EVALUATION OF SILICA FUME HIGH DENSITY THIN BONDED OVERLAYS

Construction Report
March 2000

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15. SUPPLEMENTARY NOTES
Silica fume concrete is important in limiting the amount of chloride ion penetrating the overlay.

16 . ABSTRACT

In September 1999, Bridges "A" and "B" of contract TBOI-0035-1(110)044 were overlaid with a silica fume concrete surface. The bridges are located on Interstate 35 in Carter County, 1.6 km north of State Highway 53. The deteriorated bridge decks were prepared by coldmilling the surface and removing the delaminated areas with jackhammers. Reinforcement bars were cleaned and exposed areas patched.

The mix design was changed several times before a workable mix was developed. Every load was tested at the plant and the job site. Several slump and air content problems were experienced before a consistent mix was finalized. Silica fume concrete was mixed at a batch plant and transported on the job site with ready mix trucks. After each lane was completed, the curing process took another 78 hours.

Post construction testing included skid resistance, compressive strength, bond strength, and chloride permeability testing. All these requirements were met. Recommendations were made to establish the slump and use a high range water reducer for construction ease. Other recommendations were, continue to use ready mix trucks, but fill them to a maximum volume of 60 percent. Establish seasonal limitations to minimize changes of extreme temperatures. Finally, temperature parameters should be developed.

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SI (METRIC) CONVERSION FACTORS

Approximate Conversions to SI Units				
Symbol	**When you know**	**Multiply by**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.40	millimeters	mm
ft	feet	0.3048	meters	m
yd	yards	0.9144	meters	m
mi	miles	1.609	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm
ft^2	square feet	0.0929	square meters	m^2
yd^2	square yards	0.8361	square meters	m^2
ac	acres	0.4047	hectares	ha
mi^2	square miles	2.590	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0283	cubic meters	m^3
yd^3	cubic yards	0.7645	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.4536	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	(°F-32)/1.8	degrees Celsius	°C
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.448	Newtons	N
lbf/in^2	poundforce per square inch	6.895	kilopascals	kPa

Approximate Conversions from SI Units				
Symbol	**When you know**	**Multiply by**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.0394	inches	in
m	meters	3.281	feet	ft
m	meters	1.094	yards	yd
km	kilometers	0.6214	miles	mi
		AREA		
mm^2	square millimeters	0.00155	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.196	square yards	yd^2
ha	hectares	2.471	acres	ac
km^2	square kilometers	0.3861	square miles	mi^2
		VOLUME		
mL	milliliters	0.0338	fluid ounces	fl oz
L	liters	0.2642	gallons	gal
m^3	cubic meters	35.315	cubic feet	ft^3
m^3	cubic meters	1.308	cubic yards	yd^3
		MASS		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.1023	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	degrees Celsius	9/5+32	degrees Fahrenheit	°F
		FORCE and PRESSURE or STRESS		
N	Newtons	0.2248	poundforce	lbf
kPa	kilopascals	0.1450	poundforce per square inch	lbf/in^2

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EXECUTIVE SUMMARY

In September 1999, two bridge decks were overlaid with a silica fume concrete surface on Interstate-35 (I-35) in Carter County, 1.6 km (one mile) north of State Highway (SH-53). The deteriorated bridge decks were prepared by coldmilling the surface and removing the delaminated areas with jackhammers. Reinforcement bars which were exposed during repair operations, were cleaned and the damaged areas were replaced by patches.

During construction of the overlay, the mix design was altered by agreement between the contractor and Oklahoma Department of Transportation (ODOT). This was done because concrete which apparently met air content and slump requirements at the batch plant (ready-mix), was not meeting these same requirements when it reached the construction site. This situation went on during approximately half of the overlay construction. Changing the mix design appeared to solve these problems. Slump and air were both within specification requirements after the change.

Every truck load was tested for slump, air content and temperature measurements. Additional requirements for a successful overlay included skid resistance, compressive strength, and chloride permeability testing. All of these requirements were met. The extra testing and good construction techniques were instrumental in producing a successful and smooth riding project.

INTRODUCTION

The Oklahoma Department of Transportation (ODOT) has approximately 7,300 bridges throughout the state highway system. Virtually all of these bridges have deicing salts applied to them at some time. Water from melted snow and ice contains chloride ions which penetrate the Portland Cement Concrete (PCC) bridge decks. This eventually results in corrosion of the reinforcing steel(1). Corrosion of reinforcing steel causes deterioration when the chloride ion content reaches the threshold level of about 0.8 kg/m^3 (4 lb/cy)(2).

Rehabilitation of a deteriorating bridge deck generally requires removing and replacing damaged concrete. Restoring smoothness to a repaired deteriorated deck may require an overlay. Silica fume concrete, latex-modified concrete and low-slump dense concrete are some of the products which have been tried on bridge deck overlays(3).

One of the concerns with concrete products overlaying bridge decks is premature cracking. Premature cracking is associated with poor air void content and improper curing. Good pavements and bridge decks, without premature cracking, have a narrow air void content range, between five and nine percent(4).

BACKGROUND

Silica fume is a replacement additive for Portland cement used in bridge decks overlays to increase strength and lower permeability. Silica fume is "a 'by-product' material from the production of silicon metal or ferrosilican alloys in an electric arc furnace." More than 85 percent of the material is amorphous silica (SiO_2), which is a very fine spherical particle. It is two magnitudes finer than ground Portland cement. Silica fume when mixed with water forms calcium silicate hydrates, which fills the spaces in the cement paste matrix, resulting in a more dense, stronger, and relatively impermeable material(5).

Before the contract on this project was let, ODOT retained a private testing lab to evaluate prospective silica fume modified Portland Cement Concrete (PCC) mix design guidelines. A selection was made of specifications that performed best in regards to slump, air content, compressive strength, permeability, drying and shrinkage. Table 1 describes specifications which were used for this project.

Before overlay placement operations began, the contractor had a trial batch mixed which met the requirements of Table 1. ODOT field personnel and the contractor's employees agreed that changes in the mix were needed to improve workability. A meeting on this was held, and changes in the mix design requirements resulting from this meeting are given in Table 2.

Table 1. Original Mix Design Guidelines

SPECIFICATIONS PROPORTIONS	
Material	**Requirements**
Cement Type 1	Minimum 374 Kg per cubic meter
Silica Fume	7.5 percent of cement weight
Water/Cement Ratio	0.4 maximum
Slump	200 mm maximum
Air Content	6 +/- 2 percent
Aggregate Size	#7 (ASTM C31)
Compressive Strength	24 Mpa

Table 2. Adjusted Mix Design Requirements

MIX DESIGN PROPORTIONS		
Material	**Measurement**	**Yield, yd^3**
Cement Type 1	737 lbs	3.75
Silica Fume	62 lbs	0.48
Coarse Aggregate #67	1403 lbs	8.36
Fine Aggregate, Sand Class A	1363 lbs	8.34
Water	32.5 gals	4.35
Air Content	6.5 +/- 1.0 percent	1.76
Total		27.00
Superplasticizer	119 oz	
Entrained Air / maximum	8.0 oz	
Target Retarder	35-37 oz	
Water/Cement ratio	0.34 lb/lb	
Slump	2-5 inch	
Concrete unit weight	141.2 pcf	

OBJECTIVES

The objectives of this project are as follow:

- Evaluate conditions of each installation before overlaying.
- Document procedures for specification changes in the mix design proportion and other characteristics in the mix.
- Document preconstruction preparation.
- Monitor construction and document procedures.
- Record results of job control testing for each site.
- Evaluate bridge deck placement.
- Perform an annual evaluation of the bridge deck installation.

PROJECT INFORMATION

LOCATION

Project number TBOI-0035-1(110) 044 consisted of placing a silica fume overlay on structure NBI 17229, which is bridge "A" (southbound) and NBI 17255 which is bridge "B" (northbound). The bridges are located on I-35 in Carter County, 32.55 kilometers (20.23 miles) north of the Love County line. Both bridges are over a county road, approximately 1.6 km (one mile) north of SH-53 near mile marker 45(Figure 1). The two bridges were built in 1979. Average daily traffic at this location is 27,500 vehicles, which includes 21 percent trucks.

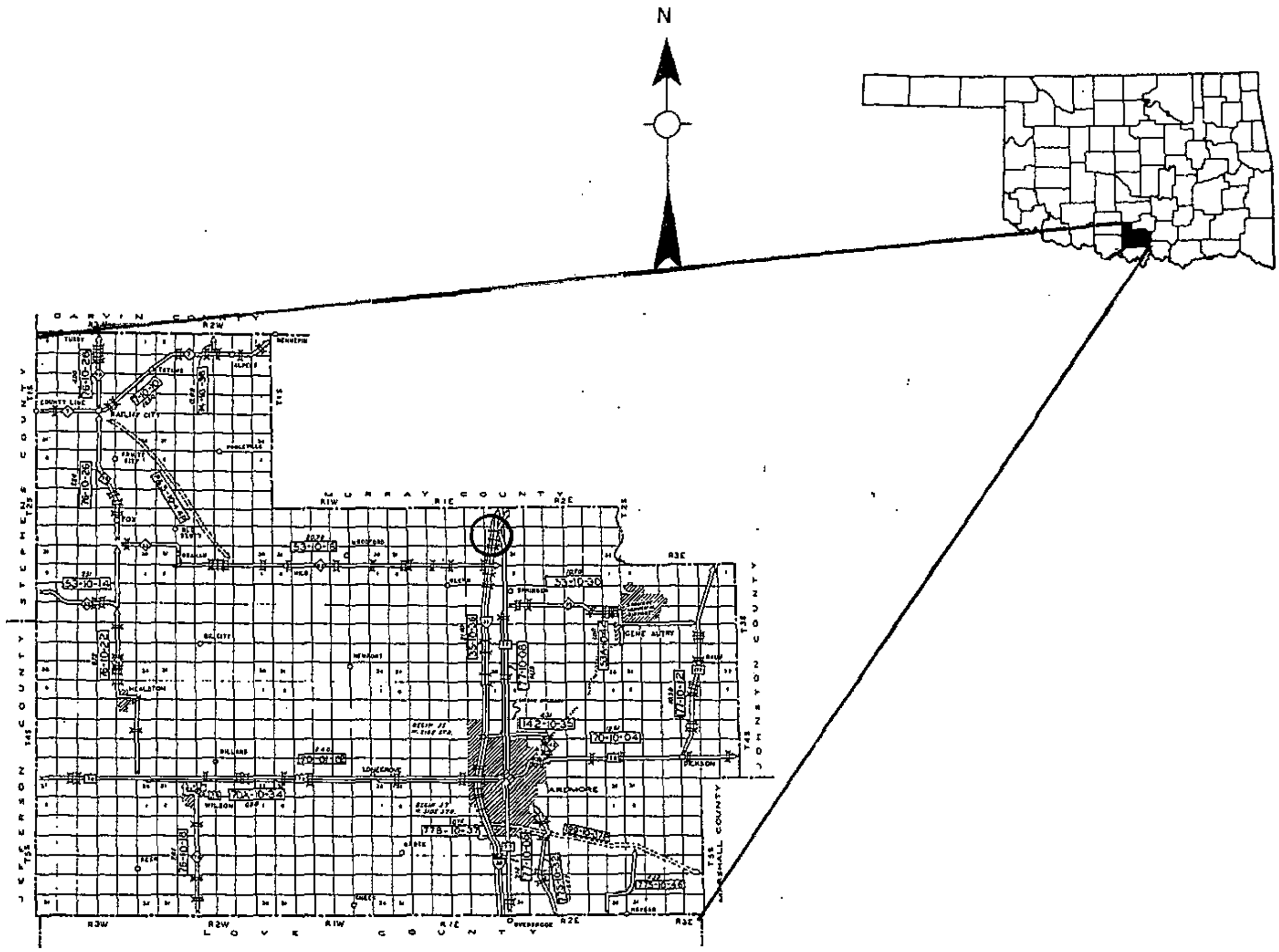


Figure 1. Silica Fume Overlay Location Map

MATERIALS

The following mix ingredients (Table 3) were used to construct the silica fume thin overlays. Other materials listed were used to complete the bridge deck overlay surface. See Appendix B for additive specifications.

Table 3. Materials and Sources

MATERIALS	SOURCES
Coarse Aggregate (#67)	Dolese -Davis Quarry Davis, Oklahoma
Fine Aggregate (Sand Class A)	TXI Ardmore, Oklahoma
Cement (Type 1)	Holnam, Inc. Joe Browns Cement Plant Ardmore, Oklahoma
"Rheomac SF100" (Silica fume mineral admixture)	Master Builders Technologies Cleveland, Ohio
Rheobuild 1000 Superplasticizer (High-range water-reducer)	Master Builders Technologies Cleveland, Ohio
MB VR (Air entraining admixture)	Master Builders Technologies Cleveland, Ohio
Pozzolith 300-R Set retarder (Reduce water retarding setting time)	Master Builders Technologies Cleveland, Ohio
Pre-cure Compound	Master Builders Technologies
White Curing Compound	Master Builders Technologies
890-SL (Single part epoxy)	Dow Corning
Backer rod	Wildcat Concrete Service
Elastomeric Joint Sealer	Wildcat Concrete Service

EQUIPMENT

Heavy equipment and hand tools were used to construct the silica fume bridge deck overlay. Equipment used on the project is listed.

- Cold Milling Machine
- Jack Hammer
- Air Compressor
- Ready Mix Truck
- Asphalt Laydown Machine
- Dump Truck
- Roller
- CMI Bid-Well Concrete Paver
- Hand Finishing Tools
- Fresno Float
- Tine Float
- Hand Broom
- Wheel Barrel
- Concrete Mixing Machine
- Hand Vibrator
- Hand Concrete Saw
- Self-propelled Concrete Saw

PRECONSTRUCTION

The existing bridges were surveyed in April, 1997. The project was delayed several times before construction was completed in September, 1999. The information below is from the 1997 survey. Approximately 74 m^2 (800 s.f.) of deck on northbound bridge had been patched. Block cracking could be seen in and around the wheel paths of the outside lane. Delamination sounding showed a total area of deterioration of approximately 102 m^2 (1100 s.f.).The southbound bridge also had cracking in the wheel paths of the outside lane. Delamination sounding according to ASTM designation: D 4580-86, showed approximately 139 m^2 (1500 s.f.) of deteriorated deck.

A considerable amount of maintenance patching (Figure 2) had been done on both bridges, and the ride over them were noticeably rough. Cracking in the wheel paths with spalls where cracks met were common (Figure 3). These conditions made the bridges an excellent candidate for a silica fume overlay. Smoothness testing was not done before construction.

Figure 2. Patching on Existing Bridge Deck, Before Overlay.

