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Estimation of Peak Flood for Durgawati Dam Located in Bihar State (INDIA)

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Abstract: This paper describes the procedure for the estimation of 100 Year return period Flood using Flood Estimation Report for Sone Sub Zone – 1(d) by Central Water Commission (CWC), New Delhi. The Dam project for which the estimation of the flood has been carried out is Durgawati Dam project, which is in Kaimur district in the Indian state of Bihar. With the help of Flood Estimation Report of CWC, 25/50/100 year return period flood can be estimated apart from the derivation of ordinates of Unit Hydrograph. In the absence of substantial rainfall data, this method can be used for the estimation of Peak Flood and unit Hydrograph of any region of India, as per the respective sub zonal report of CWC for Flood Estimation.

Keywords —Flood Estimation, Unit Hydrograph, Synthetic Unit Hydrograph, Durgawati Dam, Catchment Area, Peak Flood, 100 Year return Period Flood, Probable Maximum Flood (PMF).

I. INTRODUCTION

The estimation flood is part of Engineering Hydrology. Flood estimation are required for various purposes such as planning of dam, irrigation project, barrages, weirs etc. or other river diversion works. Flood estimation plays a very important role in planning of water resources structures and finalization of the size and type of those structures. Apart from that, it is required for planning and designing of Bridges, Drainage works and other works which are directly or indirectly related to any river or stream.

There are various method of flood estimation which are being used around the world. The various methods of Flood discharge estimation are given below:

1) Catchment-Run-Off Method
   In this method, catchment area is computed from the Topo survey map and the flood discharge is estimated from formula.
2) Empirical Formulae
   There are various empirical formulae for estimation flood such as Dicken's Formula, Ryve's Formula and Inglis's Formula.
3) Rational Method
   This method is very realistic method which considers all relevant factors influencing the peak run-off.
4) Cross Sectional Area and Bed Slope
   In this method, the discharge is calculated using Manning's formula.
5) Area of Cross-Section and Velocity as Observed at Bridge Site
   The area of cross-section is measured by taking a series of levels of the river at H.F.L. at certain intervals. The velocity in this case is determined at site by direct measurement of the velocity in place of theoretical calculation from bed slope etc.
6) Available Records
   In this method, the maximum flood discharge records available for weir, barrages, bridges sites etc. are used for calculation of the flood discharge of desired area in the vicinity.

In this paper, the flood discharge has been estimated for the Durgawati dam using Flood Estimation Report for Sone Sub Zone – 1(d) by Central Water Commission (CWC), New Delhi. This method is similar to the Available Records method.

II. DURGAWATI DAM AND RESERVOIR

The Durgawati dam and reservoir project, purporting to provide irrigation facility mainly in the Kaimur and Rohtas districts of south-western Bihar, will be fully operational soon as work on 29 canals is already in the final stages.

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The canal system is expected to irrigate 33,000 hectares of land in Kaimur and Rohtas districts, known for producing high quality rice and wheat due to the fertile characteristics of soil. Lack of irrigation facilities has been a major grouse for farmers in this belt and affected their production adversely.

The project comprises of an earthen dam on River Durgawati (Karmanasha basin) joining Shergarh Hills on the right and Rajdeo Hills on the left. The ultimate irrigation potential of the Project is 36,317 hectares. The command area of this project is spread in five blocks of Kaimur and Rohtas districts. A Feeder Outlet is located near the spillway of the dam which releases water for stabilization of irrigation due to an old scheme viz. Kudra Weir Scheme. The command of Kudra Weir scheme (16,020 ha) has now been internalized in the command of Durgawati Reservoir Project (16,020 + 20,297 ha = 36,317 ha).

III. DURGAWATI RIVER

The Durgawati River (also called Durgaoti or Durgauti and spelt as Durgawati) which flows through Kaimur district in the state of Bihar is a tributary of River Karmanasa. The source of the Durgawati is about 11 kilometer east of that of the Karmanasa. In its upper reaches, the river channel is 6 to 9 meters wide. It runs nearly north for about 14 kilometers when it plunges down the rocky boundary of the tableland into the head of deep glen named Kadhar Kho. There it is joined by three other torrents that like itself rise on the tableland of the Turkan Kharawars and fall down the rocks at the head of the same glen. These three torrents are the Lohara, Hatiyadub and Kothas. The Durgawati joins the Karmanasa as a right bank tributary.

