The second Hooghly bridge at Calcutta

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The article gives a general overview of the second Hooghly bridge under construction at Calcutta It will have the world's longest cable stayed span of 457m.*

History tells us that, since 1690, when Calcutta was founded by Job Charnok, there was no connection between the east and west banks of the river Hooghly except for a few systems of ferries for nearly 200 years. It was only in 1874 that a pontoon bridge was constructed over the river near Howrah station. A rail-cum-road bridge named Vivekananda Setu near Dakshineswar came up nearly fifty years later in 1933. The awe-inspiring Rabindra Setu, the fifth largest span in the world at that time, came into being in 1943. It is practically the only major crossing over the river Hooghly connecting Calcutta with the hinterland and other parts of India. The steel cage of this truss bridge is a towering landmark of the city. However, within two decades it was found to be inadequate to cater for the fantastic increase in vehicular traffic. The then Government of West Bengal realised it in no time and entrusted the work of carrying out a series of traffic studies and recommending a suitable location for a new bridge to the Calcutta Metropolitan Planning Organisation (CMPO) and Ford Foundation consultants. The studies revealed that the centre of gravity of origin and destination of trans-river travels of Rabindra Setu alone lay to the south of it, and that the developing road transport in movement of goods to and from the metropolis was imposing additional strain on the bridge. The traffic projection upto 1991 clearly indicated the need of a new bridge with three lanes of carriageway in each direction. The estimated volume of traffic towards the end of the century would be 85,000 vehicles per day with peak hour flow of about 8,500 vehicles.

The British consultants, Messrs Rendal Palmer and Tritton (RPT), who were consultants for the Rabindra Setu, were appointed to advise on a suitable type of new bridge, its level and location. Based on their recommendations, the Government of West Bengal decided to construct a high level bridge at Prinsep Ghat, which would provide easy connection with the National Highway to Bombay and Madras through

**The views expressed in this article are the personal views of the author. They do not in any way represent the views of the Ministry of Shipping and Transport (Roads Wing).*

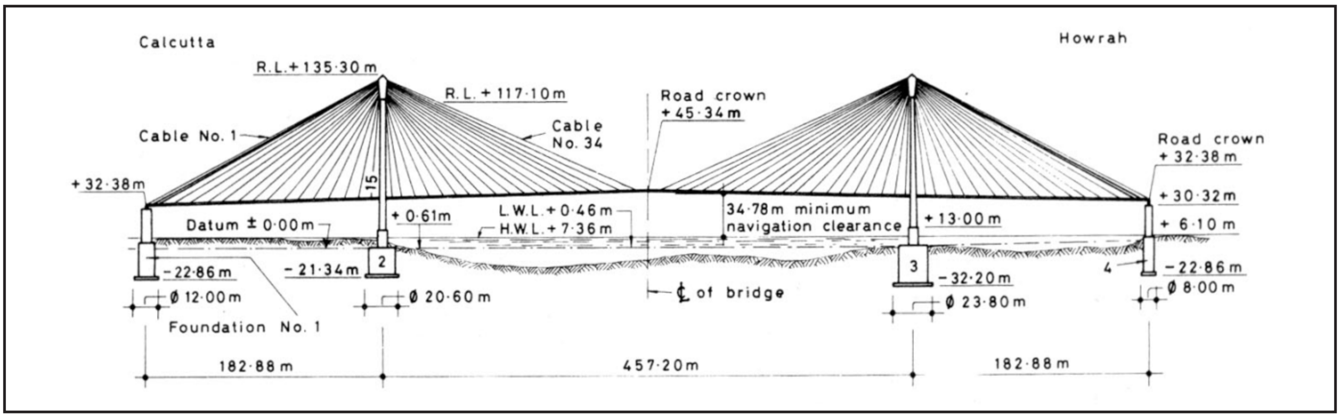

Figure 1. General elevation of the second Hooghly bridge

the Kona Expressway. It was decided to segregate the traffic at the approaches through a system of interchanges so that there was a gradual mingling of this traffic into the traffic system in the city.

Cable stayed bridge

The importance of the Hooghly bridge lies in introducing a modern bridge technology with immense potential for meeting long span bridging needs. This is the first major cable stayed bridge in India. It is a matter of pride that this first Indian cable stayed bridge will have the world's longest span, 457m, among its type. Figure 1 shows the elevation of the second Hooghly bridge.