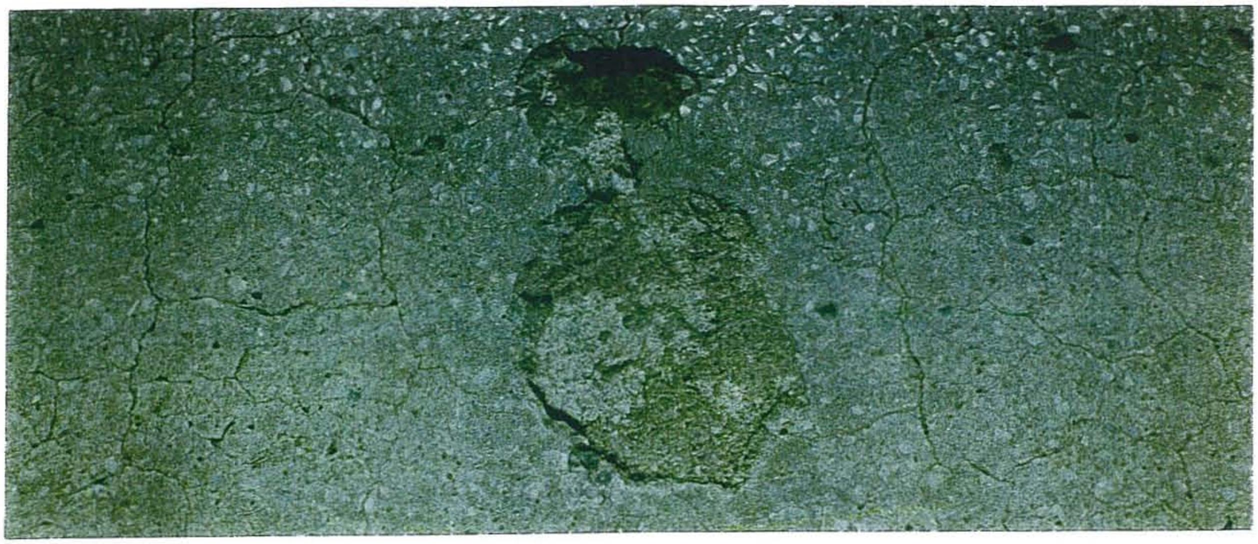


Figure 3. Typical Bridge Conditions, Before Overlay.

The engineer's cost estimate was approximately $800,000 for the two bridge deck overlays. See Appendix A for cost details. Repairing the bridge decks before an overlay is important. An extensive evaluation of the two bridge decks was performed to determine the amount of deterioration. A coldmilling machine removed 51 mm (2 inches) from the surface of the approaches, bridge decks and leave slabs. Delaminated concrete areas were removed by jackhammer. The corroded reinforcement bars were cleaned, and patches of a Class A concrete and silica fume were poured. Approximately sixty percent of the bridge decks surface area were patched (Figures 4 and 5). After patching was completed, the surfaces were cleaned with a sand blasting and high pressure water operation. The decks were then covered with plastic until placement of the overlay.

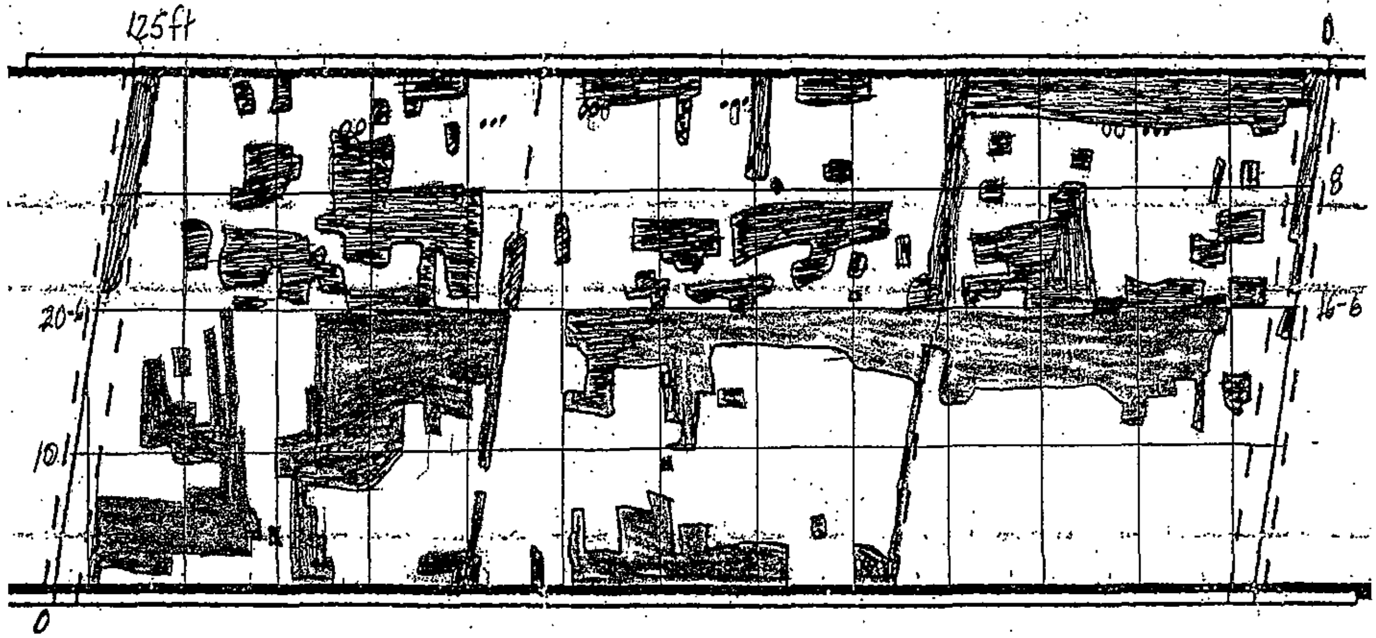


Figure 4. Bridge 'B' Patching Diagram

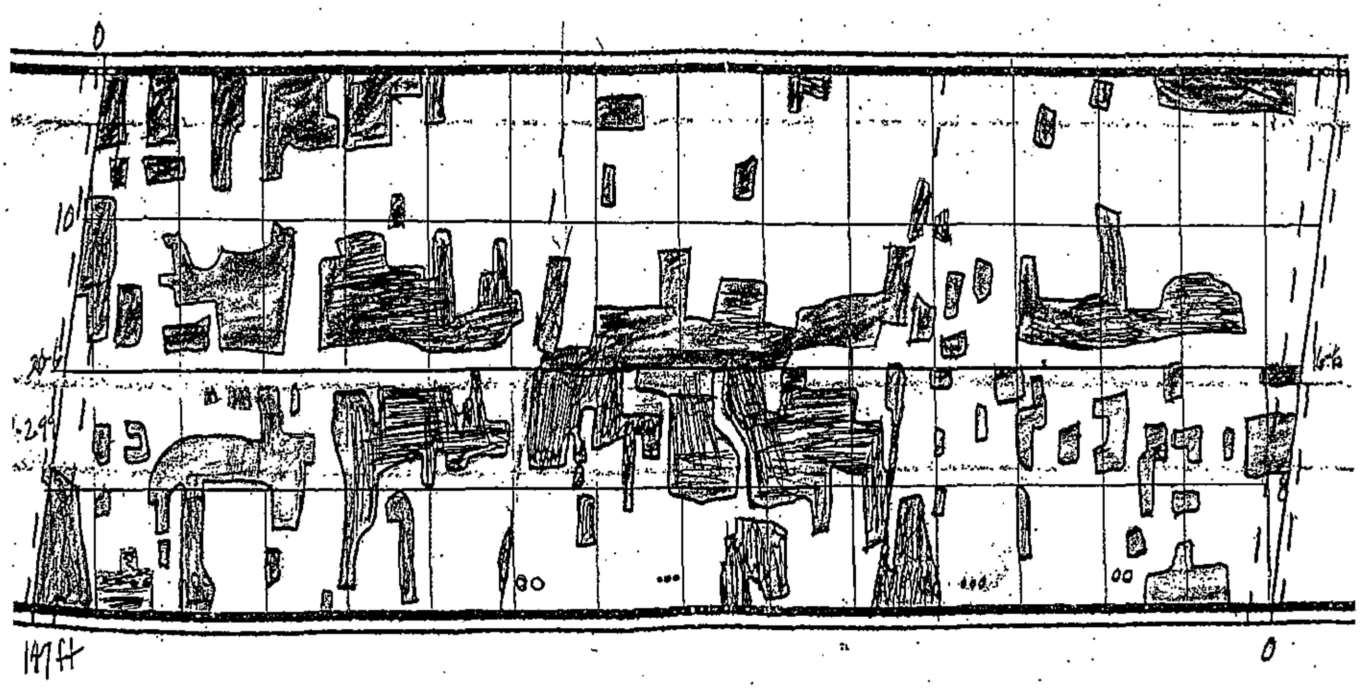


Figure 5. Bridge 'A' Patching Diagram

CONSTRUCTION

The silica fume concrete overlays were constructed in the following order:

- Site 1- Bridge "B," outside lane.
- Site 2- Bridge "A," outside lane, bridge approach.
- Site 3- Bridge "A," bridge deck and leave slab.
- Site 4- Bridge "B," inside lane.
- Site 5- Bridge "A," inside lane.

A grout cement paste meeting requirements of ODOT specification 701.10(c) was made with enough water to form a slurry. At the plant, located in Ardmore about 32 km (20 miles) from the construction site, ready mix trucks were being loaded with the silica fume concrete mix. The mix consisted of Portland cement, water, aggregate, sand, silica fume, a high range water reducer and set retarder, when needed. See Appendix B for specifications. Under ODOT specifications, when the temperature of the concrete is greater then 32 C (90 F), it was controlled by watering the aggregate and sand 12 hours before construction. Then during construction, ice was added to the mix as a substitute for water, when needed. Tables 3 - 6 can be reviewed to determine when ice was added. Each truck load was tested for slump, air content, and temperature before leaving the plant site. This information was placed on each load ticket.

When each loaded truck reached the job site, it was backed over a plastic covering to a pouring location. The plastic holds the moisture, and protects the surface from dirt and debris. A visual inspection of the slump was done by the contractor to determine when additional water was needed. Grout was broomed on the deck surface just ahead of the unloaded concrete. As the mix was being discharged, the plastic was rolled back from the deck to the back wheels of the truck. Each load was tested again for slump, air content and temperature by an independent testing firm (Tables 5 - 8).

Several problems relating to air content and slump had occurred on each pour site in the approaches. Site 1 had air content measurements on the lower half of the specification (Table 3). It's highest measurement was 6.2%, and the lowest measurement was 3.2% (out of specifications). Fifty percent of its air content tests were out of specification. Site 2 had 60% of its slump measurements out of specifications (Table 5). The bridge deck pour was stopped at that point, due to the contractor,s inability to control the mix to specifications. Site 3 had consistent slump and air measurements, with one truck out of specifications in both requirements (slump and air). That load was not accepted by the contractor. Site 4 had two air content measurements out of specification (high). One test showed 10 percent air content measurements. Its air averaged 6.3 percent. Site 5 had three air contents out of specification (high). A nine percent air content measurement was the highest amount measured.

The contractor placed the mix in 50 mm (2 inch) lifts in front of the concrete paver in even arcs across the deck. The concrete paver vibrated the mix as the paver rolled transversely across the lane. Then, dual augers on the paver leveled the material to the designated height. Concrete placed along the walls and the centerline was hand vibrated. A vibra-tamp roller, located on the paver, helped consolidate and seal the overlaid surface. Dual steel rollers (smooth) finished the mat in both directions with each pass. Fog bars, located above the rollers, misted an evaporation prevention film (pre-cure) on the concrete surface. Behind the rollers was a drag pan used for further finishing the surface. Small adjustments or corrections were made by hand finishing, while the Fresno float sealed and smoothed the mat. A tine float placed grooves in the mat for skid resistance. Shoulders on the bridge deck received a broom finish.

White curing compound was applied from a 208 liter (55 gallon) drum with a gasoline powered engine sprayer. The surface was sprayed with the compound as soon as the mat was able to take the mist without marring the concrete. The application rate was not recorded. Two hours after the completion of each silica fume lane, a burlap cover was placed over it. The cover was saturated with water and then covered with plastic for 78 hours.

Calculations were run on each site concrete pour for the evaporation rate of surface moisture. ODOT's specification 504.03(e)5 states, "*control evaporation according to the requirements of Article 504.03(c). Limit the evaporation rate of water from the fresh concrete to less than 0.5* *kilograms per square meter per hour (0.1 lb/sq ft./hr). Control evaporation adequately to prevent premature crusting of the surface or an increase in drying crack."* Sites 1 and 2 had air temperatures of 28 C (81 F) and 31 C (84 F), relative humidity of 74% and 50%, concrete temperatures of 28 C (81 F) and 33 C (86 F), and wind velocities of 8 km/h (5 mph) and 12 km/h (7mph). This results in a rate of evaporation of 0.35 $kg/m^2/h$ (0.075 lb/sq/hr) and 0.4 $kg/m^2/h$ (0.08 lb/sq/hr). Although, these sites met the evaporation requirements (no additional controls required), evaporation control of saturating burlap cloth and covering it with plastic was used. On sites 3, 4 and 5, evaporation rates were more than 0.5 $kg/m^2/h$ (0.1 lb/sq ft/hr) and required evaporation control. The following table (Table 8) has completed information on evaporation control under ODOT specification 504.03(c).

Table 4. Evaporation Control

EVAPORATION CONTROL DATA					
Location	Air Temp	Humidity	Concrete Temp	Wind Speed	Rate
	F	%	F	mph	lb/sq/hr
Site 1	81	74	81	5	0.075
Site 2	89	50	86	7	0.08
Site 3	80	42	83	5	0.13
Site 4	71	79	88	7	0.15
Site 5	60	66	80	10	0.18

After a 78 hour cure period, the covers were removed. At the existing steel expansion joints, grooves were cut in the overlay, and an elastomeric binder mixed with abrasion and chemical resistant aggregate was poured. Elastomeric mortar and binder met ODOT requirement 701.08(h)2.2. Saw joints were then cut through the overlay over the existing joints. A Backer rod was placed in the joints and self leveling silicon sealant was applied. After all four lanes were completed, the bridge project was striped and opened to traffic. See Appendix C for the construction photo sequence.

