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Mixture Proportioning and Characterization of Standard Grout Mixtures for Use at Fort Polk

Dylan A. Scott, Rudolph A. Andreatta, Wendy R. Long, Brian H. Green, Vincent P. Chiarito, Kirk E. Walker, Clifton P. Rusche, and Christopher N. Downey

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Abstract

The Engineer Research and Development Center, Geotechnical and Structures Lab (ERDC-GSL) has used Fort Polk as a large-scale testing site for many years. Many cementitious materials have been developed for design validation testing. These cementitious materials, their constituents, and their mechanical properties often went undocumented, making it difficult for researchers to replicate or draw comparison from previous testing. This report aims to begin a process of detailed cementitious material reports for all research efforts in the region.

The objective of this report is to document the development of a field castable 6 ksi sanded grout mixture and a 7 ksi sanded grout mixture used in experimental testing programs at Fort Polk in January 2014 and February 2015.

GSL required the development of a 6 ksi and 7 ksi mixture for testing scaled bridge columns. The reduced scaling of the test members resulted in very small rebar spacing. These designs lead to the development of very flowable specialized grouts.

This report details the development of this specialized grout for the purpose of aiding future cementitious mixture developments in the region. These results are applicable to efforts where reduced scaling reduces the spacing between scaled reinforcing where all aggregates in the concrete mix would not fit between reinforcing.

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Preface

This study was conducted for Headquarters, U.S. Army Corps of Engineers under two Cooperative Research and Development Agreements, C-13-GSL-06 and C-15-GSL-01. Vincent P. Chiarito acted as the customers' technical monitor for this study.

The work was performed by the Concrete and Materials Branch of the Engineering Systems and Materials Division (ESMD), U.S. Army Engineer Research and Development Center, Geotechnical and Structures Laboratory (ERDC-GSL). At the time of publication, Christopher M. Moore was Chief, Concrete and Materials Branch (CMB); Justin S. Strickler was Chief, ESMD; and Dr. Michael K. Sharp was the Technical Director for Civil Infrastructure. The Deputy Director of ERDC-GSL was Charles W. Ertle II, and the Director was Bartley P. Durst.

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

Unit Conversion Factors

Multiply	Ву	To Obtain
cubic feet	0.02831685	cubic meters
cubic inches	1.6387064 E-05	cubic meters
cubic yards	0.7645549	cubic meters
degrees Fahrenheit	(F-32)/1.8	degrees Celsius
feet	0.3048	meters
foot-pounds force	1.355818	joules
gallons (U.S. liquid)	3.785412 E-03	cubic meters
inches	0.0254	meters
ounces (U.S. fluid)	2.957353 E-05	cubic meters
pounds (force)	4.448222	newtons
pounds (force) per square foot	47.88026	pascals
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.45359237	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic meter
pounds (mass) per square foot	4.882428	kilograms per square meter
yards	0.9144	meters

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1 Introduction

1.1 Background

The Engineer Research and Development Center, Geotechnical and Structures Lab (ERDC-GSL) has used Fort Polk as a large-scale testing site for many years. Over the years, many cementitious materials have been developed for design validation testing that ranges from small arms fire to full scale blast effects. These cementitious materials, their constituents, and their mechanical properties often go undocumented, which makes it difficult for future researchers to replicate or draw comparison from previous testing programs. This report aims to begin a process of detailed cementitious material reports for all research efforts in the Fort Polk region.

In January 2014, Weidlinger Associates, Inc. (WAI*), partnered with the Geotechnical and Structures Laboratory under Cooperative Agreement C-13-GSL-06 for the testing of three variations of a recommended protection design for a specified bridge column against a simulated explosive threat. Each column was outfitted with armoring designs that upon validation was implemented as the final protective design measure. These tests were conducted on reduced-scale replicas of an actual bridge column.

Originally, the construction of the three scaled columns called for a scaled mixture proportion with a target strength of 6,000 psi at 28 days, and with a target elastic modulus to be determined by $E_c=w_c^{1.5}\times 33\sqrt{(f_c)}$, where W_c is the density of concrete in pounds per cubic foot (pcf). The sieve analysis of the largest aggregate provided for the full-scale mixture had a nominal maximum aggregate size (NMSA) of $^{3}\!/_{4}$ inch. The geometry of the scaled column to be cast was approximately 3- by 5- by 21-ft column with a chamfered bottom edge. GSL personnel determined that these members would be best if cast horizontally using steel formwork. The top face of each member was to be left open during placement, and then the armoring design would be implemented prior to initial set. The steel forms for one of the scaled columns can be seen in Figure 1. These columns were designed with a tight reinforcement scheme that that can be seen in Figure 1 as well.

^{*} Now known as Thornton, Tomasetti, Weidlinger Applied Science Practice.

Due to the tight reinforcement configuration seen in Figure 1, it was decided to not include any coarse aggregates in these concrete mixtures. The removal of the coarse aggregate would produce an elastic modulus lower than what would be predicted by the formula above. Therefore, the concrete needed was tested according to ASTM 469 to determine elastic modulus and Poisson's Ratio. This test was performed in addition to standard fresh and hardened property tests detailed in the fresh and hardened property section within this report.



Figure 1. The 6 ksi column geometry (left) and reinforcement (right).

In 2015, in a similar project with the Federal Highway Administration (FHWA) under a partnership between Parsons Brinkerhoff and GSL as part of C-15-GSL-01, it was required to test a different armoring design on a reduced-scale reinforced concrete box-shaped bridge column with chamfered corners and a hollow center. The box-shaped column can be seen in Figure 2. The box column dimensions were approximately 7- by 7- by 17 ft.

Structures and Engineering Branch (StEB) and Concrete and Materials Branch (CMB) personnel determined that due to the hollow cross section and overall length of the specimen that this test article could not be cast vertically or horizontally. These determinations were made after considering safety during test article placement, and concrete consolidation during placement. Therefore, a placement technique was developed that involved pumping the desired mixture into an inclined and fully incased steel formwork. The placement technique is detailed in the 7 ksi field placement section.



Figure 2. The 7 ksi column cross-section (left) and inclined steel formwork (right).

1.2 Objective

The objective of this report is to document the development of a field castable 6 ksi sanded grout mixture and a 7 ksi sanded grout mixture used in full-scale experimental testing programs at Fort Polk in Leesville, LA. To accomplish this objective this report includes:

- 1. Identifying and sourcing the constituent materials that were used to produce the grout mixtures.
- 2. Developing and selecting a candidate mixture proportion appropriate for each project's requirements.
- 3. Mechanical testing of the candidate mixtures to determine the unconfined mechanical properties, and documenting the results.
- 4. Providing guidance for the placement of each test item using the candidate mixtures produced with the local concrete producer.
- 5. Mechanical testing of the field cast mixtures to determine the unconfined compressive strength, density, and elastic modulus.

2 Constituent Materials

Although the same ready mix provider, Port Aggregates, Inc., Leesville, LA, was used in both years, there was a substantial change in constituent materials from the 6 ksi mixture developed in 2014 to the 7 ksi mixture developed in 2015. During that span between mixture designs, Port Aggregates, Inc., transferred from using Grace Construction Product's admixtures to using Master Builders Solutions by BASF Corporation admixtures. The concrete sand source was changed as well. These changes are described in each material section below.

2.1 6 ksi sanded grout (2014)

In order to proportion a 7 ksi grout mixture for use at Fort Polk, samples of constituent materials were taken from Port Aggregates, Inc., Leesville, LA, and delivered to the CMB laboratory in Vicksburg, MS. This material was comprised of several constituents including: an ASTM C150 Type I/II Portland cement, silica fume, concrete sand, colloidal silica, waterreducing admixture (WRA), and a high range water reducing admixture (HRWRA). The cement, sand, WRA, and HRWRA were all sampled from Port Aggregates, whereas the silica fume and colloidal silica were supplied by CMB. Material data sheets were also supplied by the manufacturer of each constituent material. This information is available in Appendix A. Information obtained from these data sheets was used in the development of the 6 ksi grout mixture proportion.

A mixture proportion for the actual 6 ksi mixture used in the construction of the full-scale bridge that this experiment was modeling was not provided. Therefore, it was difficult to determine what cementitious materials were used in the full-scale mixture proportion. Fly Ash (preferable class F) is commonly used in mass concrete applications, but the amount of fly ash (if any) used in the full-scale mixture proportion was unknown. The water/cement and cement paste/aggregate ratios were also unknown for the full-scale mixture.

2.2 7 ksi sanded grout (2015)

The proportion for the 7 ksi grout was based off of the 6 ksi sanded grout mixture proportion.

2.3 Portland cement

The cement source stayed the same throughout the 6 ksi and 7 ksi sanded grout design and field placement process. Ash Grove Cement Company located in Foreman, Arkansas produced the Portland cement. Mill tickets detailing the chemical composition of the cement were provided by Port Aggregates, Inc. The cement mill certification can be found in Appendix A.1. Commonly called a Type I/II cement, this cement met the requirements for ASTM C 150 Type I and Type II. A Type I is a standard cement for use when special properties specified for any other type of cement are not required, and Type II is for general use when moderate sulfate resistance is desired. Type I/II cement is common in the southeast United States.

Portland cement chemical analysis certificates are generally published by the manufacturer on a monthly basis. The differences between chemical composition of the cement used during laboratory mixture proportioning and the composition of the cement used during field placement were negligible.

2.4 Silica fume

The silica fume used for both the 6 ksi and 7 ksi sanded grouts was Elkem ES 900W, and was produced by Elkem Silicon Materials.* The ES 900W was purchased directly from Elkem by CMB personnel, and is not supplied by Port Aggregates, Inc. The silica fume was commonly available throughout the United States at that time. It does not meet ASTM C1240 specifications, as it is produced as a byproduct of a zirconium alloys electric arc furnace instead of the specified elemental silicon or ferro-silicon alloys electric arc furnaces. It is however, still a very fine pozzolanic material comprised mostly of amorphous silica. This silica fume is a very light colored grey and has high silica content with low carbon content. A product data sheet can be found in Appendix A.2.

^{*} Note: Elkem ES900W has been discontinued since Elkem's source for this silica fume has become unavailable.

2.5 Aggregates

Only fine aggregate was used in the proportioning of these mixtures. No coarse aggregate was present in any of the mixtures.

2.5.1 6 ksi sanded grout (2014)

The only aggregate used in this mixture proportion was concrete sand known as Grayson Sand. The Grayson Sand was sampled from Port Aggregates, Inc., Leesville, LA. Port Aggregates, Inc., Leesville obtained the Grayson sand from Larry Grayson & Son Trucking in the greater Alexandria/Woodworth, LA region. This sand had a slightly higher percent passing the No. 16 and No. 30 sieve than what is allowed by ASTM C 33.

The Concrete and Materials Branch's aggregate laboratory performed standard characterization tests on the Grayson sand. The results from those tests are documented in Appendix A.3.1.1. This testing was done in accordance with ASTM C 117, C 128, and C 136. CMB's testing showed the same Specific Gravity (SG), a slightly different absorption, and slightly different gradations from the testing performed by Port Aggregates. CMB gradations show about 8.5% more passing through the #30 sieve. The test results for this aggregate as performed by Port Aggregates are listed in Appendix A.3.1.2. Overall, these slight differences should not raise any mixture proportion concerns.

2.5.2 7 ksi sanded grout (2015)

By the end of the 2014 calendar year Port Aggregates, Inc. had stopped using the Grayson sand. In a phone conversation with the Quality Control Manager for Port Aggregates, Inc., Warner Hanks reported, "The Grayson sand is currently too far out of ASTM C 33 compliance, and the supplier is unwilling to correct it." The 'new' sand used in 2015 is Trinity Sand, which is obtained from Trinity Materials, Inc. located in Merryville, LA. An aggregate gradation report was supplied by Port Aggregates for the Trinity sand and can be seen in Appendix A.3.2. Due to project time constraints, this aggregate was not tested by CMB.

2.6 Chemical admixtures

2.6.1 6 ksi sanded grout (2014)

Three chemical admixtures for concrete, Adva© 190, Zyla© 610, Recover©, and Cembinder N8©, were used in the 6 ksi sanded grout mixture proportions. The Adva© 190, Zyla© 610, and Recover© are all produced by Grace Construction Products and were sampled from the Port Aggregates, Inc., Leesville batch plant. Adva© 190 is advertised by the producer as a HRWRA meeting the criteria for ASTM C 494 (ASTM 2013f) type A and type F admixtures. Zyla© 610 is advertised as a WRA meeting the criteria for ASTM C 494 (ASTM 2013f) type A and type D admixture. Recover© is advertised as a hydration stabilizer meeting the criteria for ASTM C 494 (2013a) type D admixtures. Product data sheets provided by Grace Construction Products for each of these three admixtures are included in Appendix A.4.1.

The Cembinder N8[©] is produced by AkzoNobel. It is an alkaline, aqueous dispersion of colloidal silica that is approximately 50% solids by weight. Cembinder N8[©] is a specialty product designed for use in concrete to control stability segregation and water loss. This admixture was primarily used in these mixture proportions in an effort to avoid segregation and bleeding. It was batched as a percent replacement of total cement, whereas all other admixtures were batched as fluid ounces per 100 kilograms of cement. This product was purchased directly from AkzoNobel, and was taken to the Port Aggregates, Inc., Leesville batch plant by CMB personnel. CMB personnel manually dosed the Cembinder N8[©] into the concrete mixture.

Amber Defoamer was used to reduce the air content of these mixtures. A data sheet for this defoaming agent is unavailable since the product was discontinued. It was not used in the 7 ksi mixtures.

2.6.2 7 ksi sanded grout (2015)

Between the field placement of the 2014 scaled-bridge columns and the initial 2015 efforts, Port Aggregates switched from Grace Construction Products admixtures to Master Builders Solutions by BASF admixtures. These changes were incorporated into the mixture proportion. The new WRA became Pozzolith 80, and the HRWRA became PS 1466. These products performed comparably to the Grace Construction Products admixtures used the previous year. The data sheets are included in Appendix A.4.2. PS 1466 has since been renamed to MasterGlenium 1466.

3 Testing Procedures

The testing procedures stayed the same for both 2014 and 2015 efforts. The fresh and hardened property results for each trial mixture can be found in their respective appendices. The testing results for the field cast mixtures will be discussed in the field placement section.

3.1 Fresh properties

The fresh properties measured were temperature, slump, air content, and unit weight. Fresh temperature was recorded in accordance with ASTM C 1064. Slump was determined in compliance with ASTM C 143. Also, each mixtures' respective flow was measured post slump by using a yard stick to measure the circumference of the slump. These data are presented in the appendices as "Flow." Air content was measured using the pressure method outlined in ASTM C 231. Unit weight was measured in accordance with ASTM C 138.

3.2 Hardened properties

Three hardened properties were measured. Hardened density was measured in compliance with ASTM C 39. Unconfined compressive strength (UCS) was determined in accordance with ASTM C 39. The static modulus of elasticity was determined according to ASTM C 469.

4 Mixture Proportioning

4.1 6 ksi sanded grout mixture proportioning (2014)

4.1.1 6 ksi selection criteria

Due to the amount of time required to conduct and analyze Elastic Modulus and Poison's ratio (E&P) testing on specimens, UCS and slump tests were critical measurements for refining mixture proportions. The design UCS for this mixture was 6 ksi at 28 days age, with a tolerance of +/- 500 psi. A slump of at least 10 inches (in.) or greater was also desired due to the difficulty of casting a large column that was expected to have a very tight steel rebar reinforcement spacing. The densities were recorded for each mixture as well.

4.1.2 6 ksi aggregate selection and optimization

The tight rebar reinforcement configuration influenced the reason the mixture was designed with only concrete sand. By designing the mixture with concrete sand as the only aggregate, it was known that the concrete density would be reduced and the resulting modulus could be reduced as well. The material deficiencies from only using a fine aggregate were considered; however, it was decided that the ability to fully cast each test specimen without the potential for any major voids would be more beneficial.

4.1.3 6 ksi trial mixture compressive strength results

Figure 3 depicts the strength development with the time each of the thirteen trial batches were cast in the CMB laboratory. Trial (T) 3 was never cast due to fresh property results obtained during the casting of Trials 1 and 2. Information on the mixture proportions, unconfined compressive strength, and fresh properties of each batch can be found in Appendix B.1. Trial 12 was ultimately selected as the optimal mix design for field placement.

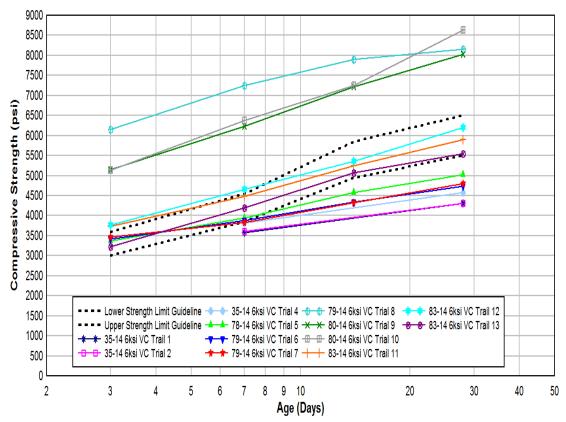


Figure 3. Summary of UCS results of Fort Polk 6 ksi sanded grout trials cast in Vicksburg, MS.

4.2 7 ksi sanded grout mixture proportioning (2015)

4.2.1 7 ksi selection criteria

Similar to the 6 ksi selection criteria, the UCS and slump tests were critical measurements for refining mixture proportions. The design UCS for this mixture was 7 ksi at 28 days age, with a tolerance of +/- 500 psi. However, the target strength age was reduced to 14 days due to scheduling constraints for the placement and full-scale testing with funds that needed to be executed within the fiscal year.

4.2.2 7 ksi aggregate selection and optimization

Aggregate selection criteria for the 7 ksi mixture remained consistent with that of the 6 ksi mixture. The fine aggregate source for Port Aggregates did change, and this change is discussed in the Constituent Materials section of this report.

4.2.3 7 ksi trial mixture compressive strength results

Figure 4 depicts the strength development with time of each of the six trial batches cast in the Concrete and Materials Laboratory. In Trial 1 the aggregates fell out of solution so no cylinders were cast for that trial mixture. Information on the mixture proportions, unconfined compressive strength, and fresh properties of each batch can be found in Appendix D.2.

