Proposal for Dredging of a Ferry Route in Mawa-Kaorakandi with Proper Protection System Due to Sedimentation

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Abstract—The present research work pertains with the river bank erosion and navigability problem of the thumping river Padma in Mawa-Kaorakandi section, Bangladesh. Whopping amount of sediments which is 1.67 billion tons (on average) is imparted by this 120 km long Padma river through the Ganges-Bhramapatra-Meghna river system in the Bay of Bengal. That princely amounts of sediment cause the navigability problem in ferry routes. The another hitch is erosion, which is an ongoing event at the left bank. This part of the river is situated at the younger floodplain, which is going to shift over geologic time. Mawa-Kaorakandi ferry route is a vital communication hub in economic aspect and exasperating those problems. A proper dredging design with appropriate method will help to maintain its navigability and protection technique will overcome those glitches and make that route more remunerative and sustainable.

Keywords—Bank protection, Dredging, Mawa-Kaorakandi ferry Route, Navigability Problem, Sedimentation Control.

I. INTRODUCTION

The mighty river Ganges which is emanated from Gangotri Glacier of the Himalaya is entitled as Padma after entering Bangladesh at Shibganj, Goalondo and Chandpur are the rendezvous of the Padma with the Jamuna and with the Meghna respectively. The Ganges-Padma is the major hydrodynamic system that formed one of the largest delta complexes. The sedimentation processes is still on. Those huge amount of sedimentation obstruct our waterways and suspended those routes. According to BIWTA there are such twelve routes that need to be dredged immediately. 15 km of Mawa-Kaorakandi ferry route is one of them and facing not only navigability problem but also river bank erosion problem for the last 30 years.

Figure-1: Location map of the study area. (Mawa-Kaorakandi)

Mawa terminal is located in Munsiganj district with the latitude of 23°28’27”N and longitude of 90°15’19”E on the other hand Kaorakandi terminal lies in Madaripur district with the latitude of 23°24’50”N and longitude of 90°10’45”E. Mawa terminals is almost 38 km far southwest from Dhaka.
Again Kaorakandi ferry terminal is almost 51 km south to the Faridpur Medical College. Existing ferry route is around 15.1 km long and have curve and narrow pass way on the Louhajang turning point. Average water depth gets higher in August around 9 m and lower in February almost 2.5 m. During monsoon, from June to October, the area gets moderate to high rainfall. The extreme rainfall in Madaripur is recorded 243 mm on 12 June 1995.

II. GEOMORPHOLOGY

Bengal basin also known as Green delta, one of the most fertile lands of the world. The great Ganges-Brahmaputra-Meghna river system runs almost 3000km and carries a huge amount of sediment to the Bay of Bengal. From physiographic point of view, about 80% of the land is floodplains with very low mean elevation above the sea level with the rest made up of hills and elevated lands.

![Figure 2: Longitudinal profile of Ganges and Jamuna River. (Source final report volume-5, feasibility study of Padma Bridge, JICA)](image)

The average floodwater slop of the river is 5 cm per km. The annual average rate of riverbank erosion is 1,000 ha/year. The platform of the river is mainly meandering with several chute channels at some reaches. The Bengal Basin is tectonically active. The Madhupur and Barind tract are Pliocene alluvial deposits uplifted. The eastward shifting of the Padma River has been pointed in the Figure clearly with the vestiges of old river course. Numerous old river course of similar scale of the present river channel are found in the flood plain use to be the river course until recent years. On the other hand, the land forms in the east side flood plain demonstrate distinctively different features from the west one. For the last 30 years bank of the river has been changed for several times. Right flank of the river is lies upon the younger floodplain which is more vulnerable than the left flank.

![Figure 3: Change in Padma River bank in last 30 years. (Source final report volume-5, feasibility study of Padma Bridge, JICA)](image)

III. GEOLOGY

The surface geology of Bangladesh is dominated by young (Holocene) alluvial and deltaic sediments deposited by the major river systems of the Bengal Basin, much of it deposited within the last 6000-10000 years. These deposits are several hundreds of meters thick and the Basin has been one of the most rapidly accreting delta systems in the world. Sediments in much of low land central Bangladesh are alluvial sands and silts.

