

**The Project for  
Operation and Maintenance of  
The Sindhuli Road Phase 2**

**Implementation Report**

**On**

**The Training on Design Manual of  
Reinforced Concrete Slab Bridge (RCSB) and  
The Workshop on Pilot Project**

**November 2022**

**JICA Expert Team**

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1. Letters
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3. Presentations (Mr. Hayakawa, Mr. Koirala, Mr. Adhikari, Participants of two groups)
4. Sample of Certificate

# 1 Outline of the Program

## Background

This Training Report has been prepared as per the program for Training on Design Manual of Reinforced Concrete Slab Bridge (RCSB) and Workshop on Pilot Project for Department of Roads (DoR) Engineers conducted from October 12 to 14, 2022 at the DoR Conference hall at Chakupat, Lalitpur with a site visit on October 13 to the Pilot Bridge site (Ghyampe, Mamti and Bhyakure) along B. P. Highway, Sindhuli Road in accordance with the Minutes of Meeting between Nepalese Government and JICA dated on 26th September 2019.

The draft version of the design manual has already been submitted to the DOR as per the letter NK-DOR-063 dated December 06, 2021 and requested for comments on it as per Letter No. DCID 12/2079-80/51 dated August 25, 2022.

## Objectives of the Training/ Workshop

The overall objective of this program was to make aware to the DoR Engineers about the use of RCSB manual as low-cost bridge refreshing the knowledge and skills of the DOR's engineers.

General objective of the Training/Workshop was to enhance knowledge and understanding of RCSB design and implementation by strengthening their capacity in Design and implementation of the RCSB. It was expected that the Engineers themselves would realize the importance of bridge site selection, design of RCSB and requirement for implementation at sites.

The specific objectives were as follows:

- 1 To impart skills for using RCSB manual for selection of bridge at site
- 2 To transfer knowledge to design RCSB as per site condition
- 3 To impart knowledge and skills to conduct necessary on-site tests on materials
- 4 To sensitize knowledge and skills to preparation of bid document
- 5 To transfer knowledge to manage the bridge construction project

## Selection of Trainees

For the selection of trainees, the DCID requested to the DoR to nominate approximate 20 participants including three participants from Sindhuli Road Project and three participants from DCID for the training. Accordingly, the DoR has nominated 25 engineers working in

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different offices. One participant could not attend the training due to personal issue. All twenty-four participants attend the training.

### Participants (Trainers and Trainees)

The name and designation of participants were presented in Table 1-1 and that of the trainers are presented below in Table 1-2, respectively.

Table 1-1 Name of Trainees

S. No.	Name	Position	Organization
1	Amit Kumar Varma	Engineer	RD Bharatpur
2	Dr. Bijaya Jaishi	SE	FRSMO Kathmandu
3	Gyanendra pd. Kalaunee	Engineer	SD,DSBR Project
4	Ishwor Bahadur Rijal	SDE	Nagdhunga - Mugling Road Project
5	Jigesh Prasad Chaudhary	Engineer	DCID,DOR
6	Karna Singh Khatri	Engineer	SD,DSBR Project
7	Khadga Lal Shrestha	SDE	QRDC, DoR
8	Krishna Raj Adhikari	SDE	DoR, Bridge Branch
9	Kshitiz Joshi	Engineer	QRDC, DoR
10	Kushalta Nyoupane	SDE	DoR, Bridge Branch
11	Madhab Paudel	Engineer	SD,DSBR Project
12	Mahendra Majhi	Engineer	HMIS-ICT, DoR
13	Manish Kumar Singh	Engineer	Pushpalal (Midhill) Road Project, DoR
14	Narendra Prasad Bhatta	SDE	DoR, Bridge Branch
15	Nijjal Shrestha	Engineer	QRDC, DoR
16	Prakriti Pokhrel	SDE	DCID,DOR
17	Radhika Prajapati Shrestha	SDE	SD,DSBR Project
18	Rajesh Prasad Paudel	SDE	NSTRIPD, DoR
19	Ram Kumar Shrestha	Engineer	Charikot Division
20	Sagar Deshar	Engineer	DoR, Bridge Branch
21	Sarala Neupane	SDE	DoR, Bridge Branch
22	Sharad Acharya	Engineer	Saljhandi - Sandhikharka- Dhorpatan Road Project
23	Shiva Saran Timalina	Engineer	DoR, MPPHD
24	Suraj Hari Adhikari	Engineer	Midhill Project Directorate

Note: SDE: Senior Divisional Engineer

RD: Road Division

FRSMO: Federal Road Supervision and Monitoring office

SDE: Senior Divisional Engineer

DCID: Development Cooperation Implementation Division

QRDC: Quality Research and Development Centre

DSBR: Dhulikhel – Sindhuli - Bardibas

NSTRIPD: North South Trade Route Improvement Project Directorate

MBPHD: Madan Bhandari Highway Project Directorate

HMIS-ICT: Highway Management Information System – ICT Unit

Source: JICA Expert Team

Table 1-2 Name of Trainers

S.No.	Name	Position
1.	Tomokuni Hayakawa	JICA Expert, Road Structure Planner
2.	Ramesh Prasad Koirala	JICA Expert, Road Structural Design
3.	Shiva Raj Adhikari	Structure Maintenance Management (Technical Support)

Source: JICA Expert Team

## Program

The Schedule of the training program with description of activities together with time allocation has been presented in Table 1-3 below.

Table 1-3 Schedule of the Training Program

DAY 1			
Date / Time:	October 12, 2022, 9:30 to 16:00 Hrs.		
Venue:	DoR Conference Hall, Chakupat, Lalitpur		
Time	Min	Activities	In charge
9:30 - 10:00	0:30	Registration of Participants	Mr. S. Rai (NK)
10:00 - 10:05	0:05	Opening of the program (explanation of the program) Chair the Program by DDG DCID, DoR, Ramhari Pokhrel	Mr. R. P. Koirala, JET
10:05 - 10:10	0:05	Welcome Speech and Highlight the Objectives of the Program	PM, Sindhuli Road; Mr. R L Das
10:10 - 10:20	0:10	Self-Introduction of Participants	
10:20 - 10:25	0:05	Remarks by QRDC	Director, QRDC Mr. Nabin Man Shrestha
10:25 - 10:35	0:10	Outline of SROM2 Project	Mr. M. Iwamaru, JET
10:35 - 10:40	0:05	Remarks by Chairperson	DDG, DCID Mr. Ram Hari Pokharel
10:40 - 10:55	0:15	Tea Break	
10:55 - 11:55	1:00	Introduction of Low-cost Bridge - Why RCSB is selected	Mr. T. Hayakawa, JET
11:55 - 12:55	1:00	Bridge Site Selection, Hydrological and Hydraulics Background	Mr. R. P. Koirala, JET
12:55 - 13:40	0:45	Lunch Break	
13:40 - 14:40	1:00	Structural Design of RCSB	Mr. T. Hayakawa, JET
14:40 - 15:10	0:30	Quality Control & Record Keeping	Mr. R. P. Koirala, JET
15:10 - 16:10	1:00	Staging Design	Mr. T. Hayakawa, JET
16:10 - 16:15	0:05	Information of the Program of the 2nd Day Onward	Mr. R. P. Koirala, JET
Total Duration	6:45	Hrs.	

**DAY 2**

Date / Time: October 13, 2022, 8:00 to 17:00 Hrs.

Venue: Site (Sindhuli Road)

Time	Min	Activities	In charge
8:00 - 8:10	0:10	Meeting point of Participants at DoR Head office, Chakupat	
8:10 - 9:10	1:00	Travel up to Dhulikhel	
9:10 - 9:30	0:20	Tea Break	
9:30 - 10:30	1:00	Travel from Dhulikhel to Mamti Bridge site	
10:30 - 12:00	1:30	Discussion and Observation of Pilot Bridge Bhyakure, Mamti and Ghyampe	Mr. T. Hayakawa, JET Mr. R. P. Koirala, JET Mr. S. R. Adhikari, Str. Maintenance
12:00 - 12:40	0:40	Travel from Bridge Site to Mulkot, Observation of Sec III Road	
12:40 - 13:40	1:00	Lunch at Kwality Resort, Mulkot	
13:40 - 17:00	3:20	Return from Mulkot to Kathmandu	
Total Duration	9:00	Hrs.	

**DAY 3**

Date / Time: October 14, 2022, 10:00 to 16:00 Hrs.

Venue: DoR Conference Hall, Chakupat, Lalitpur

Time	Min	Activities	In charge
10:00 - 11:00	1:00	Guidance for Group Work related to Bid Documents and Procurement Method (of Contractors)	Mr. S. R. Adhikari, Str. Maintenance
11:00 - 12:30	1:30	Discussion about Work and Presentation of site observation	Participants
12:30 - 13:15	0:45	Lunch Break	
13:15 - 14:15	1:00	Guidance for Group Work related to Quality Control Method, Management and Progress Control Method	Mr. S. R. Adhikari, Str. Maintenance
14:15 - 15:45	1:30	Discussion about Work and Presentation	Participants
15:45 - 16:05	0:20	Feedback	Participants
16:05 - 16:10	0:05	Vote of thanks	Director, QRDC Mr. Nabin Man Shrestha
16:10 - 16:25	0:15	Certificate distribution and Closing Remarks	DG, DOR, Mr. Arjun Jung Thapa
Total Duration	6:25	Hrs.	

Source: JICA Expert Team

**Mitigation Measures against COVID-19**

As the COVID pandemic is still underway in the country and necessary precautions as per prescribed protocol was maintained during the whole training program. For this, necessary social distancing in the seating arrangement was maintained. All participants were provided with masks and sanitization measures. All participants had to wear face mask mandatorily during the training as well as in the field visits. During the field visit it was assured that the trainees as well as other accompanying persons were to be seated on the vehicle with face masks and face shields maintain the required social distancing.

## **2 Reporting (Including Photo)**

**Day 1. October 12, 2022**

### **Opening of the Program**

On the first day of the training, a short inauguration program was conducted on the scheduled date i.e., on October 12, 2022, after the registration of the participants. The program started with the welcome remarks by Rabindra L Das, the Project Manager of Sindhuli Road Project and followed by self-introduction of the participants. The objectives of the training and its importance were briefly highlighted by Mr. Nabin Man Shrestha, the Director of QRDC.

Mr. Motoki Iwamaru, Deputy Chief Advisor of JICA Expert Team highlighted the outline of the Sindhuli Road Operation and Maintenance, Phase 2 (SROM-2) Project. In his short presentation, he recalled the history of Sindhuli Road from the feasibility stage to the completion stage. He also elaborated the technical details of the Sindhuli Road elucidating how SROM-2 project is continually working for the road improvement.

Chief Guest of the Inaugural Session Mr. Ram Hari Pokharel, DDG, DCID, in his opening remarks said that he has felt highly honored and privileged for this opportunity given to address everyone on this special occasion. In his speech, he also said that the RSCB manual and its content will be very useful to the DoR engineers for proper bridge design and construction as per site conditions. He further added that this training will help engineers to enhance their skills and requested to all participants to take this opportunity to learn from the experts. Some Photos of the Inaugural Session are presented in Table 2-1 below.

Table 2-1 photos of Inuagural Session.

	
<p><b>Photo 1:</b> Openiong of Training Program</p>	<p><b>Photo 2:</b> Welcome by Mr. Rabindra L Das, PM, Sindhuli Road Project</p>
	
<p><b>Photo 3:</b> Opening Remarks by Director, QRDC Mr. Nabin Man Shrestha</p>	<p><b>Photo 4:</b> Presentation about Outline of SROM 2 by mr. M. Iwamaru</p>
	
<p><b>Photo 5:</b> Participant in opening ceremony</p>	<p><b>Photo 6:</b> Inaguration of program by DDG Mr. Ram H. Pokharel, DDG, DCID, DoR</p>

Source: JICA Expert Team

## Technical Session

### Session 1: Introduction of Low-Cost Bridge – Why RCSB is necessary?

In the first session of the program, Mr. Hayakawa – JICA Expert presented on the topic Introduction of Low-Cost Bridge and Why RCSB is necessary? He elaborated the discussion

on the following sub-topics

- Background of river-crossing structures in Sindhuli Road
- Characteristics of RCSB
- Applicability of RCSB
- Structural features of RCSB
- Outline of Design Manual

Mr. Hayakawa tried to familiarize the participants about the RCSB manual and suggest choosing RCSB an option for low-cost bridge.

### **Session 2: Bridge Site Selection, Hydrological and Hydraulics Background**

Likewise, in the second session of the program, Mr. Koirala – JICA Expert presented on the topic Bridge Site Selection, Hydrological and Hydraulics Background. He elaborated the discussion on the following sub-topics.

- Bridge Site Selection
- Information Required for Bridge Dimensions
- Information Required - Hydrology
- Information Required - Hydraulics

Mr. Koirala advised to select bridge site based on topography, bed materials and many other aspects and the information gathered. Engineering judgment and experiences play a vital role while deciding the bridge dimensions.

### **Session 3: Overview of the Manual and Structural Design of RCSB**

In the third session of the program, Mr. Hayakawa – JICA Expert presented in the topic Overview of the Manual and Structural Design of RCSB with following outlines.

- Outline of Manual
- Explanation of each chapter
- Structural analysis
- Reinforcement

Mr. Hayakawa explained in details of each chapter of RCSB manual and structural design of bridge.

**Session 4: Quality Control & Record Keeping**

In the fourth session of the program, Mr. Koirala – JICA Expert presented in the topic Quality Control & Record Keeping with following outlines.

- Contractual provision of Specifications
- Specification (Road and Bridge works)
- Quality control Section (500)
- Other Discussion

Mr. Koirala explained about contract requirements, Quality assurance plan and method statement which should be carried out during execution of works. He also explained about the benefits of appropriate recording keeping.

**Session 5: Staging Design**

In the fifth session of the program, Mr. Hayakawa – JICA Expert presented in the topic Staging Design with following outlines.

- Definition of staging
- Requirement for the staging used for RSCB
- Material for the staging
- Calculation of staging (example)
- Conclusion and recommendation

Mr. Hayakawa explained detail Structural design of staging for bridge with example.

At the end of Day-1 program Mr. Koirala explained about second day site visit program and data to be collected at site for presentation on third day.

**Question and Answers**

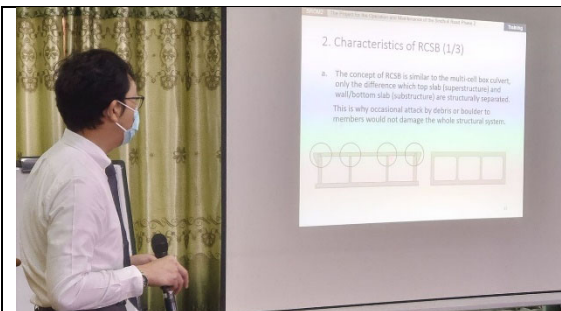
At the end of the lecture session, the following questions were asked by the participants

- How to fix bearing and Expansion Joint in RSCB?
  - What is the logic behind the weep holes that are not provided across abutment wall?
  - What is the detailed calculation procedure for designing false-work supports and their arrangements, especially the buckling calculation of support column?
  - What assumptions were made for selection of design flood? Why the design flood is almost double than that of other bridge sites generally considered by the Department of
-

Roads?

The presenter’s duo responded to the questions one by one in an interactive manner. Suggestions from the participants were also discussed.

**Photographs of Day 1**



**Photo 1:** Presentation by T Hayakawa about Introduction of Low-cost Bridge- / RCSB



**Photo 2:** Presentation by RP Koirala about Bridge Site selection, Hydrological and Hydraulics Background



**Photo 3:** Participant in training hall



**Photo 4:** Group of participants

Source: JICA Expert Team

**Day 2. October 13, 2022.****Site visit (Pilot project Ghyampe, Mamti and Bhyakure Bridge)**

All participants arrived at DOR premises at 8:00 Am on the 2<sup>nd</sup> day (October 13, 2022). The team started their visit at 8:10 AM. Heading towards Dhulikhel- Sindhuli – Bardibas Road up to Mulkot and coming back.

The site visit team reached Bhyakure Bridge construction site at 11: 25, Mr. Koirala explained about proposed bridge to be constructed at Bhyakure and discussed various aspects. The Engineers working in Sindhuli Road Project also helped in briefing to the participants.

The site visit team reached Mamti Bridge construction site at 11:45, the participants observed super structure of ongoing bridge construction and made discussion with Mr. Hayakawa about method of construction, laying of bearings, expansion joints, weepholes etc. Mr. Hayakawa answered questions related to structural design. Other general queries were clarified by Sindhuli Road Project engineers.


The site visit team reached Ghyampe bridge construction site at 12:30, participant observed detour road and foundation excavation for bridge construction and discussed about various issues including with Sindhuli Road Project engineers,

The site visit team reached Mulkot around 13:15 Noon and had Lunch. After lunch, the team started at 2:30 PM from Mulkot and arrived at Kathmandu, Department of Road head office at around 6:00 PM. Thus, concluded the second day program

**Question and Answers**

The participants asked about various aspects like features of the river, contractor's mobilization of their resources, less activities of contractor at the sites etc. The queries were responded by the DOR Engineer and JET members.

**Photographs of Day 2**

	
<p><b>Photo 1:</b> Proposed bridge construction at Bhyakure khola</p>	<p><b>Photo 2:</b> Group discussion at Bhyakure proposed bridge site</p>
	
<p><b>Photo 3:</b> Present condition of Mamti Bridge construction site</p>	<p><b>Photo 4:</b> Discussion about Design drawing at Mamti Bridge site</p>
	
<p><b>Photo 5:</b> Mr Hayakawa, JICA Expert explaining at Mamti Bridge site.</p>	<p><b>Photo 6:</b> Group photo at Mamti bridge construction site</p>

Source: JICA Expert Team

**Day 3. October 14, 2022**

**Work shop**

**Session 1: Guidance for Group Work related to Bid Documents and Procurement Method (of Contractors).**

The third day program was started with the Discussion Related to the bid documents Procurement method (Contractor), Mr. S.R. Adhikari mainly discussed about the followings.

- Bid document (Purpose, Impact, bidding methods)
- Bid document - ITB, Bid DATA sheet, Evaluation Criteria, GCC, SCC
- Preparation of Work Requirement in bid document

**Session 2: Discussion about Work and Presentation of site observation**

In this session each group has presented their finding of yesterday's site visit and made further discussion.

Group -1 present about detour management at site, finding of their observation is as.

- Provision for Detour Road (Road Diversion) Construction by maintaining all the precautions in directing river channel flow by Gabion works in BOQ
- Provision for Detour Road Maintenance in BOQ (unit month)
- Detour Road Constructed in All three bridges
- No Road Closure at Bridges site due to Detour Road Management

Group-2 present about bridge site selection at site, ideal requirement of bridge site is presented as.

- A Straight Reach of River.
- Steady River Flow without cross currents.
- A Narrow Channel with firm banks.
- Suitable High banks above high flood level.
- Hard in-erodible strata close to riverbed level.
- Absence of Sharp Curve in the approaches
- Minimum River Training Works.
- Presence of Approach Road on both sides

**Session 3: Guidance for Group Work related to Quality Control Method, Management and Progress Control Method**

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In this session Mr. S.R. Adhikari mainly discussed about following points

- Quality system, Quality Assurance/ Quality Control
- Specification
- Quality Assurance Plan
- Quality of construction material
- Management and Progress control (S-curve)

#### **Session 4: Discussion about Work and Presentation**

In this session new group comprising of four participants per group is formulated and prepared method statement of mass concreting including construction joint as per contractor capacity. Furthermore, proposal for mass concreting has been presented by the participants and JICA Expert too.

#### **Question and Answers**

In the question and answers session at the end of the program, the following questions were asked by the participants

- Question: How to Select Responsive Bids?
- Answer: check either mandatory document specified in Bid document are attach or not such as:
  - ✓ Letter of Technical Bid
  - ✓ Bid Security/Bank Guarantee
  - ✓ Company registration Certificate
  - ✓ VAT registration Certificate
  - ✓ Business Registration Certificate
  - ✓ Tax Clearance Certificate/Tax return submission evidence/evidence of time extension
  - ✓ Power of Attorney of Bid signatory
  - ✓ Bank Voucher for cost of bid document
  - ✓ Joint venture agreement
  - ✓ Qualification Documents
- Question: Can we Change requirement specified in Standard Specification?
- Answer: During preparation of Bid document as per project requirement Specification

can be modified “It should reflect the need of the Project” However after agreement requirement cannot modified to lower / worse class.

	
<p><b>Photo 1:</b> Presentation of site visit by participant</p>	<p><b>Photo 2:</b> Presentation of site visit by participant</p>
	
<p><b>Photo 3:</b> Explanation about group work on Work by Mr SR Adhikari, Str Maintenance Advisor</p>	<p><b>Photo 4:</b> Group work at workshop</p>
	
<p><b>Photo 5:</b> Group work presentation by participant</p>	<p><b>Photo 6:</b> Group work presentation by Participant</p>

Source: JICA Expert Team

### Closing of the Program

On the last day, last session of the training, a short closing program was conducted immediately after the training evaluation.

Mr. Nabin Man Shrestha, Director, QRDC stated that the training program was extremely helpful to DoR engineers. Applying these learned knowledge will certainly help to increase bridge desin and construction capacity. He further added that the materials provided will really help the DoR engineers in their day to day work.

Mr. Arjun Jung Thapa, Director General of the DoR appreciated the training program. He added this RCSB manual is outcome of efforts of JICA expert team as per our previous request. Knowledge gain from training program will be properly utilized in bridge construction by DoR Engineers. Furthermore he thanks to JICA as well as SROM 2 for conducting this training and previous Asphalt concrete training.



**Photo 1:** Feedback/ remarks from trainees , Mr. Amit Kumar Varma



**Photo 2:** Vote of thanks bu Director QRDC, Mr. Nabin Man Shrestha



**Photo 3:** Certification distribution by DG, DoR Mr. Arjun Jung Thapa



**Photo 4:** Closing of Training Program by DG, DoR Mr. Arjun Jung Thapa

Source: JICA Expert Team

### 3 Evaluations of the Training

#### Feedback from the Trainees

Trainees expressed their views during the closing of the training. Trainees were divided into two groups and one representative from each group presented whatever they learned during the training and expressed their opinions about the training. The comments of the trainees were asked about the training program and their individual answers have been filled and given in the following table.

**Participant Information**

Name \_\_\_\_\_

Position \_\_\_\_\_

Sex Male / Female Age \_\_\_\_\_

1 Did you have enough opportunities to get direct experiences such as site-visits and practices in the course?

← Yes, very much		No, not at all →	
<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

2 Was the quality/level of lecture good enough for you to understand clearly?

← Yes, very much		No, not at all →	
<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

3 Which program was especially useful or interested in for you?

4 Is there any subject that were not covered through the course?

5 Did you have enough opportunities to get direct experiences such as site-visits and practices in the course?

← Yes, very much		No, not at all →	
<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

6 Do you think the knowledge and experience you acquired through the course is useful for your future carrier?

← Yes, very much		No, not at all →	
<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

7 How do you plan to utilize the knowledge for your carrier?

End

Figure 3-1 Questionnaire Form

Source: JICA Expert Team

Table 3-1 Individual Answers to the Questionnaire

Q. No	Evaluation						
	1	2	3	4	5	6	7
	Do you have enough opportunities to get direct experience such as site visit and practice in the course?	Was the quality /level of lecture good enough for you to understand clearly?	Which program was especially useful or interested in for you?	Is there any subject that were not covered through the course?	Did you enough opportunities to get direct experiences such as site visits practices in the course?	Do you think the knowledge and experience you acquired through the course is useful for your future carrier?	How do you plan to utilize the knowledge for your carrier?
Trainee-1	4	4	Bridge Design (structural) Bridge site selection, Hydrological, Hydraulics background	Structural design is considered in this training, but it should be in more detail Construction methodology shall also be covered in this course	4	4	I will utilize that knowledge in the design (hydrologically/structurally)) as well as construction details of RCSB as well as other types of bridges.
Trainee-2							
Trainee-3	4	4	All contents of this program were relevant and good	It would be good if more were enough photos, videos and descriptions of actual sites, construction work during presentations.	4	4	Sharing knowledge and experience to other engineers of DoR and contractor as well
Trainee-4	2	2	Structural design of RCSB	Maintenance of RCSB, bearing as well as expansion joint	2	3	Implementing in field
Trainee-5	4	3	Quality control and Quality Assurance program, RCSB detailing and Design	Yes, Construction methodology in the site works	4	3	Field visit, supervision and monitoring of the contractors works and DoR projects
Trainee-6	4	4	Design of RCSB, Quality related issues, Bid document preparation	RCSB related course is enough	4	4	Study the provided document regularly and will use in profession
Trainee-7	3	3	The Site and Quality assurance is very interesting	The design steps	2	3	To implement/ Adopt suitable for the location
Trainee-8	3	3	Continuous slab	Detail Design		4	Design a typical section
Trainee-9	3	3	Program related to quality control and practical experience share by instructors		3	3	The knowledge and experience shared will be helpful while performing work in the site
Trainee-10	3	3	Design and procurement part	Not much. It would have been better if the design session use more interactive way	4	4	The Hydrology, Hydraulics and design session shall be useful while designing and reviewing the slab/ Psc bridges in the Bridge branch.
Trainee-11							
Trainee-12	4	4	Field visit Design by our valuable Japanese Er.	There is insufficient design calculation sheet shown in the presentation	4	4	It is used in the appropriate site, where it is required
Trainee-13	4	4	The fact the weep holes can cause the soil saturation in approach road		4	4	In daily site supervision work and feedback/ comment in critical site situations (construction complication)
Trainee-14	4	3	Structural analysis and Temporary staging work design lecture class	Geo technical, Hydrology and Hydraulics Analysis to RCSB specific	4	4	In our bridge construction projects
Trainee-15	4	4	RCSB bridge detailing and		4	4	Utilize knowledge in Quality control

Q. No	Evaluation						
	1	2	3	4	5	6	7
	Do you have enough opportunities to get direct experience such as site visit and practice in the course?	Was the quality /level of lecture good enough for you to understand clearly?	Which program was especially useful or interested in for you?	Is there any subject that were not covered through the course?	Did you enough opportunities to get direct experiences such as site visits practices in the course?	Do you think the knowledge and experience you acquired through the course is useful for your future carrier?	How do you plan to utilize the knowledge for your carrier?
			design, Quality Control				
Trainee-16	4	4	Site visit specifically most useful to us	Typical design process was not covered but the time duration (3 days) was not enough for teaching design aspect.	4	4	Every aspect that we learnt so far are practical and useful in our everyday work (Construction and Procurement)
Trainee-17	3	3	Site visit was especially useful for us		3	4	It will be utilized for design and implementation of bridges contract as well as road contract.
Trainee-18	4	3	Staging in bridge construction	Sub structure design	4	3	Adopting RCSB
Trainee-19							
Trainee-20	3	3	Quality control, Design of Staging	Detail design of RCSB	3	3	
Trainee-21	3	3	Practical knowledge from site visit about RCSB	It would be better if the manual of RCSB was elaborated briefly and concisely	3	3	When we review design, knowledge gain will be useful
Trainee-22	4	3	Site visit and Group discussion	Structural analysis part of bridge	4	4	By using Quality control techniques learned from training.
Trainee-23	4	3	Discussion and observation of pilot bridge Manti	Structural design of RCSB	4	4	There knowledges are directly helpful in site during bridge construction
Trainee-24	4	4	Staging design and field level quality control		4	4	For design checking and supervision of motorable bridges.

Source: JICA Expert Team

Table 3-2 Summary Answers to the Questionnaire

Q. No	1	2	3	4	5	6	7
	Do you have enough opportunities to get direct experience such as site visit and practice in the course?	Was the quality /level of lecture good enough for you to understand clearly?	-	-	Did you enough opportunities to get direct experiences such as site visits practices in the course?	Do you think the knowledge and experience you acquired through the course is useful for your future carrier?	-
Nos of score 4	13	8	-	-	14	14	-
Nos of score 3	7	12	-	-	4	7	-
Nos of score 2	1	1	-	-	2	0	-
Nos of score 1	0	0	-	-	0	0	-

Source: JICA Expert Team

**Comments from the DOR**

First of all, it is worthwhile to mention that the training program was conducted as per the request of the DoR Deputy Director General Mr. Ram Hari Pokharel, mentioned during his opening address that the trainees will learn about RCSB. During the training program most of the trainees would like to include the detail/ step by step procedure of design. During the closing remarks the DG, DoR Mr. Arjun Jung Thapa appreciates the training program.


**Comments from JICA Expert Team**

As evaluated by the trainees in given formats provided by SROM 2, most of the Trainees mentioned that the training was useful for them. They were found to be doing required exercises during the program by discussing with each other.

The Project Coordinator of SROM 2, Mr. Bindu Shamsher Rana hoped that such type of training in different fields of road construction may be arranged with consultation with JICA, if needed, and as proposed by DoR. The JICA Expert Team hopes that the training program was useful for their day-to-day work in the work fields.

## ANNEX (Attachments)

## 1. Letters



नेपाल सरकार  
भौतिक पूर्वाधार तथा यातायात विभाग  
सडक विभाग  
गुणस्तर, अनुसन्धान तथा विकास केन्द्र  
चाकुपाटे, ललितपुर

ई-मेल: dorqrdc@gmail.com  
फोन: ९७७-०१-४२६०६९६

पत्र संख्या : २०७९/८०  
चलानी नं : ८००

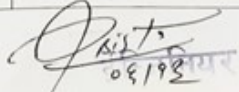
मिति: २०७९-०६-१३

**विषय : तालिम/कार्यशालामा सहभागीहरू मनोनयन सम्बन्धमा ।**


उपरोक्त सम्बन्धमा JICA EXPERT TEAM (JET) ले Project SROM2 बाट "Training on Design Manual of RC Continuous Slab Bridges & Workshop related to the implementation of Three Bridges(Mamti, Gyampe & Byakure Bridges)" विषयमा मिति २०७९/०६/२६ देखि २०७९/०६/२८ गतेसम्म संचालन तथा व्यवस्थापन हुने ३ दिने तालिम/कार्यशाला DOR Hall ,Chakupat,Lalitpur मा विहान ९:३० देखि बेलुका ५:०० बजेसम्म संचालन हुने भएकोले यस विभागको निर्णयानुसार तपशिल प्राविधिक कर्मचारीहरू (सि.डि.ई./ई.) लाई मनोनित गरिएको व्यहोरा अनुरोध छ ।

**तपशिल:**

क्र.सं.	नाम	कार्यालय
सडक विभाग वा अन्तर्गत		
१	सि.डि.ई.श्री कुवेर नेपाली	तमोर कोरिडोर,धरान
२	सि.डि.ई.श्री शम्भु आचार्य	मदन भण्डारी राजमार्ग आयोजना,सुर्खेत
३	सि.डि.ई.श्री सरला न्यौपाने	पुल महाशाखा
४	ई. श्री अमित कुमार बर्मा	सडक डिभिजन,भक्तपुर
५	ई. श्री सागर देशार	पुल महाशाखा
६	ई. श्री शिवसरन तिमिल्सिना	मदन भण्डारी राजमार्ग आयोजना निर्देशनालय
७	ई. श्री निज्जल श्रेष्ठ	गुणस्तर,अनुसन्धान तथा विकास केन्द्र
८	ई. श्री क्षितिज जोशी	गुणस्तर,अनुसन्धान तथा विकास केन्द्र
९	ई. श्री महेन्द्र माझी	हाइवे सूचना व्यवस्थापन प्रणाली तथा प्रविधि शाखा
१०	ई. श्री दमन कुमार विष्ट	गुणस्तर,अनुसन्धान तथा विकास केन्द्र
११	ई. श्री सुरज हरि अधिकारी	पुष्पलाल मध्यपहाडी राजमार्ग आयोजना निर्देशनालय
१२	ई. श्री मनिय कुमार सिंह	पुष्पलाल मध्यपहाडी राजमार्ग आयोजना कार्यालय,धुलिखेल
१३	ई. श्री सुवाश कुमार दत्त	सडक डिभिजन,चरिकोट
१४	ई. श्री शरद आचार्य	सालझण्डी सन्धिखर्क ढोरपाटन सडक आयोजना
विकास सहायता कार्यान्वयन महाशाखा तर्फ		
१	सि.डि.ई. श्री प्रकृति पोखरेल	विकास सहायता कार्यान्वयन महाशाखा
२	ई. श्री जिगेश चौधरी	विकास सहायता कार्यान्वयन महाशाखा

  
 ०६/१३

Source: JICA Expert Team

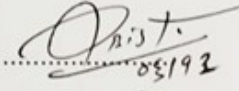


नेपाल सरकार  
भौतिक पूर्वाधार तथा यातायात मन्त्रालय  
सडक विभाग  
गुणस्तर, अनुसन्धान तथा विकास केन्द्र  
चाकुपाट, ललितपुर

ई-मेल: dorqndc@gmail.com  
फोन: ९७७-०१-४४४०१९६

३	ई. श्री आशिका पोखरेल	विकास सहायता कार्यान्वयन महाशाखा
सुर्यविनायक- धुलिखेल-सिन्धुली- बर्दिबास सडक योजना तर्फ		
१	ई. श्री गंगा बहादुर महर्जन	सुर्यविनायक- धुलिखेल-सिन्धुली- बर्दिबास सडक आयोजना
२	ई. श्री कर्ण सिंह खत्री	सुर्यविनायक-धुलिखेल-सिन्धुली-बर्दिबास सडक आयोजना
३	ई. श्री ज्ञानेन्द्र प्रसाद कलौनी	सुर्यविनायक-धुलिखेल-सिन्धुली-बर्दिबास सडक आयोजना


**बोधार्थः**  
श्री सडक विभाग, चाकुपाट, ललितपुर ।  
श्री विकास सहायता कार्यान्वयन महाशाखा, कुपन्डोल, ललितपुर ।  
श्री सबै सम्बन्धित कार्यालयहरु ।



०६/१९३

दमन कुमार विष्ट  
इन्जिनियर  
इन्जिनियर

Source: JICA Expert Team



नेपाल सरकार  
भौतिक पूर्वाधार तथा यातायात मन्त्रालय  
**सडक विभाग**  
गुणस्तर अनुसन्धान तथा विकास केन्द्र  
चाकुपट, ललितपुर

ईमेल: dorqrdc@gmail.com

प.सं: २०७९/८०  
च.नं: ६६

मिति: २०७९/०६/२५

श्री विकास सहायता कार्यान्वयन महाशाखा,  
कुपन्डोल, ललितपुर ।

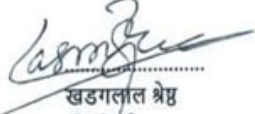
**विषय: मनोनयन संशोधन सम्बन्धमा ।**

प्रस्तुत विषयमा यस कार्यालयको प.सं.२०७९/८० च.नं.७०, मिति २०७९-०६-१३ को "तालिम/कार्यशालामा सहभागीहरू मनोनयन सम्बन्धमा" विषयको पत्रको मनोनयनमा सि.नं. १ को नाम संशोधन गरि मनोनयन स्वीकृत गरिएको व्यहोरा अनुरोध छ ।

क्र.सं.	नाम	कार्यालय
१.	सु.ई श्री डा. विजय जैसी	संघीय सुपरिवेक्षण तथा अनुगमन कार्यालय, काठमाडौं

बोधार्थ:

- श्री सडक विभाग, चाकुपट, ललितपुर।
- श्री सम्बन्धित सबै कार्यालयहरू ।



खडगलाल श्रेष्ठ  
सि.डि.ई  
सि. डि. ई.

Source: JICA Expert Team

## 2. Participant List

To be attached as separate files

## 3. Presentations

To be attached as separate files

S.N.	Day	Contents	Presenter
3.1	Day 1	Introduction of Low-Cost Bridge – Why RCSB is necessary?	Mr. T. Hayakawa, JET
3.2		Bridge Site Selection, Hydrological and Hydraulics Background	Mr. R.P.Koirala, JET
3.3		Overview of the Manual and Structural Design of RCSB	Mr. T. Hayakawa, JET
3.4		Quality Control & Record Keeping	Mr. R.P.Koirala, JET
3.5		Staging Design	Mr. T. Hayakawa, JET
3.6	Day 3	Guidance for Group Work related to Bid Documents and Procurement Method (of Contractors)	Mr. S.R.Adhikari, JET
3.7		[Groupwork Presentation -1] Observation and Detour Road Management of Bridges along BP Highway	Mr. Amit Varma, Bridge Branch, DoR
3.8		Guidance for Group Work related to Quality Control Method, Management and Progress Control Method	Mr. S.R.Adhikari, JET
3.9		[Groupwork Presentation -2] Bridge Site Selection	Ms. Prakriti Pokherel, SDE, DCID, DoR

Source: JICA Expert Team

## 4. Sample of Certificate



Source: JICA Expert Team



The Project for the Operation and Maintenance of the Sindhuli Road Phase -2

**Training on Design Manual of Reinforced Concrete Slab Bridge ( RCSB) and Workshop on Pilot Project**

Registration / Attendance of participats

SN	Name of Participants	Designation	Organization	e-mail address	mobile number	Signature		
						12-Oct-22	13-Oct-22	14-Oct-22
1	NIJJAL SHRESTHA	Engineer	QRDC/DOR					
2	AMIT KUMAR VARMA	"	RD Chaktapur/DOR					
3	JIGESH PRASAD CHAUDHARY	Er.	DCID, DOR					
4	MANISH-KUMAR-SINGH	Er.	Pushpaal (mid hill) Road project, DOR					
5	MAHENDRA MAJHI	Er.	HMS-ICT, DOR					
6	KSHETIZ JOSHI	Engineer	QRDC, DOR					
7	SURAS HARI ADHIKARI	Er.	MIDHLPD, DOR					
8	SARALA NEUPANE	S.D.E.	DOR, BRIDGE branch					
9	Prakriti Pokhrel	S.D.E	DCID					
10	Gyanendra Pd. Kabinnee	Engineer	sindhuli Bardib.					
11	Karna Singh Phatri	Engineer	"					

The Project for the Operation and Maintenance of the Sindhuli Road Phase -2

**Training on Design Manual of Reinforced Concrete Slab Bridge ( RCSB) and Workshop on Pilot Project**

Registration / Attendance of participats

SN	Name of Participants	Designation	Organization	e-mail address	mobile number	Signature		
						12-Oct-22	13-Oct-22	14-Oct-22
12	Radhika Prajapati Shrestha	S.D.E	SDDSRP					
13	Krishna Raj Adhikari	SDE	DOR Bridge Branch					
14	Dr. Bijaya Jaishi	S.E.	FRSMD Kath					
15	Shiva Saran Timalsina	Er.	DOR MBHPD					
16	NARENDRA PD. BHATTA <del>Narendra Bhatta</del>	SDE	Bridge Branch					
17	Sagar Dexhar	Er.	Bridge Branch					
18	Ishwor Ban Rijal	SDE	Nagarkhaya, M Road project					
19	Sharad Acharya	Er.	Saltkhandi Sand hikharka Dhoopata					
20	Khadga Lal Shrestha	SDE	QRDC, DOR					
21	KUSHALIA NYGUPANE Kumalta Nyupane	SDE	Bridge Branch					
22	Ram Kumar Shrestha	Er.	Charicat Division					
23	Rajesh Prasad Paudel	S.D.E	NSTRIPD, DOR					
24	Madhab Paudel	Er	Suryabinayak - Dhulikhel R.P.					

