THESIS

IMPACT OF BELA FORMATION ON HYDRAULIC OPERATIONS OF THE BARRAGE - A CASE STUDY OF TRIMMU BARRAGE

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ABSTRACT

River diversion structures are constructed across the river to raise the water level on the upstream side to feed the off-taking canals. The barrage capacity usually designed on the basis of a flood of 100 years return period which means that all gates of the barrage are opened only once in N-year. But in regular barrage operation only some gates are opened, as a result sedimentation occurs in the upstream pool usually in the front of rarely opened gates causing the formation of belas (shoals). Bela formation reduces flood capacity of barrage and adversely affects the hydraulic operations of off-taking canals.

Pakistan has the world's largest irrigation system and the Trimmu Barrage is one of the most important structures of this system. The Barrage is located in the Jhang District at latitude 31° 09' 35" N and longitude 72° 12' 51" E. Barrage diverts the river flows to Rangpur canal off-taking from right side, Haveli Main Line and Trimmu Sidhnai Link Canal off-taking from left side flank. River flows approach to barrage is oblique curvilinear due to that sediment deposited at upstream side of right under sluice. With this flow pattern, the right guide bank of the barrage remains liable to silt deposition and growth of bela occurs in close vicinity of the structure. The present study is carried out to evaluate the affect of bela formation on hydraulic operations of the barrage, particularly on off-taking canals.

Discharge and sediment data analysis of off-taking canals was carried out to study the impact on hydraulic operation of barrage in pre and post bela scenario. The sediment analysis of Rangpur canal includes the computation of sediment transport capacity using various approaches (i.e. Acker-white method, Engelund-Hansen method & Yang's method) and performing the quasi sediment analysis with the help of HEC-

RAS computer model to calculate the sediment deposition in selected reach of the canal. For the evaluation of bela impact on flood discharging capacity, weir submergence analysis and flood frequency analysis was carried out. The hydraulic performance of the barrage was evaluated by using HEC-RAS computer model for different return periods. The results show that water diverted to Rangpur canal has decreased upto 22% after bela formation. Further, sediment concentrations in all off-taking canals have increased after bela formation. The numerical model study results showed that heavy sediment concentration is causing the considerable deposition at head reach of the Rangpur canal.

Weir submergence analysis for different selected years showed that working head of weir decreased and submergence increased with the passage of time. Due to heavy siltation at upstream and downstream on the right side of weir, there was not enough space for accommodating higher discharges which resulted in loose modularity of weir with increased discharges. Flood frequency analysis was done by using Gumbel method and Log Pearson Type-III distributions. The flood peak discharges by Gumbel method for the return periods 2, 5, 10, 25, 50 and 100 years were 271663, 465408, 593685, 755762, 876000 and 995351 cusecs respectively, and by Log-Pearson Type III were 251545, 444016, 585855, 776186, 924160, 1074935 cusecs respectively. This analysis indicated that current design capacity of barrage is based at 13 years return period discharge. HEC-RAS results of Trimmu Barrage shows that barrage safely passes discharge of 593685 cusecs at 10 years return period but at discharge of 100 years return period whole barrage structure will submerge. It is recommended that design discharge capacity of the barrage should be reviewed at 100 years return period, and model studies should be performed to determine exact measures for improving river approach on upstream and downstream of the barrage.