

***DRY COMAL CREEK DAM
RCC TRIAL MIXTURE PROGRAM***

By

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Purpose

During the design stage of a project it is necessary to evaluate the performance of the selected materials. Such evaluations must determine the strength, durability, and other performance factors of the material but must also balance these properties with the design requirements of the structure and the specified or anticipated construction operations to be used on the project.

Conditions

The Dry Comal Creek Dam design results in strength performance factors that are very low. The critical factors for stability of the structure are apparent cohesion, calculated to be less than 10 psi, and direct tension at very isolated locations, calculated to be less than 10 psi. Because of the very low magnitude of these values, an extensive mixture design program is not warranted. Also, a wide variety of construction operations are allowable.

The project site is located between 2 commercial rock and aggregate production operations. In addition, other aggregate producers are located near the project site. It was early determined that significant economy was possible if commercially-available products could be used for the RCC rather than custom crush materials for the project. In this manner, the stockpile capacity of the supplier could possibly be utilized rather than produce the majority of the required aggregate and stockpile on site. The on-site staging areas for stockpiles at the project are limited. In general, commercial materials are produced to meet Texas Department of Transportation (TexDot) specifications.

Mixture Trial Approach

A full battery of mixture evaluations is not necessary for this project. The mixture evaluations are to determine the performance characteristics for a range of cement and flyash quantities for a specific range of mixture workability. Since the actual mixture strength will be significantly more than the required strength, the critical mixture performance factors become the plastic properties of the mixture; the workability of the

mixture, the tendency to segregate during dumping and spreading, and the ease with which density is achieved.

The following steps were determined to be appropriate for this project;

1. Sample and test commercially available materials from one local supplier
2. Transport several tons of aggregates to the testing laboratory.
3. Select Portland cement, flyash, and admixture for the trial mixtures.
4. Develop compressive strength vs cement content relationships
5. Develop compressive strength vs flyash content relationships
6. Determine modulus of elasticity for the range of mixtures
7. Determine splitting tensile strength for the range of mixtures
8. Determine time of setting for several mixtures.

Selected Materials

Coarse Aggregate. Aggregates meeting 1.5-inch MSA and 1-inch MSA TexDot requirements were secured from CEMEX in New Braunfels, Texas.

Concrete Fine Aggregate. Aggregates meeting fine aggregate for concrete TexDot requirements were secured from CEMEX in New Braunfels, Texas.

Structural Fill Material. Waste material used as fill, termed $\frac{3}{4}$ -dust was secured from CEMEX in New Braunfels, Texas.

Commercial Base. This material was considered for use as fine aggregate or a supplemental fine aggregate. It was not used.

Cement. Alamo Type I,II, low alkali was used. This was the only cement in the area meeting the ASTM C 150, Type II specification. The plant is located in San Antonio, Texas.

Flyash. Class C flyash was secured from Boral Materials. No Class F was readily available in the area. The plant is located in San Antonio, Texas.

Admixture. Grace retarding water-reducing admixture, WRDA 64 was used. It was provided by a local supplier.

Trial Mixture Evaluation Program

Trial batches were proportioned to approximate the typical grading recommendations of ACI 207.5R, *Roller Compacted Concrete*, for 1.5-inch MSA. Coincident goals were to achieve a minimum paste content of 19-21 percent and a paste/mortar ratio of approximately 0.42. The mixture workability target was 15 vebe seconds measured by ASTM C 1170, procedure B. Two readings were taken; one when paste formed a ring around most of the base of the plate and two when paste formed a ring around most of the top of the plate.

Mixtures were formulated for cement contents ranging from 150 lbs/cy to 300 lbs/cy. For various mixtures, 50% and 70% of the cement volume was replaced with flyash.

Commercial limestone aggregates were used for these mixtures. A combination of a 1.5-inch crushed material and a 1-inch crushed product were combined to form the coarse aggregate. The fine aggregate was also a crushed limestone produced for conventional concrete used.

A fourth aggregate, the $\frac{3}{4}$ -dust aggregate, was used as a source of fines (-200 sieve) material for the mixture. Insufficient fines were available to meet the minimum paste and p/m ratio requirements for the lower cement contents. The aggregate had a plastic index of 1-2. This material was blended in a relatively high proportion with the other 3 aggregates to most closely meet the ACI grading. The bulk of the trial mixture program used this blend (designated G1).

However, two mixtures were trialed (designated G2 and G3) to determine the effect of less $\frac{3}{4}$ -dust aggregate and more concrete sand. Table 1 summarizes the trial mixture proportions and plastic properties. Table 2 summarizes the hardened properties.

Effect of Cement Content on RCC Strength

The effect of cement content on RCC strength was directly evaluated by comparing 3 mixtures. Mixtures having 150, 200, and 300 lbs/cy of Portland cement were developed and tested for compressive strength (2 cylinders at each age) and splitting tensile strength (1 cylinder at each age). Strengths were determined at 7, 14, 28, 56, 90, and 180 days. Only compressive strengths through 90 days were determined for Mixture 150/0/G1. Figures 1 and 2 show compressive strength and splitting tensile strength performance, respectively. Compressive strengths ranged from 1600 to 4400 psi at 90 days and approximately 1800 to 4600 psi at 180 days. The splitting tensile strengths ranged from 500-900 psi at 90 days and 600 to 1000 at 180 days for the 200 and 300 lbs/cy mixtures. Figure 3 shows nearly a linear relationship between cement content and strength development. Cement efficiency for compressive strength increases from 8 psi/lb of cement at early ages to 15 psi/lb of cement at 180 days.

Effect of Flyash Content on RCC Strength

The effect of the replacement of cement with flyash on RCC strength was directly evaluated by comparing 3 mixtures. The mixture having 300 lbs/cy was modified by replacing 50% and 70% of the cement volume with Class C flyash. Compressive strength and splitting tensile strengths were determined for ages 7, 14, 28, 56, 90, and 180 days. As to be expected, strength development of the flyash mixtures was reduced as the percentage of flyash increased. Compressive strengths ranged from 3000 to 4500 psi at 180 days (Figure 4) and splitting tensile strengths ranged from 640-900 psi at 180 days (Figure 5). At 90 days, the 50% flyash mixture achieved 88 % of the no-flyash mixture compressive strength and the 70% flyash mixture achieved 63 % of the no-flyash mixture. At 180 days, the 50% flyash mixture achieved 94% of the no-flyash mixture compressive strength and the 70% flyash mixture achieved 77% of the no-flyash mixture. Cement efficiency for compressive strength at 90 days using equivalent cement (300lbs/cy) reduces from 15 psi/lb to 13 psi/lb and 10 psi/lb for the 50% and 70% flyash mixtures respectively. Cement efficiency for compressive strength at 180 days using equivalent cement (300lbs/cy) reduces from 15 psi/lb to 14 psi/lb and 12 psi/lb for the 50% and 70% flyash mixtures respectively.

Effect of Aggregate Grading on RCC Strength

Aggregate Grading 1 is a blend of 1.5-inch and 1-inch crushed coarse aggregates and crushed fine aggregate. The fine aggregate fraction is a blend of sand manufactured for conventional concrete use and a waste product called $\frac{3}{4}$ -dust. It is used as a structural fill material. It contains a high amount of -200 sieve fines having a PI of 1-2. The volume proportions of this aggregate blend is 22-22-25-31 percent of 1.5 inch, $\frac{3}{4}$ -inch, concrete sand, and $\frac{3}{4}$ -dust, respectively. This blend is shown on Figure 6 and was formulated to best approximate a target RCC grading for 1.5-inch MSA. Most of the trial mixtures used this aggregate blend.

Grading 2 was formulated to evaluate the effects of reducing the proportions of the $\frac{3}{4}$ -dust aggregate and increasing the concrete sand. The resulting blend was a 25-25-40-10 percent of 1.5 inch, $\frac{3}{4}$ -inch, concrete sand, and $\frac{3}{4}$ -dust, respectively. The grading curve of this blend is shown on Figure 7.

Grading 3 was formulated to evaluate the effects of proportions of the $\frac{3}{4}$ -dust aggregate and between that of Grading 1 and Grading 2. The resulting blend was a 23-23-34-20 percent of 1.5 inch, $\frac{3}{4}$ -inch, concrete sand, and $\frac{3}{4}$ -dust, respectively. The grading curve of this blend is shown on Figure 8.

Using the 300/70/G1 mixture as a baseline, the modification of the mixture where the proportion of $\frac{3}{4}$ -dust was reduced by more than $\frac{2}{3}$ and replaced with concrete sand had only a minor effect on strength development through 90 days as can be seen on Figures 9 and 10. Strength developed significantly after 90 days resulting in a 500 psi increase over the G1 mixture. When the $\frac{3}{4}$ -dust proportion was reduced by $\frac{1}{3}$ (G3 mixture) and

replaced with concrete sand, the strength increase was significant, approximately 20% for compressive strength and 25% for splitting tensile strength. This difference may be partly reduced if water were added to the 300/70/G3 mixture to make workability equivalent.

Effect of Cement and Flyash Content on Water Content

Cement content and water content can be related with mixtures 150/0, 200/0, and 300/0. As cement content increases, the water content increases to maintain a constant workability level. Additional water is necessary for the 150/0 mixture to be directly comparable at equivalent workability levels. The data shows that the 300/0 mixture requires a water content of 153 lbs/cy or 3.8% of the total mass. The lower cement content mixtures of 150/0 and 200/0 show water contents of 139 lbs/cy (3.5%) and 126 lbs/cy (3.1%), respectively. The relative performance of the 150/0 and 200/0 mixtures is not consistent with expectations that water content increase should be proportional to cement content increase. The higher cement content of 300 lbs/cy clearly shows an increased water demand.

Flyash content and water content can be related with mixtures 300/0, 300/50, and 300/70. As flyash content increases, the water content remains approximately the same to maintain a constant workability level. Mixture 300/50 was trialed at higher water content and resulted in significantly higher workability level, a vebe time of 3/5 seconds. Adjustments to the mixture to reduce workability to the 15/20 range would result in a water content similar to the other 2 flyash mixtures.

Bedding Mortar Mixture Performance

Bedding mortar is normally proportioned to yield strength greater than the RCC strength and in proportions that do not excessively bleed or segregate. Two mixtures were proportioned having 600 and 800 lbs/cy and a third mix where 50% of the cement volume (the 800 lbs/cy mix) was replaced with flyash. Smaller, 2 by 4-inch cylinders were cast and compressive strengths tested at 7, 28, and 90 days. No splitting tensile or modulus of elasticity testing was done. Figure 11 shows the strength development of each mixture over time. Some irregular early age results can be seen. However the 90-day performance shows nearly equivalent performance of the straight 600 and 800 lbs/cy mixtures. The mixture with flyash has a slow strength gain but ultimately almost catches up with the other mixtures at 90 days. Strength development increases with cement content as shown on Figure 12; however data problems complicate this observation. Unusually high 7-day strengths were observed for the 800/0 mixture and lower than expected strength performance after 7 days. All mixtures meet the criterion that bedding mortars exhibit strength equal to or greater than the RCC.

RCC Modulus of Elasticity

Figures 13 to 19 summarize all the modulus of elasticity testing of the mixtures. The 40% secant modulus at 90 days was calculated from each data set and recorded on Table 2. The data is generally very linear except for the 7-day results. This is not unexpected for early age properties. All the mixtures with an equivalent cement content of 300 lbs/cy exhibited a modulus range of approximately 4 to 5 million psi. Modulus values increase as the percent of replacement flyash decreases. As overall cement content decreases so do modulus values. These values are higher than data published in ACI 207.5R, *Roller Compacted Concrete*. This is attributed to the fact that the trial mixtures have higher equivalent cement factors and the Class C flyash provides a significant contribution to strength gain and modulus development than do the more commonly used Class F flyashes.

RCC Time of Setting

No time of set tests were performed during the trial mixture process. It was determined that when confirmation mixtures are to be performed at the time of construction, the effect of retarding admixture dosage can be evaluated at that time and the dosage directed as dictated by the test results and field conditions. Criteria for time of set performance is for mixtures to have an initial set at 4 hours and a final set at 8 hours for ambient temperatures greater than 80 degrees F. Field determinations may be appropriate to adjust admixture dosage for extreme heat conditions.

Aggregate Quality Testing

Exhibit 1 contains limited test results for the quality testing of the aggregates sampled from CEMEX plant in New Braunfels, Texas. The test results are gradings for the various selected materials and Atterburg limit testing for the commercial base, $\frac{3}{4}$ -dust, and the manufactured sand. No additional testing was done of the materials at this stage since the limestone materials currently have been tested and approved for Texas Department of Transportation use for concrete.

Conclusions

Exhibit 2 provides summary sheets for each of the 10 trial mixtures. Also included are mill tests for the Portland cement and flyash and a catalog cut for the water-reducing admixture.

Workability and segregation concerns for RCC mixtures require that mixtures be proportioned with at least 20% paste content. This prevents the rock-to-rock contact in the matrix leading to higher voids content, higher compaction effort, and segregation of the mixture. Segregation was observed for many of the trial batches with low paste

content. Given the low fines content of the available materials, high cementitious contents are necessary to compensate for this deficiency. Only the trial mixtures with an equivalent cement content at 300 lbs/cy achieved the necessary paste content.

Figure 20 provides a relationship between compressive strength and cohesion. Less conservative approaches assume cohesion to be approximately 10% of the compressive strength. Required cohesions for the project are so low that, based on the figure, mixtures that achieve less than 500 psi compressive strength would be satisfactory. Actual compressive strengths will be significantly higher than necessary to meet cohesion requirements.

Based on ACI 207.5R, tensile strength of RCC is often assumed to be 5-15% of compressive strength. As concluded for cohesion, tensile capacity of the mixture should be significantly higher than required. Lift joint surfaces will be the critical areas. Bedding mortar is to be applied to upstream surfaces of all lifts. This requirement should address all the zones where tensile strength development is necessary.

A mixture with only Portland cement at 300 lbs/cy would generate high internal heat and may exhibit volume change leading to cracking beyond what the joint system can accommodate. Strengths for the mixtures where flyash is substituted for 50 and 70 percent of the cement achieve more than required strength and should generate less internal heat.

Bedding mortar performance in all cases is more than required. However, significant bleeding of the 600/0 mixture was observed and lesser bleeding of the 800/0 mixture. The 800/50 mixture exhibited the least bleeding.

Recommendations

Use the mixture designated as 300/70/G1 as the target mixture for the project.

Allow the contractor to proportion fine aggregate and $\frac{3}{4}$ -dust in combinations bracketed by the G1 and G3 grading.

Expect 90-day compressive strengths in excess of 3,000 psi and 180-day compressive strengths to be approximately 3500 psi.

Expect direct tensile strength in excess of 150 psi for parent RCC and values in excess of 50 psi for lift joints for mixtures placed within 1000 degree-hours and expect a 50% reduction for exposures up to 2000 degree-hours.

Expect cohesion in the parent RCC to exceed 150 psi and values in excess of 50 psi for lift joints for mixtures placed within 1000 degree-hours and expect a 50% reduction for exposures up to 2000 degree hours.

Use the bedding mortar mixture designated 800/50 for the bedding mortar.

Acknowledgements

The laboratory trial program was performed at the San Antonio office of Fugro Consultants, Inc. The laboratory staff was under the direction of Mr. Rick Fuentes.

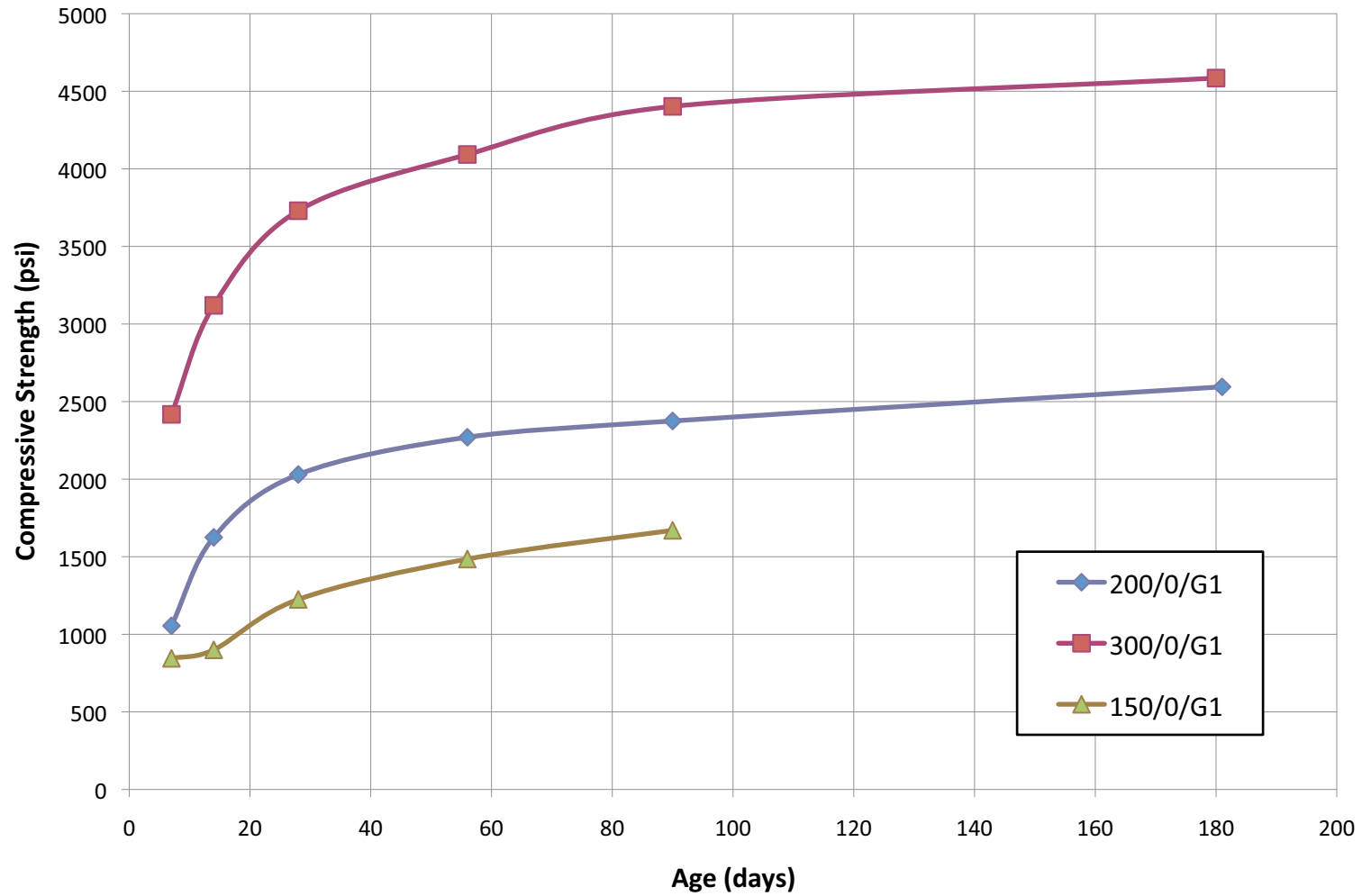
TABLE 1 - RCC Mixture Proportions and Plastic Properties Summary Sheet

Mix ID	Cement Content lbs/cy	Flyash Content lbs/cy	Water Content lbs/cy	EQ Cem lbs/cy	w/c Ratio	Pozz Repl %	Paste Content %	P/M Ratio %	Sand/Fines Content %	Air Content %	Vebe Time secs	Unit Wt. lbs/cy	Slump in
RCC Mixtures													
150/0/G1	150	0	139.5	150	0.93	0	18.2	35.4	44/5.8	2.5	40/54	148.0	na
200/0/G1	200	0	126.0	200	0.63	0	17.8	34.9	44/5.8	1.6	16/24	150.0	na
300/0/G1	300	0	153.0	300	0.51	0	21.6	40.4	44/5.8	2.2	18/24	149.6	na
300/50/G1	150	127.6	165.0	300	0.55	50	22.3	41.4	44/5.8	1.4	3/5	149.6	na
300/70/G1	90	178.7	156.0	300	0.52	70	21.8	40.7	44/5.8	2.2	16/21	149.6	na
300/70/G2	90	178.7	141.0	300	0.47	70	18.7	33.5	47.3/3.1	2.1	11/16	149.8	na
300/70/G3	90	178.7	148.2	300	0.49	70	20.2	36.3	46.8/4.4	2.1	29/40	149.1	na
Bedding Mortar Mixtures													
600/0	600	0	420.0	600	0.70	0	40.2	40.3	99.8/3.2	~	na	~	9
800/0	800	0	408.0	800	0.51	0	43.2	43.2	99.8/3.2	~	na	~	8.75
800/50	400	340.3	408.0	800	0.51	50	43.2	43.2	99.8/3.2	~	na	~	10.25

TABLE 2 - RCC Mixture Hardened Properties Summary Sheet

Mix ID	Cement Content lbs/cy	Flyash Content lbs/cy	Dry Unit Weight	Sub Unit Weight	Compressive Strength				Splitting Tensile Strength				MOE
					7-day	28-day	90-day	180-day	7-day	28-day	90-day	180-day	90-day
RCC Mixtures													
150/0/G1	150	0.0	147.3	150.7	805	1225	1670	~	~	~	~	~	2.17
200/0/G1	200	0.0	144.7	149.8	1055	2030	2375	2595	235	436	525	571	2.84
300/0/G1	300	0.0	146.5	150.7	2418	3730	4403	4585	395	708	875	984	5.01
300/50/G1	150	127.6	146.4	149.6	1098	2493	3873	4305	210	492	807	885	4.28
300/70/G1	90	178.7	147.3	150.7	1270	1925	3125	3545	260	384	657	809	3.94
300/70/G2	90	178.7	147.5	150.7	1243	2000	3115	4160	255	392	658	878	3.72
300/70/G3	90	178.7	147.7	150.8	1533	2483	3680	3970	270	474	794	856	3.78
Bedding Mortar Mixtures													
600/0	600	0.0	132.7	136.8	1570	3647	4195		~	~	~	~	~
800/0	800	0.0	137.0	137.4	4067	3602	4035		~	~	~	~	~
800/50	400	340.3	137.0	141.4	1631	2812	3768		~	~	~	~	~

