Implementing HPC on the Sunshine Bridge Project

Final Report 538

Prepared by:
Tarif M. Jaber, P.E. FACI
Jaber Engineering Consulting, Inc.
10827 E. Butherus Drive
Scottsdale, Arizona 85255

November 2007

Prepared for:
Arizona Department of Transportation
206 South 17th Avenue
Phoenix, Arizona 85007
in cooperation with
U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect official views or policies of the Arizona Department of Transportation or the Federal Highway Administration. The report does not constitute a standard, specification, or regulation. Trade or manufacturers' names that appear herein are cited only because they are considered essential to the objectives of the report. The U.S. Government and the State of Arizona do not endorse products or manufacturers.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
SPR 538		

4. Title and Subtitle	5. Report Date
Implementing HPC on the Sunshine Bridge Project	November 16, 2007
	6. Performing Organization Code
7. Author Tarif M. Jaber, P.E. FACI	8. Performing Organization Report No.
9. Performing Organization Name and Address Jaber Engineering Consulting, Inc. 10827 E. Butherus Drive Scottsdale, Arizona 85255	10. Work Unit No. 11. Contract or Grant No. T0402A0002 SPR 538
12. Sponsoring Agency Name and Address **ARIZONA DEPARTMENT OF TRANSPORTATION** **206 S. 17TH AVENUE** **PHOENIX, ARIZONA 85007** Project Manager: Christ Dimitroplos	13.Type of Report & Period Covered Technical Report 14. Sponsoring Agency Code

15. Supplementary Notes

This work is a joint effort of Jaber Engineering Consulting, Inc. and Premier Engineering, Inc. Jaber Engineering Consulting, Inc. is the Principal Investigator and Premier Engineering, Inc. is the bridge designer and engineer of record. Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

This report presents the research work from a pilot program regarding the feasibility of implementing high performance concrete on Arizona bridge decks, using the Sunshine Bridge in Holbrook, Arizona as a test case. An existing concrete slab was removed and a new concrete slab using silica fume high peformace concrete with low corrosion steel was constructed. Steps in the pilot program included developing a HPC mix design using laboratory tests of various batches. Field trial batches were conducted at a ready mix plant near the Sunshine Bridge to simulate job conditions such as concrete batching, travel time, plastic and hardened concrete properties. Test results indicated that a concrete mix design with 0.41 w/cm ratio and 5 percent silica fume by weight of cement provided overall optimum performance against project requirements.

On-site slab demonstration placements of HPC at the bridge by the selected contractor simulated actual job conditions such as concrete batching, travel time, placement, finishing, curing, etc. The purpose of this field placement is to evaluate the contractor's procedures and crew. The bridge deck consisted of a total of 206 yards were placed at a rate of approximately 37 yards of concrete per hour on August 24, 2005. A comprehensive testing program measured and documented HPC properties and filed practices as a reference for future bridge deck projects using HPC.

17. Key Words		18. Distribution Statement		23. Registrant's Seal
High performance concrete, silica fume, Implementation of high performance concrete, bridge decks, prescriptive specification, low carbon steel, chloride permeability, shrinkage, wet curing, pumping concrete, air loss, basalt aggregates, scaling resistance, concrete resistance to freeze/thaw exposure		Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161		
19. Security Classification	20. Security Classification	21. No. of Pages	22. Price	
Unclassified	Unclassified	154		

Form DOT F 1700.7 (8-72)

SI (MODERN METRIC) CONVERSION FACTORS*

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH					**LENGTH**		
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
		AREA					**AREA**		
in^2	square inches	645.2	square millimeters	mm^2	mm^2	Square millimeters	0.0016	square inches	in^2
ft^2	square feet	0.093	square meters	m^2	m^2	Square meters	10.764	square feet	ft^2
yd^2	square yards	0.836	square meters	m^2	m^2	Square meters	1.195	square yards	yd^2
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi^2	square miles	2.59	square kilometers	km^2	km^2	Square kilometers	0.386	square miles	mi^2
		VOLUME					**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft^3	cubic feet	0.028	cubic meters	m^3	m^3	Cubic meters	35.315	cubic feet	ft^3
yd^3	cubic yards	0.765	cubic meters	m^3	m^3	Cubic meters	1.308	cubic yards	yd^3
	NOTE: Volumes greater than 1000L shall be shown in m^3.								
		MASS					**MASS**		
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000lb)	0.907	megagrams (or “metric ton”)	mg (or “t”)	mg	megagrams (or “metric ton”)	1.102	short tons (2000lb)	T
		TEMPERATURE (exact)					**TEMPERATURE (exact)**		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C	°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION					**ILLUMINATION**		
fc	foot candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2	cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE AND PRESSURE OR STRESS					**FORCE AND PRESSURE OR STRESS**		
lbf	poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380

TABLE OF CONTENTS

LIST OF FIGURES

I. EXECUTIVE SUMMARY

The I-40 Sunshine Bridge deck replacement was a pilot project conducted by the Arizona Department of Transportation (ADOT) to evaluate the feasibility of using High Performance Concrete (HPC) technology for bridges in the State of Arizona. The project consisted of replacing a cast-in-place concrete deck with a durable HPC deck reinforced with low corrosion steel.

A special provisional specification was written for the pilot project that emphasized HPC bridge deck construction technology and practices. The design performance criteria for the bridge deck were:

- Durability under freeze-thaw exposure
- Lower permeability to salt penetration
- Lower shrinkage potential
- Reduced steel corrosion

Silica fume, fly ash, and chemical admixtures were used in the HPC mix placed in the bridge deck and barriers. The reinforcing steel was a low-carbon steel with a corrosion threshold estimated to be five times higher than regular reinforcing steel.

Quality control and quality assurance programs were followed during construction to collect and document information about HPC's material characteristics and the construction practices that should be followed. Test results and field conditions confirmed the intended HPC properties were achieved on the majority of the bridge deck.

Challenges

The main challenges for the project were:

1. Ensuring aggregate properties and conditions at the batch plant were suitable for producing HPC
2. Controlling air content loss of pumped concrete on the deck
3. A short project schedule that prevented refinement of the HPC mix and field practices
4. Properly simulating the deck placement conditions due to the small size of the demonstration slab

These challenges are typical for a pilot project and are considered to be project-specific quality control. With the application of lessons learned on this pilot, we expect that future HPC projects can successfully address these issues.

Conclusions

The use of HPC in bridges by other state DOTs with similar climate and service conditions has reduced maintenance and increased the service life of structures. [1, 3 &5]

Our conclusions and recommendations include:

- An inspection and evaluation program of the Sunshine Bridge deck should be performed to monitor its performance.
- HPC can be implemented successfully on future bridge projects based on the test results and experience gained from the Sunshine Bridge project to date.
- The upfront investment in dollars and resources can be justified when ADOT considers the reduced maintenance and extended service life of bridge decks using HPC technology.
- Using HPC technology raises the bar in Arizona design and construction practices toward building bridges with better performance, longer service life, and safer driving conditions for the public.

The successful implementation of HPC on the Sunshine Bridge, despite the challenges encountered, is a clear indication that HPC can be used on bridges throughout Arizona where there are wide temperature ranges including freezing conditions (-18° to 109°F).

Figure 1. Aerial view of the completed Sunshine Bridge

II. INTRODUCTION

The Arizona Department of Transportation (ADOT) has recently implemented research on High Performance Concrete (HPC) technology conducted under State Planning and Research (SPR) Project 538. ADOT chose the I-40 Sunshine Bridge deck replacement over the Burlington Northern Santa Fe Rail Road (BNSF) railroad track as a pilot project (Project H618301C: Sunshine Bridge) to test the suitability of HPC for use in Arizona.

A. Purpose

The purpose of this project is to demonstrate the feasibility of using HPC for bridge decks. The work is also intended to gather information about HPC and the challenges and obstacles that ADOT expects to encounter as it implements HPC on future bridge projects throughout the state.

B. Scope of Work

The work presented in this report was authorized by ADOT's Transportation Research Center and was prepared in cooperation with the following groups:

1. ADOT Bridge Design Group
2. ADOT Holbrook District
3. Federal Highway Administration (FHWA)

The project was done in two phases: design and construction. The work done in each phase is outlined below.

1. Design Phase

a) Visited the Sunshine Bridge area and reviewed the capabilities of local concrete suppliers to produce HPC. This included the concrete manufacturing facilities their procedures, and quality control programs.
b) Performed laboratory tests on trial batches of concrete imported from the Sunshine Bridge area and selected one that best meets project criteria.
c) Performed laboratory testing and evaluation of the selected concrete mixture made in the trial batches.
d) Performed field trials on batches made at a ready mix plant near the Sunshine Bridge to simulate job conditions such as concrete batching, travel time, plastic and hardened properties.
e) Wrote HPC specifications for the Sunshine Bridge Project using local materials. These specifications were included in the project bid documents.

2. Construction Phase

a) Attended pre-construction meetings to address HPC implementation issues and project requirements.
b) Pre-qualified the contractor for HPC implementation issues such as concrete materials, concrete supplier, mix design, concrete finishers, and other related construction and quality assurance/quality control, (QA/QC) programs critical to HPC.
c) Monitored placement of an on-site HPC demonstration slab near the bridge by the selected contractor to simulate actual job conditions such as concrete batching, travel time, placement, finishing, curing, etc. The purpose of this field placement was to evaluate the contractor's procedures and crew capabilities and also to use it as a training exercise and an opportunity to make any project-specific adjustments to the specified installation procedures.
d) Monitored field inspection and testing program to verify HPC plastic properties against project specifications.

The data collected from the Sunshine Bridge pilot will be used to evaluate the feasibility of using HPC in areas of cold weather climate in Arizona.

C. Background

The Sunshine Bridge (ADOT Bridge # 1390, Sunshine BNSF RR-OP WB,) is located between Holbrook and Flagstaff on westbound I-40 at mile post 237. The site is 5102 feet above sea level.

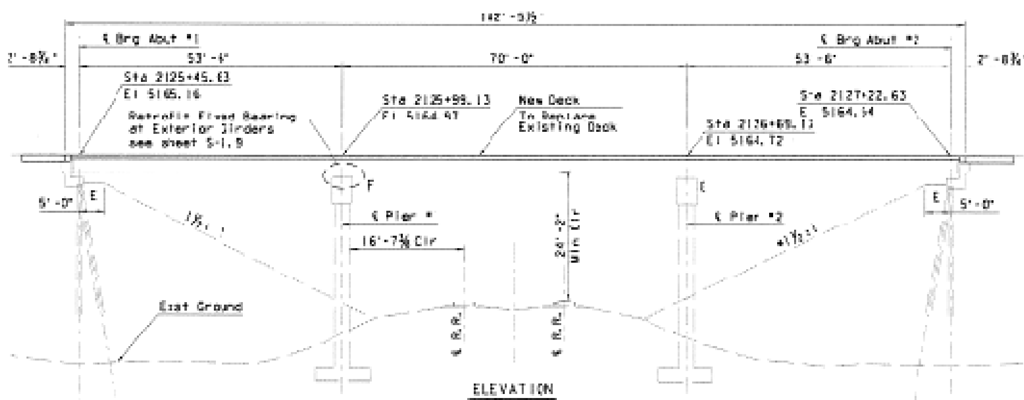


Figure 2. Bridge Elevation Profile

The bridge was built in 1968 by ADOT under project number I-IG-40-4(52). It consists of a 7.5 inch concrete deck supported by a three-span, five steel girder system with a skew of 42° 55'. The total Bridge length is 182.5 feet. (Reference

Figure 2, Figure 3, Figure 4, and Premier Engineering Corporation bridge construction plans). (8) The project involved replacing the deteriorated concrete bridge deck that is supported by steel girders.

ADOT selected the Sunshine Bridge as a pilot project to evaluate the use of HPC on bridge decks in Arizona. The new bridge deck consists of a full thickness, cast-in-place concrete deck using state-of-the-art HPC technology.

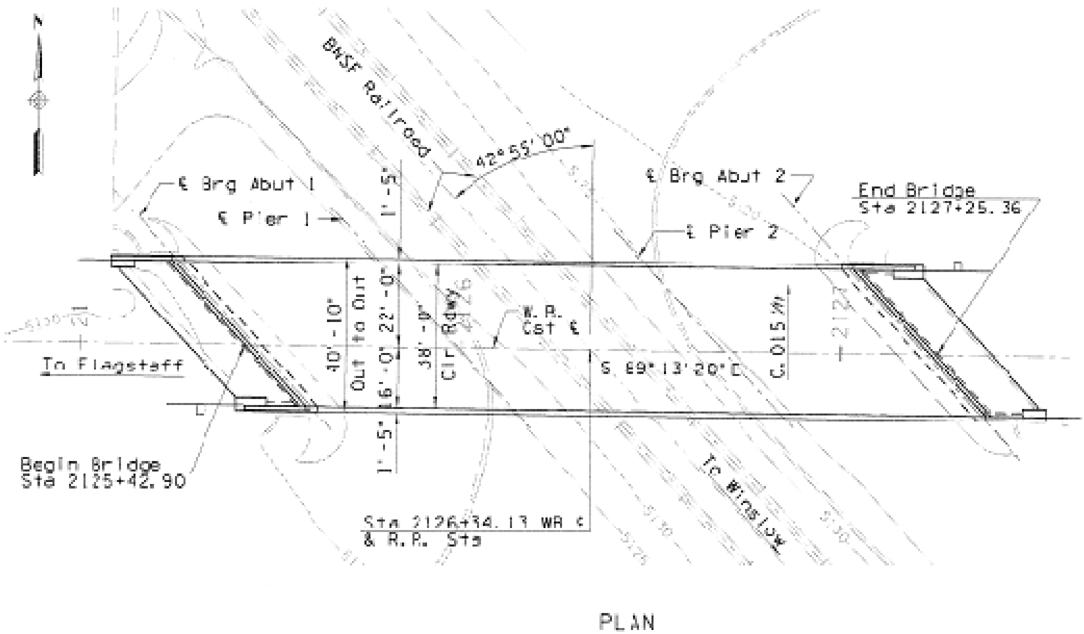


Figure 3. Bridge Plan

The Sunshine Bridge site presented the project team with several challenges:

1. *Short construction season.*-- The bridge is located in the Holbrook Construction District where the typical construction season starts at the beginning of May and ends in the middle of October. Construction on this project could not start until May 2005.

2. *All construction activities over the railroad tracks had to be completed by September 30, 2005* -- The railroad's traffic increases significantly in the last three months of the year. BNSFRR does not allow any construction activities within the railroad right-of-way during those months.

3. *Equipment access to the bridge deck from the railroad level was not feasible.* -- Because of railroad traffic and the 24-foot track clear zone, the contractor could not use a crane and bucket system or similar approach to deliver concrete onto the deck.

4. *The contractor needed a minimum of 90-days.* -- As the first ever implementation of HPC in Arizona, the contractor required at least 90 days to develop the HPC mix and make the necessary adjustments to meet project specifications. This left little room for variance in the construction schedule.

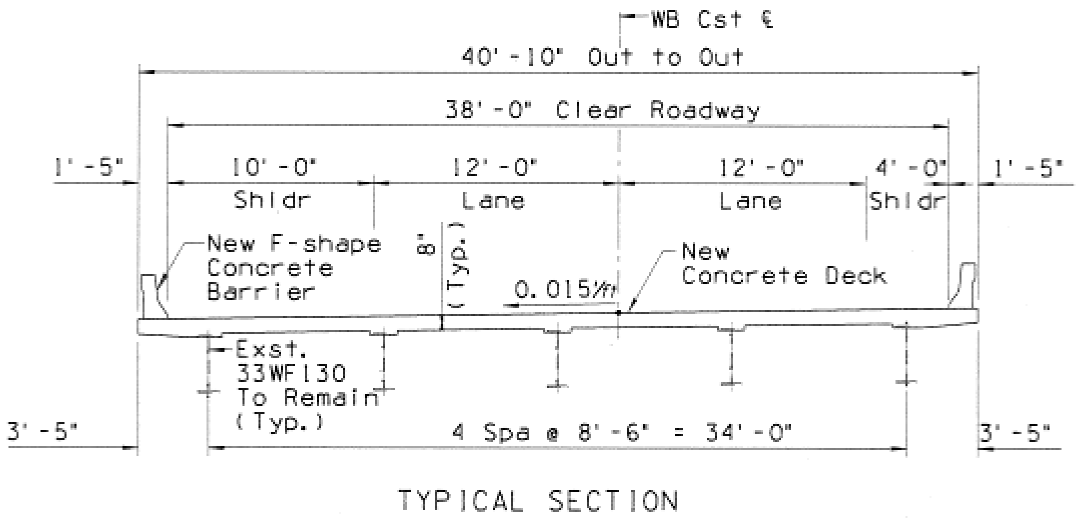


Figure 4. Proposed Bridge Section

III. HPC IMPLEMENTATION PROGRAM

The design team and ADOT selected the following concrete mix for the bridge deck:

1. An 8″ full depth cast-in-place concrete deck.
2. A HPC mix according to the trial batches developed in the field.
3. A low carbon, low corrosion steel reinforcement (MMFX Steel).

The combination of durable concrete and low corrosion steel enhances concrete performance and extends the life of the bridge deck. HPC's low permeability reduces the penetration of chloride ions through the bridge deck. The low carbon steel has a corrosion threshold estimated to be five times higher than standard steel. This means the amount of chloride needed to initiate corrosion in the reinforcing steel is not only increased, but the amount of chloride reaching the steel has decreased.

A. Laboratory Trial Batches

Developing an HPC mix design starts with performing laboratory trials and testing. A typical testing program consists of making batches of proposed mixes using local materials and following project requirements. The batch testing for this project was conducted at Rinker Materials (Rinker) ready mix laboratory in Phoenix, Arizona. See Figure 5.

Figure 5. Laboratory Trial Batches

Concrete materials including cement, fly ash, and aggregates, were imported from the Sunshine Bridge area to Phoenix for the trial batches. Aggregates were tested in the laboratory to verify gradation and other performance criteria according to American Society for Testing and Materials (ASTM) and ADOT standards.

To achieve the optimum HPC mix design, Jaber Engineering Consulting, Inc. (JEC) made a total of six batches. Three batches had silica fume contents of 5 % and three had silica fume contents of 7% by weight of cement. Each of these sets with the same silica fume content was batched with a water-to-cementitious material ratio *(w/cm*) of 0.37, 0.41, and 0.45. The *w/cm* ratios were selected based on the best information currently available. [3, 6]

Concrete from the trial batches was tested in both plastic and hardened states. In the plastic state, slump, temperature, air content, and setting times were measured. In the hardened state, samples were made to test the following properties:

1. Rapid chloride ion penetration (permeability)
2. Length change (shrinkage potential)
3. Resistance to freeze-thaw exposure (freeze/thaw)
4. Concrete compressive strength (strength)

Test results indicated that a concrete mix design with 0.41 w/cm ratio and 5 % silica fume by weight of cement provided overall optimum performance against project requirements (see Figure A-1, Appendix A):

1. Lowest possible chloride ion penetration: less than 1,200 coulombs.
2. Lowest shrinkage potential: less that 0.004 % for length change.
3. Best freeze-thaw resistance: a minimum of 85 % relative dynamic modulus.
4. Strength requirements: a minimum of 4500 psi at 28 days.

Using the laboratory test results in Appendix A, JEC developed a new concrete mix whose criteria were designed to optimize performance. Those criteria included: the lowest rapid chloride permeability, the highest freeze/thaw protection, and the required compressive strength range. The mix was field tested at a concrete ready mix plant close to the project site. The selected mix design and proportions are presented in Figure 6.

Concrete Materials	Weights
Portland cement, (lbs)	450
Fly ash, (lbs)	110
Silica fume, (lbs)	23
Fine aggregates, (lbs)	1181
Coarse aggregates, (lbs)	1765
Water, (lbs)	250
Water Reducer, (oz)	40
Superplasticizers, (oz)	18
Retarder, (oz)	20
Air Entraining Agent, (oz)	6
w/cm ratio	0.43
Paste content, (%)	27%
Air content, (%)	6.5%

Figure 6. Selected Mix Design

B. Developing the HPC Mix in the Field

Once the optimum mix design for the concrete was achieved at the laboratory, it was necessary to duplicate these results at the ready mix plant. At the plant the concrete was tested for both its hardened and plastic properties to ensure that the laboratory results could be repeated on a large scale field production. The ability to project results from the laboratory trials to a broad field application requires that the field trial batches be run using concrete material economically available to the contractors.

1. Selecting a Local Contractor

The design team was faced with a challenge of finding a ready mix supplier and a plant within a reasonable distance of the project. The project is located 40 miles from Flagstaff and 25 miles from Joseph City, Arizona, along I-40.

In cooperation with two ready mix suppliers, Rinker and Hanson Aggregates, the design team selected Quality Ready Mix (QRM), a subsidiary of Rinker in Joseph City, Arizona, to produce the field trial batches. The QRM plant, approximately 25 miles east of the Sunshine Bridge, was the closest ready mix plant to the project.

2. Batch Design

To demonstrate the improvement in concrete properties of HPC over a standard bridge deck mix, the design team elected to batch an ADOT Class S concrete mix, normally used by ADOT in bridge deck applications, for comparison.

On October 6, 2004, QRM batched a three cubic-yard load of ADOT Class S 4,500 psi concrete mix and a three cubic-yard load of HPC mix using the mix proportions developed in the laboratory trials (See Figure 7). The aggregate used in these trials was a river-rock type round aggregate from the Cottonwood Pit.

The concrete was centrally batched and discharged into trucks. To simulate and monitor concrete properties during travel time, the truck drum mixed at travel speed and was held at the plant for the anticipated travel time of one hour.

The concrete was tested at three stages: 1) right after batching; 2) during simulated truck travel time and; 3) at the end of the one hour hold period. The concrete's plastic properties, slump, air, and temperature were measured at the three stages and the results are shown in Figure B-1, Appendix B.

Figure 7. Testing HPC Trial Batches at the Ready Mix

3. Initial Sample Test Results

Concrete samples were cast at the batch plant and tested in the laboratory to measure the hardened concrete properties of the HPC mix against those of the ADOT Class S control mix.

The chloride permeability for the HPC was an average of 768 coulombs compared to 2610 coulombs for the control mix. The 70% reduction in coulombs is due to the reduced permeability of the HPC over the ADOT Class S control mix. This reflects HPC's increased ability to resist chloride ion migration.

The HPC had an air void system with paste content of 23.5 percent, compared to 31.6 for the control mix. Since most of the concrete shrinkage comes from the cement paste, (cement and water), lowering paste content reduces the shrinkage potential of concrete.[2] Air void systems for both mixes were sound and were expected to provide the concrete with durability under freeze-thaw conditions. Details of the laboratory test results are presented in Figures B-2 through B-9 in Appendix B.

C. Developing HPC Specifications

ADOT has used silica fume/HPC as a repair overlay on other bridge decks; however, the Sunshine Bridge is the first bridge deck in Arizona that uses HPC for the full deck. ADOT's current *Standard Specifications for Road and Bridge Construction* does not have provisions for HPC so the design team developed a special provisional specification to include in the bidding and construction documents.

Generally, there are two main approaches to specifying HPC for bridge deck construction:

1. ***Performance Specification:*** Specify the concrete performance criteria required for the bridge deck and require the contractor to achieve those criteria.

2. ***Prescriptive Specification:*** Require the contractor to follow certain procedures and use specific materials and/or proportion methods to achieve the performance criteria intended for the project. The contractor is not responsible for ensuring concrete performance properties are achieved provided the specification requirements are followed.

The *performance specification* is used when the contractors expected to bid on the project have prior experience with HPC. The owner normally relies on contractor knowledge and experience to achieve the required performance criteria.

The *prescriptive specification* is used when the contracting community has limited knowledge and experience in working with HPC and may have difficulty achieving the desired results.

Based on the preliminary research work performed in the field and laboratory, the design team and ADOT selected the prescriptive specification approach for this project.

The following factors played a significant role in selecting the prescriptive specification approach.

1. *First full bridge deck.* – ADOT's previous use of HPC was limited to overlays; this is the first project to use HPC for the full deck and traffic barriers.
2. *Lack of experience by local contractors and suppliers.* – There was a limited number of contractors and concrete suppliers in the project area with adequate experience in producing and constructing with HPC.
3. *Potential cost advantage of prescriptive specification.* - Contractors would increase their project bid because of the perceived risk they would face in using an unfamiliar product.
4. *Project construction schedule.* – The short construction schedule allowed minimal time for the contractor to develop a concrete mix for the project that was based on performance.

D. Project Bidding

The project was advertised; bids were opened on March 25, 2005. Vastco Construction Inc. (Vastco), headquartered in Flagstaff, was the successful bidder. Rinker won the ready mix supply contract. ADOT’s Holbrook District managed the project. ADOT gave Vastco a notice to proceed on April 15, 2005.

E. Pre-Construction Work

A day-long project partnering meeting with representatives from all firms and agencies involved in this project was held on May 19, 2005. The challenges of implementing HPC were discussed in detail, with input from Vastco, ADOT, and the design team. The design team also presented a schedule of milestones showing the time and sequence of significant events that would lead to a successful deck placement. (See Figure C-1, Appendix C.)

A quality control plan was also developed at the partnering meeting that detailed the steps in the concrete deck placement process from concrete production at the batch plant through final concrete curing. The plan, shown in Figure D-4, Appendix D, outlined each project member’s role, duties and responsibilities during the deck placement, including the responsibility of accepting each truck load of concrete before placement.

1. Trial Batches

Rinker elected to supply the HPC from its Flagstaff plant. Vastco/Rinker made five trial batches between May 18 and June 29, 2005. **None of the trial batches achieved the desired field properties for slump, air and *w/cm* ratio**. (Details of the trial batches are presented in Figure C-2, Appendix C.)

a. Discussion and Comments

ADOT and the design team were at the Rinker ready mix plant during the trial batches. Concrete mix, materials, and proportions were reviewed to verify compliance with project specifications. Concerns centered on the aggregate properties in the failed batches.

The coarse aggregates used in the trial batches were 100% crushed basalt aggregates. The basalt appeared to be a mix of approximately 40% porous and absorptive rock and 60 % harder, angular rock.

The aggregates appeared to have varied moisture conditions and seemed to be below the Saturated Surface Dry (SSD) conditions specified for the project, when visually examined at the stock pile. The low SSD conditions were later confirmed in lab tests performed by Rinker.

Because of its low and varied moisture conditions, the aggregate absorbed large portions of the mixing water during the initial stages of batching. This caused water demand to increase and made it difficult for the concrete mixture to achieve the required slump. Air content was also variable and unstable when the slump and water demand fluctuated as a result of the aggregate moisture conditions.

It was clear that the variations in aggregate moisture and the below-SSD conditions of the aggregate caused many of the trial batches to fail. The angularity of the aggregate also increased water demand compared to the mix tested during the trial batches made at QRM on October 6, 2004. The mix design proportions specified in the project documents were based on trial batches using the Cottonwood Pit aggregates. The aggregate used by Rinker for the project was from the Cherry Pit.

Because of its angular shape, the Cherry Pit coarse aggregate has higher water demand compared to the river rock type round aggregate from the Cottonwood Pit. A summary of the aggregate moisture properties by source is shown in Figure 8. Detailed properties are presented in Figure A-6 in Appendix A and Figure C-5 in Appendix C.

Aggregates Absorption			
Aggregate Source	**Application**	**Sand**	**Rock**
Cottonwood Pit	Trial batches, laboratory and field	0.97	0.73
Cherry Pit	Project batches and bridge deck	2.20	1.60

Figure 8. Aggregate Moisture Properties Comparison

Vastco and Rinker requested that ADOT and the design team make the following changes:

i. *Modify the project requirement for accepting the HPC compressive strength from 28 days to 56 days.* Rationale: The fly ash in the mix will continue to gain strength well beyond 28 days. Moving the compressive strength from 28 to 56 days will discourage the contractor from trying to increase cement content to achieve higher strength at 28 days.

Delaying concrete strength gain to later ages (by reducing cement content and adding fly ash) will generally make concrete less susceptible to cracking (3). ADOT and the design team approved this change.

ii. *Increase the specified maximum concrete temperature at placement from 80° to 85° F.* The purpose for this request is to avoid using ice in the batching process. It is generally difficult to control *w/cm* ratio when ice is added to the mix.

In the interest of maintaining and controlling the *w/cm* ratio, the design team did not object to an increase in the maximum allowed concrete temperature on deck from 80° to 85° F. The potential 5° F increase in concrete placement temperature has far less impact on the quality of concrete when compared to the potential of higher *w/cm* ratio (2, 6).

iii. *Increase fly ash content from the specified 110 lbs to 165 lbs.* The purpose of the additional fly ash is to increase the paste content in the concrete mixture and overcome the low slump and air instability caused by the low and variable moisture conditions in the aggregate.

To accommodate this field condition, ADOT and the design team allowed Rinker to proceed with the fly ash increase provided all other concrete plastic properties were maintained.

b. Adjustments & Recommendations

To help achieve the required HPC mix design, ADOT and the design team approved the contractor-proposed changes and made the following recommendations:

i. The aggregate needed to be at SSD conditions 24 hours before batching the HPC, as required by Project Specification's Section 1006-2.03(B) and (C). Project specifications were developed by the design team in tandem with ADOT's Contracts and Specifications Section.
ii. The silica fume content should be adjusted from 25 to 30 pounds.
iii. The HPC mix w/cm ratio should comply with the project requirement of minimum 0.40 and a maximum of 0.42.
iv. The contractor should produce additional batches incorporating these recommended adjustments to ensure consistent concrete production.

ADOT and the design team approved those changes and recommendations to accommodate the limitations of Rinker's materials, mainly the aggregate's increased water demand and its moisture conditions at the plant.

Using the approved changes, Rinker made trial batches # 6 and # 7 on Wednesday July 6, 2005. Batch # 6 was not successful. Batch # 7 had a 0.402 *w/cm* ratio, an 85° temperature, and an air content of 4.6% at 50 minutes after the concrete was batched so the project team considered it tentatively successful, but saw that further refinement would be needed during the required field demonstration. (See Figure C-2 for details of the tests on the trial batches.)

3. Field Demonstration

Project specifications required the contractor to perform a field demonstration of the concrete deck placement. A successful demonstration would simulate field conditions anticipated during actual deck placement. The specification would allow the contractor the option to use the bridge approach slab or other slabs at locations close to the project for the demonstration. Vastco elected to use the approach slab.

a. Slab Demonstration # 1

The first field demonstration took place on August 5, 2005 using the east approach slab The slab was approximately 46' wide by 15' long: too small for a Bidwell finishing machine to be used. Concrete was delivered to the site in three truckloads. Placement using a 42' Schwing pump began at 2:27 a.m. and concluded by 3:05 a.m. The contractor used a portable vibratory screed to finish the concrete surface (See Figure 9). Details of placement locations and properties of the concrete are presented in Figures C-4a and C-4b in Appendix C.

The first demonstration was considered unsuccessful as the project crew was unable to satisfactorily place and finish the slab. The design team requested a second slab placement demonstration to ensure that the contractor could follow proper HPC techniques prior to actual deck placement.

Figure 9. Slab Demonstration No.1

b. Slab Demonstration # 2

The second field demonstration took place on August 18, 2005 using the west approach slab. The slab was similar in size to the east approach slab but was too small for finishing machines to be used.

The air loss encountered through the pump remained unresolved in the second slab demonstration. As with the first demonstration, the crew did not follow proper HPC techniques in either placing or finishing the slab. Therefore, the slab demonstration was considered unsuccessful. Reference Figure C-3 Appendix C for demonstration slab test results.

F. HPC Deck Placement

Despite the fact that both field slab demonstrations failed to meet project specifications and therefore did not fully meet with ADOT's and the design team's approval, the need to complete all construction activities on the bridge by the end of September 2005 remained. To meet the BNSFRR deadline, ADOT allowed Vastco to proceed with deck placement. The deck placement was scheduled for 2:00 a.m. August 24, 2005.

A pre-placement meeting of the design team, ADOT, Vastco and Rinker was held on August 22, 2005 in Flagstaff. The project team reviewed the deck placement procedure, the quality control and the quality assurance plans that were developed during the partnering workshop (See Figure D-4, Appendix D).

Because of site conditions and traffic access restrictions, the contractor used two concrete pumps. Pump No.1, a 52-meter Putzmeister, (M52), was set up on the east end of the deck. Pump No.2, a 45-meter Schwing (M45), was set up on the west end of the bridge deck.

Concrete placement started on the east end using pump No.1. At approximately the midpoint of the bridge deck, beginning with load no. 12, concrete placement was continued from the midpoint to the west end using pump No.2. The Deck Placement Schematic Layout is shown in Figure D-5, Appendix D.

1. At The Batch Plant

QA/QC tests were carried out by the project team at the batch plant and on site. Vastco and Rinker's QC program included:

a. Measuring concrete materials' weights
b. Measuring the moisture conditions of both the coarse and fine aggregate
c. Testing concrete properties – slump, air content, and temperature- for compliance with specifications before the concrete trucks left for the site

Both ADOT and JEC performed a QA program to verify the information measured and tested in the contractors' QC program. The QA program included:

a. Batch plant observation during concrete production to verify that concrete batches met the approved concrete mix design. The observation was performed by a Registered Professional Engineer who documented concrete batch weights, moisture conditions, and calculated the w/cm ratio. The purpose of the *w/cm* calculation was to inform ADOT to alert the contractor should the *w/cm* ratio exceed the maximum of 0.42 allowed in the specifications. Figure D-2, Appendix D includes concrete batch weights and their variance from the proposed concrete mix design and a tabulation of the w/cm ratio for each load. A graphic representation of the w/cm ratio for each concrete load is presented in Figure D-3, Appendix D.

b. Testing of concrete properties-slump, air content, and temperature- for compliance with specifications and to confirm testing performed by the contractor before concrete trucks were allowed to travel to the site.

The slab demonstrations showed that air loss between the batch plant and the deck was 3.38 % during the first demonstration and 4.06 % during the second demonstration, an average of 3.72 % air loss for both placements. See Figure C-3 Appendix C. Based on this information, and to achieve the specified 6.5 % air content at placement, the project team agreed that concrete would be allowed to proceed to the job site only when the following plastic properties were achieved in the concrete batched at the plant:

a. Minimum air content of 10 %
b. Minimum 9 inch slump
c. Maximum temperature 80° F

The higher-than-specified air content was permitted at the batch plant to allow for the anticipated loss during transportation and pumping. The higher than specified slump was deemed necessary to maintain air in the concrete. Concrete drivers were not permitted to add water to the concrete mixer until the concrete was completely discharged.

