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Little Rock Air Force Base Aggregate and Concrete Testing

Jameson D. Shannon

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Little Rock Air Force Base Aggregate and Concrete Testing

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Final report

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Abstract

The Little Rock Air Force Base (LRAFB) tasked the ERDC to test and evaluate a concrete mixture design and the aggregates used therein. Experimentation consisted of basic aggregate test methods such as gradation, specific gravity, absorption, and organic materials. Concrete testing consisted of manufacturing a laboratory concrete mixture design provided by LRAFB and conducting compressive and flexural strength testing of cast specimens.

In most cases the selected aggregate and concrete mixture design testing met specifications. However, there were some areas, such as aggregate gradations, in which the materials did not align with specified values or standards. Final hardened concrete properties of compressive and flexural strength met the mixture design requirements.

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Preface

This study was conducted for the U.S. Army Corps of Engineers Little Rock District. The technical monitor was Dr. Jameson D. Shannon.

The work was performed by the Concrete and Materials Branch (GMC) of the Engineering Systems and Materials Division (GM), U.S. Army Engineer Research and Development Center, Geotechnical and Structures Laboratory (ERDC-GSL). At the time of publication, Mr. Christopher M. Moore was Chief, CEERD-GMC; Dr. G. William McMahon was Chief, CEERD-GM; and Ms. Pamela Kinnebrew, CEERD-GTZ, was the Technical Director for Military Engineering. The Deputy Director of ERDC-GSL was Dr. William P. Grogan, and the Director was Mr. Bartley P. Durst.

COL Ivan P. Beckman was the Commander of ERDC, and Dr. David W. Pitman was the Director.

Unit Conversion Factors

Multiply	Ву	To Obtain	
cubic feet	0.02831685	cubic meters	
degrees Fahrenheit	(F-32)/1.8	degrees Celsius	
feet	0.3048	meters	
gallons (US liquid)	3.785412 E-03	cubic meters	
inches	0.0254	meters	
square feet	0.09290304	square meters	
square inches	6.4516 E-04	square meters	
yards	0.9144	meters	

1 Introduction and Background

The construction and repair of concrete runways is an integral part of the operations of the U.S. Army Corps of Engineers for both military and civilian installations. Recently, issues involving the deterioration of runways by spalling, sometimes referred to as sliver spalling, have been designated as potentially problematic on a large scale. A possible cause of this issue was thought to be aggregate gradations used in the concrete mixture and, accordingly, studies to evaluate mixture gradation's relationship to concrete performance were desired.

This research effort seeks to investigate a concrete runway mixture design, focusing on aggregate gradations, in an attempt to determine the suitability of the mixture design for use. Aggregate gradations restrictions were based on the power 45 curve and workability versus coarseness factor. The mixture was evaluated by compressive and flexural strength, as well as fresh-mixed concrete properties and visual observations.

2 Experimental Program

2.1 Materials tested

Testing was conducted on a concrete mixture design with a focus on aggregate materials. The mixture design was originally developed for Little Rock Air Force Base (LRAFB) to be used in concrete paving operations. In total six material samples were obtained, one each of cement, fly ash, 1.5-in. crushed limestone aggregate, #57 aggregate, intermediate aggregate, and sand. The intermediate aggregate was identified only as "Product 1." Materials and proportions for the concrete mixture are listed in Table 1.

Material	Supplier	Weight (lb) per yd ³ of Concrete	Volume (ft ³) per yd ³ of Concrete
Cement	Ash Grove	428	2.18
Fly Ash	Martin Lake	183	1.17
1.5-in. Agg.	Granite Mtn.	740	4.53
#57 Agg.	Granite Mtn.	1040	6.34
Product 1	Granite Mtn.	396	2.42
Sand	Jeffrey	870	5.28
Water		208	3.33
Air			1.76

Water used in concrete mixing was onsite potable water from Vicksburg, MS. Euclid Admixtures AEA 92 (air entrainment) and Eucon NW (superplasticizer – water reducer) were used at dosage rates of 0.5-2.0 oz/cwt and 4-6 oz/cwt, respectively.

Sampling was conducted by ERDC personnel at the temporary stockpile locations at Little Rock AFB on 4 April 2017. Stockpiles were first "rolled" to remove the top layer of materials and to facilitate more accurate sampling. Samples of materials were then hand shoveled into 5-gal buckets and transferred to a larger container for transport. Cement, fly ash, and Product 1 were transported in 55-gal drums while 1.5-in., #57, and sand materials were transported in supersacks. Due to concerns about the age of admixtures at the Little Rock location, fresh admixtures were also collected by the ERDC to be used in the mixture designs.

2.2 Aggregate testing procedures

All aggregate testing was conducted by technicians with appropriate certifications and with equipment that is regularly calibrated and certified by an external laboratory. Aggregates were stored in their transportation containers, either supersacks or 55-gal drums, until tested. Aggregates were placed into a 3-ft³ concrete mixing drum and rotated before testing to alleviate any segregation that may have occurred during transportation. Gradations for all four aggregates were determined using ASTM C136 standards. Sieve sizes used for the 1.5-in. and #57 materials were 4 in. (100 mm), 3.5 in. (90 mm), 3 in. (75 mm), 2.5 in. (63 mm), 2 in. (50 mm), 1.5 in. (37.5 mm), 1 in. (25 mm), 0.75 in. (19 mm), 0.5 in. (12.5 mm), 0.375 in. (9.5 mm), No. 4 (4.75 mm), and No. 8 (2.36 mm).

For the "Product 1" aggregate, all larger sieve sizes were used, and No. 16 (1.18 mm) and No. 30 (600 μ m) were added. For the sand aggregate all larger sizes were used; and No. 40 (425 μ m), No. 50 (300 μ m), No. 100 (150 μ m), and No. 200 (75 μ m) were added. ASTM C117 standards were also conducted on all aggregates to determine materials finer than 75 μ m. All ASTM C136 and C117 testing was conducted with two different material samples, and results were based on the average.

Relative densities and absorptions of the 1.5-in., #57, and Product 1 materials were determined by ASTM C127 standards. Relative densities and absorption of sand were conducted according to ASTM C128 standards. All ASTM C127 and ASTM C128 testing was conducted on two different material samples, and results were based on the average. Organic impurity testing on the sand was conducted according to ASTM C40 standards. A test matrix for aggregate testing with the number of samples shown is in Table 2.

	ASTM Test Method and Number of Samples				
C136 C117 C127 C128					C40
1.5 in.	2	2	2		
#57	2	2	2		
Product 1	2	2	2		
Sand	2	2		2	1

Table	2.	Aggregate	testing	matrix.
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2.3 Concrete mixture design testing procedures

All concrete mixing and testing were conducted by technicians with appropriate certifications and with equipment that is regularly calibrated and certified by an external laboratory. Concrete mixtures were batched according to ASTM C192 standards. A single mixture design was batched in triplicate, and each batch had a volume of 3 ft³. The three batches were each mixed, tested for fresh properties, and placed into molds on the same day during a 6-hr period. Immediately after mixing, the batches were tested for fresh mixed properties of slump, air content, and unit weight according to ASTM C143, ASTM C231, and ATM C138 standards, respectively.

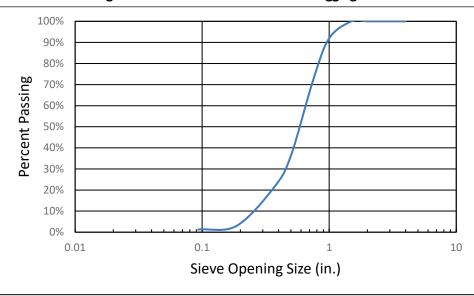
After fresh property testing was completed, four 6-in. x 12-in. cylinders and four 6-in. x 6-in. x 21-in. beams were manufactured from each concrete mixture using appropriate plastic molds. Cylinders and beams were extruded from their molds approximately 24 hr after batching and were stored in either a 100% humidity concrete curing room (cylinders) or a lime-water bath (beams) of appropriate temperature according to ASTM specifications. A single cylinder and single beam from each batch were tested at 3, 7, 14, and 28 days according to ASTM C39 and ASTM C78 standards.

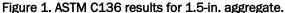
3 Results

3.1 Aggregate testing results

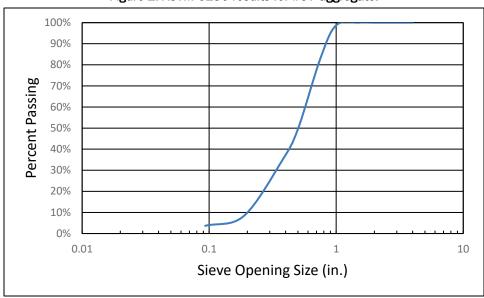
Final and processed data for aggregate testing are shown and discussed in this chapter. Raw data test results are included in Appendix A. Results from ASTM C136 for each aggregate are shown in Figures 1 through 4. Two samples were tested for each aggregate. Of the materials tested, the #57 and sand aggregates met their respective specified gradation requirements. The 1.5-in. aggregate did not meet one of the five size fraction requirements, and the Product 1 aggregate was dissimilar to any standard concrete aggregate size.

According to ASTM C33 (*Standard Specification for Concrete Aggregates*), the 1.5-in. material was most similar to a #467 aggregate. This aggregate size is constrained by 100% passing 2 in., 95-100% passing 1.5 in., 35-70% passing 0.75 in., 10-30% passing 0.375 in., and 0-5% passing No. 4. Results for the 1.5-in material are given in Figure 1. This material met all gradation requirements for a #467 aggregate except for 35-70% passing 0.75 in. For both samples, this aggregate was out of tolerance on this sieve size by an average of 2.43%, on the high side. The material was 100% passing on the 1.5-in. sieve and 92% passing on the 1in. sieve. This would indicate that the nominal maximum size is 1 in.





A #57 material is required by ASTM C33 to meet the size requirements of 100% passing 1.5 in., 95-100% passing the 1 in., 25-60% passing 0.5 in., 0-10% passing No. 4, and 0-5% passing No. 8. Results for the #57 material are given in Figure 2. The tested material met all requirements on both samples.





