



Gaining Momentum of Consulting Industry in New Normal

SCAEF MIRROR

7th Edition, 2021

ENVIRONMENT SENSITIVE

INNOVATIVE APPROACH

NEW PERSPECTIVE

THE OTHER WAY

**GAINING MOMENTUM OF
CONSULTING INDUSTRY IN
NEW NORMAL**

Society of Consulting Architectural & Engineering Firms (SCAEF)

सोसाईटी अफ कन्सल्टीङ्ग आर्किटेक्चरल एण्ड इन्जिनियरिङ्ग फर्मस्





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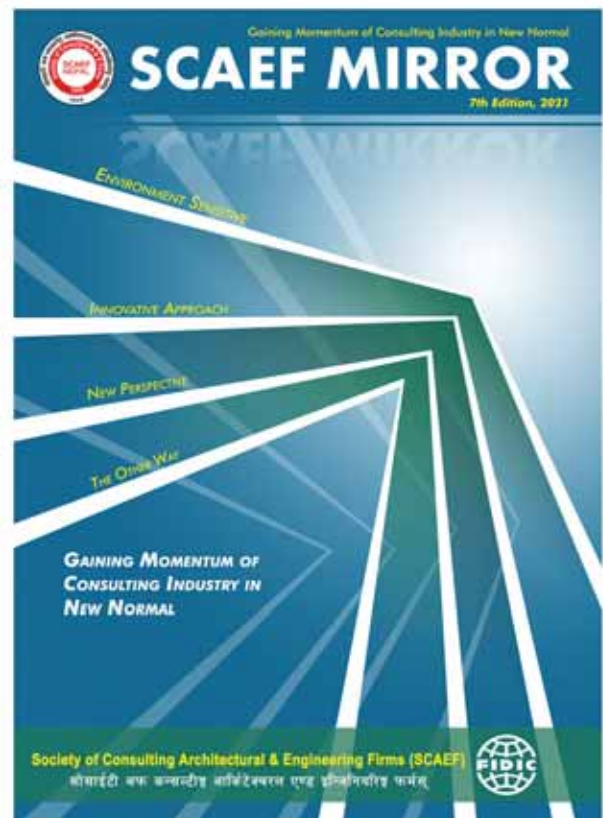
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Email: business@aacitta.com

Website: www.aacitta.com

Contact: 01-4421166, 977 9801042222



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The cover design is simply a graphical representation of this edition's theme "Gaining Momentum of Consulting Industry in New Normal" where the bright light signifying "The New Normal" that we want to achieve is acquired by various new ways like being environment sensitive, using Innovative approach, seeing things in new perspective, trying the other ways wherever required, etc. These various new ways are represented by repetitive arrow lines headed with green color, representing growth and renewal, that creates momentum towards the bright new normal.

Ar. Rakesh Maharjan
(Member-Publication Committee)

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Er. Ram Bahadur Shrestha



Er. Kichah Chitrakar



Er. Anish Joshi



Ar. Rakesh Maharjan



Er. Sudeep Adhikari



Er. Kiran Acharya

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Ms. Seena Bajracharya



Mr. Laxman Adhikari

Editorial Team

Er. Ram Bahadur Shrestha
Er. Kichah Chitrakar
Er. Anish Joshi
Ar. Rakesh Maharjan
Er. Sudeep Adhikari
Er. Kiran Acharya

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Chief Editor
Co-Editor
Co-Editor
Co-Editor
Co-Editor

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Advisor
Chairman
Co-ordinator
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Member
Member
Member
Member
Member

SCAEF Office Support

Ms. Seena Bajracharya
Mr. Laxman Adhikari

Published by

Society of Consulting Architectural & Engineering Firms (SCAEF)
Shankhamul, Kathmandu, Nepal
Tel: +977-1-5242952
Email: scaefnepal@gmail.com/scafenepal@gmail.com
Website: www.scaef.org.np

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Kathmandu
Tel: 9851033967



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Message From President

It is my immense pleasure to note that the **Publication Sub-Committee** of the Society of Consulting Architectural and Engineering Firms (SCAEF), Nepal is going to publish **SCAEF Mirror**. The publication includes articles as well as highlights of the activities of the SCAEF Nepal during the current term of the 16th Executive Committee. I believe the publication will serve as a souvenir to all SCAEF member firms and its well-wishers.

During the current term of the Executive Committee, the consulting industry had suffered due to lock downs and slack in the architectural and engineering consulting business caused by the novel coronavirus pandemic. Apart from business contraction, many of the staffs, experts and managers of the member firms had contracted COVID-19 and some of us had painfully underwent treatment. It was our misfortune to lose some of our engineers and architects due to this severe pandemic. With more awareness and vaccination, I believe most of us are better immunized to resume the normal consulting activities. The balance sheets of the member firms that may have been in negative territory during the last two years will hopefully be recovered well in the coming year. We are pleased to note that some of our member firms have already recovered the business as indicated by their financial performance during the last fiscal year.

I wish to congratulate the energetic and hard-working team of the Publication Sub-Committee to bring this issue even under such a difficult point of time. I hope this will serve as an important archive to all of us to refresh the SCAEF's activities.

Wish for a very happy new year 2022

Tuk Lal Adhikari

President, SCAEF

14 December 2021.





Editorial

Society of Consulting Architectural & Engineering Firms (SCAEF) would like to express our sincere gratitude to you for loving our periodic publication "SCAEF MIRROR". Here is one another issue after the pandemic, themed as “Gaining Momentum of Consulting Industry in New Normal”. It is to bring the prominent issues in professional discourse that our industry has been facing on the backdrop of Covid-19 and its impacts.

We will be launching both the physical book and electronic version of this 7th edition of SCAEF MIRROR for our valued readers all around the globe. The publication is receiving ISBN (International Standard Book Number) as well from this issue which helps identify our publication in future as well.

This 7th edition of SCAEF Mirror as usual covers a bit of SCAEF activities, short details of its member firms and more articles related to engineering and development. Despite of efforts, it seems hard to balance the gender and as a new comer or as a space for new people in consulting industry as well, one female writer is introduced. An innovative section been also introduced as well from this issue with an article on “Bio-hydrogen: A possibility of alternative cooking fuel”.

Again as a new feature, We communicated with the number of professional societies related to the consulting industry, requesting to send their views on the topic “how the professional societies and their think tanks can put on a collaborative effort in the new normal?” but able to get feedback from NGS only and from SONA as their article on successful project of a smart public toilet has been received. Need to do further on coming editions which may tie the linkages between professional societies further strong.

As SCAEF has already crossed its three decades of service to the consulting industry and the national development, it now has its own legacy. It has been tried to put in a black and white form through this edition with a section "SCAEF's LEGACY-Message to New Generation", in which we tried to deliver our past leaders message to our future leaders. Hope the section will bring positive impact on days to come and will be continued by future editors of SCAEF Mirror as well.

The Middle Portion of the Publication has featured articles from prominent architects, engineers and academicians who have served the community in various positions within the nation and outside the country. On behalf of SCAEF 16th Executive Committee, I hereby would like to tender our heartfelt thankfulness to all the Past Presidents, authors and advertisers for their interest, time and contribution which made this edition a reality.

The 1st article titled “SCAEF and New Normal Challenges in Consulting Sector” by Dr. Mr. Hare Ram Shrestha succinctly outlines the prominent issues (with a major focus on industry-specific policies and practices) that the consulting industry has been facing since the inception of SCAEF, with additional commentary on the changed professional environment under the effect of new pandemic-associated stressors. The 2nd article titled “Safeguards approaches that can help the consulting industry perform efficiently in the ‘New Normal’ “by Mr. Yogesh Shakya provides a comprehensive overview of the very pivotal significance of the assimilation of professional/occupational safeguard practices by the consulting industry amidst the pandemic. The 3rd article titled “Kathmandu Metropolitan City: Path towards Mitigation and Adaptation to Climate Change “by Mr. Saroj Basnet provides a very succinct exposition on the importance of building a climate-resilient urban environment, and the various studies/programs that will be significant to achieve the objective in the particular context of Kathmandu Valley. Moving further the 4th article titled “नेपालमा DPR को सस्तो लोकप्रीयता र विग्रेको विकासको जग” by Mr. Krishna Sapkota discusses the rampant culture of Studies of infrastructure projects, but lacking a holistic coordination between interlinked sub-disciplines,



thus rendering the overall quality of the studies sub-standard. The 5th article “Urban Transport - Contemporary Issues and Way Forward” by Mr. Prem Lamsal conveys a very clear message that only the coordinated action between the right policies and appropriate design methodologies can result in the development of a sustainable transportation system. The 6th article “QAQC in Infrastructure Projects, Issues & Challenges” by Mr. Jagdiswar Man Shrestha provides a very comprehensive outlook on the significance of technical quality control for the development of sustainable civil infrastructures.

The 7th article “Road Safety Audit and paradigm shift towards safer roads design in Nepal” by Mr. Subhash Dhungel and Mr. Hemant Tiwari discusses the immediate necessity of revising the relevant policies bringing in a major focus on road-safety, and also the significance of implementing the road-safety audits. The 8th article “Water Footprint Assessment: why and how?” by Mr. Ashok Kumar Chapagain discusses how, apart from being a mere quantitative technique, Water Footprint Assessment can also be used as a powerful advocacy tool that can support decision-making and policy processes and help mitigate water-related business risk. The 9th article titled “Unmasking disaster impact with Resilience: A path to prosperity” by Mr. Shaligram Pokharel discusses how the culture of resilience can be realized in different businesses with due regard to quality at its different level of deliverables.

In The 10th article “Road pavement options for Nepal: Bitumen or Cement ?” Mr. Rajendra Sharma has provided a comparative discussion between the Bitumen and Cement Road pavements, followed by his brilliant exposition about the technical and economic advantages of Cement Road Pavements over bitumen pavements on the long run. The 11th article “Hydrological Uncertainties in Design of Hydraulic Structures in Nepal” by Mr. Bhesh Raj Thapa and Mr. Anil Aryal expounds inherent uncertainties associated with hydrological studies and its further implication on the safer engineering design of associated hydraulic structures.

The 12th article “A short Discussion on the Bond Behavior of Deformed Steel Bar and Fiber Reinforced Polymer (FRP)” by Mr. Dr. Sudeep Adhikari provides a succinct comparison between the bond behavior of steel rebar and FRP bar with concrete, and its associated implications on the design of civil infrastructures. The 13th Article “From Hunter to Explorer” by DN Gongal could be considered as a result of closest outlook to the Nepali Consulting Industry with an experience of more than half century and the 16th article from Mr. Shanker Dhakal and Surat K. Bam is a bit longer and academic type but is a useful approach for design and development of water supply projects for we consultants.

Last but not the least,

Undoubtedly, the issues raised and suggestions furnished by our pioneers/brilliant past presidents as kind response to our two queries on "How has SCAEF been changed/evolved" and "What SCAEF should do to gain the momentum on new normal" are the our dire need of the day. it should be bottom line for SCAEF's annual Plans and Programs from coming year onwards.

Upgrading ceiling of 500M from 100M in International Biddings, punish & reward system to member firms, consultancy development act, SCAEF's Vision Paper, Need to speak in National interests, Revitalization of SCAEF brochure, ability of taking together both the tiers of SCAEF that is, Professional Development & Business Development, ethics integrity and safeguard of cultural aspects etc. are the very sharp agenda for SCAEF today. Upcoming SCAEF Executive Committees success and failure and in totality the sustainability of SCAEF is largely going to be depend on successful implementation of these agenda.

Thank You!

On Behalf of all the Editorial Team



.....
Kichah Chitrakar
Chief Editor



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निरन्तर सेवा निर्धक्क साथ



PROJECT MANAGEMENT

- ▶ PROFESSIONAL LIABILITY
- ▶ ERECTION ALL RISKS
- ▶ CONTRACTOR'S ALL RISKS



MOTOR
INSURANCE



PROPERTY
AND HOUSE
INSURANCE



MARINE
INSURANCE



CATTLE
AND CROPS
INSURANCE



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SCAEF Activities 2020 – 2021 (The Covid -19 Years)



Kichah Chitrakar
Jt. Secretary (SCAEF)
E-mail: info@de-fortnp.com

Just few days before the beginning of the two year teanureship of the 16th Executive Committee in January 2020, we celebrated the 30th Annual General Meeting physically fearless of the fact that COVID-19 has already whispered in few countries and it might hit Nepal soon. The AGBM gave mandate to the team of Er. Mr. Tuk Lal Adhikari (ITECO Nepal P. Ltd.) silently to face the extraordinary period of SCAEF’s history amidst the forthcoming pandemic.

It was fortunate enough that the 16th executive committee consisted of new and dynamic team, It has succeeded to perform much more and even during the pandemic when everything was halted but not the SCAEF activities. It went on, facing all the challenges, moving consistently till the end of year 2021.

Here are the some of the news/highlights of the SCAEF activities in the year 2020 / 2021;

Strengthening the SCAEF Office

SOP

In the very beginning the 16th Executive Committee felt that Standard Operating Procedure (SOP) is a must in order to make its activities in a streamlined and coherent manner. In the initiation of VP Mr. Thakur Prasad Sharma, SOP was drafted by the Communication and Publication Sub-committee and adopted by the Executive Committee.

Secretariat Staff/ CEO

EC called for the vacant position of Office Secretary with the initiation of Joint Secretary Mr. Kichah Chitrakar; who made criteria for short listing as well. There were 49 nos. of applicants who dropped their CV to SCAEF and among themselves taken interviews and recruited in August 2020. A Sub-Committee to screen and recruit the CEO for the Organization has been fomed as well.

Chapter extension to Provincial Level & Constitution Amendment draft

As the Country already in the federal system where the necessary changes were due in the existing constitution and there is increasing demand from consulting firms outside Kathmandu valley for the extension of SCAEF chapters, “Institutional Development & Membership Sub-Committee” prepared “Guideline” and TOR. Er. Kichah Chitrakar took the initiative for preparation through “National and International Relationship Development/ Business Development Sub-Committee” to extend the SCAEF Chapters in Provincial Level as soon as possible. A special Annual General Meeting has been called to amend the constitution which includes other necessary amendments as well.

FIDIC Involvement

FIDIC ASPAC General Assembly Meeting (GAM 2020) has been attended by president, IPP and other EC members. The EC has put few important queries via zoom. EC has also attended FIDIC Directors & Secretaries (D&S) and Presidents meeting 2020 . The 16th EC has actively participated in FIDIC COVID-19 Webinar Series - A pandemic that changed the world - lessons to be learned by the global infrastructure sector.

Member Firm Survey

SCAEF has conducted two member firm surveys during the lockdown and after lockdown regarding the COVID-19 and its impact in a new normal to the member firms on the co-rdination of Er. Narayan Hari Rijal.

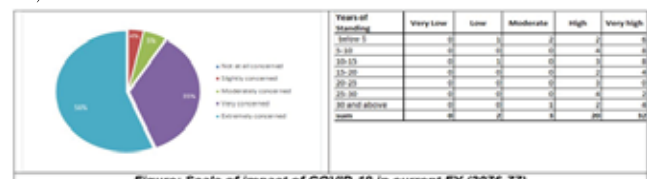
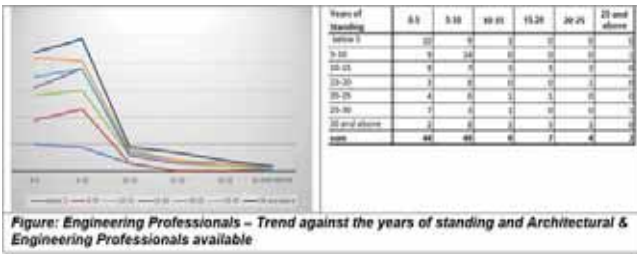


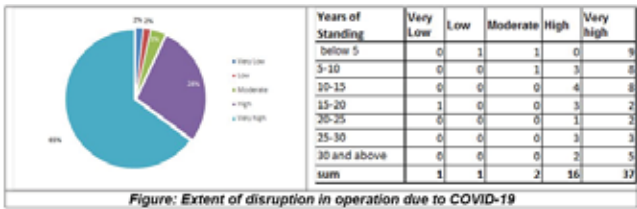
Figure: Scale of impact of COVID-19 in current FY (2076-77)



Various Suggestions received from SCAEF Member Firms on “Impact of Coronavirus on their Projects”. Analyzing the data, the results have been circulated to all.



SCAEF has also submitted Suggestion Paper to the central & provincial ministry with the attachment copy of “Description of Impacts and Suggestion of solutions to minimize the impact” from SCAEF as “Impact of COVID-19 and Lockdown to Consulting Industry”.



SCAEF EC also prepared and shared the copy of Public Appeal (on 16 April 2020) related to “COVID-19 and its Impact to all the people of Nepal in Public.

Talk Program on “Water Footprint: How Water Management is Not a Local Issue ?”

SCAEF Nepal organized a “Talk Program” jointly with Department of Water Resource and Irrigation (DoWRI) on 13th February 2020, in the topic “Water Footprint: How water management is not a local issue!” The topic paper was presented by Dr. Ashok K. Chapagain, (Senior Professor: Agricultural Economics, Faculty: Natural and agricultural Sciences, University of Free State, South Africa).

जलस्रोत तथा सिंचाइ विभाग (DOWRI) र सोसाइटी अफ कन्सल्टीङ्ग अकिटिवरल एण्ड इन्जिनियरिङ्ग फर्मस्, नेपाल (SCAEF, Nepal) को संयुक्त आयोजनामा प्रस्तुतिकरण र अन्तरकृया कार्यक्रम

WATER FOOTPRINT: HOW WATER MANAGEMENT IS NOT A LOCAL ISSUE?

प्रस्तोता : वरिष्ठ प्राध्यापक डा. अशोक कुमार चापगाई

मिति : २०७६ फागुन १ गते विहिवार
समय : अपरान्ह ४:०० बजे
स्थान : जलस्रोत तथा सिंचाइ विभागको सभाकक्ष

Discussion meeting with FCAN on the Draft Copy of PPA Amendment 2077 has been held in 2077/02/27 at 2:00 PM in FCAN Secretariat, Anamnagar, Kathmandu. General Secretary Mr. Prakash Adhikaree & Member Mr. Shrawan Kumar Thapa joined the meeting on behalf of the SCAEF.

Second Amendment of Public Procurement Act 2077

“Public Procurement (Second Revision) Act, 2077” tabled by the Government of Nepal in the Parliament. The EC prepared the feedback & suggestion paper on “Second Amendment of Public Procurement Act 2077” in the form of “3 Mahale Format” with its Clauses/ Sub-Clauses related to Consulting & Construction Industry; and submitted to PPMO and other respective authorities.

Webinar on “COVID-19: Ways Forward for Nepali Consulting Industry”

SCAEF 16th EC organized the Webinar on the topic in 10th June 2020 using Google Meet platform. Vice President Er. Thakur P Sharma, presented a paper on the situation after COVID-19 and ways forward. Comments were made by Ar. Rajesh Thapa (Immediate Past President), Dr. Hare Ram Shrestha (Past President), Ar. Baburam Baral and Er. Bijaya Thapa. The discussion focused on the paradigm shift in the technology used and way of consulting business in future. Er. Tuk Lal Adhikari, president of SCAEF Nepal concluded the webinar. The moderator of the event was Er. Narayan Hari Rijal,

PRESENTS A WEBINAR ON
COVID-19: WAYS FORWARD FOR NEPALI CONSULTING INDUSTRY

DATE: WEDNESDAY, 10th June 2020
TIME: 11:00-14:00 (NPT)

Meet [zoom-gov.com](#) [f](#) LIVE Society of Consulting Architectural and Engineering Firms, Nepal

Training on “Road Design using SMART Road Software”

SCAEF has organized The “Road Design Software Training” through online training models, which was conducted by Smart CAD Academy using Smart Road Software in mid-March and there were abundant participants from the member firms for this training. Er.



Narayan Hari Rijal, coordinator of PDCB Sub-Committee, coordinated this event.

Congratulations and Farewell program to Mr. Krishna Prasad Sapkota

Vice President of SCAEF Mr. Krishna Prasad Sapkota has been appointed as an Executive Director of prestigious organization Town Development Fund (TDF) effective from 28th July 2020. SCAEF EC unanimously made a resolution to express best wishes to him for his successful tenure and organized a felicitation cum farewell program.



Webinar on “Urban Hydrology and Urban Drainage Design: Key Considerations”

SCAEF EC organized the Webinar on the said topic on 31st July 2020. Prof. Knut Alfredsen (Norwegian University of Science and Technology, Norway) presented on Urban hydrology and stormwater management- some Norwegian experiences and focused on what could be done in short term and long term perspectives regarding urban water management. Similarly, Professor Binaya Kumar Mishra (Pokhara University, School of Engineering, Nepal) presented on Sustainable Urban Storm water Runoff Modeling and Management and focused on appropriate policy intervention for better urban drainage design and construction.



Webinar on “Short-Term and Long-Term Impacts of COVID-19 in Nepali Consulting Industry: How to Tackle It?”

SCAEF EC organized the Webinar on the topic among the member firms on 6th September 2020. The discussion was made on the contemporary issues faced by the Nepali consulting industry and interaction among the member firms in a new normal situation. Around 40 participants attended the event in which Past Presidents and General Secretaries of SCAEF Nepal along with the representatives from the member firms discussed on the possible impacts COVID-19 to the Nepali Consulting Industry on short-term and long-term basis and possible ways for cooperation and collaboration for sustaining the industry.



Seminar on “Role of SCAEF in the Infrastructural Development of Nepal”

SCAEF EC organized a Seminar on the topic along with Special AGBM on 19th February 2021. Past President Dr. Hare Ram Shrestha made a Presentation on the “Roles/Contributions of SCAEF in the Infrastructural Development of Nepal” and Er. Bal Sundar Malla (Past President) shared experiences of SCAEF to all the participants. This was followed by a panel discussion in which Er. Arjun Jung Thapa (Director General - Department of Roads), Dr. Tri-Ratna Bajracharya (President - Nepal Engineers’ Association), Dr. Jagadish Chandra Pokharel (Chairman - NIURS), Ar. Binod Neupane (Past President - SoNA), Dr. Hari Krishna Shrestha (Principal - Nepal Engineering College) and Er. Birendra Raj Pandey (Advisor - FCAN) provided their views on the role of SCAEF in the Nepalese Consulting Industry and Infrastructure Development.





Training on “Understanding of FIDIC Conditions of Contracts for Construction, and Plant & Design-Build [Module I]”

The Society of Consulting Architectural and Engineering Firms (SCAEF) organized its regular training program on the FIDIC Training Module I in collaboration with Construction Business Development Implementation Center (CBDIC) and Federation of Contractors’ Association of Nepal (FCAN) during 24-25 March 2021. The technical expert for the training program has been provided from Consulting Engineers’ Association of India (CEAI) based on the MoU signed between SCAEF Nepal and CEAI earlier. The objective of the training on FIDIC Training Module I was to impart knowledge on FIDIC Conditions of Contracts for Construction, Plant & Design-Build to the project managers/directors of member firms, clients, and contractors so that they are well versed with the FIDIC Contract Management system.

The training was successful to impart knowledge on FIDIC Conditions of Contracts for Construction and Plant & Design-Build to the participants and to enhance their skills in tackling with contract related issues in future.



Training on “Management of Claims and Resolution of Disputes for Construction and Plant & Design-Build [Module 2]”

The Society of Consulting Architectural and Engineering Firms (SCAEF) organized its regular training program on the FIDIC Training Module II in collaboration with Construction Business Development Implementation Center (CBDIC) and Federation of Contractors’ Association of Nepal (FCAN) during 26-27 March 2021. Dr. Dhaval M. Parikh, Vice-President, CEAI was the resource person for the training. Consulting Engineers Association of India (CEAI) supported this training event by providing resource persons based on the MoU signed between CEAI and SCAEF Nepal. The objective of the training on FIDIC Training Module II was to impart knowledge on Management of Claims and Resolution of Disputes for Construction, Plant & Design-Build to the project managers/directors of member firms, clients, and contractors so that they are well versed with the FIDIC Contract Management system.



The training was successful to impart knowledge on Management of Claims and Resolution of Disputes for Construction and Plant & Design-Build to the

participants and to enhance their skills in tackling with contract related issues in future.



Training on “Slope Stabilization Design”

The Society of Consulting Architectural and Engineering Firms (SCAEF) organized its regular training program on the Slope Stability Design in collaboration with Construction Business Development Implementation Center (CBDIC) and Federation of Contractors’ Association of Nepal (FCAN) during 7-9 April 2021. The technical expertise for the training program was obtained from the two engineering societies: Nepal Geotechnical Society and Nepal Landslide Society (NELS). The objective of the training on slope stability design was to impart knowledge on various ongoing slope stability measures as well as innovative measures to the participants and to familiarize them through observation tour to the applied and sustainable slope stabilization / mitigation measures. The training program was organized in two parts: classroom training and field observation tour. The classroom training consisted of imparting state-of-art knowledge and experience with subject background and case studies. The field observation tour was conducted to familiarize the participants on implemented and performing slope stability stabilization / mitigation works.



The training was successful to impart knowledge on state-of-the-art knowledge to the participants about slope stability design and management and to enhance their skills in tackling the slope stability projects in a better way.

Webinar on “QAQC in Infrastructure Projects, Issues & Challenges”

SCAEF Nepal organized the webinar on 30th May 2021 amidst the second wave of COVID-19. Er. Dr. Jagadiswar Man Shrestha (Structural Engineers’ Association, Nepal) made the presentation on the webinar in which more than 200 participants attended. Er. Dr. Shrestha discussed about the importance of QA/QC in infrastructure projects and presented about his experience of working as a Quality Control Engineer in different projects in Nepal including the national pride project of Bheri Babai Diversion Multipurpose Project



Webinar on “Construction of Cement Concrete Roads in Nepal: Possibilities & Challenges”

SCAEF Nepal organized the webinar on 6th June 2021 amidst the second wave of COVID-19. Er. Rajendra Sharma Kaphle, Technical Advisor for Road Asset Management (Department of Roads) made the presentation on the webinar in which more than 200 participants attended. Er. Kaphle discussed about the current practices of flexible and rigid road pavements and indicated possibility of construction of cement concrete roads in Nepal which would mean fostering of the local industries and development of the national economy.

Webinar on “Orientation Program on Social Security Fund to SCAEF Member Firms”

SCAEF EC organized the webinar among the member firms regarding Social Security Fund and the need for registration by the employers and the employees into SSF. Mr. Dinesh Kumar Koirala, Deputy Director of

SSF, made the presentation. Member firms’ representatives put their queries regarding the SSF which was clarified by Mr. Koirala. More than 70 participants attended the webinar.



Webinar on “River Basin Planning in Nepal: Challenges from Policy Formulation to Implementation”

SCAEF EC organized a webinar in which more than 70 participants attended on the topic River Basin Planning in Nepal: Challenges from Policy Formulation to Implementation on 17th July 2021. Various experts made presentations on the webinar including Dr. Divas B. Basyats who has focused on river basin planning, Er. Krishna Nepal focussed on planned diversion projects.

Dr. Netra Prasad Timalsina (BKK Production AS, Bergen, Norway) has also shared his experience from Norway on Resource Usefulness in Storage Projects on the program.

Webinar on “Nagmati Dam”

SCAEF EC organized a webinar on the topic among the member firms with request from few member firms regarding the project design. The presentation was made by Er. Ashish Bhadra Khanal (Senior Water Resources Engineer) who had been involved during the detailed design of the project.

Hybrid Seminar on “Managing Large Infrastructure Projects: Experience Sharing from Global to Local Context”

SCAEF EC organized a hybrid seminar with physical presence at Indreni Food Land, New Baneshwor and web presentation using Zoom platform. The presentation was made by Er. Rajesh Pathak who has experiences of working in large infrastructure projects both in Nepal and the UK. The presentation highlighted

the importance of effective and efficient project management for timely delivery of the projects, especially the large and complex infrastructure projects. More than 70 participants (combined) attended the hybrid seminar.



31st SCAEF Anniversary

SCAEF celebrated its 31st Anniversary and SCAEF Day on 20th November 2021 at Hotel Himalayan amidst it’s family and friends.

Two presentation and interaction program on “Green Building Design: Concept to Reality” – presented by Ar. Ujjwal Man Shakya and “Promoting Bicycle as a Green mode of Transportation. A case study of Lalitpur Metropolitan City” – by Ar. Rakesh Maharjan has been made.

Prominent persons from various sectors has made their contribution as panelists Dr. Santosh Shrestha (Senior Advisor, NHSSP), Er. Bhusan Tuladhar (BOD, Sajha Yatayat), Ar. Bibhuti Man Singh (P.P.SONA), Dr. Padam Bahadur Shahi (President SoTEN), Er. Chakrawarti KAnth (Joint Secretary,PPMO) and Er. Keshab Kumar Sharma (Joint Secretary, MOPIT) were among them.





SCAEF/KMA Award (Award Established in memory of late P.P. of SCAEF Er. Keshab Man Amatya) to the winning graduates of the various engineering disciplines from the universities from Nepal has been distributed and felicitation has been made in the program.



Felicitation to the member firms who are in operation for more than 25 years and staffs of the firm who have worked more than 20 years has been also made on the program.



SCAEF and New Normal Challenges in Consulting Sector



Dr. Er. Hare Ram Shrestha

E-mail : hrs@sidef.com.np

Introduction

COVID-19 pandemic posed the new challenges in Nepal and throughout the world. It affected every sectors of society. It has big impact on human life, society, and the global economy. The need to comply with social distancing limits the efficiency of construction works on sites. Under such circumstances, to carry out development activities as well as to ensure safe working environment with effective risk management strategy is a big challenge worldwide.

Consulting sector could not remain unaffected. It hit hard in sustaining and managing the consulting business. Consulting sectors which plan, design and implement resilient infrastructures became vulnerable of its own resiliency. It has profound impact on mobility to operate offices and delivery of the material and services. Consulting firms faced greater constraints on maintaining its staff, overhead costs and cash flow.

Disruption of supply chain due to the halt of transportation has severely impacted the infrastructure development sector. Impact ranges from increase in cost, delay in project completion, difficult to plan further due to uncertainty of the elimination of the pandemic. It created various problems on contractual and legal issues. Adherence of health protocol is very important aspect to avoid the possible further spreading of viruses. But this had serious impacts on smooth implementation of infrastructure development projects resulting on time and cost overrun and adding further complication on contract administration. This pandemic has impacted in financial, operational and institutional aspects also in development projects and has taught us to plan and prepare for any other pandemic and undesirable situations in future.

On the other hand, massive infrastructure development is planned globally with regional and country specific plan. Implementation of infrastructure development is

very urgent to meet the SDG goal and to maintain the economic growth of the country. Therefore huge investment is planned in this sector worldwide. Thus this sector has huge opportunities ahead of us in the consulting sector as well.

But there are numerous challenges and constraints that hinder the smooth implementation of development projects. Efforts are needed to improve the enabling environment in this sector. Thus SCAEF as a national association of engineering consulting sector has the responsibilities to collaborate with the stakeholders, to take proactive actions and to strengthen the capacity of consulting sector.

Opportunities in Infrastructure Sector

Infrastructure Development and Economic Growth

There is strong positive correlation between GDP per capita and indicators of infrastructure stock and negative relationship between poverty rate and indicators of infrastructure stock. Therefore, for the economic growth of the country, development and promotion of infrastructure development sector is inevitable to increase productivity, encourage investment, increase employment and to establish linkage in all types of productions.

Global Infrastructure Need

According to Global Infrastructure Hub/Oxford Economics 2017, global investment need during 2015 to 2040 is US\$ 9400 billion. According to current trend, likely available investment is US\$ 7900 billion. Thus investment gap will be US\$ 1500 billion.

According to FIDIC report ‘Time to \$Tn-Vest’ launched on 18 Feb 21, global infrastructure could require at least \$7 trillion spending on it every year if the world is to address the growing climate emergency and recover from the effects of the Covid-19 pandemic.



Asian Infrastructure Need

According to Asian Development Bank on Meeting Asia's Infrastructure Need published on February 2017, developing Asia will need to invest US\$2600 billion until 2030 at the rate of investment of US\$ 170 billion every year.

Development Vision of Nepal

Government of Nepal has envisaged the future vision of Nepal to graduate from LDC by 2022, to ascend to middle income country by 2030 and the accession to high income country by 2043 with per capita national income at least \$ 12,100.0.

Physical Infrastructure of Nepal for 2043/44:

Physical infrastructure development target is aligned with the goal of accession to high income country by 2043. This target opens up the big opportunities for consulting sector. According to the 15th Plan prepared by National Planning Commission, following are the status of development of physical infrastructure till 2019, and the target until the year 2043.

S.N.	Infrastructure	Status in 2019	Target for 2043
1	Electricity generation	1250 MW	40,000 MW
2	Households with electricity access	88%	100%
3	Per capita electricity consumption	245 kwh	3500 kwh
4	Families with access to motor transport	82%	99%
5	Two lane highway (NH and PH)	7794 km.	33,000 km.
6	Higher than 2 lane & fast track	96 km.	3,000 km.
7	Railway	42 km.	2,200 km.
8	Population with internet access	65.9%	100%
9	Population with improved drinking water	21%	95%

Target for Current Five Year Plan

Physical infrastructure development target for current five year plan during 2019 to 2023 also provides substantial opportunity for consulting and construction sector. Following are the brief description of infrastructure target in energy, ICT, transport, local development and urban development sector:

- **Energy Infrastructure:** Electricity generation till 2019 was 1,250 MW and the target to generate energy by the end of current five year plan is 5,000 MW. Thus additional 3,750 MW of new generation is planned. Households with electricity access is 88% and it is targeted to reach 100% households. Current per capita electricity consumption is 245 kwh and it is targeted to increase to 700 kwh.
- **ICT Infrastructure:** The Target to provide internet access by the end of 2023 is 100% from 65.9%. TV, radio and mobile access is targeted to be provided to the 100% population.

- **Transport Infrastructure:** The Target to provide access to the motor transport within 30 minutes of walking distance is 95% from the 82%. Seven thousand km. roads are to be upgraded from its present condition. Four hundreds new bridges along the national and provincial highway are to be constructed and 1,200 new bridges are to be constructed along the local road networks. Two regional airports are to be completed and operated, and construction of one international airport in Nijgadh is to be started. Ten million flight seats per year is to be achieved. Rail transport is to be expanded to 306 kilometres.
- **Local Infrastructure:** All ward offices (100%) are to be connected with road links. Trail bridges are to be constructed within the 30 minutes of walking distance in all parts of the country. All rural area are to be connected by the electricity access.
- **Urban Development:** Basic urban infrastructures are to be provided in 70 municipalities. New ten cities are to be developed along Mid-hill highway. Development of three smart cities is to be started. People living in safe housing to be increased from 40% to 60%. Population living in self-owned houses is to be increased from 85.3% to 89%. One million housing units & 100,000 plots are to be constructed. New building of 50,5424 private houses, 167 public building, 3,723 school building, 286 building for security agencies, 554 health centres, 668 archaeological heritage and 1,320 monasteries are targeted for new construction. Population with improved drinking water is to be increased from 21% to 95%.

Investment in Infrastructure to Meet SDG Nepal Target

Investment of NRs 2,025 billion annual average at constant price of 2015 is required during the period of 2016 and 2030. CNI & IIDS PUBLICATION, Nepal Infrastructure 2030, Investment and Financing Needs, September 2019, calculated the total investment requirements in four sectors of infrastructure – energy, transport, water and sanitation and urban development. Annual Investment need is US\$ 16.55 to 20.55 billion based on growth rate of 5% to 10%.

Investment requirement calculated by NPC and CNI/IIDS resembles at the range of NRs 2,000 billion. This shows the huge infrastructure investment requirement of the country, thus providing huge opportunities to consulting sector business.



Challenges in Consulting Sector in Nepal

But there are many challenges and constraints in infrastructure development of Nepal. Though periodic plan is prepared and currently 15th plan is running, development projects are still decided on piece-meal and ad-hoc manner. Investment requirements are not met. Planned investment projects are also encountering hurdles e.g. Budhigandaki project and many other projects

Construction sector of Nepal lacks the good governance practice. Therefore quality of the work is compromised and time overrun is the most common phenomenon. Law & order situation was heavily distorted during the Maoist insurgency period with extortion and various kinds of threats and risk. This situation is not completely eliminated, with residual effect still persisting. Low bidding to acquire the job is another bad practice in consulting and construction sector, which ultimately ends up in quality compromise and other negative impacts on the sector.

Public Procurement and Monitoring Office (PPMO) as the name of the regulatory body suggests, it has more focus on procurement. Construction administration is weak. Thus the most of the projects are not delivered on time.

Brain drain is another challenge for the infrastructure development sector in Nepal. Out of the over sixty thousand engineers in Nepal, about one third of qualified and competent engineers are working abroad. Since professionals get high remuneration abroad, national consulting market cannot afford to retain them for the domestic works. Client's estimation for the consulting services for national professional are low. In many cases input provision are also inadequate to deliver the services. Consulting firms' profit is not explicitly provisioned in the consulting service, whereas certain percentage of profit is provisioned in the cost estimation of construction works.

Infrastructure sector lacks the supportive environment. Delay in decision making is common. Now, there are three tiers of government in the federal system. Local governments are also investing on infrastructure sector. Thus procurement of construction works and consulting services is important function of local government functionalities. But all the local governments are not competent enough in procuring the infrastructure works and services. Therefore many anomalies are seen in the handling of infrastructure works. This has direct impact on the infrastructure works and ultimately to the consulting services.

SCAEF and FIDIC SCAEF

Consulting services started since sixties in Nepal and the registration of consulting companies started since seventies. SCAEF as the umbrella organisation of consulting firms was established in 1990. SCAEF is recognised by Construction Business Development Act 2056. President is ex-officio member in Construction Business Development Board (CBDB). Representation of SCAEF as member of Construction Business Development Implementation Committee (CBDIC), and implementing body of CBDB in Ministry of Physical Infrastructure and Transport (MoPIT) is provisioned in the Act.

Currently SCAEF has 235 Member firms. Some member firms are over 40 years of their establishment. About 4,000 engineers and 8,000 mid-level technical staffs are employed by its member firms. Annual turnover of SCAEF member firms jointly NRs 5 billion, SCAEF report June 2020.

Consultancy Development Act was drafted in the initiation of MoPIT funded by the ADB. Consulting Services Development Institute (CSDI) is envisioned in the draft Act. CSDI would be authorised government body for the overall enhancement of consulting service. But the proposed Act has not been promulgated yet. If the Act is introduced, functionalities of consulting services could be improved.

SCAEF is the member association of FIDIC and FIDIC ASPAC representing Nepal in its various international networks. SCAEF was very active in regional consulting body TCDPAP. Later with the formation of FIDIC ASPAC as the regional body of FIDIC, TCDPAP became non-functional.

FIDIC (Federation Internationale des Ingenieurs Conseils)

(International Federation of Consulting Engineers)

FIDIC was established in 22 July 1913. It has now 102 countries as member association. FIDIC First Red Book was published in 1957. Following international standard forms of contract are prepared and are in use globally;

- ❖ Green Book 1999 for short forms of contracts.
- ❖ Red Book 1999/2017 for conditions of contracts for construction.
- ❖ Yellow Book 1999/2017 for plant, design and build.
- ❖ Pink Book 2010 Red book adopted for multilateral development banks (MDBs).
- ❖ Silver Book 1999/2017 for EPC and turnkey contracts
- ❖ Orange Book 1995 for design, build and turnkey contracts, merged with yellow book.

- ❖ Gold Book 2008 for design, build and operate (DBO).
- ❖ Blue Book 2006/2016 for dredging works.
- ❖ White Book 1999/2006/2017 for client consultant model service agreement, used to appoint consultant
- ❖ Emerald Book 2019 for underground works

FIDIC is working on advocacy and policy through numbers of policy document prepared e.g. collateral warranties, conflict of interest, contingent legal fees, copyright, Engineers and Environment, Financial interest, Guarantee bonds and retentions, informed purchaser, Limitations of liability, Partnering, Professional risks and responsibility, Quality management, Quality of construction, Review of work, Selection of engineers, Site safety, The expert witness, Transfer of technology, Turnkey projects, Understanding and minimising corruption etc.

FIDIC also publishes various business practice documents such as policy papers, guidelines and training manuals. Nepal is also using FIDIC standard forms of contracts for international contract assignments. Pink book is more used in Nepal for multilateral banks funded projects e.g The World Bank and Asian Development Bank.

SCAEF to Embrace New Normal Challenges

SCAEF has to work in various fronts for its betterment to enhance the consulting sector and the infrastructure sector in Nepal as a whole.

a) Collaborate with Government

Many issues are related with government actions and cooperation. Therefore it has to work closely with government for following major issues

- ❖ To adopt supportive policy (recognize need of strong consulting, understand consulting as effective vehicle of technology transfer, knowledge platform, trainer, depositors of national expertise, employment providers)
- ❖ To promote good governance (law & order in place, fair, impartial & transparent evaluation process). Help the government in its efforts for good governance and anti-corruption.
- ❖ To increase investment level in infrastructure sector.
- ❖ To provide incentives to encourage efficient & effective delivery of consulting services, which will facilitate in retaining national experts.
- ❖ To prepare holistic and integrated plan with workable implementation plan—role of NPC.
- ❖ For the institutional revamp in regulating and monitoring bodies.

- ❖ To adopt construction governance mechanisms to improve infrastructure transparency initiative. Make transparency and accountability the norm integrating into country's standard system and practices for quality infrastructure.
- ❖ For provisioning of sufficient cost for service (important to enhance institutional capacity, present trend is to cut down overhead leading to less corporate back up, need sufficient input, rate, overhead).
- ❖ For the capacity development of consulting sector to be able to undertake the responsibilities, CPD – training, R & D, exposures.
- ❖ To improve the client capacity. FIDIC has felt necessary to improve the client capacity in emerging countries on global constructional and infrastructural contracts management, it applies to Nepal too.
- ❖ To establish the recognition that a strong and growing national consulting industry is vitally important to the country's sustainable economic development.
- ❖ To support the growth of the industry by creating a healthy environment through good governance.
- ❖ Push the government to form project preparation mission in collaboration with SCAEF and other professional societies.
- ❖ Help GoN as Think Tank in planning and prioritization of projects/programs.
- ❖ To implement consistent, transparent policies and regulations on the industry.
- ❖ To take serious actions to prevent corruptions, campaign to improve for the supportive attitude of government.
- ❖ To adopt an incentive schemes to retain the national experts and attract the national experts working abroad and minimise the brain drain.

b) SCAEF to Step Forward for Capacity Building

SCAEF as an umbrella organization of consulting architectural and engineering firms has the role to create the supporting environment for infrastructure development of Nepal;

- ❖ Maintain an effective channel of SCAEF for dialogue with government to reflect the concerns of the industry. Help GoN in formulation of sectoral policies related to development ministries/ departments/ agencies.
- ❖ Provide training programme in cooperation with government and aid agencies for the capacity building of consulting profession.



