Applicability of the Modified Einstein Procedure

Seema C. Shah-Fairbank[1] , Pierre Y. Julien[2] and Junke Guo[3]
Civil and Environmental Engineering Department, Colorado State University, Fort Collins, CO

Abstract. In sand bed channels the majority of sediment is transported in suspension. To quantify total load the Modified Einstein Procedure (MEP) has been developed, which uses a depth-integrated sampler to determine the measured load and then extrapolates to determine the unmeasured load based on the Rouse number. Over the years modifications have been made to the procedure; however, it continues to be quite tedious and complex due to the methodology used to determine the Rouse number. The purpose of this study is to provide a clear indication of the applicability of the MEP and develop a method that can simplify the procedure and include the necessary degree of accuracy.

Analysis is performed on the modes of transport and program applicability based on an analysis of the concentration and velocity profiles. The solution is solved by using the series expansion developed by Guo and Julien to solve the Einstein Integrals. The modes of transport are determined by analyzing the u_*/ω as a function of ratio of suspended sediment load to total load (q_s/q_t) and the relative submergence (h/d_s). When u_*/ω is greater then 2, the mode of transport is suspended load; when u_*/ω is between 0.5 and 2, the mode of transport is mixed load; when the u_*/ω is between 0.2 and 0.5, the mode of transport is bed load; and when u_*/ω is less than 0.2, there is no motion. Next, the applicability of the MEP can be determined by analyzing the u_*/ω as a function of ratio of measured suspended sediment load to total load (q_m/q_t) and h/d_s. When the value of u_*/ω is greater than 5, MEP is applicable; however, when the value of u_*/ω is between 1 and 5 both the Einstein Procedure and MEP must be verified.

Testing of the method has been conducted for a representative particle (d_s) using data from a Flume, the Enoree River, the Rio Grande and the Mississippi River. The results indicate the total load can be calculated quite accurately from a concentration and velocity profile. Continued analysis is being conducted on depth integrated samplers and the evaluation of the unit bed load and the Rouse number based on the measured data.

1 Graduate Research Assistant, Ph.D. Student ; Hydraulic Engineering Division; Civil and Environmental Engineering Department ; Colorado State University; Fort Collins, CO 80523-1372;
Tel: (970) 491-8783; e-mail: sshah@engr.colorstate.edu

2 Professor; Hydraulic Engineering Division; Department of Civil and Environmental Engineering; Colorado State University; Fort Collins, CO 80523-1372;
Tel: (970) 491-8450; e-mail: pierre@engr.colostate.edu

3 Assistant Professor; Water Resources; Department of Civil Engineering;
University of Nebraska-Lincoln; Omaha NE 68182-0178;
Tel: (402)554-3873; email: jguo2@unl.edu