Dry State Physical Characteristics

Test Report #1: Dry State Physical Characteristics of Typical Freshwater AquaBlok® Formulations

Background and Purpose of Testing

The AquaBlok™ composite particle system typically includes a combination of clay minerals, polymers, and an aggregate core. As show in Figure 1, each AquaBlok particle typically consists of a clay-based outer shell (sealant layer) that is fixed with polymers to a nucleus (aggregate core) comprised of stone or other hard material.

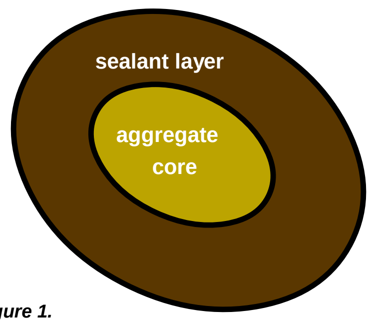

Figure 1. Configuration of Typical AquaBlok Particle.

AquaBlok's configuration facilitates efficient delivery of reactive clay components, like bentonite, through water to form a cohesive barrier between contaminated sediments and the overlying deepwater or wetland ecosystem. AquaBlok can be modified in terms of its physical or clay mineral characteristics to accommodate site-specific conditions or to meet overall project objectives. For example, bentonite based formulations are typically used for freshwater applications, whereas blended or attapulgite based formulations are typically used for most saline applications.

The purpose of this set of laboratory tests was to demonstrate general dry state physical characteristics of typical freshwater (bentonite based) formulations of AquaBlok, both in terms of bulk (mixed) characteristics as well as characteristics associated with discrete particle size classes.

Methods

Large bulk samples of AquaBlok were prepared using well graded stone aggregate plus proprietary polymers and varying quantities (weight percentages) of bentonite clay material. Aggregate used to prepare product samples for most of the testing was nominally equivalent in size gradation to AASHTO No. 57 aggregate. Some of the tested product was also prepared using core material nominally equivalent in size gradation to AASHTO No. 8 aggregate, or using selected blends of aggregate.

The formulations prepared ranged from a relatively bentonite-rich product (70% bentonite plus 30% aggregate, referred to as 7030 FW) to a much leaner formulation (20% bentonite plus 80% aggregate, referred to as 2080 FW).

Selected dry state physical characteristics of AquaBlok were demonstrated using representative subsamples of the prepared formulations. Physical characteristics determined included: air-dry bulk density and per-cent inter-particle porosity; particle size distribution and composition; moisture content; and average particle density.

Dry bulk density was determined by weighing dry masses of AquaBlok of known volumes. Percent inter-particle porosity was estimated as the quantity ((mean particle density - mean bulk density)/mean particle density) x 100. Particle size distribution was determined in general conformance with ASTM Method D421; this involved passing split-and quartered bulk sub-samples of a given formulation through a series of five metal sieves and measuring total particle mass retained on each sieve, as well as the finer material passing through the smallest (#10) sieve.

Particle composition was determined on oven-dry subsamples by physically removing clay coatings from aggregate and weighing respective clay and aggregate components.

Particle moisture content was determined in general conformance with ASTM Method D2216.

Average particle density was determined by first weighing subsamples of air-dry particles then determining the volume of water displaced by this mass of particles (to obtain sample volume).

Results

Testing results for selected formulations are presented in figures 2 through 6.

Observations and Conclusions

Air-dry bulk densities for different product formulations typically range from approximately 75 to 90 pounds per cubic foot (Figure 2). For a given aggregate type (e.g. No. 8), values tend to be higher when greater percentages of the formulation are comprised of aggregate. Bulk density values also vary with particle gradation, and to a lesser degree with moisture content.

Clay (bentonite)-rich formulations tend to be comprised of larger-diameter particles than are leaner product formulations, as illustrated by differences in the proportion of 1.00 – 0.75 inch-sized particles for the 7030 FW and 2080 FW formulations (Figure 3). This is an artifact of the manufacturing process.

Smaller particles tend to carry relatively higher percentages of clay than larger particles, particularly for relatively clay-rich formulations (Figure 4). This is also an artifact of the manufacturing process.

(continued on back)

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Figure 2. Typical Ranges for Dry Bulk Density and Estimated Inter-particle Porosity for Selected Freshwater AquaBlok Formulations

Product Formulation	Aggregate Core	Estimated Inter-particle Porosity (percent)	Dry Bulk Density, Typical Range (lbs/ft³) 75 80 85 90 95
2080 FW	No. 8	35	
3070 FW	No. 8	45	
4060 FW	No. 8	36	
2080 FW	No. 57	37	
4060 FW	No. 57	35	
5050 FW	No. 57	40	
3070 FW	Nos. 8 + 57	36	
3070 FW	Nos. 57 + 4	35	
3070 FW	No. 4	42	

Observations and Conclusions (con't)

Smaller particles tend to contain higher moisture content than larger particles (Figure 5). This is because moisture is primarily associated with the clay component and because smaller particle size fractions tend to have higher clay percentages than larger size fractions.

