THESIS

HYDRAULIC EVALUATION OF SECTION CONSTRICTION AT BRIDGE STRUCTURES OF HAIRDIN CARRIER DRAIN

SUBMITTED BY

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ABSTRACT

A ten kilometer long study reach of Hairdin Cartier Drain (RD-19500 to RD-29500) was studied in this research work which encompass the three bridges (Jamali By-Pass at RD-20657, Sukker-Quetta national highway at RD-24825 and a railway track RD-23190) where section constriction is envisaged and for which flow hydraulics is likely to be affected by the proposed constrictions of Hairdin Carrier Drain. The objective of this study was to evaluate the hydraulic situation (backwater) developed due to the proposed constrictions and to mitigate the potential scour problems.

Computer model HEC-RAS 4.1.0 was used to calculate the hydraulic situation upstream and downstream of the constricted bridge structures and then compared with hydraulic situation of the bridge structures without constriction. For estimation of back water affect, first the HEC-RAS computer model without proposed constrictions was calibrated and water surface profiles were drawn. Then computer model with the proposed bridge constrictions was developed. Then the water surface profiles with due to the proposed constriction were compared with the water surface profile without constriction.

The simulated results of HEC-RAS computer model showed that the water levels at the cross sections upstream of the bridge structures rise due to constriction of flow. The water afflux was not significant and found as 0.12 m, 0.1 m and 0.06 m for the bridges of Jacob-Abad to Dera Allah Yar Road (RD-24825), Railway crossing (RD-23190) and Jamali By Pass (RD-20657) respectively. Water afflux due to proposed bridge constrictions vanishes quickly within 3-5 km of drain length. The flow velocities at the three bridge structures of the selected study reach increases due to the proposed constricted geometry as compared with the

geometry without constriction. The maximum flow velocities in constricted sections were found as 0.87 m/s (without constriction = 0.51 m/s), 0.89 m/s (without constriction = 0.50 m/s) and 0.89 m/s (without constriction = 0.49 m/s) for the bridges of Jacob-Abad to Dera Allah Yar Road (RD-24825), Railway crossing (RD-23190) and Jamali By Pass (RD-20657) respectively.

The scour at bridges increases due to the proposed constriction in the channel geometry as compared with the existing geometry when there is no constriction. HEC-RAS bridge scour analysis over predict the magnitude of total scour depth. The maximum total scour (contraction scour plus abutment scour) was found as 3.90 m, 3.56 m and 4.05 m at bridges of Jacob-Abad to Dera Allah Yar (RD-24825), Railway crossing (RD-23190) and Jamali By Pass (RD-20657) respectively which is about 3-4 times the scour depth found by the Lacey's scour formula. Lacey's scour depth results shows that scour depth at the non-constricted sections found to be negative (i-e no scour) and at the bridge structures it was found to be 0.96 m, 0.97 m and 0.95 m for the bridge structures of Jacob Abad to Dera Allah Yar Road Bridge (RD-24825), Railway Bridge (RD-23190) and Jamali By Pass Road Bridge (RD-20657). Stone apron need to be provided near bridges to counteract scouring. The size, thickness and length of the stone apron upstream and downstream of the bridge structures were found to be 200 mm, 400 mm, 70 m and 100 m respectively for all the bridge structures. The size, thickness and length of the stone apron upstream and downstream proposed by the consultant are 225 mm, 450 mm, 70 m and 100 m respectively for all the bridge structures which is acceptable.