SERIES EXPANSION OF THE MODIFIED EINSTEIN PROCEDURE

Seema C. Shah-Fairbank, M.ASCE, Assistant Professor, Ph.D., PE; Civil Engineering Department; California State Polytechnic University; Pomona, CA 91768, Tel: (909) 869-3954; Fax: (909) 869-4342; e-mail: shahfairbank@csupomona.edu; and Pierre Y. Julien, M.ASCE, Professor, Ph.D., P.Eng; Hydraulic Engineering Division; Department of Civil and Environmental Engineering; Colorado State University; Fort Collins, CO 80523, Tel: (970) 491-8450; Fax: (970) 491-7008; e-mail: pierre@engr.colostate.edu

Abstract  In sand bed rivers most of the sediment load is transported in suspension. Quantifying the total sediment load can be achieved by using the Modified Einstein Procedure (MEP), which uses a depth-integrated sampler to determine total load. MEP was developed by Colby and Hembree (1955), who extrapolated the velocity and concentration profile to determine the unmeasured load based on an estimated value of the Rouse number ($R_o$) (Colby and Hembree 1955). Over the years modifications have been made to the procedure (Burkham and Dawdy 1980; Colby and Hubbell 1961; Lara 1966; Shen and Hung 1983). MEP continues to be quite tedious and complex due to the methodology used to estimate $R_o$.

This study is to provide a clear indication of the range of applicability of MEP and develop a method that calculate total load with a higher degree of accuracy. The Series Expansion of the Modified Einstein Procedure (SEMEP) removes the empiricism found in a traditional MEP by performing calculation based on a median particle size in suspension and calculating bed load directly from the measured load. Analysis is performed on the modes of transport and program applicability is based on the measured total sediment load. The solution is solved by using the series expansion to solve the Einstein integrals (Guo and Julien 2004). The modes of transport are determined by analyzing $u^*/\omega (2.5/R_o)$ as a function of the suspended sediment load to total load ($q_m/q_t$) and the relative submergence ($h/d_s$). The range of applicability of SEMEP was estimated on fourteen rivers in the US, by determining $u^*/\omega$ as a function of the measured suspended sediment load to total load ($q_m/q_t$), $h/d_s$ and unmeasured depth ($d_u$). The results indicate that SEMEP performs quite well when the value of $u^*/\omega$ is greater than 5 (or $R_o$ less than 0.5).