Best Practices in Glass Recycling

Developing Specifications for Recycled Glass Aggregate

Material: Recycled Glass

Issue: *Glass is a relatively new construction aggregate material. The term "glass aggregate" includes, for this Best Practice, 100% glass, glass-soil, and glass-aggregate mixtures. In general, glass aggregate is durable, strong, easy to place, and easy to compact. The material can be used for construction applications including general backfill, roadways, utility backfill, drainage medium, and in miscellaneous uses such as landfill cover and underground storage tank backfill. For each application, the material should be specified based on the cullet content, gradation, debris level, and compaction level. Criteria for developing the specifications for any aggregate rely on a combination of technical data and practical historical experience. Currently, the availability of such criteria for glass aggregate is limited. This lack of information is a barrier to the increased use of the material.*

Best Practice: This best practice presents quality control measures applicable for all glass aggregate. The intent is to define the general parameters that must be considered when developing specifications. A more detailed development of specifications for glass aggregate in load-supporting (see the *Behavior of Glass Aggregate under Structural Loads*) and non-loaded applications (see *Glass in Non-Structural Construction Applications*) are presented in separate Best Practices.

Processing and Mixing: Specifications may require that the processed glass be blended with natural aggregate to a specific percentage. Because blending adds extra costs and can be difficult in the field, the specifying engineer should give serious consideration to the need for uniform blending. In many drainage or non-structural applications, it may be permissible to switch between 100% glass and 100% natural aggregate during the job without sacrificing quality. In structural applications, it may be more important to attain uniform blending. The blending process should prevent segregation of particles and debris.

Gradation. From an engineering standpoint, it has been shown that 1, ¾, ½, or ¼-inch minus cullet all perform well in appropriate applications. Glass of ¼-inch minus has a grain size close to that of a fine to coarse sand, whereas glass of ¼-inch plus is similar to a fine to coarse gravel. In general, cullet particles over one inch in size become platy in shape and are susceptible to breaking and chipping. A cullet fill containing greater than 10% of such coarse particles can experience gradation change during transportation and compaction, and possibly volume reduction upon loading. On the other hand, glass particles smaller than US No. 200 sieve will have a large surface area and can retain a relatively large quantity of moisture. A cullet fill containing greater than 10% of such fine particles can become sensitive to moisture content during compaction, and may be difficult to use during wet weather. The specifying engineer should begin with the same gradation as is required for natural aggregates in the application, then consider whether the function of the glass is to replace the natural aggregate with the same gradation or complement it with a gradation that improves the density of the fill.

Debris Level: Debris may be defined as any materials that may impact the performance of the engineered fill if present in sufficient quantities. Organic materials may decay and result in volume reduction. Metals, ceramics, and plastic, if present in large enough quantities, can affect the engineering properties. A visual classification method has been developed for field determination of debris level. See the *Visual Inspectionfor Glass Construction Aggregate* Best Practice. The debris level obtained using this visual procedure is much higher than the debris content measured by weight or volume. This is because paper residue, which appears to represent 10% by two-dimensional classification, may actually be less than 2% by volume or weight. Finally, a specification should always indicate that no hazardous materials are allowed.

Compaction. In order to achieve the desired engineering properties in the field, glass aggregate should be compacted to a specified minimum level in the field. The compaction levels are typically specified using maximum dry densities determined in the laboratory. For 100% cullet, the compaction data is found using a Standard Proctor test (ASTM D698). For glass-soil or glass-aggregate mixture, a Modified Proctor test (ASTM D1557) is typically used. The desired level of compaction is generally 90 to 95% of maximum dry density. The glass processor should keep data on the dry density of processed glass from that facility, and, if possible, a lab confirmation should be performed for the specific job.

The level of compaction should be field-verified by in-situ testing. The frequency of testing is typically one per 2,500 square feet of fill but not less than one per lift of fill. Nuclear densometers are the most commonly used device for density testing. However, due to the porous and heterogeneous nature of the material, modifications to the common test procedures should be specified when appropriate. Such modifications are presented in the following Best Practices: 1) *Compaction of Glass Aggregate*, 2) *Density Test of Glass Aggregate Using a Nuclear Densometer*, and 3) *Moisture Content Test of Glass Aggregate Using a Nuclear Densometer.*

Design Considerations. Considerations should be made regarding the exposure of the general public to cullet fills. Depending on the application, landscaping soil and vegetation, asphalt pavement, or concrete could be used to cover the cullet fills. Also, considerations should be made regarding cullet fills which are placed in contact with synthetic liners, geotextile, PVC pipes or pipes with protective coatings.

Implementation: This Best Practice presents a starting point for specifying engineers to begin to consider the kinds of construction applications in which they will use recycled glass aggregate. Given the considerations above, engineers should judge their own potential uses based on the properties of glass aggregate, the availability of properly processed glass, and local economics.

Benefits: The material behaviors of cullet fill and thus the criteria for developing specifications are similar to those of natural sand and gravel. Dissemination of the best practice information presented here will help engineers, contractors and permitting authorities to be familiar with cullet fill materials and ultimately increase their potential use in construction.

Application Sites: Glass processing facilities, construction sites, and testing laboratories.

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

References:

Numerous studies and reports have been generated for the use of glass in construction applications. See the Best Practice *Studies of Glass in Construction Applications* for descriptions of the primary references.

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