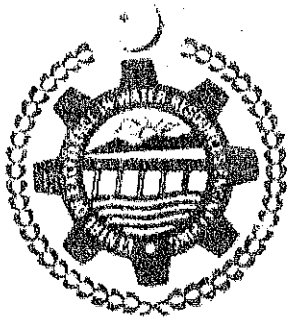
THESIS

HYDRAULIC PERFORMANCE OF OVERFLOW STEPPED SPILLWAY AND STILLING BASIN BY PHYSICAL MODELING (A CASE STUDY OF ZARWAM WEIR)



By

Syed Qammar-e-Mohammad
2004-PG-WRE-28

For the Degree of

MASTER OF SCIENCE

IN

WATER RESOURCES ENGINEERING

CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING
University of Engineering and Technology, Lahore, Pakistan.

2006

ABSTRACT

A physical model is scaled representation of hydraulic flow phenomenon. By constructing physical models using established laws of hydraulic similitude, model performance can be scaled up to prototype size. These models are often the most feasible and economical way to incorporate three-dimensional complexity. Further, these models can also include the effects of physical processes that may not be understood well enough to be accurately incorporated into computer simulations.

A hydraulic physical sectional model for stepped spillway and stilling basin was constructed and tested in the Model Testing Hall of the Centre of Excellence in Water Resources Engineering (CEWRE), Lahore. The scale selected for the model was 1:20 and its width was 2 ft, thus representing 40 ft width of prototype structure with the assumption to represent the flow pattern for the whole width of prototype structure because of similarity of flow pattern across width of the structure.

Results of the model testing revealed that hydraulic jump swept off the stilling basin for discharge higher than 70% of the design discharge. At low discharges, water jet was lifted off the spillway, got airborne and striked the downward steps with considerable spray. Flow aeration (white waters) was observed on the stepped spillway for all discharges. It was observed down the spillway for higher discharges as compared to medium and low discharges.

To evolve a better performing design for stilling basin, ten modifications were done to the stilling basin while the spillway structure remained unchanged. The length of basin was increased by 14.08 ft for modified design 1 while the depth remained

unchanged. All other modifications were based on design 1. For design 2 and 3, the depth of basin was reduced by 7 ft and 3.5 ft respectively. For all other modifications, baffle piers of different sizes were used in single and double rows with different depth combinations.

Baffle piers used with stilling basin depth of 8 ft were found to be most effective in reducing the length of hydraulic jump and reducing the scour depth downstream of the basin, but the elevation of water in stilling basin increased with baffle piers. Design 10 with 5 ft high baffle piers in single row was selected among all the tested designs for reduced length and depth of the basin at design discharge. The depth of design 10 was reduced by 7 ft as compared to the original design and its end was kept at same location as that of the original design. The elevation of sidewalls for design 10 was increased by 5 ft to prevent spillage over walls at design discharge.

The stepped spillway of design 10 was smoothened and tested for all discharge ranges to compare the effectiveness of stepped spillway with that of smooth surface spillway for the same design of stilling basin. Shorter hydraulic jumps, less scour, increased depth of flow and considerable aeration on spillway surface were observed for the design with stepped spillway as compared to smooth surface spillway, indicating that stepped spillway was effective in dissipating the kinetic energy of flow at all discharges.