

**SILICA FUME LATEX MODIFIED  
CONCRETE BRIDGE DECK  
OVERLAY**

**Tualatin River Bridge #1417N**

**Final Report  
Experimental Features  
Project No. 93-05**

By

Eric W. Brooks, E.I.T.  
Research Specialist

Prepared for

Oregon Department of Transportation  
Research Unit  
Salem, Oregon 97310

and

Federal Highway Administration  
Washington, D.C. 20590

December 1997

1. Report No. OR EF-98-10	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle  Silica Fume Modified Concrete Bridge Deck Overlay		5. Report Date  December 1997	
		6. Performing Organization Code	
7. Author(s) Eric W. Brooks		8. Performing Organization Report No.	
9. Performing Organization Name and Address  Oregon Department of Transportation Research Unit 2950 State Street Salem, Oregon 97310		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No.	
12. Sponsoring Agency Name and Address  Federal Highway Administration 400 Seventh Street S. W. Washington D. C. 20590		13. Type of Report and Period Covered  Final Report Sept. 1993-June 1997.	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract  The Oregon Department of Transportation has used either Silica Fume or Latex Modified Concrete (LMC) to lower chloride permeability in bridge deck overlays. On this project a new product combining both silica fume and LMC was used. The overlay was completed in July of 1993. Three years later, only a few cracks had developed. Chloride permeability measurements were low but not as low as the suppliers claimed.  One unexpected result was lower friction numbers on the deck surfacing. At this time it is unclear if the reduced friction was due to the modified cement or the smaller aggregates used in the mix design. ODOT plans further testing to determine the main cause of the reduced friction.  This product was difficult to mix and place and has since been discontinued by the producer.			
17. Key Words SILICA FUME, LATEX MODIFIED CONCRETE, CHLORIDE PERMEABILITY		18. Distribution Statement Available through the ODOT Research Unit.	
19. Security Classify. (of this report)	20. Security Classify. (of this page)	21. No. of Pages 37	22. Price

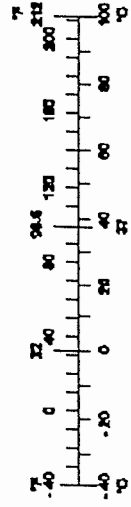
# SI\* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	645.2	millimeters squared	mm <sup>2</sup>
ft <sup>2</sup>	square feet	0.093	meters squared	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.836	meters squared	m <sup>2</sup>
ac	acres	0.405	hectares	ha
mi <sup>2</sup>	square miles	2.59	kilometers squared	km <sup>2</sup>
<b>VOLUME</b>				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft <sup>3</sup>	cubic feet	0.028	meters cubed	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.765	meters cubed	m <sup>3</sup>
NOTE: Volumes greater than 1000 L shall be shown in m <sup>3</sup> .				
<b>MASS</b>				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
<b>TEMPERATURE (exact)</b>				
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

## APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
<b>AREA</b>				
mm <sup>2</sup>	millimeters squared	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	meters squared	10.764	square feet	ft <sup>2</sup>
ha	hectares	2.47	acres	ac
km <sup>2</sup>	kilometers squared	0.386	square miles	mi <sup>2</sup>
<b>VOLUME</b>				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m <sup>3</sup>	meters cubed	35.315	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	meters cubed	1.308	cubic yards	yd <sup>3</sup>
<b>MASS</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
<b>TEMPERATURE (exact)</b>				
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



\* SI is the symbol for the International System of Measurement

## **ACKNOWLEDGMENTS**

The author would like to thank the following Oregon Department of Transportation (ODOT) personnel for their contributions and help in gathering information for this report: Bruce Patterson, Les Harkema, Keith Johnston, and Mike Dunning. In addition, the author thanks Reichhold Chemicals, Inc. for their cooperation supplying data on their product.

## **DISCLAIMER**

This document is disseminated under the sponsorship of the Oregon Department of Transportation in the interest of information exchange. The State of Oregon assumes no liability of its contents or use thereof.

The contents of this report reflect the views of the author who is solely responsible for the facts and accuracy of the material presented herein. The contents do not necessarily reflect the official views of the Oregon Department of Transportation.

The State of Oregon does not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are essential to the object of the document.

This report does not constitute a standard, specification, or regulation.