- ❖ Consulting sector of Nepal is not new, consulting companies were established and operating since last four decades. But this sector could not grow to the international markets. Therefore it is high time that SCAEF has to put its effort to promote domestic consultants to the international market.
- ❖ To improve the understanding of construction contracts, organise training to the clients, consultants and contractors on FIDIC principles and guidelines. SCAEF is occasionally organising such trainings. Contract management related trainings need to be regular activities of SCAEF.
- ❖ Engineering and technology sector is dynamic in terms of continuous innovation elsewhere in the world. Updating of the skill and knowledge is very essential for the professionals in this sector. Therefore SCAEF has to work continuously for adoption of appropriate international best practices through seminars, workshops, training, exposures, visits etc.
- ❖ Development of appropriate codes, guidelines, quality standards in construction of physical infrastructure works are vital aspects. Government bodies has to enforce such codes, guidelines and standards. SCAEF as a technical intellectual service providing entity has to take concern on its parts.
- ❖ There are more than fifty engineering colleges in Nepal. Beside the engineering colleges, there are hundreds of technical institutions affiliated with CTEVT to produce mid-level engineering technicians. They have to serve in the infrastructure sector after their graduation. Technicians and engineers has to be trained and educated to suit this sector. Therefore SCAEF has to collaborate with universities and academic institutions to fine-tune their syllabi to suit to the consulting and construction industry.
- ❖ As FIDIC prepares the guidelines and various required documents for project management and project monitoring for the global context, SCAEF has to work to prepare such documents to suit to the country specific requirements.
- ❖ Networking with regional and global FIDIC member associations is necessary so that transfer of knowledge and technology in infrastructure development works could be implemented for the benefit of Nepalese construction sector.
- ❖ Prepare the strategy to reduce the need of expensive international expertise and technology, and

implement by providing the skill and knowledge to the national professional.

- ❖ Now, there are about two dozens of sector specific engineering professional societies. SCAEF has to coordinate with such professional associations for updating the database of professionals and to develop the focussed professional expertise. Developing a functional working mechanism among the engineering professional societies will contribute in smooth infrastructural development of the country.
- ❖ Nepalese engineers are now serving in other countries. Qualified, experienced and skilled engineers are the asset of the country. Therefore SCAEF has to prepare the strategy to reduce brain drain of skilled manpower.
- ❖ Enhancing the capacity in firm's level and professional level is very important to make the consulting sector capable and competent to deliver timely and quality consulting services.

Conclusion

Role of engineering consulting services is very important for the success of physical infrastructure development. COVID-19 pandemic hit hard all sectors of life globally. Consulting sector could not remain unaffected. This pandemic gave an alarm to us to become resilient for the similar unforeseen happening in future. Infrastructure development is the key to recuperate and to lift the economic activities. Infrastructure development activities are planned throughout the world and increased investment is sought for the implementation. Similarly, Nepal has also planned to expedite the physical infrastructure development activities with increased annual investment.

But there are numbers of challenges and constraints in the sector that hinders the successful implementation of the planned development works. These challenges are to be addressed collectively by all stakeholders' e.g government, consultants and contractors. Good governance should be ensured and capacity of all sectors has to be enhanced for the effective and efficient implementation of the physical infrastructure development, finally enabling us to cope the challenges of the new normal. SCAEF as a national body of consulting sectors has to act proactively to improve the present situation.



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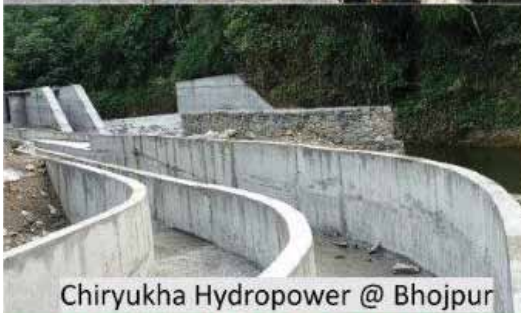
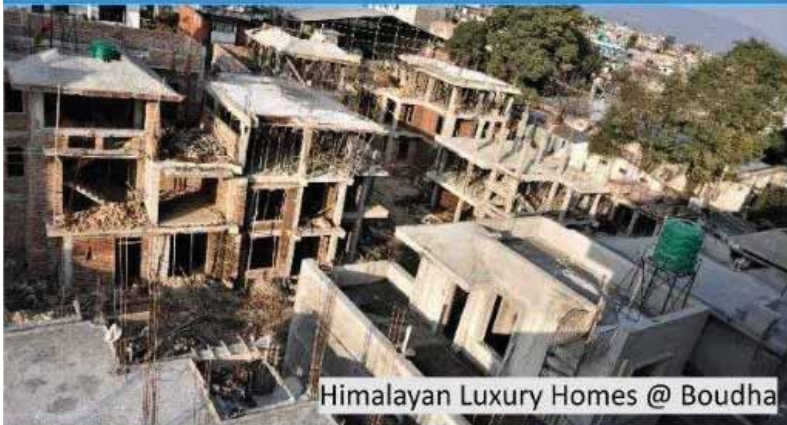
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Safeguards Approaches That can Help the Consulting Industry Perform Efficiently in the ‘New Normal’



Yogesh Shakya

Environmental Expert

E-mail : shakya.yoges@gmail.com

Let’s also view the professionals and associate workers involved in development sector as ‘Forefront-workers’ during any pandemic or natural disaster. Throughout the history of modern development, the people involved in development sector have also stepped in for service & solutions; protection & measures; and support & innovations during the most needy moments like these. And, consultancy services in development sector is also a vital & challenging task during these demanding times.

There was a heart breaking earthquake during 2015 in Nepal, and the professionals involved in development sector rushed back to works like temporary settlement development, reinstatement of infrastructures, and rehabilitation of public utilities. And now, since January 2019, we have been facing a novel virus (SARS-CoV-2) with a different pace but with equally costly consequences of COVID-19 infection. And, besides all such risks, and all the challenges of timely field studies for feasible designs, and field supervision & monitoring for assurance of quality of the works - consulting firms are performing to serve the nation.

For a demanding sector like the consulting industry, safeguards of the workers and that of the community they work for is also one of the key aspects determining the performance of the industry. Much priority is to be given for Occupational Safety & Health of the workers for overall success of the projects. Keeping the staff safe and keeping the consulting services functional is of utmost priority for any company. Use of masks all the time while at work, social distancing while working in team, online meetings and work from home are some of the not habituated practices we are following under different contexts during this time of COVID-19 pandemic.

It is a crucial need that the firms get their workers in full confidence so that they can work on desk as well as in

field during this corona virus pandemic as well. An organization should have its Occupation Safety and Health Policy, and needs to design its own OSH Programme. The staff should be provided with health insurance and additional provisions should be provided in order to cope with the COVID-19 risks. This might sound like a little costly for a company, but it is a need for the efficiency of the companies during the unforeseen situations like this one. Under normal situation also, companies would have taken OSH aspects as serious requirements. This has recently been even more highlighted as Government of Nepal has promulgated ‘National Occupational Safety and Health Policy, 2076 BS’. There are also Labour Act 2074 BS (2017 AD) and Labour Rules 2075 BS (2018 AD) under effect in Nepal. Hence, under the present sensitive situation, it is undeniable that companies plan and manage resources for dealing with COVID-19 situations so that the conventionally abnormal things are taken as a new normal by their workers as they keep moving ahead.

As of now, Corona has claimed 11,277 lives in Nepal (MoHP, 16th October 2021), but the hopes are still high to overcome the threats. Till date, Nepal has administered at least 14,857,561 doses of COVID-19 vaccines. This is around 26% of the country’s population vaccinated with double doses. Hence, the ratio of people getting seriously ill due to viral infection is expected be even lower in coming days. For any organization working under ISO standard (e.g. ISO 9001:2015), one of its prime focus is always the quality of its service delivery. Hence, OS&H is an equally important and prioritized aspect for those all organizations. In addition to this, pronouncement of the need of guiding approach for occupational health and safety in the 15th Periodic Plan of Nepal (2019/20 - 2022/23) of Nepal also requires the structured

approach for occupational safety and health. The Labour Act (2017) - in Section 68, defines for the need of formulation of a Safety and Health Policy by a firm and requires the firm to implement it effectively. The act also directs that the office shall regularly monitor whether the safety and health policy formed by the employer under this section is complied or not. Responsibility for Occupational Health and Safety is shared by all staff as well, including senior management, experts & supervisors, managers, as well as parties entering into sub-contracts, and also the visitors. The organizations need to handle the occupational safety & health aspects through its dedicated committee pursuant to the Section 74 of Labour Act 2017, GoN. So, consulting firms should activate and re-strengthen their respective OSH Committees under their updated OSH Policy as per the new context of global COVID-19 risk situation.

For the consulting firms working for study, design and supervision of development projects in Nepal, these organizations have regular as well as need-based forefront workers like the surveyors, designers, planners, environmentalists, sociologists, trainers and managers. The range of activities of these organizations varies from working under different circumstances with the field teams, travelling also to the most remote areas of the country, desk works for planning & designing, and interactions in different urban as well as national forums. This provides both opportunities as well as challenges in addressing the concerns of occupational safety and health. Hence, the best approach is to keep yourself safe, and to help others for the same. Each institution should be floating a practicable and simple COVID-19 risk management plan with defined Code of Conduct for the staff - this in turn will give confidence not only among the staff, but also to the clients and also to the communities in the vicinity of the project. This institutional approach is a must, and is not a difficult task to be undertaken. However, on the other side, there is a challenge of performance in the field implementation level, i.e. the projects. In the context of COVID19 risk management in the projects, the plan & cost should be reflected during the project design as well. For example, COVID Response Plan should be inbuilt within Emergency Response Plan in every design document, and if the environmental safeguards cost of a project is say 0.5% (3.75 millions) for a project of worth 750 millions, then at least a portion of the total safeguards cost, say 10% (.375 millions) should be entitled for emergency response. Also, the designers

should propose - say 10% of an annual O&M cost for emergency response requirements. So, these funds can be mobilized for risk management and mitigations of the COVID-19 concerns in the project. Further detailing works like development of Standard Operating Procedures (SOPs) for the COVID-19 risk managements in the projects should also be exercised and implemented as well.

There has also been some comparative advantages due to our past efforts by GoN. Our national WASH campaign led by the GoN in the past has somehow habituated Nepalese citizens even in rural areas to practice regular hand washing with soap. This time around, as the viral infections started, it was easier for the people to build on this, and take a step ahead to personal hygiene and sanitization. Likewise, but much as an irony, we Nepalese citizens - more the urban denizens were somehow used to wearing a cotton mask while exposed to open places due to high levels of air pollution (dust and smoke), primarily due to poor urban road surfaces. This made it easy for most of us to carry and use a mask unlike in the western countries where a noticeable mass of citizens took it as a violation of human rights when their governments made wearing a mask mandatory. On the other hand, there has also been some better learnings and opportunities during this period of pandemic. While work from home still needs a more robust monitoring mechanism for consulting industry, the adoption of online meetings and discussions has provided advantage in terms of resource mobilization during this time. It has taught us how to work more efficiently and take advantage through use of online mediums - primarily in saving time, and often saving the costs of travel.

On a different note, let's see this current pandemic not only as an unprecedented global crisis, but also as an opportunity to learn to tackle some of our major environmental problems of global scale. One unlikely beneficiary has emerged amidst the slowdown caused by COVID-19 - our mother Earth. Lockdowns did also result in cleaner air and less pollution. In China, carbon emissions fell by 25 per cent in February 2020 compared to the same period in 2019 (Myllyvirta L., Carbon Brief, February 2020). Air pollution decreased in Italy and in Malaysia, where the percentage of stations which recorded “good” air quality readings increased twofold from 28% to 57% after a Movement Control Order (MCO) during 2019-2020. We also experienced this in our daily lives. This teaches us to



take some needed steps in our bid to flattening the climate curve. In the context of consulting industry too, employees as well as employers are already getting habituated to the online way of working. We are developing new trends reflecting the benefits of flexible working arrangements. And, even after this pandemic, we all have the opportunity to re-evaluate the necessity for time consuming and costly business travels. For example, do we need an hour flight to attend a business meeting? Or, we could simply accept the online meetings instead? My answer is; 'Yes - whenever possible without compromising the outcome of the meeting'. Such change in work culture will also help us to reduce our carbon footprint and safeguard against the global risk of climate change.

Coming down to the deductions, our experience in living with the virus for over one-and-a-half years should enable us to take more clearer steps to continue

our businesses with due considerations of the COVID-19 risks. We have to continue to plan and to act in order to control the spread and to minimize the risks of SARS-COV-2 virus. Until a full proof vaccine against the virus is available, this is the only way to keep moving ahead in the new normal. For instance, South Korean and Australian economy were among the few national economies which exhibited resilience to COVID-19 global crisis. One of the major reasons was their relative success in controlling the pandemic. We need to learn from those success cases, and we can also learn from our own new context of working. Hence, let's mobilize our resources in each levels and aspects of our work, be it offices or be it in projects, in order to minimize the risks of the pandemic, and to gain confidence among the staff and stakeholders so that we perform efficiently, rather - more efficiently in the times of this new normal.



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Kathmandu Metropolitan City: Path Towards Mitigation and Adaptation to Climate Change



Saroj Basnet

Vice Chairman, City Planning Commission, Kathmandu Metropolitan City

E-mail : sbasnet922@gmail.com

Impacts of climate change could be experienced in all cities across Nepal, mainly due to increased extreme weather events, rise in temperature, altered rainfall pattern, and rise in new diseases. Some of the major climate change issues in Kathmandu include:

- Increase in temperature, high evapo-transpiration and increase in water abstraction to meet urban demand- resulting in depletion of ground water table as compared to ground water recharge;
- Increase in flash floods and inundation issues – resulting in loss of human life and property;
- Increase in pollution, diseases and health cost – impacting quality of life;
- Rapid and haphazard land use change and encroachment of green spaces – lead to increasing Urban Heat Island effect, while affecting food, water and energy securities.

Stringent adaptation strategies for climate change are being prepared and implemented in Nepal. Along the same line, Kathmandu Metropolitan City, as the biggest city and the country’s capital, has also been continuously working towards achieving the Sustainable

Development Goals and creating a positive impact towards issues related to climate change. The policies and programs of the Kathmandu Metropolitan City have accorded top priority towards initiatives that lead to mitigation and adaptation to climate change. As part of the programs, some of the initiatives include:

Development of Network of Green Open Spaces Green Necklace

In context of KMC, development of parks and open spaces is integral in reducing urban heat island effect, increasing groundwater recharge, reducing occurrence of landslides and floods, and providing a number of non-adaptation co-benefits that increases recreational space, improves air quality, and enhances cultural values, in addition to develop greenery in selected areas of the Valley. Hence, KMC at present, is

- working on a program to identify and map open spaces that have the potential to be developed as managed green parks;
- planning to develop an ecological corridor ‘Green Necklace’ that connects series of open spaces – including parks, urban forests, green streets, among others- and help increase the ecosystem services and environmental benefits.
- As part of ‘at least one park per ward’ policy and ecosystem based adaptation initiative, KMC has already started developing 36 parks of varying sizes and services;



- KMC has initiated the 'नगर-नगर साझेदारी कार्यक्रम' with other municipalities to collaboratively work for pollution control, open space management and local economic development. In the fiscal year 2077/78, KMC has provided financial assistance to 11 municipalities for the development of parks and open spaces within the Kathmandu Valley. In fiscal year 2078/79, KMC has provided financial assistance to 6 municipalities: Kageshwori Manohara, Chandragiri, Dakshinkali, Tarakeshwor, Kirtipur and madhyapur Thimi.



- To promote urban greenery within the city as per the policy, and to reduce the impact of climate change, KMC is working on initiatives to promote vertical garden and research on appropriate species for roadside plantation as critical strategies for increasing carbon sequestration.

Research on Current Status of Urban Ecosystem and Biodiversity

A memorandum of understanding has been signed between National Trust for Nature Conservation (NTNC) and KMC to study the current status of urban ecosystem and biodiversity in the Kathmandu Metropolitan City. The MoU stipulates for the preparation of necessary policy, strategy and action plans for KMC to strengthen its efforts in improving ecosystem and biodiversity and will require NTNC to undertake research and prepare a detailed plan for the conservation and improvement of the main urban forests and green spaces within the Kathmandu Metropolitan City.

Kathmandu as Food Green City – Development of Green School Program

The idea of developing Kathmandu as a Food Green

City is under discussion, as per the policy and program of KMC, with a view to encourage the city to have more productive greenery (Food + Green), to ensure food sustainability and positively impact the urban climate. As part of the idea, the concept of ‘Green School Program’ is being initiated as a point of departure to utilize open spaces within school areas, to encourage students towards urban agriculture and to promote school / home gardening programs that have the potential to change beliefs and practices around fresh fruit and vegetable consumption.



Recharge Kathmandu

As an initiative to replenish the depleting groundwater level in the city, KMC has launched a 3 year program - "RECHARGE KATHMANDU" on 76/77 fiscal year. Major functions under the program include:

Data Generation	<ul style="list-style-type: none"> • Mapping/updating and developing open inventory of wells, stone taps and open spaces • Estimate shallow groundwater recharge potential
Publication	<ul style="list-style-type: none"> • Development of standard design guidelines • Training manuals for schools, institution • Addition of groundwater and rainwater policies and bylaws
R&D	<ul style="list-style-type: none"> • Research and development for easy and cost effective groundwater system
Activities	<ul style="list-style-type: none"> • Maintenance and rehabilitation of ponds and stone taps • Addition of recharge pits in public/open spaces
Awareness Programs	<ul style="list-style-type: none"> • Awareness campaigns at community level • Trainings for Trainers • Publishing IEC material



Mapping of Blue Infrastructures within KMC

The policies and programs of KMC highly prioritize the need for protecting and promoting water sources within the city. As a point of departure, mapping of Blue infrastructures within the city, for traditional ponds and stone spouts, was conducted under the Mayors’ research fellowship program. To build on the information and develop publicly accessible data bank, KMC is working to map traditional wells within the city core area in the next phase. Information, thus gathered would be extremely beneficial to support evidence based policy making to mitigate the harsh impacts of climate change.



Groundwater Recharge Initiative

Kathmandu Metropolitan City has adopted the policy of setting up at least one Rainwater harvesting and Ground water initiative in a government owned/communal space per ward to ensure proper management of water and to improve the present condition of groundwater depletion in Kathmandu. A pilot project has been set up at Gongabu Landpooling area with three 24-feet recharge wells dug on 5476 sq. m. of public land area. Additionally, similar practice has been set up for Nandi Ratri School (Ward 1) and Ward No. 5 office premises.



Pilot Project: Gongabu Landpooling area

Furthermore, different scales of nature based solutions to support the ground water recharge initiatives, such as bio-retention facilities and rain gardens, are being utilized for 8 different park spaces within the city:

1. Kamal Pokhari
2. Bansbari Eco Park
3. Bagmati Nagar Park
4. Dhandyo Chitya Park
5. Kuleshwor Buddha Bihar
6. Lagan Park
7. Shanti Namuna Park
8. Tudaldevi Park



Water Quality Management of Traditional Ponds

In many areas, increased water temperatures will cause excess algal growth, which will reduce the water quality. Hence, KMC is also working on to improve water quality for blue infrastructures within the city, using nature based solutions. Such initiative would not only help to reduce cross contamination between water bodies, but would also help to minimize disease proliferation and improve visual and social value of the surrounding facilities. Water quality management of four traditional water bodies are being initiated in the first phase:

1. Rani Pokhari
2. Naag Pokhari
3. Kamal Pokhari
4. Hiti Pokhari

Promotion of Non-Motorized Transportation

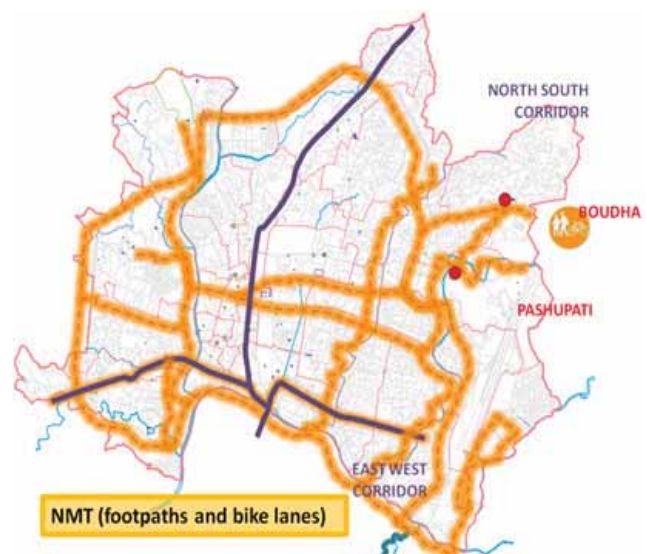
Non-motorized Transportation is a highly cost-effective clean transportation strategy and brings about large health, economic and social co-benefits. Such type of human powered transportation includes walking, cycling, skateboards, and rickshaws among others. Although the city is currently oriented towards private vehicle oriented planning approach, KMC has been conducting researches towards improving walkability and making NMT as an attractive mode of transportation in conjunction with improving public transport.

This includes research works on impact of pedestrianization city core areas such as Thamel, under the Mayors Research Fellowship program. Alongside, plans are being worked upon for a range of activities including construction of sidewalks and bike lanes, streetscape improvements, bike sharing programs, and pedestrian-oriented development approach.



The Power of Bicycles to Fight Climate Change

A 2015 study by the Institute for Transportation and Development Policy concluded that a dramatic increase (about 20 percent) in cycling worldwide could “cut carbon dioxide emissions from urban passenger transport by nearly 11 percent in 2050.” Along the same line, a pilot project on development of Cycle Track from Tinkune to Maitighar, by Kathmandu Metropolitan City, is under progress. KMC is also working on the feasibility study of cycle network within the city and beyond, collaborating with neighboring municipalities.



Conclusion

Climate change is a global challenge. Cities across the world can have a major impact in developing and implementing climate change programs, being located at the interface of local - national and international level climate change adaptation and mitigation commitments. Hence, it would be highly essential to strengthen local governments, while promoting public-private – civil society partnership. As the capital city of Nepal, Kathmandu Metropolitan City has been focusing on continuous participatory processes,

sustainable planning approach and evidence based policies to develop plans, policies and programs that support adaptation and mitigation to climate change. While translating policies into actions would be challenging, scaling up on the current projects, taking an integrated planning approach, promoting low carbon economic development and nature based solutions to reduce climate vulnerability would be critical to achieve the goal of building our Kathmandu as a resilient city.



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नेपालको संविधान २०७२ ले संघीय लोकतान्त्रिक गणतन्त्र नेपालको मुल संरचना संघ, प्रदेश र स्थानीय तह गरी तीन तहको निर्धारण गरेको छ । संविधानले निर्देशित गरेका राष्ट्रका नीतिहरू मध्ये विकास सम्बन्धी नीतिमा उल्लेखित आठवटा बुँदाहरूले राष्ट्रको सन्तुलीत विकासलाई दिशानिर्देश गरेको देखिन्छ । आयोजनाहरूको तयारी निर्माण तथा सञ्चालनमा संलग्न तीन पक्षहरू सार्वजनिक निकायहरू, निर्माण ब्यावसायिहरू तथा परामर्शदाता संस्थाहरूको पारस्परिक र आपसी सहकार्यमा काम हुने हुँदा कुनै पनि आयोजनाहरूको तयारी, निर्माण तथा सञ्चालन राम्रो हुँदा त्यसको जस तीनै पक्षलाई जान्छ भने आयोजना असफल हुँदाको जिम्मेवारी भने तीनै पक्ष लिन तयार नहुने परिपाटी नेपालमा विकास भएको छ । नेपालमा हाल ७५३ स्थानीय तहहरू, ७ वटा प्रदेश सरकार र संघीय सरकार गरी ७६१ वटा सरकारले वर्षमा एउटा मात्र १० करोड भन्दा बढी लागत भएको राम्रो आयोजना तयारी तथा निर्माण सम्पन्न गर्दा पनि ७६१ वटा आयोजनाहरू सम्पन्न हुनुपर्ने देखिन्छ । तथापी तीनै तहमा आयोजना तयारीमा देखिएका कमी कमजोरीले गर्दा समयमा Project Bank तयारी नहुँदा तथा गुणस्तरीय परामर्श सेवा खरीदगरी आयोजना तयारी नगर्दा तीनै तहका सरकारहरूसंग निर्माणको लागि तयारी अवस्थामा आयोजनाहरू नरहेको र बर्षेनी खुद्रा (एक करोड भन्दा कम) सामाजिक पूर्वाधारका आयोजनाहरूमा बजेट खर्च हुने गरेको छ र जनतालाई अनुभुती हुने खालका आयोजनाहरू कार्यान्वयनमा जान नसकिरहेको अवस्था छ । अतः तीनै तहका सरकारहरूले Project Bank को Concept मा आयोजनाको तयारी, लगानी जुटाउने तथा निर्माण र सञ्चालन गर्ने परिपाटी विकास नगर्दासम्म साना स्तरका विकास निर्माणले समृद्ध नेपालको राष्ट्रिय आकांक्षा पुरा गर्न सकिदैन ।

नेपाल र नेपालीमा रहेको तीव्र विकास प्रतीको आकांक्षा र राष्ट्रले अंगालेको “समृद्ध नेपाल सुखी नेपाली”को राष्ट्रिय आकांक्षा पुरा गर्न इन्जिनियरिङ्ग क्षेत्रको अत्यन्त महत्वपूर्ण भूमिका रहन्छ । आयोजना विकासको विभिन्न चरणहरूमध्ये आयोजनाको तयारी एउटा अत्यन्त महत्वपूर्ण चरणको रूपमा रहेको हुन्छ । त्यसैको आधारमा आयोजनाले एउटा स्वरूप धारण गर्दछ । आयोजना तयारीको चरणमा सार्वजनिक निकायहरू र निजी परामर्श कम्पनीहरूबाट भएका गल्ती तथा कमी कमजोरीहरूको असर आयोजनालाई विकास गर्न चाहिने लगानी जुटाउनेदेखि आयोजना निर्माण तथा सञ्चालन सम्ममा पर्दछ । पचास वर्ष भन्दा लामो इतिहास वोकैको इन्जिनियरीङ्ग परामर्श उद्योगले सेवामुलक क्षेत्रको रूपमा पछिल्लो समय देशमा थुप्रै आयोजनाहरूको विकास तथा निर्माणमा महत्वपूर्ण भूमिका निभाएको छ । तथापी देशमा पछिल्लो दशकमा इन्जिनियरीङ्ग परामर्श सेवाको सस्तो लोकप्रियता र त्यसै जगमा फस्टाएको DPR निर्माण गर्ने कारखानाहरूले गर्दा आयोजनाहरूको तयारी नै फितलो र कमजोर भई आयोजनाहरू अगाडी बढ्न नसक्ने अवस्था सृजना भएको छ । नेपालमा हाल इन्जिनियरहरू, कर्मचारीहरू, नेताहरू, जनप्रतिनिधीहरू, पत्रकारहरू माभ Detailed Project Report (DPR) भन्ने शब्द अत्यन्त लोकप्रिय छ । Detailed Project Report (DPR) विभिन्न क्षेत्रका विज्ञहरूको विज्ञताको सामुहिक प्रयासबाट तयार गरिनुपर्ने आयोजनाको DPR, इन्जिनियरीङ्ग परामर्श सेवाका सम्पूर्ण मूल्य र मान्यता विसेर तयार गर्ने परिपाटी विकास भएको छ । DPR बनाउने कामको लागि आफ्नो सम्बन्ध र पहुँचको उपयोग गरी काम लिने परिपाटी अत्यन्त फस्टाएको छ । विभिन्न नगरपालिकाहरूबाट नगर विकास कोषमा प्राप्त गरिने आयोजनाहरूको अध्ययन प्रतिवेदन मूल्याङ्कन गरी हेर्दा निम्न

कारणहरूले आयोजनाहरूको तयारीमा नै अत्यन्त कमजोरी देखिन्छ ।

१. **आयोजनाका लागि जग्गाको व्यवस्था :** स्थानीय तहहरूले विकास गर्नु पर्ने पूर्वाधार मध्ये आर्थिक पूर्वाधार निर्माणको लागि तयारी गरिने अध्ययन प्रतिवेदन जग्गाको स्वामित्व सुनिश्चित नभइकन गर्ने गरेको देखिन्छ । जग्गाको स्वामित्व सुनिश्चित गर्ने वा जग्गा अधिकरणको चरणमा लाग्ने लामो समय अवस्थाले गर्दा नै आयोजना अध्ययन प्रतिवेदन परिमार्जन गरेर मात्र लगानी तथा निर्माण गर्नु पर्ने देखिन्छ ।

२. **DPR का पक्षहरू:** कोषमा प्राप्त DPR हरूलाई मुल्याङ्कन गरेर हेर्दा अधिकांश नगरपालिकाहरूबाट प्राप्त DPR को गुणस्तर अत्यन्त कमजोर देखिन्छ । DPR ले समेटनुपर्ने प्राविधिक, आर्थिक, सामाजिक, वातावरणीय र कानुनी पक्षहरू मध्ये प्राविधिक पक्षमात्र समेटेर प्रतिवेदन तयार गर्ने गरेको देखिन्छ । प्राविधिक भित्रका विभिन्न पक्षहरूमध्ये Engineering /Architect विषय मात्र समावेश गरी Structural, Electrical, Sanitary, HVAC, Drainage लगायत महत्वपूर्ण पक्षहरू समावेश नगर्दा आयोजनाहरूको प्राविधिक मुल्याङ्कन तथा लगानीको लागि पुनः आयोजनाको अध्ययन गर्नुपर्ने भएको छ ।

३. **आयोजनाको वित्तिय व्यवस्थापन:** आयोजनाको DPR को आधारमा आयोजनाको प्राविधिक, आर्थिक, सामाजिक, कानुनी वातावरणीय मुल्याङ्कनको आधारमा कोषले मुल्याङ्कन प्रतिवेदन तयार गरी आयोजनामा कोषको तर्फबाट गरिने लगानी तय गर्ने गर्दछ । विभिन्न परामर्श संस्थाहरूले स्थानीय तहका पूर्वाधारहरूको DPR बनाउदै गर्दा आयोजना विकासको लागि आवश्यक पर्ने वित्तिय व्यवस्थापन वा लगानीका श्रोतहरू पहिचान नगरी वा सम्बन्धित स्थानीय तहहरूसँग यथेष्ट छलफल नगरी आयोजना अत्यन्त ठूलो र स्थानीय तहले स्रोत जुटाउन नसक्ने गरी तयार गरिदा आयोजनाहरूको लागत घटाउनुपर्ने वा विभिन्न चरणमा विकास गर्ने गरी आयोजना अगाडी पढाउनुपर्ने वा पुनः अध्ययन गर्नुपर्ने देखिन्छ । आयोजना DPR तयार हुँदै गर्दा आयोजनाको वित्तिय व्यवस्थापनलाई नजर अन्दाज गरी भौगोलिक परिस्थिती, सम्बन्धित स्थानीय तहको आर्थिक गतीविधी र अन्य पक्षलाई समेत ख्याल नगर्दा र आयोजनाको वित्तिय मुल्याङ्कनमा

आवश्यक विवरण समावेश नहुँदा पनि पुनः अध्ययन गर्नुपर्ने हुन्छ ।

४. **आयोजनाको निर्माण तथा सञ्चालन:** आयोजनाहरूको DPR तयार गर्दा आयोजनाको निर्माणको चरणमा आउने समस्याहरूलाई ख्याल नगरी तयार गर्दा आयोजना निर्माणमा तोकिएको भन्दा लामो समय लाग्ने, आयोजनाको खर्च बढ्ने र समयमा सञ्चालनमा आउन नसक्ने भएको छ ।

५. **आयोजनाको तयारी चरणमा हुनुपर्ने छलफल:** स्थानीय तहहरूमा प्राविधिक जनशक्तिको उपलब्धता अत्यन्त कमी छ । भएका जनशक्तिहरूलाई प्रयाप्त मात्रामा आयोजनाको तयारी ज्ञान, क्षमता विकास नहुँदा स्थानीय तहबाट तयार गरिएका अधिकांस DPR हरू प्रयाप्त छलफल विना नै तयार हुने गरेको देखिन्छ । परामर्श संस्थाबाट प्राप्त हुने DPR को मुल्याङ्कन गर्नसक्ने जनशक्ति स्थानीय तहमा नहुँदा DPR को गुणस्तर खस्कदै गएको छ । सार्वजनिक निकायका कर्मचारीहरूबाट पनि एथेष्ट रूपमा DPR माथिको छलफल विना DPR प्रतिवेदनलाई अन्तिम रूप दिँदा परामर्श सेवामा विकृती मौलाउदै गएको छ ।

आयोजना तयारीको चरणमा परामर्श दिने संस्थाहरू तथा सार्वजनिक निकायहरूका कमी कमजोरीहरूले गर्दा आयोजना विकासको लागि वित्तिय व्यवस्थापन समयमा हुन नसक्दा एउटा नगर प्रमुखको ५ वर्ष समय स्थानिय तहहरूमा सबैले प्रष्ट रूपमा अनुभव गर्न सक्ने सामाजिक तथा आर्थिक पूर्वाधारका आयोजनाहरू निर्माण सम्पन्न नगरी विदा हुनु पर्ने अवस्था सृजना भएको छ । DPR को नाममा तीनै तहका सरकारहरूको ठूलो श्रोत खर्च भईरहँदा प्रत्येक तहमा Project Bank तयार भई आयोजना विकासमा फड्को मार्नु पर्नेमा DPR भन्ने शब्द विभिन्न सार्वजनिक कार्यक्रममा, विभिन्न गोष्ठी तथा सम्मेलनहरूमा मजाकको विषय बन्दा परामर्श सेवामा काम गर्ने सम्पूर्ण विज्ञहरूको लागि नै लाजमर्दा अवस्था सृजना भएको छ । नेपाल सरकारको प्राथमिकतामा नपरेको यो क्षेत्रलाई ब्यबस्थित गर्न कानुन बनाई, कानुनी दायरामा ल्याई, अनुगमन, नियन्त्रण तथा क्षमता विकास गर्नसके इन्जिनियरीङ्ग परामर्श क्षेत्रमा सुशासन कायम भई विकासको जग मजबुत हुनेछ र देशमा इन्जिनियरीङ्ग परामर्श ब्यवसाय थप व्यावसायिक तथा मर्यादीत हुनेछ ।

Urban Transport - Contemporary Issues and Way Forward



Prem Lamsal

M.Tech., Transportation, IIT Delhi

Senior Consultant Engineer Practicing in the Middle East

E-mail : premlamsal@gmail.com

Background

Data shows the number of registered vehicles in Kathmandu valley has increased by more than 35 times in last two decades. This has contributed to significant rise in congestion and air pollution in the valley. The average travel speed is as low as 7 km/hr during peak hour which is much below the acceptable Levels of Service (LOS) in any capital city in the world. Though there are no established studies performed to determine the external cost to the national economy in our cities due to traffic congestion, it can be compared with other Asian cities having a similar level of congestion, which indicates the total cost of traffic congestion in Nepal being not less than 1% of the Gross Domestic Product (GDP). In addition, the contribution of traffic congestion to a significant tail pipe emission has resulted in Kathmandu to be ranked as one of the most polluted cities in the world. Recent statistics further reveals that various deadly diseases linked to air pollution are also increasing day by day, adding burden to the country's public health system.

World Health Organization (WHO) estimates fatal road crash rate of over 18 deaths per 100,000 population of Nepal, that is, an average of 13 deaths every day. Thousands are seriously injured and many of them get permanently disabled. Studies further shows the total cost to the country because of the premature deaths and disabilities resulting from road crashes is also not lesser than 1% of the GDP. In addition to such socio-economic impacts, the long-term effect on the families due to the death of the bread-winner is heartbreaking.

Another intriguing aspect that comes along the state of the country's urban transportation is trade patterns with its neighboring countries. Trade patterns of the years

shows: India is a source of, and a destination for, nearly two-thirds of Nepal's merchandise imports and exports respectively. Out of the US\$8.7 billion in officially recorded bilateral goods trade with India in 2018/19, 93.6 percent were imports by Nepal, resulting in a deficit of US\$7.6 billion. Data shows import of vehicles, their spare parts, and petroleum products from India are also the major components causing such a huge trade deficit with India, which is increasing day by day.

In light of the above discussion, it can be concluded that promoting the sustainable modes of transport systems in our cities can play a vital role to strengthen the country's weak and sluggish economy. Such models will consequently make our cities more livable by reducing air pollution, lowering road crashes, cutting down public health burden to the health system, etc. Many countries around the world are adopting or say changing their transport policies towards making their transportation system more sustainable with consideration to socio-economic and health related aspects.

Now it is of an immense need to discuss what the sustainable transport system means, and to explore the associated challenges. In line with that, the globally proven sustainable modes of transportation are mass transit systems and non-motorized modes like cycling and walking, or the combination of both, which basically discourages the private vehicle ownership. A sustainable transport system must provide mobility and accessibility to all urban residents in a safe and environment friendly mode of transport. However, this is undoubtedly a complex and difficult task to achieve, especially in a diverse country like Nepal where the

needs and demands of people belonging to different income groups are different and often conflicting. For example, when a large proportion of the country’s population cannot afford to use motorized private vehicles, they have to be dependent on either public transport or walk or ride bicycles to work. In that scenario, road/public space and investment on infrastructures should fairly be distributed considering the travel needs of medium and low-income groups, who are using public transport or walking or riding bicycles for their daily commute. But ironically, people who are in decision level mostly belong to high income group, and hence it is not difficult to say that our urban transportation systems are very much influenced by them, ignoring the needs of pedestrians, cyclist and public transport users in our cities. That’s the whole reason why public awareness and government interventions from the policy level are required to promote the sustainable modes of transportation, addressing the needs of pedestrians, cyclist, and public transport users, which comes with numerous environmental, social, and economic benefits in long run.

Here are some recommendations to improve overall urban transportation system in Nepal:

Improve Road Intersections

Recent infrastructural development in Nepal shows that road intersection design is one of the most neglected issues in the context of urban infrastructures design and development in Nepal. Authorities are working to widen the roads but not paying required attention to improve the associated intersections. The capacity of road intersection is the bottle-neck factor in the overall capacity of the road network in an urban setting. The number of lanes on the road hardly alleviates the congestion if the intersection is not properly designed. There seems a lack of appropriate knowledge and experience on intersection design. The very basic thing of intersection design is to know how traffic volumes and the turning movements are affecting the design elements and geometry of the intersection. Department of Roads (DoR) should look towards developing the team capacity on that front. It is also recommended to make use of correct technology while making design

decision and coordinate with other policy makers and stakeholders. Operation analysis can be performed using commercially available software like SYNCHRO or SIDRA for different scenario before making final decision on intersection design. Traffic simulation models can be used to demonstrate and convince the policy makers and stakeholders by emphasizing the particular design requirement. Sometimes it might not be possible to analyze individual intersections, to use in such cases; DoR shall develop a database for the design guidelines with typical options of intersections showing the relationship between threshold traffic volume, threshold turning movements and the intersection design elements, based on the operation analysis of multiple scenarios. In any case, it is very important to improve at grade intersections, signalize them as required, in order to expand the overall road network capacity. Expensive grade separated options like flyovers, which are the ultimate solutions to manage traffic, should be considered if all the at-grade options are fully utilized and exhausted.

Improve Public Transport System

This is one of the very essential components to focus to make the transport system sustainable and to reduce the number of vehicles on roads. Research shows, to discourage people to own private vehicles or to switch them from private vehicles to the public transport, there should be an acceptable option of public transport ready. Examples from various countries show government should not hesitate to intervene and if required to provide intensives to improve public transportation for the long-term benefits of the nation. This should be on both developing the public transport friendly infrastructures as well as intervening on bus fleet management system.

Global trends show Metro Rail as a preferred option for mass and rapid transit system in the cities with population above 5 million. But the question is: if it is financially viable, should it get national priority in the context of Nepal where around 25% of country’s population is below absolute poverty, and struggling for basic needs? It is important to see the cost and duration of metro rail construction in various Asian cities. The construction of Jakarta North South line (15.2km) was



started on 2013 and completed in 2019, with per kilometer cost around \$70 million. Construction of Delhi Metro Red line (8.3km) was completed on 2002, in 4-year time, with per kilometer cost \$35 million. Dhaka is struggling to complete its Metro line 6 (21.1km), which was started on 2016. So far it's per kilometer cost is around \$153 million. Considering the country's economy and the proven available managerial as well as technical capability, it is not advisable to go for eye-wateringly expensive project in Kathmandu for now. Efficiency of the transport system shall be maintained by discouraging private vehicle ownership and shall be increased by improving proper road infrastructure. Travel demand can be managed in the Kathmandu valley by introducing BRT (Bus Rapid Transit) system by developing the appropriate supporting infrastructure for it.

Improve Sidewalks and Pedestrian Crossings

Sidewalks and pedestrian crossings are the other most neglected elements among urban infrastructures in Nepal. As per WHO Global Status Report on Road safety-2018, estimated road fatalities for the year 2016 was 4,622 out of which pedestrian accounts for around 30-35% of the total deaths. Due to the lack of proper sidewalks and crossings at many places, pedestrians are forced to get mixed with high-speed motorized vehicles. While it is highly recommended to maintain minimum 2.0 m wide sidewalk separated by raised kerb on either side of all the urban roads, such standard is hardly followed in Nepal. Moreover, zebra crossings painted on streets without any safety consideration and without speed management system are giving false sense of safety to the pedestrian, and hence turning out to be more dangerous than normal crossings. Experience from various countries shows zebra crossings provided at mid-block crossing will only work, if traffic flow on that direction has been stopped due to the red phase on the traffic signal at the upstream side, so that pedestrian can utilize that gap created by that red light to cross the road. In case, where there are no traffic signals on the network to create the acceptable gaps for pedestrian to cross the road, it is highly recommended to manage the speed to not more than 30 km/hr by installing physical measures like speed humps, speed tables, speed bumps, rumble strips, etc. near the crossings. Further, it is not to

be expected that the pedestrian will cross more than 2 lanes at a time in uncontrolled mid-block crossings suggesting for the provision of a traffic island or median in between lanes to be used as a refuge in case of 4 lanes roads.

Research shows that in the case of proper infrastructures support, people are normally ready to walk for shorter trips up to 30 minutes. The climatic condition of Kathmandu valley also supports walking for shorter trips. Also, with the numerous health benefits of walking, a good proportion of urban population would prefer to walk if they don't feel hassle. Thus, a large number of local walking trips can be managed by improving infrastructures and facilities required for pedestrians.

Plan and Develop Bicycle Lanes

One of the reasons why there are not as many bicycles seen on the roads and street of Kathmandu like in Tokyo or in Copenhagen is: there are no safe facilities for bicyclist. Data shows a sizable number of cyclists being killed or injured on the roads of Nepal every year. Certainly, the reason is the non-provision of separate bicycle lanes; cyclists have to be mixed with high-speed motorized vehicles in the middle of the mismanaged road. Hence, people do not prefer to use bicycle in Kathmandu valley. Just like walking, research shows people are normally preferring to use bicycle for shorter trips ranging from 30 mins to 45 mins, again if the infrastructures support. It has also been demonstrated by several countries where cycling has been a part of the daily commute of large population. Similar to walking, cycling also has numerous health benefits which encourage people to use it as daily commute. For wider use and benefits, it has to be integrated with other modes of transportation like mass transit. It is highly recommended to plan and develop the bicycle associated infrastructures and facilities in Kathmandu and other cities in Nepal, to promote it from policy level.