Table 5. Bridge 'B' Outside Lane

SILICA FUME JOB SITE TESTING					
				BRIDGE 'B' OUTSIDE LANE	
TRUCK N0.	WATER ADDED	SLUMP	% AIR	TEMPERATURE	COMMENTS
Bridge Approach					
1		3.75	3.5	88 F	Start time 12:10am
2		5.25	4.0	82 F	Air temp 80 F
3	15 gal	2.25	4.4	84 F	Retest
4	19 gal	4.75	4.3	81 F	
5		4.75	5.5	80 F	
Bridge Deck					
6		3.25	5.6	81 F	
7		3.0	6.6	82 F	Cylinders pulled
8	5 gal	3.0	4.8	81 F	
9		3.0	6.2	78 F	

Table 6. Bridge 'A' Outside Lane

SILICA FUME JOB SITE TESTING					
				BRIDGE 'A' OUTSIDE LANE	
TRUCK N0.	WATER ADDED	SLUMP	% AIR	TEMPERATURE	COMMENTS
Bridge Approach					
1	3 gal	4.25	8.1	90 F	65 oz Superplasticizers
2		4.0	5.1	83 F	20 oz Superplasticizers
Bridge Deck					
1		3.25	5.6	84 F	Start time 12:00pm
2		2.5	5.5	90 F	Air temp 75 F
3		4.25	7.2	80 F	
4		3.25	9.5	86 F	

Table 7. Bridge 'B' Inside Lane

SILICA FUME JOB SITE TESTING					
				BRIDGE 'B' INSIDE LANE	
TRUCK NO.	WATER ADDED	SLUMP	% AIR	TEMPERATURE	COMMENTS
Bridge Approach					
1	8 gal	1.25	5.3	89 F	Cylinders pulled
2	5 gal	2.75	5.6	88 F	Start time 7:35am
3		4.0	4.5	80 F	Air temp 85 F
4		2.0	4.2	89 F	
Bridge Deck					
5	10 gal	2.4	6.0	88 F	Start time 12:00am
6		2.5	6.1	89 F	Air temp 85 F
7	5 gal	3.0	8.9	87 F	
8		3.5	10.0	87 F	
9	5 gal	3.0	4.0	80 F	

Table 8. Bridge 'A' Inside Lane

SILICA FUME JOB SITE TESTING					
				BRIDGE 'A' INSIDE LANE	
TRUCK NO.	WATER ADDED	SLUMP	% AIR	TEMPERATURE	COMMENTS
Bridge Approach					
1	10 gal	2.0	5.9	80 F	Start time 4:10am
2	10 gal	3.0	6.2	79 F	Air temp 55 F
3	5 gal	3.0	7.2	83 F	
4	7 gal	3.5	9.0	79 F	Cylinders pulled
5	15 gal	1.5	6.0	80 F	
6		2.25	5.7	81 F	
Bridge Deck					
7	5 gal	2.5	6.8	81 F	
8	15 gal	2.5	6.0	79 F	
9	10 gal	3.0	7.9	82 F	
10	20 gal	3.0	6.5	80 F	
11	20 gal	3.5	10.0	81 F	
12	10 gal	3.0	8.0	83 F	
13	10 gal	2.75	6.2	79 F	Cylinders pulled

POST CONSTRUCTION

Post construction activity consisted of several tests used to determine overlay performance were done 30 days after construction. Compressive strength, bond overlay (chain drag), smoothness (profilograph), skid resistance, bond strength, and chloride permeability are the list of tests. See Appendix D for test results.

Compressive strength testing was performed on cylinders made from each overlay mix at 7 and 28 days. Seven day results measured a low of 35,371 kPa (5130 psi), still in specification, and a high of 54,125 kPa (7850 psi). The 28 day strength results measured a low of 42,197 kPa (6120 psi) and a high of 65,847 kPa (9550 psi). The measured strengths meet specification requirements.

The chain drag method was used to determine the amount of bond area between the old bridge deck and the overlay. The results from both bridges were 100 per cent bonded. Smoothness was tested with a profilograph under ODOT specifications. The profilograph reading given for each bridge was recorded in inches of roughness per mile (profile index). Bridge "B" had a profile index average of 5.7 inches of roughness per mile, while Bridge "A" had a profile index average of 16.5 inches of roughness per mile, both meeting specification.

Skid data testing was done by the ODOT Traffic Division. The skid numbers (SN) are derived as the product of a mechanical test wherein a skid trailer tire interfaces with the road surface providing an approximate value which may be converted to a coefficient of friction. The recorded high was 53.4 SN, and the recorded low was 43.4 SN.

Bond strength testing was measured under the rules of the Virginia epoxy concrete overlay for surface preparation and adhesion's procedures. Three cores were taken from each panel in both the north and south bound bridges, and the inside and passing lanes. The core holes were drilled to approximately 6.4 mm (1/4 inch). Pipe caps were bonded to the cores. A test rig with a dynamometer was attached and a tensile load at 45.4 kg (100 lbs) every 5 seconds was applied to failure.

Five types of failure can occur during bond strength testing, but only two types occurred on this project which satisfied ODOTs Research requirements. Type 1 is a failure in the existing concrete deck at depths greater than or equal to 6.4 mm (1/4 inch) over more than 50% of test area. Type 2 is a failure in the existing concrete deck at a depth less than 6.4 mm (1/4 inch) over more than 50% of test area. A properly applied epoxy overlay on a properly prepared surface should result in a Type 1 failure of the concrete. There were 25 Type 1 and 11 Type 2 failures. The tensile strength was tested 36 times. Twenty-eight times the breaks were 276 kPa (40 psi), six times 138 kPa (20 psi), and one time each at 552 kPa (80 psi) and 414 kPa (60psi).

According to ASTM C1202, at 28 days after placement, chloride permeability testing could be performed on the bridge deck samples. The silica fume overlay was expected to have a low permeability rating (between 1000 and 2000 coulombs). Chloride ion permeability testing of the concrete was important to the project. Test results showed very low to negligible amounts of chloride ion penetration of the concrete. One test showed a moderate amount of chloride intrusion. The moderate test result was 2379 coulombs. The very low results ranged from a high of 756 coulombs to a low of 145 coulombs, with an average of 308 coulombs. The two negligible measurements were 94 and 90 coulombs. A total of 18 tests were run.

DISCUSSION

Mix design changes were instrumental for an easier and more consistent construction operation. First, changing the mix to a higher slump aided the ease of construction(9). Second, the addition of a set retarder made the mix more consistent.

The percent of silica fume was raised from a 7.0 percent to 7.5 percent. The results of the permeability testing averaged 460 coulombs which is classified as very low. Therefore, there is room in the specification for the percentage of silica fume being substituted for the Type 1 cement to be adjusted to a lower concentration.

A construction group was formed for collaboration on ideas in the "recommendation" phase of the report. The group agreed on the following. A trial mix should be made to establish~~ed~~ the range of set retarder and high range water reducer needed for the mix. The ready mix trucks should use less volume in the trucks to leave room for expansion. Moisture content needs to be determined before the water/cement ratio is determined. Temperature and seasonal parameters should be established because of the problems the silica fume overlay had during the hot weather during construction. Recommendations were made to keep the mix at a temperature below 90 F and use ice; and watering of aggregate several hours before mixing.

CONSTRUCTION

Reinforcement and patching repair were performed using standard construction methods. Equipment and manpower used in the building of the overlay was supplied by the subcontractor. The average smoothness index for a new bridge is approximately 67 m/km (27 in/mi) according to a Research & Development field report memo. Profile indexes from smoothness testing on the two overlaid decks indicated smoothness which was considerably better. Factors instrumental in producing the smooth riding surface were changes in the specifications which made the mix more workable, the use of a modified Bid-Well concrete paver, and a large amount of hand work. All of the skid data collected showed satisfactory skid numbers on the silica fume concrete surface.

The mix design was originally specified as "ODOT's High Density Concrete Overlay" specification (section 505 and 701.10) with 7.5 percent of cement by weight replaced with silica fume (Table1). During trial mixes, patch work and overlay construction, it was modified to the mix design (Table 2). The use of high range water reducers and set retarders, and specification changes in slump (4 inch maximum to a 5 ½ inch maximum) was instrumental in producing a successful overlay.

The Virginia bond test was developed for adhesion between two epoxy overlays, not between an old standard concrete deck and a silica fume concrete overlay. Therefore, the 1724 kPa (250 psi) tensile rupture strength requirement was probably not the proper value for this overlay. The important requirement from the specification was the type of failure developed during the pull. Type I and II failures are in the old concrete, indicating the bond is stronger than the old concrete deck. Those were the two types of breaks which occurred during the bond tests. Chain drag tests showed no delaminations.

Chloride ion permeability results in the concrete were very low, much lower than the threshold target value of 2,000 coulombs. There is room for changes in the specification on the amount of silica fume additives required in the mix.

RECOMMENDATIONS

The construction group produced the following recommendations:

- A trial mix should be established with a 25 to 51 mm (1 to 2 inch) slump. Then a high range water reducer should be added to achieve a maximum slump of 127 mm (5 inches) for ease of construction.
- Ready mix trucks should be used with the volume of truck being filled to a maximum 60% capacity, or to the resident engineer's recommendation.
- Moisture content should be determined on the coarse and fine aggregate, and used in the water cement ratio calculations.
- Temperature parameters should be established.
- Seasonal limits should be considered to avoid overlay placement during extreme temperatures.

REFERENCES

1. Thompson, Neil G. and Lankard, David R.. *Optimization of Concretes and Repair Materials for Corrosion Resistance*. FHWA-RD-99-096, Research, Development, and Technology, McLean, VA, September 1999.

2. Babaei, Khossrow, et al. (eds.). *Methodology for Concrete Removal, Protection and Rehabilitation.* Federal Highway Administration, Washington, D.C. 1996.

3. Whiting, D. *Effect of Rigid Overlays on Corrosion Rate of Reinforcing Steel in Concrete Bridge Deck- Final Report.* Ohio Department of Transportation, October 1992.

4. *Investigating Premature Cracking In PCC Pavements.* CTRE en route, Iowa Department of Transportation and Iowa Highway Research Board (TR-406), Ames, IA, August 1999, pp. 4-5.

5. National Cooperative Highway Research Program Report 410. *Silica Fume Concrete for Bridge Decks.* Transportation Research Board National Research Council, Washington, D.C., 1998.

6. Detwiler, Rachel J., Kojundic, Tony, and Fedjestol, Per. *Evaluation of Bridge Deck Overlays.* ACI Concrete International, August 1997.

7. Specifications for Highway Construction. *Bridge Decks, Approaches, Rails and Parapets, Section 504.* Oklahoma Department of Transportation, 1997.

8. Kummer, H. W. , and Meyer, W. E. National Cooperative Highway Research Program Report 37. *Tentative Skid-Resistance Requirements for Main Rural Highways.* Highway Research Board, 1967.

9. Miller, Bo. *Microsilica Modified Concrete for Bridge Deck Overlays,* Materials and Research Section Highway Division, Oregon Department of Transportation, October 1990.

APPENDIX A
Oklahoma Department of Transportation Special Provision, Specification and Cost Estimate

OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
FOR
SPECIAL CONTRACTOR TESTING
TBOI-00035-1(110)004, Carter County

These Special Provisions, revise, amend and where in conflict supersede applicable Sections of the Standard Specifications for Highway Construction, Edition of 1996.

100.01 DESCRIPTION. This work will consist of testing the Portland Cement Concrete Overlay treated with Silica Fume that the Engineer will specify. Testing shall be performed by an Independent Testing Laboratory acting as a subcontractor to the General Contractor at the times stated herein. A representative from the Oklahoma Department of Transportation Office of Research shall be notified at least forty-eight hours prior to each phase of testing and general construction.

101.02 General. The Contractor shall subcontract an AMRL (AASHTO Material Reference Laboratory) accredited or Cement and Concrete Reference Laboratory (CCRL) inspected Independent Testing Laboratory with relevant experience to conduct the tests outlined herein. This Independent Testing Laboratory shall provide at least two references to the Engineer to indicate prior experience.

101.02 TESTING. The following tests shall be performed at the site of construction as outlined herein and performed in accordance with the testing standard listed. Testing standards shall be performed as designated in the American Association of State Highway and Transportation Officials (AASHTO), the American Concrete Institute (ACI), the American Society for Testing and Materials (ASTM) or the Virginia Test Method (VTM) listed immediately following the name of the test. Where no testing standard is listed, the Independent Testing Laboratory shall use a testing method approved by the Engineer. The results of each test shall be properly recorded in the standard format and sent to the Engineer within thirty calendar days of testing.

101.02 (a) Chloride Permeability (AASHTO T277). This test shall be performed on three 150 mm cores prior to surface preparation of the bridge decks for construction. Three permeability to chloride ion tests shall also be performed on three 150 mm cores forty calendar days after installation from different sites on the bridge deck to be selected by the Engineer.

101.02 (b) Tensile Adhesion or Bond Strength (VTM-92, ACI 503, or equal). This test shall be performed at the time of construction. Three, reproducible tensile adhesion tests shall also be performed forty calendar days after installation at different sites on the bridge deck.

101.02 (c) Drying Shrinkage (ASTM C157). This test shall be performed at each bridge for the purposes of quality assurance testing during construction.

101.03 SAMPLING METHODS. The Independent Testing Laboratory shall provide a record of the following information based on results from sampling methods. Test methods used to obtain results must be approved by the Engineer.

101.03 (a) Rate of Evaporation

101.03 (b) Actual Mixture Proportions

101.03 (c) Water to Cement Ratio

101.03 (d) Thermal Coefficient of Concrete

101.03 (e) Entrained Air

101.04 METHOD OF MEASUREMENT. Measurement for Special Contractor Testing will be made on a lump sum basis.

101.05 BASIS OF PAYMENT. Special Contractor Testing, measured as provided above, will be paid for at the contract price for:

SPECIAL CONTRACTOR TESTING LUMP SUM

which price will be full compensation for performing the work specified and the furnishing of all materials, labor, tools, equipment and incidentals necessary to sample, test and report the treated concrete.

Payment for this item will be made in one installment after all samples have been obtained and tests performed.

5. *Evaporation Control and Curing.* Limit moisture loss from fresh concrete by first, controlling evaporation, and then, curing. Begin evaporation control immediately after concrete strike-off, and continue until the concrete is protected from moisture loss by one of the permitted curing methods.

   Control evaporation according to the requirements of Article 504.03(c). Limit the evaporation rate of water from the fresh concrete to less than 0.5 kilograms per square meter per hour. Use Figure 504-1, or other approved means, to determine the evaporation rate. Control evaporation adequately to prevent premature crusting of the surface or an increase in drying cracking. If fogging, limit the application of moisture to avoid either disturbing the finish or collecting water in puddles. Do not use water from fogging as an aid to finishing the concrete.

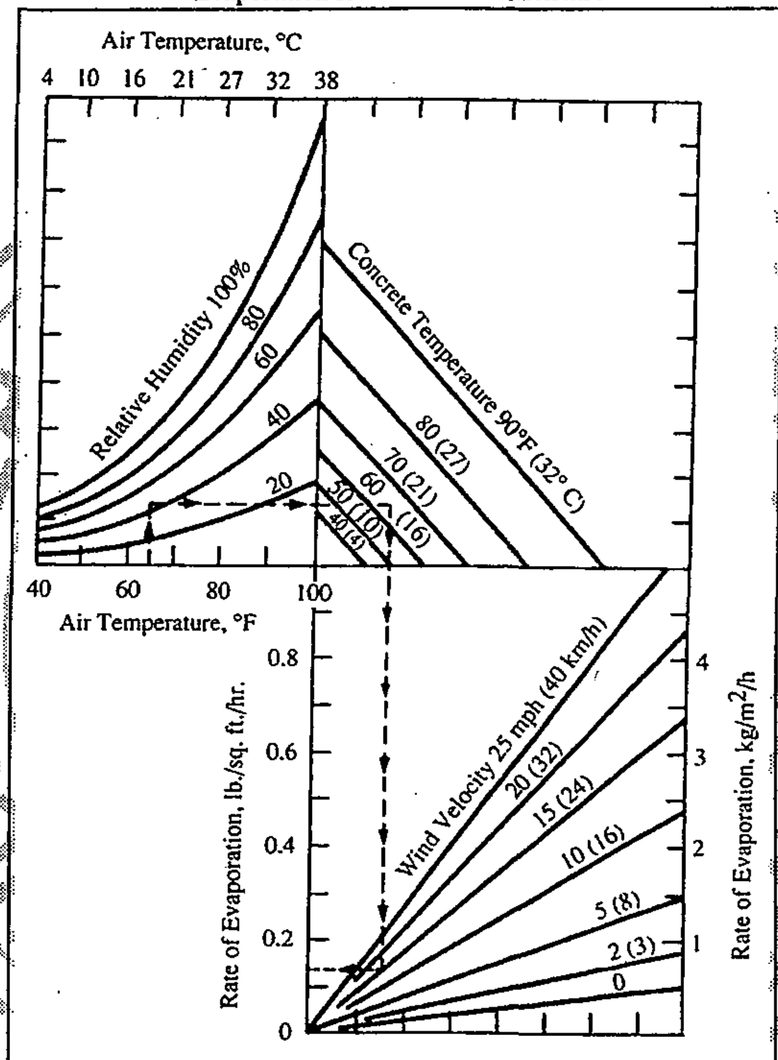
   Cure bridge deck and approach slab concrete according to the methods described in Article 509.04(f). Use the water method. The liquid membrane curing compound method may be used, before applying the water method, to shorten the time evaporation control is needed. Discontinue evaporation control after applying the either curing method.