# SILICA FUME LATEX MODIFIED CONCRETE BRIDGE DECK OVERLAY

## TABLE OF CONTENTS

ACKNOWLEDGMENTS .....	III
DISCLAIMER .....	III
1.0 INTRODUCTION .....	1
2.0 PROJECT DESCRIPTION .....	3
2.1 PROJECT LOCATION AND ENVIRONMENT .....	3
3.0 CONSTRUCTION .....	5
3.1 MIX DESIGN .....	5
3.2 QUALITY CONTROL .....	6
3.3 DECK PREPARATION .....	6
3.4 DECK OVERLAY .....	6
4.0 TEST RESULTS .....	9
4.1 CONCRETE PROPERTIES .....	9
4.2 POST CONSTRUCTION TESTING .....	9
5.0 THREE-YEAR EVALUATION .....	11
6.0 CONCLUSIONS AND RECOMMENDATIONS .....	15

### LIST OF TABLES

Table 3.1: Trial Mix Design MTC-93_11 for One Cubic Yard .....	5
Table 3.2: Mix Control Summary .....	6
Table 4.1: Concrete Properties from SFLMC .....	9
Table 4.2: Permeability of Cores and Cylinders for the SFLMC Deck Overlay .....	9
Table 5.1: Average Friction Numbers for Bridge #1417N .....	11

### LIST OF FIGURES

FIGURE 1.1 THE TUALATIN RIVER BRIDGE .....	1
FIGURE 2.1 THE PROJECT IS LOCATED NEAR PORTLAND, OREGON .....	4

**FIGURE 2.2 BRIDGE #1417N OVER THE TUALATIN RIVER ON ORE 99W.....4**  
**FIGURE 5.1 BRIDGE #1417N, NOTE POLISHED AGGREGATES. .... 11**  
**FIGURE 5.2 BRIDGE #1417N, MOST OF THE DECK IS IN GOOD CONDITION..... 13**  
**FIGURE 5.3 BRIDGE #1417N, MINOR CRACKING IS RARE. .... 13**

## 1.0 INTRODUCTION

In September of 1993, The Oregon Department of Transportation overlaid a deteriorated bridge deck. A new material was used to overlay the deck: silica fume latex modified concrete. Both silica fume and latex modified concrete have been used in earlier projects with good results. Silica fume adds strength to the concrete and latex retards cracking. Both materials also reduce chloride permeability. This report documents the construction, permeability testing and the three-year performance of the overlay. Figure 1.1 shows the general conditions of the bridge.



Figure 1.1 The Tualatin River Bridge.

## **2.0 PROJECT DESCRIPTION**

### **2.1 PROJECT LOCATION AND ENVIRONMENT**

The project is located near Portland, Oregon on Highway 99W. The north bound structure (BR#1417N) of the twin bridges over the Tualatin River at milepost 12.18 received the overlay (Figures 2.1 and 2.2). The climate in this area has mild winters although a few freezing periods are normal in winter months. The average daily traffic of 33,000 is 90% cars with the remaining 10 % percent consisting of trucks with gross weights from 20,000 lbs to 80,000 lbs

The structure, built in 1957, is a 463-foot RCDG with 8 bents. The concrete deck has a slight down grade with a curve to the left. The deck surfacing had spalled and cracked to the point it needed resurfacing.



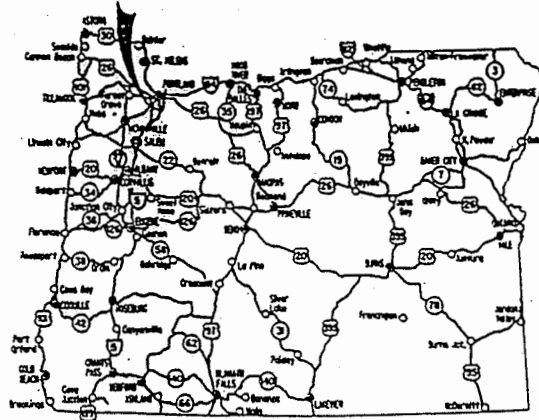


Figure 2.1 The project is located near Portland, Oregon.

