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# Hydrological Analysis for Proposing New Bridge at Vrishabhavathi River Valley, Laggere

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***Abstract: Bridges are very expensive structures. Millions of rupees are spent on bridges but most of them do not last longer, if hydrological study is not carried out properly. Therefore, there is a need to carryout hydrological and hydraulics study for a bridge and then to apply whatever the conclusion from the study is derived to a real world scenario.***

***The study area chosen for the present study is vrishabhavathi river valley at Laggere lied geographically between 77˚23'45" E - 77˚34'16" E latitude and 12˚45'00" N & 13˚02'40" N longitude and toposheet number 57G/12, 57H/9, 57H/5. At Laggere, there already exists a two-lane bridge but due to congestion because of increase in population, there is a need of four-lane bridge. Therefore another two-lane bridge has to be proposed. Before starting construction, there is a need of hydrological studies. By the results obtained from this study, level at which bridge has to be constructed can be fixed, keeping in a view of suitable free board value.***

***Keywords: Morphometric analysis, Remote sensing and GIS, Runoff, High flood level, Bridge level.***

## I. INTRODUCTION

In hydrology, discharge is the volume rate of water flow that is transported through a given cross-sectional area.It includes any suspended solids (e.g. sediment), dissolved chemicals (e.g. CaCO3 (aqua)), or biologic material (e.g. diatoms) in addition to the water itself. Synonyms vary by discipline, for example, a fluvial hydrologist studying natural river systems may define discharge as stream flow, whereas an engineer operating a reservoir system might define discharge as outflow, which is contrasted with inflow. The units that are typically used to express discharge include $m^3/s$ (cubic meters per second), $ft^3/s$ (cubic feet per second or cfs) and/or acre-feet per day. The catchment of a river above a certain location is determined by the surface area of all land which drains toward the river from above that point. The river's discharge at that location depends on the rainfall on the catchment or drainage area and the inflow or outflow of groundwater to or from the area, stream modifications such as dams and irrigation diversions, as well as evaporation and evapotranspiration from the area's land and plant surfaces. In storm hydrology, an important consideration is the stream's discharge hydrograph, a record of how the discharge varies over time after a precipitation event. The stream rises to a peak flow after each precipitation event, then falls in a slow recession. Because the peak flow also corresponds to the maximum water level reached during the event, it is of interest in flood studies.

In the present study, methodologies used for measuring & estimating the discharge is based on the catchment area by three methods are:

*A.* Emperical method
*B.* Rational method
*C.* Synthetic unit hydrograph method

## II. OBJECTIVES

*A.* To study watershed parameters.
*B.* To prevent overtopping of flood water.
*C.* Floodplain management i.e., to assist the protection of life, property and community infrastructure from flood hazard.
*D.* To maintain the unobstructed passage of flood water.
*E.* To improve transportation facility.

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## III. SCOPE OF THE STUDY

*A.* RS and GIS are used to prepare thematic maps.
*B.* This study is used to determine flood discharge and to fix different levels (bridge level and Free board).

## IV. METHODOLOGY

*A. Collection of Geographical data*

1) *Topographic map:* In modern mapping, a topographic map is a type of map characterized by large- scale detail and quantitative representation of relief, usually using contour lines, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features. A topographic map is typically published as a map series, made up of two or more map sheets that combine to form the whole map. A contour line is a line connecting places of equal elevation. These maps depict in detail ground relief (landforms and terrain), drainage (lakes and rivers), forest cover, administrative areas, populated areas, transportation routes and facilities (including roads and railways), and other man-made features.