# Introduction of Low-cost Bridge

## Why RCSB is selected

Department of Roads and JICA Expert Team

12 October 2022

# Contents

1. Background of river-crossing structures in Sindhuli Road
2. Characteristics of RCSB
3. Applicability of RCSB
4. Structural features of RCSB
5. Outline of Design Manual

# 1. Background of river-crossing structures in Sindhuli Road (1/4)

- Why the “overflow type of causeway” was selected initially in Section 1 and 4
- Why the RCSB was selected in Section 2 and 3

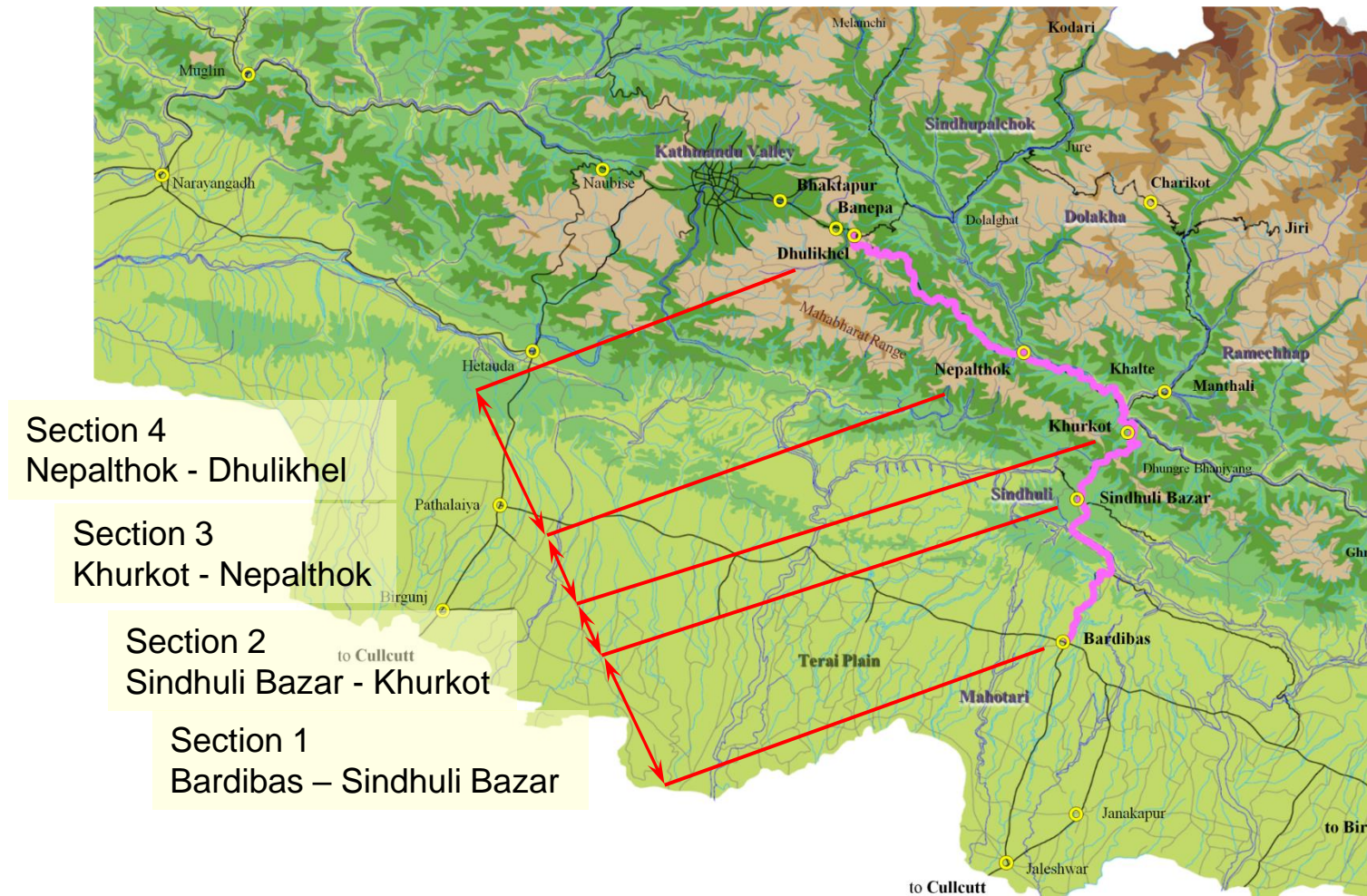


Section 4



Section 2

# 1. Background of river-crossing structures in Sindhuli Road (2/4)



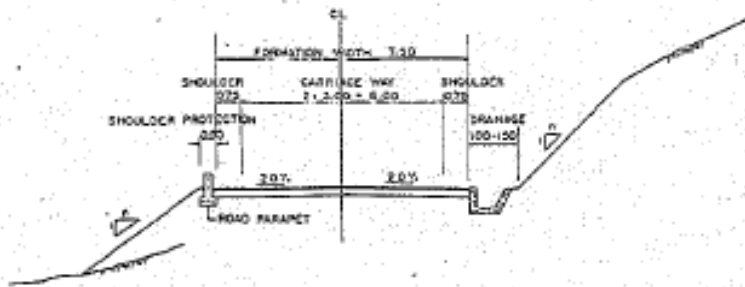
# 1. Background of river-crossing structures in Sindhuli Road (3/4)

Stage	Period
Feasibility Study	1986 – 1988
After Care study	1992 – 1993
Section 1	1994 (B/D), 1996 – 1998(C/S)
Section 4	1995 (B/D), 1997 – 2005 (C/S) 2003 – 2005 (Rehabilitation)
Section 2	1999 (B/D), 2001 – 2009 (C/S)
Section 3	2008 (B/D), 2009 – 2015 (C/S)

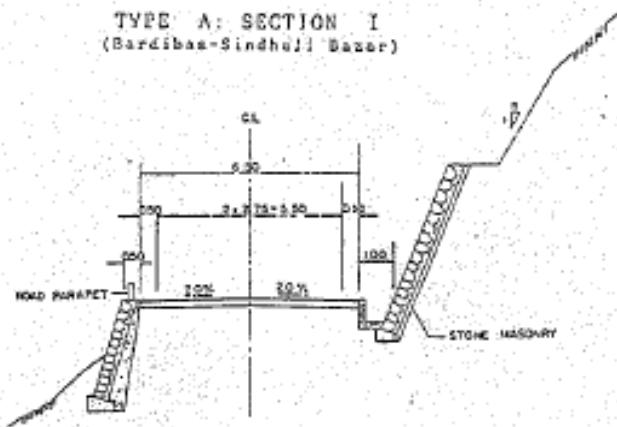
B/D: Basic Design, C/S: Construction Supervision

# 1. Background of river-crossing structures in Sindhuli Road (4/4)

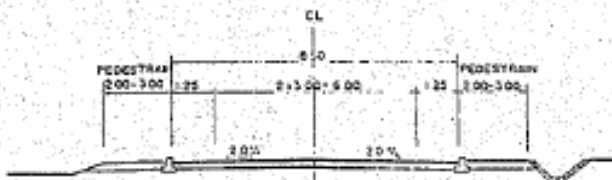
- In the Feasibility Study, Sindhuli Road was planned as 2-Lane throughout the all section
- The Project was estimated as feasible, but the total Project cost was huge and GoJ hanged the investment (no previous precedence)
- In the After Care Study, the Project was restarted with reduced scale
- River-crossing structure was planned as causeway for small rivers



TYPE A: SECTION I  
(Bardibas-Sindhuli Bazar)

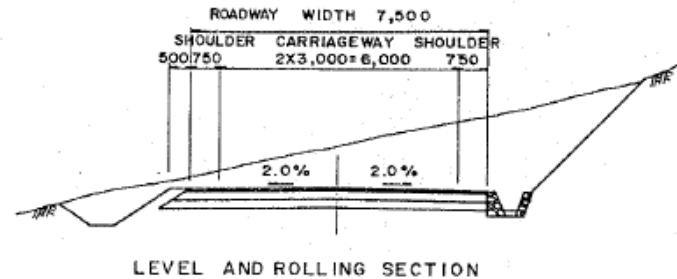


TYPE B: SECTION II  
(Sindhuli Bazar-Chuliikhel)

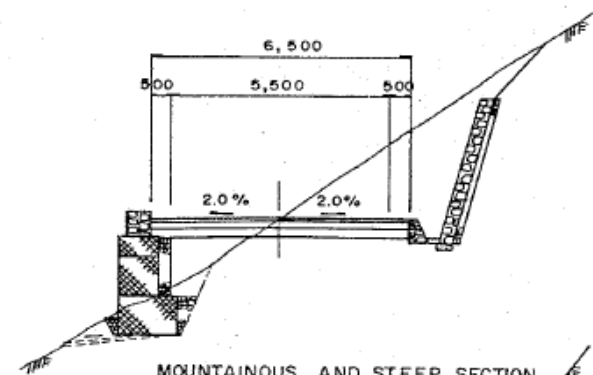


TYPE C: TOWN AND CITY AREA

Cross section in F/S



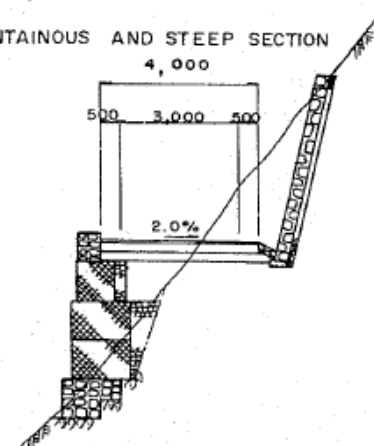
LEVEL AND ROLLING SECTION



MOUNTAINOUS AND STEEP SECTION

Notes:

- The slope protections will be selected according to the geological and topographical conditions of the slope.
- The dimensions are millimeter.
- Not to scale
- Tentative drawing only



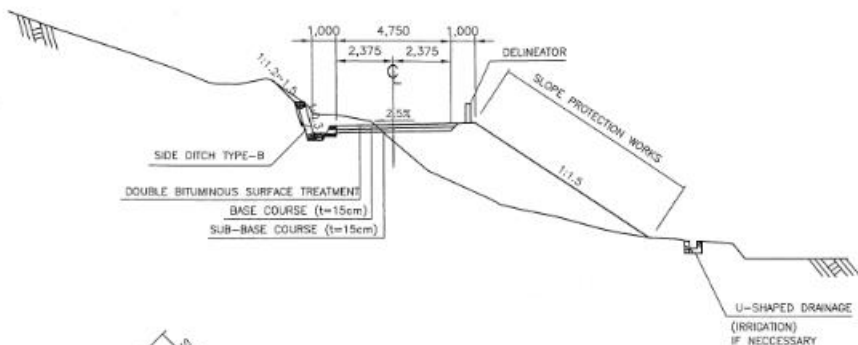
EXCEPTIONAL SECTION

Cross section in A/C

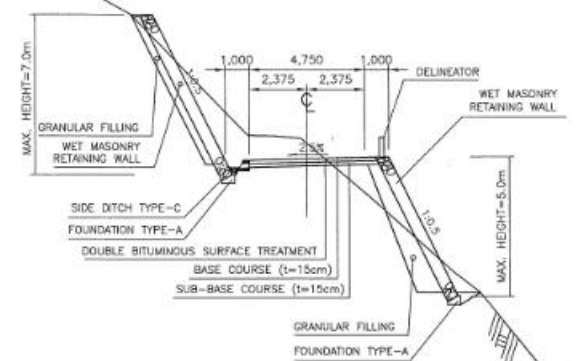
TYPICAL CROSS SECTIONS (1)

SCALE 1:200

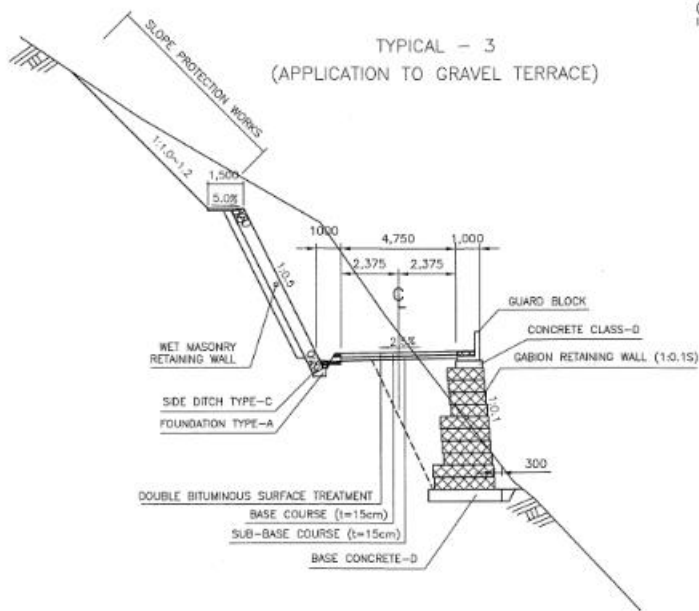
TYPICAL - 1  
(APPLICATION TO AGRICULTURAL LAND)



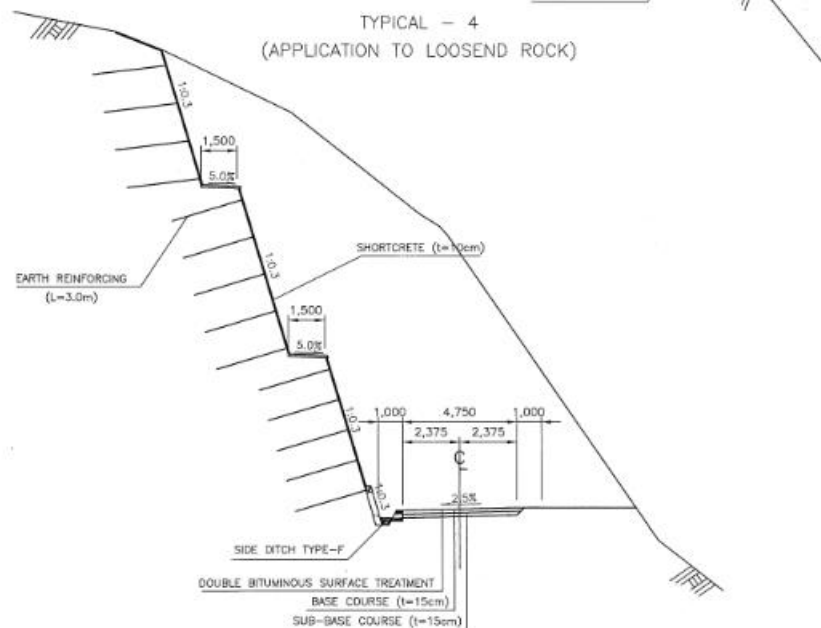
TYPICAL - 2  
(APPLICATION TO EXISTING ROAD WIDENING)



TYPICAL - 3  
(APPLICATION TO GRAVEL TERRACE)



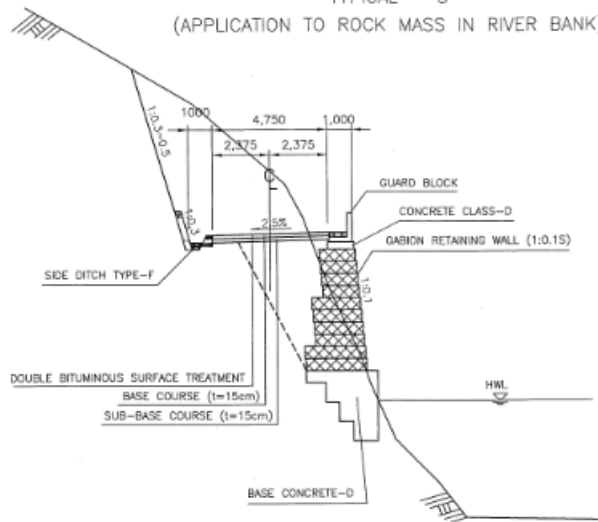
TYPICAL - 4  
(APPLICATION TO LOOSEND ROCK)



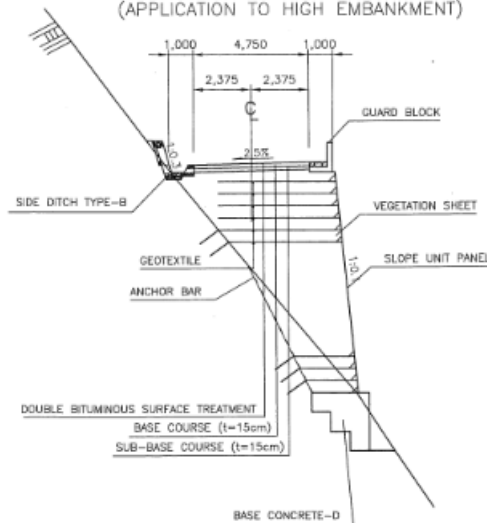
TYPICAL CROSS SECTIONS (2)

SCALE 1:200

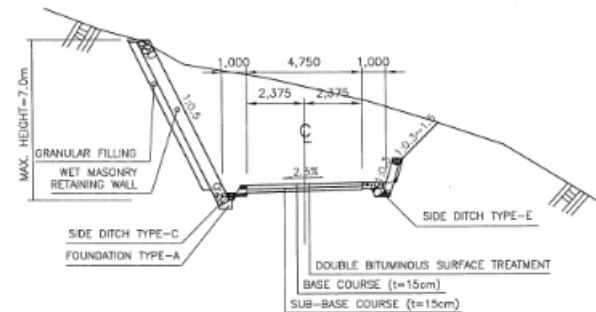
TYPICAL - 5  
(APPLICATION TO ROCK MASS IN RIVER BANK)



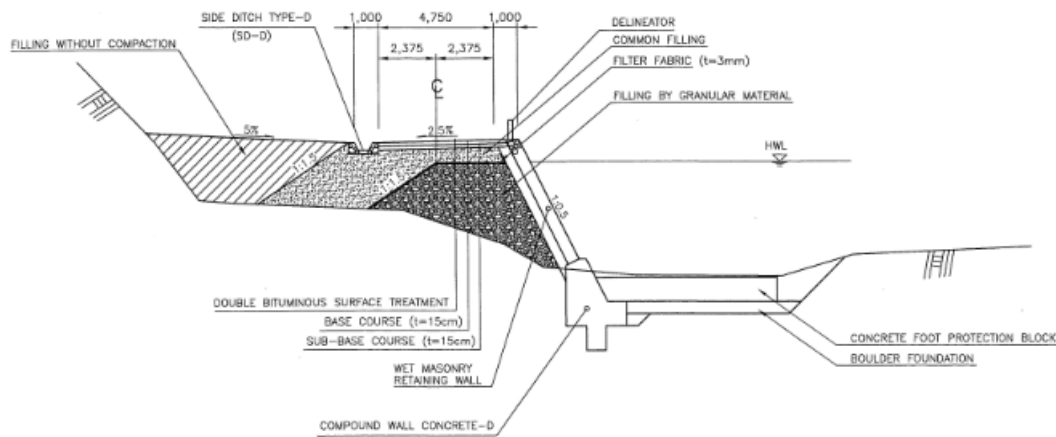
TYPICAL - 6  
(APPLICATION TO HIGH EMBANKMENT)



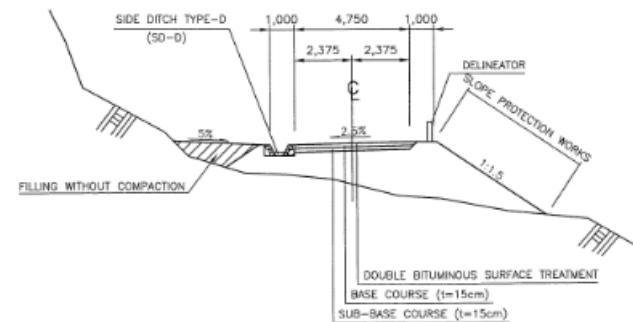
TYPICAL - 9  
(APPLICATION TO OPEN CUT SECTION)



TYPICAL - 7  
(APPLICATION TO EMBANKMENT ON RIVERBED)

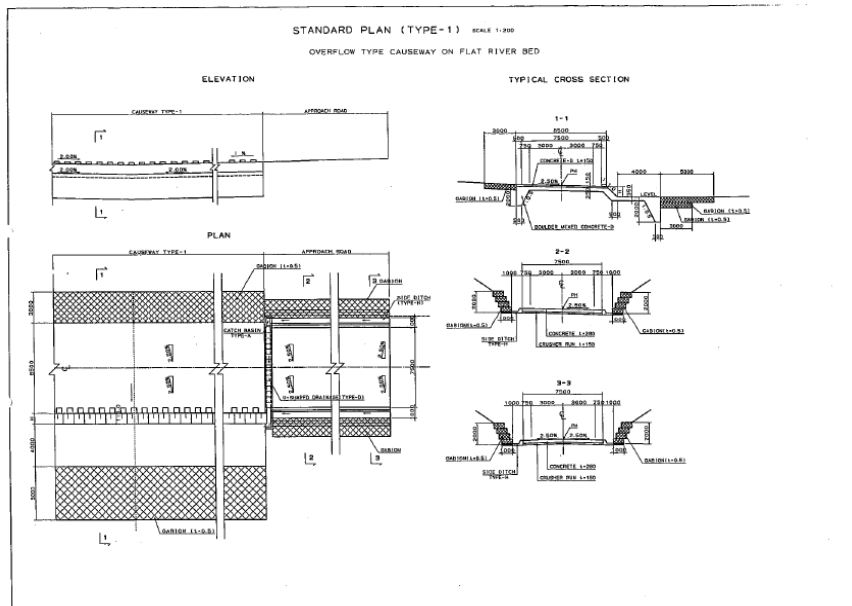


TYPICAL - 8  
(APPLICATION TO FULL EMBANKMENT SECTION)



# Over-flow type causeway (1/2)

- Lowest-cost in river-crossing structures
- Sedimentation would be covered as maintenance work
- Road closure would be considered when flooding



## Over-flow type causeway (2/2)

- Demand of smooth crossing is increasing
- Floor slab was worn and damaged by floating debris



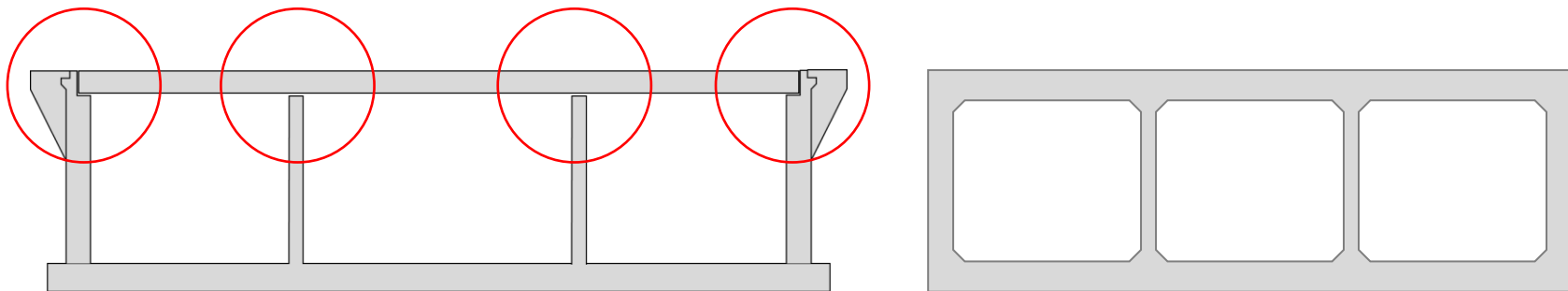
# Lesson learned from the causeway

- Over-flow type causeway was not suitable for the rivers on Sindhuli Road
  - Small traffic volume would allow the over-flow type causeway, while the traffic volume of Sindhuli Road increased and not suitable for the over-flow type causeway
  - Gravel-contained flood harms the concrete slab
- Bridge with cheaper cost was required
  - RC Slab Bridge was applied

## 2. Characteristics of RCSB (1/3)

- a. The concept of RCSB is similar to the multi-cell box culvert, only the difference which top slab (superstructure) and wall/bottom slab (substructure) are structurally separated.

This is why occasional attack by debris or boulder to members would not damage the whole structural system.



## 2. Characteristics of RCSB (2/3)

- b. Due to the separation of superstructure and substructure by movable support on the walls, there is no burden on substructure due to temperature changes.
- c. The continuous deck slab superstructure can eliminate the need of reinforcing bars connecting to the substructure. This idea avoids dense reinforcement and complicated formwork, ensuring better quality, constructability and repairability.

## 2. Characteristics of RCSB (3/3)

- d. Raft foundation is not required any increase against scour depth by any factor as in case of open foundation as stipulated in IRC SP-13.
- e. It is possible to carry out construction by all staging support without using heavy machinery such as large cranes, and then higher safety during construction works is expected.

### 3. Applicability of RCSB (1/2)

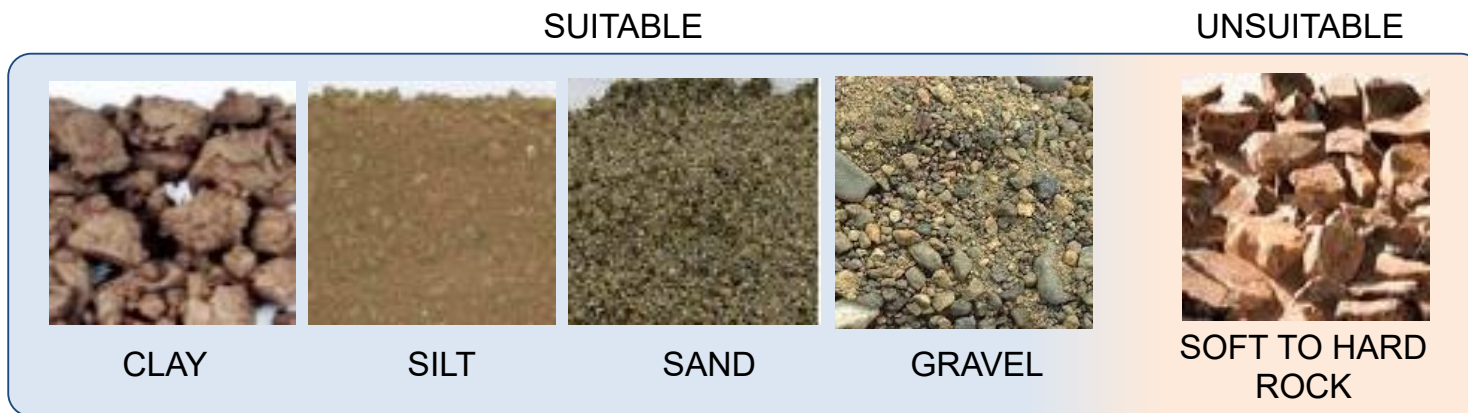
RCSB is suitable for:

- a. The river channel/stream is relatively flat, and the sedimentary layer of the riverbed is thick, and scouring is likely to occur,
- b. The river has a deep groundwater level during dry season and can be excavated without any dewatering or cut slope protection work,
- c. Geological condition of the foundation is relatively soft to medium soil layer, and
- d. Land use condition around the bridge location restricts the road elevation to keep lower as much as possible not to harm the social impact.

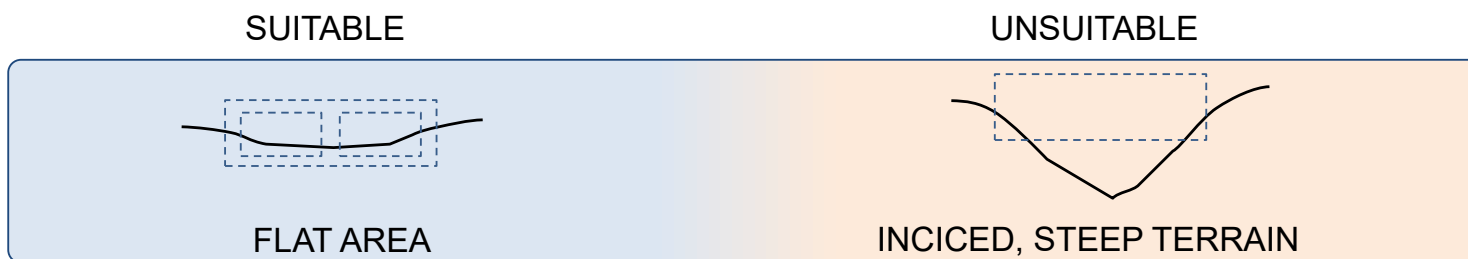
### 3. Applicability of RCSB (2/2)

RCSB is NOT suitable for:

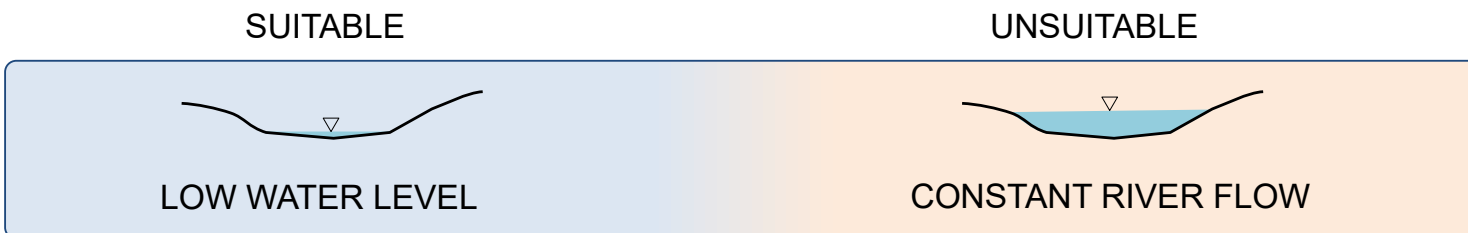
- a. Incised river, steep terrain, natural rocky bottom for waterway,
- b. Sand boiling is expected
- c. River with much amount of driftwood and/or debris flows including large sized boulders, and/or
- d. River with constant flow and/or shallow water depth in dry season.



(1) GEOLOGY AT RIVERBED

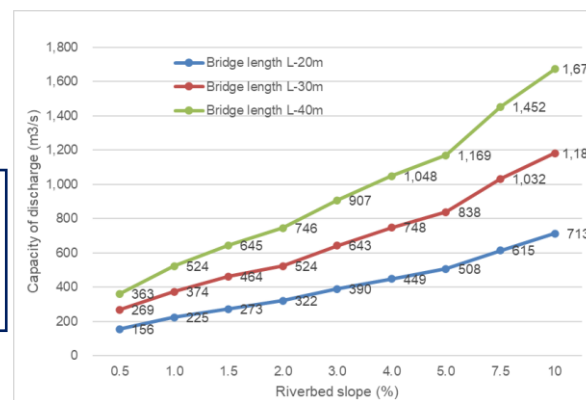
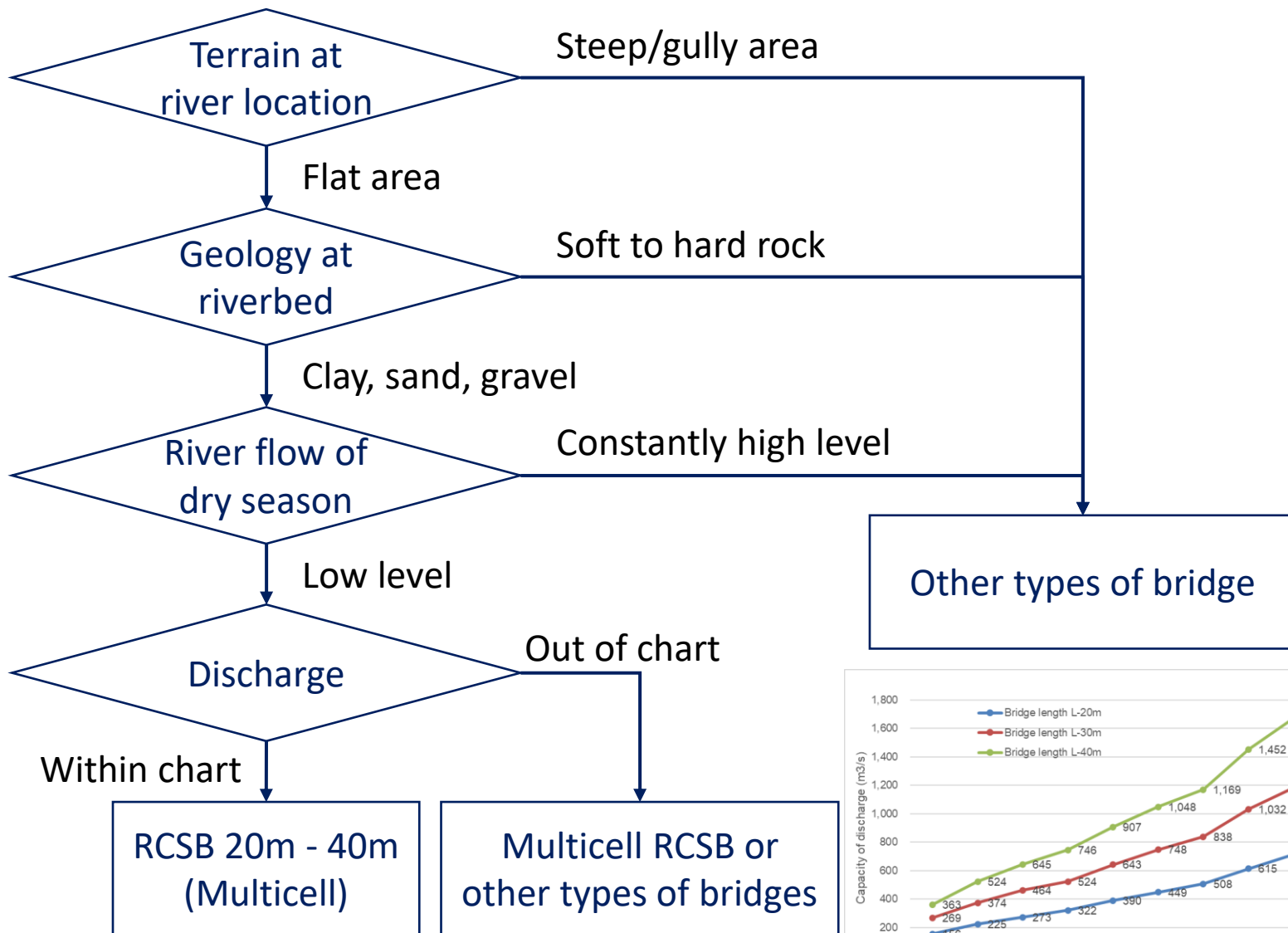


(2) TERRAIN AT RIVER LOCATION



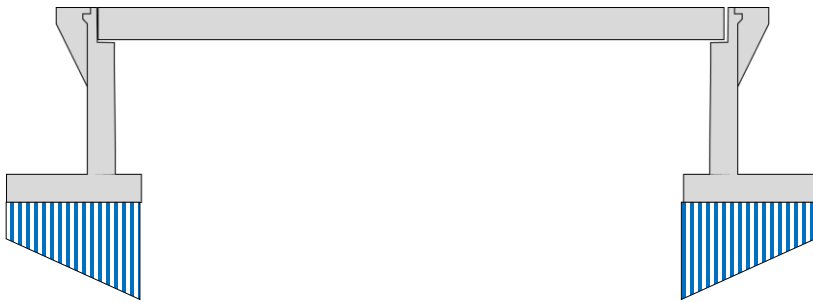
(3) RIVER FLOW DURING DRY SEASON

# Selection of RCSB flowchart

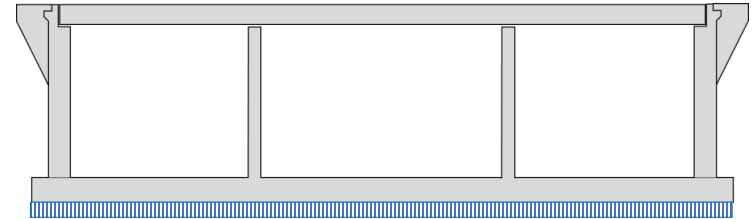


## 4. Structural features of RCSB (1/2)

### Ground reaction



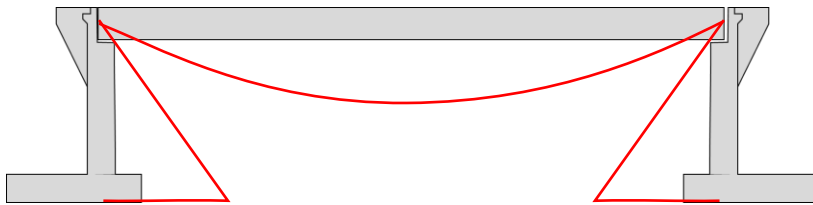
Ground reaction of bridge (abutment)  
= relatively high



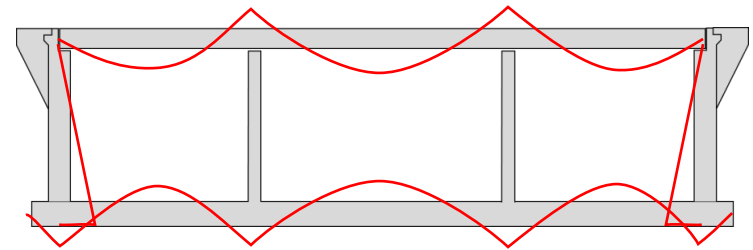
Ground reaction of RCSB  
= relatively low

## 4. Structural features of RCSB (2/2)

Bending moment by loading



Large stress



Small stress by  
Cancelling positive/negative

# 5. Outline of Design Manual

1. Introduction
2. Advantage of the RC Continuous Slab Bridge (RCSB)
3. Site condition survey for bridge location
4. Planning of RCSB
5. Structural design of RCSB
6. Supplemental information

ANNEX

Thank you for your time!

