NEWSLETTER

Department of Roads (DoR)

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1. Progress in Fiscal Year (F.Y) 2077/078

-PMEU Unit, DoR

S. N.	Details	Units	Annual Target	Progress	Progress (%)
1	Blacktop Road	Km	1400	1190	85.00
2	Gravel Road	Km	1000	739	73.90
3	Earthen Road	Km	500	472	94.40
4	Reconstruction and Rehabilitation of blacktop Road	Km	600	507	84.50
5	Periodic maintenance	Km	729	424	58.16
6	Bridge Construction	Nos	300	192	64.00
	Financial Progress:	66.27%			

2. Design and Construction of Mugling Deck Arch Bridge

-Dr Bijaya Jaishi, Director, QRDC

2.1 Introduction

The bridge site is located at Mugling along Prithivi Highway that connects the capital city, Kathmandu with a most popular tourist city, Pokhara. The google co-ordinate of bridge site is $27^0$51'16.22"N, $84^0$33'28.05"E. The Google image of bridge site is shown in Fig.1. DOR has constructed this bridge as an alternative crossing to Mugling suspension bridge that has been constructed by Chinese Government and completed in 1974 A.D (B.S. 2031). This existing suspension has several problems in its bearings, expansion joints and replaced steel deck. The contract for construction of this arch bridge was awarded in AD 2013-04-5 as a design build contract. The contractor was Elite Adventure Lohani JV, Maharajganj, Kathmandu. The construction has been completed and opened to traffic in AD 2019-07-10. This bridge has set up many records in the bridge construction history in Nepal and will be a milestone in the era of modern bridge construction in a country. Mugling arch bridge is the longest motorable arch bridge in the country till now. This is second motorable arch bridge as per IRC loading that is designed and constructed by Nepalese. The first was Chobhar arch bridge with arch span of 38.40m. The false work was significant in its complexity as handled by Nepalese contractor till now. Such Arch bridge has unique advantage in Nepalese topography since the construction does not demand construction of pier in deep gorge, work can be carried out in all seasons and flood has less effect on bridge.

Fig.1 Google map of bridge site

2.2 Salient feature:

The elevation of bridge is shown in Fig.2. The salient feature of bridge is presented below:

Total length of bridge=160m
Arch Span (L) =120.0 m
Arch Rise = 16.28m
Span Rise ratio=7.37
Numbers of arch ribs=3
Size of main arch rib= 1m (B) x 2m (D)
Side span= 20m each
Left arch block foundation size=14.5m x 10.8m
Right arch block foundation size=11.8m x 10.8m
Total width of bridge= 10.6m
Carriageway= 7.5m
Contract amount: NRs. 10,38,60000

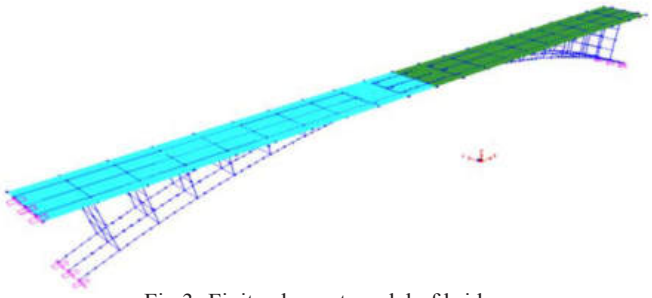


Fig.3- Finite element model of bridge

The finite element model is developed in SAP2000 (Fig.3) to find out the internal stresses in different elements which has been compared with manual analysis. In FE modeling, slab has been modeled as shell element; cross girders, longitudinal girders, spandrel columns, arch ribs and bracing connecting arch ribs are modeled as beam elements. Linear static analysis, non-linear static analysis, buckling analysis and response spectrum analysis has been carried out. The section design has been carried out for computed internal forces.

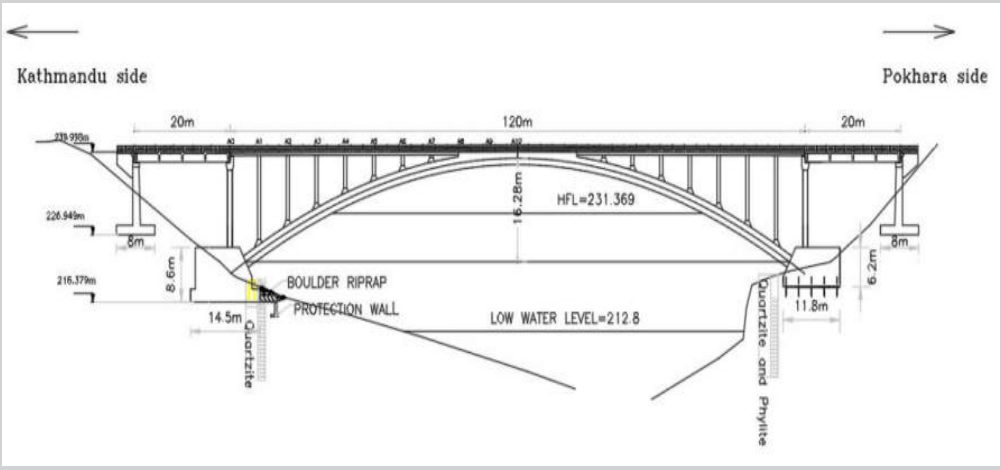


Fig.2- Elevation of bridge

2.3 Design

The bridge is designed as per IRC design specification. The main loads considered are (i) Dead load (ii) Moving load (iii) Braking load (iv) Wind load (v) Earthquake load (vi) Temperature load (vii) creep load (viii) Shrinkage loads (ix) Load due to elastic shortening etc. The main design steps are:

(a) Design of slab
(b) Design of cross girder
(c) Design of longitudinal girder
(d) Design of spandrel column
(e) Design of arch rib
(f) Design of bracing connecting arch ribs
(g) Design of arch foundation block

2.4 Construction Sequence

Construction is the most challenging issue in arch bridge than other types of bridges like suspension and cable stay bridges. Although overall bridge cost is less in arch bridge, there is always construction issue. The construction cost of temporary truss is significant and about 30% of total cost of bridge. The construction sequence is:

(a) Arch foundation block construction
(b) Construction of spandrel column above arch foundation block and abutment of end spans
(c) Side span construction
(d) Construction of temporary truss (cantilever construction) for arch construction
(e) Construction of arch rib and connecting bracing
(f) Spandrel column construction
(g) Construction of longitudinal girder and cross girder for deck
(h) Construction of slab
(i) Construction of bearings, expansion joints and appurtenances

The construction sequences are shown in Fig.4.

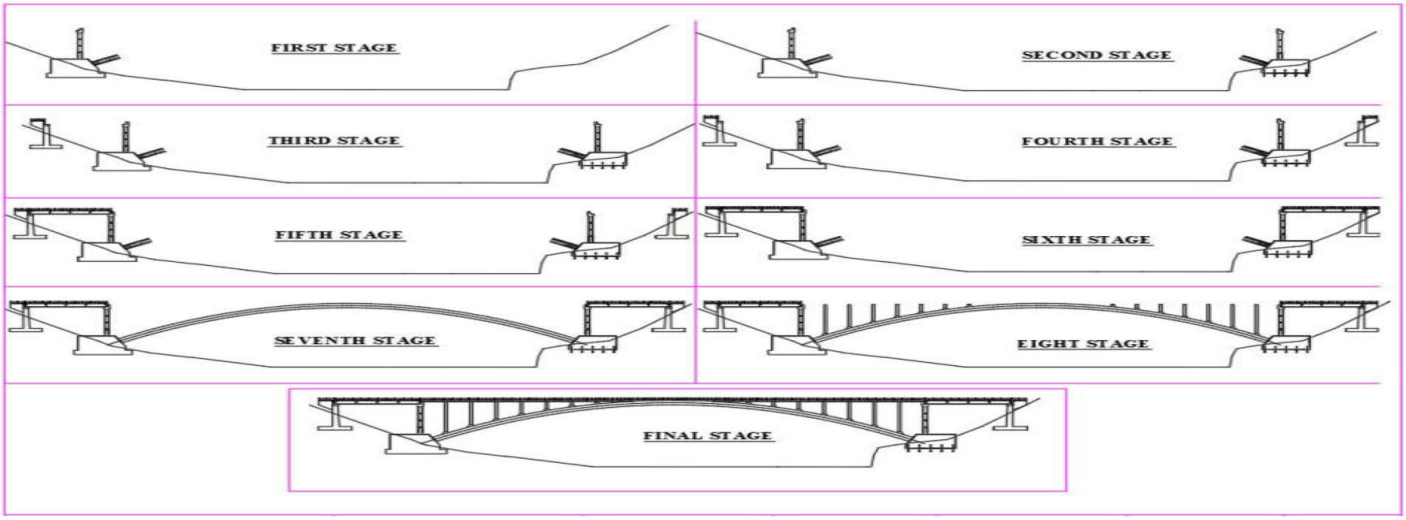


Fig.4-(a) Construction sequence

(a) Bridge site

(b) Construction of Arch block/foundation

(c) Construction of side spans

(d) Construction of temporary work for arch erection

(e) Construction of temporary work for arch erection

(f) Construction of arch rib and spandrel column

(g) Construction of arch deck slab

(h) Completed bridge

Fig.4 (b) - Construction photograph of Bridge Site

2.5 Conclusion

Successful construction of this bridge is the milestone for construction of motorable arch bridge in Nepal. The Nepalese Engineer have gained a lot of knowledge and confidence after constructing this bridge. The replication of construction of such type of bridge in other location in Nepal is highly recommended due to its low overall cost and Nepal's favorable topography.

