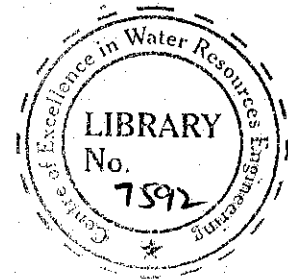
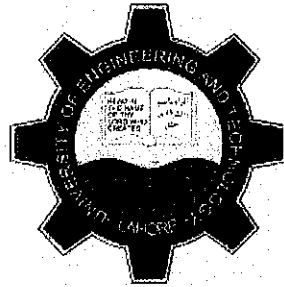


SUBSURFACE FLOW STABILITY ANALYSIS OF PUNJNAD BARRAGE



by

Hasnain Jillani
2016-MS-HPE-04

Research Supervisor
Prof. Dr. Habib-ur-Rehman

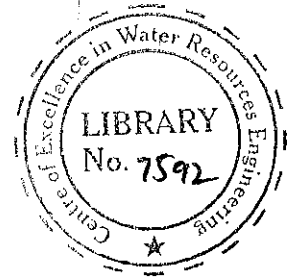
2021

Centre of Excellence in Water Resource Engineering
University of Engineering and Technology, Lahore,
Pakistan

SUBSURFACE FLOW STABILITY ANALYSIS OF PUNJNAD BARRAGE

Submitted By

HASNAIN JILLANI
(2016-MS-HPE-04)



A THESIS

presented to the university of engineering and technology, Lahore
in partial fulfillment of the requirements for the degree of
Master of Science

in

HYDROPOWER ENGINEERING

APPROVED BY

Prof. Dr. Habib-ur-Rehman
Research Advisor/
Internal Examiner

Dr. Mazhar Hussain Mahu,
Director, Hydropower Punjab
Power Development Board
(PPDB), Energy Department,
Govt. of Punjab, Lahore
External Examiner

DIRECTOR, CEWRE

Approval Date: 30-06-2021

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



ABSTRACT

Punjnad Barrage was constructed on River Chenab, downstream of the confluence point of River Sutlej during the period 1925-1929 with design discharge of 450,000 cusecs and upstream High Flood Level (HFL) of 341.5 feet amsl. In 1957, Punjab Irrigation Department (PID) carried out major repair works and sealed the PCC blocks with provision of pressure relief holes in order to achieve adequate impervious floor length with respect to the length of jump profile. A downstream sheet pile was erected to address the unsafe Exit Gradient, however, theory of seepage flow remained unsatisfied which mainly relied upon release of uplift pressure through seep holes in downstream floor. In order to rehabilitate the Punjnad Barrage, PID engaged Consultants under the projects "Punjab Irrigated Agriculture Investment Program" (PIAIP) and "Trimmu & Punjnad Barrage Improvement Project" (TPBIP). PIAIP and TPB Consultants analysed subsurface flow using Khosla's approach and different scenarios under different conditions were modelled on computer software SEEP/W. However, in order to have a best performing section, the final working paper proposal needs to be modeled on SEEP/W. Secondly, it was also required to check uplift pressures and floor thickness without water cushion of 3.0 feet as proposed by PIAIP Consultants and 4.0 feet as proposed by TPB Consultants due to end sill in their proposed sections. In order to evaluate the existing section of Punjnad Barrage for subsurface flow stability, it was required to analyze the existing section with pressure relief holes not fully operational & partially operational. In this study, adequacy of existing section of Punjnad Barrage for subsurface flow was checked along with proposed interventions and propose any modification for better hydraulic performance, if needed.

Existing section of Punjnad Barrage and sections with proposed interventions of PIAIP & TPB Consultants were analyzed using classical theories; Bligh, Lane and Khosla and SEEP/W modeling. Sensitivity analysis of SEEP/W was also carried out by varying the mesh size to three different values of 2.5 ft, 5.0 ft and 10.0 ft. Six cases with varying flow conditions and proposed interventions were analyzed. First three Cases A to C results indicate that Exit Gradient & uplift pressures are not safe for the existing sections of the barrage and Case-E with proposed intervention is also unsafe in subsurface flow stability. It is found that Cases D & F are safe for subsurface flow stability with proposed water cushion on downstream floor. However, Case-F i.e. TPB Consultants Working Paper Proposal is recommended to be adopted for the rehabilitation of Punjnad Barrage. This study is useful especially for practicing hydraulic engineers who work as rehabilitation experts.

Keywords: Punjnad Barrage; Punjab Irrigation Department (PID); Punjab Irrigated Agriculture Investment Program (PIAIP); Trimmu and Punjnad Barrage Improvement Project (TPBIP); Trimmu & Punjnad Barrage Consultants (TPBC); subsurface analysis; classical theories; SEEP/W analysis; Lane; Bligh; Khosla.