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Correct estimation of maximum flood discharge in a river, alongwith determination of maximum and minimum water levels is essential for safe and economical design of large hydraulic structures. Intensive rainfall in the upper catchments during monsoon period is generally the primary cause of devastating floods. The size of catchment area and the rainfall intensity are the two major factors which influence the magnitude of flood discharge. Many methods are available for estimating the maximum discharge for the design of hydraulic structures. The choice of a practicular method depends on the available records of hydraulic, hydrologic and meteorological data and the type of the hydraulic structure. The following discussion briefly covers various methods employed for estimation of the maximum discharge.

The available empirical formulae for estimating the maximum discharge are based on analysis of maximum flood records of rivers having· catchment areas of particular characteristics and hydrometereological conditions. Each of these formulae gives better results when applied for catchment with conditions more or less similar to those for which it was derived. The catchment formulae developed by Dickens, Ryes, Fanning, Myers, Inglis, Kuichling, Karpov and Kanwarsain are more reliable relations for predicting maximum discharge. For small hydraulic structures like culverts, syphons and aquaducts et. one should carefully select a formula essentially meant for relatively small cathment areas.

Another category of formulae includes as a variable the rainfall in the catchment and thus provides a more rational approach. We can estimate the peak discharge with the help of Chamier's or Craig's formula if catchment parameters viz its area, length, width, velocity of run-off, run-off coefficient and average intensity of rainfall are known. The run-off charcteristics of the catchment area and the rainfall intensity enter the computation to provide a more rational approach. For available data either Richard's method or Unit hydrograph method can be applied. In case of a given catchment if the length, slope, cofficient of run-off, maximum rainfall in inches and duration of storm are known, we can use Richard's formula to arrive at the maximum discharge. Richard's approach involves determination of rainfall coefficient R which is a function of intensity of storm I at the point of maximum rainfall and the duration of storm in hours. He calculates the rainfall coefficient from duration of storm T and time of concentration (t) and assumes that a storm of unit inensity is spread equally over the entire catchment area and the duration of the storm is the same as the time of concentration at the point where maximum discharge is to be determined. The coefficient of run-off K is ratio of rainfall to surface run-off. A unit hydrograph can be developed from the known total rainfall and the losses in the basin due to absorption and retention. The net rainfall can be determined by either index O method or trial and error method. The index O represents the rainfall that does not appear as run-off and represents the losses in the drainage basin. In trial and error method, rainfall excess is found by successive assumption of different rates of retention till the computed excess equals the storm run-off.

With the help of unit hydrograph drawn for a given catchment corresponding to a given storm, one can compute the maximum discharge that the catchment can yield. It is essential to select a design storm of particicular frequency and magnitude for applying it to a given catchment unit hydrograph for estimating the maximum design discharge. Unit hydrograph can be developed from the analysis of rainfall run-off record or isolated unit storm or a major storm. In case no run-off records are available, data of other similar basins of different sizes and characteristics is used to construct a synthetic hydrograph which helps in determining the maximum design discharge. The synthetic unit hydrograph can be constructed using one of the methods namely Synder's method, Linslay, Kohler and Paulhus method and Soil Conservation Services (S.C.S.) method. S.C.S. also recommends an approach based on Probable Maximum Precipitation. This approach requires a design storm arrangement and design rainfall for generating "probable maximum precipitation" for estimation of direct run-off.

There are also some statistical methods available for estimation of maximum discharge from the flood records by frequency analysis. Out of many methods used for estimation of maximum discharge, Hazen's, Fuller's and Gumbel's methods are the ones more commonly used. In Hazen's method annual maximum discharges are first arranged in chronological order and in descending order of magnitude. These are expressed as ratios of mean flood and variation (d) is computed for each value. Squares and cubes of variation are calculated to determine the Coefficient of Variation Cv and the Coefficient of Skew Cs by applying standard formulae. The coefficients help in finding the probable floods expected at different frequencies. Fuller's formula is applicable if catchment area M is known. Maximum discharge is the mean of yearly maximum flows in cusecs for data of N years. The probable maximum flood, likely to occur in N years can be determined by substituting values of maximum discharge, N and M in the formulae. In Gumble's method the probability of occurrence of a flood of magnitude X is function of a factor which depends on the inverse of the standard deviation of the X values. For values of P assumed as 0.1, 0.5, 0.8, 0.9, 0.95, 0.98, 0.99, 0.995, 0.998 correspond to the values of return period as 1.1, 2, 5, 10, 22, 50, 100, 200 and 500 respectively. The value of dimensionless parameter Y and the probable dischage of magnitude X can be determined against the assumed values of P. The plot is made on a special graph paper in which ordinate represents the flood flow and the abscissa the dimensionless parameter. Since the flood frequency analysis is based on data alone which may not include all the physical factors contributing to the maximum flood, it is preferable to use the method with a factor of safety for maximum recorded flood. The probable frequency of a flood of given magnitude can be determined by applying laws of probability using either Basic Stage method or Yearly Flood method.

In order to determine the maximum design discharge capacity for a hydraulic structure such as a bridge, one can apply Manning's equation. The expected mean operating slope corresponding to a selected flow stage near the maximum Flood Mark, and the exact geometry of cross section which has to pass the design discharge must be known. By assuming a modest value of Manning's roughness coefficient for proposed cross section or different values of the roughness coeficient for different compartments, the maximum discharge for the design of the proposed structure can be worked out.