3. International Roughness Index (IRI) of a standard road hump

-Er. Rajendra Raj Sharma, Retired-SE, DoR

In general, two important indices are used for evaluation of condition of road surface. They are International Roughness Index (IRI) and Surface Distress Index (SDI). SDI is found from the visual observation of the road surface for several distresses e.g. cracking, raveling, shoving, pot holes etc. On the other hand IRI is calculated based on the undulation of the road surface along the road surface. A road may be in a very distressed condition with respect to SDI but still have a very good IRI. SDI is usually used for determining the maintenance need of the surface of the road whereas IRI directly has a direct effect on the vehicle operation cost (VOC) on that road. The Department of Roads (DOR) carries out SDI and IRI surveys every year on the Highways. SDI is used for planning of the maintenance works. IRI is not being used yet for maintenance or other purposes.

For optimization of investment on maintenance of the roads it is essential to minimize the VOC. As mentioned earlier VOC directly depends on the IRI. For prioritizing of budget on maintenance and rehabilitation of roads it is essential to use the IRI's on various sections of the road on the whole network. Roughness or undulation of any road was measured in the past based on the vertical movement of a standard vehicle with standard suspension moving with a standard speed along the road. Many countries had their own standards which varied widely. Furthermore, the roughness obtained even with the same vehicle was different depending on the temperature, humidity and other factors that affect the stiffness of the suspension system of the vehicle.

It was later realized that a universal standard definition of the roughness be made so that it would be easier to compare various values found with different instruments. The attempt to find a solution to this problem gave rise to the concept of International Roughness Index (IRI). IRI is defined not by the vertical deflection of the axle of physical vehicle but by the deflection of the mathematical vehicle.

The mathematical vehicle usually called as a 'Quarter Car Model' (because it is a single wheel of a car) is defined as given in the Fig.1:

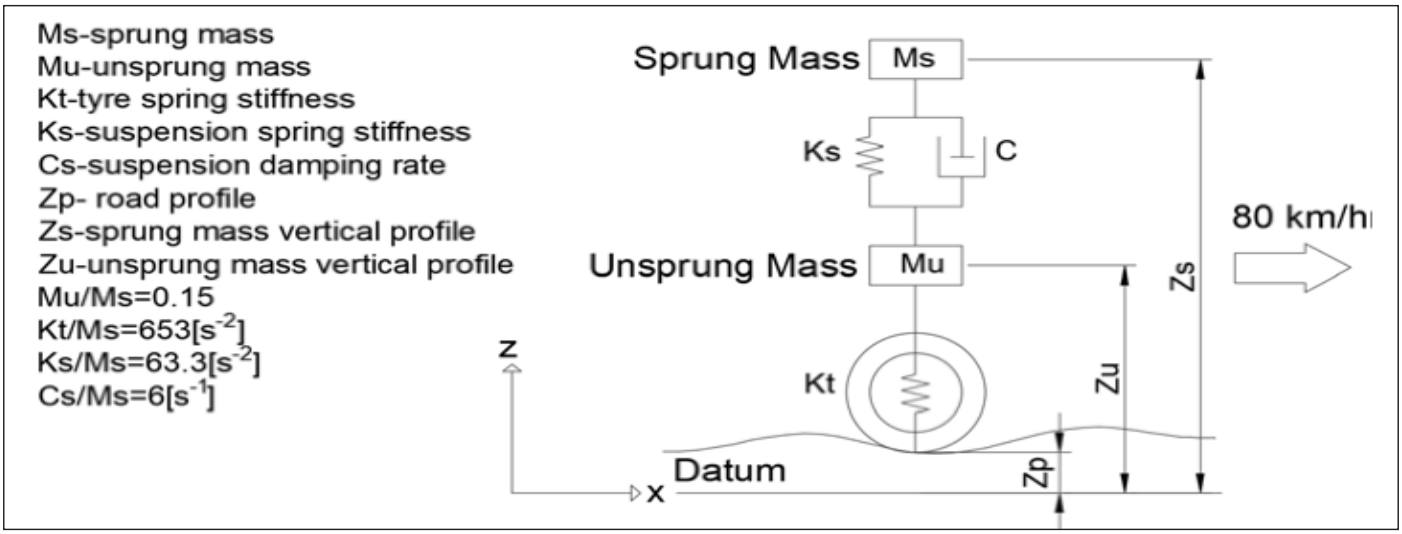


Fig.1-Quarther Car Model

To find the IRI of a road section the above Quarter Car model is 'run' along the given road profile. The differential equation of motion of this quarter car is solved. The solution gives vertical speed of the sprung ($\dot{z_s}$) and unsprung ($\dot{Z_{us}}$) masses. IRI is defined as follows.

$$IRI = \frac{1}{L}\int_0^{L/v} |\dot{z_s} - \dot{z_{us}}|\, dt$$

The calculation of IRI is carried out using Roughometer or bump integrator and a computer for calculation. Complex equipment and computers are not always easily available. An alternative method is presented here to calculate the IRI from the accurately taken road profile using simple spreadsheet which is accessible everywhere.

As an example the effect of a standard DoR hump on the IRI of a 30m long test section is calculated. The hump is located at the mid-point of the test section from 13.25m to 16.75m as shown in Fig. 2.

The solution of the equation of motion (fully done in the Excel spreadsheet) gives the following results (Fig.3).