For any formulation, smaller particles tend to be somewhat less dense than larger particles (Figure 6). This is because of the presence of higher proportions of the relatively less dense clay. This apparent relationship between particle size and density is generally accentuated in bentonite-rich formulations in which relatively greater percentages of each particle size are comprised of clay rather than aggregate.

Figure 3. Particle Size Distribution (No. 57 aggregate core)

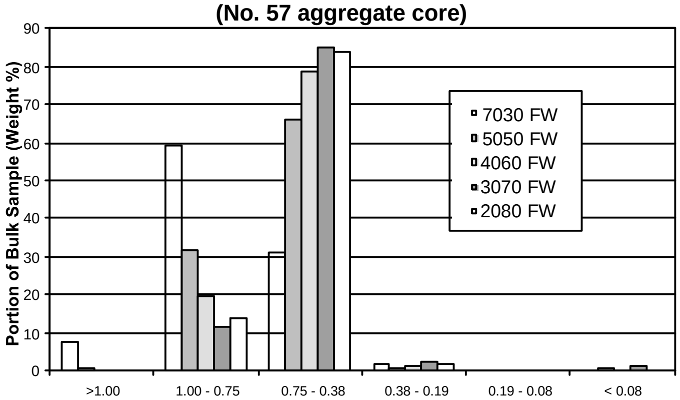


Figure 4. Relative Bentonite Content (No. 57 aggregate core)

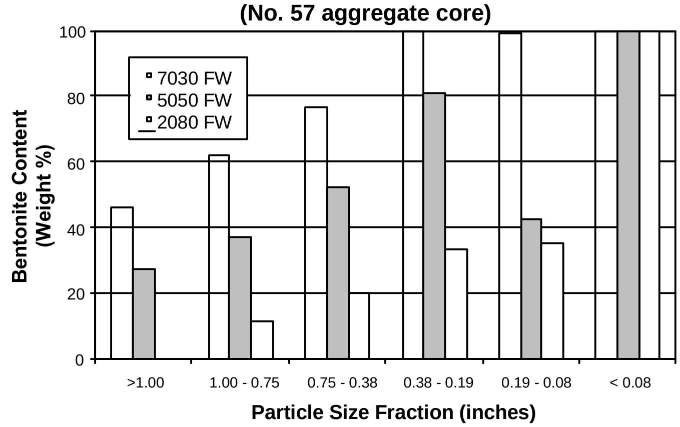


Figure 5. Moisture Content (No. 57 aggregate core)

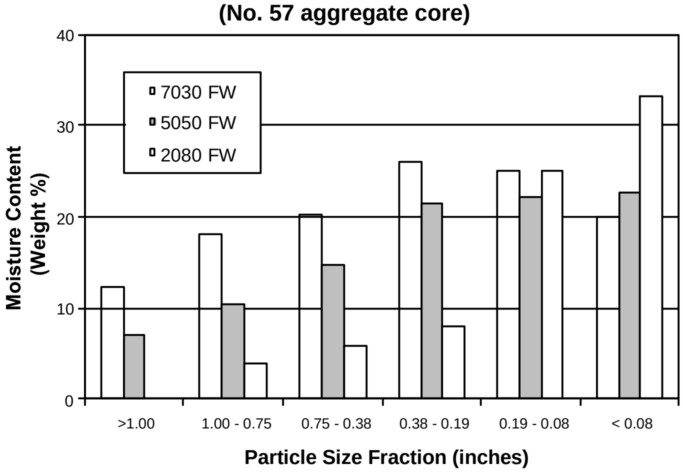
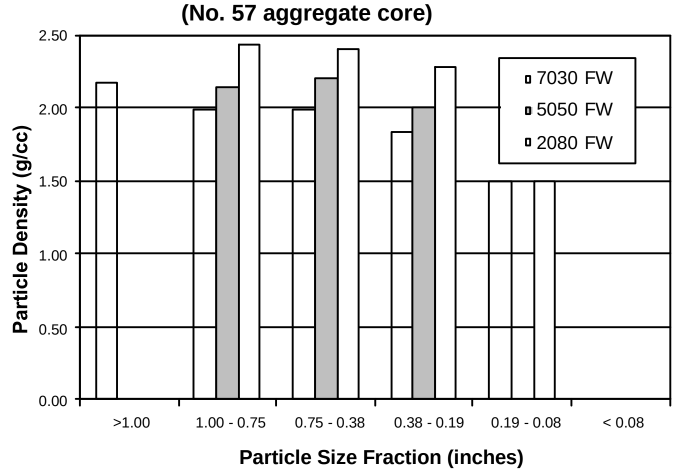


Figure 6. Particle Density (No. 57 aggregate core)



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