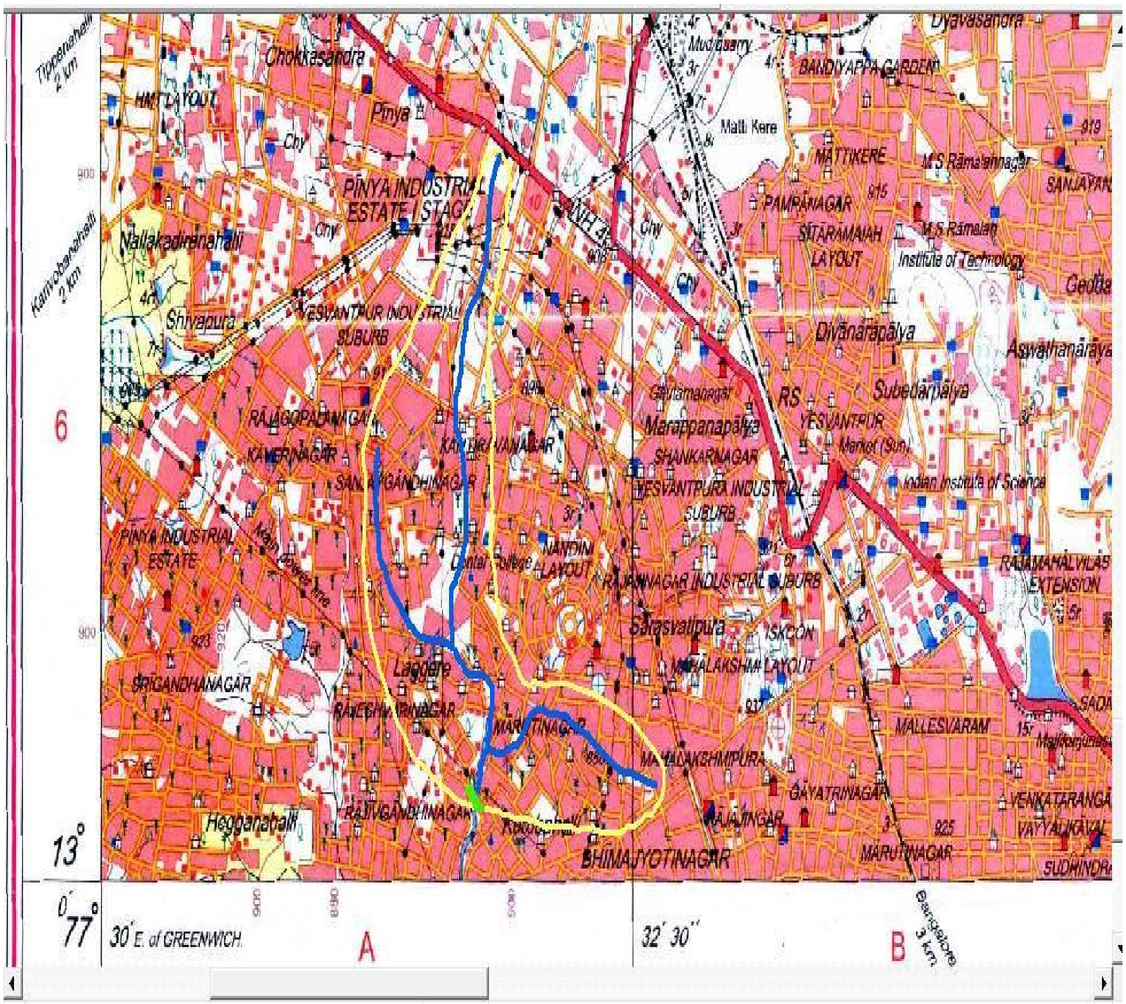


Fig 1: Toposheet Map

2) *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.

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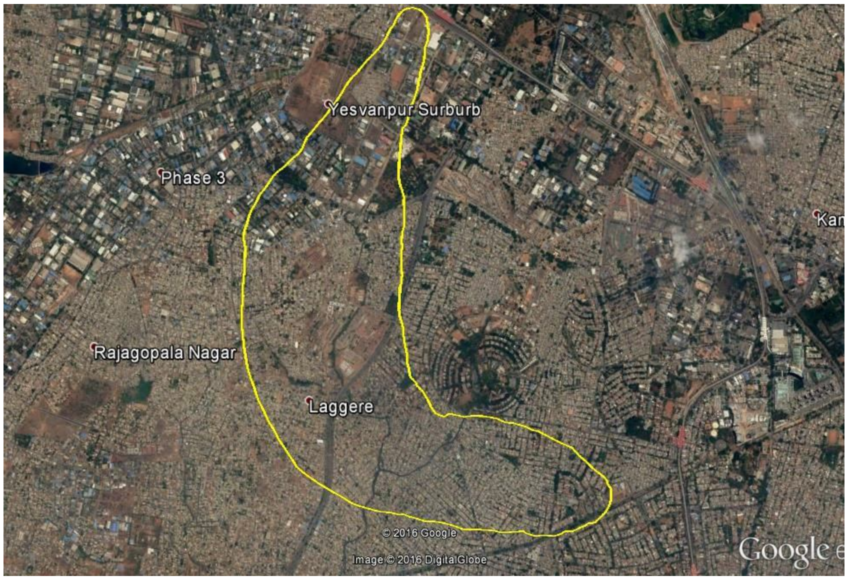



Fig 2: Google map

*B. Delineation of watershed*

1) *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.