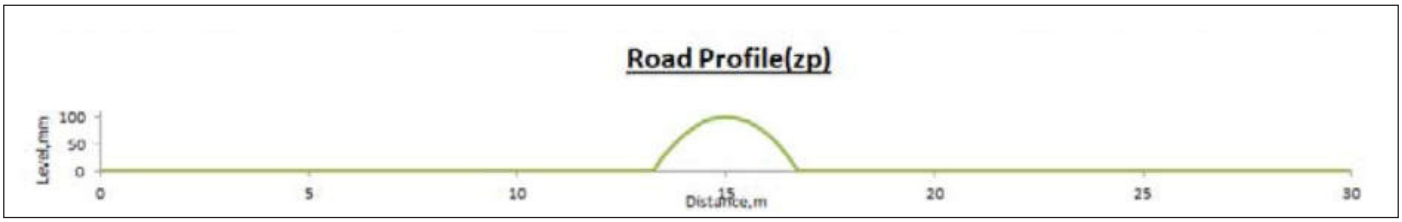


Fig. 2- Location of hump

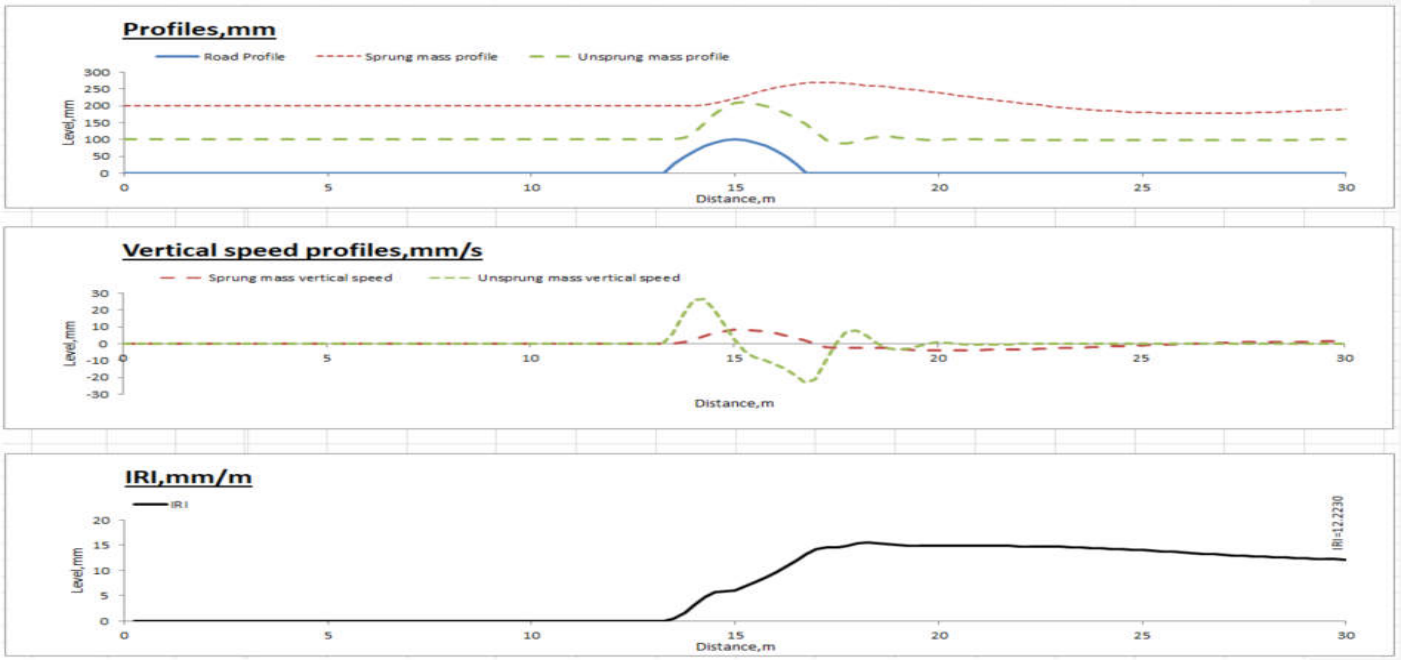


Fig. 3 Result of solution of equation of motion

IRI is equal to the area of the figure between the curves of the vertical speed profiles of sprung and unsprung masses in the middle chart above divided by the length of the road. From the above calculations it is interesting to know that the introduction of a 3.5 m wide 100mm high parabolic hump at the middle of a 30m section of perfectly plane road increases the IRI from 0 to about 12mm/m. A snapshot view of the excel calculation sheet is shown in Fig. 4. Hence, IRI of standard road hump can be easily worked out.

i	$x_{i,m}$	$zp_{i,m}$ m	zs,m m	zu,m m	zs',m m/s	zu',m m/s	$ss_{i,m}$ m/m	$su_{i,}$ mm/m	$\dot{ss}_i$	$\dot{su}_i$	RS_i	IRI_i
1	0.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
3	0.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
4	0.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
5	1.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
6	1.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
7	1.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
8	1.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
9	2.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
10	2.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
11	2.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
12	2.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
13	3.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
14	3.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
15	3.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
16	3.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
17	4.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
18	4.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
19	4.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
20	4.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
21	5.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
22	5.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
23	5.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
24	5.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
25	6.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
26	6.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
27	6.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
28	6.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
29	7.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
30	7.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
31	7.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
32	7.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
33	8.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
34	8.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
35	8.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
36	8.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
37	9.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
38	9.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
39	9.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
40	9.75	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
41	10.00	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
42	10.25	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
43	10.50	0.00	200.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000

Δx=	0.25	m
v=	80	kmph
Δt=	0.01125	s
C=	6	1/S
KT=	653	$1/S^2$
KS=	63.3	$1/S^2$
μ =	0.15	

Matrix, A

0	1	0	0
-63.3	-6	63.3	6
0	0	0	1
422	40	-4775.33	-40

Matrix, A^{-1} or invA

-0.09479	-0.017329	0.094787	-0.00023
1	0	0	0
0	-0.001531	0	-0.00023
0	0	1	0

Vector, B

0
0
0
4353.333

Vector, I

1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

State transition matrix, ST

				Particular response vector, PR
0.996607	0.0109151	-0.00208	0.000319	0.005476
-0.5563	0.9438768	-0.83247	0.050647	1.388777
0.021532	0.0021268	0.750871	0.008222	0.227597
3.335013	0.3376467	-39.1276	0.434756	35.79262

Matrix, ST-I

-0.00339	0.0109151	-0.00208	0.000319
-0.5563	-0.056123	-0.83247	0.050647
0.021532	0.0021268	-0.24913	0.008222
3.335013	0.3376467	-39.1276	-0.56524

$$|A|^{-1}\left(e^{|A|\Delta t} - |I|\right)\vec{B} = |PR|$$

$$ST = |I| + |A|\Delta t + |A|^2 \Delta t^2 / 2! + |A|^3 \Delta t^3 / 3! \ldots.$$

Fig. 4 A snapshot view of the excel calculation (Interested person can obtain the calculation by emailing to razendra@live.com.)

4. A Case Study of Construction of Tila River Bridge on Surkhet Jumla Road

-Er. Arjun Jung Thapa, DG, DoR

4.1 Introduction

The Tila Bridge is located at Serighat of Kalikot and Ch 141+360 of Karnali highway. This bridge links Ward No 8 of Bhartuwa VDC on left Bank and Ward no 1 of Manma VDC on right bank. This bridge was designed by M/s Kunhwa Engineering & Consulting C. Ltd., Korea in association in the form of sub-consultancy with ERMC P. Ltd., Nepal under Road Sector Development Project funded by the World Bank. The Construction Contract was awarded to M/s SBA - Surya JV in June 2018 by RSDP Project. The supervision was performed by a different consultant, M/s Eptisa-RDC JV. The design team performed their task and returned to their home country. The duration of the Contract was 15 months from the date of signing. The general arrangement of proposed 50 m Plate Girder Bridge with open foundation is shown in Fig. 1.

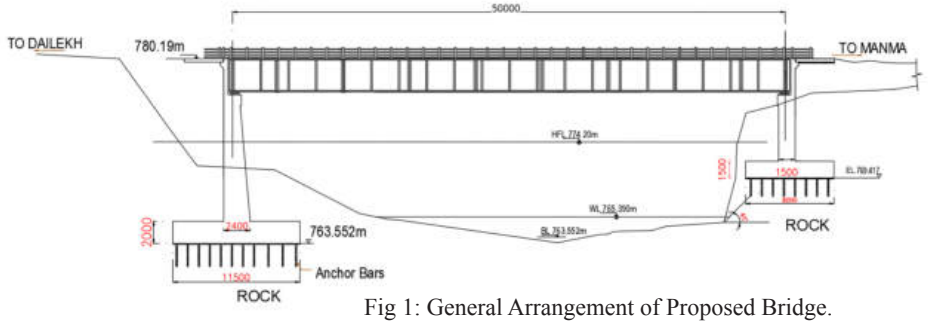


Fig 1: General Arrangement of Proposed Bridge.

4.2 Problem encountered

There was a existing Bailey Bridge crossing at the proposed site constructed by Nepal Army. The proposed bridge was designed to construct along the same axis of the Bailey bridge. It was later found that the proposed bridge could not be constructed without removing the existing one. The existing Bailey bridge could not be removed without having an alternative river crossing at the site. This is the only supply line and route to Jumla, Kalikot and Mugu. The site was verified jointly by a team from Division Roads Office (DRO) Surkhet, Supervision Consultant, and the Contractor's representatives. The joint team tried to shift the axis of the proposed bridge slightly to fit the designed bridge. The bridge was proposed at the narrowest river spot having rocks on both banks. Then the site layout was halted, and the issue was reported to RSDP Project Coordinator and Development Cooperation Implementation Division (DCID).

The proposed bridge of 50 m could not be fitted in the vicinity of the existing Bailey bridge without disturbing it. There is a narrow and constricted river channel at the existing bridge site but in the upstream and downstream it is wider. All the site personnel waited for the decision and instruction from the DCID. The issue was discussed several times in the DoR but nothing was decided for a long period of time. This case can be considered as an example of poor performance by international consultants in Nepal. The design consultant and the supervision consultants could not provide a proper solution for more than a year.

Later, a new team from Department of Roads (DoR) and DCID, visited the site, studied the problem, and discussed the matter with Bridge Branch. DCID put their dissatisfaction to the Design Consultant on their performance on the design of the bridge and issued warning letter to design consultant. It was decided to shift the axis of the new bridge to avoid dismantling of the Bailey bridge. Original design Consultant was consulted, and the problem was briefed to them. Local partner of the design Consultant was given the responsibility to resolve the problem.

