Coastal Engineering Technical Note

Sonic Sifting:
A Fast and Efficient Method for Sand Size Analysis

Purpose: This CETN introduces a cost-saving, fast and efficient method for grain size analysis of sand-size sediment. It describes a sonic sifter and outlines procedures for calibration.

Background: Dry sieving techniques for grain size analysis of sediment have historically been performed using a device called a Ro-Tap. This type of mechanical shaker (developed in the early 1900's) rapidly moves the sieve stack horizontally and at the same time delivers periodic downward strokes of a mallet to the lid. This type of three dimensional movement sorts individual sediment grains into their respective sizes. Eight-inch diameter screens are used and sieving times should be constant for all samples (minimum 15 minutes per stack at greater than 100 downward strokes per minute). Sample weights typically range from 30-100 grams. Detailed instrument procedures have been outlined in EM 1110-2-1906 (Headquarters, Department of the Army, 1970) and by Folk (1980).

Recently, another device has been developed for dry sieving called a sonic sifter. The sonic sifter combines three different motions providing complete particle separation; a vertically oscillating column of air, a repetitive mechanical pulse applied in a vertical direction (from the base of the sieve stack), and a horizontal mechanical pulse which helps to eliminate sediment agglomeration. Six clear, three-inch acrylic sieves, a fines collector, top cone, and diaphragm, are assembled in a stack of fixed height (Figure 1).

Presently, several models of sonic sifters are commercially available. Advantages over standard sieving techniques include: (1) variable intensity of sieving action by changing amplitude of sonic pulses (3600 pulses per minute); (2) noise levels are significantly decreased; (3) overall sieving times are reduced; (4) the unit is completely portable; and (5) three-inch diameter sieves allow pre-weighing (sieve empty) and post-weighing (sieve and sample), saving time and possible sand loss.

All tests were conducted with a GilSonic AutoSiever Model GA-1. This model has additional options: (1) sample timing is by user-programmable combinations of exact repeatable times and amplitudes; and (2) ramp-up and ramp-down sifting sequences avoid initial sample exposure to more severe agitation, preventing electrostatic attraction of fines to larger particles.

U. S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center
P. O. Box 631, Vicksburg, Mississippi 39180

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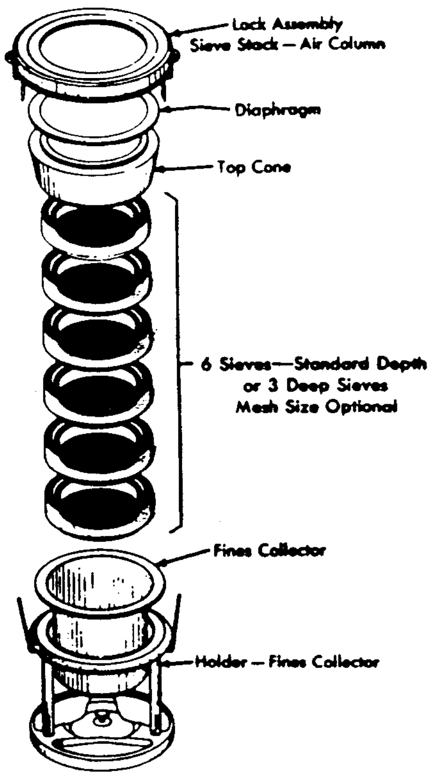

Figure 1. Sieve Stack Assembly
(ATM Corporation)

Operating Principle: The AutoSiever combines three motions to provide precise particle separation. Sonic pulses move only air in the sieve stack. The air column is driven by a voltage sensitive device, and since air velocity produced is proportional to voltage applied, relative amplitude indicates the percentage of full voltage set by the operator (0-99 %). Oscillating air introduces a vertical periodic motion to the sample (Figure 2), repeatedly giving the particles an opportunity to pass through the sieves. Sonic pulses required to separate particles are dependent upon particle size, density, and volume of sample on the screen. Various power levels may be selected to match the work required to initially oscillate materials being separated. Built-in electro-mechanical vertical and horizontal tapping helps to rearrange clustered particles, allowing sediment to pass through the sieve openings, providing an accurate grain size separation.