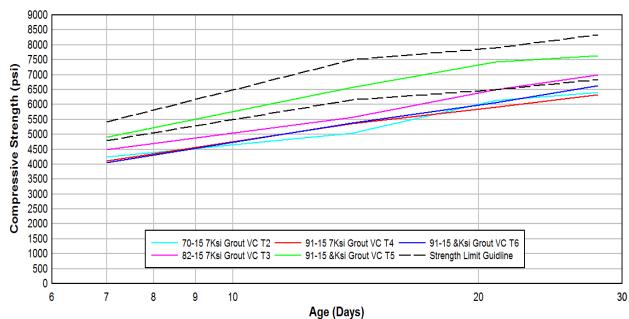


Figure 4. Summary of UCS results of Fort Polk 7 ksi sanded grout trials cast in Vicksburg, MS.

5 Field Concrete Placements

5.1 6 ksi field placement

The steel formwork, with steel reinforcing in place, for the three 6 ksi reduced-scale bridge pillars was delivered to Range 15A at Fort Polk from the Tennessee Valley Authority (TVA) a week prior to the casting dates. TVA constructed the formwork, fabricated the steel reinforcing cages, and placed the assembled reinforcing steel cages into the formwork according to ERDC specifications, approved by the customer. Since these columns were to be cast horizontally, each column was placed directly on a level casting slab previously constructed on Range 15A. The columns were aligned so that the concrete trucks would have easy access from the service road. The chute was placed over the back third of each pillar, and the driver was instructed to pull forward as the column began to fill. Each pillar was cured with wet burlap, plastic, and insulation for 7 days.

The 6 ksi field placements occurred on April 22nd, 23rd, and 24th of 2014. These mix designs were based off of the Trial 12 mixture proportion. Original plans were to cast 7.5 cubic yards per placement. Pillar 2 (P2) was cast on April 22nd, Pillar 3 (P3) on the 23rd, and Pillar 1 (P1) was cast on the 24th. Silica fume, Recover, and Amber Defoamer were loaded manually by CMB personnel at the batch plant.

During the batching of P2 the ready mix plant over-batched the cement by several hundred pounds, because of this the mix design was adjusted to an 8.6 cubic yard volume. Upon arrival, the mixture was too fluid and the aggregates were borderline segregated. An extra 3% of Cembinder N8 (approximately 150 lbs) was added to the mixture onsite to counteract segregation concerns. There was no segregation after the Cembinder addition. The adjusted proportions for P2 can be seen in Table 1 along with the casting proportions of P3 and P1. Measured aggregate moisture content was 3.16%.

P3 was batched with a significant reduction in HRWRA to alleviate segregation concerns. It was reduced from a 12.5 fluid ounce per 100 pounds of cement dose to a 4 fluid ounce per 100 pounds of cement dose. Also, 18 gallons (gal) of water was held out at the batch plant as further precaution. This mix arrived at Range 15A too stiff, therefore, 10 gal of the held out water was added and the ADVA dose was increased from 4 to 8 fluid ounces per 100 pounds of cement (approximately 15 lbs). P3 was successfully cast just as the ready mix truck became empty. Measured aggregate moisture content was 4.87%.

P1 was batched according to the final proportions of P3. No additional water or admixture had to be added onsite. The volume cast was increased from 7.5 to 8.5 cubic yards. Measured aggregate moisture content was 1.58%.

Material	112-14 6 ksi P2 (8.6 cu yd)	113-14 6 ksi P3 (7.5 cu yd)	114-14 6 ksi P1 (8.5 cu yd)
Cement (lb)	5,585	4,727	5,358
Silica Fume (lb)	201	177	201
Sand (Ib)	21,805	19,352	21,203
Water (Ib)	2,955	2,408	3,448.4
Cembinder N8 (fl oz)	6,866	3,742	4,241
ADVA 190 (fl oz)	788	207	470
Zyla 610 (fl oz)	416	363	412
Recover (fl oz)	257	207	225
Amber Defoamer (fl oz)	42	37	42

Table 1. The 6 ksi field cast mixture proportions in pounds.

Table 2 shows the UCS for the 6 ksi field cast mixtures. P2 is within design tolerance, and P3 is barely above tolerance. However, P1 compressive strengths came in a couple hundred psi below tolerance. After reviewing field notes it was determined the moisture content for P1 lowered by a couple of percentage points from the previous two days. Moisture readings were taken as the sand was going up the conveyor belt to the silo each day. This drop was due to a new shipment of the Grayson sand being delivered the afternoon before. The sand silo was not emptied the previous afternoon, and it is likely that the sand batched into the mixture had a higher moisture content than what was measured on the conveyor belt. This led to unaccounted water being introduced into the mixture and a drop in strength outside of the target tolerance. Table 3 provides the fresh properties measured onsite for each mixture. Young's Modulus and Poisson's ratio results are presented in Table 4. These results were very consistent for P2, P3, and P1. Some Poisson's ratios were excluded from the average due to slippage during testing.

Break Age (Days)	112-14 6 ksi VC P2 (psi)	113-14 6 ksi VC P3 (psi)	112-14 6 ksi VC P1 (psi)
7	5,670	4,710	3,810
14	5,435	5,750	4,740
28	6,020	6,530	5,210
Shot	6,395	6,570	5,330
Average Hardened Density (lb/cu ft)	139.1	138.3	137.6

Table 2. The 6 ksi field cast hardened property data.

Table 3. The 6 ksi field cast fresh properties.

	112-14 6 ksi VC P2	113-14 6 ksi VC P3	112-14 6 ksi VC P1
Slump (in.)	11	10.25	10.25
Air Content (%)	1.0	2.4	1.2
Temperature (F)	78.4	79.4	73.4
Unit Weight (lb/cu ft)	138	136.4	135.2

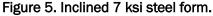
Table 4. The 6 ksi field cast 28 day elastic modulus data.

	Young's Modulus, E (psi)	Poison's Ratio, µ (in./in.)		
112-14 VC P2 #1	3.48E+06	0.147868434		
112-14 VC P2 #2	3.52E+06	0.131984071		
112-14 VC P2 #3	3.31E+06	0.130809571		
Average P2	3.44E+06	0.136887359		
113-14 VC P3 #1	3.77E+06	0.165007054		
113-14 VC P3 #2	3.75E+06	0.202970124		
113-14 VC P3 #3	3.69E+06	0.165062242		
Average P3	3.74E+06	0.165034648		
114-14 VC P1 #1	2.93E+06	0.129754527		
114-14 VC P1 #2	3.33E+06	0.095604724		
114-14 VC P1 #3	3.31E+06	0.130809571		
Average P1	3.19E+06	0.130282049		
Excluded values due to slippage during tests.				
Outliers and could possibly be excluded from average.				

5.2 7 ksi field placement

The steel form sealed structure was unloaded from a flatbed trailer using a 60 ton crane, and the structure was then placed upon timber matting that was approximately 1 ft. thick. The south end of the structure was placed on a single mat while the north end was placed on a double stack of the timber mats, giving a slight angle of about a foot throughout the length of the structure. The angling of the structure before grout placement was strategic to aid in consolidation of the grout. The structure was fabricated with 2 in. ball valves on both end caps of the steel structure. Keeping the structure at an angle throughout the entirety of the grout placement ensured that the gravity of the grout being placed would force the in-trapped air to travel to the inclined side of the structure where ball valves and vent pipes had been fabricated to the structure allowing it to vent. Additional wooden blocks were placed underneath the structure to give the bottom of the form more support and prevent sagging caused by the weight of the steel and grout. Figure 5 shows the inclined steel form.





The 7 ksi grout placement took place on 6 October 2015. CMB personnel went to Port Aggregates, Inc. to oversee batching, and to batch the silica fume and Cembinder N8© manually. This process followed the same procedures for the previously discussed 6 ksi placements. Two 8 cu yd batches were cast concurrently. Both truckloads were batched with a 15 gal water hold out. Ten gal was added to T1 onsite, and 20 gal was added to T2 on-

site. This put T1, 5 gal under design, and T2, 5 gal over design. The 10 extra gal in T2 was caused by a longer wait time, and the grout beginning to heat up as shown by the fresh temperature measurement in Table 6.

The grout was transported after batching to Range 15A, and the ready mix trucks were positioned so they could discharge the grout into the hopper of a 32 m concrete pump truck. The pump truck was equipped with a 4 in. pump line that was reduced down to a 2 in. fitting. The fitting was then attached to 2 in. pipe nipples that were screwed into the ball valves located on the lower end on the structure. Figure 6 shows the ball valve arrangement on both end caps and the concrete pump hose to ball valve connection.



Figure 6. Ball valve arrangement (left) and ball valve connection (right).

The concrete pump hose was connected to the bottom right side ball valve on the declined side. At this point all of the remaining ball valves on both end caps were open. A steady pumping speed of approximately 15 seconds per pump stroke was applied. The steel forms were monitored for leaks and level progress throughout the pumping process. As the grout was pumped though the structure and reached the level on an open ball valve, that ball valve was closed and sealed off once a steady flow of the grout was seen through the valve's 2 in. opening. Figure 7 shows the grout flowing through a ball valve on the inclined side. This process was maintained throughout the entirety of the placement. Once the level reached the top, the ventilation pipes located on the top of the inclined side were monitored to ensure no in-trapped air during the final stages.



Figure 7. Grout flowing through the first ball valve located on the inclined side.

Once the sealed structure was completely filled with grout and all valves were closed, the sides of the structure was lightly tapped with steel hammers. This would help remove any air voids that may remain. After approximately 5 minutes of tapping, the top two center ball valves of the inclined side were opened halfway. Another pump stroke was applied. The valves were closed off mid stroke forcing the rest through the top ventilation pipes. This ensured that the entire structure was completely filled with grout. The steel forms were then left in place for 7 days while the grout cured.

Table 5 gives the hardened property data for the two field cast 7 ksi grout trucks. T1 is within the 14 day desired design tolerance. T2 was a few hundred psi below design tolerance. This is due to the extra water batched into the mixture. Both batches met the original 28 day design tolerance. Also, it is worth noting the lower densities of the 7 ksi grout versus the 6 ksi grout. This is attributed to the lack of defoamer in the 7 ksi grout, and a much higher air content that can be seen in Table 3 and Table 6. Table 7 gives the Elastic Modulus and Poisson's Ratios for both batches of the 7 ksi grout. The modulus results are very consistent, and some Poisson's Ratios were excluded due to slippage during testing.

Break Age (Days)	279-15 7 ksi VC T1 (psi)	279-15 7 ksi VC T2 (psi)
3	4,830	4,470
7	5,370	5,130
14	6,590	6,130
28	7,150	6,800
Average Hardened Density (Ib/cu ft)	132.4	130.8

Table 5. The 7 ksi field cast hardened property data.

Table 6. The 7 ksi field cast fresh properties.

	279-15 7 ksi VC T1	279-15 7 ksi VC T2
Slump (in.)	10	9.5
Air Content (%)	8.3	8.8
Temperature (F)	88.7	95.6
Unit Weight (lb/cu ft)	130	127.6

Table 7. The 7 ksi field cast Young's Modulus and Poisson's Ratio.

	Young's Modulus, E (psi)	Poisson's Ratio, µ (in./in.)	
279-15 7 ksi VC T1	4.10E+06	0.2354	
279-15 7 ksi VC T1	3.94E+06	0.1601	
279-15 7 ksi VC T1	4.02E+06	0.3692	
Average T1	4.02E+06	0.1978	
279-15 7 ksi VC T2	4.28E+06	0.1898	
279-15 7 ksi VC T2	4.38E+06	0.2882	
279-15 7 ksi VC T2	4.42E+06	0.2349	
Average T2	4.36E+06	0.2124	
Excluded values due to slippage during tests.			

6 Conclusions

In January of 2014 and again in February of 2015 the ERDC under two separate partnering agreements developed a 6 ksi and 7 ksi mixture for the purpose of testing scaled bridge columns at Fort Polk near Leesville, LA. Due to the reduced scaling of the test members there were very intricate rebar patterns with very small rebar spacing. The intricacies of these designs lead to the needed mixture proportions being very flowable specialized grouts that used materials sampled from Port Aggregates, Inc. in Leesville, LA. These constituents were used with other specialized additives not available at Port Aggregates, Inc. The test members for each program were then successfully cast in April of 2014 and October of 2015 at Range 15a at Fort Polk. This report detailed the development of these specialized grouts for the purpose of aiding future cementitious mixture developments in the region. The knowledge gained from the mixture proportioning and field application of these highly flowable specialized grouts will aid in future physical model construction and grout pumping applications.

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Appendix A: Constituent Materials

A.1 Cements

ASH GROVE CEMENT COMPANY



4343 Highway 108 Foreman, Arkansas 71836 Phone: 870-542-3040

Type I/II (Low Alkali)

Production Period: July 1 thru July 31, 2015

Date: 8/7/2015

The following information is based on average test data during the production period. The data is typical of cement shipped from the Foreman, Arkansas plant. Individual shipments may vary.

STANDARD REQUIREMENTS

ASTM C150/	/C150M-09
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	CHEMICAL			PHYSICAL					
	A.S.T.M. Test	Spec.			A.S.T.M. Tes	t			
Item	Method	Limit	Test Result	Item	Method	Spec. Limit	Test Resul		
SiO ₂ (%)	C114	Α	20.05	Air content of mortar (volume %)	C185	12 max	8		
Al ₂ O ₃ (%)	C114	Α	5.00	Fineness (cm ² /g):					
Fe ₂ O ₃ (%)	C114	Α	3.72	Air permeability	C204	2800 min	4504		
CaO (%)	C114	Α	64.00	Autoclave expansion (%)	C151	0.80 max	0.00		
MgO (%)	C114	6.0 max	1.00						
SO ₃ (%)	C114		3.18	Compressive strength (psi)					
Loss on ignition (%)	C114	3.0 max	2.35	1 Day	C109	Α	2930		
Na ₂ O (%)	C114	Α	0.18	3 Days	C109	1740 min	4646		
K ₂ O (%)	C114	Α	0.55	7 Days	C109	2760 min	5481		
Insoluble Residue (%)	C114	0.75 max	0.41						
CO ₂ (%)	C114	Α	1.14						
Limestone (%)	C114		3.0						
CaCO ₃ in limestone (%)	C114		86.48	Time of setting (minutes)					
Potential compounds (%) ^D				(Vicat)					
C ₃ S	C114	Α	55	Initial: Not less than	C191	45	117		
C ₂ S	C114	Α	14	Not more than		375	117		
C ₃ A	C114		7						
C ₄ AF	C114	Α	11	Mortar Bar Expansion (%)	C1038	0.020 max	0.002		
C ₃ S + 4.75 C ₃ A	C114		88						

OPTIONAL REQUIREMENTS

ASTM C150/C150M-09, Tables 2 and 4

CHEMICAL				PHYSICAL						
A.S.T.M. Test Spec.				A.S.T.M. Test						
Method	Limit	Test Result	Item	Method	Spec. Limit	Test Result				
C114	Α		False set (%)	C451	В	68				
C114	0.60	0.54	Heat of hydration (kJ /kg)							
			7 days	C186	A					
	A.S.T.M. Test Method C114	A.S.T.M. Test Spec. Method Limit C114 A	A.S.T.M. Test Spec. Method Limit Test Result C114 A	A.S.T.M. Test Spec. Method Limit Test Result C114 A False set (%) C114 0.60 0.54 Heat of hydration (kJ /kg)	A.S.T.M. Test Spec. A.S.T.M. Test Method Limit Test Result Item Method C114 A False set (%) C451 C114 0.60 0.54 Heat of hydration (kJ /kg)	A.S.T.M. Test Spec. A.S.T.M. Test Method Limit Test Result Item Method Spec. Limit C114 A False set (%) C451 B C114 0.60 0.54 Heat of hydration (kJ /kg) C451 B				

A = Not applicable. B = Limit not specified by purchaser, test result provided for

information only.

C = Test results for this period not available.

D = Adjusted per Annex A1.6 M85

Signature:

Jloyd arnold

Floyd Arnold Title: Chief Chemist

ASH GROVE CEMENT COMPANY



4343 Highway 108 Foreman, Arkansas 71836 Phone: 870-542-3040

Type I/II (Low Alkali)

Production Period: July 1 thru July 31, 2015

Date: 8/7/2015

The following information is based on average test data during the production period. The data is typical of cement shipped from the Foreman, Arkansas

Additional Data M85

Inorganic Process	Inorganic Processing Addition Data					
Type Limestone						
Amount(%)	2.99					
SiO ₂ (%)	8.08					
Al ₂ O ₃ (%)	2.55					
Fe ₂ O ₃ (%)	1.45					
CaO (%)	46.25					
SO3 (%)	0.43					

Base Cement Phase Composition

C12	57
C ₂ S	14
C ₃ A	7
C ₄ AF	11

Floyd arnold

Signature:

Floyd Arnold Title: Chief Chemist

A.2 Silica fume

Elkem Materials

INTERNAL PRODUCT SPECIFICATION

PRODUCT: ES-900 W

Characteristic	Min	Max		
SiO2 (%)	85.5			
рН	3.0	10.0		
Carbon (%)		0.70		
Moisture (%)		0.50		
+45µm (%)		7.0		
Bulk Density (Lb/Cft)	16	40		

A.3 Aggregates

A.3.1 6 ksi aggregate

A.3.1.1 6 ksi aggregate CMB testing

Serial No.:	140043	TPP:		Date:	10-Apr-14	Tested By:	CEERD-GM-	С		
WIC:		District:		Contract No	.:					
Producer: Grayson, Port Aggregates, Leesville, I			Date Recd:	Mar-14						
Sampled By	Dylan Scott			Matl Type: fine aggrega		te				
ASTM C 13	6 Sieve Analy	/sis:								
	Run 1		Cumulative F	Percent	Run 2		Cumulative P	ercent		
Sieve Size	Mass Ret, g	% Ret.	Ret.	Pass	Mass Ret, g	% Ret.	Ret.	Pass	Avg	C33
3/8 in.	2.1	0.41%	0.41%	99.59%	0.00	0.00%	0.00%	100.00%	100%	100
No. 4	19.7	3.87%	4.28%	95.72%	15.90	3.14%	3.14%	96.86%	96%	95/100
No. 8	31.0	6.09%	10.38%	89.62%	33.90	6.70%	9.85%	90.15%	90%	80/100
No. 16	29.5	5.80%	16.17%	83.83%	28.60	5.66%	15.50%	84.50%	84%	50/85
No. 30	68.0	13.36%	29.53%	70.47%	68.00	13.45%	28.95%	71.05%	71%	25/60
No. 50	260.3	51.15%	80.68%	19.32%	260.30	51.47%	80.42%	19.58%	19%	5/30
No. 100	93.8	18.43%	99.12%	0.88%	94.20	18.63%	99.05%	0.95%	1%	0/10
No. 200	4.4	0.86%	99.98%	0.02%	4.70	0.93%	99.98%	0.02%	0%	
Pan	0.1	0.02%	100.00%		0.10	0.02%	100.00%			
Total	508.90				505.70					
Fineness M	odulus:									
ASTM C 11	7 Minus 75un	n (No. 200)								
OD Mass, g	510.90	Mass Aft, g	509	Mass Loss,	1.9	% Loss:	0.37%			
OD Mass, g	517.90	Mass Aft, g	506.3	Mass Loss,	11.6	% Loss:	2.24%		1.3%	
ASTM C 12	8 Bulk Specif	ic Gravity & /	Absorption:		Run 1	Run 2				
Flask No.					3	94			Avg	
SSD Mass,	g				501.60	508.10				
Mass Flask+	+Water, g				679.40	680.50				
Mass Flask+	+Water+Mate	rial, g			988.80	994.20				
Mass Displa	iced Water, g	J			192.20	194.40				
Water Temp	o C				21.0	21.8				
Relative Density (Bulk Specific Gravity)(SSD)			2.610	2.614						
SSD Mass,	g				501.60	508.10				
Oven Dry M	ass, g				498.10	504.86				
Moisture Lo	ss, g				3.50	3.24				
Absorption					0.70%	0.64%			0.7%	

