International Journal of Engineering Research
Volume No.5, Issue Special 1 pp : 188-191

ISSN:2319-6890(online),2347-5013(print)
8 & 9 Jan 2016

Flood Analysis Of Dhudhana River In Upper Godavari Basin Using HEC-RAS

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Abstract:The present study focus on calculation of surface water elevations on downstream side of upper catchment of Dudhana River for different amount of discharges, and also includes determination of flooding area at different amount of the discharge from dam. Hence, stimulate the critical situation of flood and its impact on Dhudhana River basin on downstream side. USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS 4.1.0) model of given study area was prepared. Study reach consists of 21 cross sections. Hydraulics model, HEC-RAS is employed to evaluate flood conveyance performance and also uniform flow computation is carried out. In the present study, existing storm drains are not only marked but based on the HEC-RAS water surface elevation computation for various flood discharges, need of flood gates on the storm drains are also assessed. The recommendations are done based on this study either to increase height of bank or construct a retaining wall at certain sections along the study reach.
Keywords: Dhudhana River, Flood Analysis, HEC-RAS, Uniform flow

I. Introduction

An essential task of flood management is determination of an effective reservoir operation strategy that minimizes downstream flooding in River. Metha *et al.* (2014) studied the different cross-sections using HEC-RAS to check the adequacy of flood carrying capacity of Tapi River basin using past flood data. The HEC-RAS gives the easy prediction of possible effects of flood in surrounding area. The discharge for given basin was varied according to last previous discharge data available during floods or storms in the Tapi River using HEC-RAS with manning's constant as 0.030. Mohammed and Qasim (2012) studied the comparison of HEC-RAS and ADH to predict the flow profiles and head-discharge relationships and verified that with laboratory experiments. Qasim (2013) noticed that HEC-RAS had general tendency to overestimate water levels during high flows and under estimate during low flows.

Talreja *et al.* (2013) developed the model in HEC-RAS for one dimensional simulating flow and estimated the sediment transport capacity of study area. The results were compared with experimental study and HEC-RAS was validated for sediment transport. The Manning's coefficient was kept 0.021 and sediment relative density as 2.65 kg/m^3. Parhi *et al.* (2012) studied the sensitive parameter in development of hydraulic model for flood forecasting and flood plane mapping. Unsteady, gradually varied flow simulation model, on finite difference solutions of Saint-Venant Equation was used on Mahanadi River basin. For Flood Forecasting and flood plane mapping, various hydrodynamic models, based on hydraulic routing, have been developed and applied to different rivers in the past using computer technology and numerical techniques.

Hameed and Ali (2013) studied unsteady flow model for Hilla River using HEC-RAS for prediction of appropriate Manning's coefficient values. Manning's roughness coefficient 0.027 gives appropriate results for computed hydrograph in study area.

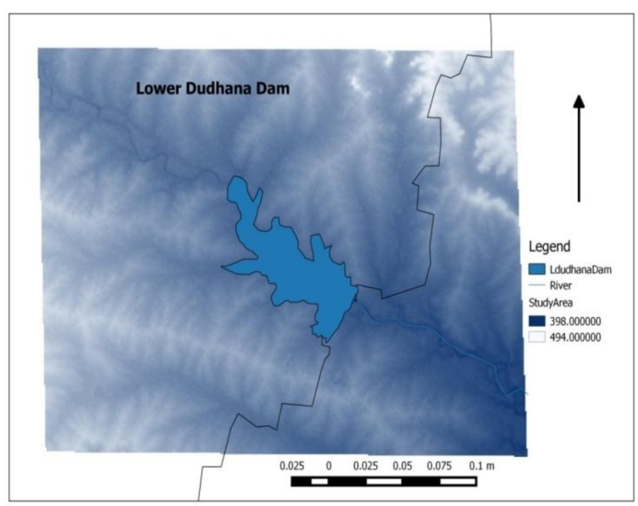
The U.S. Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS 4.1.0) model can perform three types of calculations: (1) steady flow, (2) unsteady flow, and (3) movable boundary flow. The steady flow component uses the standard step method for the solution of steady gradually varied flow. The unsteady flow component uses a numerical solution of the complete equations of gradually varied unsteady flow, commonly referred to as the dynamic wave. The movable boundary component uses the sediment continuity and one of several sediment transport equations to calculate river bed aggradations and/or degradation.

