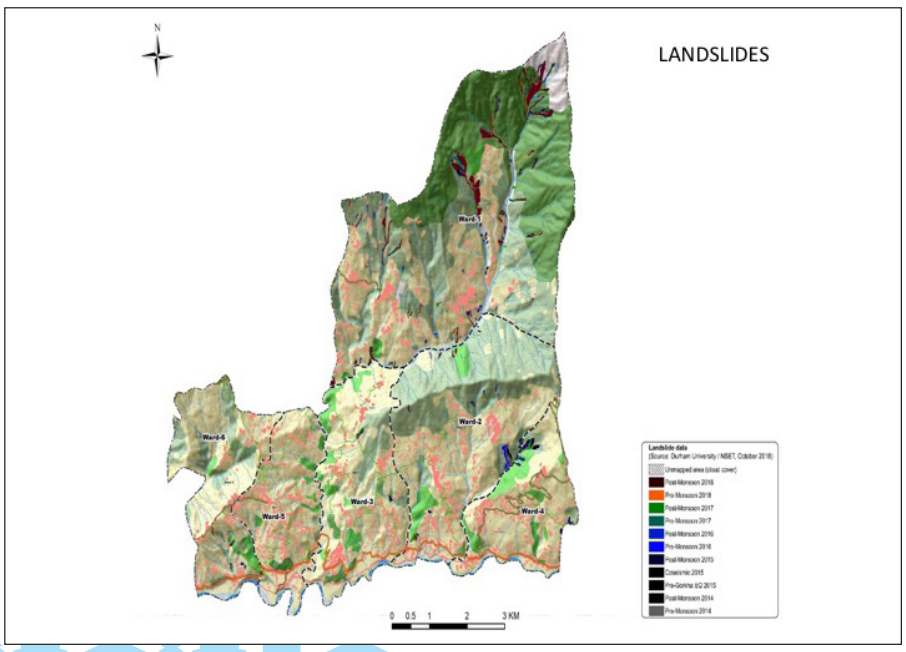


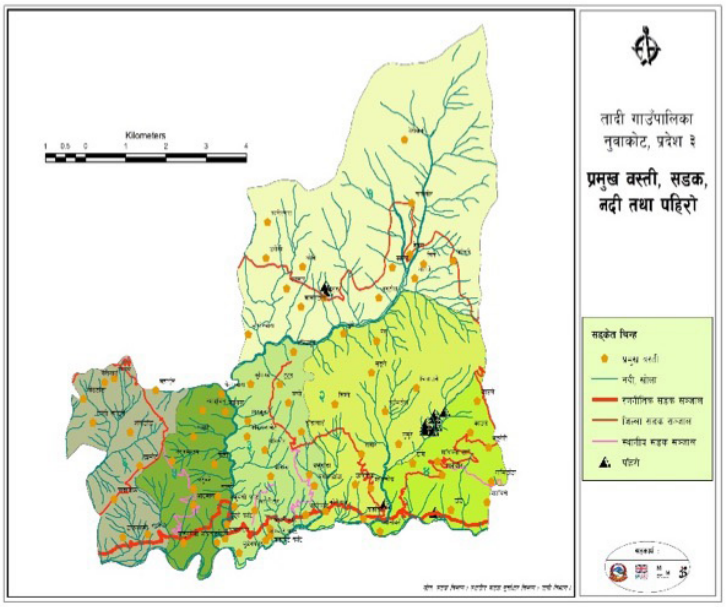


Types of Disaster by Wards in Tadi

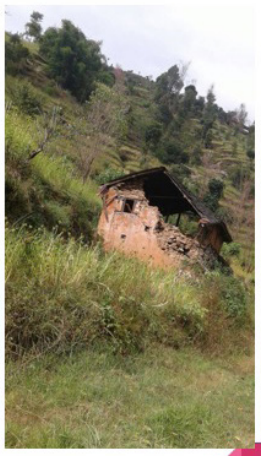
Wards	Disaster Type				
	Land slide	Flood	High slope	Others	Total
1	40	13	125	47	225
2	33	0	30	4	67
3	47	0	55	7	109
5	15	0	15	0	30
Total	135	13	225	58	431







Landslides in Urleni of Tadi Rural Municipality



20

Flood disaster

21

Human Loss by Disaster in FY 2074/75

Ward	Fire		Landslide		Pandemic disease		Earthquake	
	Died	injured	Died	injured	Injurd	injured	Died	injured
1	-	-	-	1	-	-	9	25
2	-	2	-	-	5	-	19	86
3	5	-	-	2	-	-	12	65
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
Total	5	2	0	3	5	0	40	176

Impact of Various Disasters in 2074/75

Disaster	Ward No.	Cattle shed		Animals		Crops and land		Others	
		HH	Amount	HH	Amount	HH	Amount	HH	Amount
Fire	1	1	60,000	5	60,000	-	-	-	-
Landslide	1,2,3,4	130	90,00,000		-	150	80,00,000	-	1,00,000
Pendemic Diseases	1,2,3,4,5,6	5	5,00,000	-40	45,00,000	200	70,00,000	-	-
Total		136	95,60,000	-40	45,00,000	350	150,00,000	0	1,00,000

Ward No.	Damaged Household of 2072 B.S. Earthquake			
	Damaged houses	Non-Damaged Houses	Not available	Total
1	748	3	2	753
2	845	4	4	853
3	734	30	3	767
4	545	1	2	548
5	501	36	2	539
6	563	6	3	572
Total	3936	80	16	4032
%	97.62	1.98	0.4	100

Policy Level Provisions

- NPC's Local level plan formulation directives considered disaster management as one of the sectors along with economic, social, infrastructural and governance development
- Ministry of Home Affairs issued Disaster Preparatory and Reconstruction Project Formulation Directives – 2067.
- How these two documents will be reconciled with each other will need further clarity

Resettlement in Budune Village of Tadi RM with access to cultivable land on lease

26

Other facilities to the new settlement

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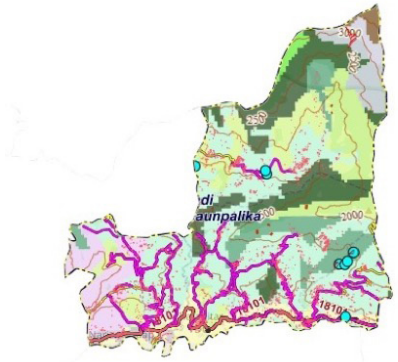
Proposed Landuse and resettlement map



Programme of Rural Municipality

रणनीतिक कार्यक्रम तथा आयोजना	इकाई	योजनाको लक्ष्य		अनुमानित लागत (रु. हजार)	स्थान, कार्यक्रम र आयोजना वितरण
		आधार वर्ष ०७५/०७६	कल लक्ष्य (२०८०/८१)		
१.४.१ वडास्तरीय विपद् जोखिम व्यवस्थापन समिति तथा कार्यदलहरुका क्षमता तथा क्रियाशीलता अभिवृद्धि कार्यक्रम (कृत्रिम अभ्यास, वडा सरसफाई, क्षमतावृद्धि तालिम र अन्य)	वडा		6	3000	सबै वडा
१.४.२ वडास्तरमा आपतकालीन उद्दार सामग्री भण्डारण तथा नियमित अद्यावधिकरणको व्यवस्था	स्थान	1	6	600	सबै वडा
१.४.३ सामुदायिक आपतकालीन आश्रयस्थल तथा सम्बन्धित पूर्वाधारसहितको बहुउद्देश्यीय भवन निर्माण	वडा	0	6	12000	सबै वडा
१.४.३ आपतकालीन राहत उद्दार कोष स्थापना सुदृढीकरण	रकम रु.		5	3000	-
१.४.४ विपद् जोखिम व्यवस्थापनको मूल प्रवाहीकरण सम्बन्धी अन्तरक्रिया तथा अन्य जनजागरण कार्यक्रम	सहभागी संख्या	500		500	-
जम्मा				**19100**	

Conclusions

- Nepal's local governments have to construct disaster resilient infrastructures instead of developing separate disaster plan. The disaster plan seems to be influenced by rescue and relief operation rather than developing resilient development concept.
- The disaster prone areas have to be delineated with that of safer areas and settlements have to be developed in the safer areas. For this federal government will need to make arrangement for land for constructing houses and clear plan for livelihood for newly migrated population.
- In the present context of abandoned land in rural areas, government may need to develop policy to acquire such land and facilitate resettlement for the people in the vulnerable areas. Such arrangement will be cost effective and will generate enough return on investment with savings in destruction of property and people's life.
- Full life cycle based planning on priority order is essential for resilient construction of infrastructure.
- The local governments need external support for developing such disaster resilient plans. The National Reconstruction Authority (NRA) will consider developing appropriate methodology and initiate supporting them which will need to be continued in the future.

Additional Papers

Road Operation and Maintenance Interventions for Cleaner Safer and Congestion free Kathmandu Valley

Dr Partha Parajuli[1], Krishna Singh Basnet[2]

Abstract

Kathmandu Valley is experiencing an unprecedented growth in both the population and motorised vehicles in recent years. Population in the Valley has grown up sharply from less than 700,000 in 2001 to a speculated level of almost 5 million in 2019. Number of registered vehicles increased to 1,125,820, an increment by more than 47 times in the last two decades. This has contributed to significant increase in congestion, exponential growth in tail pipe emissions. By 2030 annual premature deaths in Nepal, due to outdoor air pollution, are expected to reach 24,000. As many as 36 people out of every 100,000 die in Nepal due to various deadly diseases linked to air pollution. About 35,000 people died prematurely due to poor air quality in Nepal in 2016 and resulted in countless illnesses.

Many studies have indicated that outdoor air pollution would have costed Nepal well above NRs 18.25 billion (US$182.52 billion) in 2018 alone. Premature deaths and disabilities resulting from road crashes might have costed the country well above NRs 14.58 billion (US$145.82 million). Annual congestion cost in Kathmandu can be speculated to exceed well above NRs 16.5 billion (US$165.02 billion). Kathmandu Valley shares significant proportion of these costs. This Paper argues that the implementation of Intelligent Traffic System (KVITS) Project is the most effective road operation and intervention measure for making Kathmandu cleaner, safer and congestion free.

Keywords: *Road Operation and Maintenance, Traffic Congestion, Intelligent Traffic System*

1. Background

Kathmandu Valley is experiencing an unprecedented growth in both the population and motorised vehicles in recent years. Population in the Valley has grown up sharply from less than 700,000 in 2001 to a speculated level of almost 5 million in 2019. Number of registered vehicles was 24,000 in 2001/02. By 2019 it has increased to 1,125,820, an increment by more than 47 times in the last two decades (Ojha, 2019). This has contributed to significant increase in congestion resulting in exponential growth in tail pipe emissions. Kathmandu is now ranked one of the most polluted cities in the world. It is suffering from a potentially serious human health burden from air pollution. By 2030 annual premature deaths in Nepal,

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due to outdoor air pollution, are expected to reach 24,000. Ambient air pollution killed a staggering 9,943 people in Nepal in 2012 (Saud & Paudel, 2018). As many as 36 people out of every 100,000 die in Nepal due to various deadly diseases linked to air pollution. About 35,000 people died prematurely due to poor air quality in Nepal in 2016, and resulted in countless illnesses (GBDCN, 2016).

City or even country specific data on the cost of air pollution on human health are not available for Nepal. According to World Bank, South Asia has been the most affected region from pollution with a loss of more than $66 billion annually. This is approximately 1% of GDP (Saud and Poudel, 2019) of South Asian countries. Extrapolating this figure, outdoor air pollution would have costed Nepal well above NRs 18.25 billion (US$182.52 billion) in 2018 alone.

World Health Organization (WHO) estimates fatal crash rate of over 17 deaths per 100,000 of population for Nepal. Road crashes kill an average of 13 persons every day as reported in a WHO study. This is almost double the official record of 7 deaths per day reported by Nepal Police Service. Thousands are seriously injured and many of them become permanently disabled. In 2018, premature deaths and disabilities resulting from road crashes might have costed the country well above NRs 14.58 billion (US$145.82 million), which is 0.8% of GDP (Banstola, 2019, Dhakal, 2018).

Congestion in Kathmandu has also increased significantly during the same period. While there are no studies undertaken as yet on the total cost to the nation due to congestion it is not difficult to see that that this is also increasing at an alarming rate. A distance which can be easily traversed in 15 minutes by walking takes over hour by car these days. A drive time of 15 minutes with free flow speed requires over an hour quite often waiting behind the wheel. An estimate of congestion cost in Jakarta Indonesia by ESCAP in 2007 shows 0.9 percent of GDP without including marginal increase in fuel consumption and air pollution by congestion (Timilsina & Dulal, 2011). Applying similar figure for Kathmandu, annual congestion cost in Kathmandu can be speculated to exceed well above NRs 16.5 billion (US$165.02 billion).

Kathmandu Valley absorbs significant proportion of all these three major externalities of transport system cost. This suggests that there is an urgent need for the operation and maintenance interventions in the existing road network of the Valley that aim to reduce road crashes, improve travel speed and curb air pollution in the Valley thereby reducing these externalities in urban transport cost in the city. Deaths resulting from increased tail pipe emissions and from road crashes and inefficiency resulting from congested traffic can be tackled head on if traffic can be managed better by implementing smart traffic lights in the streets of Kathmandu Valley. This Paper proposes implementation of Intelligent Traffic System (ITS) as one of the major policy interventions in ongoing road operation and maintenance program to be funded by Road Board Nepal (RBN).

2. Roles of RBN in Road Operation

Historically, RBN used to fund only road maintenance works. It's mandate was to manage fund collected from road users and allocate funds to road agencies to restore pavement and drainage system in accordance with specified service standards agreed between RBN and Road Agencies (RA). In recent times it has also started funding road safety retrofits to help make existing roads safer. This is a step in the right direction taken by the current RBN management. It is also funding minor road research programs. However, reconfiguration of intersections for its improved operational performance and installation of smart traffic lights to control traffic for enhancing efficiency, safety and urban amenity performance standards of urban road system has not been the subject of RBN funding to date.

The RBN collects, manages and allocates fund for road maintenance to the Road Agencies (RA). This fund comes from direct road toll, fuel levy and vehicle registration fees. It is used to preserve existing road asset, restoration value of which is about Rs eighty five billion (1.78 billion US$) at 2000 price. It is a big challenge to preserve this asset. RBN aims to manage the preservation of asset by implementing a planned maintenance management system [PMMS] comprising of a series of inter-dependent routine, recurrent, periodic, and emergency activities on roads and bridges. It reduces rate of deterioration of road prolonging its life, reduces vehicle operating cost, and provides reliable/safer transportation of goods and passengers. Need based budget is required to maintain roads properly and to keep them in good condition. It is estimated that the country requires about one billion rupees annually for the road maintenance whereas the allocation is much less. Apart from under-financing of regular maintenance, the annual increase in road length projected at 6.5 % requires additional fund for its maintenance (http://rbn.org.np). The challenge for RBN is to set up priority areas and make value for money investment decisions. It is believed that investment on road operation for enhanced safety, efficiency air quality and urban amenity is to be the new priority areas for RBN, which is the most neglected area in road development sector.

RBN received a total of NRs 4.5 billion from the Government in FY 2017/2018 (BS 2074/75). It collected NRs 107 million from road toll. It allocates budget for the maintenance of roads in both strategic and local network. Maintenance fund for strategic roads is allocated through various Divisions Offices of DoR and for local roads through various municipalities. Of the total NRs. 742 million approved programs in FY 2017/2018, NRs. 419 million was disbursed to both state and local road agencies. The total revenue RBN is entitled to receive from the Government collected from all eligible sources (including fuel surcharge, toll fees, road construction and maintenance budget, vehicle registration etc.) is anticipated to be NRs. 22 billion. The Government does not allocate sufficient fund collected from these revenues to RBN, which adversely affects the delivery of road maintenance program. RBN would need additional allocation for funding road operation related intervention programs.

3. Objective Scope and Rationale

The objective of this Paper is to support the case that the RBN should not limit its funding to road pavement maintenance and related interventions alone. It should also fund for road operation related interventions such as improvement of intersections (reconfiguration), installation of traffic lights and other including for recurring expenses on the operation and maintenance of existing traffic lights. It should also fund for the development of technical guidance notes, manuals, hands out, road specifications and standards that are to be used by professionals for the development and implementation of road operation and maintenance works. In putting the case forward, the Paper introduces two demonstration projects: (1) Implementation of traffic lights for more efficient, safe and clean operation of valley roads and (2) Development of guidance notes in the selection of right type of pedestrian crossings for safety of pedestrians. Both these demonstration projects are extremely important in light of the recent citizens' outcry about the recently completed section of ring road and are thus very timely. In fact, it is urgent for the Department of Roads to implement operational improvement works in ring road which involve, among others, installation of smart traffic lights at intersections and mid-block (in between the intersections) pedestrian crossings in order to prevent further deaths and disabilities.

The emphasis of the Paper is to provide highlights on the urgency of such intervention projects. It does not provide technical details of the two demonstration intervention projects proposed in the Paper for consideration by RBN. The paper contains only the basic concept of the system. Department of Roads

(DOR) has technical details on these projects already which were developed by Kathmandu Sustainable Transport Project (KSUTP). The scope and extent of the Project however needs review and update, which should identify extending the scope to other major intersections in Kathmandu Valley. Keeping in mind the alarming operational and safety problems in ring road, the priority for implementation may have to be changed and project scope expanded to capture all major trouble intersections and pedestrian crossings along ring road.

Rationale for extending RBN funding to road operation (mainly intersection reconfiguration, installation of traffic lights at intersections and pedestrian crossings is obvious. Traffic light project saves VOC in the same manner as improved road pavement surface. If the improvement in road surface, which aims to reduce VOC can be funded, improvement of intersections and installation of traffic lights could also be funded as it also helps RBN to meet the same goal. It is believed that improved road intersections with traffic lights in congested urban road environment saves VOC more than the improved road surface. Other benefits, apart from saving in VOC, includes savings in travel time (congestion cost) and savings from reduction in road crashes and pollution (health cost and productivity loss).

One of the rationales for funding the development of guidelines, manuals, technical notes is the best use of available scarce resources. For example, DOR is wasting money in building expensive ugly overhead bridges over ring road. Nowhere in the world other than in LMICs can be seen these ugly overhead footbridges in the heart of city to cross arterial roads. These overhead bridges do not serve any meaningful purpose. In absence of appropriate technical guidance, engineers do not know where a particular type of pedestrian works than the other. Incorrectly installed zebra crossings provide false sense of safety to pedestrians. As it has been proved time and again that the system installed before and being restored currently has not been able to manage traffic but DOR is wasting money to install such expensive systems which do not work but only deteriorates urban amenity.

The concept proposal for the "state of art" ITS technology-based Traffic Signal System for Kathmandu Valley which is urgently required for safe and efficient operation and management of road use and which can be considered by RBN for funding as part of its ongoing road operation and maintenance programs. The Paper then introduces the draft Technical Guidelines for the selection of appropriate pedestrian crossing types which can be considered by RBN as an example for developing similar other documents on road operation and maintenance aspects. As demonstrated by the existing practice, in absence such guidance to practicing engineers, pedestrian crossings and other traffic management measures are being installed (includes overhead pedestrian bridges) incorrectly or constructed on ad-hoc basis. RBN can use these examples to demonstrate the rationale for extending its funding for road operation works to its major stakeholders and the community. Development of warrants for signalization of intersections in the road in the road network of Kathmandu Valley is considered to be a high priority for RBN to justify the need of its funding interventions in road operation and day to day road use management.

This Paper provides brief information on Kathmandu's current traffic management system and how NRNs from Australia and New Zealand can work with the Nepali Government in adapting the new ITS technology. The Paper argues that the system being proposed by the Government of Nepal is not smart and that it will not be capable of handling congested traffic environment of Kathmandu Valley. Introducing remote control, censors and CCTV cameras in the system brings only a very minor improvement in the control of traffic lights. These traffic lights cannot optimise traffic flow, nor are adaptable to changing traffic environment. The smart system should operate in real time, adjusting signal timings in response

to variations in traffic demand. It should control traffic on an area basis rather than on an individual, uncoordinated intersection basis. It should be adaptive unlike a fixed time system that is generally unable to cope with unpredictable traffic conditions. The smart system should not use pre-determined red and green signal timings and cycle times as proposed in the current system. Instead, the smart system should use logics and algorithms to analyse real-time traffic data from vehicle detectors to produce signal timings that are suitable for the prevailing traffic conditions that keep on changing every minute. System analysis-based approach which considers the entire network of traffic lights to work as one single system for optimizing traffic flows and which is managed from Traffic Management Centre using latest ITS software such as SCATS® should be used. The Paper suggests that only SCATS® or equivalent system is a truly intelligent traffic management solution that considers all aspects of traffic control and that can respond to the demands of the network in real time.

4. Intelligent Traffic System for Kathmandu

The traffic light system proposed in this Paper helps to manage traffic at intersections as well as in mid-block sections of urban roads by ensuring orderly movement of right turning, left turning and through traffic as well as pedestrians at all approaches of intersections and in between two adjacent intersections if they are too far apart. It is argued that the implementation of ITS technology will help mitigate traffic congestion, improve air quality and reduce road crashes and thus reduce all major types of urban transport externalities. The system can be implemented as a part of ongoing operation and maintenance program for strategic road network funded by Road Board Nepal. Non-Resident Nepali professionals working in this sector in Australia and New Zealand will help bring the ITS technology to Nepal and collaborate with the local counterparts in Nepal for its implementation and sustained operation.

SCATS® urban traffic management software is used to operate more than 37,000 intersections of over 250 cities in 27 countries worldwide including in Australia, Bangladesh, Brazil, Brunei, Chile, China, Ecuador, Fiji, Indonesia, India, Iran, Ireland, Jordan, Laos, Malaysia, Mexico, New Zealand, Pakistan, Philippines, Poland, Qatar, Saudi Arabia, Singapore, South Africa, Thailand, USA and Vietnam. It continues to deliver consistent and measurable results (Parajuli, 2018). Some of the countries where these are in use have similar heterogenous traffic and road use environment as of Kathmandu.

Installation of smart traffic lights using SCATS® urban traffic management software has a number of benefits: These include:

- Manage traffic better
- Reduce air pollution
- Reduce congestion (improve efficiency)
- Reduce travel time/ delay
- Improve safety
- Improve urban amenity
- Make streets pedestrian friendly
- Reduce work load of traffic police

Old fashioned traffic lights do not work any more as these lights do not talk to each other and do not have the ability to respond to change in traffic flow in real time. Smart traffic lights as envisaged in this proposal works in the traffic environment of Kathmandu. It just requires four things:

- A SCATS-compatible Traffic Signal Controller;
- A centralised computer system to manage all Traffic Signal Controllers;
- A reliable communications network for the centralised computer system to exchange data with all Traffic Signal Controllers in the city;
- Vehicle detectors at each intersection (can be under- or above- ground)

All these technologies can be implemented and managed to make work for Kathmandu Valley provided the system is designed, built, operated and maintained correctly. Because of high technology involved and absence of know how of the system, the system can be implemented as a contract package containing all phases of project life cycle: design, build, operate and maintain.

The proposed system works because its smart technology works in a coordinated manner to deliver real time efficiencies[3] involving the following main functionalities which other dumb traffic lights systems do not have:

- SCATS system operates in real time
- SCATS adjusts signal timings in response to variations in traffic demand
- SCATS controls traffic on an area basis rather than on an individual, uncoordinated intersection basis
- SCATS is adaptive unlike a fixed time system that is generally unable to cope with unpredictable traffic conditions
- SCATS requires no pre-calculations or composite signal timing plans. It does in real time
- SCATS uses logic and algorithms to analyse real-time traffic data from vehicle detectors to produce signal timings that are suitable for the prevailing traffic conditions.