				Турі	cal Prop	erties			
Product	Code:	GR	AYSON	SAND					
Project						Sam	ples Taken	STO	CKPILE
Reques	ted by:								
Contrac	tor:						Compile	d by:	W. HANKS
				AG	GRE	GAT	`E		
GRADA									
SIEVE S	SIZE	Spec.	Avg.						
IN.	MM.	% Passing							
1/2"	12.5	***	100.0						
3/8"	9.5	***	100.0						
#4"	4.8	***	98.2						
#8"	2.4	***	92.4						
#16"	1.2	***	86.0						
#30"	0.6	***	62.5						
#40"	0.41	***	29.1						
#50"	0.29	***	13.3						
#100"	0.15	***	5.1						
#200"	0.07	***	0.0						
#200	0.07		0.0						
Bulk (SS	SD) Ge		2.62	ASTM C 127					
Bulk Gs			2.63	ASTM C 127					
Absorpti			0.5	ASTM C 127					
LA Abra			NA	ASTM C 535					
	ium Sulfa	ate							1
Soundness		_	NA	ASTM C 88					
Formatio									
Liquid Li	imit		NA	ASTM D 4318					
Plastic L			NA	ASTM D 4318					
Plastic li	ndex		NA	ASTM D 4318					
Unit Wt. Loose PCF		F	98.7	ASTM C 29					

A.3.1.2 6 ksi aggregate, Port Aggregates, Inc. testing

A.3.2 7 ksi aggregate

MATT MENU SEL	ECTION - 2		Louisi	-	nt of Transportation and D			DOTD 03-22-0745 Metric/English
				AGGREG	SATE TEST REPO	Cle	ar Worksheet	Rev. 11/98
Metric / English	E (MorE-Loc	ated on Mai	t Menuj					
Project No.		<u> </u>		Mater	ial Code	Lab No		
Date Sampled	8/6/2015				itted By	Quantit		
Purp Code	1 Source Co	ode		Spec	. —	P.O. No.		
Date Tested	8/6/2015		Ident		Plant Code		Frict Rating	(1-4)
ltem No.			D.	ate Rec'd (lat	o)		Sampled By:	D. DEVILLE
Remarks 1 Fin	e Agg. Trinity Sar	d						
Tested By	. Hebert Da	ate	8/6/201	5	Checked By	W. HANKS	Date	8/7/2015
	DOTD TR 102, 11	2. 113 & 30)9			DOTD	FR 428	
Unit 1 1=	grams 2= pounds				Liguid Limit		Plastic Limit	
Sieve	grams z - pounds							
mm in.	Mass (Wt) Retained	% Retained	% Coarser	% Passing	No. of Blows		Mass Cup + Wet Soil,	g
63 21/2	0				Mass Cup + Wet Soil, g		Mass Cup + Dry Soil,	9
50 2	0				Mass Cup + Dry Soil, g		Mass Water	
37.5 11/2	0				Factor		Mass Cup, g	
31.5 11/4	0				Cup No. Mass Cup, g	1	Mass Dry Soil % Moisture	
25.0 1	0						% Moisture	
19.0 3/4	0				% Moisture		Plastic Index	
16.0 5/8	0				Absorption, % (T84 or T85 Spec. Grav SSD (T84 or T			
12.5 1/2	0				Spec. Grav APP (TR 300)	1		
9.5 3/8	0				Effective Spec Grav (TR 3 Opt Moist Content, % (TF			
4.75 No.4	12.1	2.27829	2.27829	98	Maximum Density (TR 418		ı	
Mass(Wt.) Mati. in pan					Lab Comp Method (TR 41 Cement, % (TR 432 or SP			
Accum, Total			l		Lime, % (TR 416 or SPECI	•		
Initial Dry Total Mas:	e (5-b)		ン Diff:			Code 📃	×	
· · · ·	= grams 2= pounds		7. Dir.		Clay Lumps, % (TR 119) Friable Particles, % (TR 11)	9)		
Sieve	Mass (Wt) Retained	%			Clay Lumps & Friable Part			
mm/µm No.			% Coarser	_	Flat or Elongated Part, %	(TR 119)		
2.36 8	33.1	6.232348	8.510638	91	Coal & Lignite, % (TR 119) Glassy Particles, % (TR 11	9)		
2.00 10	0	7.054000	8.510638	04	Iron Ore, % (TR 119) Wood, % (TR 119)			
1.18 16	41.7	7.851629	16.36227	84	Total (Clay Lumps, Fri. Pa	irt., Iron Ore,		
600 30 425 40	89 143.5	16.75767 27.01939	33.11994 60.13933	67 40	Coal & Lignite, Woo Foreign Matter, % (TR 109			
300 50	112.1	21.10714	81.24647	19	Clam Shell, % (TR 110)			
180 80	0		81.24647		Soundness, % Loss (T 104 Abrasion, % Loss (T 96)	H)		
150 100	95.6	18.00038	99.24685	1	Colorimetric Test (1 = Pas	s, 2 = Fail) (T 21)		
75 200	3.6	0.677838	99.92468		Asphalt Content, % (TR 3)	r .		
53 270			99.92468		Retained Asphalt Coating Percent Crushed (TR 306		 	—
Mass(Wt.) Matl. In pan	0.4	0.075315	100		Retained Marshall Stabilit	ý (TR 313)		
Decant Loss	0.00				Resistivity, ohm - cm (TR	429)		
Accum, Total	531.10	1.5	N/DW/JO	0750507	pH (TR 430) Organic Content, % (TR 4)	121		
Initial Dry Total Mas Dry Mass (Wt) Afte		1.5	% Diff: 0.	0752587	Sand Equivalent (TR 120)	13]		
Remarks 2:			L				L	
PASSED ALL	SCREENS							
					Approved By:		Date	:

A.4 Chemical admixtures

A.4.1 6 ksi chemical admixtures

A.4.1.1 6 ksi HRWRA

Grace Concrete Products

ADVA 190

High-range water-reducing admixture ASTM C494 Type A and F, and ASTM C1017 Type I

Product Description



ADVA* 190 is a polycarboxlatebased high-range water-reducing admixture specifically formulated to meet the needs of the concrete industry. It is a low

viscosity liquid, which has been formulated by the manufacturer for use as received. ADVA 190 is manufactured under closely controlled conditions to provide uniform, predictable performance and is formulated to comply with specifications for Chemical Admixtures for Concrete, ASTM Designation C494 as a Type A and F, and ASTM C1017 Type I admixture. ADVA 190 does not contain intentionally added calcium chloride. One gallon weighs approximately 8.8 lbs (1.1 kg/L).

Uses

ADVA 190 superplasticizer produces concrete with extremely workable characteristics referred to as high slump. It also allows concrete to be produced with very low water/cement ratios for high strength. While ADVA 190 is ideal for use in any concrete where it is desired to minimize the water/cementitious ratio yet maintain workability, ADVA 190 is primarily intended for use in ready-mix concrete, but may also be used in other applications such as precast concrete and self-consolidating concrete.

Addition Rates

ADVA 190 superplasticizer addition rates can vary with type of application, but will normally range from 3 to 15 fl oz/100 lbs (195 to 980 mL/100 kg) of cementitious. In most instances, the addition of 3 to 6 fl oz/ 100 lbs (195 to 375 mL/100 kg) of cementitious will be sufficient. At a given water/cementitious ratio, the slump required for placement can be controlled by varying the addition rate. Should conditions require using more than the recommended addition rates, please consult your Grace representative.

ADVA 190 dosage requirements may also be affected by mix design, cementitious content and aggregate gradations. Please consult with your Grace Construction Products representative for more information and assistance.

Product Advantages

- Highly efficient, producing high slump concrete at very low dosages
- Provides a combination of slump life with near neutral set time
- · Consistent air entrainment
- Consistent performance across cement chemistries
- Concrete finishes easily without stickiness, spotty set or tearing



JRACE

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Compatibility with Other Admixtures and Batch Sequencing

ADVA 190 is compatible with most Grace admixtures as long as they are added separately to the concrete mix. However, ADVA products are not recommended for use in concrete containing naphthalene-based admixtures including Daracem® 19 and Daracem 100, and melamine-based admixtures including Daracem ML 330 and Daracem 65. In general, it is recommended that ADVA 190 be added to the concrete mix near the end of the batch sequence for optimum performance. Different sequencing may be used if local testing shows better performance. Please see Grace Technical Bulletin TB-0110, Admixture Dispenser Discharge Line Location and Sequencing for Concrete Batching Operations for further recommendations, ADVA 190 should not come in contact with any other admixture before or during batching, even if diluted in mix water.

Pretesting of the concrete mix should be performed before use and as conditions and materials change in order to assure compatibility with other admixtures, and to optimize dosage rates, addition times in the batch sequencing and concrete performance. For concrete that requires air entrainment, the use of an ASTM C260 air-entraining agent (such as Daravair[®] or Darex[®] product lines) is recommended to provide suitable air void parameters for freeze-thaw resistance. Please consult your Grace representative for guidance.

Packaging & Handling

ADVA 190 is available in bulk, delivered by metered tank trucks, in 330 gal (1250 L) disposable totes, and in 55 gal (210 L) drums.

It will begin to freeze at approximately 32°F (0°C), but will return to full strength after thawing and thorough agitation. In storage, and for proper dispensing, ADVA 190 should be maintained at temperatures above 32°F (0°C).

Dispensing Equipment

A complete line of accurate, automatic dispensing equipment is available.

	US	Units	M	etric
	Control	ADVA 190	Control	ADVA 190
Cement (pcy) (kg/m3)	517	517	307	307
Coarse aggregate (pcy) (kg/m3)	1944	1944	1153	1153
Fine aggregate (pcy) (kg/m ³)	1144	1214	679	720
Water (pcy) (kg/m ³)	235	204	396	344
w/cm	0.455	0.405	0.455	0.405
Slump (inches) (mm)	3.75	3.5	95	90
Plastic air (%)	5.5	5.4	5.5	5.4
Compressive strength				
1 day (psi) (MPa)	1860	2670	12.8	18.4
7 day (psi) (MPa)	4520	5530	31.2	38.1
28 day (psi) (MPa)	5440	6690	37.5	46.1
Initial set time (hr:min)	4:02	3:55	4:02	3:55
Length change 28 day (%)	-0.031	-0.028	-0.031	-0.028
Freeze-thaw resistance (RDME %)	92	98	92	98

ADVA 190 ASTM C494 Type F High-Range Water Reducer Test Data

www.graceconstruction.com

North American Customer Service: 1-877-4AD-MIX1 (1-877-423-6491)

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A.4.1.2 6 ksi WRA

Grace Concrete Products

ZYLA[•] 610 Water-reducing admixture ASTM C494 Type A and D

Product Description

ZYLA® 610 water-reducing admixture is a proprietary formulation incorporating A highly purified specialty organic chemicals. ZYLA 610 promotes more complete hydration of Portland cement and has no effect on concrete air entrainment. The ZYLA product line of water reducers is specially formulated to have a synergistic effect with polycarboxylate-based mid-range and high-range water reducers that improve flat-work finishability. This product does not contain intentionally added chloride and as such is essentially chloride free. It is manufactured under rigid controls that provide uniform, predictable performance. ZYLA 610 is supplied as a light brown, low viscosity liquid, and is ready-to-use as received. One gallon weighs approximately 9.1 lbs (1.09 kg/L).

Product Advantages

- No impact on concrete air content
- Better control of water reduction and setting times as compared to traditional lignin-based water reducers
- Synergistic performance of polycarboxylate-based mid-range and high-range water reducers, which includes water reduction and concrete strength and air control
- In the hardened state, improves the compressive and flexural strengths at all ages of concrete versus traditional lignin-based water reducers

ZYLA 610 meets the requirements of *Specification for Chemical Admixtures for Concrete*, ASTM Designation C494 as Type A and Type D admixtures. Please consult your Grace representative for guidance on the ZYLA product line.

Uses

ZYLA 610 is used to produce concrete mixes with lower water content (typically 3% to 10% reduction), greater plasticity and higher compressive strengths. ZYLA 610 is suitable for normal weight and light weight concrete in ready-mix, precast and prestressed applications.

Finishability

The unique chemistry of ZYLA 610 positively impacts the finishability of concrete by providing a creamier and more homogenous texture, with more uniform and increased bleed rate relative to traditional lignin-based water reducers. The influence of ZYLA 610 on the finishability of lean mixes has been particularly noticeable. Floating and troweling, by machine or hand, imparts a smooth, close tolerance surface.

Addition Rates

The addition rate range of 3 to 5 fl oz/100 lbs (195 to 325 mL/100 kg) of cement or cementitious is typical for most applications. However addition rates of 2 to 7 fl oz/100 lbs (130 to 455 mL/100 kg) of cement or cementitious may be used if local testing shows acceptable performance. Pretesting is required to determine the appropriate addition rate for desired performance. The optimum addition rate depends on the other concrete mixture components, job conditions, and desired performance characteristics. **JRACE**

Compatibility with Other Admixtures and Batch Sequencing

ZYLA 610 is compatible with most Grace admixtures as long as they are added separately to the concrete mix, usually through the water holding tank discharge line. In general, it is recommended that ZYLA 610 be added to the concrete mix near the end of the batch sequence for optimum performance. Different sequencing may be used if local testing shows better performance. Please see Grace Technical Bulletin TB-0110, Admixture Dispenser Discharge Line Location and Sequencing for Concrete Batching Operations for further recommendations. ZYLA 610 should not come in contact with any other admixture before or during the batching process, even if diluted in mix water.

Pretesting of the concrete mix should be performed before use, and as conditions and materials change in order to assure compatibility, and to optimize dosage rates, addition times in the batch sequencing and concrete performance. For concrete that requires air entrainment, the use of an ASTM C260 airentraining agent (such as Daravair[®] or Darex[®] product lines) is recommended to provide suitable air void parameters for freeze-thaw resistance. Please consult your Grace representative for guidance.

Packaging & Handling

ZYLA 610 is available in bulk, delivered by metered tank trucks, in 275 gal (1,040 L) totes, and in 55 gal (210 L) drums. It will freeze at about 23.7°F (-4.6°C), but will be completely uniform after thawing and thorough agitation.

Dispensing Equipment

A complete line of accurate, automatic dispensing equipment is available. ZYLA 610 may be introduced to the concrete mix through the water holding tank discharge line. The ZYLA product line is formulated to be free of sediment.

Specifications

Concrete shall be designed in accordance with *Standard Recommended Practice for Selecting Proportions for Concrete*, ACI 211.

The water-reducing admixture shall be ZYLA 610, as manufactured by Grace Construction Products, or equal. The admixture shall not contain calcium chloride as a functional ingredient. ZYLA 610 will not promote corrosion of reinforcing steel embedded in concrete. It shall be used in strict accordance with the manufacturers' recommendations. The admixture shall comply with ASTM Designation C494, Type A water-reducing and Type D water-reducing and retarding admixtures. Certification of compliance shall be made available on request.

The admixture shall be delivered as a readyto-use liquid product and shall require no mixing at the batching plant or job site.

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A.4.1.3 6 ksi hydration stabilizer

Grace Concrete Products

RECOVER'

Hydration stabilizer ASTM C494 Type D

Product Description



aqueous solution of chemical compounds specifically designed to stabilize the hydration of Portland cement concretes. The ingredients are

Recover* is a ready-to-use

factory pre-mixed in exact proportions under strict quality control to provide uniform results. One gallon weighs approximately 9.6 lbs (1.15 kg/L).

Recover is approved by ASTM C494 as a Type D retarder.

Uses

Recover is used to stabilize mixer wash water and returned or leftover concrete for extended periods, allowing for use of the materials when specified or allowed. It is also used where controlled extended set of concrete is needed. It is the concrete user's responsibility to determine if leftover, returned or extendedset concrete is specified or allowed.

Wash Water

For wash water applications, Recover is used to eliminate the need to discharge wash water from the mixer. This allows the wash water to

Product Advantages

- · Eliminates the need to discharge wash water from the mixer
- · Prevents the waste of unused concrete
- · Provides predictable extended set for continuous placement on mass concrete and tremie projects, or on long hauls to remote sites

be used as mix water in the next batch of concrete produced, and prevents the residual plastic concrete from hardening. Stabilization of up to 96 hours is possible depending on dosage rate.

Returned Concrete

For returned or leftover concrete, Recover is used to prevent plastic concrete from reaching initial set. This allows the concrete to be stored in a plastic state and then used when specified or allowed. The use of this concrete may require the addition of freshly batched concrete and/or an accelerator such as Daraccel® or PolarSet®. Stabilization of concrete for up to 96 hours is possible depending on dosage rate. Use prevents the waste of unused concrete.

Set Time Control

Recover is also used in situations where a controlled set time extension is required. Examples include: extended hauls, large continuous pours or pre-batching of concrete for later use.





Performance

Recover stabilizes the hydration process of Portland cement preventing it from reaching initial set. This stabilization is not permanent and is controlled by dosage rate. For wash water, the Recover treated water is mixed or sprayed in a specific manner to thoroughly coat the interior of the mixer. The water is used as mix water in the next batch of concrete produced, which then scours the unhardened material from the interior of the mixer. Stabilization of returned or leftover concrete with Recover maintains the plasticity of the concrete for the desired storage duration. This stabilized concrete then resumes normal hydration when the Recover dosage effects subside, or when it is activated by the addition of fresh concrete and/or an accelerator. The result can be concrete with normal plastic and hardened properties.