Promote Electric Vehicles

Electric vehicles (EVs) have several benefits over conventional gasoline based internal combust engine automobiles. EVs cause reduction of local air pollution, especially in cities, as they do not emit harmful tailpipe



pollutants such as particulates (soot), volatile organic compounds, hydrocarbons, carbon monoxide, ozone, lead, and various oxides of nitrogen. As the hydropower production in the country is increasing every year, it should not be delayed on promoting and advocating for EVs to maximize its use. In addition to reducing air pollution in our cities, promoting electric vehicles, has huge economic benefits to the country as it will help to reduce the petroleum product associated trade deficit with India. It is highly recommended to plan and develop charging stations and other associated facilities to promote the use of EVs. Unless normal public do not get assurance from the state by developing associated infrastructures, they won't prefer to invest or switch on that side. So, it is the responsibility of government to take proactive initiations and actions to move towards sustainable EVs.

Make Road Safety Audit (RSA) Mandatory

RSA is defined as a formal safety performance examination of the road or intersection by an independent and multidisciplinary team. RSA qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users (pedestrians, cyclists, motorcyclists, truck and bus drivers, car drivers, and others).

The aim of an RSA is to answer the following questions:

What elements of the road may present a safety concern: to what extent, to which road users, and under what circumstances ?

What opportunities exist to eliminate or mitigate identified safety concerns ?

Almost all the road safety guidelines published by various countries have mentioned that RSA has to be conducted at the various design stages. Remedying the defects at the design stage is an economical and effective way of reducing road crashes. In Nepal, RSA manual published on 1997 by Department of Road (DoR) states that ‘earlier a project is audited the more scope there is to change things’ and it has also prescribed the requirement of safety auditing of the Road in four different stages, namely feasibility study stage, draft design stage, detailed design stage and pre-opening stage. Nepal Road Safety Action Plan (2013-2020) prepared by Ministry of Physical Planning & Transport Management has also made road-safety audits mandatory for all new constructions, major maintenance and rehabilitation projects involving the national highways and feeder roads (strategic road

network of Nepal). But despite the standards and guidelines set by the government authorities, the RSA is still not in practice in Nepal. Studies suggest that RSA of Road projects make them almost five times more effective in reducing fatal and injury crashes (US Federal Highway Administration, RSA Guidelines, 2006). It is highly recommended for carrying out RSA in road projects in various stages. In the context of Nepal, capacity building of DoR on this front, as well as developing institutional framework for RSA is highly recommended to have more effective results.

Introduce Traffic Impact Study (TIS)

As per the current regulation in Nepal, it is not mandatory to carry out the TIS by the new development in Nepal. To make the road transport system efficient especially in the urban environment, it is necessary to know the impact on the surrounding roads by the traffic generated due to any proposed new development. Only then authorities should plan the improvement on the existing road infrastructures. For example, if a new shopping mall is planned to be established at some location in Kathmandu, it is absolutely necessary to understand the impact of traffic generated by that shopping mall on the neighboring roads. Many cities on the world are making it mandatory to carry out such TIS before approving any new development on that particular locality of an urban area. TIS could be limited to development plan review, or checking access road and tie in intersections with existing road, or carrying out the full TIS, depending on size and nature of project. Hence, it is recommended to introduce the requirement of TIS for any new development from policy level.

Conclusion

Undoubtedly, promoting the sustainable modes of transport systems in our cities can play a significant role to strengthen the country's weak and deteriorating economy, and to make our cities more livable by reducing air pollution, lowering road crashes, and cutting down the public health burden to the health system. It is highly recommended to the government of Nepal to develop and amend policies and regulations to give priority to sustainable modes of transportation. At the same time, it is also recommended to work on improving existing roads and intersections in the country, thus making them safe and efficient for all kinds of users following the globally proven practices and measures.



QAQC in Infrastructure Projects, Issues & Challenges



QC Er. Jagadiswar M. Shrestha

E-mail : jagadiswar.personal@gmail.com

Introduction

Concrete is an artificial stone having basic ingredients of cement, sand, coarse aggregate and water. This is a very popular construction material having high strength and flexibility in shape and size, and can be prepared using readily available local materials in general. Most of the modern structures in the world are made of concrete. There are many causes for the lack of quality, mainly due to many steps involved during production of concrete. Design, procurement process and construction are the main components of concrete production. There is a necessity of geological investigation, planning, structural design and detailing in design stage. Proper procurement system as per site condition and national policy also form an important part to success. Item rate contract, lump sump contract, EPC (Engineering, Procurement and Construction) or a combination of one or more of the above may be used for the procurement which is necessary to be judged by experienced personals. At last, quality assurance and quality control (QAQC) of concrete ingredients and concreting procedure is highly important part for proper sustainable and durability.

The strength of the cement concrete depends upon the quality of its ingredients, relative quantities and the process of concreting i.e. mixing, compacting, curing etc. The grade of the concrete varies from low to high and the choice of the grade depends upon the purpose of the structure and strength to be achieved. The proposed grade can be achieved by mixing the ingredients in different proportion. Depending upon proportion of the ingredients, lean concrete to tough concrete can be produced. Besides, the cement concrete is considered to be superior to any other construction materials in terms of the durability, corrosive resistance, fire resistance etc. The development of concrete structures in Nepal is also rapidly rising, however major concern has always been the lack of sustainability and durability due to the current construction practices.

Quality Management

For quality construction, management of time for completion within expected period, completion within agreement amount with minimum claim is very important. Whereas the quality of Reinforced Cement Concrete (RCC) structures in infrastructure needs quality of ingredients namely cement, aggregates, admixtures if necessary and reinforcement bars. Similarly, the concreting process comprises of batching, mixing, transportation, placing, compaction and curing.

Some good examples of national priorities irrigation projects completed within targeted time and cost are mentioned below. Headworks of Sikta Irrigation Project (SIP), Banke; Side Intake of Rani Jamara Kularia

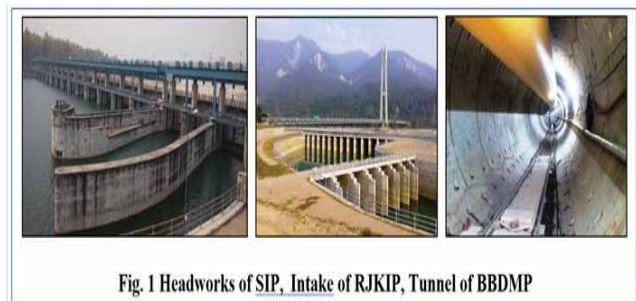


Fig. 1 Headworks of SIP, Intake of RJKIP, Tunnel of BBDMP

Project (RJKIP), Kailali and Tunnel construction of Bheri Babai Diversion Multipurpose Project (BBDMP), Surkhet. The RJKIP has a few month extension of time due to damage to the coffer dam and access road by unexpected heavy flood which was more than design. The headworks of SIP was completed with only 0.29% increment in cost, whereas less amount was expended in RJKIP and BBDMP by 4.35% and 6.89% respectively.

Table 1. Comparison of Time & Cost of the contract of different project works

Particular	Headworks of Sikta I.P, Agaiya, Banke	Intake of RJKIP, Chisapani, Karnali	Tunnel (12.2km) of BBDMP, Surkhet
Date of Agreement	2006 June 05	2011 Feb 03	2015 June 04
Date to be Complete	2009 Dec 31	2013 Aug 15	2020 Mar 28
Date of completion	2010 May 31 (EoT 5.5 month)	2014 June 29 (EoT13.5 month)	2020 Sep 18 (EoT 6.0 month)
Contract Amount (NRs)	1,855,051,757.91	1,049,030,312.18	10,569,732,141.52
Final Expenditure (NRs)	1,860,408,051.23	1,003,373,449.67	9,840,578,000.00*
Concrete Works	167,810 cum	42,348 cum	51,432
Rebar Consumed	8,011MT	3,524 MT	5,654 MT
Sample Cube Crushed	20,136 no.	5,580 no.	13,836 no.

Exact amount is to be finalized

For better quality management process, following three things has to be considered:

- Quality Standards - generally defined by the contract documents, design criteria and guidelines
- Contractor Quality Management Program - includes QA plan and QC process which is to be prepared and approved by the Consultant/Engineer
- Managing quality - requires well trained personnel deployed with clear roles and responsibilities.

The workforce involved in the construction is divided by three ways; from the employer or client side, consultant's side and the contractor's side. Most of the people involved are engineers by profession and hence any goodwill of success or bad image of failure shall be borne by the engineers. It is necessary that the relation among these three parties is horizontal with equal responsibility so that the work can be complete by the effort of team spirit. In practice, it is seen that some projects have vertical relation as clients pressurize consultants and consultants to contractor which has adverse effect in the progress and quality of the infrastructure.

There are many challenges of quality control in management and infrastructure quality. In the context of Nepal, following challenges in quality management have been faced by many projects:

- Incompatible construction plans/schedules along with quality assurance and quality control plans – these results in doing jobs quickly without following quality assurance plans.
- Site personnel for construction quality management and control are not well trained and experienced enough to understand design assumptions, principles and limitations, adapting the design to site

conditions and foresee risks and initiate preventive measures.

- Lack of innovative works due to absence of risk-taking capabilities.
- Carrying on work as it was going on in previous days without contextual logic and not following specification.
- Negative attitude towards of quality work.
- Lowest bid is not always the efficient bid.
- Genuine claim by the contractor is not paid within construction period

Genuine claim by the contractor is held and not paid at the earliest which makes the contractor reluctant in producing quality work & progress due to tendency of avoiding risks for payment. This payment is made many years later when the concerned officials related to this project will not be present and documents will be incomplete. If the claim is paid during construction by the personnel involved during the construction, it will be genuine and with minimal required amount. This will motivate an environment to complete the project as soon as possible for the contractor. For example, the damage of access road at BBDMP which was designed for 50 year return period flood but the flood of more than 100 year return period washed out 230 m of the total access road due heavy rainfall on 13 Aug 2017 just before transportation of TBM (1056 MT). This time period was very essential as the TBM was being transported during the same time. Despite the problem, the contractor completed the reconstruction of road just before arrival of TBM within one month on 13 Sep 2017. The contractor claimed for the damage with evidence and payment was made at the earliest possible





Fig. 2 Breakdown of access road and repair completed before transportation of TBM component.

It is the duty of every personnel involved in the construction to construct infrastructure in sustainable and durable manner with consideration to environmental, economic and social aspects. There is no issue if the structure does not show signs of failure during or after construction within its lifetime. Major issues arise if the structure does not perform well or is damaged or collapses. Failure of infrastructure occurs primarily due to the quality of construction whereas detailing is secondary and failure by design is the last cause. But in practice, if any structure collapses, the designer is questioned immediately. It is rare that the structure collapses due to error in design and can occur if there is a blunder in design or due to new features that need additional research. If quality construction is done properly, minor errors in design and detailing will be covered up, but if the quality is poor, structure may collapse even if the design is done by the best engineer. Design should always be carried out by experienced engineer using latest related research documents and codes.

Quality Assurance Plan

Preparation for quality assurance and quality control system is the most important aspect for the structure to perform well under construction and in its life period. Thus, the Quality Assurance Plan (QAP) specifies the project management, organization, and further identifies the procedures used during construction to

assure accuracy, precision and representativeness of the data collected. It also assures that the procedures provided shall be implemented so that the project quality objectives are achieved. The QAP presents an overall description of the methods, responsibilities and procedures associated with the field characterization and construction activities. It is the responsibility of all project personnel to help to achieve quality in construction and analyze the activities in the QAP in detail. Any ambiguity or doubtful meaning of technical specification should be decided by engineering judgement complying with QAP. The specifications expressed in language should be provided in the following tabular form. The table should consist of the tests to be carried out for each item, limiting values of tests, frequency, related codes etc. so that each and every field staff can understand the document without any ambiguity.

Table 2. QAP for Each Item of Works

Item	Material	Tests	Spec. limit Requirement	Quantity	Test Frequency	No. of test	Spec./code Reference	Equipment	Conducted at	Conducted by	Remarks

In QAP, each item shall be described in brief and major items like reinforcement bar, ingredients of concrete works etc. shall be described in detail. Testing labs must be established at the site. Due to the lack of testing labs, the materials and samples are sent outside for testing. Due to the lack of sufficient testing equipment at the site, improper testing frequency and tests not being carried out in the specified day, the efficiency of the lab decreases drastically. The cost of test does not exceed 1% of the total construction cost in general. Therefore, it is essential to mention where all the tests of materials will be done. It should be mentioned in specifications in projects exceeding about 200 million rupees that the contractor should establish their own testing facilities on site. The personnel involved in construction should be knowledgeable about ingredients in RCC construction from all three sides of client, consultant and contractor. Any quality work done is regarded as a creating problem or hassle in the work which results in degrading of quality of works.

The responsibility of quality control will be primarily of the Quality Control Engineer of contractor and then the Employer/Engineer. Quality control includes the following documents but not limited to;

- Detailed independent check of compliance with the Employer’s policies and procedures.



- Detailed independent check of compliance with the Technical Specification.
- Laboratory testing of materials before its uses in the construction purposes.
- Procurement of quality materials.
- Use of quality local materials.
- Deputation of qualified human resources.
- Documentation and record keeping.

QAP is to ensure that the technical specifications mentioned in the documents are met with required values and satisfactorily results. To produce acceptable testing results, this QAP ensures that the data is representative, comparable, complete, accurate and precise. Laboratory shall provide the test result on test schedule provided in QAP. Acceptable results are those values that fall within the acceptable range as specified in the Technical Specifications. Corrective action and continual improvement for unacceptable results for specific testing methods shall be performed with a joint effort of the Employer, Engineer, and Quality Control Engineer. All corrective actions taken will be documented and a copy should be submitted to the Employer/Engineer. No work should be pursued if the quality of the services observed is not met. In clause 16, Table 11 of IS 456:2000 (with amendment no.4-2013 May), the following table of strength compliance of concrete is mentioned.

Table 3. Compliance of Strength of the Concrete

Cube Sample	Specified Grade	% age of cube pass	Individual Test Results	Mean of the Group of 4 Non-Overlapping Consecutive Test Results
1 Sample only (3 cube)	M15 or above	-	$\geq (fck-2) N/mm^2$	$(fck + 4) N/mm^2$
≤ 30 (Std from Table 8, Clause 9.2.4.2)		Cube shall be pass > 95% of total cubes	$\geq (fck-2) N/mm^2$	$\geq fck + 0.825 X$ established Std. Dev. or $(fck + 4) N/mm^2$ whichever is greater
> 30 (with own Std)			$\geq (fck-3) N/mm^2$	$\geq fck + 0.825 X$ established Std. Dev. or $(fck + 3) N/mm^2$ whichever is greater

If the compliance of strength of above condition from IS 456:2000 is mentioned in the specification and the test results are not satisfactory, corrective measures should be followed. The corrective measures include identification of problems, causes of problems and the corrective measures to correct the problems. The suggested corrective measure should be implemented and its effectiveness should be verified. Finally, the engineer will decide if the corrective action yields satisfactory results or not. If the results are doubtful or unclear, core test should be carried out as a final measure.

In the specification of headworks construction of Sikta Irrigation Project, 19.2 m span twin precast of I shape girder was provided on pier and connected by cast in situ cross girder and deck slab was provided. A heavy weigh capacity crane was needed to lift and place girder on the pier. After placing of I shaped girder, crossed scaffold post from flange & horizontal tie scaffold post was provided (Figure 4) on which plane soffit formworks were provided for the casting of concrete. There is no any effect on formworks due to water flowing in the river and deck slab casting could be carried out without any disturbance by river water.

As pre-cast segment was used, the use of formworks was reduced to a minimum. This helped as the water flowing in the river below had no effect on the deck slab casted above. This construction methodology for the construction of bridge was mentioned in QAP at SIP.



Fig. 3 Procedure for deck slab construction with precast girder as per method of statement

Most of the superstructure of bridges above pier in Nepal is not carried out as in headworks of SIP, due to lack of heavy crane for the transportation and placing of precast girder. In general context, for formworks of the superstructure above the pier, the earth level is compacted in layers and raised upto a certain height where erection of scaffolding will be easy. This consumes a lot of time from starting till the concrete gains its strength as multiple spans should be constructed. Also, the risk of flooding is ever present which may cause failure of scaffolding, loss of time and money along with the loss of image of Engineers in the society. More than 21 numbers of deck slabs have been damaged or collapsed in the fiscal year 2078/79, most of which are due to failure of scaffolding. Scaffoldings erected for a long duration have been washed out and succumbed to failure. Design of formwork is not usually carried for small structures as it is usually safe. But for long spans with heavy weight, design of formworks should be carried out to ensure stability. Diversion of rivers may be required according to site conditions.



Fig. 4 Misguide of formworks design and procedure of deck slab construction

QAP is necessary with method of statement which assures to sustain the structure without damage/collapse during or in the life span of construction. If the precast beam is heavy for long span, multiple number of girders can be provided to reduce the weight so that working with a crane is easy.

Quality Control of RCC

Quality control is a formal systematic process designed to ensure that expected quality standards are achieved during the construction. The construction will be implemented based on approved QAP submitted by the contractor and quality of each ingredient and concreting process shall be thoroughly followed. Basically, there are two steps in quality control of RCC; one being the ingredients’ quality

before construction and the other being the whole process during the concreting process. It is easier to check the quality of ingredients used in the RCC, viz; cement, coarse & fine aggregates, admixtures water etc. as they have a specific value which can be

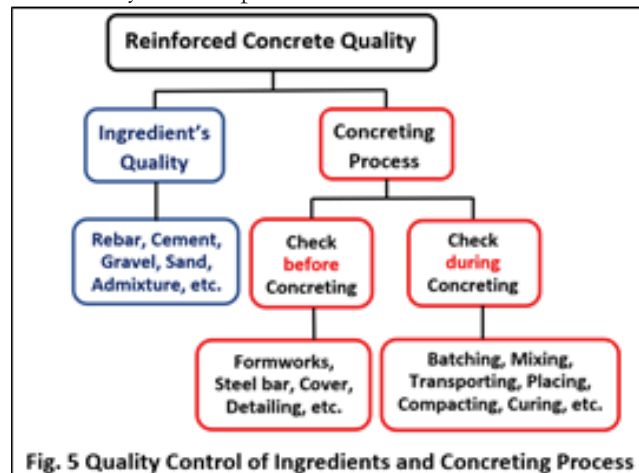


Fig. 5 Quality Control of Ingredients and Concreting Process

controlled by their lab tests. It is necessary to know individual characteristics before starting any test. There are two steps of controlling in concreting process. First one involves the checking of all associated components before concreting: from the beginning of bar-placing till before concreting day with proper cover, spacing and the necessary detailing. It cannot be corrected during concreting after the placement of all bars. The concreting process includes proper batching as per prescribed ratio, mixing system, transporting as per site condition, compacting of concrete and curing of concrete. Since there are many aspects involved in producing concrete, concrete quality will degrade if any one or more steps of the process deviate from its target. Some of the important features of ingredients and concreting process in the site which helps to enhanced quality of concrete are described below.

Cement

Cement is the most expensive ingredient in concrete. The most commonly used cement is Ordinary Portland Cement (OPC) of grade 43 and grade 53 for the reinforcement concrete. Portland Pozzolana Cement (PPC) of grade 33 cannot be used for RCC as it has low strength, but is useful for the application of low grade concrete and non-structural elements. There is new code developed by Nepal bureau of standards as NS 572:2076 published in gazette on BS 2077 Baisakh 29 for grade 43 and grade 53. There is a special feature different than previous code of NS 49:2042, i.e. the new code mentions that cement older

than 3 months from the date of manufacture should be tested again before its use. The age of cement has direct effect on the strength of concrete. Three 43 grade OPC cement (Prism, Jaypee and ACC) was considered for the experiment. The cement was tested in its manufactured week, five weeks from the manufacture date and after three months from its manufacture date. Here the blue bar represents cement older than 3 months. Similarly, red bar represents cement older than one week and the green bar represents cement older than 5 weeks from the date of manufacture during the time of testing. In general, the cement older than three months achieved only 60 percent of the 28 days strength as compared to the 28 days strength achieved by fresh cement less than one week old.

Figure 6 shows how the age of cement directly affects the strength of cement. Required strength for 43 grade cement is 43 N/mm² at 28 days of age. For fresh cement, i.e., production time is within one week, all the cement yields good result (more than 52.17 N/mm²). The normal cement older than five weeks of age has marginally passed the required criteria. All the Indian cements have manufactured date printed on them in the format of week, month year (W, M, Y). Some of the Nepali cements have no manufacture date printed on them, yet they are available for sale in the market. It is difficult to distinguish if the cement is of good quality without knowing the exact date of its manufacture.

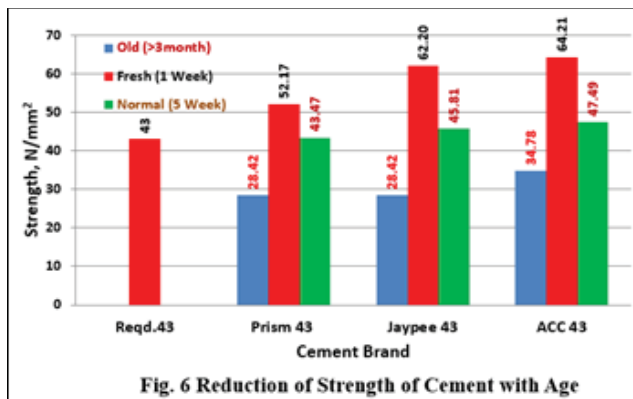


Fig. 6 Reduction of Strength of Cement with Age

Aggregates

Aggregates occupy 70 to 80 percent volume of the concrete. Therefore, the characteristics of aggregate play a vital role in the overall properties of the concrete. Any study on concrete is incomplete without knowing the properties of the aggregates. IS 456:2000 specifies maximum amount of cement that

can be used in a trial mix. If maximum cement is already being used one can rely on aggregate to improve the strength. The grading, strength and shape are the main parameters to understand the properties of the aggregate. Sieve analysis are carried out to determine the grading; similarly, aggregate crushing value (ACV) and ten percent fine value (TFV) are the



Fig. 7 Crusher Plant with Cone & Impact Crusher

parameters to measure strength, and measurement of flakiness index (FI) and elongation index (EI) defines the shape and texture of the aggregates. The production system of crusher plant also greatly influence the quality of aggregates, especially in particle shape. In general, only jaw crusher is used in the production plant to break down the maximum size of aggregates. But in BBDMP, additional arrangement of cone crusher and impact crusher were used to produce better quality of shape and size. The properties of flakiness index and elongation index were greatly improved by using this type of crusher plants.

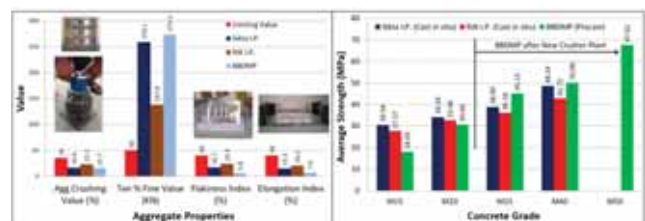


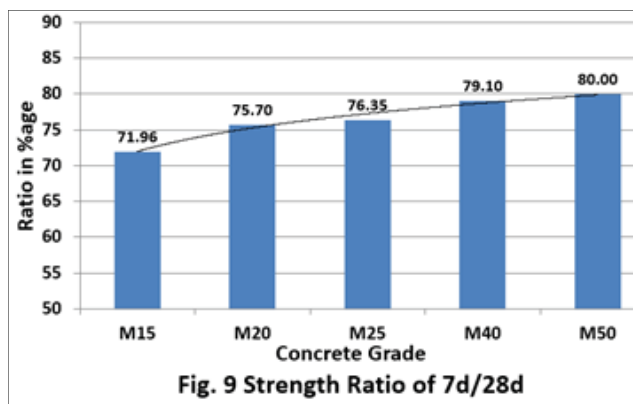
Fig. 8 Aggregate properties and effect of concrete strength due to FI & EI

Another major factor of the concrete strength is hardness or strength of the aggregate itself. This is measured by aggregate crushing value (ACV) and which plays vital role for the production of high grade concrete. Flaky & elongated aggregates also play to some extent a role in the strength of concrete. As per the specifications in the above three projects, limit of ACV was up to 35% and minimum load for ten

percent fine value (TFV) was 50 kN. Similarly, upper limit of both flakiness index (FI) and elongation index (EI) was 40 percent for concrete. The obtained values from the field of SIP & RJKIP followed similar pattern for all grades including in BBDMP up to M20 before crushing plant was established at BBDMP. RJKIP had lesser strength than that of SIP. Whereas in BBDMP, flakiness index and elongation index were very less after using the crusher plant with cone and impact crusher from which strength of concrete was increased substantially.

Ratio of 7 days to 28 days’ Concrete Strength

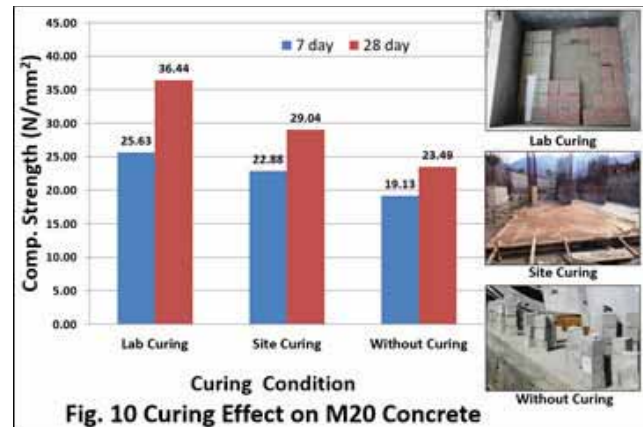
The compliance of strength is based on 28-days strength of cube. Progressive strength of 28 days is related to 7-day strength. Construction of the structure will progress rapidly within 28 days of construction. If the 28-day cube fails to meet the required criteria, it will be too late to rectify the errors in concreting done during this time period. Therefore 7-day strength can be regarded as the index that foretells the probable 28 days’ strength of concrete. Strength ratio of seven days to twenty-eight days of Figure 9 is based on data from thousands of tested cubes. It shows that the ratio of seven days to twenty-eight days strength goes on increasing as the grade of concrete become higher. This means the ratio of seven days to twenty-eight-day increase faster in higher grade in concrete.



Effect of Curing on the Strength of Cube

Curing is the process by which the concrete is protected from loss of moisture. In the field, sample cubes are cured in curing tank, while the structure is not cured properly. The cured cubes hence do not give the actual data and is not compatible to actual field condition. To solve this problem, an additional constant (k^* is added to the characteristic compressive strength (f_{ck}) in the form of $f_{ck} + k^*$ (where k is a

probabilistic constant and is the standard deviation of the strengths of tested samples) An experiment was done to check the differences in strength by site curing and lab curing. When the concrete was casted, extra cubes were made. The normal procedure of curing the cubes in the water tank in lab was done, but the extra cubes were kept on the structure so it would receive the same amount of curing as that of the structure. Another controlled sample of the same concrete was made where no curing was done. The results of the experiment are shown in Figure 10.



The cube cured in laboratory yielded 25.48 percent more strength than that of the cubes in actual field condition. Similarly, the strength of cube without curing is about 19.11 percent less than actual field condition. The cost of curing is negligible compared to the cost of concrete, but the strength of concrete is greatly influenced due to negligence of curing.

Conclusion

The following conclusion can be made from the above discussions:

- Completion of works within expected time, cost and quality represent the overall quality of the project.
- Payment of genuine claim by the contractor within construction period motivates the contractor and creates a positive environment, thus decreasing the cost of the client.
- Proper quality assurance plan assures good quality work and prevents the failure of structure.
- Better quality of cement plays vital role in the strength of concrete.
- Use of qualitative aggregate reduces the cement quantity in concrete without compromise in strength.
- Ratio of 7-day to 28-day strength increases as the grade of concrete increases.
- Proper curing is extremely important to achieve the targeted strength.





ERM (P.) Ltd.

(Environmental & Resource Management Consultant)

Phone : 01-4483064, 4465863 Fax:01-4479361

E-mail: info@ermcnepal.com,

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Hemant Tiwari

E-mail : hemu.ioe@gmail.com

“Road Safety Audit and Paradigm Shift Towards Safer Roads Design in Nepal”



Subhash Dhungel

E-mail : subhashdhungel65@gmail.com

Abstract

Over the years, more vehicles are involved in crashes, crashes and injuries have increased in Nepal. Nepal recently updated its National Road Safety Action Plan (2013- 2020) for the period 2021- 2030 with UN Declaration of Second Decade for Road Safety. This article mainly focuses on the various interventions under Pillar 2: safer roads and mobility of the global and national Road Safety Action Plan, focusing on road safety audits.

The various risks prevailing in the Nepalese hill roads ranging from single vehicle run-off crashes at unprotected steep valleys; very high casualties from single bus run-off crashes; high speed head-on collision at sub-optimal curves; running-off the road due to over speeding, inadequate sight distance, etc. are presented. Some positive developments recently in terms of provisioning a road safety is also discussed. The authors argue that road safety aspects are better incorporated in the design or construction of a road project under this latest development. However, the issue of conflict of interest when the same expert designs the safety features and conducts the road safety audit simultaneously persists.

The need for a road safety audit policy is also discussed and the formal process to an audit should ideally undergo, are presented. Finally, several recommendations are discussed to truly institutionalise road safety audit and ensure safer roads design and construction.

Keywords: Road crashes, National Road Safety Action Plan; Safer Road & Mobility; road safety audit; Road Safety Interventions.

Introduction

Approximately 1.3 million people die annually from road crashes (hereinafter simply referred as “crashes”)

as per the 2021 statistics from the World Health Organisation (WHO). These injuries lead to significant economic losses and health implications. The global road safety trends also mirror what is happening in Nepal. As shown in Figure 1, both the number of vehicles involved and crashed steadily increased over the past decade (FY 2067/68 to 2076/77). The number of injuries of all severity (fatal, serious injury and minor injury) also increased over the same decade, though at a lower growth-rate.

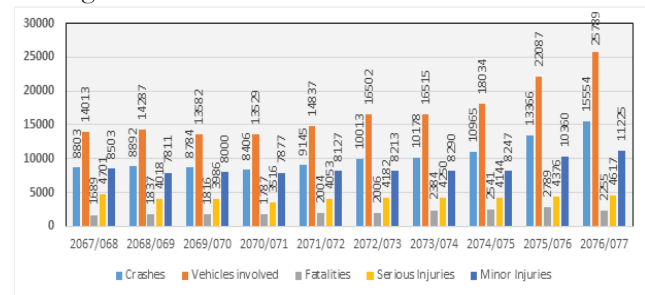


Figure 1: Historical Trend of Road Crash Injuries in Nepal

With federal government of the country, the database is managed on provincial level. Based on road crash and fatalities statistics of fiscal year 2076/77; Bagmati province shares more than two third of road crash data and even Kathmandu shares more than 50% of the crashes. And regarding road fatalities, Bagmati rank as most critical province which shares 25% of total death followed by Lumbini Province which shares around 21%. Karnali and Sudurpashchim Province; which have less population also contribute very low percentage of 4% and 6% respectively.

Between 2007- 2017, DALY in Nepal increased by 10% due to disabilities from crashes in Nepal. In the Nepalese urban roads, motorcyclists are mostly involved in the crashes while in the rural areas, buses and trucks are mostly involved. The crashes in the latter areas also lead to multiple deaths and serious injuries. The



economic loss from crashes in Nepal increased from Nepalese Rupees (NRs.) 2.7 billion (US\$ 41.5 million) in 2008 to NRs.12.6 billion (US\$ 122.88 million) in 2017 . In 2017, the national economic losses from crash injuries in Nepal was 1.52% of the gross domestic product of the Country.

To tackle the alarming loss of life and serious injuries from crashes, the United Nations launched the UN Global Decade of Action on Road Safety in 2011 and prescribed interventions under five pillars (Pillar 1: road safety management; Pillar 2: safer roads and mobility; Pillar 3: Safer vehicles; Pillar 4: Safer road users and Pillar 5: post-crash response. Subsequently, Nepal introduced its National Road Safety Action Plan (2013-2020) or NRSAP (2013- 2020). But neither the global road safety stakeholders nor Nepal could achieve the UN 2020 safety target. Thus, the UN General Assembly has now extended the ambitious target to half the number of crash deaths and injuries by 2030. On the national front, Nepal has drafted the NRSAP for 2021-2030, drafted the National Road Safety Bill 2076 (2019) or NRSB 2076 (which is in the final process for submission in the Nepalese Parliament for its endorsement). A Draft National Road Safety Policy and Strategy (2020-1- 2030) , consistent with the NRSB 2076 has been developed, to further guide road safety interventions in the coming days.

The interventions under Pillar 2: safer roads and mobility, are important intervention areas to holistically reduce crashes injuries in tandem with the activities in the remaining five pillars (safety management; safer vehicles; safer users, safer speeds, and post-crash response). This paper concentrates on the interventions under Pillar 2: safer road and mobility, with particular focus on road safety audits. Road safety audit (RSA) is a formal qualitative safety assessment of road by independent road safety auditor team who are independent from the road designer and the Client. RSAs are pro-active approach to road safety assessment because it does not rely on crash data but rather makes a qualitative assessment of the safety issues and outlines the necessary interventions required to render the road safer for all users.

Road Design Approach in Nepal

NRS 2070 stipulates the various design elements such as radii, sight distance, lateral clearance, superelevation, etc., that influence traffic safety of the road based on the adopted design speed and the terrain involved. While aspects such as superelevation, camber, etc., are

maintained in new road construction or upgrading, the prescribed minimum radius, sight distance cannot be provided at many segments of the road. NRS 2070 also prescribes a road alignment to ensure a sight distance that is preferably equal to the overtaking sight distance or at least equal to the stopping

sight distance for multi-lane roads and double the stopping sight distance for single-lane highways. However, both the minimum radius as well as the sight distance requirement, which, significantly impact traffic safety along the road, are neither entirely complied nor interventions are implemented to mitigate the inadequate radius or sight distance provided (e.g. advance warning signs, delineation, speed reduction measures, etc.) to prompt drivers to lower their speed and cautiously negotiate such design deficient road segments. Table 1 shows a sample of strategic roads under the Department of Roads (DoR) that have not complied with the NRS 2070 requirements.

Table 1 Non-compliant Geometric Features Existing in Sample of Strategic Roads in Nepal

S/N	Highway/ Road	Design Speed (kph)	Sub-optimal curves	Obscured visibility at blind corners & summits	High gradient segments
1.	TRP (Nagdhunga-Naubise section) 12.4 km	50 kph (assumed)	10 curves of radius = 20- 30 m	36 locations	7 segments with cumulative length of 5,498 m All segments warrants climbing lane
2.	PRM (Naubise-Mugling section) 82.4 km	60 kph (assumed)	231 curves of radius<110 m	71 locations	19 segments with cumulative length of 8,250 m 14 segments warrants climbing lane (cumulative length =5,750 m)
3.	Galchhi- Trishuli-Syafubesi Road 90 km Phiddim –	30 kph	265 curves of radius< 20 m	163 locations	11 segments Climbing lanes warranted at least at Dhunche- Syafubesi segment (3.2 km)
4.	Taplejung Road 84.4 km Tamakoshi- Manthali-	30 kph	62 curves of radius< 20 m	388 locations	Numerous segments with cum. length =25,961 m Climbing lane warranted at many places
5.	Ramechap Road 56 km	30 kph	(Within KM 0+000 -22+218) 52 curves of radius< 20 m	247 locations	16 segments with cum. length =6,917 m 11 segments warrant climbing lanes (cum. length = 8,470 m)
6.	Taplejung-Subetar Link Road 8 km	30 kph	39 curves of radius< 20 m	10 locations	48 segments with cum. Length= 5,250 m 17 segments warrant climbing lane (cum. Length= 1,600 m)
7.	Bhaktapur – Changanarayan Road 5.7 km	30 kph	7 curves of radius <20 m	26 locations	17 segments with cum. Length= 1,686 m 2 segments warrant climbing lane (cum. Length= 300 m)
8.	Harkapur- Okhaldhunga Road 41 km	30 kph	128 curves of radius< 20 m	145 locations	Numerous segments with cum. Length= 23,375 m Climbing lane warranted at many locations

Table 1 shows that the minimum radius, required sight distances and climbing lanes were not implemented into the road concerned. As discussed earlier, the required mitigation measures (e.g. signage, delineation, speed control, etc.) to warn drivers of the traffic safety hazards, were not incorporated in the design and implemented on the ground. For example, head-on collisions can occur at blind single/ broken-back curves and sharp hairpins, if the necessary signage, delineation and speed controls are not implemented. Secondly, no mitigation measures to



prevent rear end, side swipe collisions between the light vehicles and truck along the steep downgrade, were implemented.

NRS 2070 allows construction of hairpin bends on hilly roads where the site constraints demand the same. However, the drivers do not slow down to 20 kph that hairpins are designed for as per the NRS 2070. Therefore, there is a high risk of crashes at the hairpins due to unsafe speed of the vehicles in these areas. Therefore, appropriate traffic calming measures to slow vehicle speeds at the hairpins, increasing the curve widening at the vertex of the hairpins to improve the sight distance or even bypassing the hairpins, etc., should be pursued at these locations.

Within the strategic road network of Nepal, there is significant risk of run-off the road crash of single vehicles owing to the presence of steep vertical drops at the valley side that are open or inadequately protected. Table 2 shows the quantity of safety barriers required in some sample of Nepalese hilly roads.

Table 2 Safety Barrier Required in Sample of Strategic Hill Roads in Nepal

S/N	Road	Road length	Safety barriers required	
			Cumulative length (m)	% of the road
1.	TRP Nagdhunga –Naubise section	12.4 km	9,972 m	80%
2.	PRM Naubise- Mugling section	82.4 km	65,512 m	80%
3.	Galchhi- Trishuli- Syafrubesi	90 km	11,967 m*	13%
4.	Phiddim- Taplejung	84.4 km	8,208 m*	10%
5.	Tamakoshi- Manthali- Khurkot	56 km	17,344 m	31%
6.	Hilepani- Diktel	78 km	34,982 m	45%
7.	Harkapur- Okhaldhunga	41 km	6,625 m	16%
8.	Okhaldhunga -Salleri	57 km	25,097 m	44%

Sources: (i) RSA of TRP/ PRM Nagdhunga- Mugling –GoN MoCS Nepal India Regional Trade & Transport Project (IDA Cr-5273 NEP, 2016); (ii) RSA of project roads –Road Connectivity Sector I Project (ADB Grant 0051-NEP, 2008)

Only the bare minimum required, desirably the cumulative length actually required will much higher than the figure quoted.

From Table 2, one can easily gauge that the users in these hilly roads face significant risk of severe injuries and death from run-off the road crash of single vehicles in the absence of any vertical protection (safety barriers). Run-off the road crash of single vehicles is the most predominant form of crash in Nepalese hill roads. Single bus run-off the road crash also results in a

significant number of deaths and serious injuries. For example, a single bus run-off the road crash that occurred recently on 12 October, 2021, in Chayanaththarara Municipality, Mugu, resulted in 21 fatalities and 21 injuries (mostly serious). Therefore, it is important to construct safety barriers generously in the Nepalese hill roads to prevent significant loss of lives from potential run-off the road crashes.

One of the main factors influencing a vehicle’s ability to traverse a curve and remain stable on the road is the speed of the vehicle. There is high risk of head-on or run-off the road crash when vehicles over speed at sub-optimal curves as the vehicle mechanic is unable to maintain its stability in this case, leading to serious injury or death. Over-speeding trucks travelling on a very steep downgrade also results in high risk of run-off the road crash at the road valleys, leading to death or serious injuries. Therefore, it is also necessary to consider lowering the speed limit or implementing traffic calming measures along the steep downgrade.

Another challenge facing road safety professionals in Nepal; is the existence of bazars, schools, indiscriminate direct access of minor junctions along the highways and ribbon development along the feeder roads in the absence of systematic land development controls in the country. Therefore, the road segments in these areas continue to face the conflicting road functions at these areas (mobility versus access for the vulnerable road users, traffic calming).

The necessary mitigation measures required to tackle the above safety risks cannot be ensured through the input of the road designers. This is due to the same reason that various subject experts (e.g. engineers specialising in geotechnics, drainage, structure, environment, etc.) are required to adequately handle the various component of the road design. RSAs can make a qualitative road safety assessment of the road involved with recommendations for the road designer and/or client to consider. RSA from an independent safety auditor will also provide a real third-eye road safety assessment of the road design.

Since the recent past, there has been a positive practice of assigning a road safety expert in road projects under the DoR (entire project cycle). The expert typically conducts all the safety assessment including the RSA; monitors the work zone and traffic safety management during the construction phase; designs the schedule of the road safety furniture including a bill of quantities of the same and conducts a crash blackspot analysis. There is still the conflict of interest involved in this latest



practice in Nepal. However, it is anticipated that this practice will slowly evolve to mandate independent road safety auditors on Nepalese roads.

Road Safety Audit Process in Nepal

In Nepal, though RSA was introduced for new strategic road projects since August 1995, to date there is no RSA policy to outline the legal requirements for a RSA. Therefore, safety audits were conducted ad-hoc during the inception of the RSA practice in Nepal during the late nineties. In absence of the legal mandate for compliance of the RSA recommendations, most audit recommendations in the past were not complied. There is no legal mandate for all roads to comply with the RSA recommendations or formally communicate non-compliance of some of the recommendations (exemption letter). RSAs should extend to all types of roads (provincial, municipal, rural municipal) and should be conducted throughout the project cycle.

During the nineties, the DoR published the following documents to guide RSA in the strategic roads.

- Road Safety Note 2: Designing safe side drains; GoN DoR; November, 1996
- Road Safety Note 4: Road Safety Audit Manual; GoN DoR; April, 1997
- Road Safety Note 5: Delineation measures; GoN DoR; March, 1997
- Road Safety Note 6: Safety barrier; GoN DoR; July, 1997
- Road Safety Note 7: Safety at bridges; GoN DoR; July, 1997
- Road Safety Note 8: Identifying and treating accident sites; GoN DoR; June, 1997

Recently, more strategic roads have undergone RSA, but the process is still ad-hoc in the absence of RSA policy. Nevertheless, the adequacy of the road safety provisions in the strategic roads of Nepal has gradually improved. But there are still a lot of rooms for improvements (e.g. there are still inadequate safety barriers, signage and passing bays in single lane roads). The road safety features in other roads (provincial and local government) are grossly inadequate and do not undergo any RSAs normally.

As per Austroads, the following activities need to take place in the entire RSA process of a road:

- The client or designer selects the audit team
- The designer provides the background information of the road to the audit team

- A commencement meeting between the client, designer and the audit team takes place
- The audit team conducts a desk study of the documents received and outline preliminary findings
- The audit team inspects the site for road safety assessment
- The audit team drafts the RSA report based on the preliminary findings and site inspection
- The audit team holds a completion meeting between the client, designer and themselves to formally discuss the RSA findings
- The client and designer formally respond about their compliance to all or portion of the RSA recommendation and inability to comply with some of the RSA recommendations
- The designer implements the RSA recommendations that the client and designer has agreed to comply

The additional cost perceived in implementing the RSA recommendations had also been one of reasons for client's reluctance to comply with the RSA recommendations. Generally, the construction cost of Nepalese hill roads is expensive while the benefits are low due to the low traffic anticipated on most of the roads. World Bank requires an Economical Internal Rate of Return (EIRR) for road projects of 12% or more while the ADB requires 9% or more to be eligible for funding approval from these agencies. It is often difficult for Nepalese road projects to achieve an EIRR of 9~ 12% owing to low traffic that prevails over the roads. Unless the Government of Nepal can convince the multilateral agencies to accept various criteria to enhance the economic viability of road projects (e.g. allow inclusion of the economic benefit from crash reductions following the road improvement in the final calculation of EIRR, exclude the cost of road safety interventions in the EIRR calculation, etc.), many of the RSA recommendations in Nepal will not be implemented. If the first year of rate of return of a crash countermeasure is accepted for inclusion in the EIRR calculation, an EIRR much higher than the 12% can be achieved as the first year of the rate of return of most crash countermeasures is significantly high. Alternately, a department policy of mandating a fixed portion of the construction cost (e.g. 10- 15 %) towards the road safety items can also be mulled.