The GilSonic GA-1 sifter has a user-programmable combination of three time sequences and one maximum amplitude setting. These four test parameters are entered via a keypad:

1) Time A (ramp-up) - Time for pulsing to build from zero to maximum amplitude. During this period, small particles are gently separated from larger ones, roughly sorting grains on the sieve stack. This avoids initial exposure to more severe agitation which often creates electrostatic attraction of fines to larger particles, hindering proper separation.
2) Time B - Time for running at maximum amplitude.
3) Time C (ramp-down) - Time for amplitude to decline from maximum to zero. Gradual decrease at the end of the test allows complete separation of particles.
4) Maximum amplitude power setting (amplitude needed to begin rolling the largest particle on the sieve surface).

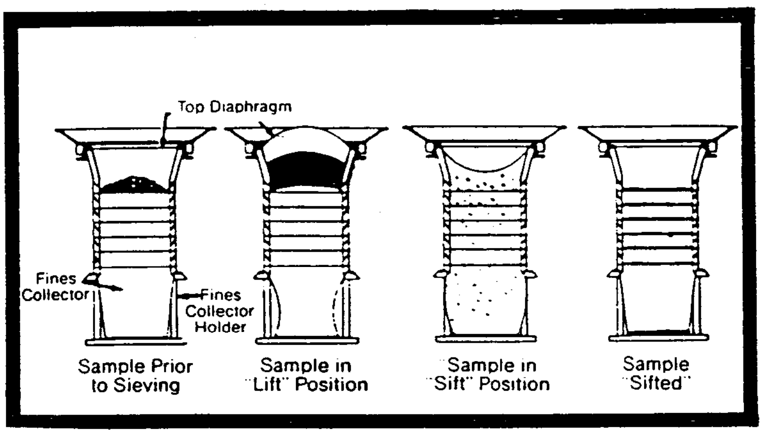

Figure 2. Diagram of four conditions during sieving operations (ATM Corporation).

Calibration Procedure: Sand-size sediment is generally divided into three broad classifications: coarse, medium, and fine. In order to establish run times for samples with means in each of the three sand-size groups, calibration tests were performed for various sample weights and particle sizes. These times were used to construct user-programmed time/amplitude sequences for processing field samples. Prior to calibration, test samples were prepared by selecting known quantities of sand from pre-sieved samples (using a Ro-Tap) at 0.25 phi intervals from gravel to very fine sand (-1.75 to 4.0 phi, 2.0 to 0.0625 mm). To prevent sieve overloading, initial sample weight selection for each broad size class was determined by calculating the maximum number of grains in a one grain layer for the range of sieves used. This provided a basis for setting standards for maximum sieving efficiency. A limit of three grain layers on any given sieve was used in setting sample weights at 50 g, 50 g, and 20 g for coarse, medium, and fine sand samples, respectively. Initial testing on variable ramp-up (A) and ramp-down (C) times showed no statistical difference in grain size analysis (mean or standard deviation) when either (A,C) was extended. Therefore, sifting calibration runs assume time A and C to be constant. Time B (time at maximum amplitude) was changed 0.2 minutes every test run.

Six different test sample times were evaluated from 1.6 - 5.6 minutes. Triplicates were run for each sample to statistically test the significance of changes in mean grain size with increased sifting time.

Results: An analysis of variance (ANOVA) F-test was used to compare computed means for each of the six test runs for coarse, medium, and fine grain samples. ANOVA results showed significant differences between the means for coarse ($F = 3.69$), medium ($F = 6.71$), and fine ($F = 10.86$) samples at the 95% probability level (critical F-value of 3.11). Additional statistical analysis (Student-Newman-Kuels Multi-Range Test) revealed no significant difference between computed means within each size class for test runs 2 through 6 (2.4 through 5.6 minutes). Therefore, samples show no significant increase in sieving efficiency after 2.4 minutes.

Summary: Sieving sand-size sediment, u-sing traditional methods, is a time-consuming process. Standard mechanical analysis typically takes 30 minutes to completely process one sample (-1.75 to 4.0 phi, 2.0 to 0.0625 mm). The sonic sifter provides a fast and accurate means of attaining the same kind of information provided by standard sieving techniques. Samples can be sieved in 2.4 minutes, providing increased production without sacrificing quality. The total cost of the GA-l, including all sieves, was approximately $4700 in 1986.

Additional Information: For additional information contact Dr. Donald K. Stauble (601) 634-2056, Donald.K.Stauble@erdc.usace.army.mil of the Coastal and Hydraulics Laboratory.

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