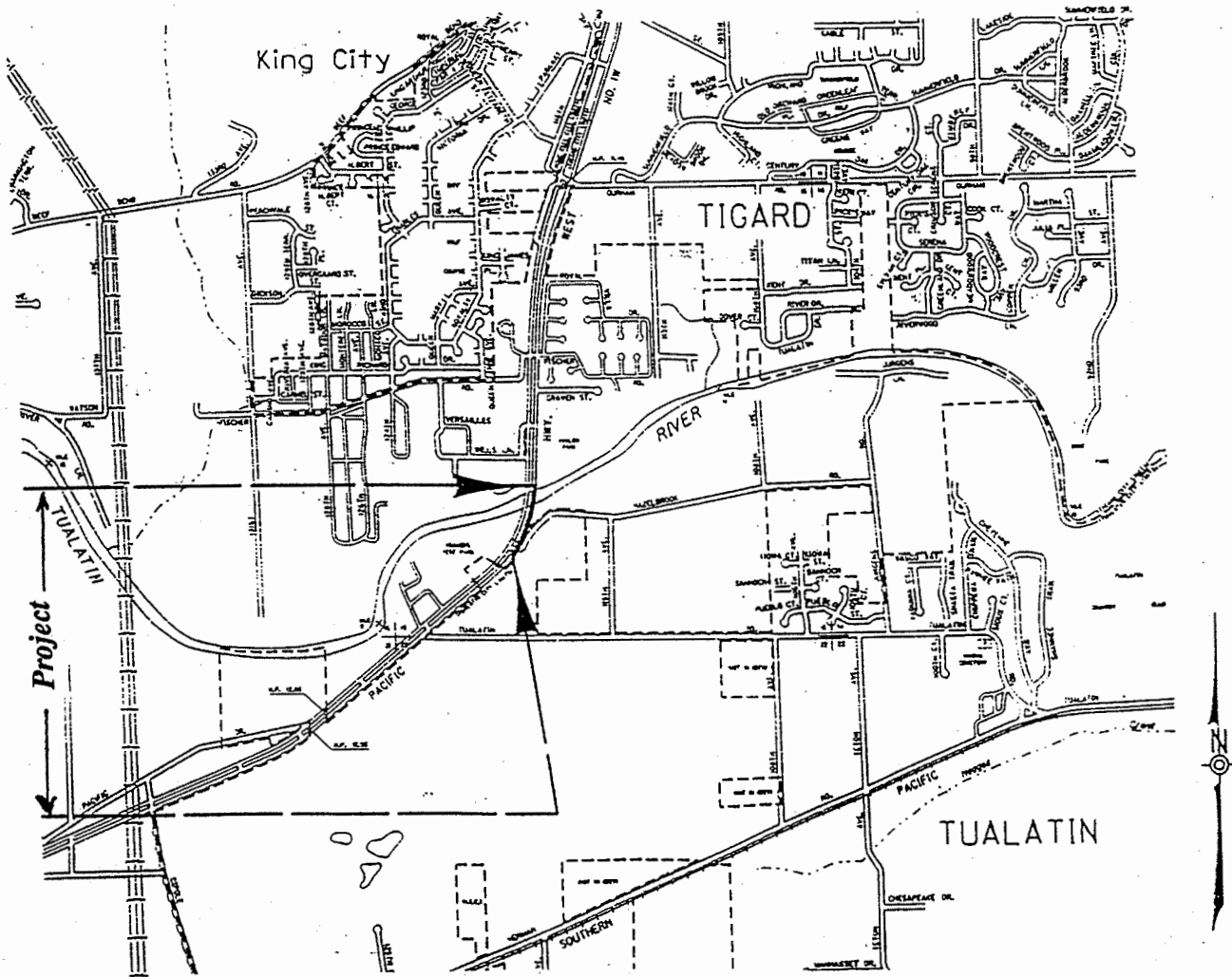


Figure 2.2 Bridge #1417N over the Tualatin River on Ore 99W.

## 3.0 CONSTRUCTION

### 3.1 MIX DESIGN

Before the overlay, a trial mix design was submitted to the ODOT Materials Lab for approval. Trial batches were made and tested by Material Testing Corporation for Hamilton Construction on July 28, 1993. ODOT personnel and representatives from Reichhold Chemical, the SFLMC supplier, witnessed the testing (see Table 3.1).

**Table 3.1: Trial Mix Design MTC-93 11 for One Cubic Yard.**

Item	Batching weights in lbs	Absolute volume in cu.ft.
Cement, Tilbury Type I-II	660	3.36
Water (10.0 gallons)	83	1.34
Concrete Sand (SSD)	1,476	9.06
Coarse Aggregate (SSD) 5/8"-3/8"	1,467	8.74
Reichhold Chemical Silica Fume (25.9 gal/cy)	238	3.43
Entrained Air	0.0	1.07
Total	3,924	27

The trial mix was tested for slump, air content, unit weight and compressive strength. All testing met ODOT specifications. The unit weight, however, was lower than the design value. Results are listed below:

- Slump = 7"
- Air Content = 8%
- Compressive strength (7 day)= 5,170 lbs (design 4,000)
- Unit Weight =139.8 lbs/cu.ft. (design 145.0)
- W/C=0.33

A complete listing is included in Appendix A.

