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STUDIES IN SOME HYDRAULIC FEATURES OF THE DESIGN OF TAUNSA BARRAGE

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By

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This paper is in two parts. In part I, (315A) alignment and location of the headworks, and in Part II, (315B) estimation of maximum and minimum discharges and levels in the Indus at Taunsa barrage are discussed.

PART - I, Paper 315 A

A number of investigations were undertaken by the Irrigation Research Institute to determine the best location of Taunsa barrage on the river Indus. It was planned to study the location of different weirs on the alluvial rivers to assess their working in relation to the site selection of headworks. The usual practice in Indo Pakistan Subcontinent is to construct the barrage outside the main channel in a bye-river temporarily closed, or in an abandoned course of creek which is dry in winter ad the river is diverted to pass over the weir after its completion.

The barrage site should be such as not to lose command and is sufficiently near the commanded area. In case such requirements require the weir siting near an existing bridge or gorge, the site below the existing control point is preferred. Other factors to be considered are minimum haulage distance for construction material, easy diversion after construction and attainment of approach to the barrage after diversion which may be good for sediment exclusion from canals.

The main factors which determine the behaviour of river flow through the barrage site are;

a. general direction of the river or the river axis
b. the river loops in the vicinity of the selected site.

During the floods the river spills over the banks and if the angle between the weir axis and river axis is large the general river approach will be oblique to the upstream noses of the guide banks. Whenever the river axis makes an appreciable angle with weir axis, shoals would appear by the side of right or left guide bank according to the river axis on the right or left of the headworks axis. Location of the barrage on one side of the centre of Khadir will increase spill area on the other side of the weir thereby enhancing the tendency to form shoal along the guide banks on that side. Islam, Sidhnai and Balloki headworks are the examples where oblique approach has caused such problems. The most suitable position of weir when constructed dry is below the outer side of a convex bend upstream of which the river is straight for some distance.

An angle of 10 degree has been recommended for Taunsa weir between headwork axis and the river axis. The location of barrage is on the outside of the convex bend above which the river is straight for some length. The weir is located towards the left of the Khadir axis in the left arm of the river which was closed by bunds leaving enough waterway to pass the floods during construction period. This site was also suitable due to the proximity of road and railway link. Th greater spill area on the right which would result from the asymmetric placement is proposed to be corrected by training works.

PART - II, Paper 315 B

The estimation of maximum discharge, maximum and minimum water levels and their limits of fluctuations due to retrogression and accretion cycles are important from design point of view. It is not possible to estimate the magnitude of the maximum possible flood on a large river to any great degree of accuracy. The following methods were used to get estimate of probably maximum flood at Taunsa:-

1. Empirical Formulae
2. Probability Method

3. Estimation based on record of floods at Kalabagh & Ghazighat.

A number of empirical formulae are available for estimation of maximum floods. In fact simultaneous existence of all the meteorological and hydrological factors responsible for heavy rainfall and runoff that contribute to make a record flood can not be represented by a simple empirical formula. These formulae give only indicative but not reliable results on which design can be based without complementary studies. The maximum flood at Taunsa from Karpov and Kanwar sain curves could be 22 lac cusecs.

There are two probability methods; Basic and Yearly Flood method. The results of analysis by probability method depend on the data input which require large number of authentic discharge observations. For Kalabagh site the data was analysed for periods 1923 to 1940, 1950 and 1952. From probability curves it was found that flood equal to or greater than 20, 13 and 11 lacs can occur on 1 in 1000,100 and 50 years respectively at Ghazighat. The observed data is not enough to make the above results reliable.

The maximum flood recorded at Kalabagh was 8,19,000 cusecs on 29.8.29. An approximate relationship between the maximum annual Kalabagh discharge (x) and the corresponding Ghazighat discharge (y) in thousand cusecs has been developed as under

$$y = 1.8495\,x = .868$$

The average net decrease in discharge per mile was determined from this and the computed discharge at Taunsa Barrage site came to 7,61,000 cusecs. If the maximum yield from Suleiman range is taken as 1 lac cusecs and allowing a further margin of 1,40,000 cusecs for the bursting of Shayok dam and other contingencies an estimate of maximum discharge of 10 lac cusecs at Taunsa is reasonable. It is emphasized that a discharge above 10 lacs cusecs may occur but it would be a rare event. A sudden on-rush of an abnormal flood would still find the waterway inadequate and therefore a margin of flexibility is provided with a factor of 1.25, and designing for maximum discharge of 12.5 lac cusecs.

In alluvial channels the same discharge can pass at different levels at various times. There are infrequent cycles of accretion and retrogression. There occurs a charge in regime of river after construction of a barrage causing extra retrogression downstream, which has to be provided for in design. The estimation of maximum and minimum accreted and retrogressed levels for Taunsa barrage site was based on Foy's method with some modifications. The nearest gauge site was at Ghazighat for which the authentic discharge gauge observations were available for a period of 9 years. The authors method gives the difference of level between accreted and retrogressed levels equivalent to about 2.4' at a discharge of 10 lacs cusecs as compared to about 9 feet at the low stage. These results are in conformity with the general trend of envelope curves of discharge and gauge in different years. The arbitrary assumptions for arriving at the discharge gauge curves are still open to further improvements. At present this method of analysis is a rational way of getting the discharge rating curve for testing the performance of weirs.

Note:-

Paper No. 315 A & B appear in the proceedings of Engineering Congress 1956, Vol. 40 at pages 1 to 18. It has two parts with 8 figures and 5 tables.