M.Sc Thesis

IMPACT ANALYSIS OF OVERFLOW SPILLWAY ON U/S FLOWS & HYDRAULIC STRUCTURE USING CFD TECHNIQUE: A CASE STUDY OF MARALA HPP

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ABSTRACT

Irrigation network of Pakistan is the backbone for its agriculture and economy. Various head works/ barrages are constructed across important rivers in order to feed water for the off-taking canals for irrigation purpose. Pakistan is also facing an acute shortage of power & energy. To resolve this issue, barrages can be considered as a readily available option for hydropower generation because ample water and head are conveniently available at such sites.

Marala Barrage was built on River Chenab in 1968 and water is diverted from left banks of the river through the Upper Chenab Canal (U.C.C.) having design discharge of 477 m^3/s and Marala Ravi (M.R.) Link having design discharge of 623 m^3/s. Both canals along with irrigation also divert water from Chenab River to Ravi River. Just downstream of UCC head regulator, it is planned to utilize the water and available head for hydropower development and the project is named as Marala Hydropower Project (MHP).

Most important aspect of this hydropower generation project is to set the levels of hydraulic structures such that there is absolutely no disturbance to the irrigation flows which is the primary purpose of the barrage and canal network. At the same time finding the optimum level for the proposed structures (powerhouse & spillway) so that the maximum benefits can be achieved through the project without compromising irrigation requirements. This was achieved by using CFD modelling and analytical approach.

The results of modelling were then compared with the physical model of the said project for validation and checking the accuracy of the model.

For numerical computer model, four cases were developed. First three cases consisted of various alternatives for analysis to be performed through FLOW 3D software, Whereas fourth case was created to validate the CFD model by comparing it with the results of physical model. In the meantime, analytical computation were performed to verify the results of numerical model. Finally, all results were compiled, analyzed and conclusions were obtained.

Results of the study depicted that more efficient and sophisticated computing machines are pre-requisite to obtain more reliable results from CFD analysis. Also, the margin of error in this study is much small because in canal operation there is not much difference between water levels. Last but not the least it was deduced that discharge passing capacity of head regulator of UCC is reduced as the crest level of the proposed spillway is increased (inversely proportional). Also, the power generation potential is directly proportional to the crest level of the proposed spillway. This study will be helpful for any future hydropower development schemes on irrigation canals in close proximity of barrages.