The aggregate "Product 1" was unknown but appeared to be an intermediate size aggregate. Results for the "Product 1" material are given in Figure 3. ASTM C136 results showed that this material did not meet the requirements of any concrete aggregate listed in ASTM C33. The most similar standard size material appeared to be a size #89, in which the material met three of the six gradation requirements for that size. Results for the sand aggregate material are given in Figure 4. The sand tested met all ASTM C33 requirements for a standard concrete fine aggregate.

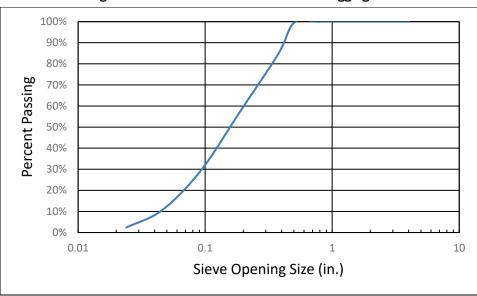
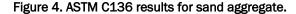
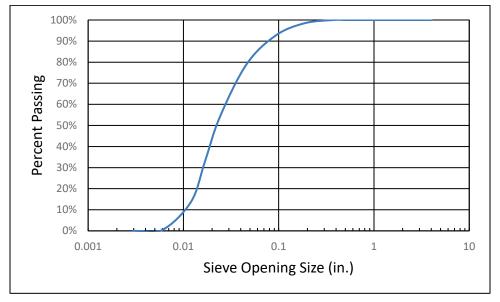


Figure 3. ASTM C136 results for Product 1 aggregate.





Results from ASTM C117 are shown in Table 3. The average value represents the percentage of material finer than the No. 200 sieve (75 μ m). The results indicate a normal to slightly low percent finer than No. 200 for the sand, and a normal to slightly high percent finer than No. 200 for the coarse and intermediate aggregates. Results from ASTM C127 and ASTM C128 are shown in Table 4. No outliers or abnormal percentage of fines was recorded for any of the materials tested.

Material	Sample 1	Sample 2	Average
1.5 in.	0.87%	0.90%	0.9%
#57	1.36%	1.51%	1.4%
Product 1	0.91%	0.90%	0.9%
Sand	0.19%	0.13%	0.2%

Table 3. ASTM C117 results.

	1.5 in.	#57	Product 1	Sand
Relative Density - OD	2.59	2.63	2.61	2.61
Relative Density - SSD	2.60	2.63	2.62	2.62
Relative Density - Apparent	2.61	2.65	2.64	2.64
Absorption	0.4%	0.3%	0.4%	0.4%

Table 4. ASTM C127 and ASTM C128 test results.

3.2 Combined aggregate testing results

A combined aggregate gradation was determined based on the specific mix design parameters listed in Table 1. Table 5 gives the results of the combined aggregate gradation. A combined percent retained chart was created and is shown in Figure 5. Each point on the percent retained curve designates a sieve size. Combined aggregate gradations were used in determining the power 45 curve (Figure 6) and coarseness and workability factors.

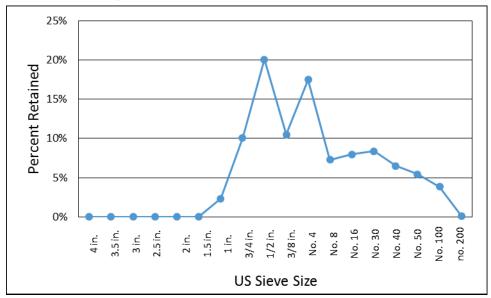
The combined percent retained showed an area of gradation between the No. 4 and No. 30 sieves in which there were two low points between two peaks. As per the specifications, it was indicated that there should be no more than one low point between two peaks.

The combined gradation curve (Figure 6) appears to stay within the upper and lower boundary with the exception of material smaller than the No. 30 sieve. This is generally normal for concrete mixtures to allow space for the paste portion. The gradation curve does approach the upper boundary from sizes No. 16 to No. 8 and again from 0.75 in. to 1 in.

Sieve Size	Individual % Ret	Cumulative % Ret	Cumulative %
	Rei	Rel	Passing
4 in.	0.00%	0.00%	100.00%
3.5 in.	0.00%	0.00%	100.00%
3 in.	0.00%	0.00%	100.00%
2.5 in.	0.00%	0.00%	100.00%
2 in.	0.00%	0.00%	100.00%
1.5 in.	0.00%	0.00%	100.00%
1 in.	2.34%	2.34%	97.66%
0.75 in.	10.06%	12.40%	87.60%
0.5 in.	20.07%	32.48%	67.52%
0.375 in.	10.50%	42.98%	57.02%
No. 4	17.50%	60.48%	39.52%
No. 8	7.26%	67.74%	32.26%
No. 16	7.96%	75.70%	24.30%
No. 30	8.39%	84.09%	15.91%
No. 40	6.50%	90.60%	9.40%
No. 50	5.42%	96.02%	3.98%
No. 100	3.86%	99.88%	0.12%
No. 200	0.12%	100.00%	0.00%

Table 5. Combined Aggregate Gradation.

Figure 5. Combined percent retained by sieve size.



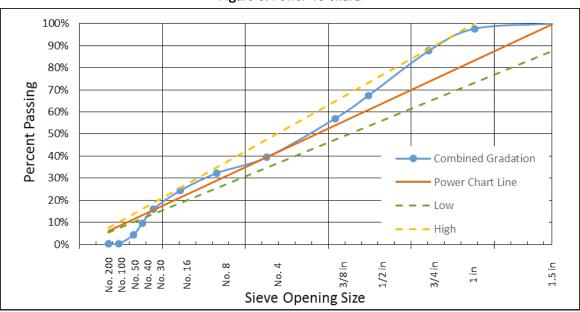


Figure 6. Power 45 chart.

The coarseness factor (CF) and workability factor (WF) for the combined aggregate gradation were determined using equations 1 and 2. Calculated values were 63.45 for CF and 33.51 for WF. Figure 7 illustrates the calculated CF versus WF factor and the target limits described in the specifications. As seen in the figure, the calculated values fell within the prescribed limits.

$$CF = \frac{cumulative \% retained on \frac{3}{8} - in \ sieve}{cumulative \% retained on \ No.8 \ sieve} * 100$$
(1)

 $WF = (cumulative \% passing No.8 sieve) + 2.5 * \frac{cementitious content-564}{94}$ (2)

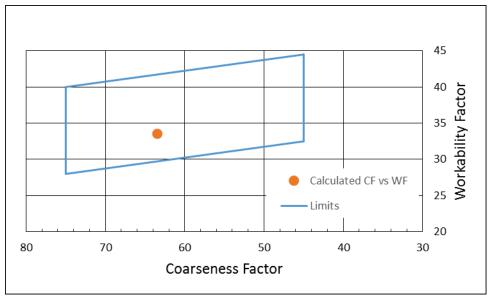


Figure 7. Calculated CF versus WF with limits shown.

3.3 Concrete mixture design results

Final and reduced data for concrete testing is shown and discussed in this section. Raw data test results are included in Appendix B. Moisture contents of the materials at the time of batching were 0.22%, 0.37%, 3.40% and 2.94% for 1.5-in., #57, "Product 1," and sand materials, respectively. Batch quantities were adjusted for moisture contents to ensure consistency with field mixtures. Fresh concrete properties are shown in Table 6 for each mixture. Target fresh properties were slump of 0-2 in., unit weight of 143.1 lb/ft³, and air content of $6\% \pm 1.5\%$. Values were rounded to either the nearest quarter inch (slump) or the nearest tenth (unit weight, air content, temperature).

	Slump (in.)	Unit Weight (lb/ft³)	Air Content (%)	Temperature (°F)
Batch 1	1.00	146.0	5.8	70.6
Batch 2	0.25	148.4	4.8	70.2
Batch 3	0.25	147.2	5.1	70.3
Average	0.50	147.2	5.2	70.4

Table 6. Fresh mixed concrete properties.

Slump met the specified requirements, but was on the lower half of the targeted values. Unit weight values were 2.9% higher than the theoretical calculated values for the mixture. Air contents were within specified tolerances, but were 1.3% lower, on average, than the target air content.

Temperature met the requirements outlined in standard ASTM specifications for laboratory mixed concrete.

Based on visual inspection immediately after mixing, the concrete appeared to be stiff or "boney." This was expected as recent studies by the Federal Highways Administration have noted that mixtures adhering closely to the maximum density line of the power 45 chart can be dense and difficult to work (FHWA-HIF-15-019, 2015). Cylinders and beams were vibrated to consolidate the mixture, and it was noted that the vibratory process took longer than for most concrete mixtures, and even with a longer vibration period there were still a large number of unclosed spaces and voids in the finished specimens. Figure 8 illustrates the unclosed holes in final specimens.



Figure 8. Specimen photos illustrating unclosed holes.

Table 7 and Table 8 show results for the flexural strength and compressive strength testing, respectively. A single specimen from each batch was tested at each test day so that the average results represent the average of one specimen each from three batches. Coefficients of variation (CoVs) are also included in the tables for statistical validation. The specification prescribed a flexural strength of 650 psi at 28 days. Based on the results from these tables, the mixture achieved sufficient flexural strength by seven days. Averages and CoV values show a good level of agreement between batches.

	3 Day	7 Day	14 Day	28 Day
Batch 1 (psi)	619	645	745	845
Batch 2 (psi)	615	675	720	970
Batch 3 (psi)	610	715	790	930
Average (psi)	615	678	752	915
CoV (%)	0.6	4.2	3.9	5.7

Table 7. Flexural strength results.

Table 8. Compressive strength results (psi).

	3 Day	7 Day	14 Day	28 Day
Mixture 1	*	4350	4980	5510
Mixture 2	4490	4610	5460	6010
Mixture 3	4010	4400	5220	5900
Average	4250	4453	5220	5807
CoV	5.7	2.5	3.8	3.7

 $^{\ast}\mbox{Cylinder}$ break was non-traditional and was excluded from average.

4 Summary and Conclusions

4.1 Summary

Of the coarse aggregate materials, the #57 material met all requirements of ASTM C33 for a #57 aggregate. The 1.5-in. aggregate was similar to a #467 material, meeting all but one of the five gradation requirements. As the "Product 1" aggregate was most similar to a #89 material but met only three of the six gradation requirements for a size #89, the "Product 1" material did not fit into any size category described in ASTM C33.