Addition Rates

Addition rates of Recover for wash water range from 6 to 128 fl oz (180 to 3800 mL) per treatment. The amount used will depend on the specific materials involved, mixer type and stabilization period. Addition rates for returned or leftover concrete will range from 3 to 128 fl oz/100 lbs (195 to 8350 mL/100 kg) of cement. The amount used will depend on the specific materials involved, concrete age, temperature conditions and stabilization period. For applications requiring set time extensions well in excess of 4 hours. Recover may be used at addition ranges from 5 to 50 oz/100 lbs (325 to 3260 mL/100 kg) of cement. For use as a traditional ASTM Type D retarder, Recover may be used at addition rates of 2 to 6 oz/100 lbs (130 to 390 mL/100 kg) of cement. Proper dosage rate selection can only be achieved through pretesting. Consult your local Grace admixture representative.

Compatibility with Other Admixtures and Batch Sequencing

Recover is compatible with most Grace admixtures as long as they are added separately to the concrete mix, usually through the water holding tank discharge line. In general, it is recommended that Recover be added to the concrete mix near the end of the batch sequence for optimum performance. Different sequencing may be used if local testing shows better performance. Please see Grace Technical Bulletin TB-0110, Admixture Dispenser Discharge Line Location and Sequencing for Concrete Batching Operations for further recommendations. Recover should not come into contact with any other admixture before or during the batching process, even if diluted in mix water.

Pretesting of the concrete mix should be performed before use, and as conditions and materials change in order to assure compatibility, and to optimize dosage rates, addition times in the batch sequencing and concrete performance. For concrete that requires air entrainment, the use of an ASTM C260 airentraining agent (such as Daravair* or Darex* product lines) is recommended to provide suitable air void parameters for freeze-thaw resistance. Please consult your Grace representative for guidance.

Packaging & Handling

Recover is available in bulk, delivered by metered tank trucks and 55 gallon (210 L) drums. Recover will freeze, but will return to full effectiveness after thawing and thorough mechanical agitation.

Dispensing Equipment

A complete line of Grace dispensing equipment is available for Recover. This includes the Reach 360[™] System which uses an innovative spray wand technology to simplify wash water procedures.

BRACE

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Recover, Daraccel, PolarSet, Daravair and Darex are registered trademarks and Reach 360 is a trademark of W. R. Grace & Co..-Conn. We hope the information here will be helpful. It is based on data and knowledge considered to be true and accurate and is offered for the users' consideration, hivestigation and verification, but we do not warrant the results to be obtained. Please read all statements, recommendations or suggestions in conjunction with our conditions of sale, which apply to all goods supplied by us. No statement, recommendation or suggestion is intended for any use which would infinge any patent or copyright. W. R. Grace & Co..-Conn., 62 Whittemore Avenue, Cambridge, MA 02140. In Canada, Grace Canada, Inc., 294 Clements Road, West, Ajax, Ontario, Canada L15 306.

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A.4.1.4 Colloidal silica



SAFETY DATA SHEET

Cembinder N8

Version 1	Revision Date 04/28/2015	Print Date 02/12/2016	US / Z8
	•		

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	: Cembinder N8
Product Use Description	: Inorganic binder, surface modifier and flocculating agent.
Chemical characterization	: Amorphous Silica, aqueous colloidal solution.
Company	: Akzo Nobel Pulp and Performance Chemicals Inc. Parkway Place Suite 1200 1850 Marietta GA 30067 United States
Telephone Fax E-mail address Emergency telephone	 +17705780858 +17705781359 psra.ppc@akzonobel.com US CHEMTREC +1-800-424-9300 Internat'l +1-703-741-5971 (collect calls accepted) CANADA CANUTEC +1-613-996-6666

2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance	Clear liquid
Color	clear, cloudy
Odor	slight

GHS Classification

Not a hazardous substance or mixture.

GHS Label element

Not a hazardous substance or mixture.

Potential Health Effects

Inhalation	: May cause respiratory tract irritation.
Skin	: Causes mild skin irritation.
Eyes	: May cause eye irritation.
Ingestion	: May cause irritation of the mucous membranes.
Aggravated Medical Condition	: None known.

A.4.2 7 ksi chemical admixtures

A.4.2.1 - ksi HRWRA



We create chemistry

	03 30 00	Cast-in-Place Concrete
0	03 40 00	Precast Concrete
3	03 70 00	Mass Concrete

MasterGlenium[®] 1466

High-Range Water-Reducing Admixture

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Description

MasterGlenium 1466 readyto-use high-range waterreducing admixture is a new generation, patent pending admixture based on polycarboxylate chemistry. MasterGlenium 1466 admixture is very effective in producing concretes with different levels of workability.

MasterGlenium 1466 admixture is particularly effective in improving concrete mixtures with reduced portland cement contents without compromising 28-day strength requirements. MasterGlenium 1466 admixture meets ASTM C 494/C 494M requirements for Type A, water-reducing, and Type F, high-range water-reducing, admixtures.

Applications

Recommended for use in:

- Concrete with varying water reduction requirements (5-40%)
- Concrete where high flowability, increased stability and durability are needed
- Producing selfconsolidating concrete (SCC)
- Strength-on-demand concrete, such as 4x4[™] Concrete
- Pervious concrete

Features

- Maximum dosage effectiveness for a given water reduction
- Controlled rheology
- Robust air-entraining admixture compatibility
- Improved strength development

Benefits

- Can be used in a wide variety of concrete mixtures as a Type A or Type F admixture
- Improved finishability and surface appearance
- Mixture development flexibility for cement reductions and/or increased use of supplementary cementitious materials

Performance Characteristics

Compressive Strength: Concrete produced with MasterGlenium 1466 admixture achieves significantly higher 28-day compressive strength compared to plain concrete and concrete mixtures containing naphthalene, melamine, and early generation polycarboxylate high-range water-reducing admixtures.

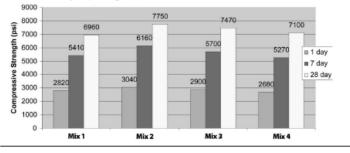
Mixture Data: Type I portland cement; Ambient Temperature, 70 °F (21 °C)

Mix 1: 620 lb/yd3 (367 kg/m3); w/c = 0.43; Conventional PC HRWR

Mix 2: 620 lb/yd3 (367 kg/m3); w/c = 0.43; MasterGlenium 1466

Mix 3: 600 lb/yd3 (356 kg/m3); w/c = 0.44; MasterGlenium 1466

Mix 4: 580 lb/yd3 (344 kg/m3); w/c = 0.46; MasterGlenium 1466





MasterGlenium 1466

Guidelines for Use

Dosage: MasterGlenium 1466 admixture has a recommended dosage range of 2-10 fl oz/cwt (130-650 mL/100 kg) of cementitious materials. For most applications, dosages in the range of 2-6 fl oz/cwt (130-390 mL/100 kg) will provide excellent performance. Because of variations in concrete materials, job site conditions and/or applications, dosages outside of the recommended range may be required. In such cases, contact your local sales representative.

Mixing: MasterGlenium 1466 admixture can be added with the initial batch water or as a delayed addition. However, optimum water reduction is generally obtained with a delayed addition.

Product Notes

Corrosivity – Non-Chloride, Non-Corrosive: MasterGlenium 1466 admixture will neither initiate nor promote corrosion of reinforcing steel embedded in concrete, prestressing steel or of galvanized steel floor and roof systems. Neither calcium chloride nor other chloride-based ingredients are used in the manufacture of MasterGlenium 1466 admixture.

Compatibility: MasterGlenium 1466 admixture is compatible with most admixtures used in the production of quality concrete, including normal, mid-range and high-range water-reducing admixtures, air-entrainers, accelerators, retarders, extended set control admixtures, corrosion inhibitors, and shrinkage reducers.

Do not use MasterGlenium 1466 admixture with admixtures containing naphthalene sulfonate. Erratic behaviors in slump, workability retention and pumpability may be experienced.

Storage and Handling

Storage Temperature: MasterGlenium 1466 admixture must be stored at temperatures above 40 °F (5 °C). If MasterGlenium 1466 admixture freezes, thaw and reconstitute by mechanical agitation. Do not use pressurized air for agitation.

Shelf Life: MasterGlenium 1466 admixture has a minimum shelf life of 6 months. Depending on storage conditions, shelf life may be greater than standard. Please contact your local sales representative regarding suitability for use and dosage recommendations if the shelf life of MasterGlenium 1466 admixture has been exceeded.

Packaging

MasterGlenium 1466 admixture is supplied in 55 gal (208 L) drums, 275 gal (1040 L) totes and by bulk delivery.

Related Documents

Safety Data Sheets: MasterGlenium 1466 admixture

Additional Information

For additional information on MasterGlenium 1466 admixture or its use in developing concrete mixtures with special performance characteristics, contact your local sales representative.

The Admixture Systems business of BASF's Construction Chemicals division is the leading provider of solutions that improve placement, pumping, finishing, appearance and performance characteristics of specialty concrete used in the ready-mixed, precast, manufactured concrete products, underground construction and paving markets. For over 100 years we have offered reliable products and innovative technologies, and through the Master Builders Solutions brand, we are connected globally with experts from many fields to provide sustainable solutions for the construction industry.

Technical Data Sheet

A.4.2.2 7 ksi WRA

BASF

We create chemistry

	03 30 00	Cast-in-Place Concrete
~	03 40 00	Precast Concrete
3	03 70 00	Mass Concrete

MasterPozzolith[®] 80

Water-Reducing Admixture

Formerly Pozzolith 80*

Description

Features

- Reduced water content required for a given workability
- Controlled setting characteristics normal or retarded

Benefits

- Increased compressive and flexural strengths
- Improved workability
- Reduced segregation
- E Flexibility in the scheduling of placing and finishing operations
- Offsets effects of early stiffening during extended delays between mixing and placing
 - Helps eliminate cold joints
 - Full-form deflection can take place (before concrete sets) in extended pours for bridge decks, cantilevers, nonshored structural elements, etc.
- Peak temperature and/or rate of temperature rise lowered in mass concrete thereby reducing thermal cracking

Performance Characteristics

Rate of Hardening: The temperature of the concrete mixture and the ambient temperature affect the hardening rate of concrete. At higher temperatures, concrete stiffens more rapidly which may cause problems with placing and finishing. The dosage range of MasterPozzolith 80 admixture can be varied to provide the desired setting characteristics.

Guidelines for Use

Dosage: Depending on the setting characteristics desired, MasterPozzolith 80 admixture is recommended for use within the dosage range of 3-10 fl oz/cwt (195-650 mL/100 kg) of cementitious materials for most concrete mixtures using average concrete ingredients. Because of variations in job conditions and concrete materials, dosages other than the recommended amounts may be required. In such cases, contact your local sales representative.



MasterPozzolith 80 readyto-use, liquid admixture is used for making more uniform and predictable quality concrete.

MasterPozzolith 80 admixture meets ASTM C 494/C 494M requirements for Type A, water-reducing, Type B, retarding, and Type D, retarding and waterreducing, admixtures.

Applications

Recommended for use in:

- Prestressed concrete
- Precast concrete
- Reinforced concrete
- Shotcrete
- Lightweight concrete
- Pumped concrete
- 4x4[™] Concrete
- Pervious concrete
- Self-consolidating concrete (SCC)

MasterPozzolith 80

Product Notes

Corrosivity – Non-Chloride, Non-Corrosive: MasterPozzolith 80 admixture will neither initiate nor promote corrosion of reinforcing steel in concrete. This admixture does not contain intentionally-added calcium chloride or other chloride-based ingredients.

Compatibility: MasterPozzolith 80 admixture may be used in combination with any BASF admixtures. When used in conjunction with other admixtures, each admixture must be dispensed separately into the mixture.

Storage and Handling

Storage Temperature: MasterPozzolith 80 admixture should be stored above freezing temperatures. If MasterPozzolith 80 admixture freezes, thaw at 35 °F (2 °C) or above and completely reconstitute by mild mechanical agitation. Do not use pressurized air for agitation.

Shelf Life: MasterPozzolith 80 admixture has a minimum shelf life of 18 months. Depending on storage conditions, the shelf life may be greater than stated. Please contact your local sales representative regarding suitability for use and dosage recommendations if the shelf life of MasterPozzolith 80 admixture has been exceeded.

Packaging

MasterPozzolith 80 admixture is supplied in 55 gal (208 L) drums, 275 gal (1040 L) totes and by bulk delivery.

Related Documents

Safety Data Sheets: MasterPozzolith 80 admixture

Additional Information

For additional information on MasterPozzolith 80 admixture or its use in developing a concrete mixture with special performance characteristics, contact your local sales representative.

The Admixture Systems business of BASF's Construction Chemicals division is the leading provider of solutions that improve placement, pumping, finishing, appearance and performance characteristics of specialty concrete used in the ready-mixed, precast, manufactured concrete products, underground construction and paving markets. For over 100 years we have offered reliable products and innovative technologies, and through the Master Builders Solutions brand, we are connected globally with experts from many fields to provide sustainable solutions for the construction industry.

Technical Data Sheet

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* Pozzolith 80 became MasterPozzolith 80 under the Master Builders Solutions brand, effective January 1, 2014.

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Appendix B: Mixture Proportions, Unconfined Compressive Strength, and Fresh Properties of Trial Batches

B.1 6 ksi grout trial mixtures

			REPORT OF CONCRETE MIXTURE PROPORTIONS								
Project: Fort Po		ed Grout	Grayson Concrete Sand								
Mixture No. 03											
Proportioned: (
6ks i Sanded Gr	out for use a	it Fort Polk									
1. MIXTURE	PROPORTI	ONS									
			Aggre	egate, %	Solid Vo	lume	Mass,	S.S.D.	Bulk Sp. Gr.	Absorption,	
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%	
Por	tland cemen	t			3.490	0.129	686	407	3.15		
							┟───┤				
Fir	e aggregate		100.0	100.0	14.789	0.548	2427	1441	2.63	0.50	
Fine aggregate			100.0	100.0	14.769	0.548	2427	1441	2.03	0.50	
F	Batch water				7.695	0.285	480	285	1.0		
Ce	embinder N8						224.9 fl. oz	8.7 Ltrs			
	Air				1.026	0.038		2122			
	Totals:		100	100	27	1	3594	2133			
W/(C+M), by 3. TEST RESU	-			100.0% 0.700			/t., kg/m ³ (lb /ft ³) Factor, kg/m ³ (ll		2133 407	6	
		Air	Air			Unce	onfined Com	pressive Str	ength, MPa (p	si) ^c	
Batch Number	Slump in.	Content %	Content ^b %	Unit Weight	Relative		28-Day				
				lb/ft ³	Yield	7-day ^d					
1	0.0	0	-0.2	0	0.0%	3570	4320				
COARSE AGG FINE AGGREG CEMENT: TyF POZZOLANS: Admixture: Cer REMARKS:	ATE: Grays pe I/II, Ash C n/a nbinder N8, .	on concrete irove Cemen AkzoNobel u	t Company., F	oreman, Arkans	sas	-	andria/Woodwo and in suspensio		region		
COARSE AGG FINE AGGREG CEMENT: TyF POZZOLANS: Admixture: Cer REMARKS: a Compressiv	REGATE: N iATE: Grays be I/II, Ash C n/a mbinder N8, . e strength te	on concrete irove Cemen AkzoNobel u sts made on	t Company., F sed as a Visc nominal 4 x 8	oreman, Arkans	sas	-			region		
COARSE AGG FINE AGGREG CEMENT: Typ POZZOLANS: Admixture: Cer REMARKS:	REGATE: N iATE: Grays pe I/II, Ash C n/a nbinder N8, . e strength te orrection fac	on concrete drove Cemen AkzoNobel u sts made on tor = 0.2 perc	t Company., F sed as a Visc nominal 4 x 8- cent applied	oreman, Arkans	sas	-			region		

**Fresh properties not measured for this trial.

REPORT OF CONCRETE MIXTURE PROPORTIONS Project: Fort Polk 6ksi Sanded Grout Grayson Concrete Sand Mixture No. 035-14 vc-T2 Proportioned: 04-Feb-14 6ksi Sanded Grout for use at Fort Polk 1. MIXTURE PROPORTIONS Aggregate, % Solid Volume Mass, S.S.D. Bulk Sp. Gr. Absorption, by vol. S.S.D. % Material by wt. ft3 m³ lb/yd³ kg/m³ 3.414 0.126 Portland cement 671 398 3.15 0.004 2.25 Silica Fume 9 14.759 0.547 2422 100.0 100.0 1438 2.63 0.50 Fine aggregate Batch water 7.695 0.285 480 285 1.0 Cembinder N8 90 fl. oz 3.5 Ltrs 1.026 0.038 Air 100 100 27 3589 2130 Totals: 1 2. MIXTURE CHARACTERISTICS S/A, % :by volume Theo. Unit Wt., kg/m³ (lb /ft³) 133.0 100.0% 2130 W/(C+M), by weight: 0.700 Cementitious Factor, kg/m3 (lb/yd3): 407 671 3. TEST RESULTS Unconfined Compressive Strength, MPa (psi) c Air Air Batch Slump Content Unit Weight Relative Content Number 7-day 28-Day in. % % lb/ft^3 Yield 4310 -0.2 0.0% 3610 0.0 0 1 0 MATERIALS: 4. COARSE AGGREGATE: None FINE A GGREGATE: Grayson concrete sand, Larry Grayson & Son Trucking in the greater Alexandria/Woodworth, Louisiana region CEMENT: Type I/II, Ash Grove Cement Company., Foreman, Arkansas POZZOLANS: Elkem ES900W silica fume Admixture: Cembinder N8, AkzoNobel used as a Viscosity Modifying Admixture to help keep sand in suspension **REMARKS:** a Compressive strength tests made on nominal 4 x 8-in. cylinders b aggregate correction factor = 0.2 percent applied c Elkem ES900W Silica fume has been discontinued. d Specimens cured at 72°F in 100% relative humidity room