The following is a list of design aspects that RSA should consider:

- Obscured visibility and lack of inter-visibility to/from passing bays in single lane hill roads



- Lack of visibility at single lane roads in deep box-cut formation
- Deep vertical drops at the valley side that are unprotected
- Safety issues at cross-drain structures and bridges (carriageway narrowing, lateral protection, grade difference, pedestrian segregation, visibility issues to/from approaches, etc.)
- Lack of consistency in the carriageway and dangerous edge-drop at the shoulders
- Safety hazards at urban areas including lack of segregation for different users (pedestrians, cyclists, non-motorised vehicles, motorised vehicles, persons with disability)
- Lack of appropriate speed management and/or enabling design speed along the urban or ribbon development segments
- Unforgiving drains
- Damaged safety barriers left unattended and improper installation of W-beam barriers, especially the end-treatments
- Adequacy of the signage schedule

Conclusion and Recommendation

Road Safety is one of the prime concerns globally and nationally. With under-achievement of set target of UN Decade of Action Plan 2011-2020; second decade of action plan was declared with reduction of 50% in road traffic related injuries and fatalities. As road safety improvement measures, five pillar were envisioned and among five pillar, safer road and mobility is one of the important pillars which also focus on Road Safety Audits. RSA, which is a formal qualitative safety assessment of road is one of the major tolls of improvement of road safety features.

Considering the significant number of run-offs, the road crashes of single vehicles in Nepalese hill roads and the corresponding catastrophic casualties that results from these collisions when a bus is involved, safety barriers should be generously provided in Nepalese hill roads without any exemption.

It is necessary to lower the speed limits and adopting low-cost traffic calming devices; improved signage (larger size, reflectorized warning signs on both sides, single chevrons, and wider road marking, etc.) along the sub-optimal and blind broken back curves, and steep gradients. Priority should be given to modify the road cross-section to enhance traffic safety of the vulnerable road users till the different users can be segregated (e.g. grade separation, divided carriageway with service roads, provision of pedestrian overhead bridge or pedestrian underpass, etc.) should be pursued.

It is recommended to revise RSA Manual based on the global best practices that are adaptable for Nepalese transportation-ecosystem and to align this Manual in the subsequent National Road Safety Regulation. Similarly, it is also recommended to develop and implement a Road Safety Audit Policy to provide comprehensive guidance on the audit process that all Nepalese roads must undergo and to initiate a strategy to increasingly conduct road safety inspections of existing roads.

To prioritize road safety, it is recommended to ensure at least 10- 15% of the construction cost for the installation of road safety structures. Also it is imperative to convince multilateral agencies to allow the inclusion of benefits from reduced crashes when calculating the economic rate of return. Finally, it is also recommended to conduct extensive research on road safety interventions e.g. piloting various traffic calming measures, research to develop crash reduction factors for Nepalese roads, etc., and implement them in real practise.

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Water Footprint Assessment: Why and How ?



Ashok Kumar Chapagain
Pacific Institute, USA
E-mail : a.chapagain@gmail.com

Background

The strain on the world's water resources is becoming more acute and the potential impacts of scarcity and pollution on a range of stakeholders are becoming clearer. Four billion people live under conditions of severe water scarcity at least 1 month of the year, and water scarcity is projected to increase with drivers such as economic development, poor water governance, population growth and climate change. Water remains a significant obstacle to growth in both developed and developing countries irrespective of their level of water scarcity at present. Most countries will experience declining water availability, particularly those countries that experience a confluence of factors including low freshwater availability, high climate change impacts, and growing consumption patterns.

In a world of increasing interconnectedness, equitable and sustainable resource management has become not only a local phenomenon but also a global one. It is increasingly recognized that freshwater scarcity and pollution are to be understood in a global context. Local water depletion and pollution are often closely tied to the structure of the global economy. With increasing trade between nations and continents, water is more frequently used to produce export goods. International trade in commodities implies long-distance transfers of water in virtual form, where virtual water is understood as the volume of water that has been used to produce a commodity, thus virtually embedded in it. Knowledge about the virtual-water flows entering and leaving a country can cast a fresh light on the actual water consumption of a national economy. At the same time, it becomes increasingly relevant to consider the linkages between consumer goods and impacts on freshwater systems. The critical factors in managing these resources lie at both ends of the production and consumption

chains. It is increasingly acknowledged that local water depletion and pollution are often closely tied to the structure of the global economy. With the emergence of the concept of water footprint, people for the first time can see the upstream impact of their footprints on water because of their consumption pattern. Consumers, governments, and businesses are beginning to understand how their interest could be sustained in the long run using this new approach in water resource management.

Water conservation has traditionally been conceived as a local challenge to be addressed by the local stakeholders. It is true that water problems are generally local: a river running dry, a shrinking lake, a dropping groundwater table, or a polluted aquifer or a stream. The water footprint concept helps to understand the international dimension of water problems and to assess the indirect water use behind daily consumer goods. Why would it be the exclusive responsibility for local governments and local water users to ensure that water resources are used sustainably, given that many water related problems are externally driven? Many investors in the world's financial hotspots invest in new agricultural, mining, and industrial activities around the world without spending even one minute thinking about the potential consequences for local water resources. Most companies source their inputs from the cheapest place; admitted, they may look at working conditions and child labor in their supply chain or apply some environmental criteria, but sustainable water use seldomly plays a role. Consumers don't include water conservation in their purchase decisions either: think for instance of UK consumers buying asparagus from the desert in Peru, thus contributing to a quickly declining groundwater table, or American consumers buying textiles that leave a trail of water pollution, in Bangladesh because of the chemicals used to dye the textiles and in India and China

because of the fertilizers and pesticides used in cotton cultivation. In order to regain some control on the worldwide water misuse, we need greater product transparency, water footprint benchmarks for water-intensive commodities, water footprint ceilings per river basin, and a discussion about fair water footprint shares.

The concept of water footprint (WF) generated interest soon after it was introduced, mainly because it is clear and understandable and, thus a powerful advocacy tool that easily communicates a message to a broad range of stakeholders. The science behind water footprint analysis has continuously evolved since the first publications appeared in the literature. It is important to note that, regardless of how it is presented, a water footprint is not in itself a measure of the economic, social, or environmental impacts of water consumption and pollution.

The volumetric WF is useful mostly in awareness raising and in auditing process, but for a complete impact assessment, it needs to be analyzed in the light of contexts such as local economic, environmental, or social attributes¹. Doing so means that the WF concept has evolved from basic quantitative studies to a powerful advocacy tool and a tool that can be used for policy support, business risk engagement, public awareness, decision-making and now, an assessment tool for policy processes.

Water Footprint Assessment- Why, Who and How ?

In 2011 the Water Footprint Network and their partners published a manual as a global standard for Water Footprint Assessment¹ (WFA) to enable a robust and standardized analytical approach to the calculation of the WF. The field of research and application of Water Footprint Assessment can be seen from three perspectives: “why, who and how?”.

Why: Objectives	Who: Stakeholders	How: Method
<ul style="list-style-type: none"> - Awareness raising - Assessing impacts of climate change - Managing water risks - Sustainable supply chains - Public policy, regulations and SDGs 	<ul style="list-style-type: none"> - Consumer - Business - NGO - Financial institutions - Government 	<ul style="list-style-type: none"> - Product WFA - Geographical WFA <ul style="list-style-type: none"> ▪ Basin WFA ▪ National WFA ▪ WF of humanity

The WFA can be conducted from a local to global level, using multiple perspectives e.g., local level assessment can be from the perspective of a household, factory, or farm (Figure 1).



Figure 1. Levels of Water Footprint Assessment Awareness raising

Wise water governance is a shared responsibility of consumers, governments, businesses, and investors. It is a cumulative chain of actions by all the actors that can bring positive changes. Informed consumers can encourage the sale of products from sustainable regions or basins, eventually helping these products to become accepted by a larger consumer base at the expense of products from unsustainable regions or with non-transparent sourcing information.

With the emergence of the concept of water footprint the public could see, for the first time that the issue is not only related to the direct water use in their house, but also to their consumption of goods and services such as food, fiber, and electricity. The Water Footprint Assessments have been an effective means of raising awareness of global water challenges among audiences 'outside the water box', including decision makers in industry and government.

Assessing Impacts of Climate Change

The impact of climate change can also be incorporated into the information provided by the WF. Businesses, governments, and local communities face growing challenges to their sustainability as resources like water and energy are constrained, populations grow, and continued economic growth is sought. Addressing any one of these challenges is difficult enough; but there is mounting evidence to suggest complex linkages between all of these issues. Thus, responses to the multi-dimensional aspects of sustainability must be matched by indicators that are able to work holistically across multiple dimensions.

Water, like energy, is a key input into any economy. As water-related natural hazard events, such as floods and droughts increase, it is imperative that we understand and prepare for their consequences. Because countries are dependent upon each other for food, products and energy imports, this not only involves understanding how climate

change impacts on water resources in our own countries, but how it impacts on water resources in other areas of the world. This makes any economy dependent on water resources well beyond its borders. Mapping a nation's global water demand and assessing how water scarcity and drought could disrupt supplies of key food crops that it imports reveals where potential vulnerabilities to the nation's food security and economic stability exist. For example, it can identify which food products may become more expensive in the near and longer-term future.

Globalization of fresh water brings both risks and opportunities. National water resources can be saved for more appropriate alternative uses; however, a growing external dependency on a WF external to a country's boundaries increases the risks related to events elsewhere that are often not visible, not predictable and with little influence. These water-intensive production processes are vulnerable to the availability of water at the various locations where the production processes take place. The vulnerabilities may result from a range of factors from reduced river flows, lowered lake levels and declined ground water tables to increased salt intrusion in coastal areas, pollution of freshwater bodies, droughts, and a changing climate.

The vulnerability of a nation's virtual water imports can be assessed by elaborating key indicators such as drought severity, water scarcity, water pollution levels etc. at the producing locations of the key imported products for all components of virtual water imports. For example, to assign a qualitative vulnerability level that occurs in the producing regions of the selected key products, green virtual water import maps of the key products can be overlaid with drought severity maps. Similarly, the vulnerability of the selected key products for blue water footprint can be assessed by overlaying the blue virtual water import maps of the key products on the average annual water scarcity maps.

Water Footprint accounting provides information on how a nation's water demand will vary under different climatic conditions and the impacts of climate change on importing regions' water resources. This can help elaborate the challenges that different economic sectors in a country or region may face due to dependencies on imports and water resources in other regions affected by climate change and hydrological extremes. This will help governments develop key water related policies at all levels and inform mid and long-term planning of companies for sustainable development in light of climate change, population growth and increased demand for products and services.

Managing Water Risks

Water risk can affect a company's direct operations as well as its supply chain, ultimately affecting operational costs, security of inputs supply, profits, and future growth. Reducing water risk is becoming a management priority for companies globally. There is an exponential growth in the interest in understanding the water dependence of businesses and associated risks in light of increasing global awareness of water scarcity and water pollution. Recent studies have shown that water crisis is perceived as one of the risks with the highest impact, together with a high likelihood of occurrences in line with natural disaster, weapons of mass destruction, extreme weather events and failure to mitigate and adapt to climate change.

For many years, the traditional response to water risk has been a focus on water efficiency across company operations and supply chains. As water risk arises from the total water footprint in the concerned basin, water efficiency alone is not sufficient to mitigate shared water risks. Water-related business risk does not only occur in the direct operations of a company. Many companies use inputs from suppliers, which are often in locations far from the company's operations. The water-related risks affecting suppliers must also be considered as these can have a material impact on the company through association with the suppliers or through their influence on the reliability of the required inputs.

Water risk not only reflects the environmental performance and sustainability of a business, but can also affect the survival of the business itself. Reducing water risk is becoming a management priority for companies globally. Water risk can affect a company's direct operations as well as its supply chain, ultimately affecting operational costs, security of inputs' supply, profits, and future growth. Besides typical physical risks related to the lack of water availability or poor water quality, there are also regulatory risks, reputational risks, and eventually financial risks arising from water scarcity, pollution and competition (Figure 2). Sustainability assessment of the full supply chain of a business is the key to understanding these risks.

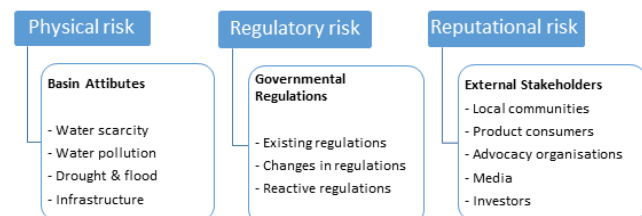


Figure 2. Water-related risks from a business perspective.

Physical risk emanates from the basin condition, and reflects issues of water quantity and water quality. In terms of quantity, it is either too little water (scarcity and drought) or too much (flood). In terms of water quality, it relates to whether the water that is available for use is of the quality needed (e.g., is pre-treatment required?) and the ability to discharge water such that water quality standards are met (e.g., the existing assimilation capacity of the receiving water bodies). When addressing physical risk, the primary stakeholders to engage with are other water users and agencies dealing with planning and management of water resources.

Regulatory risk relates to the mechanisms of water abstraction licenses, wastewater disposal permits, allocation for and prioritization of different sectors of water use. Regulations can change to address growing demand, decreasing water quantity and quality and to become more efficient and sustainable in managing the resource. When addressing regulatory risk, the primary stakeholders to engage with are regulatory agencies responsible for water quantity and water quality, as well as performance standards or criteria for specific sectors.

Reputational risk is influenced by the perception of others and reflects the company’s image from the viewpoint of other stakeholders. Transparency, engagement with stakeholders, steps taken to be a water steward, effective communication, etc. can all affect a company’s reputation positively or, when not done well, negatively. When addressing reputational risk, the primary stakeholders to engage with are local communities, product consumers, advocacy organizations, investors and media.

It is anticipated that future risks related to the variability of resource availability (due to the impacts of climate change, changing water demands driven by population growth and economic growth in the region) and uncertainties in “risk drivers” (due to evolving rules and regulations, increasing consumer awareness etc.) that impacts on physical risks will become greater due to higher competition over unreliable and scarce water resources. However, regulatory and reputational risks can also play out differently depending upon external stakeholders either becoming more aware and prepared for such variability and uncertainties, or failure in accommodating the changing environment, resulting in poor governance of the resource base etc.

As for an individual company with a global supply chain, it can often be difficult to take a leadership role in all

sourcing locations that are exposed to water risk. A commitment for collective action from each business and stakeholder operating in such locations is the best way forward. Although there is an increasing uptake of water related risk assessments using water footprint accounts, there is still a long way to go for companies to effectively contribute to making water footprints more sustainable at a relevant scale due to the poor state of transparency of companies regarding their direct and indirect water use.

Sustainable Supply Chains

This imposes risk to the water intensive agriculture sector, which increasingly faces water availability and quality challenges in its widely distributed supply chain. Therefore, achieving water sustainability in the supply chain is critical for the long-term viability of the sector as well as the sustainability of ecosystems and communities that are dependent on the same water resources. As brands and retailers aim for sustainable sourcing in their supply chain, it is crucial to work with suppliers to measure, monitor and report accurate and detailed data that can be used to pinpoint the most meaningful and strategic investments in improving technology, practices and inputs. Additionally, brands and retailers need to support collective action in water stewardship to ensure that the water resources their suppliers depend upon are managed sustainably. By working together to address both water consumption and pollution and improving water efficiency as well as local water conditions, the sector can create social, economic and environmental benefits. The following case study shows how the complex supply chain of one single ingredient, sugar, can make a global multi-national company vulnerable to water related risk. The WF can be used to prioritize and formulate the appropriate response strategy to reduce vulnerability.

An example of application of WFA for a sustainable sugar supply chain for a global multinational beverage company based in Europe (Identity withheld for confidentiality clause in the project) is presented below.

The company purchased 231,013 tons per year of refined cane sugar directly from sugar refineries situated in 14 European countries in 2017. These refineries purchased raw sugar from sugar mills located in more than 200 river basins around the world. On top of that there are a number of processing stages in the supply chain of refined sugar from sugarcane (Figure 3).



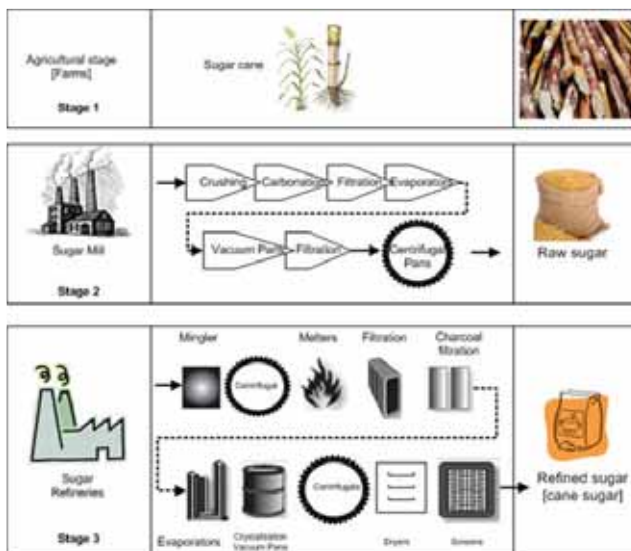


Figure 3. Supply chain of cane sugar.

Using the Water Footprint Assessment method1, the WF of all the key stages of sugar processing is calculated. It is found that the sugar refineries located in Europe are importing raw sugar globally and the crops are grown in 277 river basins around the world. With WF sustainability assessment, using the blue water scarcity and water pollution levels in these river basins as environmental criteria, a prioritization exercise of key locations is conducted.

To guide the company’s efforts to move toward a sustainable sugarcane supply chain, priority basins were selected using two criteria: the product WF compared to the benchmark WF, and share of the company’s WF in the respective basin. After prioritizing locations and processes where water footprints are not sustainable, the next step is to design appropriate action. A set of key questions are used to formulate response strategy (Figure 4).

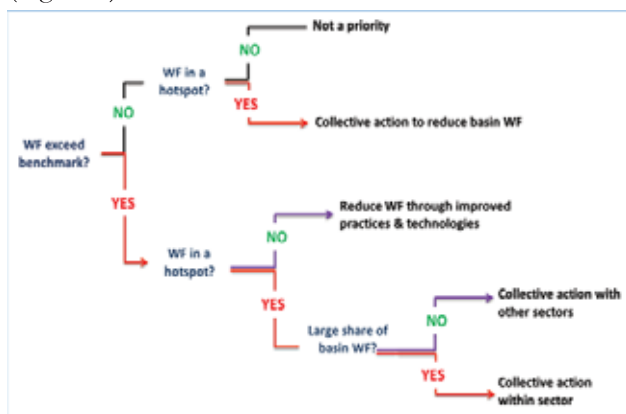


Figure 4. Formulating strategic responses in priority river basins.

From the Water Footprint Assessment, the company could take the following strategic decisions:

- If the WF exceeds the global benchmark, there is an opportunity to reduce the process WF, i.e. to make the production more efficient, whether for the blue WF or for the grey WF. It will be strategic to work on reducing the WF through better practices and technologies.
- If the WF is in a river basin, which is a hotspot, due to either blue water scarcity or water pollution levels, the sugarcane production or processing is occurring in a basin, which is unsustainably managed and is contributing to the over-allocation of resources. It will be strategic to work with others in improving the basin governance, so water resources are sustainably managed. Good governance is necessary for any long-term solution to unsustainable water use.
- Where sugarcane is a majority share of the WF of agriculture in the basin, there is a strong opportunity for collective action across producers to make improvements, which will have a cumulative positive benefit.
- If the WF is at or below the benchmark but is in a hotspot, investing in WF reduction in sugarcane production or processing will reduce the water dependence of that supplier but may happen at a higher opportunity cost than investing in WF reduction elsewhere. A further analysis of contributors to the basin WF and comparison with benchmarks can identify where lowest cost WF reduction can happen. It may be strategic to help other producers reduce their WF as a way to bring the river basin into balance instead of investing in further to reduce its process WF in already efficient sugarcane production and processing.
- Increasing the efficiency of green water, i.e. reducing non-productive evaporation and increasing yields coming from rain-fed agriculture can be part of the solution to reducing the blue WF.
- There is a synergistic effect between blue water scarcity and water pollution levels such that a reduction of collective blue WF in a basin can also lead to a reduction in water pollution levels. Therefore, in basins where water pollution levels have been highlighted as a contributing factor to unsustainability, efforts to reduce the blue WF can work in tandem with reduction of pollutant loads to improve the overall water quality.
- Water pollution needs to be addressed for both non-point sources, e.g. farm fields, and industrial point sources, e.g. mills and refineries.

Public Policy, Regulations and SDGs

Only by understanding the synergies between agriculture, trade, economics, and energy sectors and their linkages in water resources management across the UN Sustainable Development Goal (SDG) targets, an integrated policy can be adopted. In doing so, the aims of each individual sector and target can be aligned and unintended consequences that result in negative impacts on water resources and water-related ecosystems avoided. The connections between Water Footprint Assessments, water policy and other policies related to issues such as trade, economic development and agriculture have been the subject of discussions at international forum in recent years.

The laws, regulations and policies governing water use and its various components are often handled by different governmental departments, leading to a lack of coherence and weak enforcement, hence a priority to strengthen them. Recognizing the risks associated with poor water governance, companies are looking to address regulatory and other policy related risks. Stronger regulations and their enforcement can reinforce financial security.

National water footprint accounting should be a standard component in national water statistics because it provides a basis to formulate a national water plans and river basin plans that are coherent with national trade policy and national environmental policy. By using WF informed planning, governments can support consumers, producers and investors in their efforts to move towards good water stewardship. The insights obtained from a national or river basin level Water Footprint Assessment can help relevant ministries and departments concerned with water resource development and management, agricultural and economic development, trade and environmental protection support planning and policy development, as well as corporate policy development. Such studies can be used to inform decisions that improve water productivity within a holistic approach to development, thereby supporting better livelihoods, healthier ecosystems and stronger economies.

For the first time, the SDG 6 not only has fundamental targets for safe drinking water and sanitation but also for environmental sustainability. To achieve the SDG 6, to “substantially reduce the number of people suffering from water scarcity” and SDG 2, to “achieve greater food and water security”, it is necessary to ensure that:

- Water is used within sustainable limits such that ecosystem and subsistence use of water are met (this could be achieved by remaining within river basin sustainable water footprint limits);

- Water is shared equitably both locally and globally (this could be achieved by making sure that societal sustainability of the water footprint is achieved); and
- Water productivity is improved where beneficial (this can be achieved by making sure that economic sustainability of a water footprint is attained).

At COP26 Glasgow, a number of countries and institutes have come together to sign a milestone declaration “The Glasgow Declaration for Fair Water Footprints for Climate- Resilient, Inclusive, and Sustainable Development”
<https://waterwitness.org/programmes/fair-water-footprints>.

Concluding Notes

Traditionally, water resource challenges have been regarded as an issue that affects local areas or river basins. Water footprint studies show that managing freshwater resources can have a global dimension. The issue of wise water governance is a shared responsibility of consumers, governments, businesses and investors. Each of those players has a different role. Consumers should demand transparency about the water consumption and pollution underlying consumer products from business and governments, so that one is better informed about associated water resources use and impacts. Consumers can choose to consume less animal products or choose, whenever proper information allows, for products with a water footprint that meets a certain benchmark. National governments can – preferably in the context of an international agreement – put regulations in place that urge businesses along the supply chain to cooperate in creating product transparency. Governments can also tune their trade and development cooperation policies towards their wish to promote consumption of and trade in sustainable products. Governments should further play a leading role in establishing water footprint ceilings per river basin, to ensure that in each river basin, the water footprint does not exceed available water resources. Companies, particularly big food processors and retailers, can use their power in the supply chain to effectuate product transparency. They can also cooperate in water labelling, certification and



benchmarking schemes and produce annual water accounts that include a report of the supply-chain water footprints and associated impacts of their products. Investors, finally, can be an important driving force to encourage companies to put water risk and good water stewardship higher on their corporate agenda.

The Water Footprint Assessment provides a sound method to analyze the water footprint in the relevant context and to formulate appropriate response strategies. The water footprint assessment breaks down the different water footprint components and informs the sustainability of these components against three sets of criteria: environmental, economic and social. The application of Water Footprint Assessment has evolved from basic quantitative studies to a powerful advocacy tool that can support decision-making and policy

processes and help mitigate water-related business risk. It has been pivotal in the strategic assessment of corporate risks on water and there is a growing application of Water Footprint Assessment particularly in Latin America, Spain, and India with regard to national policy formulation. Water Footprint Assessment can be used to monitor and evaluate progress towards the SDGs and through other sustainable development initiatives, advance government policy making, inform investment decisions and the management of corporate water risk.

Key Reference

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Unmasking Disaster Impact with Resilience: A Path to Prosperity



Shaligram Pokharel

Professor, Qatar University, Doha, Qatar

E-mail : shaligram.pokharel@gmail.com

Repeating the problems on a project is often our habit, which is supported by our inability to develop an organizational learning process. The organizations and project developers are often focused on the short term and quick fix decisions to resolve the problem. In some organizations, strategies may be in place but they may not encompass the complex disaster situation and complex project situations. Which means, such strategies often fail to yield any fruitful long term results.

As a consequence of this process, we face the same situation again and repeat the same mistake again while addressing to resolve the situation. This situation is lesson unlearned and it makes us negatively resilient—avoiding the problems, looking at short term gain; we mask the problem and assume that the problem will go away, or has gone away and be content with the myopic ‘not in my yard’ syndrome.

Can we become positively resilient by unmasking the problem of discontinuity, white washing and short term gain?

Resilience

Resilience is related to the sustenance of strategy or operations to contain the impact of the anticipated disturbance, that may happen suddenly or as a result of a series of mishaps occurred earlier. This is an undesirable state in any location or in any country. Therefore, to overcome such an undesirable state that brings chaos, every individual, organization, and the government policy maker should be prepared to analyze and address the short comings in their approaches to tackle such a situation to bring it back to the pre-event continuity as soon as possible.

Disturbances could be related to social, environmental, economic, weather (storms/hurricanes), health and infrastructural conditions. We have situations like economic and political blockades, landslides, floods and

glacial lake outbursts, earthquakes, fires, and pandemic situations which can severely impact the national preparedness system. The degree to which policies, plans, programs and projects are devised, implemented, monitored, and controlled to overcome the impact of such situations indicates the level of preparedness of a country, called resilience. Being resilient is interesting and desirable, but developing the resilient characteristics needs experience, expertise, and motivation as it is challenging and is long term oriented. Resilience is a direction not a state and is often dynamically defined. For example, having an electrical system with no blackouts can be considered as resilient in some countries, whereas in other countries, sustaining the growth and providing quality electricity can be considered as resilient. A resilient system assures shorter disturbance, shorter recovery and shorter improvement period to the ‘new’ state of affairs. It can act either autonomously (due to training, legislation, and resources available for addressing the disturbance) or semi-autonomously (by providing situation specific inductions in terms of funds, resources and legislation). As resilience is a direction, the desirable definition of resilience can also change over time. This brings to the forefront the notion that there is a resilient expectation ladder that depends on the socio-economic, environmental, and technological development.

Preparing for Resilience

The author believes that there are experiences in each society or the country that have built local resilience over time and have sprung back to ‘life’ after encountering an unexpected situation. Therefore, for a resilient system, both local and national actions become necessary. Those actions could be preventive or corrective. They could be mostly localized, for example, to cover the situation created by massive floods (June 2021) like that in Melamchi, Nepal due possibly to earthquake

triggered-rain soaked and landslide instigated or disastrous local situation due possibly to glacial lake outburst instigated floods and devastation (February 2021) in the upcoming hydropower development site in Uttarakhand state, India. The Hurricane Sandy in October 2012 in New York that led to massive power outage for days is another example. The earthquake related situation is also similar as it impacts infrastructure and the social system. These type of events usually create destabilization for a very short period time, days or weeks but leave the impact for a long time to recover. It also impacts the population, settlement, and infrastructure.

State of Economy and Effort for Resilience (Floods)

Figure 1 below shows the event, and resilience related effort to bring the flood affected area to the normal situation. The impact and the effort shown in the figure are relative rather than absolute.

Recovery from such a disaster can be considered in four main phases. For example, for the flood event mentioned in Figure 1, the four main phases are: preparedness and planning, chaos (when the event strikes), response, and post response. If the system to address this type of situation is resilient, the impact of the event can be minimized as soon as possible. The preparedness planning phase, shown in Figure 1, can be longer. The chaos phase (which is unavoidable) is desired as shorter as possible. The response phase in a resilient system will also be as short as possible, but the planning phase would be as elaborate as possible.

Figure 1 shows that economic activities starts slowing down in anticipation of the disaster, for example, slowing down on transportation, trade activities, local project activities and other related economic activities in the expected disaster area during the preparedness phase. The time period for this situation is given as diamond 1 (Δ1) in the figure.

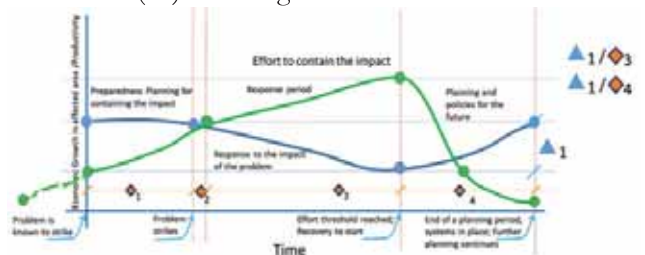


Figure 1: Resilience phases for disaster related to floods

The figure shows that it is better to have the Δ2 phase as small as possible, that means the response activities

should be ready to jump in as soon as possible. But this phase may be beyond the control of the human being, although the onset can be delayed by controlling the release of flood water (for example, caused by landslides related damming of the river).

If the resources are available and can be provided to the affected site on time, the Δ3 phase will be shorter, otherwise, it will take a long time to ‘heal’ the impact of the disaster. Once effort threshold is reached, the focus is on providing regular support and disengaging disaster support. This phase is marked as Δ4 in the figure. During this phase, the lesson learned from the disaster, response activities, and the impact of responses are collected, analyzed and used for future planning. An effective lesson learned exercise during this phase can help to develop policies, programs, projects and tasks, for infrastructure health (using standards and strengthening the existing ones), for social cohesiveness and impact containment (relocation, where possible and reworking on the problem areas, like constructing barriers, outlets and stabilizing the areas, assessing legislative barriers and removing any implementation hurdles. This phase, which requires the involvement of the stakeholders from all areas, can help to devise a more resilient system.

What makes this type of system resilient? The focus here should be on the measurement of delta (Δ) and diamonds mentioned in the figure. The resilience in this case should be to focus on the maximization Δ1, Δ3, and Δ4, and to bring down the ratio of Δ1/Δ4 and Δ1/Δ3. The Δ1 variable shows the end state which is ‘as normal’ condition in the affected area. That means to reduce the economic impact, the response time, and the planning time for devising and implementing a resilient system. It also shows that, all planning activities should be ready for implementation when the economic situation springs back to the ‘as normal’ situation’. These performance result, when there are investments made for containing the impact of the disaster situation, or when there are codes and standards used for the management of environment. Nature has its own way of releasing itself; there are different levels of floods, different levels of earth movements and changes in the ecosystem of the area. A resilient system would focus on obtaining these information and incorporating them in the design of new habitat or new infrastructure along the rivers or in a particular geographical area.

State of Economy and Effort for Resilience (Pandemic, COVID-19 Type, Situation)

Figure 2 shows the economic impact, effort to contain pandemic and the effort phases. Pandemic situation are more prolonged compared to a flood or an earthquake

situation and the pre-event time could also be longer. That means there could be a longer period available for developing effort and programs to contain the impact of the disaster.

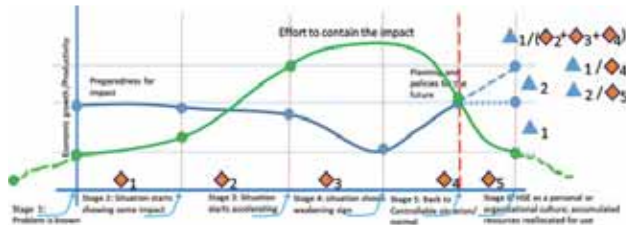


Figure 2: Resilience phases for disaster related to pandemic situation

There is a difference between the flood characteristics and pandemic in relation to resilience as well. Pandemic situation is relatively known in advance, however, complacency may impact in triggering the response mechanism to contain the impact.

For pandemic related situations, six stages and five phases can be considered. Stage 1 starts with known information on the problem and known information on the available tools and techniques to tackle the problem situation. Preliminary activities can be started in Δ1 phase, if there are such regulations available to manage disease control, or epidemic or pandemic situation control. The scale of impact in this case may or may not be known in advance.

Once pandemic situation kicks in, the economic activities start sinking in to a prolonged U or V-shape with a probable longer flange on the upper sides of the shape as shown in Δ2 phase in Figure 2. Nevertheless, a prolonged Δ2 phase might be better in some cases as it might give an opportunity for the decision makers to develop mechanism for containing a deep V- or U-shock in economy. If preparation is not adequate, the economy condition can depress to more steeply.

There are multitudes of impact that relates to this economic depression. The fear of disaster can contain social activities, construction activities, production activities, exploration activities, educational activities, mining activities, and so on, which form the economic fabric of the nation. This containment, however, does not necessarily translate to a reduction in the recurring expenditure, neither at the personal level, nor at the organizational level, nor at the government level.

The phase represented by Δ3 (stage 4) can be illusive as pandemic does not follow a structured path. The only way to address this situation is to address the halo environment around the pandemic situation (like

vaccination, ramping hospital facilities, education and enforcing legislation to create new social norms, and investing in developing pandemic containment product, providing investments to spring back to the pre-pandemic situation).

Stage 5 can be perpetual as well as it can take a really long time to reach to the self-learning and self-adjustment stage. Therefore, phase 5 situation can turn back to phase 3 very quickly as that happened in many countries in terms of second, third or fourth wave of panic.

During phase 5 (which brings back the economic situation to the pre-pandemic situation), two things can happen. One, the economy is stunned with the pandemic situation and therefore, all attempts are made to stabilize the economy to the pre-pandemic level. Two, companies and countries invest on innovation during phase 5, either incremental or radical, so that they quickly jump to new normal of higher economic output. The current experience and the experience from the previous (1918-1919) influenza pandemic shows that phase 2 and 3 are very difficult to control, although not impossible. However, these phases can be shortened with heavy investment in the facilities and progressive opening of the economic and social activities.

Figure 2 also shows the level of effort to address pandemic. Existence of previous plans can help to ramp up the effort, which normally peaks during stage 3 and stage 4. The attempt of resilience planner should be to maximize Δ1 to make the recovery steep and to maximize Δ2 to create a new normal as quickly as possible. The attempt should be to minimize Δ2, Δ3, and Δ4 by introducing new effort, mechanisms and investments. A resilient system would have a maximized value of $\Delta1/(\Delta2+\Delta3+\Delta4)$, $\Delta1/\Delta4$, $\Delta2/\Delta5$. This is difficult, but not unachievable. Consistency, long term planning, preparing the industry, manpower and legislation are all important for achieving this kind of resilience.

Posterior for Architects and Engineers

The two examples given above are for sensitizing the topic of resilience with down to earth situations that we



know. Resilience is a character away from complacency, and away of containment. Therefore, this is a very suitable concept, specifically in the business sector.

Specific to the architects and the engineers, the concept calls for innovation and standardization in design, planning, development and validation of the design. It also calls for stakeholders’ participation right from the beginning of the design stage. Resilient systems are designed to run in an autonomous gear at least for a period of time, for example, by having a clear procurement plan to obtain and store a good safety stock of the construction materials, by having human resource on the site, by developing a good cash flow for the continuity of the activities on site, and by using standard material and procedures. These steps will help to run the project almost perpetually, when viewed from outside the project’s conceptual boundary. However, many may consider this as difficult and impractical, given the bidding process, which normally calls for awarding the project to the minimum cost proposal. But these procedures are adopted by the successful companies around the world. What it needs is planning. Storming and norming the workforce in the field can help in orienting the people working in the site and the office to work in unison, to reflect changes, to reflect the impact of changes in the design, to validate the quality of the work and to validate the scope that is delivered on site. The view to encompass—one relates to other. Therefore, suppliers, stakeholders, contractors and designers are in the same bowl, when we consider a project. This could sound theoretical to many and that is why projects still fail to deliver on time, quality, costs, and sometimes on scope.

Although resilient measures may not be important in all projects, but specifically for the larger projects, resilience starts right from the conceptualization phase of the project itself. Maybe the architects and engineers should start influencing their prospective clients to get involved in the conceptualization of the project and work for integrated project delivery (IPD) in large projects. In IPD, the design and implementation is

progressive, standardized, integrated and combines the effort of all parties (including sponsors). This method is known to have avoided risks, or managed risks in most cost effective way and to deliver quality projects. This is increasingly combined with lean project management and sustainability in order to design and implement better projects.

If IPD is not possible, due to the constraints in the involvement of all parties with the sponsor, the next method should be to push for design and build. This method would help to cut short lead time for procurement, assurance of good quality for the client, regular interaction with the client as stakeholder satisfaction often becomes the requirement to proceed from a project gate. Design and Build is adopted by large companies and there is also an institute for design-build (DBIA.ORG). Implicitly, they bring in resilience in a project through the use of standard materials, methods, designs and tools and meet stakeholder expectations. This is to say that, it is difficult to bring in resilience in projects, when the primary focus is on the cost and not the quality. The cost of quality means that over time, a good quality product will pay for itself, therefore, it is worth investing in quality. These investments will shorten the phases to economic recovery of any organization, as there would be a quality culture and motivation to move forward from any given worst situation. This will bring resilience as a culture and prosperity as the by-product of this culture.

About Author

Dr. Shaligram Pokharel is a Professor of Industrial and Systems Engineering at Qatar University, Doha, Qatar. He teaches courses like project management, innovation and technology management, and engineering management and conducts research in those areas. He is cited by a publication from Stanford University as one of the top 2% scientists (https://elsevier.digitalcommonsdata.com/datasets/btc_hxktzyw/2) of the world.



Road Pavement Options for Nepal: Bitumen or Cement ?



Er. Rajendra Raj Sharma

E-mail : razendra@live.com

Introduction

Among all modes of transportation, road transport plays a vital role in the development of a country. This is particularly prominent for a landlocked country (with insignificant maritime ways) with 85% land covered with mountains and with a territory that is very narrow (about 120 km wide) with the difficulty of railroad construction and operation.

At present more than 90% of passenger and freight transportation is accomplished with road transport.

As per the statistics published by the Department of Roads and Department of Local Infrastructures, the total length of the roads in Nepal is about 100,000 km. About 15% of all roads (about 15000 km) fall under the jurisdiction of the Federal Government and 85% (about 85000km) under the Provincial and Local Governments. As per the target fixed by Nepal for the achievement of the Sustainable Development Goal, a road density of 1.5 km per square km of the territory i.e about 200,000 km of roads will be available in the country by 2030 AD. Let’s look at the condition of the roads. Out of the all roads, only 25% (about 25,000 km) are all-weather roads i.e. with hard-topped or graveled pavements with major cross drainage structures. Only about half of all weathered roads are paved with either bitumen or cement-treated materials.

The contribution of an efficient road transportation system to the socio-economic development of a country is very high. To make the system more efficient it should be safe, reliable, and comfortable with the least cost for the road users construction cost, maintenance cost, and vehicle operation cost). One of the many and the most important factors for getting an efficient road system is the quality of the pavement. Our road statistics shows how urgent it is to upgrade all roads to all-weather standards and pave them to bring the transportation cost to a minimum.

What is Pavement ?

Pavement is a specially constructed engineered structure on the surface of a road that is hard, durable, weather-resistant, smooth yet with adequate friction, usually with a water-tight surface for the transmission of loads to underlying subsoil in a safe way. A pavement usually has a layered structure. The pavement is the most expensive part of a road. The cost of pavement alone is usually 50% to 80% of the road. So it is very important to judiciously select the appropriate type of pavement structure. The pavement must be durable and strong enough for carrying the loads from traffic throughout its life. Selection of material and quality control during construction is very important.

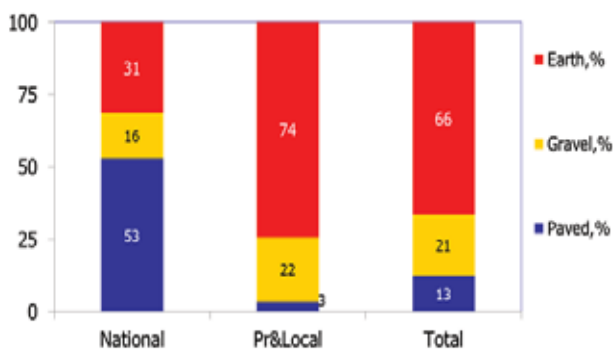


Figure 1: Status of Roads in Nepal

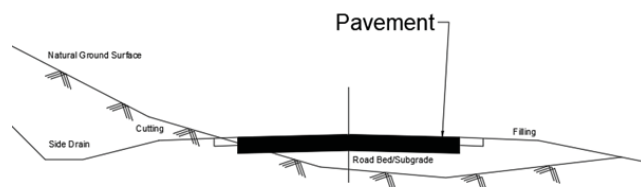


Figure 2: Road Pavement

Types of Pavements

According to the way in which the pavement transfers the load to the underlying soils, road pavements can be broadly divided into two types:

1. Flexible Pavements

2. Rigid Pavements

Flexible pavements work by distributing the loads to a wider area due to various layers of its components (base, subbase, etc.). Pavements made from mixes of various bituminous materials and aggregates fall under flexible types. In the following paragraphs flexible pavements, Asphalt Concrete pavements, Bituminous pavements, Black Topped pavements are used interchangeably to mean the same.

Rigid pavements work by slab action or flexural strength of a rigid slab laid over the underlying layers (base, subbase, or subgrade) permitting to bridge over minor irregularities in these underlying layers. Pavements made from cement concrete fall under rigid type. In the following paragraphs, rigid pavements and Cement Concrete pavements are used interchangeably to mean the same.

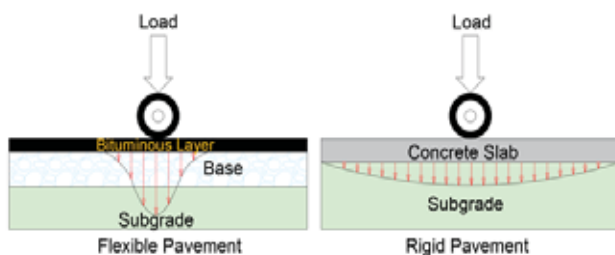


Figure 3: Flexible vs. Rigid Pavements

For the construction of hard-topped or paved roads, two alternative options of using Flexible pavement or Rigid pavement are available. The surface of flexible pavements being constructed from bitumen (sometimes called Asphalt) which is black in color are often called blacktopped pavements. Such a surface spreads load of traffic over a relatively small area. Therefore, to build such a Pavement, a strong subgrade soil or foundation is required. Such a surface can absorb the shrinkage and expansion caused by the weight of traffic or the change in weather conditions caused by the actions of wind, rain, and sun, thus reducing the chances of cracking or spalling. Therefore, such a pavement can be built even in small thickness, so it is relatively cheap.

