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Standard Guide for Elements of a Complete Data Set for Non-Cohesive Sediments[1]

1. Scope

1.1 This guide covers criteria for a complete sediment data set.

1.2 This guide provides guidelines for the collection of non-cohesive sediment alluvial data.

1.3 This guide describes what parameters should be measured and stored to obtain a complete sediment and hydraulic data set that could be used to compute sediment transport using any prominently known sediment-transport equations.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1129 Terminology Relating to Water[2]

D 4410 Terminology for Fluvial Sediment[2]

D 4411 Guide for Sampling Fluvial Sediment in Motion[3]

D 4822 Guide for Selection of Methods of Particle Size Analysis of Fluvial Sediments (Manual Methods)[3]

D 4823 Guide for Core-Sampling Submerged, Unconsolidated Sediments[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology D 1129 and D 4410.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *diameter, intermediate axis*—the diameter of a sediment particle determined by direct measurement of the axis normal to a plane containing the longest and shortest axes.

3.2.2 *diameter, nominal*—the diameter of a sphere of the same volume as the given particle **(1)**.[4]

3.2.3 *diameter, sieve*—the size of sieve opening through which a given particle of sediment will just pass.

3.2.4 D_x—the diameter of the sediment particle that has x percent of the sample less than this size (diameter is determined by method of analysis; that is, sedimentation, size, nominal, etc.).

3.2.4.1 *Discussion*—Example: D_{45} is the diameter that has 45 % of the particles that have diameters finer than the specified diameter. The percent may be by mass, volume, or numbers and is determined from a particle size distribution analysis.

4. Summary of Guide

4.1 This guide establishes criteria for a complete sediment data set and provides guidelines for the collection of data about non-cohesive sediments.

5. Significance and Use

5.1 This guide describes what parameters should be measured and stored to obtain a complete sediment and hydraulic data set that could be used to compute sediment transport using any prominently known sediment-transport equations.

5.2 The criteria will address only the collection of data on noncohesive sediment. A noncohesive sediment is one that consists of discrete particles and whose movement depends on the particular properties of the particles themselves **(1)**. These properties can include particle size, shape, density, and position on the streambed with respect to other particles. Generally, sand, gravel, cobbles, and boulders are considered to be noncohesive sediments.

6. Procedure

6.1 Parameters discussed here are divided into three major categories: sediment, hydraulic, and others. Within each of these categories there is a listing of the minimum parameters that should be collected or analyzed for and some additional parameters that, although are not critical, would add significant information to the data set if recorded.

6.2 *Sediment Parameters (Minimal)*:

6.2.1 There are give basic sediment parameters that must be collected in order to have a complete data set. They are: concentration, bedload, bed material, particle-size distribution, and specific gravity.

6.2.1.1 *Concentration*—Report concentration of suspended-sediment or total-sediment samples in milligrams per litre (mg/L) or in parts per million (ppm). Collect these samples in

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.02.

[4] The boldface numbers in parentheses refer to the list of references at the end of this guide.

such a way that they represent either the point, vertical, or cross section sampled. Follow sampling guides set forth in Guide D 4411 or in Ref **(2)** when collecting suspended-sediment or total-load samples.

6.2.1.2 *Bedload*—Report discharge of bedload in megagrams per day (Mg/d) or some other form of mass per time unit. The procedures for the collection of bedload samples, both in a flume and in the field, have not been standardized as well as those for suspended sediment. This is in part because the sampler development has not achieved the state of uniformity that the suspended-sediment samplers have and because not enough is currently known about bedload transport in open channels to accurately define a protocol for data collection. However, the procedure outlined in Ref **(2)** appears to be a reasonable approach to the problem and gives the state of knowledge and equipment at the present time.

