SIMULATION DRIVEN HYDRAULIC DESIGN OF BRIDGE

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ABSTRACT

For designing of bridge different designing criteria's are considered like waterway design, site selection and scour calculation for foundation design also design of other components of bridge such as guide banks approach protection work etc.

We simulate mathematical model of bridge structure so as to minimize damage of structure by natural disaster which can occurs in future. Excessive scour can cause undermining of pier which can cause bridge failure by this paper we are putting light on simulation driven hydraulic analysis of bridge which considers software based approach of mathematical modeling. The software we using is one dimensional software designed by US Army corps i.e. HEC-RAS. This technology gives us a careful planning and deep study to minimize the risk which can be encountered in the actual construction which can lead us to loss of capital and time. We can simulate and run the bridge model in this software for various site condition and environment so that it can be feasible in extreme weather conditions.

Key words- Simulation, HEC-RAS, Scouring

I. INTRODUCTION

For the horizontal movement of vehicles and peoples to cross the obstacle like stream, river, nala, etc, A bridge is constructed. Collection and interpretation of hydraulic data is necessary for any type of bridge constructed across the water bodies. . Cost effectiveness and safety of project is achieved by suitable hydraulic approach. by mathematical modeling we can reduce the extent of uncertainty and minimize the risk. The structure is safe only if it is design considering all loading conditions . The hydraulic behavior changes as per flow conditions therefor we must simulate the project and carryout hydraulic analysis as per the flow conditions so that we will know about hydraulic behavior of the structure .

The main aim of our research is to carry out hydraulic analysis on the basis of which mathematical model can be prepared and analysis effect of different flow condition on the component parts of Bridge with the help of simulation.

A. Simulation

Simulation created with mathematical language can give us the idea about any system. Simulatory model created by software can analysis the results and predict the exact working behavior . The general idea about working of model converted into mathematical visualization. The conventional system can be replaced effectively for easement of user . The software uses mathematical equations to evaluate flow parameters.

B. HEC-RAS One Dimensional Software

This software developed by Mr. Grey W. Brunner (U.S. Army Corps of Engineers) at the division of Institute of water resource of Hydraulic Engineering Center. HEC-RAS has many field applications such as River flow analysis of steady and unsteady flow, Scour Analysis, temperature analysis of water, etc. HEC-RAS perform one dimensional analysis for simulation of different hydrological parameters such as flow analysis, sedimentation analysis, modeling for temperature variation in water etc. HEC-RAS come with a software package which includes integrated systems, graphic facilities, reporting facilities, management facilities, data

storage, and separate analysis facilities. Hence this software is used to perform multitasking operations of

analysis and design.

The HEC-RAS system performs following one-dimensional river analysis modules :

(1) Scour Analysis

(2) Water quality analysis

(3) Steady flow analysis

(4) Unsteady flow simulation

The advance feature of this software is by using same geometric data and input routines all four river analysis modules can be carried out . By using which various water surface profiles can be computed

II. NEED AND FUTURE SCOPE OF WORK

The different aspects of bridge such as design and analytical aspects are studied. In this research we predicted and analyzed the different behaviors of the river flow. The effect of behavior of river flow on different components is analyzed by systematic manner with following objectives:

1. To access different flow characteristics of River.
2. To explicate the modeling software
3. Hydraulic analysis using mathematical modeling
4. To analyze behavior of bridge components using simulation

CW&PRS provided us all data necessary for analyzing and studying above features. The software is very helpful for creating simulation and hydraulic calculation very accurately and effectively. The outcome of research is achieved by proper planning, analyzing and designing model. This software will help us to increase the speed of work and guide decision makers to complete the project within time.

Following is the future scope of this research work :

1. The flood discharge can be predicted before it occurs.
2. The Safety of bridge against flood can be achieved by designing hydraulic model.
3. Scour Calculation can be done by using various advance recording instruments.