### 3.2 QUALITY CONTROL

Mix proportions were controlled by calibration of the two mobile mixers the same as a latex modified concrete overlay is controlled. Control settings on trucks #2518 and #2519 were calibrated on August 31, 1993. Settings for cement, fine and coarse aggregates, latex emulsion and water gauges were calibrated. Representatives from MTC and ODOT witnessed and approved the calibration shown in table 3.2.

**Table 3.2: Mix Control Summary**

Item	Truck # 2518	Truck # 2519
Cement Meter Count	7.28	7.13
Time to Discharge	32.42	33.18
F.A. Sand Dial	5.6	5.8
C.A. Stone Dial	4.45	4.95
Latex(Gauge setting)	7.0=6.8 GPM	7.2=Bottom of mark
Water(Flow Meter)	1.9 Maximum	2.0 Maximum

The cement used in the mix was sampled and tested by ODOT. No defects were reported. The TYLAC 680015-00 (Silica Fume Latex Modifier) was accepted on the supplier's certification. Aggregates, both coarse and fine were sampled and tested by ODOT. The first sample of sand had 1.4% light weight particles. The maximum allowable was 1%. A second sample passed with 0.2% light weight particles. The coarse aggregates met all of ODOT specifications. However, a price agreement had to be written to allow crushed material. Construction testing data is included in Appendix B.

### 3.3 DECK PREPARATION

The deck was hydro-blasted before the overlay to remove deteriorated concrete. Some Class 2 preparation was needed near the north end. Rebar was very near the worn surface. Old concrete was removed to a depth of 3/4-inch below the exposed rebar as per ODOT specifications.

### 3.4 DECK OVERLAY

The deck was overlaid in two stages: the right lane was completed on September 3, 1993 and the left lane was completed on September 23, 1993. One travel lane remained open to traffic during the deck pour by placing concrete barriers near the center of the bridge. These barriers also supported the rail for the concrete deck-paving machine.

Weather conditions were reported as good. A complete summary can be found in Appendix C. Traffic was reported as heavy on the last section of the second pour. The contractor believed this contributed to the minor cracking found in this area.

The ODOT material inspector reported problems with the pumps on the mobile mixer on the

jobsite. The pumps on the mobile mixers were not designed for the stiff mix produced by adding silica fume. They clogged up several times, causing some delays and confusion about the amount of mix used because one of the mixers left the deck to be repaired. The gears on the pump were stripped. The inspector said that the silica fume proportioning might have been low before the pump problem was discovered. No testing was performed to determine the silica fume/latex content in the placed mixture.

## 4.0 TEST RESULTS

### 4.1 CONCRETE PROPERTIES

Cylinders were cast from the fresh SFLMC material for testing of concrete properties and also permeability testing. The test results of these are listed below except permeability is discussed in section 4.2.

**Table 4.1: Concrete Properties from SFLMC**

Item	Date 9/3/93 (right lane)	Date 9/23/93 (left lane)
Slump	3 ¼ inches	7 inches
Air	4.5 %	6.8 %
Unit Weight	145.2 lbs/cu.ft.	140.8 lbs/cu.ft.
7 day compressive strength	6640 lbs/cu.in.	5400 lbs/cu.yd.
Cement content	678 lbs/cu.yd.	658 lbs/cu.yd.
W/C (water cement ratio)	0.32	0.31

All tests were within specifications. However, there are some differences between the two pours. Note especially the lower unit weight of the second pour. The lower cement content is reflected in the lower breaking strength.

### 4.2 POST CONSTRUCTION TESTING

After construction, a cracking and de-lamination survey was made. Bond tests were also performed on the deck. All bond tests were acceptable. A few minor cracks, found in the north end spans, were sealed with methacrylate.

The concrete was tested for chloride permeability by the AASHTO T277 test procedure. Cylinders were cast at the time of pour while cores were cut from the deck in January of 1994. All cores and cylinders sampled had very low permeabilities (less than 500 coulombs passed) as shown in table 4.3.

