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Subject: **Final Report of ASTM C 330-17a**
Bloated Material - Russell County Reclamation
SGS TEC Services Sample ID: 23-1479

Mr. Matney

SGS TEC Services is an AASHTO R18, ANS/ISO/IEC 17025:2017, and is an Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this interim report of our testing on the expanded lightweight aggregate submitted to our laboratory in August of 2023. The results of this testing pertain only to the samples tested. The aggregate was tested in accordance with the applicable sections of ASTM C330-17 *Standard Specification for Lightweight Aggregates for Structural Concrete*.

This specification covers lightweight aggregates intended for use in structural concrete in which prime considerations are reducing the density while maintaining the compressive strength of the concrete. The maximum and minimum requirements for this specification are presented in Section 5 *Chemical Composition* and Section 6 *Physical Properties* of ASTM C330 and are reported in Table 1. Based on our results to date, the 1/2 Structural lightweight aggregate labeled as Bloated Material (Russell County Reclamation) submitted to our laboratory meet and/or exceeds the requirements of ASTM C330.

Table 1: Summary of Test Results

Section 5 - Chemical Composition	Test Results	ASTM C330 Requirements
Organic Impurities (Color change)	< 1	3 (max)
Staining (Stain index)	0	60 (max)
Loss on Ignition	2.33	5% (max)
Section 6 – Physical Properties		
Clay Lumps and Friable Particles (Dry mass)	0.3 %	2% (max)
Bulk Density (Loose)	47 lb/ft^3	55 lb/ft^3 (max)
Relative Density (Specific Gravity) (Saturated Surface-dry)	1.634	----
Relative Density (Specific Gravity) (Oven-Dry)	1.500	----
72-Hour Absorption	8.93 %	----
Compressive Strength (Requirement based off Calculated Equilibrium Density)	4380	3,740 psi (min)
Splitting Tensile (Requirement based off Calculated Equilibrium Density)	440	325 psi (min)
Drying Shrinkage	-0.032	-0.070 % (max)
Popouts	No Popouts	No Popouts
Grading	See Grading Below	
Resistance to Freezing and Thawing (Relative Dynamic Modulus, %)	100	----

Organic Impurities

The organic impurities were tested in accordance with ASTM C40-20 *Standard Test Method for Organic Impurities in Fine Aggregates for Concrete*.

Requirement – Lightweight aggregate subjected to the test for organic impurities shall not produce darker color than standard.

Result – The lightweight aggregate did not show any color change.

Iron Staining

The staining testing was tested in accordance with ASTM C641-17 *Standard Test Method for Iron Staining Materials in Lightweight Concrete Aggregates.*

Requirement – Lightweight aggregate shall have a stain index of less than sixty.

Result – The lightweight aggregate showed no stain, which indicates an index of 0.

Loss on Ignition

The loss of ignition was tested in accordance with ASTM C114-18 *Standard Test Methods for Chemical Analysis of Hydraulic Cement.*

Requirement – Lightweight aggregate shall have a loss of ignition not more than five percent.
Result – The material had a loss on ignition percentage of 2.33.

Clay Lumps and Friable Particles

The clay lumps and friable particles was tested in accordance with ASTM C142-17 *Standard Test Method for Clay Lumps and Friable Particles in Aggregates*.

Requirement – The amount of clay lumps and friable particles shall not exceed two percent by dry mass.
Results – The lightweight aggregate had 0.3 percent clay lumps and friable aggregate.

Grading

The grading was tested in accordance with ASTM C136-19 *Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*. The grading shall conform to the requirements in Table 1 of ASTM C330. The Grading and the required grading are reported in Table 2.

Table 2: Grading & Required Grading

Sieve Size	% Passing	Required % Passing (1/2 to #4)
¾ in	100.0	100
½ in	93.2	90 - 100
3/8 in	62.0	40 - 80
#4	13.8	0 - 20
#8	5.8	0 - 10
#16	3.5	---
#50	1.5	---
#100	0.7	---
#200	0.3	0 - 10

NOTE: The received material was crushed in a jaw-type crusher at SGS TEC Services in order to achieve the grading listed above.

Bulk Density (Loose)

The oven dried loose bulk density was tested in accordance with Method C-Shoveling of ASTM C29-17a *Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.*

Requirement – The maximum bulk density (loose) for coarse aggregate is 55 lbs/ft^3.
Result – The lightweight aggregate had an average bulk density (loose) of 47 lb/ft^3.

Specific Gravity & Absorption

The relative density and absorption were tested in accordance with ASTM C127-15 *Standard Test Method for Density, Relative Density (Specific Gravity) & Absorption of Coarse Aggregate*. The sample was dried to a constant mass and soaked for 72 hours. The specific gravity and absorption are reported in Table 3.

Table 3: Specific Gravity & Absorption

Absorption after 72-hour Soak (percent)	Relative Density (Specific Gravity) (Oven-Dry)	Relative Density (Specific Gravity) (Saturated Surface-Dry)
8.93	1.500	1.634

Concrete mixtures containing the lightweight aggregate were batched to make test specimens for compressive strength, splitting tensile, drying shrinkage and resistance to freezing and thawing. The material sources and amount of material used in the concrete mix are reported in Table 4. Fresh properties are reported in Table 5.

