Design Flood Estimation in Satluj Basin-Challenges for Sunni Dam Hydro Electric Project, Himachal Pradesh-India

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Abstract : Introduction: Design Flood studies are essential for effective planning and functioning of water resource projects. Design flood estimation for Sunni Dam Hydro Electric Project located in State of Himachal Pradesh, India, on the river Satluj, was a big challenge in view of the river flowing in the Himalayan region from Tibet to India, having a large catchment area of varying topography, climate, and vegetation. No Discharge data was available for the part of the river in Tibet, whereas, for India, it was available only at Khab, Rampur, and Luhri. The estimation of Design Flood using standard methods was not possible. This challenge was met using two different approaches for upper (snow-fed) and lower (rainfed) catchment using Flood Frequency Approach and Hydro-metrological approach. i) For catchment up to Khab Gauging site (Sub-Catchment, C1), Flood Frequency approach was used. Around 90% of the catchment area (46300 sqkm) up to Khab is snow-fed which lies above 4200m. In view of the predominant area being snow-fed area, 1 in 10000 years return period flood estimated using Flood Frequency analysis at Khab was considered as Probable Maximum Flood (PMF). The flood peaks were taken from daily observed discharges at Khab, which were increased by 10% to make them instantaneous. Design Flood of 4184 cumec thus obtained was considered as PMF at Khab. ii) For catchment between Khab and Sunni Dam (Sub-Catchment, C2), Hydro-metrological approach was used. This method is based upon the catchment response to the rainfall pattern observed (Probable Maximum Precipitation - PMP) in a particular catchment area. The design flood computation mainly involves the estimation of a design storm hyetograph and derivation of the catchment response function. A unit hydrograph is assumed to represent the response of the entire catchment area to a unit rainfall. The main advantage of the hydro-metrological approach is that it gives a complete flood hydrograph which allows us to make a realistic determination of its moderation effect while passing through a reservoir or a river reach. These studies were carried out to derive PMF for the catchment area between Khab and Sunni Dam site using a 1-day and 2-day PMP values of 232 and 416 cm respectively. The PMF so obtained was 12920.60 cumec. Final Result: As the Catchment area up to Sunni Dam has been divided into 2 sub-catchments, the Flood Hydrograph for the Catchment C1 has been routed through the connecting channel reach (River Satluj) using Muskingum method and accordingly, the Design Flood was computed after adding the routed flood ordinates with flood ordinates of catchment C2. The total Design Flood (i.e. 2-Day PMF) with a peak of 15473 cumec was obtained. Conclusion: Even though, several factors are relevant while deciding the method to be used for design flood estimation, data availability and the purpose of study are the most important factors. Since, generally, we cannot wait for the hydrological data of adequate quality and quantity to be available, flood estimation has to be done using whatever data is available. Depending upon the type of data available for a particular catchment, the method to be used is to be selected.

Keywords : design flood, design storm, flood frequency, PMF, PMP, unit hydrograph
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