On the other hand, the Rigid Pavements made by using cement concrete slab help to spread the load over a large area. Therefore, such a Pavement can be constructed even in places with relatively weaker soil or foundation. Since such a surface is less flexible and hard, it will not be recovered once it is cracked. Therefore, in order to

prevent cracks, the pavement has to be made as a thicker slab. Therefore, pavements that are made using cement concrete are relatively expensive.

Bitumen is produced as a by-product of fractional distillation of crude oils in refineries. In the process of refining crude oil, after the extraction of various lighter fractions like gas, petrol, kerosene, diesel etc, the black residue settles to the bottom. This residue after some modification of properties is the Bitumen we use in road pavement.

As Nepal neither produces its own crude oil nor refines imported crude oil, all bitumen is supplied from imports. According to the statistics of the customs department in 2076/77, Nepal imported 1,85,345 MT of bitumen worth Rs. 7.61 billion. Countries from where bitumen is imported to Nepal include India, Saudi Arabia, UAE, Iran, Singapore, and Qatar. For a poor country like Nepal, building roads by importing costly bitumen by paying foreign currency is really becoming very expensive.

There are large varieties of flexible pavements that can be constructed using bitumen as a binding material. Surface Dressing and Asphalt or Bituminous concrete pavements are the two most commonly used.

Cement is produced basically by burning together limestone and clay and a few other ingredients. Limestone, the main ingredient required for cement production, is found in abundance in Nepal. Therefore, there is a possibility of producing sufficient cement within the country. 87,75,000 tons of cement was produced from more than two dozen cement plants in the country and 6,23,280 tons were imported in 2076/2077.

At present, cement is very insignificantly used for the construction of road pavements. Most of the cement produced within the country is consumed in the construction of buildings, bridges, canals, dams, walls, and other structures.

Various types of cement concrete pavements are in use. More than 90% of the cement concrete pavements are constructed as Jointed Plain Concrete Pavements (JPCP). Other most commonly used types are Jointed Reinforced Concrete Pavements (JRCP) and Continuously Reinforced Concrete Pavements (CRCP).

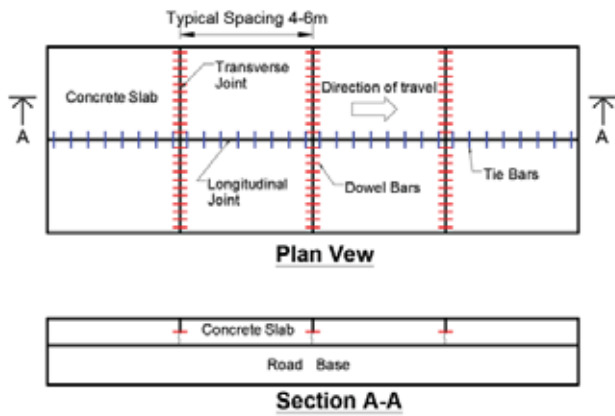


Figure 4: Jointed Plain Concrete Pavements(JPCP)

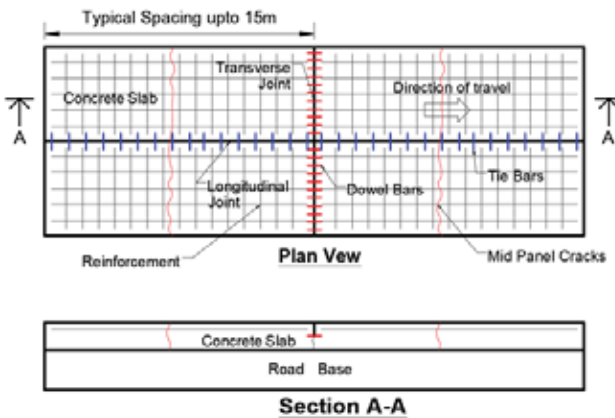


Figure 5: Jointed Reinforced Concrete Pavements(JRCP)

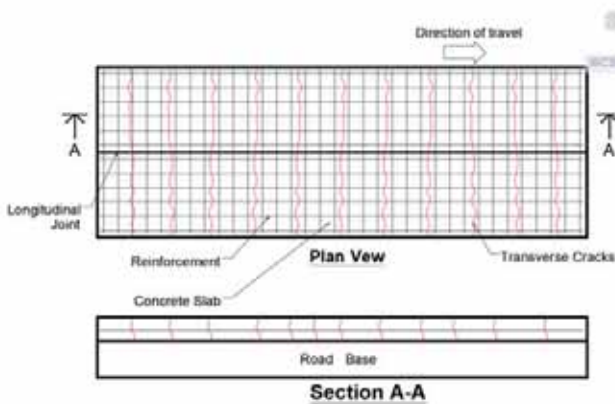


Figure 6: Continuously Reinforced Concrete Pavements(CRCP)

Comparison of Flexible and Rigid Pavements

The life of blacktop roads is usually 10-20 years if constructed with strict quality control. In Nepal where quality control is a serious problem, the normal life span is even far less. Even if it lasts longer, some overlays have to be added to the surface every 5-6 years. Some blacktop roads in Nepal have deteriorated within 1-2 years of construction.

On the other hand, roads made of cement concrete can easily last for 30-40 years without any maintenance.

Because of this, although it may seem a bit more expensive to build in the beginning, when analyzing the cost of a 30-40 year life cycle, cement concrete roads are much cheaper than blacktop roads. Author's 30-year economic analysis found that cement concrete roads are 30% cheaper than blacktop roads.

In the following analysis, Flexible Pavement is represented by Asphalt Concrete (AC), and Rigid Pavement is represented by JPCP (Jointed Plain Concrete Pavement), JRCP (Jointed Reinforced Concrete Pavement), and CRCP (Continuously Reinforced Concrete Pavements).

	AC	JPCP	JRCP	CRCP
Structure	Subgrade(CBR 10%) Subbase 20cm Base 15cm Prime+Tack coats 10% 10 cm	Subgrade(CBR 10%) Subbase 20cm PCC 100-25cm	Subgrade(CBR 10%) Subbase 15cm RCC(M30) 25cm Reinf. 12mm @200 (bothways)	Subgrade(CBR 10%) Subbase 15cm RCC(M30) 25cm Reinf. Main 10mm@150c/c 12mm@60c/c
Cost/sqm	Subbase-600@3000/cum Base-750@5000/cum Prime+Tack-300 10%+2500@25000/cum	Subbase-450@3000/cum Conc.-425@25000/cum Joints and forme-1000	Subbase-450@3000/cum Conc.-425@25000/cum Joints and forme-1000 Reinf-125@1125/kg	Subbase-450@3000/cum Conc.-425@25000/cum Joints and forme-200 Reinf-1875@125/kg
Total	4150	7700	8950	8775

Figure 7: Cost comparison of pavement alternatives

For rigid pavements, JPCP type is used in more than 90% of cases throughout the world, so a life cycle cost comparison is made between AC and JPCP, which is simply denoted by CC (Cement Concrete) as shown in Figure 8. The comparison is made for a period of 30 years with prevailing maintenance and construction rates as stipulated by Department of Roads. For simplicity, vehicle operation costs (VOC) on both types of pavements are taken equal, although cement concrete roads give cheaper VOC from savings on fuel and vehicle maintenance costs.

Length of the road 1 km
Width of the road 7 m
Discount Rate 10 %
Inflation Rate 10 %

Year	Description	Cost per km, NPR		Discounted/Inflated cost, NPR		Remarks
		AC	CC	AC	CC	
0	Construction	29,050,000	53,900,000	29,050,000	53,900,000	
1	Routine/Recurrent	300,000	140,000	300,000	140,000	
2	Routine/Recurrent	300,000	140,000	300,000	140,000	
3	Routine/Recurrent	300,000	140,000	300,000	140,000	
4	Routine/Recurrent	300,000	140,000	300,000	140,000	
5	Resealing/ Routine/Recurrent	5,000,000	140,000	5,000,000	140,000	
6	Routine/Recurrent	300,000	140,000	300,000	140,000	
7	Routine/Recurrent	300,000	140,000	300,000	140,000	
8	Routine/Recurrent	300,000	140,000	300,000	140,000	
9	Routine/Recurrent	300,000	140,000	300,000	140,000	
10	Resealing/ Routine/Recurrent	5,000,000	140,000	5,000,000	140,000	
11	Routine/Recurrent	300,000	140,000	300,000	140,000	
12	Routine/Recurrent	300,000	140,000	300,000	140,000	
13	Routine/Recurrent	300,000	140,000	300,000	140,000	
14	Routine/Recurrent	300,000	140,000	300,000	140,000	
15	Rehabilitation/ Routine/Recurrent	29,050,000	140,000	29,050,000	140,000	
16	Routine/Recurrent	300,000	140,000	300,000	140,000	
17	Routine/Recurrent	300,000	140,000	300,000	140,000	
18	Routine/Recurrent	300,000	140,000	300,000	140,000	
19	Routine/Recurrent	300,000	140,000	300,000	140,000	
20	Resealing/ Routine/Recurrent	5,000,000	140,000	5,000,000	140,000	
21	Routine/Recurrent	300,000	140,000	300,000	140,000	
22	Routine/Recurrent	300,000	140,000	300,000	140,000	
23	Routine/Recurrent	300,000	140,000	300,000	140,000	
24	Routine/Recurrent	300,000	140,000	300,000	140,000	
25	Resealing/ Routine/Recurrent	5,000,000	140,000	5,000,000	140,000	
26	Routine/Recurrent	300,000	140,000	300,000	140,000	
27	Routine/Recurrent	300,000	140,000	300,000	140,000	
28	Routine/Recurrent	300,000	140,000	300,000	140,000	
29	Routine/Recurrent	300,000	140,000	300,000	140,000	
30	Resealing/ Routine/Recurrent	5,000,000	140,000	5,000,000	140,000	
				80,300,000	58,100,000	

Figure 8: Life cycle cost analysis of pavement alternatives

Opportunities for Using Cement Concrete for Pavements

As the flexible pavement spreads the load over a small area, soon after the construction, the road will start to develop localized depressions with undulations and potholes. This needs frequent maintenance operations. On the other hand, cement concrete roads provide almost maintenance-free operation throughout their life.

As cement concrete pavement surface is relatively smoother than blacktopped roads, vehicles can be driven at higher speeds on concrete roads. Since the weight of the vehicle wheels on the road surface does not bend the concrete slab so much, there is not much obstruction to traction. This reduces the damage to tires and vehicles and fuel consumption is also reduced. According to research done in India, more than 14% of fuel saving is achieved on concrete roads compared to blacktop roads.

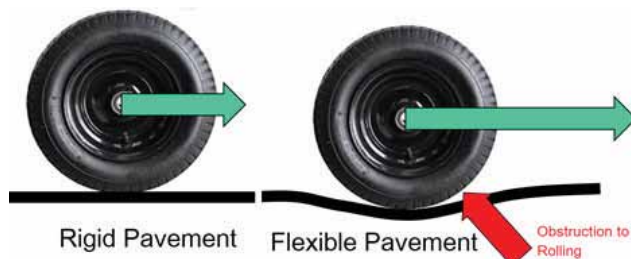


Figure 9: Why fuel saving is more in rigid pavements?

Diesel, petrol, and lubricating oil are often spilled on the road for various reasons. Such oils dissolve bitumen easily. In this way, after dissolving in the oil, the adhesion between bitumen and aggregates is reduced and potholes start appearing on the road and the road deteriorates quickly. But spilling of such oil has no effect on the cement concrete road.

The road pavement is always exposed to extreme weather conditions e.g. of the sun and water. The pavement made of bitumen is black in color, so it absorbs more heat from the sun and heats up faster. Melting of the bitumen in the hot sun can make the pavement slippery (also called bleeding) and cause accidents. When the pavement gets too hot, driving at high speed can cause the bursting of tires, thus posing an additional safety challenge. As the pavement of cement concrete is white or gray, the effect of sunlight is very less.

Water weakens the bond between bitumen and aggregates on the bituminous surface and eventually separates them from each other. Water is often seen as the enemy of the road engineer. In the case of cement

concrete, on the other hand, since water also helps in the setting process of cement, the adverse effects of water are lessened. Therefore, a concrete road can also be called a 'water friendly' road.

An adequate amount of friction between the tire and the road is required for the safe movement of vehicles on the road, i.e. the pavement should be sufficiently rough. Concrete roads provide more friction to tires compared to bituminous roads.

Night driving is safer on the white surface of the cement concrete pavement that reflects plenty of light, making the surrounding environment brighter and safer than on the black-colored blacktop roads.

Cement concrete roads are also 'environmentally friendly' as compared with bituminous roads which emit a lot of harmful gases during the heating and burning of bitumen itself. The reflective properties of white or grey-colored cement concrete pavements on urban roads have proved to mitigate the effects of 'urban heat islands' which contribute to reducing the harmful effects of global warming.

Promotion of the use of cement concrete roads in place of bituminous roads can help a country like Nepal, which does not have its own oil production, to save foreign currency reserve by cutting down the import of bitumen by paying expensive foreign currency.

Challenges for Using Cement Concrete for Pavements

As mentioned above, although cement concrete pavements have many advantages over bituminous pavements, it is necessary to seek the causes of why they are not yet used extensively in Nepal.

The biggest reason why cement concrete roads are not used much is that they are very expensive. Cement concrete Pavements are almost three times more expensive than bituminous concrete to carry the same load and under the same traffic and other conditions.

Even though it is said above that the cement concrete road will be bright and safe at night, the brightness of the headlights of the vehicle coming from the opposite direction at night and reflection from the surface of the pavement itself at daytime can cause glare. It can sometimes cause more road accidents.

Roads made using cement concrete are very difficult to repair once they are built and damaged. Therefore, it is almost impossible to repair the water, electricity, telephone, cable, sewerage, etc. lines laid under the road

by cutting the road. Therefore, before building a road, one has to plan the management of these utility lines very well.

As the temperature fluctuates, the pavement expands, shrinks, and warps. In the case of flexible pavements, the stress on the pavement is easily redistributed and absorbed, so they do not have serious effects on the performance of the pavement. However, in the case of the surface of cement concrete, its own weight or friction with the surface below does not allow the free expansion, contraction, and warping, thus creating additional stresses. To manage these stresses, joints need to be made on the cement concrete road. These joints usually create noise during the vehicle movement and make construction and maintenance difficult.

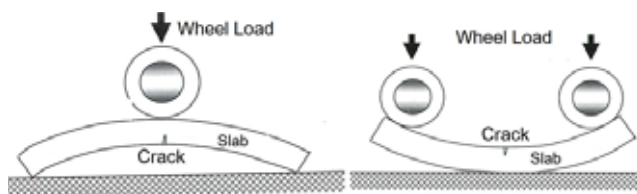


Figure 10: Stresses in concrete pavement

To provide adequate friction with the rubber tires, the concrete pavement surfaces are tined with texturing devices. These create small grooves on the surface that add to the creation of noise.

As compared to the bituminous pavements concrete pavements require a long period of time (usually 28 days) to open to the traffic after construction while traffic can be allowed immediately after laying of asphalt concrete.

Conclusions

As discussed above, although there are some challenges in using Concrete pavements, their advantages outweigh the disadvantages as compared with bituminous pavements. Many disadvantages can be easily mitigated or does not have very significant consequences.

The most important factor in the present reluctance in using Cement Concrete roads is the high initial cost. If life cycle cost analysis is carried out, it is easily seen that cement concrete pavements are cheaper in the long run. An engineer should explain this fact clearly to the policymakers.

As far as headlight glare and subsequent reduction in safety are concerned, that is not very significant if compared with the improved safety due to better visibility at night time.

The difficulty in utility (water, electricity, communication,

and sewer) location and their repair on concrete roads can be overcome by proper planning in advance.

The noise produced by the joints on the concrete pavements can be highly reduced by adopting modern jointless technology. In modern concrete pavements, it has been found that no expansion joints are necessary. Contraction joints are not formed during the concreting process, they are later formed by cutting grooves on the set concrete. Longitudinal tining (or texturing) for adding texture to the concrete surface reduces noise to some extent.

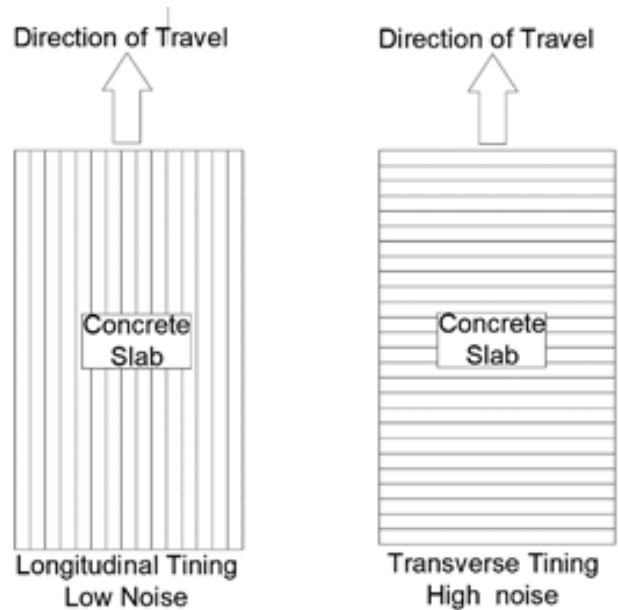


Figure 11: Effect of tining direction on noise

New methods and technology are now available for repairing damaged or broken concrete pavements. So the difficulty in maintenance of concrete pavements is not a big problem for the available technology.

Where the long time for opening to traffic cannot be allowed, this problem can be overcome using precast concrete technology .

At last, we can say that the concrete pavements that are seemingly costly and difficult to be implemented in practice at first glance are actually cheaper in the long run, and should be implemented in new road projects especially in a country like Nepal where there is no production of Bitumen, but there is a large potential for the production of cement in the future.



About the Author

Engr. Rajendra Raj Sharma holds a Master’s Degree in Civil Engineering .

He has got training in Road and Bridge Engineering from the USA, Canada, Japan, China, India, and Thailand.

He is the laureate of the Gold Medal ‘Mahendra Bidhya Bhushan’ of Nepal for excellent academic records.

He is now retired as Joint Secretary at the Ministry of

Physical Infrastructure and Transport of Nepal.

At present, he frequently delivers lectures, conducts training, providing consultancy and advisory services to various transport-related organizations of Nepal.

Recently he is the vice-president of the Society of Transportation Engineers (SOTEN), Nepal.



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Hydrological Uncertainties in Design of Hydraulic Structures in Nepal

Er. Bhesh Raj Thapa

E-mail: bthapa.ioe@gmail.com

Er. Anil Aryal

Introduction

Hydrology is the branch of science that deals with occurrence, distribution, movement, and property of water in the Earth and its relationship with the environment at each phase of the water cycle. It was developed as a science to solve the water related problems of the earth by simplifying complex global water system (USGS, 2021). The knowledge of the hydrological system provides insights on the amount of the water available in the watershed boundary at local, regional, and global level by transforming the rainfall amount to runoff quantity. The high or low discharge in the river will have potential impact on the existing water related infrastructures. With high flow, there is risk of large-scale damage of water infrastructures. For example, the floods in monsoon season in Nepal frequently wash a number of bridges (concrete, steel, or suspension bridge) annually. In contrast, low flows over a long time are responsible for damage of irrigation water ways (concrete/earthen canals) resulting in huge economic loss and reduced agricultural productivity.

Hydraulics is the branch of science that deals with the motion of liquids in relation to disciplines such as fluid mechanics and dynamics. For example, for quantification of water level in river, water flow dynamics in river is related to hydraulic engineering. Hydraulic engineering provides insight on the flow mechanics and dynamics of the river system. The design of hydraulic system depends on the hydrological properties of the river system. The knowledge of hydraulic engineering is required for the adequate design of hydraulic components of water related infrastructures. For example, in the design of irrigation canal, the design knowledge of irrigation canal type, its width, depth, or free board is important for long term efficient functioning of canal system. The gap in knowledge may led to error in design of canal which eventually have problem either during the construction

or during the operation of the canal system. Besides, the inadequacy of in-situ geological knowledge, lack of sufficient cross-sectional data, and many other factors also result in false design of the hydraulic systems. Additionally, these factors also pose uncertainties during the design phase of the hydraulic systems. Providing limited data to the designer may result in faulty design of the hydraulic properties of water infrastructures.

Further integration of hydrological and hydraulic knowledge is the foremost step in the design and construction of water related infrastructures such as bridge, dam, reservoir, and many others. Additionally, acquisition of local hydrological and hydraulic properties, sediment flow characteristics, upstream water diversion quantity, environmental flow characteristics, number of water infrastructures within the study basin, and many more in the river reach are required to design the water related infrastructures. Among them, sediment transport is one of the major factors that is responsible for increased uncertainty which is given less importance during design of water related infrastructures in Nepal. Because of fragile geology, the country has witnessed frequent landslides annually which acts as a dominant factor for increased sediment load. Beside sediment load analysis, the less considered factors may be the exclusion of upstream water diversion quantity and number of water infrastructures, which are also the key factors governing the design and construction of water infrastructures.

Unless and until, the above information of river system is adequately known, it is difficult to have proper design of water related infrastructures and it's lack results in higher degree of uncertainty. Besides, there exists error; human or modelling, during the design and construction of those infrastructures which may be driven by various factors. The driving factors may be different during design and construction phase that create uncertainties in hydraulic design. The uncertainties may arise from



various sources such as limitation in data acquisition, design knowledge, tools used for design analysis (both for hydrological and hydraulic), and many more. Hydrological river basins in Nepal

Hydrologically Nepal is divided into eight river basins as shown in Figure 1. Karnali, Narayani, and Koshi are river basins formed by major river systems and referred as major river basins. While the Mahakali, Babai, Rapti, Bagmati, and Kankai are river basins developed from medium rivers and referred as medium river basins (WECS, 2011). Drainage area of the river basins varies accordingly which classifies the basins as major river basins and medium river basins in Nepal. Among all, in terms of catchment area, Koshi is the largest river basin and Kankai is the smallest. However, in terms of river runoff, Narayani river basin is the largest and Kankai the smallest. The estimated river runoff in the large river basins varies from 1441 m³/s in Karnali river basin to 1753 m³/s in the Narayani river basin while in the medium river basins the runoff varies from 68m³/s in Kankai river basin to 698 m³/s in Mahakali river basin.



Figure 1. The river basins in Nepal

Hydrological Analysis of Nepalese River Basins

For the hydrological analysis, the required data is collected by the Department of Hydrology and Meteorology (DHM) in Nepal on daily basis. The hydrological data collected from the DHM are used for the design of hydraulic structure in the gauged rivers. The gauged or ungauged river may range from medium to major rivers depending on the river discharge. However, for the hydrological analysis of the ungauged rivers, two approaches, Medium Irrigation Project (MIP) and Water and Energy Commission Secretariat (WECS), are used and hydrological properties of the river are determined. The approach uses regression equation developed using long term historical data to represent the flow regime of ungauged rivers.

Medium Irrigation Project (MIP)

MIP method was formulated using the spot measured data established by Department of Hydrology and Meteorology (DHM) which covers a number of small catchments in the hilly region of the country. The measurement for MIP was taken by walking in an intermittent basis. Since the flow measured are the residual flows, they may not represent the natural state of the river. However, the measurement provides an insight on the water available in the basin. In order to calculate the water availability in the particular river basin, the whole country is divided into seven regional groups (For details see Figure 3.3 of Design Manuals for Irrigation Projects in Nepal, M.3 Hydrology and Agro-meteorology Manual). To minimize the uncertainties during the design phase of water related infrastructures, it is advised to use the spot measurement of the particular project together with MIP method and include all the necessary information as possible.

Water and Energy Commission Secretariat (WECS)

The other method to analyze the hydrological properties of any river basin and river system is WECS regional regression for long term mean flows and for low flows (WECS, 1989). A regression equation was developed based on the long terms flow data from DHM primary gauges considering the basin characteristics such as basin area, mainstream length, area of catchment below 5000 m elevation, and many more. The WECS developed the equation in the form

$$Q_{\text{mean}}(\text{month}) = \text{Coefficient} \times (\text{basin area})^{A1} \times (\text{basin area below 5000m} + 1)^{A2} \times (\text{mean monsoon precipitation})^{A3}$$

Where, $Q_{\text{mean}}(\text{month})$ is the monthly flow measured in m³/s

Coefficient is the constant coefficient (column second in Table 3.2)

A1 is power of basin area (column third in Table 3.2) measured in km² unit

A2 is power of basin area below 5000 m +1 (column fourth in Table 3.2) measured in km² unit

A3 is power of mean monsoon precipitation (column fifth in Table 3.2) measured in mm unit

Hydrological Uncertainties Associated with Infrastructure Design

Analysis of hydrological properties of any river basin system is the key in the design of hydraulic properties of any water related infrastructures. Limitations in the

design phase such as use of limited in-situ hydrological data, hydraulic information, and other information may lead to increase design uncertainty. For example, in the design of large span bridges and culverts, use of short-term river flow (two – four year) as an input to analyze hydrological characteristics may not truly represent the actual river flow. The uncertainty in data acquisition may be in spatial and temporal scales. In temporal scale, beside long- and short-term data use, use of daily, monthly, or annual time scale data may provide different level of design uncertainty. Higher uncertainty may arise while using coarser resolution data. In contrast, the uncertainty level may be reduced with the use of finer temporal resolution data to represent the actual flow regime. However, use of fine temporal resolution data may not reduce the uncertainty in hydraulic design of water infrastructures completely. The spatial extent of the data, existing legislation, regulatory conditions, parameter values, and conflict in knowledge of decision makers and stakeholders may be responsible for higher uncertainties in design of hydraulic properties of water infrastructures (Refsgaard, et al., 2007).

In context of Nepal, beside above-mentioned factors, rugged topography, abnormal river flow during dry and wet season, fragile geology, high sediment flow also contribute to design and construction uncertainty of water related infrastructures. High sediment flow is also responsible for damaging the head works and silting of river reach which eventually increases wear-and-tear of electro-mechanical and civil components associated with water infrastructure (Chinnasamy and Sood, 2020). With the onset of climate change, the uncertainty level has increased. The old infrastructures that were designed for 100-year return period flood is unlikely to withstand the designed flood in the current scenario. Therefore, the design engineers of the water related infrastructures must consider wider dimensions, to minimize the uncertainty level. As presented in Figure 2, the uncertainty level may come from technical aspect (data source, model development, boundary conditions, framing the problems) or social aspect (population dynamics, upstream and downstream user of water infrastructure), or environmental aspect (location site of infrastructure, environmental flow for current and future scenario, climate scenario).

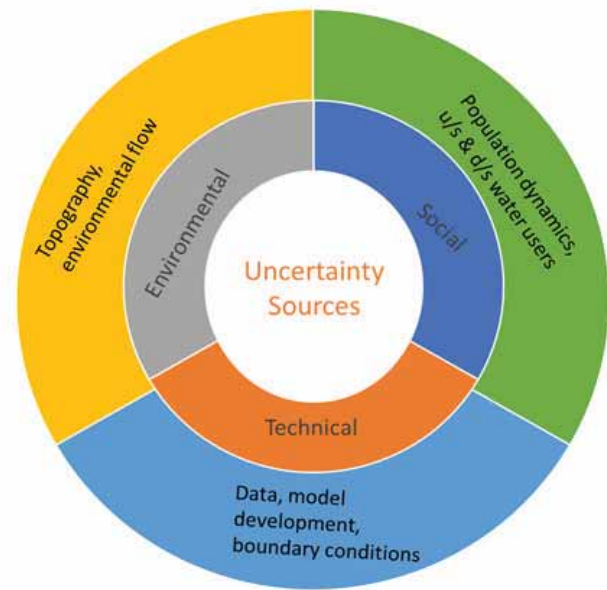


Figure 2. Sources of uncertainty in designing water related infrastructures

Challenges and Opportunities

Variation in the river runoff is associated with the design of water structures. Large variation in river flows is always a concern to the managers and practitioners of water resource management. Each year, high river flow is responsible for the damage of water infrastructures in the country which is exacerbated with the current situation of changing climate. The simulation of national climate projected an increase in the mean annual rainfall and temperature by 135% and 5.8oC, respectively by the end of 21st century. Also, increase in the sediment concentration is responsible for increased uncertainty in design and construction of water infrastructure such as bridges (Figure 3). The increased sediment load has collapsed the bridge piers (Figure 3a) and decreased free-board during the high flow season (Figure 3b). These challenges provide opportunities to both hydrologist and hydraulic engineers in incorporating the uncertainties imposed by the changing climate in designing the water related infrastructures that are climate resilient. In addition to climate change, the extreme events that are recurring frequently, and natural hazards such as Gorkha mega earthquake also challenge and thereby provide opportunity to incorporate safe engineering design practices of hydraulic structures.



Figure 3. Concentration of high sediment in the downstream river reach at XXX river

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A Short Discussion on the Bond Behavior of Deformed Steel Bar and Fiber Reinforced Polymer (FRP) Bar



Sudeep Adhikari, PhD

E-mail : adhikarisudeep0@gmail.com

Introduction

The last 100 year had been the most eventful epoch in human history in regard to major and ground-breaking paradigm-shifts in the world-view, technology and material-science. If the development of Quantum Mechanics and Relativity can be regarded as the major shift in our material world-view, it won't be an over exaggeration if we consider the introduction of composite materials to be the paradigm-shift in the field of material-science. According to L. Hollaway, the past 100 years represents the evolution of FRP composite materials in the similar way iron and then steel characterized 19th century. Apart from their multifarious applications, particularly in the performance-based sectors such as defense and aerospace, FRP composite materials are gradually finding their way to establish themselves as the very good alternative materials for the civil-engineering structural applications. Over the last 20 years, FRP composite materials have evolved into an economically and structurally viable construction material for buildings and bridges. They have proved themselves to be a very ingenious substitution to the conventional metallic materials even in civil engineering application, where both strength and stiffness play pivotal role. FRP materials are characterized by low specific weight, higher strength and electromagnetic transparency. These features have rendered FRP composite materials more attractive for the field of civil-engineering, owing to their innate capability to meet more functional requirements, alongwith the stringent structural demands. The simplicity associated with the application of FRP composite renders them very attractive in civil-engineering application, especially when dead-weight, space or time constraints are existent.

One of the prominent applications of FRP composite materials has been in the form of Fiber Reinforced

Polymer bar. While the author is incognizant of its application in the national context, it is undeniable that FRP bar is gradually finding its applicability for the development of civil-infrastructures all over the world. FRP bar is manufactured by binding micro-fibers (organic/inorganic) using some sort of high-strength binding medium: Epoxy, Vinyl Ester etc, such that they can be used as a reinforcing bar with the concrete. They are generally endowed with high tensile strength in the longitudinal direction. The approximate tensile strength for the common grade of Glass Fiber Reinforced Polymer (GFRP) bar is reported to be 475 ksi, and for the case of common grades of Carbon Fiber Reinforced Polymer bar (CFRP) to be 504 ksi (the values are only indicative and are liable to change with constantly evolving manufacturing techniques). It is apparent that FRP bars are high-strength materials and hence, they can withstand high tensile stresses depending upon the type of loading. However, a high tensile strength of the reinforcing bar can't be fully materialized in a reinforced concrete structure if we can't ensure perfect bond between the reinforcing bar and the surrounding concrete matrix. Therefore, to put the things in context, the following sub-section provides a brief comparison of the bond behavior between FRP bar and a steel bar. Bond Behavior of FRP bar relative to Steel bar

The high tensile strength of FRP bars can only be fully exploited if they can be used as a material for reinforced concrete structures, capable of developing adequate bond with the surrounding concrete-matrix. For instance, carbon fiber reinforced beams can undergo failure by interfacial debonding with the concrete due to the high tensile strength of CFRPs. Therefore, it can be stated that in case of reinforced concrete structures, high tensile strength of the reinforcing material may be a necessary criterion, but not always a sufficient one. To extract the complete advantage of the reinforcing

materials such as steel and various kinds of FRPs, the complete composite action of the concrete and the reinforcing material is of utmost requirement. As a matter of fact, in case of reinforced concrete structures, both at serviceability and at ultimate state, the various resisting mechanisms such as bending, shear and torsion are directly linked with the presumption of perfect bond between the constituent materials. Various implications of serviceability limit state, such as control of crack widths and deformations, are influenced by the phenomenon of tension-stiffening which is directly linked with bond.

Another widespread application of the FRPs is for the shear/flexural strengthening of the existing structures. For such type of application, the respective FRP material is placed in the groove cut on the surface of the structure to be strengthened and is fixed by some kind of epoxy. Such application, which includes multiple bond-interfaces (between FRP and epoxy and between the epoxy and the concrete), may necessitate more detailed analysis on the bond behavior of the FRP, as it may require more parameters to define the global joint behavior. Nonetheless, for all practical purposes, it can be easily inferred that the bond is the fundamental requirement for composite action, and thus for the structural efficacy of reinforced concrete structures, such that its importance can't be underestimated.

In the case of FRPs, this issue becomes more significant since the current methodologies for the analysis of bond behavior in flexural members are based on the research done with steel as a reinforcing material. Many experimental studies and research have depicted that various mechanical and physical properties of the FRP bars are significantly different; both quantitatively and qualitatively in comparison to steel bars. In the case of plain steel bar, the bond is transferred by chemical adhesion, followed by sliding resistance whereas in the case of FRP bars, the resisting mechanism comprises of mechanical interlock, hydrostatic pressure on FRP bars by the hardened concrete and swell of FRP bars due to moisture absorption and change in temperature. Such differences can be attributed to the significant difference in the physical/mechanical properties that exists between the steel rebars and the FRP bars, and the difference between the modes of their interaction with the concrete matrix. Fig- 1 shows the dominant components in case of deformed steel bar for the actuation of bond stress (the deformation of the ribs are not in scale and are accentuated for educational

purpose). As we can see, the bond is primarily actuated due to the bearing and friction components on the rib-face and the wedging effect generated by the concrete key between two adjacent ribs. Similarly, it depicts how sufficient radial pressure alongwith the bond-stress is developed in case of deformed steel bar. Whereas in case of FRP bar, the surface deformation is inadequate to generate sufficient bearing and friction. It is also to be noted that: unlike steel bar, FRP bar is not a homogenous material, but transversely isotropic; that is, their stiffness is significantly lower in the direction perpendicular to the longitudinal one. Hence, larger component of its bond with concrete is dependent on the adhesion. Fig-2 depicts the primary components in case of deformed steel bar and FRP rebar in a comparative manner (it's a conceptual rendering, and it is not in scale). It can be clearly observed that in case of a FRP rebar, the primary component is adhesion, such that generating lesser radial pressure and deformation.

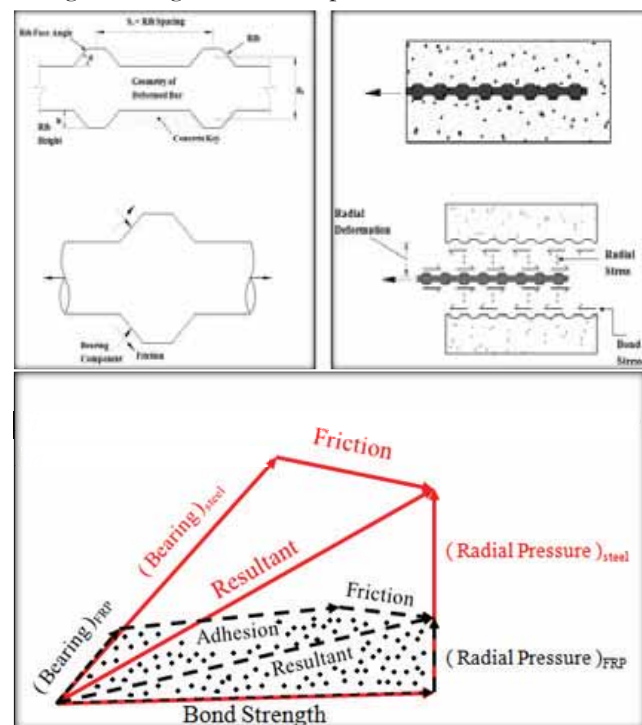


Fig- 2: Relative Comparison of Bond-Resisting Mechanisms between a Deformed Steel Bar and a FRP Bar

It can be observed in Figure 2 (red: steel bar, black: FRP bar) that the primary bond-resisting mechanism in case of deformed steel bar is bearing as facilitated by its deformed geometry, further accentuated by the radial stress developed alongwith. Whereas in case of a FRP bar, it is unable to generate sufficient radial pressure and the major contribution is provided by the adhesion and friction between the FRP bar and the concrete.

Therefore, it can be surmised that the bond between FRP bar and the adjacent concrete-matrix is still a matter of further research, and it is required to be carefully scrutinized if we want to extract the complete advantages of its high tensile strength in longitudinal direction.

Conclusion

Based on the above discussion, it can be concluded that FRP bar can be a good substitute as a reinforcing material in a reinforced concrete structure, particularly when the structure are required to meet some stringent functional requirement; for instance, in case of hydraulic structures where corrosion of the steel reinforcement is

an immediate concern. However, a detailed investigation on the bond-behavior of the FRP bar with concrete is highly imperative, considering the fact that the perfect bond between reinforcing material and the concrete-matrix is a must to ensure composite action of the resultant reinforced concrete.

Short Bio of the Author

Sudeep Adhikari is the Technical Director of CMS Engineering Consult Private Limited, Nepal; a member firm of SCAEF, and is the member of the current SCAEF Publication Sub-committee. The article is based on his research during the perusal of his PhD degree (2008-2013).

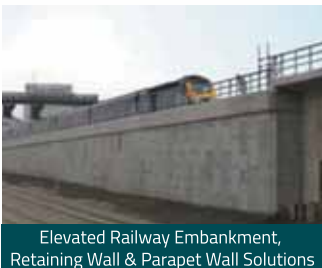


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Introduction

The consulting industry in Nepal received new opportunities and challenges from early-seventies when governmental departments started using private professional to provide services in small scale engineering projects. Since then, though the industry is in a continuous path of growth, the parallel support from the concerned quarters of the formulation of appropriate policies, regulations and environment for healthy competition could not take place.

Thus, in order to protect the interest of consulting industry of the country, the Society of Consulting Architectural & Engineering Firms (SCAEF), Nepal was registered with the then HMG/N on November 20, 1990, under the collective endeavor of the professional consulting firms. The Government has recognized SCAEF as the National Body on 15 August 1996 and has designed Ministry of Physical Planning and Works as “Line Ministry” to look after the interest of SCAEF and its member firms on 22 February 2005. The Public Works Directives (PWD), January 2002, published by the then HMG/N requires the consulting firms to be registered mandatorily with the professional societies for getting shortlisted to participate in proposal submission.

SCAEF Nepal has now more than 240 national engineering and architectural consulting firms affiliated and working together for national building by promoting quality of consulting services.

SCAEF, Nepal has started the Keshab Man Amatya (KMA) Young Engineer Excellence Award; initiated for deserving Nepalese Engineering student who has excelled in his/her performance in Civil engineering from national universities since 2016. The award has been established in the memory of SCAEF’s 6th Past President Late Er. Keshab Man Amatya. An endowment fund of NRs 1.0 million has been granted by his family for this purpose.

Similarly, SCAEF, Nepal has also initiated the SCAEF Young Architect Excellence Award for deserving Nepalese Architect who has excelled in his/her performance in Architectural engineering from national universities since 2018 by self-funding as a part of CSR initiative.

In initial two years, The KMA Award were distributed to fresh graduates of Civil engineering and Architectural engineering in alternate years. Since 2018, after the initiation of SCAEF Young Architect Excellence Award, the KMA Award has been given only to the Civil engineering graduates.

The aim of the Awards is to recognize two deserving Nepalese engineering graduates; one Civil engineering and one Architectural engineering, who have excelled in their performance in Bachelor’s in Civil Engineering and Architecture from Nepalese Universities, and who aspire to serve Nepal through their knowledge and work towards uplifting the quality of life of people. The Awards is being conferred to one B.E. or B. Sc. (Civil Engineering) Graduate and one B. Arch. Graduate on annual basis. The Awards contain a certificate along with a cash prize of NPR 75,000.00 (Seventy-Five Thousand Only) to each of the Awardees; and presented at every SCAEF Anniversary Day i.e., on November 20.

Award and CSR committee is a one of the sub-committees formed by the executives which have the responsibility for management, selection and recommendation of winner of these awards.

Continuing the tradition, SCAEF Nepal, has successfully announced and distributed 5th KMA Young Engineer Excellence Award and 3rd SCAEF Young Architect Excellence Award in the occasion of its 31st Anniversary in 2020. Selection was made by the jury assigned by the SCAEF Nepal based on their performances, family backgrounds/ incomes and aptitude tests.

Awardee Selection Process

The Award and CSR sub-committee had prepared evaluation process and set out criteria to select and recommend the winner of both Awards. The evaluation criteria are presented below in a table.

Table: Evaluation Criteria

SN	Criteria	Weight	Evaluation Stage
1	SLC Score	20 %	Preliminary Screening
2	Intermediate Score	20%	
3	Bachelor In Civil Engineering/B. Architect Score	60%	
Sub Total		100%	
1	Family background/Economic Status	30%	Interview/Final Examination
2	Personal Effort	20%	
3	Future Plan	20%	
4	Personality and attitude	20%	
5	Leadership & Extra Curricular Activities	10%	
Sub Total		100%	

Firstly, the Sub-committee will issue a letter to all Universities where the bachelor's degree of Civil and/or Architectural engineering program is running to collect list of top 5 ranked fresh graduates in each faculty with their name, address, marks obtained, name of the college, and contact number/email address by mid of November.

In response to the issued letter, it is anticipated that sub-committee will receive name-list of outstanding graduates from respective universities within end of November; if not, the follow up to the letter will be done by the SCAEF secretariat. Then, the Award and CSR sub-committee will contact all graduates and inform them to send copy of their academic certificates and citizenship along with an application directly to the SCAEF office or via mail.

All the applications received through email or manually registered at SCAEF office will be compiled and preliminary review process will be initiated by the sub-committee by first week of October. After preliminary evaluation of marks obtained in SLC/SEE to Bachelor degree by the committee members; top ranked five applicants from Civil graduate and Architecture graduate among the nominees from all universities will be selected and recommend for final interview.

The final jury of 5 members will be formed consisting of the President, Sub-Committee Coordinator, Award trustee, a Past President and an expert who will conduct

the interview process. All the graduates will be called for the interview and asked to bring along the original certificates. Previous award winners will also be invited to observe the proceeding. Each graduate will be interviewed, and marks will be given by each evaluator based on their own judgment as per given criteria.

After completion of the interview, the score given by each evaluator will be averaged for all graduates and the participant with the highest score will be selected as the winner for each category of excellence award. Every year on November 20 (SCAEF Day), the winner will be declared, and celebration of award distribution program will be observed. The sub-committee will then prepare a Report on Award process and submit it to the SCAEF EC.

Impact of the Award

These are the five fresh graduates from different Colleges under different universities who have received the KMA Young Engineer Excellence Award since its establishment in 2016.

- 1st Award Winner 2016, Er. Eshant Mishra- Nepal Engineering College, Pokhara University
- 2nd Award winner 2017, Ar. Salina Shrestha- Khwopa Engineering College, Purbanchal University
- 3rd Award Winner 2018, Er. Bishnual Shrestha- Nepal Engineering College, Pokhara University
- 4th Award Winner 2019, Er. Krishna Chand- National academy of Science and Technology, Kailali, Pokhara University
- 5th Award Winner 2020 Er. Bhagyashree Maharjan- Nepal Engineering College, Pokhara University

Similarly, hereunder is presented three fresh graduates of different universities who have received the SCAEF Young Architect Excellence Award since its establishment in 2018.