Specifications stated a coarse aggregate nominal maximum aggregate size of 1.5 in. However, based on testing contained in this report, the nominal maximum aggregate size was 1 in. The combined aggregate gradation met the requirements of the 45 power chart but was frequently at the maximum upper end of the limit. The gradation was within the limits of the coarseness versus workability factors.

The concrete mixture met the slump and air content tolerances as specified, but the air content was 1.3% lower, on average, than the target. Measured unit weight was 2.9% higher than theoretical. Visually, the mixture appeared stiff, or "boney," and was difficult to finish. The mixture was difficult to work into molds and had to be vibrated longer than usual to consolidate.

On average, hardened concrete properties of compressive and flexural strength met 28 day specification guidelines at 7 days.

4.2 Conclusions

In general, there were some discrepancies in the coarse aggregate materials, such as not fitting into ASTM C33 gradation categories and the actual nominal maximum aggregate size being lower than specified. However, the combined gradation was able to achieve the prescribed power 45 and workability versus coarseness requirements. Fresh mixed concrete properties of slump and air content and hardened properties of compressive and flexural strength also met the requirements outlined.

Despite meeting the tested concrete performance properties, the mixture was difficult to finish and consolidate. Definitive conclusions on mixture design performance are not obtainable from this study as only a portion of the specified requirements were evaluated. However, the mixture design did meet all of the combined gradation, fresh mixed concrete properties, and hardened concrete properties that were selected for testing.

5 Contact Information

Permission to publish was granted by the Director, Geotechnical and Structures Laboratory. For questions related to this investigation, contact

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- ______. 2017a. Standard test method for air content of freshly mixed concrete by the pressure method. Designation: ASTM C231/C231M-17a. West Conshohocken, PA: ASTM International.
- _____. 2017b. Standard test method for compressive strength of cylindrical concrete specimens. Designation: ASTM C39/C39M-17a. West Conshohocken, PA: ASTM International.
 - _____. 2017c. Standard test method for density (unit weight), yield, and air content (gravimetric) of concrete. Designation: ASTM C138/C138M-17a. West Conshohocken, PA: ASTM International.
- Federal Highway Administration (FHWA). 2015. *Blended aggregates for concrete mixture optimization – best practices for jointed concrete pavements*. FHWA-HIF-15-019. Washington, DC: FHWA.

Appendix A: Raw Data Sheets for Aggregate Testing

					AST	M C 136 & ASTM	C 117 WORKSHEE	T						
CMB Log I	n No.:				170076			Date:		15-May-17				
District:								Tested By:		CEERD-GM-C				
Material S	upplier:				Little Rock - AFB			Date Received:						
Sampled E	By:				S.M.			Material Type:		1 1/2in. Stone				
					ASTM C 13	6 Sieve Analysis of	Fine and Coarse Agg	regates						
			Date Tested:		15-May-17		Date Tested:		15-May-17		-	AST	IM C33 SPE	CIFICATIONS
				Ru	in 1			Ru	in 2		-		FOR: N	o. 467
Siev	e Size		Indiv	idual	Cumu	lative	Indiv	vidual	Cumu	lative	Average	Percent	Passing	
std.	mm	ŝ	Mass Retained,g	Percent Retained	Percent Retained	Percent Passing	Mass Retained,g	Percent Retained	Percent Retained	Percent Passing	Percent Passing	Min.	Max.	Results
4.0	100		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.5	90		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.0	75	×	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.5	63		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.0	50		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%	100%	100%	Pass
1.5	37.5	x	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%	95%	100%	Pass
1.0	25		1,272.20	8.46%	8.46%	91.54%	1,338.80	7.56%	7.56%	92.44%	92%			
3/4	19	x	2,986.50	19.86%	28.32%	71.68%	3,409.90	19.26%	26.82%	73.18%	72%	35%	70%	Out
1/2	12.5		5,391.10	35.85%	64.17%	35.83%	6,421.70	36.28%	63.10%	36.90%	36%			
3/8	9.5	×	2,167.00	14.41%	78.58%	21.42%	2,563.70	14.48%	77.58%	22.42%	22%	10%	30%	Pass
No. 4	4.75	×	2,768.50	18.41%	96.99%	3.01%	3,425.20	19.35%	96.93%	3.07%	3%	0%	5%	Pass
No. 8	2.36	×	260.20	1.73%	98.72%	1.28%	324.40	1.83%	98.76%	1.24%	1%			
F	an		192.30	1.28%	100.00%	0.00%	219.00	1.24%	100.00%	0.00%	0%			
Т	otal		15,037.80	100.00%			17,702.70	100.00%						
Fineness N	Aodulus:				7.026				7.001		7.01			
x = Sieves	used to c	alcu	late fineness modu	lus			Ru	n 1	Ru	n 2				
								Acceptance Range		Acceptance Range				
Yes	No		Results for	ASTM C 136 No. 200) include ASTM C 117	7 Results.	Original Dry Mass, g	15,083.0	Original Dry Mass, g	17,755.9				
	x						15,037.9	14,992.8	17,702.8	17,649.7				
		lf th	e same ASTM C 117	7 sample is used for	the above ASTM C 1	36 test then add th	e mass loss (g) from	ASTM C 117 to the p	oan mass retained (g) from ASTM C 136				
						ASTM C 117 Minus	75 μm (No. 200)							
Procee	lure A	×	Washed with Plain	Water			Date Tested:	12-M	lay-17					
Proces	lure B	h	Washed with Wett	ing Agent	I				I					
			Original D	ry Mass, g	Dry Mass A	fter Wash, g	Mass	Loss, g	Percer	nt Loss	Average			
R	un 1		15,1	69.5	15,0	37.9	13	1.6	0.8	7%	0.9%			
R	un 2		17,8	64.2	17,7	02.8	16	1.4	0.9	0%				

Table A1. ASTM C127 for 1.5-in. aggregate.

				ASTM C 127	ASTM C 127 Worksheet					
CMB Log in No.:			170076			Date:		16-M	16-May-17	
District:						Tested By:		CEERD	CEERD-GM-C	
Material Supplier:			Little Rock - AFB			Date Received:				
Sampled By:			S.M.			Material Type:		1 1/2in	1 1/2in. Stone	
			ASTM C 127 F	lelative Density and	ASTM C 127 Relative Density and Absorption of Coarse Aggregate	se Aggregate				
	ni Mass in	Oven-Drv Mase in S.S.D. Mase in Air	S.S.D. Mass in	Relative Density	Relative Dencity	Relative Dencity Annarent Relative	Dercent			
	Air, g			Oven-Dry	S.S.D.	Density	Absorption	Water Temp., C	Soak Time, hrs.	Pan No.
RUN 1	14,540.5	14,596.0	8,983.1	2.591	2.600	2,616	0.38%	22.6	21.0	R-4
RUN 2	17,154.2	17,210.9	10,592.0	2.592	2.600	2.614	0.33%	23.0	23.0	X-1
		AVERAGE		2.59	2.60	2.62	0.4%	22.8	22.00	

	ASTM C	127 Relative Densit	y and Absorption o	ASTM C 127 Relative Density and Absorption of Coarse Aggregate Precision	recision			
						ASTM C 127-15 Table 1 Precision	Table 1 Precision	
	Test F	Test Results				Vali	Values	Test Results
					Standard		Standard	Standard
				Standard	Deviation	Standard	Deviation	Deviation
	Run 1	Run 2	Average	Deviation (1s)	(d2s)1.96V2	Deviation (1s)	(d2s)1.96V2	(d2s)1.96V2
Relative Density Oven-Dry	2.591	2.592	2.59	0.001	0.002	600.0	0.025	Pass
Relative Density S.S.D.	2.600	2.600	2.60	0.000	0.000	0.007	0.020	Pass
Apparent Relative Density	2,616	2.614	2.62	0.002	0.005	0.007	0.020	Pass

Table A2. ASTM C127 for 1.5-in. aggregate.

				ASTM C 136 & C 117 PRECISION WORKSHEET								[
CMB Log	In No.:				170076			Date:		15-May-17		ĺ
District:							Tested By:		CEERD-GM-C			
Material	Supplier:				Little Rock - AFB			Date Received:				
Sampled	By:				S.M.			Material Type:		1 1/2in. Stone		
					ASTM C 13	6 Sieve Analysis of	Fine and Coarse Agg	gregates				
				Q	ımulative Test Resu	lts		ASTM C 1	36-14 Table 2 Precis	ion Values	Test Results	
Siev std.	ve Size	FM	Run 1 Total Percent Passing	Run 2 Total Percent Passing	Average Percent Passing	Standard Deviation (1s), %	Standard Deviation (d2s)1.96V2, %	Total Percent Passing	Standard Deviation (1s), %	Standard Deviation (d2s)1.96V2, %	Standard Deviation (d2s)1.96V2, %	
4.0	100		100.00%	100.00%	100.00%	0.00%	0.00%	Passing	Deviation (15), 70	(025)1.50¥2, %	(025)1.5092, %	
3.5	90	Π	100.00%	100.00%	100.00%	0.00%	0.00%					
3.0	75	Ţ	100.00%	100.00%	100.00%	0.00%	0.00%					
2.5	63	Î	100.00%	100.00%	100.00%	0.00%	0.00%					
2.0	50	Ħ	100.00%	100.00%	100.00%	0.00%	0.00%					Coarse Aggregate Values
1.5	37.5		100.00%	100.00%	100.00%	0.00%	0.00%					e Aggi
1.0	25		91.54%	92.44%	91.99%	0.63%	1.76%	95-85	0.81%	2.30%	Pass	regate
3/4	19	×	71.68%	73.18%	72.43%	1.06%	2.93%	80-60	2.25%	6.40%	Pass	Valu
1/2	12.5		35.83%	36,90%	36,37%	0.76%	2.10%	60-20	1.32%	3.40%	Pass	Sa
3/8	9.5	×	21.42%	22.42%	21.92%	0.71%	1.96%	60-20	1.32%	3.40%	Pass	
No. 4	4.75	×	3.01%	3.07%	3.04%	0.04%	0.12%	5-2	0.53%	1.50%	Pass	
No. 8	2.36	×	1.28%	1.24%	1.26%	0.03%	0.08%	2-0	0.27%	0.80%	Pass	

Table A3. ASTM C136 and ASTM C117 precision for 1.5-in. aggregate.

