

A STUDY ON IMPACTS, CONSTRUCTION CHALLENGES AND OVERCOMES OF PADMA MULTIPURPOSE BRIDGE, BANGLADESH

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ABSTRACT

Bangladesh is the riverine country located in South Asia with a coastline of 580 km on the northern littoral of the Bay of Bengal. There are 213 rivers in our country where 20 major bridges were constructed in our country. Five more bridges are now under construction among them Padma Multipurpose Bridge is the largest and most challenging. It will be the first fixed river crossing for road traffic and it will connect Louhajong, Munshiganj to Shariatpur and Madaripur, linking the south-west of the country, to northern and eastern regions. With 150 m span, 6150 m total length and 18.10 m width it is going to be the largest bridge in the Padma-Brahmaputra-Meghna river basins of country in terms of both span and the total length. The study discusses about both positive and negative impacts of the project on different aspects of Bangladesh. The study also discusses about the challenges faced during construction of the main bridge and viaducts by field survey. From the study, it is revealed that the construction of the Padma Bridge would significantly help improve various sectors of the economy nationally and regionally. Capital inflow will increase promoting industrial and commercial activity and increasing economic and employment opportunities for the local population. Construction the bridge is very challenging as Padma become a fast flowing river during monsoon and the bridge is sited in active seismic area. Advanced computational analysis and engineering solution have been employed to meet the challenges.

Keywords: *Impacts, Constructional challenges, Overcomes.*

1. INTRODUCTION

Bangladesh is riverine country. According to Bangladesh Water development board (BWDB) about 230 rivers currently flow in Bangladesh. The river network of Bangladesh as the most important transport artery in the country's communication sector plays a vital role in national life. Almost all big cities, towns and commercial centers of the country grew up on the banks of its rivers. Bangladesh, to the east of India on the Bay of Bengal, is a South Asian country marked by lush greenery and many waterways. Its Padma (Ganges), Meghna and Jamuna rivers create fertile plains, and travel by boat is common. Main bridges in Bangladesh are – Jamuna Bridge, Hardinge Bridge, Lalon Shah Bridge, Meghna Bridge, Padma Bridge, Shah Amanat Bridge, Khan Jahan Ali Bridge & Kean Bridge. Each bridge has different purposes and importance. The Padma Multipurpose Bridge and associated facilities are of great importance for the development of Bangladesh. This project has remarkable impacts on whole country and contributes to the socio-economic development on Southwest region. In addition, industrial development will be accelerated.

2. LITERATURE REIEW

The Padma Multipurpose Bridge is a multi purpose road-rail bridge across the Padma River under construction in Bangladesh. It will connect Louhajong, Munshiganj to Shariatpur and Madaripur, linking the southwest of the country to the northern and eastern regions. Padma Bridge is the most challenging construction project in the history of Bangladesh. The two-level steel truss bridge will carry a four-lane highway on the upper level and a single track railway on a lower level. With 150 m spans, 6150 m total length and 18.10 m width, it is going to be the largest bridge in the Padma-Brahmaputra-Meghna river basins of the country in terms of both span and the total length. Figure 1 shows a probable view of the dream bridge Padma Multi-purpose Bridge.



Figure 1: The Padma Multipurpose Bridge (www.padmabridge.gov.bd)

3. IMPACTS OF PADMA BRIDGE IN BANGLADESH

The proposed Padma Multipurpose Bridge will be a multipurpose road-rail bridge across the Padma River and it will be the largest bridge in Bangladesh and the first fixed river-crossing for road traffic. The Padma Multipurpose Bridge will transform the lives of nearly 30 million people living in the country's southwest region, promoting industrial and commercial activities and increasing economic and employment opportunities, according to various studies and reviews on the major economic impact of the bridge project. At least 30 million people, almost one-fifth of the country's total population, will directly benefit from the bridge, according to a study by the World Bank

3.1 Positive Impacts

Padma Multipurpose Bridge would significantly help improve various sectors of the economy nationally and regionally. With the bridge, capital inflow will increase, promoting industrial and commercial activity, increasing economic, and employment opportunities for the local population.