**Fresh properties not measured for this trial.

			REPORT OF	F CONCRETE N	AIXTURE PF	OPORTION	S			
Project: Fort Po	lk 6ksi Sand	ed Grout		Grayson Conc	rete Sand					
Aixture No. 035	5-14 vc-T4									
Proportioned: 0	4-Feb-14									
Port Aggregate	s Leesville,	La								
. MIXTURE F	PROPORTI	ONS								
				egate, %	Solid Vo			, S.S.D.	Bulk Sp. Gr.	Absorption
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
	land cement	t	ļ		3.515	0.130	691	410	3.15	
Si	ilica Fume					0.004		9	2.25	
		100.0	100.0	14.656	0.542	2405	1 429	2.02	0.50	
Fine aggregate			100.0	100.0	14.656	0.543	2405	1428	2.63	0.50
в	atch water				7.695	0.285	480	285	1.0	
	mbinder N8				,,	0.200	92.6 fl. oz	3.6 Ltrs	110	
							, <u>210 III 02</u>	510 1115		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3592	2132		
. TEST RESU	LTS									
3. TEST RESU	LTS	Air	Air			Unc	onfined Com	nnressive Str	enoth MPa(r	nsi) ^c
		Air Content	Air Content	Unit Weight	Relative	Unc	onfined Com	pressive Str	ength, MPa (p	osi) ^c
. TEST RESU Batch Number	LTS Slump in.	Air Content %	Air Content %	Unit Weight Ib/ft ³	Relative Yield	Unc 7-Day	onfined Com	pressive Str	ength, MPa (p	osi) ^c
Batch	Slump	Content	Content	Unit Weight Ib/ft ³ 0	Relative Yield 0.0%			pressive Str	ength, MPa (p	osi) ^c
Batch Number 1 . MATEF OARSE A GGF TINE A GGREG/ ZEMENT: Typ OZZOLANS:	Slump in. 0.0 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90	Content % 0 one on concrete : Grove Cement OW silica fun	Content % -0.2 sand, Larry G t Company., F ne	lb/ft ³ 0 irayson & Son T Foreman, Arkans	Yield 0.0% Trucking in th	7-Day 3820 e greater Ale:	28-Day	orth, Louisiana		osi) ^c
Batch Number 1 . MATEF OARSE A GGF TINE A GGREG/ ZEMENT: Typ OZZOLANS:	Slump in. 0.0 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90	Content % 0 one on concrete : Grove Cemen 0W silica fun AkzoNobel u	Content % -0.2 sand, Larry G t Company., F ne ised as a Visc	Ib/ft ³ 0 irayson & Son T Foreman, Arkans	Yield 0.0% Trucking in th	7-Day 3820 e greater Ale:	28-Day 4580 xandria/Woodwa	orth, Louisiana		osi) ^c
Batch Number 1 . MATEF XOARSE A GGF TINE A GGREG/ ZEMENT: Typ- YOZZOLANS:	Slump in. 0.0 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90	Content % 0 one on concrete : Grove Cemen 0W silica fun AkzoNobel u	Content % -0.2 sand, Larry G t Company., F ne ised as a Visc	Ib/ft ³ 0 irayson & Son T Foreman, Arkans	Yield 0.0% Trucking in th	7-Day 3820 e greater Ale:	28-Day 4580 xandria/Woodwa	orth, Louisiana		osi) ^c
Batch Number 1 . MATEF OARSE A GGF INE A GGREG/ EMENT: Typ OZZOLANS: vdmixture: Cent yla 610, Water REMARKS:	Slump in. 0.0 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90 abinder N8, 4 r Reducing 4	Content % 0 one on concrete : Grove Cemen OW silica fun AkzoNobel u Admixture, G	Content % -0.2 sand, Larry G t Company., F ne ised as a Visc irace Chemica	Ib/ft ³ 0 irayson & Son T Foreman, Arkans osity Modifying I Company	Yield 0.0% Trucking in th	7-Day 3820 e greater Ale:	28-Day 4580 xandria/Woodwa	orth, Louisiana		osi) ^c
Batch Number 1 . MATEF COARSE AGGF TINE AGGREG ZEMENT: Type OZZOLANS: Admixture: Cem Zyla 610, Water	Slump in. 0.0 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90 rbinder N8, 4 r Reducing 4	Content % 0 one on concrete : Grove Cemen OW silica fun AkzoNobel u Admixture, G	Content % -0.2 sand, Larry G t Company., F ne used as a Visc irace Chemica nominal 4 x 8	Ib/ft ³ 0 irayson & Son T Foreman, Arkans osity Modifying I Company	Yield 0.0% Trucking in th	7-Day 3820 e greater Ale:	28-Day 4580 xandria/Woodwa	orth, Louisiana		osi) ^c

d Specimens cured at 72°F in 100% relative humidity room

**Fresh properties not measured for this trial.

			REPORT O	F CONCRETE N	AIXTURE PI	ROPORTION	S			
roject: Fort Pol		ed Grout		Grayson Conc	rete Sand					
Aixture No. 078	3-14 vc-T5									
Proportioned: 19										
Port Aggregates	s Leesville,	La								
. MIXTURE P	PROPORTI	ONS								
			55 5 7		Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
	land cemen	t			3.405	0.126	669	397	3.15	
Si	ilica Fume					0.004		9	2.25	
Fine aggregate			100.0	100.0	15.174	0.562	2481	1472	2.63	0.50
Ba	atch water				7.290	0.270	455	270	1.0	
Cer	mbinder N8						224.3 fl. oz	8.7 Ltrs		
Water Red	ducing Adr	nixture					46.7 fl. oz	1.8 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3620	2148		
W/(C+M), by	0					Cententitious	Factor, kg/m ³ (io, yu).	406	6
. TEST RESU	LTS									
3. TEST RESUI	LTS						5 10			· · · · · · · · · · · · · · · · · · ·
		Air	Air		DIC	Unc	onfined Com	pressive Str	ength, MPa (p	osi) ^c
Batch	Slump	Content	Content	Unit Weight	Relative					osi) ^c
Batch Number	Slump in.	Content %	Content %	lb/ft ³	Yield	3-day	7-Day	14-Day	28-Day	osi) ^c
Batch	Slump	Content	Content	-						osi) ^c
Batch Number 1 . MATER XOARSE A GGR	Slump in. 9.3 RIALS: REGATE: N	Content % 3.8	Content % 3.6	lb/ft ³ 136	Yield 101.4%	3-day 3370	7-Day 3950	14-Day 4580	28-Day 5030	osi) ^c
Batch Number 1 . MATER :OARSE A GGR	Slump in. 9.3 RIALS: REGATE: N ATE: Grays	Content % 3.8 one on concrete	Content % 3.6 sand, Larry G	lb/ft ³ 136 rayson & Son T	Yield 101.4%	3-day 3370	7-Day	14-Day 4580	28-Day 5030	osi) ^c
Batch Number 1 . MATER XOARSE AGGR INE AGGREGA ZEMENT: Type	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C	Content % 3.8 one on concrete frove Cemen	Content % 3.6 sand, Larry G	lb/ft ³ 136	Yield 101.4%	3-day 3370	7-Day 3950	14-Day 4580	28-Day 5030	osi) ^e
Batch Number 1 . MATER XOARSE AGGR INE AGGREGA ZEMENT: Type	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C	Content % 3.8 one on concrete frove Cemen	Content % 3.6 sand, Larry G	lb/ft ³ 136 rayson & Son T	Yield 101.4%	3-day 3370	7-Day 3950	14-Day 4580	28-Day 5030	osi) ^c
Batch Number 1 A. MATER COARSE A GGR TINE A GGREGA TINE A GGREGA TEMENT: Type POZZOLANS: 1	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90	Content % 3.8 one on concrete Grove Cemen OW silica fur	Content % 3.6 sand, Larry G t Company., I ne	lb/ft ³ 136 rayson & Son T Foreman, Arkans	Yield 101.4% Yucking in th	3-day 3370	7-Day 3950	14-Day 4580 orth, Louisiana r	28-Day 5030	osi) ^e
Batch Number 1 A MATER COARSE A GGR TINE A GGREGA EMENT: Type POZZOLANS: 1 Admixture: Cem	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90	Content % 3.8 one on concrete Grove Cemen 0W silica fur AkzoNobel u	Content % 3.6 sand, Larry G t Company., I ne sed as a Visc	Ib/ft ³ 136 rayson & Son T Foreman, Arkans	Yield 101.4% Yucking in th	3-day 3370	7-Day 3950 xandria/Woodwo	14-Day 4580 orth, Louisiana r	28-Day 5030	osi) ^c
Batch Number 1 . MATER COARSE A GGR CINE A GGREGA CEMENT: Type POZZOLANS: 1 Admixture: Cem	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90	Content % 3.8 one on concrete Grove Cemen 0W silica fur AkzoNobel u	Content % 3.6 sand, Larry G t Company., I ne sed as a Visc	Ib/ft ³ 136 rayson & Son T Foreman, Arkans	Yield 101.4% Yucking in th	3-day 3370	7-Day 3950 xandria/Woodwo	14-Day 4580 orth, Louisiana r	28-Day 5030	osi) ^c
Batch Number 1 A. MATER COARSE A GGR TINE A GGREGA TINE A GGREGA TEMENT: Type POZZOLANS: 1	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90 abinder N8, . r Reducing A	Content % 3.8 one on concrete Grove Cemen 0W silica fur AkzoNobel u Admixture, G	Content % 3.6 sand, Larry G t Company., I ne used as a Visc race Chemica	lb/ft ³ 136 rayson & Son T Foreman, Arkans osity Modifying I Company	Yield 101.4% Yucking in th	3-day 3370	7-Day 3950 xandria/Woodwo	14-Day 4580 orth, Louisiana r	28-Day 5030	psi) ^c
Batch Number 1 . MATER OARSE A GGR OARSE A GGR INE A GGREGA EMENT: Type OZZOLANS: 1 admixture: Cem Cyla 610, Water REMARKS:	Slump in. 9.3 RIALS: REGATE: N ATE: Grays e I/II, Ash C Elkem ES90 rbinder N8, . r Reducing <i>L</i>	Content % 3.8 one on concrete Grove Cemen OW silica fur AkzoNobel u Admixture, G	Content % 3.6 sand, Larry G t Company., I ne ised as a Visc race Chemica nominal 4 x 8	lb/ft ³ 136 rayson & Son T Foreman, Arkans osity Modifying I Company	Yield 101.4% Yucking in th	3-day 3370	7-Day 3950 xandria/Woodwo	14-Day 4580 orth, Louisiana r	28-Day 5030	osi) ^c

d Specimens cured at 72°F in 100% relative humidity room

			REPORT OF	F CONCRETE N	MIXTURE PF	ROPORTION	s			
Project: Fort Po		ed Grout		Grayson Conc	rete Sand					
Mixture No. 079	9-14 vc-T6									
Proportioned: 2										
Port Aggregate	s Leesville, I	La								
I. MIXTURE I	PROPORTI	ONS								
				egate, %	Solid Vol	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
	land cement	İ.			3.424	0.127	673	400	3.15	
S	ilica Fume					0.004		9	2.25	
P '			100.0	100.0	15.020	0.596	2500	1526	2.02	0.50
Fine aggregate			100.0	100.0	15.829	0.586	2588	1536	2.63	0.50
В	atch water				6.615	0.245	413	245	1.0	
Ce	mbinder N8						225.6 fl. oz	8.7 Ltrs		
Water Re	ducing Adn	nixture	·				48.2 fl. oz	1.9 Ltrs		
High Range Wa	ter Reducin	g Admixture					20.6fl. oz	0.8 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3689	2189		
6/A, % :by vol W/(C+M), by 8. TEST RES U	weight:			100.0% 0.600			/t., kg/m ³ (lb /ft ³ Factor, kg/m ³ (l		2189 408	136
		Air	Air			Une	onfined Com	nressive Str	ength, MPa (p	ci) ^c
Batch	Slump	Content	Content	Unit Weight	Relative	Olic				(51)
	-	%	%	lb/ft ³	Yield	3-day	7-Day	14-Day	28-Day	
Number	in.	/0	/0	10/11						
1	7.5	8.7	8.5	129.6	94.8%	3420	3880	4340	4740	
1 4. MATEL COARSE AGGE FINE AGGREGA CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Water REMARKS: a Compressive	7.5 RIALS: REGATE: No ATE: Grayso e I/II, Ash C Elkem ES900 abinder N8, 4 r Reducing 4	8.7 one on concrete s irove Cement DW silica fur AkzoNobel u: Admixture, Gr	8.5 sand, Larry G t Company., F re sed as a Visc race Chemical nominal 4 x 8	129.6 rayson & Son T Foreman, Arkans osity Modifying Company; AD	94.8% Trucking in th sas	e greater Ale: to help keep s	3880 xandria/Woodwo and in suspensio r Reducing Adm	orth, Louisiana 1 on;	region	
1 4. MATEL COARSE AGGE FINE AGGREGA CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Water REMARKS: a Compressive	7.5 RIALS: REGATE: No ATE: Grayso e I/II, Ash C Elkem ES900 abinder N8, 4 r Reducing 4	8.7 one on concrete s irove Cement DW silica fur AkzoNobel u: Admixture, Gr	8.5 sand, Larry G t Company., F re sed as a Visc race Chemical nominal 4 x 8	129.6 rayson & Son T Foreman, Arkans osity Modifying Company; AD	94.8% Trucking in th sas	e greater Ale: to help keep s	xandria/Woodwo	orth, Louisiana 1 on;	region	
1 4. MATEI COARSE AGGE FINE AGGREGA CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Water REMARKS:	7.5 RIALS: REGATE: No ATE: Grayso e I/II, Ash C Elkem ES900 abinder N8, 4 r Reducing 4	8.7 one on concrete s drove Cement DW silica fur AkzoNobel u: Admixture, Gr sts made on to tor = 0.2 perc	8.5 sand, Larry G t Company., F re sed as a Visc race Chemical nominal 4 x 8- cent applied	129.6 rayson & Son T Foreman, Arkans osity Modifying Company; AD	94.8% Trucking in th sas	e greater Ale: to help keep s	xandria/Woodwo	orth, Louisiana 1 on;	region	

			REPORT O	F CONCRETE N	MIXTURE PR	OPORTION	S			
Project: Fort Po	olk 6ksi Sanded	Grout		Grayson Conc	rete Sand					
Mixture No. 079	9-14 vc-T7									
Proportioned: 2										
Port Aggregate	es Leesville, La									
. MIXTURE	PROPORTION	NS								
				egate, %	Solid Vol	ume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
	tland cement				3.394	0.126	667	396	3.15	
S	Silica Fume					0.004		9	2.25	
Fin	ie aggregate		100.0	100.0	15.590	0.577	2549	1513	2.63	0.50
В	atch water				6.885	0.255	430	255	1.0	
Ce	mbinder N8						223.6 fl. oz	8.6 Ltrs		
Water Re	educing Admixt	ture					47.8 fl. oz	1.8 Ltrs		
ligh Range Wa	ater Reducing A	Admixture					20.5fl. oz	0.8 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3661	2173		
/A, % :by vol		STICS		100.0% 0.630			/t., kg/m ³ (lb /ft ³ Factor, kg/m ³ (l		2173 405	
2. MIXTURE (S/A, % :by vol W/(C+M), by 3. TEST RESU	lume weight:					Cementitious	Factor, kg/m ³ (b/yd ³):	405	66
S/A, % :by vol W/(C+M), by	lume weight: LTS	STICS Air Content	Air Content			Cementitious	Factor, kg/m ³ (b/yd ³):		135. 66 psi) ^c
S/A, % :by vol W/(C+M), by 3. TES T RES U	lume weight: LTS	Air		0.630		Cementitious	Factor, kg/m ³ (b/yd ³):	405	66
S/A, % :by vol W/(C+M), by 3. TFST RESU Batch Number 1	lume weight: LTS Slump C	Air Content	Content	0.630 Unit Weight	Relative	Cementitious	Factor, kg/m ³ ()	b/yd ³): pressive Str	405 ength, MPa (p	60
S/A, % :by vol W/(C+M), by 3. TEST RES U Batch Number 1 4. MATEI COARSE AGGI FINE A GGREG CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate: REMARKS:	lume weight: LTS Slump Gin. 9.5 RIALS: REGATE: None ATE: Grayson be I/II, Ash Grov Elkem ES900W nbinder N8, Akz r Reducing Ada	Air Content % 6.9 e concrete s ve Cement / silica fun zoNobel u: mixture, W	Content % 6.7 sand, Larry G c Company., F re sed as a Visc '. R. Grace; A	0.630 Unit Weight Ib/ft ³ 130.8 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High 1	Relative Yield 96.4% [°] rucking in th sas	Cementitious Unc 3-day 3470 e greater Ale	Factor, kg/m ³ (onfined Com 7-Day	b/yd ³): pressive Str 14-Day 4320 orth, Louisiana r	405 ength, MPa (p 28-Day 4810	66
S/A, % :by vol W/(C+M), by Batch Number 1 4. MATEI COARSE AGGI FINE AGGREG. CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate: REMARKS: a Compressive	lume weight: LTS Slump in. 9.5 RIALS: REGATE: None ATE: Grayson De I/II, Ash Grov Elkem ES900W Inbinder N8, Akz r Reducing Ada	Air Content % 6.9 e concrete s ve Cement 7 silica fun zoNobel u: mixture, W	Content % 6.7 Sand, Larry G Company., F sed as a Visc '. R. Grace; A nominal 4 x 8	0.630 Unit Weight Ib/ft ³ 130.8 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High 1	Relative Yield 96.4% [°] rucking in th sas	Cementitious Unc 3-day 3470 e greater Ale	Factor, kg/m ³ (onfined Com 7-Day 3830 xandria/Woodwo	b/yd ³): pressive Str 14-Day 4320 orth, Louisiana r	405 ength, MPa (p 28-Day 4810	60
 S/A, % :by vol W/(C+M), by 3. TES T RES U Batch Number 1 4. MATEI COARSE A GGI FINE A GGREGA CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate: REMARKS: Compressive a ggregate composition 	lume weight: LTS Slump Gin. 9.5 RIALS: REGATE: None ATE: Grayson be I/II, Ash Grov Elkem ES900W nbinder N8, Akz r Reducing Ada	Air Content % 6.9 e concrete s ve Cement 7 silica fun zoNobel u: mixture, W	Content % 6.7 Sand, Larry G Company., F sed as a Visc '. R. Grace; A nominal 4 x 8 sent applied	0.630 Unit Weight Ib/ft ³ 130.8 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High 1	Relative Yield 96.4% [°] rucking in th sas	Cementitious Unc 3-day 3470 e greater Ale	Factor, kg/m ³ (onfined Com 7-Day 3830 xandria/Woodwo	b/yd ³): pressive Str 14-Day 4320 orth, Louisiana r	405 ength, MPa (p 28-Day 4810	6