- 1st Award Winner 2018, Ar. Rajina Shrestha, Nepal Engineering College, Pokhara University
- 2nd Award winner 2019, Ar. Subina Tuladhar- Nepal Engineering College, Pokhara University



- 3rd Award Winner 2020, Ar. Aastha Shrestha, Pulchowk Campus, Tribhuvan University

Such awards motivate young engineers to work harder during their student life as well as their professional life. The award program provides positive reinforcement to young engineers and architects to explore the existing issues regarding planning, design, implementation, operation, and maintenance that are often encountered in civil and architectural projects and find the ways to overcome these issues.

According to the award winners, it has helped in building their confidence. Receiving the award title has empowered them to work harder and has also supported their further studies financially. The Award has uplifted professional career as an Architect as well as a Civil engineer and they felt as if they got to share some wonderful memories with respected seniors and other fraternity. This award made them more responsible in their profession as well as in the society.

As we followed up on the award winners, we found that some award winners are studying master's degree and some of them are working in reputed organization like DFID. It was found that most of the award winners utilize the award money to further their studies, but some of them also used the money for family member's education. First KMA award winner Er. Eshant Mishra got a scholarship from Asian institute of Technology (AIT), Thailand for Master's in structural engineering. Currently he is working as an engineering consultant for Kozo Keikaku Engineering Inc. in Tokyo. He states that the door for the abroad study and working was opened by the KMA excellence award.

Beneficiaries view on Awards and SCAEF Nepal

First KMA Young Engineer Excellence Award Winner Er. Eshant Mishra thought that being a recipient of the award has given him a new family in the form of trustee Tara Amatya, members of SCAEF, Nepal, and other fellow award recipients. Now they constantly stay in touch, brainstorm about future social work events and at times volunteer for SCAEF's events.

Second SCAEF Young Architect Excellence Award, 2019 winner Ar. Subina suggested that besides providing award, SCAEF should involve KMA winners along with other members in various activities to uplift the professional interest like organizing Design/ research competitions, Conducting Trainings, and Webinars etc. Another award winner Ar. Rajina added such Awards inspire every student and the right person would be acknowledged without any biases.

Fifth Keshab Man Amatya Young Engineer Excellence Award-2020 winner Er. Bhagyashree suggested that Engineering firms should invest more for quality and quantity on improving consulting business and further suggested that all consulting firms should go through filter of SCAEF's approval which further assists in enhancing the quality of consulting work. Fourth KMA Award Winner 2019, Er. Krishna Chand felt that the activities of SCAEF are very obliging whether it is in importing innovative technology or establishing strong bond among various consulting firms to meet the present and future need of nation regarding infrastructure development.

Conclusion

KMA Young Engineer Excellence Award and SCAEF Young Architect Excellence Award since being initiated has helped transform the lives of many young aspiring engineers and has become a milestone of CSR activity. Such programs, either through the acknowledgement or the financial aid encourage the graduates to work harder, further their studies and be a better professional and in turn work for the betterment of the engineering profession and the society. Thus, SCAEF Nepal plans to continue this noble work and every year inspiring fresh graduates to come together and work hard for the betterment of engineering profession SCAEF Nepal also invites and encourages member firms, organizations, and institutions for collaboration to initiate such different award programs.





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From Hunter to Explorer



Devendra Nath Gongal
Architect/Urban Planner
 E-mail: gongaldn@gmail.com

Architecture and engineering consulting business in Nepal is in its adolescence stage despite over half a century of its life span. It is difficult to advocate that it has achieved adulthood and so guaranteed its space in the country's business world. Searching for some escaping plot for this may be part of our liberty for self-satisfaction; but the history of the momentum in technological, socio-cultural and economic development of the country has an unequivocal role for this dilemma though. Nevertheless, by saying this, the consultants cannot run away from its genuine responsibility to push, provoke and impact the speed and characteristics of such development, because by virtue of its distinctive qualification they are the inherent parts of the movers and the shakers.

Consultants devote most of their time contemporarily, for every practical reason, in searching jobs. This is not only okay but is the *raison d'être* of a consulting firm. It is to be noted that, despite this, consulting business in Nepal with all its oddness has surpassed many obstacles and achieved quite a remarkable progress during the past five decades. But with all justification, being the *de facto* partner of National and technical development of the country, the *modus operandi* in general needs to be altered with a paradigm shift in its strategy in harmony to the time and space

The standard pattern of consultants' working culture is to run a marathon around every visible space and provide propositions, if it could hit the finish line, to solve a given issues with all accepted methodologies and available knowledge. This characteristic of the

consultants is comparable to hunting for jobs like a hunter for some palatable food. In essence, the consultants in this process are at the receiving end of the phenomenon.

Today's necessity for architectural and engineering consulting firms is to grow in quality and quantity. Many donor agencies like the Asian Development Bank and the World Bank for example, were very effective instruments to upgrade the quality of Nepal consultants besides sustaining its growth. Regularly perfecting the Financial Rules and Regulation and Public Works Directives, the Government has also been the backbone of the Consultancy Development of Nepal. Capital investment by the Government, private sector, and FDI, are growing in an impressive way and more and more technical educational institutions are also increasing recently within the country. The direct result of this is the increase in supply of multiple projects of varying nature, which is becoming the green field for consultants' experiences and job security. These positive trends are practically capacitating the Nepali consultants technically at par with international consultancy business. The outcome of this is that some of the Nepali consultants now are very effectively engaged in winning and performing international jobs. But the objective should be to make it a normal case instead of an exceptional one. Further, the climax of this situation, in almost all cases, is in the use of Nepali consultants in information sharing and other physical duties only rather than intellectual leadership roles in its own home ground. However, at



the same time, it is to be acknowledged that involvement of donor agencies and international consultants is a praiseworthy phenomenon for technological transfer from more qualified foreign experts having more experiences in multiple geographical regions. Unequivocally, this has helped in enhancing the quality of performance and delivery by Nepali consultants.

So where and how the changes in strategy and modus operandi as discussed above is to begin to transfer it into a more effective and major contributor to national development? There are many ways in combination to do this and the responsibilities are also many.

Before this, let us recap the prevailing subtle nuance in formulation of development of projects and other agendas of non-political character. Most of these are proposed, prepared and initiated by donor agencies, which can be done only if one is equipped with, not only extensive experiences, but also higher research based technological expertise, vision of national priorities with ground realities with a staunch ambition of exploration. These capabilities are the cruxes to accomplish higher leverage to move heaven and earth, explore the unexplored, display the unseen and entice to think the unthinkable. Such vision and intellectual investment are critical attributes of a consultant in need.

In consultancy business, any contract that a consultant signs is an integral part of a research work. Working, and delivering a contract is akin to completing one part of a research. ‘Research’ in general involves - understanding, analyzing, thinking, and crystallizing similar to the process when a consultant goes through to deliver its contract obligations. It is natural that a job after its delivery does not put an end to the thinking and the research process which was started at the beginning of the job. Lessons accumulated in every such delivery is a treasury. Retaining and upgrading of such treasury by documenting, sharing, disseminating, and also propagating gives credibility, authenticity and as well as value addition to it.

Modern consulting firms should contemplate on a few other simple things. First; Architecture and Engineering disciplines are not dogmas but are pure philosophical sciences. Second; a consulting firm’s strength is the experts with whom it is engaged with and the vision they possess. The firm cannot be more capable than these experts. The cognitive value of these manifests itself in transformation of the consultants to not mere ‘doers’ but ‘a leader’ and ‘a thinkers’ as well.

The domain of Nepali consultancy is expanding, the environment is favorable and the field is ready for a significant leap forward. In short, the skeleton for this jump is ready and the fraternity of consultants only needs to add flesh in the bone. This is time to raise the adrenaline emotion to up the ante. In today’s extremely fast changing world the consultants will be evaluated and recognized by the character of an explorer and not a hunter. The demand is to raise the dam before the flood hits.

This cannot happen unless investment is done into initiation, research, and propagation. Investment in time and resources are the imperatives. The situation of Nepali consultants in this respect is a pure lame duck. It is time to ponder on what Abraham Lincoln said once “Give me six hours to chop a tree, then I will spend four hours sharpening the axe”. Definitely, planning and preparation is more important than jumping in excitement. We can reap today, if we didn’t miss to sow yesterday. This is the mantra to act in the century of technical revolution.

About Author

"Devendra Nath Gongal is a senior Architect/Urban Planner with over four decades of experience. He has worked extensively in planning, consultant management, project management, and project formulation as well. He was involved in formulation of Public Works Directives and was intensively involved with the Government of Nepal, and many international donor agencies. He is presently engaged in an advisory role in design and implementation of some airports in India.





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Innovative Section - SCAEF's outlook towards SDG

Bio-hydrogen: A Possibility of Alternative Cooking Fuel

- Anish Ghimire

- Lokesh Sapkota



Bijay Thapa

E-mail: thapabijaya88@gmail.com

Many of the fuels, chemicals and raw materials that we use in our daily lives are derived from the petroleum based biorefineries. In light of depleting fossil fuels reserves and the consequences such as greenhouse gas emission and pollution problems from the by-products of the fossil fuels use, undoubtedly the source of energy and raw materials should come from renewable resources. These factors are driving bio-based economy for the production of bioenergy and useful chemicals. In this regards, current research technologies have been directed towards the creation of biorefinery based on renewable sources such as organic waste biomass. A sustainable route for the production of (bio) fuels and chemicals is development of industrial biorefineries. Moreover, biorefineries for the production of multiple fuels and products can overcome the economic hurdles. Based on production aim for the type of fuel and materials, different processes can be selected. Products yields from different physical, chemical or biological processes can be different. The physical-chemical processes such as pyrolysis, gasification are energy intensive and relies on expensive chemical catalyst while biological processes can be operated at ambient conditions mediated by biological catalyst i.e. microorganisms.

In recent years, creation of H₂-economy has been envisioned for future supply of energy owing to the higher energy content of H₂ and water being only by-products of utilization. Production of H₂ from biological pathways, which generally utilizes the renewable resources such as organic waste biomass can be promising and also ensure further sustainability of this ideal fuel. Among the different

biological technologies, dark fermentation (DF) can be one of the potential technologies to produce H₂ as well as valuable by-products in the form of organic acids and alcohols. These fine chemicals can be recovered or can be used as raw materials to produce other biofuels and platform chemicals in physical, chemical and or biological systems. Thus, creation of a biorefinery with DF as central process can allow the production of multiple biofuels and other platform chemicals. Abundant biomass sources can be used for dark fermentative biohydrogen production. However, the conversion certain feedstock such as lignocellulosic biomass (agricultural residues, forest products) requires physical, chemical or biological pre-treatment for their complete conversion into value added products. The scale-up applications of DF processes are limited by incomplete conversion of feedstock and low energy gain. Nonetheless, the unhydrolyzed biomass residues and the volatile fatty acids (VFAs) and alcohols present in dark fermentation influent can be further converted by anaerobic digestion (AD) process to methane and carbon dioxide. Therefore, with an integrated DF – AD processes conversion of biomass to multiple fuels and biochemical can be realized by creating sustainable biorefinery.

Organic Waste Based Biorefinery Concept

The solid waste management (SWM) is a one of the major challenges in the growing cities in Nepal. The local governmental agencies are spending huge amount of funds in SWM but the results are not much satisfactory. On average, the municipal solid waste contains about 55- 65% organic fraction or known as Organic fraction of municipal solid waste (OFMSW). OFMSW is readily biodegradable and

could be a potential source of greenhouse gas emissions if disposed in landfills. The sustainable management option will be to utilize this useful resource in the sustainable resource recovery processes like Anaerobic Digestion (AD) processes for energy recovery from biogas production. OFMSW often contains 25 – 30% total solids (TS) and thus, is predominantly solid and non-flowing. Therefore, high solids anaerobic digestion (HS-AD) processes operated at TS content higher than 10 – 15% can be appropriate for the treatment of OFMSW due to their technical simplicity, economic benefits from the reduced reactor size, efficient handling of digestate and lower energy requirements compared to the wet-process (operated at TS content less than 10%). Therefore, HS-AD processes can be an attractive technology for valorization of OFMSW through the production of energy (heat and electricity) from biogas and fertilizer from digestate. However, the major limiting operational parameters such as TS content, inoculation (or substrate or feed to inoculum or S/X ratio) and size of the organic solid particles has to be optimized to improve methane yield and process stability in HS-AD process. Thus, the resource recovery potential from OFMSW depends on the optimal operation of HS-AD process. Therefore, this study was studied at the laboratory and pilot scale HS-AD studies for the investigation of major limiting parameters to enhance the resource recovery potential using OFMSW. In light of growing interest of the Nepalese Governmental agencies in the commercialization of the waste-to-energy technologies, the outcomes of this study could be very important in the development of commercial biogas technologies.

Sustainable Resource Recovery from Organic Waste Using Anaerobic Digestion Process

Anaerobic digestion (AD) is a biological process which converts complex organic matter into a methane rich gas (60-70% methane-CH₄, 40-30% carbon dioxide- CO₂) through a series of processes mediated by different microbial consortia. The biogas can be either directly used (cleaning and upgrading may require in large scale) as a gaseous fuel or can be converted to heat and electricity. Apart from the

biogas, AD processes can offer attractive solution to waste treatment and recovery of biosolids or digestate which can be used as a soil amendment.

Production of Biohythane

Biohythane, which is a mixture of H₂ and CH₄ has recently attracted attention due to its versatile uses for transportation fuels. The mixture (typically 10 - 25 % volume) combines the advantages of both of the gaseous fuels, such as wide flammability range, fast burning speed and high ignition temperature. Therefore, biohythane offers an edge over stand-alone technologies producing H₂ and CH₄.

Dark Fermentation

In dark fermentation (DF) process, carbohydrate-rich substrates are breakdown anaerobically by hydrogen-producing microorganisms, such as facultative anaerobes and obligate anaerobes. The major products of the mixed fermentation are hydrogen, organic acids and alcohols. The product of the fermentation is dependent on various parameters such as microorganisms, substrate types and environmental conditions such as pH, hydrogen partial pressure.

Anaerobic Digestion as Post Treatment Step

Anaerobic Digestion (AD) is well established technology for biogas production (CH₄ and CO₂) from biomass. AD can be used as side-stream process to convert by-products of DF and the residues from pre-treatment of biomass to CH₄. The integration of AD can increase the sustainability of the process by producing energy (CH₄) and can guarantee the complete treatment of the biomass to recovery several benefits in terms of fertilizers, biofuels.

Activities performed in the study:

Inception Seminar on Biorefinery Process for Waste Treatment and Clean Energy and Bio-chemicals Recovery

An online webinar titled, “Waste Biorefinery: A New Paradigm for a Sustainable Renewable Energy” was organized on May 29, 2020 via Zoom platform. The webinar brought professionals, governmental agencies, academicians, researchers and practitioners working in the field of renewable energy to discuss



the current status and future prospect of biorefinery system. The workshop discussed innovative solutions for solving energy related problems beyond the current practices. One of the key speakers, Dr. Ram Prasad Dhital, Member of Electricity Regulatory Commission presented key challenges and prospects in electricity regulation and renewable energy development in Nepal. Dr. Dhital also highlighted the need of scientific research and innovation for the sustainability of renewable energy technologies. Similarly, Dr. Anish Ghimire, presented the role of anaerobic fermentation based biorefinery system for integrated solid waste management, energy and biochemical recovery. Dr. Ghimire provided the technical insight on the two-stage anaerobic digester and its benefit compared to one-stage digester. Dr. Ghimire further stressed that two-stage biorefinery system could be a potential solution for agricultural sector, brewery industries and even municipalities to tap in biohythane from organic waste. Finally, the Principal Investigator and President of Nawa Paila, Dr. Bijay Thapa provided an insight on the ongoing EnergizeNepal project. Dr. Thapa underlined that dark fermentation is a promising technology with the potential of producing biohythane which has higher calorific value than biomethane.

Detail Review on Technology and Parameters Incorporating Biorefinery Process

Adequate literature reviews and studies were conducted and the observed data were compiled. A review paper focusing on biohythane and biochemical production through biorefinery system (a two stage anaerobic fermentation) was prepared.

Investigation of the effect of the inoculation strategies (SI ratio), Organic loading rate (OLR), Hydraulic Retention Time (HRT), pre-treatment method on biogas production

In order to investigate the effects of inoculation strategies (SI ratio) Batch experimental setup was adopted and AD at mesophilic (35 ± 1 °C) temperature range with simulated food waste (FW) was observed. 16 reactors (500ml each) were fed with different substrate to inoculum (S: I) ratios ranging from 0.5 to 6.

Determination of the Optimal Operating Parameters

The batch test conducted to seek optimum S:I ratio lasted for 52 days and yielded clear results. The observed specific CH₄ yields in the descending order of S:I ratios is $1 > 2 > 4 > 6 > 3 > 5 > 0.5$. The kinetic parameters during the CH₄ production was predicted using the first order kinetics and modified Gompertz model. Modified Gompertz model was seen to be more accurate in predicting CH₄ production from FW. The study showed significant effect of S:I on the kinetics of anaerobic digestion and thus the energy recovery from FW. The S:I ratio of 1 was recorded to yield maximum biogas of 760ml/ g VS and the least appropriate S:I was 0.5 which yielded 500 ml biogas/ g VS.

Design and Fabrication of 2 Stage Bio Refinery

A pilot bio-reactor was designed such that it was able to be fabricated locally in Nepal. The design of the pilot bio-reactor was carried out on the basis of literature review and research conducted on the worldwide practices of bio-reactor fabrication. The experiments conducted in two stage laboratory scale plant provided diminutive concepts on smooth operation of the targeted two stage bio-refinery system. Upon the operation of the plant for two phases of 94 and 45 days respectively, the effects of OLR, HRT, recirculation as well as coupling ratio were clearly observed.

Upscaling Potential

The results obtained through this study suggest that retrofitting the existing biogas plant can produce bio-hythane (H₂ and CH₄) gas which has higher calorific value and can be used for cooking purpose.

(Recent study of a consulting firm in support of “Energize Nepal program”, a program supported by Royal Norwegian Embassy and managed by Kathmandu University, NTNU, Sintef and Hydrolab) University, NTNU, Sintef and Hydrolab)



Congratulation on 31st Anniversary of SCAEF, Nepal Celebration...



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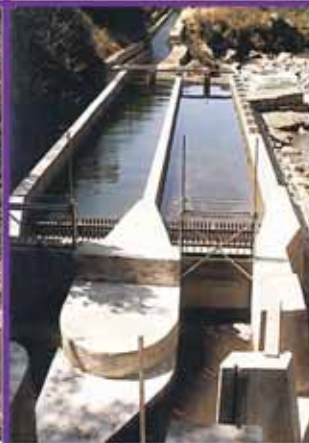
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Gender Balance Should Female Adjust to the Environment or Should Environment Adjust to the Female in Consulting Industry ?



Er. Samiksya Rijal

Director, Abhiyantra Consulting Pvt. Ltd.

I and my husband own a consulting company. One of the reasons for my involvement in this company is my husband and his desire to make me a leader, not just an engineer. During my involvement in consulting industry for past few years, I have often felt, I am in wrong sector. Consulting industry is still male dominated. I informally consulted my other engineer friends in the industry; more than 80% of the engineers are male. I wonder if there would have been any authorized survey or data related to this which I could be referenced for my own.

I am not a feminist but the gender ratio is woefully unbalanced. I thought of my engineering class. More than 70% were male. Is engineering supposed to be studied by male? Well, it starts from your childhood. I might be generalizing this with few examples of people I met. If you are a girl, parents want you to be a doctor or choose some other profession rather than choosing engineering. This must have affected the mentality of those girls and they start to dislike engineering.

When I was going through the last Tribhuvan University, Institute of Engineering (IOE) Entrance Examination Results; the ratio of male to female who passed their entrance examination was 32:7. It means that on average, every year out of total enrollment, only 18% are females. Let us assume parents are readily acceptable for you to study any subject including engineering, but they reluctantly allow you to go for a job in rural areas. Ok, let me correct this, they reluctantly allow you to join a job outside of your hometown or Kathmandu valley leave aside rural areas. Now assume, she joins an office in Kathmandu and she enters the rest room of that office. She starts to feel uncomfortable with no separate toilet for limited female staffs. I am telling this because our office started to have separate rest rooms for male and female only after I joined my husband at our company.

Because engineers are often surrounded by males, the conversations are often manly. If the company is owned by male, most of the offices will have female workers discriminated on daily basis and are not able to reach their own potential. They often ignore the ideas presented by female staff or not allowing them to speak or present. The

major problem is faced during field visits. Clients are often used to meet male engineers, some intentionally belittle the qualification and when they are confronted they usually try to get away with it by playing it as a joke.

I have tried to highlight the reasons for less involvement of female in consulting jobs. Female are often considered to have very good soft skills like designing and analysis. They are not considered for managerial jobs. At the same time, it is often understood that female are at lower position than male and they are meant to do the tasks like photocopying, preparing tea and serve in the absence of helper etc. And females are often found doing that initially and they start to feel bad for themselves and leave the job. The salary of a male engineer and female engineer with equal capacity is often mismatched. This partiality is more abundant in smaller consulting firms. Women are also less likely to be promoted or have their salary hikes in comparison to male engineers. Female are often considered to have other jobs like housekeeping, child-care work at home. This often limits them to pursue ambitions of top management careers.

However there are advantages of having female in consulting. I do not mean men and woman are different to larger extent but the way they are brought up and with discrimination they face each day, there are certain characteristics that most of the females have garnered that can have significant impact on business development at consulting firms. They are usually calm and with limited ego, they are capable of building relationships with clients. They tend to be more empathetic and better listeners (at least in their profession), which helps them to understand people. They often have a unique point of view and can make a huge impact.

It might not be easy to be a female in male dominated industry. However there are certain positives of having a female in this industry. The most important thing is to respect and include them in the team. As we talking to the gaining momentum in the new normal, we shall mentor them rather than competing and promoting them in the industry will flourish the industry in a long run and helps gaining the momentum rapidly in short run.

Integrated, Holistic and Futuristic (IHF) Approach of Infrastructure Planning, Design and Development in Water Supply Sector in Nepal



Shanker Dhakal

Design Research Support Expert

Email: shankeronlypart2@gmail.com

Surat Kumar Bam

Abstract

Some half a century ago, most of our infrastructures in Nepal were non-engineered and it was more so with water supply infrastructures. As engineering education and practice evolved in Nepal, our infrastructures such as buildings, roads and hydraulic systems certainly became better engineered. However, the more we are specialized, the narrower we are becoming in our approach of looking into the problems and issues. Furthermore, with recent political changes in the country, that achieved exceptional political and governance power shift from the central to the local and provincial levels, there has been a tendency in the latter of becoming more discrete with their planning and development approach. It is completely fine for the latter to be ambitious in developing their own electoral territories or provinces in support of the spirit of decentralization but the same is to align with the strategic national and regional level infrastructure policies and plans. Either way, it has become extremely important to integrate multiple use of water resources by taking into consideration the future growth of population or users and changed land use patterns, and by addressing the most vital issues of resilience to extreme actions of various natural hazards or their cascading effects, and environmental management, to ensure sustainable development. This philosophy and approach of holistic, integrated and futuristic planning, design and development (which we call IHF approach) is explained in this article in the context of water resource and water supply ecosystem. We present some relevant examples taken from the lessons learned from recent devastating Helambu-Malachi debris flood, concerning situation of ground water in the Far West leading to the prospects of bulk water supply transmission system having integrated to irrigation and hydropower projects, and, last but not least, the roles of impounding reservoirs and ponds in ground water recharge, river flow augmentation and contingency emergency plans through such projects as Dhap Dam and Mahadev Khola Impounding Reservoir Water Supply Project in and around Kathmandu Valley.

Keywords: Integrated, Holistic, Futuristic, Water supply infrastructures, Development, IHF approach, Nepal

Introduction

General Status of Water Supply Sector in Nepal and Goals

Nepal is a developing country with abundant natural water resource potentials. Some of these have been harnessed in the form of isolated hydroelectric projects and lately but very rarely in the form of multipurpose projects. While having abundance of fresh water sources that comes all the way from the Himalayas, the goals of accessibility and quality of water supply in the country are still receiving big question marks at times. Mostly in Terai, water supply to households is fed from ground water pumping, and it is fetched from small ponds (spring source) far away from homes in Hills and Himalayas. They are either inadequate in quantity or lack quality.

A more systematic and engineered approach featuring elevated water tanks, sump wells etc. (which still need design optimization each nevertheless) combined with treatment and in-house water quality testing facilities adopted by the small town or urban water supply and sanitation sector projects of the Government of Nepal, primarily funded by development partners such as ADB, and owned and managed by local water users and sanitation committees (WUSCs), also struggle with other serious problems such as limes causing choking and damage to the water distribution system. This eventually makes the projects uneconomical and unsustainable during operation and maintenance. Converting our villages and towns into safer water zones is therefore a big challenge.

Notably, the sixth goal of the seventeen Sustainable Development Goals (SDG) established by the United Nations (UN) General Assembly in 2015, viz. “Clean Water and Sanitation”, is aimed at achieving the “availability and sustainable management of water and sanitation for all” through 8 targets: (i) ensuring safe and affordable drinking water; (ii) ending open defecation by providing access to sanitation and hygiene; (iii)

improving water quality, water treatment and safe reuse; (iv) increasing water-use efficiency and fresh supplies; (v) implementing IWRM; (vi) protecting and restoring water related ecosystems; (vii) expanding water and sanitation support to developing countries; and (viii) supporting local engagement in water and sanitation management. In fact, this sixth goal is closely linked with and can contribute to the third goal (Good Health and Well Being) and also significantly to the first and the sixteenth goals, namely, No Poverty, and Peace, Justice and Strong Institutions, respectively. This all means, equitable access to safe and affordable water supply, sanitation and hygiene (WASH) services and facilities through the approach of strategic integrated water resources management and local engagement, which ultimately enhances water-use efficiency and contributes to the resilience and sustainability of water supply and sanitation sector in developing countries and the region, is the spirit of the sixth SDG. The goal targets to achieve a paradigm shift from the concept of access to quality (safety), reliability and overall a water-sensitive urban future. The National Planning Commission (NPC) of the Government of Nepal also reflects these targets on its 15th National Plan.

On contrary, Nepal which consists of 93 municipalities (6 metropolis, 11 sub-metropolis and 276 municipal councils) that are inhabited by approximately two third of the population has witnessed a widened urban infrastructure deficit - intermittent availability and compromised quality of water supply, poor urban wastewater services, and unhygienic living. This rapid urbanization in Nepal is leading to various health issues but good public health facilities are quite limited and private ones are getting unaffordable for ordinary citizens. Further, increasing impacts of climate change and other extreme events of hydrogeology seem to have added to the vulnerability and risk of WASH sector in Nepal. It is indeed too challenging for the governments of all levels to achieve safe citizens and get them to contribute to the economic growth without proper intervention in WASH sector.

Historical Reference and Evolution of Development Philosophy

Some half a century ago, most of our infrastructures in Nepal were non-engineered and it was more so with water supply infrastructures. However, the leaders and planners then did seem to have insights of big picture of water supply and storage system. This can, for instance, be inferred from a number of ponds developed in various strategic locations of Kathmandu valley (e.g.

Rani Pokhari, Siddha Pokhari and Kamal Pokhari among others) and they were reportedly meant to contribute primarily to ground water recharge and feed the ground water to traditional taps across the cities. This type of vision execution achieved some hundreds of years ago when there was no formal engineering education in Nepal is indeed very impressive.

As engineering education and practice evolved in Nepal, certainly our infrastructures such as buildings, roads and hydraulic structures have been better engineered, with calculated risks, with an introduction of new and alternative construction materials and technologies vis-à-vis their national guiding design standards made in place. However, the more we are specialized, the narrower we are becoming in our approach of looking into the problems.

Furthermore, due to rugged topography and inefficient transportation system that all pushed people to visit the capital city of Kathmandu for every legal and better education and health services, political changes took place in Nepal demanding for power decentralization to local and federal governance systems, which is, arguably, needed in the country with highly compromised accessibility, albeit smaller in size. The newly promulgated Constitution of Nepal in 2072 BS, ensured the same. The change also brought some negative impacts nonetheless. That is, we started to become more discrete with our planning and development. Even bigger and national consulting firms which were used to working in national strategic projects are getting more attracted to the projects of municipal and provincial level governments due to local power connections, and they started making these governments more ambitious. It is completely fine for local leaders to be ambitious in developing their own electoral territories; however, what is warranted of them is the sense of collaboration and cooperation with the development aspirations in the neighbouring electoral areas that may demand integration for various reasons. In other words, our local and provincial level developments are to align with the strategic national and regional level infrastructure plans and policies.

In either way, integrating multiple use of water resources such as water supply, irrigation, hydropower, flood mitigation and even tourism, by taking into consideration the future growth of population or potential users, changed land use patterns, addressing the most vital issues of resilience to multi-hazard and



extreme events and mitigating environmental degradation for sustainable development, have been extremely important. In this article, we call it the philosophy of integrated, holistic and futuristic (IHF) approach of planning, design and development.

Encouragingly, considering the above facts and understanding into vision, we at Department of Water Supply and Sewerage Management (DWSSM), Design Research and Appropriate Technology Section (DRATS), Panipokhari, Kathmandu, we have developed and been managing a series of projects in support of this. They include Integrated Water Supply and Sanitation Management Project, Identification of Impounding Reservoir across Nepal, Mahadev Khola Impounding Reservoir Water Supply Project, Ground Water Depletion and Recharge Study, Bulk Water Transmission System Project, Design Optimization of Elevated Water Tank, Sump Well and Pumping Systems, Water Sector Governance Project etc., and we aim to apply the discussed philosophy of IHF approach of water infrastructure planning, design and development in these projects.

This article in particular features an enumeration of the application of IHF approach in the context of water resources and water supply ecosystem in Nepal. We present some relevant examples taken from the lessons learned from recent disaster in the inter-basin diversion-type Malachi Water Supply Project, ground water situations in Far West and the prospects of bulk water supply transmission system as a part of Rani-Jamara-Kularia Irrigation Project, and the roles of impounding reservoirs and ponds in ground water recharge, river flow augmentation and contingency emergency plans to be achieved through such projects as the proposed Dhap Dam and Mahadev Khola Impounding Reservoir Water Supply Project in and around Kathmandu valley.

The Lessons Learned from Recent Flood-Debris Disaster in Malachi Water Supply Project

There are multiple aspects of the lessons learned from the recent flood-debris disaster in Helambu-Melamchi in line with the IHF approach, and we present them in three categories.

Geological and Geotechnical Investigation

Multiple landslides occurred at various locations in the

upstream of Melamchi in recent extreme floods in Helambu and Melamchi. Moreover, erosion of large river-bed sediments in the upstream having associated with historic glaciers associated moraine also exacerbated the situation of flood and debris in the river, causing damage and loss in the head-works of Melamchi Water Supply Project. In this connection, the importance of geological and geotechnical aspect in project planning and design by considering catchment scale investigations have been proven so vital.

To validate this, one could conduct the geological/geotechnical investigation of the soil/rock types from the landslide and erosion sites in the upstream and those deposited in the flood-affected downstream areas at and below Melamchi Water Supply project's head-works. This would confirm the cases of landside-damming triggered flash floods and their running out length from well-established geological and engineering methodologies. Carbon dating of the sediments could even be done. And, of course, satellite imageries of high resolution could have supported the investigation.

In fact, Melamchi Water Supply Project's coffer dam made of concrete and gabion that collapsed and it would be expected in this scale of flood, and most interestingly, local (lay) people in the neighbouring downstream settlements have been intuitively doing "common sense geotechnical investigation and analysis" of the earth carried by the flood-debris near their homes. They were claiming that these earth materials must not be the usual river bed sand but some foreign cement based materials instead. See Fig. 1 for the illustration.

Clearly, a holistic, integrated and futuristic approach of investigation and planning would be warranted. And in doing so, it may sometimes be quite prudent for consultants to moderate the arrogance of their expertise of hydrological, geological, geomatics, geotechnical and structural engineering, and take local people's observations, gut feeling and interpretations over any past disasters or probable future implications seriously as a sort of hypothesis, which would be proven true or false after necessary scientific analysis and testing anyway - implying that the locals and senior citizens living in the project areas are a wealth of knowledge.





Figure 1- Upstream & downstream scenarios in the Helambu-Melamchi landslide & flood damage

Geotechnical and Structural Damage Behaviour and Implications

The Melamchi Water Supply Project's head-works area was severely affected by the Helambu-Melamchi Flood-Debris. The flood also took the life of many site staff of the project. One of the best schools in Helambu was completely damaged by the flood. A police station was completely overturned by the flood-induced foundation scouring. There might be many other schools and infrastructures in various parts of Nepal located in such proximity of the river with potential extreme event of flash flooding and debris impacts, which need urgent attention by keeping in mind the lessons learned from the damages and loss in Helambu and Melamchi areas. In below, we present some interpretations of the structural and geotechnical damages.

In Melamchi, the flash flood carrying old or new landslide materials first started to be deposited at the river curves due to decelerated speed upon impact(i.e. the change in momentum), and the river changed its direction - towards the opposite bank. This eventually increased the overall height of the river throughout and the flood got a chance to further expand in all directions, causing more and more damage in both sides. The changed direction of the river had both the longitudinal and transverse components of the impact force, causing rapid progressive bank cutting. Not only did the seemingly engineered buildings just next to the river fail due to scour below the footings thus causing overturning of the structure (example of Helambu Police Station), but also apparently the flash flood carrying significant volume of earth created some cyclic vibrations in the buildings (firstly, the change in momentum created a huge force and secondly, the motion of the flood with thick earth itself behaved as a dynamic event). The plastic hinge at the joint of the RC structures as depicted in the photos shared in the social media support this argument. Looking deeper into the modes of structural failures due to the Melamchi flood induced debris impact actions, one can see the distinct localised damage behaviours of sort of generally monotonic loading of projectile equivalence without much inertial excitation of the building on its own. It's very interesting to observe this. See Fig. 2 to Fig. for the illustration.

These observations have emphasized the urgency of multi-hazard resistance codification in national design standards of Nepal that largely overlooks impact and blast actions. Accordingly, retrofitting against such action that seems quite a valid solution to these partially and locally damaged buildings and infrastructures through a priori non-destructive structural health assessment is recommended.



Figure 2- A police station and a top school in Helambu



damaged by the Helambu-Melamchi landslide flood



Figure 3- Bank cutting by the Helambu-Melamchi landslide flood



Figure 4- Structural damage behaviours in the Helambu-Melamchi landslide flood

Other Lessons Learned

Indeed, the Helambu-Melamchi water induced disaster, as inferred from the pictures of the infrastructures and landscapes before and after the disaster (See Fig. 5, for example), has greatly emphasized the need of making "flood routing and early warning system" a regular and ongoing part (including during the O&M) of the strategic and critical projects related to watershed, river management and infrastructures, may it be hydroelectric, irrigation, water supply, flood control or their combination. Importance of an "integrated

development approach" and "socio-environmental safeguards" were perhaps never before emphasized like this. With proper and tailored site investigation, mapping and engineering analysis and design, these issues can be properly addressed. Increased scale of upstream and downstream investigation with watershed level analysis is already warranted in new projects. Last but not least, multi-hazard modelling and interdisciplinary structural engineering are the relatively new areas of study and research that the Government and development partners should not hesitate to fund more. Accordingly, it's a high time that we thoroughly revise our design guidelines, course syllabus and other related protocols. For example, the traditional "scour depth" requirements do not seem to be any valid and dry land now can no longer remain a dry land in the future. For this, we need better engineering leaders of lateral thinking and multi- and inter-disciplinary collaboration attitude, supported by relevant researchers having integrated, holistic and futuristic mind-set, in all institutes and departments of the government of Nepal, as well as practicing consulting firms.





Figure 5 - Melamchi Water Supply Project's head-works before and after Helambu-Melamchi landslide flood

Ground Water Situations in the Far West and Considerations for Alternative Solutions

Ground Water Situation in Far West

Our recent visit to and meetings with provincial and local government leaders of Far West Province as well as the officers at federal and provincial offices of DWSSM revealed a very concerning issues of ground water depletion observed in various villages and towns in the northern belt of Terai in the neighbourhood of Chure. They feared that this problem may gradually extend to southern parts as well given the increasing encroachment and development activities in Chure range that functions as a great recharge zone for entire Terai.

Moreover, issues of arsenic and iron in shallow tube wells, and most importantly, lime in deep tube well or engineered and users-managed water supply schemes, were reported by the managers of WUSC in various towns of Tikapur in Kailali including Lamki Chuwa. Treatment of lime in particular has become economically unaffordable, thus questioning on the overall sustainability of the project.

The above situation of ground water should be generic across the country. And the same has implied that alternative safer and sustainable means of water supply are already warranted in the region. Without integrating these facilities and services with the infrastructures for irrigation, hydropower etc. in the areas, the solutions won't be feasible at all. Similarly, it is high time that in addition to conservation campaigns, other possibility of artificial reservoirs and ponds in the neighbourhood meant to facilitate the recharge in and around Chure are explored. Inter-basin river diversion projects may also aid to mitigating this ground water associated potential future disasters.

Recent Flood and Disaster Preparedness Against Extreme Events

Recently, extreme precipitation in Nepal causing inundation, floods and landslides overwhelmed the entire country in both Terai and Hills and from the West to the East. The Karnali River flood breached the great land mass between the river and the engineered canal of the prestigious and ambitious Rani-Jamara-Kularia Project. People in and around Janaki Rural Municipality in Kailali were kept in alert and it was unanticipated. This news touched us even more as we the team of DWSSM/DRATS and World Bank just recently visited there during our other innovative projects' planning and rapport building purposes.



Figure 6 – Our recent visit to Rani-Jamara-Kularia project and automation system at head-works, and representative damage and loss by the Karnali River Flood and Mahakali River Flood

DRATS and DWSSM has been considering conducting DPR for drawing some water from the existing canal for innovative bulk water supply transmission purposes in the towns of Kailalai and around as the ground water pumping in the area has had a number of unsustainability issues. From the recent site visits, we had come home appreciating so much on the excellently engineered and monitored head-works (side intake and gates controlled by sensors and early warning system). On contrary, it was so sad to see that those are being proven sort of useless by the nature when the river itself entered into the engineered canal by breaching the natural embankments (landmass) in the downstream. Similar unanticipated damage to the emerging linkage infrastructures at bordering Mahakali River in recent disaster is heart-breaking. See Fig. 6 for the illustration

This all indicated something very important that we need to consider seriously in big-picture in future infrastructure planning and layout, taking into account multi-hazard resilience, but not just focusing on the strength and serviceability design and construction of the structures only. Ensuring the preparedness for all types of hazards of very rare probability during our engineering planning, design and development of important, strategic and critical infrastructures is really very vital.

Multipurpose Importance of Artificial Reservoirs and Ponds

General

With the land development and increasing built up areas to cater for the needs of increasing population and urbanism, the natural resources are being encroached. The recharge zones and/or the processes are being disturbed. The consequence is the reduction in natural sources of water, and decreased productivity in the agricultural field as well. Moreover, the rivers have seasonal variation in the flow which is quite low in the dry season. These problems can be mitigated by creating ponds and reservoirs for seasonal and peaking storages in various parts of the country, preferably at locations higher than the agricultural fields and settlements. These ponds and artificial reservoirs featuring dams, also called impounding reservoirs, in fact, also serve the purpose of tourism promotion and prosperity of the area, as an ecologically friendly hotels, towns and business districts are likely be developed around them.

Due to potential downstream hazards imposed by the dams built across the rivers for storage purposes, it is important that these infrastructures are planned,

designed and constructed by considering the extreme events of meteorological and geo-hazards. The IHF approach of planning, design and development is highly important in the impounding reservoir projects. For example, taking into account earthquakes of 2500 years of return period, for example, is deemed necessary to achieve the performance objective of no damage in performance based seismic design of impounding reservoirs and dams for water supply in Nepal. Fig. 7 (left) shows an example of such a pond developed in Dang district of Nepal.



Figure 7- Representative existing and newly proposed sites of artificial ponds or impounding reservoirs in Dang and Gulmi districts

Identification of Impounding Reservoir and Pounding Sites across the Country

At DWSSM, DRATS, we have been working on identifying and promoting various potential sites of impounding reservoirs as representative examples. Recently, we have visited various places of Dang and Gulmi district with the same purposes and found some very promising ones, with their huge prospects of fulfilling the gaps in water supply or irrigation or both in the surrounding areas, both for now and for the future growth of population. Moreover, their contribution in ground water recharge to conserve water in the neighborhood and to function as a contingency emergency plan for critical utility service distribution, where multi-stage pumping is employed as complementary solution and that is generally considered unsustainable. See Fig. 7 illustrating DRATS visit to some of such nominated sites.

Examples of Dhap Dam and Mahadev Khola

Kathmandu valley is increasingly becoming one of the most densely populated cities due to migration and population growth. Federalization with decentralized facilities and services at provincial and local levels have not even stopped this. Therefore, existing infrastructures have become more and more inadequate. Furthermore, recent extreme events of unanticipated water-induced disasters in Melamchi, Mahakali, Karnali,

etc. have highlighted the need of contingency plans for emergency response of critical utility services in the densely populated Kathmandu valley even if ambitious projects like Melamchi Water Supply are in place in normal situation. Also, the pollution of water bodies such as religious rivers like Bagmati within Kathmandu are pushing us to identify new solutions. These very considerations have led the Government of Nepal and its water related departments to identify, design and construct impounding reservoir dams in and around Kathmandu. One of them called Dhap Dam is aimed at augmenting the flow in Bagmati River. The proposed Mahadev Khola Impounding Reservoir which is at RFP for DPR stage at DRATS of DWSSM is another attractive project that aims to serve water supply to various towns and suburbs of Changunarayan Municipality and Bhaktapur Municipality let alone its prospects of becoming one of the most successful eco-tourism development areas nearest from the maddening crowds of Kathmandu and on the way to Nagarkot. See Fig. 8 for the physical impression. Given that their distance downstream would see increasingly large settlements in the days ahead, it is highly recommended that the IHF approach by learning lessons from the disasters as emphasized in previous sections is strictly applied to such projects in the capital city.



Figure 8 –The dam sites for the Dhap Dam and proposed Mahadev Khola Impounding Reservoir Water Supply Project located around Kathmandu Valley

Conclusions and Recommendations

The reported situations of our aspirations and dreams of large and complex infrastructures in the sector of water supply challenged by the recent damage and loss in the Helambu-Melamchi 'Landslide Flood', Karnali and Mahakali River floods demand increased importance of land use planning, hazard mapping and risk modelling against the extreme (very rare) events of precipitation, inundation, floods and landslides. Similar design philosophy is applicable in earthquake risk modelling in the context of Nepal where 2500 years of

return period may be warranted for critical building and water infrastructures alike. We advise that we consider doing so in the large and critical water supply infrastructures that we are planning through DWSSM, with particular emphasis on increasing seismic gap in the Far Western part of Nepal.

It's indeed not easy to develop mega structures in our land prone to unanticipated hazards of all kinds. We need exceptional seriousness, genuine calculations and "big picture" vision and actions (IHF approach) as policy makers, planners, architectural and engineering consultants, and builders. Without integrating the basics of extreme events, multi-hazard resilience and environmental sustainability in our planning, design and construction, our journey of economic prosperity can't be achieved or won't last long even if achieved.