The first concrete truck was batched at 1:02 a.m. and the last at 7:00 a.m. Twenty one trucks delivered 206 cubic yards of concrete.

2. Arrival of Concrete On-Site

Two testing stations were set up in the median approximately 100 feet ahead of the concrete pump on both sides of the bridge deck - Test Station 1A was at the median entrance ramp east of the bridge. Test Station 1B was at the median entrance ramp west of the bridge. For details on testing stations and locations see Figure D-5, Appendix D.

On arrival at the testing stations, the concrete was tested for slump, air content, and temperature by Rinker's QC technicians and ADOT inspectors before proceeding to the pump. Any adjustments to the concrete plastic properties were made using chemical admixtures such as air entraining agents or superplasticizers.

The concrete was allowed to proceed to the pump only when slump was at least six inches and air content was a minimum of 9%

3. Concrete Placement

Actual concrete placement on the deck started with the discharge of concrete truck load no.1 at 2:37 a.m. and ended when truck load no. 21 was completely discharged at 8:10 a.m. A total of 206 cubic yards were placed at a rate of approximately 37 cubic yards per hour.

Placement started on the east end where concrete was pumped on deck through pump No.1. The first two trucks were tested before placement and showed air contents of 9.5 % and 8.8 % respectively before pumping. Air content for the second truck's load was measured at 2.5 % after pumping showing an air loss of 6.6 % through the pump. Vastco and Rinker took quick measures to reduce air loss through the pump, including adjusting pump line configuration, reducing pump pressure, installing an S-pipe at the end of the pump hose, and even laying the pump hose flat on the deck. Note S-pipe use in Figure 10.

Figure 10. Pumping Concrete Using an "S" Pipe

The measured air content on the deck for the first eight truck loads (80 cubic yards of concrete) remained below the required 5.5 % minimum, despite all attempts to control air loss through the pump. Details of air content loss are presented in Figure D-1, Appendix D. ADOT Inspector Denise Hamill made a field sketch showing the approximate placement of every truck's load placed on the deck. The hand sketch is presented in Figure D-7, Appendix D.

When concrete had been placed on the eastern half of the bridge, the trucks switched to delivering the concrete to the west end where concrete pump No.2 had been set up. The concrete was checked at testing station 1-B at the west entrance ramp and adjusted when needed for slump and air content. Trucks were allowed to proceed to the pump only when slump, air content, and temperature met project specifications.

4. Concrete Testing and Sampling

Concrete was tested and sampled by ADOT, Rinker, and JEC. Samples were taken from concrete placed on the deck at the end of the pump hose. The fresh concrete was transported off-deck to the west end of the bridge using wheelbarrows traveling on wooden planks set across the deck's reinforcing steel. Test samples were cast and cured on-site for the following purposes:

a. Contractor confirmation of Compressive Strength. Rinker made one set of 6”x12” concrete cylinders for every 20 yards of concrete placed on-deck. The cylinders were tested in the laboratory for compressive strength. Testing and sampling of concrete was made by ACI-certified field technicians.

b. ADOT Confirmation of Compressive Strength. ADOT made one set of 6”x12” concrete cylinders for every 20 yards of concrete placed on-deck. The cylinders were tested at ADOT's Materials Laboratory for compressive strength. ADOT compressive strength test results were used for concrete acceptance according to project specifications. The testing and sampling of concrete was performed by ADOT-certified field technicians.

c. JEC Confirmation of HPC properties. JEC retained Western Technology, Inc. (WTI) of Phoenix, Arizona to take test samples. The purpose of this testing was to verify and document HPC properties. The laboratory tested chloride permeability, freeze-thaw resistance, scaling resistance, modulus of elasticity and shrinkage potential. Test samples were cured on-site for 24 hours and later transported to WTI’s laboratory in Phoenix for curing.

A summary of the field testing and sampling of the concrete is presented in Figure D-1, Appendix D.

5. Concrete Finishing:

Vastco used a Bidwell finishing machine mounted across the bridge deck on a fixed railing with double rotating augers and a roller screed. After concrete was discharged on-deck and vibrated, the roller screed made one pass across the deck, followed by a paver pan to drag-close the surface. See Figure 11.

Figure 11. Concrete Finishing Machine

Minimal surface finishing was performed to avoid cracking the HPC. Surfaces between the machine rail and the furthest reach of the roller screed were hand-finished as shown in Figure 12.

Figure 12. Finishing Areas Next to the Machine Railing

6. Concrete Protection and Curing

Project specifications required the contractor to “begin curing the concrete surface no later than 10 minutes after it is finished” and that “the finishing machine cannot be more than 10 feet away from the finished surface.” To accomplish this, Vastco set up a working bridge traveling behind the finishing machine and used it to place the curing sheets as shown in Figure 13.

Figure 13. Working Bridge to Lay Down Curing Sheets

The burlene sheets used for curing are made of burlap on one side and plastic on the other, with holes in the sheets to allow added water for curing pass-through. The contractor placed the burlene across the entire width of the bridge deck. Soon after the burlene sheets were laid on the concrete surface they were wetted down to keep them in place as shown in Figure 14. Wet curing of both the concrete deck and the barriers continued for 14 days which provided the water needed for cement hydration.

Figure 14. Wetting Down Curing Sheets

7. Laboratory Test Results

Because the project was designed with a prescriptive specification approach, the contractor was not required to meet any HPC performance requirements except for compressive strength. Therefore, a special concrete testing program was authorized by ADOT and carried out by JEC. The purpose of the laboratory testing program was to measure the performance properties of the HPC placed on the Sunshine Bridge deck and confirm compliance with project requirements.

Samples were tested at WTI in Phoenix and at Construction Testing Laboratories (CTL) in Skokie, Illinois. A summary of all laboratory test results and reports is included in Figure E-1a, Appendix E. Results of compressive strength tests from ADOT, Rinker and WTI are summarized in Figure E-1b, Appendix E.

Figures B-2, E-1a and E-1b compare the properties of the HPC placed on the bridge deck to an ADOT class S mix. The rapid chloride permeability (RCP) of the bridge deck concrete was reduced three fold by using HPC instead of class S concrete. RCP results were 768 and 984 coulombs for HPC compared with 2610 for class S concrete.

IV. CHALLENGES AND LESSONS LEARNED

The Sunshine Bridge pilot project was an excellent test case for using HPC technology on Arizona bridges in freeze-thaw environments. The obstacles and challenges the project team faced presented everyone the opportunity to gain knowledge and experience in bridge deck construction.

The following lessons were part of the learning process that came out of the Sunshine Bridge pilot project.

1. Aggregates Quality and Conditions

Aggregate properties such as shape, absorption, water demand, and moisture conditions at batching time are major factors that need to be addressed when HPC is specified on a project. The coarse and fine aggregates proved to have the most significant impact on getting the HPC mix to meet field performance requirements.

A specific QC program for aggregates needs to be established by the supplier and approved by ADOT and the design team. The QC program should be a pre-requisite of any successful HPC project.

2. Batching Based on w/cm Ratio:

Ready mix suppliers in Arizona need to make the transition from their current practice of concrete batching based on slump to batching based on w/cm ratio. HPC in bridge applications focuses on durability that is associated with the w/cm ratio. To meet requirements, coarse and fine aggregate should be at SSD weights at batching time, and moisture of the aggregate should be regularly measured during batching to calculate and confirm the w/cm ratio.

3. Concrete Transportation

Concrete slump and air content at the batch plant may need to be higher than what is required at placement to compensate for losses during transportation and pumping. Concrete properties change during transport and since many bridges are long distances away from ready mix plants, maintaining the concrete's properties during travel is a critical issue that requires special planning and design considerations. Performing trial batches at the batch plant is the best way to address this issue.

For the Sunshine Bridge a minimum of 9 inch slump and a minimum of 10 % air content were required at the batch plant to allow for air losses during travel and passage through the pump.

4. Field Demonstration

Performing field demonstrations of concrete placement is an essential step in a successful HPC project. The demonstration allows the project team members to practice all steps of the concrete placement and identify and solve problems ahead of the actual deck placement. The placement slab area should be large enough to allow for placement, finishing machine, and finishing techniques to be demonstrated. Time should be allowed for conducting multiple field trials and demonstrations should they be needed.

All team members should be present to provide their input on the process and reinforce their role during deck placement. It is critical that the crew performing the field demonstration be the same as the one that will perform the actual deck placement. The demonstration should cover all aspects of deck placement including travel time, pumping, finishing, curing, and other site-specific requirements.

Future HPC projects should allocate a separate pay item for a slab demonstration. The pay item can be allocated in two ways:

- Pay directly for the cost of all materials, labor, and equipment for the demonstration.
- Pay according to size of the demonstration slab. Payment should be for successful placement only.

5. Concrete Pumping

The amount of concrete air content loss through pumping must be determined through trial batches and field demonstrations before deck placement. Concrete properties must be measured **on-deck** to see if they meet acceptance criteria, because the properties of the concrete ultimately placed and finished on-deck are the ones that determine a bridge deck's performance.

Air content in concrete should be increased before pumping in the amount pre-determined during earlier trial batches and field demonstrations to allow for air losses through the pump, so the concrete placed on-deck meets project requirements.

To compensate for air losses during transportation and through the pump, the concrete for the Sunshine Bridge was batched at higher levels of air content than the project-specified on-deck air content of 6.5% ± 1.5 %. Concrete was batched at 9-10% to allow for an anticipated air loss of 3.72% measured during the field demonstrations. Air content impacts concrete performance in the following ways:

- Increased air content improves concrete workability.
- Entraining a good air-voids system in concrete helps protect it against freeze/thaw damage and increases its durability under severe exposure conditions.
- Concrete strength is reduced when air content in concrete is increased.

When placing the concrete by pumping, the contractor should use the same pump used for establishing the air loss during trial batches and slab demonstration.

6. Wet Curing

Future HPC bridge project specifications should be written to alert the contractor to the importance of wet curing and its impact on the construction schedule. Membrane curing is the common practice for bridge decks in Arizona. HPC requires wet curing for at least 7-14 days.

7. Constructability

There were no real constructability issues in using HPC on the Sunshine Bridge. Although there were difficulties in developing the concrete mix at the batch plant and controlling air content loss through the concrete pump, most of the problems encountered were related to quality control issues that can be readily addressed on future projects.

The impacts of wet curing on the schedule must be addressed early. Wet curing for 7-14 days is required for optimal performance of HPC.

Testing needs will decrease as knowledge is gained. The concrete sampling and testing program was extensive and unique to this project because of ADOT's objective to establish a base reference for HPC performance. The extent of HPC testing programs on future HPC projects may be reduced as more information about HPC technology becomes available.

8. Safety

An HPC bridge deck requires less frequent maintenance than a conventional concrete bridge deck. Reduced maintenance results in fewer accidents, injuries, and fatalities. FHWA statistics on the relationship between maintenance/construction and the number of accidents and deaths show that the U.S. has:

- One work zone fatality every 7 hours (3 a day)
- One work zone injury every 15 minutes (96 a day)
- A financial loss of $3 billion from work zone crashes in 2001

For more information go to the following link:
http://safety.fhwa.dot.gov/wz/nwzaw_events/factsheet04.htm

9. Team Members Feedback

Feedback from project team members should be considered for future HPC projects. In order to get the input from project team on the implementation of HPC on the Sunshine Bridge project, a meeting of all participants was held on February 7, 2006. Comments from the meeting are presented in Figure D-7, Appendix D.

V. CONCLUSION:

The test results and field experience suggest that using HPC on bridge decks in Arizona is feasible and can result in improved concrete properties. In the early stages of using HPC on bridge decks cost increases can be expected as bridge contractors develop experience and knowledge in HPC technology. These costs will decrease as a result of more competitive pricing when more HPC projects are constructed and more contractors become familiar with HPC.

The design team recommends that an inspection and evaluation program of the Sunshine Bridge deck be performed to monitor HPC and bridge performance establishing the benefit of an HPC deck compared to other bridge decks in Arizona.

Based on the testing, field experience, and lessons learned on this project, the design team recommends that more bridge decks in Arizona be constructed using HPC. However, further field observations are recommended to confirm field performance and establish a base line for concrete performance. We recommend that a five-year field monitoring program be initiated to accomplish this goal.

The upfront investment in dollars and resources is justified when the reduced maintenance and extended service life of bridge decks using HPC technology are considered.

VI. REFERENCES

1. Zia, Paul Michael Leming, and Shuaib H. Ahmad. *High Performance Concretes. A State of The Art Report*. Strategic Highway Research Program. Washington D.C.: Federal Highway Administration, 1991.

2. Kraus, Paul, Ernest A. Rogalla. *Transverse Cracking in Newly Constructed Bridge Decks.* NCHRP Report 380. Washington D.C.: Transportation Research Board, 1996.

3. *Bridge Views Newsletter Compilation*, Issues Nos. 1-38. Federal Highway Administration, National Concrete Bridge Council. January 1999 through April 2005.

4. Kriesel, Roxanne, Mark Snyder and Catherine E. French. *Freeze-Thaw Durability of High Strength Concrete.* Report 1998-10 St. Paul, Minn.: Minnesota Dept. of Transportation, 1997.

5. Jaber, Tarif M. *State of the Art Report High Performance Concrete for Bridges in the State of Arizona*. ATRC Report SPR-538. Phoenix, Ariz.: Arizona Department of Transportation, 2004.

6. Holland, Terrance C. *Silica Fume User's Manual*. FHWA-IF-05-016Washington, D.C.: Federal Highway Administration, April 2005.

7. *Concrete in Practice-21, Loss of Air Content in Pumped Concrete*. Springfield Maryland: National Ready Mix Concrete Association, 1992.

8. Flagstaff-Holbrook Highway (I-40), Sunshine BNSFRR-OP WB 1390, Project Number AC-IBRC-040-D(016)A. Tracs No. H6183 01C. Project Construction Plans, Premier Engineering Corporation, Tempe, AZ; 2005Premier Engineering Corporation Sunshine Bridge construction plans, 2005 pp 38, 39.

9. "Evaporation chart, ACI Figure 2.1.5 Effect of concrete and air temperature, relative humidity, and wind speed on the rate of evaporation of surface moisture from concrete." in *Hot Weather Concreting, ACI Manual of Concrete Practice*. Farmington Hills, Michigan: American Concrete Institute, 2005.

APPENDIX A

Laboratory Trial Batches

LIST OF FIGURES

August 3, 2004

Summary of Laboratory Trial Batches
For the Sunshine Bridge

Date Batched	Tuesday, July 20, 2004			Tuesday, July 27, 2004		
Silica Fume Percent [1]	**5%**			**7%**		
Water Cementitious Ratio (w/*cm*)	**0.37**	**0.41**	**0.45**	**0.37**	**0.41**	**0.45**
Mix Designation	**L-203**	**L-204**	**L-205**	**L-206**	**L-207**	**L-208**
Portland Cement, (lbs)	505	498	492	510	505	504
Fly Ash Class F, (lbs)	109	108	106	110	109	109
Silica Fume, (lbs)	25	24	24	38	38	38
Fine Aggregates, (lbs)	1160	1117	1078	1160	1122	1094
Coarse Aggregates, (lbs)	1739	1676	1618	1740	1684	1640
Water, (lbs)	237	260	281	244	268	293
Water Reducer, (oz)	5	5	6	8	6	5
Superplasticizer, (oz)	38	38	37	40	39	39
Air Entrainig Agent, (oz)	70	19	0	53	13	52
Materials Weights, (lbs)	3775	3683	3599	3802	3726	3677
Total Cementitious, (lbs)	639	630	623	658	652	651
Percent Fly Ash	22%	22%	22%	22%	22%	22%
Percent Silica Fume [1]	5%	5%	5%	7%	7%	7%
Paste Content, percent	27.2	28.4	29.5	28.1	29.4	30.9
Total Water, (gal)	28.5	31.1	33.6	29.2	32.2	35.1

Batch Properties

Concrete Temperature, F°	89°	89°	90°	85°	86°	86°
Ambient Temperature, F°	79°	80°	80°	84°	85°	86°
Slump, (in) initial	1.75	4.5	7.75	2.0	5.50	7.75
Slump, (in) after super	5.25	5.0	7.0	6.0	6.0	7.25
Air Content, percent	5.3%	6.0%	7.9%	4.5%	5.5%	6.2%
Initial Set, (hrs)	-	8.3	7.2	9.8	7.0	7.9

[1] By weight of cement

Materials Properties

Aggregates	Fine	Coarse
Absorption %	1.34	0.74
Specific Gravity	2.61	2.61
Fineness Modulus	2.75	-

Materials Sources

Cement Type I-II	Phoenix
Fly Ash Class F	Cholla
Aggregates	Snowflake
Water Reducer	Master Builder, MBL 80
Super Plasticizer	Master Builder, Rheo 1000
Air Entraining Agent	Master Builder, Micro Air

Figure A-1

September 28, 2004

Summary of Laboratory Test Results
For Laboratory Trial Batches

Age (days)	Compressive Strength, ASTM C-39, psi					
	L-203	L-204	L-205	L-206	L-207	L-208
1	2,370	1,850	1,540	1,790	1,550	1,370
3	4,900	3,580	2,480	4,080	2,820	3,020
7	6,030	4,360	3,160	4,570	3,830	3,680
14	7,210	5,360	3,970	6,210	5,380	4,930
28	8,380	6,100	4,670	7,020	6,560	5,550
56	9,010	7,080	4,960	7,340	6,550	6,080
90	9,670	7,300	5,290	-	6,720	6,320

Age (days)	Shrinkage Potential, (Length change) ASTM C-157					
	L-203	L-204	L-205	L-206	L-207	L-208
4	-0.00933	-0.01167	-0.00933	-	-	-
7	-0.01600	-0.01567	-0.01933	0.00300	-0.00233	-0.00300
14	-0.01700	-0.01767	-0.02333	-0.00567	-0.00833	-0.01033
28	-0.02700	-0.02900	-0.03500	-0.01200	-0.01400	-0.01933
56	-0.03533	-0.03733	-0.04400	-0.02633	-0.02700	-0.03167

Sample	Rapid Chloride Ion Permeability, (Coulomb) ASTM C-1202					
	L-203	L-204	L-205	L-206	L-207	L-208
A	540	820	880	565	690	850
B	755	985	1215	660	1110	1265
Average	648	903	1048	613	900	1058

Sample	Freeze Thaw Resistance Test, (Durability Factor) ASTM C-666 Method B					
	L-203	L-204	L-205	L-206	L-207	L-208
A	101	102	95	108	108	103
B	102	104	100	95	101	103
Average	102	103	98	102	105	103

Figure A-2

September 28, 2004

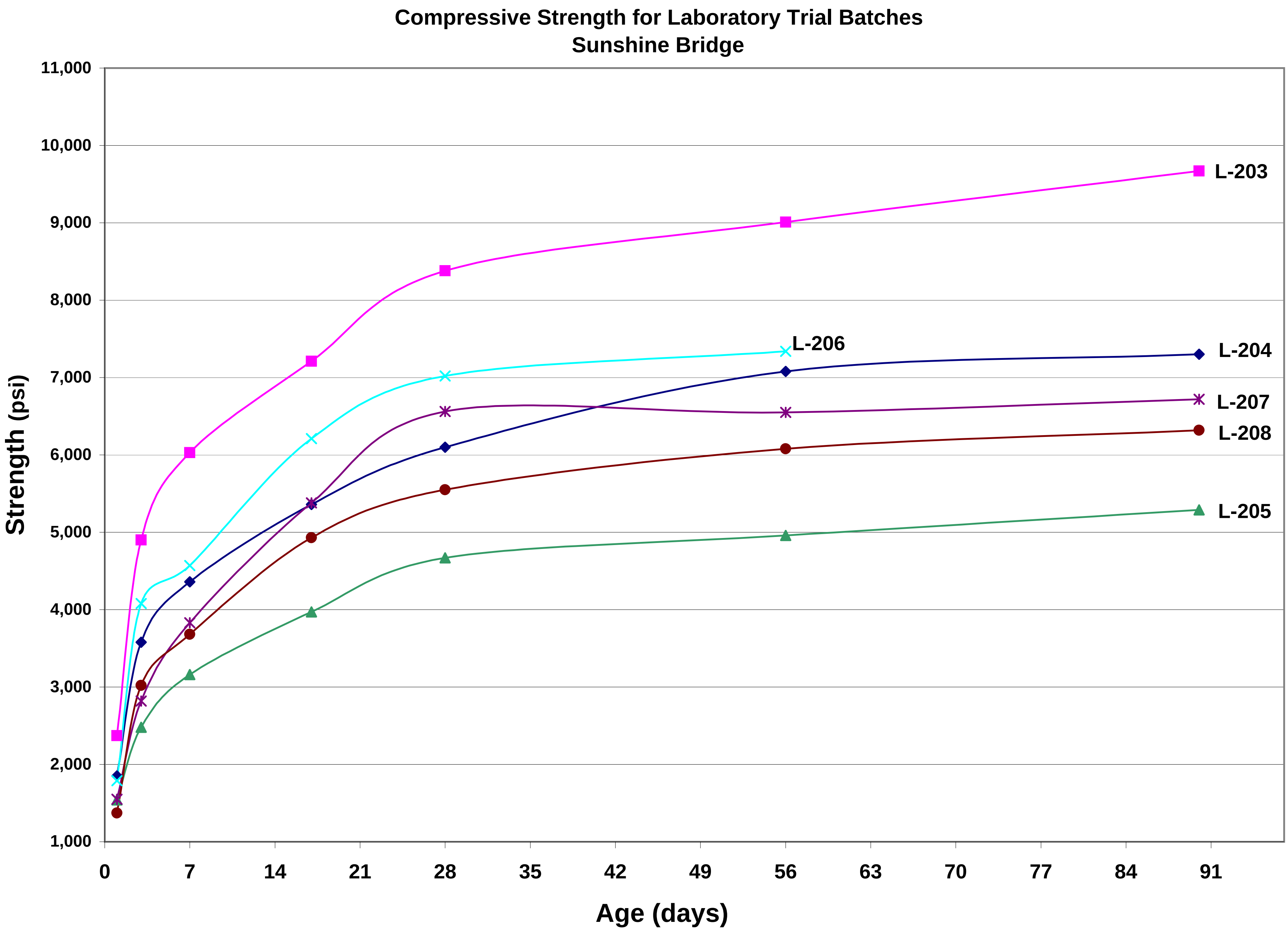


Figure A-3

September 28, 2004

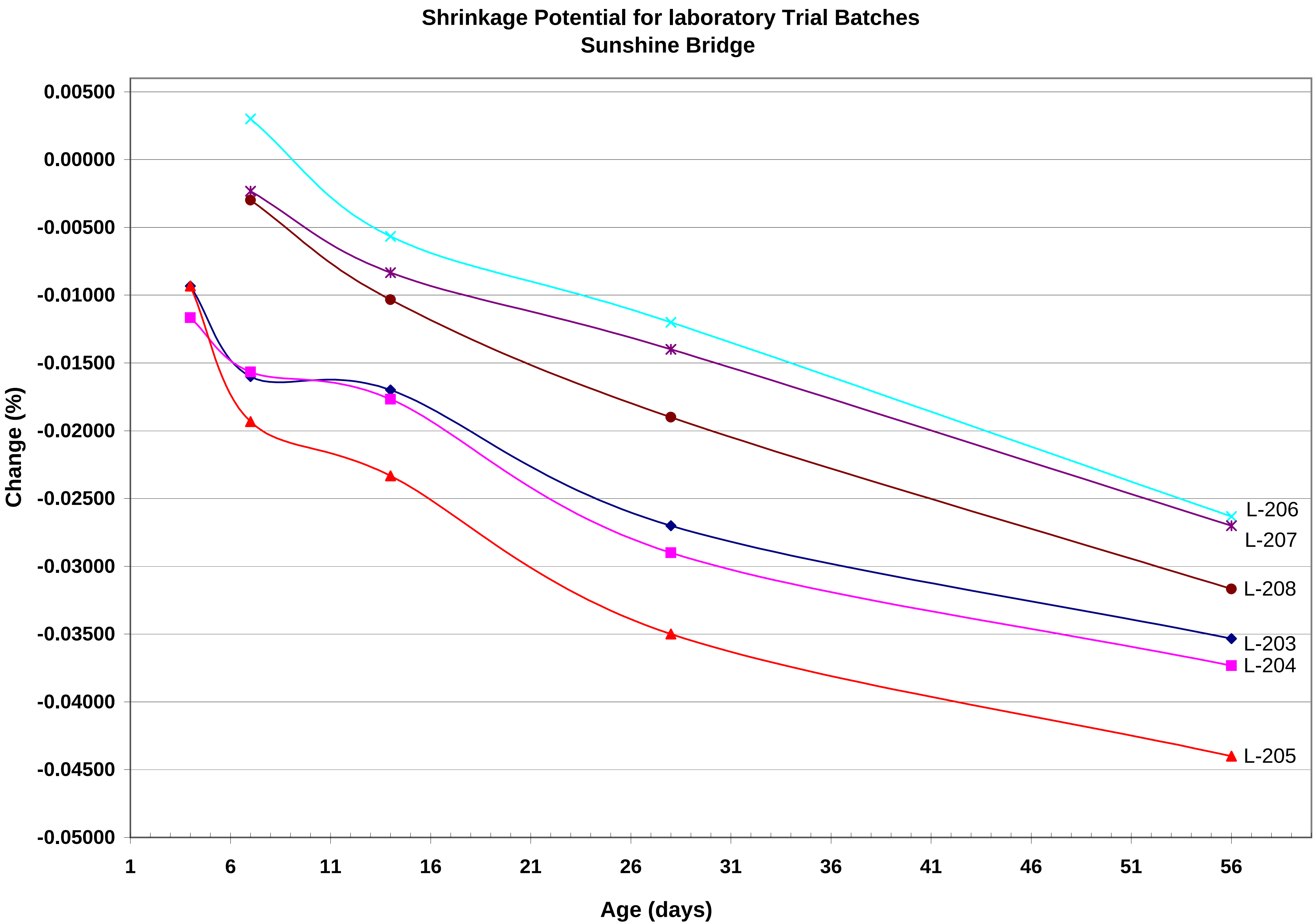


Figure A-4

August 3, 2004

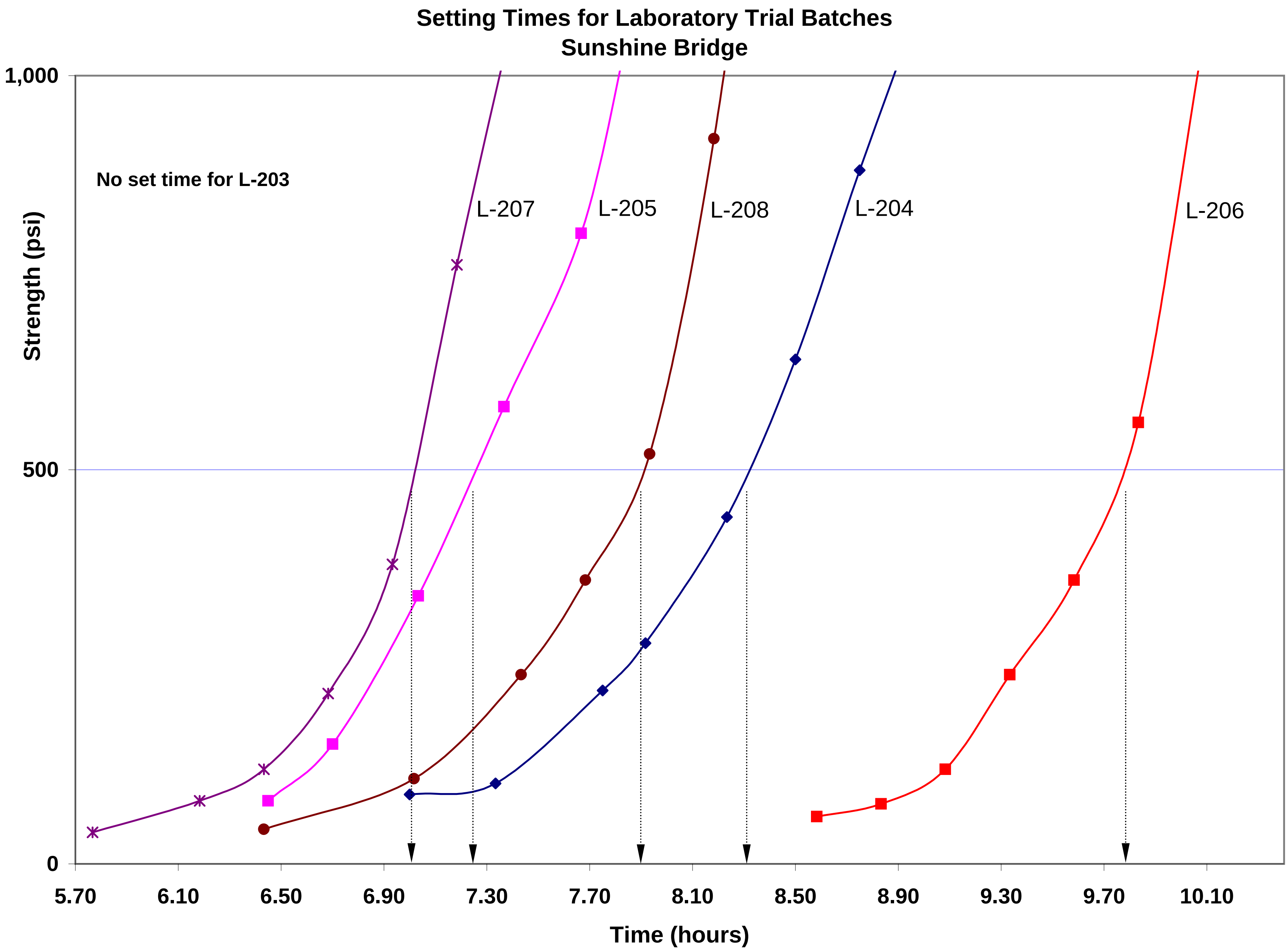


Figure A-5

KLEINFELDER

TECHNICAL REPORT

REPORT TO:	Jaber Engineering and Consulting 10827 E. Butherus Drive Scottsdale Arizona 85255	DATE: JOB NUMBER: SHEET:	September 22, 2004 49422 1 of 2

ATTENTION: Mr. Tarif Jaber

REPORT OF: Rinker, 19th Avenue Plant Concrete Sand and Course Aggregate ASTM C33 Tests for use in Portland Cement Concrete.

SAMPLE IDENTIFICATION

On August 18, 2004 our laboratory obtained one sample of concrete sand and one sample of course aggregate from the above-referenced pit. The samples were taken from stockpiles that were located near the west side of the Rinker laboratory and were identified by Michael McGurdy of Rinker. At your request, a sieve analysis, organic impurities, sodium sulfate soundness, clay lumps and friable particles, specific gravity and lightweight pieces in aggregate tests were performed. These tests were performed in general accordance with the ASTM D75, C136, C117, C40, C88, C142, C127, C128, C123 standards. Additional material was sampled and remains at our facility pending your instruction. Results of the tests are summarized on the attached sheet.

LABORATORY MANAGER: ______________________

REVIEWED BY: ______________________

MDO:jrs

As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of our clients and authorization for publication of statements, conclusions or extracts from or regarding our reports are reserved pending our written approval. Samples will be disposed of after testing is completed unless other arrangements are agreed to in writing. Copyright 1999.

Copyright 2004 Kleinfelder, Inc.

Figure A-6

TABLE NO. 1 SIEVE ANALYSIS, SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE (ASTM C136, C117, AND C128)

Sample No.	1	
Description	Rinker Concrete Sand	**ASTM C33**
Screen or Sieve Size	Percent Passing	
3/8"	100	100
No. 4	100	95 – 100
No. 8	84	80 – 100
No. 16	71	50 – 85
No. 30	52	25 – 60
No. 50	23	10 – 30
No. 100	3	2 – 10
No. 200	.4	0 – 5
Fineness Modulus	2.67	2.3 – 3.1
Bulk Dry Specific Gravity	2.591	N/A
Bulk Specific Gravity, SSD	2.616	N/A
Apparent Specific Gravity	2.658	N/A
Absorption, %	.97	N/A

TABLE NO. 2 FINE AGGREGATE PROPERTIES PERFORMED ON CONCRETE SAND

Laboratory Test	Test Method	Test Results	**ASTM C33 Table 1**
Clay Lumps and Friable Particles, %	ASTM C142	0.6	3 max*
Sodium Sulfate Soundness, % Loss after 5 Cycles	ASTM C88	1.1	10 max
Lightweight Pieces	ASTM C123	0.0	0.5 max*
Percent Finer than #200, %	ASTM C117	1.2	3.0 or 5.0
Unit Weight (Pcf)/ Voids,%	ASTM C29	106.1/ 34.3	N/A
Organic Impurities	ASTM C40	Lighter than Color Plate #1	Free of Injurious Amounts of Organic Impurities
Sand Equivalent	ASTM D2419	81	N/R

* From ASTM C33, Table 1

Copyright 2004 Kleinfelder, Inc.

Figure A-6

TABLE NO. 3 SIEVE ANALYSIS, SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE (ASTM C136, C117, AND C127)

Sample No.	1	
Description	Rinker Concrete Aggregate	**ASTM C33**
Screen or Sieve Size	Percent Passing	Number 57
1 1/2"	100	100
1"	100	95 – 100
3/4"'	90	...
1/2"	41	25 – 60
3/8"	14	...
1/4"	1	...
No. 4	1	0 – 10
No. 8	1	0 – 5
No. 200	.2	...
Finer than #200, %	.2	N/A
Bulk Dry Specific Gravity	2.582	N/A
Bulk Specific Gravity, SSD	2.601	N/A
Apparent Specific Gravity	2.632	N/A
Absorption, %	.73	N/A

TABLE NO. 4. AGGREGATE PROPERTIES PERFORMED ON COARSE AGGREGATE

Laboratory Test	Test Method	Test Results	**ASTM C33 Table 3**
Clay Lumps and Friable Particles, %	ASTM C142	0.2	3 max*
Sodium Sulfate Soundness, % Loss after 5 Cycles	ASTM C88	2.0	18 max
Lightweight Pieces	ASTM C123	0.0	0.5 max*
Unit Weight (Pcf)/ Voids,%	ASTM C29	98.5/ 38.7	N/A
%Loss on Abrasion 100/500 revolutions	ASTM C131	4 (%) & 21 (%)	50 max
Fractured Particles, %	ASTM D5821	92	N/R

* From ASTM C33, Table 3

Copyright 2004 Kleinfelder, Inc.