The concept of a cable stayed system is to help a beam cross long spans by suspending it from a tower with inclined cables, called stays. Bridges constucted abroad initially with this system had only single stay cables. With single stay cables, the spans between the towers and the anchorages of the stay cables were very large, inducing large bending moments. A small spacing of the stay cables by the use of a large number of stays, allows a very slender beam and results in small bending moments. Cable stayed systems are likely to be economical because of the reduction in the number of foundations and their cost and the consequent saving in time.

Basic features

The principal features of the second Hooghly bridge are given below:

Main bridge:

Type of structure	:	Cable syayed bridge with a composite reinforced deck over steel I-girders
Length	:	822.96m
Main span	:	457.20m
Side span	:	182.88m on either side.
Navigational clearance	:	33.87m to 34.38m
Carriageways	:	Two 3-lane carriageways each having 12.3-m width and separated by 1.7-m median
Footpaths	:	2.5-m wide footpaths on either side
Deck	:	Concrete slab, 230mm thick with 2 outer steel I-girders (2m x 1m) spaced 29.1m apart and a central I-girder
Transversals	:	Spaced at 4.1m of riveted plate girder construction
Cables	:	Parallel wire cables with ultimate tensile strength of 160 kg/mm^2 connected to the top of the tower at one end and to the main girders by means of forged steel sockets and "Hi Am" anchorages.
Towers	:	Two steel towers of height 122.30m from pier top and 129m from ground level
Piers	:	Reinforced concrete piers of 12.39-m height from foundation top for main towers.
Foundation	:	(a) Twin wells under main towers Calcutta tower: 20.6-m diameter Howrah tower: 23.8-m diameter (b) Twin wells under end piers on Calcutta side: 12-m diameter (c) Twin wells under end piers on Howrah side: 8-m diameter
Contractor	:	Messrs Bhagirathi Bridge Construction Company. (A consortium of Gammon India Limited and Braithwaite Burn and Jessop Limited.)
Prime consultant	:	L,eonhardt and Andra, West Germany.
Executive agency	:	Hooghly River Bridge Commissioners.