2) *ArcGIS includes the following Windows desktop software*

*a)* Arc Reader, which allows one to view and query maps created with the other ArcGIS products;

*b)* ArcGIS for Desktop, which is licensed under three functionality levels.

*c)* ArcGIS for Desktop Basic (formerly known as ArcView), which allows one to view spatial data, create layeredmaps, and perform basic spatial analysis.

*d)* ArcGIS for Desktop Standard (formerly known as Arc Editor), which in addition to the functionality of ArcView, includes more advanced tools for manipulation of shape files and geodatabases

*e)* ArcGIS for Desktop Advanced (formerly known as ArcInfo), which includes capabilities for data manipulation, editing, and analysis. There are also server-based ArcGIS products, as well as ArcGIS products for PDAs. Extensions can be purchased separately to increase the functionality of ArcGIS.

ArcGIS Server has extensive functionality, can deal with terabytes of data, and uses a standards-based approach, making it ideal for providing GIS capabilities to a wide range of distributed users. People use ArcGIS Server to efficiently deliver GIS applications throughout and beyond their enterprise. ArcGIS Server integrates with the larger IT environment, so the benefits of spatially enabled information can be shared with a greater number of people at a lower cost.

*C. Preparation of Thematic maps*

A thematic map is a map that focuses on a specific theme or subject area. This is in contrast to general reference maps, which regularly show the variety of phenomena geological, geographical, political-together. The contrast between them lies in the fact that thematic maps use the base data, such as coastlines, boundaries and places, only as points of reference for the phenomenon being mapped. General maps portray the base data, such as landforms, lines of transportation, settlements, and political boundaries, for their own sake.

Thematic maps emphasize spatial variation of one or a small number of geographic distributions. These distributions may be physical phenomena such as climate or human characteristics such as population density and health issues. Barbara Petchenik described the difference as "in place, about space." While general reference maps show where something is in space, thematic maps tell a story about that place (e.g., city map).

1) *Location map:* A locator map, sometimes referred to simply as a locator, is typically a simple map used in cartography to show the location of a particular geographic area within its larger and presumably more familiar context. Thematic maps are sometimes referred to as graphic essays that portray spatial variations and interrelationships of geographical distributions. Location, of course, is important to provide a reference base of where selected phenomena are occurring.