**Table 4.2: Permeability of Cores and Cylinders for the SFLMC Deck Overlay**

Date Poured	Cores, Coulombs Passed	Cylinders, Coulombs Passed
9/3/93	302	346
9/3/93	466	298
9/23/93	286	367
9/23/93	347	313
AVERAGE	350	331
STANDARD DEVIATION	81	31

The manufacturers' pre-construction laboratory test data for permeability of the SFLMC was about 140 coulombs passed. The causes of the higher values on the project are not known. Some speculate that it is a problem with the AASHTO T277 test method. Also, problems in the mobile mixer due to a pump malfunction could alter the percent of silica fume in the mixture.

## 5.0 THREE-YEAR EVALUATION

The deck was inspected after one year and again after three years. Only a few minor cracks were found at the one year inspection. After three years, only a few new cracks had developed. A survey, by means of chain dragging, found only a few minor delaminations. Overall the deck looked very good. However, some polished aggregate was reported in the wheel paths. The polished aggregates appear to be the flat side of the crushed rock used in the mix design. (See Figures. 5.1 - 5.3).

Friction testing for the first and third years of service reflected this wheel path wear (see Table 5.1).

**Table 5.1: Average Friction Numbers for Bridge #1417N.**

Date	Friction	Change
7/19/94	38	
4/17/97	32	-6

An average value for several other LMC and MC overlays was about 47. A value of 37 or lower is considered hazardous and requires some remedy.

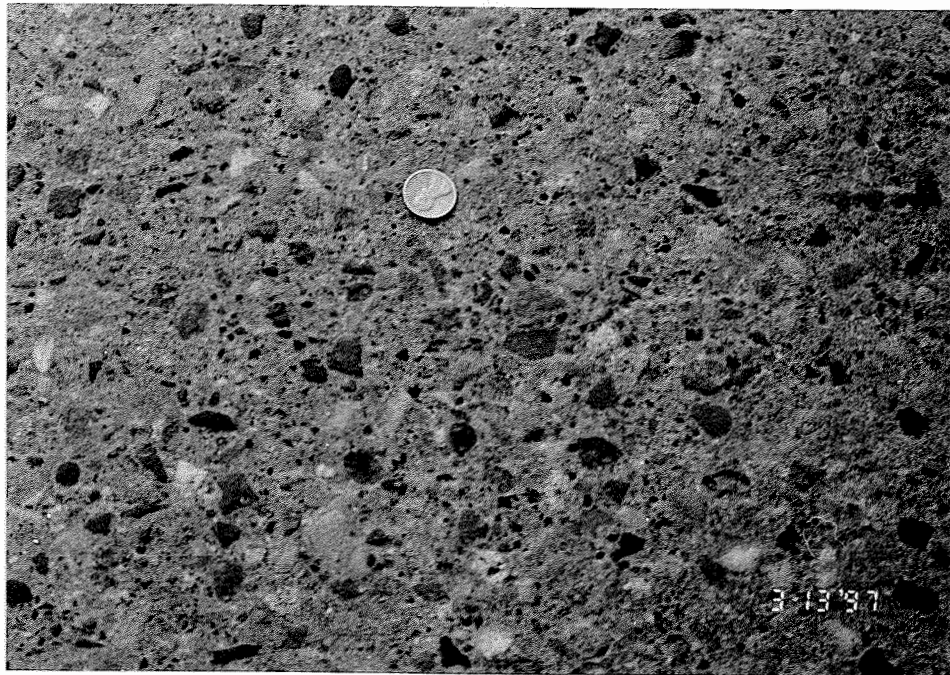


Figure 5.1 Bridge #1417N, note polished aggregates.



Figure 5.2 Bridge #1417N, most of the deck is in good condition.



Figure 5.3 Bridge #1417N, minor cracking is rare.

## **6.0 CONCLUSIONS AND RECOMMENDATIONS**

1. The silica fume latex modified concrete reduced permeability. However, the reduction was less than the producer's claim. The measured project mean value of 350 coulombs passed was higher than the 140 claimed by the manufacturer.
2. The product could not be mixed and placed by a conventional mobile mixer because of pump seals. Modifications to either the mix or the mixer would be costly. Thus the product was discontinued.
3. The wearing qualities of this mixture resulted in low friction values.

ODOT recommends against any further use of this product. Also, more work needs to be done to determine the cause of the low friction values.