IV. CATCHMENT CHARACTERISTIC

The catchment area of Durgawati river up to project location lies between Longitude E83.58° and E83.93° and Latitude N24.56° and N24.89°. The catchment area of Durgawati river up to Durgawati dam project has been workout using the Survey of India Toposheet, which is 640.1 sq. Km considered in analysis. Figure 1 showing the Catchment Area Map of Durgawati River up to Durgawati Dam.

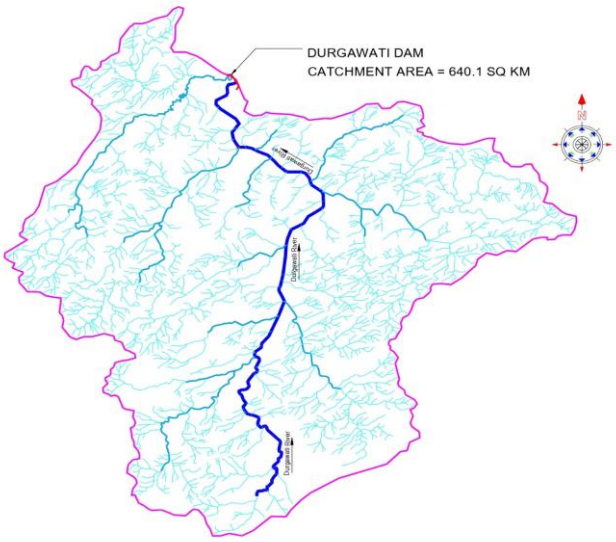

Figure 1: Catchment Area Map of Durgawati Dam

V. FLOOD ESTIMATION

No site-specific data on floods including short term gauge discharge, rainfall and flood peaks are available. Therefore, Unit Hydrograph (UG) based on observed data cannot be developed. The Flood Estimation Report for Sone Sub Zone – 1(d) by Central Water Commission (CWC), New Delhi has been referred for estimation of flood.

A. Flood Estimation report for Sone Sub Zone – 1(d)

The Flood Estimation Report for Sone Sub Zone – 1(d) is recommended for the estimation of design flood for small and medium catchments. The report deals with the estimation of design flood of 25/50/100 years return periods for small and medium catchments in the parts of Bihar, Madhya Pradesh, and Uttar Pradesh states.

The Flood Estimation Report for Sone Sub Zone – 1(d) is based on the detailed storm rainfall and runoff studies of 15 representative catchments. The data of each of the 15 catchments collected for a period varying from 4 to 9 years by the Eastern Railways, South Eastern Railways and Central railways under the guidance of R.D.S.O.

B. Physiographical Parameters

Format and save your graphic images using a suitable graphics processing program that will allow you to create the images as PostScript (PS), Encapsulated PostScript (EPS), or Tagged Image File Format (TIFF), sizes them, and adjusts the resolution settings. If you created your source files in one of the following you will be able to submit the graphics without converting to a PS, EPS, or TIFF file: Microsoft Word, Microsoft PowerPoint, Microsoft Excel, or Portable Document Format (PDF).

The Physiographic Parameters obtained and used for

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estimation of 100-year Return Period Flood are given below:

1) Area of Catchment (A) : 640.1 sq. km.
2) Length of the longest stream (L) : 38.50 Km
3) Length of the longest stream (LC) : 19.0 km from a point opposite to C.G. of catchment to point of study
4) Equivalent stream slope (S) : 2.96 m/Km

C. Synthetic Unit Hydrograph of 1-Hour

Synthetic Unit Hydrograph Parameters were computed using the equations given Flood Estimation Report. These equations are given in Table 1.

Estimated parameters of Unit Hydrograph have been calculated using above equations and are plotted. The plotted points were joined to draw synthetic Unit Hydrograph. The developed Synthetic Unit Hydrograph shown in Figure 2.

D. Estimation of Design Storm

The design storm duration (TD) has been adopted as $1.1t_p$.