**Figure 1 - RCC Compressive Strength vs Age
for Varying Cement Contents**



**Figure 2 - RCC Splitting Tensile Strenght vs Age
for Varying Cement Contents**

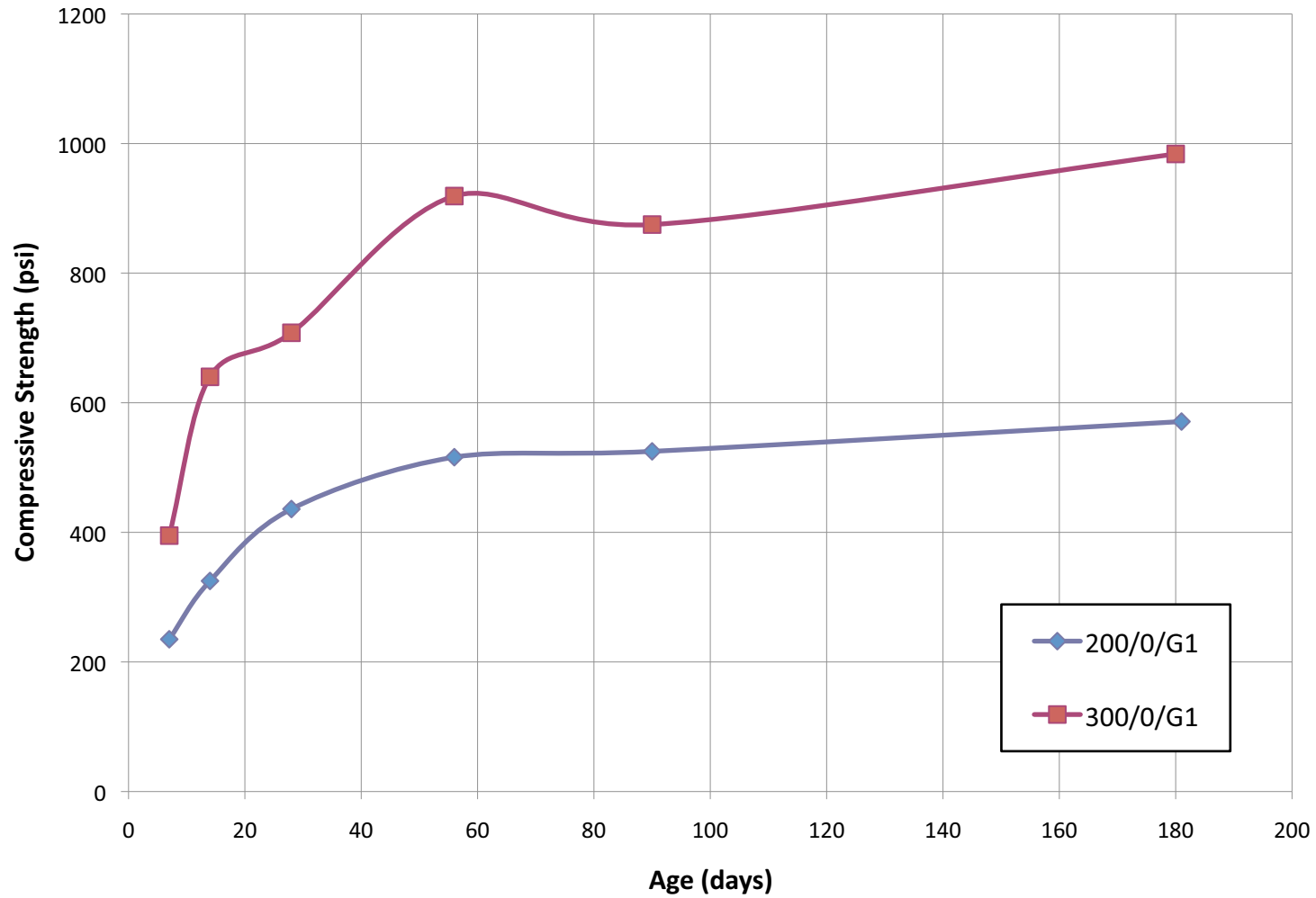
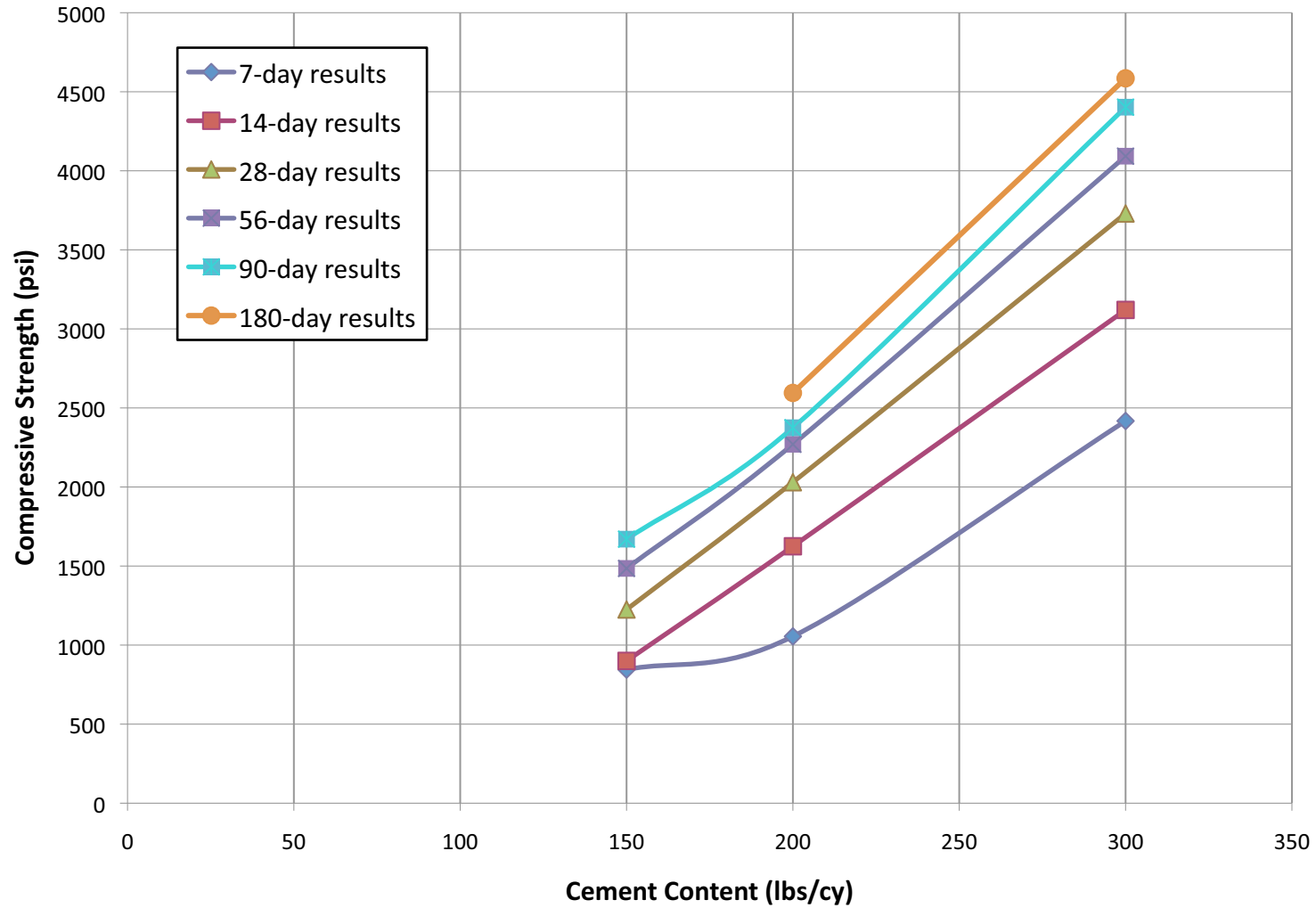


Figure 3 - RCC Compressive Strength vs Cement Content at Various Ages



**Figure 4 - RCC Compressive Strength vs Age
for Varying Flyash Replacements**

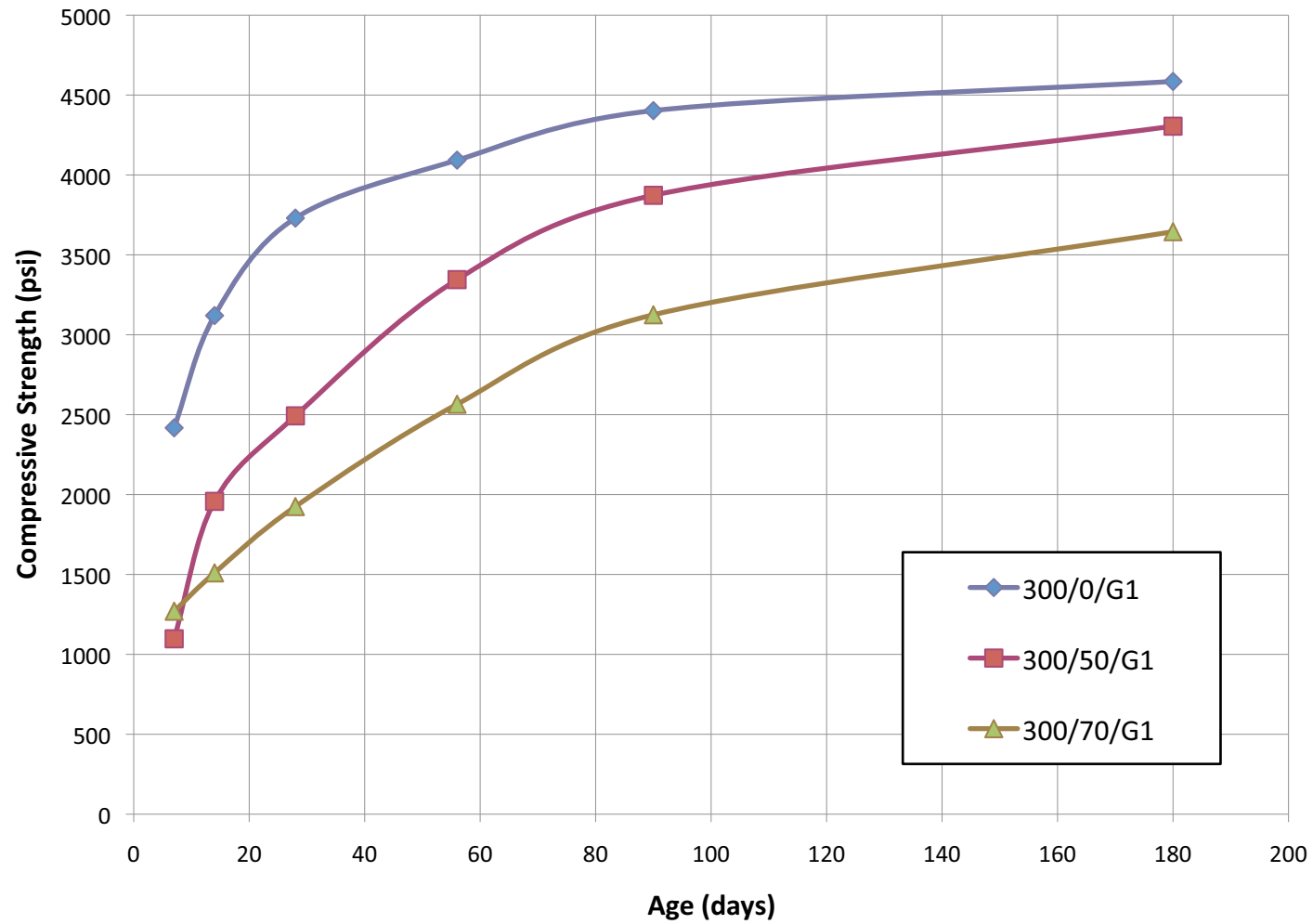
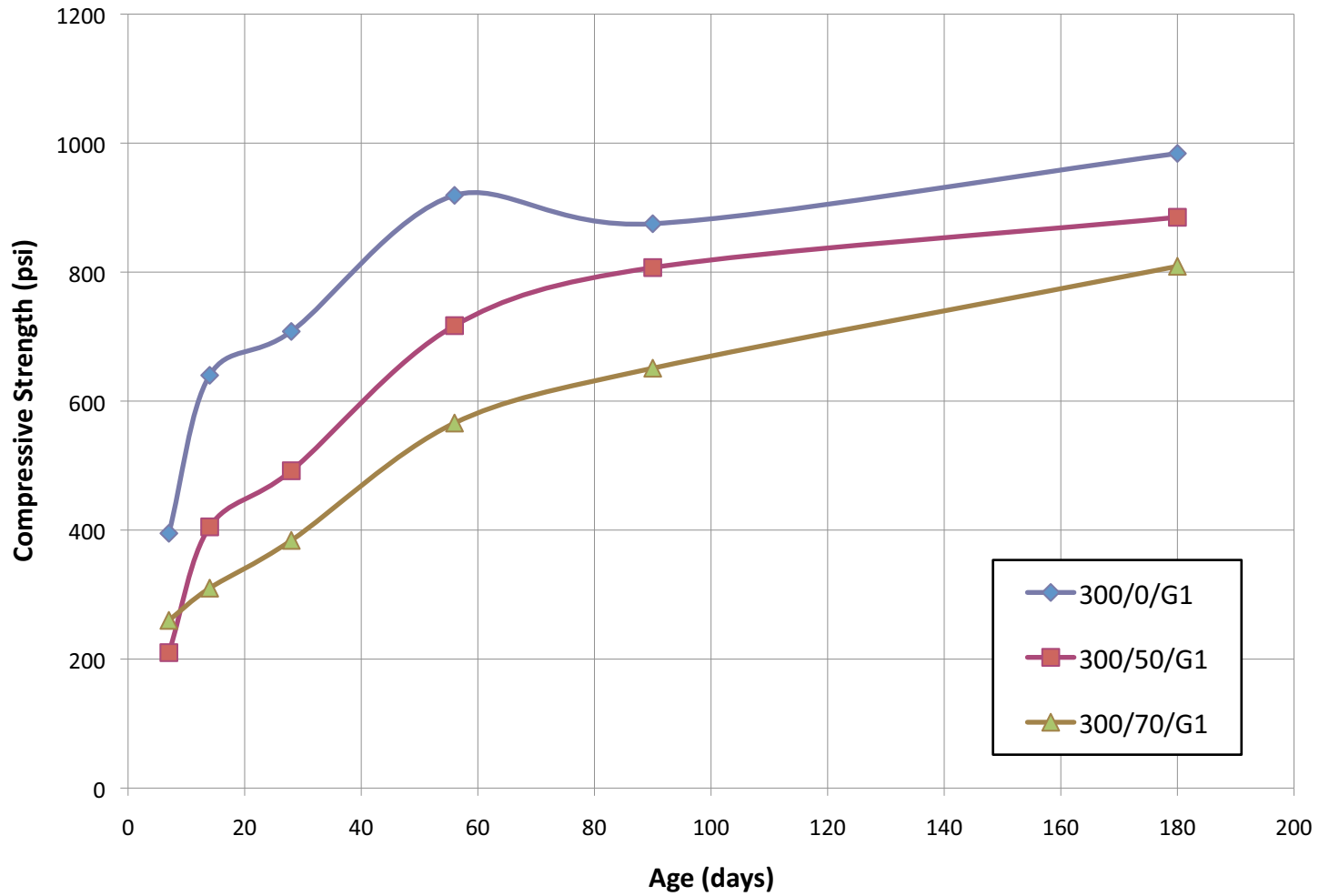
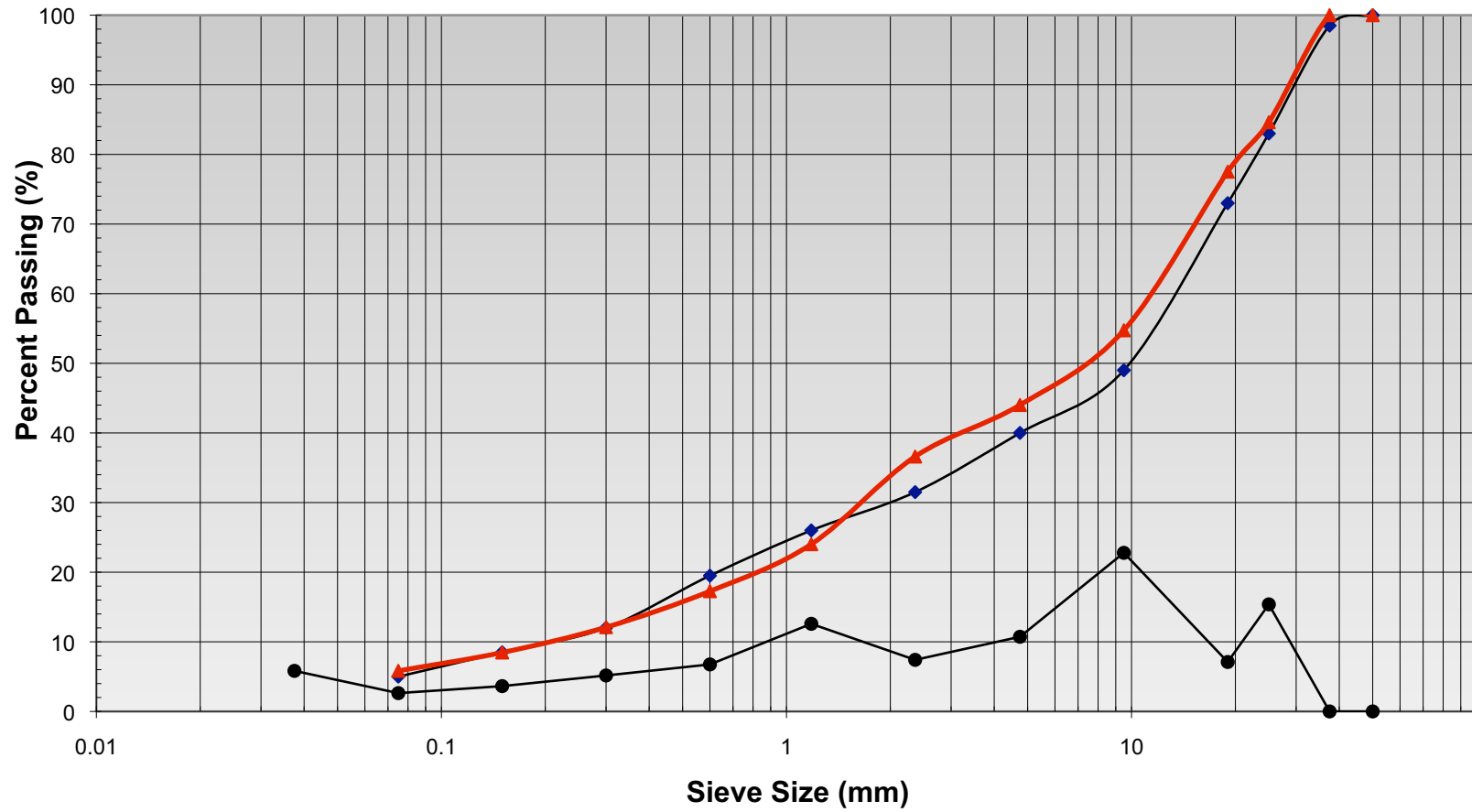