6.2.1.3 *Bed Material*—Because the bed material is the primary source of noncohesive sediments, collect detailed samples. Most field bed-material sampling programs have been restricted to sampling sand-bed streams because of the overall lack of knowledge and the practical problems associated with sampling gravel-bed streams **(3)**. References **(2)** and **(3)**, as well as Guide D 4823, present several methods for collection of bed-material samples from gravel-bed streams. Also, some of the equipment and procedures given in Ref **(2)** and Guide D 4823 can be used to collect samples from sand bed streams.

6.2.1.4 *Particle-Size Distribution*—Record the particle-size distribution in percent finer than a given diameter size. The most generally used size grading system for sediment work in the United States is the grade scale proposed by the Subcommittee on Sediment Terminology of the American Geophysical Union (AGU), which is an extension of the Wentworth scale **(1)**. Determine as an absolute minimum the percent finer than and greater than 0.062 mm. Ideally, determine all applicable breaks given on the AGU scale **(1)**. Determine particle size either as a physical size (sieve) or as a sedimentation (fall) diameter. Whichever method is used, record the method of determination. Guide D 4822 presents a way to help choose which method might work best given the particle sizes to be sampled and the units of the distribution desired. Several of the more common particle-size analysis methods are given in Ref **(4)**.

6.2.1.5 Preform particle-size distribution analysis on suspended-sediment, total-load, bedload, and bed-material samples. Results should indicate whether the diameters determined are sieve, fall, intermediate axis, or nominal diameters, and whether they are percent finer than by mass, volume, or number of particles.

6.2.1.6 Record the method or specific piece of equipment, or both, used to determine particle-size distribution.

6.2.1.7 *Specific Gravity*—The specific gravity of a particle effects to how the particle reacts in the flow. Most of the time the specific gravity is assumed to be 2.65. Although this is true most of the time, Brownlie **(5)** points out that about half of J. J. Franco's data has a specific gravity of 1.30 and that the following data sets have these ranges in specific gravity: Pang-Yung Ho, 2.45 to 2.70; C. R. Neill, 1.36 to 2.59; and U.S. Waterways Experiment Station, 1936c, 1.03 to 1.85.

6.3 *Sediment Parameters (Additional)*:

6.3.1 The following parameters are considered to be ones that are not absolutely necessary for a complete data set but would give significant additional information and clarification to the data.

6.3.1.1 *Specific Diameters*—Calculated diameters such as D_{16}, D_{35}, D_{50}, D_{65}, D_{84}, and D_{90} are quite often used in sediment transport equations. Having these computed diameter sizes stored in the data bases will allow everyone using the data in the future to use the same values for these percentiles, thus avoiding some additional sources of errors when comparing their results to the original developer's results. Store diameters in millimetres and give the type, that is, fall, sieve, etc.

6.3.1.2 *Method of Collection*—Document how the samples were collected. It is often very important to know if the samples were collected from single vertical or multiverticals, surface dipped, or point samples. This not only is important for suspended-sediment and total-load samples, but also is important for bedload and bed-material samples. If multiple verticals are used to collect the sample, note the number of verticals used and some general description of their placement in the cross section. If the sample is collected from a single point or vertical, identify the collection point.

6.3.1.3 *Sampler*—Record the type of sampler and nozzle size. The US-D, US-DH, and US-P series samplers **(1)** are depth integrating and point integrating samplers that collect samples of the water sediment mixture isokinetically. This ensures the proper concentration of sand is sampled from the stream. When collecting bedload samples, in addition to the sampler type and nozzle size, record the bag mesh opening size and nozzle flare if appropriate for the sampler being used.

6.4 *Hydraulic Parameters (Minimal)*:

6.4.1 There are four major hydraulic parameters that should be collected to provide a complete sediment-transport data set. They are water discharge, width, depth, and slope.

6.4.1.1 *Discharge, Water*—The amount or rate of water flowing past the sampling point or cross section at the time of sampling is extremely critical to understanding the interpretation of the sediment data collected. Chapter 1 of Ref **(6)** gives a good summary of how surface-water discharge data can be collected. Record water discharge in cubic metres per second (m^3/s).