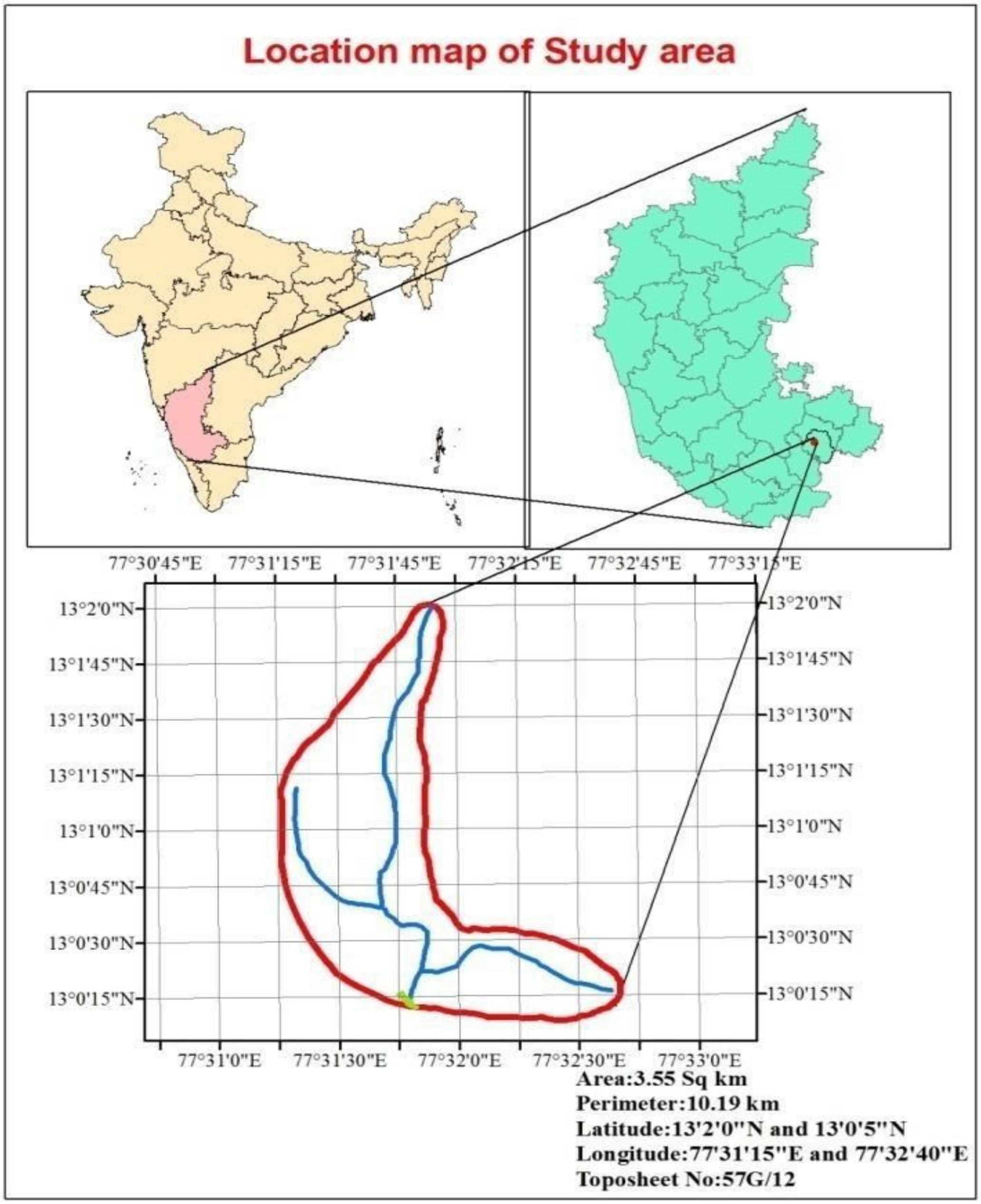



Fig 3: Location map

2) *Watershed map:* The geographic area that contributes runoff to a stream.It can be outlined on a topographic map by tracing the points of highest elevation (usually ridge crests) between two adjacent stream valleys.