Figure 5 - RCC Splitting Tensile Strength vs Age for Varying Flyash Replacement



**Figure 6 - Combined Grading Analysis No. 1
22-22-25-31**

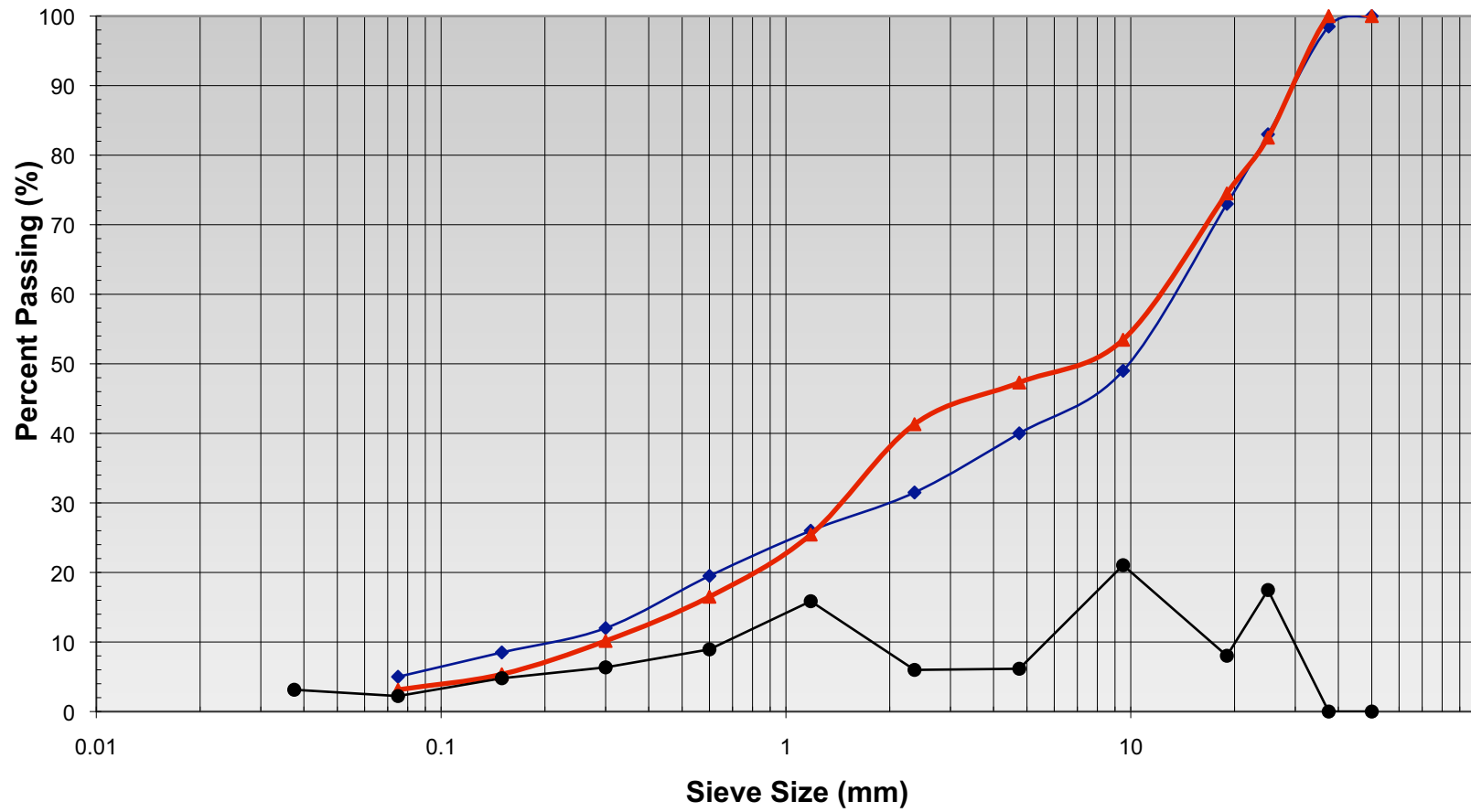


◆ Fine Target

▲ Aggregate Blend

● Blend % Retained

**Figure 7 - Combined Grading Analysis No. 2
25-25-40-10**

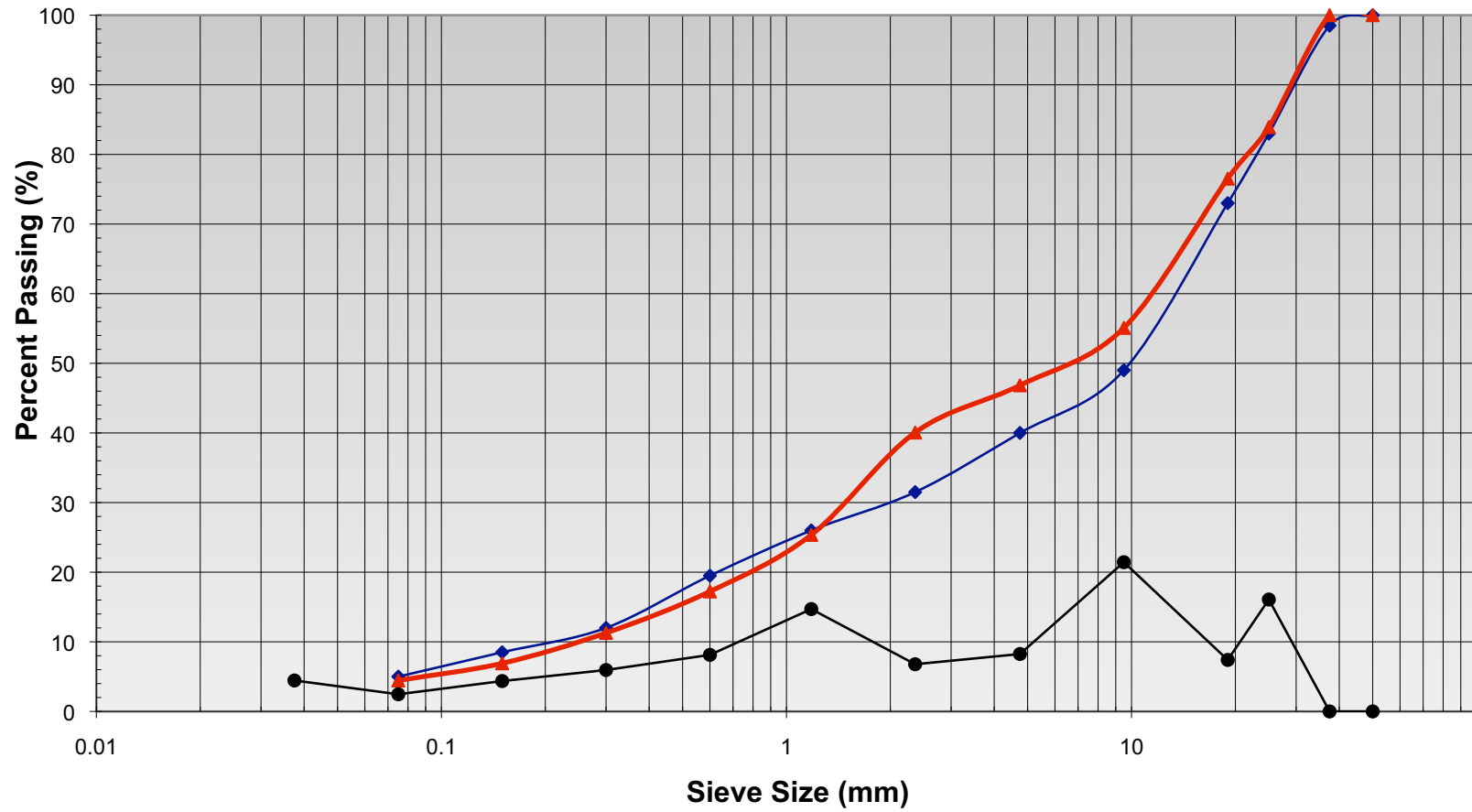


◆ Fine Target

▲ Aggregate Blend

● Blend % Retained

**Figure 8 - Combined Grading Analysis No. 3
23-23-34-20**

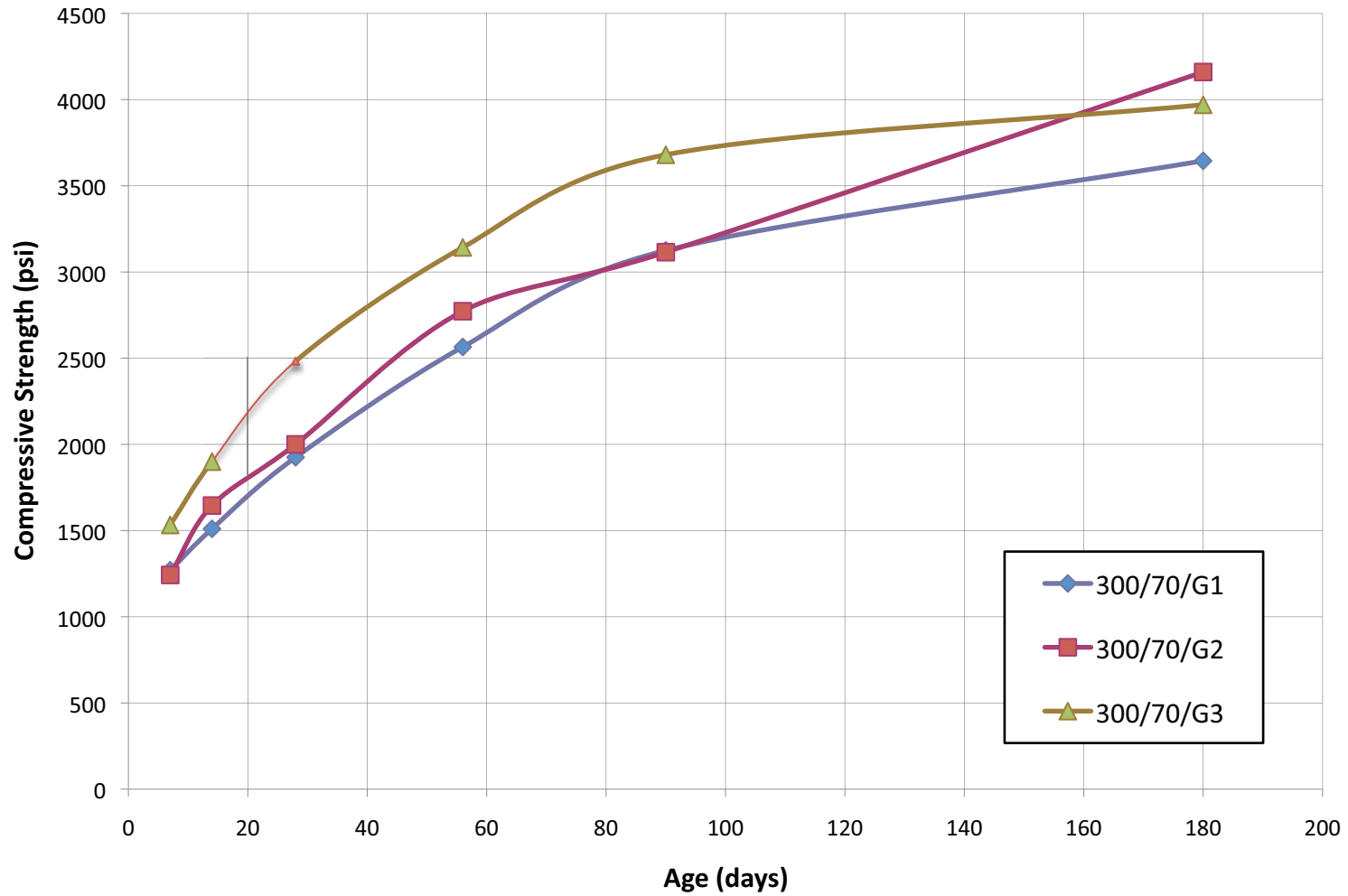


◆ Fine Target

▲ Aggregate Blend

● Blend % Retained

**Figure 9 - RCC Compressive Strength vs Age
for Varying Aggregate Gradings**



**Figure 10 - RCC Splitting Tensile Strength vs Age
for Varying Aggregate Gradings**

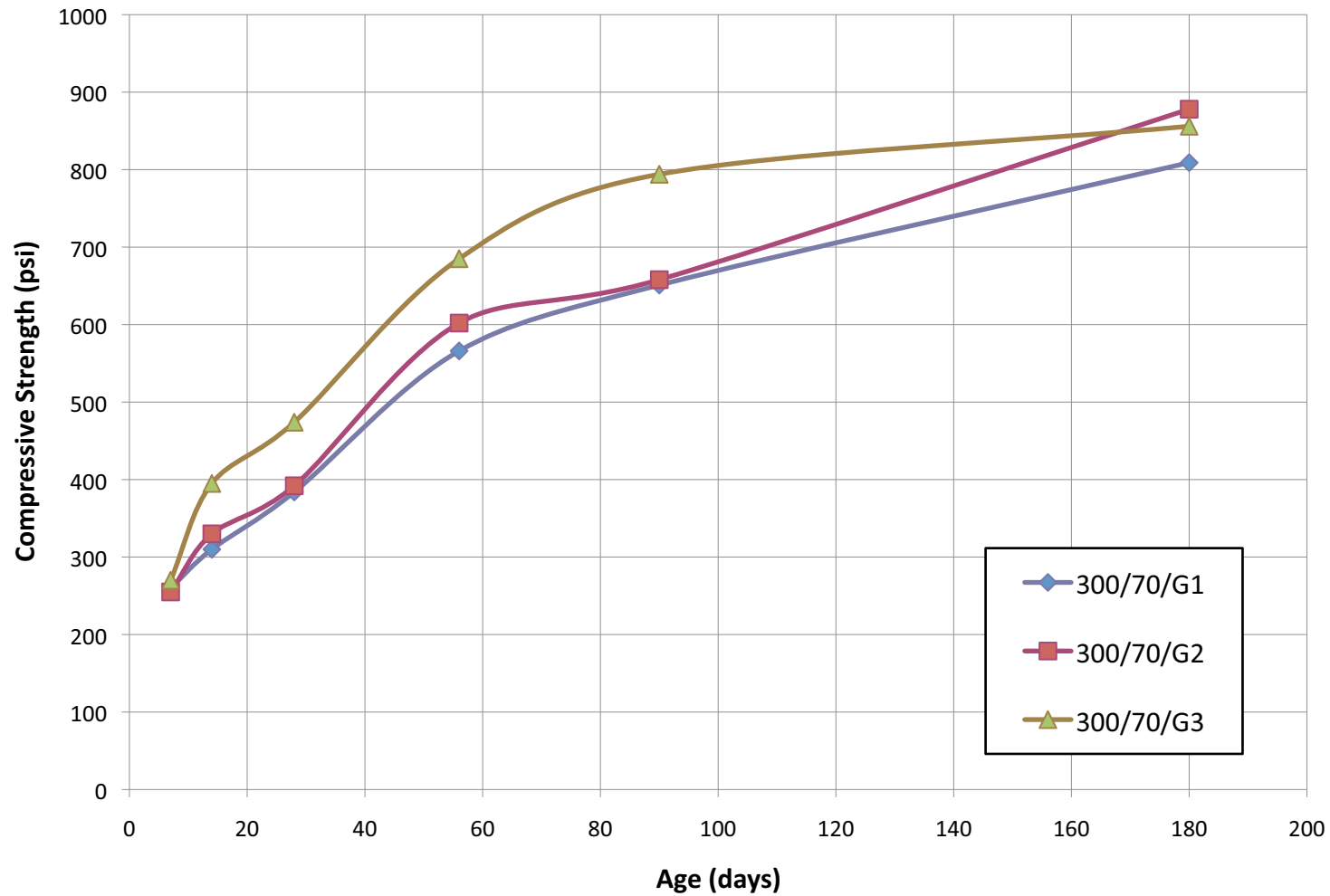


Figure 11 - Bedding Mortar Compressive Strength vs Age for Various Mixtures

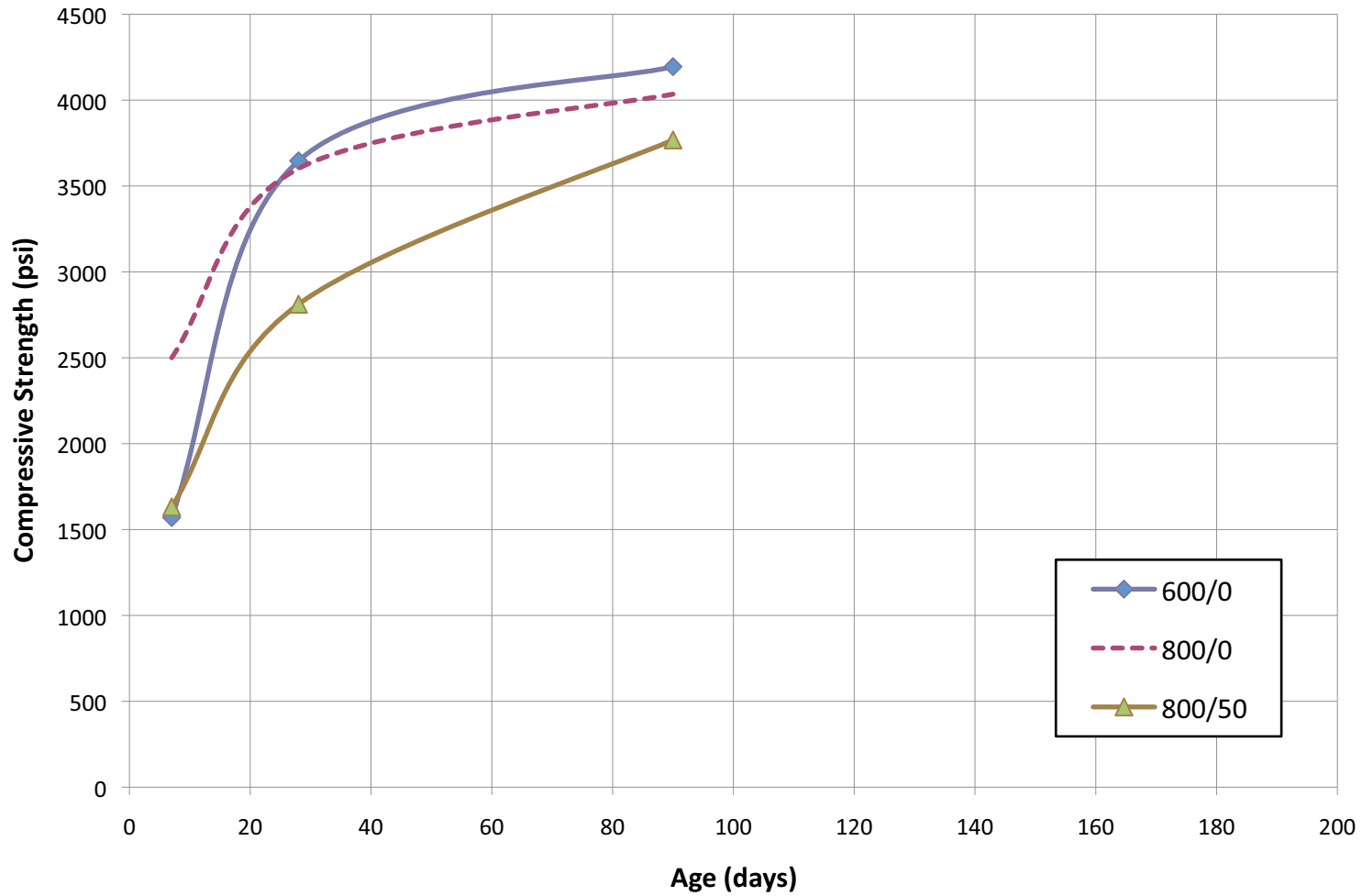
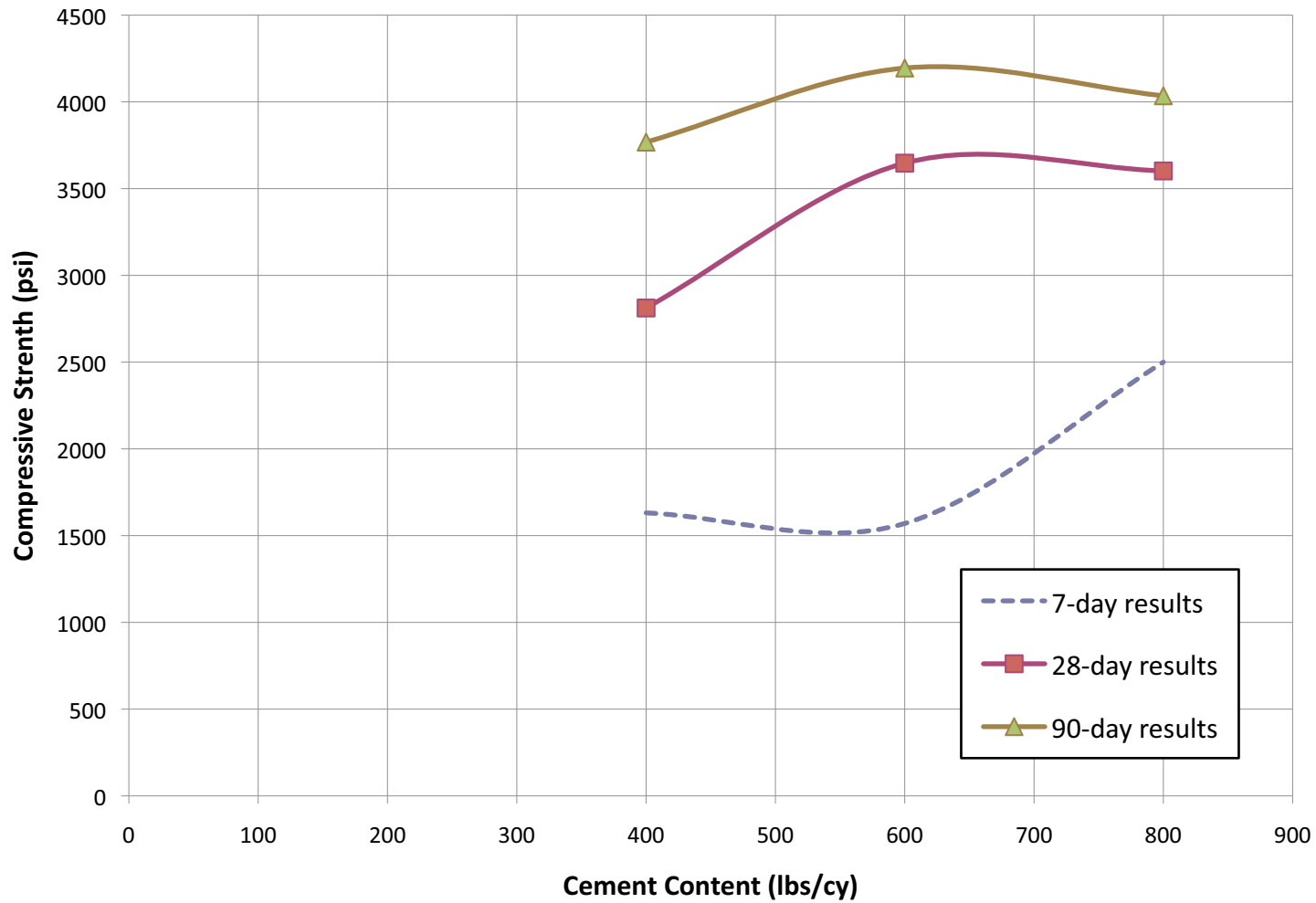
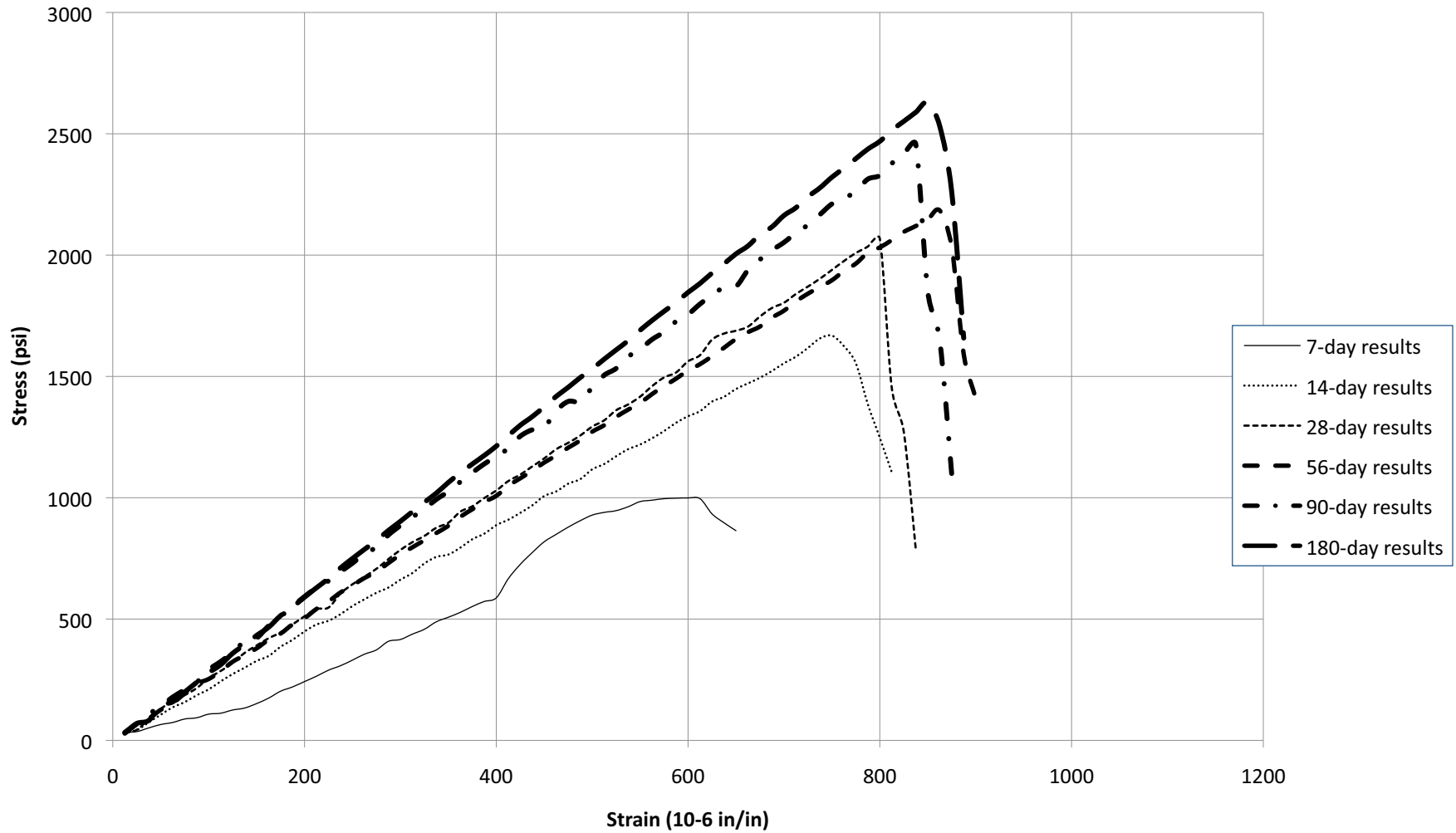


Figure 12 - Bedding Mortar Compressive Strength vs Cement Content at Various Ages