# Training on Design Manual of RCSB and Workshop on Pilot Project

Department of Roads and JICA Expert Team  
12 to 14 October 2022

**Discussion on Bridge Site Selection Aspects**  
(Hydrological and Hydraulics Background)

Ramesh P. Koirala  
JET Member

# Contents

Bridge Site Selection

Information Required for Bridge Dimensions

Information Required - Hydrology

Information Required - Hydraulics

# 3 Pilot Project Bridges in Sindhuli Road (to Replace Existing Damaged Causeways)

Existing Damaged Causeways Need to be Replaced due to

- Risk of road collapse by scouring or erosion
- Frequently road closure occurred
- Increased Traffic Flow (Economic loss, person-time loss)

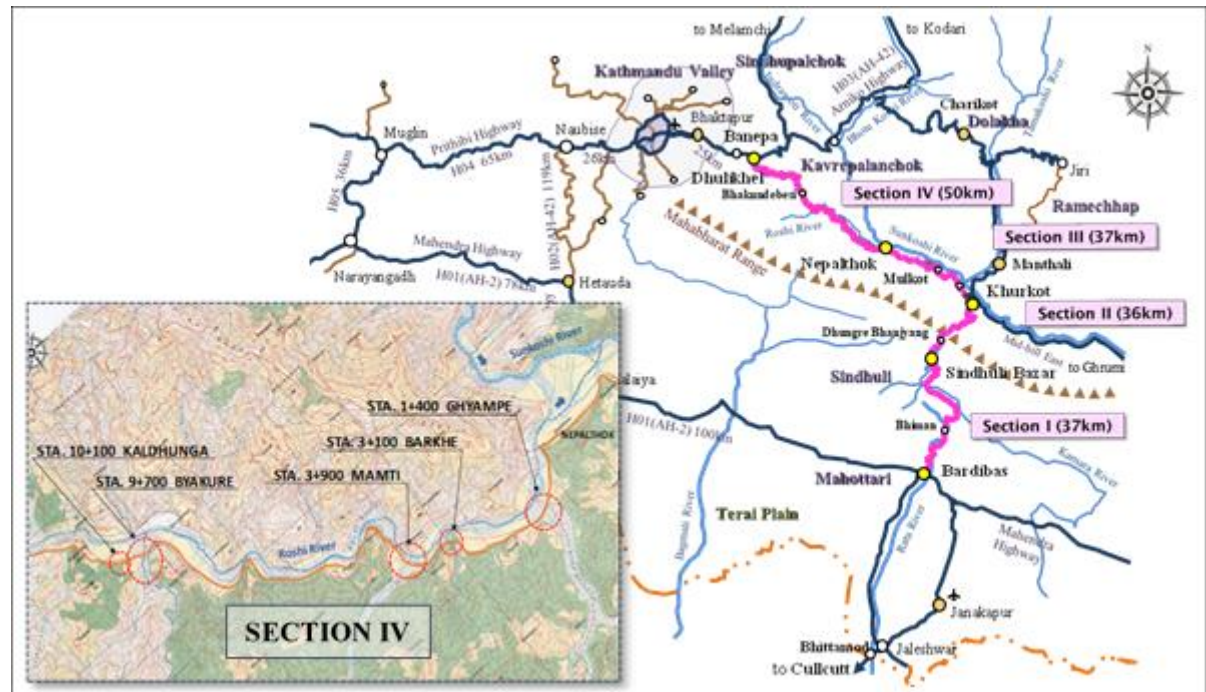
## Sindhuli Road, Section IV

STA.1+400 Ghyampe,

STA.3+900 Mamti,

STA.9+700 Bhyakure

Were selected for Pilot Project out of different 5 sites



# BRIDGE SITE SELECTION

We need to replace Existing Damaged Causeways

- ➔ The alignment is Fixed.
- ➔ No freedom to go U/S or D/S



# Information Required

- Is the site suitable for Bridge Construction
  - i. Topographic Survey (Field Related data for design and construction purposes)
  - ii. Cadastral Maps (Land Ownership and Social Issues)
  - iii. Environment Issues
  
- Is the sub-soil suitable to withstand the load
  - i. Subsoil Investigation (Open-pit, drilling, etc. DCP Test, SPT **N value**)
  - ii. Soil Characteristics & Classifications
  - iii. Type of Bridge (especially Foundation Design)

# Information Required for Bridge Dimensions

- Does the Flow ('K'-Year Return Period) Safely Pass?
  - i. What is Design Flow or Flood (Discharge)  $Q_D$  or Peak Discharge
  - ii. What should be the size of Bridge Openings to pass the  $Q_D$  Safely (Bridge Deck Level – Constraint)
  - iii. Number of Spans and Size of Span
  - iv. Length of the Bridge
  - v. For Safe passage of flood, what river training works are needed to apply?

To confirm the above question, we need to refer to **Hydrology** and **Hydraulics** to **Know the Dimension**.

What Volume of Flood Comes – **Hydrology**

What would be the effect on the Structure & Countermeasures - **Hydraulics**

After deciding on the dimension, **Structure Analysis** is the next.

# Information Required - Hydrology

- The Peak Discharge,  $Q_D$  or  $Q_P$  depends on
  - i. Precipitation (Intensity, Duration)
  - ii. What is the Catchment Area (Size)
  - iii. Shape of Catchment Area and Concentration Time (Pindalu pat, Banana Pat),
  - iv. Type of Vegetation Cover (Agriculture, Forest, etc.)
  - v. Slope

What Percentage of Rainfall Volume reaches the at the Bridge Site—**Runoff Coefficient**

Time of Concentration  $T_c$  for **Maximum Flood (Peak Discharge)**

# Information Required – Hydrology...

## Determining Peak Discharge in the Tributary

The peak discharge in the tributary is estimated using the Rational method based on runoff coefficient, catchment area, and design rainfall intensity for the time of concentration duration. The peak discharge in the tributaries is estimated using the relation presented below.

$$Q_P = \frac{C \cdot I_{TC} \cdot A}{3.6} \quad (7)$$

Where,

$Q_P$  = Peak discharge (m<sup>3</sup>/s)

$I_{TC}$  = Design rainfall intensity for the time of concentration duration (mm/hr)

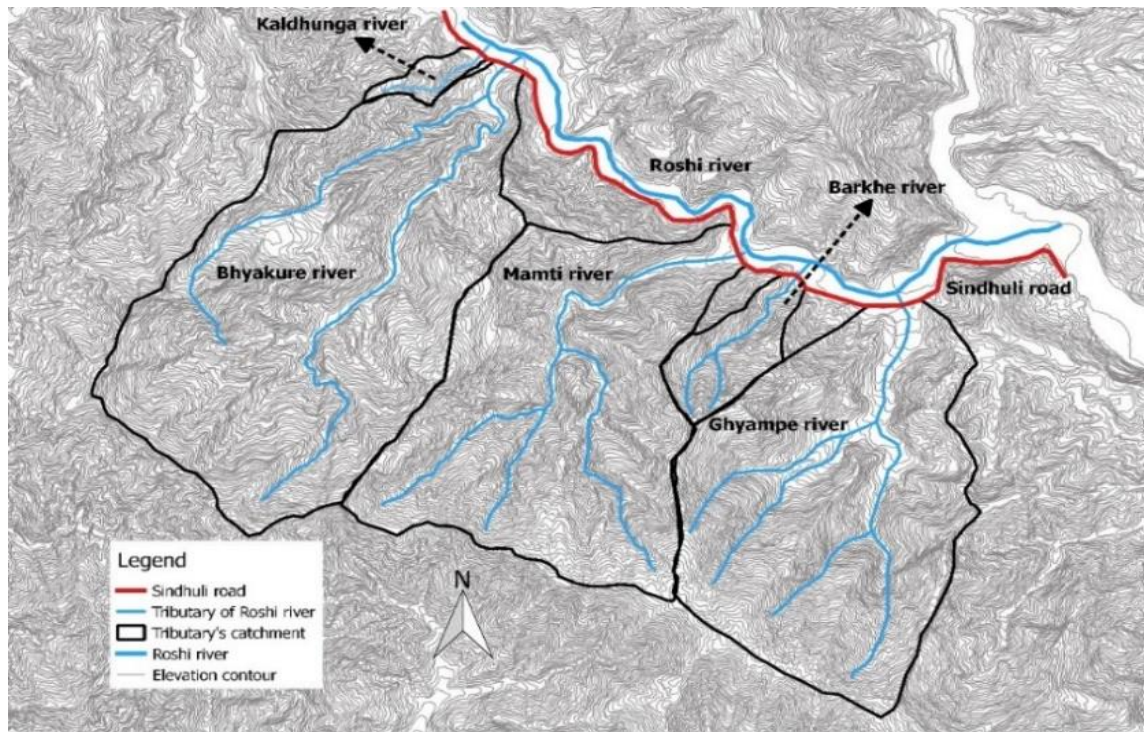
$A$  = Catchment area (km<sup>2</sup>)

$C$  = Runoff coefficient

# Information Required – Hydrology...

## Catchment Area of Tributaries

S. N.	Tributary	Catchment Area
1	Ghyampe river	17.333 km <sup>2</sup>
3	Mamti river	17.173 km <sup>2</sup>
4	Bhyakure river	22.359 km <sup>2</sup>



# Information Required – Hydrology...

The estimated peak discharge in the tributaries for various return periods are presented in Table below.

SN	Tributary	C	A km <sup>2</sup>	10-year Return Period		25-year Return Period		50-year Return Period		100-year Return Period	
				I <sub>TC</sub> mm/hr	Q <sub>P</sub> m <sup>3</sup> /s	I <sub>TC</sub> mm/hr	Q <sub>P</sub> m <sup>3</sup> /s	I <sub>TC</sub> mm/hr	Q <sub>P</sub> m <sup>3</sup> /s	I <sub>TC</sub> mm/hr	Q <sub>P</sub> m <sup>3</sup> /s
1	Ghyampe	0.8	17.333	69.98	269.53	84.32	324.77	96.33	371.04	106.17	408.93
3	Mamti	0.8	17.173	62.29	237.70	74.97	286.11	85.48	326.20	93.99	358.69
4	Bhyakure	0.8	22.359	57.61	286.23	69.29	344.30	78.90	392.04	86.64	430.50

To decide I<sub>TC</sub>, there are many parameters to be decided by the hydrologists including

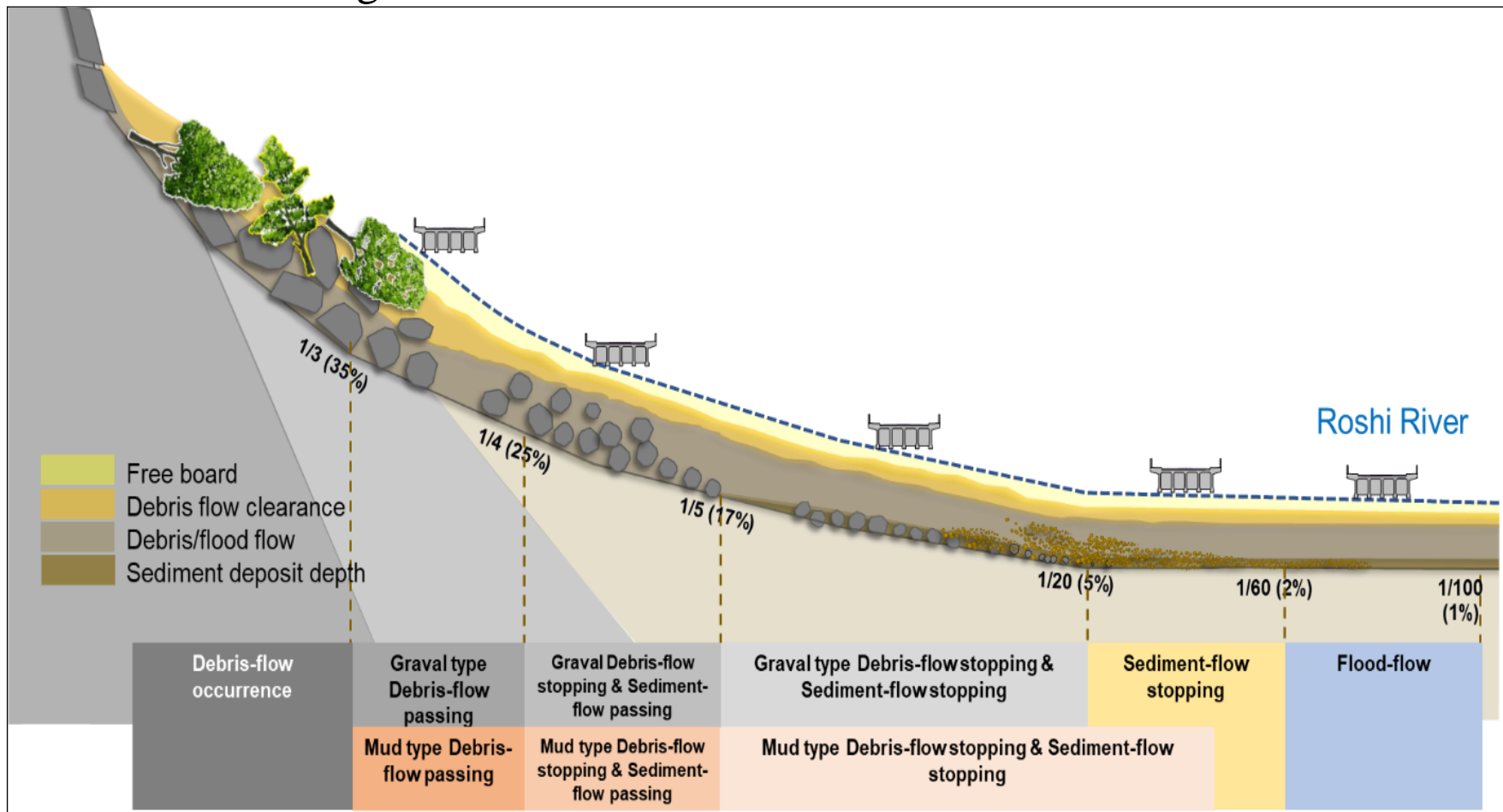
Time of Concentration of Flow (Travel Time of Overland Flow, Travel Time of Flow in Channel), **Estimation of Rainfall Intensity for Time of Concentration Duration (for 'k' return period)**, Runoff Coefficient etc.

Additional Consideration of Debris Flow in the Tributaries –Mountain (1.5 to 2, costly)

**IRC:78 - 1.30 Q<sub>p</sub>**

# Information Required - Hydraulics

- Debris Flow Phenomena
- Riverbed Grading and Nature of Debris-flow



# Information Required - Hydraulics

## River Gradient and Nature of Debris Flow based on Material Type

Gravel Type Debris-flow		Mud Type Debris-flow		Boulder Size	Location of the Sites
Gradient	Nature - Debris Flow	Gradient	Nature of Debris Flow		
steeper than 35% (>1/3)	Debris-flow occurrence section			Boulder larger than 1.5m	
35~25% (1/3~1/4)	Gravel type Debris-flow passing section	35~25% (1/3~1/4)	Mud type Debris-flow passing section		
25~17% (1/4~1/5)	Gravel type Debris-flow stopping and Sediment-flow passing section	25~17% (1/4~1/5)	Mud type Debris-flow stopping and Mud-flow passing section	Boulder size 0.5~1.0m	
17~5% (1/5~1/20)	Gravel type Debris-flow stopping and Sediment-flow stopping section	17~3% (1/5~1/30)	Mud type Debris-flow stopping and Sediment-flow stopping section	Scattering boulder size max. 0.5~1m, mostly granular material	Ghyampe, Mamti and Bhyakure tributaries
5~2% (1/20~1/60)	Sediment-flow stopping section	3~2% (1/30~1/60)	Sediment-flow stopping section		
2~1% (1/60~1/100)	Flood-flow section			Max. granular size 0.1~0.2m	U/S of Roshi River confluence

Source: The Study for the design criteria on the transit roads over devastated rivers, 1982, Technical Center

# Information Required - Hydraulics

## Determination of Length of the Bridges

### 1. General Considerations

- It is desirable to determine the waterway width (hydraulic opening) of the river at the bridge section to pass to the downstream side safely. The width is generally determined considering the following points (*Source: H10: Hydrology Manual for Roads and Bridges, WECS, GON 2018*)
  - a) The contributing watershed area
  - b) The magnitude and frequency of the design discharge
  - c) The roadway alignment and profile, and
  - d) Physical and environmental constraints

The hydraulic design process for sizing the bridge waterway opening shall include the evaluation of water surface elevations in the main channel for existing conditions and for proposed conditions. A comparison of the elevations between these two conditions shall be made to identify the effects of the bridge on the waterway. These results shall clearly identify and mitigate any backwater effects caused by the project (*ibid*).

# Information Required - Hydraulics

## Determination of Length of the Bridges

### 2. Alluvial Streams (Bed moving conditions)

- For wide alluvial streams, the stable width  $W$  can be taken equal to the wetted perimeter
- $W = P = 4.8 Q_P^{1/2}$  Lacey's Regime Condition (ibid)

Where,

$Q_P$  = Peak discharge of normal flood flow (m<sup>3</sup>/s)

$P$  = Water perimeter (m)

$W$  = Linear waterway (m) for wide river  $W$  is almost equal to  $P$

# Information Required - Hydraulics

## Determination of Length of the Bridges

2. For large alluvial streams where meandering over a wide belt, may have several active channels separated by bars, island or shallow section, the total width of the streams may be more than the regime length, no need to consider bridge length longer than the regime length.
  3. The linear waterway of the bridge across an alluvial stream should not be less than the regime width of the stream, Contraction need to be avoided
  4. For semi-alluvial streams, When the banks of a stream are high, well defined and rigid but the bed is alluvial, the linear waterway of the bridge should be made equal to the actual surface width of the stream, measured from edge to edge of water along the HFL on the Plotted cross-section at which the designed maximum discharge can be passed without creating harmful afflux.
  5. For streams with rigid boundaries, some reduction in the linear waterway may, across some streams with moderate velocity, be possible.
  6. For flashy rivers and if the bed can withstand against scour, the waterway should be determined by the area velocity method taking into account the design flood level and its water spread, the characteristics of the bed materials and the water surface slope.
- Judging by several physical characteristics stated above, the proposed three streams (Bhyakure, Mamti and Ghyampe) are very close to the category stated above in point 6, point 5 and point 4 and even among them, very close to point No. 6, Flashy Streams.

# Information Required - Hydraulics

## Determination of Length of the Bridges

### Waterway in a Hilly or Mountainous Terrain

Mazumdar describes, “In a hilly or mountainous terrain where the river flows in gorges with steep bed slope, the flow is usually in supercritical state when depth ( $y$ ) is small and velocity of flow ( $V$ ) is very high, in supercritical flow, Froude’s number of flow, defined as  $F_r = V/(gy)^{1/2}$ , is more than one (1.0). Lacey’s waterway in such situations is very high compared to liner waterway at HFL. Thus, the minimum waterway under the bridge will be determined by the liner waterway at HFL and not by Lacey’s regime waterway. In fact, Lacey’s regime condition is not valid in such a terrain at all.” (Source: Mazumdar S. K., *Determination of Waterway under A Bridge in Himalayan Region – Case Studies, Article*)

$$F_r = V/(g y)^{1/2}$$

Where,

$F_r$	=	<i>Froud’s number of flows</i>
$V$	=	<i>Velocity of flow (m/s)</i>
$g$	=	<i>Acceleration due to gravity 9.81 (m/s<sup>2</sup>)</i>
$y$	=	<i>Flow Water Depth (m)</i>

# Information Required - Hydraulics

## Determination of Length of the Bridges

### Waterway in a Hilly or Mountainous Terrain

For supercritical flow ( $F_r > 1$ ) minimum waterway under the bridge will be determined by the linear waterway at HFL corresponding to design flood discharge. (*ibid*)

The Froude's number of **three rivers** at design discharge flood corresponding to 38m width are presented below. The flow condition in all three rivers are observed as supercritical and hence **Lacey's regime condition cannot be valid**. (*ibid*)

### Determination of Froude's Number of Design Discharge (width of river 38m)

Tributary	Peak Flood Discharge $Q_p$ $m^3/s$	Riverbed Slope $S$ %	Velocity of Flow $V$ $m/s$	Flow Water Height $y$ $m$	Froude's Number of Flow $F_r$ -	Category
Ghyampe	409	7	7.7	2.0	1.7	Supercritical
Mamti	359	6	7.0	1.9	1.6	Supercritical
Bhyakure	431	4	6.6	2.4	1.4	Supercritical

# Information Required - Hydraulics

## Determination of Length of the Bridges

### Past Experience in Sindhuli Road

Sindhuli Road (Dhulikhel- Sindhuli- Bardibas Road), 54 numbers of waterway bridges and structures are constructed in total 160 km of the road with flat, hilly/rolling and mountainous terrain. In Section III of the last, twelve (12) box-type causeways (concept is a submerged bridge) were constructed.

Three (3) of them are designed bridge length in which the adopted width is as around 1/3rd of the original alluvial stream width. The list and characteristics of these box-type causeways are summarized and presented below

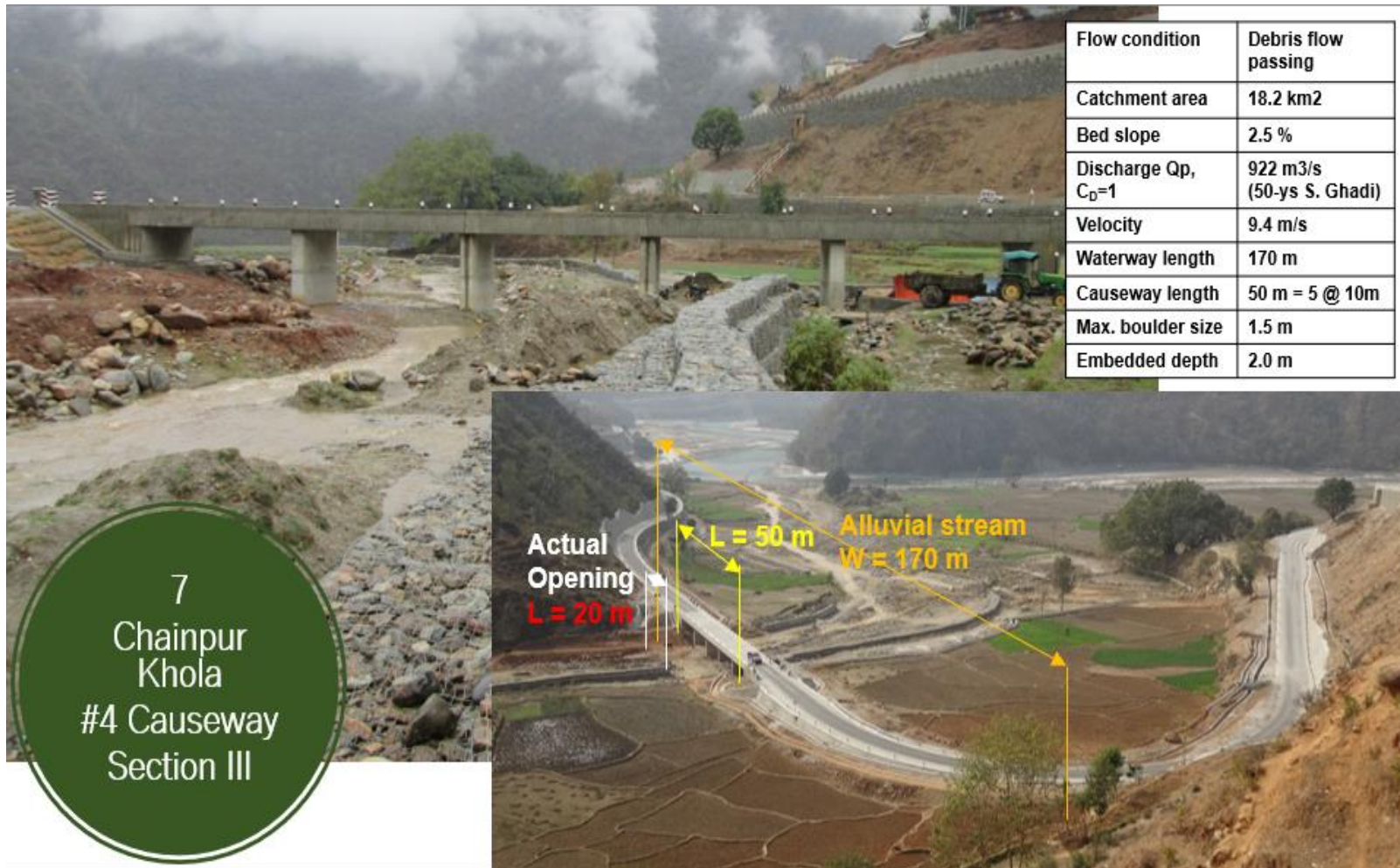
# Information Required - Hydraulics

## The list and Characteristics of these Box Type Causeways in Sindhuli Road Section III

SN	Name of Tributary (Khola)	No.	Catchment Area A	Bed Slope S	Peak Flood QP	Calculated Velocity	Waterway Width at planed Road	Constructed Causeway Length L	Froude's Number of Flow Fr	Lacey's Waterway Width W	Max. Rolling Boulder Dia.	Assumed Section in Devastated Tributaries/Alluvial Stream
			km <sup>2</sup>	%	m <sup>3</sup> /s	m/s	m	m	-	m (L/W%)	m	
1	Andheri	No.1	19.2	3.4	987	4.8	130	130	1	151 (86%)	0.5	Debris-flow stopping
2	Jagire	No.2	1.3	5.7	62	3.3	30	30	0.9	38 (79%)	-	Debris-flow stopping
3	Bhadaure	No.3	4	10.9	186	5.3	50	50	1.2	-	-	Debris-flow passing
4	Bhalu	#1	0.6	11	29	5.8	30	30	2.3	-	1	Debris-flow passing
5	Niguli	#2	21.7	3.4	1,101	3.2	190	190	0.5	159 (119%)	2	Debris-flow stopping
6	Gadaule	#3	0.7	8.9	37	7.6	20	20	2.1	-	-	Debris-flow stopping
7	Chainpur	#4	18.2	2.5	922	9.4	170	50	1.7	-	1.5	Debris-flow
8	Khahare	#5	4.5	6.9	230	5	120	90	1.7	-	0.75	Debris-flow stopping
9	Bhote	#6	18	3.2	916	8.8	70	40	1.5	-	1	Debris-flow stopping
10	Gangate	#7	19	2.9	966	7.7	130	60	1.5	-	0.75	Debris-flow
11	Dhamile	#8	28.4	3.2	1,439	7.9	190	70	1.2	-	1.5	Debris-flow stopping
12	Sadhi	#9	7.2	5	366	7.1	90	90	1.9	-	0.3	Debris-flow stopping

# Information Required - Hydraulics

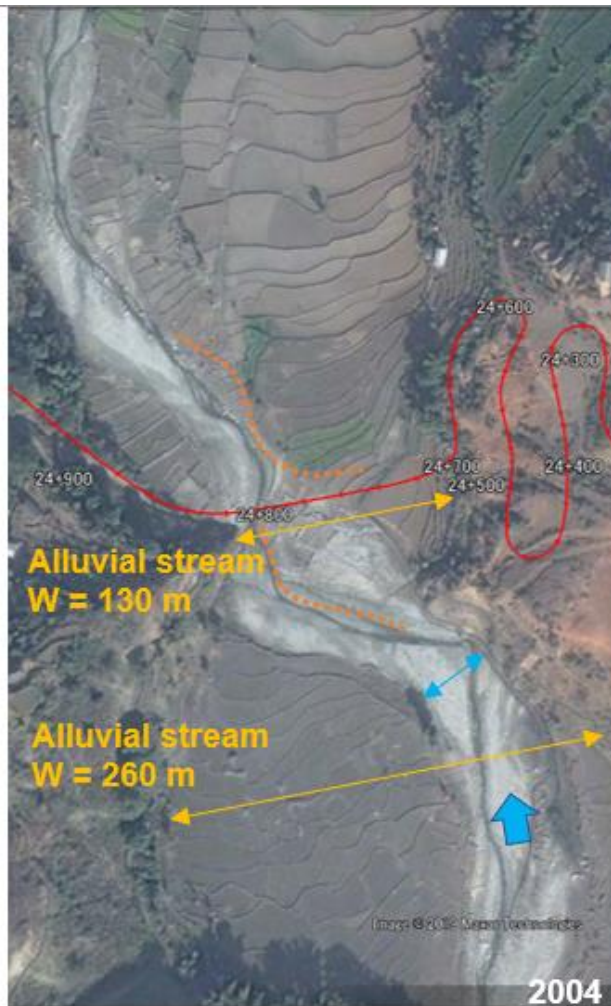
The following illustrations showing the arrangement of bridge realized at various locations of Sindhuli Road Section 3 presented in figures below.



7  
Chainpur  
Khola  
#4 Causeway  
Section III

# Information Required - Hydraulics

Flow condition	Debris flow passing
Catchment area	19.0 km <sup>2</sup>
Bed slope	2.9 %
Discharge Qp, C <sub>D</sub> =1	966 m <sup>3</sup> /s (50-ys S. Ghadi)
Velocity	7.7 m/s
Causeway length	60 m 6 @ 10m
Max. boulder size	0.75 m (1.0 m)
Embedded depth	1.0 m



10  
Gangate  
Khola  
#7 Causeway  
Section III

# Information Required - Hydraulics

Flow condition	Debris flow passing
Catchment area	19.0 km <sup>2</sup>
Bed slope	2.9 %
Discharge Qp, C <sub>D</sub> =1	966 m <sup>3</sup> /s (50-ys S. Ghadi)
Velocity	7.7 m/s
Causeway length	60 m 6 @ 10m
Max. boulder size	0.75 m (1.0 m)
Embedded depth	1.0 m

Dhamile Khola  
#8  
Causeway  
Section III



# Information Required - Hydraulics

Since a significant period has already been elapsed after completion of these bridge and they are performing satisfactorily till now. Table below shows the three causeways and their present conditions in details

SN	Name of Tributary	Alluvial Stream Original Width	Froude's Number of Flow Fr	Max. Rolling Boulder Size	Cause-way Length	Public Protest while Construction requested with Bandha	Bank Protection Work done by DWIDP (now DWRI)	Actual waterway width after protection wall constructed	Present Condition of the waterway
7	Chainpur	170 m	1.7	1.5 m	50 m	Protection of the rice field at U/S and D/S side in waterway	Construct gabion wall along the government land and narrowed waterway	20 m	Calm
					-29%			-12%	
9	Bhote	75m	1.5	1.0 m	40 m	Protection of the rice field at U/S side in waterway	Construct gabion wall along the government land and narrowed waterway	40 m	Calm
					-53%			-57%	
10	Gangate	130 m	1.5	0.75 m	60 m	Protection of the cultivated land/rice field located in the upstream waterway	Construct dry rip-rap along the government land and narrowed waterway	15 m	Calm
					-46%			-12%	
11	Dhamile	190 m	1.2	1.5 m	70 m	Protection of the rice field at U/S and D/S side in waterway	Construct gabion wall along the government land and narrowed waterway	20 m	Calm
					-37%			-11%	

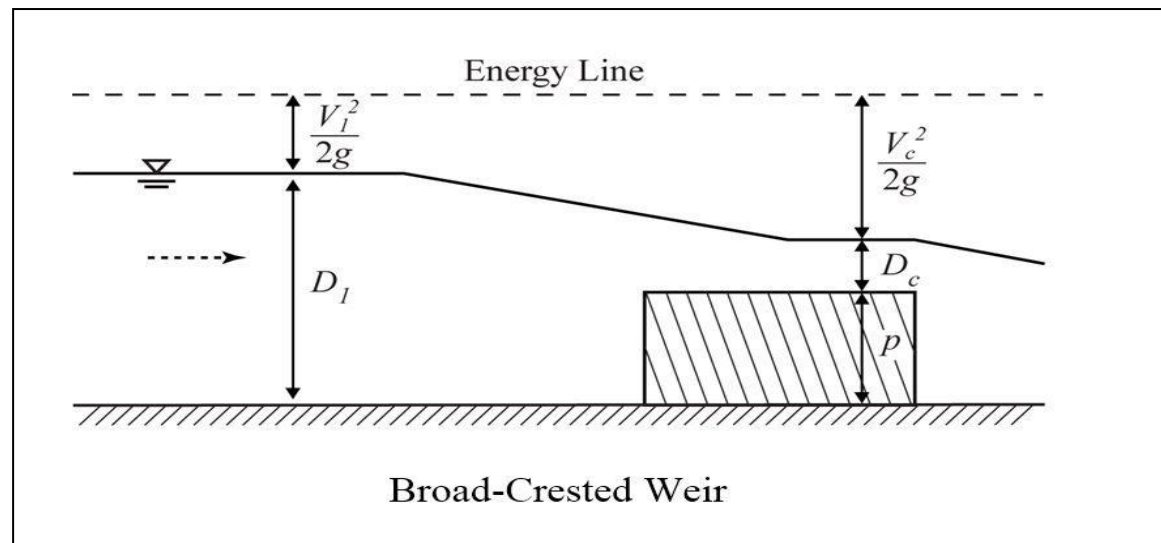
# Information Required - Hydraulics

## Determination of Length of the Bridges

### Corollary, Calculation of Discharge by Broad Crested Method

#### Bhyakure Tributary

Because of local scour on the downstream side of the road, Bhyakure Causeways has a free drop (fall) of about 8m. The flow along this river can be assumed as free flow and the equation of broad crested fall can be applied for calculating the passing discharge. The definition sketch of Broad Crested fall is presented in Figure 3-3 below.



# Information Required - Hydraulics

## Determination of Length of the Bridges

### Corollary, Calculation of Discharge by Broad Crested Method

#### Bhyakure Tributary

At the brink of fall of Broad Crested Weir (BCW) the flow becomes critical flow and hence the Froude Number becomes 1.

$$Fr = V_c / \sqrt{g \times D_c} = 1$$

$$\rightarrow V_c = \sqrt{g \times D_c} \quad \dots\dots\dots (\text{eq. 1})$$

On July 13, 2019 about 8:00 AM, the flood at Bhyakure Khola experienced highest flood and the real time photograph taken at that moment revealed that the height of flow at the brink of fall has been judged as equal to 70cm to 1.0 m. Average height can be judged as 85 cm which is critical depth of flow,  $D_c$  as shown in the figure 3-4 below with image view raised up

# Information Required - Hydraulics

## Determination of Length of the Bridges

### 3 Review of the disaster occurred by heavy rainfall on 2019.7.12 caused tributaries to flood flow

By this heavy rain, max. around 1 m height of flood over the road (floodway) had occurred on interviews with villagers and video, photo.

A video had taken at Ghyampe floodway site of a peak flood time of 8 AM shown wave height is max. less than 1m and waterway width is 33 m.

Image view of the raised up water flood on 7.12

Bhyakure Tributary  
(Movie: Peak Flood on  
2019.7.12 8 AM.)