Table 4: Mix Proportions

Material	Source	Amount (pcy)
Portland Type I/II Cement	Cemex - Clinchfield	564
Fine Aggregate – Natural Sand	Lambert, Wiregrass	1450
Lightweight Aggregate – (1/2" to #4)	Russel County Reclamation	940
Air Entrainment	Vinsol Resin	1.2 oz/yd^3
Water Reducer	Type F – High Range	4.0 oz/yd^3
Water	Lawrenceville City Water	278
	Total	3,232

Table 5: Fresh Properties

Slump (inches)	2.25
Unit Weight (lb/ft^3)	119.4
Air Content (%)	6.0
Concrete Temperature (°F)	73

The oven-dry density of the concrete mixture was calculated by the mixture quantities, aggregate moisture content, and the volume of the concrete batch. The calculated equilibrium density of 113.7 lb/ft³ was calculated by adding 3 lb/ft³ to the calculated oven-dry density. The calculated equilibrium density is used to determine the specification requirements for the compressive and split tensile strengths.

Compressive Strength and Splitting Tensile Strength

Compressive Strength

The compressive strength was tested in accordance with ASTM C39-21 *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.*

Requirement – For concrete with combinations of normal weight and lightweight aggregates and a calculated equilibrium density of 113.7 lb/ft^3, the minimum compressive strength is 3,740 psi. This was calculated by interpolation from the values presented in section 5.2.1 and are reported in Table 6. The specimens tested were 4" x 8" cylinders and the results are reported in Table 7.

Table 6: Compressive & Splitting Tensile Strength Requirements

Calculated Equilibrium Density (lbs/ft^3)	**Splitting Tensile Strength Requirements (psi)**	**Compressive Strength Requirements (psi)**
110	310	3,000
115	330	4,000

Table 7: Compressive Strength Results

Sample ID	Compressive Strength (psi)
23-1479-A	4,200
23-1479-B	4,540
23-1479-C	4,600
23-1479-D	4,190
Average	**4,380**

Splitting Tensile

The splitting tensile strength was tested in accordance with C496 C496M-17 *Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens*.

Requirement – For a concrete with combinations of normal weight and lightweight aggregates and a calculated equilibrium density of 113.7 lb/ft^3, the minimum splitting tensile strength is 325 psi. The specimens tested were 6" x 12" cylinders and the results are reported in Table 8.

Table 8: Splitting Tensile Strength Result

Sample ID	Splitting Tensile Strength (psi)
23-1479-1	520
23-1479-2	385
23-1479-3	510
23-1479-4	480
23-1479-5	445
23-1479-6	395
23-1479-7	400
23-1479-8	390
Average	**440**

Drying Shrinkage

The drying shrinkage testing was tested in accordance with C157-17 *Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete* and modified per ASTM C330. Three length change beams (4" x 4" x 11¼") were moist cured for seven days. Upon the completion of the 7-day moist curing an initial reading was obtained, which was used as the base length for the drying shrinkage calculations. The samples were then placed in a curing cabinet maintained at 100 ± 2°F with a relative humidity of 32 ± 2% for 28 days.

Requirement – The drying shrinkage of the concrete specimens shall not exceed 0.07% at 28days.

Table 9: Drying Shrinkage at 28 Days

Sample ID	Length Change at 28 Days (%)
23-1479 (1)	-0.033
23-1479 (2)	-0.032
23-1479 (3)	-0.032
Average	**-0.032**

Popouts

Requirement – There shall be no popouts observed after test concrete made with the tested lightweight aggregate is subjected to an autoclave in accordance with ASTM C151-18 *Standard Test Method for Autoclave Expansion of Hydraulic Cement.*

Result – No popouts were observed.

Resistance to Freezing and Thawing

The freeze-thaw samples were tested in accordance with ASTM C666-15 *Resistance of Concrete to Rapid Freezing and Thawing – Procedure A (freezing and thawing in water)* with the curing modifications listed in ASTM C330.

Results – The average relative dynamic modulus after 300 cycles was 100%.

Results are reported in Table 10.

Table 10– Freeze-Thaw Testing – Cast Concrete Samples (3 beams)

Total Cycles Completed	Fundamental Transverse Frequency, khz			Relative Dynamic Modulus (%)			Weight Change (grams)			Length Change (inches)		
	Beam 1	Beam 2	Beam 3	Beam 1	Beam 2	Beam 3	Beam 1	Beam 2	Beam 3	Beam 1	Beam 2	Beam 3
0	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
36	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
72	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
108	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
144	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
180	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
216	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
252	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
288	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
300	1.731	1.731	1.731	100	100	100	0	0	0	0	0	0
Average Relative Dynamic Modulus				**100**			**0**			**0**		

We appreciate the opportunity of providing our services to you. If you have any questions pertaining to this report or need any additional information, please do not hesitate to call us.

Sincerely,

SGS, TEC SERVICES, INC.

Caleb Howard
Project Manager

Steven Maloof
Laboratory Principle/Sr. Project Manager