Optimizing layout of power intakes in run-of-the-river projects

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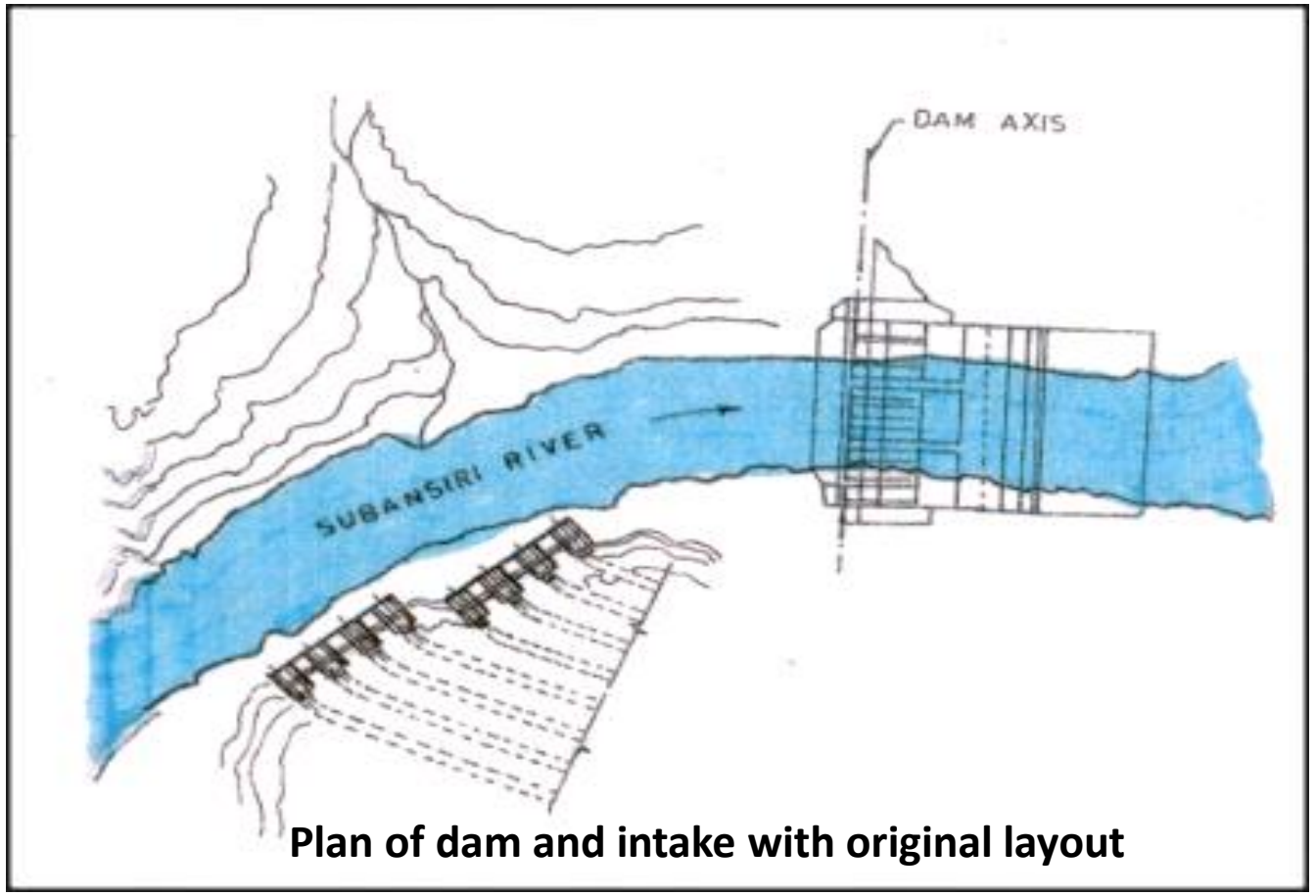
Introduction

- In India vast power generation potential is available in North and North Eastern Himalayan region because of the perennial river and steep slope.
- The main problem in harnessing this power potential is that these rivers carry huge amount of sediment leading to deposition in reservoirs
- For efficient management of the sediment, low level spillways with crest very near to the river bed are provided with arrangements for periodic reservoir flushing.