6. *Removing Forms.* Comply with Article 502.04(c).

(f) **Surface Correction through Grinding.** Test the hardened driving surfaces after curing for trueness using a 3-meter straightedge or other specified device before final acceptance. Mark and grind areas having high spots of 3 mm or more, or areas requiring grinding to meet smoothness specifications. Grind after the concrete curing period is completed, and according to Section 425. Discontinue grinding when the out-of-tolerance areas are within specified tolerances. Do not reduce the concrete cover of reinforcing steel to less than 50 mm. Restore the skid-resistant surface in ground areas using saw-cut grooving.

Remove and replace, at no additional cost, bridge decks and approach slabs which cannot be corrected to specification tolerances.

Figure 504-1
Evaporation Rate of Surface Moisture



Note: Example shown by dashed lines is for an air temperature of 18°C, relative humidity of 45%, concrete temperature of 18°C, and a wind velocity of 24 km/h. This results in a rate of evaporation of 0.64 kg/m²/hr, and requires evaporation control to be used.

(g) **Transverse Grooving.** Provide saw-cut transverse grooving for bridge decks and approach slabs under the following conditions:

- Saw-cut transverse grooving is specified in the contract documents as a pay item.
- Transverse grooving must be replaced after grinding.
- Out-of-tolerance transverse grooving (either finned-float or saw-cut) must be corrected.

COST ESTIMATE

Contract: 990057, TBOI-35-1(110)044 - BRIDGE REHABILITATION ON I-35

Project: 1625704, BRIDGE REHABILITATION80% FEDERAL FUNDS (0037K) NOT TO EXCEED 400,000 & 20% MATCH

Category: 0200, X231-BRIDGE 'A'

Item Description	Item Code	Authorized Qty.	Unit	Quantity This Estimate	Qty. Paid To Date	Total Qty. Placed	% Cpt	Unit Price	Dollar Amt. Paid To Date
(PL) CONCRETE SAWING	900.10 6141	270.000	LF	356.000	452.000	452.000	167%	10.00000	$4,520.00
(PL) SEALED EXPANSION JOINT	901.14 6264	77.120	LF		0.000			350.00000	
(SP) ASPH. CONCRETE TYPE A (PG 64-22) (F-66)	411(A) 4302	567.500	TON		641.040	641.040	113%	65.00000	$41,667.60
(SP) ASPH. CONCRETE TYPE B (PG 64-28) (F-66)	411(B) 4402	276.300	TON	269.680	269.680	269.680	98%	75.00000	$20,226.00
(SP) ELASTOMERIC MORTAR	504(C) 639(	14.000	CF		21.330	21.330	152%	900.00000	$19,197.00
(SP) G.E.T. GUARD RAIL END SECTION	623(H) 8571	2.000	EA		2.000	2.000	100%	2,900.00000	$5,800.00
(SP) RAPID CURE JOINT SEALANT (3)	504(B) 6389	360.000	LF	356.000	356.000	356.000	99%	50.00000	$17,800.00
(SU) PRIME COAT (F-55)	408 5774	254.000	GAL		0.000			2.00000	
BRIDGE FLOOR OVERLAY (TYPE A)	532 6071	1,844.000	SY	44.440	1,843.660	1,843.660	99%	52.00000	$95,870.32
CLASS B BRIDGE FLOOR REPAIR	530 6019	90.000	SY		186.440	186.440	207%	240.00000	$44,745.60
CLASS C BRIDGE FLOOR REPAIR	530 6020	10.000	SY		10.180	10.180	102%	500.00000	$5,090.00
FLOODLIGHTING	532 6027	14.000	DAY		3.000	3.000	21%	1,500.00000	$4,500.00
MOBILIZATION	641 1399	1.000	LSUM		1.000	1.000	100%	79,300.00000	$79,300.00
REMOVAL OF ASPHALT PAVEMENT (1)(F-43)	619(B) 4728	1,690.000	SY		1,688.880	1,688.880	99%	10.00000	$16,888.80
REMOVAL OF GUARD RAIL (SP-6)(F-43)	619(B) 478(	150.000	LF		150.000	150.000	100%	10.00000	$1,500.00
SUBGRADE, METHOD B (2)	310(B) 0149	1,689.000	SY		1,688.890	1,688.890	99%	10.00000	$16,888.90
TACK COAT (F-25)	407 0250	200.000	GAL	73.000	73.000	73.000	37%	2.00000	$146.00

Project: 1625704, BRIDGE REHABILITATION80% FEDERAL FUNDS (0037K) NOT TO EXCEED 400,000 & 20% MATCH

Category: 0201, X231-BRIDGE 'B'

Item Description	Item Code	Authorized Qty.	Unit	Quantity This Estimate	Qty. Paid To Date	Total Qty. Placed	% Cpt	Unit Price	Dollar Amt. Paid To Date
(PL) CONCRETE SAWING	900.10 6141	270.000	LF	423.000	519.000	519.000	192%	20.00000	$10,380.00
(PL) SEALED EXPANSION JOINT	901.14 6264	76.830	LF		0.000			350.00000	
(SP) ASPH. CONCRETE TYPE A (PG 64-22) (F-66)	411(A) 4302	373.400	TON		421.470	421.470	113%	65.00000	$27,395.55
(SP) ASPH. CONCRETE TYPE B (PG 64-28) (F-66)	411(B) 4402	272.500	TON	182.910	182.910	182.910	67%	75.00000	$13,718.25
(SP) ELASTOMERIC MORTAR	504(C) 639(	14.000	CF		23.230	23.230	166%	900.00000	$20,907.00
(SP) G.E.T. GUARD RAIL END SECTION	623(H) 8571	2.000	EA		2.000	2.000	100%	2,900.00000	$5,800.00
(SP) RAPID CURE JOINT SEALANT (3)	504(B) 6389	360.000	LF	423.000	423.000	423.000	118%	50.00000	$21,150.00
(SU) PRIME COAT (F-55)	408 5774	167.000	GAL		0.000			2.00000	
BRIDGE FLOOR OVERLAY (TYPE A)	532 6071	1,754.000	SY		2,145.780	2,145.780	122%	52.00000	$111,580.56
CLASS B BRIDGE FLOOR REPAIR	530 6019	110.000	SY		181.590	181.590	165%	240.00000	$43,581.60
CLASS C BRIDGE FLOOR REPAIR	530 6020	10.000	SY		19.310	19.310	193%	500.00000	$9,655.00
FLOODLIGHTING	532 6027	14.000	DAY		2.000	2.000	14%	1,500.00000	$3,000.00
REMOVAL OF ASPHALT PAVEMENT (1)(F-43)	619(B) 4728	1,115.000	SY		1,111.110	1,111.110	99%	10.00000	$11,111.10
REMOVAL OF GUARD RAIL (SP-6)(F-43)	619(B) 478(	150.000	LF		150.000	150.000	100%	5.00000	$750.00

Project: 1625704, BRIDGE REHABILITATION80% FEDERAL FUNDS (0037K) NOT TO EXCEED 400,000 & 20% MATCH

Category: 0201, X231-BRIDGE 'B'

Item Description	Item Code	Authorized Qty.	Unit	Quantity This Estimate	Qty. Paid To Date	Total Qty. Placed	% Cpt	Unit Price	Dollar Amt. Paid To Date
SUBGRADE, METHOD B (2)	310(B) 0149	1,111.000	SY		761.110	761.110	69%	10.00000	$7,611.10
TACK COAT (F-25)	407 0250	145.000	GAL	50.000	50.000	50.000	34%	2.00000	$100.00

Project: 1625704, BRIDGE REHABILITATION80% FEDERAL FUNDS (0037K) NOT TO EXCEED 400,000 & 20% MATCH

Category: 0300, Y008-CONST. TRAFFIC CONTROL

Item Description	Item Code	Authorized Qty.	Unit	Quantity This Estimate	Qty. Paid To Date	Total Qty. Placed	% Cpt	Unit Price	Dollar Amt. Paid To Date
(PL) SURVEILLANCE OF TRAFFIC CONTROL (TO-39)	960.99 8549	40.000	SD		80.000	80.000	200%	1,250.00000	$100,000.00
(PL)CONST.ZONEPAVE.MKR: TAB)TYPE 1 (TO-21,61,70,73,75,SP-1)	961.42 8606	400.000	EA		121.000	121.000	30%	5.50000	$665.50
ADVANCE WARNING DEVICE (TYPE C)	880(C) 8015	80.000	SD		133.000	133.000	166%	50.00000	$6,650.00
BARRICADES (TYPE K)	880(J) 8021	240.000	SD		417.000	417.000	174%	2.00000	$834.00
DEL.PORT.TYP.PREC.MEDIAI BARRIER (TO-1)(SP-5)	627(H) 5856	1,000.000	LF		500.000	500.000	50%	15.00000	$7,500.00
DRUMS (SP-3)	880(P) 8027	3,200.000	SD		10,378.000	10,378.000	324%	0.50000	$5,189.00
PORT. CHANG. MESS. SIGN	960.86 8651	80.000	SD		249.000	249.000	311%	100.00000	$24,900.00
REL.PORT.TYP.PREC.CONC. (TO-1)(SP-5)	627(G) 4316	3,500.000	LF		500.000	500.000	14%	10.00000	$5,000.00
REMOV.PVEMNT MRKNG TAPE(4"WIDE) (TO-19,70,75)	856(B) 8005	4,000.000	LF		0.000			1.50000	
SAND FILLED IMP. ATTENU. MODULE (TO-44,68)	870(A) 8011	30.000	EA		30.000	30.000	100%	75.00000	$2,250.00
SIGNS 0 TO 6.25 SF	880(D) 8016	1,760.000	SD		1,700.000	1,700.000	97%	0.10000	$170.00
SIGNS 16.0 SF TO 32.99 S.F.	880(F) 8018	1,200.000	SD	60.000	1,630.000	1,630.000	136%	2.00000	$3,260.00
SIGNS 6.26 TO 15.99 SF	880(E) 8017	840.000	SD		1,218.000	1,218.000	145%	0.15000	$182.70
TRUCK MOUNT. ATT. (TO-77)	961.11 8652	80.000	SD		78.000	78.000	98%	75.00000	$5,850.00
TYPE A. LIGHT	880(M) 8024	1,680.000	SD	60.000	2,582.000	2,582.000	154%	0.10000	$258.20
TYPE C LIGHT	880(O) 8026	4,000.000	SD		10,378.000	10,378.000	259%	0.10000	$1,037.80
VERTICAL PANELS (SP-2)	880(L) 8023	800.000	SD		0.000			0.10000	
WING BARRICADES	880(K) 8022	240.000	SD	20.000	344.000	344.000	143%	2.00000	$688.00

Project: 1625704, BRIDGE REHABILITATION80% FEDERAL FUNDS (0037K) NOT TO EXCEED 400,000 & 20% MATCH

Category: 0301, Y008-TRAFFIC STRIPING

Item Description	Item Code	Authorized Qty.	Unit	Quantity This Estimate	Qty. Paid To Date	Total Qty. Placed	% Cpt	Unit Price	Dollar Amt. Paid To Date
PAV. MARKERS CLASS C TYPE 2-C (TS-14,15)	857(F) 8243	20.000	EA	14.000	14.000	14.000	70%	45.00000	$630.00
PAVEMNT MRKNG REMOV.(TRAF.STRP) (TO-22)	859(A) 8006	2,800.000	LF		3,006.000	3,006.000	107%	0.30000	$901.80
TRAFFIC STRIPE (PLASTIC)(4" WIDE) (TS-13)	855(A) 3318	3,400.000	LF	7,231.000	7,231.000	7,231.000	213%	0.70000	$5,061.70

Percentage of Contract Completed(curr): 104% Total Amount Earned This Estimate: $93,328.83

(total earned to date / total of all authorized work) Total Amount Earned To Date: $831,909.08

APPENDIX B
Manufacturer's Literature on Concrete Admixtures used on Project TDOI-35-1(110)044

Master Builders Technologies

POZZOLITH® 300-R

Concrete admixture for retarding setting times

DESCRIPTION:

POZZOLITH® 300-R ready-to-use, liquid admixture is for making more uniform and predictable high-performance concrete while retarding its setting time to facilitate placing and finishing operations. It meets ASTM C 494 requirements for Type B retarding and Type D water-reducing and retarding admixtures, specifically:

- Increased strength—compressive and flexural
- Relative durability to damage from freezing and thawing—well above industry standards
- Reduced water content required for a given workability
- Retarded-setting characteristics

ADVANTAGES:

The set-retarding characteristics of POZZOLITH 300-R admixture aid in the production of concrete with the following special qualities:

- Improved workability
- Reduced segregation
- Superior finishing characteristics for flatwork and cast surfaces
- Moderate to extended retardation—depending on the dosage rate
- Provides flexibility in the scheduling of placing and finishing operations
- Offsets the effects of too-early hardening during extended delays between mixing and placing
- Helps eliminate cold joints
- Allows for dead-load deflection to take place (before concrete sets) in extended pours for bridge decks, cantilevers, nonshored structural elements, etc.
- Lowers peak temperature and/or rate of temperature rise in mass concrete—reduces thermal cracking
- Effective as a singular admixture or as a component in a Master Builders Admixture System

WHERE TO USE:

POZZOLITH 300-R admixture is recommended for use in all types of concrete where moderate to extended retardation of set time and improved performance are desired.

This admixture improves pumped concrete, shotcrete (wet mix) and conventionally placed concretes. It improves plain, reinforced, precast, prestressed, lightweight or standard weight concrete.

POZZOLITH 300-R admixture can be used with portland cements approved under AASHTO, ASTM and CRD specifications. The use of POZZOLITH 300-R and a Master Builders air-entraining admixture is recommended whenever concrete is required to withstand freeze/thaw cycles. When used in conjunction with another admixture, each admixture must be dispensed separately into the mix.

