



Best Practices in Glass Recycling

Moisture Content Test of Glass Fill Using a Nuclear Densometer

Material: Recycled Glass

Issue: *The moisture content of a fill material will affect its compaction characteristics and needs to be evaluated during quality control of the fill operation. When the fill is drier than its optimum moisture content, any moisture in the fill serves as a lubricant and helps the relative movement of the particles when densifying under vibratory compaction. When the fill is wetter than its optimum moisture content, the moisture absorbs part of the compaction energy and prevents the formation of a denser material. Hence, moisture content determination constitutes an important part of quality control because the information is used in evaluating the compaction efficiency and material behaviors. Accurate assessment of the moisture content of a fill material is important also because the density requirement of fill is based on the dry density of the material, and the dry density is calculated based on the measurements of wet density corrected for moisture content.*

When using a nuclear densometer, the most popular test device, these measurements are conducted simultaneously using separate mechanisms. The dry density is then calculated by an integrated circuit in the densometer. Therefore, an accurate measurement of the moisture content is necessary for an accurate assessment of dry density and meaningful quality control. For a free-draining material such as cullet aggregate, the accuracy of moisture content measurement by a nuclear densometer may suffer from non-uniform distribution of the moisture in the material. Because the nuclear gauge measures moisture content through the level of hydrogen it detects, organic content in the cullet fill may cause erroneous moisture content measurements. For a complete discussion of using the nuclear densometer to test compaction, see the Density Test of Glass Aggregate Using a Nuclear Densometer Best Practice.

Best Practice: A study was conducted by the Clean Washington Center to investigate the suitability of nuclear densometer testing on glass cullet aggregate. The study compared the results obtained using a nuclear densometer with those obtained using a sand cone. The latter is a physical test which determines the density of the compacted material by measuring its volume and weight, and the moisture content by measuring the loss of moisture using an oven. The study concluded that nuclear densometers could be used to test cullet aggregate. No correction to the test results is required and the test procedures are the same as those used for natural materials. The test frequency is recommended to be the same as for natural material at one test per lift per 2,500 square feet of fill, but not less than one per lift.

Cullet aggregate has been used since 1993 in the Seattle area. Experience has been gained in the quality control of this fill material using a nuclear densometer. Some observations and recommended adjustments to the test procedure are provided in the following paragraphs.

1. Due to the free draining nature of the cullet aggregate, it has been found that moisture content increases toward the bottom of the lift. Since a nuclear densometer can only measure moisture content near the fill surface, the measurement may not be representative of the entire lift. It is recommended that confirmation tests be conducted with the upper portion of the fill excavated and moisture content measurements taken for the lower portion of the lift. The excavation must be large enough to avoid

Best Practices in Glass Recycling

side effects while using the densometer. The operation manual of the densometer should be consulted to obtain the required excavation size. A moisture offset based on an average moisture content should be required to be input into the densometer so that an average value can be used in the dry density calculation.

2. The nuclear densometer measures the moisture content of a fill material by proportioning its hydrogen content. Since water is the only source of hydrogen in most construction materials, the nuclear densometer will measure the moisture content correctly in most cases. However, for measurements of hydrogen-rich materials such as cullet containing organic debris, the nuclear densometer will mistakenly yield moisture content measurements that are higher than the actual amount. If not corrected, this elevated moisture content will result in a lower dry density, and erroneously report a lower compaction level. It is recommended that for cullet with debris content of 10 percent or higher by the visual classification method described in the *Visual Inspection for Recycled Glass as Construction Aggregate* Best Practice, moisture content be measured using the laboratory test method ASTM D2216. Test results should be compared to those obtained using a nuclear densometer. Based on this comparison, an offset of moisture content measurement by the nuclear densometer can be implemented in the field.

Implementation: Distribute this best practice among engineers and contractors and invite input to the practice. In the future, a modified practice may be incorporated into ASTM test standards. Seminars or discussion sessions should be held with the permitting authorities at the city, county, and state levels so that quality control procedures are standardized and acceptable. Modified practices should also be disseminated among owners, developers, equipment and material suppliers, architects, engineers and contractors so that valid procedures are followed in the field and results are agreeable among project team members.

Benefits: Nuclear densometers are the most popular tool in density testing of fill materials. The test is easy to perform and requires only a few minutes to complete. The test results are available at the completion of the test. Hence, the quality of the fill can be evaluated immediately and adjustment to the placement or compaction procedures can be made without delay of the fill operation. This simple test method allows the quality of fill to be controlled effectively and efficiently. The validation of methods for testing of cullet aggregate is a crucial step for the material to be considered for construction applications.

Application Sites: All construction sites that use cullet aggregate as a fill material.

Contact: for more information about this Best Practice, contact CWC at (206) 443-7746, e-mail info@cw.org.

References:

Annual Book of American Society for Testing and Materials, Volume 4.08 for Soil and Rock.

Shin, C. J., S&EE, Inc., Bellevue, WA

Suitability of Nuclear Densometer Testing on Glass Cullet Aggregate, Clean Washington Center Report GL-94-2, 1994.

Issue Date / Update: November 1996