Table 1: Synthetic Unit Hydrograph Parameters

S. No.	Relationship	Unit
1	$t_p = 0.314\ (L/\sqrt{S})^{1.012}$	hour
2	$q_p = 1.664 / (t_p)^{0.965}$	cumec/km^2
3	$W_{50} = 2.534 /(q_p)^{0.976}$	hour
4	$W_{75} = 1.478/ (q_p)^{0.860}$	hour
5	$W_{R50} = 1.091/ (q_p)^{0.750}$	hour
6	$W_{R75} = 0.672/ (q_p)^{0.719}$	hour
7	$T_B = 5.526\ (t_p)^{0.866}$	hour
8	$T_m = t_p + t_r/2$	hour
9	$Q_p = q_p * A$	cumec

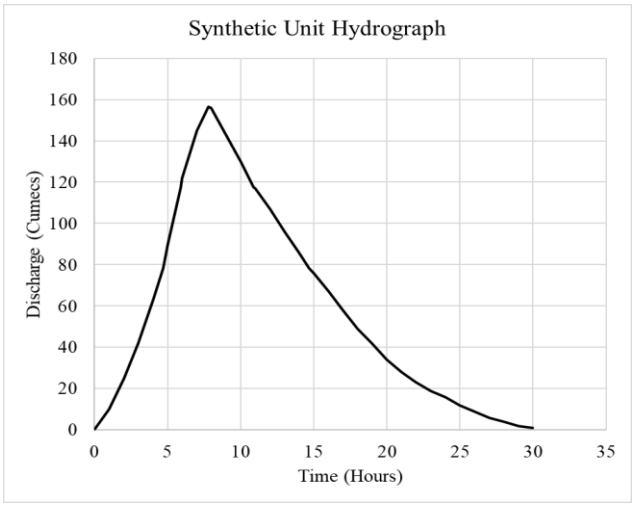

Figure 2: Synthetic Unit Hydrograph

The rainfall maps of subzone report are provided for return period of 25-year, 50-year & 100-year. However, since the dam is in large dam category, Probable maximum flood is desired for which the maximum observed daily rainfall in the vicinity of the project has been selected as given in subzone report as 47cm. The daily or 24 hours rainfall is then converted into point rain fall for TD duration using factor of 0.78 (Fig 10 of Subzone report). The point rainfall of TD duration then converted into areal rainfall using Areal reduction factor = 0.786 for catchment area of 640 sq.km (Fig 11 (a) of Subzone report).

The TD hour areal rainfall was the distributed with distribution coefficients (Fig 12 (b) of subzone report). The design loss rate of 0.25 cm/hour has been adopted. The effective rainfall & flood hydrograph has been workout using the procedures laid down by subzone report. The peak flood hydrograph is shown in Figure 3.

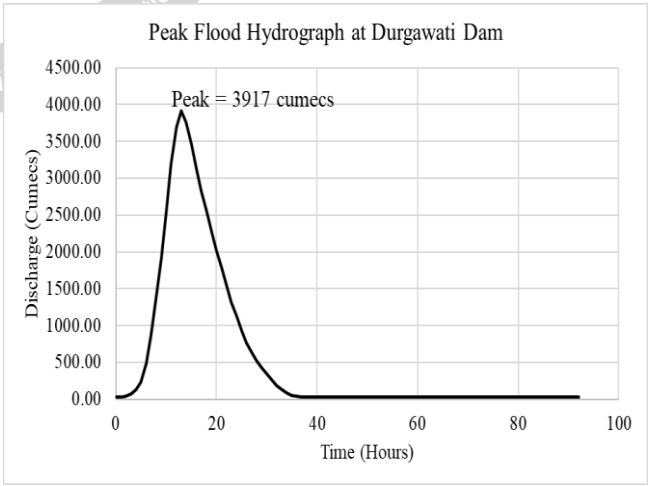

Figure 3: Maximum Flood Hydrograph - Durgawati River at Durgawati Dam

VI. RESULT

The Peak Flood for Durgawati Dam obtained from Method of Flood Estimation Report for Sone Sub Zone – 1(d) by Central Water Commission (CWC), New Delhi is

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3917 cumecs.

VII. CONCLUSION

As per the data available on the website of Water Resources Department, Government of Bihar, the spillway capacity of the Durgawati Dam is 3818 cumecs. The Peak flood estimated by the of Flood Estimation Report for Sone Sub Zone – 1(d) by Central Water Commission (CWC), New Delhi is 3917 cumecs, which almost similar to the project data. Hence, it can be concluded that the Flood estimation method of Central Water Commission is very useful for the estimation of the Floods for Medium and small catchment areas. However, the Peak flood calculated using the actual rainfall data will be more reliable and accurate. For initial planning purpose, the method proposed by Central Water Commission can be adopted.

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