DISCUSSION OF "RESISTANCE PROPERTIES OF SEDIMENT-LADEN STREAMS" BY VITO A. VANONI AND GEORGE N. HOMICOS

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The authors are to be commended for their excellent explanation of many of the important aspects of the mechanics of flow in alluvial channels. Based upon similar studies conducted in both large and small flumes by the writers, the equipment used and a few of the concepts presented by the authors are elaborated on.

One of the problems associated with a study of this type is the difficulty of evaluating the effect of flume size on data and observed flow phenomenon. The writers found that with a given bed material results obtained using a large recirculating flume 150 feet long, 8 feet wide, and 2 feet deep could not be reproduced in a smaller recirculating flume 60 feet long, 2 feet wide and 3 feet deep. For example, the forms of bed roughness observed in the order of increasing shear in the small flume were:

1. plane bed before beginning of motion
2. plane bed after beginning of motion
3. dunes
4. transition from dunes to plane bed and standing waves
5. standing sinusoidal sand and water waves which were in phase

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6. antidunes

Using the same bed material in the large flume the forms of bed roughness in order of increasing shear were:

1. plane bed before beginning of motion
2. ripples
3. ripples superposed on dunes
4. dune
5. transition from dunes to plane bed and standing waves
6. standing sinusoidal sand and water waves which were in phase
7. antidunes.

The large flume produced the forms of bed roughness observed in the field, whereas, the small flume did not. It was also noted that the height of dunes is related to the depth of sand bed. As depth of bed material is decreased the amplitude of the dunes is decrease. These differences in results, over and above those which can be compensated for by correcting for side wall effect, present a serious problem to those who are trying to utilize data collected by the various investigators, particularly that data gathered in very small flumes.

No mention is made by the authors of the fact that the form of bed roughness is related to size and gradation of bed material. This may be due to the limited range of conditions which they investigated. To illustrate using sand sizes ranging from $d = 0.2$ mm to $d = 0.5$ mm the writers have observed that the amplitude of the dunes is independent of size of bed material but the spacing and shape of the dunes are related to size of bed material. The spacing of the dunes increases with decreasing size and the angle the fore plane of the dune makes with the horizontal decreases with decreasing size of bed material. The net result is that resistance to flow is smaller with the fine sand than with the coarser sand by as much as 20 per cent. This discussion perhaps raises the question of bed form terminology. To avoid confusion, the major forms of bed roughness which have been observed in alluvial channels by the writers are illustrated in Fig. 1. From this figure, it is apparent that the form of bed roughness described by the authors, according to this classification, is ripples.

Referring to the difference in the bed friction factor for sediment-laden flow over a loose sand bed and clear water flow over a fixed sand bed, of the same configuration, it is doubtful that the total difference can be explained by the presence of the suspended sediment. It has been observed by the writers that the scale and intensity of turbulence is entirely different from a rigid bed with no bed material transport than it is in the case of a loose sand bed with on the order of 10 ppm of bed material transport, none of it in suspension, and other flow factors the same.

The effect of sediment load on resistance to flow is significant as illustrated. However, the authors conclusion that all of the computed decrease in resistance to flow can be attributed to the damping effect of the suspended sediment on the turbulence is not concurred in. The presence of fine sediment causes effects on fluid properties which change the entire fluid bed material interrelationship. These factors appear to be of more importance than the dampening effect of the suspended sediment.

The presence of very fine sediment (clays) in the water also influences resistance to flow in alluvial channels. Based upon recent studies by the writers concentrations of fine sediment on the order of 40,000 ppm can reduce resistance to flow as much as 40 per cent in the tranquil flow regime. However, under rapid flow conditions, the presence of fine sediment can increase resistance to flow.

The validity of the statement on page 104 which explains the existence of a smaller friction factor for the same discharge on a rising stage than on the falling stage, where the decrease in friction factor is presumed to result from a readjustment of the bed due to the larger sediment load is questioned. Is it not more probable that the increase in load and the reduction in friction factor are both related to the fact that with the increase in shear with stage the bed form changes and that the change in bed form will lag the change on stage?

To better cope with the problems associated with fully developing and utilizing our water resources additional work of this caliber, preferably done in larger flumes, should be initiated. Only by making studies of this type can we hope to explain the quantitative effect of size of bed material, gradation of bed material, temperature, geometry of channel, depth of sand bed, fine sediment load, and rate of change discharge with time on total bed material transport, the forms of bed roughness which develop, and the related resistance to flow.