It seems worth investing little more during inception, feasibility and detailed design and even construction than potentially having to see such heart-breaking pictures of devastation later let alone the risks we would be imposing on innocent people living in the downstream areas of the projects. It's our primary duty as engineers and planners to safeguard them first. The campaign of appropriate Engineering Education and Infrastructure Policies for the Resilience and Sustainability based Prosperity transformation of Nepal which we often abbreviate as (EIP/ReSPro transformation vision) had never been this topical, and the same can be achieved through the discussed IHF approach only.

Acknowledgement and References

We acknowledge various online and paper-based Nepali media of Nepal for timely posting the news and photos of recent water-induced disasters across the country some of which are referenced in this article. We particularly thank ekantipur, setopati, onlinekhabar, and nayapatrika. We are grateful to Eng. Narayan Subedi of Department of Irrigation for sharing photos and information of Dhap Dam. We also acknowledge the meetings and discussions with some of water infrastructure experts of the sector such as Dr. Vishnu Prasad Pandey, Dr Bishnu Prasad Gautam and Dr. Mahesh Bhattarai and the past and present leaders and colleagues of DWSSM and Melamchi Water Supply Project, Panipokhari, whose inputs have been very useful in developing the content for this article. Last but not least, we thank all of those friends, staff and local people at various project sites especially in Far West, Karnali, Lumbini and Bagmati provinces, that we have visited lately for the purpose of study of existing projects or identification of new projects or their site selection.

On behalf of ARCASIA SONA



Smart Innovative & Sustainable Universal Public Toilet For All At Lalitpur Metropolitan City



Ar. Rajesh Thapa
President SONA

Immediate Past, President SCAEF
E-mail : rtacnepal@gmail.com

The positive impact that the ARCASIA Symposium on Architecture and Social Responsibility in 2013 had on a country such as Nepal, especially with the lack of accessibility, has potential for improvements. The Society of Nepalese Architects willingness and effort, not only to the spread of awareness for universal access issues, but also designing for natural calamities, went towards this realization. The design competition for the Universal Design: Public Toilet for All made both the students as well as professionals aware of the needs for universal access.

The Design Competition was held in two Categories:

1. Student Category
2. Professional Category

The theme of the design competition was “Universal Design” - Public Toilet for All. The aim of which was to educate students and the professionals on the diverse needs of today’s society, to develop a comprehensive understanding on the issues relating to Universal Design and Accessibility, and to encourage and sensitize the professional Architects to be more socially responsible in addressing and implementing accessibility with their professional knowledge, skill sets and creativity. It is hoped that the outcome of the design competition would help to create a National Standard in providing accessible toilets for all in Nepal.

The design entries from the 10 winning finalists in each category was displayed as part of an awareness campaign during and after the events. The Design Competition was organized by ARCASIA Committee on Social Responsibility (ACSR) and facilitated by SONA (Society of Nepalese Architects) with the close co-ordination of DPOs and its leaders in Nepal.

Eligibility

1. Student Category Teams consisting of a maximum of two students enrolled in a degree-granting college of architecture or university in Nepal are invited to participate in student category.
2. Professional Category Any architectural firms or individual architects practicing in the construction industry and recognized by any of professional organization such as SONA, NEA, NEC or any authorized government body in Nepal, were eligible to participate in the Competition.

The public toilet design competition was initiated by Ar. Deepak KC (who himself is also a wheelchair user) in collaboration of ACSR (ARCASIA Committee on Social Responsibility) with the clear objective to create a design of toilet which can be easily accessible for ALL, including the differently able people. The toilet with all necessary facilities and infrastructure needs would also have to be sustainable. It also needed to set a minimum standard for an universal toilet so that it could set an example for public toilets to be constructed, in the future. At the time of competition, the project was hypothetical but later ARCASIA and SONA decided to actually build this project in Nepal as a part of its social responsibility. The sites proposed were any of the Durbar Squares of the Valley.

Toilet is a very basic necessity in our life. Public toilets play a vital role in the urban context, but in the country the numbers of public toilets are alarmingly low. And among the little, we see that very few public toilets have accessibility for differently able people and which are well managed in terms of cleanliness and other necessary infrastructure.

The design competition was won by Ar. Neeraj

Maharjan, a general member of SONA. ARCASIA later, also committed to fund towards the construction of the winning design on the allocation of suitable site arranged by SONA, as being the host nation.



This was one of the most difficult task in getting a suitable site that was hampered by the Gorkha Earthquake in 2015. The 11th EC under President Ar. Kishore Thapa and SONA CSR Chair (Ar. Rajesh Thapa). The site was also preferred at locations where tourists could benefit. Identifying a site was one of the biggest challenges because getting a free public plot was rather difficult. Kathmandu because of it's rather open concept it was ruled out. At Bhaktapur, the Municipality could not provide a suitable location and eventually SONA desperately requested Lalitpur Metropolitan City Office for suitable locations.

Initially, three sites were offered in Patan area.

- Lagankhel Bus stop
- Patan Dhoka Bus stop
- Mangal Bazar existing toilet (upgrade)

Lagankhel bus stop because of less (or very little) tourist flow, was not preferred. The best location we thought could be the upgrading of the Mangal Bazar toilet, and actually re-designed it. However, on review of the same a two storey unit may not be disabled friendly, and was also dropped.

Finally, the LMC along with the ward office and local tole inhabitants and Mr. Kanak Dixit, helped in finalizing the existing toilet at Patan Dhoka bus stop. The location also demanded demolishing the existing toilet and making a new toilet at the location. While making the foundation a very ancient storm water conduit was noticed which traversed through Patan Multiple Campus towards Bagmati; forcing in making changes to the foundation design.

The initial site for the toilet in the competition was at Basantapur durbar square, and the architect came up with the design concept to adopt the vernacular Newari

architecture using bricks texture, slope roofs, rectangular and round forms. The design saw that no resemblance should be with houses, palaces and temple structure to avoid any confusion in it's outlook. The regular circular plan and cylindrical forms has been introduced with the full length huge cut to give prominent form at the main entrance and with the inverted regular slope of roof angle which has become the front wall and metal band support gives glimpses of wooden struts commonly seen at all traditional houses and temples. These two forms are the main and highlighted parts of the entire design.



During the construction the internal plan from original design competition plan has been modified according to the site and also to incorporate some sustainable approaches but exterior design concept has remained



the same. There are 4 basic sections in this building, male toilet, female toilet, one inclusive toilet for all and entry foyer. Circular plan and cylinder shape with big cut out in the front highlights the entry and entry foyer leading to the three section of the toilet. Cut out at the ceiling provides almost all the ventilation and day light inside the toilet. Introvert planning has helped to make the toilet more private and a secure space.

The entire project was funded by ARCASIA along with

SONA; however, there were a few shortfalls and the LMC agreed to make a small contribution and they did this by introducing the operator AEROSAN Sustainable Solutions for the same. The operating company has already been handling the LMC toilet at Mangal Bazar (and the one at Swoyambhu, in Kathmandu) and SONA together with them made some internal modifications along with some improvement in operational services/utilities, as well.

Some Photos of the Inauguration Ceremony:



The toilet is also women-friendly, and its features include a pad-dispenser and pad-disposal machine that helps women during their menstruation cycle, including a Baby Diaper changing and Breast Feeding station. It has contactless soap dispenser and smart hand-dryers, too.

The effluent goes into a biogas digester; rainwater from the roof is harvested.

The interior design is made as touch-free and hygienic as possible, and the flushes installed use minimal water. The facilities are also women and disability-friendly, conforming to international safety and cleanliness standards. It has also installed CCTV cameras and a Wi-Fi facility. To add-on to the health benefits, the smart toilets are also installed with SquatEase toilet pans that better toilet habits and increase efficiency in cleaning.

The toilet offers a complete public toilet management system through a network of pay-per-use public sanitation facilities (or HUB). These are affordable, modern, clean, safe, and offer equitable access to all genders and people with disabilities. This HUB, like others, includes an anaerobic digester to collect human waste and converts it to biogas that powers the teashop around the landscaped seating area.

This new toilet is catalyst for the development of Lalitpur Metropolis as a Smart City. The innovations here have definitely added another feather to progress here. Nearly 7.0 million in all has been spent with SONA/ARCASIA contributions upto 75% and the rest by LMC (through AEROSON). It was recently inaugurated by the Mayor of LMC Mr. Chiri Babu Maharjan on Tuesday 30th November, and was handed over to LMC by SONA.

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SCAEF Legacy (Message to New Generation)

With due respect to all the Past presidents who have put their enormous effort for the sustainable growth of the SCAEF during their tenure and for whole their life all the living past presidents who are continuously contributing tirelessly till today, The editors of this edition communicated and received the feedback from all the SCAEF Past Presidents as a guidance to the SCAEF NEW GENERATION regarding how the SCAEF has changed/evolved over the years and how SCAEF should organize itself to gain the momentum in new normal.

Summary of which has been picturized below:



Bal Sundar Malla

President (1994-1995)

Third Executive Committee

President (1996-1997)

Fourth Executive Committee

How SCAEF has changed/evolved over the years ?

SCAEF has grown to matured stage and it is recognized as national body having more than 250 nos. of national members and FIDIC membership. SCAEF successfully organized national and international events in the past. But both Government and SCAEF have failed to play their important roles given to them. Government failed in the enactment of Consulting Act, drafting so many years back and SCAEF failed in the play the role of national body the Government have provided. Net effect the whole country is suffering for development efforts aim to achieve. Majority of mega national priority projects are failing in qualifying and completion time.

Strong partnership between Government and SCAEF is a dire need of the time. Performance evaluation of member firms as per FIDIC guideline is required. Earthquake and Climate Change added responsibility to all stakeholders.

How SCAEF should organize itself in coming times to gain momentum in the new normal ?

SCAEF should look back on its decisions and recommendations made in the past. It should reinforce the implementation through it's member firms and take necessary disciplinary action. Consulting industry is not flourishing but mere surviving. Despite of maturity the industry is not strong and weakening day by day. Country's development need strong support of consulting industry. Looking back to the neighboring countries one can see the status of industry in our country which is degrading year by year. SCAEF is the backbone of consulting industry. Every member have the responsibility to save the image of SCAEF. Consulting industry has two components, professional plus business. Member firms started forgetting the professional value of consulting service and treating it nowadays like any other business. Must do needful immediately.

How SCAEF has changed/evolved over the years ?

The condition of SCAEF have changed according to "Desh, Kal, Paristhiti" ie. Location, Time period and Circumstances, just like the tale of Lord Ganesh's change in his ride and number of his arms during subsequent Yugas.

At the early stage, SCAEF was striving for a professional policy maker and promulgating the Service Sector as part of the National economy. SCAEF had acquired some milestones in improving the service sector like reducing the TDS to 1.5 % from 15%, introduction of non-wooden doors and windows for protection of forest, contribution in NBC 1994, advocacy for formulation of 'Public Works Directives' in 2004,etc.

Similarly, SCAEF is facing several issues that have degraded its image like race of unequal ones in between 4000 registered consulting firms over last 30 years where many experienced and knowledgeable professionals are compelled to move abroad or stay semi-employed leaving projects in jeopardy and lacking better project management, decreasing number of member firms from 250 to 160 due to lack of appropriate policies like equal opportunity for all, appropriate formulation of project, transparency in projects award procedures, check and balance procedures avoiding errors and unforeseen disasters, new projects creating terror and panic situation among local inhabitants by encroachment of ancient settlements, culture and heritage; the universal assets of all



Badan Lal Nyachhyon

President (1998-1999)

Fifth Executive Committee

President (2000-2001)

Sixth Executive Committee

humanity, insufficient information with SCAEF on how its member firms are performing.

Lord Ganesh, through the *Yugas*, changed its forms and rides but not its characteristic qualities of “*Bighna Harta and Karunavabtar*”; the Eliminator of Hurdles and caterer of Compassion. Has SCAEF been able to maintain its Core Values: Ethics and Integrity, Professionalism, Human Rights, Transparency, Inclusiveness and Equality or is quietly engaged in catering collusion, fraud and corruption jointly with bureaucracy and contractors?

How SCAEF Should Organize Itself in Coming Times to Gain Momentum in the new Normal?

After the devastating COVID 19 pandemic, firms are compelled to fight for their own survival where over 100 member firms have already resigned from the membership of SCAEF, some firms being sold out to business groups and some even on the verge of collapse. For survival firms follow *Apad dharma in the Ramayan*, (Best dharma in famine and misery is to stay alive), and try to grab projects at any cost, even if a huge bribe had to be paid. Furthermore, even the approach and methods of contract formulation are changed to restrict the competition with weird criteria based on “Exclusion theory” catering the preference treatment to selected ones. Hence, this has become a new normal, making our nation the ultimate loser.

If SCAEF wants to become a changemaker from the current situation to a professional and sustainable Industry, there are few steps SCAEF can take. These steps are:

- ◆ Identify at least two member firms to declare Nepal as a corruption free country (FIDIC has given a challenge to SCAEF)
- ◆ Encourage SCAEF members to join UN Global Compact following ten principles related to Human Rights, Avoiding Child Labor, Environmental (and Heritage) Protection and following Anti-Corruption campaign
- ◆ Implement industrial sustainability principles through observation of SCAEF’s Core values as Ethics and Integrity, Professionalism, Human Rights, Transparency, Inclusiveness and Equal Opportunity to All.
- ◆ Review the performance of its members including sustainability, exit phenomenon.
- ◆ Come out from the usual box and take care of the community interests, use its expertise to fulfill national interest and challenges.
- ◆ Identify an entity that can take the full responsibility for the development of the industry and build consensus on national policy.

Now, it's time to look back at the performances of SCAEF and check if it has fulfilled its objectives and complied with the Ethics and Integrity. The tools of checking performances may be borrowed from teachings of Buddha or from Rotary International’s “Four way test”.



Ram Bahadur Shrestha
President (2002-2003)
Seventh Executive Committee

How Has SCAEF Changed /Evolved Over the Years ?

SCAEF was established in 1990 with the aim to provide quality consultancy services in return for a reasonable fee. There were 30 member firms in the early period (1992). The membership were increased very slowly in the first 2 decades, eg the member firms as of 2002 was only 63 (hindrances then were the requirement of a minimum of one fulltime professional (Engineer) as a partner of the company. We could not provide membership to John Sandy and Devtec due to this requirement only. The membership were increased when PWD document was published where membership in professional society became mandatory and also some additional incentives were provided to society members.

During 2002 - 2004, the constitution of SCAEF was amended to provide membership

to non-engineering firms as well. This amendment was also sought for opening of SCAEF regional office. Current growth from 30 to 248 in 30 years of period looks satisfactory to me.

To me, SCAEF is good in evolving ideas and making decisions but unfortunately poor in implementation. Burning example is "consulting industries development act ". I wonder where and at which stage it is now?

How Should SCAEF Organize Itself in Coming Times to Gain Momentum in the New Normal?

My few practical suggestions are, SCAEF should increase membership (Say 80% of working consulting firms), open regional offices, create permanent establishment (including building), adopt "award and punish" policy to the member firms, protect members in genuine case if any controversy, and punish for faulty design and implementations.

Finally, let's work together to enhance professional integrity and strictly follow the code of ethics. My best wishes to current EC and specially to the SCAEF mirror publication team including Seena who all are working day and night for the successful publication of SCAEF Mirror magazine.

How Has SCAEF Changed /Evolved Over the Years ?

Engineering Community is the backbone of the overall development of any country, but SCAEF was ignored by our government and was struggling for its recognition after its establishment in 1990 for a decade. Then and the following ECs had to put tremendous efforts to gain momentum and establish ourselves as a major development partner in the country.

Major achievement by the EC during 2004-2007 are establishing our own office with adequate equipment, bringing down the TDS of 15% to 1.5%, which in fact was a herculean task. Furthermore, assigning the ministry of Physical planning and works as a Line Ministry and fixing the annual dues of Member Firms in a scientific and logical manner based on the annual turnover was another remarkable achievement.

A practice was established to have a half-yearly meeting with ADB Nepal Resident Mission, which appeared to be very useful in the overall development of the consulting industry, however, it discontinued after 2007.

Also the EC prepared a policy document on the need for Consulting Industry

Development Act, requested ADB to organize a two-day seminar titled "Capacity Building and Institution Development of Consulting Industry in Nepal " on 2-3 August 2006. Similarly, another workshop in 2006 titled "Capacity Building of SCAEF: Preparation of Strategic and Operational Planning Document " was organized and a "Booklet on Development Consulting Industry in Nepal - An Outlook" was prepared and published.

As a result of the efforts and constant follow-ups listed above, the ADB finally provided the TA and the Consulting Industry Development Act was ready in draft, which was submitted to the concerned Government Ministry in 2010.

Furthermore, SCAEF Brochure was prepared during the early stage of its establishment with its goal, objectives, actions plans and brief details of member firms.

How Should SCAEF Organize Itself in Coming Times to Gain Momentum in the New Normal ?

It would have been more appreciable if SCAEF EC had prepared a vision paper to address this question and circulated to member firms for comments/suggestions. At this moment it would be enough if SCAEF EC follows the goals and objectives outlined in SCAEF Brochure and acts accordingly.

My sincere and humble request to SCAEF EC is to please address, as a first priority, on current burning issues of unethical and unhealthy consulting practices, application of SCAEF's Code of Conduct and amendments in the Procurement Acts and Regulations which has a negative impact on running consulting businesses instead of focusing on SCAEF's support to government on COVID-19 or Melamchi Water Supply Project, organizing Workshops/Seminars, FIDIC Conferences and even celebration of its anniversary. These should be the 2nd priority. First we must keep our home intact.

SCAEF EC has not been able to amend even one simple article for advance payment. Though significant effort was put to prepare two lengthy "Tin Mahale" documents, one with 52 pages and the other with 21 pages, in my opinion it is not an appropriate document. So, my suggestion to SCAEF EC is please focus on amending the Consulting Act and Regulation, mainly in the areas listed below:



Keshav Kunwar

President (2004-2005)

Eighth Executive Committee

President (2006-2007)

Ninth Executive Committee

- (a) Advance payment
- (b) Past experiences to be for last 10 years instead of 7 years
- (c) Increase the current ceiling of NRS 100 million for national consultants to at least NRS 500 million
- (d) Uniformity in the detailed internal narrative evaluation criteria to be adopted by all government institutions

Now, some government agencies give weightage in evolution for PHD Degree, Training, Project Cost, Consultancy Fee, etc., but some other does not.

I also suggest SCAEF EC to organize at the earliest 2 Workshops as follows:

- ◆ One Workshop with the participation by the representatives of all government and donor agencies, contractors and SCAEF. There is certain weakness from all these agencies during project implementation, but only consultants are always made scapegoat. It has to be post mortem through this Workshop, so that each actor realizes it's weaknesses and improves it's self.
- ◆ The 2nd Workshops among SCAEF Member Firms on the current consulting practices

I firmly believe that SCAEF EC will pay attention to the suggestions made by Past Presidents and will act accordingly. I am always there to provide my inputs remaining within my capacity.

With all my best wishes



Dr. Hare Ram Shrestha

President (2012-2013)

Twelfth Executive Committee

President (2014-2015)

Thirteenth Executive Committee

How SCAEF has changed/evolved over the years ?

SCAEF has made significant progress over the period of three decades since its establishment in 1990. It's institutional recognition and strength is quite visible in the development sector with its representation in various government bodies, active functional network among the professional societies in national and international level. Beside many national level technical seminar and other professional activities, it has organized three international conferences in 1997, 2009 and 2019. Member strength is also increasing every year. Major volume of engineering consulting services in the country are provided by SCAEF member firms. Though it has yet to expand its institutional network to provinces, its professional and consulting business in federal level is satisfactory.

How SCAEF should organize itself in coming times to gain momentum in the new normal ?

There are many issues that require serious effort from SCAEF to gain momentum in the consulting sector;

- A strong collaboration with government needs to be established to promulgate the Consulting Services Act already prepared by the government with active involvement of SCAEF along with addressing various other issues related to the consulting sector.
- A serious and concerted effort is needed to improve the deteriorating governance aspect of procurement of consulting services at the local government level.
- Capacity building of consulting firms and individual professional is another important agenda that SCAEF has to work continuously.

SCAEF was actively involved in national and international level of institutional and professional network since last 25 years, now it has to get involved in a leadership role in such platforms.

Reflecting to the late 80's when we envisioned about coming together on a single platform to discuss and resolve issues of the consulting industry, as an architect myself, the biggest issue was that of the consulting fee with a maximum limit of 3%, irrespective of the task size. Moreover, all contracts were client protected. I give credits to CBC, DOME, BDA, MLK & NC (JV) and ACN (all SCAEF member firms later) to having come to an understanding for job sharing and in providing better services. It was from this group that we managed to invite a few other senior consulting firms (mostly non-building) to share experiences and find ways to resolve problematic issues. But first we needed to get together. Soon through a meeting at the IOE Pulchowk Campus, we agreed to hold a Panel Discussion to discuss on the problems of the consulting industry. Here consultants, academicians, government staff and others participated and we had a Task Force formed, which was led by then Secretary of the Ministry of Works & Transport Er. Gauri Nath Rimal. This was the



Ar. Rajesh Thapa
President (2016-2017)
Twelfth Executive Committee
President (2018-2019)
Thirteenth Executive Committee

starting point of SCAEF and from here on we never looked back. In 1990, it was easy to register as independent organization and later we submitted the Report to the interim Prime Minister of the newly formed multi-party system, Rt. Hon. Late Krishna Prasad Bhattarai.

How Has SCAEF Changed /Evolved Over the Years?

I have always considered SCAEF as our child, which needed a lot of care. We were not aware of so many things that required for a proper dialogue with the government ministries/departments. We were small and about only 39 firms, who took the responsibility in establishing SCAEF, it was a commitment and linked to our image. Over the last thirty years, we have grown and matured slowly but steadily, with nearly 250 plus member firms.

It is very important that the consulting fraternity sees the need of SCAEF. I think in many ways that has happened, though there are issues that come up every day, that SCAEF as an umbrella organization, needs to address. As the only individual to have served SCAEF in all the Executive Committees, since the ad-hoc days, my experience is that every week or day new issues would come up in the Executive Committee, some similar and some very new/different. With all their experience and knowledge, the ECs have tried to meet them, at best.

In the past, SCAEF was involved in both institutional and professional matters. The EC mainly comprised of founding member firms' representatives/senior consulting companies. A number of issues from bid bond/performance bond/tax matters etc., were some of the most pressing then. Today, it is the number of government institutions from the federal/provincial/municipalities that invite consulting firms for various assignments of various sizes and scopes. The problem is that on a number of occasions the invitations for EoI/RFP are conflicting in terms of procurement modality, ambiguous scope of works, minimum requirements for shortlisting etc. While addressing these issues, SCAEF has invested lots of its efforts, which has caused distractions to SCAEF from its own institutional strengthening drives, as these issues need to be addressed immediately for the fraternity.

SCAEF today is expecting the young leaders to perform, and I do expect this will happen. The need for better professional and ethical connection amongst the political, bureaucratic and professional circles is necessary. However, if this relation is transformed for personal benefits the trouble begins. Again, in the past few years SCAEF is caught in between professionalism and business priorities amongst member firms. I know in recent ECs

this is always discussed and is I think one of the most daunting and frightful task for the consulting industry to survive.

How Should SCAEF Organize Itself in Coming Times to Gain Momentum in the New Normal ?

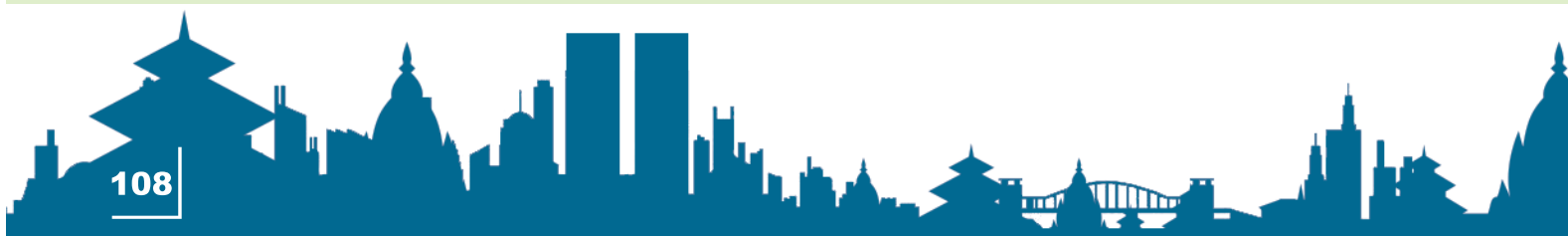
When I took up the leadership of SCAEF after 26 years of serving the institution, immediately, the 14th EC organized the first “Fact Finding and Problem Solving Workshop” at Dhulikhel, to identify key topics of urgency and attention for SCAEF/it’s member firms and then formulated an action plan for a way forward. With intense discussion and deliberations between 25 selected firms, a comprehensive road map (2015-2020) was formulated. I must confess, in my two terms all the actions were not completed, but this is something that is still pertinent and needs to be taken forward .

The COVID-19 pandemic has created a lot turmoil in the consulting sector. The current EC organized several workshops and seminars to identify the scenarios and status of firms: in terms of work and businesses during the pandemic situation. One thing that the pandemic has given us the opportunity to explore and learn from the online platform. We can meet more often and discuss more with no traveling or waiting time, in consideration. Communication has thrived. SCAEF should adopt these widely used online platforms to organize such future events virtually enabling wider participations.

Indeed, the office bearers of the SCAEF EC, may be volunteers, but each of the office bearers and members have committed to everyone that they will give their very best. I am sure this realization is there. Therefore, with the experiences shared from the past, the commitment of the present and a vision of the future needs to be analyzed and the way forward planned.

SCAEF should work on preparing guidelines especially for supervision works in the pandemic period, discuss/resolve problems that arise in the post pandemic (new normal) scenario. SCAEF could coordinate a number of situations which could be a learning knowledge platform from issues faced in the new normal, especially in terms of project time and budget. The recently concluded Interaction Program on Green Building Design & Green Transportation is something SCAEF can work to promote innovative technologies & approaches for a better and economic living environment.

Finally, I also strongly feel that SCAEF should hold serious discussions on the future of consulting firms and services; especially with the very untrustworthy practices in procurement that is fast developing. This is important for the survival of consulting firms, at large. The 3Cs (Client/Consultant/Contractor) discussion forum would be an option in also ironing out any differences for a smooth a timely project cycle. I believe that SCAEF will address this issue promptly and effectively in the larger interest of the member firms. Here too, we have signed MoUs with a number of similar professional institutions worldwide, lets also have a dialogue with them to share their similar experiences and co-learn with them.



How the Professional Societies and their Think-tanks can Put on a Collaborative Effort in the New Normal?



Ananta Prasad Gajurel, PhD

President of Nepal Geological Society

Head of Geology Department

Tri-Chandra Multiple Campus

Tribhuvan University

Since the outbreak of COVID-19, anthropogenic activities in the fields of infrastructure development and economic circulation have also been intensely affected on a worldwide scale. Vaccination against COVID-19 has been rapidly widespread in a similar way to cope with the pandemic situation at international level. As global normalcy has gradually returned, opportunities and challenges for rapid acceleration of development activities have emerged. Like other professional societies, Nepal Geological Society has been devoted to economic upliftment of Nepalese people since its establishment in 1980. The society encompasses national and international members totaling around 1400, which comprehends earth sciences, geo-technical engineering, geophysics and seismology, mining engineering, geo-hazards, etc. in its room. The society has been disseminating and enhancing concurrent knowledge related to the subject of its members by organizing national and international conferences and seminars as well as publishing scientific research journals. As one of the major foundation subjects for the infrastructural development activities of the nation, the society has been showing its keen wishes for formulation of inter-disciplinary experts' reservoir executing, for example, Memorandum of Understanding between the professional societies. It should orient to fulfill the gap between the professional fields developing a bridging subject mostly adopting the state-of-the-art knowledge gained from the context of our mountainous and plain regions.

I personally appreciate the Society of Consulting Architectural and Engineering Firms, Nepal (SCAEF) for providing space in its souvenir magazine "SCAEF Mirror" to unfold various thoughts on new horizons in the context of the national and worldwide New Normal developed scenario. The cover theme of the publication "Gaining momentum of the consulting industry in the New Normal" is a milestone for humanizing inter and intra experts' collaborative efforts in the sphere of sustainable development in Nepal.

Hearty Condolence



Late Arun Kumar Dhungana

SCAEF 16th EC would like to express the heartfelt condolence on the sad & untimely demise of its good friend and in all aspects a respected senior engineer in engineering consultancy fraternity, The Chairman of ITECO Nepal **Mr. Arun Kumar Dhungana** (Birth: 4 Pousha 1997 BS & Demise: 3 Jestha 2077 BS) at this very unfortunate moment. EC prayed to His Almighty for his soul to rest in eternal peace in heaven and to give strength to Mrs. Sabita Dhungana (his wife), other members of the family and all colleagues at ITECO Nepal Family to bear this irreparable loss.



Late Sunita Ranjit

The EC would like to extend hearty Condolence on the sad and untimely demise of its Secretariat Staff **Ms. Sunita Ranjit** (Demise: 28 August 2020). She was under treatment in Patan Hospital.

We mourned and prayed for her soul to rest in eternal peace in heaven. we also sent a condolence message to the bereaved family.



Late Manikant Mishra

SCAEF 16th EC would like to express the heartfelt condolence on the sad & untimely demise of its good friend and in all aspects a respected Engineer in Engineering consultancy fraternity, **Mr. Manikant Mishra**, Director of GEOCE Consultants (P) Ltd. at this very unfortunate moment. EC pray to His Almighty for his departed soul to rest in eternal peace in heaven and to give strength to his members of the family and all colleagues at GEOCE Family to bear this irreparable loss.



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

Sankhamul, Kathmandu, Nepal, Tel: +977 01 5242952
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Tel: +977-1-5260699, Fax: +977-1-5260699

E-mail: unecnepal@gmail.com

www.unecnepal.com.np

Unique Engineering Consultancy Pvt. Ltd. has been legally established in 2006, is a service oriented consulting firm, the company offers Technical consulting services for a multitude of development activities such as Planning, Project Management, Socio-economic Studies, Feasibility Studies, Survey, Mapping, Hydropower, Detailed Engineering Designs, Researches etc.

OUR RECENT WORKS



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Society of Consulting

Architectural and Engineering Firms, Nepal (SCAEF)

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NS Accreditation No: 12/2075/76

Soil Water and Air Testing Laboratories Pvt Ltd (SWAT Lab)

(Research and Consultancy)

Babarmahal, Kathmandu

Tel: 01-5349480, 9851002006, 9841550425

Email: Swatlab2017@gmail.com

Soil Water and Air Testing Laboratory Pvt. Ltd. (SWAT Lab) is Nepal Standard Accredited lab dedicated to high quality analytical testing of Water, Waste Water, Sludge, Soil Samples, Ambient Air Quality monitoring and Noise level monitoring. We are a team of professional Environmental Engineers, Chemists and Scientists dedicated in giving high quality test results

Our Mission is to provide accurate and timely technical investigation of environmental quality parameters at nominal cost.

Our Services

- Water and wastewater Analysis
- Air Monitoring
- Solid Waste Analysis
- Noise Level Monitoring
- Soil Analysis
- Faecal Sludge Analysis
- Water and Waste water Treatment Service



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1. M 1 : East Consult (P) Ltd.

- 📍 House NO : 115 Kailash Marga
Naksal, Kathmandu, Nepal
- 👤 Mr. Ananta Bahadur Gurung, MD
- ☎ +977-1-4422191, 4442412
- ✉ info@eastconsult.com.np
- 🌐 www.eastconsult.com.np
- Year Established : 1973**

2. M 2 : Nepalconsult (P) Ltd.

- 📍 10/47 Chamling Niwas, Kupondol
Lalitpur, Nepal
- 👤 Mr. Prakash Rudra Shrestha
- ☎ +977-1-5180170, 5180271, 5420153
- ✉ nc@mos.com.np
- 🌐 www.nepalconsult.com.np
- Year Established : 1972**

**3. M 3 : MULTI Disciplinary
Consultants (P) Ltd.**

- 📍 Kupondole-10, Lalitpur, Kathmandu, Nepal
- 👤 Mr. Badan Lal Nyachhyon
- ☎ +977-1-5525076, 5529304
- ✉ mdc.multinepal@gmail.com, mdc@multinepalfirst.com
- 🌐 www.mdcnepalfirst.com
- Year Established : 1978**

**4. M 4 : Architects Collaborate
(Nepal) Pvt. Ltd.**

- 📍 Khumaltar, Latitpur
- 👤 Ar. Rajesh Thapa
- ☎ +977-1-5526315/9851068097
- ✉ rtacnepal@gmail.com
- Year Established : 1979**

5. M 5 : SILT Consultants (P) Ltd.

- 📍 Rudranagar, Ratopul Gausala, Kathmandu, Nepal
- 👤 Mr. Keshav Kunwar
- ☎ +977-1-4473573, 4487598, 4495163
- ✉ info@silt.com.np
- 🌐 www.silt.com.np
- Year Established : 1979**

6. M 6 : Building Design Authority (P) Ltd.

- 📍 Osho Bhawan, Kamaladi, Kathmandu, Nepal
- 👤 Mr. Anil Nepal, Director
- ☎ +977-1-4248200, 4227393
- ✉ bdapvtltd@gmail.com, bda@bda.com.np
- 🌐 www.bda.com.np
- Year Established: 1974**

7. M 7 : CEMAT Consultants (P) Ltd.

- 📍 House No. 61, Pawan Marg, Maitidevi
Kathmandu, Nepal
- 👤 Mr. Bal Sundar Malla, MD
- ☎ +977-4424001, 4445748
- ✉ cemat@cemat.com.np
- 🌐 www.cemat.com.np
- Year Established : 1976**

8. M 14 : ITECO Nepal (P) Ltd.

- 📍 Panchakanya Marga, Minbhawan, New Baneshwor,
Kathmandu, Nepal
- 👤 Mr. Tuk Lal Adhikari, MD
- ☎ +977-1-4106776 (Hunting Line), 4106885, 4106838, 4106853
- ✉ iteco@mos.com.np, uddhab.khanal@gmail.com
- 🌐 www.iteconepal.com
- Year Established : 1987**

9. M16 : BDAnepal (P) Ltd.

- 📍 Pragati Marga-1, Bishalnagar -5, Kathmandu, Nepal
- 👤 Mr. Ram Bahadur Shrestha, MD
- ☎ +977-1-4540364, 4536842
- ✉ bdanep@gmail.com
- 🌐 www.bdanep.com.np
- Year Established : 1974**

10. M 19 : GEOCE Consultants (P) Ltd.

- 📍 Jhamshikhel-3, Lalitpur, Nepal
- 👤 Mr Subarna Bahadur Joshi, MD
- ☎ +977-5521175, 5545542
- ✉ info@geoceconsultants.com, geoce@info.com.np
- 🌐 www.geoceconsultants.com
- Year Established : 1986**



11. M 24 : Technical Interface (TI)

📍 147/65 Ga, Chaksibari Marga, Chhetrapati, Kathmandu, Nepal
 👤 Mr. Bibhuti Man Singh
 📞 +977-1-4268994, 01-4222408
 ✉ bibhutiman@gmail.com
 🌐 www.tecinter.com.np
Year Established : 1976

12. M 27 : Sub Structural (S.S.) Consult (P) Ltd.

📍 Rudranagar, Shantimarg, Ratopul, Kathmandu, Nepal
 👤 Mr. Keshav Kuwar
 📞 +977-1-4492979, 01-4491364
 ✉ ssconsult1987@gmail.com

13. M 30 : Engar Consult (P) Ltd.

📍 Tripureshwor, Kathmandu, Nepal
 👤 Mr. Ram Hari Shrestha
 📞 +977-1-4232454
 ✉ engarconsultants@gmail.com
Year Established : 1987

14. M 31 : TAEC Consult (P) Ltd.

📍 GPO Box 2519, Bidhyapati Marg, Ganesh Marga, Sankhamul, Kathmandu, Nepal
 👤 Mr. Gyanendra Bhattra
 📞 +977-1-5242940, 01-5242846
 ✉ taec@mos.com.np
 🌐 www.taeconsult.com

15. M 34 : Hydro Engineering Services (P) Ltd.

📍 Jyatha, Kantipath, Kathmandu, Nepal
 👤 Mr. Dharma Ratna Tuladhar
 📞 +977-1-4249527, 01-4249299
 ✉ hes@infoclub.com.np
Year Established : 1978

16. M 38 : MEH Consultants (P) Ltd.

📍 960/32 Devkota Sadak, Mid-Baneshwor Kathmandu, Nepal
 👤 Mr. Govinda Man Tamrakar, Mr. Shyam S. Sharma (MD)
 📞 +977-1-4477634
 ✉ meh@mehconsultants.com
 🌐 www.meh.consultants.com
Year Established : 1997

17. M 39 : CMS Engineering Consult (P) Ltd. (Formerly Consolidated Management Services Nepal Private Limited)

📍 126 Green House, Bhadrabinayak Marg, Thapagaun, Naya Baneshwor, Kathmandu-10, Nepal
 👤 Mr. Hari Prasad Upreti, Managing Director
 📞 +977 -1-5244139
 ✉ cms@cmsnepal.org.np
 🌐 www.cmsnepal.org
Year Established : 1992

18. M 40 : Joshi Associates

📍 GP Box 190759 Kamaladi, Kathmandu, Nepal
 👤 Mr. Tirtha Bahadur Joshi
 📞 +977-1-4435861, 01-4263943, 01-4241969
 ✉ tirtha@gmail.com, joshiassociates@gmail.com
Year Established : 1987

19. M 42 : Group of Engineers' Consortium (P) Ltd.

📍 Pulchowk, Lalitpur, Nepal
 👤 Mr. Santosh Kunwar
 📞 +977-1-5543979
 ✉ groupofengineers.gec@gmail.com
 🌐 www.gec.com.np
Year Established : 1993

20. M 43 : Soil Test (P) Ltd.

📍 Sokedhara, Kathmandu, Nepal
 👤 Mr. Mahendra B. Karki
 📞 +977 01-4373625
 ✉ support@soiltest.com.np
 🌐 www.soiltest.com.np
Year Established : 1985

21. M 44 : WELINK Consultants (P) Ltd.

📍 Kaushaltar, Madhyapur, Thimi, Nepal
 👤 Mr. Saroj Basnet
 ☎ +977-6203472/73, 6634047
 ✉ sbasnet922@gmail.com
 🌐 www.welink.com.np
Year Established : 1989

22. M 48 : Full Bright Consultancy (Pvt.) Ltd.

📍 316 Baburam Acharya Sadak, Sinamangal, Kathmandu-09, Nepal
 👤 Mr. Thakur P. Sharma, Chairman/Managing Director, Mr. Min Bahadur KC, Director
 ☎ +977-1-4568749
 ✉ fbc@mos.com.np
 🌐 www.fbc.com.np
Year Established : 1986

23. M 55 : MRB & Associates (P) Ltd.

📍 27/19 Seto Dhoka Marg, Jamal, Kathmandu, Nepal
 👤 Mr. Manohar Rajbhandari
 ☎ +977-1-4243532
 ✉ mrb.nassociates@gmail.com
 🌐 www.mrb.com.np
Year Established : 1989

24. M 58 : Shah Consult International (P) Ltd.

📍 282 Jaycees Marg, Thapathali, Kathmandu, Nepal
 👤 Dr. Sanjiv Shah
 ☎ +977-1-4232248, 01-4215046
 ✉ sanjiv@shahconsult.com
 🌐 www.shahconsult.com
Year Established : 1992

25. M 62 : SIDEF Consultants Pvt. Ltd.

📍 SIdE f House, 77 Tara Marga, Sinamangal, Kathmandu, Nepal
 👤 Dr. Hare Ram Shrestha
 ☎ +977-1-4581538, 01-4568879
 ✉ sidef@mail.com.np
 🌐 www.sidef.com.np
Year Established : 1993

26. M 65 : Environment and Resource Management Consultant (ERMC) P. Ltd.

📍 Puja Pratisthan Marga-91, New Baneshwor, Kathmandu, Nepal
 👤 Mr. Uddab Raj Chaulagain
 ☎ +977-1-4483063/64
 ✉ ermc@ermcnepal.com
 🌐 www.ermcnepal.com
Year Established : 1986

27. M 68 : Sand and Stone Consultants P. Ltd. (SASCON)

📍 Basundhara, Nepal
 👤 Mr. Nahendra Pradhan
 ☎ +977-1-4355033
 ✉ nahendrapradhan@yahoo.com
Year Established : 2043

28. M 69 : Integrated Development and Research Services (P) Ltd. (IDRS)

📍 Alok nagar, Baneshwor, Kathmandu, Nepal
 👤 Mr. Ram Chandra Paudel
 ☎ +977-1-4106570, 01-4106509
 ✉ idrsnepal@gmail.com
 🌐 www.idrs.com.np
Year Established : 1999

29. M 72 : Innovative Createers (P) Ltd.

📍 1125/51(5), Thirbam Sadak, Maharajgunj, Kathmandu, Nepal
 👤 Ar. Ujjwal Man Shakya
 ☎ +977-1-4414537, 01-4426539
 ✉ createers@mos.com.np
 🌐 www.createers.com.np
Year Established : 1986

30. M 77 : Shah Associates (P) Ltd.

📍 302 Tanka Prasad Marga, Old Baneshwor Height, Ward Number 10, Kathmandu, Nepal
 👤 Mr. Ranjan Singh Shah
 ☎ +977-1-4481442, 01-4471248, 01-4497643
 ✉ ranjan.sassociates@gmail.com
Year Established : 2035



31. M 82 : North Star Engineering Consultants (P) Ltd.

📍 Dhobighat, Lalitpur, Nepal
 👤 Mr. Shrawan Kumar Thapa
 ☎ +977-1-5435302
 ✉ nsec.consultant@gmail.com
 🌐 www.northstarnepal.com
 Year Established : 1990

32. M 83 : K.D. Associates Pvt. Ltd.

📍 Amrit Marg, Jyatha, Kathmandu, Nepal
 👤 Mr. Kul Dip Tuladhar
 ☎ +977-4215340
 ✉ kdapl@yahoo.com
 🌐 www.hurarah.com.np
 Year Established : 1994

33. M 84 : GENESIS Consultancy (P) Ltd.

📍 Sai Marg, Shree Mahal, Pulchowk-3, Lalitpur, Nepal
 👤 Mr. Anish Joshi
 ☎ +977-1-5552622
 ✉ info@genesis.com.np, genesis.geoinfo@gmail.com
 🌐 www.genesis.com.np
 Year Established : 2000

34. M 85 : Project Engineering Consultancy and Research Pvt. Ltd. (PRECAR)

📍 Devkota Sadak, Mid-Baneshwor, Kathmandu, Nepal
 👤 Mr. Amod Kumar Thapa, Executive Director
 ☎ +977-4465084
 ✉ precar2005@gmail.com
 🌐 www.precarnepal.org.np
 Year Established : 2061

35. M 86 : Tech Studio of Engineering (P) Ltd. (TSE)

📍 Bisalnagar, Kathmandu, Nepal
 👤 Mr. Sanjeev Regmi
 ☎ +977 4433828
 ✉ info@tse.com.np
 🌐 www.tse.com.np
 Year Established : 2051