Figure A-6

UNIVERSITÉ DE SHERBROOKE

Faculty of Engineering
Department of Civil Engineering
Research Group on Cement and Concrete

October 20, 2004

Tarif M. Jaber, P.E.
Jaber Engineering Consulting, Inc.
10827 E. Butherus Drive
Scottsdale, AZ 85255

Dear Mr. Jaber:

The present report summarizes the results of the testing carried out on concrete samples as part of the contract referred to in Offer of services No 04-027. In this work order, six concrete mixtures were delivered to the University of Sherbrooke to assess frost durability and rapid chloride-ion permeability of high-performance concrete.

Results

Rapid chloride-ion permeability (Coulombs) according to ASTM C1202

Concrete	Sample (a)	Sample (b)	Mean
203	540	755	650
204	820	985	900
205	880	1215	1050
206	565	660	610
207	690	1110	900
208	850	1265	1060

Note : Samples (a) were machined from the bottom part of the 100 mm × 200 mm cylinders, whereas samples (b) were machined from the top part.

In total, 12 cylinders and 12 prisms were received sealed in plastic bags with humid rags. The cylinders were preserved in a moisture room until the age of 56 days, whereas the prisms were stored in lime-saturated water for one week before starting the freeze-thaw testing.

According to Table 1, concrete mixtures 203, 204, 206 and 207 have “very low “chloride-ion permeability levels. For mixtures 205 and 208, the chloride-ion permeability level is considered as “low”.

The difference in results obtained from the bottom and top samples shows possible segregation in the concrete where samples tested from top sections of 100 mm × 200 mm cylinders had greater conductivity values.

As shown in the table below, all tested prisms exhibited excellent durability factors with regards to exposure to freezing and thawing cycles.

Variations in lengths as a function of the number of freezing and thawing cycles for all tested samples are presented in the attachment.

Frost durability factor (%) according to ASTM C666, Procedure B

Concrete	Sample (a)	Sample (b)	Mean
203	101	100	100
204	102	104	103
205	95	100	98
206	108	95	102
207	108	101	104
208	103	103	103

In the hope that you will find all to your satisfaction, I remain,

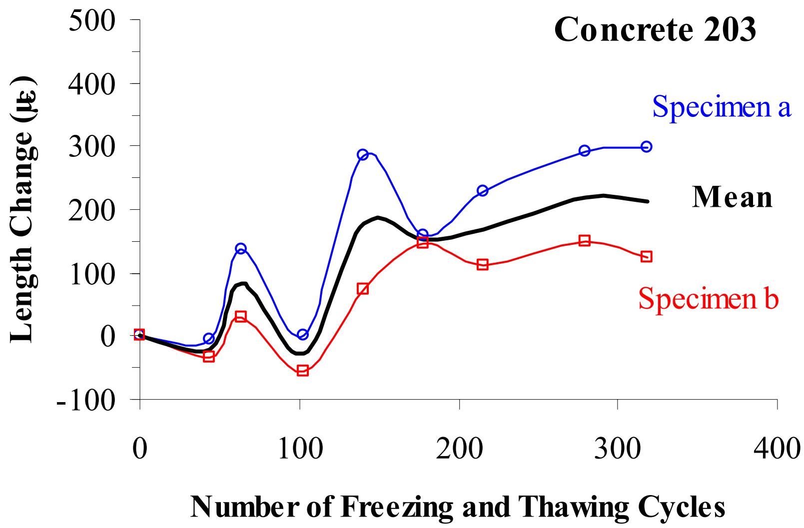
Yours sincerely,

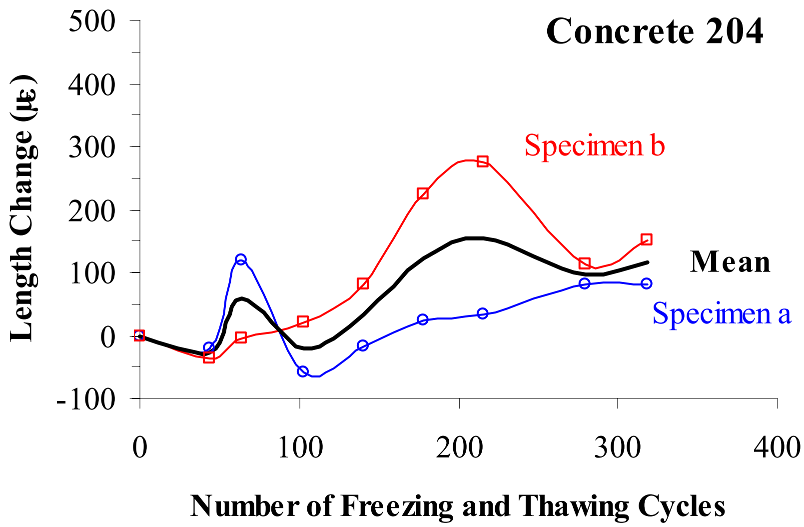
Nikola Petrov, P. Eng., Ph.D.
Adjunct Professor

Kamal H. Khayat, P. Eng., Ph.D.
Professor

Attachment

Graphs showing length changes as a function of the number of freezing and thawing cycles for the six tested concretes


Concrete 203
Specimen a
Mean
Specimen b
Length Change (με)
Number of Freezing and Thawing Cycles


Concrete 204
Specimen b
Mean
Specimen a
Length Change (με)
Number of Freezing and Thawing Cycles

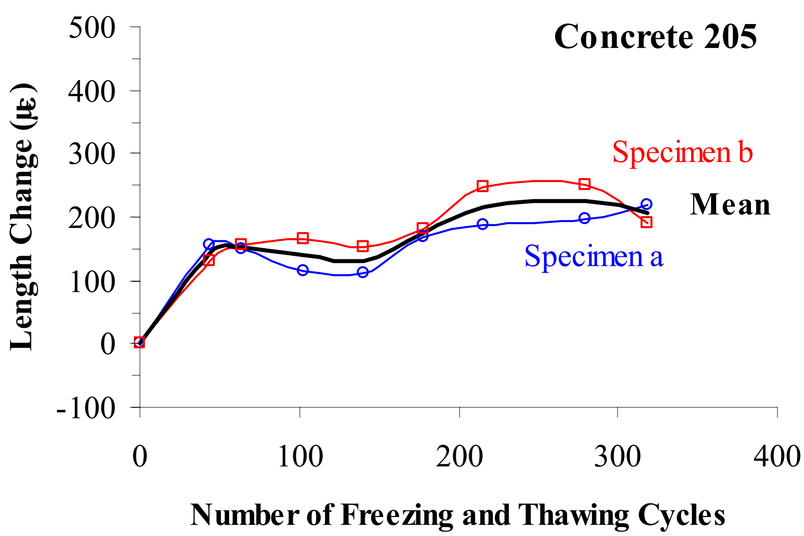
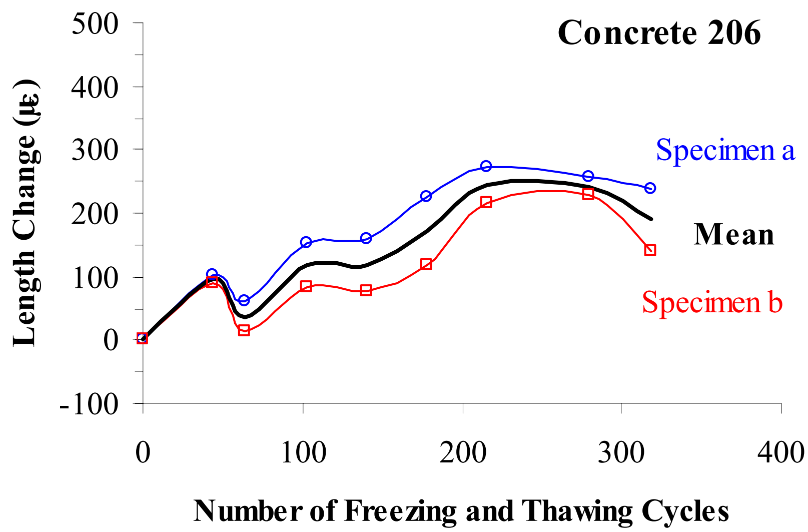
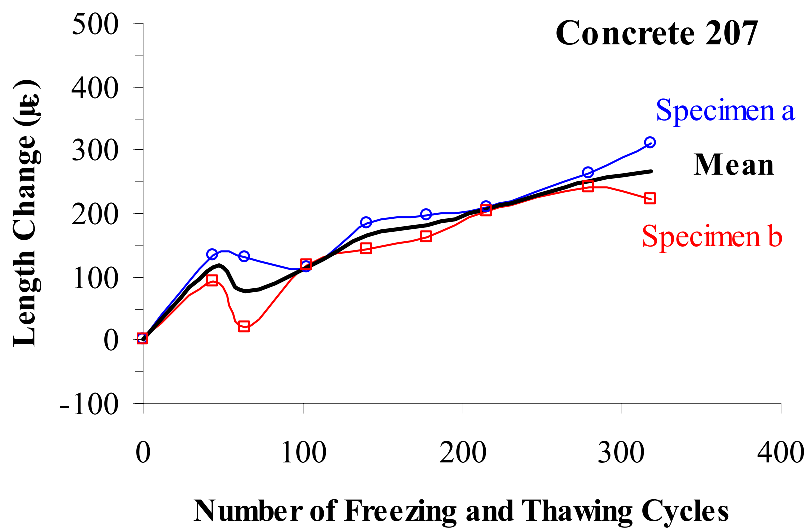

Concrete 205
Specimen b
Mean
Specimen a
Length Change (με)
Number of Freezing and Thawing Cycles

Figure A-7


Concrete 206
Specimen a
Mean
Specimen b
Length Change (με)
Number of Freezing and Thawing Cycles


Concrete 207
Specimen a
Mean
Specimen b
Length Change (με)
Number of Freezing and Thawing Cycles

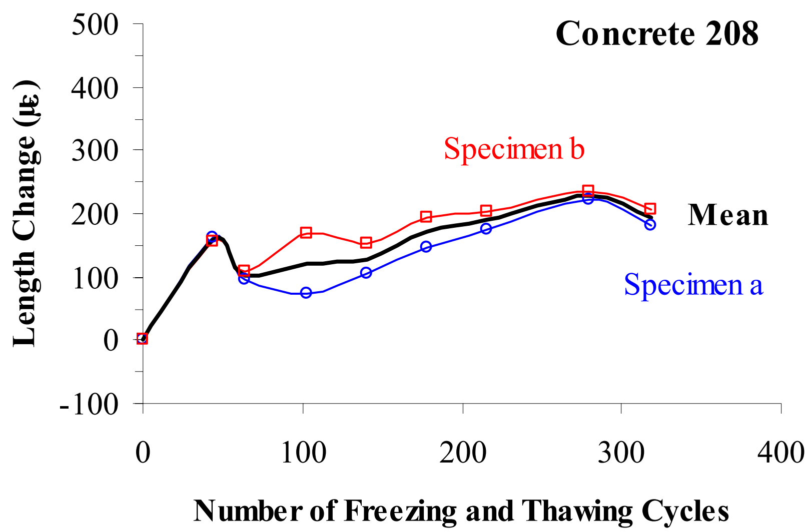

Concrete 208
Specimen b
Mean
Specimen a
Length Change (με)
Number of Freezing and Thawing Cycles

Figure A-7

APPENDIX B

Field Trial Batches
Quality Ready Mix

LIST OF FIGURES

Summary of Ready Mix Field Trial Batches
Sunshine Bridge

Concrete Mix	**ADOT Class S**	**Silica Fume HPC**
Ready Mix Designation	**1332439**	**1344969**
Water/Cementitious Ratio *w/cm*	**0.43**	**0.43**
Portland Cement, (lbs)	533	450
Fly Ash Class F, (lbs)	110	110
Silica Fume, (lbs)	0	23
Fine Aggregates, (lbs)	1244	1181
Coarse Aggregates, (lbs)	1592	1765
Water, (lbs)	276	250
Water Reducer, (oz)	38.0	38.0
Superplasticizer, (oz)	0.0	17.0
Retarder, (oz)	9.3	10.7
Air Entrainig Agent, (oz)	5.3	4.7
Materials Weights, (lbs)	3755	3779
Total Cementitious, (lbs)	643	583
Percent Fly Ash	21%	24%
Percent Silica Fume (1)	0%	5%
Paste Content, percent	29.4	26.9
Total Water (gal)	33.1	30.0

Batch Properties

Time Batched	10:36 a.m.		12:40 p.m.
Time Tested	10:55 a.m.	11:40 a.m.	1:00 p.m.
Age at Testing	19 minutes	1 hr, 4 minutes	1 hr, 20 minutes
Concrete Temperature, F°	80°	80°	75
Ambient Temperature, F°	78°	78°	72
Slump, initial,(in)	6.0	5.50	3.50
Air content, percent	7.4%	5.3%	5.6%
Air content, Gravimetric, percent	8.6%	7.8%	8.1%
Unit Weight, (pcf)	136.7	137.90	137.10
Unit Weight, theoretical, (pcf)	149.5	149.5	149.2

(1) By weight of cement

Materials Properties

Aggregates		
Absorption %	Fine	Coarse
Specific Gravity	1.34	0.74
Fineness Modulus	2.61	2.61
	2.75	-

Materials Sources

Cement Type I-II	Phoenix
Fly Ash Class F	Cholla
Aggregates	Snowflake
Water Reducer	Pozzolith 80
Super Plasticizer	Master Builder, Rheo 1000
Air Entraining Agent	Master Builder, Micro Air
Retarder	Master Builder, Delvo

Figure B-1

January 26, 2005

Summary of Laboratory Test Results
Field Trial Batches, Joseph City , AZ

Compressive Strength, ASTM C-39, (psi)		
Age (Days)	**ADOT Class S Control Mix**	**Silica Fume Mix**
2	1,970	2,460
3	2,040	2,810
7	2,700	3,340
28	3,810	4,810
56	4,230	5,510
90	4,770	5,710

Static Modulus of Elasticity, ASTM C- 469		
Parameters	**ADOT Class S Control Mix**	**Silica Fume Mix**
28 days Strength	3,450	4,620
Measured Ec	3,690,000	4,380,000
40% f_c	3,730,000	4,370,000
450 μ strain	3,730,000	4,380,000

Rapid Chloride Permeability, ASTM C-1202, (Coulomb)		
Sample No.	**ADOT Class S Control Mix**	**Silica Fume Mix**
A	2723	743
B	2496	792

Air Void System Analysis, ASTM C-457 98		
Parameters	**ADOT Class S Control Mix**	**Silica Fume Mix**
Air Content	5.40	3.20
No. of Voids/inch	15.50	10.30
Specific Surface	1157	1281
Spacing Factor	0.004	0.004
Paste Content	31.6	23.5

Figure B-2

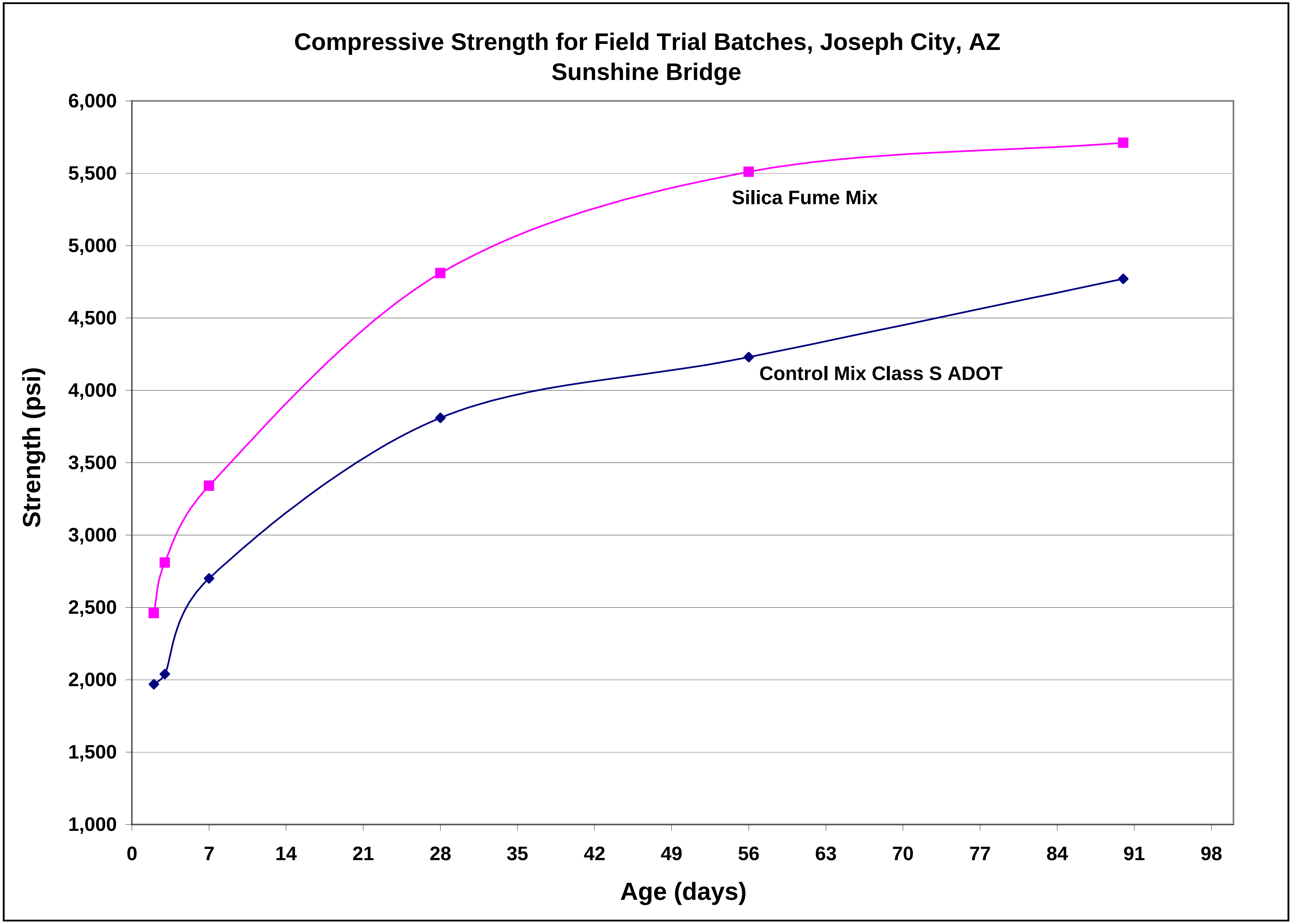

Compressive Strength for Field Trial Batches, Joseph City, AZ
Sunshine Bridge
Strength (psi)
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
0
7
14
21
28
35
42
49
56
63
70
77
84
91
98
Age (days)
Silica Fume Mix
Control Mix Class S ADOT

Figure B-3

ASTM C 469–02, Static Modulus of Elasticity Results

Project No.	390322	Maximum Load, lb	130,500	
Diameter 1, in.	6.000	**Compressive Strength, psi**	**4,620**	
Diameter 2, in.	6.000	**40% Comp Stength, psi**	**1,848**	
Cross-sectional area	28.27	**Measured Ec Linear Reg.**	**4,380,000**	($R2$ = 1.000)
Load increment, lbs	6,500	**ASTM Ec @ 40% fc**	**4,370,000**	
Rig Factor*	1.200	**ASTM Ec @ 450 μstrain**	**4,380,000**	
No. of Readings	11	Identification: 49422 SF - Sample 2		

Reading No.	Stress	Gage Readings Run 2	Run 3	μstrain	Stress, psi	3 Point Tangent Ec
1	0	95	95	0	0	--
2	230	145	165	50	230	4,600,000
3	460	215	215	100	460	4,410,000
4	690	280	280	154	690	4,240,000
5	920	345	345	208	920	4,330,000
6	1149	405	410	260	1,149	4,330,000
7	1379	470	475	315	1,379	4,410,000
8	1609	530	535	365	1,609	4,410,000
9	1839	595	600	419	1,839	4,410,000
10	2069	655	660	469	2,069	4,500,000
11	2299	720	720	521	2,299	

*Rig Factor = (Gage Length x Multiplaction Factor) ÷10

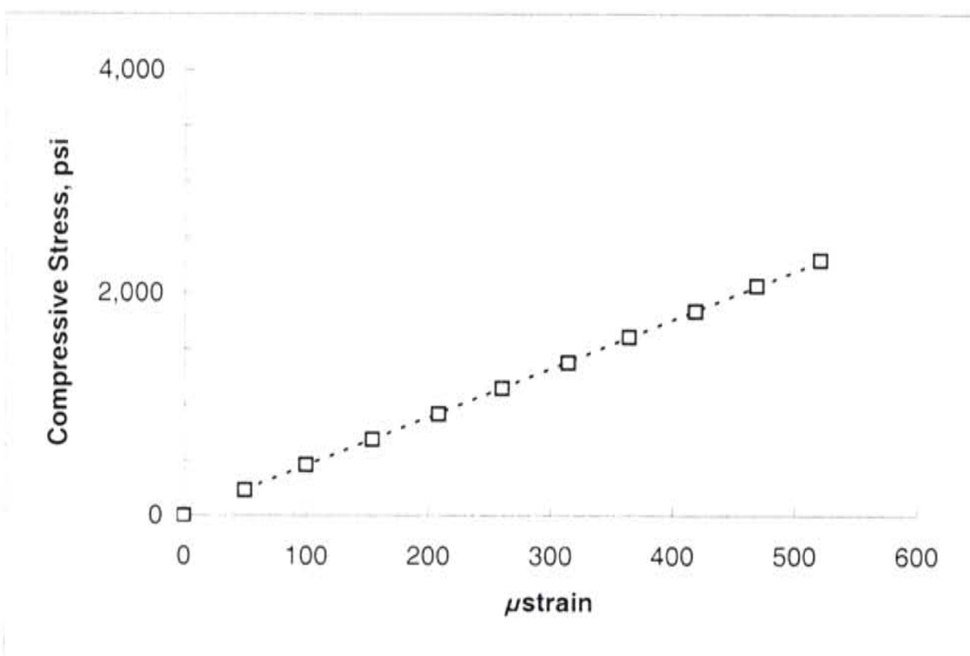


Figure B-4a SF Mix

ASTM C 469–02, Static Modulus of Elasticity Results

Project No.	390322	Maximum Load, lb	98,000	
Diameter 1, in.	6.010	**Compressive Strength, psi**	**3,450**	
Diameter 2, in.	6.020	**40% Comp Stength, psi**	**1,380**	
Cross-sectional area	28.42	**Measured Ec Linear Reg.**	**3,690,000**	($R2 = 1.000$)
Load increment, lbs	5,500	**ASTM Ec @ 40% fc**	**3,730,000**	
Rig Factor*	1.200	**ASTM Ec @ 450 μstrain**	**3,730,000**	
No. of Readings	11	Identification: 49422 C - Sample 2		

Reading No.	Stress	Gage Readings Run 2	Run 3	μstrain	Stress, psi	3 Point Tangent Ec
1	0	25	25	0	0	--
2	194	70	85	44	194	4,220,000
3	387	130	140	92	387	3,870,000
4	581	195	200	144	581	3,570,000
5	774	260	270	200	774	3,510,000
6	968	325	335	254	968	3,710,000
7	1161	385	395	304	1,161	3,790,000
8	1355	450	455	356	1,355	3,720,000
9	1548	510	520	408	1,548	3,720,000
10	1742	575	580	460	1,742	3,640,000
11	1936	640	645	515	1,936	

*Rig Factor = (Gage Length x Multiplaction Factor) ÷10

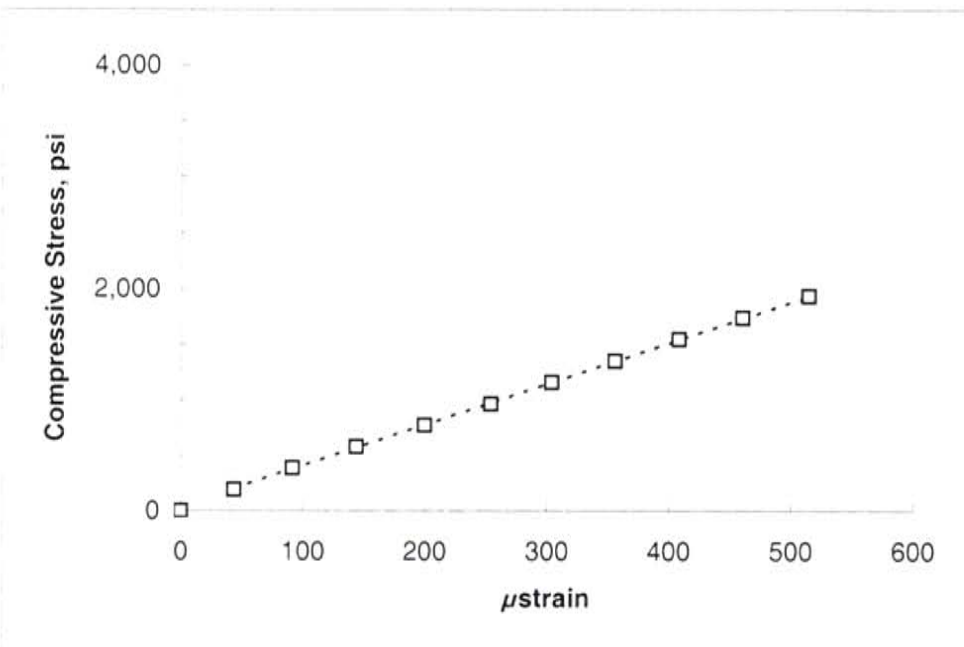


Figure B-4b Control Mix

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 390322
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: January 26, 2005

RAPID CHLORIDE PERMEABILITY RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
49422 SF A	11-30-04	743	Very Low
49422 SF B	11-30-04	792	Very Low

Sample Type: 4-in. diameter concrete cylinders.
Age at Test: 56 days.
Specimens History: The cylinders were received at CTL in moist condition. Upon receipt at CTL, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

Figure B-5a SF Mix

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 390322
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: January 26, 2005

RAPID CHLORIDE PERMEABILITY RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
49422 C A	11-30-04	2723	Moderate
49422 C B	11-30-04	2496	Moderate

Sample Type: 4-in. diameter concrete cylinders.
Age at Test: 56 days.
Specimens History: The cylinders were received at CTL in moist condition. Upon receipt at CTL, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

Figure B-5b Control Mix

CTLGroup
Building Knowledge. Delivering Results.
CONSTRUCTION TECHNOLOGY LABORATORIES
ENGINEERS & CONSTRUCTION TECHNOLOGY CONSULTANTS
www.CTLGroup.com

REPORT OF AIR-VOID SYSTEM ANALYSIS
ASTM C 457-98 Modified Point-Count Method

CTLGroup Project No.: 390322

Report Date: February 22, 2005

Client: Jaber Engineering

Samples Received: February 11, 2005

Client Project: Sunshine Bridge Materials Testing

Tested By: V. Jennings

Maximum Size Aggregate: ¾ in.

Sample ID	Total Air Content, %	No. Voids/ inch	Specific Surface, $in.^2/in.^3$	Spacing Factor, in.	Paste Content, %	Length of Traverse, in.
Control Mix	5.4	15.5	1157	0.004	31.6	93
Silica Fume Mix	3.2	10.3	1281	0.004	23.5	93

Comments: The concrete specimens are air entrained, based on the presence of small, spherical voids in the hardened paste matrix and measured air-void parameters. Distribution of entrained air voids is uniform in both samples.

American Concrete Institute,
ACI 201.2R-92
"Guide to Durable Concrete"
TABLE 1.4.3 RECOMMENDED AIR CONTENTS FOR FROST-RESISTANT CONCRETE

Nominal maximum aggregate size		Average air content, percent*	
in.	(mm)	Severe exposure+	Moderate exposure++
⅜	(9.5)	7½	6
½	(12.5)	7	5½
¾	(19)	6	5
1½	(38)	5½	4½
3§	(75)	4½	3½
6§	(150)	4	3

* A reasonable tolerance for air content in field construction is ± 1½%.

+ Outdoor exposure in a cold climate where the concrete may be in almost continuous contact with moisture prior to freezing, or where deicing salts are used. Examples are pavements, bridge decks, sidewalks, and water tanks.

++ Outdoor exposure in a cold climate where the concrete will be only occasionally exposed to moisture prior to freezing, and where no deicing salts will be used. Examples are certain exterior walls, beams, girders, and slabs not in direct contact with soil.

§ These air contents apply to the whole mix, as for the preceding aggregate sizes. When testing these concretes, however, aggregate larger than 1½ in. (38 mm) is removed by hand-picking or sieving and the air content is determined on the minus 1½ in. (38 mm) fraction of the mix. (The field tolerance applies to this value.) From this the air content of the whole mix is computed.

There is conflicting opinion on whether air contents lower than those given in the table should be permitted for high-strength [more than 5500 psi (37.8 MPa)] concrete. This committee believes that where supporting experience and/or experimental data exists for particular combinations of materials, construction practices, and exposure, the air contents may be reduced by approximately 1 percent. [For maximum aggregate sizes over 1½ in. (38 mm), this reduction applies to the minus 1½ in. (38 mm) fraction of the mix.]

AIR-VOID SYSTEM: Most authorities consider the following air-void characteristics as representative of a system with adequate freeze-thaw resistance:

1. Calculated spacing factor (average maximum distance from any point in cement paste to edge of nearest air void)--less than 0.008 in. (0.20 mm).
2. Specific surface (surface area of the air voids)-- 600 $in.^2$ per cubic inch (23.6 mm^2/mm^3) of air-void volume, or greater.
3. Number of voids per linear inch (25 mm) of traverse be significantly greater than the numerical value of the percentage of air in the concrete.

References: (1) Design and Control of Concrete Mixtures, 14th Edition, Portland Cement Association, 2002, p. 146.
(2) American Concrete Institute, ACI 212.3R-91, (Section 2.2).

Main Office 5400 Old Orchard Road Skokie, Illinois 60077-1030 Phone 847-965-7500 Fax 847-965-6541
Northeast Office 5565 Sterrett Place Suite 312 Columbia, Maryland 21044-2685 Phone 410-997-0400 Fax 410-997-8480

Figure B-6

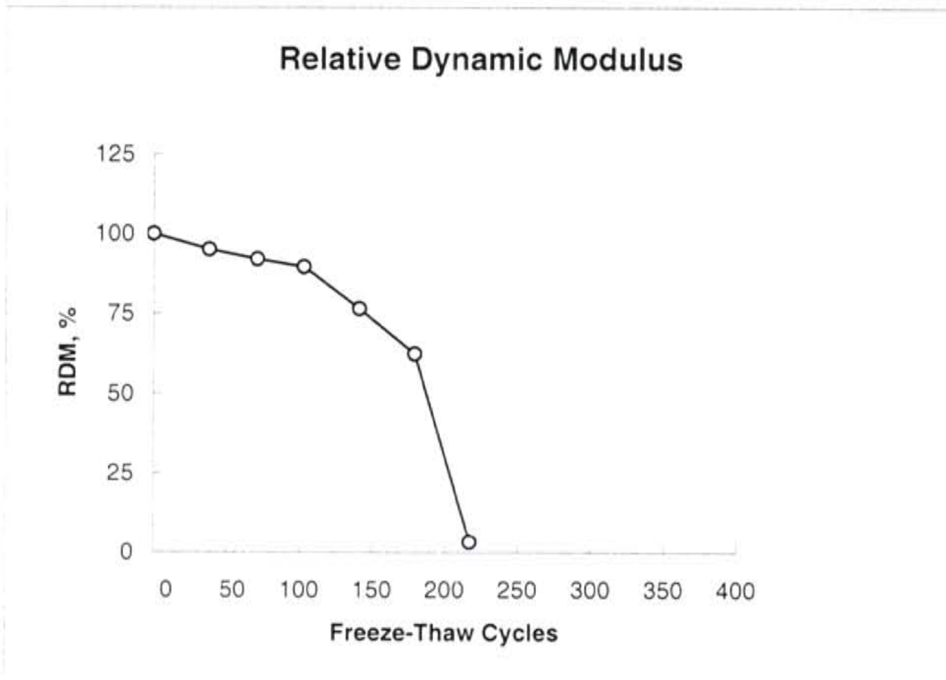
Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 390322
CTL Project Mgr.: T. Muresan
Technician: L. Duval
Approved: W. Morrison
Date: January 26, 2005

Test Results† of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0.000	0.00	100
	38	0.003	- 0.08	95
Mix 1 (SF)	71	0.048	- 0.21	92
A and B	103	0.040	0.12	90
	141	0.045	- 0.07	77
	179	0.061	- 0.44	62
	217	0.108	- 1.16	3

† Values are the average of two specimens.



Note: Samples were discontinued after 217 cycles due to severe deterioration of the samples.

Figure B-7a SF Mix

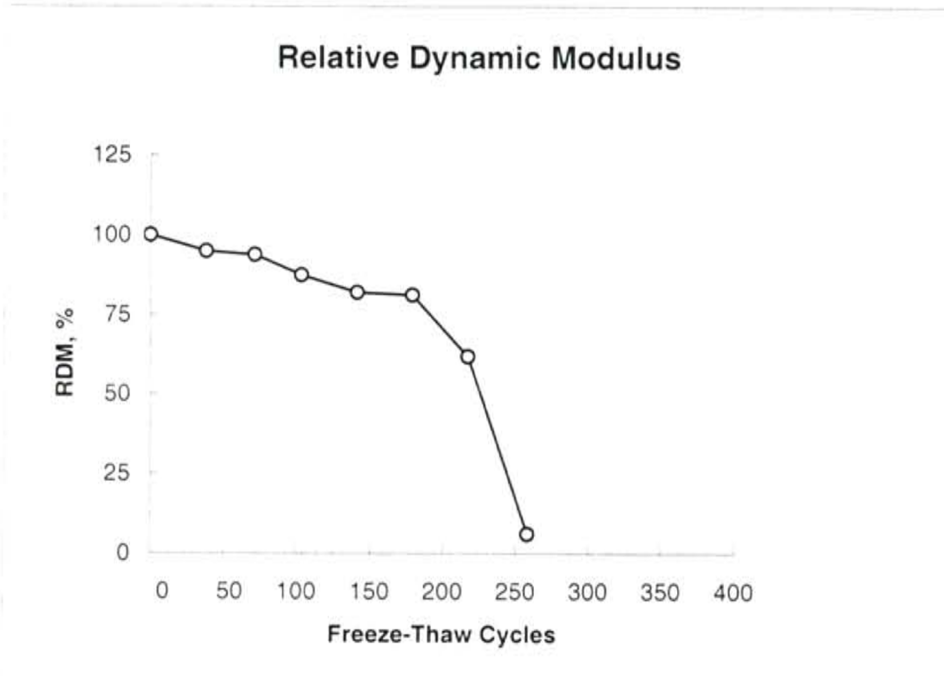
Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 390322
CTL Project Mgr.: T. Muresan
Technician: L. Duval
Approved: W. Morrison
Date: January 26, 2005

Test Results† of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0.000	0.00	100
	38	0.003	- 0.10	95
Mix 2 (C)	71	0.006	- 0.03	94
A and B	103	0.006	0.01	88
	141	0.009	- 0.20	82
	179	0.012	- 0.37	81
	217	0.030	- 0.63	62
	258	0.048	- 1.41	6

† Values are the average of two specimens.