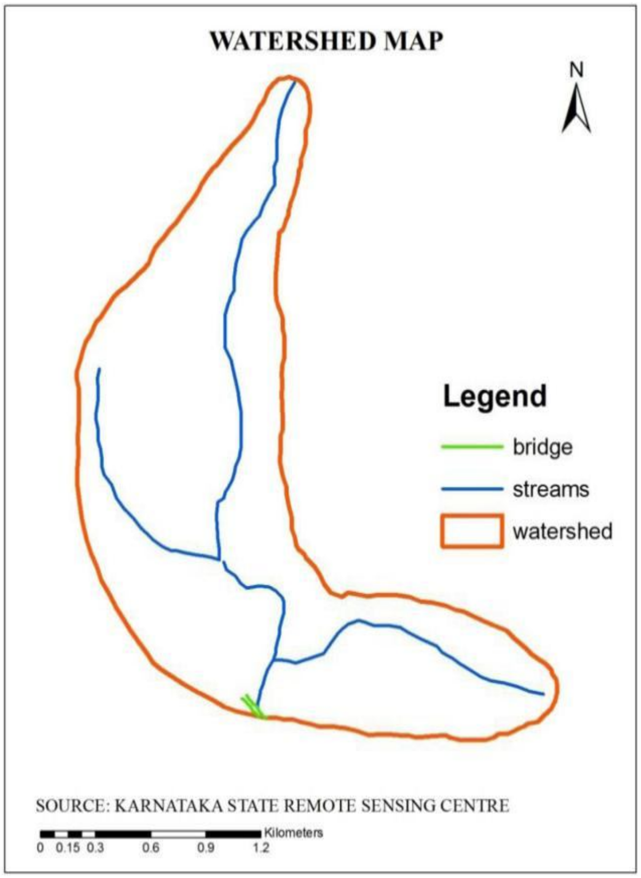



Fig 4: Watershed Map

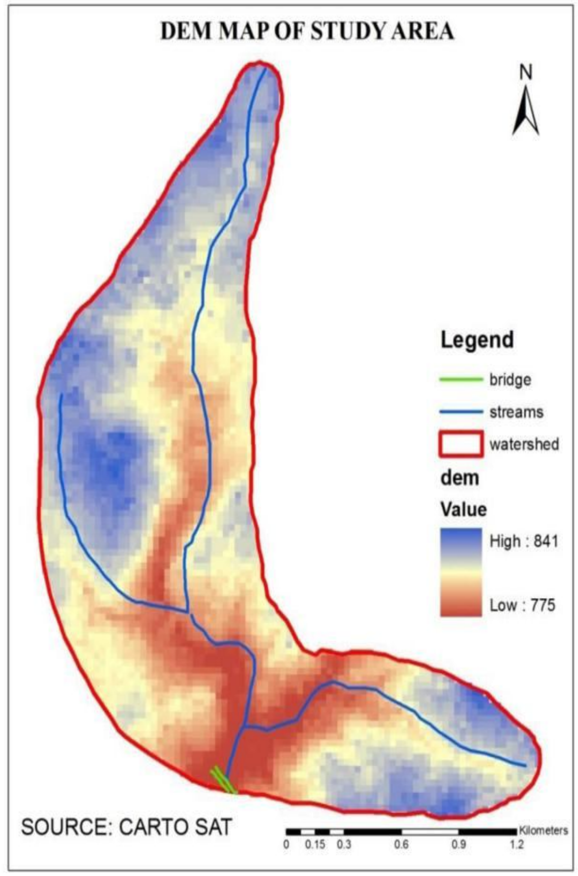



Fig 5: DEM map

3) *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. The DEM could be acquired through techniques such as photogrammetry, lidar, IfSAR, land surveying, etc. (Li et al. 2005). 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) *Empirical method:* The empirical formulae used for the estimation of the flood peak are essential regional formulae based on statistical correlation of the observed peak and important an catchment properties. To simplify the form of the equation, only a few of the many parameters affecting the flood peak are used. For example, almost all formulae use catchment area as a parameter affecting the flood peak and most of them neglect u flood frequency as a parameter. In view of these, the empirical formulae are applicable only in the region from which they were developed and when applied to other areas they can at best give approximate values.

$$Q = CA^{3/4} \text{(IRC: SP-13-2004, Cl.4.2)} \quad (1)$$

Catchment Area A = 3.552277 Sq. Km. Coefficient C = 14

C = 11 -14, where the annual rainfall is 60 -120cm.

C = 14 -19, where the annual rainfall is more than 120 cm. C = 22, in Western Ghats

Peak Runoff in m3/sQ = Peak discharge, cfs

C = Rational method runoff coefficient = 0.3 (Residential area) i = Rainfall intensity, inch/hour, 885mm = 6.25 inch/hr

A = Catchment area, acres =3.5522sqkm = 877.786 acres Q = 0.3(6.25) * (877.786)

Q = 1643.21 cfs

$Q = 46.53\ m^3/sec$

2) *Synthetic unit hydrograph method:* Synthetic unit-hydrograph methods are utilized to describe the entire unit hydrograph for a gaged watershed with one or two hydrograph parameters. These hydrograph parameters can be related to the characteristics of the watersheds and storms from which they were determined. Therefore, unit hydrographs may be estimated for ungaged watersheds with geomorphology, soils, land cover/land use, and climate similar to that for the gaged basins. Many synthetic unit-hydrograph methods have been proposed in the hydrologic literature. In this report, only three synthetic unit-hydrograph methods are considered: the Clark (1945) unit-hydrograph method, the SCS dimensionless unit-hydrograph method (Snider, 1971), and the linear-reservoir method. The first two methods are commonly applied for hydrologic design and analysis in Illinois. The third method is frequently applied for small watersheds in Du Page County, Ill, and was found to result in reliable unit hydrographs for watersheds smaller than 5 mi2 (Rao and others, 1972). Relations between hydrograph parameters for two synthetic unit-hydrograph methods and characteristics of Illinois watersheds have been developed in previous studies.