6.4.1.2 *Width*—Channel or flume width is important in computing other hydraulic parameters, such as area and mean velocity, and for determining depth to width ratios that are used, among other things, to assess the bank or boundary effects. In addition, repeated measurements of channel width at the same location over a period of time can be useful, when used with other data, in determining bank and channel stabilization.

6.4.1.3 *Depth*—Record the average depth of flow. This depth is normally calculated by dividing the area of flow by the channel or flume width.

6.4.1.4 *Slope*—There are three common types of slope that are used: bed, water surface, and energy. For whichever slope is measured, or computed, record the value and type.

6.5 *Hydraulic Parameters (Additional)*:

6.5.1 *Area*—Cross sectional area of flow is normally one of the parameters computed when making discharge measurements, especially in the field. It is used in computing average stream depth in natural channels.

6.5.2 *Gage Height*—Record gage height, or stage, when repetitious measurements are made at a site over a long period of time or when flow conditions might be changing during the time taken to collect the sediment data, or both. Reference gage height to some fixed point at the site. By periodically recording gage height, water discharge, and cross sectional area, overall change of scour or fill in a channel. Also, assessment can be made of any changes in flow that occur during and between collection of sediment data, for example between the time the suspended-sediment samples were collected and the bedload discharge was measured, can be assessed.

6.5.3 *Hydraulic Radius*—Compute hydraulic radius from the area and wetted perimeter. Sometimes it is computed as, and assumed to be equivalent to, the average stream depth. It is always good to record what was used as the hydraulic radius and to describe how it was computed.

6.5.4 *Roughness Coefficient*—Record a roughness coefficient, usually either Manning's "*n*" or Chezy's "C". Estimate either in the field **(7, 8)** or compute using other hydraulic information.

6.6 *Other Parameters*:

6.6.1 In addition to the parameters listed above, record the following.

6.6.1.1 *Temperature*—Record temperature for each sediment data set collected. The concentration and distribution of sand particles with depth is affected by water temperature **(1)**. Lane and others **(9)** found that sediment transport for the same water discharge was approximately 2.5 times greater in the winter than in the summer on the lower Colorado River.

6.6.1.2 *Sample Information*—Record information about the sample. As a minimum, record the date, time, and sampling location (that is, stream name and location of sampling point on the stream). Record any information pertinent to the sample, such as any angle between the cross section and the perpendicular of the flow. If the samples were collected from a flume, note this as well as the location of the flume.

6.6.1.3 *Bed Forms*—If possible, record a description of the bed forms present at the time of data collection. If the bed forms cannot be observed, record a description of the water surface, that is, standing waves, boils, smooth, etc. Bed form can be a major contribution to the overall bed roughness of a stream. They also can cause alternating increases and decreases in stream depth and thus can cause locally strong eddies, which can bring about larger, short-term variations in sediment concentration.

6.6.1.4 *Conductivity/Dissolved Solids*—Like temperature, changes in dissolved solids can affect sediment-transport rates. Increases in dissolved solid can cause increases in sediment-transport rates for the same flow conditions.

6.6.1.5 *Site Description*—Whether the samples are collected in a flume or in the field, give a general description of the sampling site. Special note should be made of flow conditions, weather, sampling apparatus used, anything upstream or downstream that might have affected the sample collection process, and any tributary inflow that might have affected flow or mixing at the sampling cross section.

6.6.1.6 *Particle Shape*—Size alone may not be sufficient to adequately describe sediment particles **(1)**, also, use shape and roughness (p. 21 of Ref **(1)**). Shape describes the form of a particle. Roughness is a measure of the sharpness of radius of curvature of the edges.

6.6.1.7 *Collector*—Record the name of the individual(s) that collected the sample. This will allow others analyzing the data to evaluate the experience of the collector and therefore be better able to evaluate the data.

7. Precision and Bias

7.1 The precision is a function of the conditions encountered and the measurement techniques used for each measurement.

8. Keywords

8.1 data elements; sampling; sediment; surface-water

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