- In the run-of-river projects the intakes are provided very near to the spillway and are generally aligned at 90^{o} to the dam axis
- The basic function of intake structure in hydro power plant is to help in safely withdrawing water from the river and then to discharge this water in to the withdrawal conduit, while leaving the sediment behind
- The sediment deposition pattern in reservoirs is highly site specific and depends on various factors such as reservoir geometry, flow and sediment characteristics and operation of the reservoir
- The present paper discusses three case studies of major Himalayan run-of-river schemes in which unique solutions were evolved to solve the sediment problems at the intake structures

CASE STUDY: I- SUBANSIRI H E PROJECT

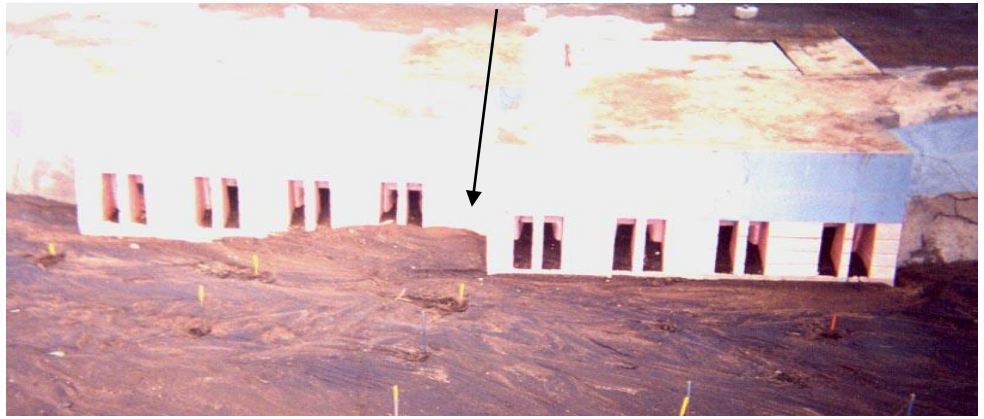


Plan of dam and intake with original layout

- The studies were conducted on 1:100 geometrical similar (G.S.) scale model of lower Subansiri reservoir covering the reach of 10 km upstream and 0.5 km downstream. Dam and intake structures were reproduced in the model as per the design.

- Initially Intakes in staggered

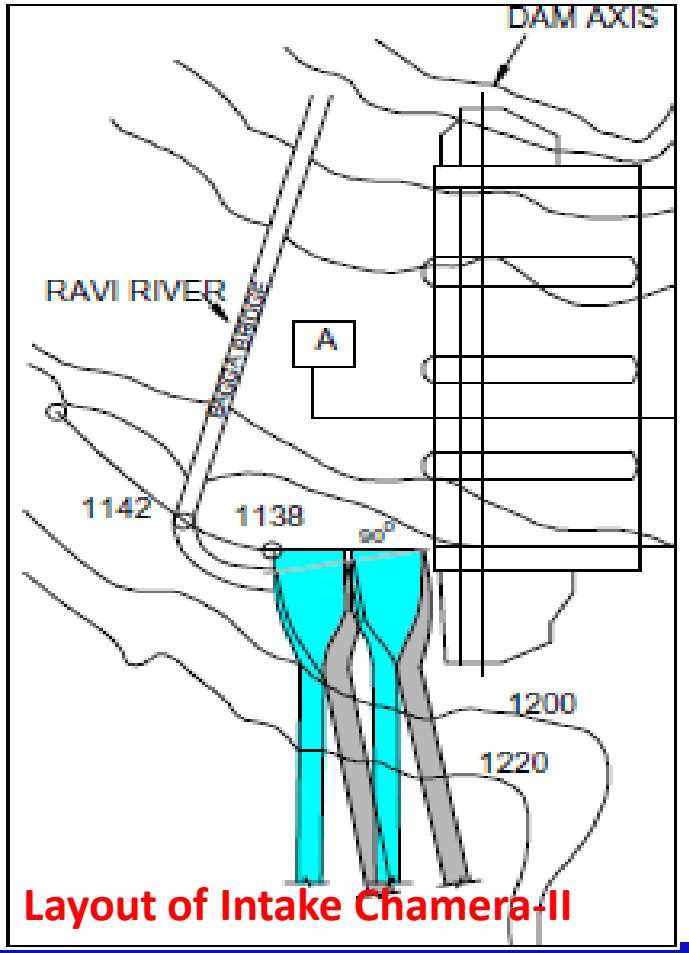
- Initially flushing studies were carried out with the staggered intake layout for the discharge of 6000 m^3/s. The full reservoir level of 205 m at the dam was maintained in the reservoir before commencing the drawdown flushing for 24 hours