III. PROCEDURE FOR CREATING MATHEMATICAL MODEL BY USING SOFTWARE

The Procedure for developing Mathematical model is as follow :

a) Preliminary Steps to start new project

b) Geometric Data input

c) Define Boundary Condition And Inputting Flow data

d) Simulate the hydraulic calculations

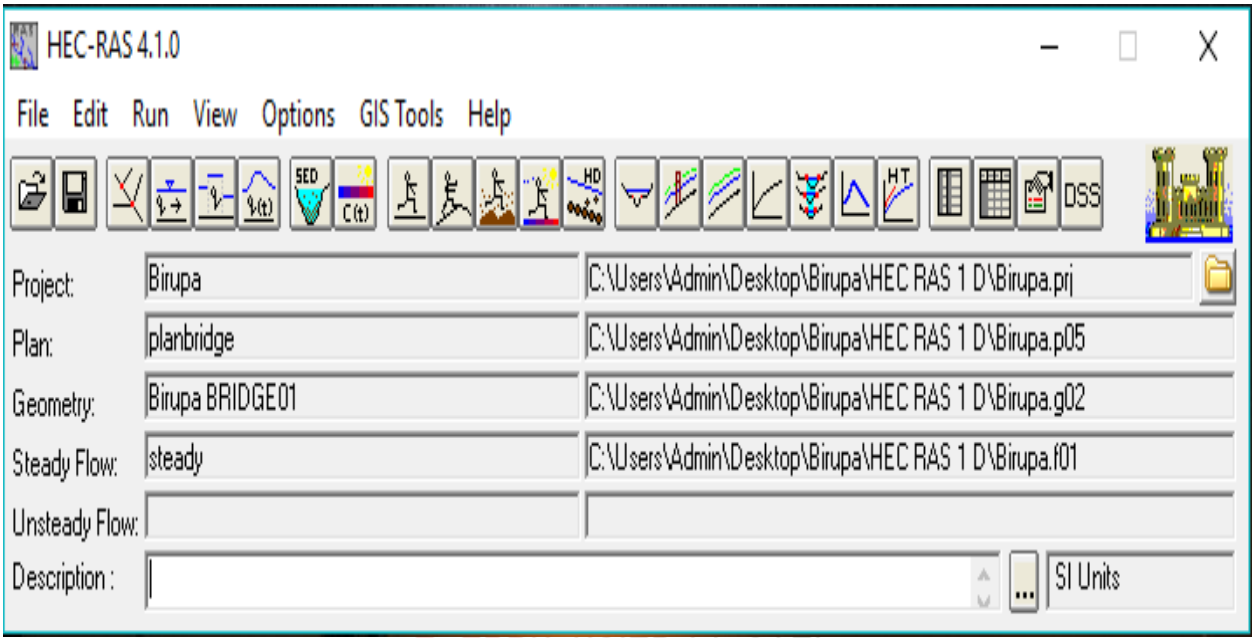
e) Evaluate the Output.

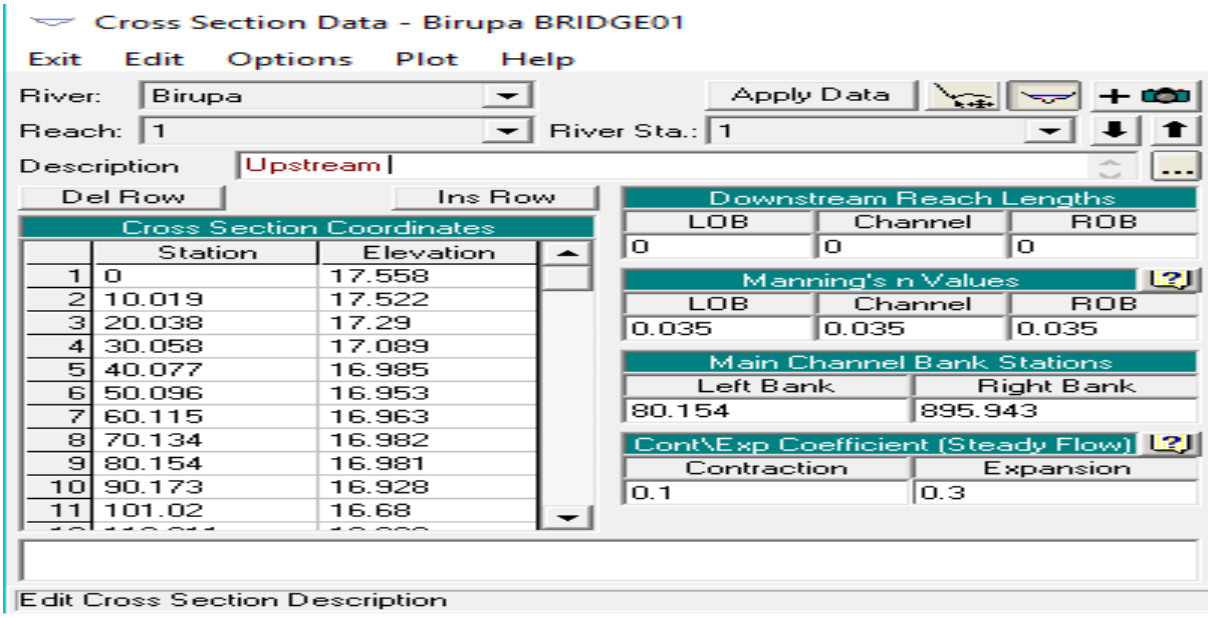
A. Preliminary Steps to start new project