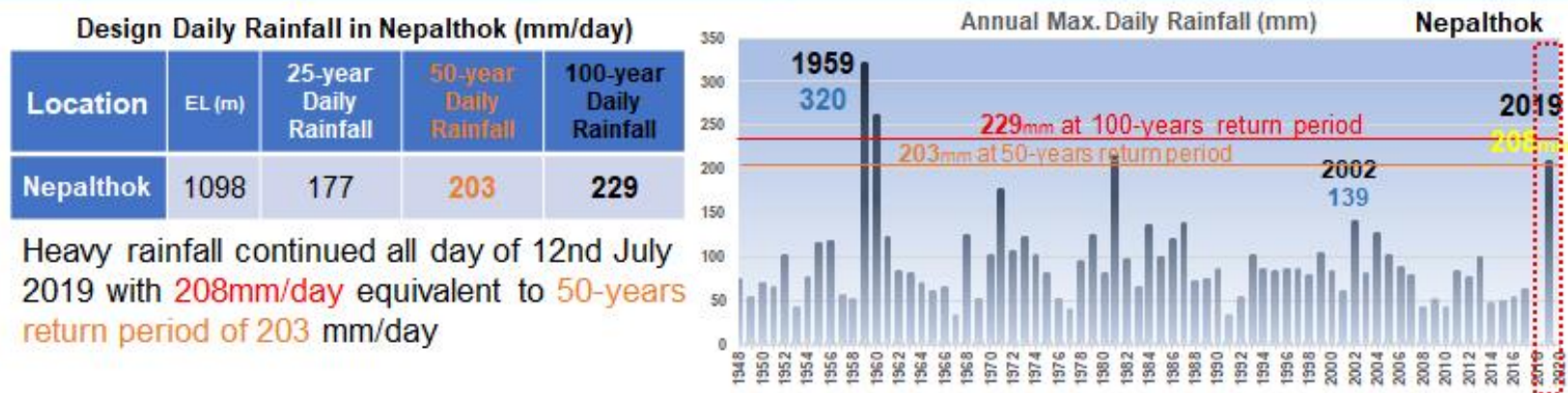


# Information Required - Hydraulics

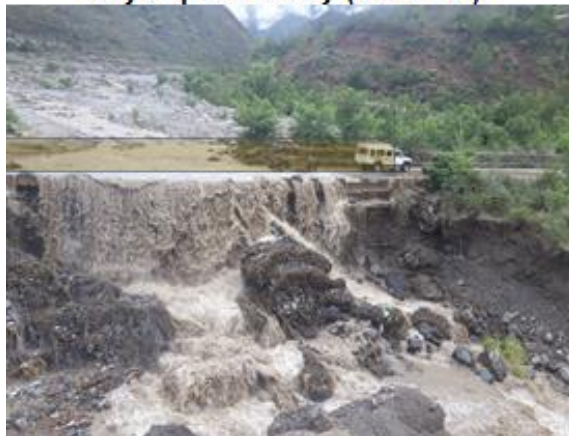
Considering the flow as critical flow (being over Broad Crest), the velocity is critical as per eq – 1 above, equal to 2.89 m/s and hence  $Q = Ax V_c (0.85 \times 33 \times 2.89) = 81 \text{ m}^3/\text{s}$

From the record of Department of Hydrology and Meteorology, Government of Nepal, the Rainfall occurred at Nepalthok Station for the period has been shown in the figure 3-5 below

**Study after the Heavy Rainfall: Comparison of the Daily Rainfall of Annual Max. and 100-years Return Period**



Ghyampe Tributary (2019.7.13)



Mamti Tributary (2019.7.13)



Bhyakure Tributary (2019.7.14)



# Information Required - Hydraulics

## Corollary, Calculation of Discharge by Broad Crested Method

### Bhyakure Tributary

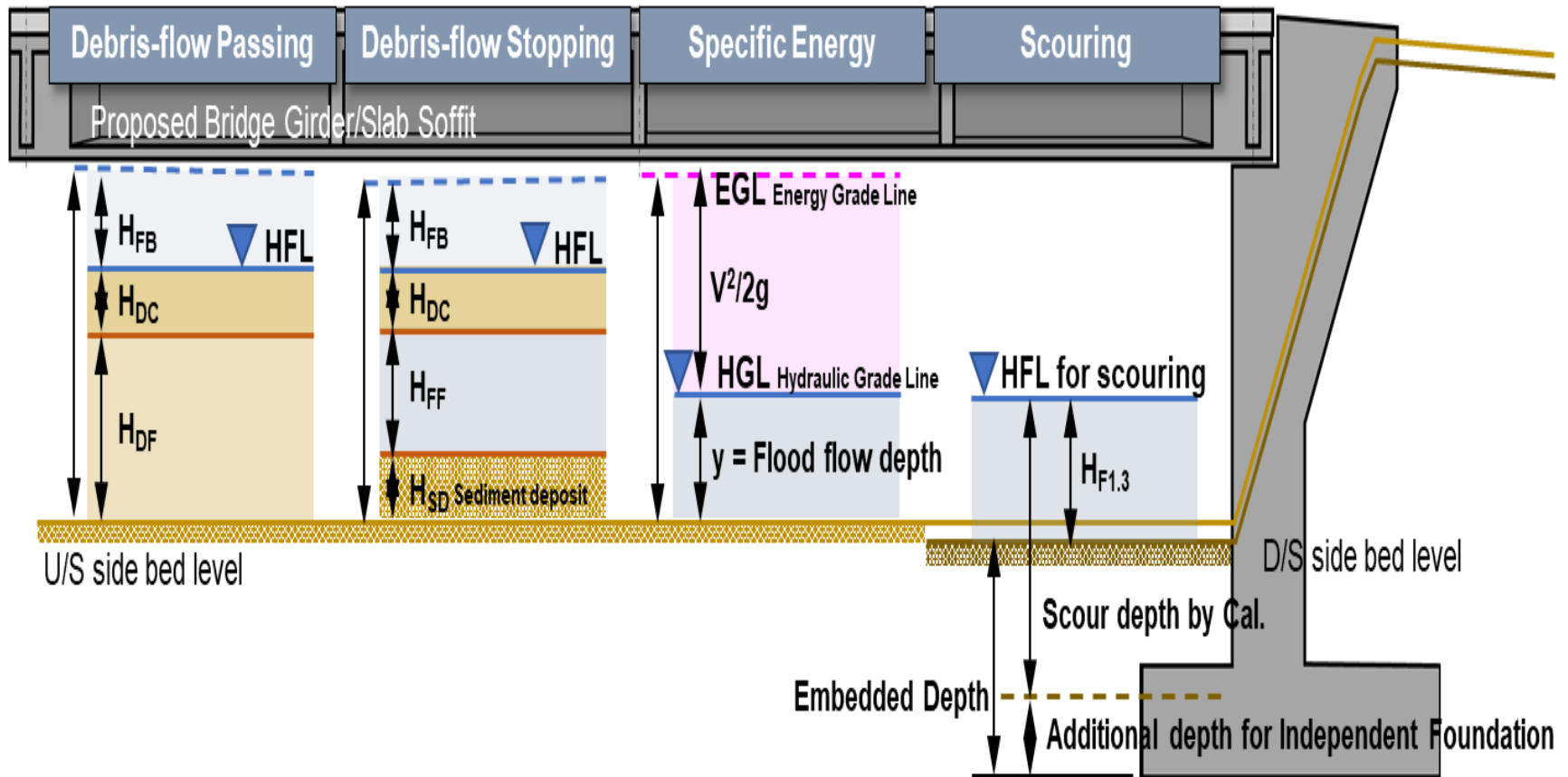
Heavy rainfall continued all day of 12<sup>th</sup> July 2019 with 208mm/day which is equivalent to a 50-year return period of 203mm/day. That means, the observed discharge at Bhyakure at peak flood time at 8:00 AM of July 13, 2019, is equal to 81 m<sup>3</sup>/s, which is nearly 50 years of returned period discharge. Forecasting 100 years return period flow that from 50 years return period is about additional 10% more, which would be about 90 m<sup>3</sup>/s.

**In conclusion, the Design Discharge of Bhyakure Tributary calculated from the rational method for a 100-year return period is 430 m<sup>3</sup>/s is far higher than the observed value equivalent of 90 m<sup>3</sup>/s.**

# Information Required - Hydraulics

## 1. Determination of Vertical Clearance of the Bridges

A definition sketch showing various aspects of vertical clearance based on the hydraulics requirement is presented below.



# Information Required - Hydraulics

The Vertical Bridge Clearance basically can be defined from the following two cases by the linear waterway at HFL and Specific Energy Head.

Case 1 The Linear Waterway at HFL corresponding to Design Flood Discharge

Case 1-1

$H_{VCI}$  Against Passing of Highly Viscous Debris-flow (Bed Slope  $S=17\sim5\%$ )

Where,

$H_{DF}$  = Maximum height of Sediment-flow Wave (m) at  $Q_{DF}=2.857Q_P$

$H_{DC}$  = Clearance for Gravel/Mud type debris-flow (m)

$H_{FB}$  = Free board for Bridge based on  $Q_{DF}$  (m) = Maximum size of Boulder

$H_{VCI}$  = Vertical Clearance =  $H_{DF} + H_{DC} + H_{FB}$  (m)

Case 1-2

$H_{VC2}$  Against Stopping of Highly Viscous Debris-flow (Bed Slope  $S=17\sim5\%$ )

Where,

$H_{SD}$  = Sediment deposit depth (m) = Maximum size of Boulder

$H_{FF}$  = Height of Peak Flood-flow (m) at  $Q_P$

$H_{DC}$  = Clearance for Gravel/Mud type Debris-flow (m) = Maximum size of Boulder

$H_{FB}$  = Free board for Bridge based on  $Q_P$  (m)

$H_{VC2}$  = Vertical Clearance =  $H_{SD} + H_{FF} + H_{DC} + H_{FB}$  (m)

# Information Required - Hydraulics

## Case 2 Specific Energy Head

$$E = y + V^2/2g$$

Where,

$E$	=	<i>Specific Energy Head (m)</i>
$y$	=	<i>Flow Water Depth (m)</i>
$V$	=	<i>Velocity of flow (m/s) at Peak Flood-flow</i>
$g$	=	<i>Acceleration due to gravity 9.81 (m/sec<sup>2</sup>)</i>

To pass normal and debris flows of 100-year return period from bridges safely the vertical clearance of the bridges are determined considering the free board of 1.5m (1.2 m for normal flood and 1.5 m for debris flow) and the two-meter (2.0 m) margin recommended by the DOR. The two-meter margin recommended by DOR is used for compensating the reduced clearance by sediment deposition (1.0 m) and for providing clearance to debris (1.0 m). The design vertical clearances for bridges to be constructed in the tributaries are presented in Table 3-30 and Table 3-31 below.

# Information Required - Hydraulics

## Selection of Vertical Clearance

Table Calculation of Vertical Clearance Case 1-1 against **Passing** of Highly Viscous Debris-flow

a) Bridge Opening = 38.0m								
Tributary	100-year Return Period		Bed Slope	Velocity at $Q_P$	Max. Flow wave height	Clearance of debris-flow	Free board at $Q_{DF}$	Total Clearance Height
	Flood-flow	for Max. Wave						
	$Q_P$	$Q_{DF}=2.857Q_P$	S	V	$H_{DF} (y)$	$H_{DC}$	$H_{FB}$	$H_{VC}=H_{DF}+H_{DC}+ H_{FB}$
	$m^3/s$	$m^3/s$	%	m/s	m	m	m	m
Ghyampe	409	1169	7	7.8	2.5	1.0	1.5	5.0
Mamti	359	1024	6	7.0	2.4	1.0	1.5	4.9
Bhyakure	431	1230	4	6.6	3.1	1.0	1.5	5.6

Table 3-31 Calculation of Vertical Clearance Case 1-2 against **Stopping** of Highly Viscous Debris-flow

(a) Bridge Opening = 38.0m,								
Tributary	100-year Return Period	River Bed Slope	Velocity at $Q_P$	Sediment Deposit Depth	Flood-flow Height	Clearance of Debris-flow	Free Board at $Q_{DF}$	Total Clearance Height
	Flood-flow							
	$Q_P$	S	V	$H_{SD}$	$H_{FF} (y)$	$H_{DC}$	$H_{FB}$	$H_{VC}=H_{SD}+H_{DF}+H_{DC}+ H_{FB}$
	$m^3/s$	%	m/s	m	m	m	m	m
Ghyampe	409	7	7.8	1.0	1.3	1.0	1.5	4.8
Mamti	359	6	7.0	1.0	1.3	1.0	1.5	4.8
Bhyakure	431	4	6.6	1.0	1.6	1.0	1.5	5.1

# Information Required - Hydraulics

1. **Determination of Scour Depth**
2. **Scour Depth Calculation by IRC:78-2014**
3. IRC:78-2014 explains the conditions regarding the determination of Scour Depth for Foundation
4. As per §703.1.1, the design discharge to adopt needs to be increased by 30% in addition for the river having catchment area less than 3000 km<sup>2</sup>.

*Mean Scour Depth*

$$R_s = 1.34 (q^2/f)^{1/3} \quad \text{for Lacey's Regime}$$

*Condition*

*Where,*

$$\begin{aligned} q &= \text{Discharge intensity} = (\text{Design Discharge} / \text{width of River}) \\ f &= \text{Silt factor} = 1.76\sqrt{m} \\ m &= D_{50 \text{ (median size)}} \text{ of bed materials (mm)} \end{aligned}$$

For Constriction of Regime Condition

*Normal Scour Depth*

$$D_N = R_s (W/L)^{0.61}$$

*Where,*

$$\begin{aligned} W &= \text{Lacey's Regime Waterway Width } B = 4.75\sqrt{Q}_{F1.3} \\ L &= \text{Contracted Width} = \text{Bridge Length} \\ m &= D_{50 \text{ (median size)}} \text{ of bed materials (mm)} \end{aligned}$$

$$\text{Max. Depth of Scour} = 1.27 \times D_N \quad \text{§ 705.3.1.1 of IRC:78-2014}$$

# Information Required - Hydraulics

## 1. Determination of Scour Depth

Based on these conditions, the Maximum Scour Depth for Ghyampe, Mamti and Bhyakure rivers have been calculated and presented in Table below.

Table Scour Depth Calculation by IRC:78

Tributary	Cases	General Parameters			B=W	L	m	f	$R_s$	$D_N = R_s (W/L)^{0.61}$	Scour Depth below from <b>HFL</b> $1.27 \times D_N$
		$Q_P$ m <sup>3</sup> /s	$C_D = Q_{DF}/Q_P$	$Q_{F1.3}$ m <sup>3</sup> /s							
Ghyampe	II	409	1.3	532	109.5	38	150	22	2.82	5.4	6.7
Mamti	II	359	1.3	467	102.6	38	150	22	2.58	4.7	5.9
Bhyakure	II	431	1.3	560	112.4	38	160	22	2.91	5.7	7.0

**Add additional 2 m below Deepest Scour Level → Foundation Level**

**THANK YOU**

# Overview of the Manual and Structural Design of RCSB

Department of Roads and JICA Expert Team

14 October 2022

# Contents

1. Outline of Manual
2. Explanation of each chapter
3. Structural analysis
4. Reinforcement

# 1. Outline of Manual

1. Introduction
2. Advantage of the RC Continuous Slab Bridge (RCSB)
3. Site condition survey for bridge location
4. Planning of RCSB
5. Structural design of RCSB
6. Supplemental information

ANNEX

## 2. Each chapter (1/13)

### 1. Introduction

- Briefly described why JET adopted RCSB as river crossing structure in Sindhuli Road projects

SR0M 2

Planning and Design Manual for RC continuous Slab Bridge

#### I. INTRODUCTION

Sindhuli Road (B. P. Highway) has many multi-cell-shaped-causeways which have been designed and constructed as waterway crossing structures on the widely flat alluvial fans in the Lower Himalayan and the Siwalik Hills. By allowing occasional overflow on its slab and easy reparability for damage on RC members by debris or sediment flow, they become economical structures and can be used for bridges of small to medium length with lower height.

Based on the proven causeway on the Sindhuli Road, a RC continuous slab bridge (hereinafter called as RCSB) has been adopted for structural type of the Mamti Bridge on SR0M 2 Project (The Project for the Operation and Maintenance of the Sindhuli Road Phase 2).

Because of these accomplishments, JICA Expert Team was asked to establish the planning and design manual for RCSB. This manual complies with the Nepal Bridge Standards as well as the Indian, Japanese and other relevant standards.

In this manual, general planning, design procedures and conditions for RCSB are regulated, and three standard bridge types of length are summarized.



Source: JICA Expert Team

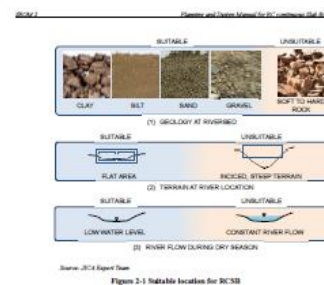
Figure 1-1 Photo of RCSB on Sindhuli Road and its feeder line

# 2. Each chapter (2/13)

## 2. Advantage of RCSB

- Characteristics of RCSB, Applicability of RCSB are described
- Type and length of RCSB are standardized

Length (m)	Span (m)	Height (m)
20	10+10	10
30	10+10+10	10
40	12+16+12	12



Source: JICA Report Team

Figure 2-1 Suitable location for RCSB

### 2.3 Standardization of RCSB

Based on the economic comparison, RCSB might be most economic bridge when the total height of structure is relatively low (less than 10m or around).

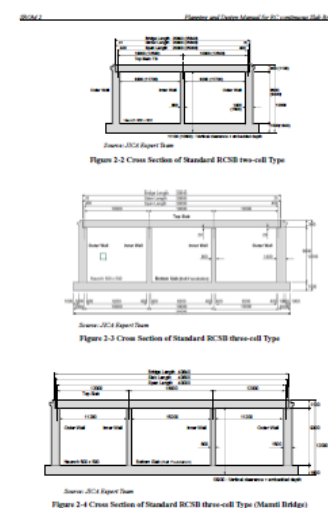
In this manual, overall design procedures and methods are described for RCSB. Especially for the bridge length of 20m, 30, and 40m, the length which might be frequently planned and adopted, general drawings and reinforcement bar arrangement are prepared.

Table 2-3 Alternative List of Typical Bridge with Bridge Condition

Type	Span length	Span arrangement	total height	clear height	side-girder reaction for design	Remarks
1	20m	10m + 10m	10m	5.0m	60% (10+10)	
2	30m	10m + 10m + 10m	10m	5.0m	60% (10+10)	
3	40m	12m + 16m + 12m	12m	6.0m	60% (12+12)	

Source: JICA Report Team

The elevation view of the RCSB are shown in Figure 2-2 for the one case of two-cell type and Figure 2-3 and 2-4 for the two cases of the three-cell type.



Source: JICA Report Team

Figure 2-2 Cross Section of Standard RCSB two-cell Type

Source: JICA Report Team

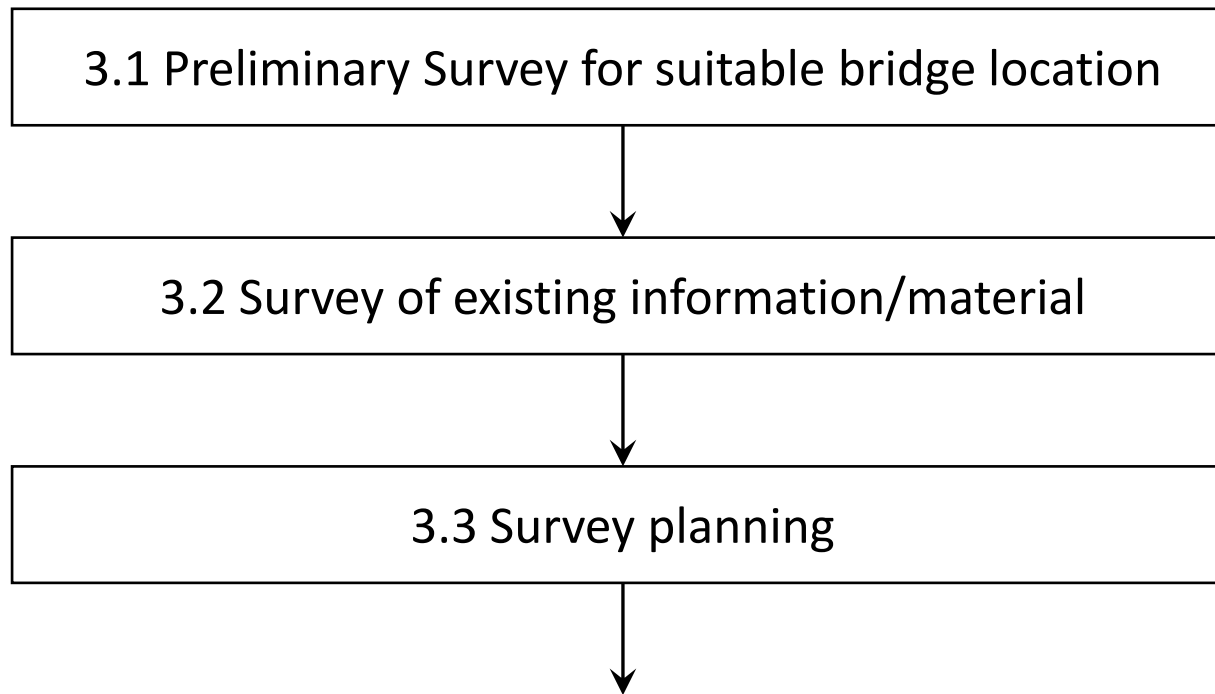
Figure 2-3 Cross Section of Standard RCSB three-cell Type

Source: JICA Report Team

Figure 2-4 Cross Section of Standard RCSB three-cell Type (Mixed Bridge)

## 2. Each chapter (3/13)


### 3. Site condition survey for bridge location



## 2. Each chapter (4/13)

### 3. Site condition survey for bridge location (cont.)

#### 3.4 Types of survey

- 1) Surveys of river characteristics (discharge)
  - 2) Topographical survey (sub-contract survey)
  - 3) Geotechnical survey (sub-contract survey)
  - 4) Surveys of construction conditions
- 

## 2. Each chapter (5/13)

### 3. Site condition survey for bridge location (cont.)

#### 3.5 Particular survey for bridge locations

- 3.5.1 Survey of alluvial fan in Hilly Terrain
- 3.5.2 Surveys of Soft Ground
- 3.5.3 Test Pit Survey in the Alluvial Plain
- 3.5.4 Survey of River Characteristics and Water Utilization
- 3.5.5 Topographical Survey for Hydrological and Hydraulic Study
- 3.5.6 Evaluation of Geotechnical Parameters for Foundation Design
- 3.5.7 Survey of Construction Condition

## 2. Each chapter (6/13)

### 4. Planning of RCSB

#### 4.1 Underground water condition at alluvial plain

A bridge is planned in an alluvial plain, for selection of the proposed bridge site, it is required to confirm the underground water table and condition in dry season for construction of foundation by open excavation method to avoid sand boiling and spring water.

## 2. Each chapter (7/13)

### 4. Planning of RCSB (cont.)

#### 4.2 Bearing Ground Condition

To apply the slab bridge, the following points must be satisfied. In addition, it is desirable to confirm the design conditions by geotechnical survey.

- 1) Sub-grade below the raft foundation shall be equal or more than SPT N-value 10.
- 2) It is required to confirm no sand boiling in the ground water at plain area.

## 2. Each chapter (8/13)

### 4. Planning of RCSB (cont.)

#### 4.3 River condition for RCSB

##### 4.3.1 Considerations for incidental large debris-flow

Since the slab bridge has a short span and a limited horizontal opening width, the principle is that there are no occurrence debris-flows that will be obstacles after construction.

##### 4.3.2 River flow with debris and boulders

In river with debris-flow, if the boulder size is medium and the river stream tends to stabilize riverbed and bank year by year, it may be possible to adopt the bridge.

##### 4.3.3 Floating obstacles (driftwood)

To avoid applying the slab bridge to rivers where driftwood (especially rooted driftwood) flows down.

## 2. Each chapter (9/13)

### 4. Planning of RCSB (cont.)

#### 4.4 Determination of RCSB outer walls and bridge length

##### 4.4.1 Positioning the Outer Walls and Bridge Length

The engineers should choose trial positions of the abutments (outer walls) and which location of them must be determined from the flow path during floods in the past rainy season and while flooding.

##### 4.4.2 Bridge length by Lacey's Regime Theory

The linear waterway of the bridge  $W$  should be equal to Lacey's regime waterway given by the equation of  $W=4.8QP^{1/2}$  as stated in IRC:5-1998.

##### 4.4.3 Bridge length at waterway in hilly terrain

The slab bridge located in a hilly terrain with steep bed slope, for supercritical flow (Froude's number  $>1$ ) minimum waterway under the bridge will be determined by the linear waterway at HFL.

## 2. Each chapter (10/13)

### 4. Planning of RCSB (cont.)

#### 4.5 Determination of RCSB height

##### 4.5.1 Peak Flood Discharge

The peak flood discharge (QP) at 100-years return period in the river is required for estimate of the adequate linear waterway of the bridge by hydrological analysis.

##### 4.5.2 Vertical clearance height under slab girder

Assumed vertical clearance height above the design riverbed of the bridge considering two cases of debris-flow.

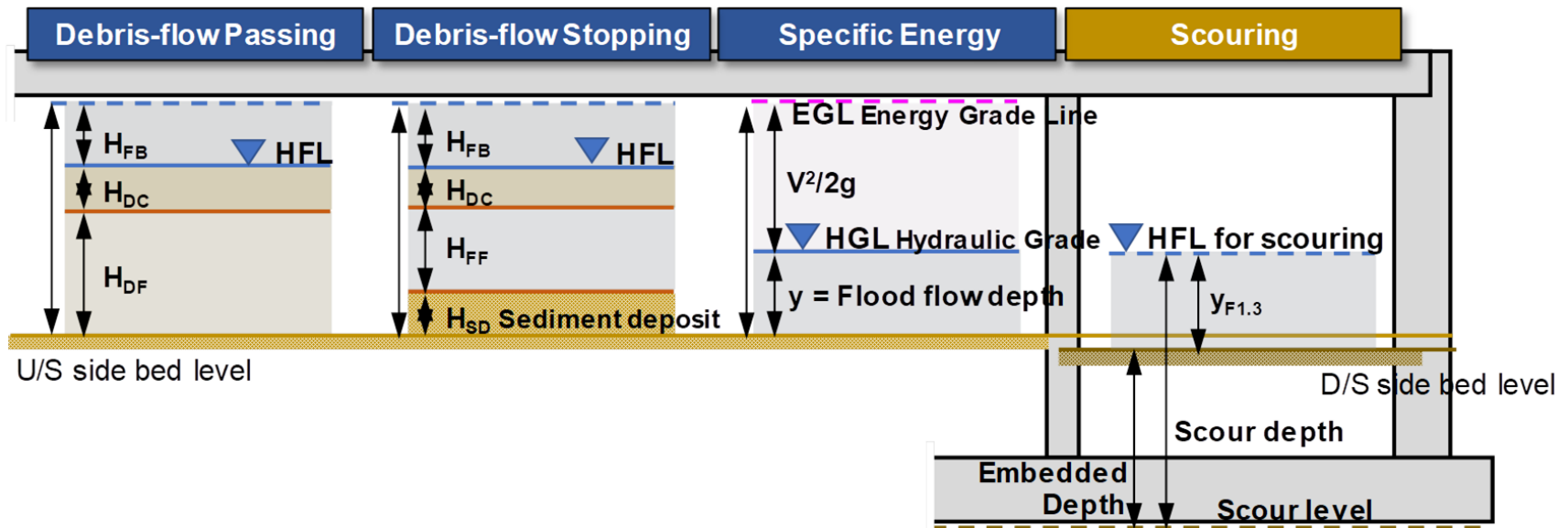
##### 4.5.3 Scouring Depth

Assumed scouring depth below the downstream side bed of the bridge considering Lacey's.

## 2. Each chapter (11/13)

### 4. Planning of RCSB (cont.)

#### 4.6 Determination of the RCSB dimension



## 2. Each chapter (12/13)

### 5. Structural design of RCSB

5.1 Design conditions

5.2 Actual load value to the structural analysis model

5.3 Design calculation procedure

## 2. Each chapter (13/13)

### 6. Supplemental information

6.1 Counterplan for deep-embedded bottom slab

6.2 Discharge diagram

# 3. Structural design of RCSCB (1/9)

## 3.1 determination of design conditions

- Summarization of design criteria
  - Design standard including supplemental and reference documents
  - General condition
  - Road condition
  - Natural condition
  - Loadings
  - Materials

### 3. Structural design of RCSB (2/9)

- Design standard including supplemental and reference documents

Item	RCSB Manual
Standard specifications and code of practice of road bridges	IRC 5:1998
Code of practice for concrete road bridges	IRC 21:2000 (Working Stress Method)
Guidelines for Design and Construction of River Training and Control Works for Road Bridges	IRC 89:1997

Above specifications, code and guidelines were adopted through the discussion with JICA and DOR during the design of Pilot Project.

# 3. Structural design of RCSB (3/9)

- Loading
  - Dead load  
Concrete, steel, asphalt, stone masonry, earth (backfill), water, etc.
  - Live load  
One Lane of IRC Class 70R Loading of Wheeled and Tracked (uniform strength load)  
Two Lanes of IRC Class A Loading, and  
One Lane of IRC Class A Loading, whichever governs

### 3. Structural design of RCSB (4/9)

- Material (and its strength)

- Concrete

Main body of RCSB      M30     $f_{ck}=30\text{N/mm}^2$

Precast footpath slabs, Parapet post and base, road curb      M35     $f_{ck}=35\text{N/mm}^2$

Approach slab      M30     $f_{ck}=30\text{N/mm}^2$

Retaining wall      M20     $f_{ck}=20\text{N/mm}^2$

Lean concrete      M15     $f_{ck}=15\text{N/mm}^2$

- Reinforcing bar

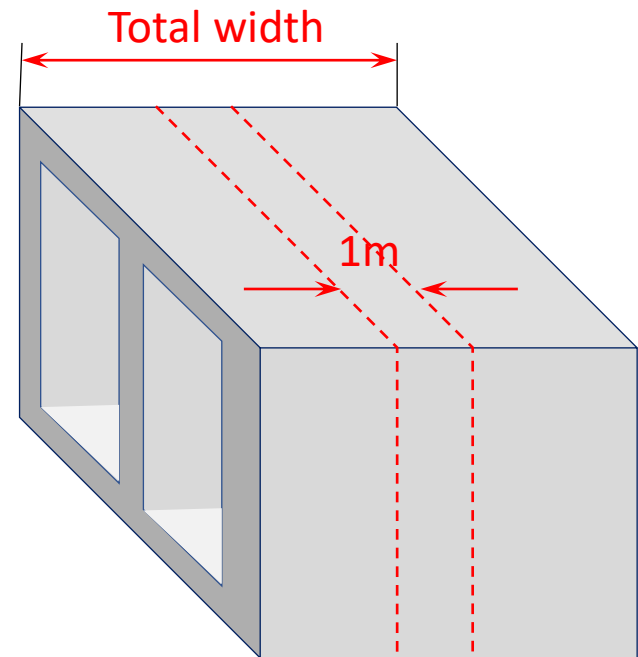
Fe500 (Min. 0.2 percent proof stress  $500\text{N/mm}^2$ )

# 3. Structural design of RCSB (5/9)

## 3.2 Actual load value to the structural analysis model

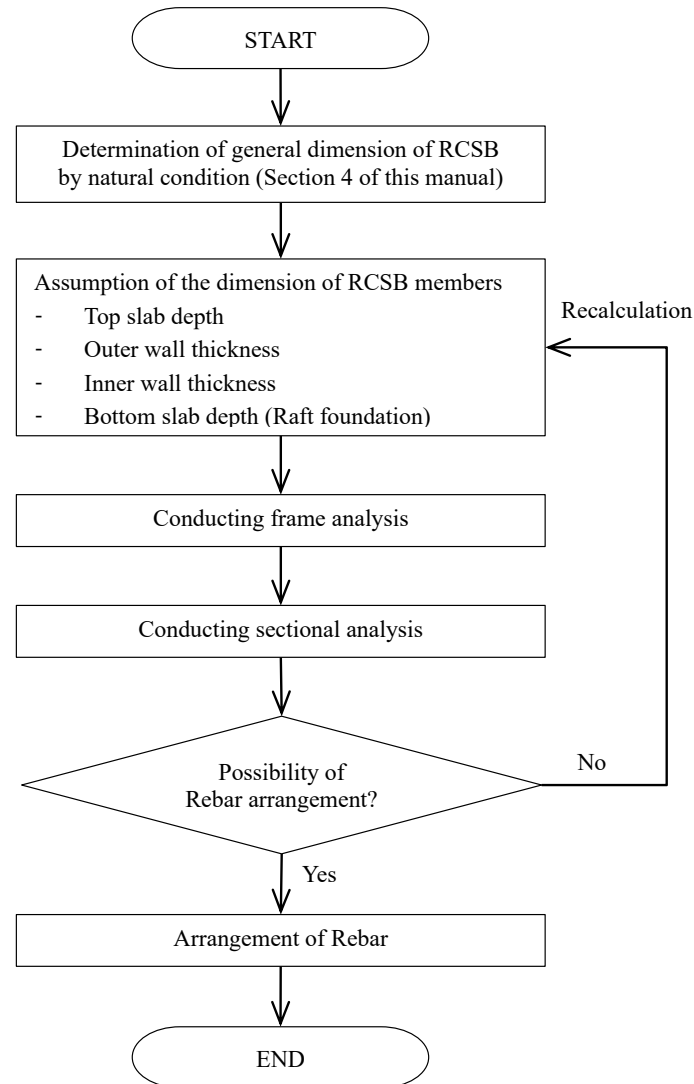
- Point of calculation

Structural analysis is carried out by a unit width of the RCSB, so basic loading and calculation model will not change even if the transversal width of the RCSB (road width) will change