Objective

The Main objective of Study is to carryout steady flow analysis on the Dudhana River and to calculate the water head difference on downstream side of dam at different discharges. The study focuses to check the destruction rate in nearby areas at different amount of the discharge from dam. Hence, stimulate the critical situation of flood and its impact on Dhudhana River basin on downstream side.

II. Study Area

The Dhudhana river basin, a part of the upper Godavari basin under hydro-meteorological subzones 3e, lies between 19.6022 N' to 19.4766 N latitudes and 76.3118 E to 76.5101 E longitudes and is located in the Marathawada region of Maharashtra. DEM of Study area is prepared and shown in figure 1, using Q-GIS software.



III. Model Description

HEC-RAS 4.1.0 is open source soft-tool available on US Army Crop website. Software is capable of performing the steady gradually varied flow on river and channel geometry. In the present study, steady gradually flow stimulation model has been used to perform one dimensional hydraulic calculation for full network of natural river bed. Figure 2 shows the methodology of model performance. Figure 3 represent the default conveyance subdivision of section in HEC-RAS. The Left bank and Right bank elevation are required for steady flow analysis using roughness coefficient.

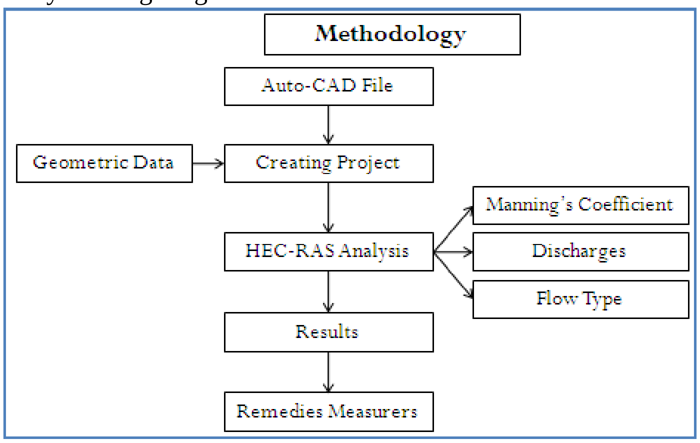


Fig 2. Flow chart of steady flow HEC-RAS Modeling

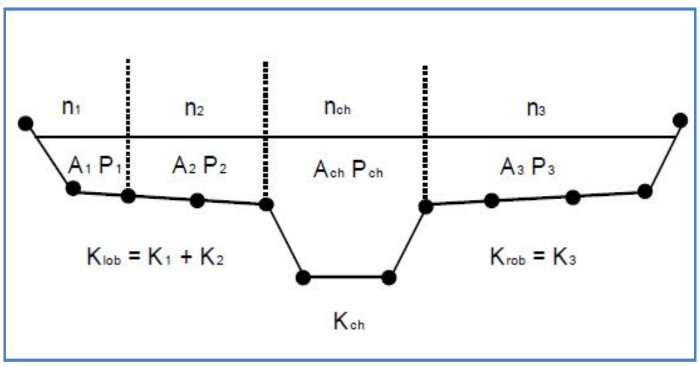


Fig 3. HEC-RAS Default conveyance subdivision method

Geometric and Hydrologic Data

The river geometry, boundary conditions and basin resistance are required for conducting flow simulation through HEC-RAS 4.1.0. Water Resources Department has provided the geometric data of the reach for present study as contour map in Auto CAD (.dwg file) format. The cross-section data at 50 meter intervals exceeding over a length of 1100m has been provided. Data includes the station and elevation coordinates, reach length, channel width at the sections, manning's coefficient and contraction/expansion coefficient. The flood hydrograph has been used for validation of the model.

Simulation of flow for different value of Manning's "n"

In the present study, effort has been made to calibrate Manning's roughness coefficient for single value of using aforesaid data and subsequently, different values have been used to justify their adequacy for simulation of flood in the study reach. Perceptive view of interpolated cross-section and field cross-section are as shown in Figure 4. For given study manning's roughness coefficient is taken as 0.030 for each section.