Modelling of intersection with and without reconfiguration of Lainchaur Intersection and smart traffic light was undertaken by Kathmandu Sustainable Urban Transport Project. Findings from the analysis of Lainchair intersection in Kathmandu and from the review of selected research works undertaken overseas are promising as evident from below:

- Level of Service (LOS) will be improved from F to C
- Capacity of intersection will be increased by 12 times
- Delay reduced by 30 times
- Travel speed will be increased by 12 times
- Fuel consumption will be reduced by 8 times
- Reduction in pedestrian crashes could be down by up to 55%
- Reduction in multi-vehicle crashes could be down by up to 35%
- BC Ratio of traffic lights is found to be as high as 58:1

3 http://www.scats.com.au/how-scats-works-adaptive.html

How Proposed Option improves Congestion and Pollution

Performance Measures	Unit	Proposed (AM-PC/ET)	Existing (AM-EC/ET)
Demand Flows (Total)	veh/h	4193	3868
Degree of Saturation		0.829	9.665
Practical Spare Capacity	%	8.6	-91.7
Effective Intersection Capacity	veh/h	5057	400
Control Delay (Total)	veh-h/h	35.13	1287.57
Control Delay (Average)	sec	30.2	1198.2
Control Delay (Worst Lane)	sec	45.6	3965.7
Intersection Level of Service (LOS)		LOS C	LOS F
95% Back of Queue - Vehicles (Worst Lane)	veh	21.5	186.0
95% Back of Queue - Distance (Worst Lane)	m	80.3	695.3
Travel Distance (Total)	veh-km/h	2320.3	2378.3
Travel Distance (Average)	m	553	615
Travel Time (Total)	veh-h/h	94.2	1364.4
Travel Time (Average)	sec	80.9	1269.7
Travel Speed	km/h	24.6	1.7
Cost (Total)	NRs. /h	82914.52	677592.10
Fuel Consumption (Total)	L/h	248.9	1983.1
Carbon Dioxide (Total)	kg/h	622.9	4964.1
Hydrocarbons (Total)	kg/h	1.052	11.163
Carbon Monoxide (Total)	kg/h	26.81	87.91
NOx (Total)	kg/h	0.858	3.302

Source: KSUTP's Model for Intersection Analysis, 2013

While the above results are not to be considered as a true picture of the key indicators, they show the extent of benefits of installing smart traffic lights to the country. Modelling results are usually indicative and relative. The reliability and accuracy of the results can be improved through detailed model calibration and validation process, which can be done as a part of the due diligence review of existing design and estimate and the analysis and detailed design of traffic lights at additional intersections identified in the implementation process.

5. Guidance Notes on Pedestrian Crossings

Pedestrian safety is one of the main concerns in the safe operation of urban road network in Nepal. Planning, design and construction of urban roads in the country do give little attention in the provision of pedestrian crossings. In fact, their needs are not usually identified in the design phase. The provision of pedestrian crossing facilities is quite inadequate in most urban arterial roads of all cities including Kathmandu. Even where pedestrian crossings are provided, their functions are less understood by both the road asset owners and users. Proper understanding of various types of pedestrian crossing facilities, their applicability and suitability in the given road use environment is essential for these crossing facilities to

function properly in the safe operation of roads. This understanding is very important for managing traffic in urban environment safely and efficiently.

With the completion of widening of major roads in the Valley to four lanes or to eight lanes, crossing of roads in the Valley has become very difficult and unsafe. There has been a strong opposition from civil societies, pedestrian and bicycle safety activists as well as general members of public regarding inadequate or no pedestrian crossing facilities in the recently widened ring road. Pedestrians have no options than taking their life at risk while crossing many wide roads using incorrectly painted zebra crossings or at any points without designated crossings. In spite of the best practice warrants for pedestrian crossings and engineering practice available in the literature for the selection of one or other types of facilities these standards and practices are not used in Nepal during design as well as operation. Suitability of painted zebra crossings on wide roads with more than two lanes with two- way traffic is seriously questioned in these practices but engineers in Nepal continue to ignore those practices and put people's lives at great risk. It is perhaps due to lack of knowledge skill and experience in managing urban roads. This is also largely because of the absence of appropriate legislation, rules, regulations on one side and engineering standards, guidelines, technical notes which should be easily accessible to practicing engineers on the other side.

Existing Nepal Road Standards provides little guidance in the design and operation of urban roads. Proposed Urban Road Standards, which is understood to be in the draft form, also does not provide enough guidance to practicing engineers in the design and operation of intersections, mid-block pedestrian crossings and other facilities required for proper management of both vehicular and pedestrian traffic in urban roads. This resulted in improper planning and design of urban roads including pedestrian crossing and allied facilities.

The Technical Note presented in this Paper was developed and sent to Nepal Engineers' Association for comments and local input. The Note is expected to fill the gap in the local reference materials on the subject field which can be used by practicing engineers in Nepal. The Note provides guidance on the planning and selection of pedestrian crossing facilities in the interim which may be used until such time as Nepal's own Guideline for Planning and Designing for Pedestrians would not be available.

The Department of Roads (DOR)) has recently announced it will construct 6 more overhead pedestrian crossings along the new widened section of ring road. This makes a total of 9 crossings over the 11 km section of road. The Paper argues that these overhead crossings are neither desirable nor they will serve the intended purpose. In contrary, these facilities discriminate all pedestrians let alone disadvantaged groups of road users. Also, these pedestrian crossings are not sufficient given that pedestrian crossings are normally required at least at every 500m intervals in order to maintain an average walking distance of 250m to access crossing points. Not many people are prepared to walk 500m to find crossing points and climb 5 m high overhead bridges and down in order to cross the roads. Instead, they will continue to intrude into roads putting the lives at risk and slowing the traffic down significantly. These expensive overhead bridges will not address traffic chaos and congestion in ring road. Pedestrians are found crossing roads at grade even where overhead bridges are provided and the ring road will not be an exception. It is because the impedance (opposition) of overhead bridges to crossing is simply too high.

Traffic lights at intersections are to be provided any way to manage conflicting vehicular movements if we would like to manage traffic safely and efficiently. There are no alternatives to traffic lights. These are to be installed sooner or later. Question arises then why the same facilities cannot be used at no extra cost to provide safe pedestrian crossings as are done in many cities of both developed and developing

countries. Pedestrian overhead bridges or underground crossings are not the right solution in situations where there is enough capacity for vehicular traffic, nor they are cost effective and convenient. Grade separated crossings are rarely provided in roads with interrupted traffic flow. They are provided only in roads such as expressways and freeways (motorways) with full control of access. The Technical Note is highly beneficial to road agencies as its application will help save money and improve safety and efficiency.

The Notes include many sections. Starting from the brief background/ context behind the need of the Guidance Notes and purpose of the document, it introduces various types of pedestrian crossing facilities, visibility requirements to locate pedestrian crossings of certain types, requirement for at-grade pedestrian crossings and warrants for pedestrian priority crossings. It further attempts to provide guidance on where a zebra crossing should be considered and why zebra crossings are not recommended for use on multilane roads, where a signalised pedestrian crossing should be considered and where a grade separated pedestrian crossing should be considered. In order to strengthen the reasoning for costly and difficult to negotiate grade separated crossings over low cost and equally treating at-grade pedestrian crossings, both advantages and disadvantages of the former type of crossing are provided and guidance on circumstances where would be the preferred locations for such types of crossings. The Guidance Notes also provide further advice on design considerations and where the designer of overhead pedestrian crossing can get further guidance on the design. The document is concluded with the summary Table that provides the planner and designer with a quick guide to the selection of pedestrian facilities for different types and function of roads.

Table 1: Road Types and Crossing Facilities

Facility	Expressway	Major arterial	Arterial	Collector	Local
Mall	X	X	X	O	O
Refugee / Traffic Island/ Median	X	O	O	A	A
Kerb Extension	X	X/O	O	A	A
Road Narrowing/ Indented Parking	X	X	X	A	A
Pedestrian Fencing	X	O	O	O	X
Speed Control Devices	X	X	X	O	A

Source: (Bennett et al, 2007)

A: Most likely Appropriate

O: May be Appropriate (When volumes of both vehicular traffic and pedestrian traffic are so high that green time for pedestrians causes excessive queues and delay to vehicular traffic)

X: Inappropriate

Internationally, there are two streams of guidance available as far as warrants, planning and design of pedestrian crossing facilities are concerned. The one presented here is to adopt more prescriptive (objective) approach for warrants than a more non-prescriptive (subjective) approach being widely used in New Zealand and other European countries. While both approaches have merits and demerits, more objective approach is suggested for Nepal as the later approach requires more experience and exposure to be able to make a right decision. The decision can be controversial at times, especially when the engineering practice in this regard is not matured in the country. It is a matter of policy (if not preference of the responsible person) whether to follow more prescriptive or less prescriptive approach. However, safety, equality, efficiency, cost effectiveness, amenity should not be compromised in selecting the types of pedestrian crossings.

This Technical Note provides guidance on the selection and use of various types of pedestrian crossing facilities. Warrants for two main types of pedestrian crossings (painted and signalised) are provided to guide practitioners under what circumstances a pedestrian crossing facility with pedestrian priority (zebra crossing) would function and under what circumstances it will cease to function. It further provides guidance on when zebra crossing should be considered, when time separation with police/signal control would be needed and when space separation with over- or underpasses should be considered in order to ensure value for money and safe crossing solutions acceptable to all road users. Agencies responsible for city planning, road design and operation, traffic management and the law enforcement agencies are required to work further to successfully implement these recommended Notes in the ground.

The guidance note does not cover detailed design aspect of pedestrian crossing facilities. The selection of right type of crossings is the subject of concern at this stage. once the type is decided, the design is pretty straight forward. Engineering guides are available both regionally or internationally. The need of the time is to stop the selection and construction of overhead crossing facilities indiscriminately which do not serve the purpose and which do not fit in the urban environment. Accordingly, the Guide is developed keeping in mind of the urgent need to encourage spend money in the provision of right type of crossing facilities, which in case of urban roads, is at grade pedestrian crossings. Zebra marking with or without raised platform is the most preferred type of crossings for low volume two lane roads and signalised pedestrian facilities is the most appropriate type of crossings for multi lane roads with high traffic volume. Signalised pedestrian crossings are also required even in low volume two lane roads sometimes (e.g. restricted visibility due to sharp crest, acute bends, presence of buildings. Signalised pedestrian crossings provide full protection to pedestrians. This type of crossings treats pedestrians and motorists equally. With little effort for enforcement, it is possible to control pedestrians from intruding roads at any place other than at designated places. Signalised pedestrian crossings at intersections can be supplemented by additional mid-block signalised or zebra crossings depending on the distance between the two adjacent intersections and extent of platoon dispersion. Properly selected at-grade pedestrian crossings is visually pleasant and improves urban amenity.

6. Role of NRNs in improving Road Operation in Nepal

Non-Resident Nepalese Association (NRNA) has joined hands with the Ministry of Physical Infrastructure and Transport (MOPIT), Government of Nepal and Nepal Engineers' Association (NEA) to deliver better road safety outcomes in the country. Memoranda of Understanding were signed between NRNA and MOPIT and between NRNA and NEA for collaboration in this effect. Interested NRNs can potentially use this already established framework to contribute to these and other initiatives in the field of sustainable transport and traffic solutions for Kathmandu or for the entire country.

It's important that NRNA continues to pursue with the Government for the adoption of the Smart Traffic Signal Technology, Nepal Road Rules, Pedestrian Crossing Guidance Notes and other documents developed by NRNs for use in the country after incorporating inputs from consultation with relevant stakeholders. Installation of right types of pedestrian crossings using this guide, provision of signalised control of intersections using smart traffic lights, enforcement of traffic rules on roads using Nepal Road Rules for maintaining orderly movement of traffic on roads, running nationwide road safety awareness campaigns using audio-visual tool kits currently being developed by NRNA Australia Road Safety team will help make ring road pedestrian friendly. Members of NRNA have been involved in some ways in all of these works and other interrelated works (Nepal Road Crash Database System, Proposal for the Development of Nepal Road Safety Management System, Proposal for Project Preparatory Works/ Road Safety Retrofit

Trial Projects), being planned or delivered in Nepal. Such collaborative works should benefit the country and communities at large thereby enhancing the image of NRNA greatly. RBN can work as an excellent link between NRNA Australia Road Safety Project Team and other line agencies of the Government of Nepal (MOPIT, DOR, DOTM, IOE and potentially DOLI) to develop strategy for road operation and maintenance interventions which will help deliver sustainable transport and traffic solutions for Kathmandu Valley

7. Summary and Recommendations

Deaths and disabilities resulting from air pollution and road crashes and inefficiency in travel time resulting from congestion can be reduced significantly in Kathmandu Valley if traffic is managed better. Excellent opportunities are available to do so at minimum cost within the existing available road network (without acquiring properties and dismantling houses). Problem of air pollution and road crashes and congestion can in turn be tackled head on by installing smart traffic lights at intersections and at mid-blocks (within adjacent intersections). Nepal can save hundreds of billions from these transport externalities by improved emission, congestion and crash performance of urban road infrastructure.

Society of Consulting Architectural and Engineering Firms working in various development sectors in Nepal should work together with Road Board Nepal in order to improve the performance of Kathmandu Valley's road and transport infrastructure and address the inefficiencies resulting from one of the worst traffic management system in the city. RBN should immediately start getting involved in operational improvement projects by extending its current field of activities from asset maintenance and preservation to the operation and management of country's road transport infrastructure. In doing so it can start as pilot project from the road network of the Valley and gradually include other urban road network in the country.

The proposed Smart Traffic Light Project in this paper delivers smart traffic lights in real sense to help cities of Kathmandu to manage its traffic and operate its asset efficiently and safely. Installation of smart traffic lights is a one step forward for Kathmandu to become "smart" in solving traffic congestion, manage traffic better, improve deteriorating pedestrian casualties on roads significantly and reduce air pollution. The Project will result in large safety, health and economic benefits, all high priority goals for the Government of Nepal.

The features of smart traffic lights include real time information, adaptive traffic responses, override capability, scalability and flexibility, windows operating environment and backward compatibility.

The Technical Guidance Note on Pedestrian Crossing presented in this Paper provides an example of how RBN can be involved in developing this and other essential tools for professionals to do the right thing and spend RBN's money correctly and efficiently. This document together with the proposed Technical Note for Traffic Signals at Intersections is expected to provide the basis to justify the need and development of design of traffic lights at intersections and pedestrian crossings. Technical Guidance Notes on Intersection Signal should contain signal warrant analysis, intersection reconfiguration, signal phasing, cycle time and other technical design details should also be developed over time with RBN's leadership.

Urban roads in Kathmandu can be made safer for all road users gradually over time if targeted road safety treatments in the form of traffic lights at intersections and in between them are implemented as a part of regular Operation and Maintenance Interventions with the fund provided by Road Board Nepal.

Smart traffic lights at intersections and mid-block pedestrian crossings contributes to the delivery of Nepal Road Safety Action Plans thereby improving road safe outcomes in the Valley.

It is recommended that SCAEF works together with all local and international partners pursue the case of installing correct system and technology for traffic lights in the Valley. These traffic lights will provide great relief to its residents and visitors. SCAEF could be one of the powerful platforms for promoting KVITS Project and for implementing other congestion and safety management measures with technical support from various willing NRNs.

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An alternative material for interlocking prefabricated sandwich panel

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ABSTRACT

This paper present the effective utilization of non-degradable waste material like hair of human, EPS and Rice husk fly ash as a final product Fiber Reinforced Concrete Panel. According to (Mindess, 2009), Concrete is weak in tension but stronger in Compression and tends to brittle and another weakness is cracks start to form as soon as concrete is placed and before it is properly hardened. This will lead a concrete to fracture, catastrophic failure, and microscopic crack, spalling of concrete and non-quake resistant, when a certain load is applied. This problem can be solved by using the Natural Fibers and some additives(Gupta, 2018). This paper tries to develop a Prefab Panel which will be substitute product of Brick, ACC Block, Interlocking Block, EPS Panel, Local Prefab Panel and stones used in Building which will economize cost and reduce environmental problems. As ingredients will be Human hair, EPS, chemical agent, cement, Fly Ash, Water and Fiber Board. This panel will have multi-function like light in weight, Fire Proof and the main USP (Unique Selling Point) of the product will be its Flexibility. This prefab Panel will change the perception of Nepalese customer, who thinks prefab as a costly and strength less product. As, in country like Nepal, where there is a political instability and dependent culture to foreign country, there is impossible to use an artificial fiber and imported fly ash(Nepal: Company Perspectives. An ITC Series on Non-Tariff Measures, July 2017). This paper will focus about the Nepalese market perception and possibility to useHuman Hair fiber, Fly ash and Recycled EPS to solve the little portion of environmental problem.

Keywords: Fiber Reinforced Concrete, Compressive and Flexural strength, Prefab Panel, sustainable environment

1.INTRODUCTION

Increasing service loads, extreme loading events, and constant exposure to an ever-changing ambient environment are just a few reasons why civil structures, over extended service periods, degrade and ultimately become structural deficient(Ellingwood, 2005). The 1980s saw the advent of more cost effective means to manufacture advanced fiber-reinforced polymer (FRP) composite materials; making the use of such materials more suitable for construction purposes. By the late 1980's, numerous researchers began investigating the possibilities of using FRPs to strengthen reinforced concrete structures(C. E. Bakis, 2002). With excellent corrosion resistance, high strength-to-weight ratio, and stiffness-to-weight ratio, externally bonded FRP composites provided a time and strength efficient means to strengthen reinforced concrete (RC) structures which latterly synonym into Fiber reinforced concrete(haber, 2007);(C. E. Bakis, 2002). Fiber reinforced Concrete was patented and developed by French Gardener Joseph Monier the concept of using fibers as reinforcement is not new, but in our country Nepal, this concept is totally new and no any research work is done in this field. According to (Gupta, 2018),Fibers have been used as reinforcement since ancient times and historically, Horsehair was used in Mortar and straw in mud Bricks, and typically this type of mechanism can be seen in Bardia, kailali Nepal, where people are using hair, straw and husk for making their home. In 1900s, asbestos fibers were used in concrete, and in the 1950s the concept of composite materials came into but due to health risk asbestos was discouraged. New material like steel, glass and synthetic fibers replaced asbestos for reinforcement. FRC consists of Composite Material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Continuous meshes, Wovenfabrics and long wires or rods are not considered to be discrete fibers. Fibers include steel fibers, glass fibers, synthetic fibers and Natural fibers. Recently, organic and synthetic fibers such as acrylic, aramid, carbon, nylon, polyester, polyethylene, and polypropylene have also been used(McIntyre, 2004).

As, concrete is weak in tension, to overcome this deficiency, human hair can be the best option to increase the strength of concrete(Gupta, 2018). According to(Jr., 2014) presented that the effects of human hair additives in compressive strength of asphalt cement mixture as potential binder in road pavement. It stated that the elastic property of the hair fiber reinforced in asphalt pavement may produce better stand on traffic loading i.e., increases the strength by the same fundamental mechanism of transferring the high intensity forces imparted at the surface by the wheel loads to lower levels that the subgrade can accommodate without deforming(Jr, 2014). According to (Yadollah Batebi, 2013), themain element of hair composition is Keratin. Keratins are proteins with long chains of amino acids that form the cytoskeleton of all cells of outer shell. Number of investigations clearly started that Sulphur is the main reason of strength hair cords in front of disintegration in the face of environment stress and this Sulphur compounds are linked with amino acids. Sulphur in amino acids molecules is adjacent to keratin protein so it form Di-Sulphide chemical chain (chains are very strong and resistant to breakage). These chains are very resistance to acids di-sulphide

performance, but in alkaline solutions they can be decomposed(Brosnan JT, 2014). As Alkaline environment losses the hair cords so we must be aware not to take hair cords in alkaline solutions. The outer layer of hair is called "Cuticle" is much like tree trunks and bumps(Roland Moll, 2008). Hair diameter are 50 to 100 micrometer, In this paper we use hair of 80 micrometer is used and bumps on it are in Nano size these bumps help to lock cement mortar with hair cords, which prevents from microscopic cracks. According to (Matin & Hadiyanto, 2007), Hair Fiber an alternate non-degradable matter, is available in abundance and at a very cheap cost, which is the measure thing to motivate me and Rice husk ash are also one of the main problem for the Paper Industries operated in Nepal, It is a unique crop residue with uniform size and high content of ash (14–25%). According to (Joshi, 2008), the silica content of the rice husk ash (RHA) can be as high as 90–98%. These particlesSolidify as microscopic, glassy spheres that are collected from the IndustriesExhaust before they can"Fly" away—hence the product's name: Fly Ash.Chemically, fly ash is a pozzolan. When mixed with lime (calcium hydroxide), pozzolans combine to form cementitious compounds. Concrete containing fly ash becomes stronger, more durable, and more resistant to chemical attack(Corporation, 2016). Mechanically, fly ash also pays dividends for concrete production. Because fly ash particles are small, they effectively fill voids. Because flyash particles are hard and round, they have a "ball bearing" effectthat allows concrete to be produced using less water(brick, 2017). According to (Tek Raj Gyawali, 2017)EPS concrete can be mixed uniformity by using new type of Kneading Method and has proved that it is very relevant light weight concrete material to overcome the existing problem of having very high water absorption capacity in ALC. Also due to addition of fiber, there is improvement in ductility of concrete and its post-cracking load-carrying capacity(Amit Rai, 2014).According to (Joshi, 2008), Ash has been used in this project in alternative of sand,While Bioenergy Consult, has estimated that EPS foam products accounts for less than 1% of the total weight of landfill materials, the fraction of landfill space it takes up is much higher considering that it is very lightweight. Furthermore, it is essentially non-biodegradable, taking hundreds perhaps thousands of years to decompose and such recycle material can be used in this product so that the product will solve the environmental problems. As, only in fiscal year 2016/17 there is a huge budget of 140.66 billion Rupees for reconstruction, new construction and rehabilitation of house, school and other engineering structure(Finance, 2017). To complete the project, a large number of construction materials are needed but the government are importing the product to develop the structure, such problem can be solve by implementing my project, because every material needed to develop the product are easily available in local market. Recently there are 7 province with increasing number of metropolitans, sub metropolitans, municipalities etc. which means there will be development of airports, Hospitals, Schools, Urban Planning and many more structure, as which means there will be need of large amount of construction material(kathmandu, 2017).

2.OBJECTIVE OF STUDY

2.1 MAIN OBJECTIVE

The main Objective of our Project was to construct a light weight ductile concrete panel by using a Natural Fiber like human hair, Fly ash, EPS, Cement and chemical additives andadditionally solving environmental problem.

2.2 SPECIFIC OBJECTIVE

- Design a various concrete mix design containing varying ratios of cement, hair, EPS, chemical additives, Water and fly ash.
- Determine the Ratio of human hair generated from Madhyapur Thimi Municipality and check the demand ratio.
- Determine the Business strategy of Fiber reinforced concrete Panel.
- Determine the compressive strength, Flexural Strength, sound test and Fire test of our prefab panel.

3.METHODOLOGY

As, two Research methods was focused, for making this project more successful and viable. They are:

-Survey Method

- Experimental Method

3.1 Survey Method

As Research was done to find out the total amount of hair collection from Ward No 3, 4, 5 and 6 in Madhyapur Thimi Municipality. As, around 6771 male and 6376 of female with 2968 household are living over there, according to(Nepal, 2011), shown in Table 1.

Table1. Total ward population of Madhyapur Thimi Municipality(thimi, 2017)

DISTRICT : Bhaktapur [267.D.C./MUNICIPALITY : Madhyapur Thimi Municipality [12]

WARD	HOUSEHOLD	POPULATION		
		TOTAL	MALE	FEMALE
1	662	3,054	1,630	1,424
2	437	2,029	1,004	1,025
3	1,389	6,384	3,331	3,033
4	457	1,945	978	967
5	714	3,189	1,607	1,582
6	408	1,849	055	794
7	1,025	4,388	2,190	2,198
8	646	2,835	1,445	1,390
9	474	2,250	1,124	1,126
10	401	1,877	927	950
11	542	2,413	1,217	1,196
12	433	2,120	1,059	1,061
13	897	3,794	1,931	1,863
14	592	2,653	1,350	1,303
15	4,889	18,336	9,445	8,891
16	3,670	14,260	7,421	6,839
17	2,666	9,880	5,209	4,671
TOTAL	20,302	83,036	42,723	40,313

As, survey was carried out in two category, one in Beauty parlor and one in Male saloon. Moreover a Questionnaire was done with the owner of that parlor and Saloon. From that survey 10 male saloon and 7 beauty parlor are taken down and data are shown in Figure 2.As, in case of Beauty Parlor the woman didn't prefer to cut their human hair in shrawn month and averagely only 3-4 woman move to beauty parlor.

