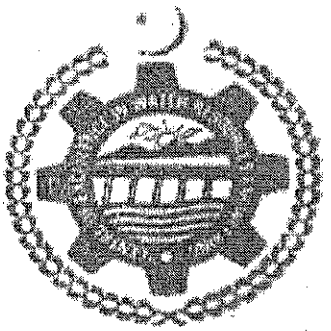
THESIS

ESTIMATION OF RIVER WATER AFFLUX USING COMPUTER MODELS



By

Muhammad Umer Azeem
(2006-PG-WRE-43)

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.

2009

ABSTRACT

The problem of water afflux computation is one of the main concerns of engineers for optimal development of river crossing design and construction of hydraulic structures such as bridges, barrages, etc. For economical design of a structure that passes floodwater, the estimation of water afflux due to its hydraulic performance is very essential, so that the design be safe and economical.

Baba Farid Bridge is planned across Sutlej River and is located between Suleimanki and Islam headworks, at about 32 km downstream of Sulemanki where it will connect the town of Pakpattan with Minchinabad. Including bridge details (width, span of bays, number of bays, piers, cunnette, guide banks etc), the hydraulic performance of the proposed bridge had been evaluated by moulding about 15 km stretch of the River Sutlej by physical modeling at Hydraulic Research Station, Nandipur in 2006. The objectives of the present study were water surface profiles calculation at proposed bridge using computer model HEC-RAS, to evaluate the water afflux and its comparison with the physical model results.

Computer model HEC-RAS 3.1.3 was used to calculate the water surface profiles of different discharges. A 20 km reach of River Sutlej was modeled using HEC-RAS comprising of 40 cross sections at 500 m interval. The survey data showed an error in the bed profile as some of the cross sections had a reasonable difference in elevation than the average slope. The physical model was formed by moulding all the cross sections at the average slope. In the computer model the bed profile was used as surveyed but the cross sections which had significant error were adjusted to model the true picture of the study reach. With the increase in flow rate in the physical model,

the stream power increased and ultimately the scouring of bed increased which resulted change in bed profile. As HEC-RAS model is a fixed bed model so it could not model the bed mobility thus the HEC-RAS model was constructed to reproduce the same scenario as in physical model.

For estimation of river water afflux, first the HEC-RAS model without bridge was constructed and water surface profiles were drawn. Then computer model with bridge was constructed to incorporate convergence of flow path due to guide banks. Also that with the change in flow rate, the river cross sections change due to scouring. To compute the water surface profile with bridge using HEC-RAS, scour depth cross sections were made using Lacey's Regime Theory for each flow for which the water levels were observed in the physical model, as the changes in the physical model cross sections were not reported with the change in flow rates. By using scoured depth cross section a set of HEC-RAS model was constructed for the study reach with bridge construction. The computed water surface profiles were compared with the simulated computer model of the study reach without bridge to estimate the river water afflux and also compared the HEC-RAS simulated results with physical model observations.

The simulated results of HEC-RAS showed that the water levels at the proposed bridge site without bridge are slightly higher than that of physical model. The simulated results range from 158.8 m to 162.06 m for a flow variation from low flow of 708 cumecs to peak flow of 16988 cumecs. In case of physical model, this variation is from 159 m to 161.6 m for the identical flows. The observed water levels in the physical model upstream of bridge structure are higher and ranges between

159.25 m to 163 m and on the other hand simulated water levels ranges between 158.81 m to 162.53 m for low flow of 708 cumecs (25,000 cusecs) to peak flow rate of 16,988 cumecs (600,000 cusecs). The difference in water levels from physical model and HEC-RAS ranges from 0.2 to 0.67 m with percentage error of 5.7 and 5.5 respectively in case of bridge construction. The simulated results of HEC-RAS showed that the water level at the cross section upstream of bridge rises due to bridge constriction to flow. The water afflux increases with increase in river flow rate. A considerable increase of water level is simulated for the flows higher than the 8494 cumecs. The simulated water afflux at upstream of proposed bridge site is 0.47 m for the peak flow of 16988 cumecs while in case of physical model it was estimated 1 m.

Considering small error in determining the water surface profile with physical model and HEC-RAS model and the grey areas in physical modeling, the HEC-RAS model can be used to model river flow hydraulics for initial studies at various hydraulic structures as bridges, barrages etc.