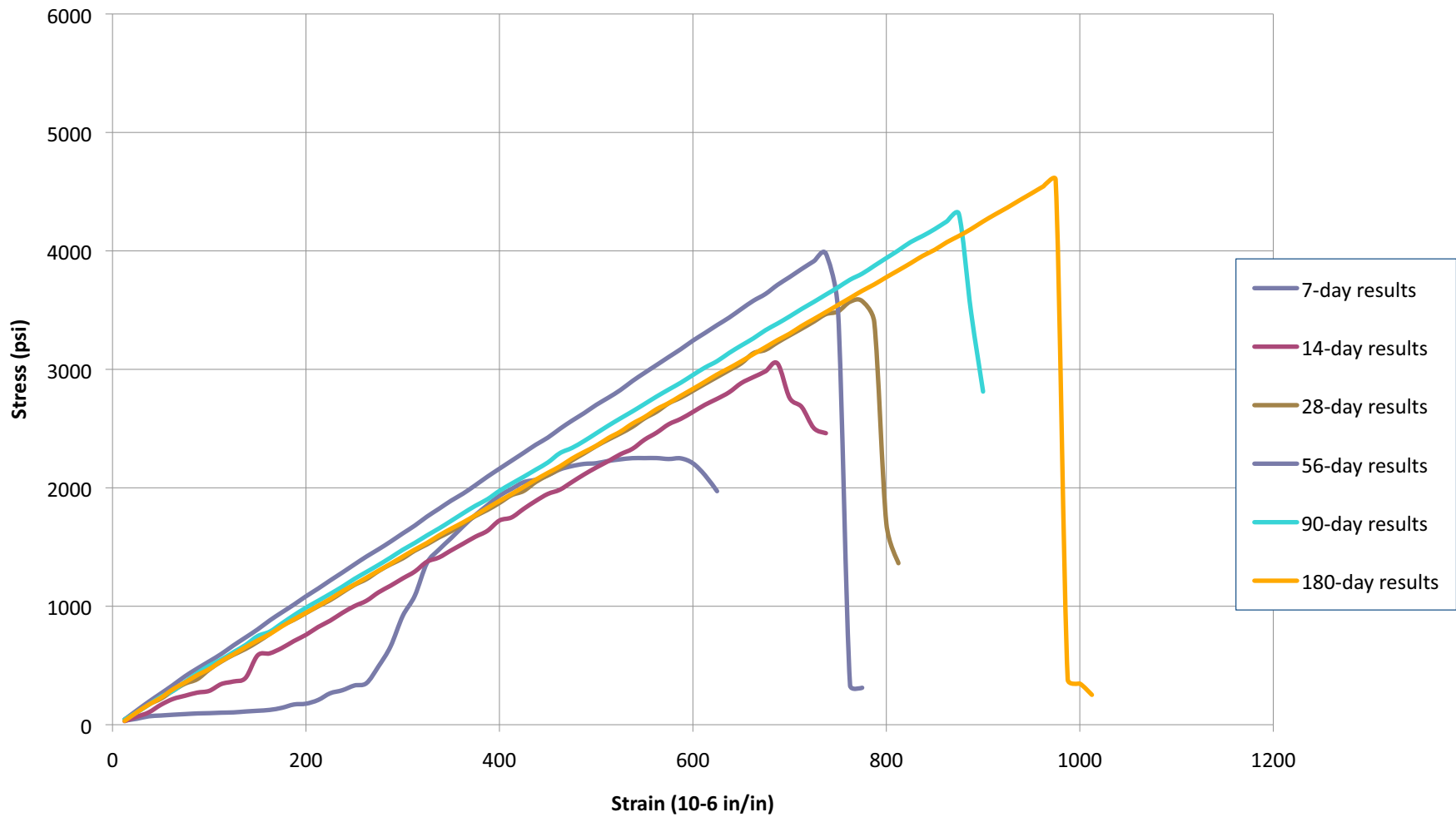
Modulus of Elasticity

Mixture No. 1: 200-0-Grad1 (1.5" MSA RCC)



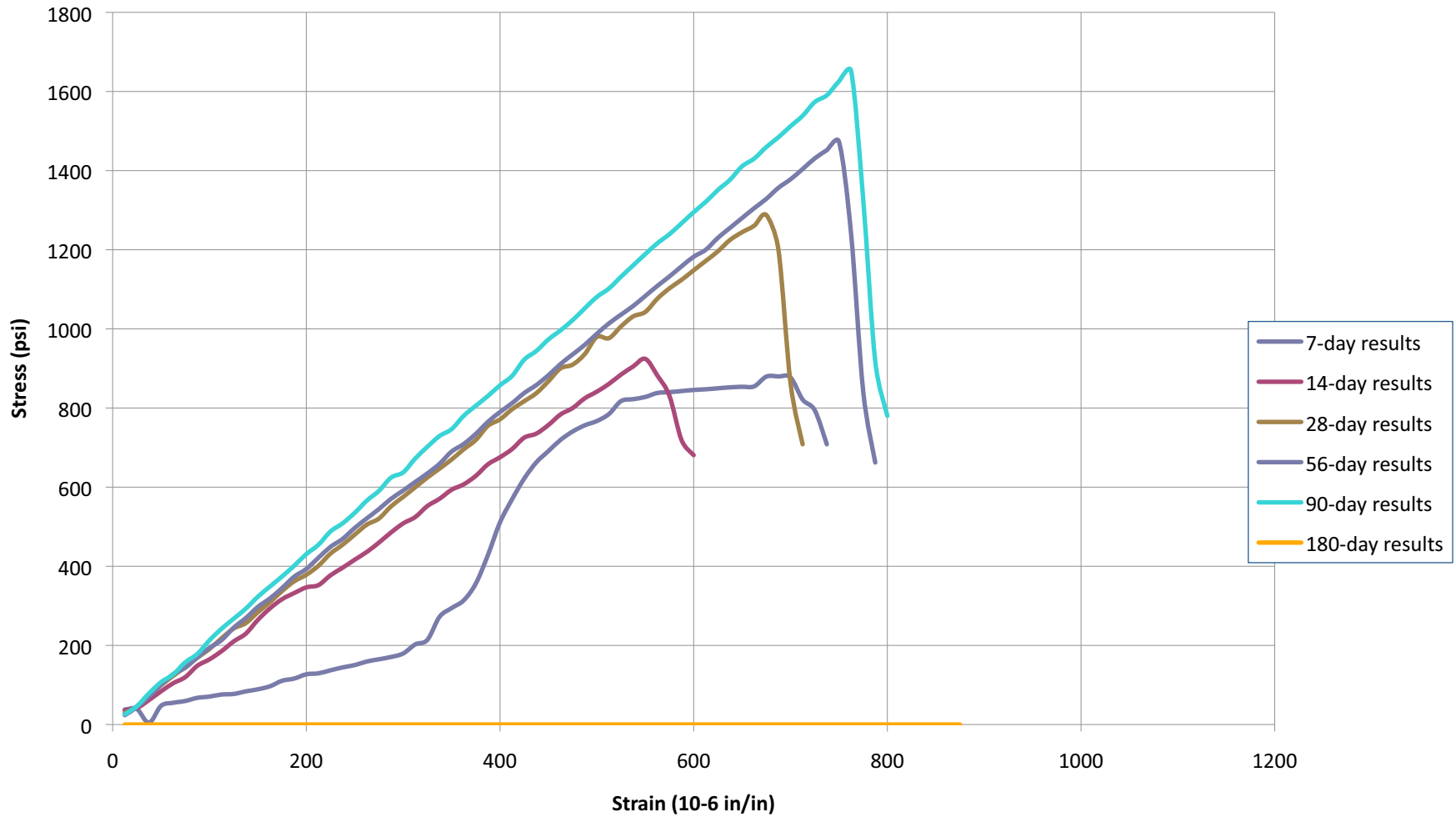
Modulus of Elasticity

Mixture No2: 300-0-Grad1 (1.5" MSA RCC)



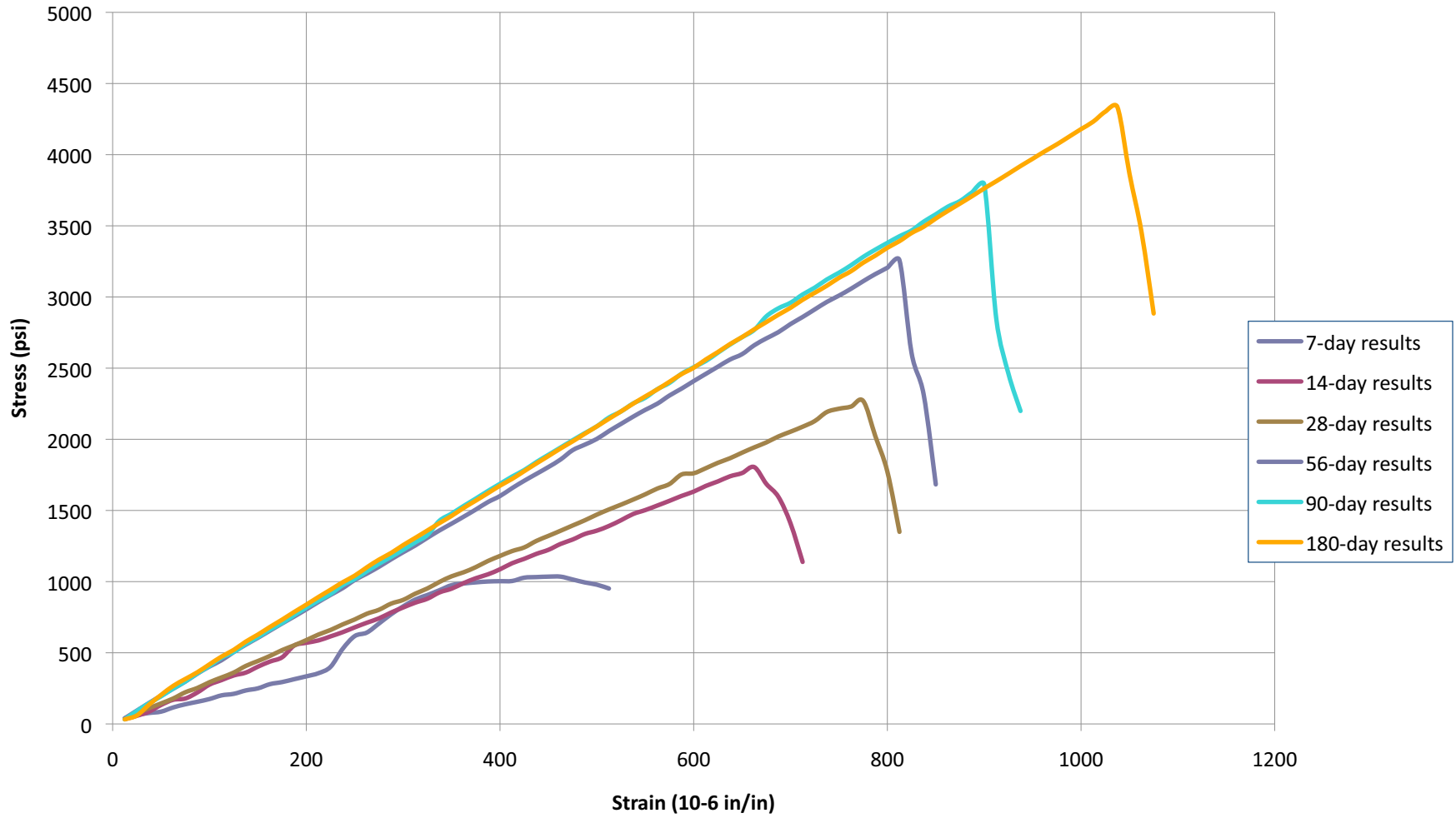
Modulus of Elasticity

Mixture No. 3: 150-0-Grad1 (1.5" MSA RCC)



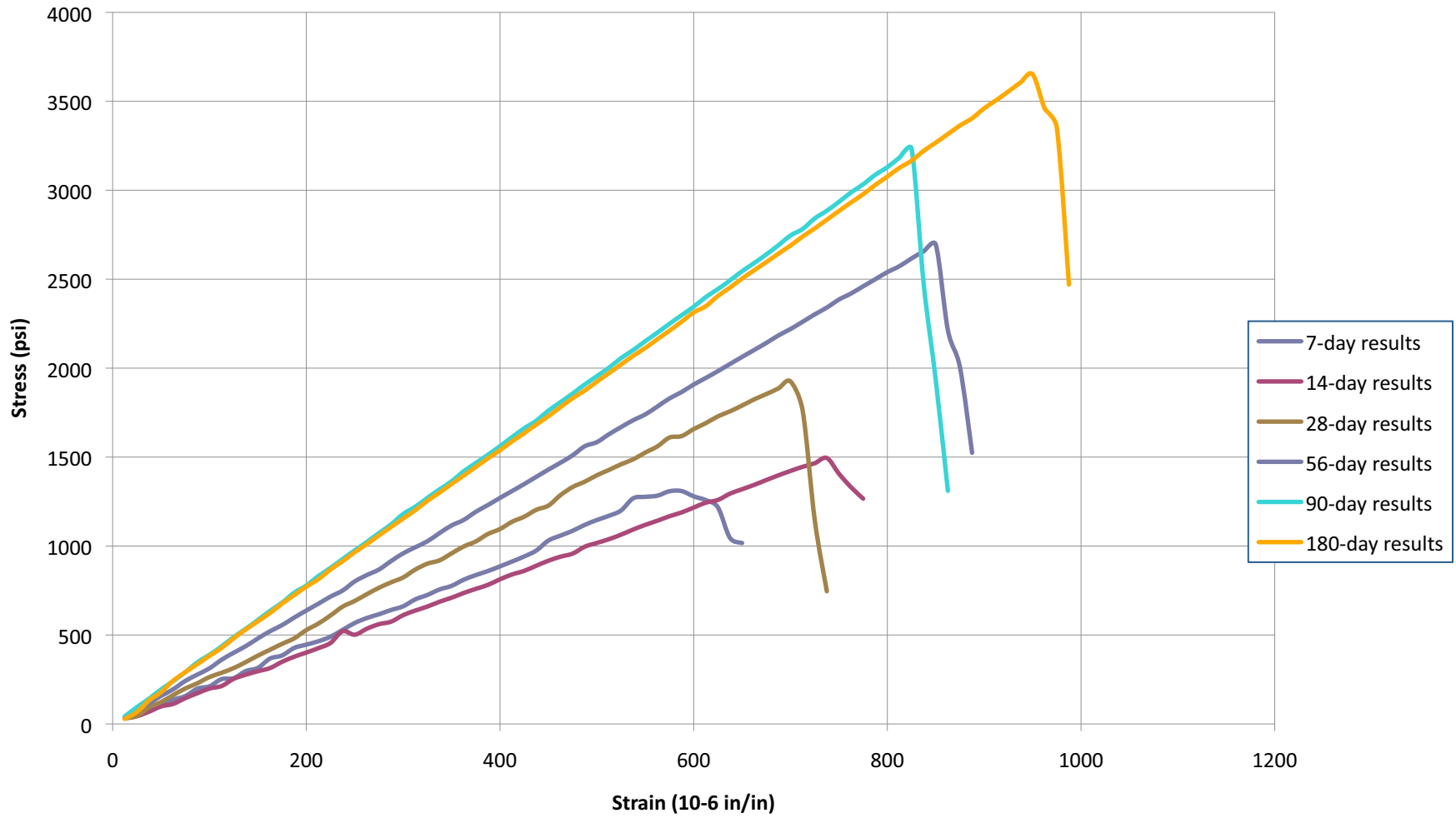
Modulus of Elasticity

Mixture No. 4: 300-50-Grad1 (1.5" MSA RCC)



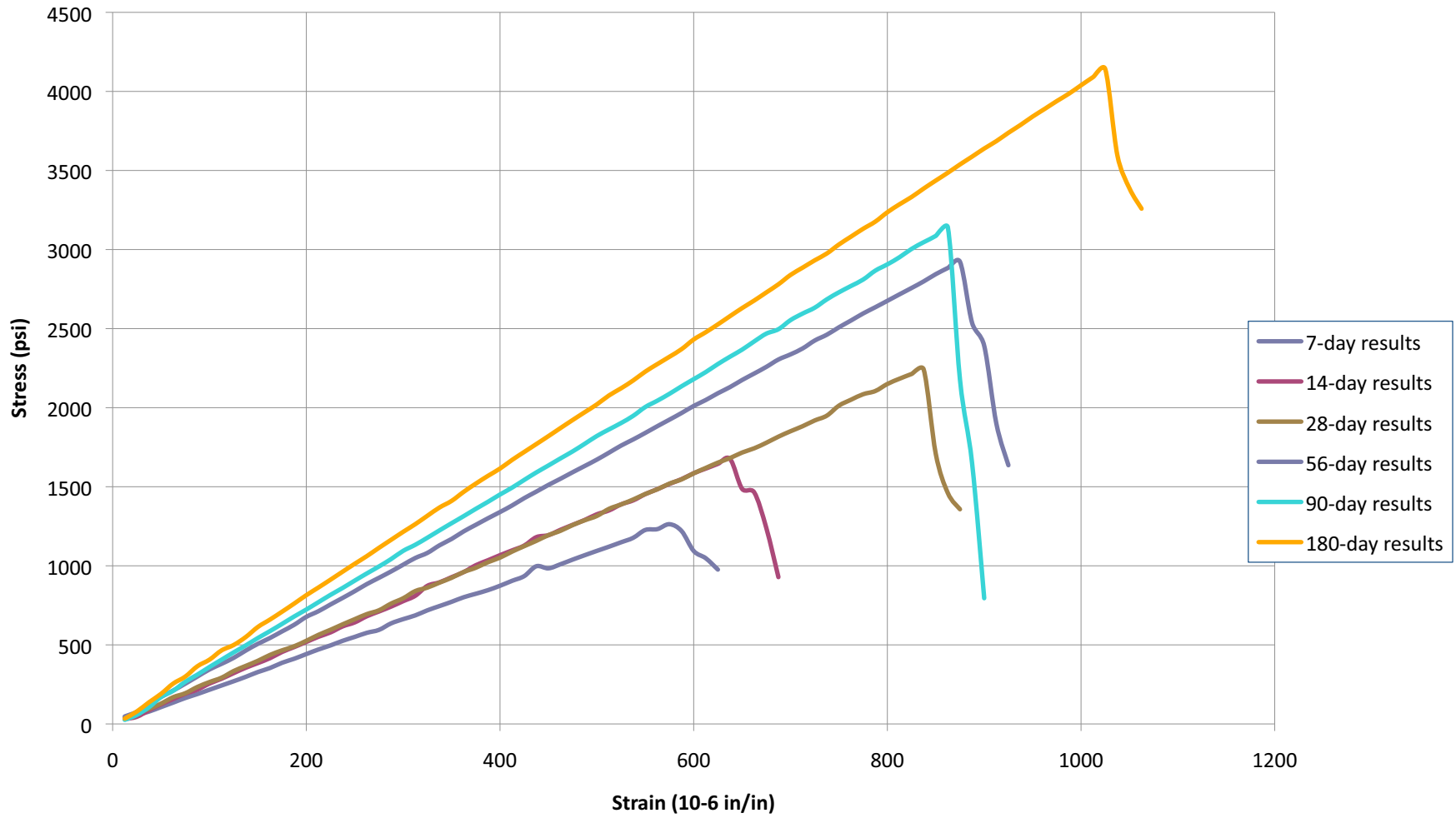
Modulus of Elasticity

Mixture No. 5: 300-70-Grad1 (1.5" MSA RCC)



Modulus of Elasticity

Mixture No. 6: 300-70-Grad2 (1.5" MSA RCC)



Modulus of Elasticity

Mixture No. 7: 300-70-Grad3 (1.5" MSA RCC)

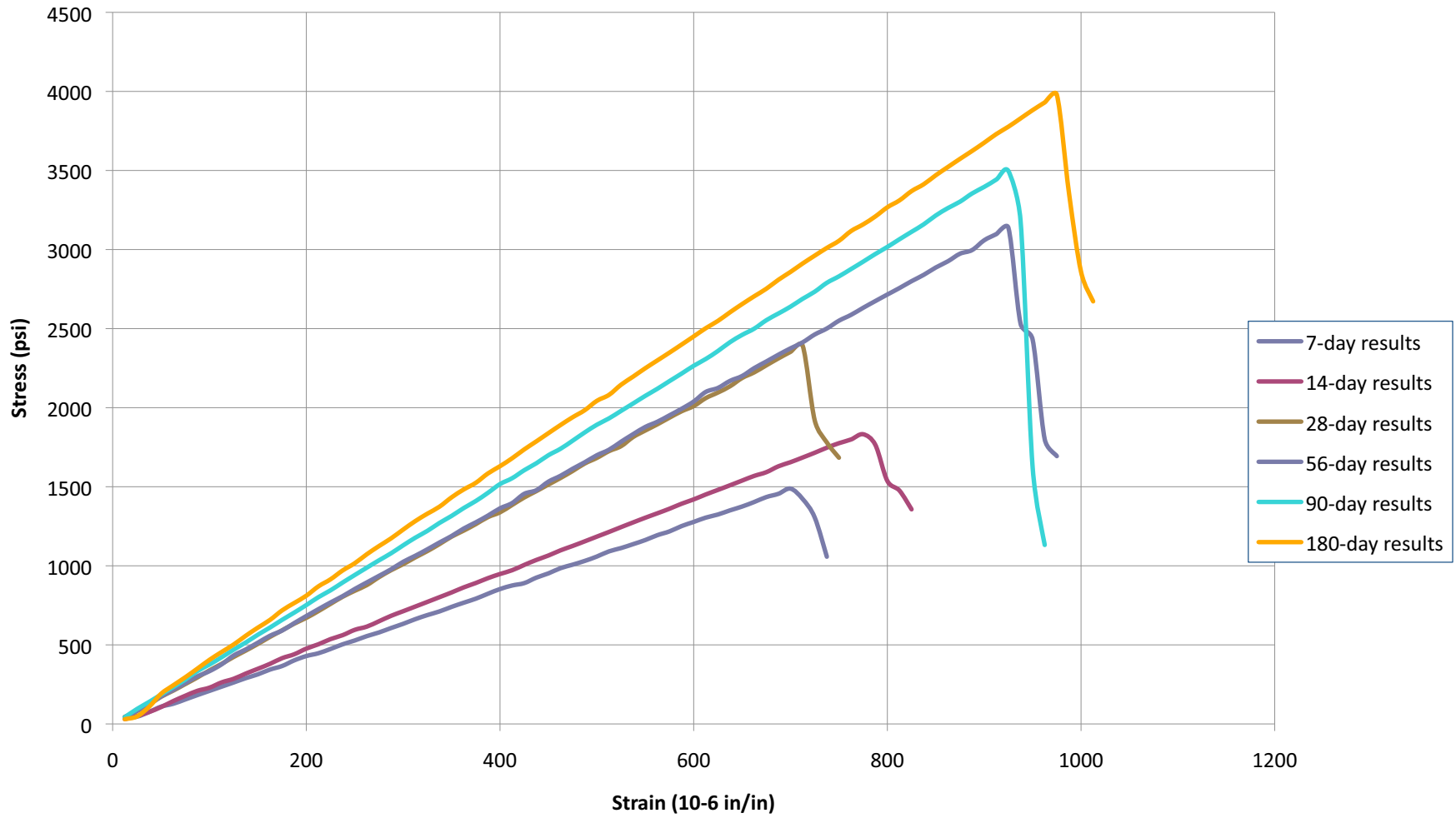
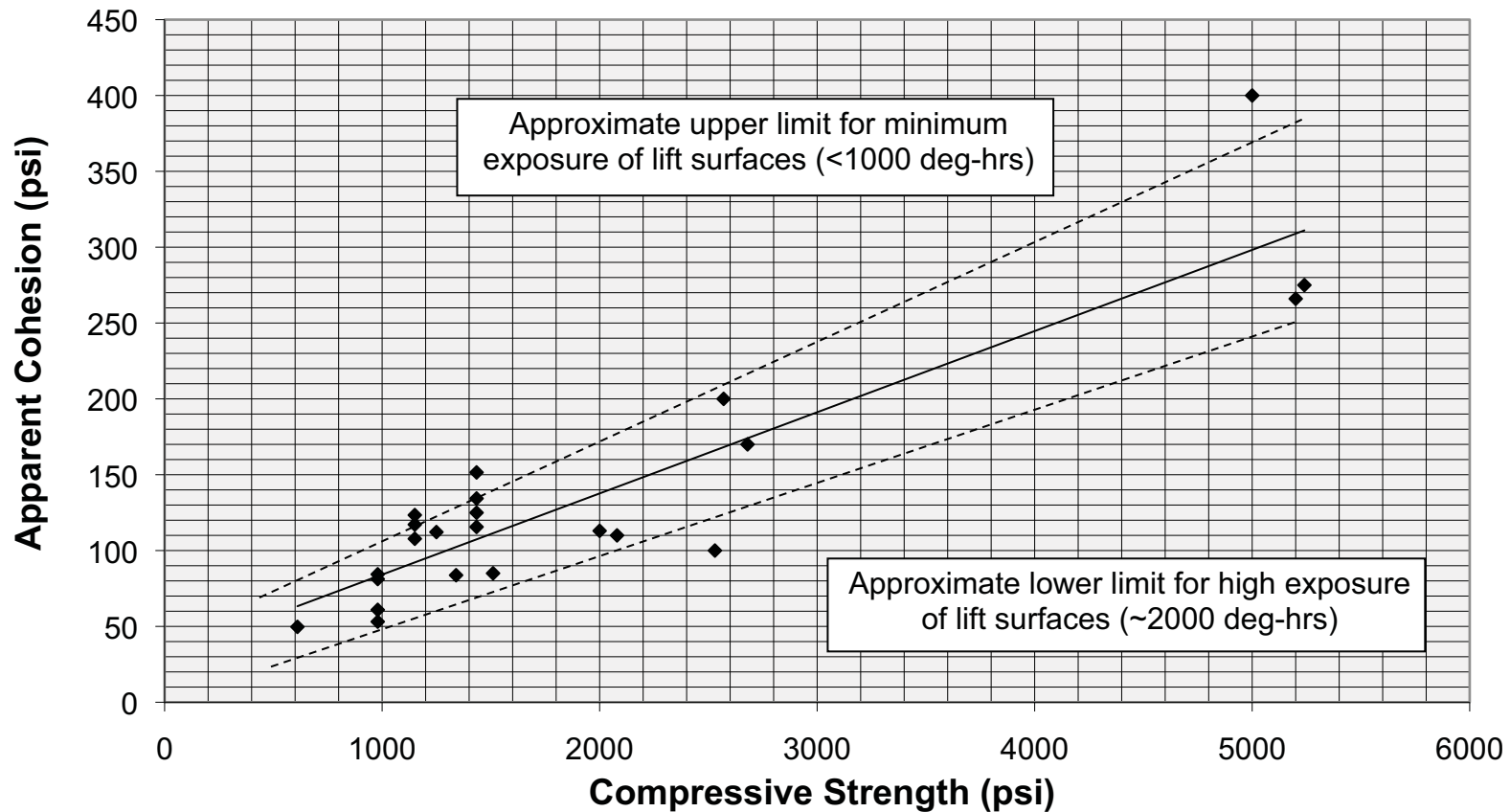


Figure 20 - RCC Cohesion vs Compressive Strength

Data from ACI 207.5R report, Table 3.4 and reports for Portuges Dam, Balambano Dam, and Miel 1 Dams.