ASTM C 1	36-14 Table 2 Preci	sion Coarse Aggrega	te Values
Total Perce	ent Passing		Standard
Less	Greater or Equal	Standard Deviation (1s), %	Deviation (d2s)1.96v2, %
100%	95%	0.32%	0.90%
95%	85%	0.81%	2.30%
85%	80%	1.34%	3.80%
80%	60%	2.25%	6.40%
60%	20%	1.32%	3.40%
20%	15%	0.96%	2.70%
15%	10%	1.00%	2.80%
10%	5%	0.75%	2.10%
5%	2%	0.53%	1.50%
2%	0%	0.27%	0.80%

ASTM C	136-14 Table 2 Pre	ision Fine Aggregat	e Values
Total Perc	ent Passing		Standard
		Standard	Deviation
Less	Greater or Equal	Deviation (1s), %	(d2s)1.96√2, %
100%	95%	0.26%	0.70%
95%	60%	0.55%	1.60%
60%	20%	0.83%	2.40%
20%	15%	0.54%	1.50%
15%	10%	0.36%	1.00%
10%	2%	0.37%	0.40%
2%	0%	0.14%	0.60%

	270	070	012170	010070				
			ASTM C 1	17 Minus 75 μm (N	o. 200)			
						ASTM C 117-13	Table 1 Precision	
Test Results						Val	ues	Test Results
					Standard		Standard	Standard
				Standard	Deviation	Standard	Deviation	Deviation
	Run 1	Run 2	Average	Deviation (1s), %	(d2s)1.96√2, %	Deviation (1s), %	(d2s)1.96√2, %	(d2s)1.96v2, %
Percent Loss	0.87%	0.90%	0.9%	0.03%	0.07%	0.10%	0.28%	Pass

ASTM C 117-13 Coarse Aggre	
Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %
0.10%	0.28%

	ble 1 Precision Fine te Values
7661684	e values
	Standard
Standard	Deviation
Deviation (1s), %	(d2s)1.96v2, %
0.15%	0.43%

					۵st	M C 136 & ASTM	C 117 WORKSHEE	т						
⊢						11 C 150 G A5111	e II, wondshiel							
CMB Log I	n No.:				170077			Date:		15-May-17				
District:								Tested By:		CEERD-GM-C				
Material	Supplier:				Little Rock - AFB			Date Received:						
Sampled I	Ву:				S.M.			Material Type:		No. 57 Stone				
					ASTM C 13	86 Sieve Analysis of	Fine and Coarse Agg	regates						
			Date Tested:		15-May-17		Date Tested:		15-May-17			AS	TM C33 SPI	CIFICATIONS
				Ru	in 1			Ru	ın 2				FOR:	No. 57
Sie	ve Size	-	Indiv	ridual	Cumu	Ilative	Indiv	ridual	Cumi	lative	Average	Percent	Passing	
std.	mm	n 🖁 Mass Retained, g Percent Retained Percent Retained Percent Passing Mass Retained, g Percent Retained Percent Retained Percent Passing Percent Passing	Min.	Max.	Results									
4.0	100		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.5	90		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.0	75	×	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.5	63		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.0	50		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1.5	37.5	×	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%	100%	100%	Pass
1.0	25		128.40	1.15%	1.15%	98.85%	144.60	1.31%	1.31%	98.69%	99%	95%	100%	Pass
3/4	19	×	1,728.00	15.46%	16.61%	83.39%	1,780.90	16.13%	17.44%	82.56%	83%			
1/2	12.5		3,721.60	33.29%	49.90%	50.10%	3,696.50	33,48%	50.92%	49.08%	50%	25%	60%	Pass
3/8	9.5	×	1,673.30	14.97%	64.87%	35.13%	1,658.30	15.02%	65.94%	34.06%	35%			
No. 4	4.75	×	2,998.30	26.82%	91.69%	8.31%	2,850.70	25.82%	91.76%	8.24%	8%	0%	10%	Pass
No. 8	2.36	×	518.50	4.64%	96.33%	3.67%	507.90	4.60%	96.36%	3.64%	4%	0%	5%	Pass
	Pan		410.20	3.67%	100.00%		401.70	3.64%	100.00%	0.00%				
	otal		11,178.30	100.00%			11,040.60	100.00%						
Fineness I					6.695				6.715		6.70			
		alca	ulate fineness modu	due			P	n 1		m 2				
	used to a			ind 5				Acceptance Range		Acceptance Range				
Ver	No	Γ					Original Dry Mass,		Original Dry Mass,	11,073.9				
Yes	No		Results for a	ASTM C 136 No. 200) include ASTM C 117	7 Results.	ь 11,178.5	11,145.0	11,040.8	11,007.7				
		y th	ie same ASTM C 117	r sumple is used for	uie doove ASTM C1			HOTHIC 117 to the J	pan mass retained (y from ASTNI C 136.				
		x				ASTM C 117 Minus								
	dure A		Washed with Plain				Date Tested:	12-M	lay-17]				
Proce	dure B	-	Washed with Wetti											
<u>├</u>				ry Mass, g		fter Wash, g		Loss, g		nt Loss	Average			
	un 1	-		32.7		178.5		4.2		16%	1.4%			
R	un 2		11,2	10.1	11,0)40.8	16	9.3	1.5	51%				

Table A4. ASTM C136 and ASTM C117 for #57 aggregate.

				ASTM C 127 Worksheet	Worksheet					
CMB Log In No.:			170077			Date:		16-M	16-May-17	
District:						Tested By:		CEERD	CEERD-GM-C	
Material Supplier:			Little Rock - AFB			Date Received:				
Sampled By:			S.M.			Material Type:		No. 57	No. 57 Stone	
			ASTM C 127 R	ASTM C 127 Relative Density and Absorption of Coarse Aggregate	Absorption of Coar	rse Aggregate				
	ni na Marcin	and the second	CCD Marris	Pol-tivo Doncine	Polotine Dencine	Dolosius Darritus Assesses Dalotius	Descont			
	Air, g		Water, g		S.S.D.	Density	Absorption	Water Temp., C	Soak Time, hrs.	Pan No.
RUN 1	10,241.3	10,273.1	6,377.7	2.629	2.637	2,651	0.31%	22.6	22.0	101
RUN 2	10,133.1	10,167.4	6,304.8	2.623	2.632	2.647	0.34%	22.4	23.5	1
		AVERAGE		2.63	2.63	2.65	0.3%	22.5	22.75	
		ASTM C 1	ASTM C 127 Relative Density and Absorption of Coarse Aggregate Precision	and Absorption of	Coarse Aggregate F	Precision				
			,				ASTM C 127-15 1	ASTM C 127-15 Table 1 Precision		

	Test Results	Standard Deviation (d2s)1.96v2	Pass	Pass	Pass
	able 1 Precision Jes	Standard Deviation (d2s)1.96v2	0.025	0.020	0.020
	ASTM C 127-15 Table 1 Precision Values	Standard Deviation (1s)	600.0	0.007	0.007
recision		Standard Deviation (d2s)1.96V2	0.011	0.010	0.007
ASTM C 127 Relative Density and Absorption of Coarse Aggregate Precision		Standard Deviation (1s)	0.004	0.004	0.003
y and Absorption of		Average	2.63	2.63	2.65
127 Relative Densit	Test Results	Run 2	2.623	2.632	2,647
ASTM C	Test R	Run 1	2.629	2.637	2,651
			Relative Density Oven-Dry	Relative Density S.S.D.	Apparent Relative Density

Table A5. ASTM C127 for #57 aggregate.

					ASTM	C 136 & C 117 PR	ECISION WORKS	IEET				ĺ
CMB Log	In No.:				170077			Date:		15-May-17		ĺ
District:								Tested By:		CEERD-GM-C		
Material	Supplier:				Little Rock - AFB			Date Received:				
Sampled	By:				S.M.			Material Type:		No. 57 Stone		
					ASTM C 13	6 Sieve Analysis of	Fine and Coarse Ag	gregates				[
				0	umulative Test Resu	lts		ASTM C 1	36-14 Table 2 Precis	ion Values	Test Results	
Sier std.	ve Size	FM	Run 1 Total Percent Passing	Run 2 Total Percent Passing	Average Percent Passing	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %	Total Percent Passing	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %	Standard Deviation (d2s)1.96v2, %	
4.0	100		100.00%	100.00%	100.00%	0.00%	0.00%	- user	Definition (15), 10	(all participate)	(azyriserzy is	
3.5	90		100.00%	100.00%	100.00%	0.00%	0.00%					
3.0	75	x	100.00%	100.00%	100.00%	0.00%	0.00%					
2.5	63		100.00%	100.00%	100.00%	0.00%	0.00%					Ι.
2.0	50		100.00%	100.00%	100.00%	0.00%	0.00%					
1.5	37.5	x	100.00%	100.00%	100.00%	0.00%	0.00%					8
1.0	25		98.85%	98.69%	98.77%	0.11%	0.32%	100-95	0.32%	0.90%	Pass	
3/4	19	x	83.39%	82.56%	82.98%	0.59%	1.63%	85-80	1.34%	3.80%	Pass	
1/2	12.5		50.10%	49.08%	49.59%	0.72%	2.00%	60-20	1.32%	3.40%	Pass	
3/8	9.5	x	35.13%	34.06%	34.60%	0.76%	2.10%	60-20	1.32%	3.40%	Pass	
No. 4	4.75	×	8.31%	8.24%	8.28%	0.05%	0.14%	10-5	0.75%	2.10%	Pass	
No. 8	2.36	x	3.67%	3.64%	3.66%	0.02%	0.06%	5-2	0.53%	1.50%	Pass	

ASTM C 1	36-14 Table 2 Preci	sion Coarse Aggrega	te Values
Total Perc	ent Passing		Standard
		Standard	Deviation
Less	Greater or Equal	Deviation (1s), %	(d2s)1.96v2, %
100%	95%	0.32%	0.90%
95%	85%	0.81%	2.30%
85%	80%	1.34%	3.80%
80%	60%	2.25%	6.40%
60%	20%	1.32%	3.40%
20%	15%	0.96%	2,70%
15%	10%	1.00%	2.80%
10%	5%	0.75%	2.10%
5%	2%	0.53%	1.50%
2%	0%	0.27%	0.80%