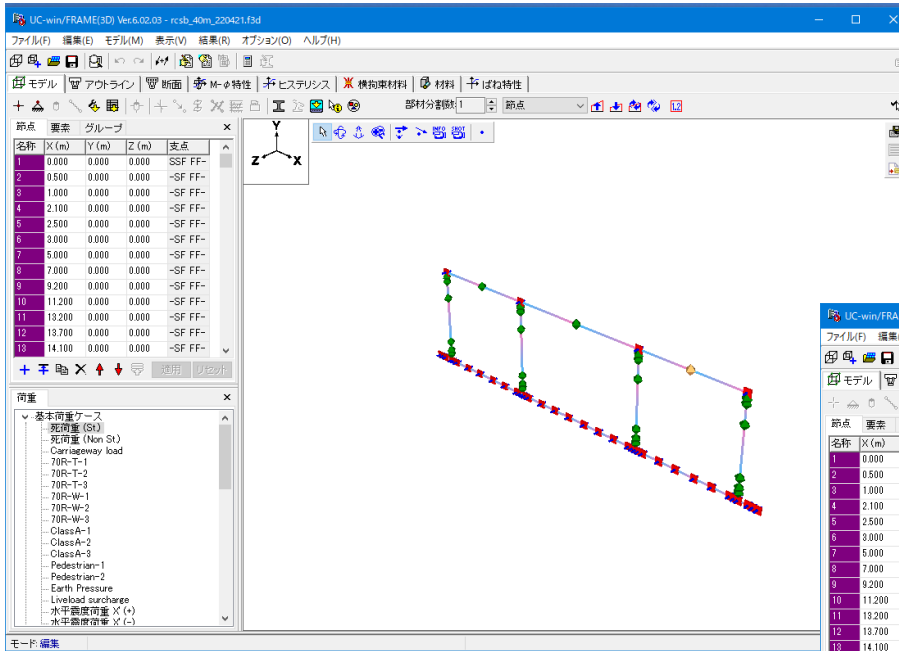


# 3. Structural design of RCSB (6/9)

p.46 Flowchart of  
RCSB design calculation

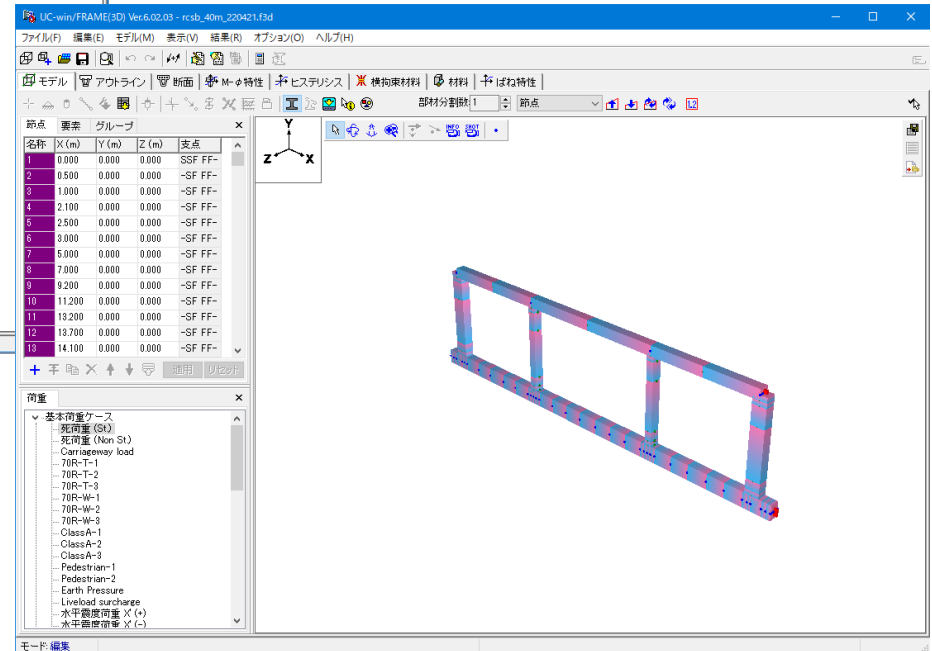


# 3. Structural design of RCSB (7/9)

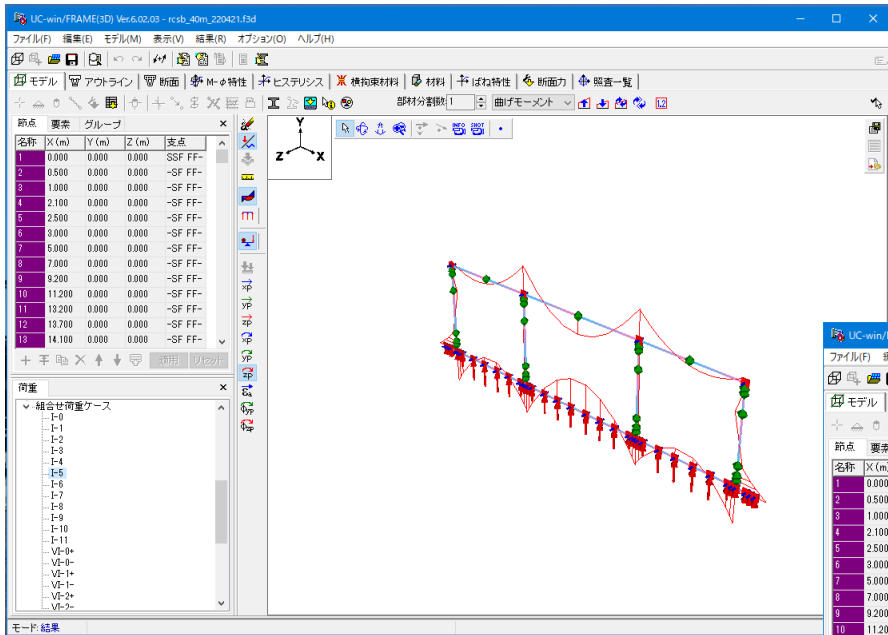


Frame model

Assuming section

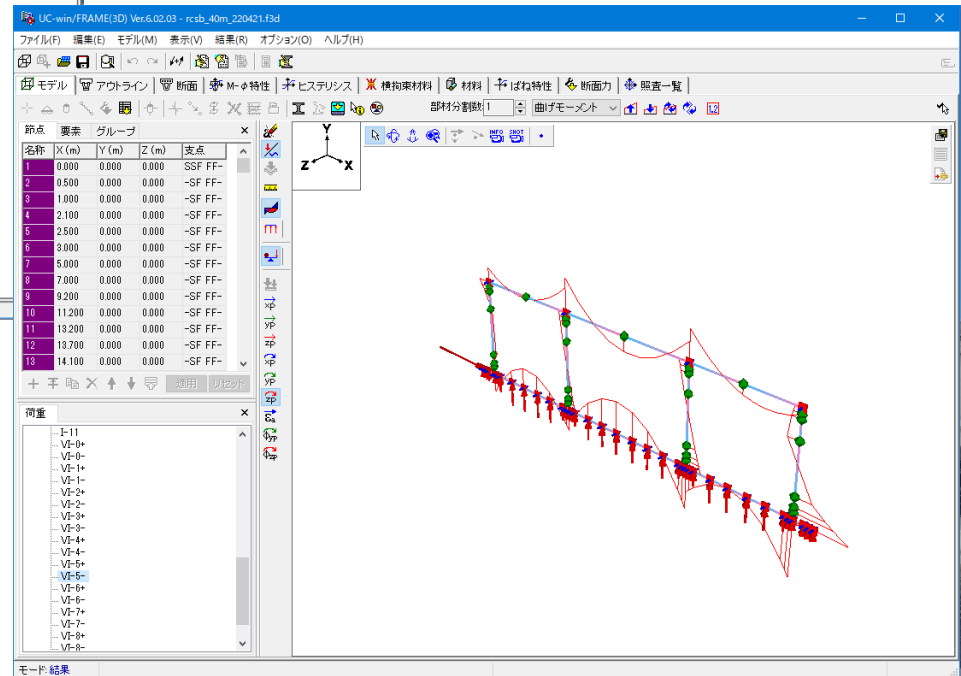


# 3. Structural design of RCSB (8/9)



Result of analysis (live load)

Result of analysis (seismic load)



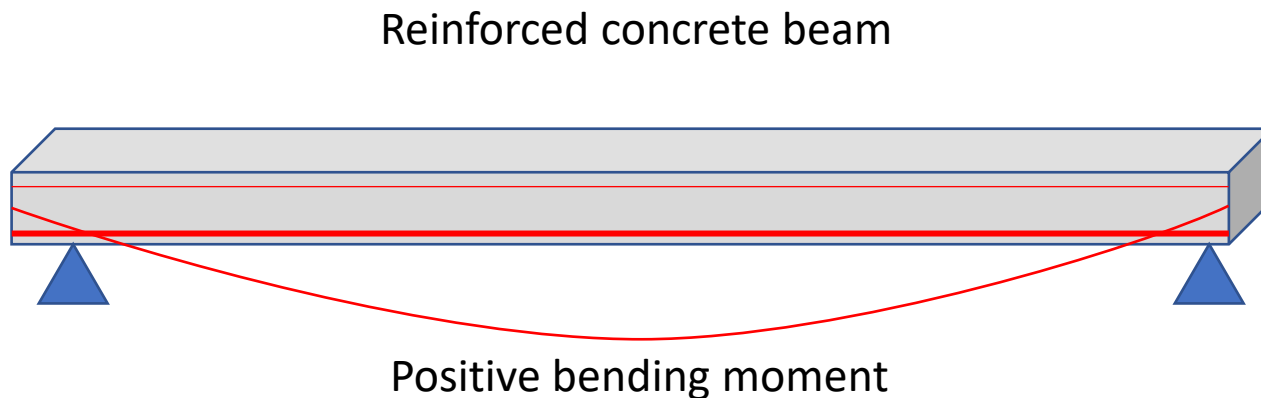
# 3. Structural design of RCSB (9/9)

Calculation result of RCSB L=40m

Member		Element No.	Case	N (kN)	S (kN)	M (kNm)	Rebar (mm)	Pitch (mm)
Top slab	Upper	102	I-11	52.9	299.8	-778.2	25	125
			VI-5-	141.0	284.2	-856.9		
	Lower	103	I-5	119.2	-4.5	476.7	25	125
			VI-5+	105.4	-25.3	377.9		
Outer wall	Outer	201	I-1	575.8	383.3	-915.1	32	150
			VI-1+	512.6	482.4	-1357.6		
	Inner	204	I-3	238.7	-54.5	182.6	25	150
			VI-3+	212.3	7.5	294.9		
Inner wall	Outer	301	I-6	748.3	19.7	-130.0	20	150
			VI-2+	690.6	87.8	-447.3		
	Inner	301	I-6	560.1	19.7	59.5	20	150
			VI-3-	301	682.9	-61.4		
Bottom slab	Upper	18	I-11	321.5	-43.1	-845.1	25	150
			VI-6+	102.3	-90.3	-839.6		
	Lower	4	I-1	383.3	-407.4	1069.9	32	150
			VI-1+	-106.9	-384.4	1471.3		

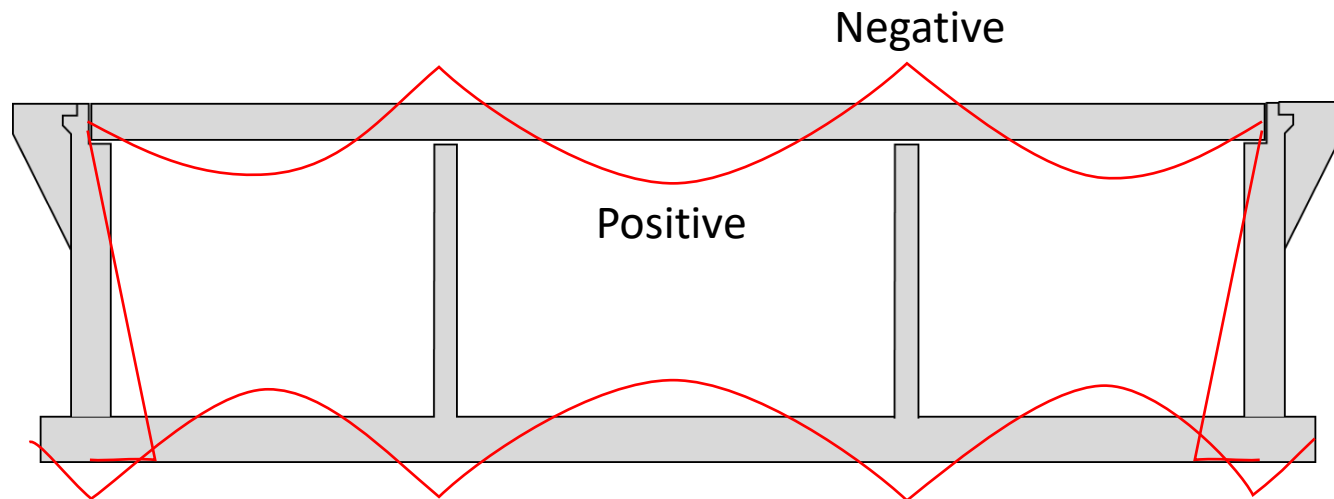
## 4. Reinforcement (1/7)

- For positive bending moment, reinforcing bar will be arranged to lower side (tensile side)
- Lesser reinforcement (half,  $1/3$ ,  $1/6$ ) will be provided to upper side (compressive side)



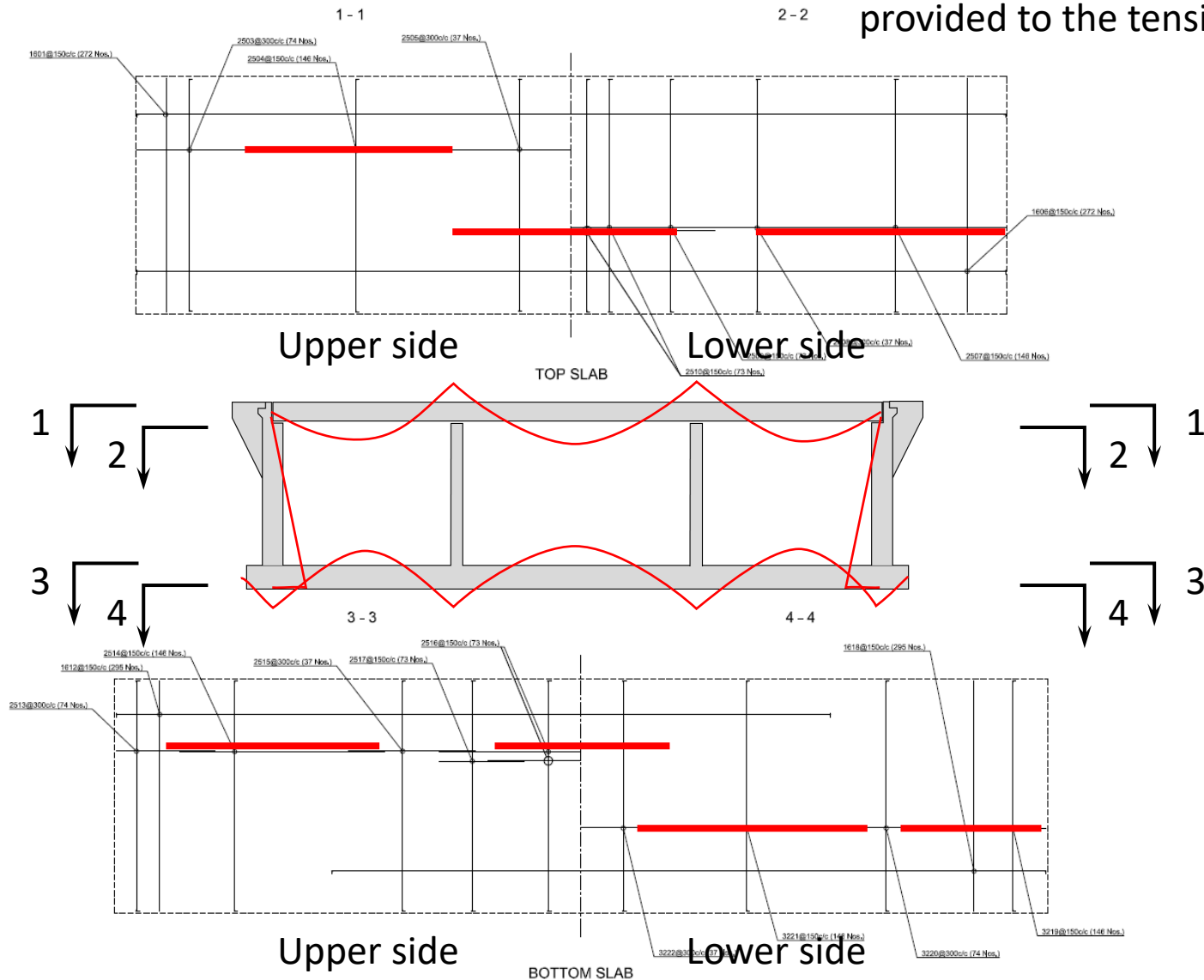
## 4. Reinforcement (2/7)

- Characteristics of RCSB
- Bending moment is alternating



# 4. Reinforcement (3/7)

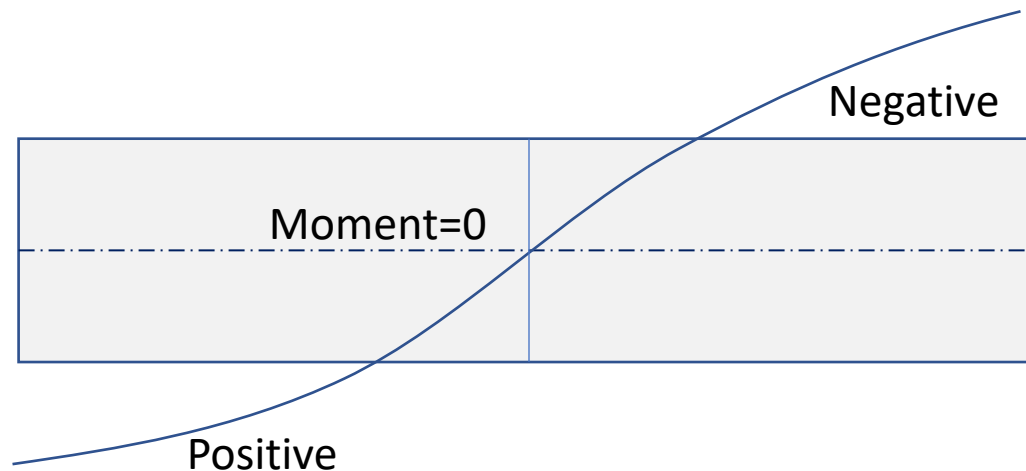
Thick reinforcement bar is provided to the tensile side



## 4. Reinforcement (4/7)

- Bond length (anchorage length)

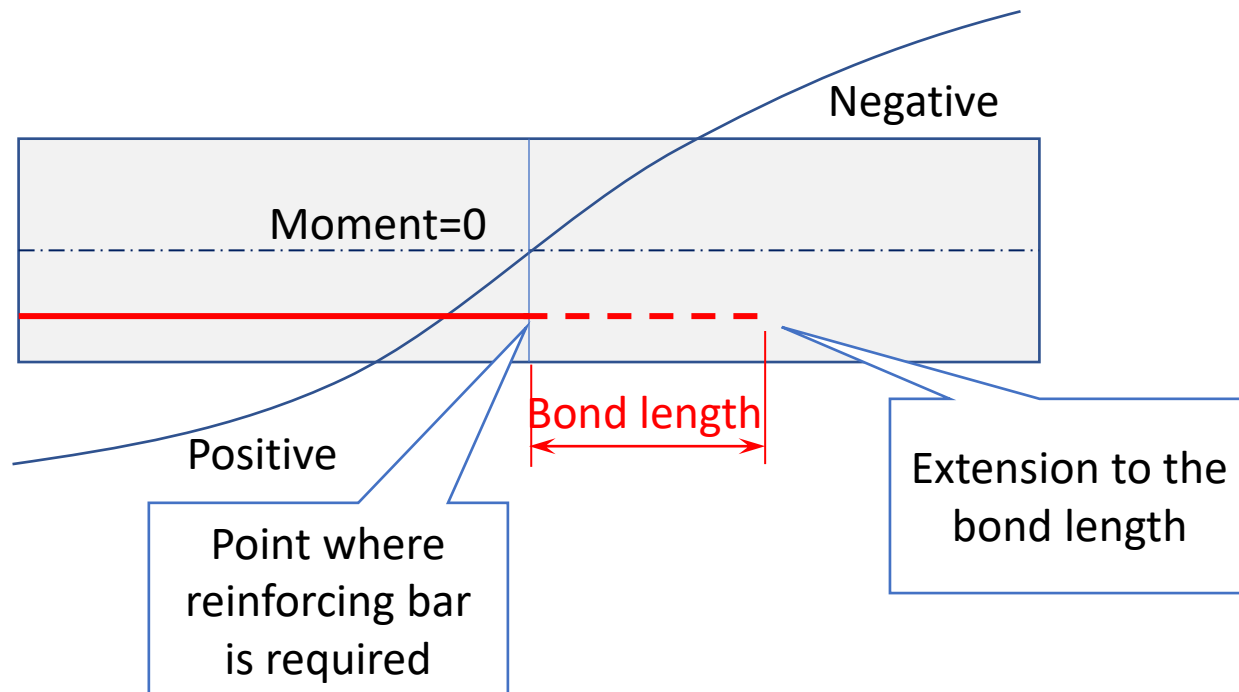
The length required to transfer the stress in the reinforcement to the concrete



## 4. Reinforcement (5/7)

- Bond length (anchorage length) cont.

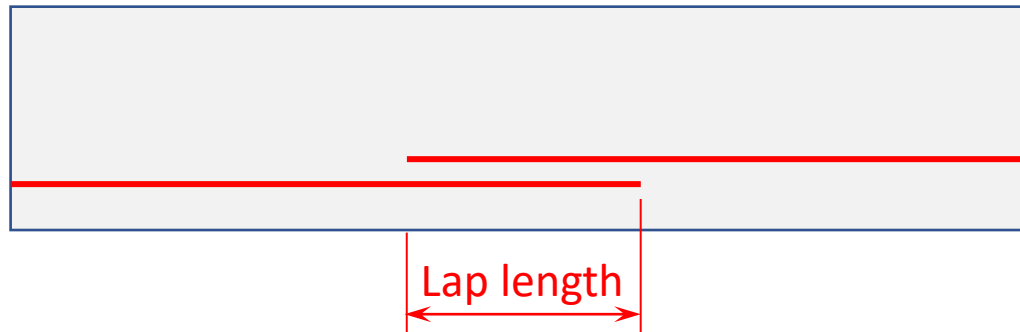
The length required to transfer the stress in the reinforcement to the concrete



## 4. Reinforcement (6/7)

- Lap length

The length that is provided to allow the overlapping of two reinforcement bars thereby ensuring safe and efficient transfer of load from one bar to another.



# 4. Reinforcement (7/7)

IRC: 21-2000

- Rules of lap length
  - Lap splices
  - Area of bars spliced
  - Stirrups
  - Maximum length of reinforcing bar (product) = 12m
  - etc.

15.2.5.1

Splices of bars by laps

(1) Arrangement of lapped splices

(a) As far as possible:

- Laps should not be located in areas of high stress
- Laps shall be staggered.
- Exceptions are however allowed under conditions as described in item (e) & (f).

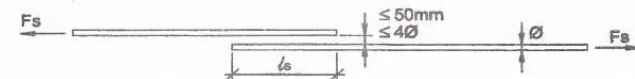
(b) The clear space between the two lapped bars in a splice should not be greater than  $4\phi$  or 50 mm as indicated in Fig.15.4 (a); otherwise the lap length should be increased by a length equal to the clear space where it exceeds  $4\phi$ .

(c) For adjacent laps, the clear longitudinal distance between two laps and transverse distance between bars be as indicated in Fig.15.4 (b)

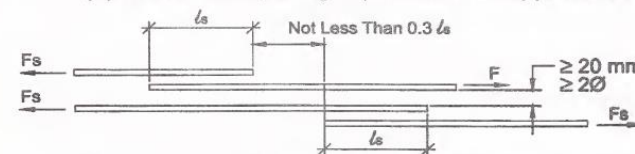
(d) Transverse reinforcement as given in Clause 15.2.5.1.3 shall be provided for avoiding spalling or cracking of concrete.

(e) Where provisions of (b) above are satisfied and the bars are all in one layer, 100 percent lapping of bars in tension at one section may be permitted for HYSD bars only. Where bars are in several layers the percentage should be reduced to 50 percent.

(f) All bars in compression and secondary (distribution) reinforcement may be lapped at one section except where ductile detailing is required.



(a) Maximum Spacing Between Two Lapped Bars



(b) Longitudinal Spacing Between Staggered Laps

Fig. 15.4 Arrangement of Splices

Thank you for your time!

# Training on Design Manual of RCSB and Workshop on Pilot Project

Department of Roads and JICA Expert Team  
12 to 14 October 2022

## **QUALITY CONTROL & RECORDS KEEPING**

Ramesh P. Koirala  
JET Member

# Contents

1. CONTRACTUAL PROVISION OF SPECIFICATIONS
2. SPECIFICATIONS (ROAD & BRIDGE WORKS)
3. QUALITY CONTROL SECTION (500)
4. OTHER DISCUSSION

# Contractual Provisions of Specifications

- National Competitive Bidding (NCB)
- **Single-Stage: Two-Envelope Bidding Procedure**

## **Part II : EMPLOYER'S REQUIREMENTS**

### **Section VI - Works Requirements**

This section contains the volumes of information that describe the Works to be constructed and includes specifications, the Drawings, and supplementary information that describe the Works to be procured Personnel Requirements and Equipment Requirements.

The General Specifications, SS

Particular (Special) Specifications to amend of SS

**[Insert Specifications] (Yellow Book)**

### **\• Specification of Works**

# SPECIFICATIONS (Road & Bridge Works)

- Main Reference:

## **STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE WORKS – 2073** (with amendments-2075)

- **SECTION 500 – QUALITY CONTROL**

- **501 SCOPE**

This Section covers the Quality Control System and procedures, Quality Assurance Plan, program of tests, trials, and general procedures for acceptance as well as laboratory arrangements and related facilities which are required for the selection and control of the quality of materials and workmanship.

# 500 QUALITY CONTROL ..

- **501 SCOPE**

This Section covers the Quality Control System and procedures, Quality Assurance Plan, program of tests, trials, and general procedures for acceptance as well as laboratory arrangements and related facilities which are required for the selection and control of the quality of materials and workmanship.

- **502 CONTRACTOR RESPONSIBLE FOR THE QUALITY OF THE WORKS**

All Materials and Workmanship – must confirm the requirements

The contractor is responsible for the Quality of the Works (under QAP)

Lab, equipment, and manpower etc. to be established/ supplied by the Contractor upon approval of the Engineer.

BOQ Item (Establishment & Operation Cost is a boq item).

Operation Cost – Incidental to the Work, no extra payment. (End of Project, Lab to be owned by the Contractor)

# 500 QUALITY CONTROL ..

## 503 QUALITY CONTROL SYSTEM

The Quality Control System comprises the methods, procedures and organization for the Quality Control of the works. The Contractor shall implement the Quality Control System in the following sequence:

### **(1) Sequence**

- (a) Complaint testing (compliance) for materials including laboratory trials,
- (b) Complaint testing for methods and equipment prior to the commencement of the work,
- (c) Control testing during construction

**(2) The supply, testing and monitoring shall be in compliance with a Quality Assurance Plan, and the provisions in the contract.**

# 500 QUALITY CONTROL ..

## 504 FIELD LABORATORY

### **(1) Location**

The Contractor shall arrange a fully furnished and adequately equipped field Laboratory on the site as described in the contract or shown on the Drawing. It shall preferably be located adjacent to the site office of the Engineer.

### **(2) Setup**

All laboratories to be provided under the contract shall be set up and shall be in fully operating condition not later than sixty days from the date of Commencement of the Works.

### **(3) Laboratory Equipment Depending on the requirements (may be adjusted)**

A. General, B. For Soils C. Bitumen & Bitumen Mixes D. Cement & Concrete, E. Control Profile and Surface Evenness (Survey equipment)

#### ***Note:***

- The Items and their numbers listed above table are indicative only and shall be decided by the Engineer as per requirements of the Project and modified accordingly*

# 500 QUALITY CONTROL ..

## 506 LABORATORY TRIALS TO CONFIRM COMPLIANCE WITH SPECIFICATIONS

- (1) **Filling and Pavement Materials**
- (2) **Concrete**
- (3) **Other items**

## 507 SITE TRIALS OR TRIAL SECTIONS

- (1) **Earthworks and Pavement Materials** using the same constructional plant and methods proposed by the Contractor. Each trial area shall be at least 100 meters long and to the full construction width. At least, eight sets of tests shall be made by the Contractor on each 100 meters length of trial section.
- (2) **Concrete** as specified in Clause 2004 shall be carried out by the Contractor to demonstrate the suitability of his mixing equipment. During the site trials, compliance with the Specifications for weighing equipment, storage of ingredients, means of transport for concrete, placing, compaction and curing shall be checked by the Engineer.
- (3) **Production of Materials and Crushing Plant**
- (4) **Other Works and Equipment**

# 500 QUALITY CONTROL ..

## **509 ACCEPTANCE TESTS FOR COMPLETED WORKS OR PARTS OF THE WORKS**

### **(1) Earthworks and Pavement Materials, Backfill to Drainage and Other Structures**

The Contractor shall request, in writing for the Engineer's approval for each layer of each section of earthwork, pavement construction and backfill to drainage and other structures accompanied by the tests results.

The Engineer shall thereupon, without undue delay est the section of the works and inform in writing acceptance or rejection

### **(1) Other Works and Equipment** As per the relevant Sections of these Specifications

## **510 SCHEDULE OF TESTS**

**(1) Test Schedule** The testing frequencies set forth are the desirable and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests and Frequency recommended in Table 5.2.

# 500 QUALITY CONTROL ..

## 511 QUALITY ASSURANCE PLAN QAP

The Contractor shall submit Quality Assurance Plan (QAP) to the Engineer for his approval.

(QAP) shall be based on the detailed Program of the Works, The Quality Assurance Plan shall include the following:

- (1) **The Quality Assurance Schedule Comprising of:** test schedule and testing program, and process oriented focus on defect prevention laboratory trials, site trials and trials sections, construction control tests and their frequencies, and tests for acceptance of the completed works with their dates.
- (2) The list of sources of materials and/or of manufactured articles, their main characteristics, their identification mode as provided by the supplier when required
- (3) The list of tests and quality control procedures to be implemented

# OTHER DISCUSSION

## METHOD STATEMENT

The Contractor shall submit METHOD STATEMENT MS, for each activity and should get prior approval.

MS should describe minutely the process of the activity **for Example**

**Activity - Concreting at Foundation** (not limited to the following)

1. Layout Plan
2. Materials stocking plan (Qty and position)
3. Equipment plan, (position and capacity)
4. Manpower (No of labours, masons, etc and their deputation)
5. Quality control Activities (Slump test, mix control, water control, record keeping, etc).
6. Safety checking, groundwater flow check, etc.
7. Etc. etc.

# OTHER DISCUSSION

## RECORDS KEEPING

Records of every activity must be well maintained from the perspective of

1. Quality of Works

(Materials Quality, Workmanship Quality)

2. Records

(Assuring proof from the legal viewpoint in the future, in case of an investigation, Other Administration purpose like Extension of Time, etc.)

3. Research and Study Purpose

To assure the records of all construction activities, it is mandatory (Contractual Provision, FIDIC, Clause 14) for the Contractor to compile and submit the test results in a prescribed format to the Engineer along with each IPC (as a part of IPC).

# SAMPLE FIELD RECORD – CONCRETING PREPARATION

## CHECK LIST BEFORE START CONCRETING

**Project:** XXXXX XXXXX XXXXXXXX  
**Contract No :**  
**Name of Bridge :**  
**Name of Road :**  
**District :** XXXXXX XXXXX  
**Contractor :**

A. Material collected on the site

- |   |  |                      |                             |                             |
|---|--|----------------------|-----------------------------|-----------------------------|
| 1 | Volume of concrete as per the drawing        | _____ m <sup>3</sup> |                             |                             |
| 2 | Volume of sand approx. in site               | _____ m <sup>3</sup> | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 3 | Volume of aggregate approx. in site          | _____ m <sup>3</sup> | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 4 | Reinforcement quantity to be checked on site |                      | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
- B. Condition of Equipment
- |   |                           |  |                             |                             |
|---|---------------------------|--|-----------------------------|-----------------------------|
| 1 | Concrete Mixture          |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 2 | Concrete transportation   |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 3 | Vibrator                  |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 4 | Test Equipments           |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 5 | Aggregate Measurement Box |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 6 | Cube test Boxes           |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |

C. Site Preparation

- |   |                                    |  |                             |                             |
|---|------------------------------------|--|-----------------------------|-----------------------------|
| 1 | Approval of the formwork           |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 2 | Safety measures                    |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 3 | Concrete Placing mechanism         |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 4 | Preparation for curing             |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
| 5 | Preparation for Construction Joint |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |

D. Material Test

- |   |                |  |                             |                             |
|---|----------------|--|-----------------------------|-----------------------------|
| 1 | Sieve Analysis |  | OK <input type="checkbox"/> | NO <input type="checkbox"/> |
|---|----------------|--|-----------------------------|-----------------------------|

I have checked according to the above list and find **satisfactory** / **dis-satisfactory**, Therefore, **RECOMMENDED** / **NOT RECOMMENDED**

Checked By  
Signature \_\_\_\_\_

Name \_\_\_\_\_  
Position \_\_\_\_\_  
Date \_\_\_\_\_

PROJECT OFFICE (Engineer)

I have received above instruction  
Received By: \_\_\_\_\_

Signature \_\_\_\_\_  
Name \_\_\_\_\_  
Position \_\_\_\_\_  
Date \_\_\_\_\_  
Contractor \_\_\_\_\_

# SAMPLE FIELD RECORD – CONCRETING PREPARATION

## CHECK LIST BEFORE START CONCRETING

**Project:** XXXXX XXXXX XXXXXXX

**Contract No :**

**Name of Bridge :**

**Name of Road :**

**District :** XXXXXX XXXXX

**Contractor :**

A. Material collected on the site

1 Volume of concre as per the drawing \_\_\_\_\_ m<sup>3</sup>

2 Volume of sand approx. in site \_\_\_\_\_ m<sup>3</sup> OK  NO

3 Volumn of agregaa approx. in site \_\_\_\_\_ m<sup>3</sup> OK  NO

4 Reinforcement quto be check on site OK  NO

B. Condition of Equipment

1 Concrete Mixture OK  NO

2 Concrete transportation OK  NO

3 Vibrator OK  NO

4 Test Equipments OK  NO

5 Aggregate Measurement Box OK  NO

6 Cube test Boxes OK  NO

C. Site Preparation

1 Approval of the formwork OK  NO

2 Safety measures OK  NO

3 Concrete Placing mechanism OK  NO

4 Preparation for curing OK  NO

5 Preparation for Construction Joint OK  NO

D. Material Test

1 Sieve Analysis OK  NO

I have checked according to the above list and find satisfactory / dissatisfactory. Therefore, RECOMMENDED / NOT RECOMMENDED

Checked By

\_\_\_\_\_  
Signature

Name

Position

Date

PROJECT OFFICE (Engineer)

I have received above instructio

Received By:

\_\_\_\_\_  
Signature

Name

Position

Date

Contractor

# CONFIRMATION CONCRETE RATIO AT SITE (MEASURING BOXES)

## Volumetric Proportion of Con (Lab results in weight basis) Mixed Design (M25)

Box size_1	0.3	0.3	0.34	0.0306	m <sup>3</sup>	Cement for 1m <sup>3</sup> /50kg coeff.	0.125
Box size_2	0.38	0.38	0.3	0.04332	m <sup>3</sup>		
Size of Bucket				5	ltr		

S. No.	Description	Batch vol	Cement	Aggregate	Sand	Water
1	By Weight for (by Lab)	1 m <sup>3</sup>	400 kg	1065 kg	710 kg	195 kg
2	By Weight for (1 bag)	0.125 m <sup>3</sup>	50 kg	133.125 kg	88.75 kg	24.375 kg
3	Bulk Density kg/m <sup>3</sup> (subject to change query)			1526 kg/m <sup>3</sup>	1479 kg/m <sup>3</sup>	1000 kg/m <sup>3</sup>
4	Proportion by volumn		1 bag	0.08724 m <sup>3</sup>	0.06001 m <sup>3</sup>	0.02438 m <sup>3</sup>
5	Vol of box.			0.0306 m <sup>3</sup>	0.04332 m <sup>3</sup>	5 Ltr
6	No of box required	0.125 m <sup>3</sup>	1 bag	2.8509 No.	1.38520 No.	4.875 Ltr

2 box

1 box

29 cm

12 cm

# Thank You

# Planning and Design of Staging

Department of Roads and JICA Expert Team

12 October 2022

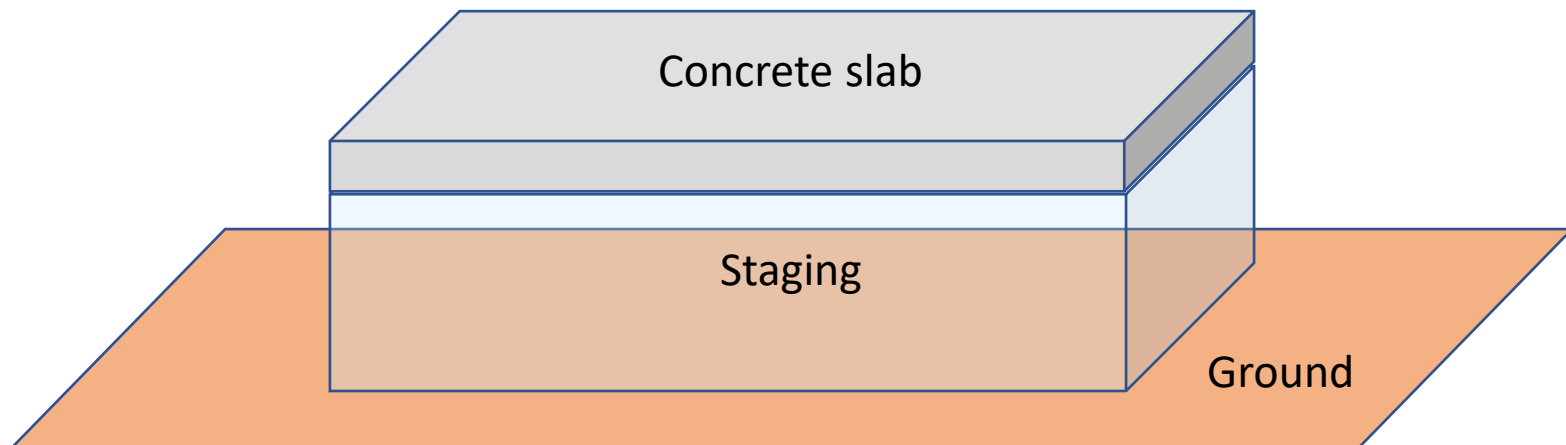


## Contents

1. Definition of staging
2. Requirement for the staging used for RCSB
3. Material for the staging
4. Calculation of staging (example)
5. Conclusion and recommendation

# 1. Definition of staging (scaffolding, support)

- Temporary structure used to support a work crew and/or materials to aid in the construction, maintenance and repair of buildings, bridges and all other man-made structures.
- Support work for the horizontal member (like top slab of RCSB) of concrete until hardening



## 2. Requirement for the staging used for RCSB

### Characteristics of top slab of RCSB

- Weight of top slab = heavy
  - Height = tall
  - Supporting ground = usually not stable
- 
- Tough requirements for staging (high-rigidity and stable)
  - While the staging is temporary structure

### 3. Material for the staging

- Any material is okay if the strength can correctly be evaluated, and stability can be verified
  - Timber
  - Prop
  - Pipe frame
- Guaranteed member of staging (material, details, connecting devices) shall be used

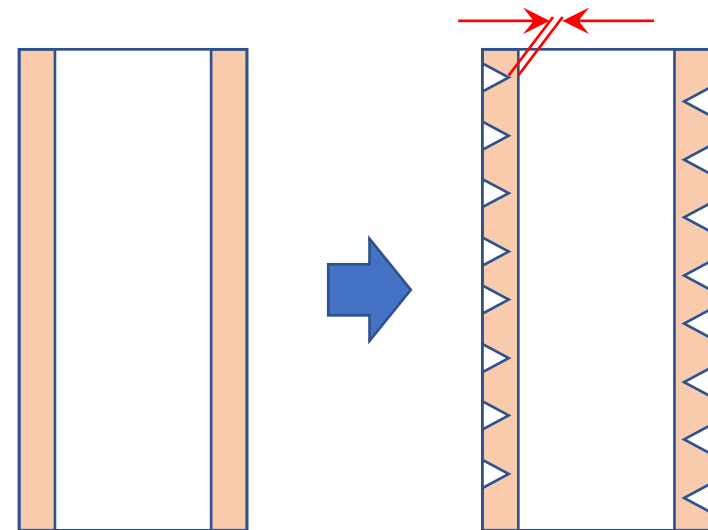
## Material for the staging of RCSCB (1/3)

- Metals are usually used and preferable
- Prop is widely used in Nepal, but not recommendable



