THESIS

SEEPAGE MODELLING FOR DESIGN AND PERFORMANCE EVALUATION OF NORTH HEADPOND EMBANKMENT OF GHAZI BAROTHA HYDROPOWER PROJECT

By

Muhammad Umar Farooq
(2004-PG-WRE-23)

MASTER DEGREE

IN

WATER RESOURCES ENGINEERING

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

2007

ABSTRACT

Seepage analysis is an important aspect of Embankment Dam Engineering to ensure the construction of reservoir storage, seepage flows and thus the stability of earthen embankments. The focus of the present study is the seepage analysis in the North Headpond embankment of Ghazi Barotha Hydropower Project.

Ghazi-Barotha Hydropower Project is state of the art run of the river environment friendly Project which generates 1450 MW power with its five 290 MW units and produce an average annual energy of 6,600 GWh. The Project has three main components; a barrage, a power channel, and a power complex. The barrage, located about 7 km downstream of Tarbela Dam, regulates the daily discharges from Tarbela, to divert water into the power channel. The concrete-lined 52 km long power channel conveys up to 1600 cumecs (56,500 cfs) to the power complex and two headponds. The headponds temporarily stores about 25 million cubic meters of water during the day to generate full power during the peak hours. The North Headpond embankment has maximum height of 60 m above the foundation level in the Dher Nullah Area. The crest of the embankment is at El. 339 m above mean sea level (a.m.s.l), while the normal operating reservoir level at El. 334 m a.m.s.l, corresponding to a gross reservoir volume of 73.2 Mm^3. The power complex is located at the end of the channel with five units of 290 MW each.

For the present study, the seepage flows are computed by setting up the SEEP/W model for the deepest section at the segment E in the North Headpond embankment and also by the conventional empirical method to compare with the designed seepage and observed seepage.

For calibration purpose, simulated results were compared with the observed one at toe of the core and the embankment, and calibrating parameters were evaluated after doing a fine tuning of the model where it simulates closer to the observed seepage flows. Reservoir level of Headponds almost daily varies from Maximum level of 334 m to Minimum level of 329 m due to peaking power demand and back to Maximum level of 334 m through filling of the reservoir during hours of non-peaking power demand. Keeping in view slight daily variation, the head could be assumed constant at all the times. Therefore, the simulated seepage flow values were validated by comparing the seepage flow values obtained by using the conventional approach; the empirical method. The results show that the SEEP/W model can simulate seepage flows for the North Headpond embankment of the Ghazi Barotha Project. Moreover, the values of the determined calibrating parameters in the study may be adopted for modeling seepage flows using SEEP/W with confidence for other projects having similar material properties.

The designed seepage flows were compared with the observed seepage flows for the total length of the North Headpond embankment. The comparison shows that the observed seepage flows are much lesser than the seepage flows estimated by the design parameter and hence validates the design assumptions.

It is suggested that seepage measuring flumes and the drainage system downstream of the embankment should be monitored on regular basis to avoid choking of these structures and consequent blockage of seepage water. It is further suggested to replace the choked pipe in the Dher Nullah street for proper disposal of seepage and to remove blockage in downstream of flume structures at several stations to correctly measure the seepage flows.