ASTM C	136-14 Table 2 Pred	cision Fine Aggregat	e Values
Total Perc	ent Passing		Standard
Less	Greater or Equal	Standard Deviation (1s), %	Deviation (d2s)1.96v2, %
100%	95%	0.26%	0.70%
95%	60%	0.55%	1.60%
60%	20%	0.83%	2.40%
20%	15%	0.54%	1.50%
15%	10%	0.36%	1.00%
10%	2%	0.37%	0.40%
2%	0%	0.14%	0.60%

	2%	0%	0.27%	0.80%				
			ASTM C 1	17 Minus 75 μm (No	o. 200)			
							Table 1 Precision	
Test Results						Coarse Aggr	egate Values	Test Results
					Standard		Standard	Standard
				Standard	Deviation	Standard	Deviation	Deviation
	Run 1	Run 2	Average	Deviation (1s), %	(d2s)1.96v2, %	Deviation (1s), %	(d2s)1.96v2, %	(d2s)1.96v2, %
Percent Loss	1.36%	1.51%	1.4%	0.11%	0.29%	0.10%	0.28%	Pass

ASTM C 117-13	Table 1 Precision
Coarse Aggre	egate Values
	Standard
Standard	Deviation
Deviation (1s), %	(d2s)1.96√2, %
0.10%	0.28%

	ble 1 Precision Fine te Values
Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %
0.15%	0.43%

					AST	M C 136 & ASTM	C 117 WORKSHEE	т						
CMB Log I	n No.:				170078			Date:		11-May-17				
District:								Tested By:		CEERD-GM-C				
Material S	iupplier:				Little Rock - AFB			Date Received:						
Sampled I	Вү:				S.M.			Material Type:		Product No. 1				
		_			ASTM C 13	6 Sieve Analysis of	Fine and Coarse Agg	regates						
			Date Tested:		11-May-17		Date Tested:		11-May-17			AST	TM C33 SPE	CIFICATIONS
				Ru	in 1			Ru	in 2			FOR:		
Siev	ve Size	Run 1 Run 2 FOR:												
std.	mm	Z	Mass Retained,g	Percent Retained	Percent Retained	Percent Passing	Mass Retained,g	Percent Retained	Percent Retained	Percent Passing	Percent Passing	Min.	Max.	Results
4.0	100	\square	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.5	90	\square	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.0	75	×	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.5	63		0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.0	50	\square	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1.5	37.5	x	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1.0	25	\square	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3/4	19	x	0.00	0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1/2	12.5		27.30	0.40%	0.40%	99.60%	41.10	0.61%	0.61%	99.39%	100%			
3/8	9.5	x	1,018.90	14.95%	15.35%	84.65%	1,003.60	14.90%	15.51%	84.49%	85%			
No. 4	4.75	x	1,887.10	27.68%	43.03%	56.97%	1,835.50	27.25%	42.76%	57.24%	57%			
No. 8	2.36	x	1,872.80	27.47%	70.50%	29.50%	1,857.70	27.58%	70.34%	29.66%	30%			
No. 16	1.18	x	1,282.60	18.81%	89.32%	10.68%	1,279.80	19.00%	89.34%	10.66%	11%			
No. 30	600 µm	x	562.20	8.25%	97.56%	2.44%	559.70	8.31%	97.65%	2.35%	2%			
	Pan	_	166.10	2.44%	100.00%	0.00%	158.30	2.35%	100.00%	0.00%				
т	otal		6,817.00	100.00%			6,735.70	100.00%						
Fineness I	Modulus:				5.158				5.156		5.16			
x = Sieves	used to c	alcu	late fineness modu	lus			Ru	n 1	Ru	n 2				
		-					Original Dry Mass	Acceptance Range	Original Doy Mass	Acceptance Range				
Yes	No		Results for I	ASTM C 136 No. 200) include ASTM C 11	7 Results.	Original Dry Mass, g	6,837.5	Original Dry Mass, g	6,755.9				
	x						6,817.0	6,796.5	6,735.7	6,715.5				
⊢	ļ	lf th	e same ASTM C 117	7 sample is used for	the above ASTM C 1	36 test then add th	e mass loss <mark>(g)</mark> from	ASTM C 117 to the J	pan mass retained (g	a) from ASTM C 136				
<u> </u>						ASTM C 117 Minus	75 μm (No. 200)							
Proces	lure A	x	Washed with Plain	Water			Date Tested:	10-M	lay-17					
Proces	dure B		Washed with Wetti	ing Agent										
⊢			Original D	ry Mass, g	Dry Mass A	fter Wash, g	Mass	Loss, g	Percer	nt Loss	Average			
R	un 1		6,87	79.4	6,8	17.0	62	2.4	0.9	1%	0.9%			
R	un 2		6,79	96.6	6,7	35.7	60).9	0.9	0%				

Table A7. ASTM C137 and C137 for Product 1 aggregate.

		Worksheet	: For Weighted Va	lues of Realative	Density and Abso.	rption Tested in S	Worksheet For Weighted Values of Realative Density and Absorption Tested in Separte Sizes By Methods ASTM C 127 & C 128	lethods ASTM C 1	127 & C 128		
CMB Log In No.:				170078			Date:		26-May-17	17-yr	
District:							Tested By:		CEERD-GM-C	GM-C	
Material Supplier:				Little Rock - AFB			Date Received:				
Sampled By:				S.M.			Material Type:		Product No. 1	t No. 1	
Size F	Size Fraction				Weighted Value of		Weighted Value of		Weighted Value of		Weighted Value of
std.	ww	Avg. Percent Retained	Sample Mass Used in Test	Avg. Relative Density Oven-Dry		Avg. Relative Density S.S.D.	Relative Density S.S.D.	Avg. Apparent Relative Density	Apparent Relative Density	Avg. Percent Absorption	Percent Absorption
1/2 to No. 4	37.5 to 4.75	42,90%	9,468.0	2,611	0.164	2.624	0.164	2,643	0.162	0.461%	0.198%
No. 8 to No. 30	2.36 to 600 µm	57.11%	2,012.2	2,615	0.218	2.625	0.218	2,642	0.216	0.380%	0.217%
Total	Results	100%	11,480.2		2.61		2.62		2.64		0.4%
				ASTM C 128	ASTM C 128 Relative Density and Absorption of Fine Aggregate	d Absorption of Fin	e Aggregate				
Test Size	Test Size: 500 ± 10g		Mass of	Mass of							
Run	Flask No.	S.S.D. Mass in Air, g	S.S.D. Mass in Air, Pycnometer with g Water, g	Pycnometer with Water & Sample, g	Pycnometer with Oven-Dry Mass in Relative Density Water & Sample, g Air, g Oven-Dry	Relative Density Oven-Dry		Relative Density Apparent Relative S.S.D. Density	Percent Absorption	Water Temp., C	Soak Time, hrs.
1	٩	502.00	1440.50	1751.40	500.10	2.617	2.627	2.643	0.38%	22.8	24.50
2	8	501.30	1429.10	1740.30	499.30	2,627	2,637	2.654	0.40%	22.9	24.40

Table A8. ASTM C127 and ASTM C128 for Product 1 aggregate.

25.00 25.00 24.75

22.8 22.8 22.8

0.40%

2.624 2.624 2.63

2.614 2.614 2.62

503.90 501.10

1761.80 1766.50

1448.70 1455.20

505.90 503.00

u 0

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AVERAGE

2.641

2.64

					ASTM C 128 Worksheet	Worksheet					
CMB Log In No.:				170078			Date:		24-M	24-May-17	
District:							Tested By:		CEERD	CEERD-GM-C	
Material Supplier:				Little Rock - AFB			Date Received:				
Sampled By:				S.M.			Material Type:	Pr	oduct No. 1 (No. 8	Product No. 1 (No. 8 to No. 30 - Sample 2)	
				ASTM C 128	ASTM C 128 Relative Density and Absorption of Fine Aggregate	d Absorption of Fin	e Aggregate				
Test Size:	Test Size: 500 ± 10g		Mass of	Mass of							
Run	Flask No.	S.S.D. Mass in Air, g	-	Pycnometer with Pycnometer with Oven-Dry Mass in Relative Density Water, g Water & Sample, g Air, g Oven-Dry	Oven-Dry Mass in Air, g	Relative Density Oven-Dry	Relative Density S.S.D.	Relative Density Apparent Relative 5.S.D. Density	Percent Absorption	Water Temp., C	Soak Time, hrs.
1	С	505.90	1448.70	1761.80	503.90	2.614	2.624	2.641	0.40%	22.8	25.00
2	D	503.00	1455.20	1766.50	501.10	2,614	2,624	2,640	0.38%	22.8	25.00
			AVE	AVERAGE		2.61	2.62	2.64	0.4%	22.8	25.00
			ASTM C	ASTM C 128 Relative Density and Absorption of Coarse Aggregate Precision	y and Absorption of	Coarse Aggregate F	recision				
			Test R	Test Results				ASTM C 128-15 Table 1 Precision Values	able 1 Precision	Test Results	

	ASTM C:	128 Relative Density	y and Absorption of	ASTM C 128 Relative Density and Absorption of Coarse Aggregate Precision	recision			
						ASTM C 128-15 Table 1 Precision	able 1 Precision	
	Test Results	esults				Values	ues	Test Results
					Standard		Standard	Standard
		C0	Automatica	Standard	Deviation	Standard	Deviation	Deviation
		7 104		fer) IIONBIASO	ZANCITICZN	(ct) IIONBIASO	TANCITICAN	ZADCITICZN
Relative Density Oven-Dry	2.614	2.614	2.61	0.000	0.001	0.011	0.032	Pass
Relative Density 5.5.D.	2.624	2.624	2.62	0.000	0.000	0.0055	0.027	Pass
Apparent Relative Density	2.641	2.640	2.64	0.001	0.002	5600'0	0.027	Pass
Percent Absorption	0.40%	0.38%	0.4%	0.000	0.000	0.11%	0.31%	Pass

Table A9. ASTM C128 for Product 1 aggregate.