4.3 Design review of the bridge in new axis

After a rigorous discussion and field study it was decided to locate new bridge axis at about 15 m upstream of the existing Bailey bridge, where the foundations rest on stable rocks both sides. The span of the bridge will be more than the originally designed 50 m. A 60 m bridge (Fig.2) can be fitted to suite the site condition at the new bridge axis. The original configuration of Plate girder was not suitable for the new bridge axis and a new configuration was to be sought. A Warren truss with vertical support configuration was proposed for the new site. Both the substructures have different sizes to suite the site condition. Right abutment is short and left abutment is of considerable height. The proposed new bridge has following advantages:

i. Both the foundation rest on stable exposed hard rocks which have enough bearing capacity
ii. Both the foundations are well outside of the water and no need of dewatering
iii. The foundations are smaller as these rest on exposed hard rock.
iv. Foundation works can be performed even in rainy season

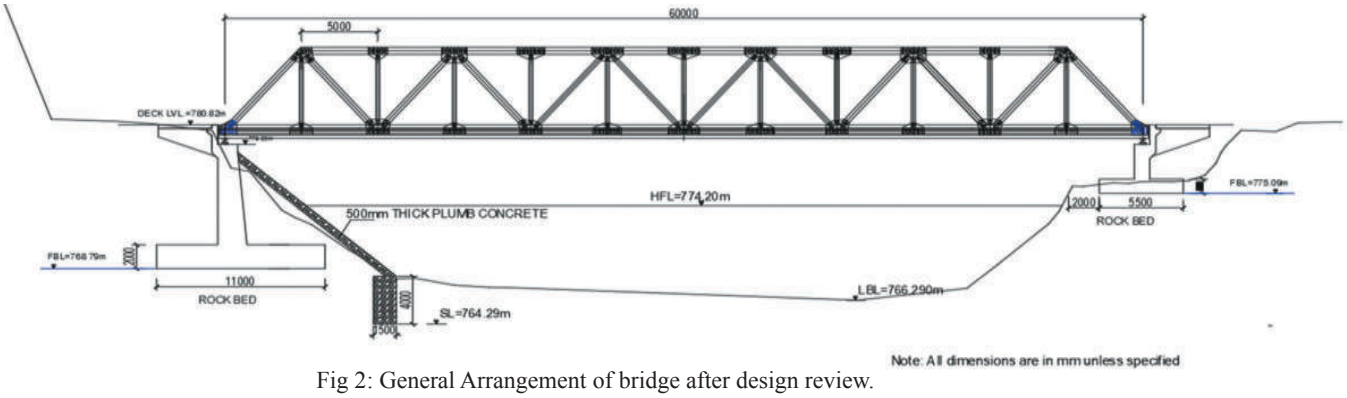


Fig 2: General Arrangement of bridge after design review.

4.4 Impact of Changes of axis and Configuration on Contract management

The originally designed and contracted bridge was a 50 m Steel Plate Girder, and the revised design is a Steel truss bridge of 60m span. Both the designs are based on structural steel works and RCC deck. Rates for the structural steel works and concrete were already in the Contract Bill of Quantities (BoQ). Hence there was no need of rate negotiation for the new type of bridge. Reduction in depth of foundation and substructure has savings and increase in length of the bridge has increase in costs. This has resulted a positive variation of 14% in overall contract. The new design and the Variation were approved before the starting of the Construction of the bridge.

4.5 Changed Foundation strata on left foundation

Before construction, it was supposed that firm rock bed may encountered on both foundations because of exposed rock outcrops on both the banks is shown in Fig 3. Construction works started according to the approved revised drawings. A solid rock base was found in the footing of abutment at right bank and the foundation was successfully constructed. While excavating the foundation at the left bank, a firm rock base was not found in whole area of the footing. About 1/3 of the area of the footing was comprised of boulder mixed soil. The boulder mixed soil is vulnerable to scour and damage by the flood with high velocity. Again, the construction team faced a dilemma of either continuing excavation or start the construction of foundation footing. In the mean time, the service of Supervision team was discontinued without resolving the problem at the site. Now, the Department itself must solve the technical problems encountered during construction of this bridge.In Construction works, any problems encountered need to be resolved quickly to keep the momentum. If the momentum is disturbed, it takes longer time to resume the remaining works. Considering all these things, DRO Surkhet immediately forwarded the issue to DCID and Bridge Branch. DCID team quickly reacted and instructed the DRO, Surkhet to continue the excavation of the 1/3 of the loosely packed boulder mixed soil to the depth where hard stratum is found. After few days' excavation, the loosly packed stones and boulder mixed soil were removed, and hard bed rock was encountered at a depth of around 5 m. The redesign of foundation was again approved by DoR. The following suggestions were given to resolve the issues:

Fig 3: Foundation construction photographs

(i) Clean and level the rock bed at the trench.
(ii) Use Plain cement Concrete to level the trench after cleaning the trench.
(iii) Construct a RCC shear wall of thickness 50 cm from bottom of the trench to the level of bottom of foundation footing. Construct the shear wall along the periphery of the foundation footing in the trench but it should be 50 cm outside of the foundation footing.
(iv) Fill the remaining void with plum concrete up to the level of bottom of foundation footing.
(v) Level and clean the remaining 2/3 rock base for foundation
(vi) Drill and place 32 mm diameter dowel bars on the firm rock.
(vii) Level whole foundation with Plain Cement Concrete
(viii) Utilize Extra width on hill side to gain more anchorage to the rock.

The foundation were constructed as per the suggestion given. The Construction team had fabricated the structural steel components at their Workshop at Hetauda. The fabricated structural steel components is shown in Fig.4.

Fig 4: Superstructure construction photographs

4.6 Conclusion

The foundation was completed before monsoon and second outbreak of Covid 19. The construction team transported the fabricated structural steel components to site immediately. Now, the assembly of the truss has already completed. Perhaps this bridge will be completed and opened to traffic within few months. Minor modification and timely decision making are most crucial for construction projects. Good judgement and experience help on decision making process. Every project must establish a good problem solving system. This case can be considered as an example of poor performance by international consultants in Nepal. The design consultant and the supervision consultants could not provide a proper solution for more than a year. Many aspects of practical difficulties should be considered while finalizing the appropriate bridge axis.

5. Engineering, Procurement and Construction Contract (EPC) in DOR

- SDE Saurabh Bajracharya and Dr Bijaya Jaishi, QRDC

5.1 Introduction

The Department of Roads has been a pioneer in contract management for civil construction works in Nepal. The department has been administering contracts from sealed quotations, National Competitive Bidding to International Competitive Bidding. The contracts have been primarily Bill of Quantities based Item rate contracts. The implementation of Item Rate Contracts has severely been affected by the abnormally low bids and unbalanced bid (front/back loading). Additionally, the error and inadequacy in design and drawings provided by the Employers have resulted in disputes and claims. The delay in claim resolution and dispute management eventually resulted in unprecedented delay in completion of the contracts. Moreover, due to abnormally low bid and unbalanced rate quotes, there has been many cases of dispute while implementing the works under the contract. The responsibility of provided design and drawings under the item rate contract lies under Employers Risk. The change in design and design review of the design also have resulted substantial delay in the completion of the contract.

As adaption of better model for contract management, the department has also implemented procurement of works under design and build modality for the construction of bridges. The Employer has the responsibility for the relevant data for the design while the contractor is responsible for design of the structure under the design and build modality. The contracts under design and build have performed well for the bridge construction. Nonetheless, the department has used a hybrid bidding document for design and build modality largely based on the item rate contract document. Further, the advent of Tunnel Design and Construction demanded well organized bidding document for implementation of the complex contract works under Design and Build model/Engineering, Procurement and Construction Modality (EPC) model.

In case of EPC model, the contract is awarded on a lumpsum basis. The Employer's Requirement clearly stipulates the requirement to be fulfilled by the contract including design, procurement of the any necessary facility and construction of the works in compliance with the specific requirement of the project. The EPC model in recent times has been implemented based on the guideline from the Donor Agency or Fédération Internationale Des Ingénieurs-Conseils (FIDIC) Standard Documents (Silver Book) modified to suit the country specific requirement in hydropower and airport projects. The major ongoing EPC contracts are Upper Trishuli Hydropower Project, Madhya Bhotekoshi and Pokhara International Airport. Further, Nepal Army has also administered the contracts for construction of Kathmandu Terai Fast Track Project under Engineering, Procurement and Construction (EPC) model under FIDIC Silver Book-2017.

5.2 Legal Aspects about EPC in Nepal

The Public Procurement Act, 2063, amendment 2073 under Clause 8 Sub Clause Ka has listed out 10 procurement methods. The Public Procurement Act only mentioned the Lumpsum Piece Rate method but does not identify Engineering, Procurement and Construction (EPC) as an applicable method. The function, duties and powers of the Public Procurement Monitoring Office has been specified under clause 65 of the Public Procurement Act. As per the clause, PPMO is to issue such directives, procedures and technical guidelines as required in the field of procurement methods such as turn-key, EPC, framework or unit rate contract, management contract. Based on the delegation, the PPMO prepared the directive for procurement under Engineering, Procurement and Construction modality 2078 which has been duly approved by the Cabinet. Consequently, the PPMO has published the Standard Bidding Document for Procurement of Works (EPC Contract) for both National Competitive and International Competitive Bidding.

5.3 Main Provisions under Engineering, Procurement and Construction Modality (EPC Directive 2078 and Standard Bidding Document)

The directive has clearly specified the scope of the EPC Contract. The road projects with tunnel/flyover, irrigation, water supply, hydropower or technically complex bridge, airports, stadium, conventional hall, complex waste management plant, treatment plant or any other project considered suitable by the public entity. The public entity shall conduct feasibility study of the project including economic analysis, social analysis, technical and environmental study and prepare conceptual design of the project for implementation under EPC Modal. The proposed project to be executed under EPC modality shall duly be approved from respective ministry. The main provision under the EPC Contract can be listed as the following,

(a) The contract is lumpsum based. The bidder shall bid the lumpsum price for the whole of the works. The contract payment is made based on the progress made as specified in Activity Schedule and milestones prepared for the Contract.

