January – February 2020
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Hydrological Analysis Construction of Bridge

Pramod kumar Gangadhar[1] , Ranjitha[2],Sandesh Mysore Sathyaraj[3], Vasanth Selvam[4]

[1,3,4]Kaunas University of Technology
[2]Government Engineering College Hassan
[1]Pramodkumar2897@gmail.com, [2]123ranjitharanju@gmail.com, [3]sandesh.mysore@ktu.edu

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Abstract

Hydrological analysis is a important component for design of bridges that cross water courses. This is not necessary for under passing of bridges as they do not convey water. Because of the importance of hydraulics in the performance and safety of most bridges. The hydraulic design is the process for sizing of the bridge waterway opening will include the evaluation of water surface in the main channel for present conditions and for particular conditions. A comparison of the elevations between these two conditions shall be made to identify the effects of the bridge on the waterway. Hydrological investigations are the preliminary studies which shall be carried out and they are highly important during design and construction process. This study focused on carrying out of necessary hydrological investigations, such as estimation of probable maximum discharge, design discharge corresponding to storm event with different return periods and scour information and calculation. By the use of catchment area the design discharge is calculated in different methods. Main aim of this proposed bridge is planned to connect the villages of Rudrapattana and Basavapattana side and there will be saving in travel distance of over 15-20km for villagers, which is the main connecting road for surrounding area.

Keywords; *Discharge, Hydraulic Survey, Scour Depth, Topographic Survey.*

I. INTRODUCTION

The valley, a road, a river and a body of water is the basic structure which is needed in bridge. The Structure of bridge is depending upon the function of components and nature of the area where the structure is to be constructed. The catchment of a river above a certain distance is determined by the surface area of land which releases toward the river from above the exact point. The main components of a bridge hydraulic design project involve the following steps:

- Background investigations
- Collection of Data
- Site visit
- Hydrology analysis and calculation of flood
- Discharges
- Hydraulic analysis and calculation of flood flow patterns, flood levels and flow velocities and Scour assessment and scour protection measures

In all cases, the efforts has to be made to use whichever available stream flow data for either the bridge site itself, elsewhere on the river or on a nearby similar catchment. Hydraulic analysis is nothing but it is calculating part of flow patterns, flood levels and bridge flow velocities and nearby river reach. This data is used in calculation of the bridge and impact of bridge on the local flooding in the water course. It is depend on the data which is described above and which is used for the control of flood flow in the model.

1.1 OBJECTIVE

The main objective is to study the basic design parameters of the project site along with Engineering studies. The proposed tasks broadly

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involves mapping of the terrain features, site investigations such as topographical, traffic, geotechnical, hydrological etc. Selection of the best possible alternatives has been decide which has been taken up for detail working so as to provide a sound and appropriate engineering solution for the implementation of the project parameters.

The objectives of the hydrological and hydraulic studies are set as follows:

• To clarify the current conditions of river channel and surrounding areas, which are subject to proposed road network

• To estimate the flood discharges of the rivers in various return periods through statistical approach at crossing along proposed road alignment.

• About watershed parameters.

• For preventing the overtopping of flood water.

• Flood plain management.

• For maintaining an un obstructed passage of flood water.

• An improving of the transport facility.

Construction of this bridge will provides direct connectivity to SH-85. Hassan is the main commercial center for surrounding villages. Construction of bridge creates shorten links for surrounding villages to reach Hassan which directly have positive impact on commercial growth of thaluk and further this will give faster movements of goods.The proposed bridge will result in overall improvement between villages and will improve the tourism, Agro-commercial activity and Socio-economic improvement of the surrounding area.

II. LITERATURE REVIEW

In this study In the design of bridge structures, determination of waterways and span arrangements are important. Hydrological parameters such as runoff data with details of drainage points have been collected and compiled. The Hydrology and drainage surveys have been conducted to provide a complete description of hr features of the area. Specific topographic surveys of streams were carried out for bridges which are being reconstructed, in accordance with the requirements of the bridge and hydrology team. A total of at least three cross sections were taken either side of the centre line of the bridge location and a longitudinal section of the stream was taken covering 250m to 500m upstream and downstream based on the site conditions. The resulting soil stresses -except at the ground surface are in addition to those presently existing in the earth mass from its self weight and geological history. Also the successful performance of foundation structure depends as much as adopting standards of good load distribution successfully to the ground. Investigation of the underground conditions at site is prerequisite to the economical design of the substructure elements. It is also necessary to obtain sufficient information for feasibility and economic studies for a proposed project associated with the partially- and entirely submerged rectangular bridge deck.