Note: The solid line is a linear regression of all the data points. The dashed lines are subjective locations of possible limits for the stated degree-hour exposures.

Exhibit 1

Fugro Testing of Selected Materials Prior to Laboratory Trials

LETTER OF TRANSMITTAL

Fugro Consultants, Inc.
11009 Osgood
San Antonio, Texas 78233
Phone: (210) 655-9516 Fax: (210) 655-8189



TO: CH2M HILL, INC.
9311 San Pedro Avenue, Suite 800
San Antonio, TX 78216

ATTENTION: Mr. Mike Uchniat

Project: Comal County Dam Flood Control Project

Date: July 24, 2008 **Our Project No.:** 04.60082131 **Your Project No.:**
Your Report No.:

This transmittal includes Construction Materials Test Reports related to the above referenced construction project. These reports are transmitted for your information and use. The following reports are attached.

Date or Number	Description
Sample No. 18968-18972, Lab. Ref. No. 1-5	Laboratory Test Result(s)

Remarks:

Distribution: CH2M HILL, INC., Mr. Mike Uchniat (1)
Tatro, Mr. Stephen B. Tatro, P.E., (Mix Design Data) (1)
Project File (1)



Fugro Consultants, Inc.

Submitted by:

Karl G. Crenwelge
Karl G. Crenwelge, P.E.

**LABORATORY TEST REPORT
PARTICLE-SIZE ANALYSIS OF SOILS**



FUGRO CONSULTANTS INC.
11009 Osgood
San Antonio, Texas 78233
PH.: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/21/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: Coarse Aggregate 1 1/2" Crushed Limestone
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 1-A, Lab Ref. No. 18968 Doc. No. 04.60082131sa1-ALR18968

Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 13,162.00 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 13,162.00 Units (Metric/English) English

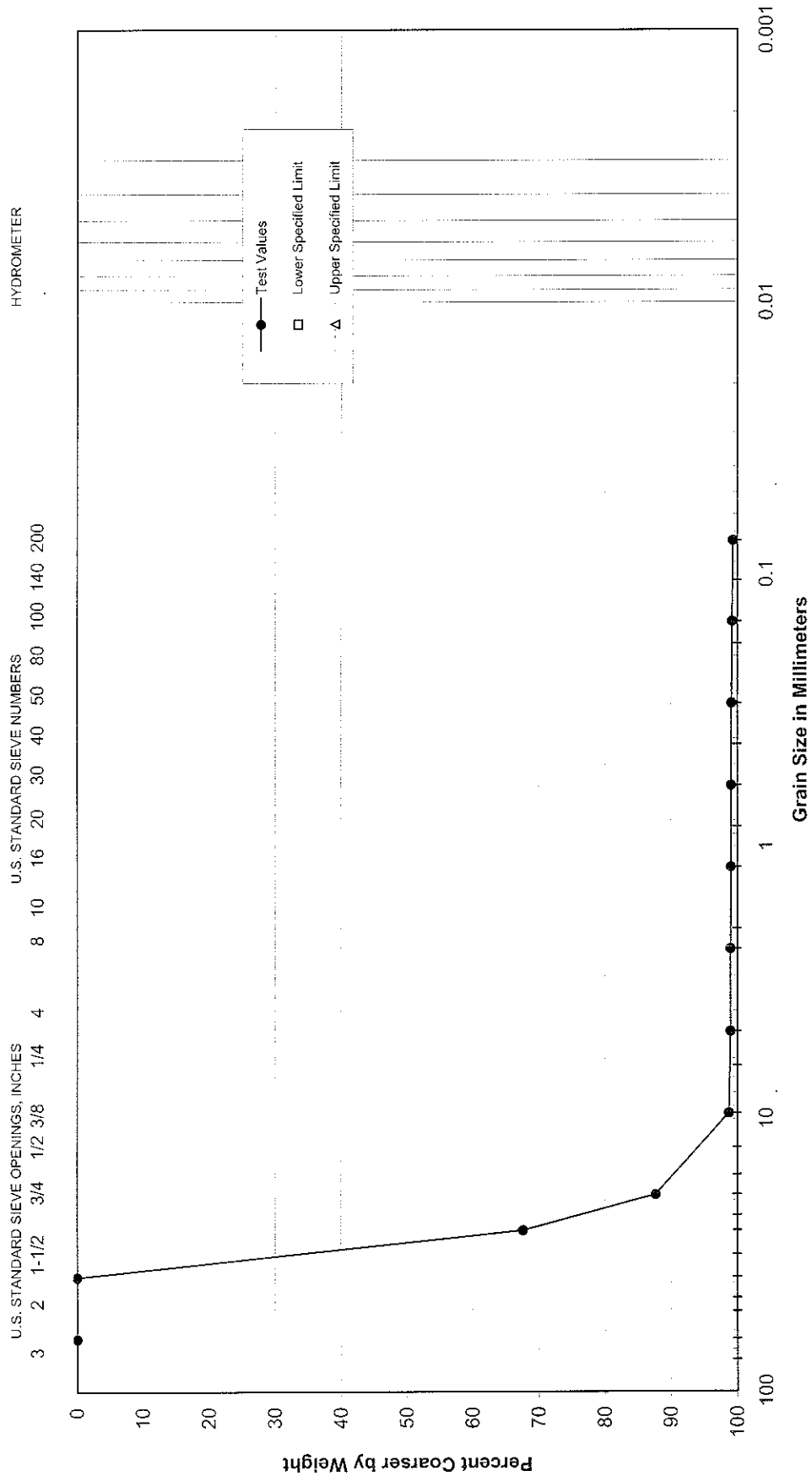
U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification	Comments
3 in.					-	
2-1/2 in.	0.00	0.00	0.0%	100.0%	-	
2 in.					-	
1-3/4 in.					-	
1-1/2 in.	0.00	0.00	0.0%	100.0%	-	
1-1/4 in.					-	
1 in.	8,898.00	8,898.00	67.6%	32.4%	-	
7/8 in.					-	
3/4 in.	2,640.60	11,538.60	87.7%	12.3%	-	
5/8 in.					-	
1/2 in.					-	
3/8 in.	1,454.30	12,992.90	98.7%	1.3%	-	
1/4 in.					-	
No. 4	31.20	13,024.10	99.0%	1.0%	-	
No. 8	4.10	13,028.20	99.0%	1.0%	-	
No. 10					-	
No. 16	5.40	13,033.60	99.0%	1.0%	-	
No. 20					-	
No. 30	5.80	13,039.40	99.1%	0.9%	-	
No. 40					-	
No. 50	7.40	13,046.80	99.1%	0.9%	-	
No. 80					-	
No. 100	9.90	13,056.70	99.2%	0.8%	-	
No. 140					-	
No. 200	13.00	13,069.70	99.3%	0.7%	-	
Plastic Index (PI) _____						
Liquid Limit (LL) _____						
Fines Classification <u>NP</u>						
Group Symbol (Coarse Grained Soils) <u>GP</u>						
ASTM Group Name <u>Poorly-graded gravel</u>						

REMARKS: Custom

Input By.: bib Checked By: Karl G. Crenwelge, P.E. Date: 7/24/2008
 Office Assistant CMET Operations Mgr.

FUGRO CONSULTANTS, INC.

GRAIN SIZE CURVE



LABORATORY TEST REPORT

PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
 11009 Osgood
 San Antonio, Texas 78233
 PH.: (210) 655-9516
 FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/21/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: Coarse Aggregate 1 1/2" Crushed Limestone
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 1-B, Lab Ref. No. 18968 Doc. No. 04.60082131sa1-BLR18968

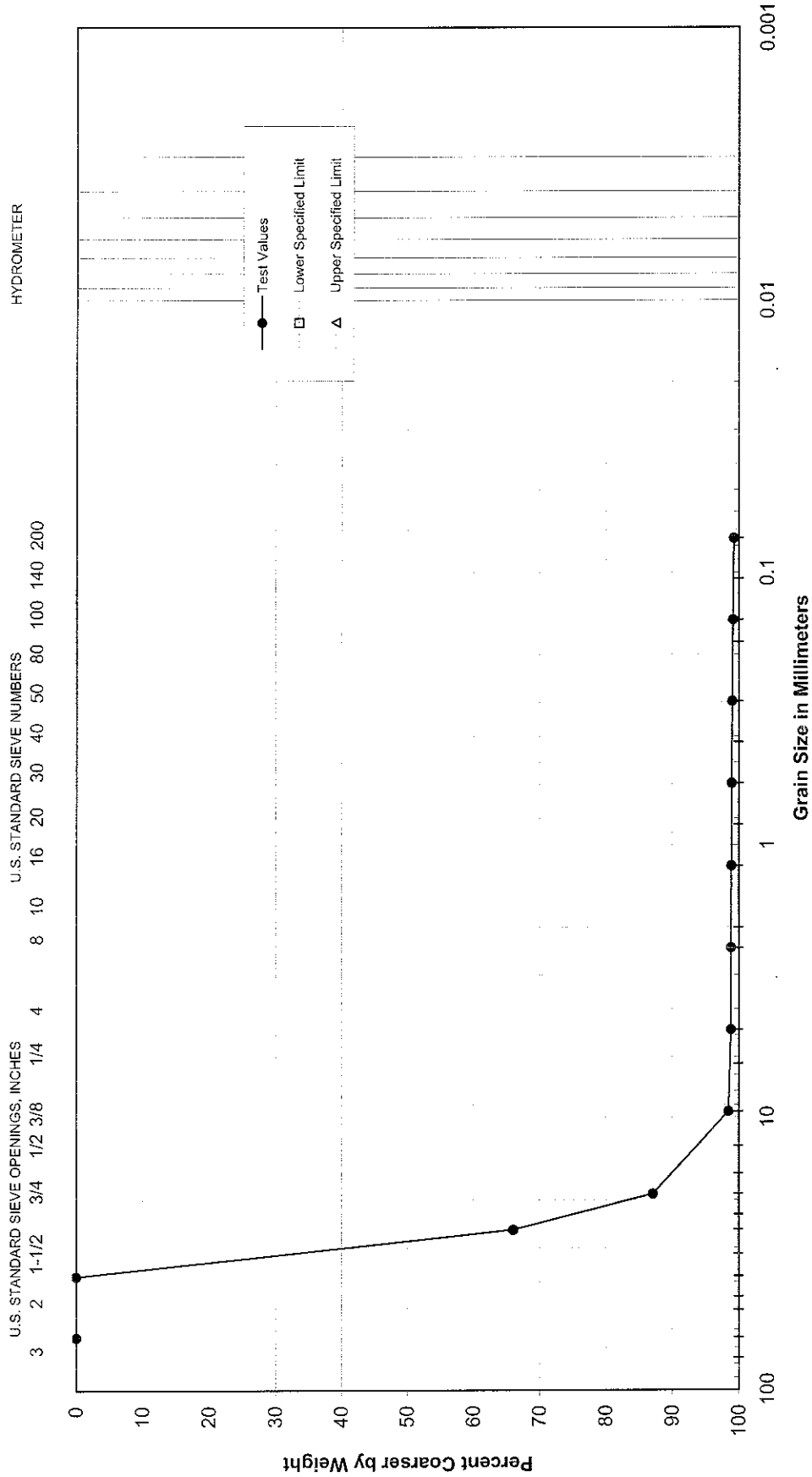
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 12,522.30 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 12,522.30 Units (Metric/English) English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification	Comments
3 in.					-	
2-1/2 in.	0.00	0.00	0.0%	100.0%	-	
2 in.					-	
1-3/4 in.					-	
1-1/2 in.	0.00	0.00	0.0%	100.0%	-	
1-1/4 in.					-	
1 in.	8,267.70	8,267.70	66.0%	34.0%	-	
7/8 in.					-	
3/4 in.	2,640.00	10,907.70	87.1%	12.9%	-	
5/8 in.					-	
1/2 in.					-	
3/8 in.	1,423.20	12,330.90	98.5%	1.5%	-	
1/4 in.					-	
No. 4	44.50	12,375.40	98.8%	1.2%	-	
No. 8	4.50	12,379.90	98.9%	1.1%	-	
No. 10					-	
No. 16	6.40	12,386.30	98.9%	1.1%	-	
No. 20					-	
No. 30	6.80	12,393.10	99.0%	1.0%	-	
No. 40					-	
No. 50	9.20	12,402.30	99.0%	1.0%	-	
No. 80					-	
No. 100	12.30	12,414.60	99.1%	0.9%	-	
No. 140					-	
No. 200	15.30	12,429.90	99.3%	0.7%	-	
Plastic Index (PI)					-	
Liquid Limit (LL)					-	
Fines Classification					-	
Group Symbol (Coarse Grained Soils)					-	
ASTM Group Name					-	

REMARKS: Custom

Input By: bib Checked By: Karl G. Crenwelge, P.E. Date: 7/24/2008
 Office Assistant CMET Operations Mgr.

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	
Job No.: 04.60082131		Date: 7/21/2008		Method: ASTM C136	
I.D. No.: Sample No. 1-B, Lab Ref. No. 18968		Location: Comal County, Texas		Source: Offsite/Cemex	
Project: Comal County Dam Flood Control Project					
Material: Coarse Aggregate 1 1/2" Crushed Limestone					

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11009 Cogwood
San Antonio, Texas 78233
PH.: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/21/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: Man Sand
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 2-A, Lab Ref. No. 18969 Doc. No. 04.60082131sa2-ALR18969

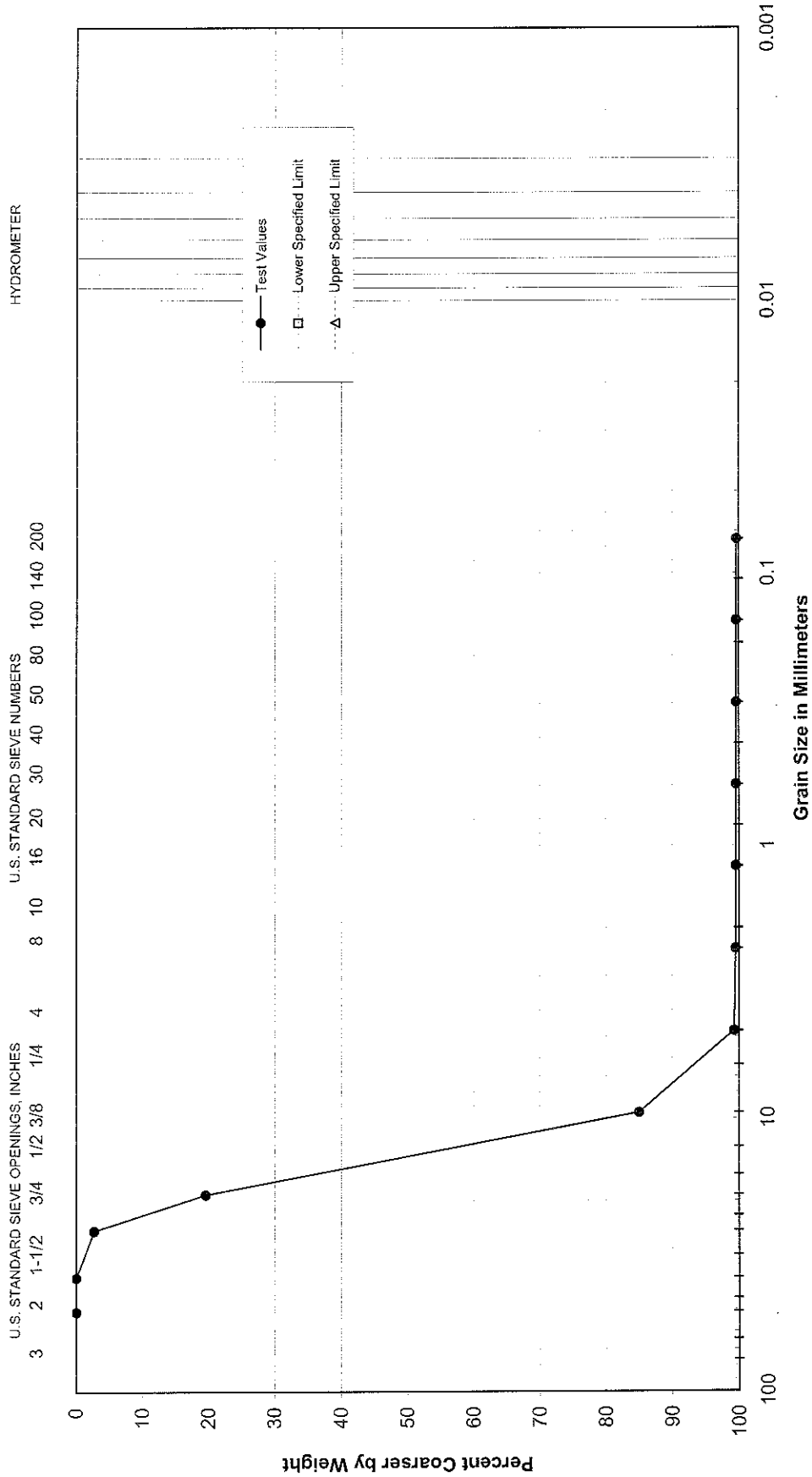
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 5,668.90 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 5,668.90 Units (Metric/English) English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification	Comments
3 in.					-	
2-1/2 in.	0.00	0.00	0.0%	100.0%	-	
2 in.					-	
1-3/4 in.					-	
1-1/2 in.	0.00	0.00	0.0%	100.0%	-	
1-1/4 in.					-	
1 in.	0.00	0.00	0.0%	100.0%	-	
7/8 in.					-	
3/4 in.	0.00	0.00	0.0%	100.0%	-	
5/8 in.					-	
1/2 in.					-	
3/8 in.	0.00	0.00	0.0%	100.0%	-	
1/4 in.					-	
No. 4	11.60	11.60	0.2%	99.8%	-	
No. 8	614.20	625.80	11.0%	89.0%	-	
No. 10					-	
No. 16	1,793.90	2,419.70	42.7%	57.3%	-	
No. 20					-	
No. 30	1,185.60	3,605.30	63.6%	36.4%	-	
No. 40					-	
No. 50	874.20	4,479.50	79.0%	21.0%	-	
No. 80					-	
No. 100	575.20	5,054.70	89.2%	10.8%	-	
No. 140					-	
No. 200	344.20	5,398.90	95.2%	4.8%	-	
Plastic Index (PI) _____					-	
Liquid Limit (LL) _____					-	
Fines Classification <u>NP</u>						
Group Symbol (Coarse Grained Soils) <u>SW</u>						
ASTM Group Name <u>Well-graded sand</u>						

REMARKS: Custom

Input By: bjb Office Assistant Checked By: Karl G. Crenwelge, P.E. CMET Operations Mgr. Date: 7/24/2008

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	

Job No.: 04-60082131 Date: 7/21/2008 Method: ASTM C136 I.D. No.: Sample No. 3-A, Lab Ref. No. 18970
 Project: Comal County Dam Flood Control Project Location: Comal County, Texas
 Material: Man Sand Source: Offsite/Cemex

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11009 Csgood
San Antonio, Texas 78233
PH.: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/21/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: Man Sand
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 2-B, Lab Ref. No. 18969 Doc. No. 04.60082131sa2-BLR18969