For starting new project you have to give specific location in your drive in which your work will be stored and giving name to new project. To open new project open file menu and select new project which will navigate you to window as shown in fig given below.

B. Geometric Data input

For inputting geometric data go to edit menu in which first create new geometric data file . after that click on cross-section button on the left side of window . In cross-section window input river name then reach name and cross-section data of the site in required format. Details about every cross-section is entered in geometric data input window such as River name & station with its description and reach name & Data. After inputting geometric data we can add any hydraulic structure such as bridge, dam, spillway, etc.





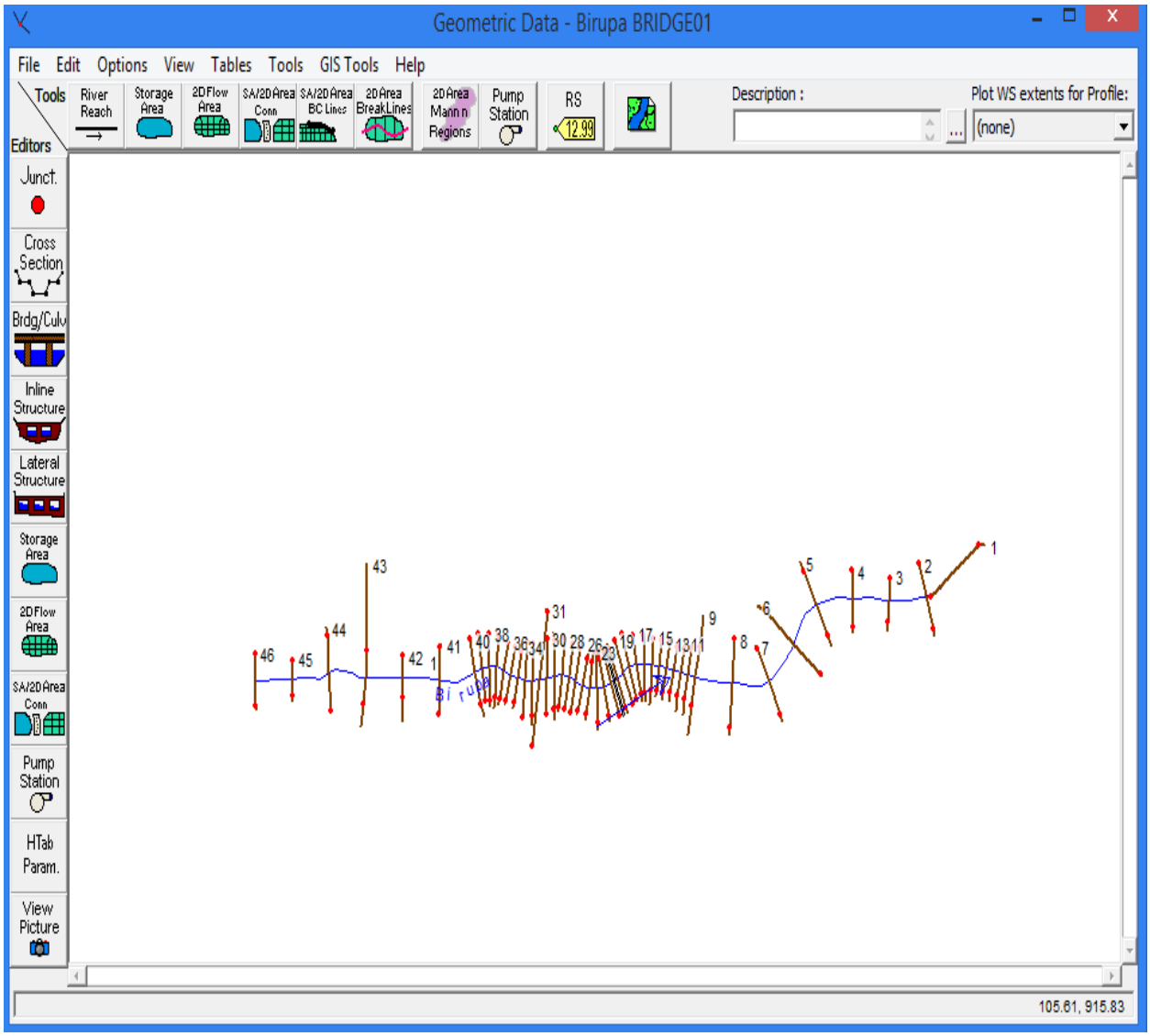


Figure 5. Cross-section Data Editor

C. Define Boundary Condition And Inputting Flow data

After finishing geometric data entry we have to run project for steady or unsteady flow . for which we have to define boundary condition so that software can perform various calculation . after that enter data of normal depth and critical depth so that software can run simulation

D. Simulate the Hydraulic Calculations

When we enter geometric and flow data in software we can begin performing hydraulic calculation . we have to select plan to run the system for steady flow calculation. After that we can click on steady flow analysis button after selecting flow regime.

E. Evaluate the Output

When software perform all the calculation on given data then the modeler can simulate to give result . In view menu we can obtain output in several options like water surface profile, xyz perspective plot, etc.