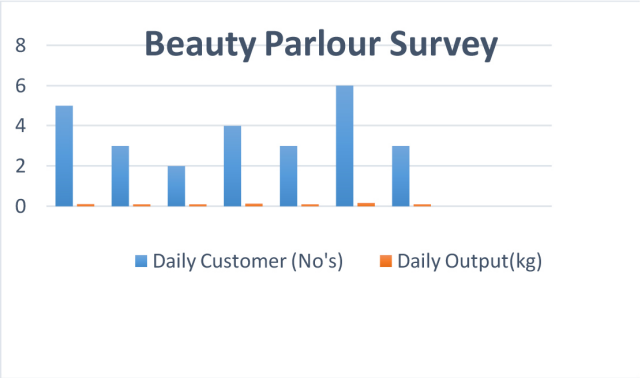


Figure 2 Beauty Parlor Survey taken in Aug 4, 2017

In case of Saloon, the amount of hair is more in Saturday and in festivals. In evaluation of waste human hair in saloon, the hair are too dusty and needs more treatment than that of beauty parlor. Mixing of beards and hair makes, more complexity in processing of the hair.

Here,we have taken a 10 saloon, where we have also found some amazing fact like, Naphit which is one of the minor caste of Newar are also involved in hair saloon but the fact is that they are not registered in any organization. Maximum proprietor and worker were belongs to Thakur caste.The amount of human hair collected in saloon are more than that of Beauty parlor that is shown in Figure 3.

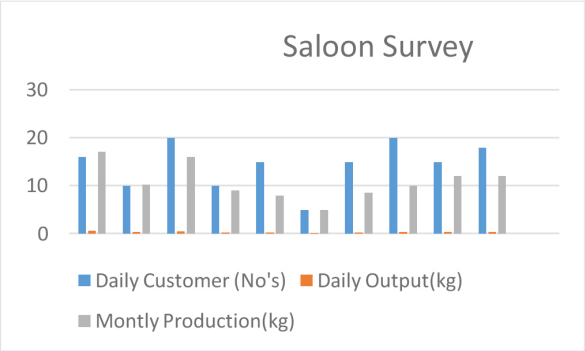


Figure 3: Saloon Survey taken in Aug 4, 2017

Average Amount of Hair obtained $= \frac{Total\ Weight\ of\ Hair\ Obtained\ from\ Parlor}{No\ of\ parlor} = 3.475kg$

Average Amount of Hair obtained $= \frac{Total\ Weight\ of\ Hair\ Obtained\ from\ Saloon}{No\ of\ saloon} = 10.799kg$

Only 15% Wastage is taken from beauty parlor and 35% Wastage is taken from Saloon. So, 3.475kg from one Beauty parlor and 10.799kg from one Saloon is taken. As, Waste like beard and some unfluctuating disperse hair comes into saloon so, we have taken maximum wastes percentage than that of Beauty Parlor obtained from 4 wards of Madhyapur thimi municipality.

Hair Producer	Average Amount of hair*No of parlor *year	Total	Waste percentage	Total hair obtained
Beauty Parlor	3.475*12*7	291.9kg	292-(0.15*292)	248.2
Saloon	10.799*10*12	1295.88kg	1296-(0.35*1296)	842.4
			Total	1091kg

Figure 4: Total amount of hair collection data

As, from the 1091kg of hair, we can develop 2100 numbers of Prefab board. If (7'*2') panel of Rs 4172 is taken then we could generate a rough amount of 8,761,200. So, this survey shows the feasibility of implementing the project.

3.2 Experimental Method

3.2.1 Material Used

Cement: It is the mixture of calcareous, siliceous, aluminous substances and crushing the clinkers of a fine powder. The Portland cement of 43 Grade is used, Normally Sarvottam and Argakhachi cement is used for the project. The specific gravity of cement is 3.15. For Ordinary Portland cement, the initial setting time is 45 minutes and the final setting time is 600 minutes. The oxide contents are as follows: 60-67% Cao, 17-25% SiO_2, Al_2O_3, 0.5-0.6% Fe_2O_3 and 0.1-0.4% MgO(Yahaya, 2009).

Fine Sand: Normally for experiment of concrete with mixture of hair, we have used a sand. And firstly for cube test and flexural test with ratio of hair we have used the fine sand. The sand used for the experimental act was locally procured. The sand was sieved first through 4.75mm sieve to remove any particles greater than 4.75mm and was then washed to remove dust(Manpreet Singh, 2016). As, for the testing for flexural test sand was sieve from 1.7mm sieve. The properties of fine aggregates are as follows: Specific gravity – 2.65 and Fineness Modulus – 3.35.

Coarse Aggregate: According to (B. P. R. V. S. Priyatham, 2017), material whose particles are of size as are retained on I.S. Sieve No. 480 (4.75 mm) is termed as Coarse Aggregate. The size of coarse aggregate depends upon the nature of work. The coarse aggregate used in this experimental investigation are of 25mm Sieve and crushed

angular in shape. The aggregates are made free from dust before being used in the concrete. Its specific gravity is 2.74(B. P. R. V. S. Priyatham, 2017).

Human Hair Fibers: As, Hair has a high tensile strength(Gupta, 2018) so, we have used human hair as the alternative of artificial fiber. Here are some properties human hair.

TECHNICAL SPECIFICATIONS :

PROPERTY	VALUE
Hair diameter	80 to 120 µm
Hair length	60mm
Aspect ratio	500 – 600
Tensile strength of Human Hair fiber	380 MPa
Ultimate Tensile Strain	50.16%

Source(Williams, 2016)

Water: Water used in the experimental work is clean and safe for mixing as well as curing of Concrete specimens.

Rice Husk Ash: Rice husk is an agro-industrial by-product with high silica content. With proper incineration and controlled burning, this husk becomes a pozzolanic material that can be used for replacement of cement at various percentages of dosage(Seyed Alireza, 2017). Proper techniques of combustion and grinding are two main factors for producing reactive rice husk ash (RHA)(Halstead, 1987). It has been Oven dried and sieve in 0.075mm sieve for making the product. Incorporating RHA with concrete and mortar mix showed higher compressive strength(B V A PereraSajith Madhushanka, 2015). It is due to both the filler and the pozzolanic effect of RHA in concrete and mortar mix. It is possible to maintain high strength in concrete and mortar with RHA up to 30% replacement of cement.
It is a residue resulting from the combustion of powder coal (Halstead, 1987)

Data on Rice Husk

- One ton of Paddy generates 200 kg's of Husk(Seyed Alireza, 2017)
- 200 kg's of Husk gives 50 kg's of Ash(Seyed Alireza, 2017)
- The ash contains 80~90% Silica (i.e.) 40 kg's silica per ton of paddy(Singh, 2018).

TECHNICAL SPECIFICATIONS :

SiO2 – Silica	85 % minimum
Humidity	2 % maximum
Particle size	25 microns
Color	Grey
Loss on ignition at 800^0C	4 % maximum
pH value	8

Source: IRO.org

MODIFIED NEPALI STOVE

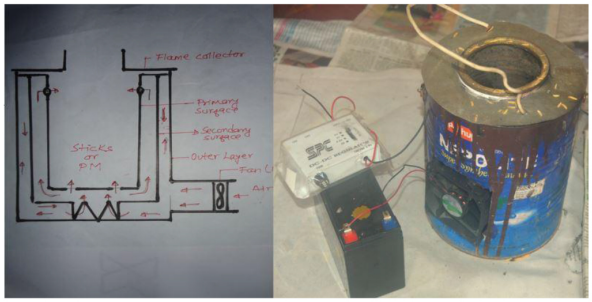


Figure 5: MDS Developed in Karmalaya-IV

EPS (Expanded Polystyrene)

Expanded polystyrene is a polymer resin obtained by heating and curing the polystyrene resin to generate foams. Expanded polystyrene is white in color, light in weight, and has superior water resistance, thermal insulation, sound absorption and buffering properties((ICOA), 2017). A plastic material, expanded polystyrene (E.P.S.) is composed of individual cells of low density polystyrene. The structure of the material provides it with special features. Its cells are not interconnected, therefore, heat cannot pass through it easily, making it a great insulator.

TECHNICAL SPECIFICATIONS:

Density Range	15-30 Kg/m
Thermal conductivity at 10 means temperature	0.028-0.031 Kcalm/hr. M c
Compressive Strength	0.8-1.6 Kg/cm
Tensile Strength	3-6 kg/cm
Water absorption by % Volume for 7 days in water	0.5%
Melting Range	100 - 200 C

Source: http://insulfoam.com/specifications/

Mix Design: The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design(Dasgupta, 2016). Variation of mixing has been done to achieve the strength.

3.2.1 Compressive strength test (on cubes):

The compressive strength of concrete is its ability to resist a crushing force. It is the ratio of load at failure to surface area of concrete specimen. Compressive strength test is the most common test conducted on hardened concrete as it is an easy test to perform and also most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compression test is carried out on specimens cubical in shape of the size 150 × 150 ×150 mm(Er. Chinnadurai, 2017);(Dongqi Jiang, 2017).

The test is carried out in the followingsteps:
First of all the mould preferably of cast iron, isused to prepare the specimen of size 150 × 150 × 150 mm. Calculating the quantity of hair fiber is gradually adding on a concrete mix manually(Gupta, 2018). During the placing of concrete in the mould it must be compacted with the tamping bar with not less than 25 strokes per Layer. After 24 hours the specimens are removed from the mould and immediately submerged in clean fresh water. After 7, 14 and 28 days the specimens are tested under the load in a compression testing machine is applied uniformly at the rate of 14 N/mm^2 in the compression testing machine(Nanda, 2016). The test is made in the following manner: The cubes are made by adding cement, sand, aggregate, EPS and hair. Another cubes was made with adding Cement, Rice Husk Fly Ash, EPS, Human Hair and Chemical Additives. The results from the compression test are obtained from Destructive test and one from Non-destructive Test (Schmidt Hammer)(Aliakbar Sayadi, 2016).

Cube compressive strength (f_{ck}) in MPa, $\sigma=\frac{P}{A}$

Where,
P= Cube compression load in Newton's (N)
A= Area of the side of cube on which load is applied (i.e., 150*150=22500 mm^2)(Nanda, 2016)

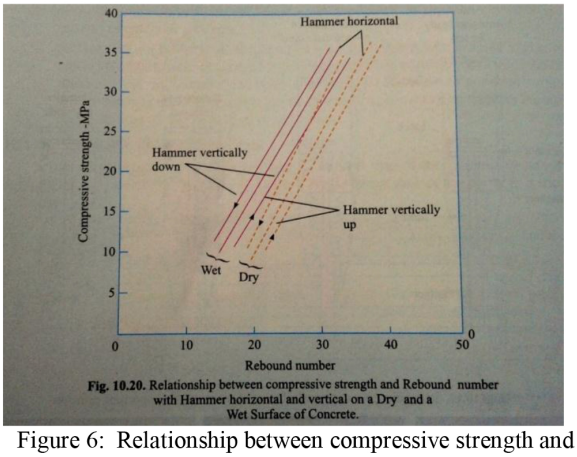


Fig. 10.20. Relationship between compressive strength and Rebound number with Hammer horizontal and vertical on a Dry and a Wet Surface of Concrete.

Figure 6: Relationship between compressive strength and rebound number (SHETTY, 2000)


Figure 7: Destructive Test for compression strength Test


Figure 8: Non- Destructive Test using Schmidt Hammer

3.2.2 Flexural strength test

A flexural test is the most common procedure used to measure the tensile strength of concrete. Although concrete is not designed to resist direct tension, the knowledge of tensile strength is of importance in estimating the load under which cracking develop. The test is very useful especially in relation to the design of road slabs and runways because the flexure tension is a critical factor in these cases. The system of loading used in finding out the flexural tension is Third-point Loading Method(MohdJaved Mallick, 2014). In this method the critical crack may appear at any section, where the bending moment is maximum. The test is carried out in the following steps: First of all the mould preferably of cast iron, is used to prepare the specimen of size 150 × 150 × 700 mm(Kumar Shantverayya, 2014). During the placing of concrete in the mould, it is compacted with the tamping bar with not less than 25 strokes per layer and in our case I have tempered into 3 layers. After 24 hours the specimens are removed from the moulds and immediately submerged in

clean fresh water. After curing, place the specimen in the machine in such a manner that the load is applied to the uppermost surface along two lines spaced at a proper gauge length, at specified rate. Increase the load till the specimen fails. Note the appearances of the fractured faces of concrete. As, due to time limit we have just tested the specimen in 7 days. 3 sample was taken down of different ratio as shown in figure 7. First sample of w/c ratio of 0.6 was taken and another of 0.8 w/c ratio was taken and lastly 0.8 w/c ratio specimen was taken but adding of Human hair(Gupta, 2018);(Jr, 2014).

The modulus of rupture is calculated using the formula $\sigma_b = \frac{PL}{bd^2}$

Where,

P= Breaking load in N at which specimen fails

L= Length in mm of the span on which the specimen is supported (600)

B= measured width in mm of the specimen (150)

d= measured depth in mm of the specimen at point of failure (150)

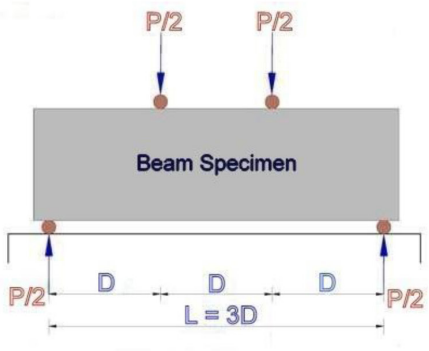


Fig9.2: loading pattern
http://me.ikc.edu.tr

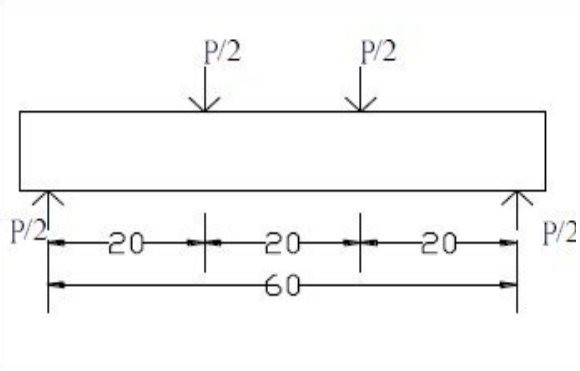


Fig9.1 Flexure test setup
http://me.ikc.edu.tr

Figure 9: Different three specimen with different w/c ratio.

Figure 10: Flexural strength test of three point loading method

Figure 11: Schmidt hammer test

3.2.3 SOUND TEST

We have made a homemade Incubator, which is enclosed by close Clear Glass. As the clear glass of size (15.41"*6"*6") was made by enclosing with Hot Glue and Ramro Brand silica, brought from market. As100W Hot melt glue gun was used to make, no air gap in Glass box. The 6"*6"*4" specimen was taken down into the Glass box. As intensity of sound is measured by dB. The decibel (dB) is the unit used to measure the intensity of a sound(HowStuffWorks, 2016). The decibel scale is a little odd because the human ear is incredibly sensitive. On the decibel scale, the smallest audible sound (near total silence) is 0 dB. A sound 10 times more powerful is 10 dB. A sound 100 times more powerful than near total silence is 20 dB. A sound 1,000 times more powerful than near total silence is 30 dB(pulsarinstrument, 2016). Here are some common sounds and their decibel ratings:

- Near total silence - 0 dB
- A whisper - 15 dB
- Normal conversation - 60 dB
- A lawnmower - 90 dB
- A car horn - 110 dB
- A rock concert or a jet engine - 120 dB
- A gunshot or firecracker - 140 dB

Any sound above 85 dB can cause hearing loss, and the loss is related both to the power of the sound as well as the length of exposure(WHO, 2015);(HowStuffWorks, 2016).

Figure 12: sound test

3.2.4 FIRE TEST

A Fire test was done to check the resistance of fire. A surface test was done where we have compared with local prefab panel also(Elzbieta LukaszewskaMassimo Fragiacomo, 2010). The main doubt was whether the hair and EPS will burn in fire or not but the conclusion was, it will not capture the fire because it was bind by the cementations material, so it is impossible to catch fire. Three Test was done to check the prefab board. As, 4 Hours continuous fire was given in specimen so that comparison between Local Prefab and our Panel was made, where after the evaluation, we have found that the local panel was separated from internal EPS bonding but in case of our panel the result was completely different, where we found that the surface of prefab panel was little crack. A comparison test was done between the existing local prefab panel and our panel, where the product was continuous up to 4 hours. As, stop watch was taken to find out the time period and after the 4 hours heating, the result of local panel's silicate board was broken down into the number of pieces and it was separated from the internal material but in case of my prefab board, nominal amount of crack was seen but it was not separated into number of pieces. As surface spread of flame test was also done by using the petroleum product but in this test also there was no change in the prefab panel.

Figure 13: Fire test

4.0 RESULTS

As Various Experiment was done to know the actual strength, quality and variation of product. Some experiment is listed as 1, 2 and so on.

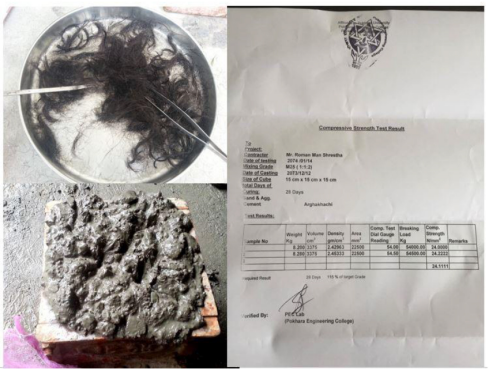
Experimental 1

SPECIFICATION	DATE	RATIO	REMARKS
R1	2073/12/15	1:1:2	Plain cement concrete

Experimental 2

SPECIFICATION	DATE	RATIO	REMARKS
R2	2073/12/15	1:1:2	Plain cement concrete

HAIR SPECIMEN



Source: Cube test done in 2074/1/14

Experimental 3

Flexural Strength Test

This test was done in Nepal Engineering College, RCC lab in the date 2074/4/14, where we have used a Sarvottam Brand cement. Firstly. We have sieve from 25mm for aggregate and 1.7mm for sand. This sample was mix design where 10kg of sand, 20kg of Aggregate and 5 kg of cement was taken for one experimental mould.

RESULTS

SPECIFICATION	DATE	RATIO	REMARKS
SAMPLE 1	2074/4/14	1:2:4	W/c=0.6, Time of casting=3:50pm
SAMPLE 2	2074/4/14	1:2:4	W/c=0.8, Time of casting=4:00pm, Normal Plain cement concrete
SAMPLE 3	2074/4/14	1:2:4	W/c=0.8, Time of casting=4:20pm, Human hair additive

Table14: Result done in *nec* lab

RESULTS:

SPECIFICATION	DATE OF TESTING	bd^2	Breaking Load (P)	Modulus of Rupture, $\sigma_b = \frac{PL}{bd^2}$
SAMPLE 1	2074/4/22	3375000	14700N	2.61 Mpa
SAMPLE 2	2074/4/22	3375000	15190N	2.70 Mpa
SAMPLE 3	2074/4/22	3375000	17150N	3.048 Mpa

Table15: Result done in *nec* lab

Experimental 4

Schmidt Hammer test or rebound Hammer test

This test was done in Nepal Engineering College, RCC lab starting from date 2074/4/14, where we have used a Sarvottam Brand and Arghakhachi cement. Firstly. the sample like Rice husk fly ash was Sieve in 1.7mm sieve and oven dried for an hour.

SAMPLE 1(Prefab 4" Panel)

SPECIFICATION	DATE/TIME	Size of Mould	REMARKS
SAMPLE 1	2074/4/14 (7:00pm)	10"*10"*4"	Sarvottam cement used

SAMPLE 2 (Cube of size 15cm*15cm*15cm)

SPECIFICATION	DATE/Time	Size of Mould	REMARKS
SAMPLE 2	2074/4/16 (8:00pm)	(150*150*150)mm	Arghakhachi cement used and Fly ash sieve in 1.7mm sieve and Oven for 60 minutes at 80°C

SAMPLE 3(Prefab 4" Panel)

SPECIFICATION	DATE/TIME	Size of Mould	REMARKS
SAMPLE 3	2074/4/17 (7:50pm)	10"*10"*4"	Sarvottam cement used

SAMPLE 4(Prefab 2" Panel)

SPECIFICATION	DATE/TIME	Size of Mould	REMARKS
SAMPLE 4	2074/4/17(10:00pm)	10"*10"*2"	Sarvottam cement used

SAMPLE 5(Hollow Prefab 4" Panel)

SPECIFICATION	DATE/TIME	Size of Mould	REMARKS
SAMPLE 5	2074/4/20(8:00pm)	10"*10"*4"	Sarvottam cement used

SAMPLE 6(Hollow Prefab 2" Panel)

SPECIFICATION	DATE/Time	Size of Mould	REMARKS
SAMPLE 6	2074/4/20(8:45pm)	10"*10"*2"	Sarvottam cement used

RESULTS

SPECIMEN	REBOUND NUMBER	MEAN COMPRESSIVE STRENGTH FROM GRAPH	WEIGHT	60% COMPRESSIVE STRENGTH	FLEXURAL STRENGTH ($0.7\sqrt{fck}$)
SAMPLE 1((Prefab 4" Panel)	21.22	14 MPa	4.348(dry)	8.4 MPa	2.02MPa
SAMPLE 4(Prefab 2" Panel)	24.778	18.5 MPa	2.420(dry)	11.1MPa	2.33MPa
SAMPLE 6(Hollow Prefab 2" Panel)	20.11	19 MPa	3.044(wet)	11.4MPa	2.36MPa

Table16: Result done in *nec* lab

EXPERIMENTAL 5

SOUND TESTING

This testing was done, by comparison between existing Prefab Panel and our Prefab Panel. As, we went through different engineering lab and in different college to find out the equipment but didn't get a solution. So, we have made a homemade Incubator, which was enclosed by close Clear Glass. As the clear glass of size (15.41"*6"*6") was made by enclosing with Hot Glue and Ramro Brand silica, brought from market. As100W Hot melt glue gun was used to make, no air gap in Glass box.The 6"*6"*4" specimen was taken down into the Glass box and equal division of gap was made.so, that comparison will be more efficiently taken. As Sound Meter Apps was used to taken down the maximum and minimum decibel (dB), so we can get an average dB and a stop watch was used for 2:20sec for both of specimen(Clason, 2017).

	TIME	LOWEST dB	HIGHEST dB	Mean dB
Local Prefab panel	02:20sec	17dB	83dB	52dB
Sitaldevi Prefab Panel	02:20sec	17dB	84dB	50dB

Table17: Result done by own effort

3 BUSINESS STRATEGY

To check the feasibility and viability of our project we have done a Business strategy, which will show the risk factor of the project and future of it. We use business plan to make the project more feasible so that it can shows the real picture of the project.This analysis helps to find out the strategic analytical and decision-support tool that highlights the bases where project can create value for the customers. In simple terms, is a documented plan on how a project is setting out to achieve their goals**.** A business strategy contains a number of key principles that outlines how a project will go about attaining these goals. For example it will explain, how to deal with your competitors, look at the needs and expectations of customers, and will examine the long term growth and sustainability of their researched project. Business strategy try to remedy the weaknesses so that project don't trip up and suffer their impact too greatly. Strategies look at these future risks and help develop ways in which they can overcome these obstacles.A well-defined business strategy will offer a guide on how a project is performing internally. Also, how you are performing against your competition and what you need to stay relevant into the future. Basically in this paper, it will talk about the customer retention, resources and project expansion in near future of prefab panel.

3.1 Business Model Canvas

Business Model Canvas of Fiber Reinforced Concrete Panel "Sitaldevi Panel"

<table>
<tr>
<td rowspan="2">Key Partners

Doing a Strategic Alliances with my Key Partners like NEA, CAN, Crusher Udyog and Research club of Engineering College.

We are acquiring an Intellectual and Physical product from our partners</td>
<td>Key Activities

Key Activities are Design, Manufacture, Delivery and Quality Control.</td>
<td rowspan="2">Value Proposition

We are delivering High strength concrete light weightprefab panel to our customer

We are solving the problems of customer who needs the Quality product with easy installation.

We aresatisfying there needs like Easy and fast installation, risk reduction and cost reduction of product.</td>
<td rowspan="2">Customer Relationships

We are focusing on Long Term Relationship with our customer.

We will focus on Three V's (Valued Customer, Value Proposition and Value Network)</td>
<td rowspan="2">Customer Segments

People working in Construction line.

our most important customers are Experienced Engineers and High class of Contractors.</td>
</tr>
<tr>
<td>Key Resources

Need a Specialize machines and Equipment's to provide value to customers.</td>
</tr>
<tr>
<td colspan="3">Cost Structure

Our expensive Key Resources are Construction Goods (Variable in Nature).

Our Expensive Key Activities are delivering the goods and Labors.</td>
<td colspan="2">Revenue Streams

We areproviding a Product containing a value with Light weight, Flexible and High Quality product. Revenue is generated by selling the finished goods.