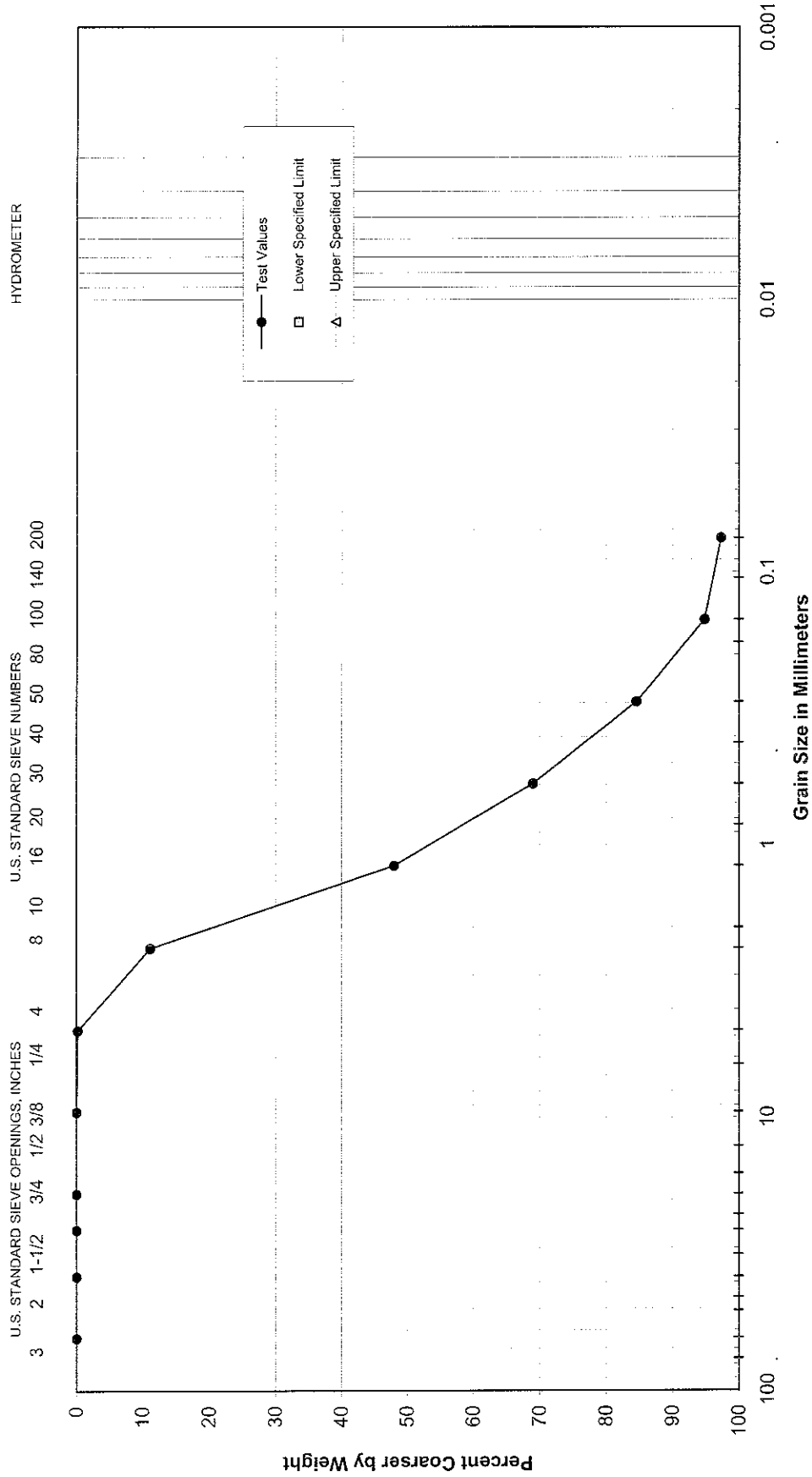
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 6,077.30 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 6,077.30 Units (Metric/English) English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification			Comments
3 in.						-		
2-1/2 in.	0.00	0.00	0.0%	100.0%		-		
2 in.						-		
1-3/4 in.						-		
1-1/2 in.	0.00	0.00	0.0%	100.0%		-		
1-1/4 in.						-		
1 in.	0.00	0.00	0.0%	100.0%		-		
7/8 in.						-		
3/4 in.	0.00	0.00	0.0%	100.0%		-		
5/8 in.						-		
1/2 in.						-		
3/8 in.	0.00	0.00	0.0%	100.0%		-		
1/4 in.						-		
No. 4	12.10	12.10	0.2%	99.8%		-		
No. 8	666.90	679.00	11.2%	88.8%		-		
No. 10						-		
No. 16	2,237.60	2,916.60	48.0%	52.0%		-		
No. 20						-		
No. 30	1,275.20	4,191.80	69.0%	31.0%		-		
No. 40						-		
No. 50	950.30	5,142.10	84.6%	15.4%		-		
No. 80						-		
No. 100	621.40	5,763.50	94.8%	5.2%		-		
No. 140						-		
No. 200	149.70	5,913.20	97.3%	2.7%		-		
Plastic Index (PI) _____						-		
Liquid Limit (LL) _____						-		
Fines Classification _____ NP						-		
Group Symbol (Coarse Grained Soils) _____ SW						-		
ASTM Group Name _____ Well-graded sand						-		

REMARKS: Custom

Input By: bjb Office Assistant Checked By: Karl G. Crenwelge, P.E. CMET Operations Mgr. Date: 7/24/2008

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	

Job No.: 04-60082131 Date: 7/21/2008 Method: ASTM C136 I.D. No.: Sample No. 2-B, Lab Ref. No. 18969
 Project: Comal County Dam Flood Control Project Location: Comal County, Texas
 Material: Man Sand Source: Offsite/Cemex

**LABORATORY
TEST REPORT**



FUGRO CONSULTANTS, Inc.
11009 Osgood
San Antonio, Texas 78233
PH.: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 **Contract/Project/Line Item :** Comal County Dam Flood Control Project
Date: 7/23/08 **Location:** Comal County, TX
Client: CH2M Hill, Inc. **Client Lab ID:** N/A
Made On: Tan Sand – Man Sand **Source:** N/A
Identification: Project Sample No. 2, Lab. Ref. No. 18969

Atterberg Limit

(Reference: ASTM D4318-05)

Sample No. 2

LL: -

PL: -

PI: Non-Plastic

Distributions:

CH3M Hill, Inc. Mr. Mike Uchniat (1)
Project File

Fugro Consultants, Inc.
Submitted by: _____

Karl G. Crenwelge, P.E.

LABORATORY TEST REPORT

PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
 11009 Osgood
 San Antonio, Texas 78233
 PH.: (210) 655-9516
 FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/21/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: 1" Limestone
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 3-A, Lab Ref. No. 18970 Doc. No. 04.60082131sa3-ALR18970

Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 8,398.50 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 8,398.50 Units (Metric/English): English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification	Comments
3 in.					-	
2-1/2 in.					-	
2 in.	0.00	0.00	0.0%	100.0%	-	
1-3/4 in.					-	
1-1/2 in.	0.00	0.00	0.0%	100.0%	-	
1-1/4 in.					-	
1 in.	227.10	227.10	2.7%	97.3%	-	
7/8 in.					-	
3/4 in.	1,410.50	1,637.60	19.5%	80.5%	-	
5/8 in.					-	
1/2 in.					-	
3/8 in.	5,501.30	7,138.90	85.0%	15.0%	-	
1/4 in.					-	
No. 4	1,197.90	8,336.80	99.3%	0.7%	-	
No. 8	20.50	8,357.30	99.5%	0.5%	-	
No. 10					-	
No. 16	4.10	8,361.40	99.6%	0.4%	-	
No. 20					-	
No. 30	0.90	8,362.30	99.6%	0.4%	-	
No. 40					-	
No. 50	1.10	8,363.40	99.6%	0.4%	-	
No. 80					-	
No. 100	1.70	8,365.10	99.6%	0.4%	-	
No. 140					-	
No. 200	3.70	8,368.80	99.6%	0.4%	-	
Plastic Index (PI) _____						
Liquid Limit (LL) _____						
Fines Classification <u>NP</u>						
Group Symbol (Coarse Grained Soils) <u>GP</u>						
ASTM Group Name <u>Poorly-graded gravel</u>						

REMARKS: Custom

Input By.: bjb Checked By: Karl G. Crenwelge, P.E. Date: 7/24/2008
 Office Assistant CMET Operations Mgr.

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11009 Osgood
San Antonio, Texas 78233
PH: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/21/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: 1" Limestone
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 3-B, Lab Ref. No. 18970 Doc. No. 04.60082131sa3-BLR18970

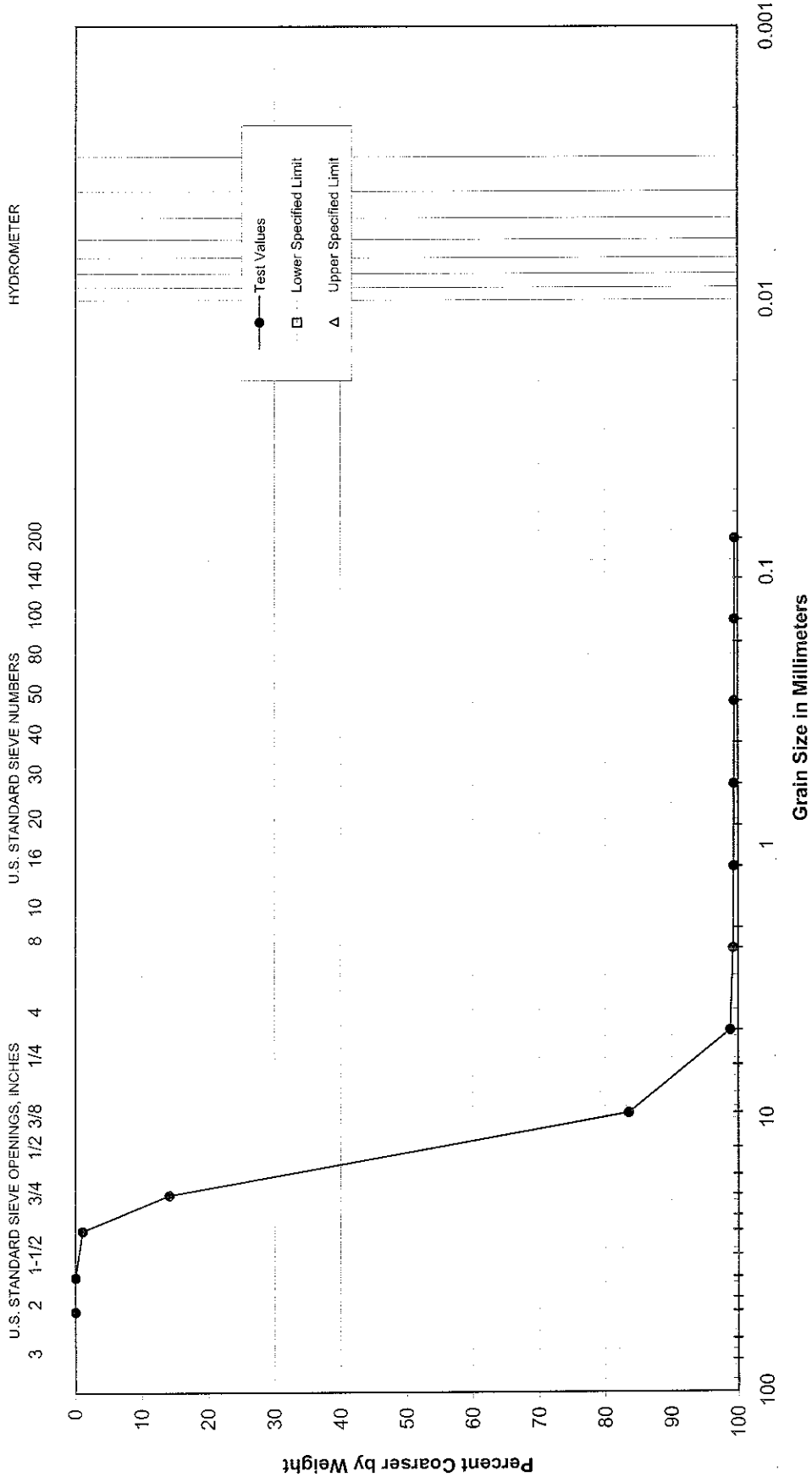
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 7,822.40 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 7,822.40 Units (Metric/English): English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification			Comments
3 in.					-			
2-1/2 in.					-			
2 in.	0.00	0.00	0.0%	100.0%	-			
1-3/4 in.					-			
1-1/2 in.	0.00	0.00	0.0%	100.0%	-			
1-1/4 in.					-			
1 in.	84.00	84.00	1.1%	98.9%	-			
7/8 in.					-			
3/4 in.	1,021.20	1,105.20	14.1%	85.9%	-			
5/8 in.					-			
1/2 in.					-			
3/8 in.	5,430.50	6,535.70	83.6%	16.4%	-			
1/4 in.					-			
No. 4	1,195.00	7,730.70	98.8%	1.2%	-			
No. 8	33.60	7,764.30	99.3%	0.7%	-			
No. 10					-			
No. 16	9.00	7,773.30	99.4%	0.6%	-			
No. 20					-			
No. 30	3.20	7,776.50	99.4%	0.6%	-			
No. 40					-			
No. 50	2.00	7,778.50	99.4%	0.6%	-			
No. 80					-			
No. 100	2.20	7,780.70	99.5%	0.5%	-			
No. 140					-			
No. 200	4.90	7,785.60	99.5%	0.5%	-			
Plastic Index (PI) _____								
Liquid Limit (LL) _____								
Fines Classification _____ NP								
Group Symbol (Coarse Grained Soils) _____ GP								
ASTM Group Name _____ Poorly-graded gravel								

REMARKS: Custom

Input By.: bjb Checked By: Karl G. Crenwelge, P.E. Date: 7/24/2008
 Office Assistant CMET Operations Mgr.

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	
Job No.: 04.60082131		Date: 7/21/2008		Method: ASTM C136	
I.D. No.: Sample No. 3-B, Lab Ref. No. 18970		Location: Comal County, Texas		Source: Offsite/Cemex	
Project: Comal County Dam Flood Control Project		Material: 1" Limestone			

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11009 Osgood
San Antonio, Texas 78233
PH.: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/23/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: 1.5" Base A-2
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 4-A, Lab Ref. No. 18971 Doc. No. 04.60082131sa4-ALR18971

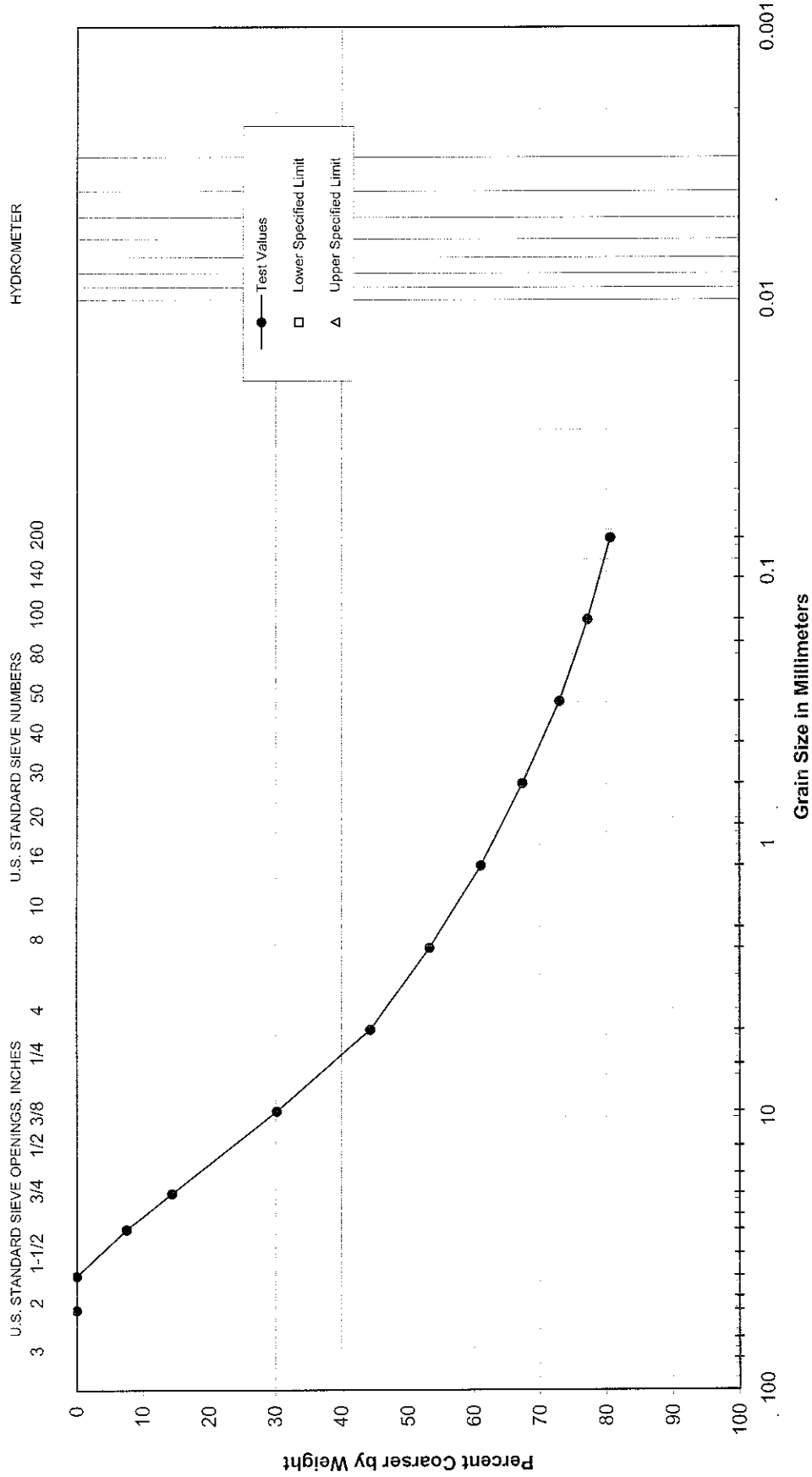
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 6,006.40 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 6,006.40 Units (Metric/English): English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification	Comments
3 in.					-	
2-1/2 in.					-	
2 in.	0.00	0.00	0.0%	100.0%	-	
1-3/4 in.					-	
1-1/2 in.	0.00	0.00	0.0%	100.0%	-	
1-1/4 in.					-	
1 in.	456.00	456.00	7.6%	92.4%	-	
7/8 in.					-	
3/4 in.	409.40	865.40	14.4%	85.6%	-	
5/8 in.					-	
1/2 in.					-	
3/8 in.	947.50	1,812.90	30.2%	69.8%	-	
1/4 in.					-	
No. 4	846.70	2,659.60	44.3%	55.7%	-	
No. 8	540.50	3,200.10	53.3%	46.7%	-	
No. 10					-	
No. 16	466.30	3,666.40	61.0%	39.0%	-	
No. 20					-	
No. 30	377.90	4,044.30	67.3%	32.7%	-	
No. 40					-	
No. 50	338.20	4,382.50	73.0%	27.0%	-	
No. 80					-	
No. 100	254.00	4,636.50	77.2%	22.8%	-	
No. 140					-	
No. 200	206.30	4,842.80	80.6%	19.4%	-	
Plastic Index (PI)			1.0		-	
Liquid Limit (LL)			14.0		-	
Fines Classification			ML		-	
Group Symbol (Coarse Grained Soils)			GM		-	
ASTM Group Name			Silty gravel with sand		-	

REMARKS: Custom

Input By.: bjb Office Assistant Checked By: Karl G. Crenwelge, P.E. CMET Operations Mgr. Date: 7/24/2008

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	

Job No.: 04-60082131 Date: 7/23/2008 Method: ASTM C136 I.D. No.: Sample No. 4-A, Lab Ref. No. 18971

Project: Comal County Dam Flood Control Project Location: Comal County, Texas

Material: 1.5" Base A-2 Source: Offsite/Cemex

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11069 Osgood
San Antonio, Texas 78233
PH: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/23/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: 1.5" Base A-2
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 4-B, Lab Ref. No. 18971 Doc. No. 04.60082131sa4-BLR18971

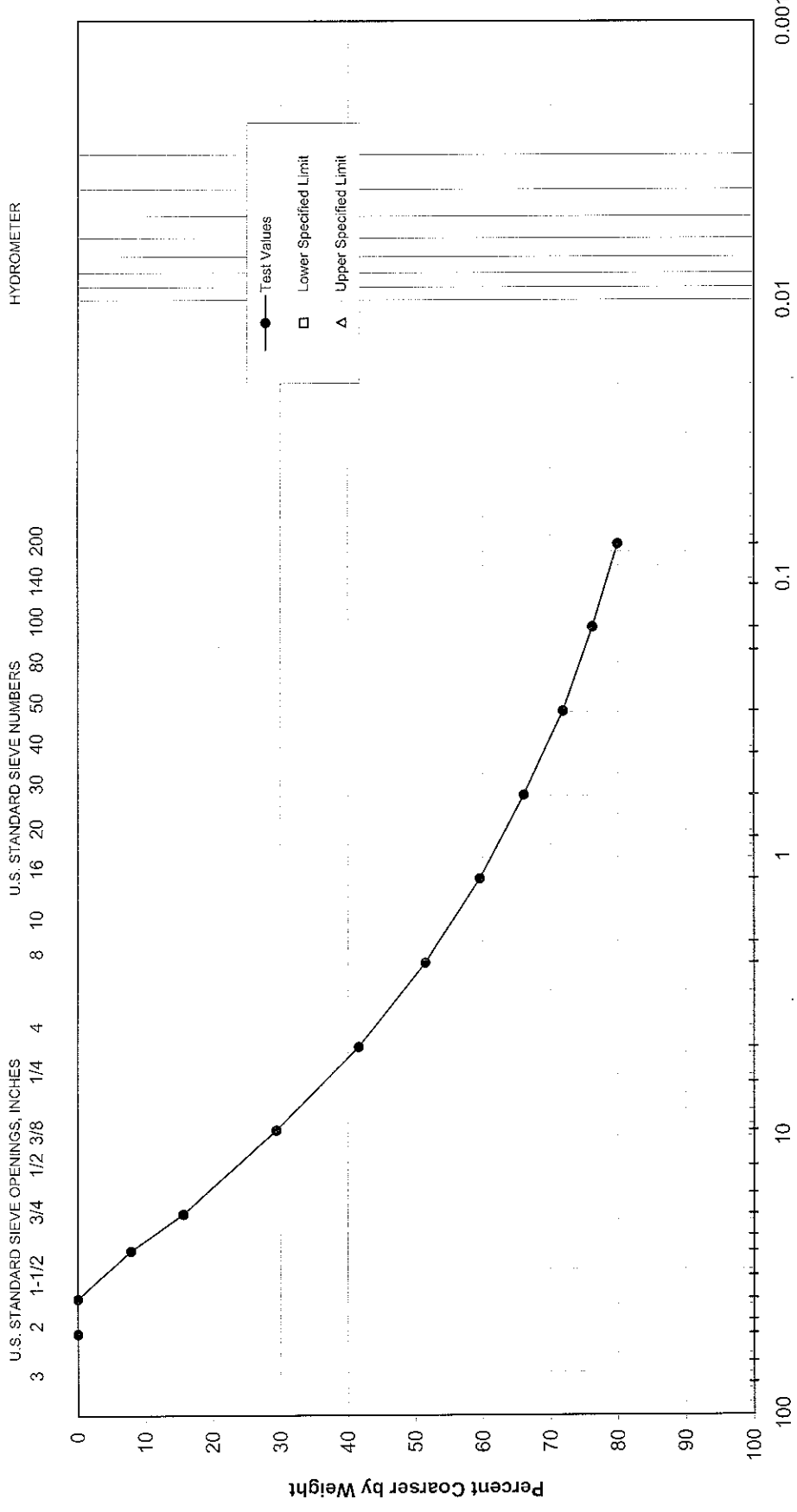
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 6,041.50 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 6,041.50 Units (Metric/English): English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification			Comments
3 in.					-			
2-1/2 in.					-			
2 in.	0.00	0.00	0.0%	100.0%	-			
1-3/4 in.					-			
1-1/2 in.	0.00	0.00	0.0%	100.0%	-			
1-1/4 in.					-			
1 in.	476.60	476.60	7.9%	92.1%	-			
7/8 in.					-			
3/4 in.	467.20	943.80	15.6%	84.4%	-			
5/8 in.					-			
1/2 in.					-			
3/8 in.	833.70	1,777.50	29.4%	70.6%	-			
1/4 in.					-			
No. 4	738.40	2,515.90	41.6%	58.4%	-			
No. 8	595.60	3,111.50	51.5%	48.5%	-			
No. 10					-			
No. 16	488.20	3,599.70	59.6%	40.4%	-			
No. 20					-			
No. 30	390.90	3,990.60	66.1%	33.9%	-			
No. 40					-			
No. 50	349.20	4,339.80	71.8%	28.2%	-			
No. 80					-			
No. 100	265.60	4,605.40	76.2%	23.8%	-			
No. 140					-			
No. 200	225.60	4,831.00	80.0%	20.0%	-			
Plastic Index (PI)			1.0		-			
Liquid Limit (LL)			14.0		-			
Fines Classification			ML		-			
Group Symbol (Coarse Grained Soils)			GM		-			
ASTM Group Name			Silty gravel with sand		-			

REMARKS: Custom

Input By.: bjb Checked By: Karl G. Crenwelge, P.E. Date: 7/24/2008
 Office Assistant CMET Operations Mgr.