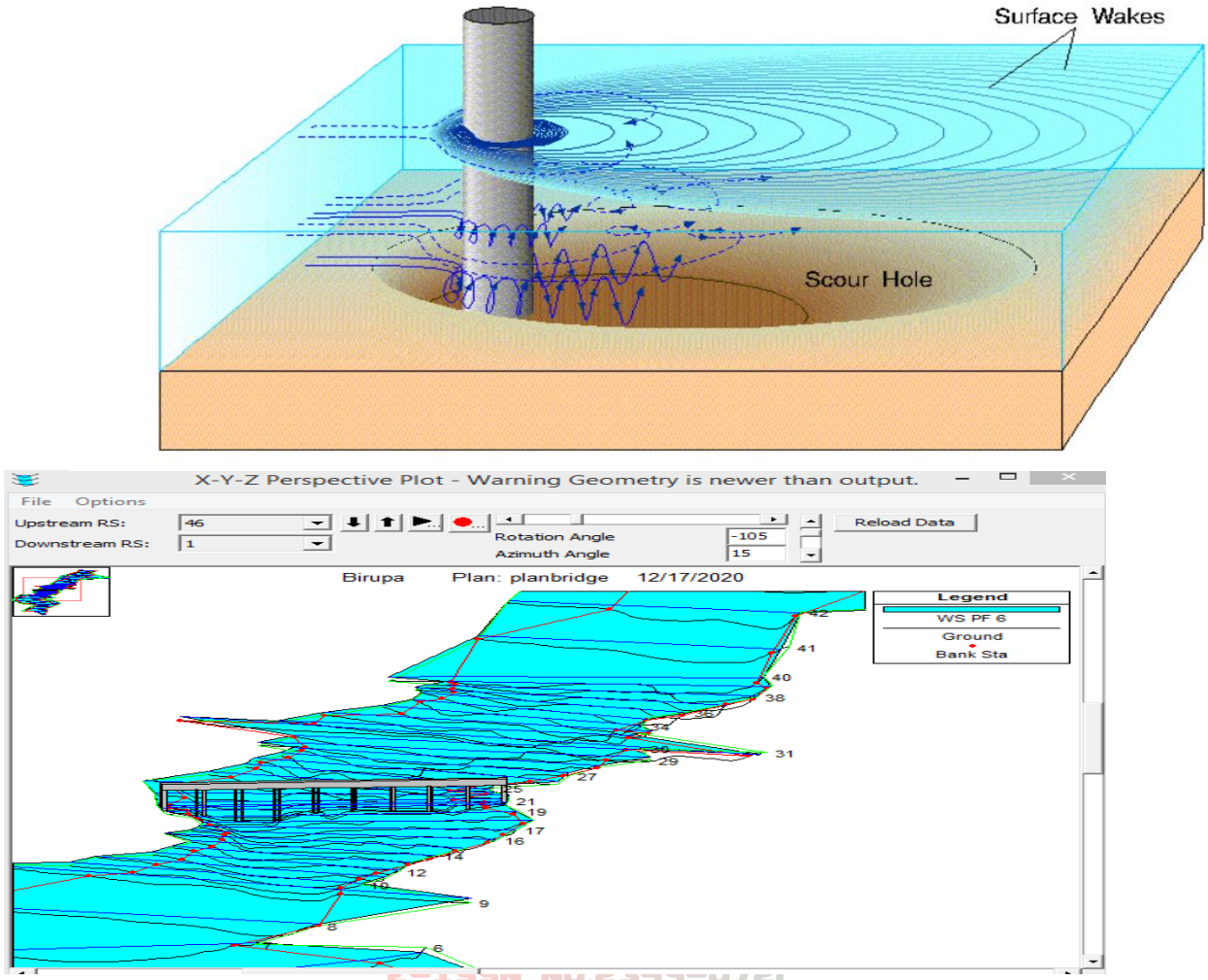


Figure 6. X-Y-Z Perspective Plot of River Reach with a Bridge

IV. SCOUR ANALYSIS

A. Introduction to scour :

The formation scour occurs due to sudden swift of moving water near the pier of bridge. Due to this scour hole can be formed near the bridge pier. Around 60% bridge structure fails due to scouring action without warning. Scouring is depends on Depth of flow, size and shape of pier, attacking angle of water and the characteristics of sediments in river bed. We estimate scour depth so as to provide sufficient depth to pier which gives anchorage to stabilize foundation.

B. Estimation of scour Depth:

The HEC-RAS is used to determine the water surface profile with which we estimate the scour depth near the bridge pier. By using scour depth in the bridge design we can reduce the construction cost of bridge foundation effectively. Scouring reduces the load carrying capacity of bridge foundation by eroding soil in river bed. Scouring also reduces flow area which can increase the velocity for constant discharge which leads to increase in shear stress over river bed

C. Design of scour depth:

In India for estimating scour depth Lacey-Inglis method is commonly used and it is recommended for Indian Road Congress and Indian Railways. This method gives the relation between Depth (D) and perimeter (P) of the channel as following :

$$DLQ = 0{\cdot}47(Q/f)\ 1/3\ , \quad \text{……...(1)}$$

$$P = 4{\cdot}75\ Q. \quad \text{...…..… (2)}$$

Here, DLQ = the normal scour depth in m below the design flood level,
Q = the design flood discharge in m3/s and
f =the Lacey's silt factor related to the median size of bed material
$= 1{\cdot}76\sqrt{d}$ …….. (3)

CONCLUSION

In this study we focused mainly on design of bridge by using software. There are number of causes of bridge failure in which excessive scouring can cause bridge failure without warning. By using this software we can compare, analyze and evaluate water level data up to 100 years. The simulation of bridge model gives us the warnings so that we can prevent and minimize the damage which can occurs in future. We can avoid instant failure of bridge structure caused due natural calamities. This paper mainly focuses on the software based approach for planning & designing of the bridge. The simulation of bridge model gives us clear idea about operations and maintenance strategies of component of bridge up to foundation of pier. Hence by our experimental study we can conclude that by using simulation of bridge model in hydraulic analysis by using HEC-RAS software we can effectively plan and manage lifecycle of bridge and achieve cost effectiveness.

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