THESIS

EVALUATION OF DESIGN AND LAYOUT FOR DEWATERING OF FOUNDATION AT TAUNSA BARRAGE

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ABSTRACT

Barrages play pivotal role in sustaining supplies to millions of hectares of irrigated lands in Punjab. Many barrages in Punjab are planned for rehabilitation work due to several problems like; suffering from aging, sedimentation/retrogression problems, etc. Rehabilitation programs invariably involve structural activities in the river bed and efficient dewatering of the site always play vital role for undisturbed structural works at new barrages. The purpose of this study is to formulate a numerical model (MODFLOW) to simulate the performance of dewatering system at Taunsa barrage and compare the site observed and calculated results.

Taunsa barrage was constructed in 1954-58 across River Indus with designed capacity of 1 M cusecs. The total length of area across the flow which had to be dewatered was 1325 m. This length was divided in stage 01 and stage 02 works. Construction work of stage 01 was carried out on the right half of the barrage by enclosing the area with cofferdam and river water was guided to flow through the left half part of the barrage and vice versa for stage 02. The area which was selected for analyzing the dewatering system consists of 233 m length along the flow and 266 m length across the flow in stage 02, Phase I (pocket I).

Soil samples of river bed material at Taunsa barrage was collected for evaluating hydraulic conductivity and profile layering. Three borehole locations were selected and from each borehole location 5 soil samples were collected by percussion method at an interval of 5 ft. The hydraulic conductivity of these soil samples was determined by using Kozeny-Carman equation and constant head permeameter test. The value of K varies from 8.22 m/d to 11.69 m/d by using the Kozeny-Carman equation and 11.88 m/d to 14.46 m/d by constant head permeameter test. Constant head permeameter test results in 29 % higher value of K than the value obtained by using Kozeny-Carman equation. It was found that the model calibrated values of K and values obtained by constant head method were comparable closely. Therefore, constant head method results

better estimation of hydraulic conductivity than by using Kozeny-Carman equation. The river bed hydraulic conductivity may be taken 12-14 m/d for Pakistan Rivers.

A detailed 3-D finite difference numerical model of dewatering system was prepared using MODFLOW model by assigning the input parameters such as initial conditions, boundary conditions, initial observed water levels in the individual wells, river bed hydraulic conductivity in different layers, pump discharges and their locations etc. The area of flow domain was divided into cells for MODFLOW modeling. Mesh size of 106 x 115 (rows × columns) was used with the grid size of 4 m x 4 m dimension. The model covers a total area of 195040 m^2 in which actual works area is 70432 m^2. Five layers of MODFLOW model were selected on the basis of variation in the value of hydraulic conductivity with depth below river bed, bottom of strainer of different wells and an additional fifth layer to incorporate the pumping influence below the bottom of strainer. Model parameters like initial hydraulic heads, bore hole and observations, horizontal and vertical hydraulic conductivity values, anisotropic ratio, specific yield, specific storage and effective porosities were assigned initially and adjusted during model calibration.

MODFLOW shows that the wells installed at the boundaries take more time to achieve the steady water levels due to large amount of inflows from river water storage than the wells installed in the central part of the area. The volume of seepage/infiltration entering into the construction area was calculated by using the field data, analytical method and numerical model and results in the values of 7.4 Mm^3, 6.9 Mm^3 and 7.5 Mm^3 respectively but these results cannot be compared as the analytical model cannot simulate the effect of sheet pile. The value of 6.9 Mm^3 was obtained by using the value field observed value of head up to dewatering level. The volume of water pumped was also estimated by using the analytical method when no sheet pile installation and results a value of 6.2 Mm^3 in comparison to 7.5 Mm^3 for the field simulated condition. The analytical model underestimates the pumping volume by 21% than the field simulated results obtained by MODFLOW.

Effect of sheet pile installation was significant for the wells installed at the boundaries of construction area. The water level was higher up to 2 m without sheet pile as compared with sheet pile installation. Layout of the dewatering system was found to be satisfactory but operation of wells was on higher side as the water table was maintained 1.5-3 m lower than the targeted value but accepted considering safety margins. The analytical model is silent about the time taken by individual wells to achieve steady water levels but the MODFLOW model results the daily water levels in each well. The simulated and observed water levels were comparable closely and an average error of 0.48 m against a head drop of approximately 10 m was found by using the mean squared error method in all selected wells which is very much in acceptable range considering the complexity of the system.