We areimplementing Manufacturing Model, for revenue stream.</td>
</tr>
</table>

Table18: Paper done by self-effort

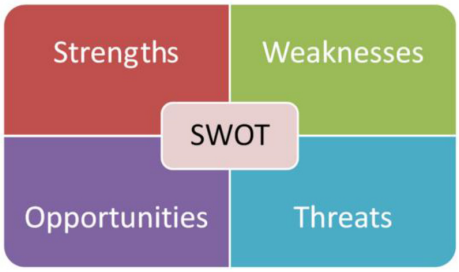
3.2 PESTLE ANALYSIS

PESTLE Analysis is a framework for assessing the key features of the external environment facing by a project(B2U, 2016).The purpose of a PESTLE analysis is to identify all of the various external political, economic, social, technological, legal and environmental factors that might affect a project. For instance, a new prefab panel factory might discover that local laws impose harsh penalties on businesses that harm the river by through the chemical on river as a result of a PESTLE analysis, which might prompt the factory to institute a policy on environment rules and regulation(Contributor, 2015).

Source: (B2U, 2016)

4.3 .SWOT ANALYSIS

SWOT analysis is a strategic analytical and decision-support tool that highlights the bases where businesses can create value for their customers. SWOT Analysis helps a project to find out the competitive strength and the nature of its external and internal environment. As SWOT means Strength, Weakness, Opportunities and Threats of the project. As, Strength and Weakness related to the internal of the project andOpportunities and threats related to the external of the project.



Source:(Dudovskiy, 2016)

PESTLE ANALYSIS OF OUR PREFAB PANEL

POLITICAL	• Fluctuation in Law and rules. • Change in Bylaws and policy according to 7 province
ECONOMY	• Labor and Energy Cost • Fluctuation in Price of Plants and Equipment and Construction Goods
SOCIAL	• Many Festivals and Holidays • Local strike
TECHNOLOGICAL	• Emerging Technologies • New technology like Interlocking Brick, Polystyrene Sandwich Panel
LEGAL	• 8hrs working Schedule • Engaged in Different Trade Union
ENVIRONMENTAL	• CO2 emission of brick is 838.241gm and Panel is estimated to be around 90 gm.

Table19: Paper done by self-effort

SWOT ANALYSIS OF FIBRE REINFORCED CONCRETE PANEL

STRENGTH	WEAKNESS
-Required less manpower -Have more strength and less cost than that of local Prefab Panel. -Have more quality and finishing than that of Local Prefab Panel. - All raw material needed to build a Prefab Panel are available in country, so trouble for Blockade -Flexibility of Product, so can be used for several times	-Is costly than that of Normal Brick -Well Equipped factory must be set up - Need to change the thinking perception of Nepalese People about the Prefab Panel.

OPPORTUNITIES	THREATS
-Rising market in Nepal - Changing consumer preference - Emerging technology - Small Grant from Government	-Emergence of new competitors -Manpower settlement in other project -Construction goods variable

Table20: Paper done by self-effort

4.4OPERATION

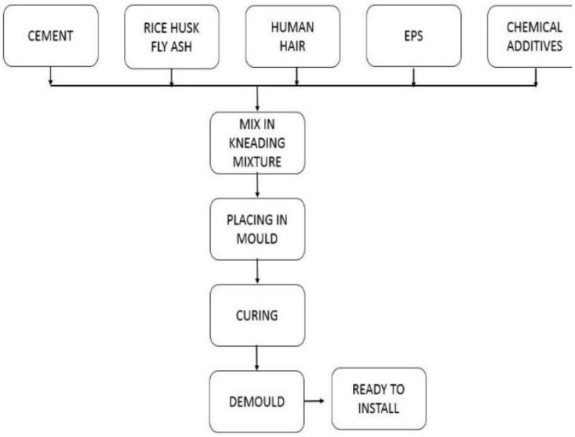
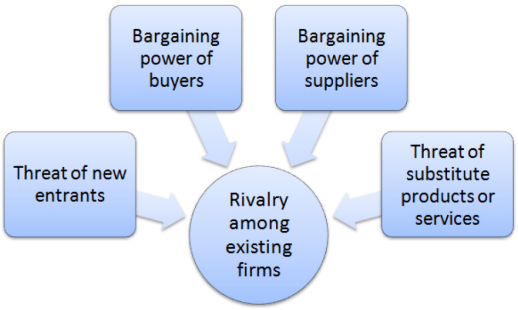


Figure 21: Production process Flowchart

4.5PORTER'S FIVE FORCES

Porter's Five Forces is a strategic analytical tool that is used to assess the level of intensity of competition in the project when finalize(CGMA, 2016). This analysis will show the situation of the market, whether my product is feasible or not to compete with other product.



Source:(CGMA, 2016)

PORTER'S FIVE FORCES OF FIBRE REINFORCED CONCRETE PANEL

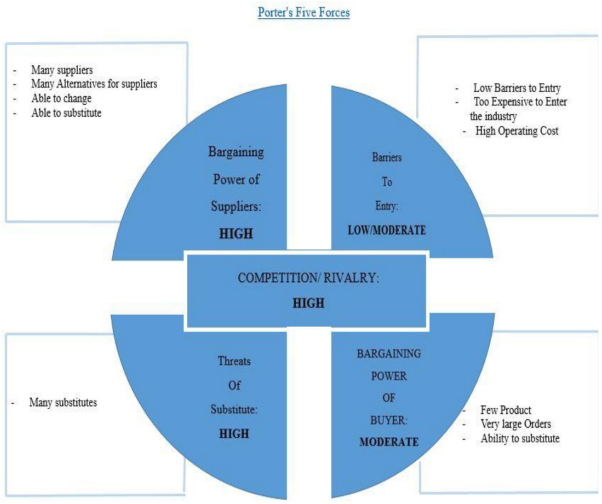


Figure 22: Paper done by self-effort

5.ANALAYSIS AND DISCUSSION

Figure 23: Sketch up design ofOur Panel required for 1369 sqft

As in this section, we have compared our product with the Normal Brick and Local Available Prefab Panel. A calculation has been done to make the clear vision. we have only focus on the product not on the structure.

As we have assumed a size of area 1369 sq.ft. which equals to 4anna. Assume the, I section column having breadth 6" and length of 9'.Let's assume we are using a 4" prefab panel

For Our Prefab Panel

Description	Length	Breadth	Numbers	Area(sqft)
Total Wall	(37-1.5)'=35.5'	9'	4	1278sqft
Opening	4'	4'	7	112
	7'	4'	1	28
				140sq.ft
Only Wall				(1278-140)=1138sqft
Our Panel	7'	2'		14sqft

No of Prefab Panel Required= $(\frac{1138}{14})$ = 81.28= 82

Price Calculation for Our Prefab Panel 4"

Description	Quantity	Rate	Total
Our Prefab Panel 4"	82*14	298	3,42,104
Miscellaneous (Transportation, Laboretc.)			50,000
Total			**Rs 3,92,104**

For Normal Brick

Description	Length	Breadth	Numbers	Area(sqft)
Total Wall	35.5'	(9'-8")=8.33'	4	1183.286sqft
Opening	4'	4'	7	112
	7'	4'	1	28
				140sq.ft
Only Wall				(1183-140)=1043 sqft
Volume of Wall(9" wall assume)				(1043*0.75')=728.46cuft
Brick	9"	4"	2.5"(height)	0.052cuft
Brick with mortar9.5"	3"	4.5"	3"(height)	128.25 $inch^3$=0.0742cuft
Volume of Brick with Mortar				0.0742cuft

No of Brick required= $(\frac{728.46}{0.0742})$ =9814.8= 9815no's

Volume of mortar=728.46-9815*0.052

=217.88cuft*1.5(increasing dry volume)

=325.59cuft

For (1:4)

Volume of cement= $(\frac{325.59}{5})$*1=65.118cuft= 1.84393642m^3=53.10 bags of cement=2657.87kg of cement required

Volume of Sand= $(\frac{325.59}{5})$*5=260.472cuft

Plaster work

Area of wall= 1043.86sqft

Volume of mortar=1043.286*$(\frac{0.5"}{12})$ =65.205cuft

For (1:4)

Cement= $(\frac{1}{5})$*65.205=13.04cuft (1 cuft=0.816 bag) =10.64 bag of cement

Sand= $(\frac{4}{5})$*65.205= 52.164 cuft

Price Calculation for Brickwork

Description	**Quantity**	**Rate**	**Total**
Brick	9815	18	1,76,670
Cement	(53.15+10.64)=63.79	915	58,367.85
Sand	(260.472+52.164)=312.636	(300cuft =Rs 25000)	26,053
Miscellaneous like Painting, Labors, scaffolding etc.	-	-	1,00,000
Total			**Rs 3,61,090**

For Local Available Panel

Description	Length	Breadth	Numbers	Area(sq.ft)
Total Wall	(37-1.5)'=35.5'	9'	4	1278sqft
Opening	4'	4'	7	112
	7'	4'	1	28
				140sq.ft
Only Wall				(1278-140)=1138sqft
Local Panel	7.5"	2'		15sqft

No of Prefab Local Panel Required= $(\frac{1138}{15})$ = 75.86= 76no's

Price Calculation for local panel of 90mm=3.55"

Description	Quantity	Rate	Total
local panel of 90mm=3.55"	76*15	450	**5,13,000**

Dry Density:

Bulk density Y (gamma) in g/cc of each compacted specimen should be calculated from the equation,

$Y(gamma) = (W_2-W_1)/ V$

where, V = volume in cc of the mould.

The dry density Yd in g/cc (1g/cc to kg/m^3)

$Yd = \frac{100Y}{(100+w)}$

For Sample 1,

W_1=4.3428kg

W_2=4.8428kg

V=0.69m^3

Water cement ratio (w) =0.4

$Yd=\frac{100Y}{(100+w)}$=0.721g/cc=**721kg/m^3**

6. COMPARISION WITH SUBSTITUTE PRODUCT

PRODUCT	*INTERLOCKING HOLLOW BRICK*	*ECOP ANEL*	*AAC BLOCK*	*OUR PANEL*	*NORMAL BRICK*
Minimum compressive strength	5.41 Mpa (800psi)	4.7MPa	3Mpa	**10Mpa**	9.54Mpa
fire resistance	Yes	Yes	Yes(4 hours for 200cm wall)	**Class 1(surface spread test), yes**	Yes
Finishing	Not so good	Crack in Joint	Level displacement	**Use of hot glue and compound for better response**	Level management
Manpower	Skilled	Skilled	Skilled	**Not so much skilled needed.**	Skilled
Installation time	Medium	Short	Long	**Short**	Long
Earthquake Resistance	No	Yes	Yes	**Yes**	Normal Brick
Insulating properties/ Energy Saving	Medium	High	Medium	**High**	Medium
Dry Density	1600kg/m3	650kg/m3	750kg/m3	**721kg/m3**	1800kg/m3
Usability	Maximum Wastes in re-use	Re-Usable	Maximum Wastes in re-use	**Re-Usable**	Maximum Wastes in re-use
Thermal conductivity KW - M/C	1	*not given	0.16	**0.00035999999999999**	0.81
Availability	12 month	12 month	12 month	**12 month**	seasonal
NO's of Item for 0.74635m3 and 73.25sqft	102nos(177.8*406.4*101.6)	4.88nos(2*7.5)sqft	27nos (660*204*204)8"*8"*26"	**5.23nos(2*7)sqft**	537nos(230*110*55)
Rate	Per piece Rs 55	(90mm- Rs 450sqft)	Per piece Rs 320	**(100mm-Rs 298 sqft)**	High per piece Rs 18

7.CONCLUSION

From this research survey and Experimental work we have concluded that by addition of Human Hair fibers, it will make concrete more homogeneous and isotropic and it will transform form brittle to more ductile material.we have also concluded that by collection of human hair from certain local area, my actual requirement can be fulfilled As, we have concluded that by addition of Human hair there is increase of 12.88% flexural strength then that of Normal concrete. As, in case of prefab panel comparison with our panel, it is found to be double compressive strength than that of existing prefab panel which came by experimental test and In-case of sound and Fire test, our panel became the strongest resistant than that of Normal Available prefab Panel.As, in case of cost comparison our prefab panel is 31% less cheaply than that of other prefab Panel and 9% costly than that of Brickwork. As, our prefab panel is proofed as Energy-saving, Flexible, lightweight, well finished and environmental protection product. As it can be used in various buildings additions or renovations for interior wall, exterior wall, roof and floor on steel or in concrete structure. As, number of experiment was done in various size,we can provide a number of size of panel as per future customer requirement. As, we have found that micro cracks form in concretewas arrested by the fibers. Thus improve of strength and ductility, and under loading reinforced fibers will stretch more than concrete.

By this research we have conclude that there will be remarkable increment in properties of concrete such as compressive strength, Modulus of Elasticity, Flexural Strength and Impact resistance, according to the exact ratio addition of Rice Husk Ash, Human Hair, EPS, Cement and chemical additive .

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Resilient Hydropower for Economic Development of Nepal

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Abstract

In Nepal, the plan of achieving a goal of economic development through hydropower expansion is driving a new era of dam construction. Nepalese dams are, however, exposed to a broad spectrum of natural hazards which increases potential dam safety risks. Sound dam safety management program is commonly used around the world to increase safety and resiliency of hydropower projects.

While efforts by the Government of Nepal and other organizations are being made to improve dam safety, the nation currently has a relatively weak dam safety management program with no national dam safety regulation for effective implementation of consistent dam safety best practices. With the rapid development of hydropower projects, the quality of life will keep on improving and the expectation on the dam safety and the public safety will continue to grow. This paper explores how dam incidents and failures around the world have changed the regulatory landscape and the evolution in dam safety management practices, emphasizing the need for robust dam safety programs and stringent regulation to improve public safety. It explores why effective dam safety management program become even more critical in mountainous countries such as Nepal to increase community resiliency and discusses how dam safety management "best practices", from around the world may be implemented in Nepal for resilient hydropower development.

Keywords: *Resilient Hydropower, Economic Development, Dam Safety management, Natural Disaster, Residual Risks; Emergency Management; Public Safety*

1. Introduction

Water is one of the most precious resources for Nepal and can become the nation's the most powerful economic engine if safely developed and wisely utilized. To ensure continued benefits from flowing water, dams have been constructed and used around the world for thousands of years to store water for a variety of societal needs, including hydropower, dependable water supply, flood control and enhanced recreational opportunities. Given these benefits, coupled with increasing power demands around the world, many countries are expanding hydropower development. As such, dams are now critical and vital part of many countries national infrastructures and has helped significantly to the growth of national GDP. However, while dams provide considerable economic and societal benefits, the failure of large dams can pose significant risks to downstream populations, the environment, and regional economies should an uncontrolled release of the reservoir occur during the life cycle of the facility. As such, the public perception of dams has been diverse and complex throughout history requiring a continuous improvement in dam safety practice to restore, maintain and enhance the public and professional confidence in dam and hydropower industry.

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Unlike most other infrastructure, the expected useful life of a competently engineered, robustly constructed and properly maintained dam can easily exceed 100 years. For example, the Bahman and Mizan Dams, built in Iran in the first and fourth century A.D. respectively, are still in operation demonstrating that the actual lifespan of well-maintained dams can be almost indefinite if the owner implements a dam safety management program that includes conducting routine monitoring and inspections, retains the technical ability/expertise to recognize and implement repairs on a timely basis and carries out routine preventive maintenance. However, despite the advances in dam safety management that have significantly reduced the frequency of dam failures (in the order of 10^{-4} dam failures per dam year per year according to information reported by Donnelly (2015)), failures can and do occur. In the future, the potential for these incidents to occur will be further influenced by the effect of climate change. As such, the development of a sound dam safety management program throughout dam's life cycle have become a well-accepted approach around the world to help minimize the likelihood and impacts of dam safety incidents and to manage an owner's overall risk.

It is understood that most developing countries like Nepal with high natural hazards are in need of robust dam safety management program. Nepal and its booming hydropower industry would significantly benefit from a consistent and modern dam safety practice reducing the additional risks posed by dams in the Himalayan region. In such situation, the dam safety program should be simpler and easy to implement so that it helps the nation and the people who needs it the most. As such, a true motivation of writing this paper is to help Nepal and Nepalese dam professional to develop their capacity to guide their dam safety industry towards the right direction.

2. Hydropower Safety Risks and the natural hazards of NePal

2.1 Dams in Nepal and Related Risks

Nepal has no known oil, gas or coal deposits, except for limited lignite deposits. All commercial fossil fuels (mainly oil and coal) are either imported from India or from international markets and are routed through India. In this context, water is a vital natural resource of Nepal which is abundantly available and represents a source of potential wealth. Virtually all of the nation's dams, and certainly all dams that can pose a public safety risk, have been constructed to facilitate hydroelectric power production across the country. Figure 1 summarizes the location of all existing and planned developments. These existing and new dams, that are being developed to harness Nepal's hydroelectric potential, will enhance the nation's development but will test its resilience in the face of natural disasters. Nepal is faced with a higher potential for dam failure when compared to many other nations due to the frequency and intensity of natural hazards such as earthquakes, monsoon rains, landslide and debris flows.

Unfortunately, as is the case for most developing countries, the nation's focus is generally on the construction of new hydropower projects that are often in remote areas with poor access with no provisions for the implementation of a formal dam safety management programs designed to address the full range of potential risks that these new dams may pose._For many of these projects the safety and liability of owning a dam is quite limited or simply ignored, and, often, inadequate budgets are allocated to conduct regular surveillance and routine maintenance. Past experience has shown that dam safety incidents, or even the partial or complete failure of dams, are an expected outcome of inadequate maintenance, an improper standard of care and an insufficient level of effort to identify and correct dam safety deficiencies in a timely manner.

The country's ability to efficiently deal with the impacts of these hazards is reduced because many dam sites are remote and have poor access. In addition, the steep topography and valley walls result in rapidly moving flood waves that can increase the severity of the flood and consequences downstream. In many river valleys there is often little opportunity for flow to attenuate making downstream populations and infrastructure considerably more vulnerable.

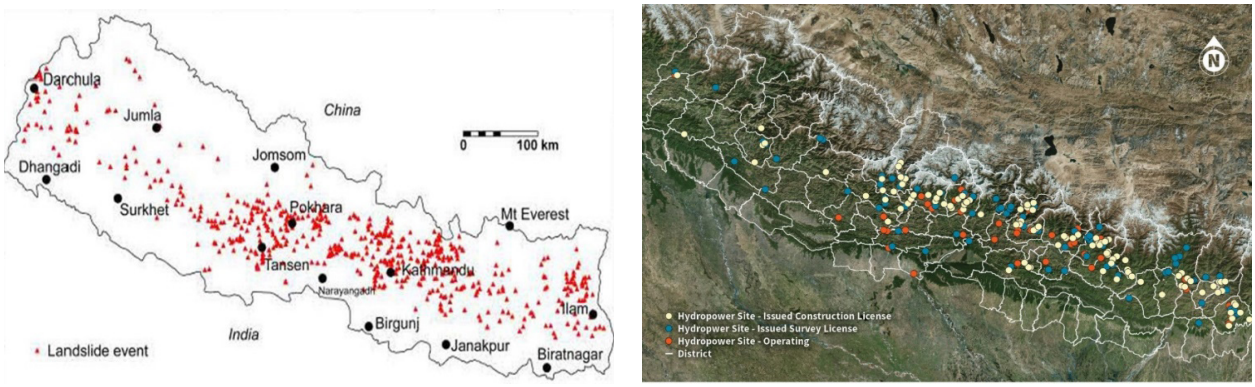


Figure 1a: Existing and planned hydropower power plants in Nepal and 1.b: Historic Landslide Events showing increased geohazard risks to dams (data from the GoN)

2.2 The Natural Hazards of Nepal

Natural hazards that can pose risks to the development of hydropower projects in Nepal include;

- earthquakes
- floods
- landslides
- debris flows.

Debris flows are often the result of a combination of mechanisms including Glacial Lake Outburst Floods ("GLOFs"), Landslide Dam Outburst Floods ("LDOF's") and rainfall induced landslides.

The well-known natural hazards presented by flood flows and earthquake loadings are generally adequately understood and addressed in the design of Nepal's hydroelectric power facilities. For example, a survey of small hydro facilities indicates that seismic vibrations from the Gorkha earthquake did not cause significant damage to HPPs in the area. Nearly half reported no damage or only minor damage, while 16% reported some structural damage. However, 30% of these facilities experienced damage because of earthquake induced landslides and monsoon rains. It is, in fact, the natural hazards presented by landslides and debris flows that present the greatest risks to hydropower development, new and existing, in Nepal (Donnelly, 2018). While the construction of new, larger hydropower projects will further increase the potential for reservoir induced seismicity, it is the preconditioning effects that these seismic events have on increasing the potential for earthquake or rainfall induced landslides and associated debris flows that is, and will remain, the most significant natural hazard in Nepal. As such, an integrated geohazard assessment is essential to reduce the risk and to increase resiliency in hydropower development in Nepal.

2.3 Climate change impacts on Hydropower Risks in Nepal

Current climate change science indicates that there is a strong likelihood of increasing Probable Maximum Flood in the next century due to the effect of Climate Change (Ouranous 2015). Determining the impact of climate change on the PMF , however, is probably one of the most important questions

facing dam industry and utility owners (Dick et. al. 2019). Although the actual impact of climate change may be uncertain, available evidences, indicate that the rate of global warming is higher in the Himalayan Range and is expected to result in more frequent extreme climatological events leading to more frequent and severe geohazards and increased costs to deal with the overall impact. In this regard, Bhatta (2017) projected that the economic costs of climate change including hydropower, agriculture and water-induced disasters could be 2–3% of current GDP/year by mid-century.

Dick at el. 2019 indicated that the most influential impact of climate change will come from the influence of climate change on PMP. Climate change also affects other climate variables that contribute to the PMF estimate, such as the winter snowpack, temporal distribution of PMP, and the magnitude and timing of antecedent events. Kunkel and Easterling (2011) note that PMP values are used in the design of long-lived structure with lifetime of many decades, such as dams. As such, the impact of climate change and the potential risks it might generates, needs to be one of the consideration for a sustainable development of hydropower projects in Nepal.

Currently around 80% of Nepal's annual rainfall occurs during the monsoon season, between June and October. Climate change model studies suggest that there will be a further 23% increase in summer precipitation and a 13% increase in annual precipitation. Therefore, there will be a more pronounced seasonal imbalance and the potential for extreme flood events may increase in the future, increasing the potential for severe landslides and Landslide Dam Outburst Floods (LDOFs), Glacial Lake Outburst Floods (GLOF's) and debris flows (Donnelly et al. 2018). Debris flows triggered by Glacial Lake Outburst Floods (GLOFs) represent a particularly serious threat, since at the end of 2010 twenty-one of the 1466 glacial lakes located in the Nepalese Himalayas have been identified (based on socioeconomic and physical parameters) as being potentially dangerous (ICIMOD 2011).

Recently, Nepal's Climate Change Policy has promoted the development of more clean energy to reduce greenhouse gas emissions, and to build climate resilient infrastructure that can adapt to climate change impacts in Nepal. These policies encourage the development of hydropower projects to help meet the region's energy demand (Bhatta 2017). A number of structural, operational and regulatory adaptation measures suitable to the project specific conditions may be used to lower the risks and increase the resilience of hydropower projects to cope with the effects of climate change.

3. Examples of Dam Safety Incidents

A review of the history of dam safety incidents and failures provides a valuable perspective on the importance of a sound dam safety management program including an effective emergency preparedness and response systems in the dam and hydropower industry. In this regards, Jensen 1980 has presented a dam and their implications in public safety. He has noted that there have been about 200 notable reservoir failures globally in the 20th century alone with more than 8,000 fatalities.

3.1 Worldwide Examples of Dam Failure and Related Consequences

In the spring of 1889, the largest dam failure incident in North American history occurred in Pennsylvania, US. Following a period of heavy rain, the 22 m high South Fork Dam broke, releasing over 20 million tons of water and debris into a narrow valley, resulting in more than 2200 human fatalities (ICOLD 1975). Over a century later, during the devastating Saguenay floods in 1996, Canada's most significant dam safety incident took place. Total rainfall was estimated to be 2 to 3 times the maximum event in record over 120

years. One of the main issues identified was inability to remove stoplogs and flashboards when flooding commenced. In this case, eight dams were overtopped. Seven people tragically lost their lives indirectly as a result of the failure and thousands were displaced, making this event one of the largest natural disasters in Canadian history.

