THESIS

ANALYSIS OF EFFECTIVENESS OF D/S SHEET PILE/CUT-OFF WALL FOR FALL CUM REGULATOR OF LOWER CHENAB CANAL USING COMPUTER MODEL

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ABSTRACT

Lower Chenab Canal (LCC) structure at RD 78+000 whose data was taken from Irrigation and Power Department, Government of Punjab Lahore and the general structure from Garg (1987) were the chosen case study. These structures possess sheet piles/cut-off walls at upstream, intermediate and downstream positions.

LCC structure constructed in 1892, takes off from Khanki Headwork at the left side of the River Chenab located near Hafizabad. It is also partially fed from Qadirabad barrage through LCC feeder, off taking from Qadirabad Balloki Link Canal. It caters to areas of Gujranwala, Hafizabad, Sheikhupura, Faisalabad, Toba Tek Singh and Jhang districts.

The groundwater flow analysis have shown that the seepage or percolation of water through the soil surrounding a hydraulic structure result into problems of uplift pressure and exit gradient, which may ultimately lead to failure. For this; Khosla proposed the safety measure of providing sufficiently deep sheet piles/cut-off walls at upstream and downstream end of impervious floors, provisionally with an intermediate pile.

The study aims to analyze the seepage flow problems of uplift pressure and exit gradient by utilizing Geo-Slope office package, SEEP/W. The results were assessed against the conventional Khosla's equations and relative factor of safety standards for the stability analysis.

The comparative study of SEEP/W for selected profile depth of 40m and Khosla theory, by using typical structural data, interpreted slight variation in results of exit gradient and uplift pressure at upstream and bottom point of downstream pile.

By using typical structural data, the exit gradient and uplift pressure at key points in SEEP/W were quantified with variable profile depths and then compared against single result of Khosla for infinite depth of profile. Significant variation between SEEP/W and Khosla results of exit gradient up to profile depth of about 6 to 8 times the depth of downstream pile and between results of uplift pressure at key points up to profile depth of about 4 to 6 times the depth of downstream pile was observed. Further increase in the depth of downstream pile showed insignificant variation between the results.

The exit gradient was then again quantified in SEEP/W by using typical structural data but with variable depths of upstream and intermediate piles and with constant selected profile depth of 40m. The SEEP/W results clearly reflected minor decrease in the value of exit gradient with increase in the depth of upstream and intermediate piles whereas the Khosla theory ignored the effect of respective piles.

LCC structural data was then used for quantification of exit gradient, uplift pressure and floor thickness by using SEEP/W and Khosla method respectively with variable depths of downstream sheet pile/cut-off wall to counteract its effect on respective parameters. The increase in error between SEEP/W and Khosla results of exit gradient with downstream pile depth from 5 to 30+% was observed. SEEP/W results indicated over estimation of about 5 to 5.5% than Khosla results, thus reflecting less safety of the structure. The Khosla results of uplift pressure at upstream point of downstream pile reflected more safety while the subsequent SEEP/W results reflected economical suitability and on the other hand both methods gave alternate safer and economical values of uplift pressure at bottom point of downstream pile. The constant error of ± 1 ft in results of uplift pressure at both key points corresponding to 0.6ft of floor thickness for each depth of downstream pile was observed.

The design data for fall-cum-regulator of LCC at RD 78+000 shows that structure is safe against seepage exit gradients for most likely conditions of full and partial gate openings.

It was concluded that, although both Khosla and SEEP/W results are based on potential theory but there exist small difference in potential which could be due to some errors in solution techniques at these singularity points on account of rounding errors, numerical errors etc and/or due to finite profile depth and finite length of upstream and downstream flow areas for the case of SEEP/W. Thus, it was recommended to consider profile depth consistent at the site and sufficiently large inflow + outflow but not less than profile depth in SEEP/W to make it comparable with the Khosla theory. Also lower depth of downstream pile consistent with the safety at the exit must be selected, so as to keep the uplift pressure and floor thickness minimum.