3.1.1 Communication

The construction of Padma Multipurpose Bridge will solve the communication problem of the southwestern part of Bangladesh, which comprises 25% of the total land mass. Introduction of both the road and the rail will help to transport raw materials from the port of Chittagong at a cheaper rate. By constructing the bridge, economic development of the southwest will promote industrial and commercial activity and improve economic and employment opportunities for local people.

3.1.2 Quicker Travel Time and Reduction of Distance

The proposed bridge will provide direct links between two major seaports of the country. The distance from Dhaka to nearly all major destinations in the southwest region will be reduced by 100 kilometers (km) or more and hauling time of vehicles will reduce by over 3 hours each trip that will bring considerable savings in passenger and commodity movement time and costs.

3.1.3 Safety of Public Lives

There is an urgent need to replace unsafe ferry and launch operations between Dhaka and the southwest region by safer and more reliable surface transport. Overloaded vessels frequently sink in this waterway when passing through the turbulent confluence of the Padma and Meghna Rivers. Construction of Padma Multipurpose Bridge is a remedy to this misery.

3.1.4 Electricity, Telecommunication and Gas Supply

Construction of Padma Multipurpose Bridge will connect the southwestern part of the country with national power grid. An electric circuit will join the two halves. Therefore, this immense power supply will generate both present economy and rapid industrialization.

3.1.5 Agriculture

The economy of the southwestern region was dependent on irrigation system. Non-availability of power forced the local farmers to use fuel based irrigational pumps. With its limited capacity and fuel consumption, very often made its use uneconomical. With the availability of electricity, the production cost of agro-products are bound to come down, with a considerable increase on production.

3.1.6 Industrialization

The major setback, which the southwestern region faced due to the absence of a bridge, is the industrialization of the region. No industry except those based on local resources could be established because of the transportation and consequence-marketing problem of both raw material and finished good. Now that the Padma Multipurpose Bridge will bring the power necessary for industrialization at the doorstep of common people, industries of various scale and dimension will flourish on the region ultimately boosting the national economy.

3.1.7 Improvement of living Standard

For construction, residences nearby the sites had to be evacuated and a large number of local people had to be relocated to resettlement sites. These local people moving to resettlement sites will greatly improve the living environment since many civic amenities and social infrastructure would be made available.

3.1.8 Cultural Integration

In Bangladesh, diversity in language, food habit and culture is seen in different regions. People from one region sometimes find it difficult to understand the language of another. The Bridge, which will play the

role of a development catalyst for the nation's culture. The cumulative socializing effects of all this will bring people closer in thought, outlook, interaction and action, which are likely to be more uniform than what it is now.

3.2 Negative impacts

Because of the sudden economic development in the southwestern region, the livelihood and lifestyle of many will change. With this change, many other social and political factors will arise which may pose threat to the success of Padma Bridge in the future.

3.2.1 Loss of Households

The project will need to acquire 755 hectares (ha) of land for the construction of the bridge and its associated infrastructure, including the development of five resettlement sites. In addition, about 163 ha of land will be temporarily required for construction sites for a period of about 6 years. About 5500 households comprising of 26,500 persons would be affected. Total population affected (directly and indirectly) may run into Mawa - 70,000-80,000 and Paturia - 40,000-45,000.

3.2.2 Loss of Agricultural Land

A total of about 507 thousand acres of land will be affected Munshiganj, Shariatpur and Madaripur districts because of the component. Of the total land affected, the majority of land affected is located on the Janjira side amounting to 83% of the total acquired land, whereas the remaining affected land lies on the Mawa side. About 30,000 people in 10,000 households will lose their income and livelihoods due to the loss of agricultural land.