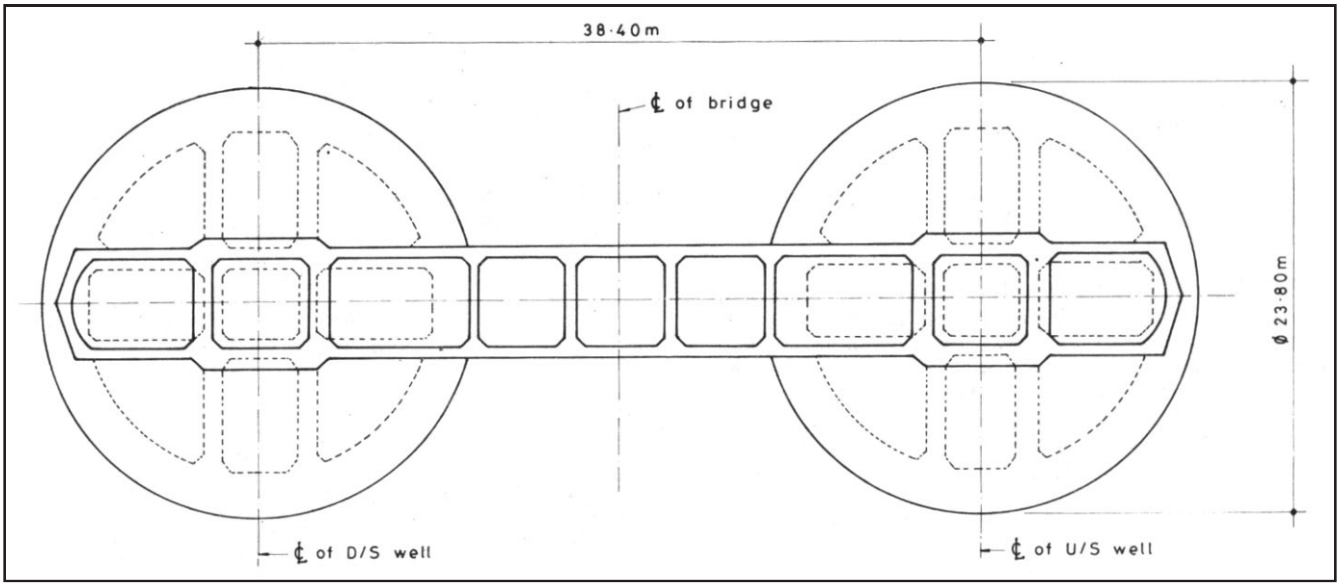

Figure 2. Plan showing well foundation No.3

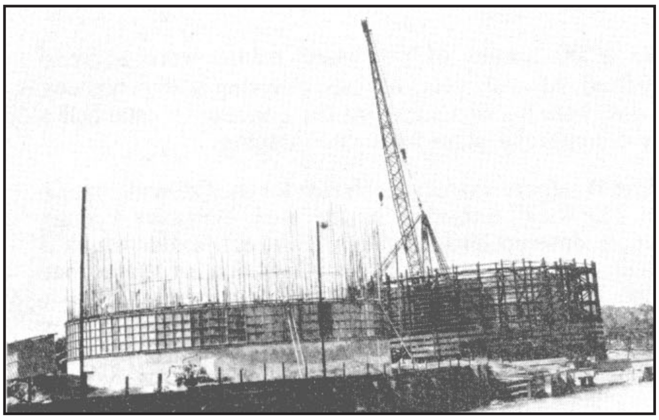

Figure 3. Wells for foundation No. 2 under construction

Approaches

	Calcutta side	Howrah side
Length of viaduct	527 m	875 m
Length of interchange	7.5 km	7.8 km
Executive Agency	Calcutta Improvement Trust	Howrah Improvement Agency

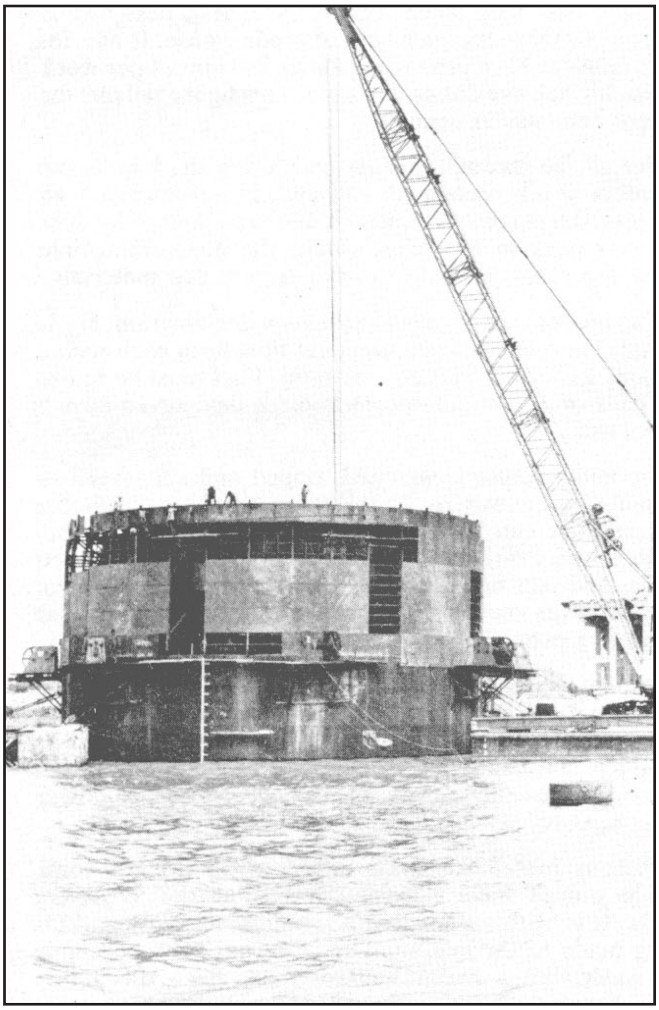

Figure 5. Another view of floating cassion for foundation No. 3

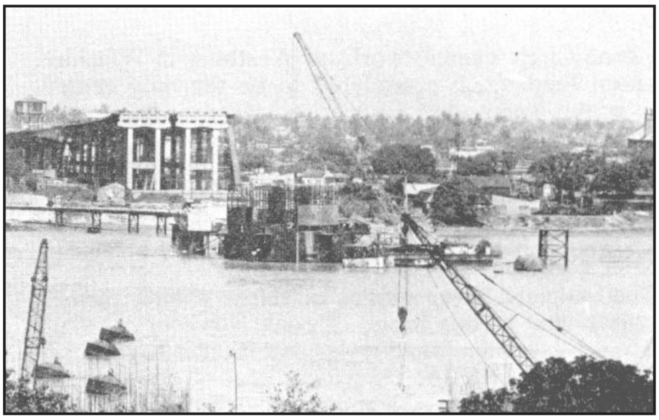

Figure 4. Upsteam side floating caisson for foundation No. 3

Contractor	Hindustan Steel Works Construction Limited

Some other aspects

The Hooghly bridge incorporates recent developments in design and building concepts of cable stayed bridges. Some of them are given below:

1. Use of multiple stays with a reduced spacing of stays. The concept of the new structure system is a truss, with the deck forming a strut. Improved structural response has been reflected in decrease of deflections and superior quality of dynamic behaviour because of the intrinsic system damping.