Deposition pattern after flushing duration-24 hours

Modified layout of Intake

CASE STUDY: II- CHAMERA-II H E PROJECT



Layout of Intake Chamera-II

Model Layout of Intake Chamera-II

- The studies were conducted in 1:70 G.S. scale model covering entire fetch of reservoir of 3.5 km upstream and 0.5 km downstream

- The original alignment of power intake at 100^0 to the dam axis on the right bank

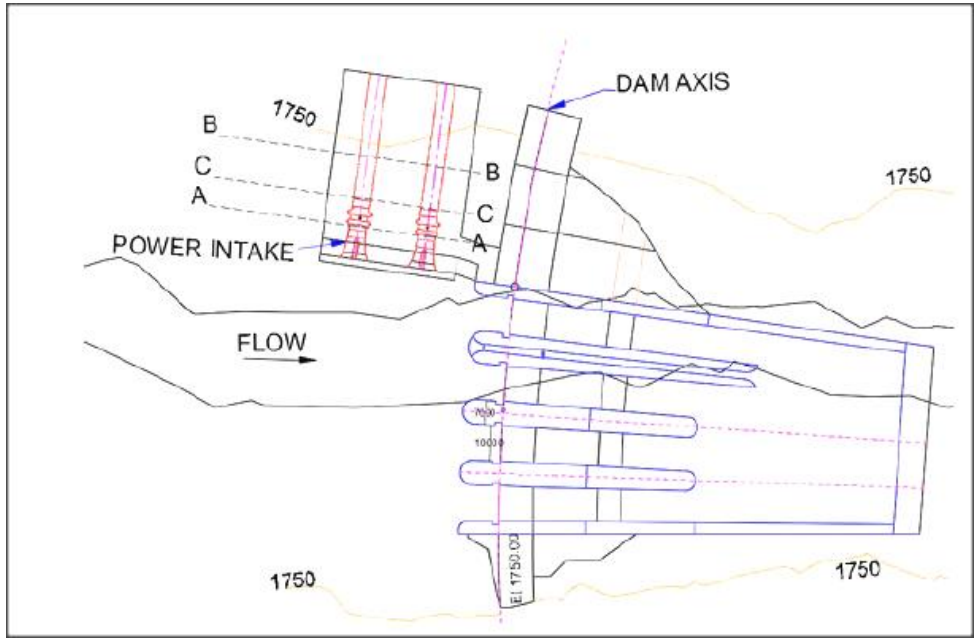
- Experiments for reservoir flushing were conducted for the discharge of 500 m^3/s with sedimentation profile derived from mathematical model studies

- During flushing it was observed that return flow occurred in front of the intake and the extreme right bay of dam. This return flow induced deposition of sediment in front of the intake. As there is very little cushion of about 2 m between spillway crest and intake invert, the deposition in front of intake lead to passage of suspended sediment through water conductor system.
- In order to improve the flow condition near the intake, the alignment was revised. In the new layout, the intake was aligned at 90^0 to dam axis

CASE STUDY: III- MANGDECHHU H E PROJECT

Model reach 825 m upstream to 200 m downstream

General layout of Mangdechhu Project with intake position A-A, B-B and C-C



- The model of Mangdechhu Reservoir was constructed to a G.S. scale of 1:100 for the reach of the Mangdechhu River from 825 m upstream to 200 m downstream of the dam axis

- Reservoir flushing was simulated in the model for various discharges and durations. Experiments were conducted with three alternate intake alignments viz. A-A, B-B and C-C

- It was observed that from sediment deposition point of view, the intake location along A-A is more favourable than B-B.

- Due to geological conditions at the site, positioning of the intake along both A-A and B-B was not possible

- The project officials came with new proposal for alignment of intake. This is marked as C-C as shown in the figure

- Further flushing experiments were carried out for the new layout. It was observed that there is no appreciable change in the sediment deposition pattern after flushing in case of alternatives A-A and C-C.

- The sediment deposition level in front of intake varies between El 1710.00 to El 1712.00 m which is below the intake invert of El 1720 m

CONCLUSIONS

- Present studies highlighted importance of physical model studies in finalizing the intake position with respect to sediment deposition levels after flushing

- The present studies it can be seen that experiments on physical scale models can be used to optimize alignment of intake for increasing flushing efficiency and thereby reducing the deposition in front of intakes

- Efficient solutions can be derived to suit the site conditions and project constraints with the help of physical scale model studies

THANKS