The Teton Dam located in Idaho United States failed in 1976 upon initial impoundment. Eleven lives were lost, 13,000 cattle killed, and thousands of homes and businesses were destroyed (ICOLD 1995). This failure was one of the catalysts for the development of today's approach to dam safety management.

However, despite significant improvements in dam safety management, failures continue to occur. In 2010, a privately-owned earthen dam on a man-made reservoir in British Columbia (BC), Canada failed resulting a debris and mud torrent that severely impacted a number of homes and agricultural areas. It was found that Emergency management plan for this dam was not in place and owner and the community both were unaware of the hazard that this dam posed. The Mount Polley tailings dam failure in BC (2014) released 25 million cubic meters of tailings water and resulted in severe environmental damage (Cuervo et al. 2017). The Fondao dam failure in Brazil (2015) claimed 19 lives, destroyed an entire town and caused severe environmental damages for over 400 kilometers extending to the Estuary in the Atlantic Ocean. The failure triggered over 8 billion dollars in capital losses, approximately 45 billion-dollars in litigation, and over five billion-dollars in settlement costs (Marta-Almeida et al. 2016). It was determined that had a sound emergency preparedness and response plan been in place, including effective warning and evacuation plans, it would have significantly reduced the loss of lives and owner's overall liabilities.

More recently, in 2017, a spillway incident at the multipurpose Oroville Dam Figure 2 (a), caused by record rainfalls, high spillway flows, and the progressive failure of the spillway slab, triggered the mandatory evacuation of at least 188,000 people from several northern California cities and counties near Lake Oroville. In the worst-case scenario, the uncontrolled release of the reservoir from this, the tallest dam in the US, could have unleashed a 10 m high wall of water into the downstream river channel, severely impacting a huge population and countless properties downstream (France et al. 2018). In the case of Oroville, although the evacuation was carried out successfully, the emergency management plan did not actually match the actual emergency very well. The plan had been developed for the failure of the much larger 232 m high main dam whereas the actual emergency occurred in the spillway chute about 152 m below the dam. This points to the fact that, without accurate emergency management plans, public safety requirements may be over- or under-estimated. In another recent example, in July 2018, a "saddle dam" that was an auxiliary component at one of two hydro dams that make up the Xe-Pian Xe-Nam.

(a) (b)

Figure 2: (a) Oroville Spillway Incident USA 2017 (b) Xe-Pian Xe-Nam Failure, Laos 2018

Hydropower Project in Laos (Figure 2(b), collapsed during initial impoundment resulting in 39 fatalities, hundreds missing and leaving over 8000 homeless across multiple nations (Laos and Cambodia). Although the real cause has yet to be determined, failure appeared to have been due to poor construction and rapid initial reservoir filling exacerbated by extreme monsoon weather conditions.

Most recently, tragedy struck at the Feijao project located near Brumadinho, Brazil. On Jan. 25, 2019, Tailings Dam 1 burst, unleashing a tsunami of thick, reddish mud that killed 177 people working downstream of the dam. An additional 133 people are missing and presumed dead, making this the deadliest mining disaster of its type in more than 50 years. The investigation continues into the cause of this failure.

3.2 Recent Dam Safety Incidents in Nepal

In Nepal, a devastating 7.8 magnitude earthquake occurred, followed by a 7.3 magnitude aftershock within a three-week period in April and May 2015 (Sharma & Deng 2017). This left dozens of Nepalese Hydropower dams (e.g. Upper Bhotekoshi, Kulekhani, Sunkoshi, Upper Trishuli) severely damaged, making them vulnerable to failure. About 115 MW of hydropower facilities were severely damaged with another 60 MW impacted, representing over 20% of the nation's available capacity (Donnelly et al. 2018). Hundreds of national and international workers were also reported to be trapped within the construction site of the Rashuagadi Hydropower Project during the earthquake. However, these devastating earthquakes were a contributing factor but typically not the cause of dam failure incidents in Nepal. Rather, the earthquakes "preconditioned" the steep mountain slopes that subsequently failed creating landslides, GLOFs, LDOFs and other debris flows that devastated many hydroelectric facilities (Reynolds et. al. 2018). As illustrated in Figure 2, a relatively small GLOF that was augmented by a series of LDOFs and landslides triggered by heavy rainfall during the monsoon season quickly blocked the gates, destroying the headworks of Bhote Koshi Hydropower Project (Donnelly et al. 2018).

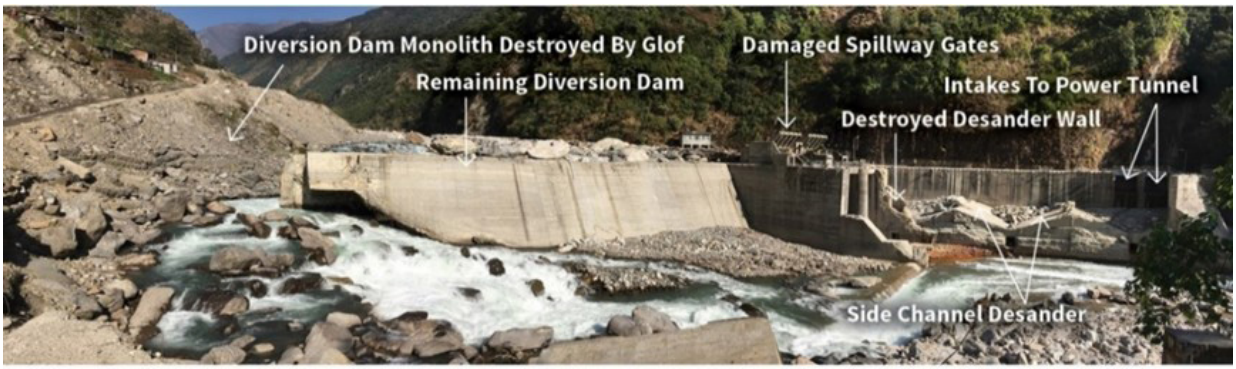


Figure 3. Impact of a rainfall induced Debris Flow at the Upper Bhote Koshi HPP

4. Globally Evolving Regulatory Landscapes

The above examples provide a sense of the risk and liabilities a large dam can impose. In addition to the loss of its intended use, such as water conservation, hydropower, flood control, recreation, fish and wildlife management, when these failures occur, the public will eventually begin to lose their confidence and trust in the dam industry and its infrastructure, significantly affecting a project's social license and, potentially, the viability or appetite of the public for future developments. Morgenstern 2018 recognized the ongoing failure as a dam safety crisis. He noted that the crisis has resulted from recent high profile failure of dams at locations with strong technical experiences, contentious operation and established regulatory procedures.

4.1 Global Outlook

In general, the public policy for dam safety is established by legislation with the support from expert professionals. To reduce the risks imposed by dams to the public and the environment, industry professionals and regulatory authorities around the world have developed new policies and procedures to improve the safety of dams. Although most of the dam safety policies have common objectives, some variations can be found mainly due to the differences in legal system in various countries. In addition, considerable time and effort is being invested to educate the public with respect to the critical importance of dams and to demonstrate that most existing dams are, in fact, very safe. The regulatory landscape has also evolved globally in response to historical dam safety incidents, improving dam safety practices around the world. For example, following a sudden collapse of the St Francis Dam in US in 1929 placed dams under an effective system if government supervision with jurisdictions over all dams, except those owned by the federal government (Jansen 1980). The reservoir Safety legislation came into effect in the United Kingdom in 1930 following two major dam failure in 1925 with 21 fatalities (Morgenstern 2018). The failure of Buffalo Creek Dam in the United States in 1972 resulted the passage of the National Dam Inspection Act. The general philosophy of these evolving regulations is more or less consistent. Dams and hydropower projects should not present an unacceptable and unreasonable hazard to the public, environment or to significant cultural heritage sites. As a result, there has been a continuous improvement globally on the dam safety management programs, policies, regulations, and guidelines.

The implementation of these types of regulations, directives, and guidelines can have a marked impact on dam safety and public safety. For example, following the enactment of dam safety legislation in the USA in 1996, the occurrence of dam safety incidents declined significantly, dropping from an average of about 39 per year between 1995 and 2000 to about nine incidents per year after dam safety programs began to be implemented. As shown in Figure 4, the incident curve flattened further once the risk based approach was introduced in the United States in 2000. The success of the evolving dam safety management methods and increased regulatory oversight is also highlighted in the International Committee on Large Dams Bulletin 99 (ICOLD 1995). In this bulletin, it is reported that the percentage of failures of large dams has shown a remarkable decrease, from 2.2% of dams built before 1950 to less than 0.5 % of dams built since 1950. Foster Fell 2000 noted failure rates before 1950 as 8.6x10-4 and after 1950 as 2.7x10-4 and gives the credit for improvement to the modern dam safety practices.

Failure of the Teton Dam was a major catalyst for new approaches for ensuring enhanced safety of the dams. Extensive reviews of the Teton Dam Project revealed that the dam failed due to a combination of the extensive fracturing in the surrounding wall rock and cracking in the internal, fine-grained sediment core of the dam. This unprecedented and unanticipated failure sent shockwaves through the dam engineering community around the world and triggered the creation of more rigorous and comprehensive dam safety program in the US (Morgenstern 2018). Investigators argued that "a safe dam could have been built at the site utilizing "state-of-the-art" design concepts that were known at the time." The collapse provided a cautionary tale for future dam design and construction and heavily influenced subsequent dam safety reviews and stringent regulations. One positive outcome of this event was the growth of dam safety regulation worldwide.

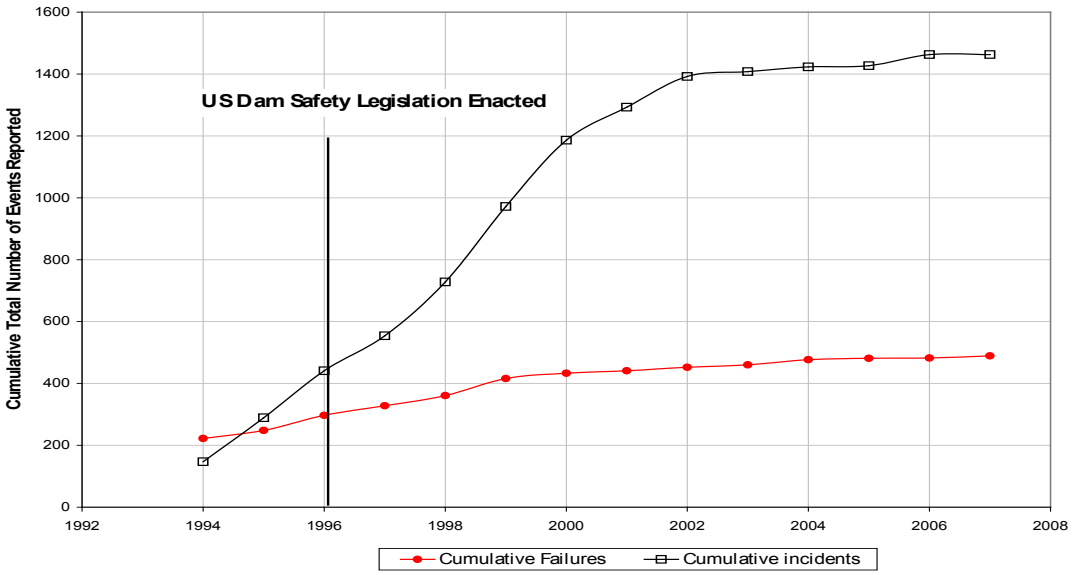


Figure 4: Effect of sound dam safety management practice on dam incidents

Likewise, in Canada, the catastrophic Saguenay flood in Quebec in 1996, triggered the development of Dam Safety Regulation in Quebec. More recently, in the aftermath of the Mount Polley dam failure in BC, Canada (2014), the BC Dam Safety Regulation was overhauled sending ripple effects across the nation. Despite the lack of fatalities associated with this incident, the government took strong policy action to improve its risk posture associated with dam safety programs and dam failure incidents. Three mine engineers face disciplinary hearings in 2018 under the BC Engineers and Geoscientist Act for alleged inadequate due diligence at the facility, regardless of the fact that there were no fatalities.

In Brazil, several company executives including the president, and one consultant faced arrest warrants after the Fondao dam failure (2015) because of alleged negligence for not providing emergency management plans and/or early warning system. This is also true of the recent (2019) Feijao Tailings Dam failure – several arrests have been made. The Oroville Spillway Incident has exposed disconcerting practice dam safety evolution. Independent Forensic Team (IFT) Analysis recommended several improvements in U.S Dam Safety practice including the major improvement in Failure Modes and Effect Analysis methodologies for large existing dams (France et al.2018). The 2018 report findings encouraged the dam safety community to avoid professional hubris by embracing "creative discomfort" with the status quo. They state "Although the practice of dam safety has certainly improved since 1970's, the fact that this incident happened to the owner of the tallest dam in the United States, under regulation by a federal agency, with repeated evaluations by reputable outside consultants, in a state with a leading dam safety program, is a wake-up call for everyone involved in dam safety." The recent dam failures in Laos were also a wake-up call with inadequate emergency management programs, poor public safety practices, unclear evacuation procedures, and poor emergency communication strategies highlighted as contributing to the large number of fatalities and many other impacts. A sound emergency management program could have significantly reduced the loss of life and impacts downstream.

Globally there is a strong push to continue developing dams and hydropower projects due to the multiple benefits that they provide, highlighting the need for effective dam safety management and sound regulatory oversight. For example, in the 20th century, when dam development in many part of the world began to encroach on populated centers, it became increasingly important for the dam industry

and the regulatory authorities to better account for the risks that a dam poses to the public and establish mechanisms to minimize the risks to a level that is "As Low As Reasonable Practicable" (ALARP). The public and the professional societies around the world have started to demand stricter regulations and higher transparency around dam design, construction, operations and maintenance. As a result, the dam owner is increasingly responsible for protecting the public and the environment from the effects of dam failure through appropriate advance warnings and actions. Therefore, maintenance of comprehensive dam safety management programs and up to date emergency preparedness and response plans have become the dam owner's legal and moral responsibility (Acharya and Wog 2010).

4.3 Recent Trend – evolution from standard based approach towards risk based approach (Rick to refine)

Traditional standard based approach have been the most commonly used approach in dam safety industry and what is normally required by regulators for approvals in all phases of dam's life cycle. This approach is based on the engineering principles and norms that uses a form of design checking against set criteria. In recent years, there is considerable interest in "risk-informed or risk-based assessment of dams" which brings into play the interaction of events in a probabilistic framework. This is of particular interest in the safety evaluation of existing dams for which some or many characteristics and parameters may be unknown. Even in the design of a new dam, where a Standards Based or Deterministic approach may be appropriate and certainly easier in application, there is a need to assess the interaction of various seemingly independent events. The dam safety professionals have started to recommend the tools such as "Failure Modes and Effects Analyses" (FMEA), Bow-Tie model, "Event Trees", Potential Failure Mode Analyses (PFMA) and "Multiple Account Analyses" for even small dams with few appurtenant structures. The process that is involved in such an exercise may bring to light events or combinations of events that were previously ignored or dismissed as being of little consequence. This constitutes a further example of the need to examine the system. The recent trend of thinking for design and safety evaluation should, therefore, be Risk Informed even if not Risk Based. In most cases, standard based approach and risk-informed or risk based approach complement each other to a degree given the limitations of each approaches and brings maximizes the value of analysis, design, and safety evaluation benefiting the owner.

With some exceptions, most of the historic failures seem to be happening due to the unusual combination of chain of usual events rather than due to the extreme loading conditions. In response to these historic incidents, the regulatory landscape is also rapidly evolving improving dam safety practice globally. Risk-informed and/or risk-based approaches to regulation are becoming accepted practices in many jurisdictions around the world including in Alberta since 2018 regulatory update. It helps the owner to better understand dam safety vulnerabilities so that the appropriate controls can be put in place to reduce the likelihood of adverse events. This way the inherent residual risks of these large engineered structures are better managed, and societal and professional confidence on the safety of these structures is improved (Donnely et al. 2019). Morgenstern (2018) has summarized the evolution of risk-based regulation, and its merits and limitations and recent trends. He noted how this approach has helped dam professionals in critically assessing the way dams could fail along with the relative likelihood of the different failure modes and their consequences, which ultimately serves to enhance the dam safety decision-making process for the dams and hydropower owners. He also note that the decision affecting public policy required consideration of "feasibility, fairness, and affordability".

4.4 Dam Safety Management System - Canadian Perspective

As the effort to increase safety of the dam continued globally, the development of the CDA dam safety guidelines in 1995 and subsequent revisions in 1999, 2007, and 2013 have improved dam safety management practices in Canada in an effort to enhance public safety. More recent addition of supporting technical bulletins (2007; 2016; 2019) developed by Canadian Dam Association are indications of continuous efforts for improvement in dam safety management practice in Canada to increase the professional and public confidence in the industry. Some form of dam safety regulatory requirements now exist in many jurisdictions to assume that the potential impacts of dam failure are minimized, and overall public safety is addressed.

In Canada and many other countries around the world, the owner is fully responsible for the safety of the structure. Dams are generally classified based on the consequence of failure (e.g. life loss, environment, economy, cultural heritage) and the dam classification system is used to develop the standard of care for each dam. A sound dam safety management systems involve fundamental elements of the "plan-do-check-act-report" cycle as explained below in Figure 5 with clearly identified roles and responsibilities.

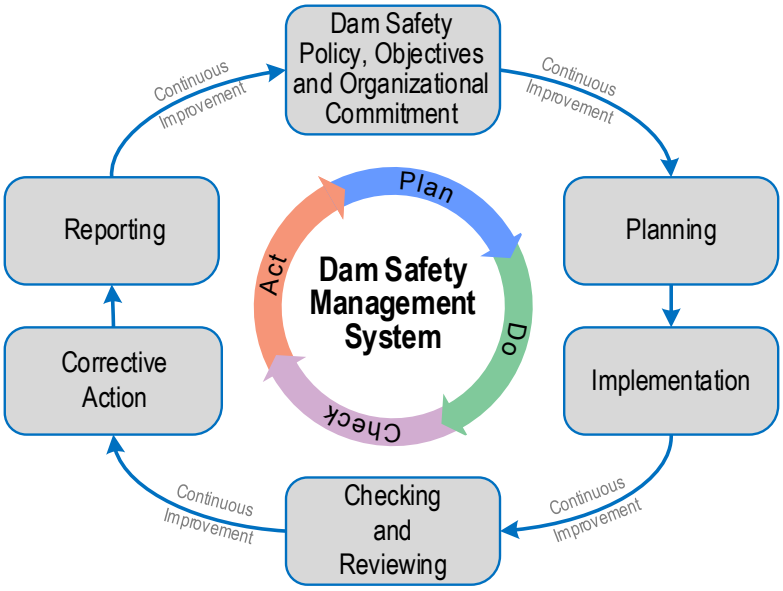


Figure 5 Simple Schematic showing the elements of Dam Safety Management System (Adopted from CDA 2013)

1. Policy and objectives: The owner's dam safety policy and objectives should clearly demonstrate the organization's commitment to safety management at all phases of dam's life cycle.
2. Planning: The planning process involves identifying the components of the dam safety work program, assigning the responsibilities for executing each component, and ensuring that adequate resources are allocated to carry out the work. The plans should define the acceptable standards, implementation methodologies, and required frequencies for carrying out certain tasks.
3. Implementation: The implementation component involves the execution of the activities that are planned each year. Activities include reviews and inspections, taking corrective action when required, operation, maintenance, and surveillance, as well as emergency preparedness. These activities should be carried out according to a clear plan so that the intended function of the dam is achieved without compromising its safety. Detailed emergency preparedness plans and response procedures should also be integrated into the overall dam safety management plan.

4. Checking and Reviewing (monitoring/evaluation): Dam safety management system should include formal processes for checking and reviewing the overall dam performance. It requires that the owner undertakes routine and detailed inspections, monitoring and assessment of data, testing of equipment, and emergency exercises to check and review the condition and evaluate performance of the dam and its components. The review process should also include periodic independent review and refinement of the dam safety management system itself, including policies, planned activities, management frameworks, and the efficiency with which dam safety activities are executed each year.

5. Corrective Actions (Audit/review): Dam owner needs to have an acceptable process for timely follow-up and correction of potential deficiencies, confirmed deficiencies, and non-conformance. These deficiencies should be tracked throughout the mitigative process from their identification to follow-up and correction. Surveillance, maintenance, operating equipment tests, Dam Safety Reviews, emergency preparedness tests, incident investigations, management system reviews, and audits should be a part of the dam safety management process to identify or confirm safety deficiencies or non-conformances. Annual audit/review of the EPP/ERP and flood action plan prior to the flood season should be developed and followed each year.

6. Reporting: Dam owner needs to develop a comprehensive reporting method and created a permanent record of the various dam safety activities and management activities undertaken each year. This includes documentation related to ongoing inspection and maintenance activities, design activities, construction activities, and records of dam safety incidents. Some jurisdictions require that senior management and company executives/officers should be updated annually on the status of the dam safety program on items such as A) Results of the various inspections and reviews; B) Outstanding issues and deficiencies; C) Incidents D) Corrective actions; E) Adequacy of resources.

Besides these elements, the dam safety management system should also include the safety management supporting processes, which should have training, program communication and record keeping components.

4.5 Dam Safety Jurisdictional setup in Canada (CDA website)

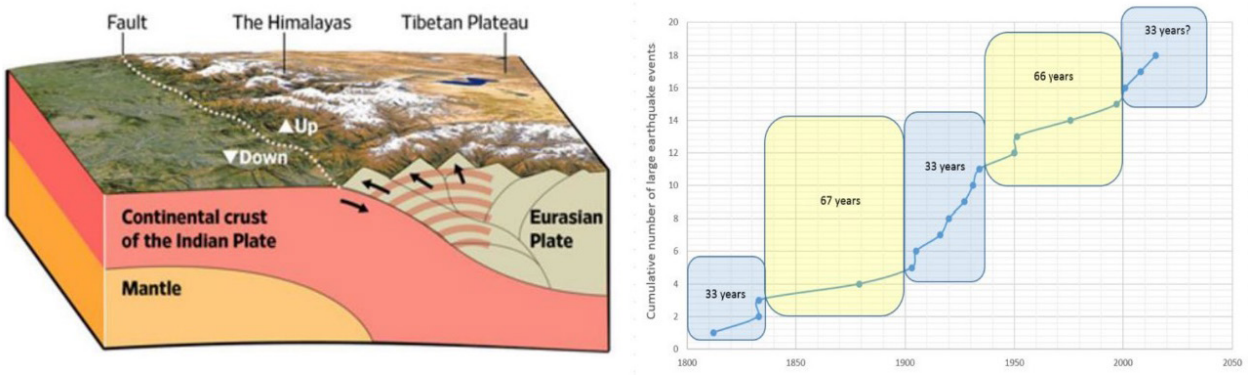
The regulation of construction, operation, maintenance and decommissioning of dams in Canada is a provincial/territorial responsibility and is similar to other areas of provincial jurisdiction such as health and education. Most provinces have legislations that follows the standards presented in the Canadian Dam Association's Dam Safety Guidelines. Unlike some other countries (e.g. France, Portugal, Mexico, South Africa, etc…), Canada does not have a federal regulatory agency or over-arching program to guide the development of requirements for the safe management of dams.

However, the Federal Government has regulatory requirement over some aspects such as approval of dams to be constructed in navigable waters and dams located on boundary waters with the US (via International Joint Commissions), and dams constructed and operated by the Canadian's nuclear industry (via Nuclear Safety Commission). The Federal Government also has regulatory interests through the Fisheries Act, Species at Risk Act, the Environmental Protection Act, and the Nuclear Safety and Control Act. The federal government manages its own dams, which are exempt from provincial regulation (e.g. Parks Canada Dams).

5. Vulnerability and need for integrated risk assessment for Nepalese hydro-power projects

Over the next decade, the demand for electricity in Nepal is projected to increase by more than 1 GW. Power exports to neighbouring countries are also expected to increase significantly requiring the development of another 1000 GW of hydropower in the next 30 years (NEA 2017; Rutherford et al., 2018). While the economic and social impacts of hydropower development and dam construction are considered to provide significant benefits to the country, additional dams pose risks that are unique to Nepal that are related to the geological and hydrological hazards present in Himalayan mountains.

Nepal is geographically situated in a location vulnerable to earthquakes, landslides, debris flows and flooding. These geohazards increase the risk of a dam incident or failure (Sharma & Deng 2017). Reynolds et. al. 2018 has also made a compelling argument that in the geologically young and dynamically active mountainous region, catastrophes and hydrometeorological processes can lead to a major slope instabilities and geological disasters. The first documented earthquake event, with a suspected magnitude of 7.8, dates back to 1255. M8 earthquakes have occurred every century since then as is shown in Figure 6.