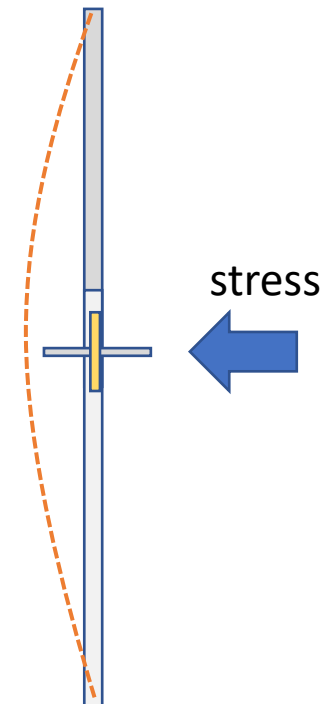
## Material of the staging of RCSB (2/3)

- Prop is made by threading the pipe with same thickness
- Threaded part of the pipe is thinner than other part



## Material of the staging of RCSCB (3/3)

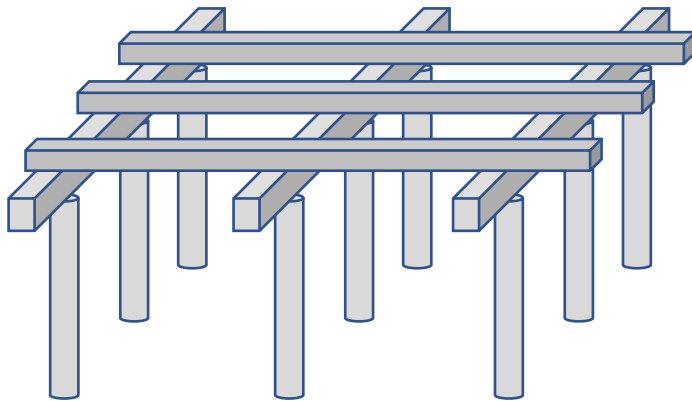
- Resistance force against buckling would be lower when using the prop
- This resistance force cannot be calculated



## 4. Calculation of staging (example) (1/20)

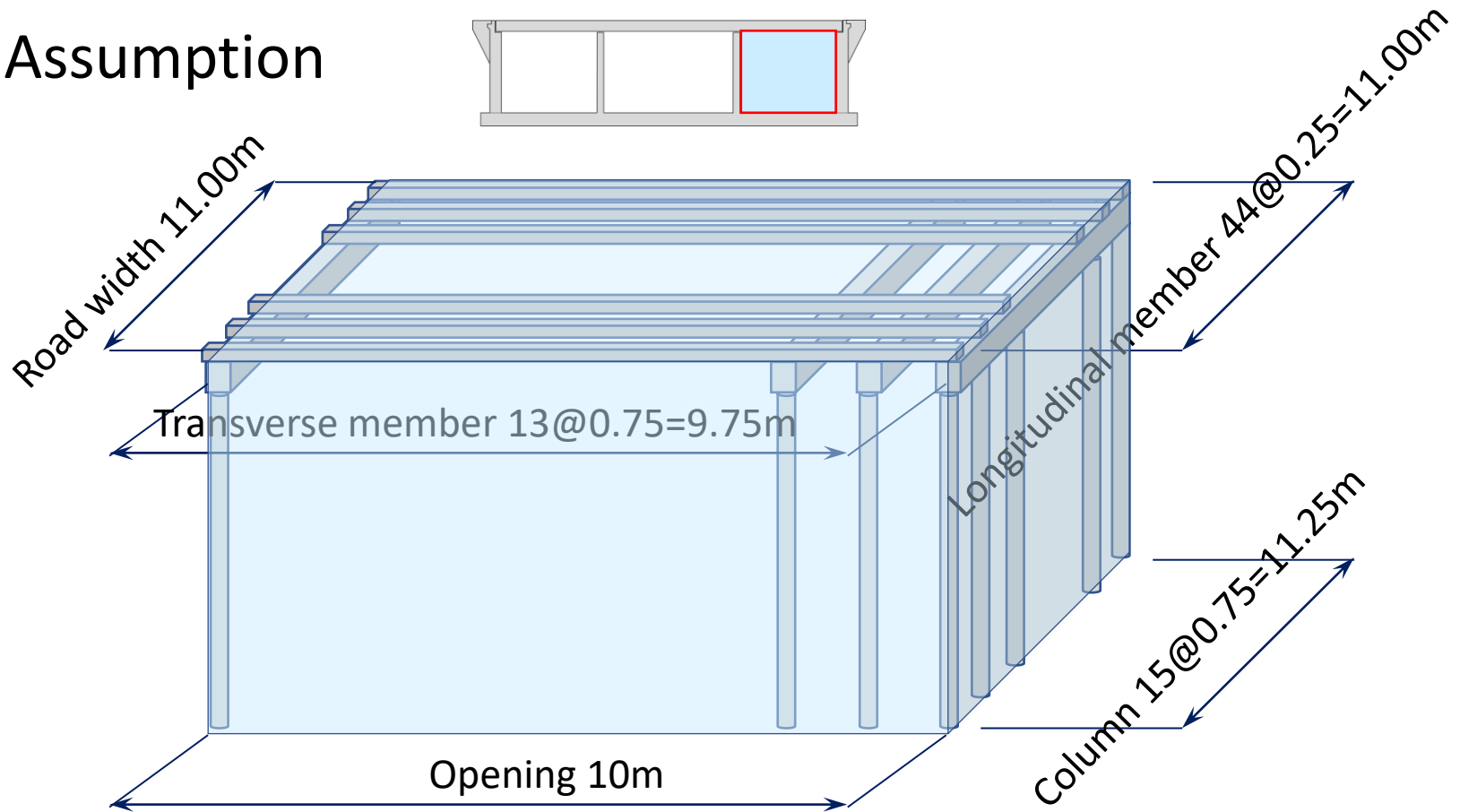
A sample staging consists of

- Lower plate of formwork
- Longitudinal member
- Transverse member
- Supporting column



## 4. Calculation of staging (example) (1/20)

Assumption



## 4. Calculation of staging (example) (3/20)

### (1) Calculation of Loading

Thickness of the slab		1.0m
Unit weight of the concrete		25.0kN/m <sup>3</sup>
Self weight	W0	25.0kN/m <sup>2</sup>
Temporary load	W1	0.50kN/m <sup>2</sup>
Service load (worker, machine)	W2	3.50kN/m <sup>2</sup>

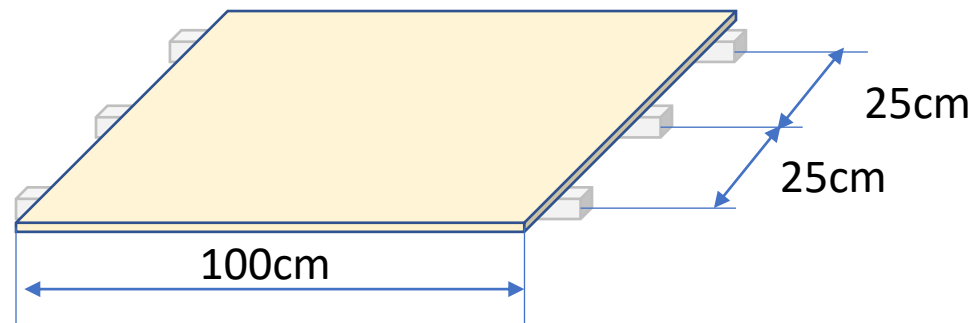
$$W=W0+W1+W2 = 29.0\text{kN/m}^2$$

$$W'=W0+W1 = 25.5\text{kN/m}^2$$

## 4. Calculation of staging (example) (4/20)

### (2) Calculation of formwork (Plate)

Thickness of timber plate	$t$	1.2cm
Section modulus	$Z$	12.0cm <sup>3</sup>
Moment of inertia	$I$	14.4cm <sup>4</sup>
Young's modulus	$E$	550kN/cm <sup>2</sup>
Allowable bending stress	$f_b$	1.370kN/cm <sup>2</sup>
Allowable flexure	$\delta_a$	0.300cm



## 4. Calculation of staging (example) (5/20)

### (2) Calculation of formwork (Plate) cont.

Distribution load

$$w = W \times b = 29.0 / (100 \times 100) \times 100 = 0.290 \text{ (kN/cm)}$$

$$w' = W' \times b = 25.5 / (100 \times 100) \times 100 = 0.255 \text{ (kN/cm)}$$

## 4. Calculation of staging (example) (6/20)

### (2) Calculation of formwork (Plate) cont.

Bending moment

$$M = w \times l^2 / 8 = (0.290 \times 25.0^2) / 8 = 22.7 (\text{kN} \cdot \text{cm})$$

Bending stress

$$ab = M / Z = 22.7 / 24 = 0.946 (\text{kN} / \text{cm}^2)$$

Then,  $ab = 0.946 < fb = 1.370$       ok

## 4. Calculation of staging (example) (7/20)

### (2) Calculation of formwork (Plate) cont.

Flexure

$$\delta = (5 \times w' \times l^4) / (384 \times EI)$$

$$= (5 \times 0.255 \times 25.0^4) / (384 \times 550 \times 14.4) = 0.163 \text{ cm}$$

Then,  $\delta = 0.163 < \delta_a = 0.300$       ok

## 4. Calculation of staging (example) (8/20)

### (3) Calculation of longitudinal member

Square pipe 50 x 50 x 3.2 is used

Section modulus  $Z$  8.16cm<sup>3</sup>

Section area  $A$  5.727cm<sup>2</sup>

Moment of inertia  $I$  20.4cm<sup>4</sup>

Young's modulus  $E$  20600kN/cm<sup>2</sup>

Allowable bending stress  $f_b$  16.3kN/cm<sup>2</sup>

Allowable shear stress  $f_s$  9.3kN/cm<sup>2</sup>

Allowable flexure  $\delta_a$  0.300cm



## 4. Calculation of staging (example) (9/20)

### (3) Calculation of longitudinal member cont.

Distribution load

$$w = W \times b = 29.0 / (100 \times 100) \times 25 = 0.073 \text{ (kN/cm)}$$

$$w' = W' \times b = 25.5 / (100 \times 100) \times 25 = 0.064 \text{ (kN/cm)}$$

## 4. Calculation of staging (example) (10/20)

### (3) Calculation of longitudinal member cont.

Bending moment

$$M = w \times l^2 / 8 = (0.073 \times 75.0^2) / 8 = 51.328 (\text{kN} \cdot \text{cm})$$

Bending stress

$$ab = M / Z = 51.328 / 8.16 = 6.290 (\text{kN} / \text{cm}^2)$$

Then,  $ab = 6.290 < fb = 16.3$       ok

## 4. Calculation of staging (example) (11/20)

### (3) Calculation of longitudinal member cont.

Shear force

$$Q = w \times l/2 = (0.073 \times 75.0)/2 = 2.738 (\text{kN} \cdot \text{cm})$$

Shear stress

$$\tau = \kappa \times Q/A = 2.0 \times 2.738/5.727 = 0.956 (\text{kN}/\text{cm}^2)$$

$\kappa$ : shaper factor 2.0

Then,  $\tau = 0.956 < f_s = 9.300$       ok

## 4. Calculation of staging (example) (12/20)

### (3) Calculation of longitudinal member cont.

Flexure

$$\begin{aligned}\delta &= (5 \times w' \times l^4) / (384 \times EI) \\ &= (5 \times 0.064 \times 75.0^4) / (384 \times 20600 \times 20.4) \\ &= 0.062 \text{ cm}\end{aligned}$$

Then,  $\delta = 0.062 < \delta_a = 0.300$       ok

## 4. Calculation of staging (example) (13/20)

### (4) Calculation of transverse member

Square pipe 50 x 50 x 3.2 is used

Section modulus  $Z$  8.16cm<sup>3</sup>

Section area  $A$  5.727cm<sup>2</sup>

Moment of inertia  $I$  20.4cm<sup>4</sup>

Young's modulus  $E$  20600kN/cm<sup>2</sup>

Allowable bending stress  $f_b$  16.3kN/cm<sup>2</sup>

Allowable shear stress  $f_s$  9.3kN/cm<sup>2</sup>

Allowable flexure  $\delta_a$  0.300cm



## 4. Calculation of staging (example) (14/20)

### (4) Calculation of transverse member cont.

Distribution load

$$w = W \times b = 29.0 / (100 \times 100) \times 25 = 0.073 \text{ (kN/cm)}$$

$$w' = W' \times b = 25.5 / (100 \times 100) \times 25 = 0.064 \text{ (kN/cm)}$$

## 4. Calculation of staging (example) (15/20)

### (4) Calculation of transverse member cont.

Bending moment

$$M = w \times l^2 / 8 = (0.073 \times 75.0^2) / 8 = 51.328 (\text{kN} \cdot \text{cm})$$

Bending stress

$$ab = M / Z = 51.328 / 8.16 = 6.290 (\text{kN} / \text{cm}^2)$$

Then,  $ab = 6.290 < fb = 16.3$       ok

## 4. Calculation of staging (example) (16/20)

### (4) Calculation of transverse member cont.

Shear force

$$Q = w \times l/2 = (0.073 \times 75.0)/2 = 2.738(\text{kN} \cdot \text{cm})$$

Shear stress

$$\tau = \kappa \times Q/A = 2.0 \times 2.738/5.727 = 0.956(\text{kN}/\text{cm}^2)$$

$\kappa$ : shaper factor 2.0

Then,  $\tau = 0.956 < f_s = 9.300$       ok

## 4. Calculation of staging (example) (17/20)

### (4) Calculation of transverse member cont.

Flexure

$$\delta = (5 \times w' \times l^4) / (384 \times EI)$$

$$= (5 \times 0.064 \times 75.0^4) / (384 \times 20600 \times 20.4)$$

$$= 0.062 \text{ cm}$$

Then,  $\delta = 0.062 < \delta_a = 0.300$       ok

## 4. Calculation of staging (example) (18/20)

### (5) Calculation of support column

Steel tube  $\phi 40 \times 3.2$  is used

Allowable load  $P_a = 26.156 \text{ kN}$

(Buckling load when  $H=3.0\text{m}$ )

Supporting area of a pipe

$A_s = 0.75 \times 0.75 = 0.563 \text{ m}^2$

Supporting load of a pipe

$P = A_s \times W = 0.563 \times 29.0 = 16.327 \text{ kN}$

Then,  $P=16.327 < P_a=26.156$  ok

## 4. Calculation of staging (example) (19/20)

### (6) Load at column base

Supporting load of a pipe

$$P = A_s \times W = 0.563 \times 29.0 = 16.327 \text{ kN}$$

$$\cong 1.6 \text{ ton}$$

Please consider how to support the pipe with some structure (steel plate, longitudinal member, etc.)



## 4. Calculation of staging (example) (20/20)

### (7) Arrangement of member

- Lower plate of formwork t=12mm
- Longitudinal member @25cm
- Transverse member @75cm
- Supporting column @75cm
  
- Crossbeam and Horizontal member shall be arranged (by assuming the horizontal force (5% of vertical force, for example)

# Photos of the project “Community Access”



## 5. Conclusion and recommendation

- For the staging of RCSB, because relatively stable members are required, guaranteed materials of staging shall be used
- Proper evaluation of cost for staging is required
- Procurement of staging (lease system)
- Guarantee system (industrial standard)

Thank you for your time!

# Training on design manual of RCSB and Workshop on Pilot Project

Department of Roads and JICA Expert Team

12 to 14 October 2022

# **Discussion Related to the bid documents Procurement method (contractor)**

**Oct 12 2022**

# Presentation outline

- Bidding document (Purpose, Impact, bidding methods)
- Bid document - ITB, Bid DATA sheet, Evaluation Criteria, GCC, SCC
- Bid document= work Requirement

# Bidding Documents

## Purpose:

- Equal Information to ALL Bidders
- What is to be Procured
- Technical Requirements
- How to Prepare a RESPONSIVE BID
- Evaluation Criteria
- Form of Contract

# Bidding documents

Impact of poorly drafted documents:

- Complaints from Bidders
- Selection of Poorly Qualified Firm
- Delays in Project Implementation
- Delays in Disbursements
- Lack of Credibility of Institutions
- Misprocurement
- Claims and Disputes

# Bid Documents Based on:

## Procurement Methods

ICB, NCB, Sealed Quotation, Direct Procurement,  
User's Group or Beneficiary Community

## Process/Stages

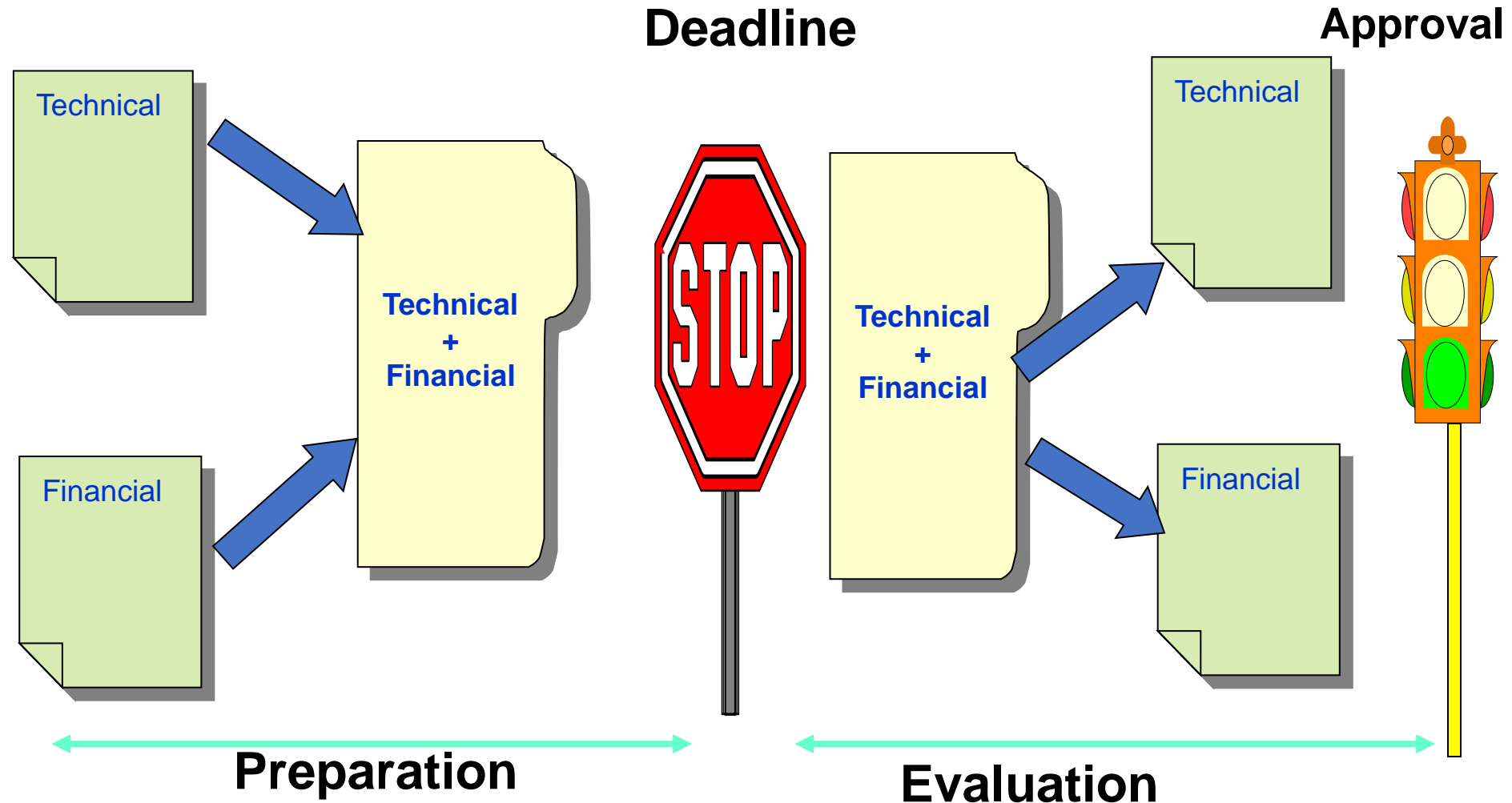
Single Stage, Two Stage

Open Competition (with or without Pre-Qualification)

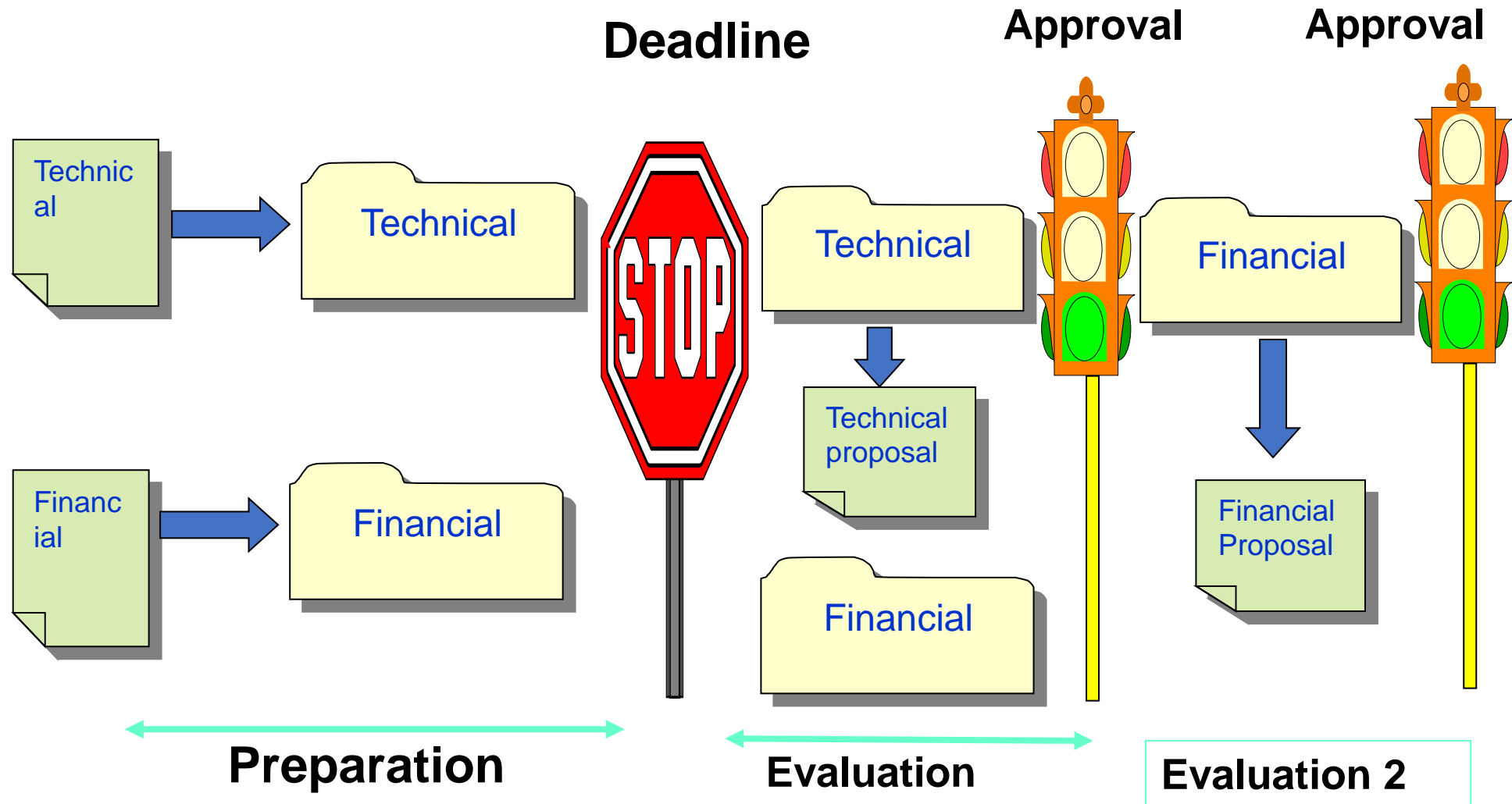
## Type of Contract

## Donor Guidelines

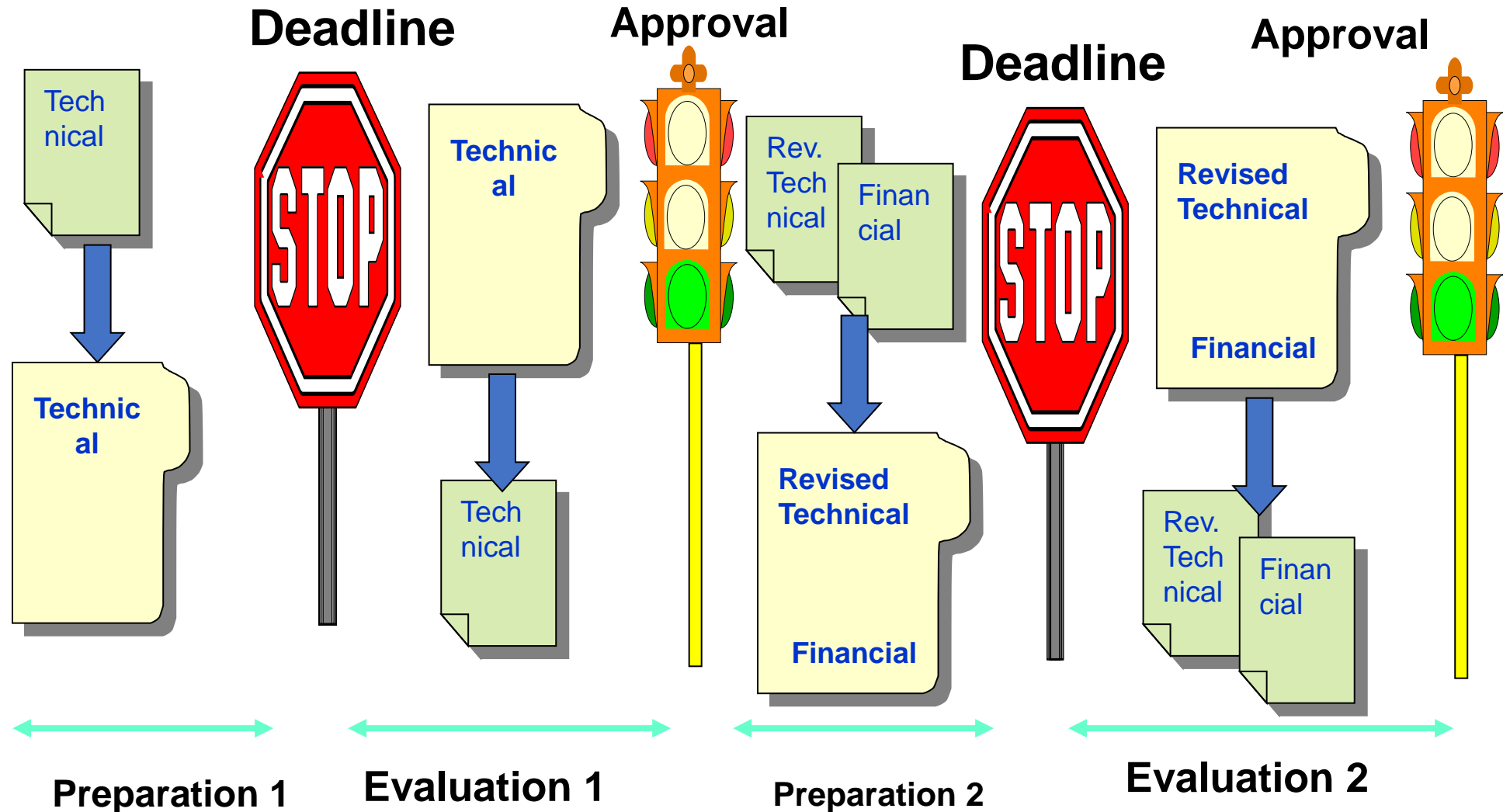
# Single Stage- One Envelop



# Single Stage – Two envelop



# Bidding Process (Two stage bidding)



# Bidding Documents

## Purpose:

- Equal Information to ALL Bidders
- What is to be Procured
- Technical Requirements
- How to Prepare a RESPONSIVE BID
- Evaluation Criteria
- Form of Contract

## Bidding documents

### **Impact of poorly drafted documents:**

- **Complaints from Bidders**
- **Selection of Poorly Qualified Firm**
- **Delays in Project Implementation**
- **Delays in Disbursements**
- **Lack of Credibility of Institutions**
- **Misprocurement**
- **Claims and Disputes**

# Bid Documents Based on:

- Procurement Methods
  - ICB, NCB, Sealed Quotation, Direct Procurement, User's Group or Beneficiary Community
- Process/Stages
  - Single Stage, Two Stage
    - Open Competition (with or without Pre-Qualification)
- Type of Contract
- Donor Guidelines

# SBDs available at:

Public Procurement Monitoring Office - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Public Procurement Monitoring Office +

www.ppmo.gov.np/leftmenu\_page.php?menu\_id=34

Government Of Nepal  
Office Of The Prime Minister and Council of Ministers  
Public Procurement Monitoring Office

Time : 2014-03-28 23:05:50

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Standard Bid Document

S.N	Description	Download
1	Procurement of Goods[NCB],July 2010	<a href="#">Download</a> ↓
2	Procurement of Goods[ICB],January 2012	<a href="#">Download</a> ↓
3	Procurement of Works for above 6 Million Rupees [NCB]	<a href="#">Download</a> ↓
4	Procurement of Woks for NRs. 1.00 Million to NRs 6.00 Million [NCB],January 2009	<a href="#">Download</a> ↓
5	Procurement of Works Single Stage Post Qualification Procedure [ICB], January 2012	<a href="#">Download</a> ↓
6	Procurement of Works for above 6 Million Rupees [NCB] PDF	<a href="#">Download</a> ↓

E-Procurement Portal

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Ammendment of PPR  
Reports  
Review Panel Decision  
Forum Proceedings  
Notice & Circular  
Procurement of Ration  
Standard Bid Document  
Direct Purchase  
Sealed Quotation  
Prequalification Document  
Request of Proposals  
Suggestion Form for PPA  
2063 & PPR 2064  
Blacklisting Form

# Contents of Bid Documents

- Instructions to Bidders (ITB)
- Bid Data Sheet (BDS)
- Evaluation and Qualification Criteria (EQC)
- Bidding Forms
- Works Requirement (Specifications/Drawings)
- Bill of Quantities
- General Conditions of Contract (GCC)/Special Conditions of Contract (SCC)
- Contract Forms

## Instruction to Bidders (ITB)

- For bidders to prepare *Responsive bid*,
- On composition of bidding documents and preparation of bids,
- On bid submission, opening, evaluation, and award of contract,
- Contents in ITB are to be changed as per project requirement by BDS
- ITB will not be a part of contract,

# Instruction to Bidders (ITB)

- Information on whether alternative bids are permitted or not, and if permitted What details are to be given and how they will be evaluated to be clearly mentioned,
- Information on whether the bidders are permitted to submit the bid for part or not,
- Information on whether details of bid prices (rate analysis) to be submitted or not ,
- Whether the prices are Fixed or Adjustable (as per price adjustment formula),
- Currency acceptable in the bid price,

# Instruction to Bidders (ITB)

- Details of the Bid/ Performance/ Advance security (Acceptable instruments, Formats indicating principal terms and conditions, amount, and validity)
- Provision of Bid Withdrawal or Modification prior to deadline for Bid submission (without forfeiture of bid security),
- Procedure for seeking clarification, pre-bid meeting, field visit etc,
- Validity of Bids and Bid Security,

# Instruction to Bidders (ITB)

- How the bids to be submitted (Sealed, Original, Copy, Place, Deadline, etc.);
- Bid Opening (Place, Date, Time, Procedures);
- Criteria and Methodology for Bid Examination, Comparison, and Evaluation\_ (including the currency and source/ date for exchange rate);
- Criteria and methodology for assessing Qualification of Bidders;
- Agreeing for the proposed Dispute Settlement;

# Instruction to Bidders (ITB)

- **Formalities to be fulfilled** by the Bidder before entering in to contract;
- **Right to reject** all bids or cancel the proceedings without assigning any reasons;
- **Title, Address, and Contact Persons** of the Employer;
- **Bidder's right to lodge complaint** against unlawful act/ decision and or procedures of Employer;

## **Instructions to Bidders (ITB) & Evaluation process information;**

- **Only substantially responsive bids will be evaluated**
- **For comparison purpose the Bid price is determined by:**
  - Correcting arithmetical errors,
  - Excluding fixed amounts (PS, Contingencies etc.),
  - Employer reserves the right to accept or reject any deviations/ variations and adjust the acceptable deviations,
  - Converting the bid amount to a single currency,
  - Applying any discount offered,
  - Domestic preference, if any
  - Exclusion of Price adjustment provisions,
  - Employer's right to ask for detail rate analyses & additional performance security in case of unbalanced or very low bid,

# Instructions to Bidders (ITB) & Qualification for Joint Ventures; *Example*

- Bid & Form of Agreement shall be signed so as to be legally binding to all partners,
- One firm to be In-Charge through a power of attorney signed by legally authorized signatories,
- Partner In-Charge shall be authorized to deal with the Employer in all respect,
- All partners of the JV shall be Jointly & Severally liable for the execution of work,
- JV Agreement (original) shall be submitted along with the Bid,
- Resources and experiences of each partner shall be added,
- A firm can not bid in more than one bid either in JV or in single,

# **Bidding documents: Large Works**

- **Invitation for bids**
- **Instructions to bidders [no changes]**
- **Bidding data**
- **Part 1. General conditions of contract [no changes]**
- **Part 2. Conditions of particular application**
- **Technical specifications**
- **Form of bid, appendix to bid, and bid security**
- **Bill of quantities**

## **Bidding documents: Large Works ...contd**

- **Form of agreement, forms of performance security and bank guarantee for advance payment**
- **Drawings**
- **Explanatory notes**
- **Postqualification**
- **Disputes resolution procedure**
- **Eligibility for the provision of goods, works, and services in bank-financed procurement**

# **Bidding Documents: NCB Works (2022)**

Invitation for Bids (IFB)

Section 1 - Instructions to Bidders (ITB)

Section 2 - Bid Data Sheet (BDS)

Section 3 - Evaluation and Qualification Criteria (EQC)

Section 4 - Bidding Forms

Section 5 - Works Requirements

Section 6 - Bill of Quantities (BOQ)

Section 7 - General Conditions of Contract (GCC)

Section 8 - Special Conditions of Contract (SCC)

Section 9 - Contract Forms

## Preparation of Bidding Documents

**No modifications in Instruction to Bidders (ITB) and General Conditions of Contract (GCC).**

**Any Modifications** required to meet specific Project needs to be provided in the **Bid Data Sheet (BDS)** and the **Special Conditions of Contract (SCC)** only.

## Instruction to Bidders (ITB) & Eligibility/Qualification information

Required documentary evidences to prove Eligibility and Qualifications such as;

- Written Power of Attorney
- Copy of company registration certificate ,
- Copy of income tax registration/PAN certificate,
- Copy of VAT registration certificate,
- Copy of updated income tax clearance/submission certificate,
- Copy of audit reports for the last .... years or up to ... FY,
- Information on works in hand (details of financial sources, employer's address, start/completion dates, value of contract & work completed)

# Instruction to Bidders (ITB) & Eligibility/Qualification information

## Required documentary evidences to prove Eligibility and Qualifications such as;

- Financial sources and amount available for the proposed works,
- General and specific experiences (certificates),
- List of manpower available (CV),
- List of equipment available (ownership, lease or hire agreement),
- Litigation history of firm,
- Any other data required by the Entity.