POZZOLITH 300-R admixture will not initiate or promote corrosion of reinforcing steel in concrete. This admixture does not contain intentionally added calcium chloride or chloride-based ingredients. The admixture, due to chlorides originating from all the ingredients used in its manufacture, contributes less than 0.0002% (2.0 ppm) chloride ions by weight of the cement when used at the rate of 1 fl oz per 100 lb (65 mL per 100 kg) of cement.

POZZOLITH 300-R admixture can be used in white or colored concrete and in architectural concrete.

QUANTITY TO USE:

POZZOLITH 300-R admixture is recommended for use at the rate of 3 to 5 fl oz per 100 lb (195 to 326 mL per 100 kg) of cement for most concrete mixes using average concrete ingredients. Because of variations in job conditions and concrete materials, dosage rates other than the recommended amounts may be required. In such cases, contact your local Master Builders representative.

RATE OF HARDENING:

The temperature of the concrete mix and the ambient temperature (forms, earth, reinforcement, air, etc.) affect the hardening rate of concrete. At higher temperatures, concrete hardens more rapidly which may cause problems with placing and finishing.

One of the functions of POZZOLITH 300-R admixture is to retard the set of concrete. Within the normal dosage range, it will generally extend the working and setting times of concrete containing normal portland cement approximately 1 hour to 5 hours compared to a plain concrete mix, depending on job materials and temperatures. Trial mixes should be made with job materials approximating job conditions to determine the dosage required.

PERFORMANCE CHARACTERISTICS:

Concrete produced with POZZOLITH 300-R admixture will have rapid strength development after initial set occurs. It develops higher early (24 hour) and higher ultimate strengths than plain concrete when used within the recommended dosage range and under normal, comparable curing conditions.

When POZZOLITH 300-R admixture is used in heat-cured concrete, the length of the preheating period should be increased until initial set of the concrete is achieved. The actual heat-curing period is then reduced accordingly to maintain existing production cycles without sacrificing early or ultimate strengths.

Building Tomorrow Together® SKW-MBT CONSTRUCTION CHEMICALS

Master Builders Technologies

MB VR®

Admixture for entraining air in concrete

REQUIREMENTS/ADVANTAGES:

MB VR®(Master Builders Neutralized VINSOL* Resin solution) admixture for entraining air in concrete meets the requirements of ASTM C 260, AASHTO M 154, CRD-C 13 and other Federal and state specifications.

The entrainment of optimum air in concrete results in the following improvements in concrete quality:

- Increased resistance to damage from freezing and thawing
- Increased resistance to scaling from deicing salts
- Reduced permeability—Increased watertightness
- Reduced segregation and bleeding
- Improved plasticity and workability
- Improved properties of mixes used for making concrete block, concrete pipe and other precast products

Concrete durability research has established that the best protection for concrete from the adverse effects of freeze/thaw cycles and deicing salts results from: proper air content in the hardened concrete; a suitable air-void system in terms of bubble size and spacing; and adequate concrete strength, assuming the use of sound aggregates and proper mixing, placing, handling and curing techniques.

When unusually low or high amounts of an air-entraining admixture are required to achieve normal ranges of air content or if the required amount of air-entraining admixture necessary to achieve required levels of air content is observed to change significantly under given conditions, the reason should be investigated. In such cases, it is especially important to determine: (a) that a proper amount of air is contained in the fresh concrete at the point of placement; and (b) that a suitable air-void system (spacing factor) is being obtained in the hardened concrete.

FEATURES/BENEFITS:

Ready to Use – Solution is the proper concentration for rapid, accurate dispensing.

Compatible for Use – MB VR admixture is compatible with concrete containing other admixtures – water-reducers, high-range water-reducers, accelerators, retarders, and water repellents. The use of MB VR air-entraining admixture with Master Builders water-reducing, set-controlling admixtures forms a desirable combination for producing high-quality normal or lightweight concrete. Heavyweight concrete normally does not contain entrained air.

NOTE: As stated in ACI 212 and other publications, when two or more admixtures are used, each must be added to the mix separately (through dispensers or manually) and must not be mixed with each other prior to adding to the concrete mix.

For optimum, consistent performance, the air-entraining admixture should be dispensed on damp, fine aggregate or with the initial batch water. When using lightweight fine aggregate, field evaluations should be conducted to determine the best method to dispense the air-entraining admixture.

USAGE INFORMATION:

Add MB VR admixture to the concrete mix using a dispenser designed for air-entraining admixtures; or add manually using a suitable measuring device that ensures accuracy within plus or minus 3% of the required amount. Measure the air content of the trial mix and either increase or decrease the quantity of MB VR admixture to obtain the desired air content in the production mix. Check the air content of the first batch and make further adjustments if needed.

Due to possible changes in the factors that affect the dosage rate of MB VR, frequent checks should be made during the course of the work. Adjustments to the dosage should be based on the amount of entrained air in the mix at the point of placement.

QUANTITY TO USE:

There is no standard dosage rate for MB VR admixture. The exact quantity of air-entraining admixture needed for a given air content of concrete is not predictable because of differences in concrete making materials. Typical factors which might influence the amount of entrained air are: temperature, cement, sand grading, mix proportions, slump, means of conveying and placing, use of extra fine materiels such as fly ash, etc.

The amount of MB VR admixture used will depend upon the amount of entrained air required under actual job conditions. In a trial mix use 1/4 to 4 fl oz/100 lb (16 to 260 mL/100 kg) of cement. In mixes containing water-reducing, set-controlling admixtures, the amount of MB VR needed may be somewhat less than the amount required in plain concrete. In mixes requiring a higher or lower dosage to obtain the desired air content. Consult your local Master Builders representative.

Building Tomorrow Together®   SKW-MBT CONSTRUCTION CHEMICALS

AIR CONTENT DETERMINATION:

The total air content of normal weight concrete should be measured in strict accordance with ASTM C 231, "Standard Test Method for Air content of Freshly Mixed Concrete by the Pressure Method" or ASTM C 173, "Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method." The air content of lightweight concrete should only be determined using the Volumetric Method.

The air content should be verified by calculating the gravimetric air content in accordance with ASTM C 138, "Unit Weight, Yield, and Air content (Gravimetric) of concrete." If the total air content, as measured by the Pressure Method or Volumetric Method and as verified by the Gravimetric Method, deviates by more than 1-1/2%, the cause should be determined and corrected through equipment calibration or by whatever process is deemed necessary.

TEMPERATURE PRECAUTION:

MB VR admixture should be stored and dispensed at 35 °F (2 °C) or higher. Although freezing does not harm this product, precautions should be taken to protect it from freezing. If it freezes, thaw and reconstitute by mild mechanical agitation. **Do not use pressurized air for agitation.**

PACKAGING:

MB VR admixture is supplied in 55 U.S. gallon (208 liter) drums and by bulk delivery.

CAUTION:

MB VR admixture is a CAUSTIC solution. Chemical goggles and gloves are recommended if transferring or handling large quantities of material. (See MSDS and/or product label for complete information.)

NON-CHLORIDE, NON-CORROSIVE:

MB-VR admixture will not initiate or promote corrosion of reinforcing steel embedded in concrete, prestressed concrete or concrete placed on galvanized steel floor and roof systems. Calcium chloride is not an added ingredient in the manufacture of MB-VR admixture. Based on the chlorides originating from all ingredients used in manufacture, MICRO-AIR admixture contributes less than 0.0001% (1.0 ppm) chloride ions by weight of the cement when used at the rate of 1 fl oz per 100 lb (65 mL per 100 kg) of cement.

For suggested specification information or for additional product data on MB-VR air-entraining admixture, contact your local Master Builders representative.

Master Builders, Inc.

United States
23700 Chagrin Boulevard
Cleveland, Ohio 44122-5554
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(800) 387-5862
Fax (416) 741-7925

Mexico
Blvd. M. Avila Camacho 80, 3er Piso
53390 Naucalpan, México
011-525-557-5544
Fax 011-525-395-7903

mb_vr.p65 #112510
Printed in U.S.A. 698

RHEOBUILD® 1000

For the production of rheoplastic concrete

Master Builders Technologies

DESCRIPTION:

RHEOBUILD 1000 high-range, water-reducing admixture, is one of a complete line of RHEOBUILD admixtures formulated to produce rheoplastic concrete. Rheoplastic concrete flows easily, maintaining high plasticity for time periods unmatched by any other superplasticized concrete. Yet it has the low water/ cement ratio of no-slump concrete, providing excellent engineering (hardened) properties. The slump-retention characteristics of rheoplastic concrete permit the addition of RHEOBUILD 1000 admixture at the batch plant.

This ready-to-use, liquid admixture meets ASTM C 494 requirements for Type A and Type F admixtures.

ADVANTAGES IN THE PLASTIC STATE:

RHEOBUILD 1000 admixture aids in the production of concrete with these special qualities:

- Plasticity range of 8 to 11" (200 to 280 mm)
- Extended slump retention
- Controlled time of set
- Cohesive and non-segregating
- Minimal bleed water

ADVANTAGES IN THE HARDENED STATE:

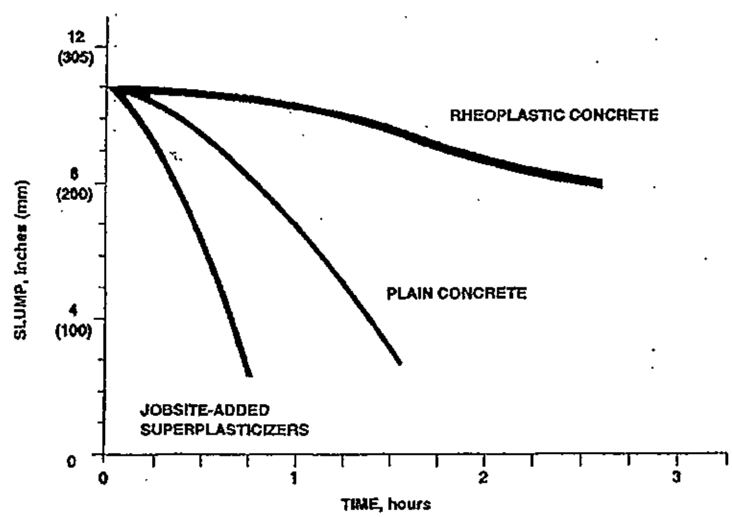
Through improved cement hydration efficiency, less dependence on consolidation energy and potential mix proportion adjustments, concrete treated with RHEOBUILD 1000 admixture provides the following engineering properties:

- Higher earlier strengths than can be achieved with conventional superplasticizers
- Increased ultimate compressive strength
- Higher modulus of elasticity
- Improved bond strength to steel
- Low permeability
- High durability
- Reduced shrinkage and creep
- Highly reliable in-place structural integrity

BENEFITS:

The economic benefits are both immediate and long-term, and extend to the total construction team. Use of rheoplastic concrete saves job time and cost through higher productivity rates or reduced labor. The higher early strength achieved with rheoplastic concrete allows for accelerated construction methods, resulting in completion dates ahead of schedule. Also, rheoplastic concrete permits engineering specification changes that allow for greater limits on the free-fall of concrete, lift heights and concrete temperatures, and potential economic mix adjustments.

SLUMP RETENTION VS. TIME



WHERE TO USE:

RHEOBUILD 1000 admixture is recommended for use in concrete where high plasticity, normal-setting characteristics and accelerated strengths are desired.

As a result of the preceding advantages and benefits, this admixture will improve performance in prestressed, precast and ready-mixed concrete applications.

RHEOBUILD 1000 admixture can be used with portland cements approved under ASTM, AASHTO or CRD specifications. The use of RHEOBUILD 1000 and a Master Builders air-entraining admixture is recommended whenever concrete is required to withstand freeze/thaw cycles. It is strongly recommended that concrete be properly cured.

RHEOBUILD 1000 admixture can be used effectively as a singular admixture or as a component in a Master Builders admixture system. When used in conjunction with another admixture, each admixture must be dispensed separately into the mix.

DIRECTIONS FOR USE:

Because slump retention is increased using RHEOBUILD 1000 admixture, it may be batched at the ready-mix plant as opposed to jobsite addition often required when using other high-range water-reducers.

NOTE: For directions on the proper evaluation and use of RHEOBUILD 1000 admixture in specific applications, contact your local Master Builders representative.

WORKABILITY:

Concrete containing RHEOBUILD 1000 admixture has the ability to maintain a rheoplastic state [8 to 11" (200 to 280 mm)] for up to two hours, if such workability is required. The precise duration of workability depends not only on temperature, but also on the type of cement, mix proportions, the nature of the aggregates, the method of transport, and the dosage rate of RHEOBUILD 1000 admixture.

For additional information on RHEOBUILD 1000 admixture or on its use in developing a concrete mixture with special performance characteristics, contact your local Master Builders representative.

QUANTITY TO USE:

RHEOBUILD 1000 admixture is recommended for use at a rate of 10 to 25 fl oz per 100 lb (0.65 to 1.6 liters per 100 kg) of cementitious materials, depending upon the application, and the amount of strength acceleration needed or slump increase desired.

This dosage range applies for most concrete mixes using average concrete ingredients. However, variations in job conditions and concrete materials, such as silica fume, may make usage rates outside the recommended dosage range desirable. In such cases, contact your local Master Builders representative.

RATE OF HARDENING:

RHEOBUILD 1000 admixture is formulated to produce normal-setting characteristics throughout its recommended dosage range.

Setting time of concrete is influenced by the chemical and physical composition of the basic ingredients of the concrete, temperature of the concrete and climatic conditions. Trial mixes should be made with job materials to determine the dosage required for a specified setting time and a given strength requirement.

PACKAGING:

RHEOBUILD 1000 admixture is supplied in 55 U.S. gallon (208 liter) drums and bulk delivery.

TEMPERATURE PRECAUTION:

If RHEOBUILD 1000 admixture has frozen, thaw at 45 °F (7 °C) or above and completely reconstitute by mild mechanical agitation. **Do not use pressurized air for agitation.**

NON-CHLORIDE, NON-CORROSIVE:

RHEOBUILD 1000 admixture will not initiate or promote corrosion of reinforcing steel embedded in concrete, prestressed concrete or concrete placed on galvanized steel floor and roof systems. Neither calcium chloride nor any chloride-based ingredients are used in the manufacture of RHEOBUILD 1000. In all concrete applications, RHEOBUILD 1000 admixture conforms to the most stringent or minimum chloride ion limits currently suggested by construction industry standards and practices.

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53390 Naucalpan, México
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Fax 011-525-395-7903

Form RH-3d
Printed in U.S.A. 496

Master Builders Technologies

RHEOMAC® SF100

(Formerly MB SF)
Silica fume mineral admixture

DESCRIPTION:

RHEOMAC SF100 dry compacted silica fume admixture is formulated to produce extremely strong, durable concrete possessing special performance qualities. RHEOMAC SF100 meets ASTM C1240 Standard Specification for Silica Fume for Use in Hydraulic-Cement Concrete and Mortar.

BENEFITS:

RHEOMAC SF100 silica fume is a critical component in the production of high-performance concrete with the following unique engineering properties:

- Dramatically **Reduced Permeability** that effectively inhibits the ingress of moisture, chlorides and other contaminants into concrete.
- Effective **Corrosion Protection** of steel-reinforced concrete.
- **Highly Durable** concrete with **increased resistance to:**
  - Corrosion
  - Abrasion/erosion
  - Chemical attack
  - Sulfates
  - Freeze/thaw damage
- **High-Strength** concrete with strengths in excess of 15,000 psi (105 MPa).
- Extremely **High Modulus of Elasticity** exceeding 6,000,000 psi (40,000 MPa).
- **High-Early Strengths** that enable more efficient and cost effective production of prestressed and/or precast concrete.