	ASTM C 136 & C 117 PRECISION WORKSHEET											
CMB Log	in No.:				170078			Date:		11-May-17		
District:								Tested By:		CEERD-GM-C		
Material S	Supplier:				Little Rock - AFB			Date Received:				
Sampled I	By:				S.M.			Material Type:		Product No. 1		
					ASTM C 1	36 Sieve Analysis of	Fine and Coarse Agg	egates				
				0	umulative Test Resu	lts		ASTM C 1	36-14 Table 2 Precis	ion Values	Test Results	
Sie std.	ve Size mm	FM	Run 1 Total Percent Passing	Run 2 Total Percent Passing	Average Percent Passing	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %	Total Percent Passing	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %	Standard Deviation (d2s)1.96v2, %	
4.0	100		100.00%	100.00%	100.00%	0.00%	0.00%					
3.5	90		100.00%	100.00%	100.00%	0.00%	0.00%					
3.0	75	x	100.00%	100.00%	100.00%	0.00%	0.00%					
2.5	63		100.00%	100.00%	100.00%	0.00%	0.00%					
2.0	50		100.00%	100.00%	100.00%	0.00%	0.00%					chai se vegi egare v aines
1.5	37.5	x	100.00%	100.00%	100.00%	0.00%	0.00%					0000
1.0	25		100.00%	100.00%	100.00%	0.00%	0.00%					
3/4	19	x	100.00%	100.00%	100.00%	0.00%	0.00%					
1/2	12.5		99.60%	99.39%	99.49%	0.15%	0.41%	100-95	0.32%	0.90%	Pass	
3/8	9.5	x	84.65%	84.49%	84.57%	0.12%	0.32%	95-85	0.81%	2.30%	Pass	
No. 4	4.75	×	56.97%	57.24%	57.11%	0.19%	0.53%	60-20	0.83%	2.40%	Pass	
No. 8	2.36	x	29.50%	29.66%	29.58%	0.11%	0.32%	60-20	0.83%	2.40%	Pass	THE TOP OF A DEC
No. 16	1.18	x	10.68%	10.66%	10.67%	0.02%	0.05%	15-10	0.36%	1.00%	Pass	
No. 30	600 µm	×	2.44%	2.35%	2.39%	0.06%	0.17%	10-2	0.37%	0.40%	Pass	

Table A10. ASTM C136 and C117 precision.

ASTM C	136-14 Table 2 Preci	sion Coarse Aggregat	e Values
Total Perce	ent Passing		
			Standard Deviation
Less	Greater or Equal	(1s), %	(d2s)1.96v2, %
100%	95%	0.32%	0.90%
95%	85%	0.81%	2,30%
85%	80%	1.34%	3.80%
80%	60%	2.25%	6.40%
60%	20%	1.32%	3.40%
20%	15%	0.96%	2.70%
15%	10%	1.00%	2.80%
10%	5%	0.75%	2.10%
5%	2%	0.53%	1.50%
2%	0%	0.27%	0.80%

ASTM	C 136-14 Table 2 Pre	cision Fine Aggregate	Values
Total Perc	ent Passing		
Less	Greater or Equal	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %
100%	95%	0.26%	0.70%
95%	60%	0.55%	1.60%
60%	20%	0.83%	2,40%
20%	15%	0.54%	1.50%
15%	10%	0.36%	1.00%
10%	2%	0.37%	0.40%
2%	0%	0.14%	0.60%

			ASTM C	117 Minus 75 μm (No	o. 200)			
						ASTM C 117-13 Tal	ole 1 Precision Fine	
Test Results						Aggregat	e Values	Test Results
				Standard Deviation	Standard Deviation	Standard Deviation	Standard Deviation	Standard Deviation
	Run 1	Run 2	Average	(1s), %	(d2s)1.96√2, %	(1s), %	(d2s)1.96√2, %	(d2s)1.96√2, %
Percent Loss	0.91%	0.90%	0.9%	0.01%	0.02%	0.15%	0.43%	Pass

ASTM C 117-13 Tabl	e 1 Precision Coarse
Aggregat	te Values
Standard Deviation	Standard Deviation
(1s), %	(d2s)1.96v2, %
0.10%	0.28%

ble 1 Precision Fine
te Values
Standard Deviation
(d2s)1.96√2, %
0.43%

					ASTM C 1	36, ASTM C 117, 8	ASTM C 40 WOF	RKSHEET						
CMB Log	n No.:				170079			Date:		10-May-17				
District:								Tested By:		CEERD-GM-C				
Material S	supplier:				Little Rock - AFB			Date Received:						
Sampled I	Ву:				S.M.			Material Type:		Sand				
					ASTM C 13	36 Sieve Analysis of	Fine and Coarse Ag	gregates						
		Date Tes	ted:		10-May-17		Date Tested:		10-May-17			AST	TM C33 SPE	CIFICATIONS
				Ru	n 1			Ru	in 2			FOR: Fine	Aggregat	2
Siev	ve Size		Indiv	vidual	Cumi	lative	Indi	vidual	Cumu	lative	Average	Percent	Passing	
std.	mm	Mass Reta	ined,g	Percent Retained	Percent Retained	Percent Passing	Mass Retained,g	Percent Retained	Percent Retained	Percent Passing	Percent Passing	Min.	Max.	Results
4.0	100	0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.5	90	0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3.0	75	x 0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.5	63	0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
2.0	50	0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1.5	37.5	x 0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1.0	25	0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3/4	19	x 0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
1/2	12.5	0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%			
3/8	9.5	x 0.00		0.00%	0.00%	100.00%	0.00	0.00%	0.00%	100.00%	100%	100%	100%	Pass
No. 4	4.75	x 7.80		1.48%	1.48%	98.52%	7.30	1.59%	1.59%	98.41%	99%	95%	100%	Pass
No. 8	2.36	x 30.5)	5.79%	7.27%	92.73%	26.80	5.83%	7.42%	92.58%	93%	80%	100%	Pass
No. 16	1.18	x 71.3)	13.53%	20.79%	79.21%	62.90	13.69%	21.11%	78.89%	79%	50%	85%	Pass
No. 30	600 µm	x 133.5	0	25.33%	46.12%	53.88%	115.10	25.04%	46.15%	53.85%	54%	25%	60%	Pass
No. 40	425 µm	112.9	0	21.42%	67.54%	32.46%	97.50	21.21%	67.36%	32.64%	33%			
No. 50	300 µm	x 98.0)	18.59%	86.13%	13.87%	86.00	18.71%	86.07%	13.93%	14%	5%	30%	Pass
No. 100	150 µm	x 69.9)	13.26%	99.39%	0.61%	61.10	13.29%	99.37%	0.63%	1%	0%	10%	Pass
No. 200	75 µm	2.20		0.42%	99.81%	0.19%	1.93	0.42%	99.79%	0.21%	0%	0%	3%	Pass
-	Pan	0.06		0.01%	99.82%	0.00	0.01	0.00%	99.79%	0.00				
	otal	526.1	6	99.82%			458.64	99.79%						
Fineness I	Modulus:				2.612				2.617		2.61			
x = Sieves	used to ca	alculate finene	ss modu	ılus			Ru	in 1	Ru	n 2				
							Original Dry Mass,	Acceptance Range 528.7	Original Dry Mass,	Acceptance Range 461.0				
Yes	No	Res	ults for	ASTM C 136 No. 200	include ASTM C 11	7 Results.	g 527.1	525.5	g 459.6	458.2				
x														
<u> </u>	l,	f the same AST	M C 11	7 sample is used for	the above ASTM C			ASTM C 117 to the p	pan mass retained (g	g) from ASTM C 136.				
<u> </u>		x				ASTM C 117 Minus								
Proces		Washed wit					Date Tested:	9-M	ay-17	I				
Proces	dure B	Washed wit			_									
<u> </u>		0		Pry Mass, g		fter Wash, g		Loss, g		nt Loss	Average			
	un 1			7.1		6.1		1.0		9%	0.2%			
R	un 2		45	9.6		9.0		0.6	0.1	3%	L			
<u> </u>						Organic Impurities i				0	a			
L		Dates	tarted:	8-M	ay-17	Date Ended:	9-M	ay-17	1	Organic Plate No.:	Clear	I		

Table A11. ASTM C136, ASTM C117, and ASTM C40.

					ASTM C 128	ASTM C 128 Worksheet					
CMB Log In No.:				170079			Date:		10-May-17	w-17	
District:							Tested By:		CEERD-GM-C	-GM-C	
Material Supplier:				Little Rock - AFB			Date Received:				
Sampled By:				S.M.			Material Type:		Sand	p	
				ASTM C 128	Relative Density an	ASTM C 128 Relative Density and Absorption of Fine Aggregate	ie Aggregate				
Test Size:	Test Size: 500 ± 10g		Mass of	Mass of							
Run	Flask No.	S.S.D. Mass in Air, g	Pycnometer with Water, g	Pycnometer with Oven-Dry Mass in Relative Density Water & Sample, g Air, g Oven-Dry	Oven-Dry Mass in Air, g	Relative Density Oven-Dry		Relative Density Apparent Relative S.S.D. Density	Percent Absorption	Water Temp., C	Soak Time, hrs.
1	A	500.20	1440.50	1749.40	497.90	2.603	2.615	2.634	0.46%	22.8	24.00
2	B	504.60	1428.60	1741.20	502.70	2.618	2.628	2,644	0.38%	22.8	24.00
			AVERAGE	AGE		2.61	2.62	2.64	0.4%	22.8	24.00
			ASTM	ASTM C 128 Relative Density and Absorption of Fine Aggregate Precision	ty and Absorption c	of Fine Aggregate Pr	recision				
								ASTM C 128-15 Table 1 Precision	able 1 Precision		

	Test Results	Standard Deviation	(d2s)1.96v2	Pass	Pass	Pass	Pass
	ASTM C 128-15 Table 1 Precision Values	Standard Deviation	(d2s)1.96v2	0.032	0.027	0.027	0.31%
	ASTM C 128-15 1 Val	Standard	Deviation (1s)	0.011	0.0095	0.0055	0.11%
ecision		Standard Deviation	(d2s)1.96v2	0.030	0.026	0.020	0.002
ASTM C 128 Relative Density and Absorption of Fine Aggregate Precision		Standard	Deviation (1s)	0.011	0000	0.007	0.001
y and Absorption o			Average	2.61	2.62	2.64	0.4%
128 Relative Densit	esults		Run 2	2.618	2.628	2.644	0.38%
ASTM C	Test Results		Run 1	2.603	2.615	2,634	0.46%
				Relative Density Oven-Dry	Relative Density S.S.D.	Apparent Relative Density	Percent Absorption

Table A12. ASTM C128.

