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Discussion by Jin Wu,[5] M. ASCE, and Ruo-Shan Tseng[6]

The authors performed a series of laboratory experiments studying temperature effects on the flow and sediment-transport characteristics of sand-bed streams. Their results indicated that at high velocities with Froude numbers ranging between 0.5 and 0.85, a reduction in water temperature produced increases in both sediment discharge and friction factor; for the case of low velocity ($F \cong 0.3$), a similar trend was observed for the friction factor while the sediment discharges were not significantly affected by water temperature.

From the measured and computed data shown in Table 1, the writers plotted in Fig. 8(*a*) the bed friction factor (f_b) versus the Reynolds number ($R = Ud/\nu_{20°C}$, where U = the mean flow velocity, d = the water depth, and $\nu_{20°C}$ = the kinematic viscosity of water at 20°). A similar diagram is presented in Fig. 8(*b*), except that the kinematic viscosity corresponding to the actual water temperature was used. It is shown in the figure that by simply using the temperature modified value of ν, all the data appear to collapse onto a single curve, the well-known Moody-type diagram. In other words, variations of f_b, at least at low water temperatures (0°–30° C), can be interpreted on the basis of the Reynolds number.

As for the sediment transport, it depends not only on flow conditions but also on the particle fall velocity; both are affected by the water temperature. The settling of solid particles released from a point in an open channel was suggested to be related to a parameter $\lambda = W_f/\kappa u_*$, where W_f is the terminal fall velocity of the particle, κ the von Karman constant, and u_* the friction velocity of flows; the necessary condition for a particle staying in suspension almost all the time is $\lambda < 1$ (16). Inasmuch as λ is an undetermined constant, the writers tried different values smaller than unity. For any assumed value of λ, a W_f corresponding to the mea-

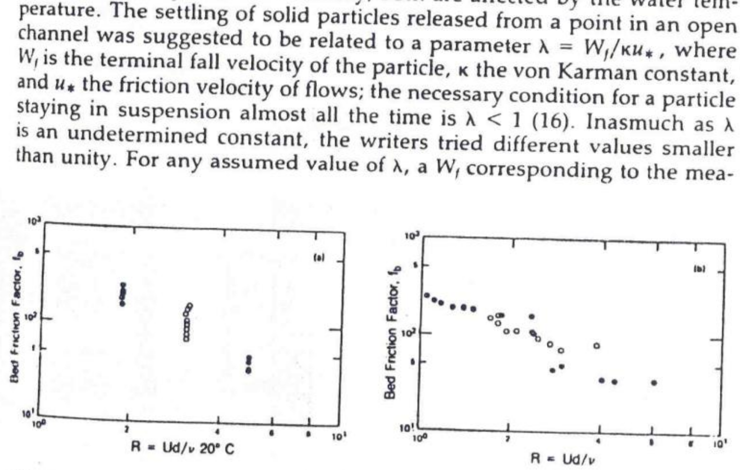

FIG. 8.—Variations of Bed Friction Factor with Reynolds Number: (*a*) Kinematic Viscosity of Water at 20° C; and (*b*) Kinematic Viscosity of Water Varied with Water Temperature (◑, F = 0.3; ○, F = 0.5; ●, F = 0.85)

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sured u_*, varied with temperature and listed in Table 1, can be calculated. Subsequently, the critical diameter of a particle, d_f, can be found from the calculated value of W_f. Sand particles with a diameter smaller than d_f are transported as the suspended load; its concentration, $\bar{C}_{ss}$, can be estimated from the sieve analysis results shown in Fig. 1. The estimated concentration can then be compared with the measured value, also listed in Table 1. More detailed descriptions of this procedure are discussed in the following:

1. With a chosen value of λ, the fall velocity can be obtained from $W_f = \lambda \kappa u_*$, and the corresponding diameter from the balance between gravity and drag forces acting on the particle, i.e.

$$\frac{\rho_s g d_f^3}{6} = \frac{\rho_w C_D W_f^2 d_f^2}{4} \qquad (20)$$

where ρ_s and ρ_w are, respectively, the densities of sand particles and water; g is the gravitational acceleration; and C_D is the drag coefficient found from the table of Clift, et al. (15).

2. The percentage, by weight, of sand finer than d_f can be estimated from the sieve-analysis results reported by the authors. This percentage can be interpreted as the fraction of particles retained in suspension, and should be proportional to $\bar{C}_{ss}$. By using 20° C as the reference temperature, the concentration at temperature t° C can be obtained from

$$\frac{\bar{C}_{ss,\, t^\circ C}}{\bar{C}_{ss,\, 20^\circ C}} = \frac{P_{t^\circ C}}{P_{20^\circ C}} \qquad (21)$$

where $P_{20^\circ C}$ and $P_{t^\circ C}$ are the estimated percentages corresponding to 20° C

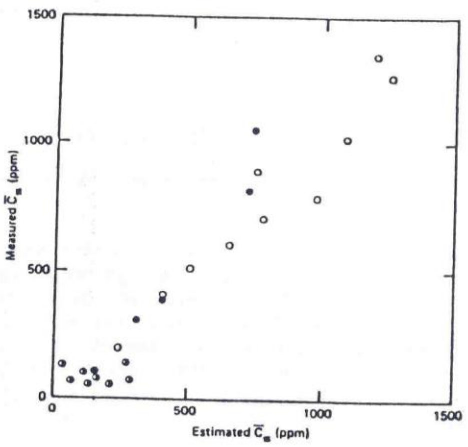

FIG. 9.—Comparison between Measured and Estimated $\bar{C}_{ss}$ for Case of $\lambda = 0.2$ (◑, F = 0.3; ○, F = 0.5; ●, F = 0.85)

and t° C, respectively. Since there was no measurement at exactly 20° C, the results obtained at the temperature closest to 20° C were used.

Following trials of different values of λ, the optimum correlation between measured and estimated $\hat{C}_{ss}$ was found to be at $\lambda = 0.2$. For this case, the estimated $\hat{C}_{ss}$ was plotted in Fig. 9 against the measured quantity. It is seen that an excellent correlation exists between estimated and measured values, and that $\lambda = 0.2$ seems to be reasonable (16). Therefore, variations of sediment transport at low temperature can also be considered to be a combination of the Reynolds number effect on flow conditions and temperature effect on the particle fall velocity.

In summary, the authors have provided timely and comprehensive measurements of temperature effects on both bed friction factor and sediment transport. Their data are further explored, and the correlations appear to be interesting. More studies, however, are recommended to substantiate the suggested effects.

ACKNOWLEDGMENT

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APPENDIX.—REFERENCES

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16. Sumer, B. M., "Settlement of Solid Particles in Open-Channel Flow," *Journal of the Hydraulics Division*, ASCE, Vol. 103, 1977, pp. 1323–1337.

SMEMAX? CAUTION![a]

Discussion by Arun Kumar[2] and Rema Devi[3]

The author has done a detailed study on the efficiency of SMEMAX transformation in transforming the LP III and GEVI distribution into a near normal one. However, the writers feel that a practicing engineer hardly gains anything from such a study, as the results obtained cannot be applied to the real-time problem. This discussion highlights the shortcoming of the SMEMAX transformation, suggests possible modification

[a]March, 1984, Vol. 110, No. 3, by Jerome A. Westphal (Paper 18657).

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