HOW IT WORKS:

RHEOMAC SF100 silica fume is a micro-filling material that physically fills the voids between cement particles. RHEOMAC SF100 silica fume dramatically lowers concrete permeability, and reduces the size and number of capillaries that allow contaminants to enter concrete.

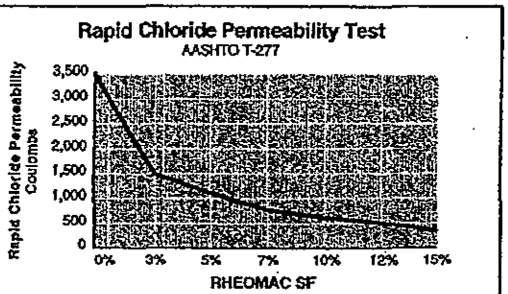
RHEOMAC SF silica fume maximizes concrete service life by providing superior resistance to attack from damaging environmental forces.

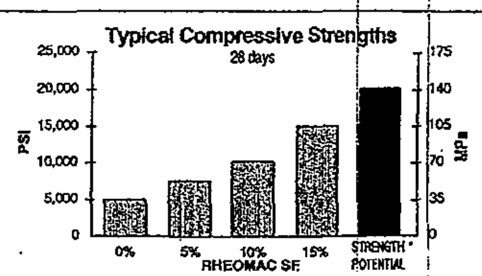
As a pozzolan, RHEOMAC SF100 silica fume reacts chemically within concrete to increase the amount of calcium silicate hydrate (CSH) that is formed. CSH is the bonding agent that holds concrete together. The additional CSH significantly increases the compressive strength and decreases the permeability of concrete.

WHERE TO USE:

RHEOMAC SF100 silica fume will improve performance in precast, paving, shotcrete and ready-mixed concrete applications. RHEOMAC SF100 silica fume increases concrete strength and reduces permeability, thereby increasing the concrete's resistance to environmental attack. This makes RHEOMAC SF100 silica fume ideal for use in structures exposed to deicing salts such as **parking garages and bridge decks**, as well as for marine structures, slabs, and in any construction project **requiring the protection provided by highly durable, low permeability concrete.**

Continued...





* Compressive strengths attainable when mix is optimized regarding w/c ratio, eggregate and other factors affecting strength.

Master Builders Technologies

...Continued

RHEOMAC SF100 silica fume's pozzolanic and void-filling properties enable concrete to attain ultra-high compressive strengths. RHEOMAC SF100 silica fume is ideal for use in projects requiring **high strength/high performance** concrete for **reducing member size, increasing span lengths, improving structural economics,** and meeting other high-performance structural requirements.

DRY COMPACTED VS. SLURRY:

The high-performance benefits of silica fume concrete can be achieved by using either dry compacted or slurried forms of silica fume. Dry compacted and slurried forms of silica fume provide identical performance in concrete. Both require effective mixing for maximum results.
Master Builders provides both dry compacted and slurried forms of silica fume for the convenience of the concrete producer in storing, handling and batching.

DIRECTIONS FOR USE:

RHEOMAC SF100 silica fume is batched at the ready-mix plant in a manner similar to cement or other cementitious materials such as fly ash and granulated slag. It may be batched in a central or truck mixer, and may be added at any point in the batching process. Follow ASTM C-94 procedures to ensure effective mixing and distribution throughout the mixer.

QUANTITY TO USE:

RHEOMAC SF100 silica fume is recommended for use at an addition rate of 5 to 15% by weight of cement. Dosage rates may vary according to application and desired concrete properties. For dosages outside the recommended range, contact your local Master Builders representative.

STORAGE/HANDLING/DISPENSING:

RHEOMAC SF100 silica fume stores, handles, and dispenses similar to cement or fly ash. In bulk, RHEOMAC SF100 silica fume may be stored in a silo. Packaged material may be stored indefinitely in a dry area. RHEOMAC SF100 silica fume requires no special dispensing equipment.

PACKAGING:

RHEOMAC SF100 silica fume is available in 25 lb (11.6 kg shreddable bags, 50 lb (23 kg) bags, 2,000 lb (907 kg) bulk bags or bulk delivery.

SPECIFIC GRAVITY:

The specific gravity of RHEOMAC SF100 silica fume is 2.2.

COMPATIBILITY:

RHEOMAC SF100 silica fume can be used with Portland cements approved under ASTM, AASHTO, or CRD specifications. It is compatible with most concrete admixtures, including all Master Builders admixtures. RHEOMAC SF100 silica fume is recommended for use with high-range water-reducing admixtures, such as RHEOBUILD 1000 admixture, for maximum workability while maintaining a low water-cementitious materials ratio.

RATE OF HARDENING:

Setting time of concrete is influenced by the chemical and physical composition of the cement and/ or cement type used to produce the concrete, temperature of the concrete, weather conditions, and the use of chemical admixtures. Trial mixes should be made with job materials to determine the setting time of a specific mixture.

NON-CHLORIDE:

RHEOMAC SF100 silica fume will not initiate or promote corrosion of reinforcing steel embedded in concrete, prestressed concrete, or concrete placed on galvanized steel floor and roof systems. Neither calcium chloride nor any chloride-based ingredients are used in the manufacture of RHEOMAC SF100 silica fume.

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Fax 011-525-395-7903

Form MBSF-1c
Printed in U.S.A. 597

Master Builders Technologies

PACKAGING:

POZZOLITH 300-R admixture is supplied in 55 U.S gallon (208 liter) drums and by bulk delivery.

TEMPERATURE PRECAUTION:

If POZZOLITH 300-R admixture has frozen, thaw at 35 °F (2 °C) or above and completely reconstitute by mild mechanical agitation. **Do not use pressurized air for agitation.**

For additional information on POZZOLITH 300-R admixture or on its use in developing a concrete mix with special performance characteristics, contact your local Master Builders representative.

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Fax (416) 741-7925

Mexico
Blvd. M. Avila Camacho 80, 3er Piso
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011-525-557-5544
Fax 011-525-395-7903

PZL300R.P65 #112449
Printed in U.S.A.998

APPENDIX C
Photographs of Overlay Construction Operation

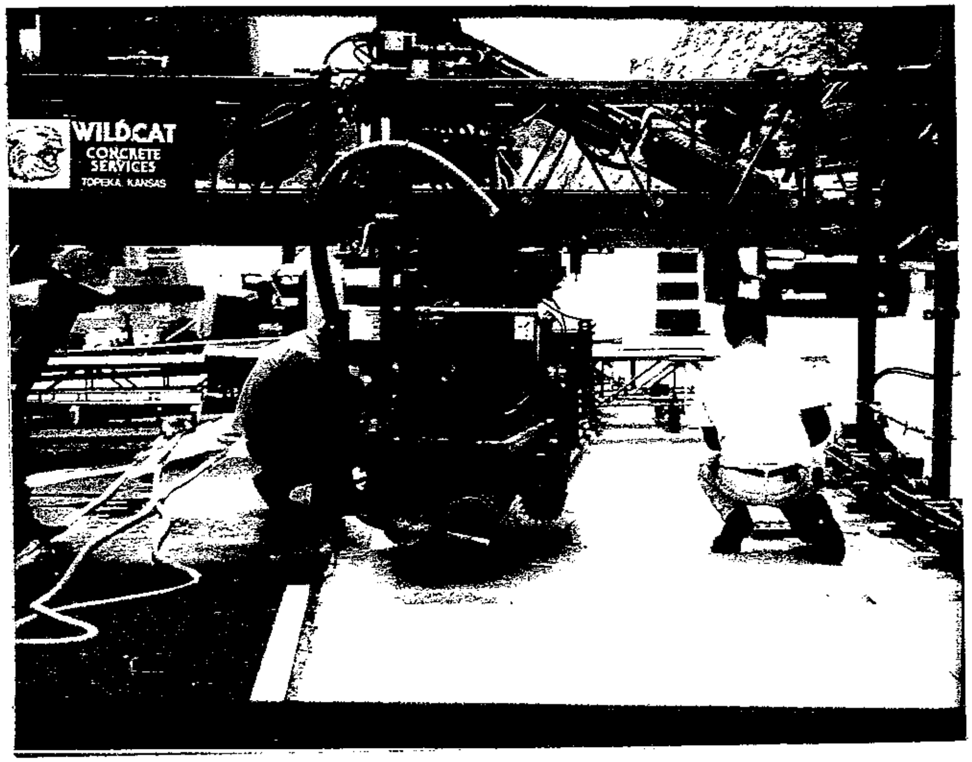

Figure 1. Calibrating finish grade height.

Figure 2. Mixing grout for overlay bond strength.

Figure 3. Spreading silica fume concrete for the overlay.

Figure 4. Spreading silica fume concrete by hand.

Figure 5. Concrete paver spreading silica fume concrete.

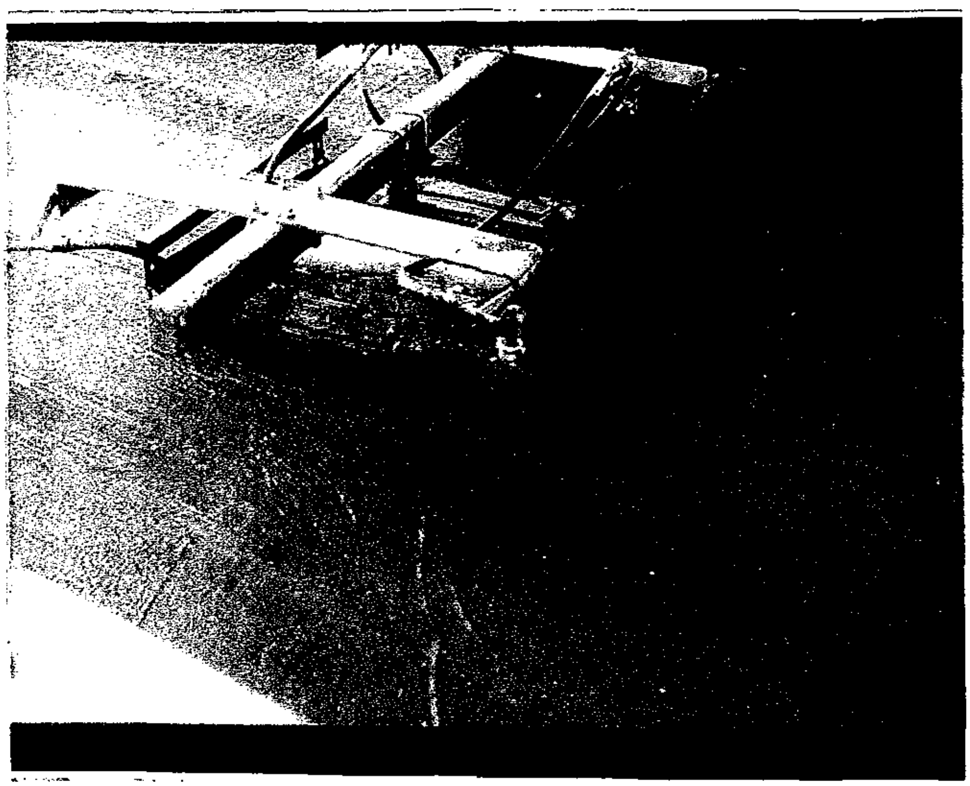

Figure 6. Spray bars and finish board on the back of the concrete paver.

Figure 7. Repairing pits by hand left by the concrete paver.

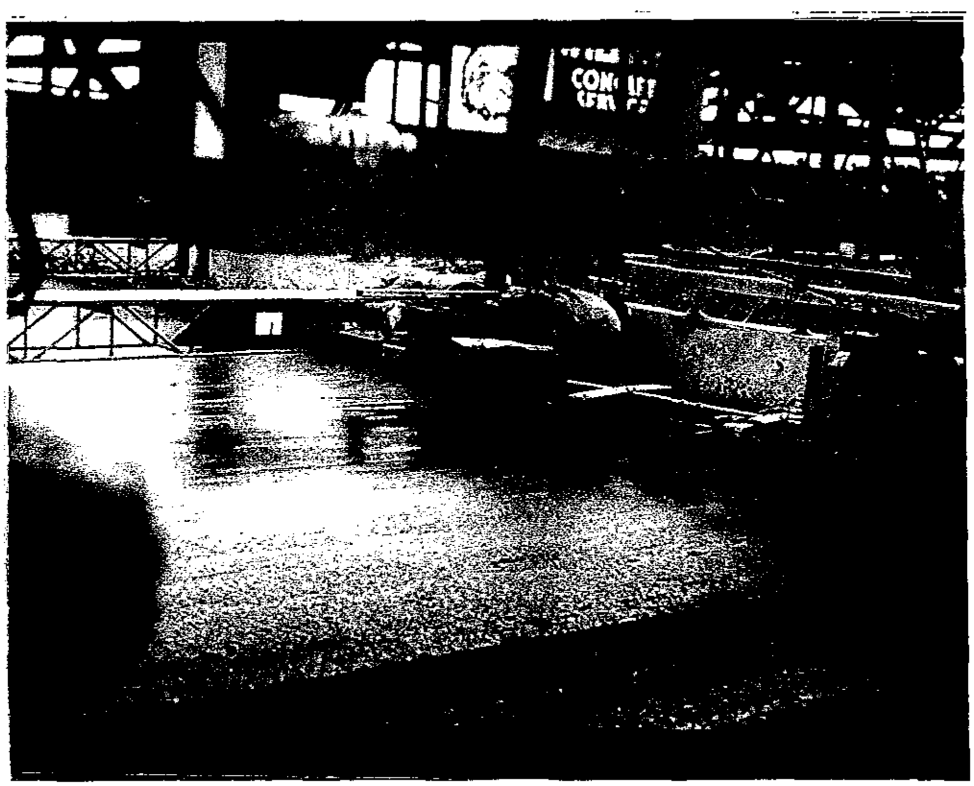

Figure 8. Hand finishing the edge of the bridge deck.

Figure 9. Final finish made with a Fresno float.

