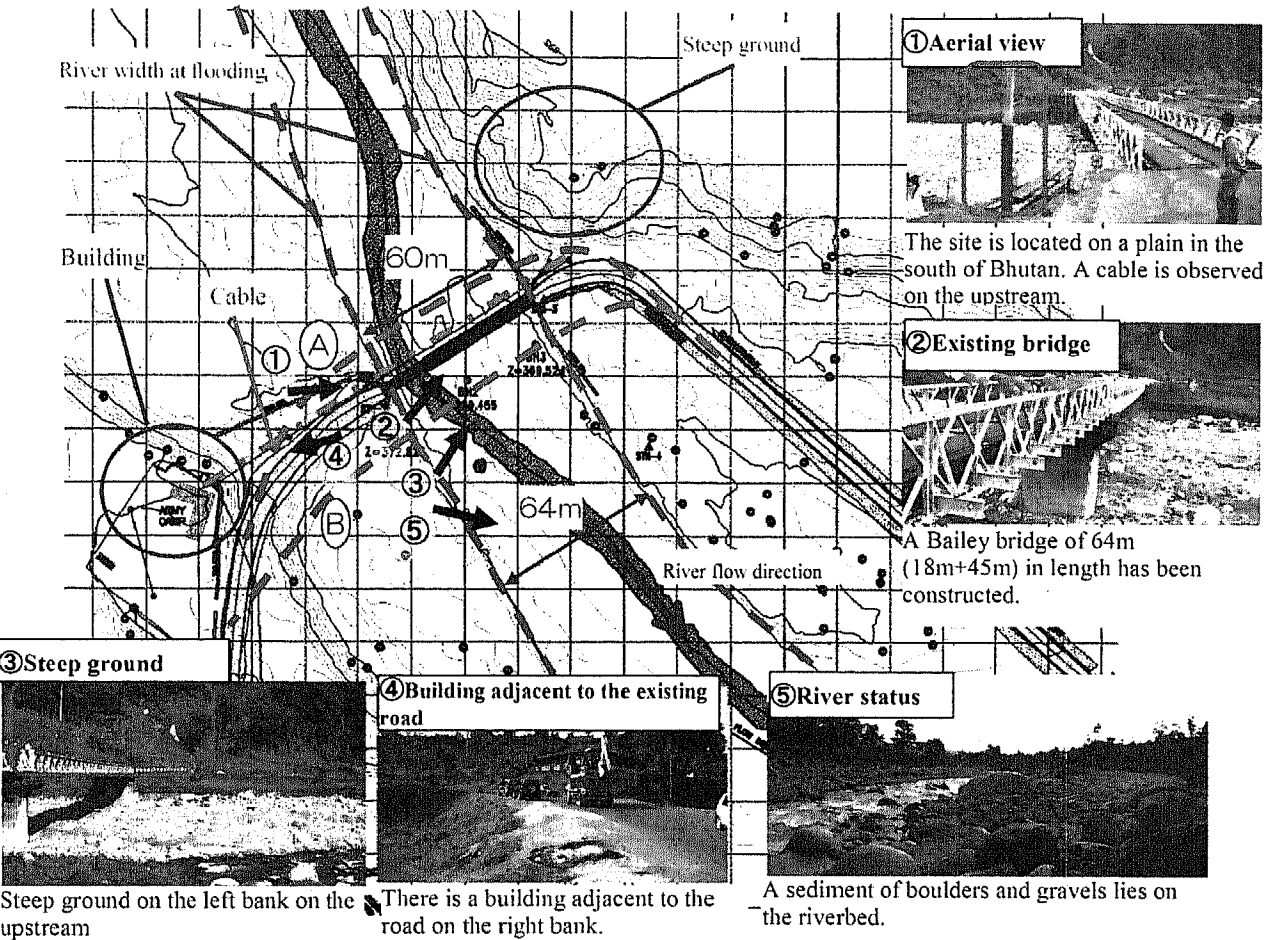


# No.18 Jigmiling Bridge



## (1) Outline of the site

### 1) Outline of the topography and the geology

The site is located on a plain in the south of Bhutan. A sediment of boulders and gravels lies on the riverbed. Gravels are deposited up to the depth of around 10m. The average N value is over 50.

### 2) Outline of the river

The site is plain, the riverbed gradient is gentle and the river width is wider than in the mountains. Judging from the flood mark, the river width is around 60-64m.

## (2) Setting the bridge route

The following two routes are conceivable. As a result of comparative study, route B, which is considered superior, is adopted.

Route	Outline	Evaluation
A	A proposal of building the new bridge on the upstream of the existing bridge. Because the area is close to steep ground, a large cut slope will be created and the cable will obstruct the construction work. Also, the building will need to be relocated. Therefore, this proposal is rejected.	×
B	A proposal of building the new bridge on the downstream of the existing bridge. It is considered superior because the area has no obstacles and the plain curve is gentler than in route A.	○

## (3) Setting the bridge length and the span length

Judging from the flood mark, the river width on the upstream and downstream is around 64m at the maximum. Therefore, the length of the new bridge should be 70m.

Since the flow rate at flooding  $Q=1930\text{m}^3/\text{s}$ , the standard span length is  $20+0.005Q=20+0.005*1930=29.6\text{m}$ . If the impediment ratio of river flow is 5%, the total pier width is 3.5m. Considering that the minimum pier width is 2.0m per pier, it is impossible to install two piers in the river. If two piers are installed, the impediment ratio of river flow will be 5.7%, which is greater than 5%. (Pier pole width 2.0m x 2/river width 70m = 5.7%) Therefore, the bridge should have a single pier and the span length should be @35m x2.