Note: Samples were discontinued after 258 cycles due to severe deterioration of the samples.

Figure B-7b Control Mix

Client: Jaber Engineering	CTL Project No.: 390322
Project: Sunshine Bridge Materials Testing	CTL Project Mgr.: T. Muresan
Contact: Mr. Tarif Jaber	Technician: L. Duval
Submitter: Mr. Tarif Jaber	Approved: W. Morrison
	Date: January 26, 2005

Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Mix 1 (SF) Sample A" and "Mix 1 (SF) Sample 2"

	Cummulative Mass Loss, lb/ft^2				Visual Scale Rating (ASTM C 672)			
Cycle	Mix 1A	Mix 1B	*	Avg.	Mix 1A	Mix 1B	*	Avg.
0	0	0	*	0	0	0	*	0
5	0.00	0.00	*	0.00	0.0	0.0	*	0.0
10	0.01	0.03	*	0.02	0.5	0.5	*	0.5
15	0.01	0.03	*	0.02	0.5	0.5	*	0.5
20	0.02	0.07	*	0.05	1.0	1.0	*	1.0
25	0.02	0.07	*	0.05	1.0	1.0	*	1.0
30	0.06	0.11	*	0.09	1.5	1.5	*	1.5
35	0.09	0.15	*	0.12	2.0	2.0	*	2.0
40	0.12	0.18	*	0.15	2.0	2.5	*	2.3
45	0.15	0.21	*	0.12	2.5	2.5	*	2.5
50	0.19	0.27	*	0.15	3.0	3.0	*	3.0

Notes:
Deicing solution 4% calcium chloride.
* Only two samples were tested.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max. no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)

Cumulative Mass Loss Versus Cycles

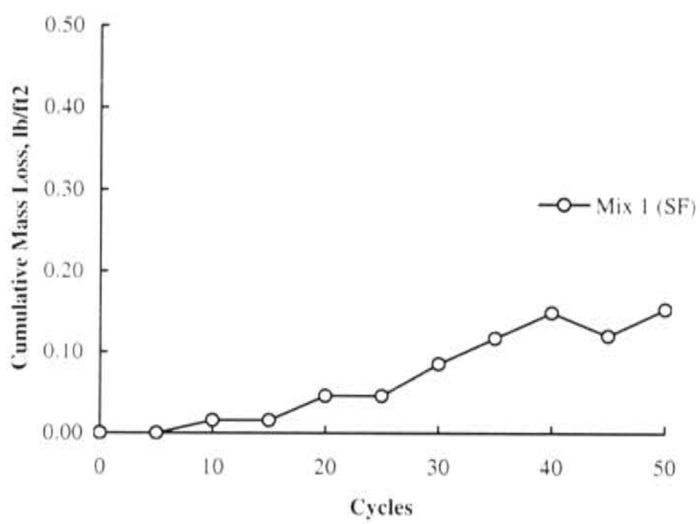


Fig 1 – Deicer Scaling Resistance–Mix 1 (SF) Sample A before testing (above) and after testing (below)

Figure B-8a SF Mix

Fig 2 – Deicer Scaling Resistance–Mix 1 (SF) Sample B before testing (above) and after testing (below)

Figure B-8a SF Mix

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 390322
CTL Project Mgr.: T. Muresan
Technician: L. Duval
Approved: W. Morrison
Date: January 26, 2005

Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Mix 2 (C) Sample A" and "Mix 2 (C) Sample 2"

	Cummulative Mass Loss, lb/ft^2				Visual Scale Rating (ASTM C 672)			
Cycle	Mix 2A	Mix 2B	*	Avg.	Mix 2A	Mix 2B	*	Avg.
0	0	0	*	0	0	0	*	0
5	0.00	0.00	*	0.00	0.0	0.0	*	0.0
10	0.00	0.00	*	0.00	0.5	0.5	*	0.5
15	0.00	0.00	*	0.00	0.5	0.5	*	0.5
20	0.02	0.04	*	0.03	1.0	1.0	*	1.0
25	0.02	0.04	*	0.03	1.0	1.0	*	1.0
30	0.03	0.06	*	0.04	1.5	1.5	*	1.5
35	0.09	0.15	*	0.12	2.0	2.0	*	2.0
40	0.15	0.18	*	0.17	2.0	2.5	*	2.3
45	0.18	0.22	*	0.14	2.5	2.5	*	2.5
50	0.25	0.28	*	0.17	3.0	3.0	*	3.0

Notes:
Deicing solution 4% calcium chloride.
* Only two samples were tested.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)

Cumulative Mass Loss Versus Cycles

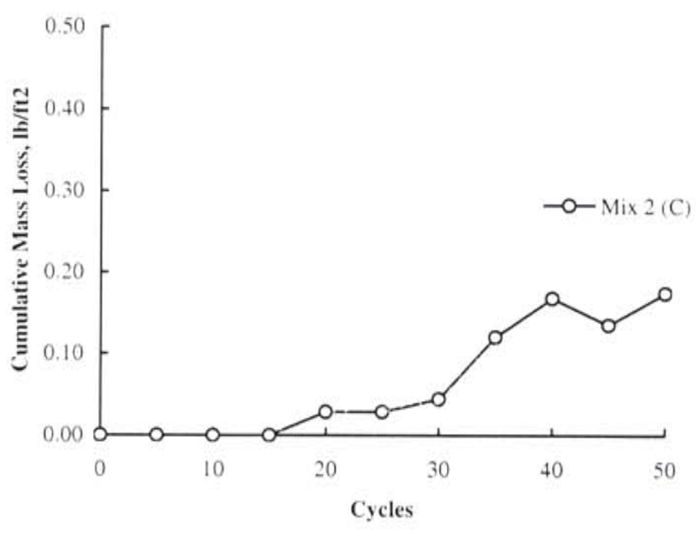


Figure B-8b Control Mix

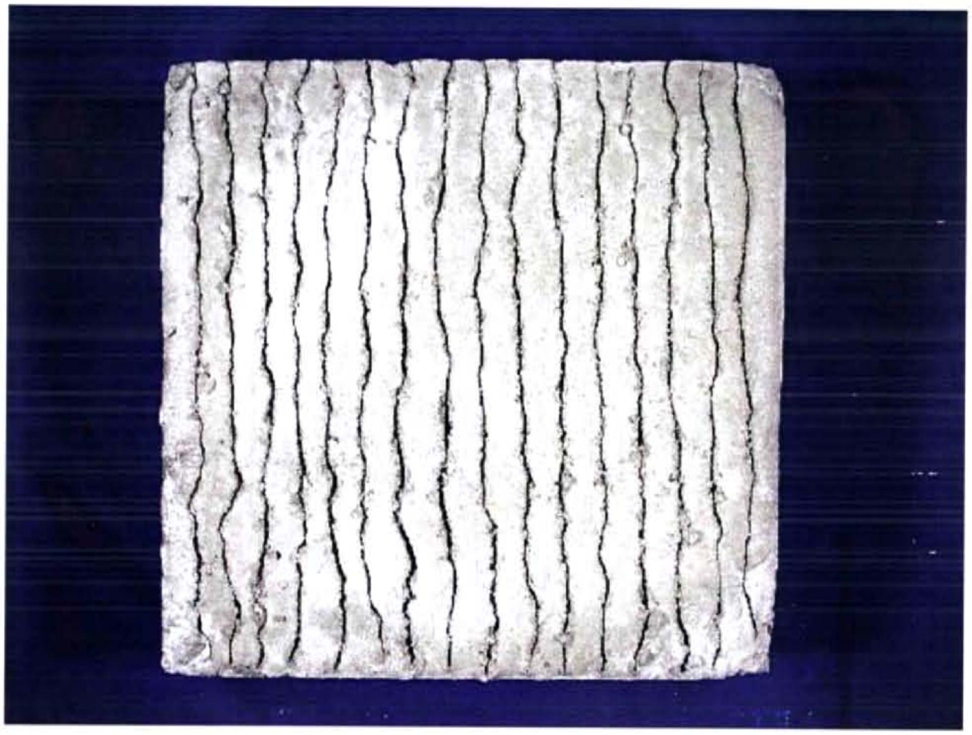


Fig 3 – Deicer Scaling Resistance–Mix 2 (C) Sample A before testing (above) and after testing (below)

Figure B-8b Control Mix

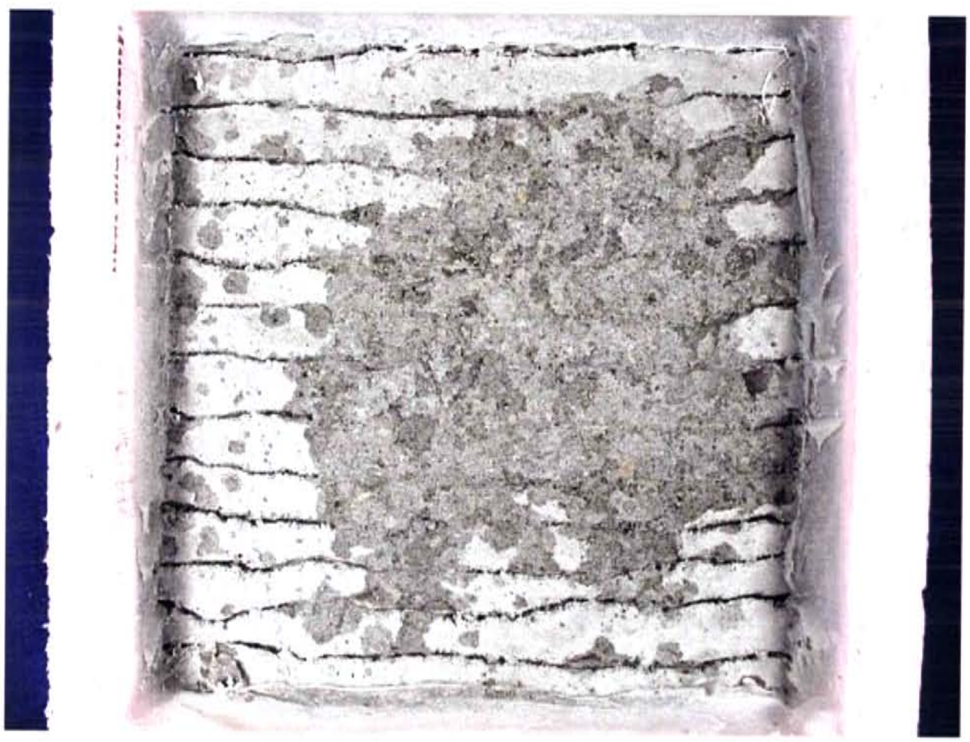


Fig 4 – Deicer Scaling Resistance – Mix 2 (C) Sample B before testing (above) and after testing (below)

Figure B-8b Control Mix

August 11, 2005

Mr. Tarif M. Jaber
Jaber Engineering
10827 E. Butherus Drive
Scottsdale, AZ 85255

Results of Further Investigation of the
Failure of Submitted ASTM C 666 Freeze-Thaw Specimens
CTLGroup Project No. 390322

Dear Mr. Jaber:

In response to our recent discussion and your concern that CTLGroup did not satisfactorily perform testing of control and silica fume samples you submitted in early November 2004 we have reviewed the test data and further examined the tested specimens.

You previously received two reports from CTLGroup dated January 26, 2005 and February 22, 2005 that indicated specimens of both mixes were not freeze-thaw durable. We conducted air-void analyses on samples from both mixes. This work showed the samples to be adequately air-entrained with respect to spacing factor and specific surface. The measured air content of the silica fume mix was 3.2%; the measured air content on the control sample was 5.4%

Since the air-void system was determined to be adequate for freeze-thaw resistance we examined one failed freeze-thaw specimen from the control and one from the silica fume mix petrographically in both lapped- and thin-section. Petrographic examination showed regular micro cracking along one side of each specimen concentrated around aggregates. Cracks are evident with large, bright crystals of calcium hydroxide along the periphery of aggregates. For the crystals to grow that large there had to have been space available. Therefore, either the aggregates were wet or gaps formed shortly after placement. These cracks indicate the specimens may have been dropped in a semi plastic state or perhaps jolted during demolding or movement from the field to the laboratory. Specimens become critically water saturated during this test and the cyclic freeze-thawing cause these cracks to expand. This appears to be the cause of failure in freeze-thaw testing.

In the future, nominally 3x3x11-inch specimens for ASTM C 666 rapid freezing and thawing should be fabricated, cured and handled as follows:

1. Place the concrete in the mold, in two layers.

2. Rod each layer 33 times with a 3/8-inch diameter rod.

3. After each layer is rodded, tap the outside of the molds lightly 10 to 15 times with a mallet.

4. After tapping, spade the concrete along the sides and ends of the beam mold with a snub-nose hand trowel.

5. Finish the surface with a magnesium or wood float. Finish the surface of the concrete with as little manipulation necessary to obtain a level surface with no depressions or projections. Finishing should be completed after 3 to 4 passes (this could be slightly more if the concrete is stiff).

6. Cover specimens with a plastic sheet and store in a temperature controlled environment of 73.5±3.5°F.

7. Remove molds after 24±8 hours or after 20±4 hours after final set. Do not knock specimens out of their molds. Molds should have a light coating of form release before concrete is introduced to help with demolding.

8. For the first 48 hours keep the specimens in a vibration free environment.

Additionally, the control and test slabs fabricated for ASTM C 672 showed moderate scaling (rating of 3). Finishing before the bleed water evaporated is the likely cause of the mortar skin coat scaling on these specimens. Also, the specimens were received with deep tine marks that may have exacerbated scaling. Following are instructions for the fabrication and curing of nominal 12x12x3-inch specimens for ASTM C 672.

1. Fill the mold in one layer.

2. Rod the layer 72 times with a 5/8-inch diameter rod.

3. After the layer is rodded, tap the outside of the molds lightly 10 to 15 times with a mallet.

4. After tapping, spade the concrete along the sides the mold with a snub-nose hand trowel.

5. Level the surface with a wood strike off board in several (3) passes.

6. After the concrete has stopped bleeding, screed the surface with three sawing motion passes with the wood strike off board. **Bleed water must be totally evaporated before screeding.**

7. The surface may be finished by dragging a stiff bristle brush along the surface or use of an appropriate finishing tool such as a steel trowel, burlap drag or whatever is going to be used in the field for finishing. **Finish the concrete surface with little manipulation as possible.**

8. Cover specimens with a plastic sheet and store in a temperature controlled environment of 73.5±3.5°F.

9. Remove molds after 20 to 24 hours after addition of water. Store in a controlled moist room at 73.5±3.5°F and 100% relative humidity for 14 days. Then remove the specimens from moist storage and store in air at 73.5±3.5°F and 45 to 55% relative humidity for and additional 14 days.

10. The first 48 hours should be in a vibration free environment.

Figure B-9

Tarif, I am confident that our test results as previously reported accurately reflected the performance of the samples submitted for test. Hopefully, our additional work has shed light on the reasons for the unanticipated behavior of the samples and provides insight on how to avoid this situation in the future.

Sincerely,

CTLGROUP
An AASHTO Accredited Laboratory – Aggregates, Cement & Concrete

Willy Morrison

W. Morrison
Principal Materials Consulting
Materials Consulting
wmorrison@CTLGroup.com
Direct Phone: 847-972-3162

Figure B-9

APPENDIX C

Preconstruction Work
Field Trial Batches
Slab Demonstrations

LIST OF FIGURES

Project Milestones Schedule for
HPC Deck Placement Sunshine Bridge Project

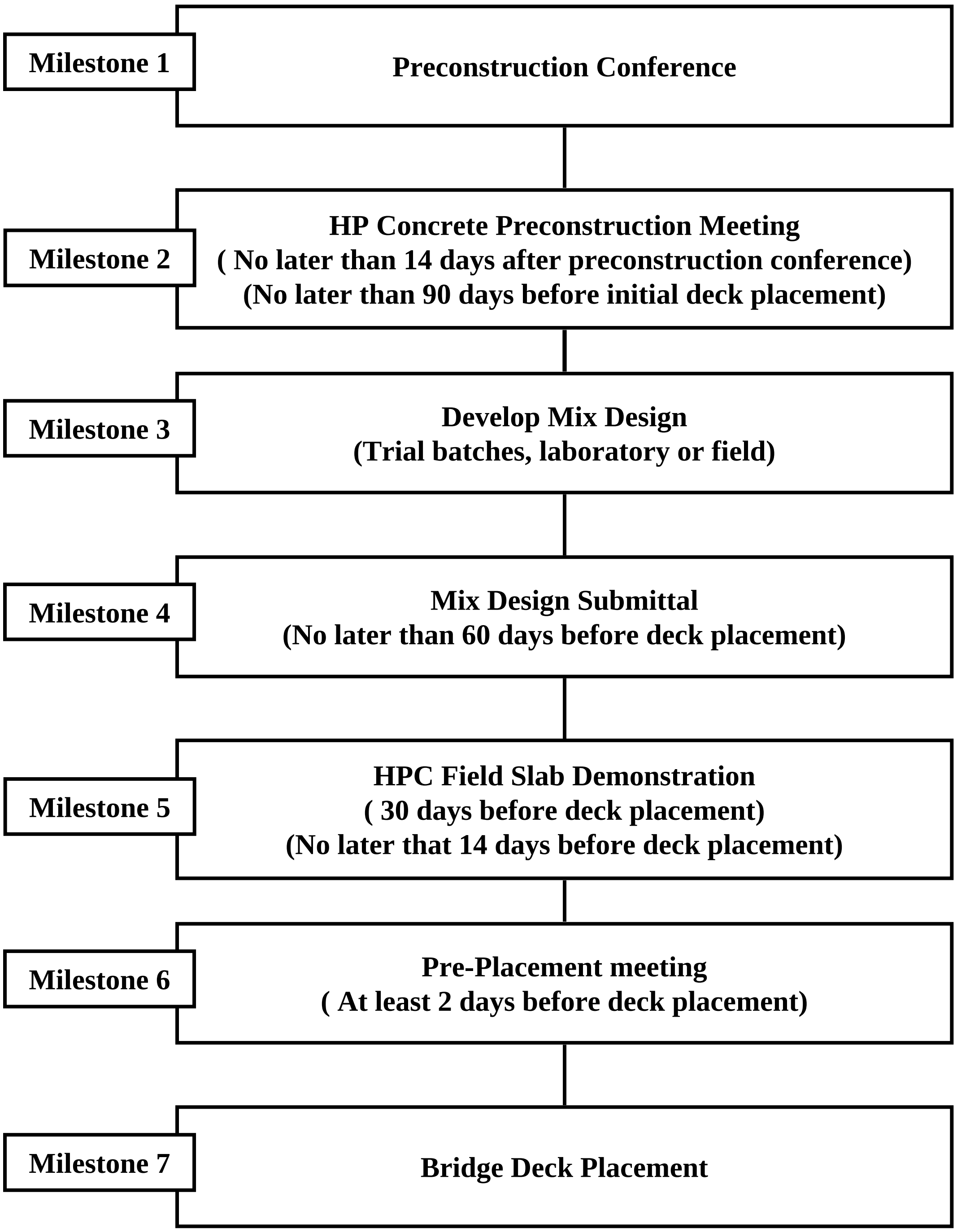


Figure C-1

Sunshine Bridge
Trial Batches

Material	Design	5/18/2005 Trial 1	5/23/2005 Trial 2	6/3/2005 Trial 3	
Cement, lbs	475	480	477	478	
Fly Ash, lbs	110	108	112	108	
Silica Fume, lbs	25	25	25	25	
Sand, lbs	1190	1176	1177	1174	
1" CA, lbs	1299	1294	1307	1310	
1/2" CA, lbs	371	373	365	377	
3/8" CA, lbs	186	198	218	189	
Water, lbs	250	282	250	259	
gls	30.0	33.8	30.0	31.0	
Micro Air, oz	9	9	9	11.5	
pozz 80, oz (water reducer)	37	37	37	37	
Rheo 1000, oz (plasticizer)	49	48		169	
				50 oz at batch	**no slump at 1 hr**
				64 oz at pump	**3 inch slump, stiffening**
Glenium 3400, oz (plasticizer)			49 / 58 (at plant / at pump)	**55 oz at pump**	**8 inch before pump**
					7 inch at 10 minutes
					5.25 inch at 20 minutes
w/c ratio	**0.410**	**0.460**	**0.407**	**0.424**	
Slump Before SP (Before Pump)		2.5	1.5		
Slump After SP (Before/After Pump)		4.5 / 4.5	6.5 / 6.5 3.25" in 15 min		
% Air (before/After Pump)		5.1 / 5.1	8.9 / 9.6	2.5	

Age	Strength, psi 6x12 / 4x8	Strength, psi 6x12	Strength, psi 6x12
1-day	1720 / 1990		2600
2-day		2150	
3-day			4370
7-day	4270 / 5030	3330	5200
14-day	5230 / 6290	3550	
28-day	6080 / 6840	4410	8970

Notes:

Trial 1	At a w/c ratio of 0.40 the slump did not respond to the super plasticizer
Trial 2	Glen 3400 entrains air, rapid slump loss, high air resulted in low strength
Trial 3	50 oz/cy SP at batch;119 oz/cy at pump; will not hold slump SP at 28 oz/cwt, not normal low initial slump may have not allowed air to build

Trial batch results were reduced to one cubic yard units for comparison to the proposed design
Information provided by Rinker

Figure C-2

Sunshine Bridge
Trial Batches

Material	Design	6/28/2005 **Trial 4**	6/29/2005 **Trial 5**	7/6/2005 **Trial 6**	7/6/2005 **Trial 7**
Cement, lbs	475	478	470	478	478
Fly Ash, lbs	110	110	165	108	168
Silica Fume, lbs	25	25	25	25	25
Sand, lbs	1190	1232	1240	1256	1192
1" CA, lbs	1299	1296	1320	1280	1256
1/2" CA, lbs	371	376	360	392	352
3/8" CA, lbs	186	192	220	216	192
Water, lbs	250	268	276	266	269
gls	30.0	32.1	33.1	31.9	32.2
Micro Air, oz	9	5	4	7	9
pozz 80, oz (water reducer)	37	37	42	37	40
Rheo 1000, oz (plasticizer)	49	48	78		101
Glen 3400, oz (plasticizer)					
w/c ratio	**0.41**	**0.437**	**0.418**	**0.435**	**0.401**
Slump Before SP		5.25 @ batch 3.50 @ 45 min	4.00 @ batch 3.75 @ 50 min	1.5 @ batch	7.75 @ batch 4.75 @ 50 min 5.25 @ 61 min
Slump After SP		7.75 @ 55 min	8.25	1.75 @ 10 min 6.25 @ 15 min 4.00 @ 60 min 5.25 @ 80 min	
% Final Air content		3.10%	1.80%	11.50%	4.60%

Age		Strength, psi 4x8	Strength, psi 4x8
1-day		1970	
2-day			
3-day		3940	2490
7-day		5070	4380
14-day			

Trial batch results were reduced to one cubic yard units for comparison to the proposed design

Information provided by Rinker

Figure C-2

Sunshine Bridge
Trial Batch

Date 18-May-05

Trial Batch No. 1

Batch Size, cu. Yd. 5

Material	Batch Weight	Free Moisture	SSD weight	Free Water, lbs	SSD 1 cy weight
Cement, lbs	2400				480
Fly Ash, lbs	540				108
Silica Fume, lbs	125				25
Sand, lbs	6200	5.4	5882	318	1176
1" CA, lbs	6520	0.8	6468	52	1294
1/2" CA, lbs	1880	0.8	1865	15	373
3/8" CA, lbs	1000	0.8	992	8	198
Water, gls	122			1016	
Ice, lbs					
Micro Air, oz	44				9
pozz 80, oz (water reducer)	184				37
Rheo 1000, oz (plasticizer)	240 (addea at pump)			(7.8 oz/cwt)	48
3400, oz (plasticizer)					
Total water, lbs				1409	282
w/c ratio				**0.46**	
Unit Weight, pcf	144.8				
Slump Before SP, in (Before pump)	2.5				
Slump After SP, in (Before pump)	4.5			Slump After SP, in (after pump)	4.5
Air,% (Before pump)	5.1			Air,% (after pump)	5.2

Notes the initial slump at .40 w/c did not respond to the Rheo 1000 plasticizer. We will switch to a second product 3400 by Master Builders for Trial # 2

Strength, psi	6x12	4x8
1 - day	1720	1990
7-day	4270	5030
14- day	5230	6290

Information provided by Rinker

Sunshine Bridge
Trial Batch

Date 23-May-05 **Trial Batch No. 2**

Batch Size, cu. Yd. 6

Material	Batch Weight	Free Moisture	SSD Weights	Free Water, lbs	SSD 1 cy weight	Target Design
Cement, lbs	2860				477	475
Fly Ash, lbs	670				112	110
Silica Fume, lbs	150				25	25
Sand, lbs	7400	4.8	7061	339	1177	1190
1" CA, lbs	7840	0	7840	0	1307	1299
1/2" CA, lbs	2200	0.4	2191	9	365	371
3/8" CA, lbs	1320	0.9	1308	12	218	186
Water, gls	101			841		
Ice, lbs	300			300	50	
Micro Air, oz	52				9	9
pozz 80, oz (water reducer)	224				37	37
Glen. 3400 plasticizer, oz (added at batch plant)	294			(8 oz/cwt)	49	
Glen. 3400 plasticizer, oz (added at job before pump)	348			(9.5 oz/cwt)	58	
Total water, lbs				1501	250	250
w/c ratio				**0.41**		
Slump with SP, in (Before pump)	1.5					
Slump w/ additional SP, in (Before pump)	1:50 PM 6.5			Slump After SP, in (after pump)	2:05 PM 6.5	2:20pm 3.25
Air,% (Before pump)	**8.9**			Air,% (after pump)	**9.6**	

Age	Strength, psi
2-day	2150
7-day	3330
14-day	3550

Notes: As recommended By Master Builders we used a new plasticizer which we were not aware entrained air. We will continue to adjust the Micro air dosage to accommodate the increased air.
It should be noted that after two trials we have not lost air as a result of pumping. Further trials to refine the design will not involve pumping. The mix has rapid slump loss.

Information provided by Rinker

Sunshine Bridge
Trial Batch

Date	3-Jun-05					**Trial Batch No. 3**
Batch Size, cu. Yd.	4					
Batch Time	8:42					

Material	Batch Weight	Free Moisture	SSD Weights	Free Water, lbs	Trial Batch SSD 1 cy weight	Target Design
Cement, lbs	1910				478	475
Fly Ash, lbs	430				108	110
Silica Fume, lbs	100				25	25
Sand, lbs	4920	4.8	4695	225	1174	1190
1" CA, lbs	5280	0.8	5238	42	1310	1299
1/2" CA, lbs	1520	0.8	1508	12	377	371
3/8" CA, lbs	760	0.8	754	6	189	186
Water, gls	59			491		
Ice, lbs	260			260	65	
Micro Air, oz	34 (at batch)	12 (before pump)		46 (total air)	11.5	9
pozz 80, oz (water reducer)	148				37	37
Rheo 1000, oz (plasticizer)	198 (at batch) (8 oz/cwt)	256 (before pump) (10.5 oz/cwt)	220 (before pump) (9 oz/cwt)	674 (total sp) (27.6 oz/cwt)	168.5 (27.6 oz/cwt)	49
per cy	50	64	55	168.5		
				1036	259	
W/C Ratio				**0.425**	**0.425**	

Temp 66 F

Rheo 1000 added 256 oz before pump @ 9:45
slump before pump = 3.0 in., air before pump = =2.6%

Rheo 1000 added 220 oz before pump @ 10:25
slump before pump = 8 in
slump after pump = 7 in @10:35, 51/4 in @ 10:45

Microair adeded 12 oz before pump,
air after pump = 2.5%

Age	Strength, psi
1-day	2600
3-day	4370

Information provided by Rinker

Sunshine Bridge
Trial Batches

Trial Batch No. 4

Date 28-Jun-05

Batch Size, cu. Yd. 5

Batch Time 8:42

Material	Batch Weight	Free Moisture	SSD Weights	Free Water, lbs	Trial Batch SSD 1 cy weight	Target Design
Cement, lbs	2390				478	475
Fly Ash, lbs	550				110	110
Silica Fume, lbs	125				25	25
Total	3065				613	610
Sand, lbs	6160	3.9	5929	231	1232	1190
1" CA, lbs	6480	-0.7	6525	-45	1296	1299
1/2" CA, lbs	1880	-1.0	1898	-18	376	371
3/8" CA, lbs	960	1.4	947	13	192	186
Water, gls	139			1158	268	277
Ice, lbs				0	0	
				1339		
Micro Air, oz	24				5	9
pozz 80, oz (water reducer)	184				37	37
Rheo 1000, oz (plasticizer)	240				48	49
W/C Ratio				0.437	0.437	0.45

	1:05 PM	1:50 PM	After Plasticizer 2:00 PM
Slump, in	5.25	3.5	7.75
Temp, F	81	83	83
% Air	6.5	5.4	3.1*

* sampled at back of load no prior discharge of concrete

Information provided by Rinker

Sunshine Bridge
Trial Batches

Date	29-Jun-05				**Trial Batch No. 5**	
Batch Size, cu. Yd.	2					
Batch Time	10:49am					
Material	Batch Weight	Free Moisture	SSD Weights	Free Water, lbs	Trial Batch SSD 1 cy weight	Target Design
Cement, lbs	940				470	475
Fly Ash, lbs	330				165	170
Silica Fume, lbs	50				25	25
Total	1320				660	670
Sand, lbs	2480	4.8	2366	114	1240	1130
1" CA, lbs	2640	-1.1	2669	-29	1320	1258
1/2" CA, lbs	720	-1.2	729	-9	360	360
3/8" CA, lbs	440	0.2	439	1	220	180
Water, gls	57			475	276	283
Ice, lbs				0	0	
				552		
Micro Air, oz	8				4	9
pozz 80, oz (water reducer)	84				42	40
Rheo 1000, oz (plasticizer)	156				78	80
W/C Ratio				0.418	0.418	0.42

	@ batch	@ 50 min	After Plasticizer
Slump, in	4	3.75	8.25
Temp, F	82	82	82
% Air	5.7	5.4	1.8*

* taken at back of load prior to discharge of concrete

Information provided by Rinker

Sunshine Bridge
Trial Batches

Date	6-Jul-05				**Trial Batch No. 6**	
Batch Size, cu. Yd.	5					
Batch Time	12:02					
Material	Batch Weight	Free Moisture	SSD Weights	Free Water, lbs	Trial Batch SSD 1 cy weight	Target Design
Cement, lbs	2390				478	475
Fly Ash, lbs	540				108	110
Silica Fume, lbs	125				25	25
Total	3055				611	610
Sand, lbs	6280	4.6	6004	276	1256	1130
1" CA, lbs	6400	-0.3	6419	-19	1280	1258
1/2" CA, lbs	1960	-1.0	1980	-20	392	360
3/8" CA, lbs	1080	0.4	1076	4	216	180
Water, gls	131			1091	266	283
Ice, lbs				0	0	
				1332		
Micro Air, oz	34				7	9
pozz 80, oz (water reducer)	184				37	40
3030, oz (plasticizer)	901				180	80
W/C Ratio				0.436	0.436	0.46

Glen 3030 SP	@ batch	12.5 oz/cwt After Sp @ 10 min	10 oz/cwt aditional sp @15 min	@ 60 min	7 oz/cwt additional sp @1 hr 20 min
Slump, in	1.5	1.75	6.25	4.0	5.25
Temp, F	81	83	83	87	87
% Air	5.4	6.4	8.4	9.5	11.5

* taken at back of load prior to discharge of concrete

Information provided by Rinker

Sunshine Bridge
Trial Batches

Date 6-Jul-05

Trial Batch No. 7

Batch Size, cu. Yd. 5

Batch Time 14:24

Material	Batch Weight	Free Moisture	SSD Weights	Free Water, lbs	Trial Batch SSD 1 cy weight	Target Design
Cement, lbs	2390				478	475
Fly Ash, lbs	840				168	170
Silica Fume, lbs	125				25	25
Total	3355				671	670
Sand, lbs	5960	4.1	5725	235	1192	1130
1" CA, lbs	6280	-0.4	6305	-25	1256	1258
1/2" CA, lbs	1760	-0.8	1774	-14	352	360
3/8" CA, lbs	960	1.1	950	10	192	180
Water, gls	137 131+6			1141	269	283
Ice, lbs				0	0	
				1347		
Micro Air, oz	46 34 +12				9	9
pozz 80, oz (water reducer)	200				40	40
Rheo 1000, oz (plasticizer)	504	added at batch plant			101	101
W/C Ratio				0.402	0.402	0.42

	@ batch	@ 50 min	@ 61 min
Slump, in	7.75	4.75	5.25*
Temp, F	82	85	85
% Air	4.3	2.9	4.6*

* added 6 gal, added 12 oz micro air
* taken at back of load prior to discharge of concrete

Information provided by Rinker

September 28, 2005

Summary of Slab Demonstration

Slab demonstration No. 1, August 5, 2005										
Batch Plant					On Site					
Truck #	Temperature, F°		Slump (inch)	Air Content %	Test location	Temperature, F°		Slump (inch)	Air Content %	Total Air content Loss. Batch to deck
	Concrete	Ambient				Concrete	Ambient			
443	75		8 1/2	7.20%	Truck	70	68	6 1/2	5.70%	
					Pump	73	68	6	3.70%	3.50%
423	75		7 3/4	7.80%	Truck	70	69	6 1/4	5.70%	
					Pump	73	68	5	5.10%	2.70%
100	74		6 1/2	7.00%	Truck	76	70	2 3/4	4.80%	
					Pump	79	70	7	4.40%	2.60%
N/A	N/A		N/A	N/A	Truck	Not Tested	Not Tested	5 3/4	7.80%	
					Pump	Not Tested	Not Tested	3	3.10%	4.70%
Average air content loss from batching to pumping on deck										3.38%