			REPORT O	F CONCRETE N	MIXTURE PR	OPORTION	IS			
Project: Fort Pc		d Grout		Grayson Conc	rete Sand					
Mixture No. 07										
Proportioned: 2										
Port Aggregate	es Leesville, L	a								
I. MIXTURE	PROPORTIO	ONS								
				egate, %	Solid Vol	ume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft^3	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Por	rtland cement				3.733	0.138	734	435	3.15	
				1						
E:+	ne aggregate		100.0	100.0	15.680	0.581	2564	1522	2.62	0.50
	Batch water		100.0	100.0	6.561	0.381	409	243	1.0	0.50
	embinder N8						384.9 fl. oz	14.9 Ltrs		
Water Re	educing Admi	xture					51.4 fl. oz	2 Ltrs		
	ater Reducing						198.2fl. oz	7.7 Ltrs		
	Defoamer						5.2fl. oz	0.2 mL		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3707	2200		
W/(C+M), by	lume weight:			100.0% 0.558			Vt., kg/m ³ (lb /ft ³ s Factor, kg/m ³ (l		2200 435	
2. MIXTURE (S/A, % :by vol W/(C+M), by 3. TEST RESU	lume weight:					Cementitious	s Factor, kg/m ³ (l	b/yd ³):	435	73
S/A, % :by vol W/(C+M), by 3. TEST RESU	lume weight:	Air	Air	0.558		Cementitious	s Factor, kg/m ³ (l	b/yd ³):		73
S/A, % :by vol W/(C+M), by	lume weight:		Air Content %	0.558 Unit Weight	Relative	Cementitious	s Factor, kg/m ³ (l	b/yd ³):	435	137. 73 psi) ^c
S/A, % :by vol W/(C+M), by 3. TEST RESU Batch	lume weight: LTS Slump	Air Content	Content	0.558		Cementitious	s Factor, kg/m ³ ()	b/yd ³): pressive Str	435 ength, MPa (p	73
S/A, % :by vol W/(C+M), by 3. TEST RESU Batch Number 1 4. MATE COARSE A GG	lume veight: LTS Slump in. 10.0 RIALS: REGATE: Nor GATE: Grayson pe I/II, Ash Gro	Air Content % 3.2 ne n concrete s ove Cement	Content % 3 sand, Larry G	0.558 Unit Weight Ib/ft ³ 140	Relative Yield 101.9%	Cementitious Unc 3-day 6150	s Factor, kg/m ³ (f	b/yd ³): pressive Str 14-Day 7900	435 ength, MPa (p 28-Day 8160	73
 S/A, % :by vol W/(C+M), by 3. TEST RESU Batch Number 1 4. MATE COARSE AGGE FINE AGGREG CEMENT: Typ POZZOLANS: Admixture: Cer 	lume weight: ILTS Slump in. 10.0 RIALS: REGATE: Not GATE: Grayson pe I/II, Ash Gra Elkem ES900V mbinder N8, A	Air Content % 3.2 ne n concrete s ove Cement W silica fun kzoNobel u	Content % 3 sand, Larry G t Company., I ne sed as a Visc	0.558 Unit Weight Ib/ft ³ 140 rayson & Son T Foreman, Arkans	Relative Yield 101.9%	Cementitious Unc 3-day 6150 e greater Ale o help keep s	s Factor, kg/m ³ (l confined Com 7-Day 7260	b/yd ³): pressive Str 14-Day 7900 prth, Louisiana n	435 ength, MPa (p 28-Day 8160	73
S/A, % :by voi W/(C+M), by B. TEST RESU Batch Number 1 4. MATE COARSE A GG FINE A GGREG CEMENT: Typ POZZOLANS: Admixture: Cer Zyla 610, Wate REMARKS:	lume weight: ILTS Slump in. 10.0 RIALS: REGATE: Nor GATE: Grayson pe I/II, Ash Gru Elkem ES900V mbinder N8, Al er Reducing Ac	Air Content % 3.2 ne n concrete s ove Cement W silica fun kzoNobel u dmixture, W	Content % 3 sand, Larry G t Company., I ne sed as a Visc 7. R. Grace; A	0.558 Unit Weight Ib/ft ³ 140 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High	Relative Yield 101.9%	Cementitious Unc 3-day 6150 e greater Ale o help keep s	s Factor, kg/m ³ (confined Com 7-Day 7260 xandria/Woodwc	b/yd ³): pressive Str 14-Day 7900 prth, Louisiana n	435 ength, MPa (p 28-Day 8160	7:
S/A, % :by voi W/(C+M), by B. TEST RESU Batch Number 1 1 COARSE A GG COARSE A GG CEMENT: Typ POZZOLANS: Admixture: Cer Zyla 610, Wate REMARKS: 1 Compressive	lume weight: ILTS Slump in. 10.0 RIALS: REGATE: Nor GATE: Grayson pe J/II, Ash Gru Elkem ES900V mbinder N8, Ai er Reducing Action	Air Content % 3.2 ne n concrete s ove Cement W silica fun kzoNobel u dmixture, W	Content % 3 sand, Larry G t Company., I te sed as a Visc 7. R. Grace; A nominal 4 x 8	0.558 Unit Weight Ib/ft ³ 140 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High	Relative Yield 101.9%	Cementitious Unc 3-day 6150 e greater Ale o help keep s	s Factor, kg/m ³ (confined Com 7-Day 7260 xandria/Woodwc	b/yd ³): pressive Str 14-Day 7900 prth, Louisiana n	435 ength, MPa (p 28-Day 8160	7:
S/A, % :by voi W/(C+M), by Batch Number 1 L. MATE COARSE A GG CEMENT: Typ POZZOLANS: Admixture: Cer Zyla 610, Wate REMARKS: Compressive aggregate co	lume weight: ILTS Slump in. 10.0 RIALS: REGATE: Nor GATE: Grayson pe I/II, Ash Gru Elkem ES900V mbinder N8, Al er Reducing Ac	Air Content % 3.2 ne n concrete s ove Cement W silica fun kzoNobel u dmixture, W	Content % 3 sand, Larry G t Company., I te sed as a Visc 7. R. Grace; A nominal 4 x 8 cent applied	0.558 Unit Weight Ib/ft ³ 140 rayson & Son T Foreman, Arkan: osity Modifying DVA 190 High	Relative Yield 101.9%	Cementitious Unc 3-day 6150 e greater Ale o help keep s	s Factor, kg/m ³ (confined Com 7-Day 7260 xandria/Woodwc	b/yd ³): pressive Str 14-Day 7900 prth, Louisiana n	435 ength, MPa (p 28-Day 8160	7:

· · · · · · · · · · · · · · · · · · ·	11 (1) (1		KEFUKI U	F CONCRETE N		UFURION	3			
roject: Fort Po		led Grout		Grayson Conc	rete Sand					
fixture No. 08										
roportioned: 2		T A								
ort Aggregate	es Leesville,	LA								
. MIXTURE	DDODODT	IONS								
. WILATUKE	IKUIUKI	0115	Aggr	egate, %	Solid Vo	ume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Por	tland cemen			-	3.779	0.140	743	441	3.15	
5	Silica Fume					0.005		11	2.25	
Fir	ie aggregate	;	100.0	100.0	15.281	0.566	2499	1483	2.63	0.50
E	Batch water				6.777	0.251	423	251	1.0	
Ce	embinder N8						671.5 fl. oz	26 Ltrs		
Water Re	educing Adı	nixture					53.4 fl. oz	2.1 Ltrs		
igh Range W	ater Reducir	ng Admixture					173fl. oz	6.7 Ltrs		
	Defoamer						5.4fl. oz	0.21 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3684	2186		
									•	
. MIXTURE	CHARACTE	RISTICS								
/A, % :by vo	lume			100.0%		Theo. Unit V	/t., kg/m ³ (lb /ft ³)	2186	136
W/(C+M), by	weight:			0.555			Factor, kg/m ³ (452	7.
. TEST RESU	LTS									
		Air	Air			Une	onfined Com	pressive Str	ength, MPa (p	osi) ^c
Batch	Slump	Content	Content	Unit Weight	Relative	0.110		pressrie 20		
Number	in.	%	%	lb/ft ³	Yield	3-day	7-Day	14-Day	28-Day	
1	9.5	3.1	2.9	138	101.1%	5160	6230	7220	8020	
1	7.5	5.1	2.7	150	101.175	5100	0200	, 220	0010	

FINE AGGREGATE: Grayson concrete sand, Larry Grayson & Son Trucking in the greater Alexandria/Woodworth, Louisiana region CEMENT: Type I/II, Ash Grove Cement Company., Foreman, Arkansas

POZZOLANS: Elkem ES900W silica fume

Admixture: Cembinder N8, AkzoNobel used as a Viscosity Modifying Admixture to help keep sand in suspension; Zyla 610, Water Reducing Admixture, W. R. Grace; ADVA 190 High Range Water Reducing Admixture, W. R. Grace

REMARKS:

a Compressive strength tests made on nominal 4 x 8-in. cylinders

b aggregate correction factor = 0.2 percent applied

c Elkem ES900W Silica fume has been discontinued.

d Specimens cured at 72°F in 100% relative humidity room

			REPORT OI	F CONCRETE N	AIXTURE PI	ROPORTION	S			
Project: Fort Polk 6	5ksi Sande	d Grout		Grayson Conce	rete Sand					
Mixture No. 080-14	4 vc-T10									
Proportioned: 21-N	/lar-14									
Port Aggregates L	æesville, L	a								
1. MIXTURE PRO	OPORTIC	ONS								
			Aggre	egate, %	Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
М	[aterial		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
	id cement				3.518	0.130	692	410	3.15	
Silica	a Fume					0.007		15	2.25	
Fine as	ggregate		100.0	100.0	15.602	0.578	2551	1514	2.63	0.50
-	h water	ŀ	10010	10010	6.669	0.247	416	247	1.0	0.20
	inder N8	ł					564.6 fl. oz	21.8 Ltrs		
Water Reduc	cing Admi	xture					50.2 fl. oz	1.9 Ltrs		
High Range Water	Reducing	Admixture					217fl. oz	8.4 Ltrs		
Def	oamer						5.3fl. oz	0.2 Ltrs		
Ret	tarder						20.8fl. oz	0.8 Ltrs		
I	Air				1.026	0.038				
То	otals:		100	100	27	1	3685	2187		
. TEST RESULTS	5					Line	onfined Com	magaine Sta	ength, MPa (p	c c
Batch	Slump	Air Content	Air Content	Unit Weight	Relative	Unc		pressive su	engui, MPa (p	(S1)
Number	in.	%	%	lb/ft ³	Yield	3-day	7-Day	14-Day	28-Day	
1	11.0	2.1	1.9	138.8	101.6%	5140	6380	7250	8630	
4. MATERIA	18.									
COARSE A GGREGATI CEMENT: Type I/ POZZOLANS: Elk Admixture: Cembin Zyla 610, Water Re	GATE: No E: Grayso /II, Ash Gr tem ES900' nder N8, A	n concrete s ove Cement W silica furr kzoNobel us	Company., F ne sed as a Visc	Soreman, Arkans	sas g Admixture	to help keep s	and in suspensio	on;	region	
COARSE AGGREGATI FINE AGGREGATI CEMENT: Type I/ POZZOLANS: Elk Admixture: Cembin Zyla 610, Water Re REMARKS:	GATE: No E: Grayso 'II, Ash Gr cem ES900' nder N8, A educing A	n concrete s ove Cement W silica furr kzoNobel us dmixture, W	Company., F ne sed as a Visc . R. Grace; A	oreman, Arkans osity Modifying DVA 190 High I	sas g Admixture	to help keep s	and in suspensio	on;	region	
COARSE AGGREGATI FINE AGGREGATI CEMENT: Type I/ POZZOLANS: Elk Admixture: Cembin Zyla 610, Water Re	GATE: No E: Grayso II, Ash Gr acem ES900 nder N8, A educing A rength tes	n concrete s ove Cement W silica furr kzoNobel us dmixture, W	Company., F ne sed as a Visc . R. Grace; A nominal 4 x 8	oreman, Arkans osity Modifying DVA 190 High I	sas g Admixture	to help keep s	and in suspensio	on;	region	
COARSE A GGREGA TI CEMENT: Type I/ POZZOLANS: Elk Admixture: Cembin Zyla 610, Water Re REMARKS:	GATE: No E: Grayso (II, Ash Gr tem ES900) nder N8, A educing A rength tes rength tes	n concrete s ove Cement W silica fur kzoNobel us dmixture, W ts made on t or = 0.2 perc	Company., F ae sed as a Visc . R. Grace; A nominal 4 x 8 ent applied	oreman, Arkans osity Modifying DVA 190 High I	sas g Admixture	to help keep s	and in suspensio	on;	region	

			REPORT O	F CONCRETE N	MIXTURE P	ROPORTION	S			
Project: Fort P	olk 6ksi Sand	ed Grout		Grayson Conc	rete Sand					
Mixture No. 08	83-14 vc-T11									
Proportioned:	24-Mar-14									
Port Aggregat	es Leesville,	La								
1. MIXTURE	PROPORTI	ONS								
			Aggr	egate, %	Solid Vo	lume	Mass,	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft^3	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Poi	rtland cement	t			3.392	0.126	667	396	3.15	
	Silica Fume					0.007		15	2.25	
	ne aggregate		100.0	100.0	15.087	0.559	2467	1464	2.63	0.50
	Batch water				7.317	0.271	457	271	1.0	
	embinder N8						499 fl. oz	19.3 Ltrs		
	educing Adn						48.4 fl. oz	1.9 Ltrs		
High Range W	ater Reducin	g Admixture					103.8fl. oz	4 Ltrs		
	Defoamer						5.1fl. oz	0.2 Ltrs		
	Retarder						26.7fl. oz	1 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3615	2146		
I FRATEREST				1						
<u>3. 113 I KESU</u>		A :	A :			Uno	onfined Com	processo Str	anoth MDa (r	ci) ¢
	Cham	Air	Air Contont	Unit Waight	Dalativa	Unc	onfined Com	pressive Str	ength, MPa (p	osi) ^c
Batch Number	Slump in.	Air Content %	Air Content %	Unit Weight	Relative			•		osi) ^c
Batch Number	in.	Content %	Content %	lb/ft ³	Yield	3-day	7-Day	14-Day	28-Day	osi) ^c
Batch Number 1	in. 10.5	Content	Content					•		osi) ^c
Number 1 4. MATE COARSE A GO FINE A GGREG	in. 10.5 ERIALS: EREGATE: N GATE: Grays pe I/II, Ash C	Content % 1.8 one on concrete s	Content % 1.6 sand, Larry G Company., I	lb/ft ³ 136.8	Yield 102.1%	3-day 3740	7-Day	14-Day 5250	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE A GO FINE A GGREO CEMENT: Ty POZZOLANS: Admixture: Ce	in. 10.5 ERIALS: BREGATE: N GATE: Grays, pe I/II, Ash C : Elkem ES900 mbinder N8, 4	Content % 1.8 one on concrete s irove Cement DW silica fur AkzoNobel u	Content % 1.6 sand, Larry G Company., I se sed as a Visc	Ib/ft ³ 136.8 rayson & Son T ?oreman, Arkan: osity Modifying	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE A GO FINE A GGREC CEMENT: Tyj POZZOLANS: Admixture: Ce: Zyla 610, Wato	in. 10.5 ERIALS: SREGATE: N GATE: Grays- pe I/II, Ash C : Elkem ES900 mbinder N8, 4 er Reducing 4	Content % 1.8 one on concrete s or concrete	Content % 1.6 sand, Larry G Company., I se sed as a Visc	Ib/ft ³ 136.8 rayson & Son T ?oreman, Arkan: osity Modifying	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE A GO FINE A GGREG CEMENT: Ty POZZOLANS: Admixture: Ce: Zyla 610, Wate Retarder, Reco	in. 10.5 ERIALS: SREGATE: N GATE: Grays- pe I/II, Ash C : Elkem ES900 mbinder N8, 4 er Reducing 4	Content % 1.8 one on concrete s or concrete	Content % 1.6 sand, Larry G Company., I se sed as a Visc	Ib/ft ³ 136.8 rayson & Son T ?oreman, Arkan: osity Modifying	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE A GO FINE A GGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Reco REMARKS:	in. 10.5 ERIALS : SREGATE: N GATE: Grays- pe I/II, Ash C : Elkem ES900 mbinder N8, <i>1</i> er Reducing <i>4</i> over, W.R. Grays-	Content % 1.8 one on concrete s irove Cement DW silica fun AkzoNobel u: Admixture, W ace	Content % 1.6 sand, Larry G Company., I ae sed as a Visc . R. Grace; A	Ib/ft ³ 136.8 rayson & Son T Foreman, Arkan osity Modifying DVA 190 High	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE AGC FINE A GGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Reco REMARKS: a Compressiv	in. 10.5 ERIALS: GREGATE: N- GATE: Grays- pe I/II, Ash C : Elkem ES900 mbinder N8, 2 er Reducing 2 over, W.R. Graves /e strength te	Content % 1.8 one on concrete s irove Cement DW silica fun AkzoNobel u: Admixture, W ace	Content % 1.6 sand, Larry G Company., I re sed as a Visc r. R. Grace; A nominal 4 x 8	Ib/ft ³ 136.8 rayson & Son T Foreman, Arkan osity Modifying DVA 190 High	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE AGC FINE A GGREC CEMENT: Tyj POZZOLANS: Admixture: Ce Zyla 610, Wato <u>REMARKS:</u> a Compressiv b aggregate c	in. 10.5 ERIALS: BREGATE: No GATE: Grayson pe I/II, Ash C : Elkem ES900 mbinder N8, 4 er Reducing 4 over, W.R. Gra ve strength te correction fac	Content % 1.8 one on concrete s irove Cement DW silica fur AkzoNobel u: Admixture, W ace sts made on a tor = 0.2 perc	Content % 1.6 sand, Larry G Company., I sed as a Visc c. R. Grace; A nominal 4 x 8 ent applied	Ib/ft ³ 136.8 rayson & Son T Foreman, Arkan osity Modifying DVA 190 High	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c
Batch Number 1 4. MATH COARSE AGC FINE A GGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Reco REMARKS: a Compressiv	in. 10.5 ERIALS: BREGATE: N GATE: Grays- pe I/II, Ash C : Elkem ES900 mbinder N8, 2 er Reducing 2 ver, W.R. Grave ver, W.R. Grave verstrength te correction fac DW Silica fum	Content % 1.8 one on concrete s irove Cement DW silica fur AkzoNobel u: Admixture, W ace sts made on : tor = 0.2 perc e has been d	Content % 1.6 sand, Larry G Company., I se sed as a Visc . R. Grace; A nominal 4 x 8 ent applied iscontinued.	Ib/ft ³ 136.8 rayson & Son T Foreman, Arkan: osity Modifying DVA 190 High	Yield 102.1% Yrucking in the sas	3-day 3740 ne greater Ale	7-Day 4480 xandria/Woodwo	14-Day 5250 orth, Louisiana r	28-Day 6020	osi) ^c