36. M 88 : I.C.G.S. (P) Ltd.

📍 Panchakanya Marga -31, Minbhawan, ITECO Building, Kathmandu, Nepal
 👤 Mr. Achyuta Nanda Bhandari, MD
 ☎ +977-1-4106912
 ✉ icgs_1997@yahoo.com
 🌐 www.icgs.com.np
 Year Established : 2054

37. M 91 : Hydro Trans (P) Ltd.

📍 Balaju, Kathmandu, Nepal
 👤 Mr. Binod Bharati
 ☎ +977-5553126
 ✉ support@soiltest.com.np
 Year Established : 2049

38. M 93 : East West Engineering Service Pvt. Ltd. (EWES)

📍 Bansbari, Kathmandu-3, Nepal
 👤 Mr. Hari Bhakta Gurung, Executive Director
 ☎ +977-1-4373316
 ✉ info@ewesnepal.com; hbgewe@gmail.com
 🌐 www.ewesnepal.com
 Year Established : 2052

39. M 94 : MULTI Lab (P) Ltd.

📍 Lalitpur, Nepal
 👤 Mr. Ram Krishna Poudel
 ☎ +977-5548900
 ✉ multilab900@gmail.com
 🌐 www.multinepal.com/multilab
 Year Established : 2052

40. AF3 : Total Management Services Pvt. Ltd. (TMS) (An ISO 9001:2008 Certified)

📍 Lalupate Marg-1, Kamalpokhari, Kathmandu, Nepal
 👤 Mr. Prajol Lal Shrestha
 ☎ +977-1-4439182, 01-4439187
 ✉ info@tms.com.np
 🌐 www.tms.com.np
 Year Established : 2002

41. M 95 : Integrated Management Engineering Research Consultancy (P) Ltd. (IMERC)

📍 Kupondole, Lalitpur, Nepal
 👤 Mr. Krishna Bdr. Thapa
 ☎ +977-5442613
 ✉ imer_consultancy@yahoo.com
 🗓 Year Established : 2059

42. M 96 : Everest Engineering Consultants (P) Ltd.

📍 Om Sai Marga, Baneshwor, Nepal
 👤 Mr. Krishna Dev Yadhav
 ☎ +977-4481449
 ✉ everest_consultant@yahoo.com
 🗓 Year Established : 2053

43. M 97 : Fuji International Design Associates (FIDA)

📍 Kupondole-10, Lalitpur, Nepal
 👤 Mr. Bibek Bastakoti
 ☎ +977-1-5535190, 9851045319
 ✉ fidanepal@yahoo.com
 🌐 www.facebook.com/fidanepal
 🗓 Year Established : 2053

44. M 98 : Design Consultants P. Ltd.

📍 Kupondole, Lalitpur, Nepal
 👤 Mr. Shakti Man Dangol
 ☎ +977-1-5180334
 ✉ shakti@dconsult.com.np
 🌐 www.dconsult.com.np
 🗓 Year Established : 2055

45. M 99 : SITARA Consult Pvt. Ltd.

📍 Patan Dhoka, Lalitpur, Nepal
 👤 Mr. Tika Bahadur Koirala
 ☎ +977-1-5549045
 ✉ sitaraconsult.np@gmail.com
 🌐 www.sitaraconsult.org.np
 🗓 Year Established : 2060

46. M 100 : Aviyaan Consulting (P) Ltd.

📍 Ekata Marg, Block No: 254, New Baneshwor, Kathmandu, Nepal
 👤 Mr. Prashant Malla
 ☎ +977-1-4104319, 01- 4104307
 ✉ info@aviyaan.com
 🌐 www.aviyaan.com
 🗓 Year Established : 2007

47. M 101 : Material Test (P) Ltd.

📍 Mid-Baneshwor, Kathmandu, Nepal
 👤 Mr. Madhukar Karki, MD
 ☎ +977-1-4486092
 ✉ matecon.lab@gmail.com
 🌐 www.materialtest.com.np
 🗓 Year Established : 2063

48. M 102 : Clean Development Consult (P) Ltd. (CDC)

📍 Babarmahal, Kathmandu, Nepal
 👤 Mr. Sudeep Hada
 ☎ +977-1-4240295
 ✉ cleandevlopmentconsult@gmail.com

49. M 103 : Inclusive Consultants Pvt. Ltd.

📍 Sitapaila, Kathmandu, Nepal
 👤 Mr. Anil Neupane (Managing Director)
 ☎ +977-4034880
 ✉ inclusive.consultants@gmail.com
 🌐 www.inclusive.consultants.com.np

50. M 104 : Rural Infrastructure Developers Consultants (P) Ltd.

📍 Buddhanagar, Kathmandu, Nepal
 👤 Mr. Jagat Ranabhat (Executive Director)
 ☎ +977-4781740, 9851132180
 ✉ ridc2006@gmail.com
 🌐 www.ridc.com.np
 🗓 Year Established : 2063

51. M 107 : Civil Informatics And Solutions P. Ltd. (CIAS)

- 📍 Chakupat, Lalitpur Sub-metropolitan
- City. W.N-11, Lalitpur, Nepal
- 👤 Mr. Sanjeev Kumar Jha
- ☎ +977-1-5260314
- ✉ info@cias.com.np
- 🌐 www.cias.com.np
- Year Established : 2061**

52. M 109 : Engineering Consultancy for Constructive Development Efforts in Nepal (P) Ltd.[ECoCoDE Nepal (P) Ltd.]

- 📍 Jwagal, Kupondol, Lalitpur - 10, Nepal
- 👤 Mr. Prakash Adhikaree
- ☎ +977-1-5261016
- ✉ ecocodenepal@ntc.net.np
- 🌐 www.ecocodenepal.com,
- Year Established : 2009 AD**

53. M 110 : Alliance Consults Pvt. Ltd.

- 📍 Shantinagar, Kathmandu, Nepal
- 👤 Mr. Awash Ghimire
- ☎ +977-1- 4107768
- ✉ awash229@gmail.com
- 🌐 www.allianceconsults.com
- Year Established : 2063**

54. M 111 : SERC Consulting Engineers (Pvt.) Ltd.

- 📍 Ghatekulo, Nepal
- 👤 Mrs. Krishna GC
- ☎ +977-4770377
- ✉ serc2046@gmail.com
- Year Established : 2046**

55. M 112 : Engineering & Planning Solution Consultancy Pvt. Ltd

- 📍 Mahalaxmi -1, Imadol, Lalitpur, Nepal
- 👤 Mr. Ranjit Lalchan
- ☎ +977-1-5201784
- ✉ eps_consultants@hotmail.com
- Year Established : 2066**

56. M 113 : Grid Nepal Design Associates Pvt. Ltd.

- 📍 Dhobighat, Lalitpur, Nepal
- 👤 Mr. Sanjay Adhikari
- ☎ +977-1-5188484
- ✉ gridnepal_design@yahoo.com
- 🌐 gridnepaldesign2018@gmail.com
- Year Established : 2066**

57. M 114 : Unique Engineering Consultancy Pvt. Ltd.

- 📍 Jwagal-10, Lalitpur, Nepal
- 👤 Mr. Umesh Prasad Chaudhari
- ☎ +977-1-5260699
- ✉ unecnepal@gmail.com
- 🌐 www.unecnepal.com.np
- Year Established : 2063**

58. M 118 : Paragon Engineering Consultancy & Research Center Pvt. Ltd.

- 📍 Bakhundole-1, Lalitpur, Nepal
- 👤 Mr. Narayan Hari Rijal, MD
- ☎ +977-1-5430600
- ✉ ourparagon2009@gmail.com
- 🌐 www.ourparagon.com
- Year Established : 2066**

59. M 119 : Digicon Engineering Consult Pvt. Ltd.

- 📍 Sanepa, Lalitpur, Nepal
- 👤 Mr. Ram Udar Yadav
- ☎ +977-1-5454028
- ✉ digicondoc@gmail.com
- 🌐 www.digicon.com.np, www.facebook.com/digicon.com.np
- Year Established : 2009**

60. M 120 : RIBS Engineering Consult (P) Ltd

- 📍 Maharjgunj, Kathmandu, Nepal
- 👤 Mr. Sunil Kumar Jha
- ☎ +977-4370965,
- ✉ ribsengineeringconsult@gmail.com
- Year Established : 2058 B.S. (2002)**

61. M 122 : Project Engineering and Environmental Studies (PEES) Consultant (P.) Ltd.

📍 Koteshwor-32, Kathmandu, Nepal
 👤 Mr. Habendra Prasad Dev
 ☎ +977-1-5242396
 ✉ peesconsult@gmail.com
 🌐 www.pees.com.np
 Year Established : 2059 B.S

62. M 126 : Institute for Professional Training and Management (IPTM) Nepal

📍 Gaushala, Kathmandu, Nepal
 👤 Mr. Nishesh Shakya (Executive Director)
 ☎ +977-1-4469808
 ✉ iptmnepal@gmail.com
 🌐 www.iptmnepal.com.np
 Year Established : 2067

63. M 127 : Rajdevi Engineering Consultant (P) Ltd.

📍 New Baneshwor, Kathmandu, Nepal
 👤 Mr. Bishal Dev
 ☎ +977-5242043, 9851094885
 ✉ info@rajdevi.com.np
 🌐 www.rajdevi.com.np
 Year Established : 2063

64. M 128 : PACE Consultant (P.) Ltd.

📍 Narayan Gopal Chowk, Maharajgunj Kathmandu, Nepal
 👤 Mr. Bishnu Prasad Khanal
 ☎ +977-1-4720718, 01-4720565
 ✉ paceconsultant@gmail.com, info@pacenp.com
 🌐 www.pace.com.np, www.pace2001.com
 Year Established : 2001

65. M 129 : Grid Consult (P) Ltd.

📍 Binayak Marga-10, Baneshwor, Kathmandu, Nepal
 👤 Mrs. Aruna Tandukar
 ☎ +977-1-5172695
 ✉ gridconsult.consult@gmail.com
 🌐 www.facebook.com/gridconsult
 Year Established : 2065

66. M 130 : Card Consult (P) Ltd.

📍 Basanta Marga - 10, Babarmahal, Kathmandu, Nepal
 👤 Mr. Sagar Prasad Mulmi
 ☎ +977-1-5324141
 ✉ cardconsultants@gmail.com
 🌐 www.cardconsult.com.np
 Year Established : 2065

67. M 131 : Socio Technical Management Services Pvt. Ltd. (STMS)

📍 Bagdole, Lalitpur, Nepal
 👤 Mr. Ramesh Chandra Jha
 ☎ +977 5190292
 ✉ stmspvtltd@gmail.com
 Year Established : 2065

68. M132 : Civil Engineering Research and Consultancy Pvt. Ltd. (CERC)

📍 Kuponhole-10, Lalitpur, Nepal
 👤 Mr. Rupak Bastola
 ☎ +977-1-5428787
 ✉ cerpvtltd@gmail.com
 🌐 www.cercnepal.com
 Year Established : 2064

69. M 134 : A. Not Architecture N. Architects (Pvt.) Ltd.

📍 Lalitpur Metropolitan City, Talchhikhel, Satdobato, Lalitpur, Nepal
 👤 Ar. Damodar Acharya
 ☎ +977-1-5526061, 01-5524998
 ✉ anotarchitect@gmail.com
 🌐 www.anotarchitects.com
 Year Established : 2064

70. M 136 : Birat Infrastructure Development Pvt. Ltd.

📍 Sai Marg, Ward 3 Lalitpur, Nepal
 👤 Mr. Subhash Gachhadar
 ☎ +977-5522953
 ✉ info@biratinfradev.com, info@biratgroup.com
 🌐 www.biratinfradev.com
 Year Established : 2067

71. M 137 : Executive Consulting Engineering and Planner Pvt. Ltd. (ECEP)

📍 Lazimpat, Kathmandu, Nepal
 👤 Mr. Laxman K.C.
 ☎ +977-1-4424915, 9851137309
 ✉ info@executivecep.com, laxmankc2000@gmail.com
 🌐 www.executivecep.com
Year Established : 2068

72. M 139 : Shrestha Consultant (P) Ltd.

📍 Ekantakuna, Lalitpur, Nepal
 👤 Mr. Indra Lal Shrestha
 ☎ +977-1-5532305
 ✉ shrestha_consultant@hotmail.com
 🌐 www.shresthaconsultant.com.np
Year Established : 2054

73. M 141 : DK Consult Pvt. Ltd.

📍 141 Minbhawan, Kathmandu, Nepal
 👤 Dr. Krishna Prasad Dulal
 ☎ +977-4115206
 ✉ info@dkconsult.com.np
 🌐 www.dkconsult.com.np
Year Established : 2059

74. M 144 : Pumori Engineering Services Pvt. Ltd.

📍 Basanta Marg-351, Jyotishree Building, Babarmahal, KMC-11, Nepal
 👤 Mr. Sabin Khadka
 ☎ +977 4216034, 4239983
 ✉ info@pumorigroup.com
 🌐 www.pumorigroup.com
Year Established : 2060

75. M 145 : SLATE Consultants Pvt. Ltd.

📍 Jwagal, Lalitpur, Nepal
 👤 Mr. Pramod Dawadi
 ☎ +977-1-5261104
 ✉ slateconsult@gmail.com
 🌐 www.slatenepal.com
Year Established : 2062

76. M 146 : Extreme Engineering Solutions (P) Ltd

📍 Kuponhole-1, Lalitpur, Nepal
 👤 Mr. Manas Karki
 ☎ +977-5180391, 5523677
 ✉ extreme.engg.solns@gmail.com
 🌐 www.exesnepal.com.np
Year Established : 2068

77. M 147 : Machhapuchhre Consultancy (P) Ltd

📍 192 BP Marg/ Newroad, Pokhara Metropolis-9 Kaski District Gandaki Province, Nepal
 👤 Ar. Baburam Baral, MD
 ☎ +977-061-521622/98560-44903/98460-26903/98560-27490
 ✉ maconpokhara@gmail.com, barabr45@gmail.com
 🌐 www.maconpokhara.business.site
Year Established : 2054

78. M 148 : CEAD Consultants (P) Ltd.

📍 Pokhara, Nepal
 👤 Mr. Suresh Prasad Shrestha
 ☎ +977-061531308/538330
 ✉ ceadcon@gmail.com
Year Established : 2059

79. M 150 : Homeland Engineering Consultancy Pvt. Ltd.

📍 Kathmandu, Nepal
 👤 Mr. Govinda Dev Adhikari, MD
 ☎ +977-1-4232034
 ✉ homeland.engg.consultancy@gmail.com
 🌐 homelandengineering.com.np
Year Established : 2062

80. M 152 : Prime Engineering & Management Pvt. Ltd.

📍 Bharatpur Metropolitan City Ward No.-7 Krishnapur, Chitwan, Nepal
 👤 Mr. Shalik Ram Paudel
 ☎ +977-9845 123456
 ✉ prime.econsult@gmail.com
Year Established : 2010

81. M 153 : PLUSH Engineers and Architects (P) Ltd.

📍 Sanepa, Lalitpur-2, Nepal
 👤 Chandeshwar Mahato
 ☎ +977-1-5184362
 ✉ plushpvtltd@gmail.com
 Year Established : 2064

82. M 154 : MEH Geo-Engineering Services (P) Ltd.

📍 Lalitpur Ward No. 22, Nepal
 👤 Mr. Bijendra Bade Shrestha
 ☎ +977-5261538, 5261539
 ✉ mehgeoengineering@gmail.com
 Year Established : 2069

83. M 155 : Sakhuwa Engineering Consultancy Pvt. Ltd.

📍 Imadol-6,-Lalitpur
 👤 Mr. Ranjit Kumar Shah
 ☎ +977-1-5202473
 ✉ sakhuwaengineering@gmail.com, shahranjit2011@gmail.com
 🌐 www.sakhuwaengineering.com.np
 Year Established : 2067

84. M 156 : CADS Consultancy & Hydro-Research Pvt. Ltd.

📍 Kupondol, Lalitpur, Nepal
 👤 Mr. Sujan Tripathi
 ☎ +977-5545786
 ✉ cads_hydro@live.com
 🌐 www.facebook.com/CADS.EngineeringConsultancy2005
 Year Established : 2065

85. M 157 : SAP Water and Energy Developers' Pvt. Ltd.

📍 Mid-Baneshwor, Kathmandu, Nepal
 👤 Mr. Rajan Raj Pande
 ☎ +977-1-4579537
 ✉ sapwaterandenergy@gmail.com
 Year Established : 2063 B.S.

86. M 158 : Green Planet Engineer's Associate (P) Ltd.

📍 Kutubahal, Chabahil-7, Kathmandu, Nepal
 👤 Mr. Bishnu Prasad Koju
 ☎ +977-1-4568885
 ✉ greenplanet.aso@gmail.com, bipik_koju@yahoo.com

87. M 159 : Guidance Engineering Consult & Research (P) Ltd.

📍 Satungal, Kathmandu, Nepal
 👤 Mr. Gahendra Prasad Thapaliya
 ☎ +977-5108063
 ✉ guidanceengineering@yahoo.com
 Year Established : 2012

88. M 161 : Create Acme Associates (ACME Group Co.)

📍 GPO 1344, Bakhundole, Lalitpur, Kathmandu, Nepal
 👤 Mr. Ritesh Amatya
 ☎ +977-1-5452413
 ✉ info@acmenepal.com
 🌐 www.acmenepal.com
 Year Established : 1998

89. M 162 : GeoCom International Pvt. Ltd.

📍 Dhobighat-04, Lalitpur, Nepal
 👤 Mr. Rabi Bhushan Jha
 ☎ +977-1-5153049, 01-5153054
 ✉ geocomnc@gmail.com
 🌐 www.geocomintl.com
 Year Established : 2066

90. M 163 : Vastumandap Consultancy (P) Ltd.

📍 Nayabazar, Kathmandu Nepal
 👤 Mr. Umesh Silwal
 ☎ +977-1-4353458, 01-4353458
 ✉ vastu123@gmail.com
 🌐 www.vastumandap.com.np
 Year Established : 2060

91. M 165 : RIDARC Nepal

📍 Bhaisepati, Karyabinayak, Municipality-01
Lalitpur, Nepal
👤 Mr. Hem Raj Shahi
☎ +977-1-5593065/ 9851016051
✉ ridarcnp@gmail.com
🌐 ridarcnepal.com.np
Year Established : 2066

92. M 166 : Bonafide Engineering Consultancy Pvt. Ltd.

📍 Sanepa, Lalitpur, Nepal
👤 Mr. Anil Manandhar
☎ +977-1-5403222
✉ bonafideengineering@gmail.com
🌐 <http://www.bonafide.com.np>
Year Established : 2071

93. M 167 : Radiant Consulting Consortium (P) Ltd.

📍 Chakupat, Lalitpur, Nepal
👤 Mr. Sujit Shrestha
☎ +977-1-5260410
✉ radiant.cc@hotmail.com
Year Established : 2060

94. M 168 : Sustainable Engineering Development (P) Ltd.

📍 Nagarjun, Kathmandu, Nepal
👤 Mr. Bishwo Vijaya Shrestha
☎ +977-4890803
✉ sedpl2015@gmail.com
🌐 www.facebook.com/gharnaksa
Year Established : 2072

95. M 169 : Naya Rastriya Engineering Consultancy Pvt. Ltd.

📍 Khumaltar, Lalitpur, Nepal
👤 Mr. Sikindar Kumar Chaudhary
☎ +977-1-5151259
✉ nrecgroup@gmail.com
🌐 www.nrecgroup.org
Year Established : 2065

96. M 170 : Technocrat Consultancy Pvt. Ltd.

📍 Shankhamul, Kathmandu, Nepal
👤 Mr. Manish Karn
☎ +977-1-4433482
✉ technocratpltd@gmail.com
Year Established : 2071

97. M 171 : National Synergy Engineering Solutions Pvt. Ltd.

📍 Shankhamul, Kathmandu, Nepal
👤 Mr. Rabin Kumar Dahal
☎ +977-1-4782601
✉ nationalsess@gmail.com
Year Established : 2065

98. AF 5 : Wekreate International (P) Ltd.

📍 Sinamangal Ward No. 9 KTM, Nepal
👤 Mr. Biswo Raj Pandey
☎ +977-1-4487528
✉ business@weki.com.np
🌐 www.weki.com.np
Year Established : 2073

99. M 172 : Three Dots Architects Pvt. Ltd.

📍 Jawalakhel, Lalitpur-20, Nepal
👤 Mr. Sandip Puri
☎ +977-1-5520823
✉ 3dotsarchitects@gmail.com
🌐 www.3dotsarchitects.com.np
Year Established : 2072

100. M 173 : One Line Architects Pvt. Ltd.

📍 Saatdobato, Lalitpur, Nepal
👤 Ar. Rakesh Maharjan
☎ +977-9851223595
✉ onelinearchitects@gmail.com
🌐 <https://onelinearchitects.business.site>
Year Established : 2070

101. M 174 : Innovation Engineering Associates Pvt. Ltd.

📍 KMC.-16, Nayabazar, Kathmandu, Nepal
 👤 Mr. Sushil Dawadi
 ☎ +977-1-4389802
 ✉ innovation073@gmail.com
 🌐 <https://www.facebook.com/IEA073>
 Year Established : 2073

102. M 175 : Research for National Development Centre Pvt. Ltd. (RND Centre)

📍 Kupondole-01, Lalitpur, Nepal
 👤 Mr. Radha Krishna Mallik
 ☎ +977-1-5455866
 ✉ rndc.np@gmail.com
 🌐 www.rndcentre.com
 Year Established : 2066

103. M 176 : Abhyantra Consulting Pvt. Ltd.

📍 New-Baneshwor, Kathmandu, Nepal
 👤 Mr. Bijaya Thapa
 ☎ +977-1-5349480
 ✉ abhyantra2012@gmail.com
 🌐 www.abhyantra.com.np
 Year Established : 2069

104. M 177 : Resilience Construction and Development Pvt. Ltd.

📍 Baneshwar-10, Kathmandu, Nepal
 👤 Mr. Naresh Nidal
 ☎ +977 9849628876
 ✉ rcadnepal@gmail.com
 🌐 www.facebook.com/rcadians
 Year Established : 2072

105. M 178 : Civil International Consultants Pvt. Ltd.

📍 CTC Mahal, Sundhara, Kathmandu, Nepal
 👤 Mr. Rajesh Thapa
 ☎ +977-1-4219244
 ✉ civilintlcon@civilgroup.com.np
 🌐 www.civilgroup.com.np
 Year Established : 2064

106. M 179 : ArEICON Pvt. Ltd.

📍 Lalitpur,-22 Jwagal-10, Nepal
 👤 Mr. Gopal Bahadur Kunwar
 ☎ +977-1-5551150, 5524457
 ✉ areiconsatelier@gmail.com
 🌐 www.aericon.com.np
 Year Established : 2071

107. M 180 : B.N. Consultancy Pvt. Ltd.

📍 Sanepa, Lalitpur-2, Ringroad, Nepal
 👤 Mr. Laxman Acharya
 ☎ +977-1-5184370
 ✉ bnconsultancy@gmail.com
 Year Established : 2062 B.S.

108. M 181 : Rural Infrastructure & Management Consultant (RIMC) Pvt. Ltd.

📍 Koteswor, Kathmandu, Nepal
 👤 Mr. Bharat Timsina
 ☎ +977-1-5147278, 01-5147299
 ✉ rimc.consultant@gmail.com
 🌐 www.rimcnepal.com
 Year Established : 2066

109. M 182 : Creative Design Architects Pvt. Ltd

📍 Kupondole-1, Lalitpur, Nepal
 👤 Mr. Sher Bahadur Chhetri
 ☎ +977-1-5545293
 ✉ sher_kc@yahoo.com
 🌐 www.ceda-nepal.com
 Year Established : 2056

110. M 183 : Group of Researcher and National Developers Consult (P) Ltd. (GRAND Consult Pvt. Ltd.)

📍 Basanta Marga, Babarmahal, Kathmandu, Nepal
 👤 Mrs. Lila Nath Nepal
 ☎ +977-1-5324998, 01-5324141
 ✉ grandconsultants@gmail.com
 Year Established : 2070

111. M 184 : Designers Pavilion Pvt. Ltd.

📍 Thamel, Kathmandu, Nepal
 👤 Mr. Poshan Thapa
 ☎ +977-1-4420736
 ✉ designerspvl@gmail.com
 🗓 **Year Established : 2063**

112. M 185 : United Engineering Solutions Pvt. Ltd.

📍 Lalitpur-10, Nepal
 👤 Mr. Thaman Bahadur Khadka
 ☎ +977-1-5528247
 ✉ info.unitedes@gmail.com, info@ues.com.np
 🌐 www.ues.com.np
 🗓 **Year Established : 2073**

113. M 186 : Harmonic Engineering Pvt. Ltd.

📍 Buddhanagar, Kathmandu, Nepal
 👤 Mr. Raman Shrestha
 ☎ +977-9852029669
 ✉ info.harmonicengineering@gmail.com
 🗓 **Year Established : 2074**

114. M 187 : MMJ_RR's Vastu And Engineering

📍 Pokhara, Nepal
 👤 Mr. Rajendra Ligal
 ☎ +977-61528959
 ✉ vrligal@gmail.com
 🌐 www.vaastu.com.np
 🗓 **Year Established : 2061**

115. M 188 : Earthquake Safety Solutions

📍 Sainbu, Bhaisepati, Lalitpur Metropolitan City-25, Nepal
 👤 Mr. Dev Kumar Maharjan
 ☎ +977-1-5590664
 ✉ ss@eqsafety.com.np
 🌐 www.eqsafety.com.np
 🗓 **Year Established : 2071 B.S.**

116. M 189 : Innovative Engineering Services Pvt. Ltd.

📍 Jwagal, Lalitpur, Nepal
 👤 Mr. Hari Krishna Dawadi
 ☎ +977-1-5261776, 01-5261774, 9851198185
 ✉ info@ies.com.np
 🌐 www.ies.com.np
 🗓 **Year Established : 2074**

117. M 190 : Pertinent Engineering Consultancy Pvt. Ltd.

📍 Jwagal, Lalitpur, Nepal
 👤 Mr. Dipendra Kumar Jha
 ☎ +977-1-5015349
 ✉ pertinentnepal@gmail.com
 🌐 www.pertinentnepal.com
 🗓 **Year Established : 2068 B.S.**

118. M 191 : Subway Nepal Engineering Consultant P. Ltd. (SWEC)

📍 Kupondol, Lalitpur, Nepal
 👤 Mr. Anand Kumar Jha
 ☎ +977-9841360414
 ✉ subwaynepal@gmail.com
 🌐 www.pertinentnepal.com
 🗓 **Year Established : 2068**

119. M 193 : Infrastructure Engineering Research & Consult (P) Ltd. (IERC)

📍 Balaju, Kathmandu, Nepal
 👤 Mr. Surendra Katwal
 ☎ +977-1-5103011
 ✉ consult@ierc.com.np
 🌐 www.ierc.com.np
 🗓 **Year Established : 2061**

120. M 194 :Engineers Revisited Consult (P) Ltd.

📍 Lalitpur-10, Nepal
 👤 Mr. Binod Prakash Pandit
 ☎ +977-50126110
 ✉ info.erconsult@gmail.com
 🌐 www.erconsult.com.np
 🗓 **Year Established : 2072**

121. M 195 : Development Support Consult (P) Ltd.

📍 Sinamangal, 9, Nepal
 👤 Dr. Bhesh Raj Thapa
 ☎ +977-4780253
 ✉ devsconsult@gmail.com
 🌐 www.pertinentnepal.com
 Year Established : 2066

122. M 196 : D.B. Multi Engineering Consultant (P) Ltd.

📍 Mahadevsthan, marg 10, Baneshwor, Nepal
 👤 Mr. Dipendra Prasad Bhatta
 ☎ +977-4104361
 ✉ multidb5@gmail.com
 🌐 www.dbmulti.com
 Year Established : 2067

123. M 197 : Global Nepal Engineering Design Consultant Pvt. Ltd.

📍 Kalanki, Kathmandu, Nepal
 👤 Mr. Aashish Khadka
 ☎ +977-9851037453
 ✉ gnedc2017@gmail.com, global.nepalengineering@gmail.com
 Year Established : 2073

124. M 198 : Artista Engineering Consulting Pvt. Ltd.

📍 Dhumbarahi-4, Kathmandu, Nepal
 👤 Mr. Dinesh Raj Bhattra
 ☎ +977-1-4410863
 ✉ artistaengineering@gmail.com
 🌐 www.artistaengineering.com.np
 Year Established : 2073

125. M 199 : Picasso Consultant Pvt. Ltd.

📍 Pulchowk, Lalitpur, Nepal
 👤 Mrs. Poonam Bajracharya
 ☎ +977-1-5522185
 ✉ picassoconsultant@gmail.com
 🌐 www.picasso.com.np
 Year Established : 2068

126. M 200 : Urban Planning & Design Consultants Nepal Pvt. Ltd. (UPDC)

📍 Sanepa, Lalitpur-2, Nepal
 👤 Mr. Manish Raj Joshi
 ☎ +977-1-526646
 ✉ info@updcn.com.np, updcnepal@gmail.com
 Year Established : 2072

127. M 201 : Nepal Architects Consult (P) Ltd.

📍 Budibazar, Kaski, Pokhara, Ward no. 26
 👤 Mrs. Sophiya Gurung
 ☎ +977-1- 5426646
 ✉ neparchi015@gmail.com
 🌐 www.nepalarchitectsconsult.com.np
 Year Established : 2072

128. M 202 : Soil Water and Air Testing Laboratories Pvt. Ltd. (SWAT Lab)

📍 Sisirmarga-11, Babarmahal, Kathmandu, Nepal
 👤 Mr. Lokesh Sapkota
 ☎ +977-1-5349480
 ✉ swatlab2017@gmail.com
 🌐 www.swat.abhyantra.com.np
 Year Established : 2074

129. M 203 : Engineerko Ghar (P) Ltd.

📍 Maitighar, Kathmandu, Nepal
 👤 Mr. Saroj Kumar Karki
 ☎ +977-9851248530
 ✉ gharengineerko@gmail.com
 🌐 www.gharengineerko.com, www.facebook.com/gharengineerko
 Year Established : 2074

130. M 204 : Pyramid Design Associates (P) Ltd.

📍 Shankadhar Chowk, Madhayapur Thimi, Nepal
 👤 Mr. Satya Sundar Shrestha
 ☎ +977-1-4239772
 ✉ pyramid.design.associates@gmail.com
 🌐 www.facebook.com/pyramid.DA,
 Year Established : 2067

131. M 205 : De Fort P. Ltd.

📍 Jawalakhel, Lalitpur Metropolitan City-03, Nepal
 👤 Mr. Kichah Chitrakar
 ☎ +977-1-5444086
 ✉ de-fort@de-fortnp.com
 🌐 www.de-fortnp.com
 Year Established : 2060

132. M 206 : E. I. Maven Pvt. Ltd.

📍 Buddhanagar, New Baneshwor, Kathmandu, Nepal
 👤 Mr. Sunil Ghaju
 ☎ +977-1-5906381
 ✉ info@eimaven.com.np
 🌐 www.eimaven.com.np
 Year Established : 2072

133. M 207 : Engineers World (P) Ltd.

📍 Gusingal, Sanepa, Lalitpur, Nepal
 👤 Mr. Padam Oli
 ☎ +977-1-6916152
 ✉ erworld70@gmail.com
 🌐 www.facebook.com/engineersworld
 Year Established : 2070

134. M 208 : Udaya Consultancy (P) Ltd.

📍 Puja Pratisthan Marg, Mid Baneshwar, Kathmandu, Nepal
 👤 Mr. Rakesh Regmi
 ☎ +977-1-4489393
 ✉ udayaconsultingpvt@gmail.com

Year Established : 2062

135. M 209 : Planet Test (P.) Ltd.

📍 KMC-31, Shantinagar, Kathmandu, Nepal
 👤 Mr. Dewakar Khadka
 ☎ +977-1-4107665
 ✉ info@planettest.com.np
 🌐 www.planetest.com.np
 Year Established : 2074

136. M 210 : Quest Engineering (P) Ltd.

📍 Balkhu, Kathmandu, Nepal
 👤 Mr. Jonesh Joshi
 ☎ +977-9849404718
 ✉ questengineering074@gmail.com
 Year Established : 2074

137. M 211 : Expert Professionals (P) Ltd.

📍 35 Narefata, Kathmandu, Nepal
 👤 Mr. Tek Bahadur Karki
 ☎ +977-5100349
 ✉ expertprofessionals2016@gmail.com
 Year Established : 2073

138. M 212 : Engineers' & Trainers' Associates (ETA Consult Pvt. Ltd.)

📍 Baluwatar, Kathmandu, Nepal
 👤 Mr. Giridhar Misra
 ☎ +977-4445565
 ✉ etadd@mos.com.np,
 🌐 www.etaconsult.org
 Year Established : 2063

139. M 213 : Bright Future International Pvt. Ltd. (BFI)

📍 KMC-10, Mid-Baneshwor, Kathmandu, Nepal
 👤 Dr. Shova Kumari Poudel
 ☎ +977-1-5172078
 ✉ bf.international2012@gmail.com
 🌐 www.bfinepal.com
 Year Established : 2068

140. M 214 : Y.G.F. Consultant (P) Ltd.

📍 Kirtipur, Kathmandu, Nepal
 👤 Mr. Shekhar Jha
 ☎ +977-9851221987
 ✉ ygfconsultant@gmail.com
 Year Established : 2070

141. M 215 : Finer Engineering Consultancy Pvt. Ltd.

- 📍 Dhumbarahi-4, Kathmandu, Nepal
- 👤 Mrs. Aadrata Regmi
- ☎ +977-1-4410863
- ✉ finer.engineering@yahoo.com
- Year Established : 2073**

146. M 221 : Ink Consult (P) Ltd.

- 📍 Chakupat, Lalitpur, Nepal
- 👤 Mr. Hari Prasad Paudel
- ☎ +977-1-5260138
- ✉ inkconsultnepal@gmail.com
- 🌐 www.inkconsult.com.np
- Year Established : 2074**

142. M 218 : Mate Engineering Solution Pvt. Ltd.

- 📍 Kupondole, Lalitpur-10, Nepal
- 👤 Mr. Sudhir Kumar Mishra
- ☎ +977-9801053527, 9851210238
- ✉ sdhrmishra14@gmail.com
- Year Established : 2069**

147. M 222 : Civil Tech Pvt. Ltd.

- 📍 Subidhanagar, Tinkune, Kathmandu, Nepal
- 👤 Mr. Raj Narayan Yadav
- ☎ +977-1-4111580
- ✉ civiltechconsultancy@gmail.com
- Year Established : 2068**

143. M 217 : Green Thumbs Consultants Pvt. Ltd. (GTC)

- 📍 Jhamshikhel, Lalitpur-03, Nepal
- 👤 Mr. Amit Kumar Jha
- ☎ +977-1-5532456
- ✉ greenthumbsnepal@gmail.com
- greenthumbs2071@gmail.com
- Year Established : 2071**

148. M 223 : Interface Engineering Pvt. Ltd.

- 📍 Naxal-1, Kathmandu, Nepal
- 👤 Mr. Deepak Bista
- ☎ +977-1-4444164
- ✉ interfaceengineering1@gmail.com
- Year Established : 2073**

144. M 219 : RITI Consultancy (P) Ltd.

- 📍 Lalitpur-03, Dhobighat, Lalitpur, Nepal
- 👤 Mr. Padam Tamang
- ☎ +977-1-5541840
- ✉ riticonsultant@gmail.com
- Year Established : 2056**

149. M 224 : Impulse Consultants Pvt. Ltd.

- 📍 Lazimpat-02, Kathmandu, Nepal
- 👤 Mr. Bhabuk Raj Aryal
- ☎ +977-1-4287705
- ✉ consultants.impulse@gmail.com
- 🌐 http://impulseconsultant.com.np/
- Year Established : 2070**

145. M 220 : RAYS Consult (P) Ltd.

- 📍 Kupondole-1, Lalitpur, Nepal
- 👤 Mr. Prabin Singh Bhandari
- ☎ +977-9851151014
- ✉ raysconsult12@gmail.com
- Year Established : 2069**

150. M 225 : Smart Engineering & Design Solution (P) Ltd.

- 📍 Gothatar, Kathmandu, Nepal
- 👤 Mr. Jyoti Mani Bhattarai
- ☎ +977-9851162172
- ✉ smart.seds.2071@gmail.com
- 🌐 www.seds.com.np
- Year Established : 2071**



151. M 226 : Benchmark Consultants and Lab Pvt. Ltd.

📍 Kaushaltar, Bhaktapur, Nepal
 👤 Mr. Nabin Thakur
 ☎ +977-1-6634968
 ✉ mailtobmcl@gmail.com
 🌐 www.facebook.com/benchmarkconsultants2010
 Year Established : 2067

152. M 227 : Strength Engineering Company (P) Ltd.

📍 Baneshwor, Kathmandu, Nepal
 👤 Mr. Bharat Chalise
 ☎ +977-1-4783183
 ✉ strength_engineering@yahoo.com
 Year Established : 2065

153. M 228 : Everest Designers' League (P.) Ltd.

📍 Balkhu, Kathmandu, Nepal
 👤 Mr. Narottam Shrestha
 ☎ +977-1-5187338
 ✉ everestleague@gmail.com
 Year Established : 2063

154. M 229 : DesignRipple Structures & Engineering Pvt. Ltd.

📍 Kathmandu- 3, Maharajgunj, Krishnadara Marg, Nepal
 👤 Mr. Kiran Acharya
 ☎ +977 9863048686
 ✉ info@designrippleengr.com
 🌐 www.designrippleengr.com
 Year Established : 2076

155. M 230 : Cube Info Company Pvt. Ltd.

📍 Bishalnagar, Kathmandu, Nepal
 👤 Mr. Shushant Koirala
 ☎ +977-1-4423194
 ✉ info@cubeinfo.com.np
 Year Established : 2068

156. M 231 : Viswa Consult Pvt. Ltd.

📍 Dillibazar, Kathmandu, Nepal
 👤 Dr. Biswa Ranjan Singh Shahi
 ☎ +977-1-4533156
 ✉ viswaconsultlab@gmail.com, viswaconsultpvtltd@gmail.com
 🌐 www.viswaconsult.com
 Year Established : 2058

157. M 232 : Civil Link Engineering Consultant

📍 Banepa Municipality ward No. 10, Kavre, Nepal
 👤 Mr. Bharat Prasad Banjara
 ☎ +977-1-5549382
 ✉ civillinkengineering@gmail.com
 Year Established : 2069

158. M 233 : N.S. Engineering & Geo-technical Services Pvt. Ltd.

📍 Dhobighat, Lalitpur, Nepal
 👤 Mr. Ananda Gupta
 ☎ +977-1-5260121
 ✉ nsgeotech@gmail.com
 🌐 www.nsengeering.com.np
 Year Established : 2072

59. M 234 : Dynamic Resources Management Services Pvt. Ltd. (DRMS)

📍 Buddhanagar-10, Kathmandu, Nepal
 👤 Mr. Sandeep Shrestha
 ☎ +977-1-4780460
 ✉ info@drms.com.np
 🌐 www.drms.com.np
 Year Established : 2074

160. M 235 : Development Oriented Consultant (P) Ltd.

📍 Subidhanagar-32, Kathmandu, Nepal
 👤 Mr. Saroj Kumar Vaidya
 ☎ +977-9841255963
 ✉ doconsultant2073@gmail.com
 Year Established : 2073



161. M 236 : Green Design Solution P. Ltd.

📍 New Baneshwor-10, Kathmandu, Nepal
 👤 Mr. Nabin Ghising
 📞 +977-1-4491403, 01-4491404
 ✉️ gdesignsolution13@gmail.com
 🌐 www.facebook.com/gdsarchitects
 Year Established : 2070

162. M 237 : Epicenter Engineering Solution (P.) Ltd.

📍 Jwagal-10, Lalitpur, Nepal
 👤 Mr. Suman Thapa
 📞 +977-1-4780632
 ✉️ info@eesnepal.com
 🌐 www.eesnepal.com
 Year Established : 2072

163. M 238 : Professional Network for Engineering Services Pvt. Ltd.

📍 Jwagal-10, Lalitpur, Nepal
 👤 Mr. Arjun Marasini
 📞 +977-1-5524889
 ✉️ pnet.pvt.ltd@gmail.com
 Year Established : 2059

164. M 239 : Research & Design Lab Pvt. Ltd.

📍 Sahayoginagar, Koteshwor, Nepal
 👤 Mr. Dinesh Neupane
 📞 +977-1-4794041
 ✉️ nepal.designlab@gmail.com
 Year Established : 2069

165. M 240 : Naksa Design & Consult Pvt. Ltd. (NDC)

📍 Koteshwor-32, Kathmandu, Nepal
 👤 Mr. Prakash Poudel
 📞 +977-1-4600069, 9756700096
 ✉️ nakshadesignconsultancy@gmail.com
 Year Established : 2070

166. M 241 : Creed Structural Design Pvt. Ltd.

📍 Jwagal-10, Lalitpur, Nepal
 👤 Mr. Birat Dev Bhatta
 📞 +977-9841847592, 9851181894, 9861444777
 ✉️ creedstructural@gmail.com
 Year Established : 2074

167. M 242 : Galaxy Engineering Trade Link Pvt. Ltd.

📍 Sarasvatikhel, Bhaktapur, Nepal
 👤 Mr. Chhabilal Adhikari
 📞 +977-9851194560,
 ✉️ galaxyen2014@gmail.com
 Year Established : 2071

168. M 243 : Ripple Training & Consulting Services Pvt. Ltd.

📍 Tokha-6, Kathmandu, Nepal
 👤 Mr. Sugandha Subedi
 📞 +977-9851223133
 ✉️ ripple2074@gmail.com
 🌐 www.ripple.com.np, www.facebook.com/ripplecompany
 Year Established 2074

169. M 244 : NKA Engineering Consultant Pvt. Ltd.

📍 Tarkeshwor-04, Kathmandu, Nepal
 👤 Mr. Dipak Bahadur Budha
 📞 +977-1-4950156
 ✉️ nkaengineering.consult@gmail.com
 🌐 www.nka.com.np
 Year Established : 2053

170. M 245 : Prajoo Engineering Consultancy

📍 Pokhara - 03, Kaski, Nepal
 👤 Er. Rajendra Prajoo
 📞 +977-061 587351/061 583370/061 576193
 ✉️ prajoo.consultant@gmail.com
 Year Established : 2050

171. M 246 : BRP Engineering Consultancy Pvt. Ltd.

📍 Pokhara-02, Kaski, Nepal
👤 Er. Aashish Parajuli
☎ +977-061-412327
✉ brp.engineering15@gmail.com
🌐 www.brpconstruction.com
Year Established : 2068

173. M 248 : Spiral Engineering & Educational Consultancy Pvt. Ltd.

📍 Chipledhunga, Pokhara-08, Kaski
👤 Er. Narayan Timilsena
☎ +977-61-536471
✉ seecpkr@gmail.com
🌐 www.seecpkr.com
Year Established : 2066

172. M 247 : Grace Engineering Pvt. Ltd.

📍 Pokhara-08, Kaski, Nepal
👤 Er. Bimal Bhandari
☎ +977-061-527650
✉ gracepltd@gmail.com
🌐 www.graceengineering.org, www.facebook.com/bimletar
Year Established : 2072



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Tripura Marg, Teku (Opposite Laxmi Bank),
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Phone: +977-9802711189

FACTORY:
Ramgram - 16,
Nawalparasi, Nepal.
Phone: +977-9802711167

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