Slab demonstration No. 2, August 16, 2005											
Batch Plant					On Site						
Truck #	Temperature, F°		Slump (inch)	Air Content %	Test location	Temperature, F°		Slump (inch)	Air	Unit Weight, (pcf)	Total Air content Loss. Batch to deck
	Concrete	Ambient				Concrete	Ambient				
1	70	61	6 3/4	8.50%	before pump	67	60	5 1/4	3.90%	140.40%	4.60%
2	69	61	7 1/2	9.20%		68	60	7	5.10%	144.40%	4.10%
3	71	61	5.5	0.09		70	61	5	5.50%	145.20%	3.50%
Average air content loss from batching to pumping on deck											4.07%

Average air content loss from batching to pumping on deck for both demonstrations	3.72%

Figure C-3

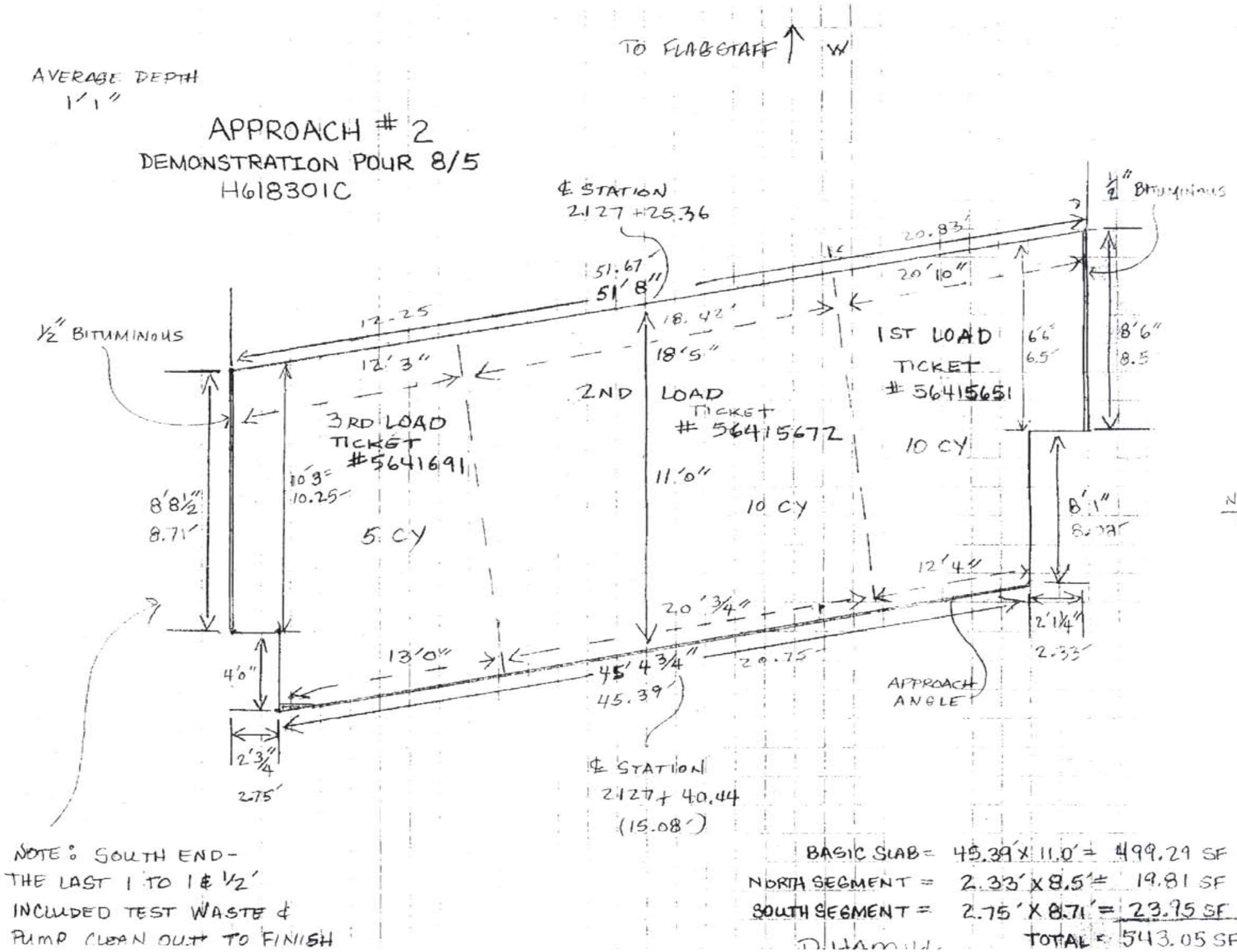
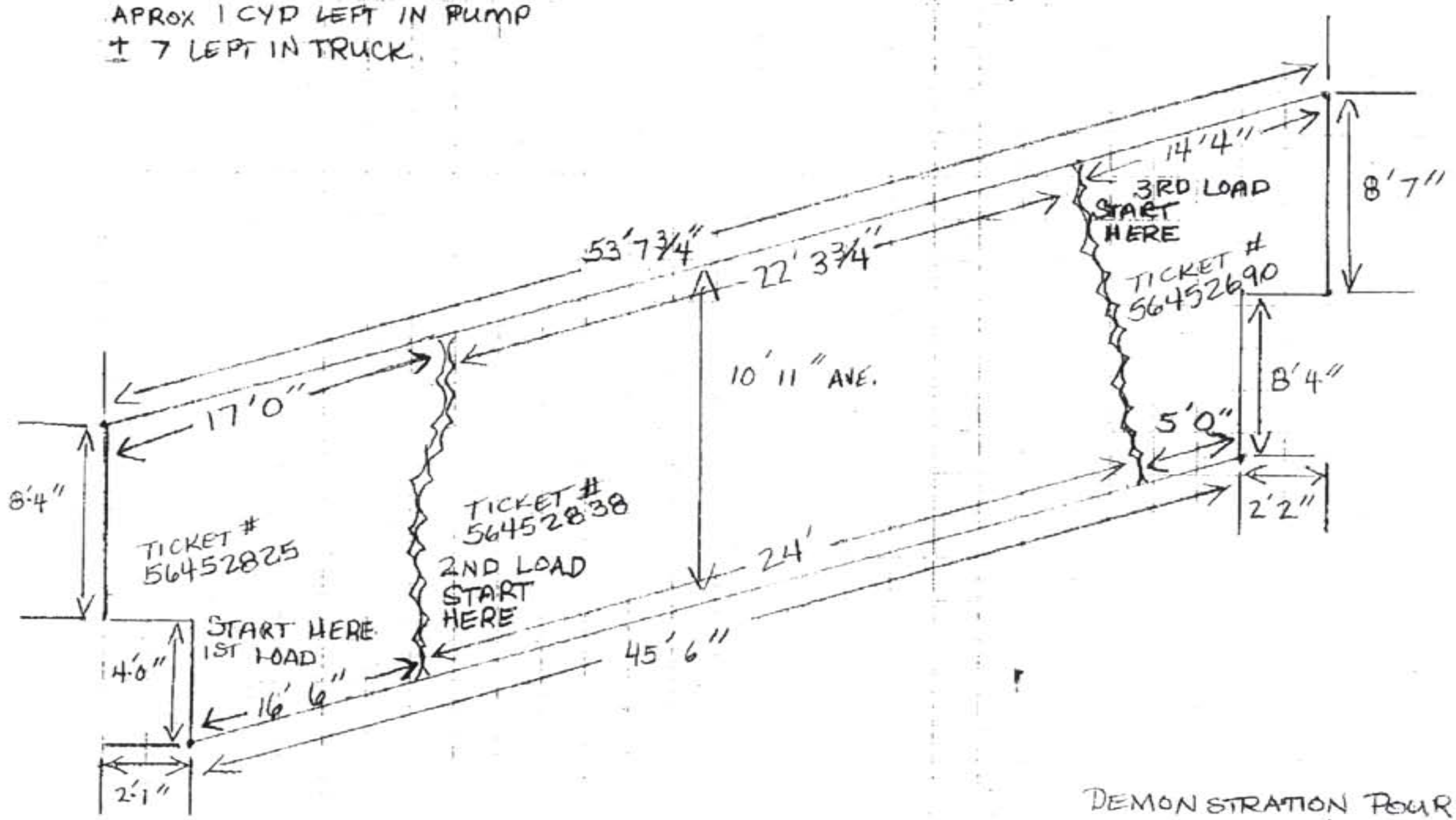

AVERAGE DEPTH
1'1"
APPROACH # 2
DEMONSTRATION POUR 8/5
H618301C
TO FLAGSTAFF W
℄ STATION
2127 +25.36
℄ STATION
2127 + 40.44
(15.08')
1/2" BITUMINOUS
1/2" Bituminous
51.67'
51'8"
20.83'
20'10"
12.25
12'3"
18.42'
18'5"
1ST LOAD
TICKET
56415651
10 CY
2ND LOAD
TICKET
56415672
10 CY
11'0"
3RD LOAD
TICKET
#5641691
5 CY
10'3" = 10.25'
8'8 1/2"
8.71'
6'6"
6.5'
8'6"
8.5
8'1"
12'4"
20'3/4"
20.75'
13'0"
45'4 3/4"
45.39'
4'0"
2'3/4"
2.75'
2'1 1/4"
2.33'
APPROACH ANGLE
NOTE: SOUTH END -
THE LAST 1 TO 1 & 1/2'
INCLUDED TEST WASTE &
PUMP CLEAN OUT TO FINISH
BASIC SLAB = 45.39' X 11.0' = 499.29 SF
NORTH SEGMENT = 2.33' X 8.5' = 19.81 SF
SOUTH SEGMENT = 2.75' X 8.71' = 23.95 SF
TOTAL = 543.05 SF

Figure C-4a

VASTCO:
CURT
ANDY
ALDEN
DAVID
LESTER
BOBBY
ED VAN BEEK
NICK.

1ST LOAD TRUCK # 44-0443 BEGIN PLACEMENT @ 2:27 AM. EMPTY @ 2:37 AM. - STOP - CLARY SCREED, MIST & COVERED BY 2:47 AM. WAIT FOR 2ND LOAD. ADD 'S' TUBE TO PUMP HOSE. 2ND LOAD TRUCK # 44-039 - BEGIN PLACEMENT @ 3:02 AM (25 MINITUS BETWEEN) EMPTY @ 3:10 AM - STOP - CLARY SCREED, MIST & COVER BY 3:19. FADDIE ADVISES THAT THE BURLAP COVERING SHOULD BE PRESOAKED BEFORE PLACEMENT, BUT NOT DRIPPING. 3RD LOAD TRUCK # 44-0423 - BEGIN PLACEMENT @ 3:29 AM. 3:33, POUR COMPLETE - CLARY SCREED, MIST & COVER BY 3:50 AM.
APROX 1 CYD LEFT IN PUMP
± 7 LEFT IN TRUCK.



TO FLAGSTAFF ↓

DEMONSTRATION POUR # 2 - 8/16
APPROACH # 1 H618301C

BASIC SLAB = 45.5 x 10.92 = 542.3
NORTH SEGMENT: 8.33 x 2.08 = 17.33
SOUTH SEGMENT = 8.58 x 2.17 = 18.62
578.31 S

APPROACH # 2 + APPROACH # 1 = 1121.36 SF DH
DOES NOT INCLUDE BACKWALL @ # 1

Figure C-4b

APPENDIX D

Field Test Results
Concrete Deck Placement

List of Figures

February 28, 2006

Summary Field Testing of Concrete Deck Placement
Sunshine Bridge

Load	Testing at the Plant							At Job Before Pump				At Job After Pump										Testing by			Slump Loss		Air Loss			Travel Time, (hrs)
	Ticket	Time (a.m.)	Slump (inch)	Air % Meas.	Air % Hard[2]	Temp Con.	Temp Air	Time	Slump (inch)	Meas. Air%	Conc. Temp	Time (a.m.)	Slump (inch)	Air% Meas[1]	Air% Hard[2] JEC	Air% Hard[2] ADOT	Air% Grav[3]	Unit Weight Meas.	Unit Weight Theo	Temp Con.	Temp Air	Rinker	ADOT	CTL	Travel	Pump	Travel	Pump	pump vs. hard	
1	89324	1:02	8 1/4	8.8%		73	63	2:18	5 1/4	9.5%	70										70									
2	89361	1:45	8 1/4	11.0%	9.6%	74	63	2:45	6	8.8%	68	3:12	7 1/4	2.5%	2.2%	2.9%	2.8%	148.2	152.5	70	62	X	X	X	2 1/4	-1 1/4	2.2%	6.3%	0.30%	1:00
3	89393	2:12	8 1/2	10.2%		71	63	3:13	6 1/2	10.0%	65														2		0.2%			1:01
4	89415	2:30	8	11.5%		72	62	3:37	6	9.0%	67	3:55	7	3.5%			3.3%	147.4	152.5	68		X			2	-1	2.5%	5.6%		1:07
5	89439	2:45	8 3/4	10.0%		70	62	3:49	6	9.5%	66														2 3/4		0.5%			1:04
6[4]	89462	3:01	9	9.0%		70	62	4:15	4 1/4	7.2%	66														4 3/4		1.8%			1:14
7	89494	3:15	8	11.5%		71	59	4:32	6 1/2	9.0%	68		6 3/4	5.4%	4.0%		5.0%	144.8	152.5	69		X		X	1 1/2	- 1/4	2.5%	3.6%	1.40%	1:17
8	89539	3:33	8 3/4	10.0%	10.3%	71	59	4:39	7 1/2	10.8%	67	5:00	8 1/2	4.1%		2.6%	4.8%	145.2	152.5	68		X	X		1 1/4	-1	-0.8%	6.7%		1:06
9	89619	3:50	8 1/2	10.2%		70	59	4:50	5	10.0%	70														3 1/2		0.2%			1:00
10	89653	4:03	8	10.0%	8.4%	73	57	5:09	5	10.0%	67	5:25	6 1/2	6.0%		4.7%	6.4%	142.8	152.6	70			X		3	-1 1/2	0.0%	4.0%		1:06
11	89726	4:18	8	10.0%		71	57	5:21	6 1/2	9.0%	70				4.7%									X	1 1/2		1.0%			1:03
Averages			8 1/3	10.2%		71	61		5 6/7	9.3%	68		7 1/5	4.3%	3.6%	3.4%	4.5%	145.7	152.5	69	66				2 4/9	-1	1.0%	5.2%	0.85%	1:05

Load	Testing at the Plant							At Job Before Pump				At Job After Pump										Testing by			Slump Loss		Air Loss			Travel Time, (hrs)
	Ticket	Time (a.m.)	Slump (inch)	Air % Meas.	Air % Hard[2]	Temp Con.	Temp Air	Time	Slump (inch)	Meas. Air%	Conc. Temp	Time (a.m.)	Slump (inch)	Air% Meas[1]	Air% Hard[2] JEC	Air% Hard[2] ADOT	Air% Grav[3]	Unit Weight Meas.	Unit Weight Theo	Temp Con.	Temp Air	Rinker	ADOT	CTL	Travel	Pump	Travel	Pump	pump vs. hard	
12	48776	4:32	8	10.2%		71	57	5:34	6 3/4	9.0%	67		7	6.7%			6.8%	142.2	152.5	67		X			1 1/4	- 1/4	1.2%	2.3%		1:02
13	89833	4:41	8	9.3%		70	57	5:49	5 3/4	10.0%	67														2 1/4		-0.7%			1:08
14	89868	4:50	7 1/2	9.1%	7.4%	73	56	6:04	5 3/4	10.0%	67	6:18	6 1/4	6.2%	5.2%	5.2%	5.4%	144.2	152.5			X	X	X	1 3/4	- 1/2	-0.9%	3.8%	1.00%	1:14
15	89919	5:01	8	10.0%		71	56	5:59	6 1/2	8.0%	66														1 1/2		2.0%			0:58
16	90014	5:10	7 1/2	9.0%		70	55	6:19	6	9.0%	67	6:30	5 1/4	7.2%			6.4%	142.8	152.5	70		X			1 1/2	3/4	0.0%	1.8%		1:09
17	90102	5:22	8	11.0%		70	55	6:25	4 1/4	10.0%	67														3 3/4		1.0%			1:03
18	90195	5:34	7 1/4	12.0%	9.8%	73	55	6:36	5 1/2	10.5%	65	6:55	5	6.8%	6.5%	6.0%	7.5%	141.0	152.5	70			X	X	1 3/4	1/2	1.5%			1:02
	Rinker testing													12.9%			13.2%	132.4	152.5			X							0.30%	
19	90293	5:50	7 1/4	11.2%		70	53	6:48	5 3/4	10.5%	69														1 1/2		0.7%			0:58
20	90648	6:25	8 1/4	8.0%		69	53	7:25	7 1/4	9.5%	67	7:31	7 3/4	6.0%			6.4%	142.8	152.5	70			X		1	- 1/2	-1.5%	2.0%		1:00
	Rinker testing													7.5%			8.1%	140.2	152.5			X								
21	90192																													
Averages			7 3/4	10.0%		71	55		6	9.6%	67		6 1/4	7.6%	5.9%	5.6%	7.7%	140.8	152.5	69					1 4/5	0	0.4%	2.5%	0.65%	1:03

(1) Average of ADOT and Rinker Materials test results

(2) Air content from petrographic analysis by CTL (JEC and ADOT samples)

(3) Based on the theoretical and measured unit weights

(4) Added 60 oz of superplasticizer and 35 oz of air before pump

Notes:

Concrete was placed on August 24, 2005

Loads 1 through 11 were placed with a 52 meter Putzmeister pump

Loads 12 through 20 were placed with a 45 meter Schwing pump

Information compiled by Jaber Engineering from testing data from ADOT, Rinker and CTL

Figure D-1

August 24, 2005

Summary of Batch Weights, Rinker Materials, Flagstaff
Sunshine Bridge

Load No.	Yds	Cement	Fly Ash	Silica Fume	Coarse Aggregates 3/4 in.	Coarse Aggregates 1/2 in.	Coarse Aggregates 3/8 in.	Sand	Water	Total	Pozzolith 80	Rheobuild 1000	Micro Air	*w/cm Ratio*
		lbs per cubic yard			lbs per cubic yard (SSD)				lbs/ cubic yard		ounce per cubic yard			
1	10	477	160	30	1253	361	184	1122	263	3850	40.0	90.6	19.0	0.395
2	10	473	160	30	1253	361	184	1122	263	3846	40.0	90.0	25.0	0.397
3	10	473	159	30	1249	361	184	1130	264	3849	40.0	90.6	25.0	0.398
4	10	473	161	30	1245	364	184	1122	263	3843	40.0	90.0	25.0	0.397
5	10	474	160	30	1249	364	184	1126	264	3852	40.4	90.0	25.0	0.398
6	10	474	160	30	1257	361	184	1126	264	3855	40.4	90.0	25.2	0.397
7	10	473	161	30	1241	364	187	1126	265	3848	40.0	90.0	25.0	0.398
8	10	472	159	30	1249	361	180	1122	263	3836	40.4	90.0	25.0	0.398
9	10	473	159	30	1249	368	184	1122	264	3850	40.0	90.0	25.0	0.399
10	10	474	160	30	1249	364	180	1122	263	3843	40.0	90.6	25.0	0.396
11	10	473	160	30	1249	364	184	1122	263	3846	40.0	90.0	25.0	0.397
12	10	473	161	30	1257	364	180	1122	264	3852	40.0	84.0	25.0	0.398
13	10	474	160	30	1249	364	184	1122	263	3847	40.0	84.0	25.0	0.397
14	10	474	160	30	1253	361	184	1119	264	3844	40.0	84.0	25.0	0.398
15	10	474	160	30	1249	364	180	1119	263	3839	40.0	76.8	27.0	0.396
16	10	475	160	30	1249	364	184	1122	264	3849	40.0	76.8	27.0	0.397
17	10	473	160	30	1249	361	180	1126	263	3842	40.0	76.8	27.0	0.397
18	10	474	161	30	1253	361	184	1126	264	3853	40.0	76.8	27.0	0.398
19	10	474	163	30	1245	364	184	1134	264	3858	40.0	76.8	27.0	0.396
20	10	474	159	30	1249	364	184	1115	264	3839	40.4	76.8	27.0	0.398
21	6	475	160	30	1265	359	185	1105	263	3842	40.0	77.0	26.7	0.395
Average		474	160	30	1251	363	183	1123	264	3847	40.1	84.8	25.375	0.397
Mix design		475	160	30	1254	358	182	1121	271	3851	40	86	19	

Deviation of batch weights from mix design

Load No.	Yds	Cement	Fly Ash	Silica Fume	3/4 in.	1/2 in.	3/8 in.	Sand	Water	Total	Pozzolith 80	Rheobuild 1000	Micro Air
1	10	0.4%	0.0%	0.0%	-0.1%	0.7%	0.9%	0.1%	-2.8%	0.0%	0.0%	5.3%	0.0%
2	10	-0.4%	0.0%	0.0%	-0.1%	0.7%	0.9%	0.1%	-2.8%	-0.1%	0.0%	4.7%	31.6%
3	10	-0.4%	-0.6%	0.0%	-0.4%	0.7%	0.9%	0.8%	-2.7%	0.0%	0.0%	5.3%	31.6%
4	10	-0.4%	0.6%	0.0%	-0.7%	1.8%	0.9%	0.1%	-2.8%	-0.2%	0.0%	4.7%	31.6%
5	10	-0.2%	0.0%	0.0%	-0.4%	1.8%	0.9%	0.5%	-2.4%	0.0%	1.0%	4.7%	31.6%
6	10	-0.2%	0.0%	0.0%	0.3%	0.7%	0.9%	0.5%	-2.7%	0.1%	1.0%	4.7%	32.6%
7	10	-0.4%	0.6%	0.0%	-1.0%	1.8%	3.0%	0.5%	-2.4%	-0.1%	0.0%	4.7%	31.6%
8	10	-0.6%	-0.6%	0.0%	-0.4%	0.7%	-1.2%	0.1%	-2.9%	-0.4%	1.0%	4.7%	31.6%
9	10	-0.4%	-0.6%	0.0%	-0.4%	2.9%	0.9%	0.1%	-2.4%	0.0%	0.0%	4.7%	31.6%
10	10	-0.2%	0.0%	0.0%	-0.4%	1.8%	-1.2%	0.1%	-2.9%	-0.2%	0.0%	5.3%	31.6%
11	10	-0.4%	0.0%	0.0%	-0.4%	1.8%	0.9%	0.1%	-2.8%	-0.1%	0.0%	4.7%	31.6%
12	10	-0.4%	0.6%	0.0%	0.3%	1.8%	-1.2%	0.1%	-2.5%	0.0%	0.0%	-2.3%	31.6%
13	10	-0.2%	0.0%	0.0%	-0.4%	1.8%	0.9%	0.1%	-2.8%	-0.1%	0.0%	-2.3%	31.6%
14	10	-0.2%	0.0%	0.0%	-0.1%	0.7%	0.9%	-0.2%	-2.6%	-0.2%	0.0%	-2.3%	31.6%
15	10	-0.2%	0.0%	0.0%	-0.4%	1.8%	-1.2%	-0.2%	-2.9%	-0.3%	0.0%	-10.7%	42.1%
16	10	0.0%	0.0%	0.0%	-0.4%	1.8%	0.9%	0.1%	-2.5%	0.0%	0.0%	-10.7%	42.1%
17	10	-0.4%	0.0%	0.0%	-0.4%	0.7%	-1.2%	0.5%	-2.8%	-0.2%	0.0%	-10.7%	42.1%
18	10	-0.2%	0.6%	0.0%	-0.1%	0.7%	0.9%	0.5%	-2.4%	0.1%	0.0%	-10.7%	42.1%
19	10	-0.2%	1.9%	0.0%	-0.7%	1.8%	0.9%	1.2%	-2.6%	0.2%	0.0%	-10.7%	42.1%
20	10	-0.2%	-0.6%	0.0%	-0.4%	1.8%	0.9%	-0.6%	-2.6%	-0.3%	1.0%	-10.7%	42.1%
21	6	0.0%	0.0%	0.0%	0.9%	0.3%	1.6%	-1.5%	-3.0%	-0.2%	0.0%	-10.5%	40.4%

Figure D-2

August 24, 2005

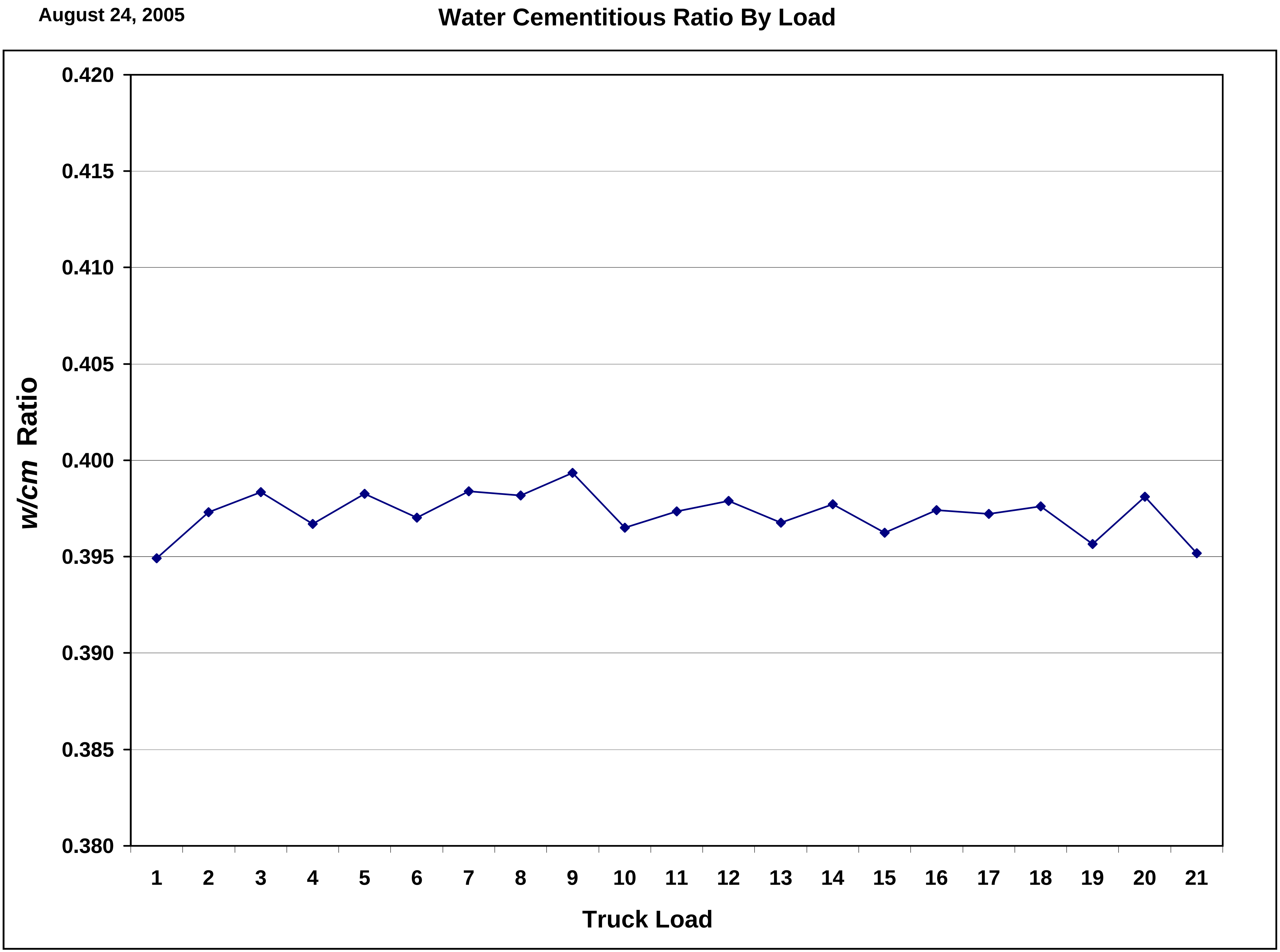


Figure D-3

August 24, 2005

Deck Placement QA/QC Schematic Plan

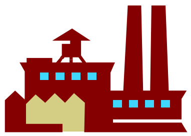
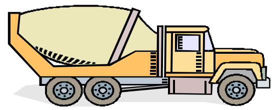
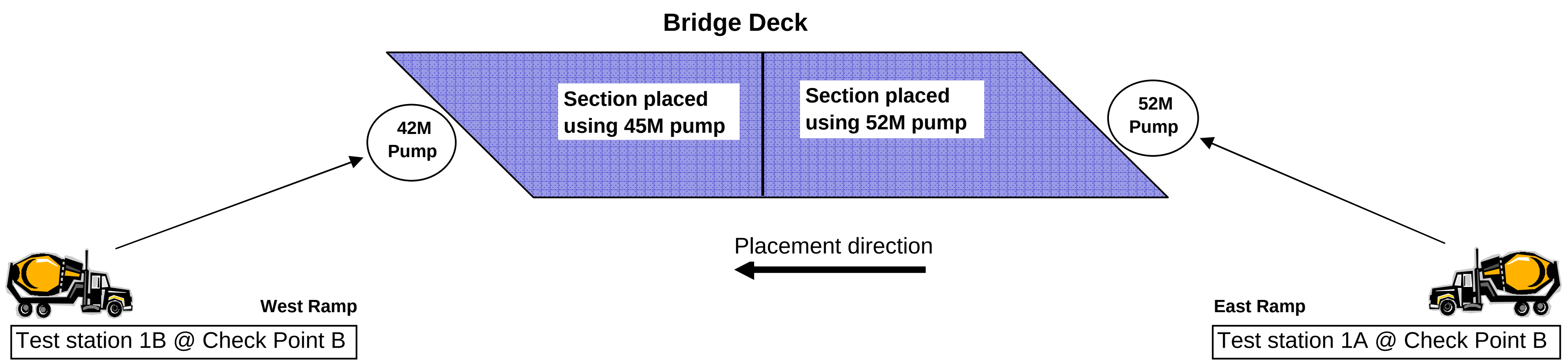
	 Batch Plant		 Transportation		 Pumping Concrete		 Testing	
TEAM MEMBERS	***Batching Concrete***	***Check Point A***	***Travel to Site***	***Check Point B***	***Pumping***	***Check Point C***	***Testing***	***Placement***
	Batch Plant	***Batch Plant***	***Interstate I-40***	***Ramp on-site***	***On Site***	***On Deck***	***On Site***	***On Deck***
JEC	Verify Mix Proportions	Report *w/cm* to ADOT when not in specifications					Cast concrete samples to confirm HPC Properties	
ADOT	Check aggregates moisture and absorption	Test slump, air and temperature and verify truck water tank is empty		Test concrete for slump, air and temperature. Allow truck to go to pump only when within agreed criteria	Test air content on deck and determine air loss. Feedback to check points A & B for air adjustment	Reject if concrete on deck is not within project requirements	Test slump, air and temperature. Cast 6x12 cylinders for compressive strength testing	
Vastco Rinker	Batching	Test slump, air and temperature and verify truck water tank is empty	No water added	Test slump, air and temperature. Make adjustments to air slump as needed using admixtures			Test slump, air and temperature. Cast 6x12 cylinders for compressive strength testing	Place, finish protect and cure concrete

Figure D-4

August 24, 2005

Deck Placement Schematic Layout



Notes

1- Placement started at the east side of the bridge deck using a 52M pump
2- Placement continued at the west side of the bridge deck using a 45M pump starting with load number 12
3- Trucks were allowed to proceed to pump only when air content was a minimum of 9%
4- ADOT and Rinker testing crews performed concrete testing at test stations 1A and 1B before the pump
5- ADOT and Rinker testing crews cast concrete test cylinders from concrete placed on deck after the pump
6- WTI made concrete test specimens to verify properties of HPC
7- Concrete was sampled from the deck using wheel borrows