III. MATH

1. Empirical methods: Based on studies conducted, some empirical formulae for specific regions have been evolved. The empirical formulae for flood discharge suggested are in the form.

$$\mathbf{Q = CA^n}$$

Where, Q= maximum flood discharge in m^3/s

A= catchment area in Km^2

C= An empirical constant. Depending upon nature and location of catchment

n= A constant

2. A-V method:

It has been used to estimate the discharge from the river across sections. The formula is given below.

$$\mathbf{Q = A \times V}$$

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ISSN: 0193-4120 Page No. 13733 – 13738

Where, Q = Discharge in m^3/s or cumecs

A = area in m^2

V = Velocity of flow in m/sec which can be calculated by manning's formula

$V= 1/n\ R^{(2/3)}\ S^{(1/2)}$

Where, R =Hydraulic mean depth,

S = The energy slope which may be taken as equal to bed slope of the stream.

n = manning's coefficient (Rugosity coefficient)

3. Modified Rational method :

The rational method for flood discharge takes into account the intensity, distribution and duration of rainfall.

$Q_{50}= 0.278CIA$

Where, Q = Maximum flood discharge in m^3/sec

A = Catchment area in km^2

C = Runoff coefficient

I = 100 year intensity (mm/hr) lasting t_c, hour duration

t_c= Concentration of time

For estimating I, the time of concentration t_c has to be determined using following formula.

$t_c = (0.87L^3/H)^{0.385}$

Where, t_c = the concentration time in hours

L = length of the longest stream from source to the bridge point in kms.

H = The fall in level from the farthest point to the bridge point(m).

4. Scour depth calculation:

The main thing is that the calculation of the scour depth is by the 2 times of Lacey's depth and the formula is given below

R = 0.473(Q/f)1/3, when L/W > 1,

R = 1.34(q2/f)1/3, when L/W <1,

Where, Q = Discharge

R= Regime Depth

Q/L and F= Lacey's Silt Factor

L= Length

5. Computation of waterway for a new structure (bridge):

When a new structure is to be constructed then the designer should give the waterway which is required. The waterway is to be calculated by Lacey's regime waterway method and the equation is given below.

$P =W= 4.8\ Q^{1/2}$

Where,Q = design flood discharge in m3/sec cumec,

P = Wetted perimeter in meter.

W = Linear waterway in meter (for wide river W is almost equal to P)

IV. CONSTRUCTION OF BRIDGE BY DIFFERENT METHODS

1. Methodology of Hydrological Analysis:

In order to set appropriate methodology of hydrological analysis to determine the probable flood discharge and other design parameters at arbitrary crossings where structures are to be designed, following factors were examined:

(i) Basin parameters: size of catchments, channel length, riverbed gradient(traveling time of discharge) Relatively small catchments (> 200 km2), short river length (> 50 km) and 1/80 to 1/100 of average riverbed gradient

(ii) Existing structures for flood control no major control structures, which can retard and store flood

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discharge and no inter-basin connection or floodways

(iii) Availability of rainfall and discharge record Fairly reliable daily rainfall records (sufficient duration and coverage of area) but no flood discharge measurement record in the subject river basin (no measured hydrograph)

(iv) Requirement for design parameters of structure (bridge, culvert, revetment and embankment, etc.) Flood peak discharge can be converted to the flood water level based on the channel geometry by means of appropriate runoff model.

(v) Future flood control/drainage improvement plan: No major flood control/drainage improvement plan to be taken account to estimate flood discharges is not identified except minor channel improvement managed by LGUs. As the result of examination, flood runoff analysis by rational formula and uniform flow theory will be applied to estimate probable peak discharges and associated water levels at arbitrary locations in the Study Area.

2. DATA COLLECTION

2.1 Rainfall data

The average annual rainfall of Hassan district lies between 920 to 1100 mm. Most of the rainfall in the district is confined to the period from May to October, July is the rainiest month.

Tables 1:Annual Rainfall (mm) variability between 1971to 2011 (42 years) at Hassan

DECADES	1971-1981	1981-1990	1991-2001	2001-2011
Monsoon	1289.3	981.53	788.5	817.39
Winter	16.1	19.8	6.1	8.8
pre-monsoon	65.4	85.6	22.6	38.79
post monsoon	182.7	72.3	72.3	72.3

2.2 Stream flow data: Where the stream flow is more there stream flow data is used.

Table 2:High flood level(m) data (42years).