(b) The contract shall not be subjected to any price escalation during the period of the contract. The estimated escalation amount is added to the estimated of the contract as per the annex included in the directives.

(c) The accuracy of design and drawing including underground works, and unforeseen difficulties include physical conditions like man-made or natural physical conditions including sub-surface and hydrological conditions which the Contractor encounters at the Site during execution of the Works lies in the obligation of the contractor.

(d) The Contractor shall be entitled to an extension of the Time for Completion if natural disaster such as earthquake, fire, Excessive rainfall (atibrishti), flood and landslide occurs and affects the component of the project adversely or the contractor cannot perform the work due to the notification from the Government of Nepal during the occurrence of any pandemic.

(e) The contract shall not be subjected to any variation order unless and otherwise any addition or alteration to the work is made by the Employer.

(f) The Contractor shall be liable for maintenance of defect for minimum of 2 years Defect Liability Period and also for any latent defect for the period specified under Latent Defect Liability Period.

5.4 Adoption of EPC Modality in DOR

The concept for adoption of Engineering, Procurement and Construction modality advent with the proposal for implementation of Siddababa Tunnel Project. The department has developed and approved Standard Specifi cation for Tunnel Works and subsequently the Norms for Rate Analysis of Road Tunnel Construction under DB/EPC Modality has been duly approved by the Cabinet. The issuance of the standard bidding document by Public Procurement Monitoring Office has paved our way towards procurement of our first tunnel project. The Siddababa Tunnel Project has been formulated on the basis of the standard document and is currently under bidding procedure. Similarly, as deviation from ongoing procurement trend, the procurement for construction of 4 lane Gwarko flyover with ramp has been foreseen under the Engineering, Procurement and Construction Modality and is currently under bidding process. The flow chart for project formulation, procurement and implementation of EPC contract for tunnel work is shown in Fig. 1.

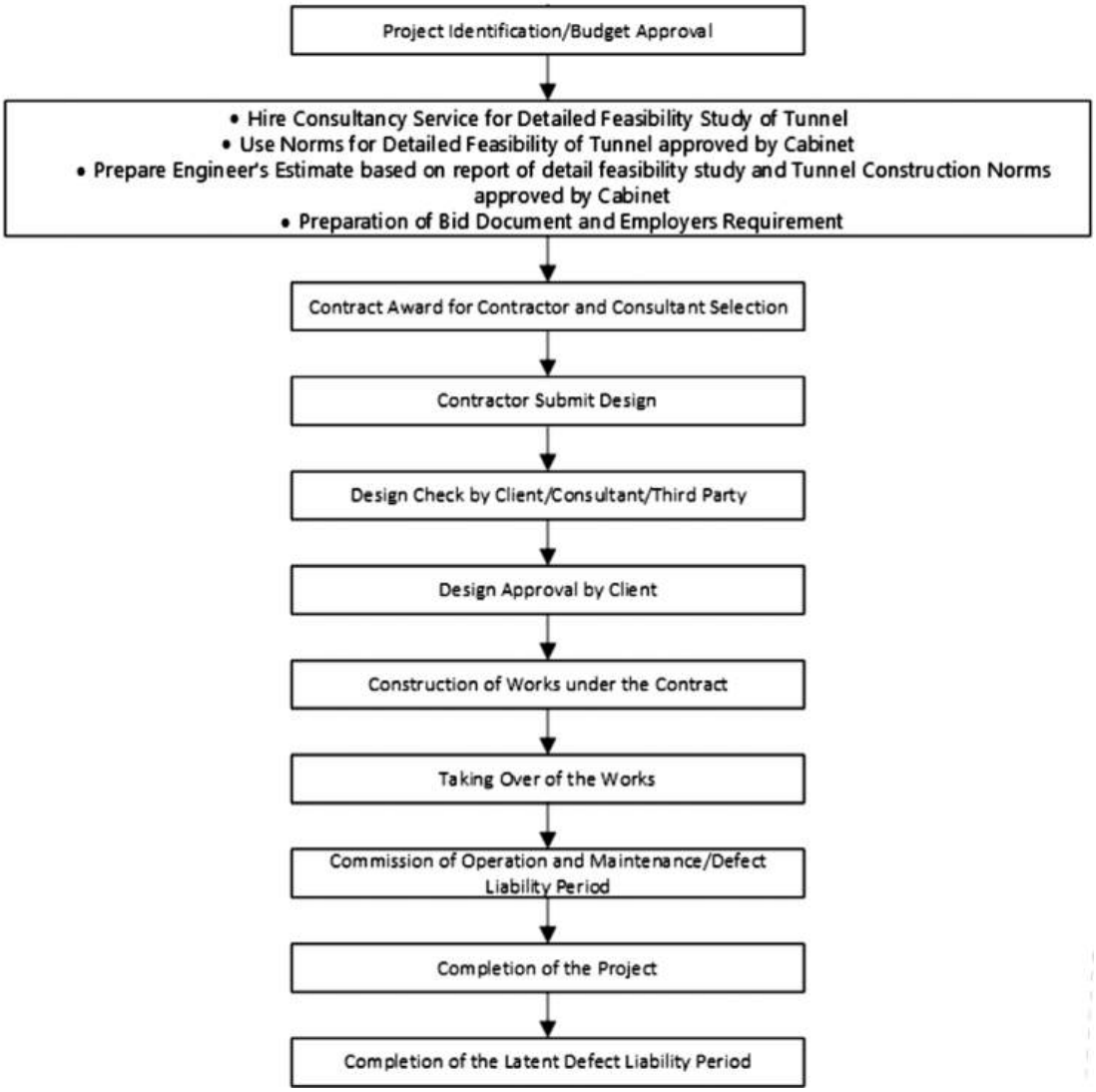


Fig.1 Road Tunnel Procurement under EPC Modality

5.5 Suggestion for Future Improvement

The directive and standard document has been prepared after extensive discussion between experts from different infrastructure department including personnel from Department of Roads organization. In the present context of Nepal, the possibility of embracing all principle of EPC is not possible. Hence, the document has been prepared keeping in align with the current practice and limitation and shall be updated on a regular basis to accommodation the trends and practice in the construction industry. However, there are still some issues which can be amended for improvement in the Standard Bidding Document pointed as the following,

(a) The directive set out the criteria as for one partner shall meet requirement of one DB/EPC contract of similar nature with contract value not less than 40% of the estimated value. The value is suggested to be at least 80% of the estimated value as prevalent in other construction works.

(b) The criteria for each partner have been set as each partner shall meet requirement of one civil construction contract with contract value not less than 25% of the estimated value. The criteria shall be amended to each partner shall meet requirement of one civil construction contract of similar nature with contract value not less than 25% of the estimated value.

(c) The directive suggest that the design and drawings submitted by the Contractor shall be approved by the Department Head. However, the EPC contract allocates the risk of design and execution to the contractor. In such case, the approval from the client can result in undue claim from the contractor stating the approval of the design and drawing from the Employer. Instead, the provision of review and no objection to the submitted design and drawing shall be included in the directive.

(d) The directive has imparted the responsibility of quality assurance to the Public Entity. The provision deviates from the principle of EPC as the EPC contractor is a highly specialized entity capable of performing complex task. The EPC contract allocates the responsibility of compliance with the Employers Requirement. Instead, the provision of monitoring shall be imparted to the public entity while all quality control and assurance shall be sole responsibility of the EPC Contractor.

5.6 Conclusion

The adoption of Engineering, Procurement and Construction Contract modality is a way forward towards improvement of contract management and administration in implementing large and complex contract packages. Embracing the EPC modality is foreseen to overcome the following contract administration issue predominant in Department of Roads,

(a) The dispute and claims resulting in delay of the contraction works due to errors in Employers Design and drawing shall be minimized.

(b) The EPC Contract is based on lumpsum item. Hence, the delay and dispute due to abnormally low bid and unbalanced bid (front loading/back loading) shall be minimized.

(c) The quality assurance, control and compliance with the requirement stipulated in the Employers Requirement lies in the obligation of the Contractor. The EPC modality shall provide better control over the contract administration and management.

Pertaining to the numerous advantages of the Engineering, Procurement and Construction Contract Modality, the following points are worth mentioning,

(a) The cost of the project is increased as the estimated price adjustment is already incorporated in the cost estimate of the project. Further, as the risk associated with unforeseen condition and design is allocated to the Contractor, the bid is expected to be on the higher side.

(b) The role of Client/Employers is limited in EPC contracts.

