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AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 at large B/b values, separation will occur, and a curved wall flare will not prevent it. In other tests (not part of the reported study) various exponential curves were studied for the sidewalls of an expansion downstream from a syphon outlet. Although the performance was slightly improved in some cases, the difference was small and the curves were abandoned in favor of a simpler, straight-wall expansion.

HYDROGRAPHS OF EPHEMERAL STREAMS IN THE SOUTHWEST[a]

Closure

KENNETH G. RENARD,[27] M. ASCE AND ROBERT V. KEPPEL[28].—The writers wish to thank Hudlow and Clark, and Riggs for their discussions, which have added to the scope of the paper and especially in emphasizing the complexity of hydrograph analysis in ephemeral streams.

The writers agree with Riggs' statement that the problem of defining characteristics of flood peaks at ungaged sites is a difficult one. The effects of transit phenomenon are so complex as to make such an undertaking one of considerable scope. As shown in a previous paper[9], the effects of translatory waves and transmission losses can cause two conditions in a channel segment with no tributary inflow. In Case I, the flow volume and the peak discharge are reduced, whereas in Case II, the flow volume is reduced, but the peak discharge may remain nearly constant or in some instances may even increase. To the writers' knowledge, sufficient data are not available to adequately quantify such phenomena, although studies such as are being conducted on the Walnut Gulch Watershed should shed considerable light on the problem.

The discussion of Hudlow and Clark raises an interesting point. That is, whether there is actually an inverse relationship between hydrograph rise-time and size of drainage area. The major difference between the watersheds considered for their relationship in Fig. 15 and that of the writers is the nature of the input, that is, the Walnut Gulch Watershed is undoubtedly the only area shown which has runoff-producing storms generally covering less than the entire watershed.

For the analysis of hydrograph rise-time versus watershed area, the entire area of a subwatershed was used to simplify the analysis. As suggested by

[a] March, 1966, by Kenneth G. Renard and Robert V. Keppel (Proc. Paper 4710).

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Hudlow and Clark, if the total area of the watershed or a subwatershed is used instead of the actual contributing area of rainfall excess, a more pronounced inverse relationship between rise-time and area is likely to result. This relationship is also extremely complicated because of associated transmission loss and translatory wave phenomena.

Perhaps some of the difficulty in understanding the inverse relationship between drainage area and rise-time lies in the definition of rise-time used by the authors. Hudlow and Clark state that, "Intuitively, it would be expected that the larger the basin, the longer it should take for the runoff to occur and thus, the longer the rise-time." This is true, but rise-time has little to do with the time it takes runoff to occur. Rise-time was defined and used in the paper as the time from beginning of runoff at the measuring station to the time of peak discharge. Because runoff does not necessarily begin at the measuring station with the beginning of rainfall excess, the inverse relationship is physically quite possible.

Errata.—The following corrections should be made in the original paper:

Page 42, line 24 should read: "Studies reported herein indicate no relationship of basin lag to the rise-time for semiarid watersheds of more than a few square miles in area."

Fig. 9 should have shown the computed line for $V = \sqrt{gd}$ as in the revised figure. Thus, it can be seen that the measured velocities as indicated by the water level recorders exceed either the velocities computed using the Manning equation with n = 0.035, or the velocity of a pure gravity wave ($V = \sqrt{gd}$). This might be expected, because the measured velocities include the mean velocity