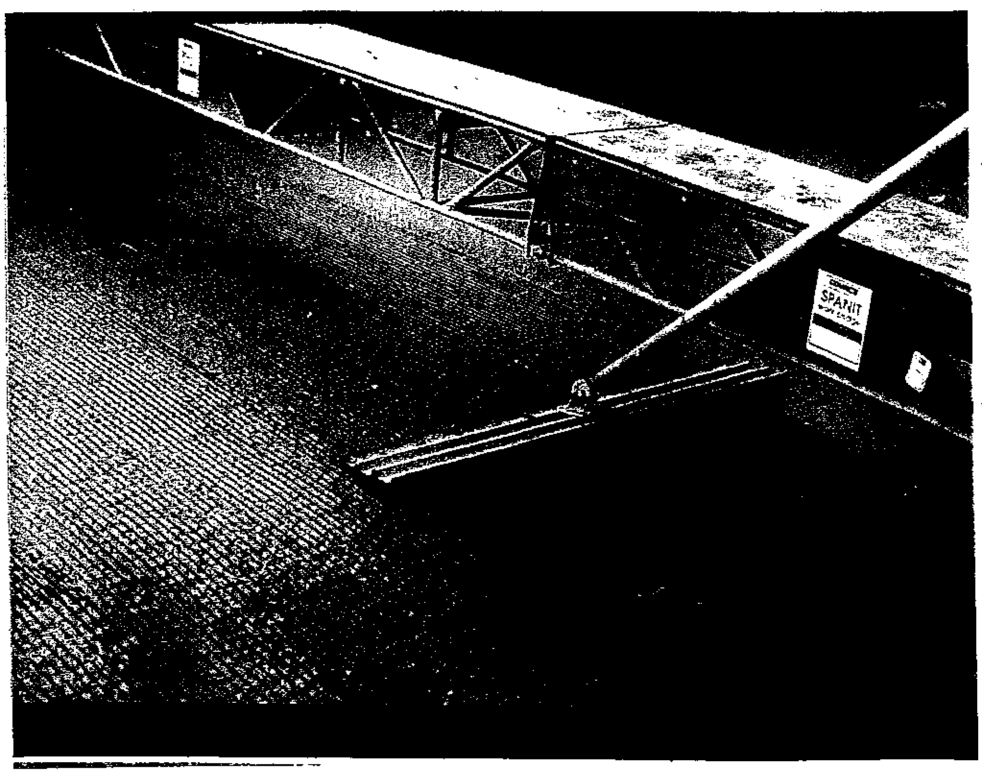

Figure 10. Surface texturing with a tine float.

Figure 11. Spraying white curing compound.

Figure 12. Curing deck with burlap blanket.

Figure 13. Wetting burlap and covering overlay with plastic for 72 hours.

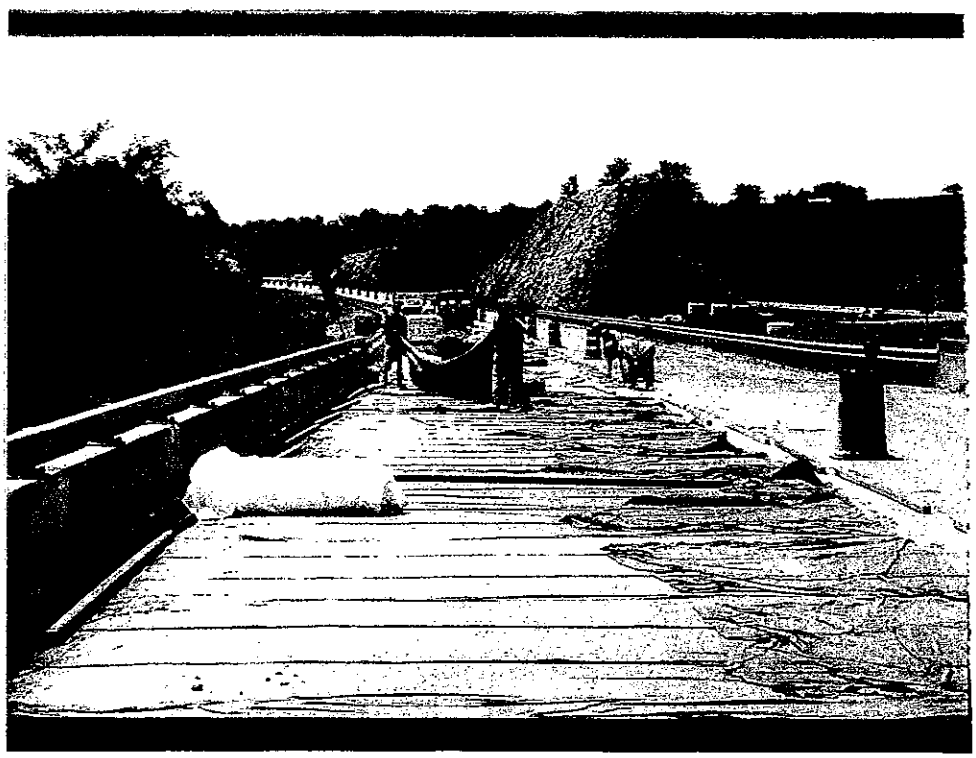

Figure 14. Removing curing blanket on the completed overlay.

APPENDIX D
Test Results

Oklahoma Department of Transportation
Research & Development Division

To Gary Williams **Date** October 27, 1999

From Michael E. Sawyer

Subject Field Report (Profilograph Testing of Silica Fume Overlay Bridge)
Item 2211

Profilograph work has been completed on the Silica Fume overlay bridge and approaches. The table below shows the profilograph readings along with the numbers from the K.J. Law Profilometer.

LOCATION	PAY FACTOR	ROUGHNESS (inches/mile)	
		PROFILOGRAPH	PROFILOMETER
Northbound Outside lane	1.05	6.33	7.5
Northbound Inside lane	1.05	5.21	5.06
Southbound Outside lane	1.01	20.43	25.26
Southbound Inside lane	1.05	12.49	11.79

The coefficient of variation for the profilometer in the above table is 7.63%. This figure is slightly higher than has been seen in roadway testing (an average of 6%). The interim report will be completed by the end of October and will contain the results of all the profilometer testing to date.

From the standpoint of profilograph smoothness, this is one of the smoothest bridges that the Research office knows about in the state. The maximum allowable roughness on the typical bridge in new construction is 40 in/mi. The average bridge is approximately 27 in/mi. Anything under 15 in/mi is awarded the highest pay factor (1.05). Taking these figures into consideration, the Silica Fume overlay seems to be a success. Additional factors like performance over time will need to be considered, but the start is very encouraging.

SITE:	035-10-36 Carter
LANE:	NBOL
DRIVER:	RMB
OPERATOR:	JAL
DATE:	11/01/1999
TIME:	10:45:04

REF POST	SN	WHEEL	SN PEAK	AIR TEMP	TEST TIME	CYCLE NUMBER	EVENT
20.331	52.9	Left	94.5	61.7	10:44:27	510014585	
20.370	43.4	Right	88.6	61.7	10:44:31	510014586	BRIDGE
20.412	50.9	Left	78.4	60.8	10:44:35	510014587	

SKID TEST DISCLAIMER

This test is conducted solely for the purpose of generating input data for priority programming of maintenance and construction projects. Tests are performed by field personnel not trained nor expert in scientific testing procedure. While every effort is made to conduct tests accurately, tests are not subject to rigorous scientific control. The test results are calculated as the product of a mechanical test wherein a skid trailer tire interfaces with the road surface providing an approximate value which may be converted to a coefficient of friction only for that portion of the road surface actually in contact with the tire of the test trailer. The calculated coefficient of friction has value only as to the surface actually tested and no attempt should be made to use this test as a means of evaluation of untested surface areas or for correlation of this test with tests of other tested surface areas.

TEST IS PERFORMED SOLEY FOR THE PURPOSES INDICATED AND NO REPRESENTATIONS AS TO ITS ACCURACY, RELIABILITY, OR APPLICABILITY FOR OTHER PURPOSES ARE EXPRESSED OR IMPLIED.

Rev. October 1, 1990 Oklahoma Department of Transportation, Traffic Engineer Division Form TE-2-46B

SKID DATA SHEET

SITE:	035-10-36 Carter
LANE:	NBIL
DRIVER:	RMB
OPERATOR:	JAL
DATE:	11/01/1999
TIME:	10:49:29

REF POST	SN	WHEEL	SN PEAK	AIR TEMP	TEST TIME	CYCLE NUMBER	EVENT
20.331	51.5	Left	87.9	61.7	10:48:53	510014591	
20.370	53.4	Right	89.9	61.7	10:48:56	510014592	BRIDGE
20.412	52.0	Left	78.2	61.7	10:49:00	510014593	

Rev. October 1, 1990 Oklahoma Department of Transportation, Traffic Engineer Division Form TE-2-46B

SKID DATA SHEET

SITE: 035-10-36 Carter
LANE: SBOL
DRIVER: RMB
OPERATOR: JAL
DATE: 11/01/1999
TIME: 10:42:56

REF POST	SN	WHEEL	SN PEAK	AIR TEMP	TEST TIME	CYCLE NUMBER	EVENT
20.412	48.6	Left	85.6	60.8	10:42:25	510014582	
20.370	48.9	Right	98.5	60.8	10:42:29	510014583	BRIDGE
20.331	51.5	Left	86.7	60.8	10:42:33	510014584	

SKID TEST DISCLAIMER

This test is conducted solely for the purpose of generating input data for priority programming of maintenance and construction projects. Tests are performed by field personnel not trained nor expert in scientific testing procedure. While every effort is made to conduct tests accurately, tests are not subject to rigorous scientific control. The test results are calculated as the product of a mechanical test wherein a skid trailer tire interfaces with the road surface providing an approximate value which may be converted to a coefficient of friction only for that portion of the road surface actually in contact with the tire of the test trailer. The calculated coefficient of friction has value only as to the surface actually tested and no attempt should be made to use this test as a means of evaluation of untested surface areas or for correlation of this test with tests of other tested surface areas.

TEST IS PERFORMED SOLEY FOR THE PURPOSES INDICATED AND NO REPRESENTATIONS AS TO ITS ACCURACY, RELIABILITY, OR APPLICABILITY FOR OTHER PURPOSES ARE EXPRESSED OR IMPLIED.

SITE: 035-10-36 Carter
LANE: SBIL
DRIVER: RMB
OPERATOR: JAL
DATE: 11/01/1999
TIME: 10:47:34

REF POST	SN	WHEEL	SN PEAK	AIR TEMP	TEST TIME	CYCLE NUMBER	EVENT
20.412	50.2	Left	77.1	61.7	10:47:13	510014588	
20.370	53.0	Right	83.4	61.7	10:47:17	510014589	BRIDGE
20.331	46.7	Left	72.2	60.8	10:47:20	510014590	

SKID TEST DISCLAIMER

This test is conducted solely for the purpose of generating input data for priority programming of maintenance and construction projects. Tests are performed by field personnel not trained nor expert in scientific testing procedure. While every effort is made to conduct tests accurately, tests are not subject to rigorous scientific control. The test results are calculated as the product of a mechanical test wherein a skid trailer tire interfaces with the road surface providing an approximate value which may be converted to a coefficient of friction only for that portion of the road surface actually in contact with the tire of the test trailer. The calculated coefficient of friction has value only as to the surface actually tested and no attempt should be made to use this test as a means of evaluation of untested surface areas or for correlation of this test with tests of other tested surface areas.

TEST IS PERFORMED SOLEY FOR THE PURPOSES INDICATED AND NO REPRESENTATIONS AS TO ITS ACCURACY, RELIABILITY, OR APPLICABILITY FOR OTHER PURPOSES ARE EXPRESSED OR IMPLIED.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon

832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 1

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/06/99 Time: 12:30

Sampled by: Callaway

Placement Description: I-35 overlay

Sample Location: far right north bound lane, mile marker 47

Placement Method: direct discharge
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE

Design Strength at 28 days 6000 psi

Material Supplier: Joe Brown

Delivery Ticket No: 66151 Truck No.: 1623

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): 5 Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	5.25	
Air Content, %	4.0	
Concrete Temperature, °F	82	
Ambient Temperature, °F	74	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 08/09/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	28.1	27.9	28.0	28.1		
Tested By	Burton	Burton	Speaks	Speaks		
Date Tested	08/13/99	08/13/99	09/03/99	09/03/99		
Age at Test, days	7	7	28	28		
Fracture Type	c	c	d	d		
Min. Compressive Strength, psi						
Total Load, lbs.	170000	182000	200000	190000		
Compressive Strength, psi	6010	6440	7070	6720		

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 2

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/06/99 Time: 3:50

Sampled by: Callaway

Placement Description: I-35 overlay

Sample Location: on bridge, far right north bound lane

Placement Method: direct discharge
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete

Design Strength at 28 days 6000 psi

Material Supplier: Joe Brown

Delivery Ticket No: 66156 Truck No.: 1623

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.: 8

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.0	
Air Content, %	6.2	
Concrete Temperature, °F	82	
Ambient Temperature, °F	88	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 08/09/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	27.5	27.5	27.9	27.8		
Tested By	Burton	Burton	Speaks	Speaks		
Date Tested	08/13/99	08/13/99	09/03/99	09/03/99		
Age at Test, days	7	7	28	28		
Fracture Type	c	c	a	a		
Min. Compressive Strength, psi						
Total Load, lbs.	180000	225000	210000	205000		
Compressive Strength, psi	6370	7960	7430	7250		

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:
☐ Field mix and field test data provided by others
☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 3

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/10/99 Time:

Sampled by: Stevenson

Placement Description: northbound land east shoulder

Sample Location: 40' from south end

Placement Method: direct discharge
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete

Design Strength at 28 days 6000 psi

Material Supplier: Joe Brown

Delivery Ticket No: Truck No.:

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.5	
Air Content, %	4.2	5.5-7.5
Concrete Temperature, °F	88	
Ambient Temperature, °F	95	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	28.4	28.5	28.6	28.5		
Tested By	Burton	Burton	Speaks	Speaks		
Date Tested	08/17/99	08/17/99	09/07/99	09/07/99		
Age at Test, days	7	7	28	28		
Fracture Type	c	c	a	d		
Min. Compressive Strength, psi						
Total Load, lbs.	145000	152000	175000	173000		
Compressive Strength, psi	5130	5380	6190	6120		

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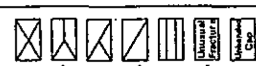
Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon



a b c d e f u
Fracture Types

Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report
In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159
Report No. 4

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/13/99 Time: 2:35
Sampled by: Callaway
Placement Description: south bound lane

Sample Location: truck #4, right before bridge

Placement Method: direct discharge
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete
Design Strength at 28 days 6000 psi
Material Supplier: Joe Brown
Delivery Ticket No: 66243 Truck No.: 1598
Mix I.D. No.: SILICA AA
Coarse aggregate size:
Admixtures:
Batch size (cu.yd.): Cu.Yd placed:
Water added on site, gal.: 5
Batch time: Time in mixer, min.:
(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.75	
Air Content, %	8.9	
Concrete Temperature, °F	88	
Ambient Temperature, °F	79	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	27.9	27.8	28.1	28.2		
Tested By	Tanner	Tanner				
Date Tested	08/20/99	08/20/99	09/10/99	09/10/99		
Age at Test, days	7	7	28	28		
Fracture Type	d	c				
Min. Compressive Strength, psi						
Total Load, lbs.	167000	152000				
Compressive Strength, psi	5910	5380				

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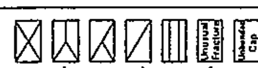
Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon



a b c d e f u
Fracture Types

Notes:
☐ Field mix and field test data provided by others
☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 5

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/20/99 Time: 2:00AM

Sampled by: Broomfield

Placement Description: Bridge Deck Paving

Sample Location: South Bound right lane

Placement Method: Paving Machine
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown

Delivery Ticket No: Truck No.: 1623

Mix I.D. No.: SILICA "AA"