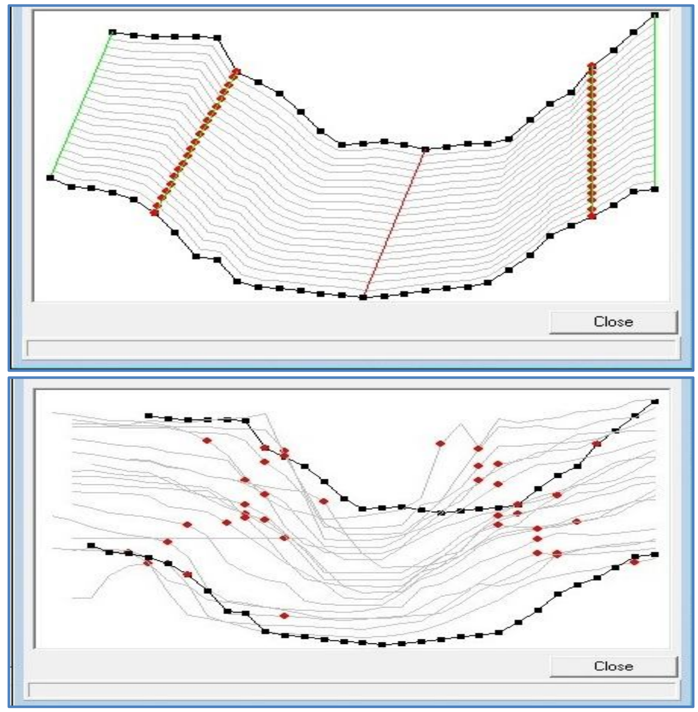
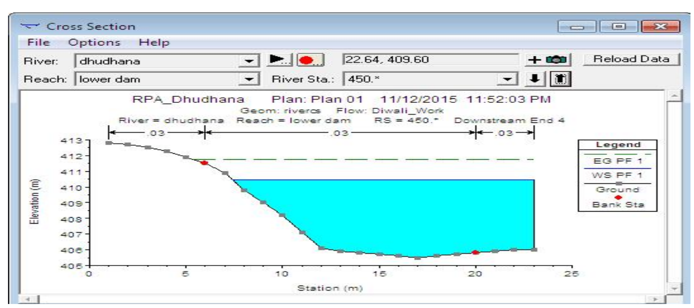
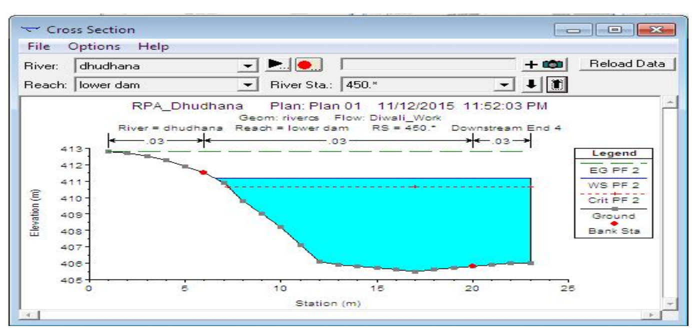


Fig 4. XYZ Perceptive View of Interpolated C/S and Field C/S

Simulation of flow for different value of discharge

In this section, the results on Dudhana River have been discussed. The readings on 21different cross section have been taken. To study the flow of river in the basin we have taken three different discharges Q_1=3000m³/s, Q_2=4000m³/s, Q_3=5000m³/s.





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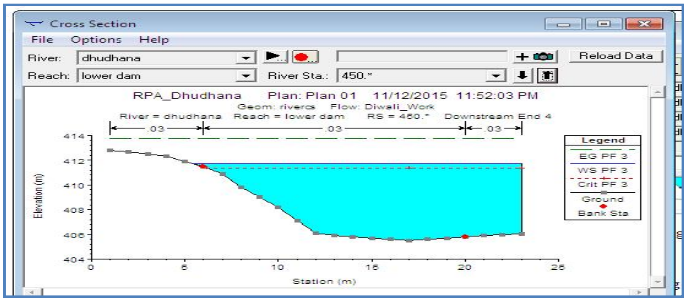
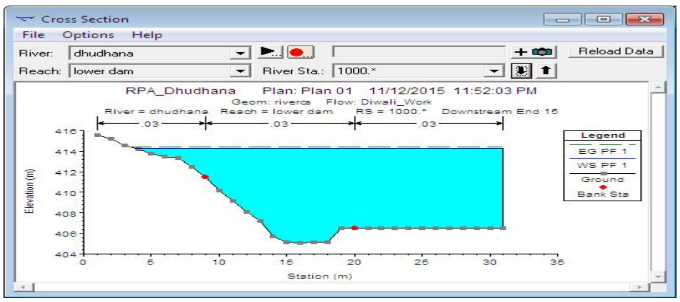
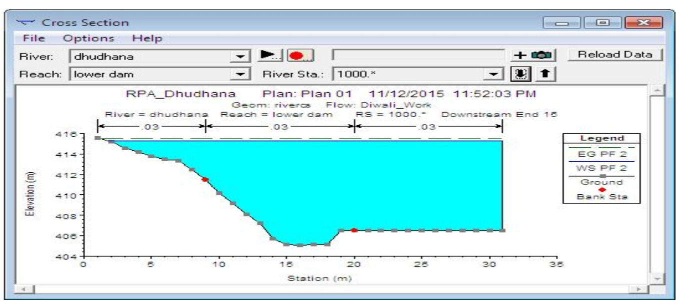