$$Q = 0.278\ CIA \qquad (3)$$

$Q$ = Discharge in $m^3/sec$ C = Runoff coefficient

I = Rainfall intensity in mm/hr

A = Catchment area in sqkm

$$C = X\ (R\ F)^{0.2} \qquad (4)$$

X= 0.249 (sandy soil or sandy loam or arid areas)

R = Rainfall in cm from fig given in the country = 16cm F = 0.8 for area 2.5 – 5.0 sq km

$$C = 0.249 * (16 * 0.8)^{0.2} = 0.41$$

$$Q = 0.278 * 85.5 * 3.552277 * 0.542 \qquad (5)$$

$Q = 35.80\ m^3/sec$

*E. Peak discharge*

Highest rate of discharge of a volume of water passing a given location during a given period of time. Discharge is estimated using above three methods and maximum value is taken as design discharge. For the same 30% discharge is increased as per IRC 78-2000, cl : 703.11.

*F. Fixing bridge level & free board*

Freeboard at a bridge is the minimum clearance between the bottom of the girders and the design highwater or ice elevation. In general, freeboard amounts have been provided at bridges in Alberta to allow passage of drift, debris, and ice at highwater levels, as well as to accommodate uncertainty in the design high water elevation or the possibility of an event more extreme than the design event. Assignment of fixed minimum freeboard amounts can result in lost opportunity to optimize a crossing, especially at sites where there are significant constraints on the gradeline due to existing infrastructure. Recent practice has accounted for potential to optimize a bridge opening by considering a range of freeboard amounts and selecting the optimal value. According IRC 5-1998 we have adopted the different levels for the above calculated discharge.

## V. RESULTS AND DISCUSSIONS

Utilization of the Arc GIS software, along with some other associated extensions, has resulted in delineating the watershed of Vrishabhavathi river valley, Laggere Command Area.

*A. Discharge*

Table 1: Discharge values

| METHODS | FORMULAE | RESULT |
|---|---|---|
| Empirical method (Dicken's Formula) | Q = CA^(3/4) | Q = 36.224 m3/s |
| Rational method | Q = CiA | Q = 46.53 $m^3$/sec |
| Synthetic unit hydrograph method | Q = 0.278 CIA | Q = 35.80 $m^3$/sec |

Therefore, Peak discharge = 46.53 $m^3$/sec
As per IRC 78-2000, cl : 703.11, increase discharge by 30% Therefore,
Q = 1.3 * 46.53
Q =60.489 $m^3$/sec