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	

Job No.: 04:60082131 Date: 7/23/2008 Method: ASTM C136 I.D. No.: Sample No. 4-B, Lab Ref. No. 18971
 Project: Comal County Dam Flood Control Project Location: Comal County, Texas
 Material: 1.5" Base A-2 Source: Offsite/Cemex

LABORATORY TEST REPORT

ATTERBERG LIMITS



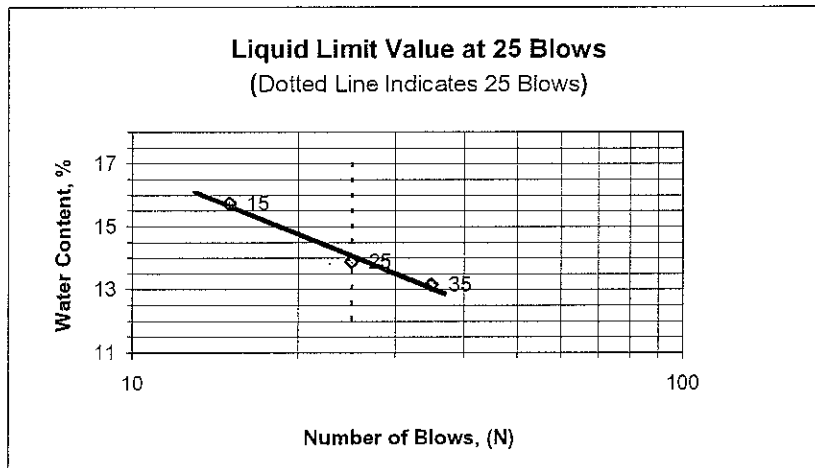
FUGRO CONSULTANTS INC.
 11009 Osgood
 San Antonio, Texas 78233
 PH.: (210) 655-9516
 FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/23/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc. Contractor: N/A

Visual Classification: Tan Crushed Limestone A-2 Fines Classification: #N/A
 Sample Source: Onsite Tested By: Joseph Enriquez
 Sample Identification: Sample No. 4, Lab Ref. No. 18971 Laboratory Technician
 Received Date: 7/17/2008 Test Method: ASTM D-4318 Method A

MULTIPOINT LIQUID LIMIT DETERMINATION

Can No.	Ft	UP	XO			
Wet Wt. + Tare (gm)	143.87	174.19	168.45			
Dry Wt. + Tare (gm)	141.16	172.28	165.42			
Tare Wt. (gm)	123.90	158.51	142.33			
Wt. of Dry Sample	17.26	13.77	23.09			
Wt. of Water	2.71	1.91	3.03			
% Moisture (W _N)	15.7	13.9	13.1			
No. of Blows (N)	15	25	35			
Liquid Limit (LL)*	15	14	14			



ATTERBERG LIMIT	
<u>Sample</u>	<u>Spec.</u>
LL	14
PL	13
PI	1

PI = LL - PL

***Calculated Liquid Limit**
 $LL = W_N * (N/25)^{0.121}$
 Where:
 W_N = Moisture Content at N Blows
 N = Number of Blows

PLASTIC LIMIT DETERMINATION

Can No.	PG	FN
Wet Wt. + Tare (gm)	168.22	177.26
Dry Wt. + Tare (gm)	167.14	176.31
Tare Wt. (gm)	159.48	168.87
Wt. of Dry Sample	7.66	7.44
Wt. of Water	1.08	0.95
Plastic Limit (PL)	14	13

REMARKS: _____
 Input By./Checked By.: bjb Check By: Karl G. Crenwelge, P.E. Date: 7/24/2008
 Office Assistant CMET Operations Mgr.

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11009 Osgood
San Antonio, Texas 78233
PH.: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/22/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: 3/4" to Dust
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 5-A, Lab Ref. No. 18972 Doc. No. 04.60082131sa5-ALR18972

Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 14,233.10 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 14,233.10 Units (Metric/English): English

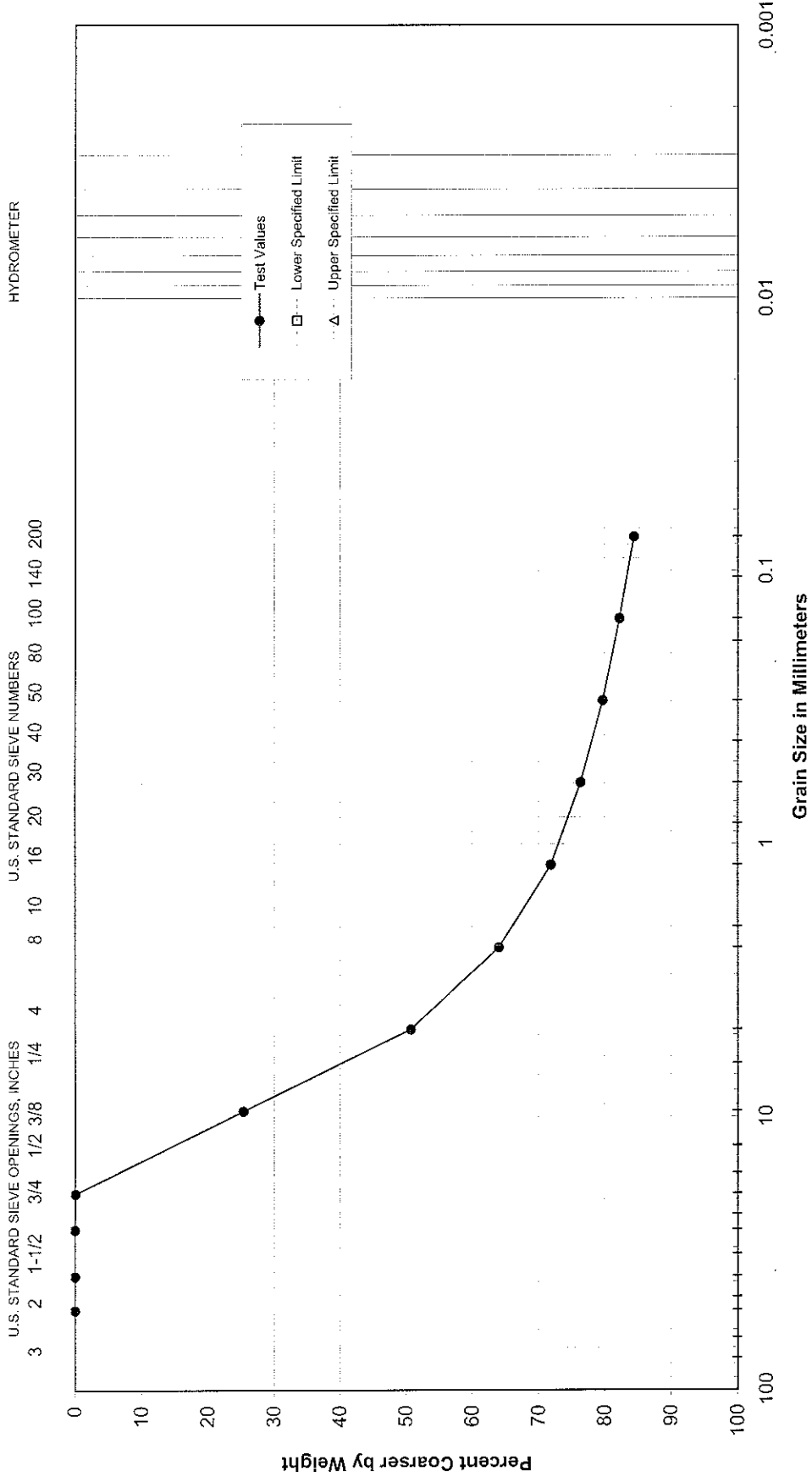
U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification		Comments
3 in.					-		
2-1/2 in.					-		
2 in.	0.00	0.00	0.0%	100.0%	-		
1-3/4 in.					-		
1-1/2 in.	0.00	0.00	0.0%	100.0%	-		
1-1/4 in.					-		
1 in.	0.00	0.00	0.0%	100.0%	-		
7/8 in.					-		
3/4 in.	9.10	9.10	0.1%	99.9%	-		
5/8 in.					-		
1/2 in.					-		
3/8 in.	3,606.70	3,615.80	25.4%	74.6%	-		
1/4 in.					-		
No. 4	3,607.20	7,223.00	50.7%	49.3%	-		
No. 8	1,897.10	9,120.10	64.1%	35.9%	-		
No. 10					-		
No. 16	1,108.60	10,228.70	71.9%	28.1%	-		
No. 20					-		
No. 30	639.90	10,868.60	76.4%	23.6%	-		
No. 40					-		
No. 50	477.70	11,346.30	79.7%	20.3%	-		
No. 80					-		
No. 100	357.00	11,703.30	82.2%	17.8%	-		
No. 140					-		
No. 200	314.70	12,018.00	84.4%	15.6%	-		
Plastic Index (PI)			<u>2.0</u>		-		
Liquid Limit (LL)			<u>16.0</u>		-		
Fines Classification			<u>ML</u>		-		
Group Symbol (Coarse Grained Soils)			<u>GM</u>		-		
ASTM Group Name			<u>Silty gravel with sand</u>		-		

REMARKS: Custom

Input By.: bjb Office Assistant Checked By: Karl G. Crenwelge, P.E. CMET Operations Mgr. Date: 7/24/2008

THE ABOVE TEST RESULTS APPLY ONLY TO THE ITEMS TESTED.
THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE APPROVAL OF FUGRO CONSULTANTS INC.

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	

Job No.: 04:60082131 Date: 7/22/2008 Method: ASTM C136 I.D. No.: Sample No. 5-A, Lab Ref. No. 18972

Project: Comal County Dam Flood Control Project Location: Comal County, Texas

Material: 3/4" to Dust Source: Offsite/Cemex

LABORATORY TEST REPORT PARTICLE-SIZE ANALYSIS OF SOILS



FUGRO CONSULTANTS INC.
11009 Osgood
San Antonio, Texas 78233
PH: (210) 655-9516
FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/22/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc Contractor: N/A

Visual Classification: 3/4" to Dust
 Sample Source: Offsite/Cemex Received Date: 7/17/2008
 Sample Identification: Sample No. 5-B, Lab Ref. No. 18972 Doc. No. 04.60082131sa5-BLR18972

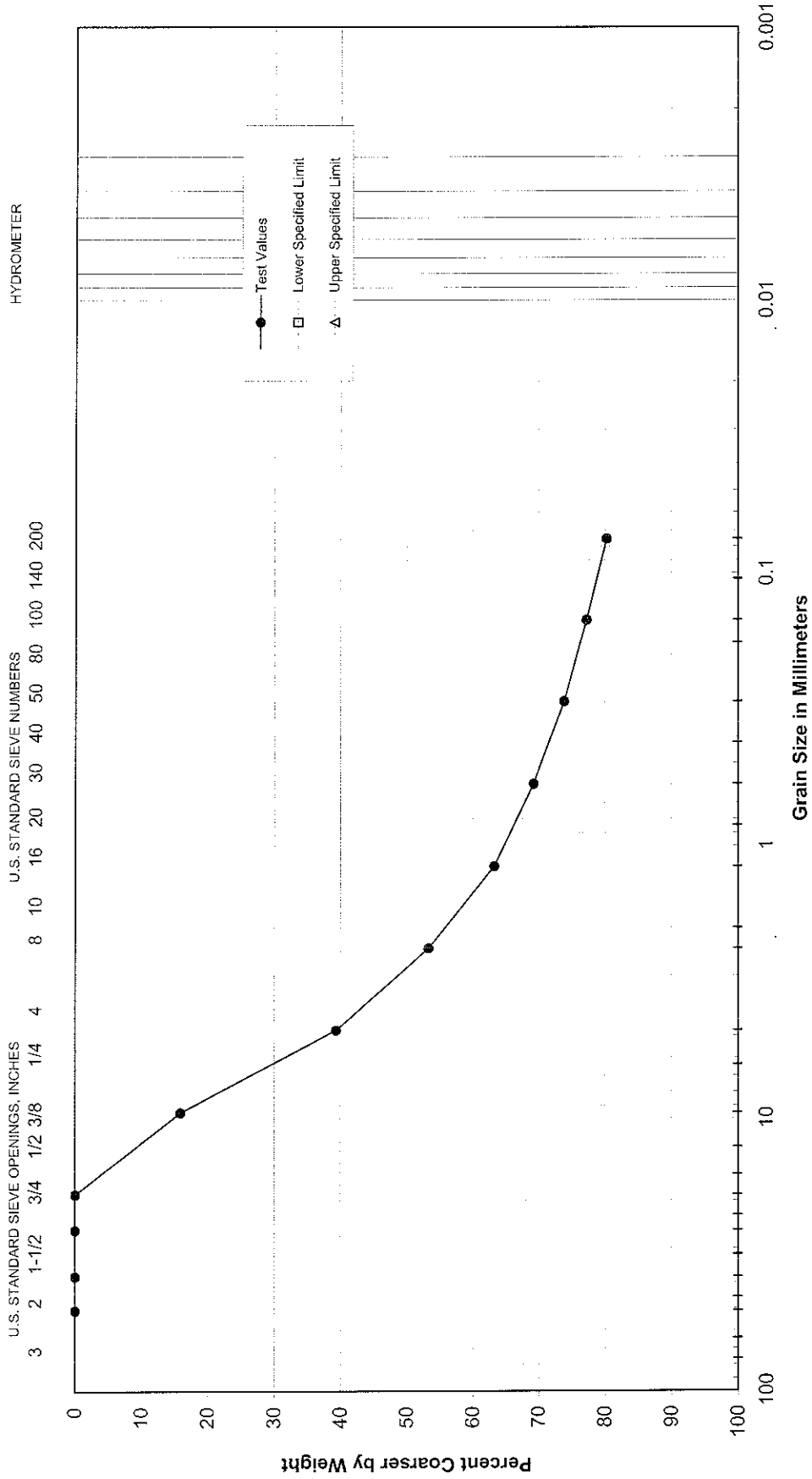
Tare Weight (gm): 0.00 Test Method: ASTM C136
 Dry Soil Mass + Tare (gm): 6,073.40 Prep. Method: Wet Prep
 Dry Soil After Wash + Tare: _____ Specification: Custom
 Dry Mass Before Test (gm): 6,073.40 Units (Metric/English): English

U.S. Standard Sieve No.	Weight Retained Individual, (gm)	Weight Retained Cumulative, (gm)	% Retained Cumulative	% Finer Cumulative	Project Specification	Comments
3 in.					-	
2-1/2 in.					-	
2 in.	0.00	0.00	0.0%	100.0%	-	
1-3/4 in.					-	
1-1/2 in.	0.00	0.00	0.0%	100.0%	-	
1-1/4 in.					-	
1 in.	0.00	0.00	0.0%	100.0%	-	
7/8 in.					-	
3/4 in.	0.00	0.00	0.0%	100.0%	-	
5/8 in.					-	
1/2 in.					-	
3/8 in.	963.50	963.50	15.9%	84.1%	-	
1/4 in.					-	
No. 4	1,427.40	2,390.90	39.4%	60.6%	-	
No. 8	848.00	3,238.90	53.3%	46.7%	-	
No. 10					-	
No. 16	602.30	3,841.20	63.2%	36.8%	-	
No. 20					-	
No. 30	364.90	4,206.10	69.3%	30.7%	-	
No. 40					-	
No. 50	280.00	4,486.10	73.9%	26.1%	-	
No. 80					-	
No. 100	207.30	4,693.40	77.3%	22.7%	-	
No. 140					-	
No. 200	181.20	4,874.60	80.3%	19.7%	-	
Plastic Index (PI)			2.0		-	
Liquid Limit (LL)			16.0		-	
Fines Classification			ML		-	
Group Symbol (Coarse Grained Soils)			SM		-	
ASTM Group Name			Silty sand with gravel		-	

REMARKS: Custom

Input By.: bjb Office Assistant Checked By: Karl G. Crenwelge, P.E. CMET Operations Mgr. Date: 7/24/2008

GRAIN SIZE CURVE



GRAVEL		SAND		SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine	

Job No.: 04.60082131 Date: 7/22/2008 Method: ASTM C136 I.D. No.: Sample No. 5-B, Lab Ref. No. 18972

Project: Comal County Dam Flood Control Project Location: Comal County, Texas

Material: 3/4" to Dust Source: Offsite/Cemex

LABORATORY TEST REPORT

ATTERBERG LIMITS



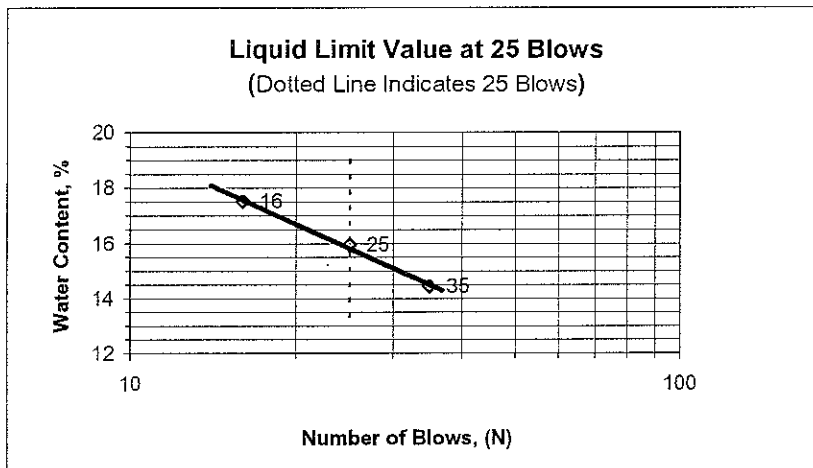
FUGRO CONSULTANTS INC.
 11009 Osgood
 San Antonio, Texas 78233
 PH.: (210) 655-9516
 FAX: (210) 655-9519

Job No.: 04.60082131 Project: Comal County Dam Flood Control Project
 Test Date: 7/23/2008 Location: Comal County, Texas
 Client: CH2M Hill, Inc. Contractor: N/A

Visual Classification: Tan Crushed Limestone A-2 Fines Classification: #N/A
 Sample Source: Onsite Tested By: Jesus Mejia
 Sample Identification: Sample No. 5, Lab Ref. No. 18972 Laboratory Technician
 Received Date: 7/17/2008 Test Method: ASTM D-4318 Method A

MULTIPOINT LIQUID LIMIT DETERMINATION

Can No.	XXX	O1	WT			
Wet Wt. + Tare (gm)	180.86	98.29	178.71			
Dry Wt. + Tare (gm)	177.36	95.59	176.25			
Tare Wt. (gm)	157.36	78.62	159.18			
Wt. of Dry Sample	20.00	16.97	17.07			
Wt. of Water	3.50	2.70	2.46			
% Moisture (W _N)	17.5	15.9	14.4			
No. of Blows (N)	16	25	35			
Liquid Limit (LL)*	17	16	15			



ATTERBERG LIMIT		
Sample	Spec.	
LL	16	_____
PL	14	_____
PI	2	_____
PI = LL - PL		

*Calculated Liquid Limit
 $LL = W_N * (N/25)^{0.121}$

Where:
 W_N = Moisture Content at N Blows
 N = Number of Blows

PLASTIC LIMIT DETERMINATION

Can No.	STEPH	AX
Wet Wt. + Tare (gm)	90.93	185.94
Dry Wt. + Tare (gm)	89.98	184.56
Tare Wt. (gm)	83.16	174.70
Wt. of Dry Sample	6.82	9.86
Wt. of Water	0.95	1.38
Plastic Limit (PL)	14	14

REMARKS: _____
 Input By./Checked By.: bjb Office Assistant Check By: Karl G. Crenwelge, P.E. CMET Operations Mgr. Date: 7/24/2008