## (4) Setting the types of the substructure and foundation work

Since the skeleton height is 10m, the abutment of the substructure should be inverted T-type and the pier should be wall-type. Also, since the layer of which the N value is 50 or higher at an average is observed less than 50m below the ground surface, the foundation should be a spread foundation.

## (5) Setting the type of the superstructure

### 1) Basic conditions

- The superstructure should be applicable to the bridge length of 70m and the span length of 35m.
- It should consist of a continuous structure that excels in maintainability and trafficability.
- As the bridge is constructed at a location where the river width is relatively large, stationary scaffolding should not be adopted to ensure safety during the construction work against flooding.

### 2) Selection of the proposals to be compared

Considering 1) basic conditions and based on the bridge type selection table below, steel continuous non-composite plate girder bridge (proposal 1) and PC connection post-tension T girder bridge (proposal 2) should be selected.

		Span length (m)								Features				Selection	
Bridge type	Construction method	10	30	50	70	90	110	130	150	Construction method	Construction in a confined area	Face of construction	Construction cost	Choice	Reasons for rejection
		20	40	60	80	100	120	140	160	Construction method	Construction in a confined area	Face of construction	Construction cost	Choice	Reasons for rejection
Steel bridge	Simple non-composite plate girder bridge									Crane launching	Slightly difficult	Easy	Normal	×	Simple girder construction
	Simple composite plate girder bridge									Crane launching	Slightly difficult	Easy	Normal	×	ditto
	Simple non-composite box girder bridge									Crane launching	Slightly difficult	Easy	Normal	×	ditto
	Simple composite box girder bridge									Crane launching	Slightly difficult	Easy	Normal	×	ditto
	Continuous non-composite plate girder bridge									Crane launching	Slightly difficult	Easy	Normal	○	
	Continuous non-composite box girder bridge									Crane launching	Slightly difficult	Easy	Normal	×	Uneconomical span length
	Rigid frame bridge									Cable erection (diagonal suspension)	Easy	Easy	Easy	×	Topographically inappropriate
	Simple truss bridge									Overhang launching, cable erection (straight suspension)	Easy	Easy	Easy	×	Uneconomical span length
	Langer bridge									Cable erection (straight suspension)	Easy	Easy	Easy	×	ditto
	Truss bridge									Cable erection (straight suspension)	Easy	Easy	Easy	×	ditto
Concrete bridge	RC Simple floor system bridge									Stationary scaffolding	Easy	Easy	Difficult	×	Simple girder construction, stationary scaffolding construction
	RC Simple hollow floor system bridge									Stationary scaffolding	Easy	Easy	Difficult	×	ditto
	PC Simple post-tension T girder									Crane, erection beam	Difficult	Difficult	Normal	×	Simple girder construction
	PC Simple box girder									Stationary scaffolding	Easy	Difficult	Difficult	×	Simple girder construction, stationary scaffolding construction
	PC Continuous post-tension T girder									Crane, erection beam	Difficult	Difficult	Normal	○	

3) Comparison of the types

As shown in the comparison table below, the PC connection post-tension T girder bridge (proposal 2) that excels in economic performance and constructability should be selected.

Proposals to be compared		Proposal No. 1	Proposal No. 2
Material		Simple non-composite steel plate girder bridge	PC connection post-tension T girder bridge
Schematic diagram		Steel	Concrete
Economic performance		550 million yen (1.50)	360 million yen (1.00)
Construction	Total	22 months	18 months
	Construction method	Launching method	Erection beam method
	Outline	The procurement and delivery of a large crane to be used in construction poses a challenge. Also, it is difficult and uneconomical to cast bent foundations on a riverbed strewn with boulders, although this construction method requires the erection of bents for construction in the river. Therefore, the construction is impossible during the rainy season, because the erection of bents is essential.	The "erection beam method" should be selected, because it is commonly employed for bridges of this type and enables construction to take place during the rainy season.
	Remarks	Construction is impossible during the rainy season, because the erection of bents is essential.	Construction is possible during the rainy season.
Evaluation		× Poor economic performance, difficulties in construction	○ Excellent economic performance and ease of construction

Setting the planned road surface height

1) Basic conditions

- The vertical clearance should ensure a sufficient margin against the HWL (at least 1.0m higher than the water level at high flow rate  $Q=920\text{m}^3/\text{s}$ ).
- The planned road surface height should be higher than the current road surface height.

2) Setting the planned road surface height

As shown in the figure to the right, the current road surface height of 376.500, that is, the current road height of  $376.00\text{m} + 0.500\text{m}$ , should be secured at measurement point No. 1 (in front of the bridge). The road surface height should be set by assuming the vertical gradient of the bridge section to be 0.3%, that is the lowest drainage gradient.

3) Examining the margin of vertical clearance

As shown below, the vertical clearance ensures the necessary margin.

Road surface height at bridge abutment A1	376.254m
Difference due to the horizontal gradient	0.070m( $3.5\text{m} \times 2\%$ )
Structural height of superstructure	2.300m
Vertical clearance	373.884m

Margin of vertical clearance Vertical clearance  $373.884 - \text{HWL} 372.739 = 1.145\text{m} > 1.0\text{m} \therefore \text{OK}$

※limit value Margin of vertical clearance become 1.0m, because of flood Inverse calculation  $1930 \text{ m}^3/\text{s}$ . (Law of river structure )