Figure D-5

SUNSHINE BNSFRR OP WB 1390
AC-IBRC-040-D(016)A // H618301C
HPC DECK POUR MAP 8/24/05
D HAMILL

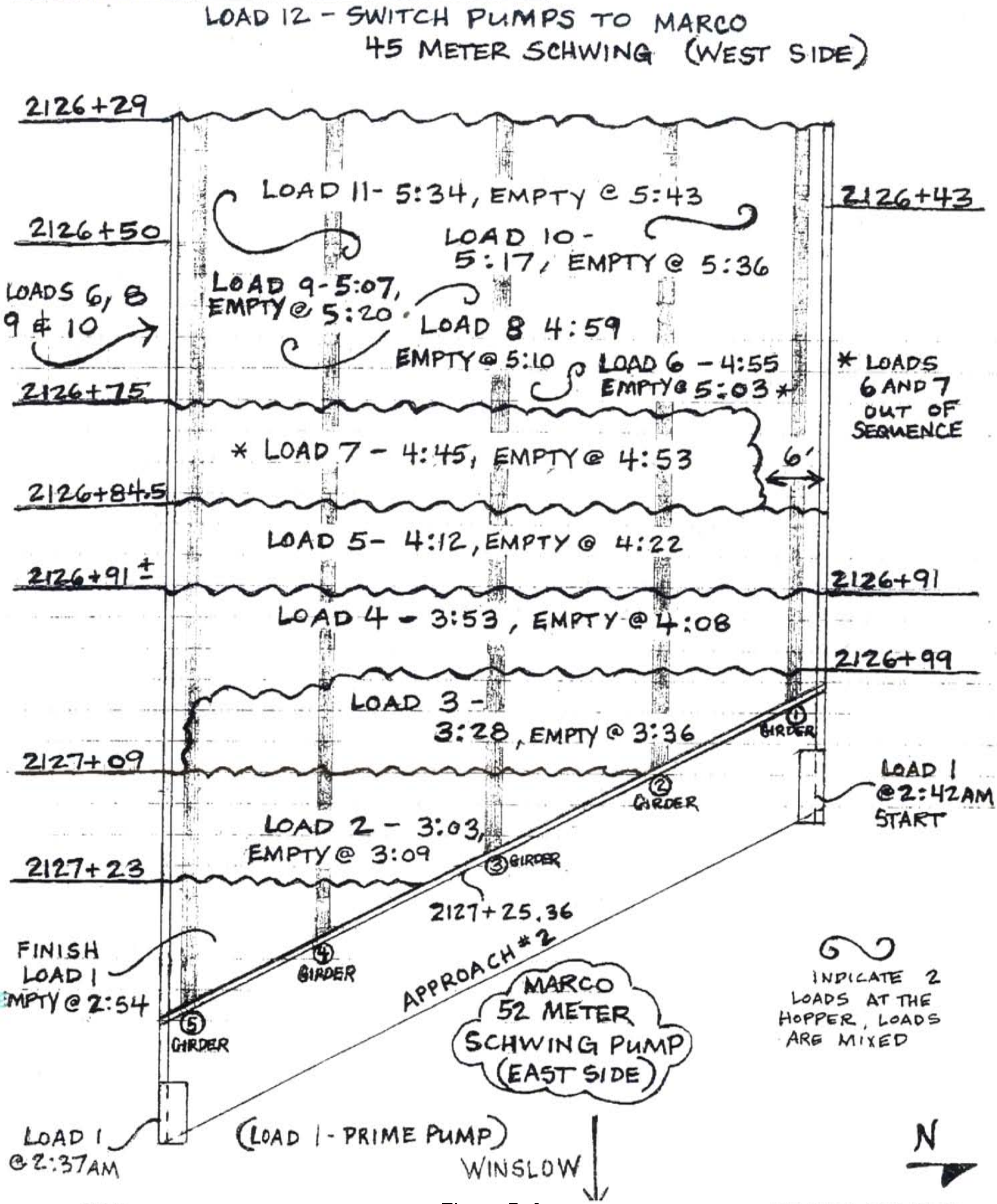


Figure D-6a

002
02/03/2006 08:55 FAX

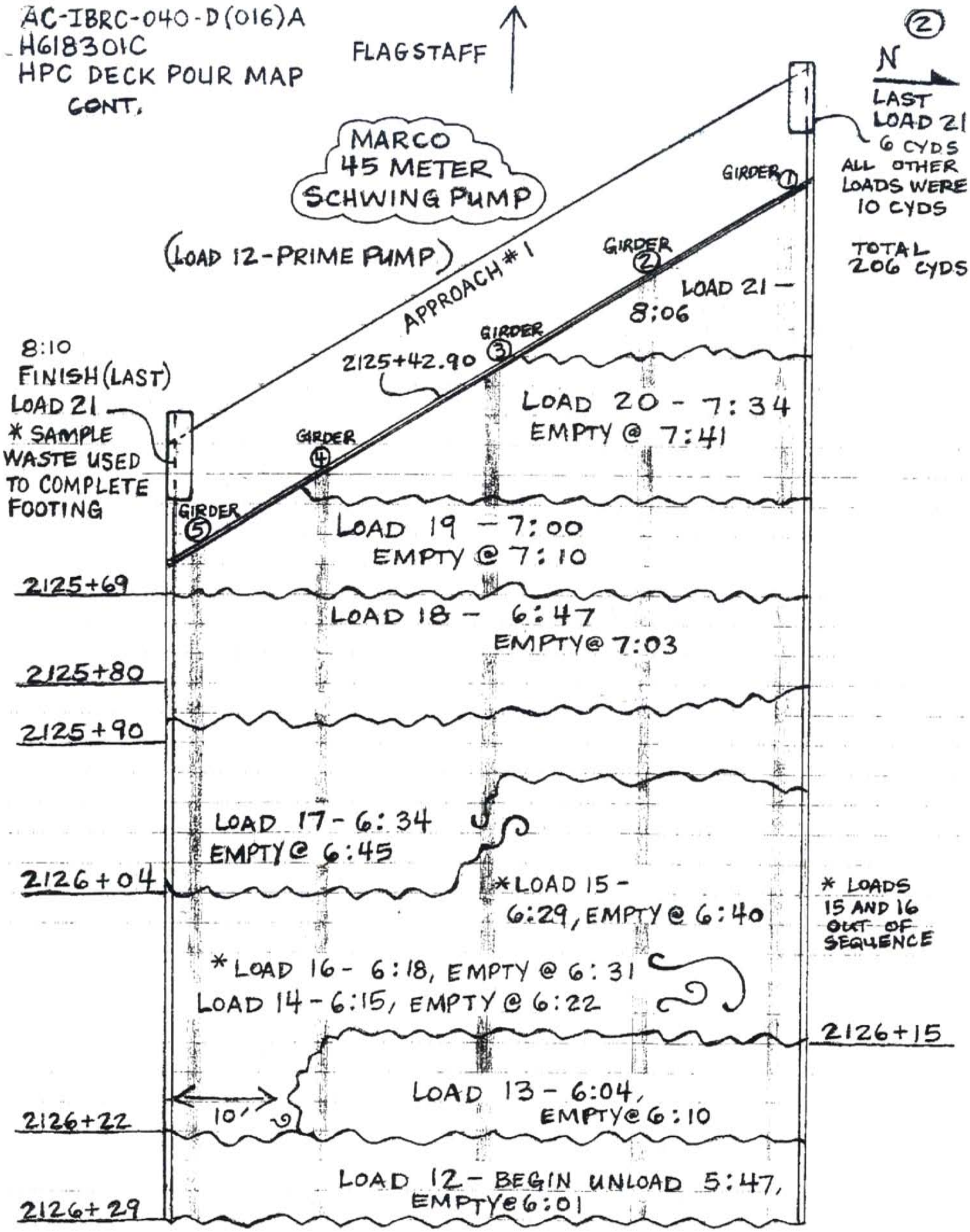

AC-IBRC-040-D(016)A
H618301C
HPC DECK POUR MAP
CONT.
FLAGSTAFF
②
N
LAST LOAD 21 6 CYDS
ALL OTHER LOADS WERE 10 CYDS
TOTAL 206 CYDS
MARCO 45 METER SCHWING PUMP
(LOAD 12-PRIME PUMP)
APPROACH #1
GIRDER ①
GIRDER ②
GIRDER ③
GIRDER ④
GIRDER ⑤
LOAD 21 - 8:06
2125+42.90
8:10 FINISH (LAST) LOAD 21
* SAMPLE WASTE USED TO COMPLETE FOOTING
LOAD 20 - 7:34 EMPTY @ 7:41
LOAD 19 - 7:00 EMPTY @ 7:10
2125+69
LOAD 18 - 6:47 EMPTY @ 7:03
2125+80
2125+90
LOAD 17 - 6:34 EMPTY @ 6:45
2126+04
*LOAD 15 - 6:29, EMPTY @ 6:40
* LOADS 15 AND 16 OUT OF SEQUENCE
*LOAD 16 - 6:18, EMPTY @ 6:31
LOAD 14 - 6:15, EMPTY @ 6:22
2126+15
LOAD 13 - 6:04, EMPTY @ 6:10
10'
2126+22
LOAD 12 - BEGIN UNLOAD 5:47, EMPTY @ 6:01
2126+29

Figure D-6b

Comments from the Sunshine Bridge project meeting February 7, 2006

Attendees:

1.	Fadi Jalaghi	Premier Engineering
2.	John Scoggin	ADOT Holbrook Lab
3.	Christ Dimitroplos	ADOT ATRC
4.	Mike Kohout	Riker Materials
5.	Aryan Lagrange	FHWA
6.	Ed Van Beek	Vastco
7.	Clifton Guest	ADOT Bridge Management
8.	John Ivanov	ADOT Materials
9.	Carl Ericksen	ADOT Holbrook District
10.	David Sikes	ADOT Holbrook District
11.	Chad Auker	ADOT Materials
12.	Henry Sung	ADOT Bridge
13.	Jean Nehme	ADOT Bridge

The following comments were made during the February 7, 2006 project meeting held with the contractor, the design team and ADOT to get input from all team members about lessons learned from the project:

1. Include a separate pay item or a force account to pay for the demonstration trial slab.

2. Specify a larger trial demonstration slab so the contractor can make the necessary adjustments. This may reduce the number of unsuccessful demonstration placements.

3. Eliminate pump requirement during the batch plant trials and require pump verifications of air and slump loss at the demonstration slabs.

4. Select aggregate with low or reduced absorption, preferably river-washed aggregate known for its low absorption and low water demand

5. Use volumetric meters rather than pressure meters for testing air content in the field.

6. Specify the targeted air at the point of placement or possibly the hardened air.

7. Provide a uniform hole-pattern with a minimum size of 1″ inch in the burlap/plastic (burlene) to allow curing water to go through the plastic to the burlap and prevent water runoff on the plastic surface.

8. Allow adequate time in the construction schedule for water curing. In the case of the Sunshine Bridge project, a 28-day schedule was needed to accommodate a 14-day cure for the deck and a 14-day cure for the barriers. This schedule was underestimated in the project original schedule.

9. Vastco indicated that the use of HPC on bridge projects can increase overall construction costs by approximately 10 percent compared to using a standard ADOT class S concrete. The unit cost for the concrete is expected to be 50 to 100 percent higher for HPC compared to an ADOT class S concrete, however eliminating the pump requirement during batching trials would reduce the unit cost of concrete.

10. For a performance-based specification, Vastco would require approximately 120 days for the concrete supplier to complete testing for the mix design acceptance.

APPENDIX E

Laboratory Test Results
Concrete Deck Placement

LIST OF FIGURES

May 5, 2006

Summary of Laboratory Test Results
Bridge Deck Placement

Core	Rapid Chloride Permeability, (Coulomb) ASTM C-1202					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
A	984	983	1042	1029	1123	936
B		953	973	944	989	871
At 56 days		968	1008	987	1056	904

Parameters	Freeze Thaw Resistance Test, ASTM C-666 Method A					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
No of cycles	*N/A*	67	203	203	203	203
RDME % *	*N/A*	< 60%	67%	75%	91%	93%
Air Void %	4.5	2.2	4.0	4.7	5.2	6.5

Parameters	Scaling Resistance, ASTM C-672					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
A	1.45	1.5	1.5	2.0	1.0	1.0
B		2.0	1.0	2.5	1.0	1.0
At 50 cycles		1.8	1.3	2.3	1.0	1.0

Parameters	Air Void System Analysis, ASTM C-457					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Air Content	4.5	2.2	4.0	4.7	5.2	6.5
No of Voids/inch	7.10	3.30	6.20	6.70	9.00	10.30
Specific Surface	621	589	624	570	688	632
Spacing Factor	0.009	0.012	0.009	0.009	0.008	0.007
Paste Content	31.50	29.0	31.9	32.0	33.4	31.2

Variable	Modulus of Elasticity, ASTM C-470					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
3-day Strength	3,283,333		3,400,000	3,200,000	3,250,000	
7-day Strength	3,500,000		3,550,000	3,450,000	3,500,000	
28-day Strength	3,980,000	4,100,000	4,150,000	3,900,000	4,000,000	3,750,000

Age (days)	Shrinkage Potential, ASTM C-157					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
1	0.012	0.017	0.011	0.005	0.015	0.012
4	0.001	0.007	-0.002	-0.001	0.003	-0.002
7	-0.005	-0.001	-0.004	-0.010	-0.005	-0.006
14	-0.012	-0.006	-0.011	-0.018	-0.015	-0.011
28	-0.027	-0.016	-0.026	-0.027	-0.031	-0.034
56	-0.032	-0.024	-0.032	-0.035	-0.036	-0.035
112	-0.041	-0.032	-0.042	-0.044	-0.044	-0.041
224	-0.058	-0.051	-0.057	-0.060	-0.062	-0.058

* RDME: Relative Dynamic Modulus of Elasticity

Figure E-1a

Summary of Compressive Strength Test Results
Deck Placment

Age (days)	WTI Test Results					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
3	3,607		3,750	3,560	3,510	
7	4,483		4,660	4,430	4,360	
28	6,478	7,170	6,640	6,240	6,190	6,150

Age (days)	ADOT Test Results					
	Average	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
7	4,854	5,240	4,480	5,070	4,700	4,780
14	5,900	6,430	5,450	5,940	5,760	5,920
28	6,848	7,570	6,790	6,910	6,420	6,550
56	7,450	8,270	6,800	8,250	6,790	7,140

Rinker Test Results										
Age (days)	Load Number									
	Average	4	7	8	10	12	14	16	18	20
7	4,981	6,060	5,700	5,870	5,080	4,320	4,610	4,230	4,420	4,540
14	5,319	6,170	5,940	5,940	5,160	4,790	4,920	4,990	5,040	4,920
28	6,428	7,430	6,690	6,840	6,190	6,020	7,070	6,050	6,050	5,510
56	7,410	8,280	7,610	7,960	7,110	7,040	7,820	6,860	7,250	6,760

Compilation of all test results

Age (days)	Compressive Strength (psi)
0	0
3	3,610
7	4,770
14	5,610
28	6,590
56	7,430

Figure E-1b

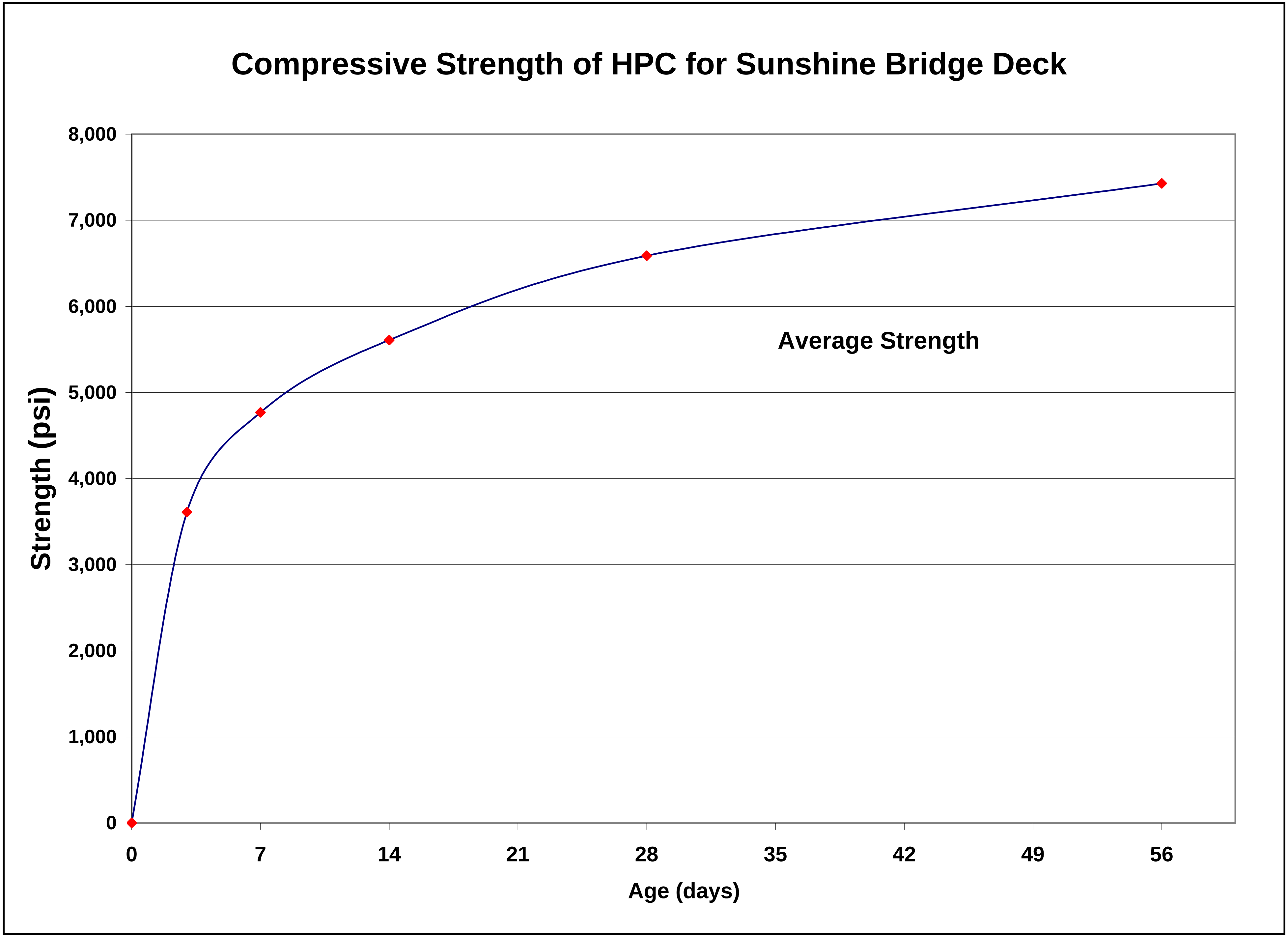

Compressive Strength of HPC for Sunshine Bridge Deck
Strength (psi)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Average Strength
0
7
14
21
28
35
42
49
56
Age (days)

Figure E-2

May 5, 2006

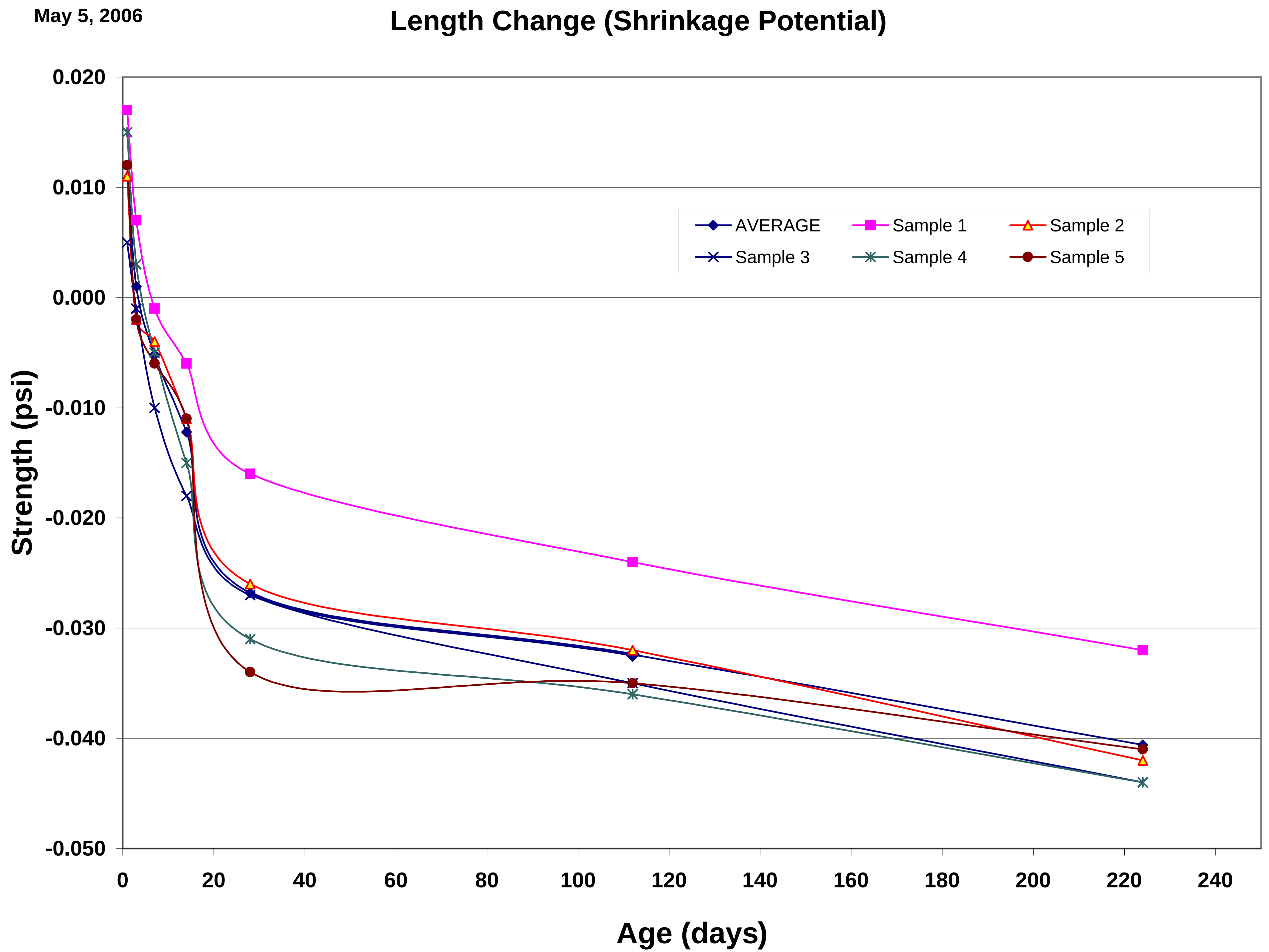


Figure E-3

Building Knowledge. Delivering Results.
CONSTRUCTION TECHNOLOGY LABORATORIES
ENGINEERS & CONSTRUCTION TECHNOLOGY CONSULTANTS
www.CTLGroup.com

February 10, 2006

Mr. Tarif Jaber
Jaber Engineering
10827 E. Butherus Drive
Scottsdale, AZ 85255
E-Mail: tariff@jaber-engineering.com

Via E-Mail

Concrete Testing – Sunshine Bridge Project
CTLGroup Project No. 395179

Dear Mr. Jaber:

Attached are results for concrete testing. You submitted five sets of concrete samples that were received at CTLGroup on September 30, 2005. Each set consisted of two 4x8-in. concrete cylinders, two 12x12x3-in. concrete slabs, and two 3x3x11-in. concrete beams. All samples were reportedly cast on August 24, 2005. Per your e-mail of September 30, 2005, all samples were moist cured until they reached 56 days of age.

The concrete samples were tested in accordance with the following test methods:

- AASHTO T 277–96, "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration"
- ASTM C 672/C 672M–03, "Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemical"
- ASTM C 666/C 666–03, "Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing"

Set 1

Freeze-thaw samples were discontinued after 67 cycles due to the fact that relative dynamic modulus dropped below 60% of the initial modulus. Also, the length change exceeded the 0.10% expansion criteria of ASTM C 666. Results are consistent with the air-void analysis testing that showed that the air content was 2.2% (CTLGroup Project No. 159074).

Set 2

After 300 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus. The samples are considered not freeze-thaw durable. Air-analysis showed the air content was 4%.

Set 3

After 300 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus. The samples are considered not freeze-thaw durable. Air-analysis showed the air content was 4.7%.

Set 4

Relative dynamic modulus indicates the samples are freeze-thaw durable. Air-analysis showed the air content was 5.2%.

Set 5

Relative dynamic modulus indicates the samples are freeze-thaw durable. Air-analysis showed the air content was 6.5%.

We will retain the remainder of the samples until May 9, 2006 at which time they will be discarded unless we hear otherwise from you.

We appreciate the opportunity to conduct specialized testing for you again. Should you have any questions, please contact me.

Sincerely,

T. Muresan
Associate Materials Technologist
Materials Testing and Analysis

TMuresan@CTLGroup.com
Phone: (847) 972-3160

W. Morrison
Principal Materials Technologist
Materials Consulting

WMorrison@CTLGroup.com
Phone: (847) 972-3162

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Project No.: 395179
CTLGroup Proj. Manager: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

Concrete Testing

Set 1

AASHTO T 277, Rapid Chloride Ion Penetration, 4x8-in. cylinders, Coulombs		
	Sample A	Sample B
56 Days	983	953
ASTM C 672, Scaling Resistance, 12x12x3-in. slabs, visual rating		
50 Cycles, average of two samples		**1.8**
ASTM C 666, Freezing and Thawing - Procedure A, 3x3x11-in. beams, RDM%		
67 Cycles, average of two samples		**22**

Note:
After 67 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus.
Also length change exceeded the 0.10% expansion criteria. The samples were removed from test.

CTLGroup
Building Knowledge. Delivering Results.

www.CTLGroup.com

Figure E-4

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Project No.: 395179
CTLGroup Proj. Manager: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: February 9, 2006

Concrete Testing

Set 2

AASHTO T 277, Rapid Chloride Ion Penetration, 4x8-in. cylinders, Coulombs		
	Sample A	Sample B
56 Days	1042	973
ASTM C 672, Scaling Resistance, 12x12x3-in. slabs, visual rating		
50 Cycles, average of two samples		**1.3**
ASTM C 666, Freezing and Thawing - Procedure A, 3x3x11-in. beams, RDM%		
300 Cycles, average of two samples		**54**

Note:
After 300 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus.
The samples are considered not freeze-thaw durable.

CTLGROUP Building Knowledge. Delivering Results.

www.CTLGroup.com

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Project No.: 395179
CTLGroup Proj. Manager: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

Concrete Testing

Set 3

AASHTO T 277, Rapid Chloride Ion Penetration, 4x8-in. cylinders, Coulombs		
	Sample A	Sample B
56 Days	1029	944
ASTM C 672, Scaling Resistance, 12x12x3-in. slabs, visual rating		
50 Cycles, average of two samples		**2.3**
ASTM C 666, Freezing and Thawing - Procedure A, 3x3x11-in. beams, RDM%		
300 Cycles, average of two samples		**58**

Note:
After 300 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus.
The samples are considered not freeze-thaw durable.

CTLGROUP Building Knowledge. Delivering Results.

www.CTLGroup.com

Figure E-4

Concrete Testing

Set 4

AASHTO T 277, Rapid Chloride Ion Penetration, 4x8-in. cylinders, Coulombs		
	Sample A	Sample B
56 Days	1123	989
ASTM C 672, Scaling Resistance, 12x12x3-in. slabs, visual rating		
50 Cycles, average of two samples		**1.0**
ASTM C 666, Freezing and Thawing - Procedure A, 3x3x11-in. beams, RDM%		
300 Cycles, average of two samples		**88**

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Project No.: 395179
CTLGroup Proj. Manager: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: February 9, 2006

Concrete Testing

Set 5

AASHTO T 277, Rapid Chloride Ion Penetration, 4x8-in. cylinders, Coulombs		
	Sample A	Sample B
57 Days	936	871
ASTM C 672, Scaling Resistance, 12x12x3-in. slabs, visual rating		
50 Cycles, average of two samples		**1.0**
ASTM C 666, Freezing and Thawing - Procedure A, 3x3x11-in. beams, RDM%		
300 Cycles, average of two samples		**91**

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 395179
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: October 20, 2005

RAPID CHLORIDE PENETRATION RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
Set 1 Sample A	10-19-05	983	Very Low
Set 1 Sample B	10-19-05	953	Very Low

Sample Type: 4-in. diameter concrete cylinders.
Age Since Casting: 56 days from the client's reported cast date of August 24, 2005.
Specimens History: The cylinders were received at CTLGroup in moist condition. Upon receipt at CTLGroup, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 395179
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: October 20, 2005

RAPID CHLORIDE PENETRATION RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
Set 2 Sample A	10-19-05	1042	Low
Set 2 Sample B	10-19-05	973	Very Low

Sample Type: 4-in. diameter concrete cylinders.
Age Since Casting: 56 days from the client's reported cast date of August 24, 2005.
Specimens History: The cylinders were received at CTLGroup in moist condition. Upon receipt at CTLGroup, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

CTLGROUP Building Knowledge. Delivering Results.
www.CTLGroup.com

Figure E-5

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 395179
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: October 20, 2005

RAPID CHLORIDE PENETRATION RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
Set 3 Sample A	10-19-05	1029	Low
Set 3 Sample B	10-19-05	944	Very Low

Sample Type: 4-in. diameter concrete cylinders.
Age Since Casting: 56 days from the client's reported cast date of August 24, 2005.
Specimens History: The cylinders were received at CTLGroup in moist condition. Upon receipt at CTLGroup, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 395179
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: October 20, 2005

RAPID CHLORIDE PENETRATION RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
Set 4 Sample A	10-19-05	1123	Low
Set 4 Sample B	10-19-05	989	Very Low

Sample Type: 4-in. diameter concrete cylinders.
Age Since Casting: 56 days from the client's reported cast date of August 24, 2005.
Specimens History: The cylinders were received at CTLGroup in moist condition. Upon receipt at CTLGroup, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTL Project No.: 395179
CTL Project Mgr.: T. Muresan
Technician: P. Brindise
Approved: W. Morrison
Date: October 20, 2005

RAPID CHLORIDE PENETRATION RESULTS
ASTM C 1202

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
Set 5 Sample A	10-20-05	936	Very Low
Set 5 Sample B	10-20-05	871	Very Low

Sample Type: 4-in. diameter concrete cylinders.
Age Since Casting: 57 days from the client's reported cast date of August 24, 2005.
Specimens History: The cylinders were received at CTLGroup in moist condition. Upon receipt at CTLGroup, the specimens were immersed in saturated limewater until prepared for test.

See ASTM C 1202 Table below for interpretation of results.

Charge Passed Coulombs	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

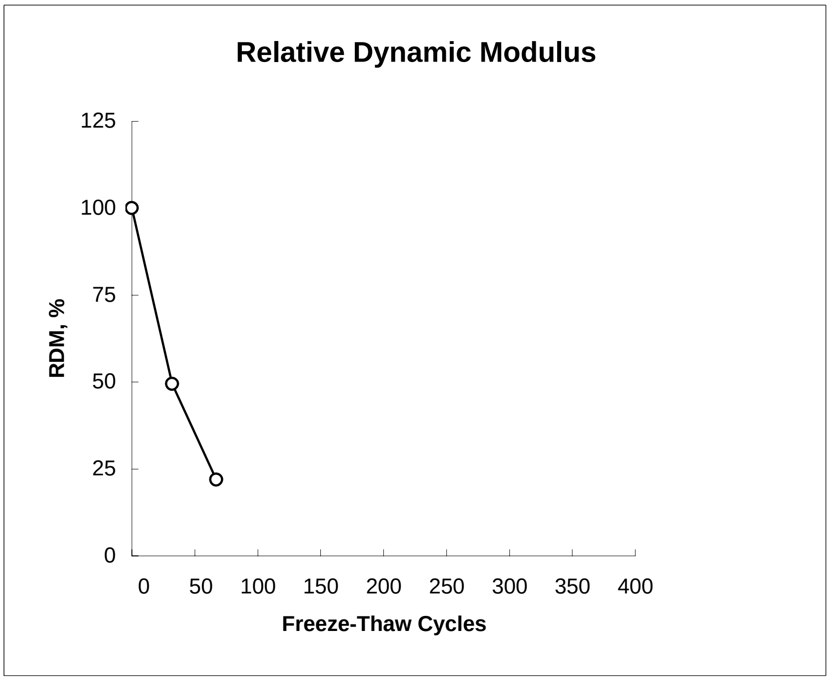
Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Proj. No.: 395179
CTLGroup Proj. Mgr.: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

Test Results of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens†

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0	0.00	100
Set 1	32	0.08	0.04	50
A and B	67	0.17	0.07	22

† Values are the average of two specimens.



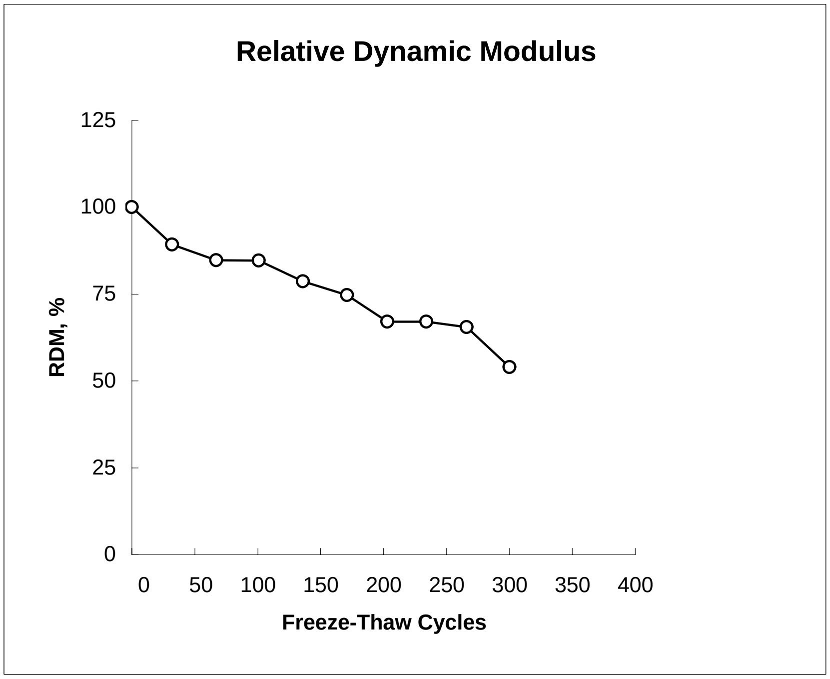
Note:
After 67 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus. Also length change exceeded the 0.10% expansion criteria. The samples were removed from test.

CTLGROUP Building Knowledge. Delivering Results. www.CTLGroup.com

Test Results of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens†

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0	0.00	100
Set 2	32	0.02	- 0.08	89
A and B	67	0.02	- 0.08	85
	101	0.02	- 0.05	85
	136	0.03	- 0.15	79
	171	0.02	- 0.43	75
	203	0.04	- 0.99	67
	234	0.04	- 1.67	67
	266	0.04	- 2.70	65
	300	0.05	- 3.60	54

† Values are the average of two specimens.



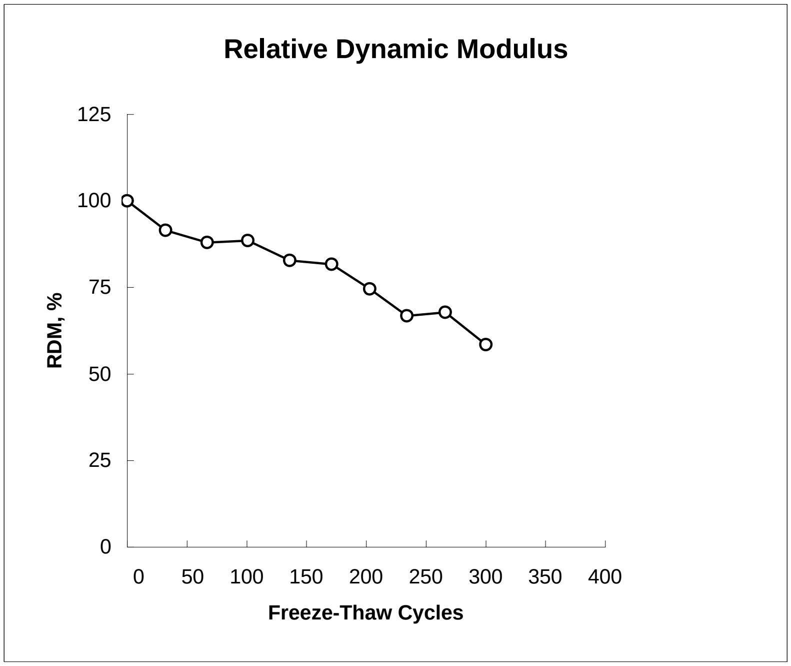
Note:
After 300 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus. The samples are considered not freeze-thaw durable.