*B .Level fixation of bridge*

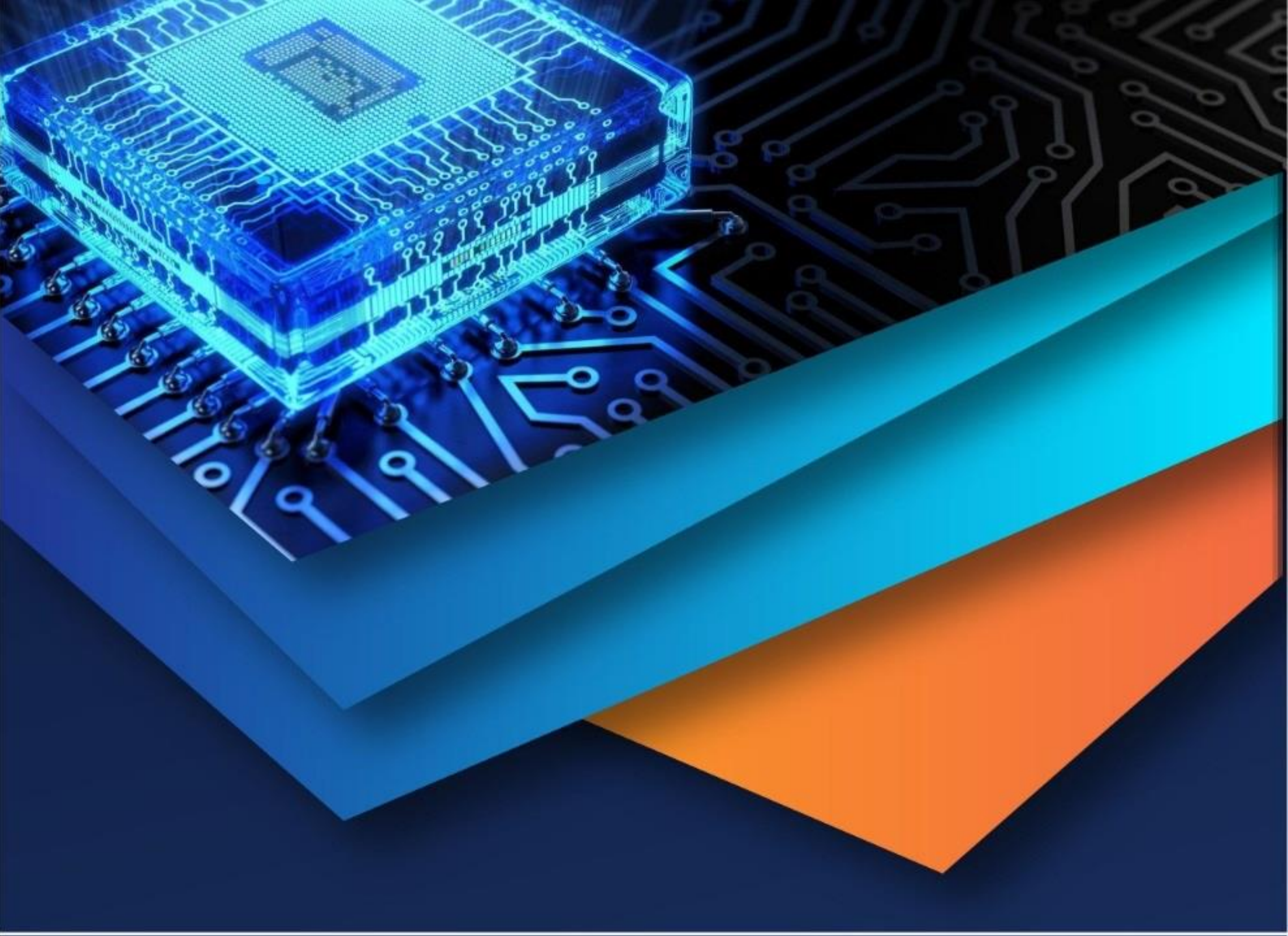
1) Finished road level at construction site = 93.110
2) Level at bridge should be constructed according to our project=94.669m
3) Existing road level = 85.562 m
4) Min pier height = 6.457m
5) Min free board= 1.750m ( IRC 5- 1998 cl :107.1)
6) Min vertical clearance=0.9m ( IRC 5-1998 cl:106.21
7) Therefore, level at which bridge to be constructed, 85.562+6.457+0.9+1.750=94.669m

## VI. CONCLUSION

In the present study Laggere command area is often selected as a unit of hydrological investigation. According to our discharge calculation we obtain peak discharge as Q=60.489 m3/sec. Hence under vicinity of our project we propose that bridge should be constructed at a height of 94.669m.

## REFERENCES

[1] Rafiq Ahmad Hajam, Aadil Hamid and SamiUllahBhat-A Case Study of Vishav Drainage Basin.
[2] Rudraiah, Govinaiah, Vittala., (2008), Morphometry Using Remote Sensing and GIS Techniques In The Sub-Basins of Kagna River Basin, Gulburga District, Karnataka, India, Journal of Indian society of Remote Sensing 36, 351-360.
[3] Sethupathi. A.S , Lakshmi Narasimhan C , Vasanthamohan V , MohanS.P, (2011), Prioritization of mini watersheds based on Morphometric analysis using Remote Sensing and GIS techniques in a draught prone BargurMathur sub watersheds.
[4] Ponnaiyar river basin, India, International Journal of Geomatics and Geosciences, 2(2), pp 403-414.
[5] Indian Roads Congress: SP:13 (1998) : Guidelines for the design of small bridges and culverts
[6] Lars Gottschalka, Rolf Weingartnerb (1998) : Distribution of peak flow derived from a distribution of rainfall volume and runoff coefficient, and a unit hydrograph.
[7] R. Sinha . G.V. Bapalu . L.K. Singh . B. Rath (2008) :Flood Risk Analysis in the Kosi River Basin, North Bihar Using Multi-Parametric Approach of Analytical Hierarchy Process (AHP).
[8] Noumankhattak, Salman afzal, Syed azmatali shah, Muhammad ejazshabab, Navidahmad. (2013) :Hydrological and Hydraulic Study of Bridges / Culverts.
[9] M S Adnan, N C Ali, Y Erfen, S N Rahmat, M A M Razi and S Musa (2016).



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