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					ASTM	C 136 & C 117 PR	ECISION WORKSH	EET				
CMB Log I	n No.:				170079			Date:		10-May-17		
District:								Tested By:		CEERD-GM-C		
Material S	upplier:				Little Rock - AFB			Date Received:				
Sampled E	ly:				S.M.			Material Type:		Sand		
					ASTM C 1	36 Sieve Analysis of	Fine and Coarse Aggr	egates				
				0	umulative Test Resu	lts		ASTM C 1	136-14 Table 2 Precisi	on Values	Test Results	
	ve Size	FM	Run 1 Total Percent	Run 2 Total Percent	Average Percent	Standard Deviation		Total Percent			Standard Deviation	
std.	mm	3	Passing	Passing	Passing	(1s), %	(d2s)1.96√2, %	Passing	(1s), %	(d2s)1.96√2, %	(d2s)1.96√2, %	
4.0	100		100.00%	100.00%	100%	0.00%	0.00%					
3.5	90		100.00%	100.00%	100%	0.00%	0.00%					
3.0	75	×	100.00%	100.00%	100%	0.00%	0.00%					9
2.5	63		100.00%	100.00%	100%	0.00%	0.00%					8
2.0	50		100.00%	100.00%	100%	0.00%	0.00%					1994
1.5	37.5	×	100.00%	100.00%	100%	0.00%	0.00%					Coal Se Agglegate values
1.0	25		100.00%	100.00%	100%	0.00%	0.00%					Value
3/4	19	×	100.00%	100.00%	100%	0.00%	0.00%					Ů
1/2	12.5		100.00%	100.00%	100%	0.00%	0.00%					
3/8	9.5	×	100.00%	100.00%	100%	0.00%	0.00%					
No. 4	4.75	×	98.52%	98.41%	98%	0.08%	0.21%	100-95	0.26%	0.70%	Pass	
No. 8	2.36	×	92.73%	92.58%	93%	0.11%	0.30%	95-60	0.55%	1.60%	Pass	
No. 16	1.18	×	79.21%	78.89%	79%	0.22%	0.61%	95-60	0.55%	1.60%	Pass	
No. 30	600 µm	×	53.88%	53.85%	54%	0.02%	0.06%	60-20	0.83%	2.40%	Pass	28 C
No. 40	425 µm		32.46%	32.64%	33%	0.12%	0.35%	60-20	0.83%	2.40%	Pass	
No. 50	300 µm	×	13.87%	13.93%	14%	0.04%	0.11%	15-10	0.36%	1.00%	Pass	aiues
No. 100	150 µm	×	0.61%	0.63%	1%	0.02%	0.05%	2-0	0.00%	0.60%	Pass	
No. 200	75 µm		0.19%	0.21%	0%	0.02%	0.04%	2-0	0.00%	0.60%	Pass	

Table A13. ASTM C136 and C117 precision.

ASTM C	136-14 Table 2 Preci	ion Coarse Aggregat	e Values
Total Perce	ent Passing		
Less	Greater or Equal	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %
100%	95%	0.32%	0.90%
95%	85%	0.81%	2,30%
85%	80%	1.34%	3.80%
80%	60%	2.25%	6.40%
60%	20%	1.32%	3.40%
20%	15%	0.96%	2,70%
15%	10%	1.00%	2,80%
10%	5%	0.75%	2,10%
5%	2%	0.53%	1.50%
2%	0%	0.27%	0.80%

ASTM	C 136-14 Table 2 Pre	cision Fine Aggregate	Values
Total Perc	ent Passing		
Less	Greater or Equal	Standard Deviation (1s), %	Standard Deviation (d2s)1.96v2, %
100%	95%	0.26%	0.70%
95%	60%	0.55%	1.60%
60%	20%	0.83%	2.40%
20%	15%	0.54%	1.50%
15%	10%	0.36%	1.00%
10%	2%	0.37%	0.40%
2%	0%	0.14%	0.60%

			ASTM C	117 Minus 75 μm (No	o. 200)			
						ASTM C 117-13 Tal	ble 1 Precision Fine	
Test Results						Aggregat	te Values	Test Results
				Standard Deviation	Standard Deviation	Standard Deviation	Standard Deviation	Standard Deviation
	Run 1	Run 2	Average	(1s), %	(d2s)1.96v2, %	(1s), %	(d2s)1.96√2, %	(d2s)1.96v2, %
Percent Loss	0.19%	0.13%	0.2%	0.04%	0.12%	0.15%	0.43%	Pass

ASTM C 117-13 Table 1 Precision Coarse

165165	
Standard Deviation	Standard Deviation
(1s), %	(d2s)1.96v2, %
0.10%	0.28%

ASTM C 117-13 Tal	ole 1 Precision Fine
Aggregat	te Values
Standard Deviation	Standard Deviation
(1s), %	(d2s)1.96v2, %
0.15%	0.43%

Appendix B: Raw Data Sheets for Concrete Testing

perator	VILSON	VILSON	NILSON	perator		IE DI.		-95	ua	y C		pre	500	ve strengtn 6x12 cylinder.
Defects 0	NONE WILSON	NONE WILSON	NONE WILSON	Defects 0										-
ype of fracture		1	Ч	ype of fracture										
Curing History Peak Load Compressive Strength type of fracture Defects Operator	NO DATA BROKE W/NO DATA	4490	4010	Curing History Peak LoadCompressive Strengthtype of fracture Defects Operator	4250									-
Peak Load C	NO DATA	127010	113440	Peak Load C	120225									_
Curing History	fog room	fog room	fog room	Curing History		Jensity (Ib/ft3		144.7584744	147.0550766	145.8186033	145.8773848	1.149428906		
Age	з даү	3 DAY	3 DAY	Age		Density (kg/m3) Jensity (lb/ft3)		2318.741243	2355.528217	2335.722388	2336.663949	18.41155222	0.007879418	
Density Ib/cubic ft	146	146	146	Density lb/cubic ft										-
Area	28.2743	28.2743	28.2743	Area	28.2743	Submerged Mass (grams)		7280	7495	7387				PC2423 PC2423 PC2425
Diameter	9	9	9	Diameter	٥									400TO-PC2423 400TO-PC2423 400TO-PC2424
LENGTH	12.25	12.25	12.25	LENGTH		Specimen # Dry Mass (grams)		12780	13004	12897	imens =	= (on =	
Project	LRAFB	LRAFB	LRAFB	Project		Specimen # 1		LRAFB B1	LRAFB B2	LRAFB B3	S UAY Average Density of Specimens =	Standard Deviation =	Coefficient of Variation =	Position
Ы	AY SHANNON	AY SHANNON	AY SHANNON	Ы			LRAFB	177-17	6/29/2017	MILSON	3 UAY Average De	Stand	Coeffic	Stress vs. Po
TestKey	6/29/2017 12:50:22 PM 177-17 LRAFB B1 JAY SHANNON	6/29/2017 12:52:44 PM 177-17 LRAFB B2 JAY SHANNON	6/29/2017 12:58:45 PM 177-17 LRAFB B3 JAY SHANNON	Test Key			PROJECT:	JULIEN DATE:	TEST DATE:	TESTED BY:	AGE:			
StartTime	:2:50:22 PM	2:52:44 PM	.2:58:45 PM	StartTime										
StartDate StartTime	6/29/2017 1	6/29/2017 1	6/29/2017 1	StartDate StartTime	AVEKAGE									5000 5000 4500 3500 3500 5000 1500 1500 500 500 500 0

Figure B1. Three-day compressive strength 6x12 cylinder.

NONE WILSON	NONE WILSON		Operator									e strength 6x12 cylinder.
		NONE	Defects (
	1 c	7	type of fracture									
4350	4610	4400	Peak Load Compressive Strength type of fracture Defects Operator	4453, 33333								
123020	130340	12439U		125916.6667								
FOGROOM	FUGROOM		Curing History		(ft3)							
7 DAY		/ UAT	t Age		Density (Ib/ft3)	144.7	147.2	145.4	145.8	1.276		
148	147 145	C4T	Area Density Ib/cubic ft Age Curing History									
28.2743	28.2/43	0.2/43	Area	28.2743	ed Mass	7285	7498	/3/0				51
9 0			Diameter	9	Submerged Mass (grams)							400TO-PC2449 400TO-PC2450 400TO-PC2451
12.25	12.25 12.75	C2.21	LENGTH		Dry Mass (grams)	12790	13000	12897	imens =	=	on =	0 ²⁵
LRAFB	LKAFB	LKAFB	Project		Specimen #	LRAFB B1	LRAFB B2	LRAFB B3	Density of Specimens =	Standard Deviation =	Coefficient of Variation =	Position
SHANNON	SHANNON	NIONNEHO	Ы			LRAFB 177-17	7/3/2017	7 DAY	e	Stan	Coeffi	Stress vs. P
7/3/2017 10:43:32 AM 177-17 LRAFB B1 SHANNON	//3/2017 10:46:55 AMI 177-17 LKAFB B2 SHANNON 7/3/2017 10:50:49 AM 177-17 LBAEB B3 SHANNON	L//-1/ LKAFB 53	Test Key			PROJECT: JULIEN DATE:	TEST DATE:	TESTED BY: AGE:				S 0.01
10:43:32 AM 1	10:46:04 AM		StartDate StartTime									
7/3/2017	1/10/2//2/1	· / TOZ /s //	StartDate	AVERAGE								5000 5000 3500 3500 1500 1000 5700 500 500 500 0 0

Figure B2. Seven-day compressive strength 6x12 cylinder.

