Technical Review of Pak Beng Hydropower Project – Navigation

The 2nd Regional Stakeholder Forum
The Pak Beng Hydropower Project
5th May 2017
Vientiane, Lao PDR
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Background

- Document reviewed:
  - Hydrodynamic characteristics research on valve and culvert section for Pak Beng ship Lock, September 2015.
  - Engineering status report, September 2015
  - Engineering status report Drawings, September 2015.
- Discussions with Ministry of Energy and Mines representatives
- Discussions with PB Project designers and developers
Main Review Findings

Single lift lock or tandem lock?

The main concern: the current proposal is for a single lift system which needs more than 30m to lift or lower shipping

• MRC Design guidance for Mekong mainstream dams: “greater than 30m lift should use two locks in a series (tandem);
• The single lift proposed for Pak Beng dam: 36.46m high
• Problem of single lift: There have been many studies on cavitation problems in high lift ship locks, particularly with the valves
• It is recommended that the single lift system be redesigned to a double lift system.
Cavitation problem

- The current design is similar to the Yingpan lock which has cavitation and heavy vibration.
- Several locks with similar water heads, amongst others the John Day lock, have encountered severe cavitation problems.

Pak Beng and Xayabouri (same scale)

Xayabouri dam; double ship lock of 2 times 120.00 x 12.00 x 4.00m and equal lift of 19.50m
Important remark: The size of vessels

With a lock chamber of 120m x 12m x 4m ships of class Va (CEMT classification) can enter the ship lock with limited draft (less than 3.50m)

<table>
<thead>
<tr>
<th>CEMT classe</th>
<th>Vessel size</th>
<th>Lock chamber dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>length [m]</td>
<td>beam [m]</td>
</tr>
<tr>
<td>I</td>
<td>38.5</td>
<td>5.05</td>
</tr>
<tr>
<td>II</td>
<td>50-55</td>
<td>6.60</td>
</tr>
<tr>
<td>III</td>
<td>67-80</td>
<td>8.20</td>
</tr>
<tr>
<td>IV</td>
<td>80-85</td>
<td>9.50</td>
</tr>
<tr>
<td>Va</td>
<td>95-110</td>
<td>11.40</td>
</tr>
<tr>
<td>Vb</td>
<td>172-185</td>
<td>11.40</td>
</tr>
</tbody>
</table>

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Important remark: The size of vessels

In comparison with the Chinese ship classification, a convoy of 2 x 500t (IV China) can be accommodated.

<table>
<thead>
<tr>
<th>Waterway Class</th>
<th>Vessel Capacity (T)</th>
<th>Length of Ship Convoy (m)</th>
<th>Width of Ship Convoy (m)</th>
<th>Draught of Ship Convoy (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Europe</td>
<td>1,250 / 1,450</td>
<td>85</td>
<td>11.4</td>
<td>2.5 – 2.8</td>
</tr>
<tr>
<td>Va Europe</td>
<td>1,600 / 3,000</td>
<td>95 -110</td>
<td>11.4</td>
<td>2.5 – 4.5</td>
</tr>
<tr>
<td>Vb Europe</td>
<td>3,200 / 6,000</td>
<td>172 -185</td>
<td>11.4</td>
<td>2.5 – 4.5</td>
</tr>
<tr>
<td>Vla Europe</td>
<td>3,200 / 6,000</td>
<td>95 -110</td>
<td>22.8</td>
<td>2.5 – 4.5</td>
</tr>
<tr>
<td>IV China</td>
<td>2 x 500</td>
<td>109</td>
<td>10.8</td>
<td>1.6</td>
</tr>
<tr>
<td>IV China</td>
<td>4 x 500</td>
<td>112</td>
<td>21.6</td>
<td>1.6</td>
</tr>
<tr>
<td>IV China</td>
<td>6 x 500</td>
<td>160</td>
<td>21.6</td>
<td>1.6</td>
</tr>
<tr>
<td>III China</td>
<td>2 x 1,000</td>
<td>160</td>
<td>10.8</td>
<td>2.0</td>
</tr>
<tr>
<td>III China</td>
<td>4 x 1,000</td>
<td>167</td>
<td>21.6</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Upstream approach channel

- The upstream approach channel is narrow: The downstream approach layout is the mirror of the upstream approach with preferably the guiding wall on the same river bank.
- PIANC recommendation: sufficient lay-by area for vessels, waiting area (in accordance with the traffic) and overnight berths
The upstream approach channel


Lock approach area / outer port

Lst = length for slowing down the vessel
Lwt = waiting area
Lib = lay-by area
Lgd = length of lead-in jetty or guard wall
Lch = lock chamber
The upstream approach channel

Upstream approach channel - proposal nr.1

Two additional pontoons under angle for widening the access

These pontoons should be fixed by dolphins
The upstream approach channel

Upstream approach channel - proposal nr.2
The upstream approach channel

Fixing the floating pontoons by dolphins
The upstream approach channel

The upstream approach wall

- Will have to be broken down for the future eventual construction of the second lock
- Heavy duty in massive reinforce concrete;
- Not suitable as guiding wall;
- Under angle of 1/6 with axis of the lock chamber
The downstream approach channel

• The downstream channel has to be redesigned, especially the slope at the right embankment for improving accessibility;

• Visibility should be improved in the bend. Thereby accepting that the design vessel should be the 1,500t – 2,000t vessel that theoretically can enter the lock chamber;

• Modeling the right river bank (the steep slope) should be able to accommodate the second ship lock. Therefore the channel axis of both ship locks has to harmonize up- and downstream and smoothly link with the navigation channel up- and downstream.
The downstream approach channel

To be removed in order to improve the visibility (PIANC-recommendation)
The downstream approach channel

DOWNSTREAM APPROACH CHANNEL
(with doubled lock being tandem tock)

Drawing prepared by eng. Jacques Dezeure
The downstream approach channel

Second [tandem] ship lock of 341 x 42 m
The downstream approach channel

Downstream approach channel

15.00 m

44.00 m
Mooring system

- **Line Hooks** have to be provided in all access walls, up- and downstream, left and right bank. Useful tools for last-minute adjustments while entering the ship lock.
- **At least every 100 meter there need to be a ladder** in recesses of the guiding walls of the lock, up- and downstream.
- The 4 planned dolphins **upstream the ship lock must have access (catwalk) to the road** for skippers and boatmen.
The ship lock equipment

- There is no **control house** on the lock platform
- There is no **upstream apron**
- The grouting screen should be at the deepest point and **double**: one upstream, one downstream;
- The access bridge over the lock chamber should respect the 15.00m air clearance and has to be lifted by approx. 3 m
- Possible danger for **seepage**;
- Possible danger for **piping** if there are *dispersive soils* in the subsoil;
+ It is not clear to where this road leads?
+ The access over the ship lock must have 15.00m air clearance
+ There is no control room for the lock
+ The lock platform does not allow to deploy a crane
Alignment with the PDG

The proposed navigation lock does not comply with the recommendations for a double lift lock for heads greater than 30m in the PDG.

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Recommendations

- Redesign the ship lock from single lift to **tandem lock** with 2 x 16.19m lift);
- Redesign **both of the access and approach channels**, especially the downstream approach with the embankment to be excavated with considering the second lock-design;
- Complete the **lock equipment** with the suggestions in the report: amongst others: additional ladders in the approach walls, line hooks, upstream apron, grouting screen, etc.;
- Complete the lock with a **control house**;
- Lift the **service bridge** over the lock by approx. 3 m.;
- Redesign the **access road** to the lock platform;
- Prepare the list of required **spare parts** to be delivered.
Thank you!