DECADE	HFL(meters)
1971-1981	99.81m
1981-1990	88.38m
1991-2001	76.89m
2001-2011	81.43m

2.3 Traffic volume: It is needed in the knowing of the crossing of road in daily process.

Table 3:Traffic volume per hour.

Vehicle	vehicle /hour
car	16
motorcycle	35
bus	6
trucks	4
other vehicles	20

Presently there is no bridge at the location. In summer when there is less water, the people / cattle will commute from Rudrapattana to Basavapattana side. The key plan of the bridge is shown in the Fig.

Fig. INDEX MAP

V. RESULTS AND DISCUSSION

The scope of project for a detailed Hydrology study for bridge across Kaveririver to connect Rudrapattana and Basavapattana in the district of Hassan. The project work included:

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• Review of Hydraulic study in further process.

• Compute catchment area required for estimate the design flood discharges.

• Estimate flood discharges based on 100year return period.

• collect an approximate flood level, based on a 100year flood, for detailed road design purposes.

• Estimate linear water way , scour depth by collecting various data like velocity , high flood level etc.

Establish afflux criteria based on potential effects

ABSTRACTS OF HYDRUIC PARTICULARS

1) Catchment area - ABSTRACTS OF HYDRUIC PARTICULARS

1) Catchment area - 2488 km^2

2) Proposed span arrangement - 9×24

3) Design discharge - 2745.16 m^3/sec

4) Velocity through vent - 2.10m/s

5) Low bed level - 93.65 m

6) High flood level - 99 m

7) Vertical clearance - 1.20 m

8) Free Board - 3 m

9) Road formation level - HFL + vertical clearance + Free board- (99 + 1.200 + 3) =103.200m

10) Spread Length - 210 m

11) Required linear waterway - 251.90 m

12) Provided linear waterway - 205 m

13) Scour Depth at abutment - 6.95 m

14) Scour depth at piers - 11.17m

15) Scour level at abutment - 93.25m

16) Scour level at piers - 89.074m

17) Afflux - 0.0000m

18) Affluxed HFL - 100.20m

VI. CONCLUSION

The main purpose of the construction of bridge is to connect the two villages namely Rudrapattana and Basavapattana ofArakalagudthaluk across the Kaveri river to save the travelling distance of about 12kms from villagers of Rudrapattana to reach Basavapattana. Hydrological investigations has been done for the construction of bridge and these investigations provides clear information about site characteristics and physical features.

1) By constructing the bridge across Kaveririver, connectivity between Hassan district and Mysore district will improved.

2) Construction of this bridge will provides direct connectivity to SH-85. Hassan is the main commercial center for surrounding villages. Construction of bridge creates shorten links for surrounding villages to reach Hassan city.

3) The proposed bridge will result in overall improvement between villages and will improve the tourism, Agro-commercial activity and Socio-economic improvement of the surrounding area.

4) Hydrology analysis and hydraulic design provides an idea about constructing bridge across river with proper orientation, shape and type (type of abutment, type of pier,).

5) Scour depth is estimated in this paper. Estimating of scour is important in deciding their foundation level.

REFERENCES

1. R Ahmad Hajam, and Sami UllahBhat- "Case Study of the Basin of Vishav Drainage ".
2. RudraiahGovinaiahVittala., (2008), "Morphometry Using Remote Sensing and GIS Techniques In The Sub-Basins of Kagna River Basin" Gulburga District Karnataka

Published by: The Mattingley Publishing Co., Inc.

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ISSN: 0193-4120 Page No. 13733 – 13738

India Journal of Indian society of Remote Sensing 36(351-360).

3. Sethupathi A.S Lakshmi Narasimhan C VasanthamohanMohanS.P, (2011), "Prioritization of mini watersheds based on Morph metric 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 RolfWeingartnerb 1998 : Distribution of peak flow derived from a distribution of rainfall volume and runoff coefficient.
7. Noumankhattak, Salman afzal, Syed azmatali shah, Muhammad ejazshabab, Navidahmad. (2013) :"Hydrological and Hydraulic Study of Bridges / Culverts".
8. A.O Aksoy, O.Y Eski (2016) "Experimental investigation of local scour around circular bridge piers under steady state flow conditions".
9. Dr. P. D. Dahe, S. B. Kharode (2015): "Evaluation of Scour Depth around Bridge Piers with Various Geometrical Shapes"
10. R I Siregar,(2008). "Hydraulic modeling of flow impact on bridge structures: A case study on Citarum"

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