CWC

Best Practices in Glass Recycling

The Behavior of Glass Aggregate under Structural Loads

Material: Recycled Glass

Issue: *Recycled glass aggregate is a relatively new construction aggregate material. For this Best Practice, glass aggregate includes 100% glass and glass-aggregate mixtures. In general, glass aggregate is durable, strong, and easy to place and compact. For each application, specifications regarding the cullet content, cullet gradation, debris level, and compaction level are required. Specifications should be generated based on criteria that are related to the engineering behavior of the in-place material. When the material is used in structural load applications, the behavior and properties must be especially well understood.*

Best Practice: This best practice presents the material behaviors that can be expected for glass aggregate in load-supporting applications. General specifications, which relate mainly to quality control measures, are presented in the *Developing Specifications for Glass Aggregate* Best Practice.

Load-supporting backfill includes fills that support heavy stationary loads such as fill beneath footings and slabs, fluctuating loads such as those beneath reciprocating pumps, compressors or other machinery, and light-loaded conditions such as fill placed beneath pedestrian sidewalks.

Load-supporting fills must be strong, with minimal settlement potential under material self-weight and applied loads. The strength requirement can be achieved by compacting the material to a pre-determined density. The settlement potential can be minimized by controlling the gradation and deleterious debris content. Glass aggregate is a granular material that will deform elastically under load, but will return to the original volume when the load is removed. However, both organic and inorganic debris in the glass can effect the elasticity of the aggregate. No long-term deformation is expected if the debris is limited to less than 5% to 10% as determined by visual inspection. (See the *Visual Inspection for Recycled Glass as Construction Aggregate* Best Practice).

Cullet fill will apply lateral loads including active, at-rest, and passive pressures to a retaining structure. The magnitude of these loads is a function of the strength and density of the fill. Since glass aggregate is non-cohesive, its strength can be represented by its internal friction angle which is typically 38 to 42 degrees. Glass aggregate is generally lighter than natural aggregate because the specific gravity values of glass cullet (about 2.0 to 2.5) are less than those of natural aggregate. Therefore, the density of glass aggregate is a function of both the percentage of cullet content and the gradation of the material. Generally, the internal friction angle of a granular material is proportional to its density, which is in turn proportional to the level of compaction achieved in the fill.

Frictional resistance develops at the interface of fill particles and at the structure surface. In construction applications, the load-applying surfaces may include concrete, wood, steel, or plastic. Typically, the frictional resistance can be estimated using about 2/3 to 3/4 of the internal friction angle of the fill material. For critical structures, a laboratory direction shear test is recommended for the determination of the interface frictional resistance.

For fill under cyclic loading, both the strength and durability of the material are critical. The latter depends on gradation and material characteristics. The suitability of such fill can be evaluated using laboratory tests such as CBR (California Bearing Ratio), Resistance R-Value, or Resilient Modulus tests. The resilient modulus can be determined by cyclic triaxial tests. However, this test requires special equipment and is not commonly conducted. In engineering practice, the resilient modulus is often obtained from other test values such as CBR. For data on several gradations and mixtures of glass aggregate see (1).

The workability of a glass aggregate is generally good. The material is typically free-draining, therefore, its compaction characteristic is insensitive to moisture content. In dry weather, wetting the material is necessary for dust control.

Implementation: Enough laboratory research and field data has been accumulated to have a good understanding of the physical characteristics of glass as a construction aggregate (see the references below). However, in every region research data and anecdotal experience must be combined with the characteristics of local materials to determine the niche glass aggregate can fill in local aggregate applications.

Benefits: The material behaviors of cullet fill are similar to those of natural sand and gravel, and thus the criteria for specifications are relatively similar to those of natural materials. However, because glass aggregate is a relatively new construction material, the performance of glass aggregate in construction applications may draw more scrutiny than expected for customary materials. This makes it all the more important to be familiar with and understand the behavior of cullet fill materials.

Application Sites: Glass processing facilities, materials recovery 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:

Developing Specifications for Waste Glass and Waste-to-Energy Bottom Ash as Highway Fill Materials, Volume 2 of 2 (Waste Glass), Paul J. Cosentino Ph.D., P.E., et al., Florida Institute of Technology, 1995.

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