EPC contract has recently been initiated for Siddababa Tunnel Project and Gwarko Fly over in DOR. As Norms, specification and SBD for road tunnel works are readily available, the construction of tunnel in EPC modality will gain momentum in Nepal. It also has a potential to adopt EPC contract in road/ bridge construction industry in country.

6. Concreting for Bridge Pile Foundations.

-Er Prabhat Kumar Jha, Superintendent Engineer, DoR

1. Under the section 1612 (5) Construction Methods of Standard Specifications for Road and Bridge works – 2073, there is a provision that the Contractors shall demonstrate to the satisfaction of the Engineer that his proposed construction method for the pile do not weaken the pile shaft a) by contamination of the concrete, b) by sectional reduction, c) by washing out of cement, d) by breaking during pulling of temporary casing or e) in any other way including the construction of neighboring piles.
2. Concreting of pile falls under under-water concreting category, which shall be specially designed to enhance constructability and performance in water environments. It can be characterized by the concrete resistance to washout, segregation and bleeding and is affected by the mix proportioning, aggregate shape and gradation, admixtures, vibration and placement conditions.
3. Typical rheology characteristic of underwater concreting is shown in Figs.1 and 2.

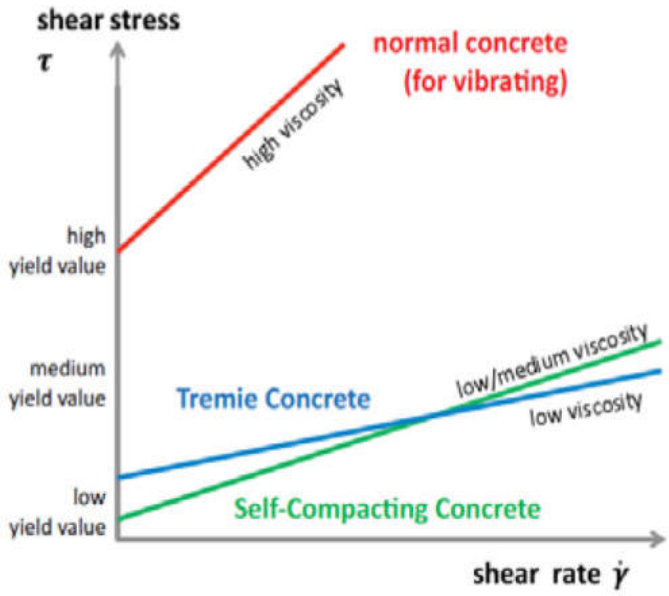


Fig.1- Plastic behavior comparison of different concrete types

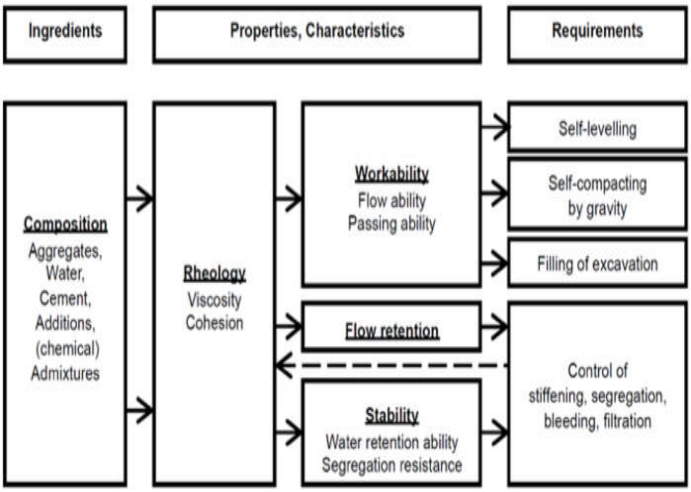


Fig.2- Dependencies between composition, rheology and related characteristics, and overall requirements

4. EFFC/DFI Concrete Task Group has recommended below values for under water concreting in Guide to Tremie Concrete for Deep Foundation: (Fig.3)

   Slump > 180mm

   Slump Flow 400-550mm

   Time to reach final spread 3-6 Sec.

   Visual Stability Index (VSI) Zero

Fig.3- Slumped concrete of Visual Stability Index =0

5. Understanding Visual Stability Index (Fig 4)

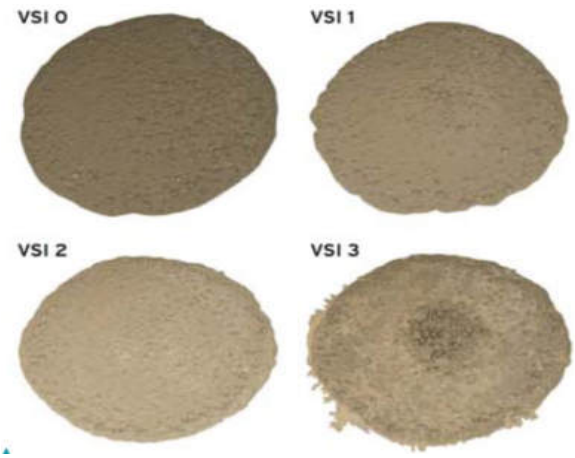


TABLE A.1 VISUAL STABILITY INDEX VSI CLASSES (ACCORDING TO ASTM C1611)

VSI VALUE	CRITERIA
0 = Highly Stable	No evidence of segregation or bleeding
1 = Stable	No evidence of segregation and slight bleeding observed as a sheen on the concrete mass
2 = Unstable	A slight mortar halo ≤ 10 mm [½ in] and/or aggregate pile in the center of the concrete mass
3 = Highly Unstable	Clearly segregating by evidence of a large mortar halo > 10 mm [½ in] and/or a large aggregate pile in the centre of the concrete mass

Fig.4-Visual stability index VSI classes

6. Appropriate Anti-washout admixture use is always recommended for underwater concreting. Such admixtures mainly composed of microbial polysaccharides for example gum or polysaccharide derivatives like hydroxyethyl cellulose and hydroxypropyl methyl cellulose. (Fig.5)
7. No concreting shall take place before the bottom of excavation has been cleaned. The Contractor shall get borehole inspected and obtain approval in writing from the Engineer. The use of pumped concrete and the methods in its use shall be approved. The method of placing and workability of the concrete shall be such that a continuous monolithic concrete shaft of the full cross section is formed.
8. Inspection and Cleaning bottom of Excavation**:** The time between final excavations including bottom cleaning and the start of concreting shall be reduced as much as possible and in any case shall not exceed 6 hours. The cleaning shall be done by an approved method. Before cleaning bottom of every excavation, notice shall be given to the Engineer. The Contractor shall show, to the satisfaction of the Engineer, that the bottom of the excavation is clean.

Fig.5- Explanatory example of underwater concrete without and with use of anti-washout admixture

9. If boring is done without casing, the diameter of the borehole for a representative number of piles shall be measured by caliper to the placing of concrete. Before concreting, bentonite suspensions should have density less than 1.15 g/ml, and sand content less than 4%. (Fig.6)

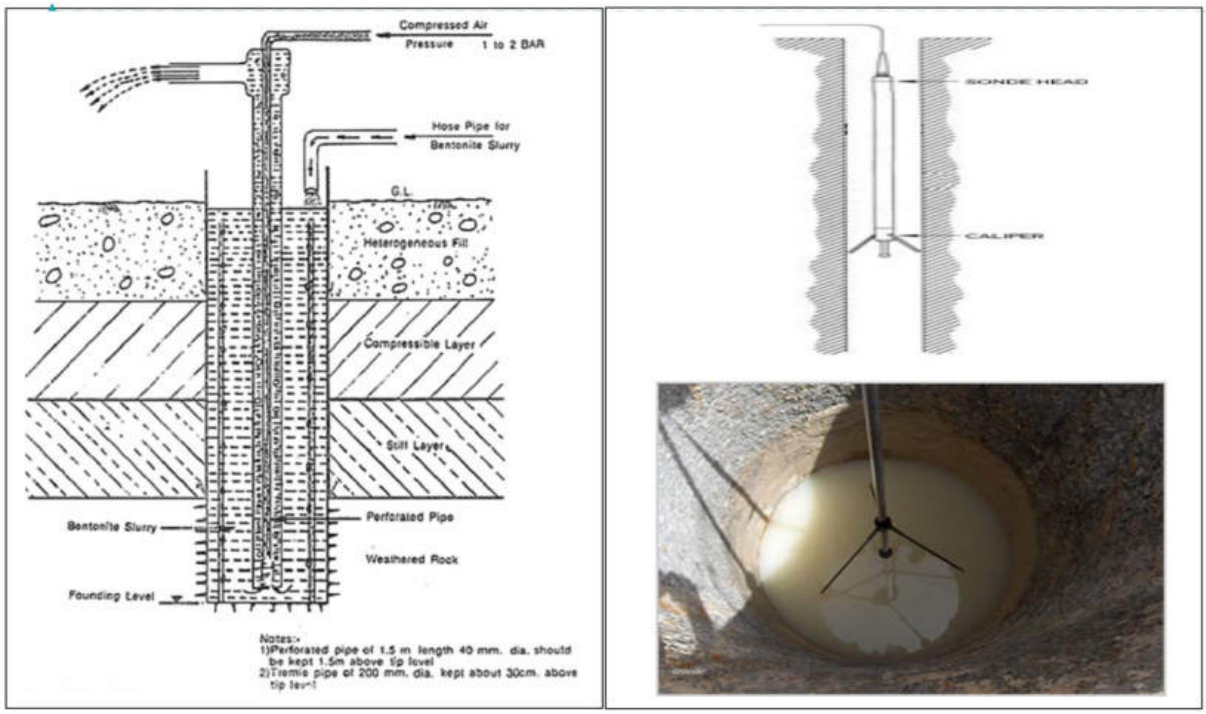


Fig.6- Typical Arrangement for Bottom cleansing (Left) & Hole Inspection by Mechanical caliper (Right)