Generally, the field area falls within the Bengal foredeep tectonic region. The foredeep (Geosyncline) is a deep Basin which has mild or no undulation in the sedimentary strata (Imam, 2005). The coastal morphology is furnished by the sediments of Ganges-Meghna-Brahmaputra river system that forms an overlapping deltaic arc.

The study area composed of floodplain sediments mainly clay, silty clay, sandy clay and sand (Hasan & Pekdager, 1998). The depositional pattern is complex and it is really hard to find a homogenous and continuous succession.

IV. METHODOLOGY AND CALCULATION

The present ferry route is 15.1 km long which has some turning zones where ferry faces impediments to run and these informations are discovered by assembling Hydrographic Chart and Hydrographic data. Moreover, in some places occluding occurs so randomly and regularly that a new route is being indispensable for that route. In the proposed route (figure-5) Mawa Ghat has been shifted about 3.3 km to the southeast to Shimulia ferry Ghat. Which is about 12.4 km long and almost 2.7 km less than the existing route.
A. Volume calculation

Proposed route was divided into 13 blocks. The volume of sediments of each block was calculated individually. Since the required water depth is 3.05 m so we need to subtract the LLW of a block from it to get the sediment height. Here is the calculation of Block A.

![Figure-4: Cross profile of Block A](image)

LLW is 5.75 m (1.8+1.1+.9+1.2+.75) from HC
Average LLW is 1.15 m.
Sediment height that need to extract is 1.9 m.

So the volume of the sediments that need to dredge from that block is 267,187 m³. Total volume of sediments from the proposed route is 1,286,672 m³.

B. Dredging cost calculation

BIWTA can dredge an area with only $1.875 per m³. At present BIWTA have total 17 dredgers and 4 new dredgers have been brought from Chin recently. Proper placement of the extracted sediments make the route sustainable. BIWTA need $0.5 per m³ to place those extracted sediments. We can easily sell at least 10% of that sand with $3.75 per m³ to the local contractors since there is a high demand of river sand as a construction materials. Total dredging cost will be $3,663,348.

C. Ferry transport calculation

There are total 17 ferries run on this route 4 RO-RO ferry, 6 k-type, 6 Dumb ferry and one small ferry. How fast a ferry can run it depends on several factors like load, engine condition, river flow direction, navigability etc. the average time schedule of the ferries of that route is given in table I.

<table>
<thead>
<tr>
<th>Ferry type</th>
<th>Time per trip (in hour)</th>
<th>Total trip (in a day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO-RO</td>
<td>1:30</td>
<td>8</td>
</tr>
<tr>
<td>K-type</td>
<td>1:15</td>
<td>10</td>
</tr>
<tr>
<td>Small</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Dumb</td>
<td>2:30</td>
<td>6</td>
</tr>
</tbody>
</table>

The fuel consumption rate of a ferry is totally depends on the engine condition and the ferry running technique. It changes time to time. It partially depends on the tide of the river. When the river is clam, on an average the fuel consumption rate of the ferry are quite similar to the table II.

<table>
<thead>
<tr>
<th>Ferry type</th>
<th>Fuel per km (in liter)</th>
<th>Total fuel trip (in liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO-RO</td>
<td>25</td>
<td>300</td>
</tr>
<tr>
<td>K-type</td>
<td>12</td>
<td>150</td>
</tr>
<tr>
<td>Small</td>
<td>10</td>
<td>120</td>
</tr>
<tr>
<td>Dumb</td>
<td>25</td>
<td>300</td>
</tr>
</tbody>
</table>

The rate of fare for vehicle transportation by ferry and the crew salary is fixed by BIWTC. Total income of those ferries are calculated after collecting field data.