						igure i	50.1	oui			uaj	y C		ιP	163	531	ve a	ue	3116	Surv			<i>'</i> , ''''	luc						
Operator	NONE WILSON	NONE WILSON	NONE WILSON	Operator																										
Defects	NONE	NONE	NONE	Defects																										
ype of fracture	1	2	сı	ype of fracture																										
Peak Load Compressive Strength type of fracture Defects Operator	5220	5460	4980	Peak Load Compressive Strength type of fracture Defects Operator	0001	077 C																								
Peak Load	146990	153780	140280	Peak Load	2333 3102 F	/000'0T0/+T																								
Curing History	FOG ROOM	FOG ROOM	FOG ROOM	Curing History				t3)																						
Age (14 DAY	14 DAY	14 DAY	Age (Density (Ib/ft3)		145.81	147.76	144.57		146.05	1.6111															
Density Ib/cubic ft	145	148	146	Density lb/cubic ft																										
Area	28.1802	28.1802	28.1802	Area	00 1 000	7001.02		Submerged Mass (grams)		7392	7544	7246											400TO-PC2480	400TO-PC2481	400TO-PC2482					
Diameter	5.99	5.99	5.99	Diameter		<i>cc.</i> c																	400TO	400TO	400TO					
LENGTH	12.25	12.25	12.25	LENGTH				Mass (grams)		12906	13043	12733		mens =		= uo													0.2	
Project	LRAFB	LRAFB	LRAFB	Project				Specimen #		LRAFB B1	B2	B3		Average Density of Specimens =	Standard Deviation =	Coefficient of Variation =	Position		(C			-	_					0.15	
Ы	SHANNON	SHANNON	SHANNON	Ы					LRAFB	177-17	7/10/2017	Wilson	14 day	Average	Star	Coeff	Stress vs. P			$\left\langle \right\rangle$	\langle								0.1	Position
Test Key	7/10/2017 2:00:59 PM 177-17 LRAFB B3 SHANNON	7/10/2017 2:05:23 PM 177-17 LRAFB B2 SHANNON	7/10/2017 2:10:09 PM 177-17 LRAFB B1 SHANNON	Test Key					PROJECT:	JULIEN DATE:		TESTED BY:	AGE:											_		_	+		0.05	
StartTime	2:00:59 PM 1	2:05:23 PM 1	2:10:09 PM 1	StartTime																									0	
StartDate StartTime	7/10/2017	7/10/2017	7/10/2017	StartDate	AVERAGE													6000		5000		4000	3000 3000	45	2000		1000	c		

Figure B3. Fourteen-day compressive strength 6x12 cylinder.

—		Bai				ine de	_	
Operator	NEWELL	NONE NEWELL	NEWELL	Operator				
Defects	NONE	NONE	NONE	Defects				
type of fracture	3	2	£	type of fracture				
Area Density Ib/cubic ft Age Curing History Peak Load Compressive Strength type of fracture Defects Operator	5510	6010	5900	Peak Load Compressive Strengthitype of fracture Defects Operato		5806.666667		
Peak Load	152190	166550	163430	Peak Load		160723.3333		
Curing History	FOG ROOM	FOG ROOM	FOG ROOM	Age Curing History				
Age (28 DAYS	28 DAYS	28 DAYS	Age (
Density Ib/cubic ft	146 2	146 2	146 2	Density Ib/cubic ft				
Area	27.6184	27.7117	27.7117	Area		27.6806		400T0-PC2579 400T0-PC2580 400T0-PC2581
Diameter	5.93	5.94	5.94	Diameter		5.936666667 27.6806		400TG
Project LENGTH	12.24	12.22	12.31	Project LENGTH				0.25
Project	ON LRAFB	on Lrafb	on Lrafb	Project			Position	0.2
PI	SHANNON	SHANNON	SHANNON	Ы			Stress vs. Pc	1 0.15 Position
Test Key	7/24/2017 2:14:58 PM 177-17 LRAFB B1 SHANN	7/24/2017 2:19:37 PM 177-17 LRAFB B2 SHANN	7/24/2017 2:24:28 PM 177-17 LRAFB B3 SHANN	TestKey			Str	0.05 0.1
StartDate StartTime	. 2:14:58 PM	. 2:19:37 PM	2:24:28 PM	StartDate StartTime				
StartDate	7/24/2017	7/24/2017	7/24/2017	StartDate	AVERAGE			7000 5000 5000 2000 1000 0 0

Figure B4. Twenty-eight-day compressive strength 6x12 cylinder.

perator	Wilson	Wilson	Wilson	perator			-		
Peak Load Flexural StrengthCuring Historyapperant moisture condition Operator	MOIST	MOIST	MOIST	Support Span Peak Load Flexural StrengthCuring Historyapperant moisture condition Operato					
Curing History	LIME WATER	LIME WATER	LIME WATER	Curing History					
Flexural Strength	610	615	619	Flexural Strength		614.6666667		3.11111111	
Peak Load	7380	7485	7735	Peak Load		7533.333333		134.444444	
Support Span	18	18	18	Support Span		18		0	32 33
Depth	6.03	6.02	6.03	Depth		6.026666667		0.00444444	
Width	5.98	6.03	6.19	Width		6.06666667 6.026666667		0.082222222 0.00444444	01
AGE DAYS				AGE DAYS					Position
Test Key	6/29/2017 SHANNON 177-17 LRAFB B3	6/29/2017 SHANNON 177-17 LRAFB B2	6/29/2017 SHANNON 177-17 LRAFB B1	Test Key					Load vs. Po
Ы	SHANNON	SHANNON	SHANNON	Ы					0.02
StartDate	6/29/2017	6/29/2017	6/29/2017	StartDate	AVERAGE		AVEDEV		Load 1000 1000 1000 1000 1000 1000 1000 10

Figure B5. Three-day flexural strength 6x6x21 beam.

tor	Ę	Ę	ہ ہ					
Opera	Wilson	Wilson	Wilson	Opera				
Peak Load Flexural StrengthCuring Historyapperant moisture conditionOperato	MOIST	MOIST	MOIST	Peak Load Flexural Strength Curing History apperant moisture condition Operator				
Curing Histor	LIME WATER	LIME WATER	LIME WATER	Curing Histor				
Flexural Strength	715	675	645	Flexural Strength	678.333333		24.4444444	
Peak Load	8515	8315	7880	Peak Load	8236.666667		237.777778	
Support Span	18	18	18	Support Span	18		0	454 453 452
Depth	5.99	6.05	6.06	Depth	6.033333333		0.031111111 0.02888889	
Width	5.99	6.07	6.01	Width	6.02333333 6.03333333		0.031111111	
AGE DAYS				AGE DAYS				s. Position
Test Key	7/3/2017 SHANNON 177-17 LRAFB B3	7/3/2017 SHANNON 177-17 LRAFB B2	7/3/2017 SHANNON 177-17 LRAFB B1	Test Key				Load vs.
Ы	SHANNON	SHANNON	SHANNON	Ы				- 6
StartDate	7/3/2017	7/3/2017	7/3/2017	StartDate	AVERAGE	AVEDEV		Load 0 0 0 0 0 0 0 0 0 0 0 0 0

Figure B6. Seven-day flexural strength 6x6x21 beam.

Operator	WILSON	WILSON	WILSON	Operator					
Depth Support Span Peak Load Flexural Strength Curing History apperant moisture condition Operator	DRY	DRY	DRY	apperant moisture condition Operator					
Curing History	LIME WATER	LIME WATER	LIME WATER	Curing History					
lexural Strength	745	720	790	Depth Support Span Peak Load Flexural Strength Curing History	751.666667		25.55555556		
Peak Load F	9105	8810	9655	Peak Load F	9190		310		
Support Span	18	18	18	Support Span	18		0		
Depth	6.04	6.04	6.04	Depth	6.04		0	400TO-PC2483 400TO-PC2483 400TO-PC2485	
Width	6.04	6.02	6.05	Width	6.036666667		0.011111111		
AGE DAYS				AGE DAYS				00.0	
Test Key	/10/2017 SHANNON BEAM 177-17 LRAFB-T1	//10/2017 SHANNON BEAM 177-17 LRAFB-B2	7/10/2017 SHANNON BEAM 177-17 LRAFB-B3	Test Key				Load vs. Position	Position
Ы	HANNON	HANNON	SHANNON	Ы				0.02	
StartDate	7/10/2017 5	7/10/2017 5	7/10/20175	StartDate	AVERAGE	AVEDEV		Load 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 100000 100000 100000 100000 100000 100000 100000 1000000	

Figure B7. Fourteen-day flexural strength 6x6x21 beam.

StartDate	Ы	Test Key	AGE DAYS	Width	Depth	Support Span		Flexural Strength	Curing History	Peak Load Flexural Strength Curing History apperant moisture condition Operator	on Operator
7/24/2017	SHANNON	7/24/2017 SHANNON BEAM 177-17 LRAFB-B3	28	6.03	6.03	18	11355	930	LIME WATER	DRY	WILSON
7/24/2017	SHANNON	7/24/2017 SHANNON BEAM 177-17 LRAFB-B2	28	6.011	6.06	18	11905	970	LIME WATER	DRY	WILSON
7/24/2017	SHANNO	7/24/2017 SHANNON BEAM 177-17 LRAFB-B1	28	6.08	6.04	18	10420	845	LIME WATER	DRY	WILSON
StartDate	Ы	Test Key	AGE DAYS	Width	Depth	Support Span	Peak Load	Flexural Strength	Curing History	Flexural Strength Curing Historyapperant moisture condition Operator	on Operator
AVERAGE						6	72222 21111	36			
AVEDEV				0,000000	0,000		/0000.02711	CTL			
				0.026444444 0.01111111	0.011111111	0	537.777778	46.6666667			
Load 10000 12000 6000 2000 0 0		Load v 0.05 0.1 0.15 0.2	Load vs. Position	0.3 0.35	0.4		582 583 583				

Figure B8. Twenty-eight-day flexural strength 6x6x21 beam.

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				5c.	PROGRAM ELEMENT NUMBER				
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therein. Experimenta materials. Concrete t	tion consisted of basic	aggregate test method nufacturing a laborator	ls such as gradatio	n, specific grav	design and the aggregates used rity, absorption, and organic led by LRAFB and conducting				
In most cases the selected aggregate and concrete mixture design testing met specifications. However, there were some areas, such as aggregate gradations, in which the materials did not align with specified values or standards. Final hardened concrete properties of compressive and flexural strength met the mixture design requirements.									
15. SUBJECT TERMS		Workability vs Coa	rseness Factor	Runw	ays				
Concrete Runway		Gradation		Concr	ete – additives				
Power 45 Curve 16. SECURITY CLASS	FICATION OF:	Little Rock Air For	ce Base (Ark.) 17. LIMITATION	Concr 18. NUMBER	ete - mixing 19a. NAME OF RESPONSIBLE				
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