10. Pile concrete is always done by appropriate use of Tremie, which (or whose) diameter shall not be less than 250mm and sufficient head, not less than 4m to overcome a) force required to encounter concrete vicious property, b) reverse bentonite h-force & c) head loss due to friction loss.
11. The Contractor shall maintain a continuous record of the volume of concrete used and the level of the concrete in the pipe. Any deviations from the theoretical, or expected, volume/level relationship shall be immediately reported to the Engineer.The volume of concrete: not less than 105% of the nominal volume of the pile.

Fig.7-Typical field arrangement of Tremie Concreting of Pile

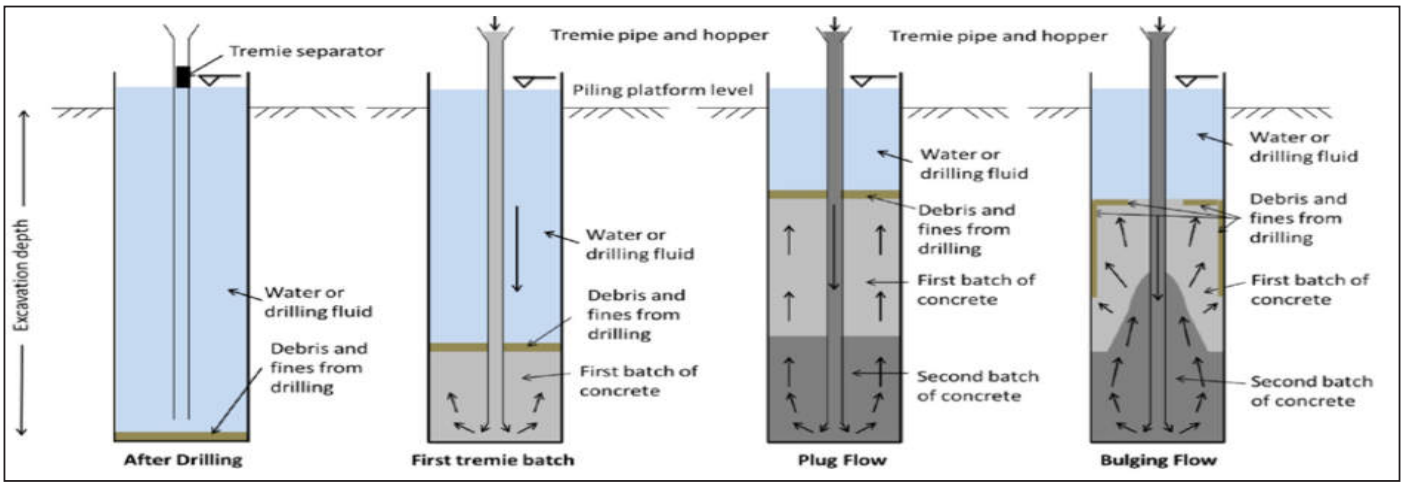


Fig.8-Typical concrete movement during pile concreting

12. Tremie pipe pullout process : Tremie pipe should always embedded inside the concrete by minimum 1.5m. (Fig.9)

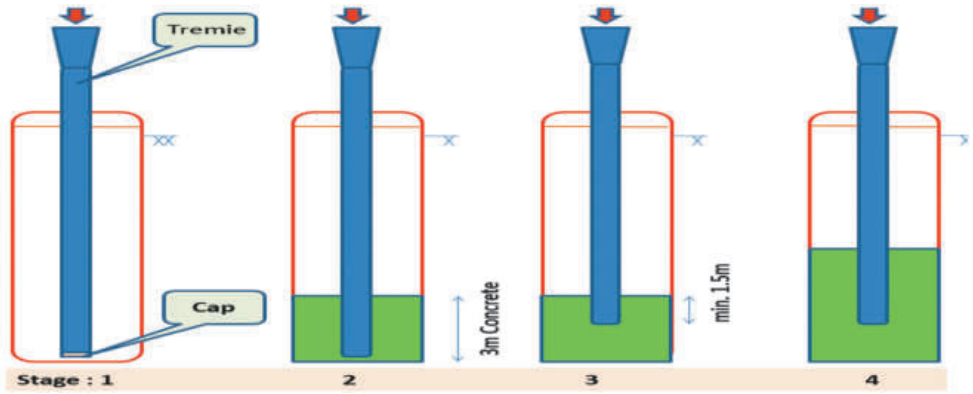
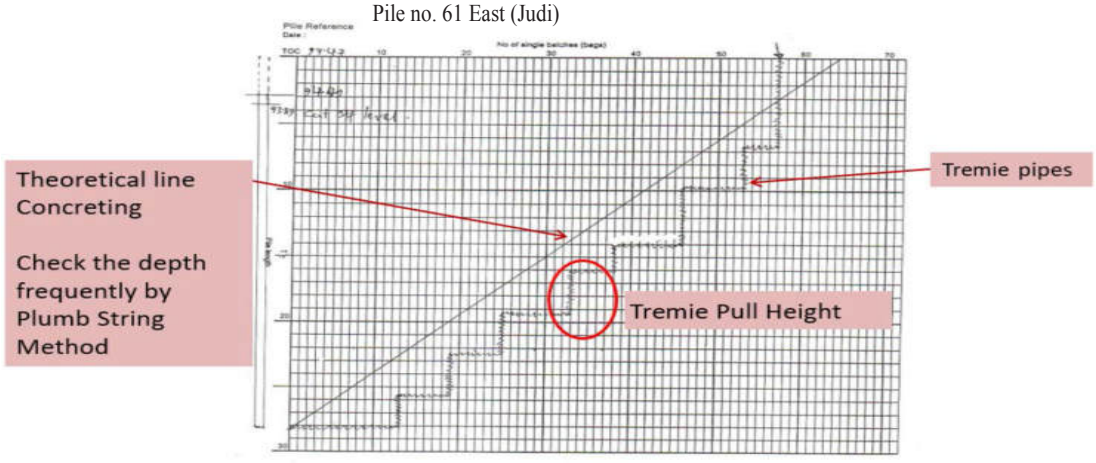


Fig.9- Tremie pipe pullout process

13. Record of the Tremie Concreting should be done graphically (Fig 10). Typical example is :

Tremie - conc Vol - Pile depth graph
Pile no. 61 East (Judi)



Bore length = 29.3 m. Bore Vol = $28.3 \times \frac{\pi\, 0.6^2}{4} = 8\ m^3$

Bamboo Dipping for top cone = 2.98 meter i. e. $8 \times \frac{400}{50} = 64$ bags

Fig.10- Record of the Tremie Concreting

14. Extraction of Temporary Casing:
    - When the casing is being extracted a sufficient quantity of concrete shall be maintained in it to ensure that pressure from external water, drilling fluid or soil is exceeded and that the pile is neither reduced in section nor contaminated.
    - The toe of the temporary casing shall be kept at a minimum of 2 meters under the outlet of the termite.
    - The pile shall be concreted with certain over height to allow for chiseling off the top concrete down to sound hard concrete.
15. The Contractor shall keep records as stated in specification for the installation of each pile and shall submit two signed copies of these records to the Engineer not later than noon of the next working day after the pile was installed. The signed records shall form a record of the work.

7. Design and Construction of Research and training Center at Gajuri, Dhading

- Er Laxmi Datta Bhatta, SDE, DCID

7.1 Background

The government of Nepal with loan support from the World Bank has launched a project intending to improve the efficiency and safety of select transport infrastructure, improve the efficiency of cross-border trade, and strengthen capacity for strategic road network management. The outcome of this Strategic Road Connectivity and Trade Improvement Project (SRCTIP) will be measured through (a) reduction in travel time, vehicle operating costs and annual fatalities related to road crashes on the roads being improved or upgraded; (b) reduction in the time taken for goods transit at a major border crossing point; (c) reduction in time taken for sanitary and phyto-sanitary clearances in the export of selected agricultural commodities; (d) increase in the percentage of Core Road Network (CRN) in "good" condition.