Fig 5. Graphical results of cross section 4 at Q_1, Q_2, Q_3 discharges respectively





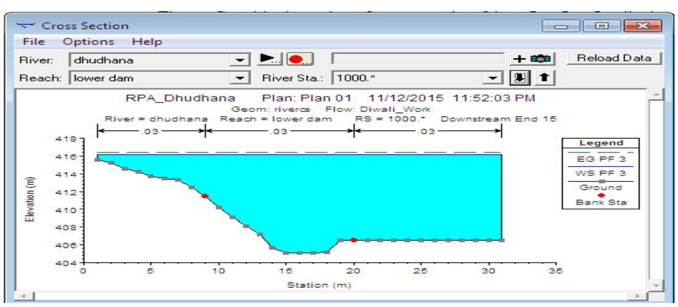
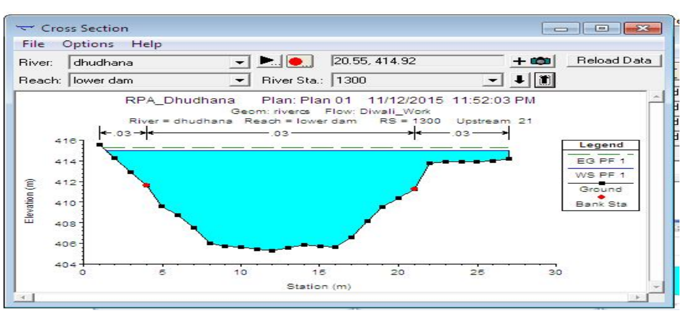
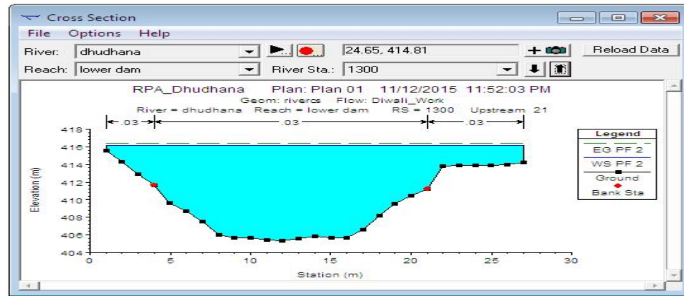


Fig 6. Graphical results of cross section 15 at Q_1, Q_2, Q_3 discharges respectively





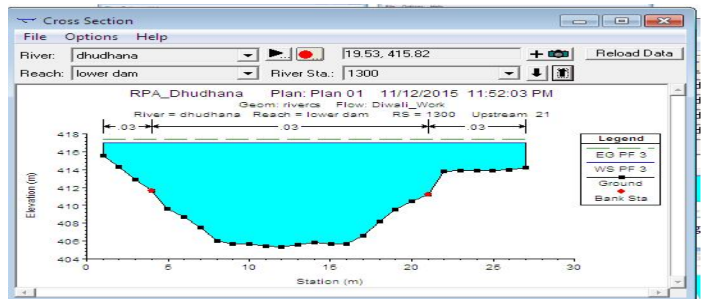
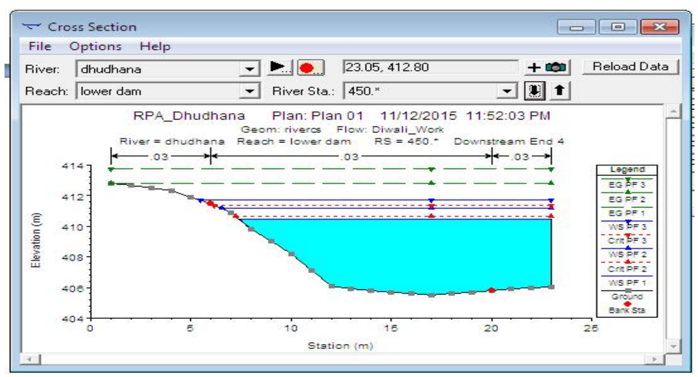


