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ESTIMATION OF HYDROLOGICAL AND HYDRAULICS PARAMETERS FOR BRIDGE DESIGN

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Abstract - Estimation of hydrological and hydraulic parameters viz. Peak Flood Discharge (PFD) and High Flood Level (HFL) at a point of interest are the most important factors for the safe design as well as economic viable of hydraulics structures viz., bridge, culvert, underpass, etc. Estimation of PFD consists of various components such as delineation of catchment, estimation of physiographic parameters (viz., length of stream, unified slope, area, land use etc.), extreme value of rainfall and adopting suitable rainfall-runoff model for estimation of flood. The one dimensional (1-D) mathematical model (steady state condition) is adopted for hydraulic routing through the existing stream network of estimated peak flow. From the 1-D model results, HFL are estimated with suitable free board. In this project work, appropriate bridge location is selected as per the IRC (Indian Road Congress) guidelines on Mutha River, which is the upstream of Rajaram Bridge located at Pune. The design parameters of hydrologic and hydraulics aspects are estimated with respect to the location point of interest at the bridge.

Keywords : Arc GIS software , 1-D HEC-RAS (Hydrologic Engineering Center's - River Analysis System) Model , HFL, Bridge Level , DEM (Digital elevation model) , Rainfall .

I. INTRODUCTION

As the many of bridge are very expensive structures. Millions of rupees are spent on bridges, but most of them does not last longer .If hydrological study and hydraulics study is not carried out properly bridge can be fail due to such reason. Presently, there is no bridge in between Warje Bridge to Raja ram Bridge; therefore, there is congestion of traffic on Sinhgad road stretch. In this regard, there is urgently needed a 2 Lane Bridge across the Mutha river to divert the traffic to Nal Stop (i.e. Karve Road) via DP Road from Sinhgad road. In this project work, a bridge is Proposed to reduce the traffic congestion on Sinhgad Road. The location of bridge was selected as per IRC guidelines on Mutha River, which is upstream of Raja ram Bridge, Pune and estimated hydrological and hydraulics parameters for different bridge design periods. The bridge located in between Sun City and Warje NH Bridge. The geographically co-ordinates of the bridge is longitude $75^0$48'55.5" E and latitude $18^0$28'49.55"N. The location of map is shown in Figure xx. In the present study, methodologies used for measuring and estimating the discharge is based on the catchment is by method are:

A] Rational method

II. OBJECTIVES

A. To study the bridge parameter

B. Flood management i.e., to assist the protection of life, property and community infrastructure from flood hazard.

C. To maintain the unobstructed passage of flood water.

D. To improve transportation facility.

III. SCOPE OF STUDY

By using Arc-GIS tool for delineation of catchment area of steady reach and estimation of physiographical parameter .

This study is used to estimate peak flood discharge and to fix different levels (Bridge level and Highest flood level (HFL).

Flood Routing model 1-D HEC-RAS (Hydrologic Engineering Center's -River Analysis System) with steady state condition

IV. METHODOLOGY

A. Google map: Google Maps is a web mapping service developed by Google. It offers satellite imagery, street maps, 360° panoramic views of streets (Street View), real-time traffic conditions (Google Traffic), and route planning for traveling by foot, car, bicycle (in beta), or public transportation. Google earth map is a computer program that renders a simulacrum of the Earth based on satellite imagery. It maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and geographic information system (GIS) onto a 3D globe.

FIG.NO 1

B. ArcGIS software: ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database. The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

C. Dem map: digital elevation model (DEM) is a digital model or 3D representation of a terrain's surface commonly for a planet (including Earth), moon, or asteroid created from terrain elevation data. A DEM can be represented as a raster (a grid of squares, also known as a height map when representing elevation) or as a vector-based triangular irregular network (TIN). The TIN DEM dataset is also referred to as a primary (measured) DEM, whereas the Raster DEM is referred to as a secondary (computed) DEM. DEMs are commonly built using data collected using remote sensing techniques, but they may also be built from land surveying. DEMs are used often in geographic information systems, and are the most common basis for digitally produced relief maps. While a DSM may be useful for landscape modeling, city modeling and visualization applications, a DTM is often required for flood or drainage modeling, land-use studies, geological applications, and other applications.

D. Calculation of Flood Discharge using different methods:

1. RATIONAL METHOD:

The rational method is found to be suitable for peak flow prediction in small size (<50km^2) catchments. It finds considerable application in urban drainage designs and in the design of small culverts and bridges. At the start of a rainfall event, the portions nearest the outlet contribute runoff first. As rain continues , farther and farther portions contribute runoff, until flow eventually arrives from all points on the watershed ‘‘concentrating’’ at the outlet .An isochrones is a line on the catchment joining points having equal time of travel of surface runoff from the point to the catchment outlet . An isochrones is a line on the catchment joining the points having equal time of travel of surface runoff from the point to the catchment outlet. A catchment can have infinite number of isochrones but the time of concentration isochrones is the last isochrones on the catchment. For a rainfall of uniform intensity and very long duration over the catchment the runoff increases as more as flow from remote areas

of the catchment reach the outlet. If the rainfall continues beyond the of concentration (t > tc) , the runoff will be constant and at the peak values (Qp) equal to

Qp = CIA

Where i = rainfall intensity; A-catchment area; C-runoff coefficient-runoff rainfall.