3.2.3 Income Loss

25,000 people will suffer income loss from affected fisheries, services, trading and transportation, and wage employment. Some of these people will be affected indirectly upon the opening of the bridge to traffic.

3.2.4 Environmental Affect

The salient findings from the initial environmental assessment study were reported as part of the feasibility study but have not yet been included in the proposed mitigation measures and proper management plan. The salient findings include the following:

- The impact of the bridge on regional hydrology and flooding patterns, as the high-water level of the Padma River rises due to the bridge construction, is not expected to be significant, but detailed assessment will be required.
- Adequate openings on the planned right bank, approach road are required for drainage.
- Limited erosion and siltation is expected, but detailed assessment will be required.
- About 295,072 trees loss (Excluding 485,074 bamboo and banana trees).
- About 58 ponds covering 4.18 ha and 74 ditches covering 2.66 ha will be affected by the Project. Total loss of fish breeding area about 767 ha.
- The Padma River is an important migratory route for hilsa fish. Fish production losses of about 11 tons per year may be compensated by fish culture in new ponds in borrow pits.
- About 50 million cubic meter dredge material will be generated from the river.
- Traffic congestion, safety hazards, noise pollution, sanitation, health and hygiene, waste generation etc.

4. CONSTRUCTION CHALLENGES AND OVERCOMES OF PADMA MULTIPURPOSE BRIDGE

At 6.15 km in length the Padma Multipurpose Bridge will be a landmark structure in Bangladesh and one of the great river crossings of the world. The design of the bridge has been a major challenge with

the river changing in nature dramatically during the monsoon season, when the flow rate and major fluctuations in river bed level threatening to undermine any bridge piers. . The bridge site is also in an area of considerable seismic activity. To design the bridge, advanced computational analysis and engineering solutions have been employed, in order that the bridge will be able to meet the challenges of nature during its long life. Figure 2 illustrates the installation of Padma Multipurpose Bridge.



Figure 2: Intallation of Span (www.padmabridge.gov.bd)

4.1 Construction Challenges

The constructional challenges of Padma Multi-purpose Bridge are discussed below.

4.1.1 Insufficient Pile Capacity

According to design, each pile should have the capacity of 8200 ton. But where clay layer is encountered, Pile capacity has reduced to about 6250 ton.

4.1.2 Increased Scouring at Banks

The length of pile varies from pier to pier. The average length of pile is taken as 115-120m. But due to increased scouring at the bank (Janjira) Pile length has to be increased (123.75m) under some piers (P-37, P-38, P-39, P-40, P-41).

4.1.3 Limitations in Increasing Pile Length

Bearing capacity of piles can be increased by increasing skin friction which requires an increase in pile length. But it is found that there is presence of stiff clay layers at the depth of 130-160 m which will cause accountable settlement. So increase in pile lengths cannot be taken as a solution.

4.1.4 Limitations in increasing Pile Number

Capacity to support the piers can also be increased by simply increasing the number of piles under each. But increasing the number of piles (more than 7) will make the design complex and also will require further space. So not more than 7 piles can be provided under each pier (excluding viaducts).

4.1.5 Skin Grouting

The procedure of skin grouting is another challenge in this project. Recently this process is being tested on the piles of viaducts.

4.1.6 Rising of Bed

The piling depth of Padma Multipurpose Bridge is a world record (115-120m). For this huge pile a deep hole had to be dug up. When the work started, the dredged soil was deposited in river bed. As a result, there rose a bed creating problems for river vehicle.

4.1.7 Sedimentation

Sedimentation in Padma also creates problems for the floating crane by reducing water depth which requires dredging.

4.1.8 Pile Driving Hammer

For pile driving purpose 3 MENCK hammers are used with the capacity of 3500kj, 2400kj, and 1800kj respectively. Such massive hammers are being used in our country for the first time and their operation and maintenance can be considered as a challenge. The pile driving hammer is shown in figure 3.