CTLGROUP Building Knowledge. Delivering Results. www.CTLGroup.com

Test Results of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens†

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0	0.00	100
Set 3	32	0.00	- 0.17	92
A and B	67	0.00	- 0.17	88
	101	0.00	- 0.20	89
	136	0.01	- 0.29	83
	171	0.01	- 0.61	82
	203	0.02	- 1.60	75
	234	0.02	- 2.39	67
	266	0.03	- 2.94	68
	300	0.03	- 3.92	58

† Values are the average of two specimens.

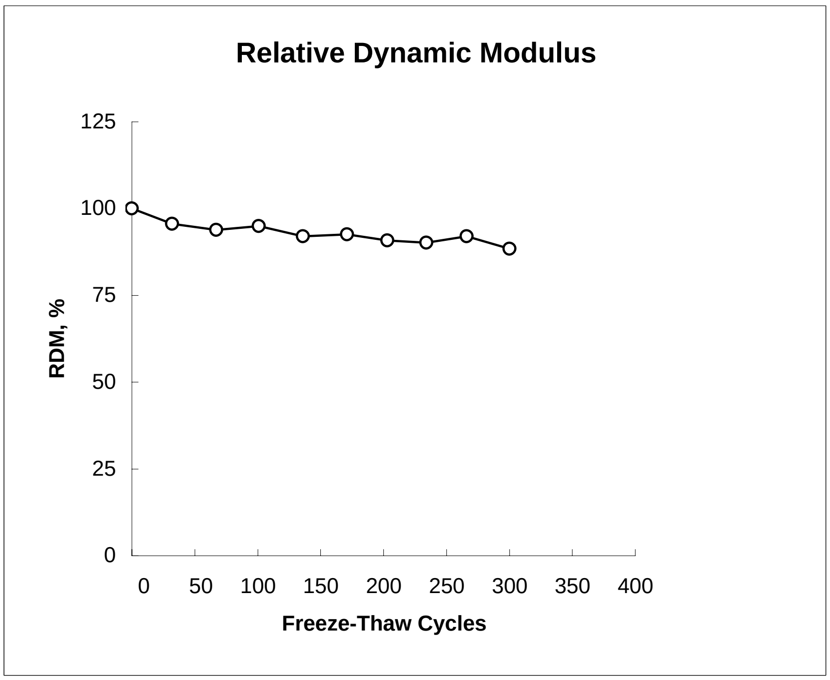


Note:
After 300 freeze-thaw cycles, relative dynamic modulus dropped below 60% of the initial modulus. The samples are considered not freeze-thaw durable.

Test Results of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens†

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0	0.00	100
Set 4	32	0.01	- 0.13	96
A and B	67	0.01	- 0.15	94
	101	0.01	- 0.17	95
	136	0.01	- 0.31	92
	171	0.00	- 0.46	93
	203	0.01	- 1.15	91
	234	0.01	- 1.79	90
	266	0.01	- 2.69	92
	300	0.00	- 3.77	88

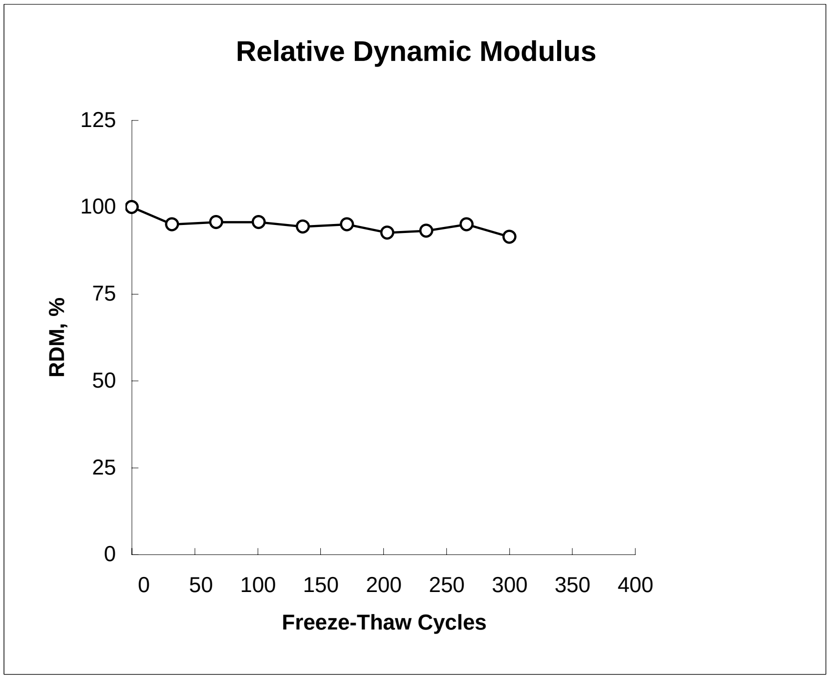
† Values are the average of two specimens.



Test Results of ASTM C 666 - Procedure A
Freezing and Thawing in Water of Concrete Specimens†

Samples Identification	Freeze-Thaw Cycles	Length Change, %	Mass Change, %	Relative Dynamic Modulus, %
	0	0	0.00	100
Set 5	32	-0.01	- 0.14	95
A and B	67	-0.01	- 0.21	96
	101	-0.01	- 0.26	96
	136	-0.01	- 0.51	94
	171	-0.02	- 0.86	95
	203	-0.01	- 1.55	93
	234	-0.01	- 2.32	93
	266	-0.01	- 3.21	95
	300	-0.01	- 3.91	91

† Values are the average of two specimens.



Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Proj. No.: 395179
CTLGroup Proj. Mgr.: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

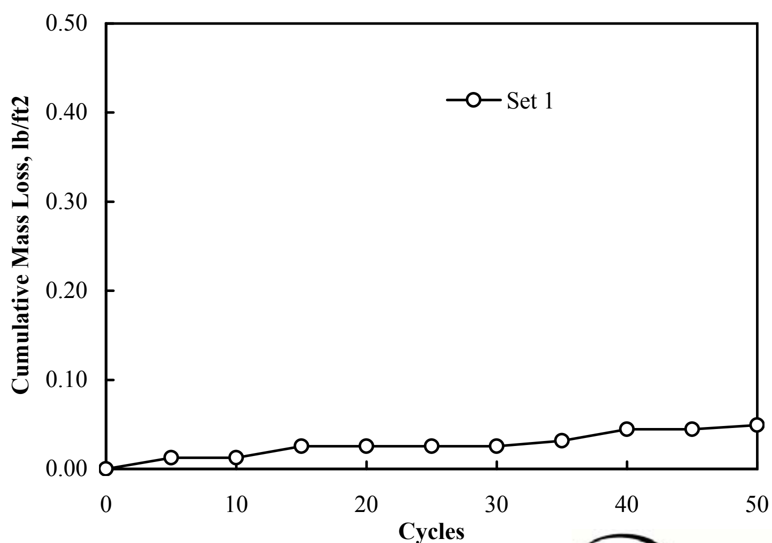
Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Set 1 A and B"

	Cummulative Mass Loss, lb/ft^2			Visual Scale Rating (ASTM C 672)		
Cycle	A	B	Avg.	A	B	Avg.
0	0	0	0	0	0	0
5	0.03	0.00	0.01	0.5	0.0	0.3
10	0.03	0.00	0.01	0.5	0.0	0.3
15	0.04	0.01	0.03	1.0	1.0	1.0
20	0.04	0.01	0.03	1.0	1.0	1.0
25	0.04	0.01	0.03	1.0	1.0	1.0
30	0.04	0.01	0.03	1.0	1.0	1.0
35	0.04	0.02	0.03	1.0	1.0	1.0
40	0.05	0.04	0.04	1.0	1.5	1.3
45	0.05	0.04	0.04	1.0	1.5	1.3
50	0.05	0.04	0.05	1.5	2.0	1.8

Notes:
Deicing solution 4% calcium chloride.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)

Cumulative Mass Loss Versus Cycles



CTLGROUP Building Knowledge. Delivering Results. www.CTLGroup.com

Figure E-7

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Proj. No.: 395179
CTLGroup Proj. Mgr.: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

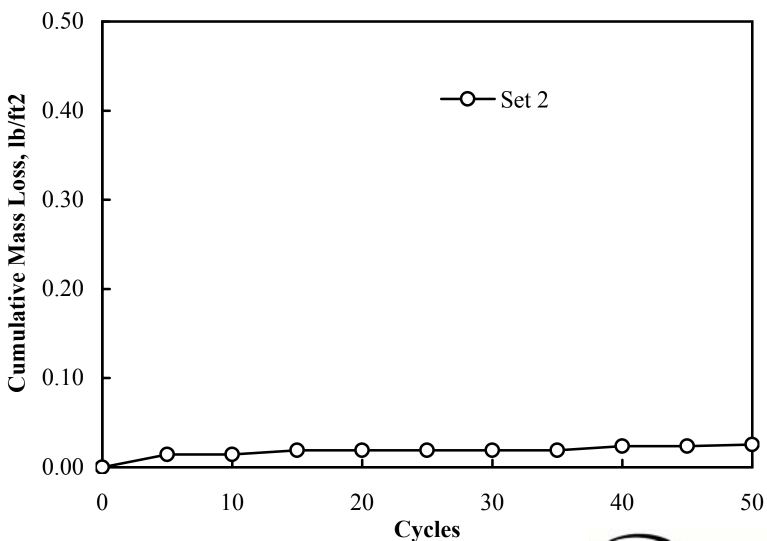
Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Set 2 A and B"

	Cummulative Mass Loss, lb/ft^2			Visual Scale Rating (ASTM C 672)		
Cycle	A	B	Avg.	A	B	Avg.
0	0	0	0	0	0	0
5	0.03	0.00	0.01	0.5	0.0	0.3
10	0.03	0.00	0.01	0.5	0.0	0.3
15	0.03	0.00	0.02	1.0	1.0	1.0
20	0.03	0.00	0.02	1.0	1.0	1.0
25	0.03	0.00	0.02	1.0	1.0	1.0
30	0.03	0.00	0.02	1.0	1.0	1.0
35	0.03	0.00	0.02	1.0	1.0	1.0
40	0.04	0.01	0.02	1.5	1.0	1.3
45	0.04	0.01	0.02	1.5	1.0	1.3
50	0.04	0.01	0.03	1.5	1.0	1.3

Notes:
Deicing solution 4% calcium chloride.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)

Cumulative Mass Loss Versus Cycles



CTLGroup Building Knowledge. Delivering Results. www.CTLGroup.com

Figure E-7

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

CTLGroup Proj. No.: 395179
CTLGroup Proj. Mgr.: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

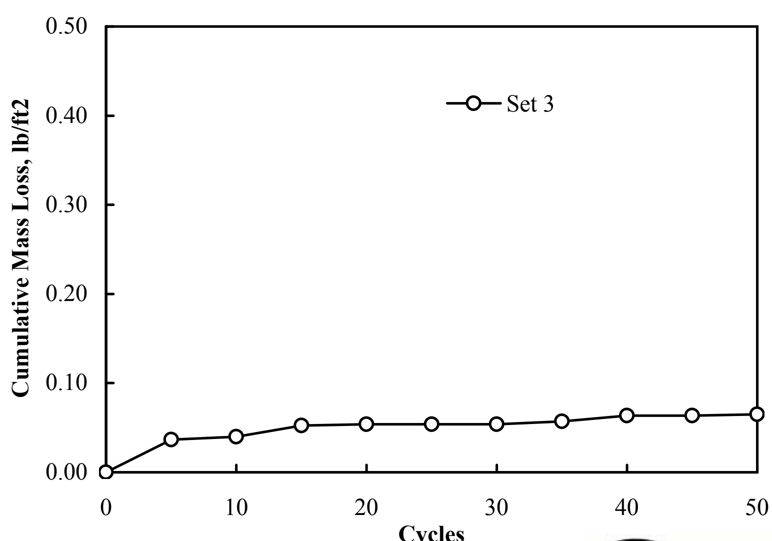
Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Set 3 A and B"

	Cummulative Mass Loss, lb/ft^2			Visual Scale Rating (ASTM C 672)		
Cycle	A	B	Avg.	A	B	Avg.
0	0	0	0	0	0	0
5	0.00	0.07	0.04	0.0	1.0	0.5
10	0.00	0.08	0.04	0.0	1.0	0.5
15	0.01	0.10	0.05	1.0	1.0	1.0
20	0.01	0.10	0.05	1.0	1.0	1.0
25	0.01	0.10	0.05	1.0	1.0	1.0
30	0.01	0.10	0.05	1.0	1.0	1.0
35	0.02	0.10	0.06	1.0	1.0	1.0
40	0.02	0.11	0.06	2.0	2.0	2.0
45	0.02	0.11	0.06	2.0	2.0	2.0
50	0.02	0.11	0.07	2.0	2.5	2.3

Notes:
Deicing solution 4% calcium chloride.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)

Cumulative Mass Loss Versus Cycles



www.CTLGroup.com

Figure E-7

Client: Jaber Engineering
Project: Sunshine Bridge Materials Testing
Contact: Mr. Tarif Jaber
Submitter: Mr. Tarif Jaber

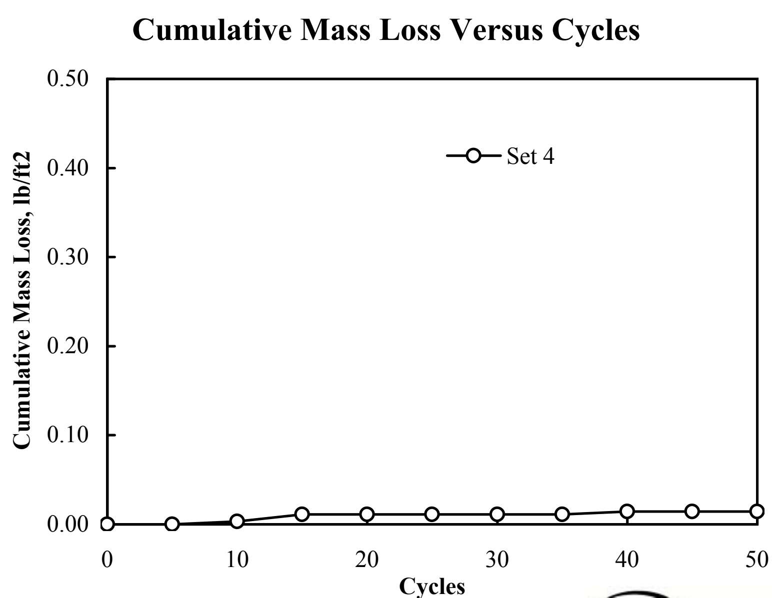
CTLGroup Proj. No.: 395179
CTLGroup Proj. Mgr.: T. Muresan
Technician: B. Szczerowski
Approved: W. Morrison
Date: January 12, 2006

Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Set 4 A and B"

	Cummulative Mass Loss, lb/ft^2			Visual Scale Rating (ASTM C 672)		
Cycle	A	B	Avg.	A	B	Avg.
0	0	0	0	0	0	0
5	0.00	0.00	0.00	0.0	0.0	0.0
10	0.00	0.01	0.00	0.0	0.0	0.0
15	0.00	0.02	0.01	1.0	1.0	1.0
20	0.00	0.02	0.01	1.0	1.0	1.0
25	0.00	0.02	0.01	1.0	1.0	1.0
30	0.00	0.02	0.01	1.0	1.0	1.0
35	0.00	0.02	0.01	1.0	1.0	1.0
40	0.01	0.02	0.01	1.0	1.0	1.0
45	0.01	0.02	0.01	1.0	1.0	1.0
50	0.01	0.02	0.01	1.0	1.0	1.0

Notes:
Deicing solution 4% calcium chloride.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)



CTLGroup Building Knowledge. Delivering Results. www.CTLGroup.com

Figure E-7

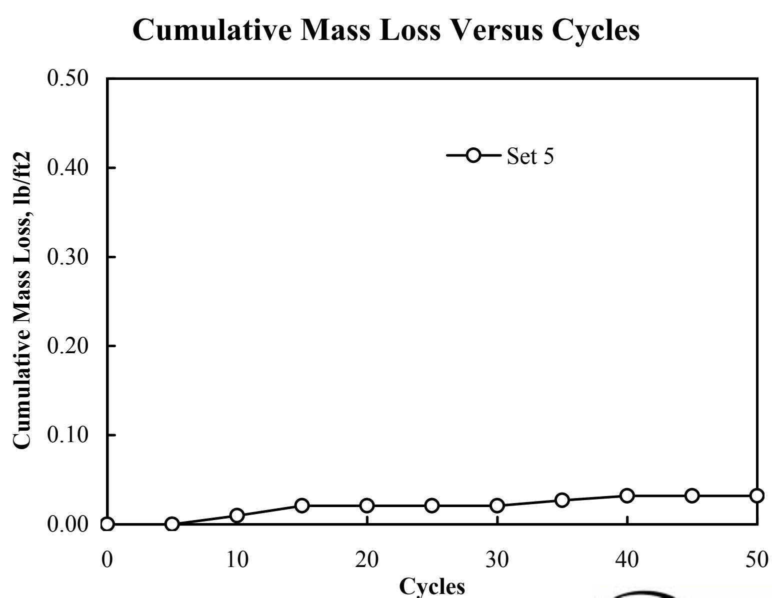
Client: Jaber Engineering	CTLGroup Proj. No.: 395179
Project: Sunshine Bridge Materials Testing	CTLGroup Proj. Mgr.: T. Muresan
Contact: Mr. Tarif Jaber	Technician: B. Szczerowski
Submitter: Mr. Tarif Jaber	Approved: W. Morrison
	Date: January 12, 2006

Test Results - ASTM C 672
Scaling Resistance of Concrete Surface Exposed to Deicing Chemicals
for Two 12x12x3-in. Slabs Identified as "Set 5 A and B"

	Cummulative Mass Loss, lb/ft^2			Visual Scale Rating (ASTM C 672)		
Cycle	A	B	Avg.	A	B	Avg.
0	0	0	0	0	0	0
5	0.00	0.00	0.00	0.0	0.0	0.0
10	0.01	0.01	0.01	0.0	1.0	0.5
15	0.03	0.02	0.02	0.5	1.0	0.8
20	0.03	0.02	0.02	0.5	1.0	0.8
25	0.03	0.02	0.02	0.5	1.0	0.8
30	0.03	0.02	0.02	0.5	1.0	0.8
35	0.03	0.02	0.03	0.5	1.0	0.8
40	0.03	0.03	0.03	1.0	1.0	1.0
45	0.03	0.03	0.03	1.0	1.0	1.0
50	0.03	0.03	0.03	1.0	1.0	1.0

Notes:
Deicing solution 4% calcium chloride.

Rating / Condition of Surface
0 - no scaling
1 - very slight scaling (1/8 in. depth max, no coarse aggregate visible)
2 - slight to moderate scaling
3 - moderate scaling (some coarse aggregate visible)
4 - moderate to severe scaling
5 - severe scaling (coarse aggregate visible over entire surface)



CTLGroup
Building Knowledge. Delivering Results.
www.CTLGroup.com

Figure E-7

Building Knowledge. Delivering Results.

CONSTRUCTION TECHNOLOGY LABORATORIES

ENGINEERS & CONSTRUCTION TECHNOLOGY CONSULTANTS

REPORT OF AIR-VOID SYSTEM ANALYSIS
ASTM C 457-98 Linear Traverse Method

www.CTLGroup.com

CTLGroup Project No.: 159074

Report Date: October 24, 2005

Client: Jaber Engineering Consulting, Inc.

Samples Received: September 9, 2005

Project: Sunshine Bridge Deck Replacement

Maximum Size Aggregate: ¾ in.

Tested By: V. Jennings

Sample ID	Total Air Content %	Spacing Factor, in	Specific Surface ($in.^2/in.^3$)	No. Voids/ inch	Paste Content, %	Length of Traverse, in.
Set 1A	2.2	0.012	589	3.3	29.0	90.1
Set 2A	4.0	0.009	624	6.2	31.9	90.0
Set 3A	4.7	0.009	570	6.7	32.0	90.0
Set 4A	5.2	0.008	688	9.0	33.4	90.0
Set 5A	6.5	0.007	632	10.3	31.2	90.0

American Concrete Institute,
ACI 201.2R-92
"Guide to Durable Concrete"
TABLE 1.4.3 RECOMMENDED AIR CONTENTS FOR FROST-RESISTANT CONCRETE

Nominal maximum aggregate size in.	(mm)	Average air content, percent* Severe exposure+	Moderate exposure++
⅜	(9.5)	7½	6
½	(12.5)	7	5½
¾	(19)	6	5
1½	(38)	5½	4½
3§	(75)	4½	3½
6§	(150)	4	3

* A reasonable tolerance for air content in field construction is ± 1½%.

+ Outdoor exposure in a cold climate where the concrete may be in almost continuous contact with moisture prior to freezing, or where deicing salts are used. Examples are pavements, bridge decks, sidewalks, and water tanks.

++ Outdoor exposure in a cold climate where the concrete will be only occasionally exposed to moisture prior to freezing, and where no deicing salts will be used. Examples are certain exterior walls, beams, girders, and slabs not in direct contact with soil.

§ These air contents apply to the whole mix, as for the preceding aggregate sizes. When testing these concretes, however, aggregate larger than 1½ in. (38 mm) is removed by hand-picking or sieving and the air content is determined on the minus 1½ in. (38 mm) fraction of the mix. (The field tolerance applies to this value.) From this the air content of the whole mix is computed.

There is conflicting opinion on whether air contents lower than those given in the table should be permitted for high-strength [more than 5500 psi (37.8 MPa)] concrete. This committee believes that where supporting experience and/or experimental data exists for particular combinations of materials, construction practices, and exposure, the air contents may be reduced by approximately 1 percent. [For maximum aggregate sizes over 1½ in. (38 mm), this reduction applies to the minus 1½ in. (38 mm) fraction of the mix.]

AIR-VOID SYSTEM: Most authorities consider the following air-void characteristics as representative of a system with adequate freeze-thaw resistance:

1. Calculated spacing factor (average maximum distance from any point in cement paste to edge of nearest air void)--less than 0.008 in. (0.20 mm).
2. Specific surface (surface area of the air voids)-- 600 $in.^2$ per cubic inch (23.6 mm^2/mm^3) of air-void volume, or greater.
3. Number of voids per linear inch (25 mm) of traverse be significantly greater than the numerical value of the percentage of air in the concrete.

References: (1) Design and Control of Concrete Mixtures, 14th Edition, Portland Cement Association, 2002, p. 146.
(2) American Concrete Institute, ACI 212.3R-91, (Section 2.2).

Main Office 5400 Old Orchard Road Skokie, Illinois 60077-1030 Phone 847-965-7500 Fax 847-965-6541
Northeast Office 5565 Sterrett Place, Suite 312 Columbia, Maryland 21044-2685 Phone 410-997-0400 Fax 410-997-8480

Figure E-8a

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

LABORATORY REPORT

Client JABER ENGINEERING CONSULTING INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Date of Report 9-26-05
Job No. 2145XU342
Event / Invoice No. 1 — Lab No. 1
Authorized By JEC/JABER — Date 8-22-05
Sampled By WT/MILLS — Date 8-24-05
Submitted By WT/WHITMAN — Date 8-25-05

Project SUNSHINE BRIDGE
Location I-40 @ MILEPOST 227, AZ
Contractor - -
Arch. / Engr. - -
Type / Use of Material PORTLAND CEMENT CONCRETE
Supplier / Source RINKER MATERIALS/FLAGSTAFF
Sample Source / Location STA 2127 + 15 20' N OF S EDGE
Source / Location Desig. By JEC/JABER — Date 8-24-05
Reference: ASTM C 469
Special Instructions:

TEST RESULTS

TYPE OF SPECIMENS : 6 X 12 CYLINDERS

CURING HISTORY : PER ASTM C 31

OTHER INFORMATION:
SEE REPORT *SAMPLING/TESTING OF PORTLAND CEMENT CONCRETE* REFERENCED EVENT NO. Y342-001 LAB NO.1

AGE (DAYS)	COMPRESSIVE STRENGTH (PSI)	CHORD MODULUS OF ELASTICITY (PSI)
28	7270	4,100,000

Comments: LOAD 2

Copies To: CLIENT (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY RT 9-26-5

450©95WT
062899

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

LABORATORY REPORT

Date of Report 9-26-05
Job No. 2145XU342
Event / Invoice No. 1 Lab No. 2
Authorized By JEC/JABER Date 8-22-05
Sampled By WT/MILLS Date 8-24-05
Submitted By WT/WHITMAN Date 8-25-05

Client JABER ENGINEERING CONSULTING INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Location I-40 @ MILEPOST 227, AZ
Contractor - -
Arch. / Engr. - -
Type / Use of Material PORTLAND CEMENT CONCRETE
Supplier / Source RINKER MATERIALS/FLAGSTAFF
Sample Source / Location STA 2126 +75 6' S OF N EDGE
Source / Location Desig. By JEC/JABER Date 8-24-05
Reference: ASTM C 469
Special Instructions:

TEST RESULTS

TYPE OF SPECIMENS : 6 X 12 CYLINDERS

CURING HISTORY : PER ASTM C 31

OTHER INFORMATION:
SEE REPORT *SAMPLING/TESTING OF PORTLAND CEMENT CONCRETE* REFERENCED EVENT NO. Y342-001 LAB NO.2

AGE (DAYS)	COMPRESSIVE STRENGTH (PSI)	CHORD MODULUS OF ELASTICITY (PSI)
3	3730	3,400,000
7	4670	3,550,000
28	6710	4,150,000

Comments: LOAD 7 (PLACED AS LOAD 6)

Copies To: CLIENT (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY RT 9-26-5

450(©95WT)
062899

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

LABORATORY REPORT

Date of Report 9-26-05
Job No. 2145XU342
Event / Invoice No. 1 Lab No. 3
Authorized By JEC/JABER Date 8-22-05
Sampled By WT/MILLS Date 8-24-05
Submitted By WT/WHITMAN Date 8-25-05

Client JABER ENGINEERING CONSULTING INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Contractor - -
Type / Use of Material PORTLAND CEMENT CONCRETE
Sample Source / Location STA 2126 + 35 15' N OF S EDGE
Reference: ASTM C 469
Special Instructions:

Location I-40 @ MILEPOST 227, AZ
Arch. / Engr. - -
Supplier / Source RINKER MATERIALS/FLAGSTAFF
Source / Location Desig. By JEC/JABER Date 8-24-05

TEST RESULTS

TYPE OF SPECIMENS : 6 X 12 CYLINDERS

CURING HISTORY : PER ASTM C 31

OTHER INFORMATION:
SEE REPORT *SAMPLING/TESTING OF PORTLAND CEMENT CONCRETE* REFERENCED EVENT NO. Y342-001 LAB NO.3

AGE (DAYS)	COMPRESSIVE STRENGTH (PSI)	CHORD MODULUS OF ELASTICITY (PSI)
3	3600	3,200,000
7	4390	3,450,000
28	6330	3,900,000

Comments: LOAD 11

Copies To: CLIENT (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY RT 9.26.5

4500 95WT
062899

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

LABORATORY REPORT

Date of Report 9-26-05
Job No. 2145XU342
Event / Invoice No. 1 Lab No. 4
Authorized By JEC/JABER Date 8-22-05
Sampled By WT/MILLS Date 8-24-05
Submitted By WT/WHITMAN Date 8-25-05

Client JABER ENGINEERING CONSULTING INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Location I-40 @ MILEPOST 227, AZ
Contractor - -
Arch. / Engr. - -
Type / Use of Material PORTLAND CEMENT CONCRETE
Supplier / Source RINKER MATERIALS/FLAGSTAFF
Sample Source / Location STA 2126 + 10 9' S OF N EDGE
Source / Location Desig. By JEC/JABER Date 8-24-05
Reference: ASTM C 469
Special Instructions:

TEST RESULTS

TYPE OF SPECIMENS : 6 X 12 CYLINDERS

CURING HISTORY : PER ASTM C 31

OTHER INFORMATION:
SEE REPORT *SAMPLING/TESTING OF PORTLAND CEMENT CONCRETE* REFERENCED EVENT NO. Y342-001 LAB NO.4

AGE (DAYS)	COMPRESSIVE STRENGTH (PSI)	CHORD MODULUS OF ELASTICITY (PSI)
3	3550	3,250,000
7	4320	3,500,000
28	6430	4,000,000

Comments: LOAD 14

Copies To: CLIENT (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY RT 9-26-5

4500@95WT
062899

Figure E-9

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

LABORATORY REPORT

Date of Report **9-26-05**
Job No. **2145XU342**
Event / Invoice No. **1** Lab No. **5**
Authorized By **JEC/JABER** Date **8-22-05**
Sampled By **WT/MILLS** Date **8-24-05**
Submitted By **WT/WHITMAN** Date **8-25-05**

Client **JABER ENGINEERING CONSULTING INC.**
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project **SUNSHINE BRIDGE**
Contractor - -
Type / Use of Material **PORTLAND CEMENT CONCRETE**
Sample Source / Location **STA 2125 + 75 20' CENTER OF DECK**
Reference: **ASTM C 469**
Special Instructions:

Location **I-40 @ MILEPOST 227, AZ**
Arch. / Engr. - -
Supplier / Source **RINKER MATERIALS/FLAGSTAFF**
Source / Location Desig. By **JEC/JABER** Date **8-24-05**

TEST RESULTS

TYPE OF SPECIMENS : 6 X 12 CYLINDERS

CURING HISTORY : PER ASTM C 31

OTHER INFORMATION:
SEE REPORT *SAMPLING/TESTING OF PORTLAND CEMENT CONCRETE* REFERENCED EVENT NO. Y342-001 LAB NO.5

AGE (DAYS)	COMPRESSIVE STRENGTH (PSI)	CHORD MODULUS OF ELASTICITY (PSI)
28	6250	3,750,000

Comments: **LOAD 18**

Copies To: **CLIENT (1)**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY K 9-26-5

4500095WT1
062899

Project: Sunshine Bridge

GAGE LENGTH (IN.): 8

			Stress (psi)		Gage readings		Strain		
Age (days)	Lab No.	Run No.	S1	S2	e1	e2	ε 1	ε 2	CHORD MODULUS (psi)
3	2	1	240	1504	8	67	5.0E-05	4.2E-04	**3,400,000**
		2	230	1504	8	68	5.0E-05	4.3E-04	
		3	240	1504	8	68	5.0E-05	4.3E-04	
	3	1	230	1402	8	66	5.0E-05	4.1E-04	**3,200,000**
		2	230	1402	8	67	5.0E-05	4.2E-04	
		3	230	1402	8	66	5.0E-05	4.1E-04	
	4	1	230	1385	8	65	5.0E-05	4.1E-04	**3,250,000**
		2	220	1385	8	66	5.0E-05	4.1E-04	
		3	230	1385	8	65	5.0E-05	4.1E-04	

			Stress (psi)		Gage readings		Strain		
Age (days)	Lab No.	Run No.	S1	S2	e1	e2	ε 1	ε 2	CHORD MODULUS (psi)
7	2	1	250	1854	8	80	5.0E-05	5.0E-04	**3,550,000**
		2	250	1854	8	80	5.0E-05	5.0E-04	
		3	240	1854	8	80	5.0E-05	5.0E-04	
	3	1	270	1778	8	79	5.0E-05	4.9E-04	**3,450,000**
		2	230	1778	8	80	5.0E-05	5.0E-04	
		3	220	1778	8	80	5.0E-05	5.0E-04	
	4	1	240	1756	8	77	5.0E-05	4.8E-04	**3,500,000**
		2	250	1756	8	76	5.0E-05	4.8E-04	
		3	260	1756	8	77	5.0E-05	4.8E-04	

Figure E-9

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

Project: Sunshine Bridge

GAGE LENGTH (IN.): 8

			Stress (psi)		Gage readings		Strain		
Age (days)	Lab No.	Run No.	S1	S2	e1	e2	ε 1	ε 2	CHORD MODULUS (psi)
28	1	1	285	2824	8	108	5.0E-05	6.8E-04	
		2	264	2824	8	107	5.0E-05	6.7E-04	
		3	277	2824	8	108	5.0E-05	6.8E-04	**4,100,000**
	2	1	303	2693	8	100	5.0E-05	6.3E-04	
		2	320	2693	8	100	5.0E-05	6.3E-04	
		3	303	2693	8	100	5.0E-05	6.3E-04	**4,150,000**
	3	1	294	2450	8	96	5.0E-05	6.0E-04	
		2	309	2450	8	95	5.0E-05	5.9E-04	
		3	302	2450	8	96	5.0E-05	6.0E-04	**3,900,000**
	4	1	287	2377	8	92	5.0E-05	5.8E-04	
		2	278	2377	8	93	5.0E-05	5.8E-04	
		3	267	2377	8	92	5.0E-05	5.8E-04	**4,000,000**
	5	1	240	2418	8	99	5.0E-05	6.2E-04	
		2	270	2418	8	99	5.0E-05	6.2E-04	
		3	260	2418	8	101	5.0E-05	6.3E-04	**3,750,000**

Figure E-9

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report 09-26-05
Job No. 2145XU342
Event/Invoice No. Y342-001 Lab No. 1
Authorized By JEC/JABER Date 08-22-05
Sampled By WT/MILLS Date 08-24-05
Submitted By WT/WHITMAN Date 08-25-05

Client JABER ENGINEERING CONSULTING INC
ATTN TARIF JABER
10827 EAST BUTHERUS DRIVE
SCOTTSDALE, AZ 85255

Client JABER ENGINEERING CONSULTING INC
Project SUNSHINE BRIDGE
Location I-40 @ MILEPOST 227, AZ
Source of Sample STA 2127+15 20' N OF S EDGE
Architect/Engineer ADOT
Contractor VASCO
Supplier RINKER MATERIALS/FLAGSTAFF
Truck/Ticket No. 424/56489361 Mix Identification 1352839 Maximum Size Aggregate 1 inches
Batch Size 10.0 cubic yards Required Strength 4500 psi @ 28 days Water Added Before Sampling 0 gallons
Time In Mixer 1 hours 38 minutes Ambient Air Temperature °F Time Sampled 3:03 AM

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH AASHTO T141

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight: lbf/cu.ft. Temperature: ASTM C1064 °F
Air Content: % Slump: AASHTO T119 inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH AASHTO T23

No. of Specimens Molded 2 Diameter/Length 6.00 in.x 12 in. Cross Sectional Area 28.27 sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH ASTM C31 & C39