## **Instructions to Bidders (ITB) & Evaluation process information;**

- **Only substantially responsive bids will be evaluated**
- **For comparison purpose the Bid price is determined by:**
  - Correcting arithmetical errors,
  - Excluding fixed amounts (PS, Contingencies etc.),
  - Employer reserves the right to accept or reject any deviations/ variations and adjust the acceptable deviations,
  - Converting the bid amount to a single currency,
  - Applying any discount offered,
  - Domestic preference, if any
  - Exclusion of Price adjustment provisions,
  - Employer's right to ask for detail rate analyses & additional performance security in case of unbalanced or very low bid,

## Bid Data Sheet (BDS)

- **Bid Data Sheet (BDS) – PPMO SBD for NCB**
- **Bidding Data Sheet (BDS) – World Bank,**
- **Bidding Data – PPMO SBD IA, IIA and Medium Contract; FIDIC 1987;**

## Bid Data Sheet (BDS)

**This section consists of provisions that are specific to each procurement and supplements the information or requirements included in Instructions to Bidders (ITB)**

# Bid Data Sheet (BDS)

- **Bidding Data must refer to Instructions to Bidders (ITB) Clauses,**
- **Bidding data is used to specify the ITB clauses by inserting specific data (name, days, amount etc.) and required changes,**
- **Bidding data replaces the ITB clauses, if changed,**
- **Bidding data to be filled out by the Employer before issuance of the Bidding documents.**

# Preparation of BDS

Type of Bidding Document: **NCB Contracts**

Name of Project: **Road Construction Project**

Type of works included: **Earthwork, Retaining structure, gabion, sub-base, bituminous work**

Estimated Cost: **30,000,000 (with VAT)**

Construction period: **15 months**

Notice of Invitation for Bid: **8 Nov 2022**

Bid Submission deadline: **9 Dec 2022**

# Bid Data Sheet

<b>ITB 1.1</b>	The number of the Invitation for Bids is : _____
<b>ITB 1.1</b>	The Employer is: <u>Department of Roads</u>
<b>ITB 1.1</b>	The number and identification of lots comprising this bidding process is <b><i>[insert the name and contract number of the lots]:</i></b> <u>Road Construction Package 1</u>
<b>ITB 2.1</b>	The name of the Project is: <u>Road Construction Project</u> The DP is: <u>N/A</u> The implementing agency is: _____ Select one option as appropriate. <b><i>[GoN Funded or DP Funded]</i></b>

**Fill all the spaces. Specify N/A etc. if not applicable.**

# Bid Data Sheet

<b>ITB 4.1</b>	Eligible countries <i>[insert if GoN funded – all countries, For DP funded as per <b>there</b> their list of eligible country (may be added as Annex)]</i>  <i>(Specify the list of eligible countries in a separate section)</i>
<b>ITB 4.1 (a)</b>	<b>One partner of the joint venture at least 40 (forty) percent.</b>  <b>Each partner of the joint venture at least 25 (twenty five) percent.</b>
<b>ITB 4.9</b>	The foreign bidder is to submit <i>[insert the list of documents and the type of declaration required]</i>

# Bid Data Sheet

ITB 7.1	<p>For <u>clarification purposes</u> only, the Employer's address is:</p> <p>Attention: _____</p> <p>Address: _____</p> <p>Telephone: : _____</p> <p>Facsimile number: _____</p> <p>Electronic mail address: _____</p>
ITB 7.4	<p>A Pre-Bid meeting <i>[insert "shall" or "shall not"]</i> be held. Pre-Bid meeting will take place at the following date, time and place:</p> <p>30 April 2014</p> <p>Date: _____</p> <p>Time: _____</p> <p>Place: _____</p> <p>A site visit conducted by the Employer. <i>[insert "shall be" or "shall not be"]</i> organized</p>

# Bid Data Sheet

ITB 7.5	Time for request: Requests for clarification should be received by the Employer no later than: <b>10 days prior</b> to the deadline for submission of bids .
ITB 10.1	The language of the bid is: _____ <b><i>(English / Nepali)</i></b> _____
ITB 11.1 (b)	In accordance with ITB 12 and ITB 14, the following schedules shall be submitted with the bid, including the priced Bill of Quantities for Unit Rate Contracts and Schedule of Prices for lump sum contracts:  _____
ITB 11.1 (i)	The Bidder shall submit with its bid the following additional documents:  <b><i>[insert if any additional documents required]</i></b>
ITB 13.1	Alternative bids <b><i>[insert "shall be" or "shall not be"]</i></b> permitted.
ITB 13.2	Alternative times for completion <b><i>[insert "shall be" or "shall not be"]</i></b> permitted.  If alternative times for completion are permitted, the evaluation method will be as specified in Section III (Evaluation and Qualification Criteria).

# Bid Data Sheet

<b>ITB 13.4</b>	<p>Alternative technical solutions shall be permitted for the following parts of the Works:</p> <p>If alternative technical solutions are permitted, the evaluation method will be as specified in Section III (Evaluation and Qualification Criteria).</p>
<b>ITB 14.5</b>	<p><del>The prices quoted by the Bidder shall be: <i>[insert “shall be” or “shall not be”]</i> subject to price adjustment.</del></p>
<b>ITB 14.6</b>	<p>The prices quoted by the Bidder.... <i>[insert “shall be” or “shall not be”]</i> subject to adjustment during the performance of the Contract.</p>
<b>ITB 14.7</b>	<p>The date for all duties, taxes, and other levies payable by the Contractor under the contract or for any other cause, as of the date 30 days prior to the deadline for submission of bids</p>
<b>ITB 18.1</b>	<p>The bid validity period shall be: .....<del>Ninety days</del>.....<b>[insert Ninety or One Hundred Twenty (90/120) days].</b></p>

**Price adjustment always applies, BUT different clauses are applicable**

# Bid Data Sheet

<b>ITB 19.1</b>	The Bidder shall furnish a bid security, from "A" class commercial bank with a minimum of <b>NRs. 750,000</b> <b>2.5%</b> of the quoted bid amount (inclusive of VAT), which shall be valid for 30 days beyond the validity period of the bid.
<b>ITB 19.2 (b)</b>	Account Name: _____ Bank Name: _____ Bank Address: _____ Account Number: _____
<b>ITB 20.1</b>	In addition to the original of the bid, the number of copy/ies is/are: <u>one</u> _____
<b>ITB 20.2</b>	The written confirmation of authorization to sign on behalf of the Bidder shall indicate: (a) The name and description of the documentation required to demonstrate the authority of the signatory to sign the Bid such as a Power of Attorney; and (b) In the case of Bids submitted by an existing or intended JV, an undertaking signed by all parties (i) stating that all parties shall be jointly and severally liable, and (ii) nominating a Representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the JV during the bidding process and, in the event the JV is awarded the Contract, during contract execution.

# Bid Data Sheet

ITB 21.1	Bidders <i>[insert “shall” or “shall not”]</i> have the option of submitting their bids electronically.
ITB 21.1 (b)	If bidders shall have the option of submitting their bids electronically, the electronic bidding submission procedures shall be: <i>[insert a description of the electronic bidding submission procedures]</i> .
ITB 22.1	<p>For bid submission purposes only, the Employer’s address is:</p> <p>Attention:</p> <p>Address:</p> <p>The deadline for bid submission is:</p> <p>Date: <b>9 May 2014</b> Time: <b>12.00 Hrs</b></p>
ITB 25.1	<p>The bid opening shall take place at:</p> <p>Address: <b>9 May 2014</b> Time: <b>12.30 Hrs</b></p> <p>Date: Time:</p>
ITB 25.1	If electronic bid submission is permitted in accordance with ITB 21.1, the specific bid opening procedures shall be: <i>[insert description of the procedures]</i>
ITB 32.5	The amount of the performance security be increased by Eight (8) percent of the quoted bid price.
ITB 40.3	The bid amount up to <b>Rupees Twenty Million (Rs. 20,000,000)</b>

# Invitation For Bids (IFB)

- Provides information that enables potential Bidders to decide whether to participate.
- Indicates any important bid evaluation criteria:
  - Domestic preference;
  - Qualification requirement;
  - Prequalification/Post Qualification;
  - Minimum level of experience required
- Invitation for Bids is not a part of the Bidding Document and therefore it shall not be included in the Bidding Document.

# Invitation for Bid

- Publication of Procurement Notice
- Place and Period in Which the Bidding Documents are Made Available
- Date of Closing and Extensions, if any
- Pre-bid Conference
- Place of Submission of Bids
- Date and Time of Public Bid Opening

# Invitation For Bids (IFB)

- The Government of Nepal [**GoN**] has allocated funds or received a loan/credit/grant from [**GoN or Development Partner**] towards the cost of [**Name of Project**] and intends to apply part of the funds to cover eligible payments under the Contract for [**Name and identification number of Contract**]. Bidding is open to all eligible Nepalese and Foreign Bidders.
- [**Name of Employer**] invites sealed bids from eligible bidders for the construction of [**Brief description of the Works**] [Insert an additional paragraph indicating clear cut, fail-pass qualification criteria in order to enable bidders to make an informed decision whether to pursue a specific contract and, if so, either as a single entity or in joint venture.]

# Invitation For Bids (IFB)

- Eligible Bidders may obtain further information and inspect the Bidding Documents at the office of **[Name, location, mailing address, telephone and facsimile numbers and email address of the Employer]**.
- A complete set of Bidding Documents may be purchased from the above office of **[insert name and address]** and the office of **[insert name and address]** by eligible Bidders on the submission of a written application, along with the copy of company/firm registration certificate, and upon payment of a non-refundable fee of **[Insert amount]**. If so requested, the Bidding Documents can also be sent by post/courier services upon payment of additional cost of NRs. **[amount]**. However, the Employer will not be responsible for delay or non-delivery of the documents so sent

# Invitation For Bids (IFB)

- Sealed Bids must be submitted to the above office [**Name and address**] on or before [**Time**] on [**Date**]. Bids received after this deadline will be rejected.
- Bids will be opened in the presence of Bidders' representatives who choose to attend at [**Time and date**] at the office of [**Address of office**]. Bids must be valid for a period of [**Insert number of days**] after bid opening and must be accompanied by a bid security amounting to a minimum of [**2.5% of the quoted Bid Amount (Inclusive of VAT)**], which shall be valid for 30 days beyond the validity period of the bid (i.e. [**Date**]).
- If the last date of purchasing, submission and opening falls on a government holiday, it shall be extended to the next working day
- The Employer reserves the right to accept or reject, wholly **or partly** any or all the bids without assigning reason, whatsoever.

# Instructions

The footnotes and notes for the Employer are not part of the text; they should not be incorporated in the Bidding Documents issued to the bidders.

# Bid Purchase

**Bid can be Purchased at two or more places**

**Public Procurement Act clause 14.5**

# Evaluation and Qualification Criteria

- **The bidders are required to be qualified by meeting predefined, precise minimum requirements.**
- **The method entails setting pass-fail criteria, which, if not met by the bidder, results in disqualification.**
- **It will therefore be necessary to ensure that a bidder's risk of having its bid rejected on grounds of qualification is remote if due diligence is exercised by the bidder during bid preparation.**

# **Evaluation and Qualification Criteria**

- **Clear-cut, fail-pass qualification criteria need to be specified in order to enable bidders to make an informed decision whether to pursue a specific contract and, if so, either as a single entity or in joint venture.**
- **The criteria adopted must relate to characteristics that are essential to ensure satisfactory execution of the contract, and must be stated in unambiguous terms.**

## 2.3.2 Average Annual Construction Turnover

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
<b>2.3.1 Historical Financial Performance</b>					
Submission of audited balance sheets and income statements, for the last .....(1)..... years to demonstrate the current soundness of the Bidder's financial position. As a minimum, a Bidder's net worth calculated as the difference between total assets and total liabilities should be positive.	must meet requirement	must meet requirement	must meet 25 %	must meet 40 %	Form FIN - 2

## 2.3.3 Required Bid Capacity

Criteria		Compliance Requirements			Documents Submission Requirements
Requirement	Single Entity	Joint Venture			
		All Partners Combined	Each Partner	One Partner	
<p><b>The bidding capacity of the bidder should be equal to or more than the NRs...(2a).....</b></p> <p><b>. (2a) Equal to Engineer's Estimate( without VAT and Contingencies but including Provision Sum )in round figure</b></p> <p><b>(3a) Usually not less than 25 %</b></p> <p><b>(4a) Usually not less than 40 %</b></p>	must meet requirement	must meet requirement	must meet 25 %	must meet 40 %	Form FIN – 3,4

## 2.4.1 General Construction Experience

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
<b>Experience under construction contracts in the role of contractor, subcontractor, or management contractor for at least the last ..... (1)..... years prior to the applications submission deadline.</b>	must meet requirement	not applicable	must meet requirement	not applicable	Form EXP-1

## 2.4.2 Specific Construction Experience

### a. Contracts of Similar Size and Nature

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
<p><b>Participation as Prime contractor, management contractor, or subcontractor, in at least ..... (2) .... Contracts within the last ten (10) years, each with a value of at least NRs .....(3).... that have been successfully or are substantially completed and that are similar to the proposed works. The similarity shall be based on the physical size, complexity, methods, technology or other characteristics as described in Section VI, Works Requirements.</b></p>	<p>must meet requirement</p>	<p>must meet requirement</p>	<p>not applicable</p>	<p>not applicable</p>	<p>Form EXP-2a</p>

## 2.4.2 Specific Construction Experience

### b) Construction Experience in Key Activities

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
<p>For the above or other contracts executed during the period stipulated in 2.4.2(a) above, a minimum construction experience in the following key activities :</p> <p><i>[list activities indicating volume, number or rate of production as applicable; for the key activity (ies) in the subject contract. The rates should be about 80% of the estimated production rates of the key activity(ies) in the subject contract as needed to meet the expected construction schedule with due allowance for adverse climatic conditions.]</i></p>	must meet requirement	must meet requirement	not applicable	not applicable	Form EXP-2a

## 2.3.1 Historical Financial Performance

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
<b>2.3.1 Historical Financial Performance</b>					
<b>Submission of audited balance sheets and income statements, for the last .....(1)..... years to demonstrate the current soundness of the Bidder's financial position. As a minimum, a Bidder's net worth calculated as the difference between total assets and total liabilities should be positive.</b>	must meet requirement	not applicable	must meet requirement	not applicable	Form FIN - 1 with attachments

# Works Requirement: Specifications

- Precise and clear Specifications are a prerequisite for bidders to respond realistically and competitively to the requirements of the Employer without conditioning their bids.
- In the context of international competitive bidding, the Specifications must be drafted to permit the widest possible competition and, at the same time, present a clear statement of the required standards of materials, Plant, other supplies, and workmanship to be provided. Only if this is done will the objectives of economy, efficiency, and equality in procurement be realized, responsiveness of bids be ensured, and the subsequent task of bid evaluation facilitated.

# Works Requirement: Specifications

- The Specifications should require that all materials, Plant, and other supplies to be incorporated in the Works are new, unused, of the most recent or current models, and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.
- A clause setting out the scope of the Works is often included at the beginning of the Specifications, and it is customary to give a list of the Drawings.
- Where the Contractor is responsible for the design of any part of the Permanent Works, the extent of his obligations must be stated.

# Works Requirement: Drawings

- It is customary to bind the drawings in a separate volume, which is often larger than other volumes of the contract documents. The size will be dictated by the scale of the drawings, which must not be reduced to the extent that details are reduced illegible.
- A simplified map showing the location of the Site in relation to the local geography, indicating major roads, posts, airports, and railroads, is helpful.
- The construction drawings, even if not fully developed, must show sufficient details to enable bidders to understand the type and complexity of the work involved and the price the Bill of Quantities.

# **Bill of Quantities**

# Bill of Quantities

**The objectives of the Bill of Quantities are**

- (a) to provide sufficient information on the quantities of Works to be performed to enable Bids to be prepared efficiently and accurately; and**
- (b) when a Contract has been entered into, to provide a priced Bill of Quantities for use in the periodic valuation of Works executed.**

# Bill of Quantities

**The Bill of Quantities should be divided generally into the following sections:**

**(a) Preamble;**

**(b) Work Items (grouped into parts);**

**(c) Day works Schedule;**

**(d) Provisional Sums; and**

**(e) Summary.**

# BIDDING DOCUMENT

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# General Conditions of Contract

# General Condition of Contracts

- The Conditions of Contract have been prepared for an ad measurement (unit price or unit rate) type of contract and cannot be used without major modifications for other types of contract.
- The use of **standard conditions of contract** for all civil Works will ensure comprehensiveness of coverage, better balance of rights or obligations between Employer and Contractor, general acceptability of its provisions, and savings in time and cost for bid preparation and review, leading to more economical prices

# Special Conditions of Contract

# Special Condition of Contracts

- The SCC complement the General Conditions (GC) to specify data and contractual requirements linked to the special circumstances of the country, the Employer, the Engineer, the sector, the overall project, and the Works.
- While drafting SCC, one should be thoroughly familiar with the provisions of the GC and with any specific requirements of the Contract.
- Legal advice is recommended when amending provisions or drafting new ones.

# Contract Forms

# Bidding Document

The Bidding Documents should be;

- clearly understandable,
- specific,
- complete,
- correct, and
- unambiguous.

In case of ambiguities each party will try to interpret the words in his favor

In cases of ambiguities the **court will interpret the writing against the author** (law of contrareferentum)

Meaning of sentences or words in a document are to be understood as how a reader understands and not what is understood or meant by the entity.

# Precedence of Laws and Regulations

If any provisions of this document are inconsistent with Public Procurement Act (PPA), 2063 or Public Procurement Regulations (PPR), 2064, the provision of this document shall be void to the extent of such inconsistency and the provision of PPA and PPR shall prevail.

**Clauses/Requirements of SBD**  
to be Made Consistent With  
the ACT and REGULATION

## Use of Standard Bid Document

### ● **Standard Documents issued by PPMO**

**Procurement Clause 67:**

**Procurement process under this Act not to be followed:**

**If, under an agreement made between the Government of Nepal and a donor party, procurement is to be made in accordance with the procurement guidelines of the donor party**

**The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.**

- (a) the Letter of Acceptance;**
- (b) the Letters of Technical and Price Bid;**
- (c) the Addenda Nos ..... Insert addenda numbers if any .....**
- (d) the Special Conditions of Contract;**
- (e) the List of Eligible Countries that was specified in Section V of**

**The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.**

**(f) the General Conditions of Contract;**

**(g) the Specification;**

**(h) the Drawings;**

**(i) Bill of Quantities (or Schedules of Prices for lump sum contracts), and**

**(j) Table of Price Adjustment Data**

**(k) List of Approved Subcontractors *[For GoN funded project]***

**(l) 10/10/2022 10:00 PM ..[Specify if there are any other document]**

# Priority of Documents

**What is order of priority?**

**BOQ/ Specifications / Drawing**

# Priority of Documents

- (a) Contract Agreement,**
- (b) Letter of Acceptance,**
- (c) Contractor's Bid,**
- (d) Special Conditions of Contract,**
- (e) General Conditions of Contract,**
- (f) Specifications,**
- (g) Drawings,**
- (h) Bill of Quantities (or Schedules of Prices for lump sum contracts), and**
- (i) Any other document listed in the SCC as forming part of the Contract.**

# DRAWINGS

- Design drawings
- Tender/ Contract drawings
- Construction drawings/  
drawings
- As built drawings

Workshop

# **Bill of Quantities and its Importance**

- Basis for evaluating the total Bid Price (comparison, loading, high or low rates),
- Basis for executing the works and prepare payment certificates,
- Basis for assessment of variation and rate/price review or new item rates, if needed

Any questions ???

■ **Thank you.**



GOVERNMENT OF NEPAL

MINISTRY OF PHYSICAL INFRASTRUCTURE AND TRANSPORT

DEPARTMENT OF ROADS



# Observation and Detour Road Management of Bridges along BP Highway

PRESENTED BY: GROUP-1





# Bridges as Pilot Projects in B.P Highway

1. GHYAMPE BRIDGE CH. 111+400 : PRE-STRESS BRIDGE

2. MAMTI BRIDGE CH. 113+900 : RCSB

3. BHYAKURE BRIDGE CH. 119+700 : PRE-STRESS BRIDGE



# Detour Road Management

- PROVISION FOR DETOUR ROAD (ROAD DIVERSION) CONSTRUCTION BY MAINTAINING ALL THE PRECAUTIONS IN DIRECTING RIVER CHANNEL FLOW BY GABION WORKS IN BOQ
- PROVISION FOR DETOUR ROAD MAINTENANCE IN BOQ (UNIT MONTH)
- DETOUR ROAD CONSTRUCTED IN ALL THREE BRIDGES
- NO ROAD CLOSURE AT BRIDGES SITE DUE TO DETOUR ROAD MANAGEMENT



# Detour Road in Ghyampe Bridge





# Detour Road in Bhyakure Bridge





# Detour Road in Mamti Bridge

ROAD  
CLOSURE  
IN  
PREVIOUS  
YEAR AT  
MAMTI  
BRIDGE  
DURING  
MONSOON.





# Detour Road in Mamti Bridge



**MAMTI BRIDGE RIVER CHANNELING IN U/S  
OF DETOUR ROAD.**



# Detour Road in Mamti Bridge





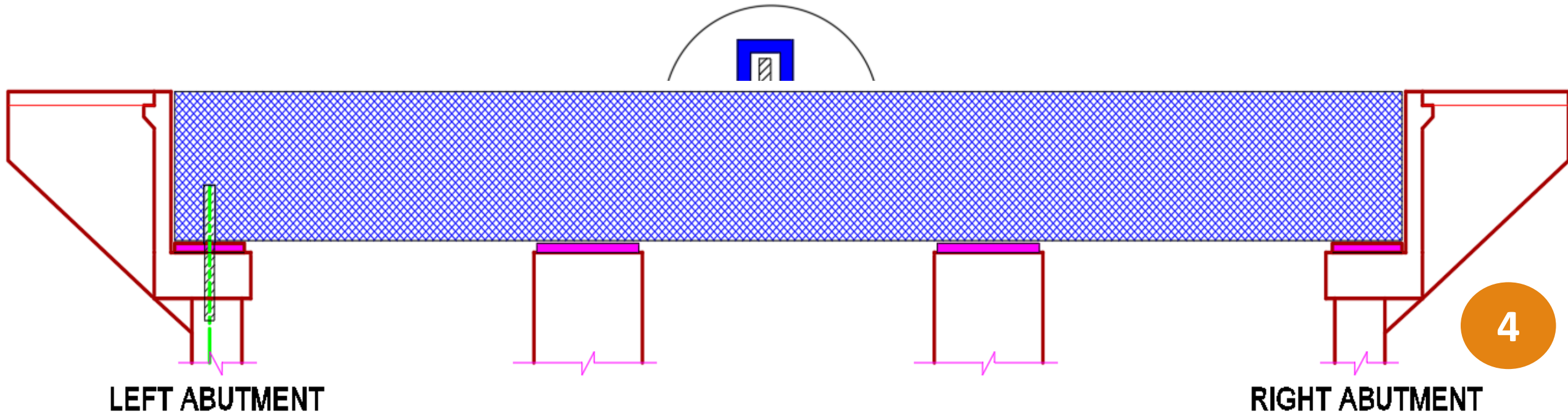
# Observation on Mamti Bridge





# Observation on Mamti Bridge

- HOW THE RCSB (REINFORCED CONCRETE SLAB BRIDGE) WILL TRANSFER THE LOAD/CONSTRUCTED...





# Observation on Mamti Bridge

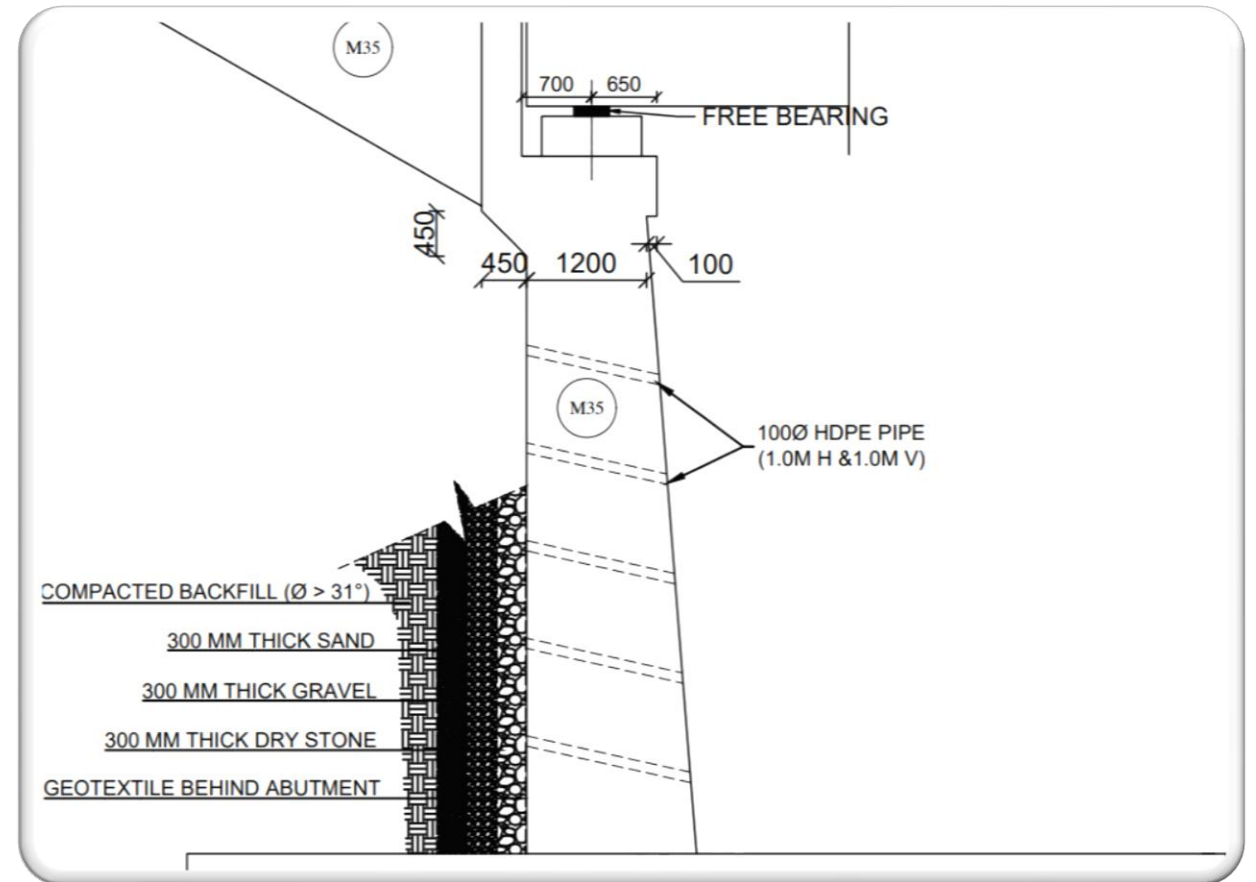
- THE FOUNDATION SEEMS WELL BELOW THE SCOUR DEPTH.





# Observation on Mamti Bridge

- WEEP HOLES ARE MISSING IN BOTH ABUTMENT STEM.





# Observation on Mamti Bridge

- STOPPER MAY BE NEEDED TO COUNTERACT THE HORIZONTAL MOVEMENT OF DECK SLAB.

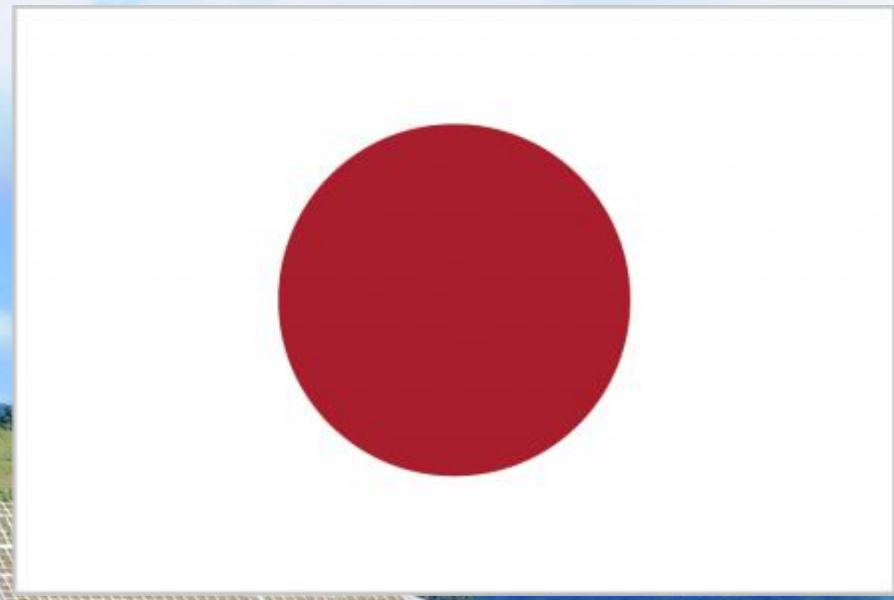




# Observation on Mamti Bridge

- BEARING DETAILS AT PIER IS MISSING IN DRAWING.





*DOMO ARIGATO  
GOZAIMASU!!!*

*धन्यबाद्!*

*Thank you !!*

# **Discussion Related to the, Quality control method, Management and Progress control method**

**Oct 14 2022**

# Presentation outline

- **Quality system , Quality Assurance/ Quality Control**
- **Specification**
- **Quality Assurance Plan**
- **Quality of construction material**
- **Management and Progress control**

# Quality System

**The organizational structure, responsibilities, procedures, process and resources for implementing quality**

The quality system should only be comprehensive as needed to meet the quality objectives.

For contractual mandatory and assessment purpose demonstration of the implementation of identified elements in the system may be required.

# Quality Assurance

**All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirement of quality**

**Unless given requirements fully reflect the needs of the user, quality assurance will not be complete.**

**For effectiveness, quality assurance usually requires a continuing evaluation of the factors that affect the adequacy of the design or specification for intended applications as well as verifications and audits of productions installation and inspection operations. Providing confidence may involve producing evidence.**

**Within an organization , Quality assurance serve as management tool. In contractual situation, QA also serve to provide confidence in the supplier.**

# Quality Control

- **The operational techniques and activities that are used to fulfill requirements for quality.**
- **Operational techniques or activities aimed both at monitoring a process and at eliminating causes of unsatisfactory performance at relevant stages of the quality loop ( quality spiral) in order to result in economic effectiveness.**

## **Quality Control**

**The routine application, at prescribed frequencies, of a system of procedures for the sampling and testing of materials prior to placing and following completion that ensures that specified standards are achieved.**

## **Quality Assurance**

**The identification of roles and responsibilities of all parties, together with procedures and systematic management to be followed that will ensure that the Quality Control System is implemented effectively.**

# Quality construction

- **Quality construction can be considered in two broad headings:-**
  - **Quality of material**
  - **Quality in workmanship**
  - **Procedure of work**

# DRAWINGS

- **Design drawings**
- **Tender/ Contract drawings**
- **Construction drawings/ Workshop drawings**
- **As built drawings**

# Specifications and Drawings

- **Specifications and Drawings are the two integral parts of contract, which shows the requirements of the Employer.**
- **Specifications are referred more in cases of conflict and disputes whereas the drawings are dealt in day-to-day work execution.**
- **Notes: *mentioned in the drawings are also treated as specifications and are effective.***

# **Specifications and Drawings**

- **It is advised to include clauses stating that “the Engineer will decide in case of discrepancy in drawings and specifications”.**
- **Such authority to the Engineer may avoid disputes and litigations arising from some small mistakes.**

# **Bill of Quantities and its Importance**

- **Detail work breakdown of total works,**
- **An outcome of Estimated items in a Unit Rate Contract,**
- **Should be clear, precise, and unambiguous as it is basis for a Bidder to prepare bid,**

# **Bill of Quantities and its Importance**

- **Basis for evaluating the total Bid Price (comparison, loading, high or low rates),**
- **Basis for executing the works and prepare payment certificates,**
- **Basis for assessment of variation and rate/price review or new item rates, if needed**

# Specifications

- **Specifications are a part of contract documents**
- **It defines the quality requirement, workmanship, and the end product to be constructed or produced or supplied.**
- **The end product should conform to the requirement of specification**

# Specifications .....

**Specifications can be divided in to 2 parts**

- **General Standard Specifications**
- **Specific Specification**

**To avoid the repetitive works and ambiguity in the wording and sentences, a set of standard specifications are commonly used.**

**Standard specification needs to be updated to accommodate the change in technology**

# Specifications .....

- **If the standard specification does not cover the requirement of works in such cases specific specifications has to be prepared.**

**During execution of works Specific specification could be prepared and approved at Department level**

# Specifications .....

- **Specification to be prepared considering each item of works in Bill of Quantities,**
- **Standard or Specific specification reference should be specified for each item in BOQ for easier cross reference,**

# The Importance of Complete and Accurate Specifications!

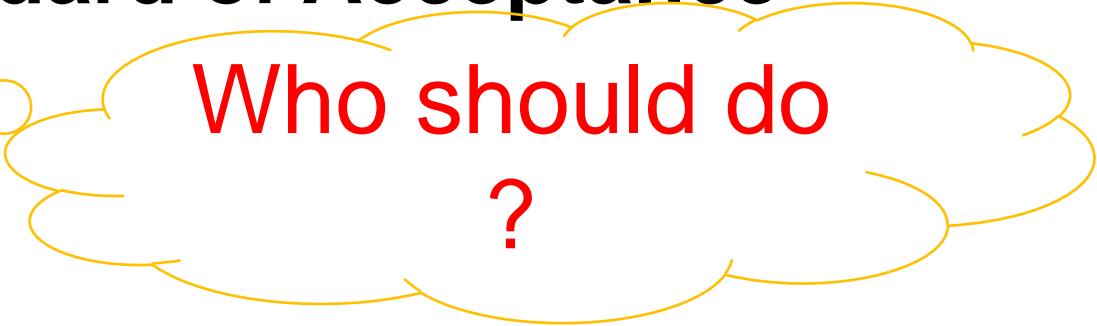
# ATTENTION

# !!!

**Specification should reflect the need of the Project**

# General Content of specifications Item

- **Scope**
- **Material**
- **Construction**
- **Tests and Standard of Acceptance**
- **Measurement**
- **Payment**



Who should do  
?

# Quality Assurance Plan

- **Specification Clause 511**

“ The Contractor shall submit Quality Assurance Plan (QAP) to the Engineer for his approval. The Quality Assurance Plan (QAP) shall be based on the detailed Program of the Works, and process oriented focus on defect prevention, as per Clause 115 of these Specifications.”

# Contents of QAP

- Back ground
- Project
- Quality Assurance Procedure
- Organization and Responsibility
  1. Organization for Quality Assurance
  2. Role and Responsibility
- Schedules
  1. Project Work Schedule
  2. Material Testing Schedule
- Quality Assurance
  1. Laboratory for Testing
  2. Test Format for Testing
  3. Working Procedure
  4. Non Compliance corrective measures



# Common materials used for Bridge construction/maintenance...

- **Reinforcing Steel**
- **Water**
- **Admixtures**
- **Aggregate**
- **sand**

# **CEMENT**

- **Cement to be used shall conform to the requirements of**
- **IS : 269 for ordinary and rapid hardening Portland cement**
- **IS : 455 for Portland blast furnace slag cement**
- **IS : 3466 for masonry cement (for use in mortars for masonry only) until similar Nepal's Standards are in place.**
- **NS: 49:2041 Ordinary portland cement    Second Amendment**

# Cement ....

- **Source, make and manufacture date (i.e. age of cement) is to be checked**
- **Proper storage arrangement in a damp free environment is to be arranged if substantial quantity is to be handled**
- **Random sampling and test for setting time (initial and final) and compressive strength is to be done if the work volume is substantial**

## ***Cement...***

- **Lumps, partial set and cement older than 60 days needs check. Sample weight is to be checked**
- **Initial setting time should not be less than 30 minutes and final setting time should not exceed 10 hours.**
- **For ordinary Portland cement, 7 days ( $\pm 2$  hours) strength on standard mortar cube (1:3) should not be less than 22 N/m<sup>2</sup>**

# Sand

Sand to be used shall conform to the requirements of

- IS : 2116 for masonry work
- IS : 383 for cement concrete work
- until similar Nepal's Standards are in place.

# Sand....

- **Natural sand (not mechanically crushed) is in use for general road maintenance.**
- **Particles between 0.06 mm and 0.002 mm is silt and that less than 0.002 mm is classified as clay.**
- **Allowable max. limit for organic impurities:**
  - **Coal and lignite 1%**
  - **Clay lumps 1.5%**
  - **Material passing 0.75 mm 3%**
  - **Mica 1%**
  - **Shale 1%**

# ***Sand...***

- **Total impurities** not to exceed **5%**.
- **General gradation requirement** for sand is specified based on nature of work.
- **Fine impurities** *can be tested in field by filling 100 ml of sand in 200 ml measuring cylinder, adding 50 ml water, shaking well and measuring silt height after 3 hours in room temperature.*

# Sand...

- **Organic impurities can be found by heating known weight of sand to constant heat and finding the weight loss.**
- **Bulking of sand is another phenomenon that needs to be checked and controlled so as to prevent use of incorrect quantity of sand.**

# Water

- **Water for concrete/mortar works should be of potable quality and thus free from harmful substances e.g. oil, salt, sugar, acid, alkali and organic matter.**

**If you cannot see through water, it is dirty.**

- **-If your nose feels that water smells, don't use it.**
- **-Organic solid content should not exceed 200 mg/l.**
- **-Inorganic solid contents should not exceed 3000 mg/l.**

# Coarse aggregate

- All coarse aggregate material shall be chemically inert, strong and hard.
- Thin or elongated pieces ( $l > 1.5 d$ ) shall not exceed 15%.
- Strength of aggregate is in general, more than strength of concrete.
- Loss Angels Abrasion value shall not exceed 42%.
- Soft or disintegrated rock particles shall not exceed 2.5%.
- Clay ball or lumps not to exceed 0.25%.
- Specified gradation requirement shall be satisfied.

# Slump test apparatus



# Compressive strength of concrete



# STEEL

## High Tensile Steel for Pre-stressing

Steel for pre-stressing shall conform to the requirements of IS : 1785 (Part I) until similar Nepal's Standards are in place.

## Mild Steel Reinforcement

- Mild steel reinforcement shall conform to the requirements of
- IS : 432 for Mild Steel Grade I or medium tensile steel bars
- IS : 1139 for high yield strength deformed (hot rolled) bars
- IS : 1786 for high yield strength deformed (cold twisted) bars until similar Nepal's Standards are in place.
- NS: 84:2042 Mild steel rod

# Steel....

- **It should be free from rust and surface cracks.**
- **Tensile strength should not be less than specified for particular steel grade (e.g. 415 N/mm<sup>2</sup> for Torsteel).**
- **Elongation on failure shall be as specified (e.g. Minimum 14.5% for Torsteel).**
- **Reinforcing steel should not crack/fracture when it is bent or rebent cold.**

# steel...

- Reinforcing steel shall be in specified position and shall be free from mortar, oil, grease, rust, etc. at the point of pouring concrete.
- If there is a complaint from bar bending crew regarding hardness of steel pay attention to it because it may be due to improper ductility.
- Test may be requested in such situation.