2. ESTIMATION OF PEAK FLOOD AND FLOOD ROUTING:

Estimation of peak flood from catchments required its area and extreme value of rainfall. It is observed that, the most part of the study area is situated in urban of Pune City. It is mentioned that, no detailed maps (i.e. Survey of india, toposheets) were available for delineation of catchments during project work. Therefore, latest Google Earth images and NRSC DEM data used for delineation of catchments by adopting ArcGIS software and estimated of physicological paremeters. The sub-catchments that contribute flood flow in Mutha river, which is the upstream of present proposed bridge to Khadakwasla dam. The delineated catchment map shown in Figure xx. 24-hr Extreme value of rainfall (mm) was taken from Maharashtra Isopluvial Maps of 25-yr, 50-yr and 100-yr return period.

The left bank stream catchments of Mutha River are coded as LB-1, LB-2, LB-3, and LB-4. Similarly, for right bank stream catchments are RB-1, RB-2, RB-3, and RB-4. The areas of sub catchments are presented in Table 1. The PFD of sub-catchments for different return periods are computed by using rational formula , which is given below :

Q = 0.278*CIA

Where , Q is peak flood discharge (m^3/s) , C is runoff coefficient, I is rainfall intensity (cm/h) and A is the catchment area (Ha). By considering topography of the project work area, the value of C is considered as 0.80 while computing the flood discharge. The estimated peak flood discharge for different return periods for sub-catchments are also presented in Table2.

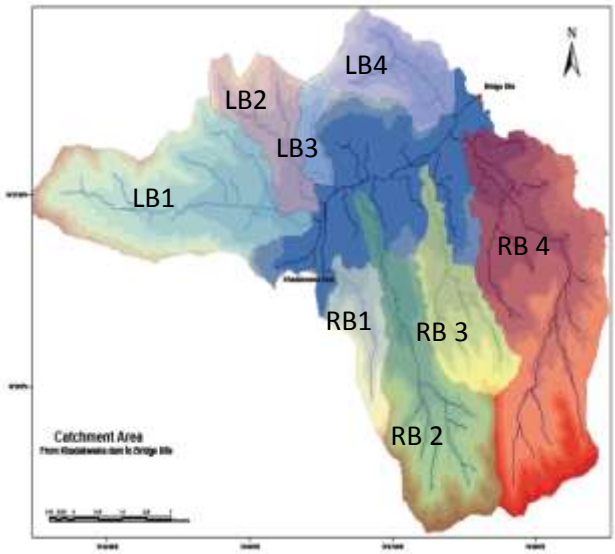

FIG NO 2 : Catchment area Map

SR.NO	CATCHMENT	AREA	
		M^2	Ha
1.	Total catchment	10833422	10833.422
2.	LB1	19484462	1948.4462
3.	LB 2	6431773	643.1773
4.	LB 3	2047577	204.7577
5.	LB 4	6856707	685.6707

6.	RB 1	4303974	430.3974
7.	RB 2	15486803	1548.6803
8.	RB 3	7653582	765.3582
9.	RB 4	27573582	2757.3582

Table 1: Catchment Areas

SR No.	Catchment	Catchment Area [ha]	Peak flood discharge (m^3/s)		
			25-yr	50-yr	100-yr
1.	LB1	1948.446	91.654	104.748	144.029
2.	LB2	643.177	30.255	34.577	47.543
3.	LB3	204.757	9.631	11.007	15.135
4.	LB4	685.670	32.253	36.861	50.684
5.	RB1	430.397	20.245	23.138	31.814
6.	RB2	1548.680	72.849	83.257	114.47
7.	RB3	765.358	36.002	41.145	56.575
8.	RB4	2757.901	129.731	148.264	203.864
9.	Total Catchment	10833.422	509.604	582.404	800.806

Table 2: Estimated peak flood discharge for different return periods for catchment

3. FLOODROUTING AND ESTIMATION OF HIGH FLOOD LEVEL:

Moderation of flood wave as it traverses through the channel could be studied by flood routing .Flood routing in river channels could be performed using hydrologic or hydraulics routing (viz,1D or 2D)models based on the available data and the requirements of the project. In the present study, 1-D HEC-RAS model steady state condition was adopted for flood routing of Mutha River.

V. RESULTS

Utilization of the Arc GIS software & 1-D HEC-RAS (Hydrologic Engineering Center's – River Analysis System) Model, for estimation of peak flood discharge and HFL . Peak discharge for 100 year design estimation:

METHODS	FORMULAE	RESULT
Rational method	Q = 0.028CiA	800.806 m^3/s

Therefore, Peak discharge = 800.806 m^3 /sec

VI. CONCLUSIONS

In the present study of Mutha river is often selected as a rational investigation. According to our discharge calculation we obtain peak discharge as Q=800.806 m^3/sec.

Bridge is located at chainage **7785.5m** from Khadakwasla dam.

The highest water level (HWL) at bridge location = **554.57m**

Estimated flood at the bridge location are **3575.57 m^3/s**

Flood routing model 1-D HEC-RAS with steady state condition was adopted for the study assessment for removal of bunds.

SR.NO	CROSS-SECTION ID(m)	RIVER STATION ID (m)	INVERT ID (M)	HWL (m)
1.	7740	400	544.93	554.55
2.	7500	390	545.71	554.59

VII. REFERENCES

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