			REPORT O	F CONCRETE N	AIXTURE PH	ROPORTION	IS			
Project: Fort P	olk 6ksi Sand	ed Grout		Grayson Conc	rete Sand					
Mixture No. 08	83-14 vc-T12									
Proportioned:	24-Mar-14									
Port Aggregat	tes Leesville,	La								
I. MIXTURE	PROPORTI	ONS								
			Aggr	egate, %	Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft^3	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Po	rtland cemen	t			3.396	0.126	668	396	3.15	
	Silica Fume					0.007		15	2.25	
	ne aggregate		100.0	100.0	15.406	0.571	2519	1495	2.63	0.50
	Batch water				6.993	0.259	436	259	1.0	
	embinder N8	.,					499.6 fl. oz	19.3 Ltrs		
	educing Adr						48.5 fl. oz 124.7fl. oz	1.9 Ltrs 4.8 Ltrs		
High Range W		g Admixiure					4.9fl. oz	4.8 Ltrs 0.19 Ltrs		
	Defoamer						26.7fl. oz			
	Retarder Air				1.026	0.038	20.711.0Z	1 Ltrs		
	Totals:		100	100	27	1	3648	2165		
				100.0% 0.630			Vt., kg/m ³ (lb /ft ³ s Factor, kg/m ³ (l		2166 411	
W/(C+M), by	v weight:									
W/(C+M), by	v weight:					Cementitious	s Factor, kg/m ³ (l	b/yd ³):	411	66
W/(C+M), by	v weight:	Air	Air	0.630	Divi	Cementitious	s Factor, kg/m ³ (l	b/yd ³):		135. 66 psi) ¢
W/(C+M), by	v weight:	Air Content %	Air Content %		Relative Yield	Cementitious	s Factor, kg/m ³ (l	b/yd ³):	411	66
W/(C+M), by 3. TEST RESI Batch Number 1	/ weight:	Content	Content	0.630 Unit Weight		Cementitious	s Factor, kg/m ³ ()	^{b/yd³): pressive Str}	411 ength, MPa (p	66
Number 1 4. MATH COARSE AGO FINE AGGREO CEMENT: Ty POZZOLANS: Admixture: Ce	 veight: JLTS Slump in. 10.5 ERIALS: GREGATE: N GATE: Grays pe I/II, Ash C Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr 	Content % 2.3 one on concrete s Grove Cement OW silica fun A kzoNobel u A dmixture, W ace	Content % 2.1 sand, Larry G Company., I re sed as a Visc '. R. Grace; A	0.630 Unit Weight Ib/ft ³ 136.8 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High 1	Yield 101.2% Yrucking in the sas	Unc 3-day 3760	s Factor, kg/m ³ (f	b/yd ³): pressive Str 14-Day 5350 orth, Louisiana r	411 ength, MPa (p 28-Day 6230	66
W/(C+M), by Batch Number 1 A. MATH COARSE A GO FINE A GGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Recc REMARKS: a Compressiv	/ weight: //LTS Slump in. 10.5 ERIALS: GATE: Grays pe I/II, Ash C : Elkem ES90 mbinder N8, er Reducing A over, W.R. Gr	Content % 2.3 one on concrete s Grove Cement OW silica fun AkzoNobel u Admixture, W ace	Content % 2.1 sand, Larry G Company., I c Company., I ne sed as a Visc '. R. Grace; A nominal 4 x 8	0.630 Unit Weight Ib/ft ³ 136.8 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High 1	Yield 101.2% Yrucking in the sas	Unc 3-day 3760	s Factor, kg/m ³ (f confined Com 7-Day 4670 xandria/Woodwc	b/yd ³): pressive Str 14-Day 5350 orth, Louisiana r	411 ength, MPa (p 28-Day 6230	66
W/(C+M), by 3. TEST RESI Batch Number 1 4. MATH COARSE AGC FINE A GGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Recc REMARKS:	/ weight: //LTS Slump in. 10.5 ERIALS: GREGATE: N GATE: Grays pe I/II, Ash C : Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr /e strength te correction fac	Content % 2.3 one on concrete s Grove Cement OW silica fun AkzoNobel u Admixture, W ace ests made on tor = 0.2 perc	Content % 2.1 sand, Larry G Company., I sed as a Visc '. R. Grace; A nominal 4 x 8 sent applied	0.630 Unit Weight Ib/ft ³ 136.8 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High 1	Yield 101.2% Yrucking in the sas	Unc 3-day 3760	s Factor, kg/m ³ (f confined Com 7-Day 4670 xandria/Woodwc	b/yd ³): pressive Str 14-Day 5350 orth, Louisiana r	411 ength, MPa (p 28-Day 6230	66

			REPORT O	F CONCRETE N	AIXTURE PI	ROPORTION	IS			
Project: Fort P	olk 6ksi Sand	ed Grout		Grayson Conc	rete Sand					
Mixture No. 08	83-14 vc-T13									
Proportioned:	24-Mar-14									
Port Aggregat	tes Leesville,	La								
1. MIXTURE	PROPORTI	ONS								
			Aggr	egate, %	Solid Vo	lume	Mass.	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Ро	rtland cemen	t			3.402	0.126	669	397	3.15	
	Silica Fume					0.007		15	2.25	
	ne aggregate		100.0	100.0	14.833	0.549	2425	1439	2.63	0.50
	Batch water				7.560	0.280	472	280	1.0	
	embinder N8						552.3 fl. oz	21.4 Ltrs		
	educing Adr						48.6 fl. oz	1.9 Ltrs		
High Range W	ater Reducin	g Admixture					83.3fl. oz	3.2 Ltrs		
	Defoamer						5.3fl. oz	0.21 Ltrs		
	Retarder						7fl. oz	0.3 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3591	2131		
. TEST RESI	ILTS									
3. TEST RESU						T	6 10			
		Air	Air			Unc	onfined Com	pressive Stre	ength, MPa (p	osi) ^e
3. TEST RESU Batch Number	Slump in.	Air Content %	Air Content %	Unit Weight lb/ft ³	Relative Yield	Unc 3-day	onfined Com	pressive Stro 14-Day	ength, MPa (p 28-Day	osi) ^c
Batch Number 1	Slump in. 10.3	Content	Content	e				•		osi) ^c
Batch Number 1 4. MATH COARSE AGC FINE AGGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Recc REMARKS: a Compressiv	Slump in. 10.3 ERIALS: GREGATE: N GATE: Grays pe I/II, Ash C : Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr	Content % 1.9 one on concrete s Grove Cement OW silica fun AkzoNobel u: Admixture, W ace	Content % 1.7 sand, Larry G Company., I re sed as a Visc r. R. Grace; A nominal 4 x 8	Ib/ft ³ 135.6 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High I	Yield 101.9% Yrucking in the sas	3-day 3230 te greater A le	7-Day	14-Day 5070 orth, Louisiana r	28-Day 5700	osi) ^c
Batch Number 1 4. MATH COARSE AGC FINE AGGREC CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Recc REMARKS: a Compressiv	Slump in. 10.3 ERIALS: GREGATE: N GATE: Grays pe I/II, Ash C : Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr	Content % 1.9 one on concrete s Grove Cement OW silica fun AkzoNobel u: Admixture, W ace	Content % 1.7 sand, Larry G Company., I re sed as a Visc r. R. Grace; A nominal 4 x 8	Ib/ft ³ 135.6 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High I	Yield 101.9% Yrucking in the sas	3-day 3230 te greater A le	7-Day 4190 xandria/Woodwo	14-Day 5070 orth, Louisiana r	28-Day 5700	osi) ^c
Batch Number 1 4. MATH COARSE A GO FINE A GGREG CEMENT: Ty POZZOLANS: Admixture: Ce Zyla 610, Watu Retarder, Recc REMARKS:	Slump in. 10.3 ERIALS: GREGATE: N GATE: Grays pe I/II, Ash C : Elkem ES90 mbinder N8, . er Reducing <i>J</i> over, W.R. Gr ve strength te correction fac	Content % 1.9 one on concrete s Grove Cement OW silica fun AkzoNobel u: Admixture, W ace	Content % 1.7 sand, Larry G Company., I sed as a Visc . R. Grace; A nominal 4 x 8 ent applied	Ib/ft ³ 135.6 rayson & Son T Foreman, Arkans osity Modifying DVA 190 High I	Yield 101.9% Yrucking in the sas	3-day 3230 te greater A le	7-Day 4190 xandria/Woodwo	14-Day 5070 orth, Louisiana r	28-Day 5700	osi) ^c

B.2 7 ksi grout trial mixtures

			REPORT OF	F CONCRETE N	MIXTURE PI	ROPORTION	s			
Project: Fort Po	olk 6ksi Sand	ed Grout		Trinity Concre	te Sand					
Mixture No. 07	0-15 7Ksi Gr	out-T1								
Proportioned: 1	11-Mar-15									
Port Aggregate	es Leesville,	La		NO CYLI	NDERS CAS	<mark>ST - MIX HAI</mark>	<mark>) AGGREGATE</mark>	FALL OUT		
1. MIXTURE	PROPORTI	ONS								
			Aggre	egate, %	Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft^3	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Por	tland cemen	t			3.745	0.139	736	437	3.15	
S	Silica Fume					0.005	19	11	2.25	
Fir	ne aggregate	-	100.0	100.0	15.316	0.567	2504	1486	2.63	0.50
	Batch water	ŀ			6.777	0.251	423	251	1.0	
	embinder N8	ŀ			0.777	01201	665.5 fl. oz	25.7 Ltrs		
High Range Wa		g Admixture					166.2fl. oz	6.4 Ltrs		
	Defoamer	-								
I	Retarder Air	-			1.026	0.038				
	Totals:	-	100	100	27	1	3683	2185		
	Totals:		100	100	21	1	5085	2185		
2. MIXTURE (CHARACTE	RISTICS								
S/A, % :by vo	lume			100.0%		Theo. Unit W	/t., kg/m ³ (lb /ft ³)	2185	136.4
W/(C+M), by	weight:			0.560		Cementitious	Factor, kg/m ³ (lb/yd ³):	448	755
3. TEST RESU	LTS					1				
		Air	Air			Unc	onfined Com	pressive Str	ength, MPa (p	si) ^v
Batch Number	Slump in.	Content %	Content %	Unit Weight	Relative	3-day	7-Day	14-Day	28-Day	
1	0.0	0	-0.2	lb/ft ³	Vield 0.0%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
1	0.0	0	-0.2	0	0.070	#DIVIO.	"DIVO.	in D1 (10).	mB100.	
	RIALS:									
COARSE AGG	REGATE: N	one								
EINIE A CODEC	ATE: Crows	an aananata a	and Lawry C	novia on la Son T	Impolition of the th		una daio /W o o davi	ath Louisiana		
	-		-	-	-	ie greater Ale	xandria/Woodwo	orth, Louisiana i	region	
POZZOLANS:				oreman, Arkans	sas					
	2									
Admixture: Cer	nbinder N8, .	AkzoNobel us	sed as a Visc	osity Modifying	g Admixture	to help keep s	and in suspensi	on;		
Zyla 610, Wate	r Reducing	Admixture, W	. R. Grace; A	DVA 190 High	Range Water	r Reducing Ad	lmixture, W. R. C	irace		
Retarder, Reco	ver, W.R. Gr	ace								
REMARKS:										
a Compressive	e strength te	sts made on i	nominal 4 x 8-	in. cylinders						
b aggregate c	orrection fac	tor $= 0.2$ perc	ent applied							
c Elkem ES900										
d Specimens cu	ured at 72°F	in 100% relati	ve humidity i	room						

			REPORT O	F CONCRETE N	AIXTURE PE	ROPORTION	S			
Project: Fort Polk	k 6ksi Sanded (Grout		Trinity Concre	te Sand					
70-15 7ksi Grout	VC-T2									
Proportioned: 11	l-Mar-15									
Port Aggregates	s Leesville, La									
I. MIXTURE P	ROPORTION	S								
			Aggr	egate, %	Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption
J	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Portla	land cement				3.745	0.139	736	437	3.15	
Sil	lica Fume					0.005	19	11	2.25	
Fine	e aggregate		100.0	100.0	15.316	0.567	2504	1486	2.63	0.50
	tch water		10010	10010	6.777	0.251	423	251	1.0	0.00
	nbinder N8				01777	0.201	665.5 fl. oz	25.7 Ltrs		
	lucing Admixtu	1re					75.5 fl. oz	2.9 Ltrs		
High Range Wat	-						32.5fl. oz	2.9 Ltrs		
0 0	0	unixuic					52.511.02	1.5 Lus		
	Defoamer									
R	Retarder Air				1.020	0.029				
	Air Totals:		100	100	1.026 27	0.038	3683	2185		
8/A, % :by volu	ime	STICS		100.0%			/t., kg/m ³ (lb /ft ³		2185	13
S/A, % :by volu W/(C+M), by v	ime weight:	STICS		100.0% 0.560			/t., kg/m ³ (lb /ft ³ Factor, kg/m ³ (2185 448	
2. MIXTURE CI S/A, % :by volu W/(C+M), by v 3. TEST RESUL/	ime weight:		Air			Cementitious	Factor, kg/m ³ (lb/yd ³):	448	7
S/A, % :by volu W/(C+M), by v 3. TEST RESUL	ime weight: .TS	Air	Air	0.560	Relative	Cementitious	Factor, kg/m ³ (lb/yd ³):		7
S/A, % :by volu W/(C+M), by v	ime weight: .TS		Air Content %		Relative Yield	Cementitious	Factor, kg/m ³ (lb/yd ³):	448	13 7 0si) ^c
S/A, % :by volu W/(C+M), by v 3. TEST RESUL Batch Number 1	Ime weight: TS Slump in. 10.5	Air	Content	0.560 Unit Weight		Cementitious	Factor, kg/m ³ (b/yd ³):	448 ength, MPa (p	,
S/A, % :by volu W/(C+M), by v 3. TEST RESUL Batch Number 1 4. MATER COARSE AGGREGA CEMENT: Type POZZOLANS: E Admixture: Cemb Zyla 610, Water 1 Retarder, Recover	Ime weight: .TS Slump C in. 10.5 RIALS: EGATE: None XTE: Grayson o Elkem ES900W Elkem ES900W binder N8, Akz Reducing Adn	Air Sontent % 4.2 concrete s ve Cement silica fun soNobel u: nixture, W	Content % 4 sand, Larry C Company., I re sed as a Visc	0.560 Unit Weight Ib/ft ³ 135.2 irayson & Son T Foreman, Arkans	Yield 99.1% Yrucking in the sas	Cementitious Unc 3-day 4250 e greater Ale:	Factor, kg/m ³ (onfined Com 7-Day 5040 xandria/Woodwo	b/yd ³): pressive Str 14-Day 6130 orth, Louisiana n	448 ength, MPa (p 28-Day 6390	
S/A, % :by volu W/(C+M), by v 3. TEST RESUL/ Batch Number 1 4. MATER COARSE AGGRI FINE AGGREGA CEMENT: Type POZZOLANS: E Admixture: Cemb Zyla 610, Water 1 Retarder, Recove REMARKS:	ume weight: .TS .Slump C in. 10.5 RIALS: .EGATE: None ATE: Grayson of e I/II, Ash Grov Elkem ES900W binder N8, Akz Reducing Adm er, W.R. Grace	Air Sontent % 4.2 concrete s concrete s ve Cement silica fun xoNobel u: nixture, W	Content % 4 sand, Larry C t Company., I te sed as a Visc 7. R. Grace; A	0.560 Unit Weight Ib/ft ³ 135.2 Foreman, Arkans cosity Modifying DVA 190 High 1	Yield 99.1% Yrucking in the sas	Cementitious Unc 3-day 4250 e greater Ale:	Factor, kg/m ³ (onfined Com 7-Day 5040 xandria/Woodwo	b/yd ³): pressive Str 14-Day 6130 orth, Louisiana n	448 ength, MPa (p 28-Day 6390	,
S/A, % :by volu W/(C+M), by v 3. TEST RESUL/ Batch Number 1 4. MATER COARSE A GGRI FINE A GGREGA CEMENT: Type POZZOLANS: E Admixture: Cemb Zyla 610, Water I Retarder, Recove REMARKS: a Compressive :	ume weight: .TS .Slump in. 10.5 EGATE: None ATE: Grayson of ElKem ES900W Elkem ES900W binder N8, Akz Reducing Adn er, W.R. Grace strength tests	Air ontent % 4.2 concrete s re Cement silica fun xo Nobel u: mixture, W made on t	Content % 4 sand, Larry C t Company., I te sed as a Visc 7. R. Grace; A nominal 4 x 8	0.560 Unit Weight Ib/ft ³ 135.2 Foreman, Arkans cosity Modifying DVA 190 High 1	Yield 99.1% Yrucking in the sas	Cementitious Unc 3-day 4250 e greater Ale:	Factor, kg/m ³ (onfined Com 7-Day 5040 xandria/Woodwo	b/yd ³): pressive Str 14-Day 6130 orth, Louisiana n	448 ength, MPa (p 28-Day 6390	
S/A, % :by volu W/(C+M), by v 3. TEST RESUL/ Batch Number 1 4. MATER COARSE A GGRI FINE A GGREGA CEMENT: Type POZZOLANS: E Admixture: Cemb Zyla 610, Water 1 Retarder, Recove REMARKS:	Ime weight: .TS .TS 	Air Sontent % 4.2 concrete s ve Cement silica fun soNobel u: mixture, W made on t = 0.2 perce	Content % 4 sand, Larry C t Company., I te sed as a Visc 7. R. Grace; A nominal 4 x 8 cent applied	0.560 Unit Weight Ib/ft ³ 135.2 Foreman, Arkans cosity Modifying DVA 190 High 1	Yield 99.1% Yrucking in the sas	Cementitious Unc 3-day 4250 e greater Ale:	Factor, kg/m ³ (onfined Com 7-Day 5040 xandria/Woodwo	b/yd ³): pressive Str 14-Day 6130 orth, Louisiana n	448 ength, MPa (p 28-Day 6390	