# *Admixtures*

- **Admixtures are materials used in concrete to modify its properties to suit our needs.**
- **Accelerating admixtures such as calcium chloride help develop strength rapidly.**
- **Retarding admixtures such as sugar, cellulose products etc. help retard setting and thereby reduce evolution of heat.**
- **Common dose of sugar is 0.05% by weight of cement.**
- **But use of admixture shall be reserved for special case only.**
- **Water reducing admixtures such as hydroxylated carboxylic acids reduce the water content while maintaining workability.**
- **Since admixtures are costly they are used in special circumstances only**

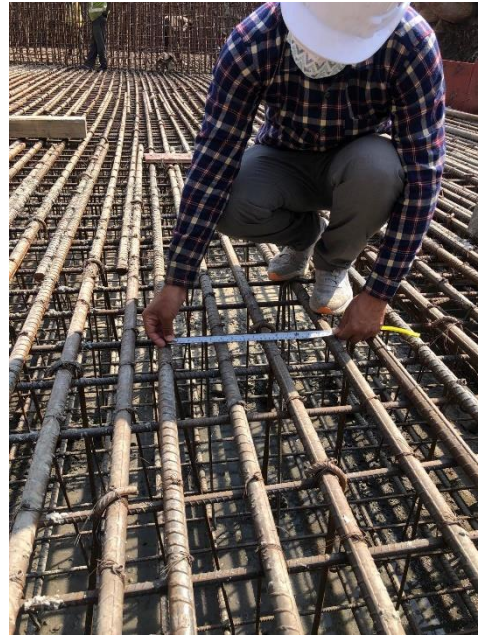
# Quality in workmanship

- **Workmanship quality is equally important as material quality to get a good product.**
- **Following are some important points to be borne in mind to maintain good workmanship quality in different road construction/ maintenance activities.**

# Concrete works

- **Ratio must be maintained**
- **Thoroughly mixed.**
- **Fresh/Green mix used and compacted within 30 minutes**
- **Vertical drop should not exceed 1m height.**
- **Well compacted**
- **Cured for at least 15 days.**
- **Form works tightly fixed in position.**
- **Sufficient support for formwork.**

# Foundation excavation and reinforcement works , Mamti



# Mass concreting



- **Where to keep construction joint?**

- **Mass concreting is suitable for Nepali contractor?  
(contract value NRS 62 million, time 23 month)**

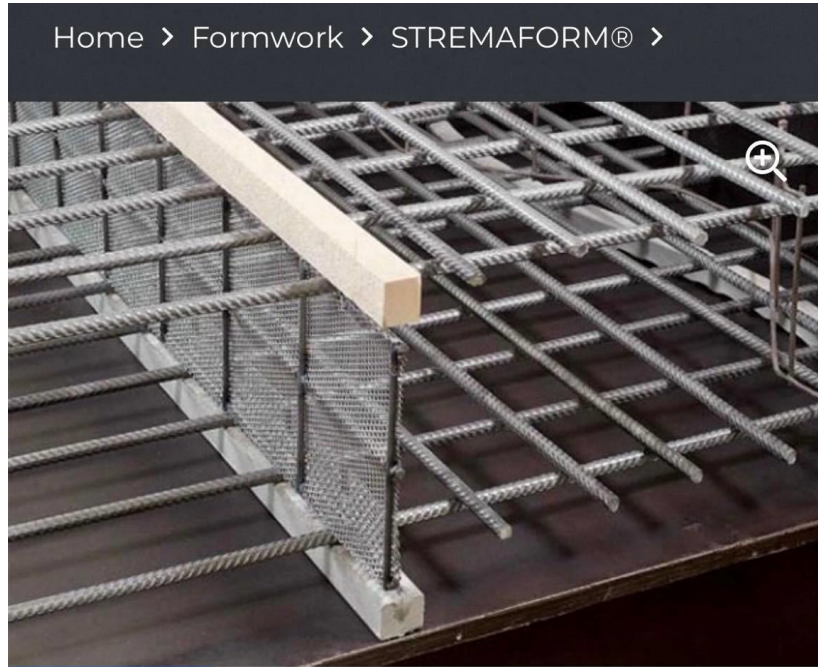
# **Preparation of Construction Joint**

- **The Construction Joint in concrete used to prevent any crack during its life period.**
- **Concrete has the property of expansion and contraction due to temperature changes, which is resulting in a change in the volume of concrete.**
- **This change in the volume of concrete can be the cause of concrete cracking.**
- **To prevent concrete crack construction joints are provided in concrete.**

# Principal for construction joint ....

- location to be at  $1/3$  to  $1/4$  th distance from support.
- within 12 hrs ( green concrete) : provide key joints ( vertical as per specification clause 2012) + remove Laitance / lose concrete
- within 12 hours to 3 days : provide key joints ( vertical as per specification clause 2012) + remove Laitance / lose concrete + use cement slurry ( @ 24 kg /sqm)
- within 3 days to 7 days : provide key joints ( vertical as per specification clause 2012) + remove Laitance / lose concrete use Epoxy / resin
- after 7 days : use shear connector

# Construction Joint ( Chicken Joint)



# Management and Progress control

- GCC 34.1 Within the time **stated in the SCC**, after the date of the Letter of Acceptance, the Contractor shall submit to the Project Manager for approval a Program showing the general methods, arrangements, order, and **timing for all the activities** in the Works. In the case of a lump sum contract, the activities in the Program shall be consistent with those in the Activity Schedule.
- An update of the Program : if actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work, including any changes to the sequence of the activities.

# Typical work schedule for bridge

S. N	Description of Works					
		Magh	Falgun	Chaitra,	Baisak,h	Jestha
1	Foundation and sub structural works					
2	Superstructure work					
3	Approach road					
4	River training and protection works					

# **Management and Progress control (contd.)**

- 38.1 Either the Project Manager or the Contractor may require the other to attend a management meeting to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.

# Earned Value Investigation

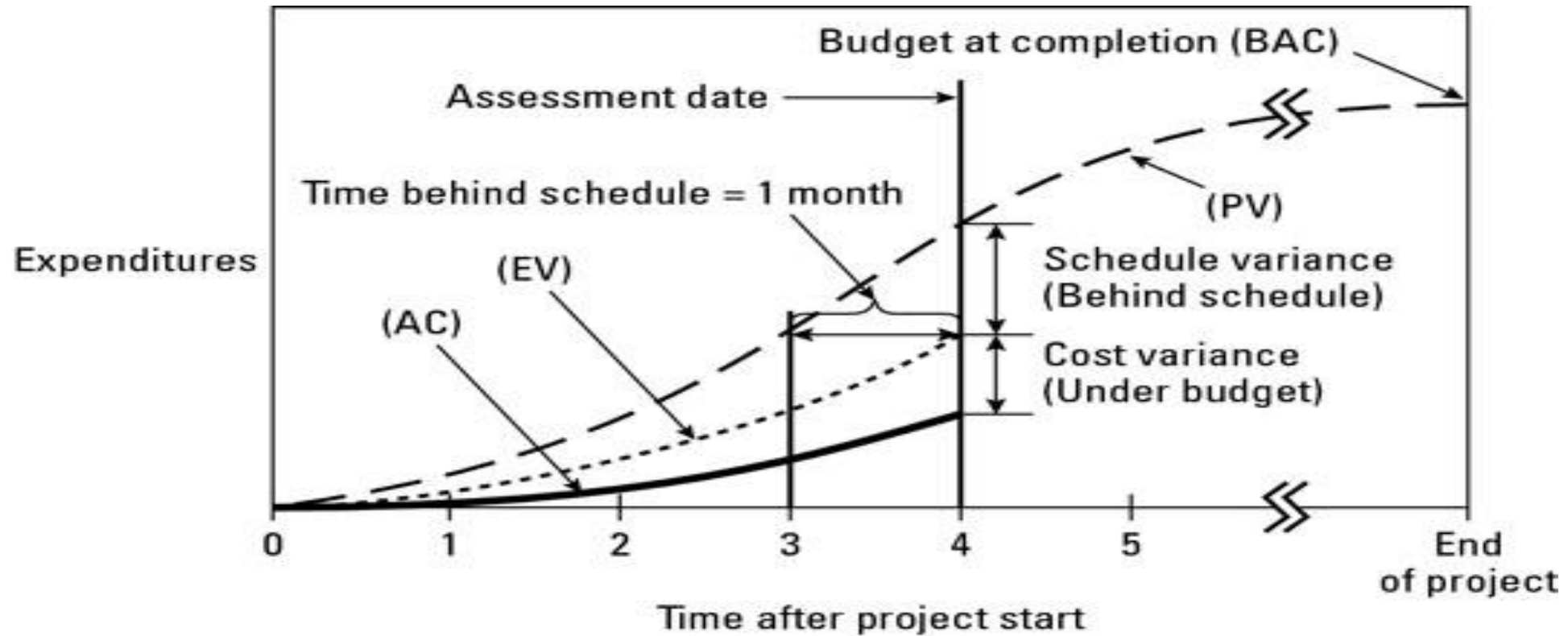
- Earned value chart has been mandated by PWD
- It allows to know the current status of the project at a glance
- Helps in identifying areas for detailed probe

e.g. How much period project lag behind or ahead of schedule?  
Expenditure status ? Etc

# EARN-VALUE , example to calculate

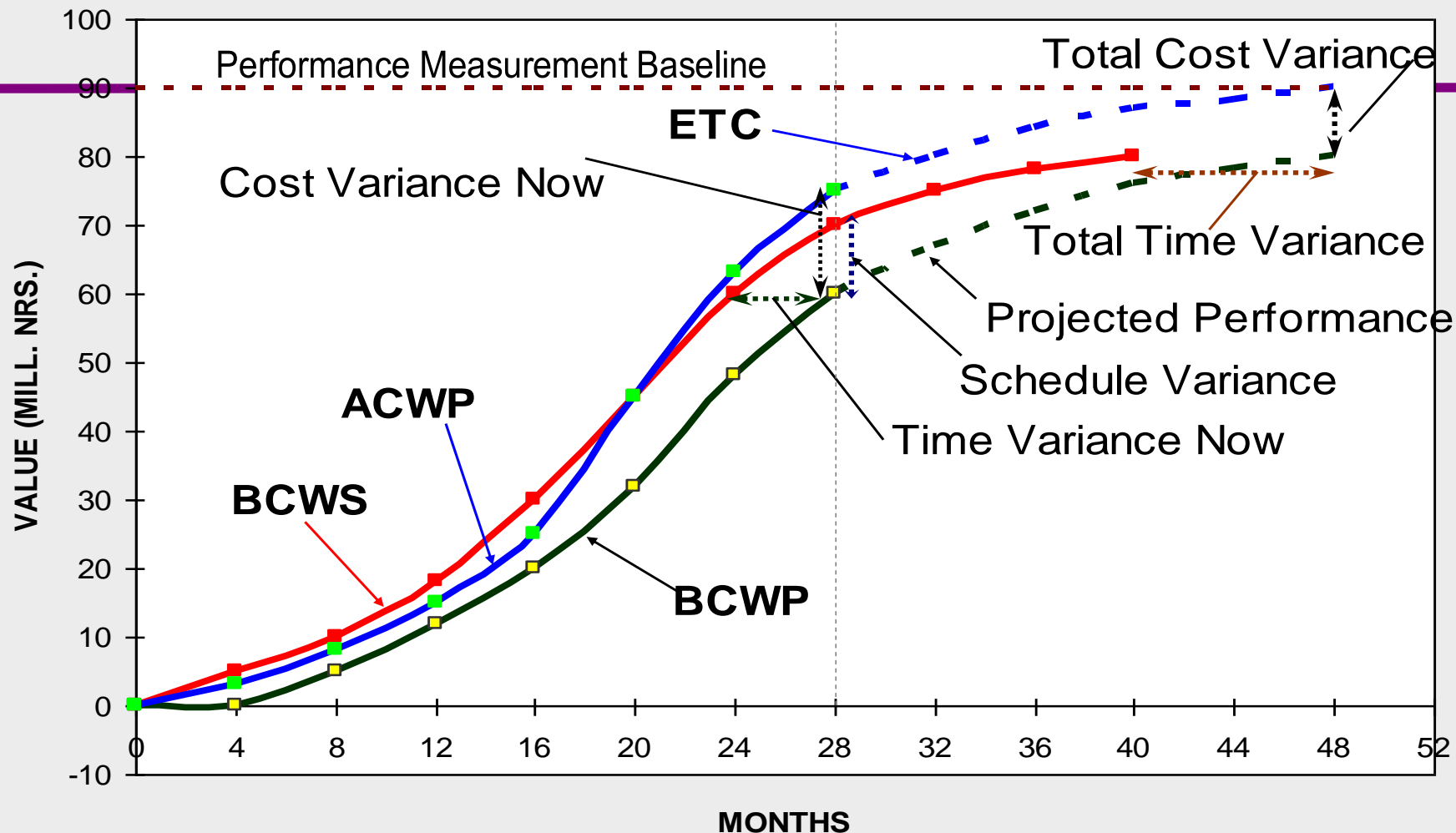
Task	Task Budget (M.Rs)	Planned progress (%)	Actual progress (%)	Planned E.Value (M.Rs)	Actual E. Value (M.Rs)
1	20	40	40	8	8
2	40	100	90	40	36
3	10	20	0	2	0
4	40	0	0	0	0
5	20	0	0	0	0
<b>Total</b>	<b>130</b>			<b>50</b>	<b>44</b>
Earned Value			$44/130 = 34\%$		
Monthly Progress			$44/50 = 88\%$		

# Earn value investigation



- **Planned value (PV):** The approved budget for the work scheduled to be completed by a specified date; also referred to as the *budgeted cost of work scheduled* (BCWS). The total PV of a task is equal to the task's *budget at completion* (BAC) — the total amount budgeted for the task.
- **Earned value (EV):** The approved budget for the work actually completed by the specified date; also referred to as the *budgeted cost of work performed* (BCWP).
- **Actual cost (AC):** The costs actually incurred for the work completed by the specified date; also referred to as the *actual cost of work performed* (ACWP).

# CONCEPT OF EARN-VALUE (S-CURVE)



**ACWP** =Actual Cost of Work performance; **ETC**=Estimated Cost to Complete;  
**BCWS** =Budgeted Cost of Work Schedule; **BCWP**=Budgeted Cost Work performed

# Earn value investigation

To describe your project's schedule and cost performance with EVM, you use the following indicators:

- **Schedule variance (SV):** The difference between the amounts budgeted for the work you actually did and for the work you planned to do. The SV shows whether and by how much your work is ahead of or behind your approved schedule.
- **Cost variance (CV):** The difference between the amount budgeted and the amount actually spent for the work performed. The CV shows whether and by how much you're under or over your approved budget.
- **Schedule performance index (SPI):** The ratio of the approved budget for the work performed to the approved budget for the work planned. The SPI reflects the relative amount the project is ahead of or behind schedule, sometimes referred to as the project's *schedule efficiency*. You can use the SPI to date to project the schedule performance for the remainder of the task.
- **Cost performance index (CPI):** The ratio of the approved budget for work performed to what you actually spent for the work. The CPI reflects the relative value of work done compared to the amount paid for it, sometimes referred to as the project's *cost efficiency*. You can use the CPI to date to project the cost performance for the remainder of the task.

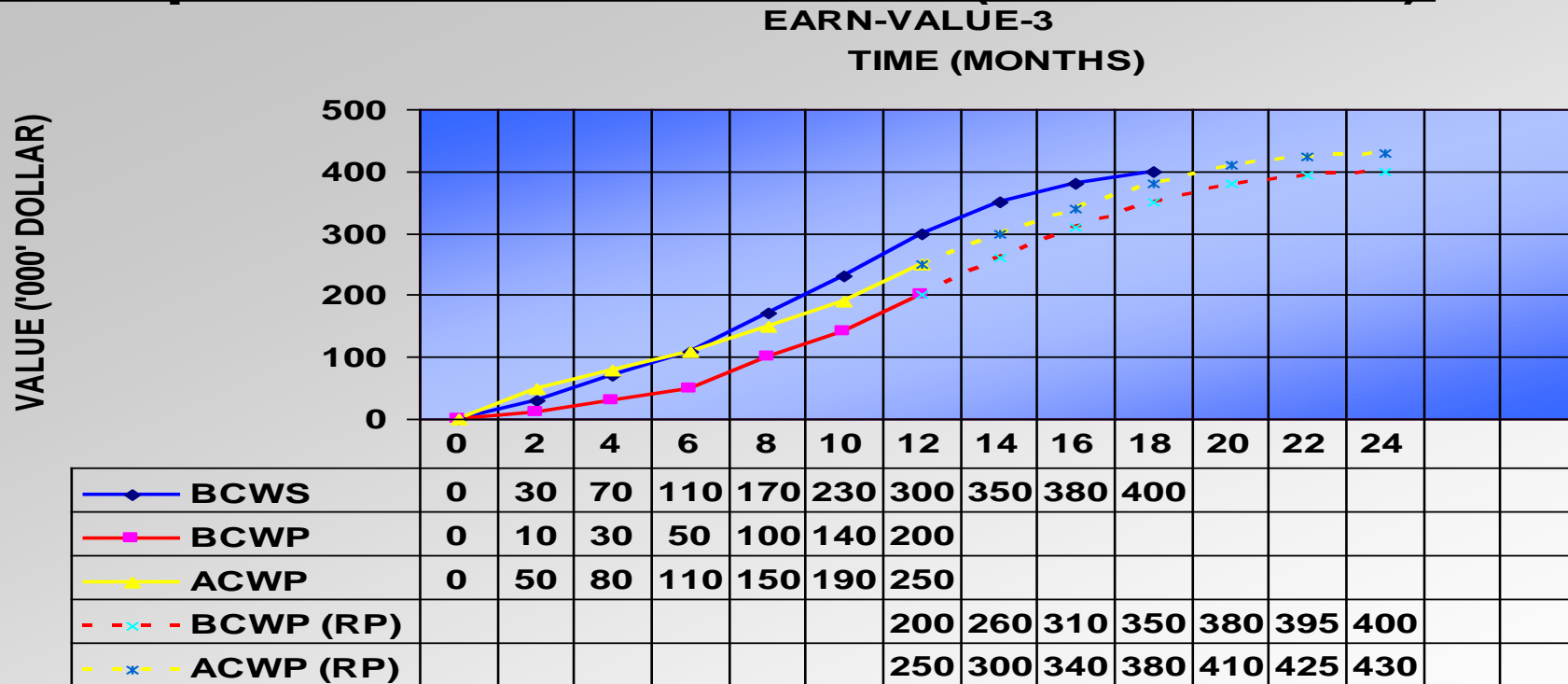


# Group work exercise

Progress ('000' M.NPR)	Months	0	2	4	6	8	10	12	14	16	18	20	22	24	
	Planned (Schedule)	0	30	40	40	60	60	70	50	30	20				
	Performed (Earned)	0	10	20	20	50	40	60	60	50	40	30	15	5	
	Actual (Expenditure)	0	50	30	30	40	40	60	50	40	40	30	15	5	
Cumulative Progress ('000' M.NPR)	Planned (Schedule)														
	Performed (Earned)														
	Actual (Expenditure)														

- i) Plot the Time-phased Budget Curve and show the following:
- a. Budgeted Cost of Work Schedule (BCWS)
  - b. Budgeted Cost of Work Performed (BCWP)
  - c. Actual Cost of Work Performed (ACWP)

# Group work exercise ( solution)



Schedule variance = performed earned – Planned Schedule = 200-300

Cost variance = Earned value (BCWP)-Actual Expenditur (ACWP) 200-250= 50

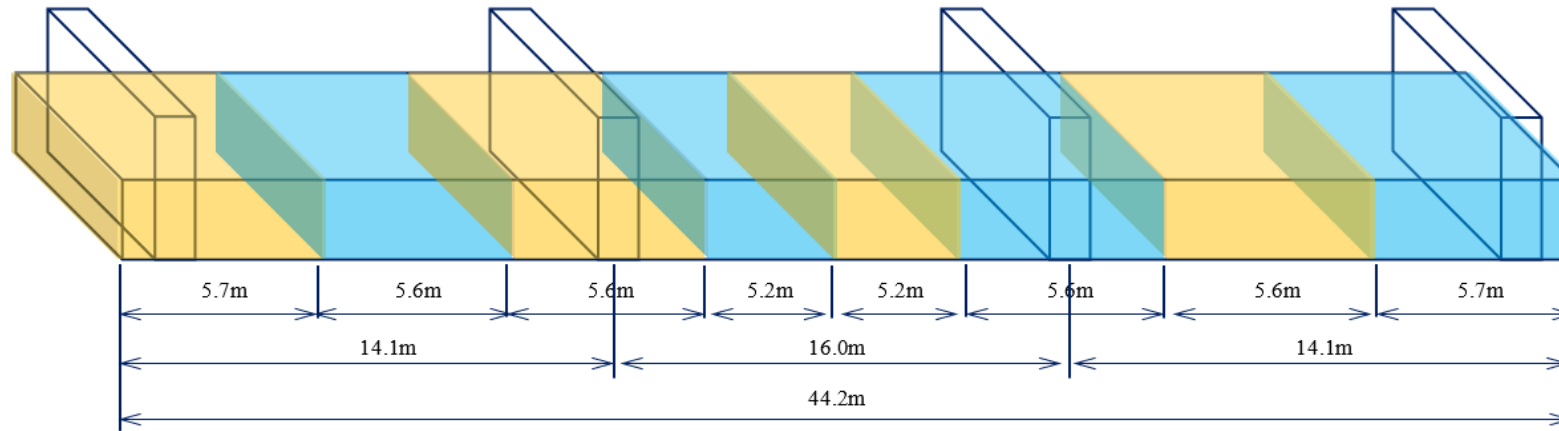
PARAMETER	SV (12)	TV (12)	CV (12)	BCWS	ACWP	TVC
VALUE	100	3	50	400	430	6
UNIT	'000' M.NPR	Months	'000' M.NPR	'000' M.NPR	'000' M.NPR	Months

# Group work

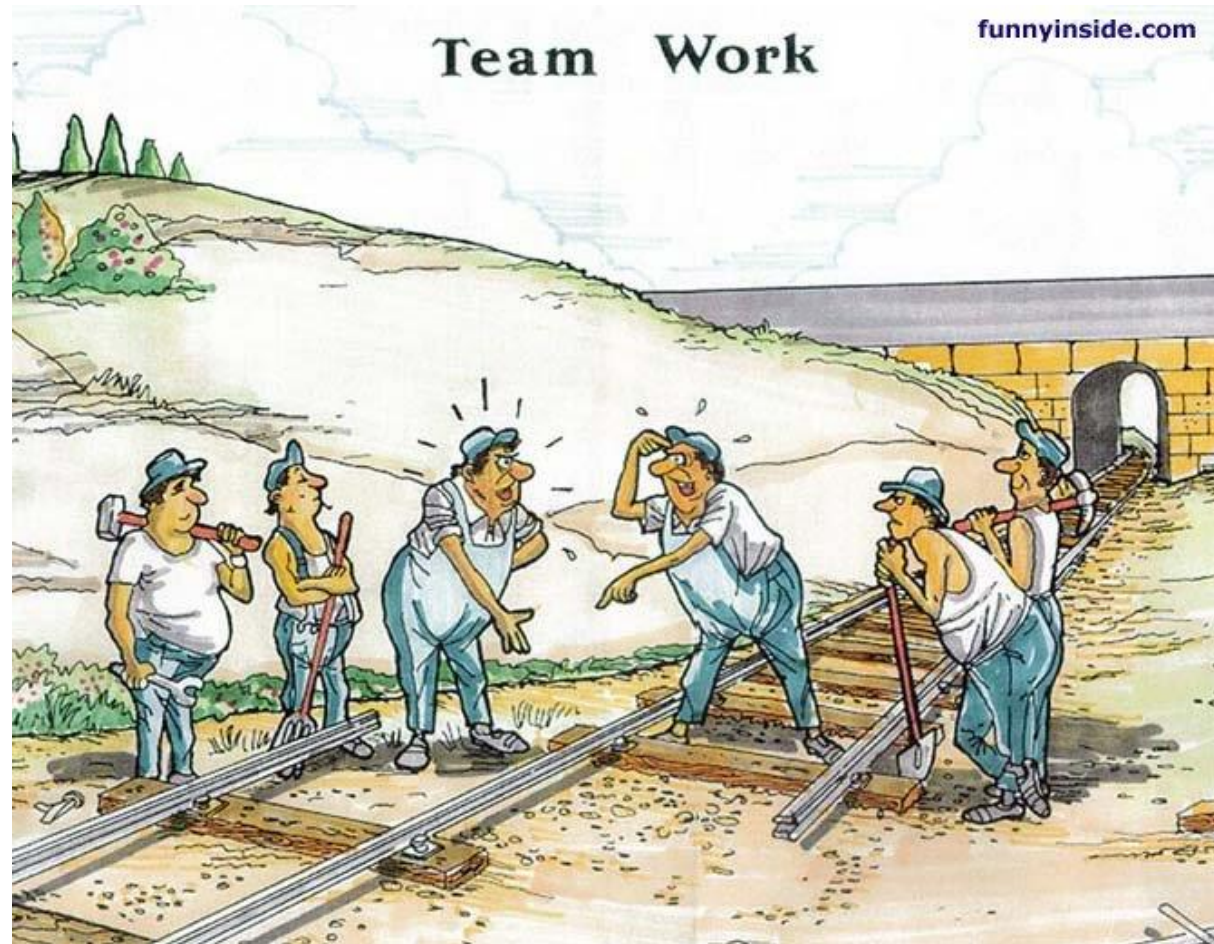
- **Group 1: Management and Progress control method, ;**  
**prepare list of action in case of bridge construction work, Contractor started work and left site after foundation excavation for more than 6 month , which is not as per schedule and problem for traffic management also .**
- **Group 2: Quality control method;**
- **Suggest working method related to foundation concrete =**  
 **$44.2 * 11 * 1.6 = 777.92 \text{ cum}$**

# Mamti Bridge

- Total foundation concrete =  $44.2 \times 11 \times 1.6 = 777.92 \text{ cum}$



Any  
questions ???



**Work in  
team.**

**Thank you.**

# **BRIDGE SITE SELECTION!!!**



**WELCOME!**

**Group 2 :**

**Training on Design Manual of  
(RCSB) Reinforced Concrete Slab Bridge**

# Ideal Bridge Site Selection:

- ❖ A Straight Reach of River.
- ❖ Steady River Flow without cross currents.
- ❖ A Narrow Channel with firm banks.
- ❖ Suitable High banks above high flood level.
- ❖ Hard in-erodible strata close to river bed level.
- ❖ Absence of Sharp Curve in the approaches
- ❖ Minimum River Training Works.
- ❖ Presence of Approach road on both sides

# Ideal Bridge Site Selection:

HOWEVER,

LIFE IS RARELY IDEAL AND RARER  
IS THE IDEAL BRIDGE SITE.

Hence, Site Selection should be done  
based on the existing technical and  
administrative prioritization.

# Planning for Bridge Site Selection:

## ❖ Integration with Road Network.



5 crore motorable bridges where there is no road

# Planning for Bridge Site Selection::

## ❖ Economic Consideration .

Designing a bridge isn't the big deal, BUT designing the most cost- effective ;VALUE-ENGINEERING in bridge design is the key factor.

1. Is the bridge Really Necessary at the proposed site?
2. How many lives does this bridge affect ?
3. How it helps in uplifting the socio-economic standard of people of the nation?
4. Which is the most appropriate bridge structure for the site??

# Planning for Bridge Site Selection::

## ❖ **Administrative Consideration .**

Often, Bridge sites are selected based on administrative or political interest rather than specific technical standards.

1. Future Development of the Area.
2. Coherence with National Interest and priorities.
3. Co-relating bridge-site with other development activities. (HYDROPOWER; TOURISM etc)

# Bridge and Surrounding..

What's your comment on this??



Is Bridge Span adequate???

# Bridge and Surrounding..

What's your comment on this??



River outflanking???

# Bridge and Surrounding..

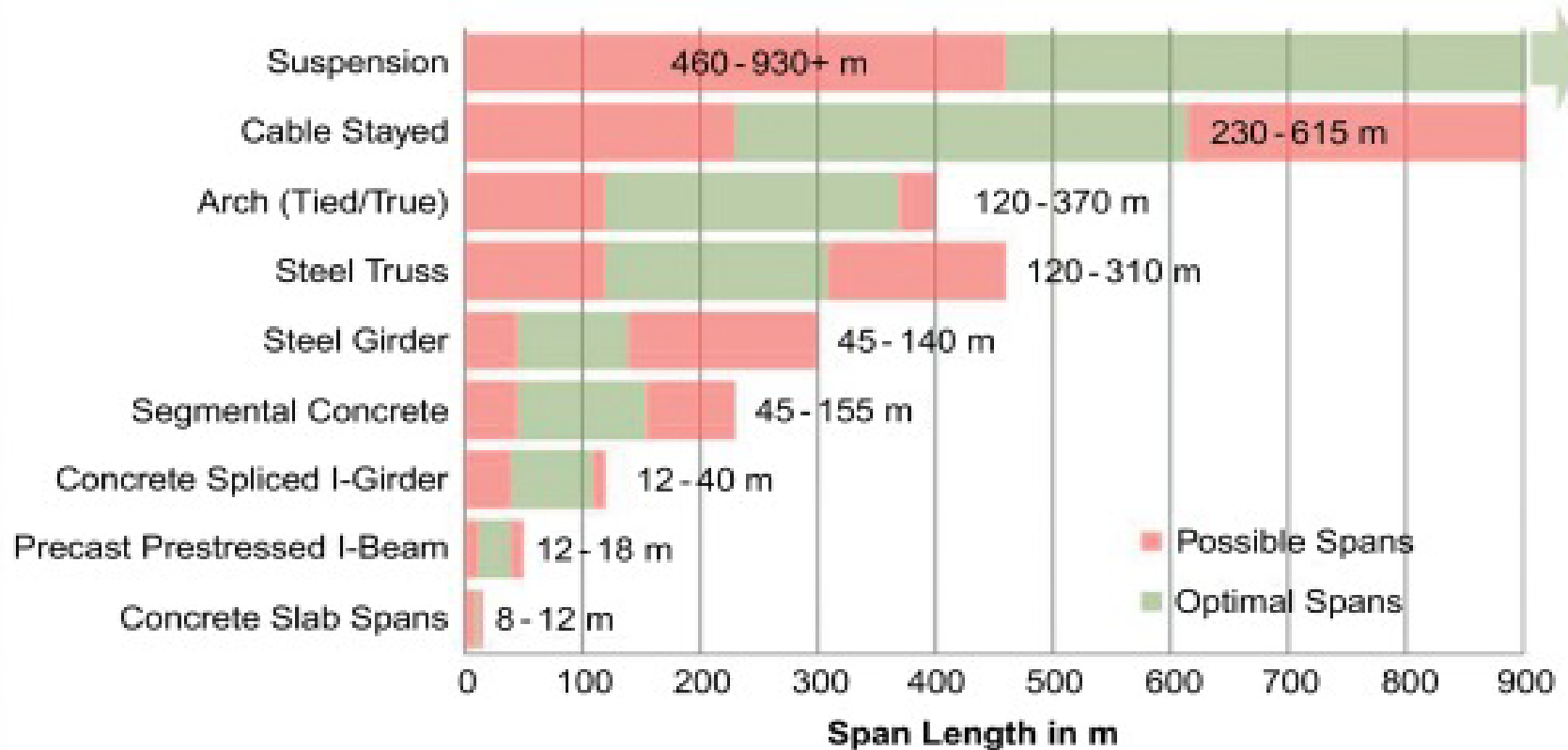
What's your comment on this??



Free board???

# Technical Selection of Bridge Type based on Existing site

Highway Bridge Types and Optimal Span Lengths



# CHOICE OF STRUCTURE FOR THE EXISTING SITE.

## Selection of appropriate bridge structure.

- Bridge vs Culvert vs Causeway.
- Open foundation vs pile foundation vs well foundation.
- Abutment(wall type vs pier type
- Pier (single column vs double column)
- Superstructure (RCC, PSc, Box Girder, Arc Bridge)

# Bridge Site Selection:

Bridge-1: Construction of Prestressed Concrete (PSC) Post-Tensioned 2 webbed Slab Bridge on Bhyakure Khola

Construction not yet started

Site Characteristics:-

Small Catchment Area

Sharp fall at the downstream

Length of Bridge Required:- 40m

Alternative Bridge Axis:-

- i. Along the existing causeway
- ii. At Upstream of existing causeway
- iii. At Downstream of Existing Causeway.

# Bridge-1: Construction of Prestressed Concrete (PSC) Post-Tensioned 2 webbed Slab Bridge on Bhyakure Khola



# Bridge-1: Construction of Prestressed Concrete (PSC) Post-Tensioned 2 webbed Slab Bridge on Bhyakure Khola

Chainage 119+700

Structure Type : PC Post-tensioned 2-webbed-slab

Sub Structure Type : Reversed-T type Abutment

Length of Bridge : 40m single span

Total Structure Ht. : 16 m

## Structure Size

**Span Arrangement: 3 span : single span 40 m**

**Profile : Level**

**Skew : 90 degree**

**Hz. Alignment : Infinity**

Foundation Type : Open Foundation (Isolated)

Carriageway : 7.5 m carriageway with 1.5 m footpath each side

# Bridge-1: Construction of Prestressed Concrete (PSC) Post-Tensioned 2 webbed Slab Bridge on Bhyakure Khola

Along the existing causeway

Pros:-

- i. Along the Road Alignment (No need of shifting the highway alignment.)

Cons:-

- i. Construction Difficulty
- ii. Diversion Required

# Bridge-1: Construction of Prestressed Concrete (PSC) Post-Tensioned 2 webbed Slab Bridge on Bhyakure Khola

At Upstream of existing causeway

Pros:-

- i. Ease during construction (No need for diversion)
- ii. Land available at upstream

Cons:-

- i. Need for slight diversion of Road Alignment.

# Bridge-1: Construction of Prestressed Concrete (PSC) Post-Tensioned 2 webbed Slab Bridge on Bhyakure Khola

- i. At Downstream of Existing Causeway.

Pros:-

- i. Ease during construction (No need for diversion)
- ii. Land available at downstream

Cons:-

- i. Presence of Sharp fall at downstream (Not ideal for bridge alignment)

# Bridge Site Selection:

Bridge-2: Construction of RCC Continuous Slab Bridge over Mamti Bridge.

Site Characteristics:-

Small Catchment Area

Flow along narrow channel

Length of Bridge Required:-  $12+16+12\text{m}= 40\text{m}$

# Bridge-2: Construction of RCC Continuous Slab Bridge over Mamti Bridge.



# Bridge-2: Construction of RCC Continuous Slab Bridge over Mamti Bridge.

Chainage 113+900

Structure Type : RC Continuous Slab

Sub Structure Type : Cellular Mat Foundation

Length of Bridge : 40m

Total Structure Ht. : 12 m

## **Structure Size**

**Span Arrangement: 3 span : 12 m+16m+12m**

**Profile : Level**

**Skew : 90 degree**

**Hz. Alignment : Infinity**

Foundation Type : Raft Foundation

Carriageway : 7.5m carriageway with 1.5 m footpath each side

# Bridge-2: Construction of RCC Continuous Slab Bridge over Mamti Bridge.

Along the existing causeway

Pros:-

- i. Along the Road Alignment (No need of shifting the highway alignment.)

Cons:-

- i. Construction Difficulty
- ii. Diversion Required

# Bridge-2: Construction of RCC Continuous Slab Bridge over Mamti Bridge.

At Upstream of existing causeway

Pros:-

- i. Ease during construction (No need for diversion)
- ii. Land available at upstream

Cons:-

- i. Need for slight diversion of Road Alignment.

# Bridge-2: Construction of RCC Continuous Slab Bridge over Mamti Bridge.

- i. At Downstream of Existing Causeway.

Pros:-

- i. Ease during construction (No need for diversion)
- ii. Land available at downstream

Cons:-

Need for slight diversion of existing alignment.

# Bridge-3: Construction of Prestressed Concrete (PSc) Post-tensioned 2 webbed slab bridge on Ghyampe Khola.



# Bridge-3: Construction of Prestressed Concrete (PSc) Post-tensioned 2 webbed slab bridge on Ghyampe Khola

Chainage 111+400

Structure Type : PC Post tensioned 2-webbed-slab

Sub Structure Type : Reversed-T type Abutment

Length of Bridge : 40m single span

Total Structure Ht. : 16 m

## Structure Size

**Span Arrangement: Single span 40 m**

**Profile : Level**

**Skew : 90 degree**

**Hz. Alignment : Infinity**

Foundation Type : Open Foundation (isolated)

Carriageway : 7.5m carriageway with 1.5 m footpath each side

# Bridge-3: Construction of Prestressed Concrete (PSc) Post-tensioned 2 webbed slab bridge on Ghyampe Khola.

Along the existing causeway

Pros:-

- i. Along the Road Alignment (No need of shifting the highway alignment.)

Cons:-

- i. Construction Difficulty
- ii. Diversion Required

# Bridge-3: Construction of Prestressed Concrete (PSc) Post-tensioned 2 webbed slab bridge on Ghyampe Khola.

At Upstream of existing causeway

Pros:-

- i. Ease during construction (No need for diversion)
- ii. Land available at upstream

Cons:-

- i. Need for slight diversion of Road Alignment.

# Bridge-3: Construction of Prestressed Concrete (PSc) Post-tensioned 2 webbed slab bridge on Ghyampe Khola.

- i. At Downstream of Existing Causeway.

Pros:-

- i. Ease during construction (No need for diversion)
- ii. Land available at downstream

Cons:-

Need for slight diversion of existing alignment.