Fig 7. Graphical results of cross section 21 at Q_1, Q_2, Q_3 discharges respectively

The cross section of 3, 15 and 21 with different discharge are seen in figure 5, 6 and 7 respectively. The study states that cross section 4 and 15 are to be repaired, as the elevations of left end bank is lower with respect to other banks. The normal discharge 200 m³/s can cause the flood in nearby area for these sections. These banks are to be repaired to get the flooded discharge to flow without disturbing the village near river banks.



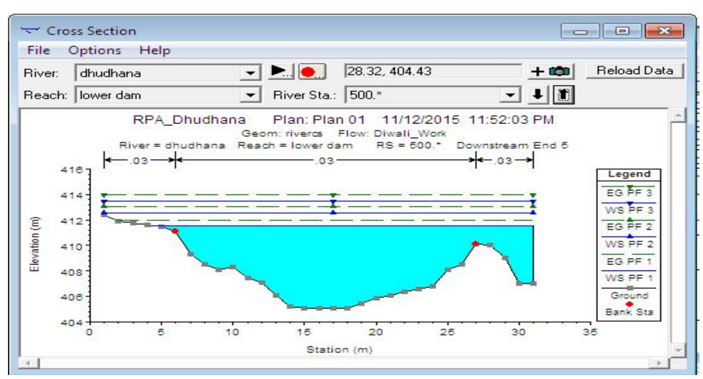


Fig 8. Cross-section profiles of Section 3 and 4 respectively for three different discharge

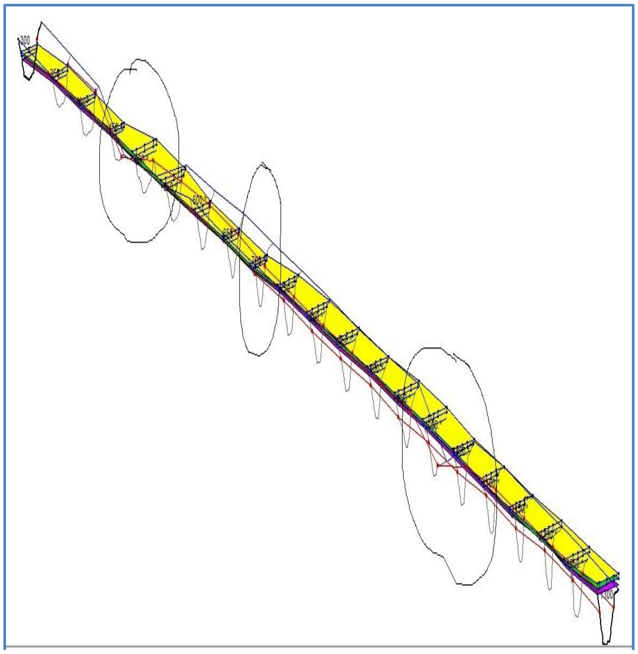


Fig 9. Perceptive Plot in 3-D view

The cross section of section 3 and 4 for three different discharges are shown in figure 8. The figure 9 shows the X-Y-Z perceptive plot for three different discharges. The Circle shows the sections of river bank are under floods. The level of water flow is suddenly decrease or increased in this section as discharge increases which represent the change in the water level leading to flood in surrounding area. The precautions which are to be given for given study are marked with circle in Figure 9.

IV. Conclusion

On the basis of river cross sections, hydrologic data of river, one-dimensional mathematical model (HEC-RAS) was carried out to estimate the flood level in the river for given discharge. 3D view of perceptive plot for three different discharges for given study area are shown in figure. Based on the studies, the level of embankment of section 3, section 15 and section 21, should be increased. The performance of calibrated model has been verified for previous discharges from dam in last year records. Furthermore, model can be geo-referenced with Google earth and flooding can be highlighted on Google map.

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