Figure 3: Pile Driving Hammer (youtube.com)

4.1.9 Lowered Water Surface

The largest floating crane is introduced to carry the spans of the bridge. But the problem is it needs sufficient depth of water to float. But in December 2017, due to dry season the surface water level had lowered at a huge depth. For this it was not possible to carry the spans through the cranes. So the work had to be stopped for a while.

4.2 Overcomes of Challenges of Padma bridge

4.2.1 Inclined Piles

To deal with the massive river current the designers decided to provide inclined piles. The piles were designed in 1H:6V ratio. Because of this it can resist more lateral force which also helps to resist earthquake as well. A pile arrangement is shown in figure 4.



Figure 4: View of pile Layout (UNB)

4.2.2 Provision of one Extra Pile

According to initial design, each pier supposed to have 6 steel tubular driven piles beneath. But due to insufficient bearing capacity and inability to increase pile length, 22 of the piers are later decided to be provided with 7 piers to support them. These piers are P-6,P-7,P-8,P-9,P-10,P-11,P-12,P-15,P-19,P-24,P-25,P-26,P-27,P-28,P-29,P-30,P-31,P-32,P-33,P-34,P-35 and P-36.

4.2.3 Base Grouting

Base Grouting is another effective process to increase the capacity of piles. Micro-Fine cement grout is used for this process (P14-4). Grout Mix Design-Water: Micro-Fine Cement (Prefine-80): Admixture (BASF master Rheobuild 1000) = 0.8 : 1 : 0.01

4.2.4 Artificial River

To place the 5th span on no. 41 and 42 piers, an artificial river was created by dredging. It provided sufficient depth for the floating crane to move.

5. CONCLUSIONS

The Padma Multipurpose Bridge will stand as a landmark structure in Bangladesh, not only providing a vital communications link, but also signaling another milestone engineering solution in a region of extreme environmental hazards. The Padma Multipurpose Bridge will provide a vital missing link in the transport network of Bangladesh. The bridge will provide significant travel time savings, particularly between the Dhaka Division to the south-east of Bangladesh and possibly onto India. The bridge will be a safe and easy fixed river crossing replacing the often unsafe and unreliable ferries. Nevertheless, the possible prospective impacts discussed before has proven the worth of having this bridge in place. All the people of Bangladesh can hope now is a successful completion of the construction of this Multipurpose Bridge.

REFERENCES

- De Silva, S., Wightman, N.R. & Kamruzzaman, Md. 2010. "Geotechnical ground investigation for Padma Main Bridge". Proc. IABSE – JSCE Conference, Dhaka, 10-12 August 2010.
- Islam, M.R. 2010. "General and design features of Padma Multipurpose Bridge". IABSE – JSCE Conference, Dhaka, 8-10 August 2010.
- McLean, D., Neill, C. & Oberhagemann, K. 2010. "Design of River Training Works for Padma Multipurpose Bridge", Bangladesh. Proc. IABSE – JSCE Conference, Dhaka, 10-12 August 2010.

- Sham, S.H.R. & Tapley, M.J. 2010. “The design of Padma Multipurpose Bridge – challenges and solutions in design of the river spans”. Proc. IABSE-JSCE Conference, Dhaka, 10-12 August 2010.
- Sham, S.H.R., Yu & De Silva, S. 2010. “Foundation Design Methodology for Padma Main Bridge”. Proc. IABSE – JSCE Conference, Dhaka, 10-12 August 2010
- Tapley, M.J., Sham, S.H.R. & Holmberg, R.A. 2010. “Developing the Operations and Maintenance Strategy for the Padma Multipurpose Bridge”. Proc. IABSE-JSCE Conference, Dhaka, 10-12 August 2010.
- Wheeler, W.K., Aves R.J., Tolley, C.J., Zaman Md., Islam, M.R. 2010. “Detailed design of Padma Multipurpose Bridge- Bangladesh, An overview”. . IABSE – JSCE Conference, Dhaka, 8-10 August 2010.