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.25	
Air Content, %	9.4	
Concrete Temperature, °F	86	
Ambient Temperature, °F	78	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 08/21/99

Specimen No.	A	B	C			
Specimen Size, inches	6	6	6			
Cross-Section Area, sq. inches	28.27	28.27	28.27			
As Received Specimen Wt., lbs.	28.4	28.4	28.4			
Tested By	Burton	Tanner	Tanner			
Date Tested	08/27/99	09/17/99	09/17/99			
Age at Test, days	7	28	28			
Fracture Type	b	c	c			
Min. Compressive Strength, psi						
Total Load, lbs.	220000	230000	227000			
Compressive Strength, psi	7780	8140	8030			

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Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon

832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 6

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/20/99 Time: 3:00AM

Sampled by: Broomfield

Placement Description: Bridge Deck

Sample Location: Right south bound lane

Placement Method: Paving Machine
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown

Delivery Ticket No: Truck No.: 1625

Mix I.D. No.: SILICA "AA"

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.25	
Air Content, %	5.6	
Concrete Temperature, °F	84	
Ambient Temperature, °F	81	
Plastic Unit Weight, pcf		

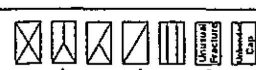
Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 08/21/99

Specimen No.	A	B	C			
Specimen Size, inches	6	6	6			
Cross-Section Area, sq. inches	28.27	28.27	28.27			
As Received Specimen Wt., lbs.	27.9	27.9	27.9			
Tested By	Burton	Tanner	Tanner			
Date Tested	08/27/99	09/17/99	09/17/99			
Age at Test, days	7	28	28			
Fracture Type	b	a	b			
Min. Compressive Strength, psi						
Total Load, lbs.	240000	245000	232000			
Compressive Strength, psi	8490	8670	8210			

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon



a b c d e f u
Fracture Types

Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 7

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/27/99 Time: 12:05

Sampled by: Callaway

Placement Description: north bound left lane

Sample Location: Truck #1

Placement Method: direct discharge
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown

Delivery Ticket No: Truck No.: 1624

Mix I.D. No.: SILICA "AA"

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	2.0	
Air Content, %	4.9	
Concrete Temperature, °F	89	
Ambient Temperature, °F	86	
Plastic Unit Weight, pcf		

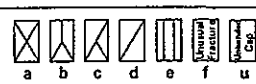
Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 08/28/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	28.6	28.7	28.6	28.7		
Tested By	Speaks	Speaks				
Date Tested	09/03/99	09/03/99	09/24/99	09/24/99		
Age at Test, days	7	7	28	28		
Fracture Type	b	c				
Min. Compressive Strength, psi						
Total Load, lbs.	222000	210000				
Compressive Strength, psi	7850	7430				

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon



Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159
Report No. 8

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 08/26/99 Time: AM
Sampled by: Sloan
Placement Description: approach to bridge deck
Sample Location: north bound lane, left of center
Placement Method: direct discharge
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) Concrete
Design Strength at 28 days 6000 psi
Material Supplier: Joe Brown
Delivery Ticket No: 62053 Truck No.: 1511
Mix I.D. No.: SILICA AA
Coarse aggregate size:
Admixtures:
Batch size (cu.yd.): Cu.Yd placed:
Water added on site, gal.:
Batch time: Time in mixer, min.:
(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	1.25	
Air Content, %	5.3	
Concrete Temperature, °F	89	
Ambient Temperature, °F	84	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 09/09/99

Specimen No.	A	B	C			
Specimen Size, inches	6	6	6			
Cross-Section Area, sq. inches	28.27	28.27	28.27			
As Received Specimen Wt., lbs.	28.4	28.4	28.4			
Tested By	Stinson	Stinson	Stinson			
Date Tested	09/23/99	09/23/99	09/23/99			
Age at Test, days	28	28	28			
Fracture Type	d	d	d			
Min. Compressive Strength, psi						
Total Load, lbs.	270000	265000	270000			
Compressive Strength, psi	9550	9370	9550			

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon


a b c d e f u
Fracture Types

Notes:
☐ Field mix and field test data provided by others
☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

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Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 9

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 09/14/99 Time: 8:25

Sampled by: Callaway

Placement Description: Patching on Bridge

Sample Location: South Bound, Left

Placement Method: DIRECT DISCHARGE
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown Co.

Delivery Ticket No: 0762334 Truck No.: 1624

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	1.75	
Air Content, %	5.5	
Concrete Temperature, °F	83	
Ambient Temperature, °F	70	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 09/15/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	28.1	28.0	28.1	28.0		
Tested By	Tanner	Tanner				
Date Tested	09/21/99	09/21/99	10/12/99	10/12/99		
Age at Test, days	7	7	28	28		
Fracture Type	a	c				
Min. Compressive Strength, psi						
Total Load, lbs.	182500	185000				
Compressive Strength, psi	6460	6540				

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 10

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 09/15/99 Time: 11:05

Sampled by: Callaway

Placement Description: Bridge Deck Patching

Sample Location: South Bound, Left Lane

Placement Method: DIRECT DISCHARGE
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown

Delivery Ticket No: 62355 Truck No.: 1512

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.: 18

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3	
Air Content, %	6.9	
Concrete Temperature, °F	87	
Ambient Temperature, °F	79	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory

Specimen No.	A	B	C	D	X	
Specimen Size, inches	6	6	6	6	6	
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27	28.27	
As Received Specimen Wt., lbs.	27.6	27.6	27.6	27.6	27.5	
Tested By	Tanner	Tanner				
Date Tested	09/22/99	09/22/99	10/13/99	10/13/99	11/10/99	
Age at Test, days	7	7	28	28	56	
Fracture Type	c	c				
Min. Compressive Strength, psi						
Total Load, lbs.	155000	155000				
Compressive Strength, psi	5480	5480				

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:
- ☐ Field mix and field test data provided by others
- ☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon

832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 11

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 09/21/99 Time: 5:45

Sampled by: Callaway

Placement Description: Paving North of the Bridge

Sample Location: South Bound, I-35 Left Lane

Placement Method: DIRECT DISCHARGE
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown Company

Delivery Ticket No: Truck No.: 1598

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.5	
Air Content, %	9	
Concrete Temperature, °F	79	
Ambient Temperature, °F	54	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 09/29/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	27.1	27.1	27.2	27.2		
Tested By	Hesby	Hesby				
Date Tested	09/30/99	09/30/99	10/19/99	10/19/99		
Age at Test, days	9	9	28	28		
Fracture Type	c	c				
Min. Compressive Strength, psi						
Total Load, lbs.	155000	175000				
Compressive Strength, psi	5480	6190				

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Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:
☐ Field mix and field test data provided by others
☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 11

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 09/21/99 Time: 5:45

Sampled by: Callaway

Placement Description: Paving North of the Bridge

Sample Location: South Bound, I-35 Left Lane

Placement Method: DIRECT DISCHARGE
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown Company

Delivery Ticket No: Truck No.: 1598

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	3.5	
Air Content, %	9	
Concrete Temperature, °F	79	
Ambient Temperature, °F	54	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 09/29/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	27.1	27.1	27.2	27.2		
Tested By	Hesby	Hesby	Howell	Howell		
Date Tested	09/30/99	09/30/99	10/19/99	10/19/99		
Age at Test, days	9	9	28	28		
Fracture Type	c	c	c	c		
Min. Compressive Strength, psi						
Total Load, lbs.	155000	175000	220000	230000		
Compressive Strength, psi	5480	6190	7780	8140		

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

Notes:

☐ Field mix and field test data provided by others

☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Fracture Types

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159

Report No. 12

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 09/21/99 Time: 9:10

Sampled by: Callaway

Placement Description: Paving, South Bound Left Lane

Sample Location: South End of Bridge

Placement Method: DIRECT DISCHARGE
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE

Design Strength at 28 days 5000 psi

Material Supplier: Joe Brown Company

Delivery Ticket No: Truck No.: 1624

Mix I.D. No.: SILICA AA

Coarse aggregate size:

Admixtures:

Batch size (cu.yd.): Cu.Yd placed:

Water added on site, gal.:

Batch time: Time in mixer, min.:

(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	2.75	
Air Content, %	6.2	
Concrete Temperature, °F	79	
Ambient Temperature, °F	57	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 09/29/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	28.1	28.1	28.0	28.1		
Tested By	Hesby	Hesby				
Date Tested	09/30/99	09/30/99	10/19/99	10/19/99		
Age at Test, days	9	9	28	28		
Fracture Type	c	c				
Min. Compressive Strength, psi						
Total Load, lbs.	197500	181500				
Compressive Strength, psi	6990	6420				

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:
☐ Field mix and field test data provided by others
☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

Compressive Strength Test Report

In general compliance with ASTM.

Terracon
832 NW 67th Street
Oklahoma City, OK 73116
(405) 848-1607

Terracon Project No. 03991159
Report No. 13

Client Wildcat Concrete Services, Inc.
PO BOX 750075
Topeka, KS 66675

Attn: Mr. Raymond E. May

Project Carter County Bridge Overlay
I-35 Bridges

Field Mix Data

Sample Date: 09/21/99 Time: 10:45
Sampled by: Callaway
Placement Description: On Roadway Paving South of the Bridge
Sample Location: South Bound I-35 Left lane
Placement Method: DIRECT DISCHARGE
(direct discharge, crane and bucket, pump)

Material: (concrete, grout, mortar) CONCRETE
Design Strength at 28 days 5000 psi
Material Supplier: Joe Brown Company
Delivery Ticket No: Truck No.: 1624
Mix I.D. No.: SILICA AA
Coarse aggregate size:
Admixtures:
Batch size (cu.yd.): Cu.Yd placed:
Water added on site, gal.:
Batch time: Time in mixer, min.:
(the preceeding information obtained from delivery ticket)

Field Test Data

Test	Result	Specification
Slump, in.	2.5	
Air Content, %	4.7	
Concrete Temperature, °F	82	
Ambient Temperature, °F	62	
Plastic Unit Weight, pcf		

Laboratory Test Data (ASTM C 39)

Nominal Specimen Size 6x12 Date submitted to laboratory 09/29/99

Specimen No.	A	B	C	D		
Specimen Size, inches	6	6	6	6		
Cross-Section Area, sq. inches	28.27	28.27	28.27	28.27		
As Received Specimen Wt., lbs.	28.7	28.8	28.7	28.9		
Tested By	Hesby	Hesby				
Date Tested	09/30/99	09/30/99	10/19/99	10/19/99		
Age at Test, days	9	9	28	28		
Fracture Type	c	c				
Min. Compressive Strength, psi						
Total Load, lbs.	195000	203000				
Compressive Strength, psi	6900	7180				

Comments:

Distribution: Wildcat Concrete Services, Inc. (2)
ODOT (1) Ms. Kimberly Gordon

a b c d e f u
Fracture Types

Notes:
☐ Field mix and field test data provided by others
☒ Field test data by Terracon in general compliance with sampling ASTM C 172, Casting Specimens C 31, Slump C143, Air Content C 173 or C 231, Temperature C 1064, Unit Weight C 138

Reviewed by: Thomas Hawes
Construction Services Mgr.

CARTER COUNTY I-35 BRIDGES

ODOT PROJECT NUMBER TBOI-0035-1(110)044
STRUCTURES NBI 17229 & 17255

VIRGINIA TEST METHOD FOR OVERLAY ADHESION

Test Number	Location	Type of Failure	Tensile Load (lbs)	Result (psi)	Overlay Thickness
1A	South bound lane	1	200	80	2.13
1B	(inside)	1	100	40	2.03
1C	Panel #1 South	1	100	40	2.25
2A	South bound lane	1	100	40	1.99
2B	(inside) Panel #2	1	100	40	2.29
2C	South Cap Failure	1	100	40	2.03
3A	South bound lane	1	100	40	2.59
3B	(inside)	2	100	40	2.73
3C	Panel #3	1	100	40	2.55
Tests 1 thru 6 performed on 09/28 & 09/29/99	Test Area: 2.57 inches				
4A	North bound lane	1	100	40	2.60
4B	(inside)	2	100	40	2.64
4C	Panel #1 North	2	100	40	2.53
5A	North bound lane	1	100	40	3.05
5B	(inside)	2	100	40	2.96
5C	Panel #2	2	100	40	3.08
6A	North bound lane	2	100	40	3.42
6B	(inside)	2	100	40	3.31
6C	Panel #3	2	100	40	3.52
7A	South bound land	1	100	40	3.90
7B	(inside)	1	100	40	3.91
7C	Panel #1 South	1	100	40	2.09

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Terracon

Form 101—1-87

CARTER COUNTY I-35 BRIDGES

ODOT PROJECT NUMBER TBOI-0035-1(110)044
STRUCTURES NBI 17229 & 17255

VIRGINIA TEST METHOD FOR OVERLAY ADHESION

Test Number	Location	Type of Failure	Tensile Load (lbs)	Result (psi)	Overlay Thickness
8A	South bound lane	1	100	40	2.32
8B	(passing)	1	100	40	2.33
8C	Panel #2 South	1	100	40	2.31
9A	South bound lane	1	100	40	2.52
9B	(passing)	2	100	40	2.42
9C	Panel #3 South	2	100	40	2.68
10A	North bound lane	1	50	20	2.28
10B	(passing)	1	50	20	2.25
10C	Panel #1	1	50	20	2.36
11A	North bound lane	2	50	20	2.55
11B	(passing)	1	100	40	2.55
11C	Panel #2	1	150	60	2.68
12A	North bound lane	1	50	20	2.91
12B	(passing)	1	50	20	2.96
12C	Panel #3	1	100	40	2.95
Tests 7 thru 12 perfromed on 11/09/99					

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Terracon

Form 101—1-87

**RAPID DETERMINATION OF THE
CHLORIDE PERMEABILITY OF CONCRETE
AASHTO T 277**

JOB NAME: CARTER COUNTY BRIDGE
JOB NO.: 03991159
DATE: 1/19/00

DATE TESTED: 1-5-00 THRU 1-17-00

TEST RESULTS

SAMPLE ID	MAXIMUM CURRENT RECORDED, AMPS	TOTAL CHARGE PASSED, COULOMBS	CHLORIDE PERMEABILITY
1NL-A	0.017	385	VERY LOW
1NL-B	0.025	578	VERY LOW
2NL-A	0.02	438	VERY LOW
2NL-B	0.031	679	VERY LOW
3NL-A	0.017	385	VERY LOW
3NL-B	0.013	333	VERY LOW
S-1 NB	0.114	2379	MODERATE
S-2 NB	0.014	333	VERY LOW
S-3 NB	0.011	238	VERY LOW
1SL-A	0.013	302	VERY LOW
1SL-B	0.007	171	VERY LOW
2SL-A	0.003	90	NEGLIGIBLE
2SL-B	0.003	94	NEGLIGIBLE
3SL-A	0.016	353	VERY LOW
3SL-B	0.006	145	VERY LOW
S-1 SB	0.015	393	VERY LOW
S-2 SB	0.009	216	VERY LOW
S-3 SB	0.036	756	VERY LOW

TYPE OF SAMPLE: 3.75" DIAMETER CORE
LOCATION OF TEST SAMPLE WITHIN SAMPLE: TOP 0.2" TO 2.2"

Terracon