			REPORT O	F CONCRETE N	AIXTURE PR	ROPORTION	IS			
Project: Fort P	olk 7ksi Sand	ed Grout		Trinity Concre	te Sand					
Mixture No. 08	82-15 7Ksi Gr	out-T3								
Proportioned:	23-Mar-15									
Port Aggregat	es Leesville,	La								
I. MIXTURE	PROPORTI	ONS								
			Aggre	egate, %	Solid Vol	lume	Mass	S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft^3	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Po	rtland cemen	t			3.813	0.141	750	445	3.15	
	Silica Fume					0.005	19	12	2.25	
	ne aggregate		100.0	100.0	15.246	0.565	2493	1479	2.63	0.50
	Batch water	-			6.777	0.251	423	251	1.0	
	embinder N8						655.5 fl. oz	25.4 Ltrs		
w ater R ligh Range W	educing Adr						53.8fl. oz	2.1 Ltrs		
	Defoamer	g Aumixiure					55.611. 0Z	2.1 LUS		
	Retarder Air	-			1.026	0.038				
	Totals:		100	100	27	1	3685	2187		
. TEST RESU	JLTS									
						TT	C 10			·> ¢
D (1	C1	Air	Air	TT '4 XX7 ' 1 4	DIC	Unc	onfined Com	pressive Str	ength, MPa (p	0S1)
Batch Number	Slump in.	Content %	Content %	Unit Weight lb/ft ³	Relative Yield	7-day	14-Day	21-Day	28-Day	
	<u> </u>				99.9%	4490	5580	6500	6990	
1	10.3	5	4.8	136.4	99.9%	4490	5580	0500	0990	l
4. MATE	TRIALS:									
JOARSEACC	INEXATE. IN	one								
	GATE: Trinit	y concrete sa	nd, obtained	from Trinity Ma	aterials, Inc. 1	ocated in Me	rryville, Louisian	a		
FINE A GGREO				Foreman, Arkans						
	pe I/II, Ash (
CEMENT: Ty	-	0W silica furr	e							
CEMENT: Ty	-	0W silica furr	le							
CEMENT: Tyj POZZOLANS: Admixture: Cer	Elkem ES90	AkzoNobel us	sed as a Visc		-		and in suspension			
CEMENT: Tyj POZZOLANS: Admixture: Cer	Elkem ES90	AkzoNobel us	sed as a Visc		-		and in suspensio dmixture, W. R. G			
CEMENT: Typ POZZOLANS: Admixture: Ce Zyla 610, Wato Retarder, Reco	Elkem ES90 mbinder N8, . er Reducing .	AkzoNobel us Admixture, W	sed as a Visc		-					
CEMENT: Typ POZZOLANS: Admixture: Cer Zyla 610, Wata Retarder, Reco REMARKS:	Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr	A kzo Nobel us A dmixture, W ace	sed as a Visc . R. Grace; A	DVA 190 High	-					
CEMENT: Tyj POZZOLANS: Admixture: Cer Zyla 610, Wata Retarder, Reco REMARKS: a Compressiv	Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr	AkzoNobel us Admixture, W ace ests made on t	sed as a Visc . R. Grace; A nominal 4 x 8	DVA 190 High	-					
CEMENT: Tyj POZZOLANS: Admixture: Cer Zyla 610, Wate Retarder, Reco REMARKS: a Compressiv o aggregate c	Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr ve strength te correction fac	AkzoNobel us Admixture, W ace sts made on t tor = 0.2 perc	sed as a Visc . R. Grace; A nominal 4 x 8 ent applied	DVA 190 High	-					
CEMENT: Typ OZZOLANS: Admixture: Cer Zyla 610, Wate Retarder, Reco REMARKS: A Compressiv	Elkem ES90 mbinder N8, . er Reducing . over, W.R. Gr ve strength te correction fac JW Silica fun	A kzoNobel us Admixture, W ace sts made on t tor = 0.2 perc he has been di	sed as a Visc . R. Grace; A nominal 4 x 8 ent applied iscontinued.	DVA 190 High	-					

			REPORTO	F CONCRETE N		ROPORTION	IS			
Project: Fort P				Trinity Concre	te Sand					
Mixture No. 09		out-T4								
Proportioned:	•									
Port Aggregat	es Leesville,	La								
. MIXTURE	PROPORTI	ONS								
			Aggr	egate, %	Solid Vo	lume	Mass,	S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Por	rtland cemen	t			3.842	0.142	755	448	3.15	
:	Silica Fume					0.000		0	2.25	
			400.0	100.0		0.500		4.400		
	ne aggregate Batch water		100.0	100.0	15.355 6.777	0.569	2511 423	1490 251	2.63	0.50
	embinder N8				0.///	0.251	423 665.5 fl. oz	251 25.7 Ltrs	1.0	
	educing Adr	aivtura					45.3 fl. oz.	1.8 Ltrs		
High Range W	-						43.3 fl. 02. 22.7fl. oz	0.9 Ltrs		
	Defoamer	g / tulinature					22.711.02	0.9 Eus		
	Retarder									
	Air				1.026	0.038				
	Totals:		100	100	27	1	3689	2189		
. TEST RESU	ILTS									
				1						
		Air	Air			Unc	onfined Com	pressive Str	ength, MPa (p	si) ^c
Batch Number	Slump	Content %	Content %	Unit Weight	Relative	7 4	14-Day	21 D	29 D	
	in.			lb/ft ³	Yield	7-day		21-Day	28-Day	
	9.0	5.7	5.5	133.6	97.8%	4100	5360	5920	6323	
1										
4. MATE COARSE AGO FINE AGGREC	GATE: Trinity pe I/II, Ash C	y concrete sa Grove Cement	Company., I	from Trinity Ma Foreman, Arkans		located in Me	rryville, Louisian	a		
4. MATE COARSE A GO FINE A GGREC CEMENT: Tyj POZZOLANS:	REGATE: N GATE: Trinit pe I/II, Ash (Elkem ES90	y concrete sa Grove Cement OW silica fun	e Company., I ne	Foreman, Arkans	sas					
I. MATE COARSE AGO TINE AGGREC CEMENT: Tyj POZZOLANS: Admixture: Cen	REGATE: N GATE: Trinity pe I/II, Ash (Elkem ES90 mbinder N8, .	y concrete sa Grove Cement OW silica fun AkzoNobel u	: Company., I ne sed as a Visc	Foreman, Arkans osity Modifying	sas g Admixture	to help keep s	and in suspensio	on;		
I. MATE COARSE AGO FINE AGGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate	REGATE: N GATE: Trinity pe I/II, Ash C Elkem ES90 mbinder N8, <i>i</i> er Reducing <i>i</i>	y concrete sa Grove Cement OW silica fun AkzoNobel u Admixture, W	: Company., I ne sed as a Visc	Foreman, Arkans osity Modifying	sas g Admixture	to help keep s		on;		
I. MATE COARSE AGO FINE AGGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate	REGATE: N GATE: Trinity pe I/II, Ash C Elkem ES90 mbinder N8, <i>i</i> er Reducing <i>i</i>	y concrete sa Grove Cement OW silica fun AkzoNobel u Admixture, W	: Company., I ne sed as a Visc	Foreman, Arkans osity Modifying	sas g Admixture	to help keep s	and in suspensio	on;		
COARSE A GO TINE A GGREC CEMENT: Typ YOZZOLANS: Admixture: Cen Zyla 610, Wate Retarder, Reco REMARKS:	REGATE: N GATE: Trinity pe I/II, Ash C Elkem ES90 mbinder N8, . er Reducing <i>J</i> vver, W.R. Gr	y concrete sa irove Cement OW silica fun AkzoNobel u Admixture, W ace	: Company., I ne sed as a Visc '. R. Grace; A	°oreman, Arkans osity Modifyin₁ DVA 190 High I	sas g Admixture	to help keep s	and in suspensio	on;		
I. MATE COARSE A GO FINE A GGREC CEMENT: Tyj POZZOLANS: Admixture: Cen Zyla 610, Wato Retarder, Reco REMARKS: 1 Compressiv	REGATE: N GATE: Trinity pe I/II, Ash C Elkem ES90 mbinder N8, . er Reducing <i>2</i> ver, W.R. Gr	y concrete sa iro ve Cement OW silica fun A kzo Nobel u A dmixture, W ace sts made on	: Company., I ne sed as a Visc '. R. Grace; A nominal 4 x 8	°oreman, Arkans osity Modifyin₁ DVA 190 High I	sas g Admixture	to help keep s	and in suspensio	on;		
I. MATE COARSE AGO FINE AGGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate Retarder, Reco	REGATE: N GATE: Trinity pe I/II, Ash C Elkem ES90 mbinder N8, . er Reducing . vver, W.R. Gr e strength te correction fac	y concrete sa prove Cement OW silica fun AkzoNobel u Admixture, W ace sts made on tor = 0.2 perc	Company., I ne sed as a Visc '. R. Grace; A nominal 4 x 8 eent applied	°oreman, Arkans osity Modifyin₁ DVA 190 High I	sas g Admixture	to help keep s	and in suspensio	on;		

			REPORT OI	F CONCRETE N	MIXTURE PI	ROPORTION	S			
Project: Fort Po	olk 7ksi Sand	ed Grout		Trinity Concre	te Sand					
91-15 7ksi Grou	ut VC T5									
Proportioned:	01-Apr-15									
Port Aggregat	es Leesville,	La								
I. MIXTURE	PROPORTI	ONS								
			Aggre	egate, %	Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Po	rtland cemen	t			4.112	0.152	809	480	3.15	
:	Silica Fume					0.006	21	12	2.25	
Fi	ne aggregate		100.0	100.0	14.936	0.553	2443	1449	2.63	0.50
Ι	Batch water				6.777	0.251	389	251	1.0	
С	embinder N8						730.8 fl. oz.	28.3 Ltrs		
Water R	educing Adn	nixture					83.0 fl. oz.	3.2 Ltrs		
ligh Range W	ater Reducin	g Admixture					41.5 fl. oz.	1.6 Ltrs		
	Defoamer									
	Retarder									
	Air				1.026	0.038				
	Totals:		100	100	27	1	3694	2192		
3. TEST RESU	JLTS									
3. TEST RESU						Line	onfined Com	magging Str	anoth MDa (r	ci) ¢
		Air	Air		Dir	Unc	onfined Com	pressive Str	ength, MPa (p	osi) ^c
Batch	Slump	Content	Content	Unit Weight	Relative					osi) ^c
Batch Number	Slump in.	Content %	Content %	lb/ft ³	Yield	7-day	14-Day	21-Day	28-Day	osi) ^c
Batch	Slump	Content	Content	-						osi) ^c
Number 1 4. MATE COARSE A GO	Slump in. 9.5 ERIALS: BREGATE: N GATE: Trinity pe I/II, Ash C	Content % 5.5 one y concrete sa	Content % 5.3 nd, obtained c Company., F	lb/ft ³ 134.4	Yield 98.5%	7-day 4910	14-Day	21-Day 7420	28-Day	osi) ^c
Batch Number 1 4. MATE COARSE A GO FINE A GGREO CEMENT: Tyj POZZOLANS:	Slump in. 9.5 ERIALS: REGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90	Content % 5.5 one y concrete sa drove Cement OW silica fur	Content % 5.3 nd, obtained Company., F	lb/ft ³ 134.4 from Trinity Ma	Yield 98.5% aterials, Inc. I sas	7-day 4910	14-Day 6570	21-Day 7420	28-Day	osi) ^c
Batch Number 1 4. MATE COARSE A GO FINE A GGREC CEMENT: Tyj POZZOLA NS: Admixture: Cen	Slump in. 9.5 ERIALS: REGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90 mbinder N8, 4	Content % 5.5 one y concrete sa irove Cement 0W silica fur AkzoNobel u	Content % 5.3 nd, obtained Company., F æ sed as a Visc	Ib/ft ³ 134.4 from Trinity Ma foreman, Arkan	Yield 98.5% aterials, Inc. 1 sas	7-day 4910 located in Mer	14-Day 6570 nyville, Louisian	21-Day 7420 a	28-Day	osi) ^c
Batch Number 1 4. MATE COARSE AGC FINE AGGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate	Slump in. 9.5 ERIALS: 3REGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90 mbinder N8, 4 er Reducing 4	Content % 5.5 one y concrete sa drove Cement 0W silica fur AkzoNobel u: Admixture, W	Content % 5.3 nd, obtained Company., F æ sed as a Visc	Ib/ft ³ 134.4 from Trinity Ma foreman, Arkan	Yield 98.5% aterials, Inc. 1 sas	7-day 4910 located in Mer	14-Day 6570 rryville, Louisian and in suspensio	21-Day 7420 a	28-Day	osi) ^e
Batch Number 1 4. MATE COARSE A GO FINE A GGREC CEMENT: Tyj POZZOLA NS: Admixture: Cen	Slump in. 9.5 ERIALS: SREGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90 mbinder N8, <i>2</i> er Reducing <i>2</i> over, W.R. Gr	Content % 5.5 one y concrete sa drove Cement 0W silica fur AkzoNobel u: Admixture, W	Content % 5.3 nd, obtained Company., F æ sed as a Visc	Ib/ft ³ 134.4 from Trinity Ma foreman, Arkan	Yield 98.5% aterials, Inc. 1 sas	7-day 4910 located in Mer	14-Day 6570 rryville, Louisian and in suspensio	21-Day 7420 a	28-Day	osi) ^c
Batch Number 1 4. MATE COARSE AGO FINE A GGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate Retarder, Reco	Slump in. 9.5 ERIALS: GREGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90 mbinder N8, <i>i</i> er Reducing <i>i</i> over, W.R. Gr	Content % 5.5 one y concrete sa drove Cement OW silica fun A kzo Nobel u: A dmixture, W ace	Content % 5.3 nd, obtained Company., F re sed as a Visc '. R. Grace; A	Ib/ft ³ 134.4 from Trinity Ma foreman, Arkans osity Modifying DVA 190 High	Yield 98.5% aterials, Inc. 1 sas	7-day 4910 located in Mer	14-Day 6570 rryville, Louisian and in suspensio	21-Day 7420 a	28-Day	psi) ^c
Batch Number 1 4. MATE COARSE AGO FINE AGGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wato Retarder, Reco REMARKS:	Slump in. 9.5 ERIALS: BREGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90 mbinder N8, <i>i</i> er Reducing <i>i</i> over, W.R. Gr	Content % 5.5 one y concrete sa drove Cement OW silica fun AkzoNobel u: Admixture, W ace sts made on t	Content % 5.3 nd, obtained Company., F re sed as a Visc '. R. Grace; A nominal 4 x 8	Ib/ft ³ 134.4 from Trinity Ma foreman, Arkans osity Modifying DVA 190 High	Yield 98.5% aterials, Inc. 1 sas	7-day 4910 located in Mer	14-Day 6570 rryville, Louisian and in suspensio	21-Day 7420 a	28-Day	osi) ^c
Batch Number 1 4. MATE COARSE AGG FINE AGGREC CEMENT: Typ POZZOLANS: Admixture: Cen Zyla 610, Wate Retarder, Reco REMARKS: a Compressiv	Slump in. 9.5 ERIALS: EREGATE: N GATE: Trinity pe I/II, Ash C : Elkem ES90 mbinder N8, <i>i</i> er Reducing <i>i</i> over, W.R. Gri ver, W.R. Gri	Content % 5.5 one y concrete sa Grove Cement OW silica fur AkzoNobel u: Admixture, W ace sts made on f tor = 0.2 perc	Content % 5.3 nd, obtained Company., F sed as a Visc '. R. Grace; A nominal 4 x 8 eent applied	Ib/ft ³ 134.4 from Trinity Ma foreman, Arkans osity Modifying DVA 190 High	Yield 98.5% aterials, Inc. 1 sas	7-day 4910 located in Mer	14-Day 6570 rryville, Louisian and in suspensio	21-Day 7420 a	28-Day	osi) ^c

			REPORT O	F CONCRETE N	MIXTURE PF	ROPORTION	S			
Project: Fort Po	olk 7ksi Sand	ed Grout		Trinity Concre	te Sand					
91-15 7ksi Grou	ut VC T6									
Proportioned:	01-Apr-15									
Port Aggregat	es Leesville,	La								
1. MIXTURE	PROPORTI	ONS	Aggre	egate, %	Solid Vo	lume	Mass	, S.S.D.	Bulk Sp. Gr.	Absorption,
	Material		by vol.	by wt.	ft ³	m ³	lb/yd ³	kg/m ³	S.S.D.	%
Por	tland cemen	t	-)	- ,	3.745	0.139	736	437	3.15	
Silica Fume					517 10	0.005	19	11	2.25	
							-		-	
Fi	ne aggregate		100.0	100.0	15.317	0.567	2505	1486	2.63	0.50
Batch water					6.777	0.251	332	251	1.0	
C	embinder N8						665.5 fl. oz.	25.7 Ltrs		
Water R	educing Adr	nixture					45.3 fl. oz.	1.8 Ltrs		
High Range W	-						22.7 fl. oz.	0.9 Ltrs		
	Air				1.026	0.038				
	Totals:		100	100	27	1	3682	2185		
							Factor, kg/m ³ (•		
3. TEST RESU	LTS									
			• :			Line	onfined Com	magging Sta	ength, MPa (p	c c
Batch	Channe	Air	Air	I	Deleting	Unc	onlined Com	pressive Str	engin, MPa (p	551)
Number	Slump in.	Content %	Content %	Unit Weight lb/ft ³	Relative Yield	7-day	14-Day	21-Day	28-Day	
1	6.5	6.6	6.4	133.2	97.6%	4060	5390	6070	6630	
1	0.3	0.0	0.4	155.2	97.070	4000	5590	0070	0050	
COARSEAGO										
				-		ocated in Me	rryville, Louisian	a		
CEMENT: Typ	pe I/II, Ash (Grove Cement	Company., I	oreman, Arkan	sas					
POZZOLANS:	Elkem ES90	0W silica fun	ne							
							and in suspension			
2yla 610, Wate	r Reducing	Admixture, W	. R. Grace; A	DVA 190 High	Kange Water	Reducing Ac	lmixture, W. R. C	irace		
Retarder, Reco	ver, W.R. Gr	ace								
REMARKS:	a atmos - il. i	ata ma l		in arrivet						
a Compressiv				-m. cymaers						
b aggregate c										
c Elkem ES900										
d Specimens c		in 100% rolot.	ve humidity	nom						

REPORT DO		Form Approved OMB No. 0704-0188					
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The Engineer Research and Devel testing site for many years. Many als, their constituents, and their mo	cementitious materials h echanical properties ofte	ave been developed for m went undocumented	or design valio l, making it di	SL) has used Fort Polk as a large-scale dation testing. These cementitious materi- fficult for researchers to replicate or draw s material reports for all research efforts			
The objective of this report is to document the development of a field castable 6 ksi sanded grout mixture and a 7 ksi sanded grout mix- ture used in experimental testing programs at Fort Polk in January 2014 and February 2015.							
GSL required the development of a 6 ksi and 7 ksi mixture for testing scaled bridge columns. The reduced scaling of the test members resulted in very small rebar spacing. These designs lead to the development of very flowable specialized grouts. This report details the development of this specialized grout for the purpose of aiding future cementitious mixture developments in the							
gates in the concrete mix would not fit between reinforcing.							
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