

Third Karnaphuli Bridge in Bangladesh – Design & Construction

N. BANDYOPADHYAY

Director
STUP Consultants P. Ltd.
New Delhi, INDIA
nbando@stupmail.com

Dr. N. Bandyopadhyay received his Civil Engineering degree from Calcutta University in 1973. He has been associated with Bridge Engineering activity for many years.



Sanjib MITRA

Principal Consultant
STUP Consultants P. Ltd.
Kolkata, INDIA
Sanjib.mitra@stupmail.com

Sanjib Mitra, received his Civil Engineering degree in 1989 and Master's degree in 2004. He has been involved in the design of large number of bridges and flyovers over last twenty years.



Summary

The third Karnaphuli Bridge is the first major cable supported bridge constructed in Bangladesh. The 950m long bridge has three main spans of 200m. The 830m long main bridge is a single plane extradosed pre-stressed concrete box girder bridge. The bridge is located on soft alluvial soil. 3m diameter bored cast-in-situ piles were adopted for foundation. The bridge was opened to traffic in July 2010.

Keywords: extradosed bridge, pre-stressed concrete box girder, large diameter piling, base grouting

1. Introduction

The third Karnaphuli Bridge, the first major cable supported crossing in Bangladesh, is located near port city of Chittagong. The main three navigational spans of the 950m long bridge are 200m long. It is the first major cable supported long span bridge in Bangladesh. It was opened to traffic in 2010.

The Roads and Highways Department (RHD), Government of Bangladesh executed the project which was jointly funded by Kuwait Fund for Arab Economic Development (KFAED) and Government of Bangladesh. It was constructed on a design & build contract by MBEC-ACL-COPRI JV, a joint venture of Chinese, Bagladeshi and Kuwaiti firms. High-Point Rendel Ltd. of UK were the Design Consultants to JV and Benaim Ltd of UK proof checked the definitive design. KEI-BCL-TAEP-STUP JV was assigned the task of construction supervision consultancy who also assisted RHD in bid evaluation and design review during pre-construction stage.



Fig. 1: 3rd Karnaphuli Bridge (2010)

2. Bridge Configuration

The bridge consists of 120m approach Viaduct of six spans (16m + 4x22m + 16m) on the northern end and the 830m (115m+3x200m+115m) long main bridge is a single plane extradosed prestressed concrete box girder bridge. The bridge has a gentle 3200m horizontal curvature.

The bridge carries four traffic lanes of 3.65m width (2x7.3m), two 1.65m wide lanes for slow moving vehicles. Besides there are two footpaths on either side. Space for services is provided at the footpath and central median. The overall deck width including the pylon is 24.47m.



3. Design Considerations

The design was carried out on the basis of AASHTO LRFD (2004) and British Standards BS 5400. The site is located at a potentially active seismic zone and the 100 year return ground surface acceleration corresponds to 0.05g as per Bangladesh National Building Code. The site is also located in a cyclone prone area where the design wind speed is 210 km/hr.

The river bed consists of soft alluvial deposit. It undergoes deep and non-uniform scour. The saturated sandy bed is susceptible to liquefaction during seismic event. Top 30m of the river bed was considered to be unavailable to provide support to foundation due to scour, liquefaction and dredging.

Detailed global as well as local analysis under all possible state were carried out using standard software like RM2000, LUSAS and LPILE.

4. Foundation

The foundations of main river piers were cast-in-situ vertical bored pile of 3m diameter. The maximum length of the piles (from bottom of pile caps) is 77m. The piles were base grouted to improve end bearing capacity. The maximum design vertical load on these piles (under service conditions) was calculated as 53 MN. The piles on approach viaduct were of 1.5m diameter. The pile capacities were verified by load testing.

5. Substructure

Substructure of the main bridge consisted of four circular columns that directly transferred loads from superstructure bearings to piles. A combination of Metal POT / PTFE-POT bearings, Shock Transmission Units were adopted to effectively transmit the vertical and horizontal forces from the five span continuous superstructure to foundation under different loading and scour conditions.

6. Superstructure

The superstructure of the main bridge is a five span continuous single plane extradosed pre-stressed concrete box girder bridge of configuration 115m+3x200m+115m. The tower, which is integrated with the superstructure, is 25m tall. Six sets of stay cables pass through saddles in the tower and are anchored on the deck at a distance between 36m and 78m from tower centreline. The stay cables are individually galvanised, greased and sheathed for corrosion protection. They can also be replaced at a later date. The box girder is also prestressed longitudinally by internal cables. The depth of the box girder varied from 6.75m at pier to 4m at mid span. The bridge superstructure was constructed by cast-in-situ balanced cantilevering method employing travelling formwork.

7. Conclusions

Third Karnaphuli bridge is a major cable supported bridge and first of its type in Bangladesh. The bridge was constructed within time due to “appropriate” technology adopted by the design and build contractor in design and construction.