(a) (b)

Figure 6. (a) Geological Setting of Nepal Tectonic Plate Movement (McLain, 2015) (b) Frequency of Historic Major Earthquakes in Nepal (Hatch, 2016)Experts have estimated that the recurrence period of the 2015 earthquake is about 1:180 years indicating that long-life infrastructure such as dams and hydropower facilities will be subject to at least one M_w 8.0 earthquake during the operating life of the facility (Reynolds et al. 2018). To emphasize this point, a new study has warned that an enormous stacking up of strain in the region portends at least one earthquake of magnitude 8.5 or more in the western part of Nepal anytime in the future (Rajendran et al., 2018). In the steep Himalayan valleys, prolonged monsoon rain compounded by a cloudburst or can induce very destructive landslide mudslide and debris flow (Reynolds et. al. 2018). Therefore, it is critical that these loadings be considered in the planning and design of dams and hydropower facilities.

The tradition approach of studying individual loading conditions in isolation e.g. earthquake, hydrology, Geotechnical, Glacial hazard) is not enough to increase the resiliency. Dam design in Nepal must also consider other natural hazards acting alone or in combination. These phenomena not only contribute to the potential dam safety risks individually but can also be compounded resulting in extraordinarily hazardous situations that can increase the risk of a dam failure. Therefore, a need for a comprehensive integrated risk assessment is essential for resilient (safer) hydropower development in Nepal (Reynolds et. al. 2018).

Sedimentation management is another important consideration on dam design, operation and maintenance in Nepal as all the natural hazards discussed above yield extraordinary amount of sediments. Kaini and Annandale (2019) have identified sedimentation control and management as one of the mostly overlooked area in planning and design of hydropower projects in Nepal.

Under these conditions, the implementation of a sound dam safety management program tailored to specific need of Nepal that include integrated hazard assessment and management becomes one of the most effective and essential vehicle to help minimize the likelihood and consequence of dam failure, and to increase public safety.

6. Need for a dam Safety Regulation and a Sound Dam safety Management Program to increase resilience

To manage risks associated with dams, other countries have successfully implemented dam safety legislation and programs and continuously improving the practice. However, no dam safety programs have addressed complex situations such as those found in Nepal and (Donnelly et al. 2018). Currently, Nepal does not have the national regulatory requirement to help ensure consistent dam safety standards and to enforce the use of effective dam safety management program. Nepal also lacks integrated emergency management programs for dams although the hazards exposed to dams in Nepal are unique and significant compare to the other jurisdictions around the world. The management of dam safety risks is left to the discretion of the designer, owner, and operator of each dam, each with limited accountability for public safety and economic consequences of dam failure. Most of the major dams in Nepal are designed by international standards or standards of consultant's country of origin and hazards unique to Nepal are not always well accounted for (Donnelly et al., 2018). As a result, dam designs can vary significantly and depend on the judgment and experience of the practitioner, the standards with which they are familiar and the risk tolerance of the owner of the facility. As such, the risks that an individual dam poses may vary considerably.

Under these conditions, the implementation of a sound dam safety management program becomes one of the most effective and essential vehicle to help minimize the likelihood and consequence of dam failure and to increase public safety. As such, the dam safety management program with a primary objective of improving the safety and preventing failure is an urgent need for the safe and sustainable hydropower development in Nepal. The program should also include elements to respond to unusual conditions so that hazardous situations can be brought under control. This should help the owners to continuously and proactively managed the inherent risks of these large engineered projects to a as-low-as-reasonably-practicable level during all phases of dam's life cycle and provide guidance during transitioning to recovery from any incidents and failures. A sound dam safety management program should consist of a legal framework and should include fundamental elements of the "policy-plan-do-check-act-report-improve" cycle as illustrated above in Figure ?

7. Effective Emergency Management Program A Vital Strategy To Increase Community Resiliency

The potential for natural hazards to occur and their range of impacts are hard to predict and completely address in design. This means that even well planned, designed, constructed and operated dams and hydropower projects will remain vulnerable to natural hazards to some degree. There are many ways the owner might be able to manage the risks related to dams as shown in Figure 7. The use of an Emergency

Management Program is increasingly being accepted as "good industry practice" and are essential elements of a modern dam safety management program. It is also one of the low cost yet very vital strategy to manage the residual risks of dam failure.

The objective of an effective emergency management program is to ensure that practicable measures are taken to minimize the impacts on human life, property, infrastructure, the environment and the cultural heritage from reasonably foreseeable incidents, mis-operation, flood events, or dam failure (ICOLD 2017). Fully understanding the consequence of dam failure is a critical step towards developing a sound emergency management plan. To understand the consequence of dam failure typically a hypothetical dam breach is considered, flood wave routings are performed, inundation mapping developed, and potential impacts are assessed for a range of failure scenarios. A wide range of methods may be applied in each of these steps depending on the purpose of the assessment (CDA 2013).

Figure 7 Strategies for Managing Residual Risks of Dam Incidents (CDA 2019)

Furthermore, the recent advances in emergency planning practice can lead to more accuracy in setting protection priorities and improved decisions by incident commanders. For example, more recent guidelines, like Alberta Environment and Park's new dam safety directive (AEP 2018) and CDA's new technical bulletin (CDA 2019), would require individual plans for individual components of a hydropower system.

As is conceptually illustrated in Figure 8, an effective emergency management program typically consists of four elements:

(1) A prevention and Mitigation Plan;

(2) An emergency Preparedness Plan (EPP);

(3) An emergency Response Plan (ERP) and/or a Flood Action Plan (FAP); and

(4) A Recovery Plan.

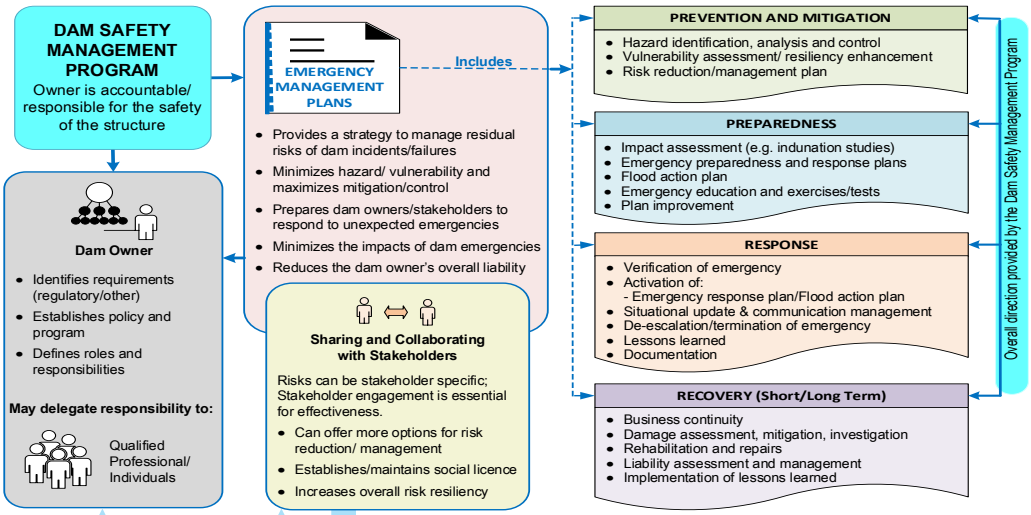


Figure 8. The key Elements of an effective emergency management program

All four of these plans are critical elements in a comprehensive dam safety emergency management program (CDA 2019). An effective emergency management program aims towards minimizing hazards through prevention and mitigation effort; reduces vulnerability through preparedness plan including community engagement; and increase mitigation through response and recovery function. A sound emergency management program is, therefore, the low cost yet very effective strategy to reduce the residual risks of dam incidents as it has a goal of shifting a disaster towards a manageable emergency while increasing community resiliency.

A Prevention and Mitigation Plan includes actions to be taken throughout the life cycle of the dam to identify and reduce vulnerabilities. The overall direction comes from a robust dam safety management program with the objective to prevent an emergency from developing and/or to reduce/eliminate the effects of an emergency. Ongoing actions to prevent hazards from developing into catastrophes, to reduce or eliminate vulnerabilities and to increase community resiliency are critical elements of the mitigation and prevention phase.

Emergency preparedness is a plan of action that is focused on achieving the best possible response when, and if, an emergency occurs. The EPP is the document that identifies potential emergency conditions at a dam and outlines preplanned actions to be taken before an actual emergency begins to escalate, ensuring an effective response during an emergency. Emergency preparedness measures involve an ongoing cycle that consists of planning, organizing, meeting with impacted stakeholders, evaluating the program and continually improving.

An ERP includes the actions to be taken by dam owners and other key personnel to save lives and prevent further damages in specific emergency situations, such as before, during and after a major flood event, after a seismic event, or when anomalous behavior of dam is noted. Emergency preparedness and response plans always need to be in a state of constant readiness. Plan testing, training, validation, and stakeholder engagement are all vital to the success of the plan (Zare et al., 2018).

A Recovery Plan outlines the actions to be taken after an emergency to return the situation to a normal or near normal condition and to restore stability and business continuity. The recovery phase includes all decisions and actions needed to restore basic services, clean debris, rebuild or repair infrastructure. More details regarding the elements of emergency management program is presented in Acharya et. al., 2018.

8. Need For Dam Safety Risk Communication

Bosewell at el. 2019 have identified risk communication as one of the major gaps in modern dam safety practice and areas in which attention to dam integrity could be improved. They noted that over the past few years, the world has witnessed a number of high profile dam failures; vivid images have made the concept of risk progressively less abstract in the minds of the Alberta public and dam engineers alike. It has become correspondingly more important to communicate more effectively about technical facts and judgements on one hand, and about societal values on the other hand. They iemphasized the need for thinking clearly and communicating effectively about the dam safety risks which needs a collaborative approach with all stakeholders for effectiveness.

Morgenstern, 2018 also recognized that while identifying and quantifying risk can often be challenging, communicating risks to inform public policy is equally challenging. Managing risk effectively is the responsibility of dam ownership and requires risk communication. Thus, stakeholders must be included in

risk management processes (estimation, evaluation, reduction) to involve them in the design and decision-making process and prepare them for upcoming operational phases, including possible emergencies (MAC 2016). Including stakeholders early and often will help establish and maintain social license to operate with key constituents.

The development of effective dam safety management programs and related public education and awareness material targeting dam safety issues, will become increasingly important in order to reduce risks to the public and the environment as Nepal develops its hydro resources and builds more dams. A clear communication, and effective collaboration are critical to a successful implementation of dam safety management program including emergency preparedness and response process. As situation stands in Nepal, community engagement and appropriate public consultation sessions are critical in developing public awareness of the potential risks of dam failures.

Developing effective community engagement strategies should be performed in parallel with the development of national standards. Regular communication and collaborative emergency response plan exercises with national, sub-national and local government response agencies will help to ensure understanding of all parties on what resources may be available and the roles each needs to play to manage the dams and associated risks they pose. These actions will also assist decision-makers and incident commanders in keeping high-hazard dams in mind when considering response resource allocations.

Bosewell 2019 emphasized that it is time for dam engineers to rethink the societal acceptability, and thus the professional acceptability, of the current ways we think about and talk about risks as "extreme consequences" gradate towards "unbearable consequences". Engineers cannot solve this alone, but we can provide proactive leadership by treating the right-hand portion of the F-N plot as beyond the limits of analytical decision-making and into the realm of societal values. We can invite and facilitate the needed conversation between engineering experts, corporate decision-makers, regulators and the public. (placeholder for idea, rick to refine this concept).

Professional organizations can also play a critical collaborative communication role to ensure the integration of the engineering community with their professional counterparts in disaster and emergency management so that local engineers are familiar with disaster risk management programs and procedures. Nepal professional organizations should take a lead in connecting the Nepalese engineering community to the national and international dam safety industry and thereby introduce them to related best practices such as emergency management for dams (CDA 2019), conducting failure modes and effect analysis (FMEA) at the design stage and the use of risk informed decision-making systems, and the establishment of independent review boards for major hydropower projects. It greatly helps in developing a common understanding on risk posed by dams and possible mitigation measures.

9. Conclusion and Recommendations

9.1 Conclusions

In Nepal, water is one of the most precious resources and has a potential to become the nation's the most powerful economic engine if safely developed and wisely utilized. The goal of economic development through hydropower expansion is driving a new era of dam construction. In a mountainous, seismically active area like Nepal, natural hazards that can initiate a dam failure are varied and significant.

The lack of consistent, formal operation and maintenance practices, coupled with the impacts of climate change, significantly increases the risk to hydropower projects and dams and downstream communities. In addition, the continued population growth and increased development downstream of dams is increasing, compounding the consequences of dam failure. All of these factors point to the fact that dam safety risks in Nepal are significant and can be expected to increase in the future as more and larger projects are constructed. Under these conditions, the implementation of a sound dam safety management program tailored to specific need of Nepal that include integrated hazard assessment and management becomes one of the most effective and essential vehicle to help minimize the likelihood and consequence of dam failure and its consequences, and to increase public safety.

Dam safety practice have continuously evolved globally over time albeit ironically triggered mainly by historic incidents. A consistent and modern dam safety practice is essential for Nepal in order to reduce the life safety risk and minimize impacts to people, property, the economy and the environment. With the rapid development of hydropower projects, the quality of life will keep on improving and the public expectation on the dam safety and the public safety will continue to grow. All dams and hydropower owners, the public and the government would significantly benefit from the implementation of a consistent dam safety best practices. In the case of Nepal, the dam safety program should be simpler and easy to implement so that it helps the nation and the people who needs it the most.

9.2 Recommendations

The Government of Nepal has been planning to increase its hydropower generation capacity significantly, requiring the construction of many dams in recent years and indeed into the future. Nepal would significantly benefit from:

1) Implementing the recently developed Dam Safety Guidelines so that consistent design standards and practices are applied across the nation and provide a suitable capacity building program with opportunities for continuous improvement.

2) Supporting the development and implementation of a sound dam safety regulation including requirements for a comprehensive dam safety management program and policy.

3) Adopting relevant lessons learned from the available modern dam safety concepts around the world that are included in the guidelines, technical documents and best practices developed by international dam safety agencies.

4) Establishing a dam safety section within the appropriate government agency to ensure continuous improvement in the capacity of individuals and institutions to develop, implement and promote the consistent dam safety management standards and best practices across the nation.

5) Incorporating adequate public participation and consultation during planning, site selection, design, and developing sustainable and effective operational strategies for new dams to minimize risks and maximize resiliency.

6) Offering introductory level educational seminars and courses in high schools and universities for dam safety, and emergency management to enhance education, and awareness and risk communication.

7) Collaborating with other governments, international dam safety organizations and regulatory agencies to accelerate the learning by sharing knowledge and experiences.

Finally, Given that a major dam building era is approaching quickly, Nepalese engineering professionals, disaster managers, government agencies and industry veterans should proactively demonstrate visionary leadership in establishing high standards for dam safety and emergency management. Robust dam safety program will increase public awareness and safety and would strengthen societal and professional confidence that the inherent risks of these large engineered structures are appropriately addressed and managed during all phases of their life cycle. This will, ultimately helps to create an attractive investment climate in Nepal for national and international investors on major hydropower development project in a safe and sustainable manner.

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Resolution

Third International Conference 2019 on Title "Resilient Infrastructure for a Better Tomorrow"

Resolutions Adopted by the Conference Organizers

Through an intensive deliberation in the Third international Conference, jointly organized by the Society of Consulting Architectural and Engineering Firms (SCAEF) and the National Reconstruction Authority (NRA), held on 18-20 November 2019 in Kathmandu, Nepal, the following Resolutions as consensually agreed by all the Members of the Resolution Committee, has been endorsed by both the organizers on their respective rights, which may subsequently get adopted by the relevant governmental, non-governmental and private sector institutions, for the purpose of planning and implementation of the "Resilient Infrastructure for A Better Tomorrow":

1. Ensure adequate resources for resilient infrastructure development by all levels of government and private sector.
2. Create conducive environment to promote national consulting industry to grow by promulgating Consulting Services Development Act.
3. Contracts for construction and consultancy shall be based on 'workable rates' rather than the lowest bid amount and the principles of fair play shall be adopted.
4. The corporate organizations shall exhibit their social responsibility by allocating at least one per cent of their income as Corporate Social Responsibility (CSR) Fund for supporting resilient infrastructure development
5. Consider the needs of economically and socially vulnerable communities during project planning and implementation.
6. Adopt comprehensive approach in planning, financing and engineering in developing resilient infrastructure by engaging all the stakeholders.
7. Ensure adequate investment in producing and retaining skilled human resources within the country.
8. Promote domestic consulting firms and construction companies by ensuring their participation in large projects.
9. Enhance institutional memory of the knowledge and experience gained by NRA from the Gorkha Earthquake 2015 and set up a framework for sharing and disseminating of the same.
10. Adequate resources shall be allocated for further research and development (R&D) of resilient infrastructure.
11. Infrastructure development projects shall be planned and executed in the context of local environment, economic and socio-cultural perspectives.
12. Create conducive environment for foreign direct investment (FDI), multi-national companies (MNC) and public-private partnership (PPP) by fiscal and legal reforms and thereby enhance the private investments in resilient infrastructures.

13. Allocate adequate resources for climate change adaptation and mitigation and consider regional effects in planning and implementation of resilient infrastructures.
14. Formulate policies and implement ground water recharge scheme immediately in Kathmandu valley.
15. Ensure adequate resources and participation of local people for cultural heritage conservation and enhance the capacity of Nepalese Consulting and Construction Industries in the area of cultural conservation and development.
16. Ensure public safety to all including comfortable accessibility to differently-abled and elderly citizens.
17. Revise and implement the National Building Code considering the experiences gained during Gorkha Earthquake 2015. Likewise prepare and adopt the National Infrastructure Code considering the geological, geographical, socio-economic and other factors relevant to our own context.
18. Establish the proposed National Disaster Risk Reduction and Management Authority (NDRRMA) as soon as possible and make arrangement for handing over the institutional memory and the knowledge gained by the National Reconstruction Authority (NRA) during post EQ reconstruction in Gorkha EQ.
19. Utilize the knowledge gained in earthquake housing reconstruction program conducted by national reconstruction authority for the structural safety of the private houses all over the country so as to achieve he national objective of making our nation resilient
20. For spreading the experience of Gorkha Earth Quake 2015 in all cycles of rescue, relief, reconstruction and recovering to our future generation establish an Earthquake museum before the period of NRA expires.
21. For making systematic research and training in earthquake technology and over all disaster risk management aspect, establish an international research center an earthquake and disaster risk management in Nepal

The Members of the Resolution Committee have unanimously agreed to these Resolutions and have signed on their respective rights as listed hereunder on 11 December 2019:

On behalf of the Resolution Committee

Er. Bal Sundar Malla Coordinator Past President of Society of Consulting Architectural and Engineering Firms (SCAEF)	Er. Mahendra Bahadur Gurung Member Past President of Nepal Engineers' Association (NEA) and Former Chief Executive Officer of Pancheshwar Multipurpose Project	Prof. Dr. Triratna Bajracharya Member President of Nepal Engineers' Association (NEA), Former Dean of Institute of Engineering (IoE)

2

Ar. Kishor Thapa Member Former Secretary of the Government of Nepal (GoN), Past President of Society of Nepalese Architects (SONA), Executive Member of National Reconstruction Authority (NRA)	Ar. Anju Malla Pradhan Member President of Society of Nepalese Architects (SONA)	Er. Birendra Raj Pandey Member Vice President of Confederation of Nepalese Industries (CNI)

The above-written Resolutions are endorsed by the Conference Organizers on their respective rights as signed hereafter with respective seals:

On Behalf of Society of Consulting Architectural and Engineering Firms (SCAEF)	On Behalf of National Reconstruction Authority (NRA), Government of Nepal (GoN)
Ar. Rajesh Thapa President Date: 20 November 2019	Er. Sushil Gyawali Chief Executive Officer Date: 20 November 2019
Seal	Seal

Closing Session

Address by Conference Manager

- Namaste and a warm Good Evening to all
- Respected Ar. Rajesh Thapa, Session Chair of the Closing Ceremony, Conference Convener & President SCAEF
- Respected Chief Guest, Er. Shanker Nath Rimal
- Er. Sushil Gyawali, CEO, National Reconstruction Authority
- Er. Mahendra Bahadur Gurung, Past President Nepal Engineers' Association
- Mrs. Tara Amatya, KMA Award Trustee
- Er. Krishna Prasad Sapkota, Conference Secretary and General Secretary of SCAEF
- Distinguished Invitees, International and National Participants
- Journalists,
- Ladies & Gentleman

It is a matter of great pleasure for me as Conference Manager to get this opportunity in welcoming you all for this closing session of Third International Conference being organized by Society of Consulting Architectural and Engineering Firms (SCAEF), Nepal jointly with the National Reconstruction Authority-Government of Nepal and other partner institutions Federation of Contractors Association Nepal and National Society for Earthquake Technology along with various knowledge partners on the title "***Resilient Infrastructures for A Better Tomorrow"***. As you all know by now the conference objective was a small effort to support Nepal's economy towards prosperity through the development of resilient and sustainable infrastructures.

We organized this conference to celebrate SCAEF's 29th anniversary

This conference related to broad arena of resilient infrastructural development in the context of Disaster Risk Reduction and Climate Change adaptation initiatives inclusive of relevant aspects of the engineering and consulting profession, sharing knowledge and experience between its member firms and international delegates. This conference we believe lived to the expectation and to be instrumental in providing valuable feedbacks to the government of Nepal, policy makers and multitude of project actors and stakeholders in the infrastructural development for resilient nation building.

The international conference, we believe provided a forum for building effective networking and fostering cooperation with international societies like earlier TCDPAP, country societies of consulting firms and Asia-Pacific community (FIDIC/ASPAC) of The International Federation of Consulting Engineers. The conference also aimed to develop a platform for Nepalese consulting firms to seek opportunities in international consulting market through business networking with international firms, partner organizations in ASPAC region, FIDIC members, and friendly countries.

The conference, which also intended to introduce international firms on the consulting and business environment in Nepal. At a time when the government is seeking more investments in infrastructure sector, the gap in technical knowledge and experiences between the Nepalese and international consultants must be minimized by creating an enabling environment for sharing of knowledge and experience. Therefore, to initiate dialogue between international partners, Nepalese consulting sector and government bodies for creating an enabling environment, the participants of the conference must have utilized this platform fully.

On behalf of SCAEF; I would like to welcome and extend hearty thanks to Chief Guest, Er. Shanker Nath Rimal for gracing this occasion and to all distinguished Guests, Invitees, International and National Participants, Conference Sponsors and Journalists in this august evening for participating in the closing session of the conference and 29th SCAEF day celebration.

Enjoy the evening!!

Thank you,

Thakur Prasad Sharma

Address by Chief Guest

Dear Friends,

I am very pleased to see my dear friend Mr. Amitabh Ghoshal and Madam Ghoshal. He is my class friend from 1953 to 1957 and we are in touch ever since now of course through facebook. Anyway, now to see him in person is really really a pleasure and I am really happy that you have organized to bring him down to Kathmandu, Thank you for that. And also thank you for giving me such an honor.

You know I am not very much in circulation nowadays and my activities are mostly limited to find art, architecture and religious architecture specially. I am writing book and articles on whatever I have done previously. This is an opportunity where I feel at home because I have been doing this for very long time and because it needs lot of energy I have really withdrawn myself from wasting and using so much energy which I don't have. So it gives me pleasure to less energy and create more noise.

Anyway Thank you very much for giving me this opportunity all the organization and my friends. I see lot of my old friend faces and really it is a pleasure and it is an honor to be with you.

Thank you very much.

Ar. Shanker Nath Rimal[1]

1 Former President of Nepal Engineers' Association and Chief Guest of the Session 6: Closing Session and SCAEF's 29th Anniversary Celebration

ASNEngr
American Society of Nepalese Engineers

COLLABORATION WITH NATIONAL AND INTERNATIONAL ORGANIZATIONS

MEMORANDUM OF UNDERSTANDING (MOU)

Between

AMERICAN SOCIETY OF NEPALESE ENGINEERS (ASNEngr)
PO Box 1606, Centreville, VA 20122 USA

and

SOCIETY OF CONSULTING ARCHITECTURAL AND ENGINEERING FIRMS (SCAEF), NEPAL
PO Box 1513 Budhanagar, Kathmandu Nepal

1. Purpose

1.1 The American Society of Nepalese Engineers (hereinafter ASNEngr) and the Society of Consulting Architectural and Engineering firm, Nepal (hereinafter SCAEF) do hereby agree to cooperation and supplement each other's resources with a view to promoting development of the engineering industry of both countries in the new century.

