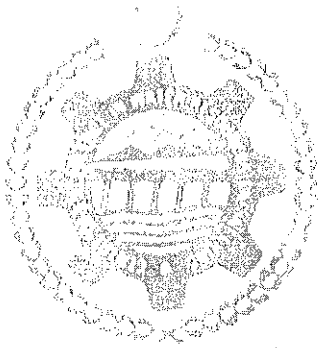
THESIS

EFFECTS OF LOWER SPAT GAH DAM HEIGHT ON EFFICIENCY OF SEDIMENT SLUICING



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ABSTRACT

All rivers carry large sediment load but the large river sediment capacity keeps the river in a dynamic equilibrium state in term of river sedimentation. However large dams construction on the river lowers the sediment transport capacity and thus disturbs the sediment equilibrium. Large volumes of sediments become deposited in the dam reservoirs reducing its storage capacity. The sediment deposition will ultimately severely affect the performance of intake structure and the hydropower machinery etc.

Studies indicate that, on average, one per cent of the water storing capacity of the globe's reservoirs is being lost annually because of a build up of muds and silt. In Pakistan the past storage loss is estimated as 1% per annum. With this situation, the original reservoirs capacity have decreased from 22.18 MCM (million cubic meter) in 1976 to 16.72 MCM in 2000, which is expected to further drop to 12.33 MCM by 2010. Apart from rapidly filling reservoirs, sediment laden rivers also cause headaches for dam operators due to the abrasion of turbines and other dam components.

The Spat Gah is a left hand tributary of the Indus River and is located in the District Kohistan in North West Frontier Province (NWFP) of Pakistan. It originates at an elevation of 4,800 m.a.s.l. and joins the Indus River some 190 km upstream of Tarbela. A run-of-river hydropower project is being planned at a site 15 Km u/s of its confluence. A dam/diversion weir will divert flows to the powerhouse. This will also create a head pond reservoir for peaking and increasing water head. Due to steep gradient and young soil formation of the river, high amounts of sediments are transported especially during flood events. Floods and the associated sediments can cause serious damage to intake works

and turbines and will also cause sedimentation of the reservoir. It is desired that sediment deposition may be maintained at lowest level and larger particles are effectively trapped in the reservoir and are flushed during high flow season such that larger particles would not affect turbine blade. Therefore a study was undertaken for lower Spat Gah hydropower project with the objective to find an effective sediment management strategy in terms of selecting suitable dam height with highest efficiency for sediment transport and subsequent flushing.

Spat River was in initial investigation and very limited data was available. Reservoir cross section data and elevation area capacity curves was developed from topographic maps on scale 1:2500 providing reservoir storage of 2.51 MCM and 5.72 MCM between El. 1520 m to El. 1540 m. At El. 1540 m, the reservoir impounds an area of about 0.02 Km^2 in a length of about 950 m. Observed daily flows was available for 7-years at gauge Goshali located about 7 Km d/s of damsite, which was firstly extended by using correlation from historic record of nearby river gauge (Garhi on Kunhar river) and then transposed to damsite. The flow duration curves show flows of 20, 50 and 100 m^3/s with exceedence probability of 30, 49 and 10 % of time. Sediment rating curve was developed from historic suspended measurements at gauge Garhi. Based on topographical and geological characteristics, catchment Kunhar was taken similar to Spat Gah and daily suspended loads were derived by using computed inflows at damsite. Bed load was taken as 15 % of suspended load to obtain total sediment loads. The computed annual total sediment load for lower Spat Gah damsite varied between minimum of 67 thousand tonnes and maximum value of 1900 thousand tonnes with average of 517 thousand tonnes. Bed material particles were sampled by line by number method and

gradation curve was developed by Fehr method. The method accounts for sediment size upto 10 mm. The smaller particles (upto 2 mm) were included by using Fuller distribution technique.

Numerical model GSTARS3.0 was used to facilitate long term sediment simulation mainly because of its stream tube and handling of various flow regimes capabilities. The model was first tested for natural river (no dam) condition and yielded equilibrium behavior with no deposition and scouring behavior. The model was then tested for post dam condition for various scenarios differing only due to dam height both with and without flushing scenarios.

The results provide reservoir deposition rates of 41, 36 and 27 % with dam heights of 1540, 1530 and 1520 m, respectively, without flushing. It was observed that reservoir will be silted up and power intake situated at El 1476 m will be chocked after 15-30 years of dam operation. Each scenario was then tested with flushing. Each year the reservoir level was drawdown to El. 1480 m for fifteen (15) days during period of highest discharge and sediment inflows in the month of June, providing reservoir sediment deposition rates of 27, 26 and 24 % indicating net decrease of about 14, 10 and 3 % in reservoir sediment deposition in comparison to no-flushing scenario. The thalwages remain below power intake with flushing without any threat of its chocking. In light of above, it is recommended to develop lower Spat Gah project with dam height providing water regulation at El. 1540 m.