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength Maximum Load lbf	Compressive Strength lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	09-21-05	28		199620	7060		CONE	AA
	09-21-05	28		205610	7270			RT
	AVERAGE	28			7170	YES		

Comments: LOAD 2

Distribution : JABER ENGINEERING CONSULTING INC (1)
RINKER MATERIALS WEST (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY R. TIXIER
(SIGNED COPY ON FILE)

401 ©98 WTI

Figure E-9

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Client **JABER ENGINEERING CONSULTING INC**
ATTN TARIF JABER
10827 EAST BUTHERUS DRIVE
SCOTTSDALE, AZ 85255

Date of Report	09-26-05		
Job No.	2145XU342		
Event/Invoice No.	Y342-001	Lab No.	2
Authorized By	JEC/JABER	Date	08-22-05
Sampled By	WT/MILLS	Date	08-24-05
Submitted By	WT/WHITMAN	Date	08-25-05

Client **JABER ENGINEERING CONSULTING INC**
Project **SUNSHINE BRIDGE**
Location **I-40 @ MILEPOST 227, AZ**
Source of Sample **STA 2126+75 6' S OF N EDGE**
Architect/Engineer **ADOT**
Contractor **VASCO**
Supplier **RINKER MATERIALS/FLAGSTAFF**

Truck/Ticket No. **443/56489494** Mix Identification **1352839** Maximum Size Aggregate **1** inches
Batch Size **10.0** cubic yards Required Strength **4500** psi @ **28** days Water Added Before Sampling **0** gallons
Time In Mixer **1** hours **59** minutes Ambient Air Temperature °F Time Sampled **4:55 AM**

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **AASHTO T141**

Deviations: **BATCH 2:56 AM**

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight: lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content: % Slump: **AASHTO T119** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **AASHTO T23**

No. of Specimens Molded **6** Diameter/Length **5.99** in.x **12** in. Cross Sectional Area **28.18** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength Maximum Load lbf	lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	08-27-05	3		105940	3760			RT
	08-27-05	3		105180	3730			RT
	08-31-05	7		130640	4640			RT
	08-31-05	7		131530	4670			MK
	09-21-05	28		184730	6560			AA
	09-21-05	28		189190	6710			RT
	AVERAGE	3			3750			
	AVERAGE	7			4660			
	AVERAGE	28			6640	YES		

Comments: **LOAD 7 (PLACED AS LOAD 6)**

Distribution : **JABER ENGINEERING CONSULTING INC (1)**
RINKER MATERIALS WEST (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY **R. TIXIER**
(SIGNED COPY ON FILE)

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Client **JABER ENGINEERING CONSULTING INC**
ATTN TARIF JABER
10827 EAST BUTHERUS DRIVE
SCOTTSDALE, AZ 85255

Date of Report **09-26-05**
Job No. **2145XU342**
Event/Invoice No. **Y342-001** Lab No. **3**
Authorized By **JEC/JABER** Date **08-22-05**
Sampled By **WT/MILLS** Date **08-24-05**
Submitted By **WT/WHITMAN** Date **08-25-05**

Client **JABER ENGINEERING CONSULTING INC**
Project **SUNSHINE BRIDGE**
Location **I-40 @ MILEPOST 227, AZ**
Source of Sample **STA 2126 + 35 15' N OF S EDGE**
Architect/Engineer **ADOT**
Contractor **VASCO**
Supplier **RINKER MATERIALS/FLAGSTAFF**

Truck/Ticket No. **437/56489726**
Batch Size **10.0** cubic yards
Time In Mixer **1** hours **30** minutes

Mix Identification **1352839**
Required Strength **4500** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate **1** inches
Water Added Before Sampling **0** gallons
Time Sampled **5:33 AM**

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **AASHTO T141**

Deviations: **BATCH 4:03 AM**

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight: lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content: % Slump: **AASHTO T119** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **AASHTO T23**

No. of Specimens Molded **6** Diameter/Length **5.98** in.x **12** in. Cross Sectional Area **28.09** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	08-27-05	3		98480	3510			RT
	08-27-05	3		101090	3600			RT
	08-31-05	7		125270	4460			RT
	08-31-05	7		123170	4390			MK
	09-21-05	28		172540	6140		CONE/SHEAR	AA
	09-21-05	28		177760	6330			RT
	AVERAGE	3			3560			
	AVERAGE	7			4430			
	AVERAGE	28			6240	YES		

Comments: **LOAD 11**

Distribution : **JABER ENGINEERING CONSULTING INC (1)**
RINKER MATERIALS WEST (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY **R. TIXIER**
(SIGNED COPY ON FILE)

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report 09-26-05
Job No. 2145XU342
Event/Invoice No. Y342-001 Lab No. 4
Authorized By JEC/JABER Date 08-22-05
Sampled By WT/MILLS Date 08-24-05
Submitted By WT/WHITMAN Date 08-25-05

Client JABER ENGINEERING CONSULTING INC
ATTN TARIF JABER
10827 EAST BUTHERUS DRIVE
SCOTTSDALE, AZ 85255

Client JABER ENGINEERING CONSULTING INC
Project SUNSHINE BRIDGE
Location I-40 @ MILEPOST 227, AZ
Source of Sample STA 2126+10 9' S OF N EDGE
Architect/Engineer ADOT
Contractor VASCO
Supplier RINKER MATERIALS/FLAGSTAFF
Truck/Ticket No. 306/56489868 Mix Identification 1352839 Maximum Size Aggregate 1 inches
Batch Size 10.0 cubic yards Required Strength 4500 psi @ 28 days Water Added Before Sampling 0 gallons
Time In Mixer 1 hours 41 minutes Ambient Air Temperature °F Time Sampled 6:16 AM

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH AASHTO T141

Deviations: BATCH 4:35 AM

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight: lbf/cu.ft. Temperature: ASTM C1064 °F
Air Content: % Slump: AASHTO T119 - - inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH AASHTO T23

No. of Specimens Molded 6 Diameter/Length 6.00 in.x 12 in. Cross Sectional Area 28.27 sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH ASTM C31 & C39

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength Maximum Load lbf	lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	08-27-05	3		97910	3460			RT
	08-27-05	3		100380	3550			RT
	08-31-05	7		124120	4390			RT
	08-31-05	7		122240	4320			MK
	09-21-05	28		168020	5940		CONE	AA
	09-21-05	28		181870	6430			RT
	AVERAGE	3			3510			
	AVERAGE	7			4360			
	AVERAGE	28			6190	YES		

Comments: LOAD 14

Distribution : JABER ENGINEERING CONSULTING INC (1)
RINKER MATERIALS WEST (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY R. TIXIER
(SIGNED COPY ON FILE)

Figure E-9

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Client JABER ENGINEERING CONSULTING INC
ATTN TARIF JABER
10827 EAST BUTHERUS DRIVE
SCOTTSDALE, AZ 85255

Date of Report 09-26-05
Job No. 2145XU342
Event/Invoice No. Y342-001 — Lab No. 5
Authorized By JEC/JABER — Date 08-22-05
Sampled By WT/MILLS — Date 08-24-05
Submitted By WT/WHITMAN — Date 08-25-05

Client: JABER ENGINEERING CONSULTING INC
Project: SUNSHINE BRIDGE
Location: I-40 @ MILEPOST 227, AZ
Source of Sample: STA 2125+75 CENTER OF DECK
Architect/Engineer: ADOT
Contractor: VASCO
Supplier: RINKER MATERIALS/FLAGSTAFF

Truck/Ticket No. 7854/56490195 — Mix Identification 1352839 — Maximum Size Aggregate 1 inches
Batch Size 10.0 cubic yards — Required Strength 4500 psi @ 28 days — Water Added Before Sampling 0 gallons
Time In Mixer 1 hours 38 minutes — Ambient Air Temperature °F — Time Sampled 6:57 AM

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH AASHTO T141

Deviations: BATCH 5:19 AM

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight: lbf/cu.ft. — Temperature: ASTM C1064 °F
Air Content: % — Slump: AASHTO T119 -- inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH AASHTO T23

No. of Specimens Molded 2 — Diameter/Length 6.01 in.x 12 in. — Cross Sectional Area 28.37 sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH ASTM C31 & C39

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength Maximum Load lbf	lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	09-21-05	28		171530	6050		CONE/SHEAR	AA
	09-21-05	28		177310	6250			RT
	AVERAGE	28			6150	YES		

Comments: LOAD 18

Distribution: JABER ENGINEERING CONSULTING INC (1)
RINKER MATERIALS WEST (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY R. TIXIER
(SIGNED COPY ON FILE)

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

CEMENT MORTAR / CONCRETE LENGTH CHANGE

Date of Report 06-06-06 REVISED
Job No. 2145XU342
Event / Invoice No. Y342-01 Lab No. 1
Authorized By JEC/JABER Date 08-22-05
Sampled By WT/WHITMAN Date 08-24-05
Submitted By WT/WHITMAN Date 08-25-05

Client JABER ENGINEERING CONSULTING, INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Contractor VASCO
Type / Use of Material CONCRETE MIX 1352839/BRIDGE DECK
Sample Source / Location STA. 2127 + 15, 20' N. OF S. EDGE
Reference: ☒ LENGTH CHANGE, ASTM C157
☐ DRYING SHRINKAGE, ASTM C596
Special Instructions: STORAGE IN AIR AT 50 ± 4% HUMIDITY AT 73 ± 3 °F

Location I-40 @ MILEPOST 227, AZ
Arch. / Engr. ADOT
Supplier / Source RINKER MATERIALS WEST/FLAGSTAFF PLANT
Source / Location Desig. By JEC/JABER Date 08-24-05

MATERIALS	SOURCE
CEMENT	*
AGGREGATE	*
MAXIMUM SIZE	*
GRADING	*
ADMIX / POZZOLAN	*
WATER	*

MIXTURE CHARACTERISTICS
WATER / CEMENTITIOUS MATERIAL RATIO *
CONSISTENCY: FLOW, % N/A SLUMP, IN. NOT TESTED
CONSOLIDATION: TAMPING N/A RODDING X
EXTERNAL VIBRATION N/A
SPECIMEN SIZE 4" X 4" X 11"
SPECIMENS MOLDED: NO. 3 DATE 08-24-05
CURING CONDITIONS 28-DAY CURE IN LIME-SATURATED WATER

AVERAGE LENGTH CHANGE, %

AGE	CHANGE, %	AGE	CHANGE, %
28 DAYS	+0.017		
32 DAYS	+0.007		
35 DAYS	-0.001		
42 DAYS	-0.006		
56 DAYS	-0.016		
12 WEEKS	-0.024		
20 WEEKS	-0.032		
36 WEEKS	-0.051		
68 WEEKS	**		

Comments: * PER LOAD 2, TICKET 56489361 BATCH PROPORTIONS
**READINGS PENDING

Copies To: CLIENT – (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY

445 ©98WTI 092899

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

CEMENT MORTAR / CONCRETE LENGTH CHANGE

Date of Report 06-06-06 REVISED
Job No. 2145XU342
Event / Invoice No. Y342-01 Lab No. 2
Authorized By JEC/JABER Date 08-22-05
Sampled By WT/WHITMAN Date 08-24-05
Submitted By WT/WHITMAN Date 08-25-05

Client JABER ENGINEERING CONSULTING, INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Contractor VASCO
Type / Use of Material CONCRETE MIX 1352839/BRIDGE DECK
Sample Source / Location STA. 2126+75, 6' S. OF N. EDGE
Reference: [X] LENGTH CHANGE, ASTM C157
[ ] DRYING SHRINKAGE, ASTM C596
Special Instructions: STORAGE IN AIR AT 50 ± 4% HUMIDITY AT 73 ± 3 °F

Location I-40 @ MILEPOST 227, AZ
Arch. / Engr. ADOT
Supplier / Source RINKER MATERIALS WEST/FLAGSTAFF PLANT
Source / Location Desig. By JEC/JABER Date 08-24-05

MATERIALS	SOURCE
CEMENT	*
AGGREGATE	*
MAXIMUM SIZE	*
GRADING	*
ADMIX / POZZOLAN	*
WATER	*

MIXTURE CHARACTERISTICS
WATER / CEMENTITIOUS MATERIAL RATIO *
CONSISTENCY: FLOW, % N/A SLUMP, IN. NOT TESTED
CONSOLIDATION: TAMPING N/A RODDING X
EXTERNAL VIBRATION N/A
SPECIMEN SIZE 4" X 4" X 11"
SPECIMENS MOLDED: NO. 3 DATE 08-24-05
CURING CONDITIONS 28-DAY CURE IN LIME-SATURATED WATER

AVERAGE LENGTH CHANGE, %

AGE	CHANGE, %	AGE	CHANGE, %
28 DAYS	+0.011		
32 DAYS	-0.002		
35 DAYS	-0.004		
42 DAYS	-0.011		
56 DAYS	-0.026		
12 WEEKS	-0.032		
20 WEEKS	-0.042		
36 WEEKS	-0.057		
68 WEEKS	**		

Comments: * PER LOAD 7, TICKET 56489494 BATCH PROPORTIONS
**READINGS PENDING

Copies To: CLIENT - (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY

449 (05WT)
092899

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

CEMENT MORTAR / CONCRETE LENGTH CHANGE

Date of Report 06-06-06 REVISED
Job No. 2145XU342
Event / Invoice No. Y342-01 Lab No. 3
Authorized By JEC/JABER Date 08-22-05
Sampled By WT/WHITMAN Date 08-24-05
Submitted By WT/WHITMAN Date 08-25-05

Client JABER ENGINEERING CONSULTING, INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Contractor VASCO
Type / Use of Material CONCRETE MIX 1352839/BRIDGE DECK
Sample Source / Location STA. 2126+35, 15' N. OF S. EDGE
Location I-40 @ MILEPOST 227, AZ
Arch. / Engr. ADOT
Supplier / Source RINKER MATERIALS WEST/FLAGSTAFF PLANT
Source / Location Desig. By JEC/JABER Date 08-24-05

Reference: [X] LENGTH CHANGE, ASTM C157
[ ] DRYING SHRINKAGE, ASTM C596

Special Instructions: STORAGE IN AIR AT 50 ± 4% HUMIDITY AT 73 ± 3 °F

MATERIALS	SOURCE
CEMENT	*
AGGREGATE	*
MAXIMUM SIZE	*
GRADING	*
ADMIX / POZZOLAN	*
WATER	*

MIXTURE CHARACTERISTICS

WATER / CEMENTITIOUS MATERIAL RATIO *

CONSISTENCY: FLOW, % N/A SLUMP, IN. NOT TESTED

CONSOLIDATION: TAMPING N/A RODDING X

EXTERNAL VIBRATION N/A

SPECIMEN SIZE 4" X 4" X 11"

SPECIMENS MOLDED: NO. 3 DATE 08-24-05

CURING CONDITIONS 28-DAY CURE IN LIME-SATURATED WATER

AVERAGE LENGTH CHANGE, %

AGE	CHANGE, %	AGE	CHANGE, %
28 DAYS	+0.005		
32 DAYS	-0.001		
35 DAYS	-0.010		
42 DAYS	-0.018		
56 DAYS	-0.027		
12 WEEKS	-0.035		
20 WEEKS	-0.044		
36 WEEKS	-0.060		
68 WEEKS	**		

Comments: * PER LOAD 11, TICKET 56489726 BATCH PROPORTIONS
**READINGS PENDING

Copies To: CLIENT - (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY [signature]

449 ©98WTI
092899

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

CEMENT MORTAR / CONCRETE LENGTH CHANGE

Date of Report 06-06-06 REVISED
Job No. 2145XU342
Event / Invoice No. Y342-01 — Lab No. 4
Authorized By JEC/JABER — Date 08-22-05
Sampled By WT/WHITMAN — Date 08-24-05
Submitted By WT/WHITMAN — Date 08-25-05

Client JABER ENGINEERING CONSULTING, INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project SUNSHINE BRIDGE
Contractor VASCO
Type / Use of Material CONCRETE MIX 1352839/BRIDGE DECK
Sample Source / Location STA. 2126 + 10, 9' S. OF N. EDGE
Reference: [X] LENGTH CHANGE, ASTM C157
[ ] DRYING SHRINKAGE, ASTM C596
Special Instructions: STORAGE IN AIR AT 50 ± 4% HUMIDITY AT 73 ± 3 °F

Location I-40 @ MILEPOST 227, AZ
Arch. / Engr. ADOT
Supplier / Source RINKER MATERIALS WEST/FLAGSTAFF PLANT
Source / Location Desig. By JEC/JABER — Date 08-24-05

MATERIALS	SOURCE
CEMENT	*
AGGREGATE	*
MAXIMUM SIZE	*
GRADING	*
ADMIX / POZZOLAN	*
WATER	*

MIXTURE CHARACTERISTICS

WATER / CEMENTITIOUS MATERIAL RATIO *

CONSISTENCY: FLOW, % N/A — SLUMP, IN. NOT TESTED
CONSOLIDATION: TAMPING N/A — RODDING X — EXTERNAL VIBRATION N/A
SPECIMEN SIZE 4" X 4" X 11"
SPECIMENS MOLDED: NO. 3 — DATE 08-24-05
CURING CONDITIONS 28-DAY CURE IN LIME-SATURATED WATER

AVERAGE LENGTH CHANGE, %

AGE	CHANGE, %	AGE	CHANGE, %
28 DAYS	+0.015		
32 DAYS	+0.003		
35 DAYS	-0.005		
42 DAYS	-0.015		
56 DAYS	-0.031		
12 WEEKS	-0.036		
20 WEEKS	-0.044		
36 WEEKS	-0.062		
68 WEEKS	**		

Comments: * PER LOAD 14, TICKET 56489868 BATCH PROPORTIONS
**READINGS PENDING

Copies To: CLIENT – (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OF SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY

449 ©98WT
092899

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

CEMENT MORTAR / CONCRETE LENGTH CHANGE

Date of Report: 06-06-06 REVISED
Job No.: 2145XU342
Event / Invoice No.: Y342-01 Lab No.: 5
Authorized By: JEC/JABER Date: 08-22-05
Sampled By: WT/WHITMAN Date: 08-24-05
Submitted By: WT/WHITMAN Date: 08-25-05

Client: JABER ENGINEERING CONSULTING, INC.
ATTN: TARIF JABER, P.E.
10827 EAST BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Project: SUNSHINE BRIDGE
Contractor: VASCO
Type / Use of Material: CONCRETE MIX 1352839/BRIDGE DECK
Sample Source / Location: STA. 2125+75, CENTER OF DECK
Reference: [X] LENGTH CHANGE, ASTM C157
[ ] DRYING SHRINKAGE, ASTM C596
Special Instructions: STORAGE IN AIR AT 50 ± 4% HUMIDITY AT 73 ± 3 °F

Location: I-40 @ MILEPOST 227, AZ
Arch. / Engr.: ADOT
Supplier / Source: RINKER MATERIALS WEST/FLAGSTAFF PLANT
Source / Location Desig. By: JEC/JABER Date: 08-24-05

MATERIALS	SOURCE
CEMENT	*
AGGREGATE	*
MAXIMUM SIZE	*
GRADING	*
ADMIX / POZZOLAN	*
WATER	*

MIXTURE CHARACTERISTICS

WATER / CEMENTITIOUS MATERIAL RATIO: *

CONSISTENCY: FLOW, %: N/A SLUMP, IN.: NOT TESTED
CONSOLIDATION: TAMPING: N/A RODDING: X
EXTERNAL VIBRATION: N/A
SPECIMEN SIZE: 4" X 4" X 11"
SPECIMENS MOLDED: NO. 3 DATE: 08-24-05
CURING CONDITIONS: 28-DAY CURE IN LIME-SATURATED WATER

AVERAGE LENGTH CHANGE, %

AGE	CHANGE, %	AGE	CHANGE, %
28 DAYS	+0.012		
32 DAYS	-0.002		
35 DAYS	-0.006		
42 DAYS	-0.011		
56 DAYS	-0.034		
12 WEEKS	-0.035		
20 WEEKS	-0.041		
36 WEEKS	-0.058		
68 WEEKS	**		

Comments: * PER LOAD 18, TICKET 56490195 BATCH PROPORTIONS
**READINGS PENDING

Copies To: CLIENT - (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY ______

449 ©98WTI
052899

Western Technologies Inc.
The Quality People
Since 1955
3737 East Broadway Road
Phoenix, Arizona 85040-2921
(602) 437-3737 • fax 470-1341

TENSION & BEND TESTS ON STEEL

Client JABER ENGINEERING CONSULTING INC
10827 E BUTHERUS DRIVE
SCOTTSDALE AZ 85255

Date of Report 10/20/05
Job No. 2165je327
Event / Invoice No. Y327-001
Authorized By TARIF JABER Date 10/18/05
Sampled By TARIF JABER Date 10/18/05
Submitted By TARIF JABER Date 10/18/05

Project SUNSHINE BRIDGE
Contractor - -
Type / Use of Material REBAR
Reference: ASTM A615

Location WT/PHX LAB
Arch. / Engr. - -
Supplier / Source MMFX STEEL

TEST DATA

SAMPLE NO.		1	2	3	4	5			
SIZE		#4	#5	#5	#6	#7			
IDENTIFICATION									
MILL									
HEAT NO.									
LENGTH, IN.									
WEIGHT, PLF									
GRADE		75	75	75	75	75			
AREA, SQ. IN.		.20	.31	.31	.44	.60			
YIELD POINT	LB	26894	43343	43219	60268	77635			
	PSI	134471	139816	139415	136974	129391			
TENSILE STRENGTH	LB	31569	51424	50808	73347	100670			
	PSI	157845	165884	163897	166698	167783			
GAUGE LENGTH, IN.		8	8	8	8	8			
FINAL LENGTH, IN.		8.5	8.9	8.7	9.0	8.6			
ELONGATION, %		8	11	9	13	8			
BEND TEST									
DIAMETER OF PIN									
DEGREE BENT									
OBSERVATION	IN SPEC. / CODE	X	X	X	X	X			
	NOT IN SPEC. / CODE								

Comments:

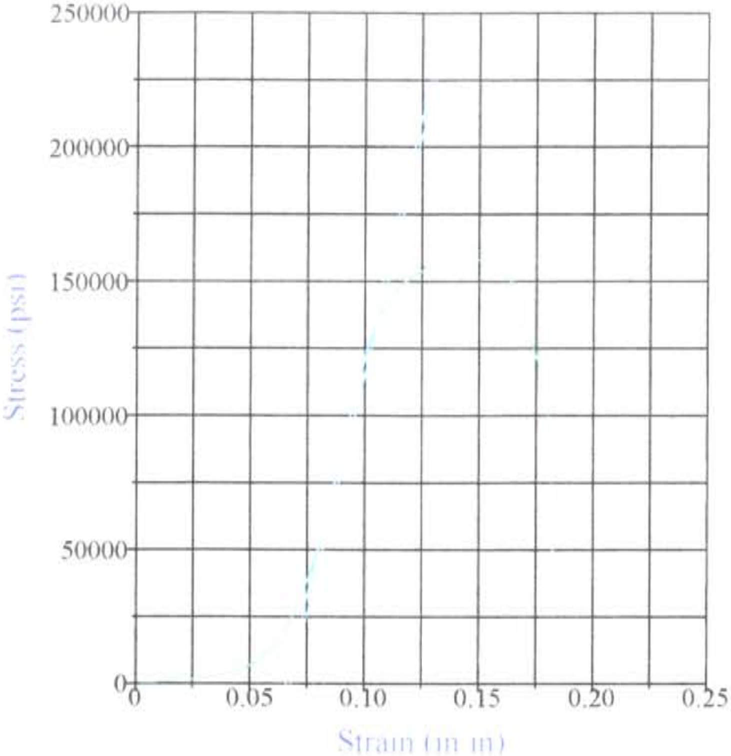
Copies To: CLIENT (1)

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY Randy Tennee

498©96WTI
082799

Figure E-11



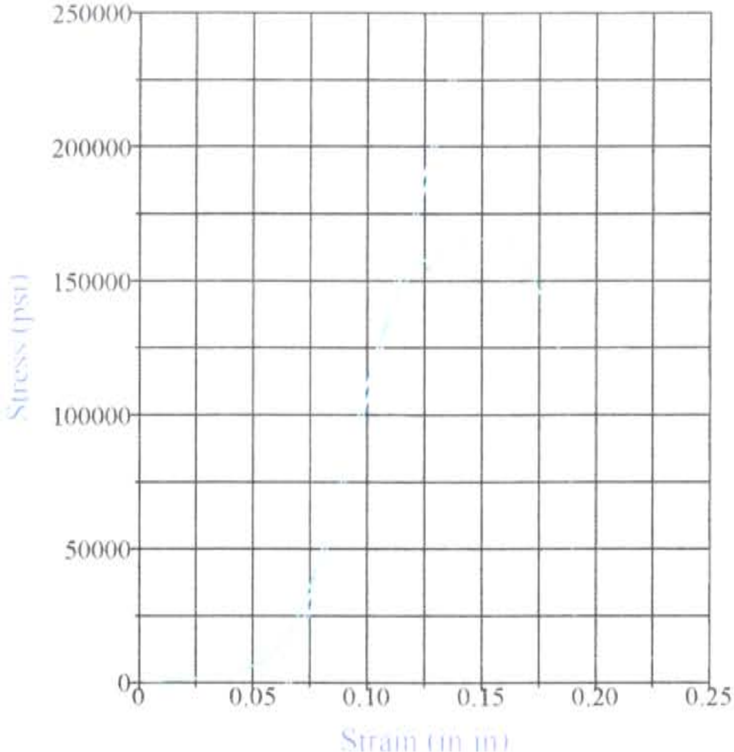
Test Results

Specimen Gage Length:	8.0000 in
Area:	0.2000 in²
Peak Load:	31569 lbf
Tensile Strength:	157845 psi
Tangent Modulus:	3566744 psi
Load at Offset:	26894 lbf
Stress at Offset:	134471 psi

Test Summary

Counter:	6702
Elapsed Time:	00:05:48
Customer:	JABER
Specimen Identification:	1
Material:	
Grade:	
Operator:	RS
Comments:	
Procedure Name:	ROUND TENSILE
Start Date:	10/18/05
Start Time:	11:48:55 AM
End Date:	10/18/05
End Time:	11:54:43 AM
Workstation:	Western Technologies, Inc.
Tested By:	Default

Figure E-11



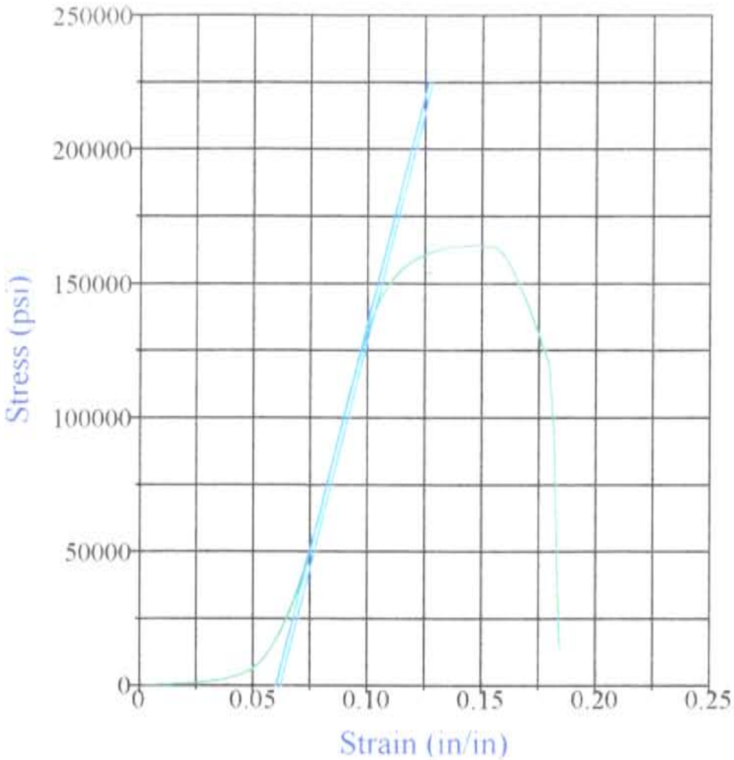
Test Results

Specimen Gage Length:	8.0000 in
Area:	0.3100 in²
Peak Load:	51424 lbf
Tensile Strength:	165884 psi
Tangent Modulus:	3154135 psi
Load at Offset:	43343 lbf
Stress at Offset:	139816 psi

Test Summary

Counter:	6703
Elapsed Time:	00:06:12
Customer:	JABER
Specimen Identification:	2
Material:	
Grade:	
Operator:	RS
Comments:	
Procedure Name:	ROUND TENSILE
Start Date:	10/18/05
Start Time:	12:02:53 PM
End Date:	10/18/05
End Time:	12:09:05 PM
Workstation:	Western Technologies, Inc.
Tested By:	Default

Figure E-11



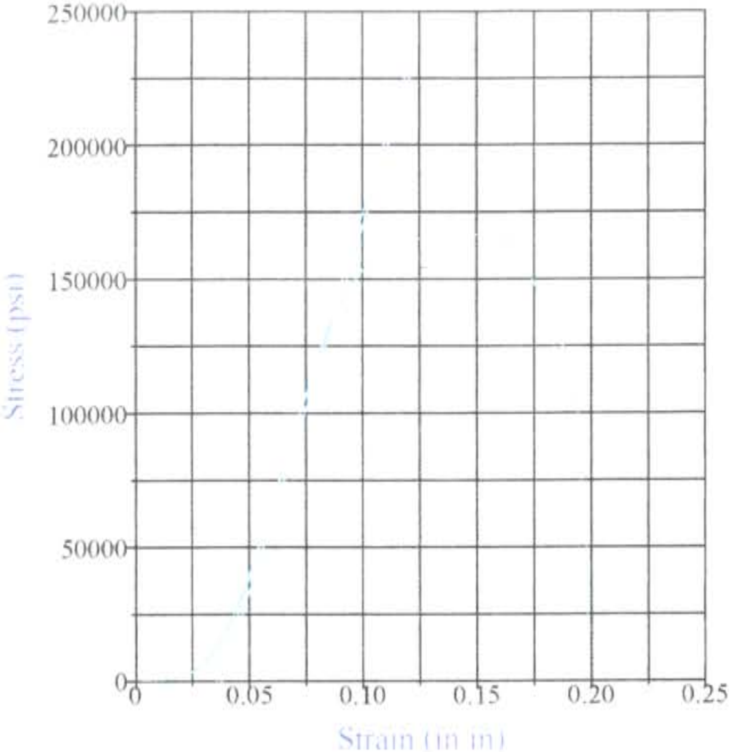
Test Results

Specimen Gage Length:	**8.0000** in
Area:	**0.3100** in²
Peak Load:	**50808** lbf
Tensile Strength:	**163897** psi
Tangent Modulus:	**3398749** psi
Load at Offset:	**43219** lbf
Stress at Offset:	**139415** psi

Test Summary

Counter:	**6704**
Elapsed Time:	**00:06:10**
Customer:	**JABER**
Specimen Identification:	**3**
Material:	
Grade:	
Operator:	**RS**
Comments:	
Procedure Name:	**ROUND TENSILE**
Start Date:	**10/18/05**
Start Time:	**12:35:24 PM**
End Date:	**10/18/05**
End Time:	**12:41:34 PM**
Workstation:	**Western Technologies, Inc.**
Tested By:	**Default**

Figure E-11



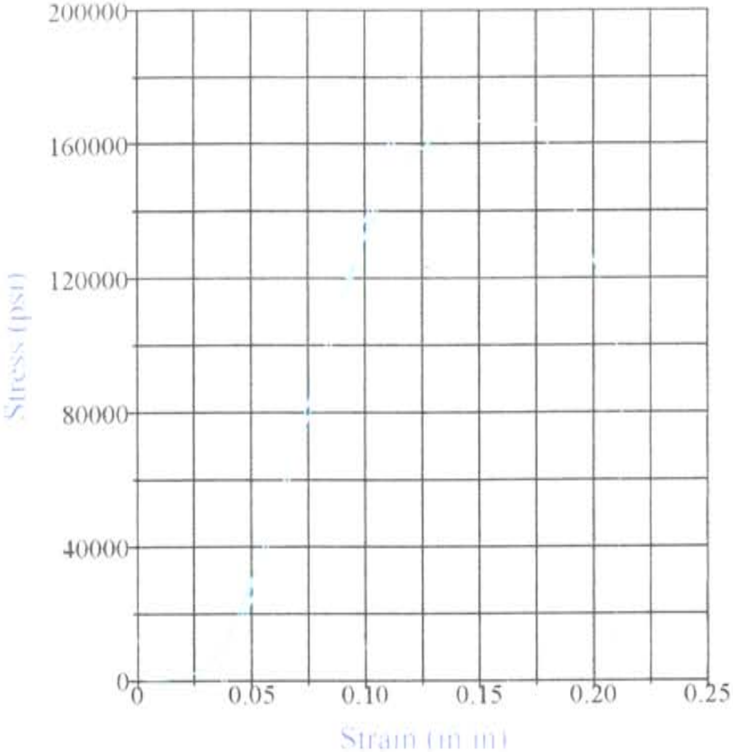
Test Results

Specimen Gage Length:	8.0000
Area:	0.4400
Peak Load:	73347
Tensile Strength:	166698
Tangent Modulus:	2711560
Load at Offset:	60268
Stress at Offset:	136974

Test Summary

Counter:	6705
Elapsed Time:	00:06:15
Customer:	JABER
Specimen Identification:	4
Material:	
Grade:	
Operator:	RS
Comments:	
Procedure Name:	ROUND TENSILE
Start Date:	10/18/05
Start Time:	12:45:55 PM
End Date:	10/18/05
End Time:	12:52:10 PM
Workstation:	Western Technologies, Inc.
Tested By:	Default

Figure E-11



Test Results

Specimen Gage Length:	8.0000 in
Area:	0.6000 in²
Peak Load:	100670 lbf
Tensile Strength:	167783 psi
Tangent Modulus:	2169595 psi
Load at Offset:	77635 lbf
Stress at Offset:	129391 psi

Test Summary

Counter:	6706
Elapsed Time:	00:06:23
Customer:	JABER
Specimen Identification:	5
Material:	
Grade:	
Operator:	RS
Comments:	
Procedure Name:	ROUND TENSILE
Start Date:	10/18/05
Start Time:	12:55:39 PM
End Date:	10/18/05
End Time:	1:02:02 PM
Workstation:	Western Technologies, Inc.
Tested By:	Default

Figure E-11