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Charge per vehicle ($)</th>
<th>Number of vehicle</th>
<th>Total income ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>28</td>
<td>10</td>
<td>280</td>
</tr>
<tr>
<td>Truck</td>
<td>22</td>
<td>4</td>
<td>88</td>
</tr>
<tr>
<td>Microbus</td>
<td>9</td>
<td>7</td>
<td>63</td>
</tr>
<tr>
<td>Private Car</td>
<td>9</td>
<td>8</td>
<td>72</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>3</td>
<td>11</td>
<td>33</td>
</tr>
</tbody>
</table>

Total income of the ferry per trip 536
Considering ferry income, fuel cost and crew salary net annual income from those 17 ferries is $7,177,150.

### Revenue calculation

Book Value is the value at which an asset is carried on a balance sheet. It is a type of deposit money as for the security of machines. Sometimes, with the increasing value of machines have to buy for repairing the damaged parts of ferry. This surplus money is sanctioned from book value.

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**Figure-5: Proposed route for dredging.**

**TABLE IV**  
MONTHLY CREW SALARY FOR A RO-RO FERRY

<table>
<thead>
<tr>
<th>Worker’s designation</th>
<th>Number of person</th>
<th>Per person salary ($)</th>
<th>Total salary ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
<td>1</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Chief Operator</td>
<td>1</td>
<td>375</td>
<td>375</td>
</tr>
<tr>
<td>Assis. Operator</td>
<td>2</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Dock controller</td>
<td>3</td>
<td>188</td>
<td>564</td>
</tr>
<tr>
<td>Word boy</td>
<td>1</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td><strong>Total salary of the crew per month</strong></td>
<td><strong>2064</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hidden Cost is mainly denoted as the unwanted cost which is invisible. Any type of problems can be confronted with this money like the transfer of ferry terminal due to the subsidence of river bank.

Total income = (Net ferry income + Sand selling money)
Total expenditure = (Dredging cost + Maintenance cost + Hidden cost + Book value)
Revenue = (Total income - Total expenditure)
= ($7,659,652 - $6,805,846)
= $853,806.

V. DISCUSSION

Expeditious sedimentation on Louhajang turning point, which is in Mawa-Kaorakandi route, congests that course. Though the Government has paid tremendous amount of money in dredging to resolve this eccentric problem, those attempts have been failed due to the absence of protection system and improper dredging system.

A. River bank protection

Proposed Padma Bridge is almost 6.15km long which is near to the ferry route. According to the JICA report the right bank of the river is more vulnerable since it lies on the younger floodplain. They proposed 12.4km long bank protection which is not technically sound. We can use Tetrapod revetment technique.

B. Construction of Dam

To control sedimentation and to gain navigability in river, Dam can be a useful key. Three Gorges Dam on the Yangtz River is one of them. Source of that river is a glacier and mouth is in the East China Sea whereas Padma River’s source is also a glacier and mouth is in the Bay of Bangel. Their discharge rates are also same.

C. Artificial channel bar

Creating artificial channel bar is a well-known technique in modern river engineering. In Mississippi River that method has been applied successfully in several places (Review of Sedimentation Issues on the Mississippi River, Pierre Y. Julien and Chad W. Vensel). An artificial channel bar can be made on Louhajang turning point to make the route navigable naturally.
VI. CONCLUSION

As Mawa-Kaorakandi ferry route plays a cardinal role to connect the eastern and the western part of Bangladesh this course always should be feasible. The aim was to make the route sustainable and effortless. We curtail the route about 2.7 km, which will save the time and also make this route economically eminent.

To maintain the route’s navigability unharmed a proper design is made for dredging. It will be more sustainable and profitable with the proposed protection system than the previous one. And the Government does not have to pay as all the expenditure can be paid from the turnover and sand selling price, as can be seen from revenue. And in conclusion it can be said, if the proper monitoring can be done the new route of Mawa-Kaorakandi will be more fruitful.

REFERENCES