2. Scope

2.1. Exchange of engineering information and materials
Engineering information produced in the form of papers, periodicals, books, non-proprietary reports and others engineering references shall be furnished when requested by either side. The scope of this exchange shall be mutually determined by participating collaborative staff.

2.2. Exchange of engineering personnel
ASNEngr will accept the engineering personnel of SCAEF when requested by SCAEF and when ASNEngr finds it is possible to comply with proposal, and on the other hand, SCAEF shall likewise accept the engineering personnel of ASNEngr in the said fields.

2.3. Joint study and research activities
Study and research activities will be conducted jointly when the staffs of each organization find it mutually beneficial especially in the field of engineering. The subject and content of such activities will be discussed or reviewed in advance through joint consultations.

2.4. Joint seminar and symposium
The two parties will hold joint seminar or symposium that furthers the industry's interests in both countries and encourage cross attendance or joint participation on such professional events.

2.5. Capacity Building Training
The parties will collaborate to enhance the capacity of its members through providing training by sharing knowledge and experience of each organisation or

ASNEngr
American Society of Nepalese Engineers

collaborate with each other to mobilise appropriate third party organisation as may be agreed from time to time between the parties.

2.6. Firm level cooperation

ASNEngr and SCAEF encourage and promote their member firms to explore actively opportunities of contracting project jointly in Nepal and other world markets; to build up business relations, exchange experience, improve understanding and enlarge cooperation; to promote mutual visits between firms.

2.7. Promotion of others cooperation

Activities to promote cooperation will be discussed and conducted jointly when the staff of each organization finds it mutually beneficial especially in the field of engineering.

3. Implementations

3.1 Joint standing cooperation committee (JSCC)

The two parties will constitute joint committees with equal members from two sides to promote greater understanding and deeper Cooperation and will hold joint meetings on mutual agreement.

Within a month of the signing of the MOU, each party will nominate a contact point for communication and coordination of the Plan of Action to be undertaken under this MOU.

3.2 Financial Commitments

The approval of this MOU does not constitute Financial Commitment on either party for implementation of the agreed Plan of Action under this MOU. Each party will be responsible to meet its own costs. If required, a separate contract will be agreed upon for executing such activities.

3.3 Maintenance of secrecy

One party shall not disclose to any third party any secret or confidential information of the other party. The dispatched personnel shall abide by all instruction regarding maintenance of secrecy to be given by responsible persons of the receiving party.

3.4 Effective periods of this agreement

The effective period of this agreement shall be five (5) years starting from the date of signing. In the event that one of the parties' desire to extent the effective period, it may be extended after mutual consultation and new agreement signing.

3.5 Modification

The agreement may be amended by mutual written agreement of the parties, and specifying the period of validity of the amendments. The parties will carry out annual review and report to the respective governing bodies on the progress made and on a plan mutually agreed for the following year for approval. A specific term review will be carried out 6 months before the expiry, which will serve as the basis for extension of the MOU to the next term.

ASNEngr
American Society of Nepalese Engineers

3.6 Interpretation of terms

In the events doubts should arise regarding the interpretation of the provisions of this agreement or problems about matters not described therein, both parties shall consult with each other and settle them amicably in the spirit of this agreement.

IN WITNESS WHEREOF, each of the parties hereto has signed the MOU on **Wednesday 20th November 2019**, at Kathmandu Nepal; and has caused this agreement to be executed in duplicate by its duly authorized officer, and retains one each of the duplicate texts having equal authenticity.

For American Society of Nepalese Engineers (ASNEngr)

Dr. UPENDRA LAL KARNA, P. E.
President

For Society of Consulting Architectural & Engineering Firms, Nepal (SCAEF)

Ar. RAJESH THAPA
President

Seal:

Witness:

1. Ananta R Baidya

2.

1. Krishna Prasad Sapkota
General Secretary
SCAEF

2.

CONSULTING ENGINEERS ASSOCIATION OF INDIA
Creating Value Ethically for Engineers

COLLABORATION WITH NATIONAL AND INTERNATIONAL ORGANIZATIONS

MEMORANDUM OF UNDERSTANDING (MOU)

Between

CONSULTING ENGINEERS ASSOCIATION OF INDIA (CEAI)

and

SOCIETY OF CONSULTING ARCHITECTURAL AND ENGINEERING FIRMS (SCAEF), NEPAL

1. Purpose

1.1 The Consulting Engineers Association of India (hereinafter CEAI) and the Society of Consulting Architectural and Engineering firm, Nepal (hereinafter SCAEF) do hereby agree to cooperation and supplement each other's resources with a view to promoting development of the engineering industry of both countries in the new century.

2. Scope

2.1. Exchange of engineering information and materials
Engineering information produced in the form of papers, periodicals, books, non-proprietary reports and others engineering references shall be furnished when specially requested by either side. The scope of this exchange shall be mutually determined by participating collaborative staff.

2.2. Exchange of engineering personnel
CEAI will accept the engineering personnel of SCAEF when requested by SCAEF and when CEAI finds its possible to comply with proposal, and on the other hand, SCAEF shall likewise accept the engineering personnel of CEAI in the said fields.

2.3. Joint study and research activities
Study and research activities will be conducted jointly when the staff of each organization finds it mutually beneficial especially in the field of engineering. The subject and content of such activities will be discussed or reviewed in advance through joint consultations

2.4. Joint seminar and symposium
The two parties will hold joint seminar or symposium that furthers the industry's interests in both countries and encourage cross attendance or joint participation on such professional events.

2.5. Capacity Building Training
The parties will collaborate to enhance the capacity of its members through providing training by sharing knowledge and experience of each organisation or collaborate with each other to mobilise appropriate third party organisation as may be agreed from time to time between the parties.

CONSULTING ENGINEERS ASSOCIATION OF INDIA
Creating Value Ethically for Engineers

2.6. Firm level cooperation
CEAI and SCAEF encourage and promote their member firms to explore actively opportunities of contracting project jointly in India, Nepal and others markets; to build up business relations, exchange experience, improve understanding and enlarge cooperation; to promote mutual visits between firms.

2.7. Promotion of others cooperation
Activities to promote cooperation will be discussed and conducted jointly when the staff of each organization finds it mutually beneficial especially in the field of engineering.

3. Implementations

3.1 Joint standing cooperation committee (JSCC)
The two parties will constitute joint committees with equal members from two sides to promote greater understanding and deeper Cooperation and will hold joint meetings on mutual agreement.

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CONSULTING ENGINEERS ASSOCIATION OF INDIA
Creating Value Ethically for Engineers

IN WITNESS WHEREOF, each of the parties hereto has signed the MOU on **Wednesday 20th November 2019**, at Kathmandu Nepal; and has caused this agreement to be executed in duplicate by its duly authorized officer, and retains one each of the duplicate texts having equal authenticity.

For Consulting Engineers Association of India (CEAI)

Er. AMITABHA GHOSHAL
President

For Society of Consulting Architectural & Engineering Firms, Nepal (SCAEF)

Ar. RAJESH THAPA
President

Seal:

Witness:

1. Shankar Nath Rimal
Shankar Nath RIMAL

2.

1. Er. Krishna prasad Saphota
General Secretary
SCAEF

2.

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AAC Itta are non-combustible and fire -resistant up to 1200°C and up to 6 hours of direct exposure.

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The manufacturing process requires lower input, consumption of energy and raw materials and minimum waste generation. No pollutants or hazardous waste are generated during production.

FASTER CONSTRUCTION & WORKABILITY

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BUILD YOUR STRUCTURE WITHOUT DESTROYING THE ENVIROMENT

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Conference Glimpses

1. Inauguration Session

President and GS receiving Chief Guest of Inauguration Session Vice President

Welcome Dance in Opening Session

Welcome Dance in Opening Program

SCAEF General Secretary and Vice President with Former FIDIC Board Member K KKapila

Welcome by President Rajesh Thapa to Guest of inauguration Session

Cultural musical during inauguration Session

Participants of inauguration Program

Participants of inauguration Program

Participants of inauguration Program

Key Note Speech from Rt. Hon Dr. BabnuramBhattarai

Opening Remarks from Cheif Guest Vice President
Rt. Hon. Nanda BahadurPubn

Welcome Speech from SCAEF President Ar. Rajesh Thapa

Closing Remarks from NRA CEO as a
Chair of Opening Session

SCAEF EC and Past President with Chief Guests and
other Guests

SCAEF SecretariatRegistration

2. Technical Session

NPC Vice Chairman Dr. PuspaKandel Addressing Session

Technical Session 1 Challenges in Infrastructure Development Sector in Nepal

Technical Session 02- Business Networking and Regional Best Practices in Resilience

Technical Session 03- Indigenous, Innovative Technologies and Heritage Conservation

Investment on implementation of Resilient Infrastructure

NRA CEO Mr. SushilGyawali Chairing Technical Session

Participants of Technical Sessions

Key Note Speech in Session 01 KK Kapila Former FIDIC Board Member

Key Note Speech in Technical Session 02 DrMahendraSubba

Technical Presentation in Session 02

Key Note Speech in Session 03 from Dr. Sudharshan Raj Tiwari

Key Note Speech in Session 04 DrBinduNathLohani

Participants during Program

Participants during Program

3. Closing Session

Dignitaries on Dias during Closing session and SCAEF 29th Anniversary Celebration Program

MOU between SCAEF and American Society of Nepalese Engineers

MOU Between SCAEF and Consulting Engineers Association of India (CEAI)

SCAEF EC Committee Members and other officials

SCAEF and KMA Award Distribution to Young Architect and Civil Engineer

SCAEF PresidentWelcome Dignitaries

Welcome Speech from Conference Manager Thakur Prasad Sharma

Participants of Program

Mr. MahendraBahadurGurung Presented Resolution of Conference

Participants of Closing Session Program

NPC Member Hon. SuhilBhatta addressing Closing Session

Addressing from KMA Award Trustee Mrs. Tara Amatya

Token of Love to Supporting Partner from SCAEF Vice President

Closing Remarks from Chief Guest of Closing Session Er. Shankar NathRimal

ote of Thanks from SCAEF General Secretary and Conference Secretary Mr. Krishna Prasad Sapkota

Cultural Program during Closing Session

Dance Program from SCAEF officials at last

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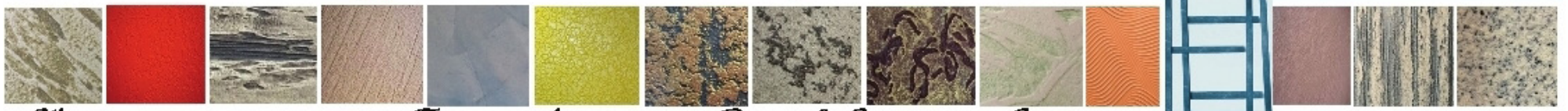

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Annexes

1. Presentation Slides

Third International Conference

'Resilient Infrastructure for Better Tomorrow'

Organized By NRA/SCAEF

November 18-20, 2019, Kathmandu, Nepal

Advanced Geotechical Considerations in Deep Foundation scheme for Resilient Infrastructure Development

Author/Presenter:

Dr. Upendra L. Karna, P.E.

President, U&S Engineers, P.C., NJ, USA

Outline

- INTRODUCTION
- DEEP FOUNDATION SCHEMES IN THE USA
  - Geotechnical and Relevant Considerations for Foundation Design
  - Standards and Accountability for Design and Construction
  - Advanced Geotechnical Considerations – Examples
- DEEP FOUNDATION SCHEMES IN NEPAL
  - Current Practice of Deep Foundations
  - Suitable Deep Foundation Scheme
  - Advantages of Using Advanced Technology
- CONCLUSIONS AND SUGGESTIONS
- QUESTIONS AND ANSWER

Introduction

- General understanding of deep foundation
- Standards and Accountability
- Advanced geotechnical consideration for deep foundation
- Deep foundation scheme in Nepal
- Current practices of deep foundation design and construction in Nepal

Deep Foundation Schemes in the USA

- Geotechnical and Relevant Considerations for Foundation Design
  - Hydrology and Hydraulics
  - Geotechnical
  - Structural

Deep Foundation Schemes in the USA (Cont.)

- Standards and Accountability for Design and Construction
  - Standards
    - ✓ Federal Regulations by Federal Agencies (AASHTO, FHWA, NHI, TRB etc.)
    - ✓ State Agencies
    - ✓ Local Agencies
    - ✓ Knowledge Updating

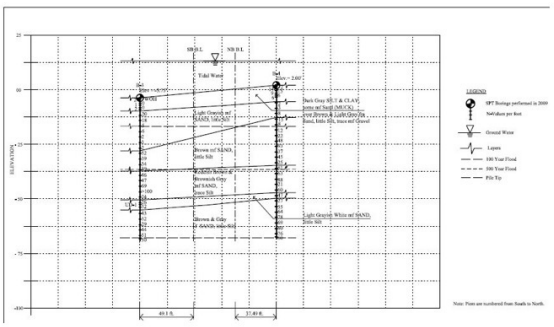
Deep Foundation Schemes in the USA (Cont.)

- Standards and Accountability for Design and Construction
  - Accountability
    - ✓ Professional Licensing
    - ✓ Professional Liability
    - ✓ Professional Ethics
    - ✓ Institutional Accountability

Deep Foundation Schemes in the USA (Cont.)

- Advanced Geotechnical Considerations
  - Pile Foundation
    - ✓ Design Consideration
    - ✓ Use of Advance Technology in Design and Construction
    - ✓ Examples

Deep Foundation Schemes in the USA (Cont.) - Pile Foundation



Third International Conference by NRA/SCAEF - 2019

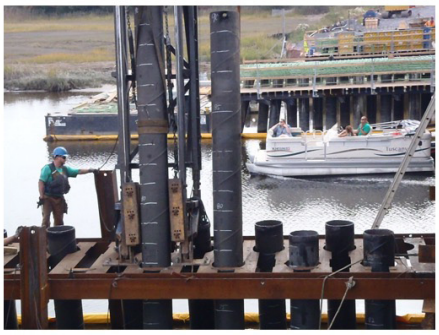
Deep Foundation Schemes in the USA (Cont.) – Pile Foundation

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.) – Pile Foundation

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.) – Pile Foundation



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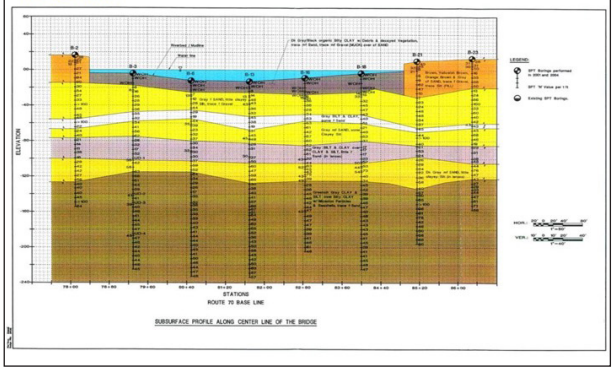
Deep Foundation Schemes in the USA (Cont.) – Pile Foundation-cohesive soil

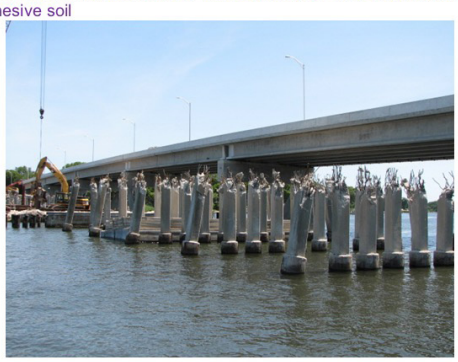
Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.) – Pile Foundation-cohesive soil



Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.) – Pile Foundation-cohesive soil



Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.)

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.) – Pile Foundation-cohesive

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.)

- Load Testing for Piles
  - Static
  - Dynamic
  - Stato-dynamic

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Pile Load Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Pile Load Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Pile Load Testing

Third International Conference by NRA/SCAEF - 2019

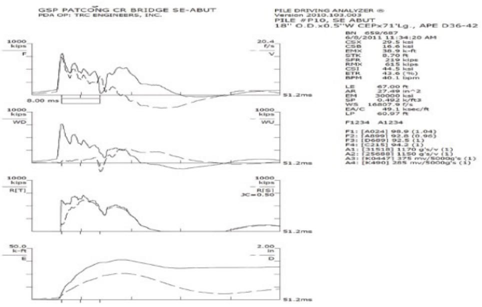
Deep Foundation Schemes – Pile Load Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Pile Load Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Pile Load Testing



Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Pile Load Testing

Mobilized Pile Capacity Data

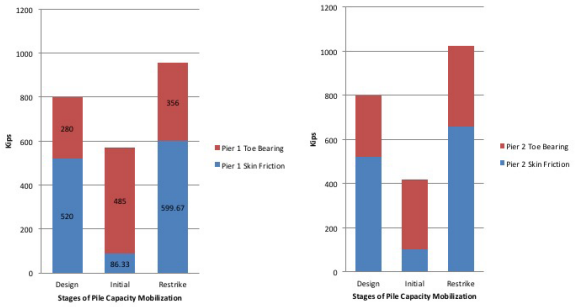
Structure	Pile Test #	Pile Penetration	Initial Drive			Restrike		
			Total	Skin Friction	Toe Bearing	Total	Skin Friction	Toe Bearing
PIER 1	P6	113.5	585	101	483	992	595	396
	P10	114	490	40	450	915	468	447
	P35	113.5	640	118	522	961	736	225
PIER 2	P5	119	420	93	327	915	339	576
	P19	119	326	110	218	1100	857	243
	P24	119	505	102	403	1053	773	280
PIER 3	P6	119	536	114	422	1215	789	426
	P10	119	640	188	452	1029	771	258
	P30	119	575	117	458	1140	637	503
PIER 4	P6	116	675	109	566	960	595	365
	P10	110	513	177	336	900	635	265
	P35	116	810	227	583			
PIER 5	P5	111	225	77	148	925	670	255
	P21	109	625	360	265	845	615	230
	P24	111	350	135	215	1095	728	367

Mobilized Pile Capacity Data

Note: Pile penetration in feet, pile capacity in Kips and design pile penetration 101 feet for 800 kips.

Deep Foundation Schemes – Pile Load Testing

Mobilized Pile Capacity



Deep Foundation Schemes – Pile Load Testing

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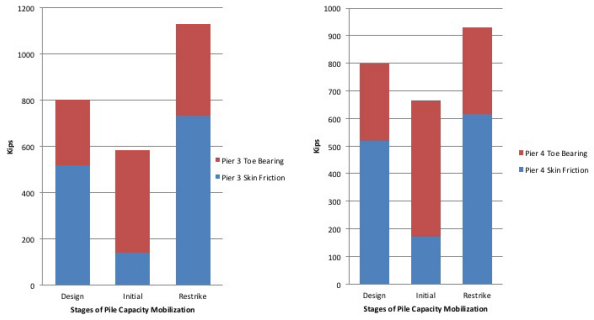

Deep Foundation Schemes – Pile Load Testing

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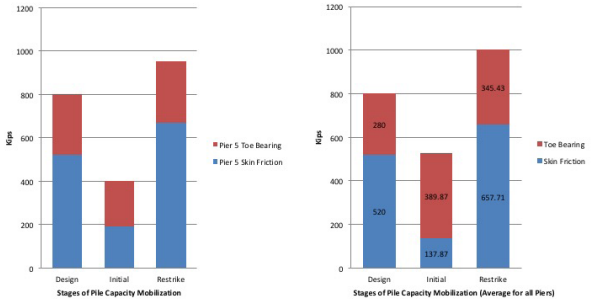
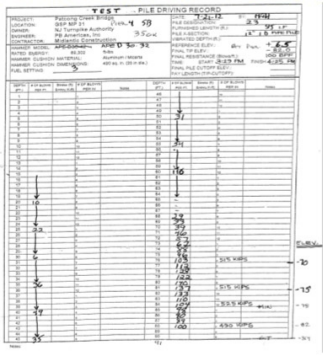


Deep Foundation Schemes – Pile Load Testing



Deep Foundation Schemes in the USA (Cont.)

- Production Pile Driving
  - Development of Pile Driving Criteria Based on Load Test Result

Deep Foundation Schemes in the USA (Cont.)

- Advanced Geotechnical Considerations
  - Drilled Shafts
    - ✓ Design Consideration
    - ✓ Use of Advance Technology in Design and Construction
    - ✓ Examples

Deep Foundation Schemes- Drilled Shafts

Deep Foundation Schemes- Drilled Shafts Construction

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Construction

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Construction

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Construction

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Construction

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Construction

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Deep Foundation Schemes in the USA (Cont.)

- Load Testing for Drilled Shafts
  - Static
  - O-Cell Test
  - CSL Test (Integrity Test)

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Deep Foundation Schemes- Drilled Shafts Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Testing

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Testing

Load Cell Test

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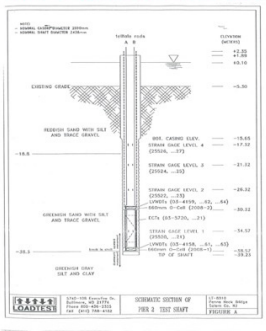
Deep Foundation Schemes in the USA (Cont.)

MULTI LEVEL TESTING STAGES



		STAGE		
		1	2	3
UPPER CELL	Max Q_{gross} (MN/Kips)	0	15.8/ 3552	16.2/ 3642
	O-Cell Hydraulics System	C	P	P
	Total Expansion (mm/inch)	-0.13/ 0.005	+10.97/ 0.43	+17.05/0.67
LOWER CELL	Max Q_{gross} (MN/Kips)	16.2/ 3642	0	0
	O-Cell Hydraulics System	P	C	D
	Total Expansion (mm/inch)	+44.68/ 1.76	+24.91/0. 98	+13.11/ 0.52

C-Closed, P-Pressurized, D-Draining

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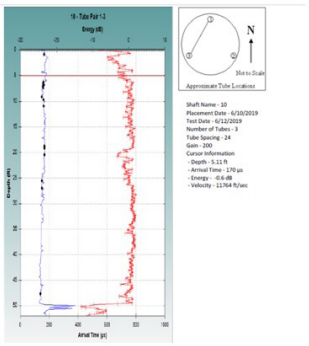
Deep Foundation Schemes- Drilled Shafts Testing-CSL

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Drilled Shafts Testing-CSL



CSL Test Result

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Deep Foundation Schemes in the USA (Cont.)

- Production Shaft
  - Development of Drilled Shaft Construction Criteria Based on Load Test Result

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Deep Foundation Schemes- Production Shafts

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.)