2. Use of parallel wire or strand tendon type cable enables realisation of large stay forces.

3. Use of "Hi Am" anchorages for cables result in high fatigue strength of the anchors.

4. The modern system of corrosion protection for cables comprises of a PE (polyethylene) tube encasing with cement mortar filling. A maintenancefree protection may be anticipated for 20 to 40 years. -Hi Am" anchorages permit easy replacement of cables.

The bridge is built with a concrete deck supported on riveted steel girders. The reasons for not adopting an orthotropic steel plate deck, commonly used for all long span steel bridges, are as below:

1. The orthotropic plates are highly intolerant to lax controls on quality of construction. High standards of quality and rigid controls first apply to welding as the joints are vulnerable to fatigue cracking. So availability of a high quality fully automated welding system must be ensured before opting for an orthotropic deck.

2. The quality of surfacing is equally critical for serviceability.

3. Durability demand, which is heightened by the highly humid environment coupled with critical temperature

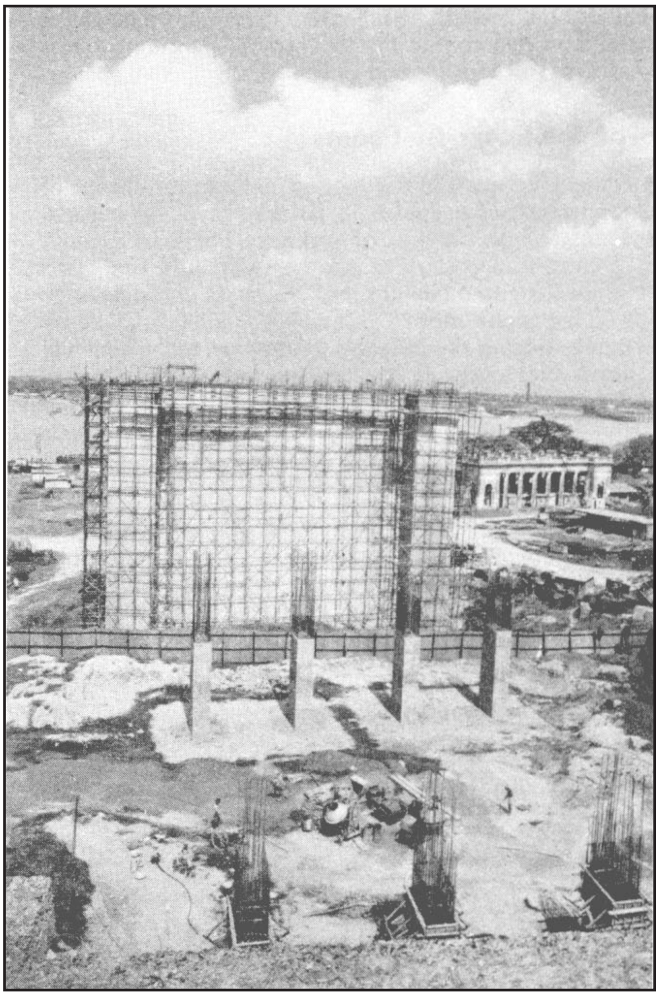

Figure 6. Calcutta side pier on foundation No. 1 under construction

spectra, does not favour orthotropic steel plate deck.

4. There is a lack of adequate system for performance measurement and maintenance in case of the orthotropic steel deck.

Some other special features of the Hooghly bridge are:

1. Steel caissons of about 22-m height have been prefabricated, floated into position and grounded for concreting the main foundations.

2. As the load to be carried by foundations number 2 and 3 is very heavy, a large size of well was required for the foundation. Each foundation has 2 wells. The size of each well, 20.6/23.8 m, was itself so big that it had to be divided into 9 cells by means of diaphragm walls. Figure 2 shows inter alia diaphragm walls provided for foundation No. 3.

3. In order to reduce the load on the foundation, the steining has been made waterproof and the cellular space has been left unfilled. The inside of the well has been made accessible for maintenance.

Figure 3 shows wells for foundation No. 2 under construction while Figures 4 and 5 show two views of floating caisson for foundation No. 3. The Calcutta side pier under construction is shown in Figure 6.

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