To enhance the institutional strengthening of the Department of Roads (DOR)'s personnel regular training and capacity building activities shall be carried out. DOR is now facing difficulty in conducting the required technical training due to a lack of physical facilities/training center. Component 3 of the project aims to improve the capacity of the Department of Roads (DOR) for better management of the Strategic Road Network in Nepal. One of the activities considered under this component is the development of DoR camp at Gajuri, Dhading as full-fledged research and training center. The camps' land area is under the ownership of the Department of Roads having fencing all around the boundary and existing facilities at camps serving as Site Camp of Road Division Office, Bharatpur, Chitwan. DCID.

7.2 Description of the Project

Site for training center, Gajuri is a part of the Road Division Office (RDO), Bharatpur Chitwan. It is located approximately 230 m west from the right of Prithvi Highway (from existing Naghdhunga-Naubise-Mugling (NNM) road).The tentative location of the proposed site is 27° 48' 26.19" N, 84° 52' 45.64" E.(Fig.1) The access road that connects RDO with Prithvi Highway is blacktopped having carriage width of about 5 m with no any curve/bends. The width of the entrance gate of the RDO is 4 m with the easy access road to the compound of RDO. The total area of the site camp is approximately12500 sq.m. The area is fully fenced with barbed wire and there is not any encroachment inside the premises of RDO camp. As per the proposed design, the built-up area is approximately 3000-3500 sq.m consisting of a training block, a trainer's guest house, a participant's hostel, lab, and other minor structures.

Fig.1: Location Map of Proposed Research and Training Center at Gajuri

The main structures and facilities included in the Research and Training Centre are;

(i) Main Training Block (for approx. 70-75 participants)
(ii) Trainer Guest House Block
(iii) Participants Hostel Block
(iv) Trainers Guest House
(v) Building for Road Division Staffs
(vi) Building for Lab
(vii) Canteen, Recreational Area, Parking and others

7.3 Current Progress

To accomplish the task Department of Roads, Development Cooperation Implementation Division (DCID) has hired a Design and Project Management Consulting Firm since 10th June, 2021. The duration of the consulting firm is 6 months for design and 18 months for construction supervision. The consultant has already mobilized at the site and has submitted preliminary concept design report. The proposed master plan of the Research and Training Centre at Gajuri is shown Fig.2.

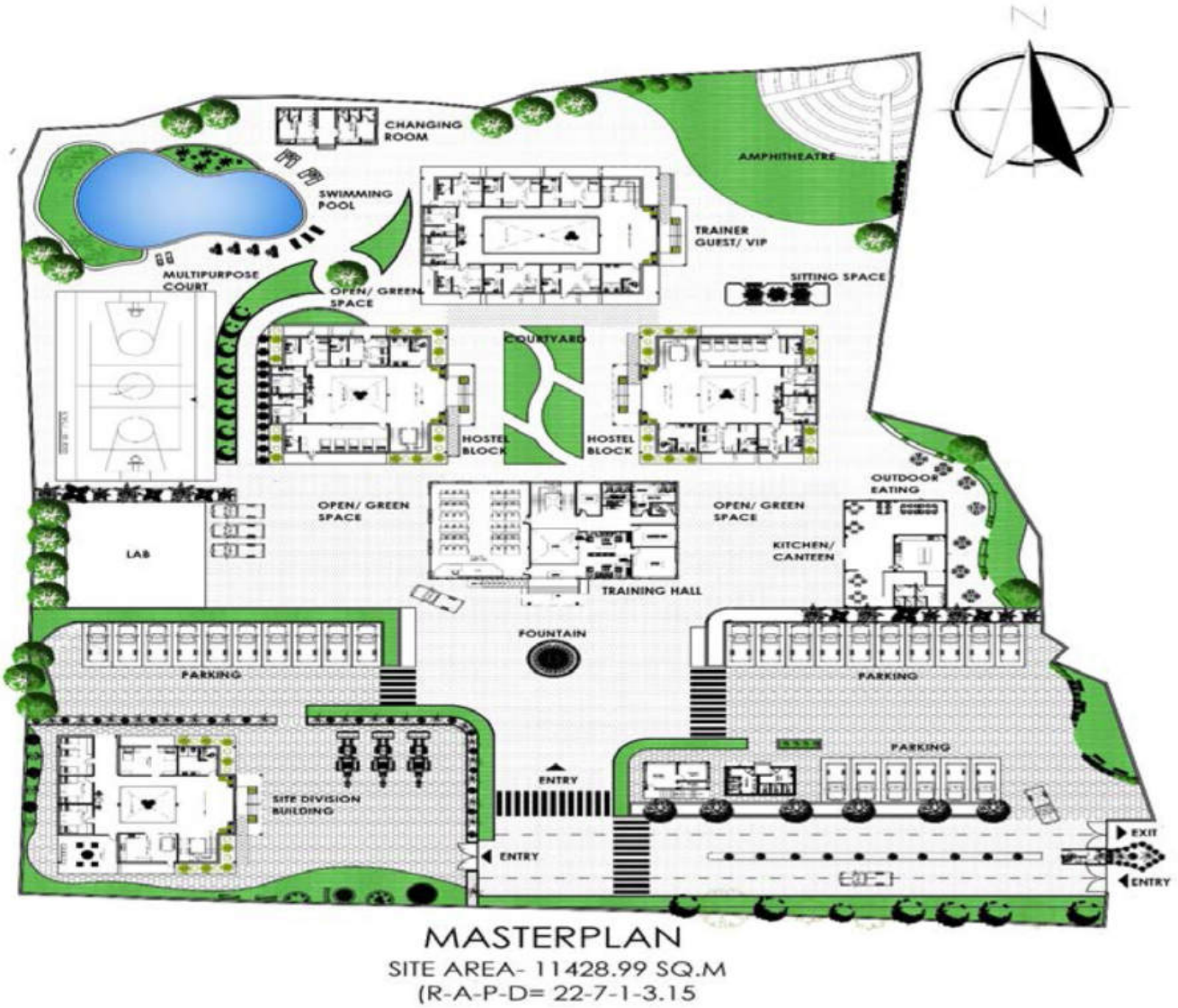


Fig.2: Proposed master Plan of Research and Training Center at Gajuri

8. Lists of Guidelines/Manual/Standard drawings Published in 2077/78, in DoR

-QRDC, DoR

S.N.	Name of Guidelines/Manual/Standard drawings
1	Guidelines for the design of Flexible Pavement 2021
2	Manual for Dense Graded Bituminous Mixes (DBM-BC).
3	Rigid Pavement Guideline 2021
4	Guideline for Defect Liability Management
5	Guideline for Work Acceptance
6	Guidelines for Estimation of Construction Time for Road and Bridge Works 2021
7	Standard drawings of RCC T girder- 3 girder/4 girder bridge
8	Standard Drawings for RCC Box cell Structures

9. Lists of Trainings Conducted in 2077/78 from QRDC, DoR

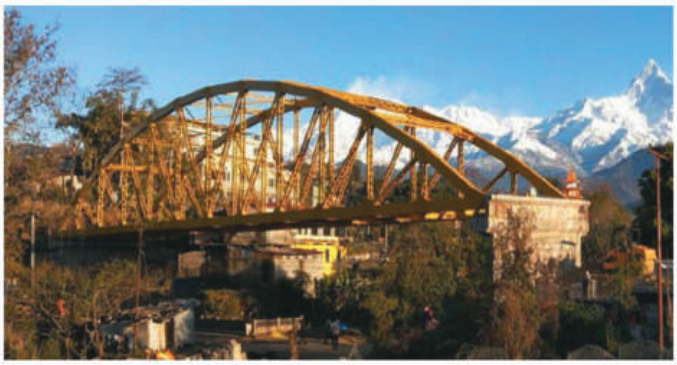
-QRDC, DoR

S.N.	Name of Training - 077/078	No of Participants		
		1st Group	2nd Group	3rd Group
1	GIS Training for Highway Engineers	15	15	15
2	Software Based Design of Roads	15	15	
3	Survey and Layout of Road Alignment and Bridge Axis using Total Station	20	20	18
4	Bridge Construction Issues (Pre-stressing and Pile Foundation	17	19	
5	Quality Control and Material Testing	15	15	

10. Photographs of Some Major Works in Fiscal Year 2077/078

Bio-Engineering (Madan-Bhandari Rajmarg, Bhiman-Sindhuli Road Section)

Intersection at Katari Bazar Chainage : 127+500



Bridge over seti River, Nadipur, Pokhara (Span=80m)

Road Alignment chainage 93+500, Madan-Bhandari Rajmarg, Udayapur

Road Safety Barrier (W-Beam type) at Khodpe Bajhang Road.

Rani Biratnagar Itahari Dharan Road, Sunsari Ch: 32+080 to 34+720 (Itahari-Tarhara section)

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