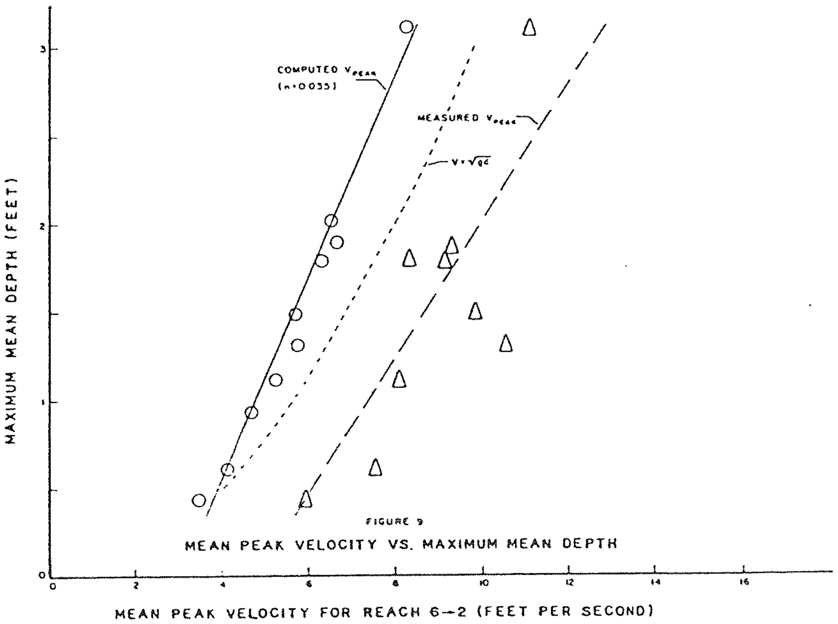

FIG. 9.—WAVE VELOCITIES FOR CHANNEL REACH 6—2 ON WALNUT GULCH (REVISED)

of the flow plus the velocity of overriding individual waves. In the analysis presented in this paper, no effort was made to separate for the observed flood-wave velocities, the relative velocity due to the individual waves from the mean velocity of the flow.

INLAND DELTA BUILDING ACTIVITY OF KOSI RIVER[a]

Discussion by Claude C. Inglis

CLAUDE C. INGLIS,[17] F. ASCE.—A point which the writer had not dealt with in his earlier discussion[18] was in connection with what might happen if the barrage and high embankment scheme were adhered to, and a large proportion of the sediment now passing through the gorge was not trapped.

The authors state that Shillingford (1893) had considered that the Kosi, having reached the limit of its westerly movement, would revert to its extreme eastern course similar to that in 1731; whereas the authors express as their opinion that "If the Kosi is left to itself, the delta building process would continue, and the river would shift from east to west, and back to east, and so on over the cone." There are, however, three factors which would have a strong influence on keeping the Kosi flowing along its western flank: (1) The Cariolus effect, caused by the rotation of the earth; (2) the tendency of a river to be attracted by its higher flank; and (3) the tendency of a river to flow along and erode its outer, concave, bank.

Although the Cariolus effect is small, if long continued it may have a marked effect on the westerly movement of a river flowing in a north to south direction, as in the case of the Indus and the Punjab rivers in India. Factor (2) is well exemplified by the holding effect of Belka Hill; and Factor (3) by the progressive erosion and consequent movement of the Kosi into the Balan and Kaljuga areas to the west. When to these three influences the effect of the concentration of sediment in the Kosi between the high embankments is added, the bed levels upstream of the barrage at Hanumannagar will progressively rise between the gorge and the barrage by approximately the ponding height, as explained in the writer's original contribution to the discussion. Though there will be a time lag in the deposition of sediment downstream of the barrage, when this occurs, a relatively narrow width of "deposit cone" will extend further and further to the south-west, from the downstream end of what would then remain of the right high embankment. This might lead to the Kosi overtopping the low ridge along the north side of the Ganga, and hence to the Kosi cutting a new channel into the Ganga.

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[a] March, 1966, by Chintaman V. Gole and Shrikrishna V. Chitale (Proc. Paper 4722).

[17] Cons. Engr., Henfield, Sussex, England.

[18] Inglis, Claude C., discussion of "Inland Delta Building Activity of Kosi River," by Chintaman V. Gole and Shrikrishna V. Chitale, Journal of the Hydraulics Division, ASCE, Vol. 93, No. HY1, Proc. Paper 5059, January, 1967, pp. 93-100.