- Advanced Geotechnical Considerations
  - Bridge Approach
    - ✓ Embankments
    - ✓ Soil improvements
    - ✓ Retaining Wall Systems (MSE, Soil Nailing, RSS etc)

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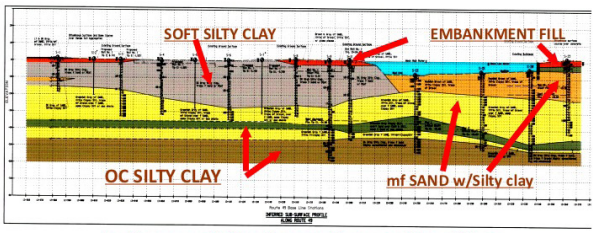
Deep Foundation Schemes - Approach

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes - Approach



Inferred Subsurface Profile

N.T.S

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Deep Foundation Schemes - Approach

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Wick Drain

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Wick Drain

Third International Conference by NRA/SCAEF - 2019

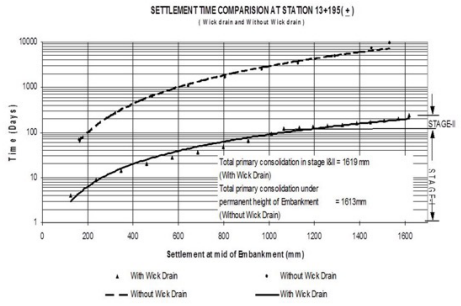
Deep Foundation Schemes – Approach Wick Drain

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Surcharge

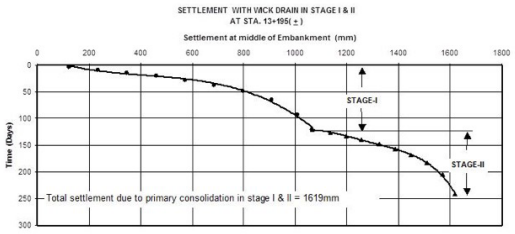
Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Settlements



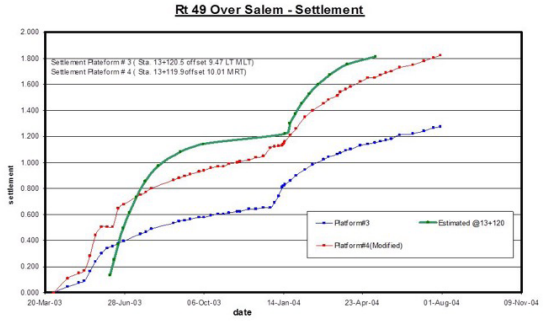
Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Settlements



Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Settlements



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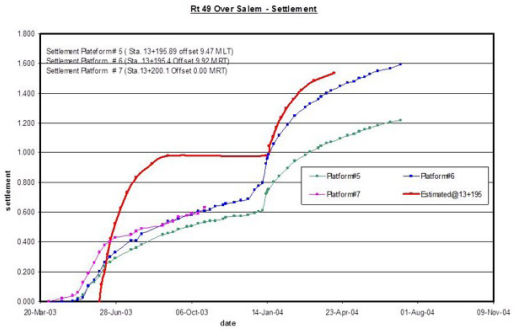
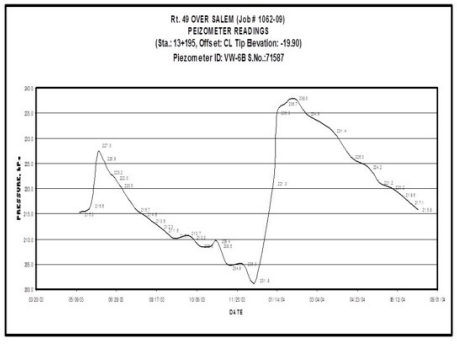
Deep Foundation Schemes – Approach Settlements



Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Settlements



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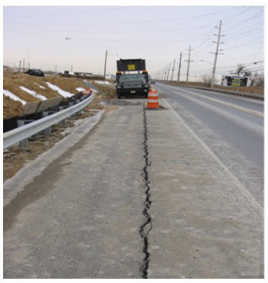
Deep Foundation Schemes in the USA (Cont.)



Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes – Approach Wall

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes in the USA (Cont.)

- Advanced Geotechnical Considerations
  - Integral Foundation
    - ✓ Design Consideration
    - ✓ Use of Advance Technology in Design and Construction
    - ✓ Benefits
    - ✓ Examples

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Deep Foundation Schemes – Integral Abutment

I-95 Scotch Road (Integral Abutment Design)

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Deep Foundation Schemes – Integral Abutment

Pile with Cushion Tie Back Wall

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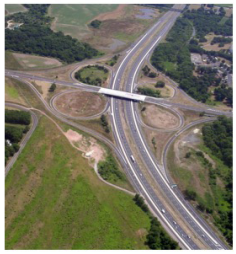
Deep Foundation Schemes – Integral Abutment



I-95 Road Bridge-Progress Br. Completed

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Deep Foundation Schemes in the USA (Cont.)

- Advanced Geotechnical Considerations
  - Special Foundation Design
    - ✓ Micro-piles
    - ✓ Deep soil improvement
    - ✓ Tie-backs
    - ✓ Retaining Wall Systems (MSE, Soil Nailing, RSS etc)

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Wall Tie backs

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Wall Tie backs

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- Wall Tie backs

Third International Conference by NRA/SCAEF - 2019

Deep Foundation Schemes- MSE Wall

Deep Foundation Schemes in Nepal

- Current Practice of Deep Foundations
  - CIP Piles, Caissons etc.
  - Design Standards
  - Design Considerations
    - ✓ Hydrology and Hydraulics
    - ✓ Geotechnical
    - ✓ Structural
  - Specifications

Deep Foundation Schemes in Nepal (Cont.)

- Suitable Deep Foundation Scheme
  - Piles Foundation
  - Drilled Shafts
  - Integral Foundation
  - Special Foundations

Deep Foundation Schemes in Nepal (Cont.)

- Advantages of Using Advanced Technology
  - Higher Loads and Earthquake Resistance
  - Schedule
  - Cost
  - Quality Assurance
  - Risk Reduction
  - Maintenance Cost
  - Life Cycle Cost

Conclusions and Suggestions

- Conclusions
  - Deep Foundations in the USA
  - Deep Foundations in Nepal
  - Advantages of Using Advanced Technology

Conclusions and Suggestions (Cont.)

- Suggestions
  - Develop design standards and specifications
  - Develop regulations for accountability
  - Enforce regulations and policies
  - Encourage local consultants, designers and contractors participation
  - Develop local skills and labor
  - Involve academia and industry for research
  - Develop framework of skill designers within government agencies
  - Engage diaspora participation
  - Develop partnership with neighboring countries as well as globally

DISCLAIMER

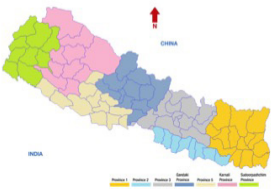
This presentation is based on the direct involvement of presenter as designer for various public transportation projects in the USA. The interpretation presented here in is purely understanding of the presenter and solely for the information purposes.

Investment Opportunities in Nepal

GOVERNMENT OF NEPAL
OFFICE OF THE INVESTMENT BOARD

PROFILE

2



Indicator (as of 2018/2019)		Significance
Population	29.49 Million	49th in World
Area	147,181 sq.km	93rd in World
GDP	US$ 30 Billion	
Economic Growth Rate	6.81%	Low income developing countries avg, 2018: 5%
Inflation	4.5%	Low income developing countries avg, 2018: 9%
Per Capita Income	US$ 1034	
Foreign Currency Reserves	US$ 9.08 Billion	Enough for 7.7 months import

Source : NRB Macroeconomic update & CBS National Accounts 2018/2019

PRIORITY, ASPIRATION AND REALITY

3

THE GOALS

become a middle income country by 2030

To achieve SDGs by 2030

THE REALITIES

Need to increase investment in Infrastructure development (Energy, Transport, Manufacturing etc)

Need to invest approximately NPR 2025 Billion YOY To achieve SDGs

Considering these facts and our aspirations, government realizes role and importance of FDI and therefore has brought up several policy and legal reforms to attract FDI in recent years.

PLANS AND PROGRAMS

4

TARGETS FOR THE NEXT DECADE

- **2,000KM** Railway
- **2,000KM** Paved Way
- **5** International Airports
- **15,000MW** Energy
- **5 Million** Tourists

5

WHY INVEST IN NEPAL

WHY INVEST IN NEPAL?

6

- Strategic Location between India and China
- **Land Linked Country**

DOING BUSINESS

- Improving business climate
- **Ranked 94th in Ease of Doing Business Ranking** by the World Bank

- **100% repatriation** allowed
- **75% of employees salary** also allowed for repatriation

- **National Treatment**
- **Non Discrimination**

- **Tourist, non-Tourist and business visa** for foreign workers on recommendation of investment approving agencies such as DOI, IBN
- **Residential visa** granted directly to investors who invest more than USD 1million in convertible currency

- Foreign investors are allowed to have **100% ownership in almost all sectors**
- **Land ownership** in company's name allowed

- Improved **Labor Relations**
- Implementation of Social Security Scheme

PROTECTION OF INVESTMENT

7

- Signing of Project Development Agreement **(PDA)** and Project Investment Agreement **(PIA)**
- Documents developed and signed as per the international best practices
- International bankability ensured
- Obligations of both developer and Government clearly spelt out
- Protection from change in law, non discrimination, non-nationalization, among others assured

TAX INCENTIVES

8

Corporate Tax Rates in Nepal

Nature of Entity	Tax rate
Normal rate for entities	25%
Manufacturing industries (which excludes tobacco, alcoholic beverages, etc.) are entitled to 20% discount on the applicable tax rate (currently 20%) making the effective tax rate 16% under Industrial Enterprise Act 2016	20%
Enterprises operating **roads, bridges, railways hydropower stations, transmission lines on BOOT** basis etc	20%
Banks and financial institutions	30%
General insurance 30%, life insurance 25%	25-30%
Enterprises involved in petroleum businesses	30%
Saving and credit cooperatives located in urban areas	20%

Nepal has one of the lowest **Corporate Income Tax (CIT)** rate amongst its neighboring countries

Country	CIT rate (%)
Bangladesh	27.5
China	25
India	22
Nepal	25
Pakistan	34
Sri Lanka	28

WINDOWS TO THE WORLD - AGREEMENTS/MARKET ACCESS

9

Members of Regional Agreements

Members of Multilateral Agreements

Multilateral Investment Guarantee Agency World Bank Group

WORLD TRADE ORGANIZATION

Market Access

BIPPA

- ✓ Finland
- ✓ France
- ✓ Germany
- ✓ Mauritius
- ✓ United Kingdom
- ✓ India – yet to be ratified

- ✓ Duty free and open border access to India (except some products)
- ✓ Duty free access to China for 8,000 + products
- ✓ Duty free, quota free market access to European Union under Everything But Arms (EBA) arrangements
- ✓ Duty free US market access to (77 products) 66 types of garment items for 10 years (starting from 2016) (GST facility market)

DTAA

- ✓ Austria
- ✓ Bangladesh
- ✓ China
- ✓ India
- ✓ Mauritius
- ✓ Norway
- ✓ Pakistan
- ✓ Qatar
- ✓ Sri Lanka
- ✓ South Korea
- ✓ Thailand

POLICIES WITH PREDICTABILITY

10

GUARANTEE TO THE PROPERTY RIGHTS

Article 25 (2) of the **Constitution says,**

"The State shall not, except for public interest, requisition, acquire, or otherwise create any encumbrance on, property of a person."

LEADING ROLE OF THE PRIVATE SECTOR

The directive principles of the state presented in Article 51 d (1) identifies *private sector as one of the three means of partnership for development.*

NEPAL WELCOMES AND NURTURES FOREIGN INVESTMENTS

Article 51 d (10) says,

"The policy of the state is to encourage foreign capital and technological investment in areas of import substitution and export promotion....."

POLICY & LEGAL REFORMS

11

- PPP AND INVESTMENT ACT
- FITTA
- SEZ ACT

- INTEGRATED INTELLECTUAL PROPERTY RIGHTS POLICY
- HEDGING POLICY

- INTELLECTUAL PROPERTY RIGHT
- COMPANY ACT
- INDUSTRIAL ENTERPRISE ACT
- LABOR ACT
- BAFIA AMENDMENT

- GUIDELINES FOR CONSTRUCTION FOR INDUSTRIAL INFRASTRUCTURES
- MINES AND MINERALS REGULATIONS
- LAND CEILING WAIVER
- FOREST LAND ACQUISITION

VISION: PROSPEROUS NEPAL, HAPPY NEPALI

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Investment Board Nepal

IBN – ORGANIZATIONAL ARRANGEMENT

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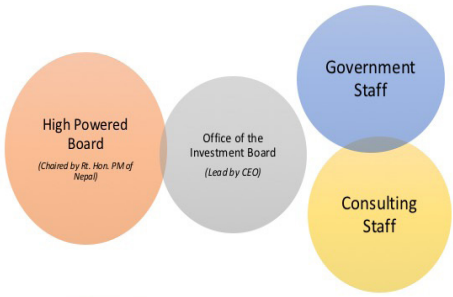

IBN MANDATES

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Government of Nepal

FDI Approval	Project Implementation
Project Cost > or equal to NPR 6 Billion	Project Capacity > 200 MW (In case of Energy Projects)
	Project Cost > or Equal to NPR 6 Billion (In case of Other Projects)

INVESTMENT BOARD NEPAL (IBN)

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PPP and Investment Act 2019

- Investment Promotion
- Project Development
- Investment Approval
- One-stop Service
- Stakeholders' Coordination
- Policy Advocacy

ONE STOP SERVICE : SERVICES

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Registrations

- Company Registration
- Permanent Account Number (PAN) Registration
- Industry Registration
- Central Bank Foreign Currency Record and Repatriation

Facilitation

- Work Permit/Non Tourist and Business Visa
- IEE/EIA
- Land and Ceiling Waiver
- Access Road/Bridges
- Transmission Line/Electricity
- Project Implementation/Coordination with Local Bodies
- Forest Land Clearance
- Customs Clearance (Machinery and Equipment Import)
- Project Security
- Explosives
- Fiscal and Non Fiscal Incentives
- Sectoral Licenses

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PROJECTS

18

LAND OF OPPORTUNITIES

- Energy
- Transportation
- Tourism
- Agriculture
- Manufacturing
- ICT
- Health
- Mines and Minerals
- Education
- Banking and Finance

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PROJECTS OPEN FOR INVESTMENT

Industrial Infrastructure

S.N	Name of the Project	Project Location/Province
1	Block B and C of SEZ Simara	Province 2
2	Industrial Park in Motipur Butwal	Province 5
3	Industrial Park in Naubasta Banke	Province 5

Tourism Infrastructure

S.N	Name of the Project	Project Location/Province
1	Dreamland Dhulikhel Project	Province 3
2	Film City in Dholakha	Province 3
3	Damauli Multipurpose Tourism Project	Gandaki Province
4	Dolakha Mountain Academy Project	Province 3
5	Shey-Phoksundo Luxury Resort	Karnali Province
6	Ski-Resort in Manang	Province 3
7	Gautam Buddha International Maternity Hospital Project	Province 5
8	Khaptad Integrated Tourism Project	Sudurpaschim Province

Education and Health Infrastructure

S.N	Name of the Project	Project Location/Province
1	Dhulikhel Medicity Project	Province 3
2	Gandaki Technical University Project	Gandaki Province
3	Education, Health and Sport City	Location not decided

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PROJECTS OPEN FOR INVESTMENT

Transport Infrastructure

S.N	Name of the Project	Project Location/Province
1	Kathmandu Valley Metro Rail Project	Province 3
2	Dhangadi Regional International Airport	Sudurpaschim Province
3	Biratnagar Regional International Airport	Province 1
4	BRT in in Ramgram - Tilaurakot Project	Province 5

Urban Infrastructure

S.N	Name of the Project	Project Location/Province
1	Intregrated Solid Waste Managment Project - Ratnanagar package	Province 3
2	Integrated Solid Waste Managment Project - Jitpur Simara package	Province 2
3	Smart City Project in Hetauda	Province 3

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EXECUTION OF AGREEMENT AND IMPLEMENTATION OF THE PROJECT

- MOU with the Developer
- Investment approval
- Incorporation of a company
- Performance security
- Environmental studies: EIA/IEE
- Formation of PMU
- Termination in the case of non achievement of milestones

Handover of the Project (PPP modality)

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THANK YOU

Contact:
Office of the Investment Board
ICC Complex, New Baneshwor
Kathmandu, Nepal
Phone:977-1-4475277
Fax:977-1-4475281
Email: info@ibn.gov.np

SOCIETY OF CONSULTING ARCHITECTURAL AND ENGINEERING FIRMS (SCAEF) AND NATIONAL RECONSTRUCTION AUTHORITY (NRA)

3rd International Conference on

Resilient Infrastructure for a Better Tomorrow"

18-20 November 2019

RESOLUTIONS

Presented by
Er. Mahendra Bahadur Gurung
On behalf of the Resolution Committee
Wednesday, 20 November 2019

ABOUT THE CONFERENCE

- Three-Day International Conference on title "Resilient Infrastructure for a Better Tomorrow" was held in Kathmandu on 18-20 November 2019.
- It was jointly organized by NRA and SCAEF with FCAN and NSET as Co-organizers and 12 other Organizations as Knowledge Partners.
- The participants included 30 international representatives from 10 countries and associations.
- More than 200 participants from Nepal.

2

RESOLUTION COMMITTEE

S. No.	Name	Designation
1.	Er. Bal Sunder Malla	Coordinator
2.	Ar. Kishore Thapa	Member
3.	Prof. Dr. Triratna Bajracharya	Member
4.	Er. Mahendra Bahadur Gurung	Member
5.	Er. Birendra Raj Pandey	Member
6.	Ar. Anju Malla	Member

3

TABLE OF CONTENTS

4

INTRODUCTION

Total no. of Sessions: 5

- **Session 1: Inaugural Session:**
  1 keynote paper presentation
- **Session 2: Challenges in Infrastructure Development in Nepal;**
  1 keynote and 5 papers
- **Session 3: Business Networking / Regional Best Practices in Resilience;**
  1 keynote and 5 papers
- **Session 4: Indigenous / Innovative Technologies and Heritage Conservation;**
  1 keynote and 5 papers
- **Session 5: Investment on and Implementation of Resilient Initiatives;**
  1 keynote and 5 papers

Total papers: 26

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DEFINITION

The term **Resilient** means:

- To be able to absorb shocks and get back to original position
- To be better able to deliver the services during and after natural shocks

6

Three quotes from the inaugural speech of Rt. Hon'ble Vice President Nanda Bahadur Pun

- *"If the assigned works are completed quicker the country will progress quicker, if delayed the country will fall behind."*
- *"We should keep in mind about what state of country we will handover to our next generation."*
- *"Engineers' role must make sure that there is no space for compromise within the broader agreement of an undertaking."*

WHERE WE ARE?

The challenge is associated with Nepal's current status in global ranking:

- Nepal ranks among top risk countries
  - 4th in terms of climate risk
  - 11th in terms of global risk for earthquake occurrence
  - In the top 20 as multi-hazard country in the world
- Nepal ranks among lowest performing countries (in 141),
  - 112th in global infrastructure index (GII score of 52/100)
  - 101st in road connectivity and 120th in quality of road
  - 101st in electricity access and 119th in electricity supply quality
  - 122nd in supply of quality water and 125th in reliability of water supply
  - 109th in ICT

Challenges

- In the last 60 years, in terms of per capita income, China, India, Korea and Malaysia took a leap by US$ 7,500, US$ 1,800, US$ 25,800 and US$ 10,700, where as Nepal frog-leaped from US$ 269 to US$ 812, a mere increase of US$ 512 (Bhattarai BR).
  To catch up with the global economic pace in the next 20 years is the biggest challenge.
- **Policy challenges:** Asymmetry in the perspectives of the policy makers over the cost of resilient infrastructures and the benefits of such investments.
- **The question of design, construction and operation:** infrastructure systems are insufficient to meet demand
- **Inadequate data and skilled manpower:** Data available are inadequate and skilled manpower are brain-draining

Challenges

- **Financial constraints:** Building resilient structure would involve increase in the cost which will add to the financing challenge
- The approach of contracting out on the basis of 'lowest cost' and not the 'lowest rate'
- Government policy is not consistent, honest and fair to the private sector; and not conducive enough
- Huge resource and capacity gap. How to generate an aggressive investment?
  - For transport sector, the five year requirement is around US$ 1.70 trn., the available is only US$ 886 bn.

Challenges

- Donor driven approach is still dominating
- The mistaken mindset that we lack capacity and must rely on external engineering consulting and construction firms
- Too much and too less of water / seasonal variation
- Disjointed institutional arrangements and not compatible to federal setup
- National water policies and updation of acts, strategy and plan are badly lacking
- Policy inconsistency with the change of government

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Resilience in Practice

- People live in hazard prone area like the land having steep slopes and the flood plains which account for huge damage during natural disaster.
- Municipalities are dumping wastes in the river banks and thus shrinking the natural waterway and adding pollution
- Resilient spatial planning and growth management should include basic principles such as inclusivity, green asset and technology, efficiency, resilience and sustainability
- The 2015 Gorkha Earthquake caused an estimated loss of NPR 132 billion in private sector.

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Resilience in Practice

- PPP for Earthquake Risk Management (3P-ERM) appears to work effective with role of corporate business sector (@ one per cent of their annual profit)
- Let all the employers comply with National Building Code (NBC) and Disaster Risk Management (DRM) Act 2017 (Clause 20 and 21).
- Historic core cities are to be rebuilt and conserved with the earthquake emergency urban regeneration plan.
- Regional cooperation on climate change adaptation and mitigation.

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Innovative Technology and Heritage Conservation

- It is highly important to document lessons learned by the USAID's Nepal Reconstruction Engineering Services Project (NRES) through the Project "Build back Safer" in health and educational facilities.
- The Post Disaster Recovery Framework 2016 needs to be followed to construct resilient building structures
- Walkability is useful in creating resilient urban mobility.
- Pedestrianization is the basis of sustainable mobility, helps in social harmonization of communities and helps in reducing air pollution thus enhancing

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Innovative Technology and Heritage Conservation

- Innovative tools and instruments for safeguarding the traditional construction materials and technology providing better solution for earthquake safety measures. Such as intelligent ultrasonic device to assess damage, 3D Panel technology.
- Pedestrianization of core cities for sustainable urban mobility, social harmony to enhance the public health.
- In-depth knowledge is essential for indigenous materials and technologies to be retained and patented.
- Careful in depth study and adoption of indigenous materials and technology in heritage conservation should be mandatory with more research done to prove the authenticity and practicality of it.
- Proper technology transfer is desirable to minimize the huge economic loss due to natural disaster worldwide.

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Investment Needs

- In South Asian region, 2-7 per cent of national GDP is allocated for climate resilience, whereas less than 1 per cent is being allocated in Nepal.
- Financial Tools and instruments for project financing have not been utilized in Nepal.
- Around 30 per cent of the project budget is being lost in the course of financial management procedures.
- PPP practice in Nepal is still in rudimentary stage and no framework is available for blended financing and risk sharing.
- Harmonization of investment among the three tiers of the government in federal set up.
- Investment Board Nepal is promoting foreign direct investment in project development and investment
- Investment in preventive solution gives twenty times in return.

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Recommendations for Better Tomorrow

- Ensure adequate resources to national priority projects so as to complete them on time and with quality
- Create a conducive policy environment to promote national consultancy industry to grow
- Allocate a budget equivalent to around 10 per cent of the national budget to enhance resilient infrastructure
- The corporate organizations exhibit their social responsibility by allocating at least 1 per cent of their income as CSR Fund for support to resilient infrastructure development

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Recommendations for Better Tomorrow

- Relationship is that one per cent growth in the stock of infrastructure is often associated with the same one per cent per capita GDP growth.
- Designs for more resilient infrastructures in transport, power, water supply, etc would need an incremental cost of around 3 per cent.
- Investment required for building resilience, adaptive and mitigating capacity, strengthening climate data, M&E and climate-proofing technology etc would be around another 2 per cent.
- On the other hand, one rupee (one dollar) invested in resilience gives about NRs 4 (four dollar) equivalent of benefit.

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Recommendations for Better Tomorrow

- Invest in regulations and planning in the early stages of project design to include resilience measures which will considerably outweigh the costs of repairs and/ or reconstruction after a disaster hits the system.
- Retrofitting, federalization and documentation are the measures of resilience for the earthquake affected buildings.
- Set aside around 10 per cent of total investment on road infrastructure for road safety.
- Translate the 'donor driven' funding apprach into the 'owner driven' funding approach

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Resolutions

- Ensure adequate resources for resilient infrastructure of national importance.
- Create conducive environment to promote national consulting industry to grow by promulgating Consulting Service Development Act.
- Contracts for construction and consultancy shall be based on 'workable rates' rather than the lowest bid amount and the principles of fair play shall be adopted.
- The corporate organizations shall exhibit their social responsibility by allocating at least one per cent of their income as Corporate Social Responsibility (CSR) Fund for supporting resilient infrastructure

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Resolutions

- Consider the needs of economically and socially vulnerable communities during project planning and implementation.
- Adopt comprehensive approach in planning, financing and engineering in developing resilient infrastructure by engaging all the stakeholders.
- Ensure adequate investment in producing and retaining skilled human resources within the country.
- Promote domestic consulting firms and construction companies by ensuring their participation in large projects

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Resolutions

- Enhance institutional memory of the knowledge and experience gained by NRA from the Gorkha Earthquake 2015 and set up a framework for sharing and disseminating of the same.
- Adequate resources shall be allocated for further research and development (R&D) of resilient infrastructure.
- Infrastructure development projects shall be planned and executed in the context of local environment, economic and socio-cultural perspectives.
- Create conducive environment for foreign direct investment (FDI), multi-national companies (MNC) and public-private partnership (PPP) by fiscal and legal reforms.

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Resolutions

- Allocate adequate resources for climate change adaptation and mitigation and consider regional effects in planning and implementation of resilient infrastructures
- Formulate policies and implement ground water recharge scheme immediately in Kathmandu valley
- Ensure adequate resources for cultural heritage conservation
- Ensure public safety to all including comfortable accessibility to differently-abled and elderly citizens.

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Thank You

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