Exhibit 2

Mix Design Summary Sheets and Material Data Sheets

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 1, 200-0-Grad1**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	22.0	22.0	5.179	0.192	837	497	2.59	1.6
3/4" to No 4	22.0	22.0	5.179	0.192	837	497	2.59	1.6
Sand	25.0	25.8	5.884	0.218	984	584	2.68	2.5
3/4" to dust	31.0	30.2	7.307	0.271	1149	682	2.52	3.1
Cement			1.018	0.038	200	119	3.15	--
Pozzolan			0.000	0.000	0	0	2.68	--
Water			2.019	0.075	126	75	1	--
Air (1.5%)			0.405	0.015	--	--	--	--
Totals:	100	100	26.991	1.000	4133	2452		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.63	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.63	Design/Measured:	153.1 150.0
WATER CONTENT	% by wt. above SSD of total :	3.05%	FINES, % by Volume:	5.8
CEMENT:	% by wt. above SSD of dry materials:	3.14%	SAND/ AGG., % by Volume:	44
POZZOLAN:	lb/yd ³ , equiv. cement:	200.0	PASTE CONTENT, % by Volume	17.8
	%, replaced by volume:	0%	PASTE MORTAR RATIO, % by Volume	34.9
			TEMP. AIR/PLASTIC CONCRETE:	94/92°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 19-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (40% Secant Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	16/24	1.6	149.8	1055 (1.47) [235]	2030 (2.60) [436]	2270 (2.43) [516]	2375 (2.84) [525]	2595 (3.13) [571]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 2, 300-0-Grad1**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	22.0	22.0	4.944	0.183	799	474	2.59	1.6
3/4" to No 4	22.0	22.0	4.944	0.183	799	474	2.59	1.6
Sand	25.0	25.8	5.615	0.208	939	557	2.68	2.5
3/4" to dust	31.0	30.2	6.976	0.258	1097	651	2.52	3.1
Cement			1.526	0.057	300	178	3.15	--
Pozzolan			0.000	0.000	0	0	2.68	--
Water			2.452	0.091	153	91	1	--
Air (2.0%)			0.54	0.020	--	--	--	--
Totals:	100	100	26.997	1.000	4087	2425		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.51	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.51	Design/Measured:	151.4 149.6
WATER CONTENT	% by wt. above SSD of total :	3.74%	FINES, % by Volume:	5.8
	% by wt. above SSD of dry materials:	3.89%	SAND/ AGG., % by Volume:	44
CEMENT:	lb/yd ³ , equiv. cement:	300.0	PASTE CONTENT, % by Volume	21.6
POZZOLAN:	%, replaced by volume:	0%	PASTE MORTAR RATIO, % by Volume	40.4
			TEMP. AIR/PLASTIC CONCRETE:	80/81°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 20-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	18/24	2.2	150.7	2418 (3.44) [395]	3730 (4.69) [708]	4093 (5.38) [919]	4403 (5.01) [875]	4585 (4.71) [875]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 3, 150-0-Grad1**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	22.0	22.0	5.160	0.191	834	495	2.59	1.6
3/4" to No 4	22.0	22.0	5.160	0.191	834	495	2.59	1.6
Sand	25.0	25.8	5.860	0.217	980	581	2.68	2.5
3/4" to dust	31.0	30.2	7.281	0.270	1145	679	2.52	3.1
Cement			0.763	0.028	150	89	3.15	--
Pozzolan			0.000	0.000	0	0	2.68	--
Water			2.236	0.083	139.5	83	1	--
Air (2.0%)			0.540	0.020	--	--	--	--
Totals:	100	100	27.001	1.000	4083	2422		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.93	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.93	Design/Measured:	151.2 148.0
WATER CONTENT	% by wt. above SSD of total :	3.42%	FINES, % by Volume:	5.8
CEMENT:	% by wt. above SSD of dry materials:	3.54%	SAND/ AGG., % by Volume:	44.0
POZZOLAN:	lb/yd ³ , equiv. cement:	150.0	PASTE CONTENT, % by Volume	18.2
	%, replaced by volume:	0%	PASTE MORTAR RATIO, % by Volume	35.4
			TEMP. AIR/PLASTIC CONCRETE:	78/88°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 20-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	40/54	2.5	150.7	805 (0.95) [~]	1225 (1.88) [~]	1485 (1.95) [~]	1670 (2.17) [~]	~ (~) [~]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 4, 300-50-Grad1**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	22.0	22.0	4.901	0.182	792	470	2.59	1.6
3/4" to No 4	22.0	22.0	4.901	0.182	792	470	2.59	1.6
Sand	25.0	25.8	5.567	0.206	931	552	2.68	2.5
3/4" to dust	31.0	30.2	6.913	0.256	1087	645	2.52	3.1
Cement			0.763	0.028	150	89	3.15	--
Pozzolan			0.763	0.028	127.6	76	2.68	--
Water			2.644	0.098	165	98	1	--
Air (2.0%)			0.54	0.020	--	--	--	--
Totals:	100	100	26.991	1.000	4045	2400		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.55	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.59	Design/Measured:	149.8 149.6
WATER CONTENT	% by wt. above SSD of total :	4.08%	FINES, % by Volume:	5.8
CEMENT:	% by wt. above SSD of dry materials:	4.25%	SAND/ AGG., % by Volume:	44
POZZOLAN:	lb/yd ³ , equiv. cement:	300.0	PASTE CONTENT, % by Volume	22.3
	%, replaced by volume:	50%	PASTE MORTAR RATIO, % by Volume	41.4
			TEMP. AIR/PLASTIC CONCRETE:	90/85°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 20-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	3/5	1.4	149.6	1098 (1.82) [210]	2493 (2.92) [492]	3345 (3.88) [717]	3873 (4.28) [807]	4305 (4.16) [885]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 5, 300-70-Grad1**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	22.0	22.0	4.931	0.183	797	473	2.59	1.6
3/4" to No 4	22.0	22.0	4.931	0.183	797	473	2.59	1.6
Sand	25.0	25.8	5.603	0.208	937	556	2.68	2.5
3/4" to dust	31.0	30.2	6.957	0.258	1094	649	2.52	3.1
Cement			0.458	0.017	90	53	3.15	--
Pozzolan			1.070	0.040	179	106	2.68	--
Water			2.500	0.093	156	93	1	--
Air (2.0%)			0.54	0.020	--	--	--	--
Totals:	100	100	26.991	1.000	4050	2403		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.52	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.58	Design/Measured:	150.0 149.6
WATER CONTENT	% by wt. above SSD of total :	3.85%	FINES, % by Volume:	5.8
CEMENT:	% by wt. above SSD of dry materials:	4.01%	SAND/ AGG., % by Volume:	44.0
POZZOLAN:	lb/yd ³ , equiv. cement:	300	PASTE CONTENT, % by Volume	21.8
	%, replaced by volume:	70%	PASTE MORTAR RATIO, % by Volume	40.7
			TEMP. AIR/PLASTIC CONCRETE:	90/86°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 21-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	16/21	2.2	150.7	1270 (2.21) [260]	1925 (2.86) [384]	2565 (3.21) [566]	3125 (3.94) [657]	3545 (3.87) [809]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 6, 300-70-Grad2**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	25.0	24.7	5.664	0.210	915	543	2.59	1.6
3/4" to No 4	25.0	24.7	5.664	0.210	915	543	2.59	1.6
Sand	40.0	40.9	9.065	0.336	1516	899	2.68	2.5
3/4" to dust	10.0	9.6	2.270	0.084	357	212	2.52	3.1
Cement			0.458	0.017	90	53	3.15	--
Pozzolan			1.070	0.040	179	106	2.68	--
Water			2.260	0.084	141	84	1	--
Air (2.0%)			0.540	0.020	--	--	--	--
Totals:	100	100	26.991	1.000	4114	2441		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.47	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.52	Design/Measured:	152.4 149.8
WATER CONTENT	% by wt. above SSD of total :	3.43%	FINES, % by Volume:	3.1
	% by wt. above SSD of dry materials:	3.55%	SAND/ AGG., % by Volume:	47.3
CEMENT:	lb/yd ³ , equiv. cement:	300	PASTE CONTENT, % by Volume	18.7
POZZOLAN:	%, replaced by volume:	70%	PASTE MORTAR RATIO, % by Volume	33.5
			TEMP. AIR/PLASTIC CONCRETE:	97/93°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 21-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	11/16	2.1	150.6	1243 (2.23) [255]	2000 (2.65) [392]	2773 (3.33) [602]	3115 (3.72) [658]	4160 (4.03) [878]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 7, 300-70-Grad3**
1.5" MSA RCC

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	23.0	22.8	5.185	0.192	838	497	2.59	1.6
3/4" to No 4	23.0	22.8	5.185	0.192	838	497	2.59	1.6
Sand	34.0	35.0	7.666	0.284	1282	761	2.68	2.5
3/4" to dust	20.0	19.4	4.515	0.167	710	421	2.52	3.1
Cement			0.458	0.017	90	53	3.15	--
Pozzolan			1.070	0.040	179	106	2.68	--
Water			2.375	0.088	148.2	88	1	--
Air (2.0%)			0.540	0.020	--	--	--	--
Totals:	100	100	26.995	1.000	4085	2424		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.49	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.55	Design/Measured	151.3 149.1
WATER CONTENT	% by wt. above SSD of total :	3.63%	FINES, % by Volume:	4.4
	% by wt. above SSD of dry materials:	3.76%	SAND/ AGG., % by Volume:	46.8
CEMENT:	lb/yd ³ , equiv. cement:	300	PASTE CONTENT, % by Volume	20.2
POZZOLAN:	%, replaced by volume:	70%	PASTE MORTAR RATIO, % by Volume	36.3
			TEMP. AIR/PLASTIC CONCRETE:	89/86°F

STRENGTH TEST DATA - Tests made on nominal 6 x 12-inch cylinders¹

CAST: 22-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi (Modulus of Elasticity, psi x 10 ⁶) ³ [Splitting Tensile Strength, psi]				
	Vebe ⁵	Air ²	Unit Wt ⁴	7-dy	28-dy	56-dy	90-dy	180-dy
	sec	%	lb/ft ³					
1	29/40	2.1	150.8	1533 (2.12) [270]	2483 (3.38) [474]	3143 (3.40) [685]	3680 (3.78) [794]	3970 (4.11) [856]

¹ Cylinders consolidated by vibration on vebe table

² Aggregate Correction = 0.0%

³ MoE through age 180-days det using Forney compression test machine and externally mounted compressometer with dial indicator.

⁴ Submerged unit weight, average of all tested cylinders

⁵ Vebe time measured at nearly full circumference base of ring and nearly full circumference top of ring

MATERIALS

COARSE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

Crusher waste (structural fill), CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 8, BM 600-0**
RCC Bedding Mortar

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	0.0	0.0	0.000	0.000	0	0	2.59	1.6
3/4" to No 4	0.0	0.0	0.000	0.000	0	0	2.59	1.6
Sand	100.0	100.0	16.665	0.617	2787	1653	2.68	2.5
3/4" to dust	0.0	0.0	0.000	0.000	0	0	2.52	3.1
Cement			3.053	0.113	600	356	3.15	--
Pozzolan			0.000	0.000	0	0	2.68	--
Water			6.731	0.249	420	249	1	--
Air (2.0%)			0.540	0.020	--	--	--	--
Totals:	100	100	26.989	1.000	3807	2259		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.70	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.70	Design/Measured	141.1 ~
WATER CONTENT	% by wt. above SSD of total :	11.03%	FINES, % by Volume:	3.2
CEMENT:	% by wt. above SSD of dry materials:	12.40%	SAND/ AGG., % by Volume:	99.8
POZZOLAN:	lb/yd ³ , equiv. cement:	600	PASTE CONTENT, % by Volume	40.2
	%, replaced by volume:	0%	PASTE MORTAR RATIO, % by Volume	40.3
			TEMP. AIR/PLASTIC CONCRETE:	~ /87°F

STRENGTH TEST DATA - Tests made on nominal 2 x 4-inch cylinders¹

CAST: 22-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi				
	Slump inches	Air ² %	Unit Wt ³ lb/ft ³	7-dy	28-dy	56-dy	90-dy	180-dy
1	9.0	~	136.8	1570	3647	~	4195	~

¹ Cylinders consolidated per ASTM C

² Aggregate Correction = 0.0%

³ Submerged unit weight, average of all tested cylinders

MATERIALS

COARSE AGGREGATE:

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 9, BM 800-0**
RCC Bedding Mortar

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	0.0	0.0	0.000	0.000	0	0	2.59	1.6
3/4" to No 4	0.0	0.0	0.000	0.000	0	0	2.59	1.6
Sand	100.0	100.0	15.840	0.587	2649	1572	2.68	2.5
3/4" to dust	0.0	0.0	0.000	0.000	0	0	2.52	3.1
Cement			4.070	0.151	800	475	3.15	--
Pozzolan			0.000	0.000	0	0	2.68	--
Water			6.538	0.242	408	242	1	--
Air (2.0%)			0.540	0.020	--	--	--	--
Totals:	100	100	26.989	1.000	3857	2288		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.51	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.51	Design/Measured	142.9 ~
WATER CONTENT	% by wt. above SSD of total :	10.58%	FINES, % by Volume:	3.2
CEMENT:	% by wt. above SSD of dry materials:	11.83%	SAND/ AGG., % by Volume:	99.8
POZZOLAN:	lb/yd ³ , equiv. cement:	800	PASTE CONTENT, % by Volume	43.2
	%, replaced by volume:	0%	PASTE MORTAR RATIO, % by Volume	43.2
			TEMP. AIR/PLASTIC CONCRETE:	~ /84°F

STRENGTH TEST DATA - Tests made on nominal 2 x 4-inch cylinders¹

CAST: 22-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi				
	Slump inches	Air ² %	Unit Wt ³ lb/ft ³	7-dy	28-dy	56-dy	90-dy	180-dy
1	8.75	~	139.4	4067	3602	~	4035	~

¹ Cylinders consolidated per ASTM C

² Aggregate Correction = 0.0%

³ Submerged unit weight, average of all tested cylinders

MATERIALS

COARSE AGGREGATE:

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company

REPORT OF CONCRETE MIXTURE DESIGN

Project: **Dry Comal Creek Dam**
New Braunfels, Texas

Mix : **No. 10, BM 800-50**
RCC Bedding Mortar

MIX DATA

Material	Aggregate, percent		Solid Volume		Weight, S.S.D.		Bulk Sp. Gr. S.S.D.	Absorp, %
	by vol.	by wgt.	ft ³	m ³	lbs	Kg		
1.5" to 3/4"	0.0	0.0	0.000	0.000	0	0	2.59	1.6
3/4" to No 4	0.0	0.0	0.000	0.000	0	0	2.59	1.6
Sand	100.0	100.0	15.840	0.587	2649	1572	2.68	2.5
3/4" to dust	0.0	0.0	0.000	0.000	0	0	2.52	3.1
Cement			2.035	0.075	400	237	3.15	--
Pozzolan			2.033	0.075	340	202	2.68	--
Water			6.538	0.242	408	242	1	--
Air (2.0%)			0.540	0.020	--	--	--	--
Totals:	100	100	26.987	1.000	3797	2253		

MIX CHARACTERISTICS

WATER-CEMENT RATIO	By weight, equiv. cement:	0.51	UNIT WEIGHT, lb /ft ³	
	By weight, water/cement+pozzolan	0.55	Design/Measured	140.7 ~
WATER CONTENT	% by wt. above SSD of total :	10.75%	FINES, % by Volume:	3.2
CEMENT:	% by wt. above SSD of dry materials:	12.04%	SAND/ AGG., % by Volume:	99.8
POZZOLAN:	lb/yd ³ , equiv. cement:	800	PASTE CONTENT, % by Volume	43.2
	%, replaced by volume:	50%	PASTE MORTAR RATIO, % by Volume	43.2
			TEMP. AIR/PLASTIC CONCRETE:	~/89°F

STRENGTH TEST DATA - Tests made on nominal 2 x 4-inch cylinders¹

CAST: 22-Aug-08

Batch No.	Plastic Properties			Unconfined Compressive Strength, psi				
	Slump inches	Air ² %	Unit Wt ³ lb/ft ³	7-dy	28-dy	56-dy	90-dy	180-dy
1	10.25	~	141.4	1631	2812	~	3768	~

¹ Cylinders consolidated per ASTM C

² Aggregate Correction = 0.0%

³ Submerged unit weight, average of all tested cylinders

MATERIALS

COARSE AGGREGATE:

FINE AGGREGATE: Crushed limestone, CEMEX Quarry, New Braunfels, TX

CEMENT: ASTM Type I, II, low alkali, Portland Cement, Alamo Cement Company, San Antonio, TX

POZZOLAN: ASTM Class C flyash, Boral Material Technologies, San Antonio, TX

ADMIXTURES: Grace WRDA 64, W. R. Grace and Company



ALAMO CEMENT COMPANY, LTD.

SAN ANTONIO, TEXAS

GENERAL OFFICES AND PLANT SAN ANTONIO, TEXAS

SPECIFICATION: ASTM C-150-07

ALAMO TYPE I/II

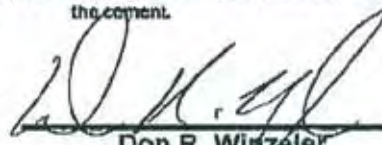
SAMPLE IDENTIFICATION: Monthly Average

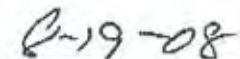
Jul-08

PHYSICAL DATA			CHEMICAL DATA	
FINENESS			CHEMICAL COMPOSITION (%)	
Blaine (m ² /kg) :		371	SiO:	20.4
-325 Mesh (%) :		94.8	Al ₂ O ₃ :	5.0
			Fe ₂ O ₃ :	3.6
			CaO:	63.8
			MgO:	0.8
			SO ₃ :	3.1
COMPRESSIVE STRENGTH (C109 cubes)			Co ₂ (%)	1.6
	psi	MPa	Limestone (%)	3.8
1 day :	2160	14.9	CaCo ₃ In Limestone (%)	96.0
3 day :	3560	24.6	Loss On Ignition:	2.4
7 day :	4690	32.3	Free Lime:	1.1
* 28 day:	6330	43.7		
SETTING TIME			Insoluble Residue:	0.38
Gilmore Method			POTENTIAL COMPOUNDS (%)	
	Initial (min) :	170	(Per ASTM C150,Annex)	
	Final (min) :	350	** C ₃ S:	57
FALSE SET (% Free) :		87	** C ₃ A:	7.2
AIR CONTENT (% vol) :		7	ALKALI TOTAL (NaEq): 0.55	
AUTOCLAVE EXPN (%) :		-0.01		

* PREVIOUS MONTH'S 28 DAY COMPRESSIVE STRENGTH

** Under ASTM C150 process additions are allowed when the additive is qualified according to ASTM C485. The process addition may alter the calculations of the Bogue compounds, but does not harm the physical properties of the cement.


 Don R. Wenzel
 Quality Control Manager


 Date

ADDRESS ALL CORRESPONDENCE TO THE COMPANY AT P O BOX 34807, SAN ANTONIO, TEXAS 78265

PHONE: AREA CODE 210-208-1680 WATS: 1-800-292-5510 FAX: 210-208-1990

ASTM C 618 TEST REPORT

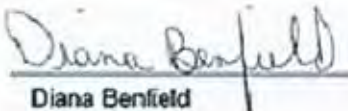
Sample Number:	S-080605006	Report Date:	7/16/2008
Sample Date:	May 2008	Sample Source:	Deely
		Tested By:	jx


TESTS	RESULTS	ASTM C 618 CLASS F/C	AASHTO M 295 CLASS F/C
CHEMICAL TESTS			
Silicon Dioxide (SiO ₂), %	36.64		
Aluminum Oxide (Al ₂ O ₃), %	20.79		
Iron Oxide (Fe ₂ O ₃), %	5.75		
Sum of SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , %	63.18	70.0/50.0 min.	70.0/50.0 min.
Calcium Oxide (CaO), %	25.01		
Magnesium Oxide (MgO), %	4.27		
Sulfur Trioxide (SO ₃), %	1.33	5.0 max.	5.0 max.
Sodium Oxide (Na ₂ O), %	1.48		
Potassium (K ₂ O), %	0.52		
Total Alkalies (as Na ₂ O), %	1.82		
PHYSICAL TESTS			
Moisture Content, %	0.00	3.0 max.	3.0 max.
Loss on Ignition, %	0.32	6.0 max.	5.0 max.
Amount Retained on No. 325 Sieve, %	14.79	34 max.	34 max.
Specific Gravity	2.68		
Autoclave Soundness, %	0.01	0.8 max.	0.8 max.
SAI, with Portland Cement at 7 Days, % of Control	93.7	75 min.*	75 min.*
SAI, with Portland Cement at 28 Days, % of Control	104.1	75 min.*	75 min.*
Water Required, % of Control	94.6	105 max.	105 max.

Meets ASTM C 618 and AASHTO M 295, Class C

The Class (C) Fly Ash from this plant meets the requirements of the MDOT and SCDHPT specifications.

* Meeting the 7 day or 28 day Strength Activity Index will indicate specification compliance.

Approved By: 
Diana Benfield
 QC Specialist

Approved By: 
Brian Shaw
 Materials Testing Manager

ASTM C 618 TEST REPORT

Sample Number: S-080702031
Sample Date: June 2008

Report Date: 8/15/2008
Sample Source: Spruce
Tested By: jx

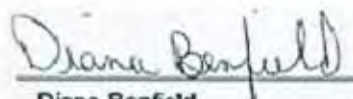
TESTS	RESULTS	ASTM C 618 CLASS F/C	AASHTO M 295 CLASS F/C
CHEMICAL TESTS			
Silicon Dioxide (SiO ₂), %	37.02		
Aluminum Oxide (Al ₂ O ₃), %	20.86		
Iron Oxide (Fe ₂ O ₃), %	5.58		
Sum of SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , %	63.46	70.0/50.0 min.	70.0/50.0 min.
Calcium Oxide (CaO), %	24.18		
Magnesium Oxide (MgO), %	4.56		
Sulfur Trioxide (SO ₃), %	1.37	5.0 max.	5.0 max.
Sodium Oxide (Na ₂ O), %	1.46		
Potassium (K ₂ O), %	0.50		
Total Alkalies (as Na ₂ O), %	1.79		
PHYSICAL TESTS			
Moisture Content, %	0.01	3.0 max.	3.0 max.
Loss on Ignition, %	0.09	6.0 max.	5.0 max.
Amount Retained on No. 325 Sieve, %	9.87	34 max.	34 max.
Specific Gravity	2.73		
Autoclave Soundness, %	0.01	0.8 max.	0.8 max.
SAI, with Portland Cement at 7 Days, % of Control	106.5	75 min.*	75 min.*
SAI, with Portland Cement at 28 Days, % of Control	106.7	75 min.*	75 min.*
Water Required, % of Control	92.6	105 max.	105 max.

Meets ASTM C 618 and AASHTO M 295, Class C


The Class (C) Fly Ash from this plant meets the requirements of the MDOT and SCDHPT specifications.

* Meeting the 7 day or 28 day Strength Activity Index will indicate specification compliance.

Approved By:


Diana Benfield
QC Specialist

Approved By:


Brian Shaw
Materials Testing Manager

WRDA® 64

Water-reducing admixture

ASTM C494 Type A and D

Product Description

WRDA® 64 is a polymer based aqueous solution of complex organic compounds. WRDA 64 is a ready-to-use low viscosity liquid which is factory pre-mixed in exact proportions to minimize handling, eliminate mistakes and guesswork. WRDA 64 does not contain calcium chloride and weighs approximately 10.1 lbs/gal (1.21 kg/L).

Uses

WRDA 64 produces a concrete with lower water content (typically 8 to 10% reduction), greater plasticity and higher strength. It is used in ready-mix plants, block and concrete product plants, in lightweight and prestressed work wherever concrete is produced.

WRDA 64 also performs especially well in concrete containing fly ash and other pozzolans.

Finishability

The cement paste, or mortar, in WRDA 64 admixed concrete has improved trowelability. The influence of WRDA 64 on the finishability of lean mixes has been particu-

larly noticeable. Floating and troweling, by machine or hand, imparts a smooth, close tolerance surface.

Addition Rates

The addition rate range of WRDA 64 is 195 to 3 to 6 fl oz/100 lbs (390 mL/100 kg) of cement. Pretesting is required to determine the appropriate addition rate for Type A and Type D performance. Optimum addition depends on the other concrete mixture components, job conditions, and desired performance characteristics.

Compatibility with Other Admixtures and Batch Sequencing

WRDA 64 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 WRDA 64 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

Product Advantages

- Consistent water reduction and set times
- Improves performance concrete containing supplementary cementitious materials
- Produces concrete that is more workable, easy to place and finish
- High compressive and flexural strengths



better performance. Please see Grace Technical Bulletin TB-0110, *Admixture Dispenser Discharge Line Location and Sequencing for Concrete Batching Operations* for further recommendations. WRDA 64 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 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

WRDA 64 is available in bulk, delivered by metered tank trucks, and in 55 gal (210 L) drums. It will freeze at about 28°F (-2°C), but will return to full strength after thawing and thorough agitation.

Dispensing Equipment

A complete line of accurate, automatic dispensing equipment is available. WRDA 64 may be introduced to the mix on the sand or in the water.

Specifications

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

The water-reducing (or water-reducing and retarding) admixture shall be WRDA 64, as manufactured by Grace Construction Products, or equal. The admixture shall not contain calcium chloride. It shall be used in strict accordance with the manufacturers' recommendations. The admixture shall comply with ASTM Designation C494, Type A water-reducing (or Type D water-reducing and retarding) admixtures. Certification of compliance shall be made available on request.

The admixture shall be considered part of the total water. The admixture shall be delivered as a ready-to-use liquid product and shall require no mixing at the batching plant or job site.

www.graceconstruction.com

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

WRDA, Daravair and Darex are registered trademarks of W. R. Grace & Co.—Conn.

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