**APPENDIX A**  
**TRIAL MIX TESTING**



HAMILTON CONSTRUCTION  
3140 NW 185th Avenue  
Portland, Oregon 97229

Attn: Kevin Gothberg

Re: Silica Fume Latex Modified Concrete Mix Design  
Tualatin River Bridge No. 1417 Section

Gentlemen:

As per your request, the attached Proposed Concrete Proportions are based upon laboratory trial batches performed by MTC for the above referenced project.

A trial batch was performed on Wednesday, July 28, 1993. Those in attendance included Mike Merrigan, ODOT, Jerry Walters and Steven Lucas, Reichhold Chemical Company representatives. This Mix Design has been assigned with the number MTC-93-11.

The trial batch and proportions were performed in accordance the most recent version of ACI 211. The testing was performed in accordance with the current applicable ASTM standard.

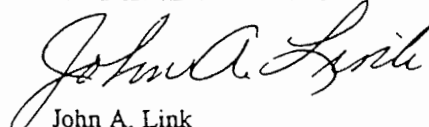
The concrete proportions shown on the attached pages are based upon a saturated surface dry (SSD) condition for the aggregates. This is an almost dry condition and typically the aggregates will be wetter in the field. Therefore, the batch weights for the aggregates and water must be corrected for the moisture content of the aggregates in the field.

This can be done by taking the SSD batch weight of the aggregate, multiplying by  $(100 + \% \text{ moisture})$  and dividing by  $(100 + \% \text{ absorption})$ . Then decrease the amount of water by the total number of pounds the aggregates are increased.

In order to assure a workable and acceptable mix in the field, the total moisture in the fine aggregate cannot exceed 9%.

If you have any questions concerning the mix design process, the concrete proportions as proposed, or if we can be of any further assistance please call us at (503) 238-3824.

Respectfully submitted,  
MATERIALS TESTING CORPORATION

  
John A. Link  
Division Manager

RECEIVED  
AUG 05 1993

PM    APM    OM



HAMILTON CONSTRUCTION  
3140 NW 185th Avenue  
Portland, Oregon 97229

Attn: Kevin Gothberg

Re: Silica Fume Latex Modified Concrete Mix Design  
Tualatin River Bridge No. 1417 Section

Gentlemen:

As per your request, the attached Proposed Concrete Proportions are based upon laboratory trial batches performed by MTC for the above referenced project.

A trial batch was performed on Wednesday, July 28, 1993. Those in attendance included Mike Merrigan, ODOT, Jerry Walters and Steven Lucas, Reichhold Chemical Company representatives. This Mix Design has been assigned with the number MTC-93-11.

The trial batch and proportions were performed in accordance with the most recent version of ACI 211. The testing was performed in accordance with the current applicable ASTM standard.

The concrete proportions shown on the attached pages are based upon a saturated surface dry (SSD) condition for the aggregates. This is an almost dry condition and typically the aggregates will be wetter in the field. Therefore, the batch weights for the aggregates and water must be corrected for the moisture content of the aggregates in the field.

This can be done by taking the SSD batch weight of the aggregate, multiplying by  $(100 + \% \text{ moisture})$  and dividing by  $(100 + \% \text{ absorption})$ . Then decrease the amount of water by the total number of pounds the aggregates are increased.

In order to assure a workable and acceptable mix in the field, the total moisture in the fine aggregate cannot exceed 9%.

If you have any questions concerning the mix design process, the concrete proportions as proposed, or if we can be of any further assistance please call us at (503) 238-3824.

Respectfully submitted,  
MATERIALS TESTING CORPORATION

A handwritten signature in cursive script that reads 'John A. Link'.

John A. Link  
Division Manager

RECEIVED  
AUG 05 1993

PM    APM    OM

## CONCRETE PROPORTIONS ONE CUBIC YARD

 Prepared for: **HAMILTON CONSTRUCTION**
**DESIGN STRENGTH: 4,000 psi @ 7 days  
 BASED ON TRIAL BATCH #1 - MTC 93-10**
**MIXTURE CRITERIA:**

Cement	Tilbury Type I-II	Specific Gravity: 3.15	
Fine Aggregate	Sand	Specific Gravity: 2.61	Absorption: 3.2 %
Coarse Aggregate	5/8"-3/8"	Specific Gravity: 2.69	Absorption: 1.4 %
Silica Fume	Reichhold	Specific Gravity 1.11	

**BATCHING DATA RESULTS & REVIEW:**

Slump: 7"

Air Content: 8.0%

W/C ratio: 0.325

**EXPECTED COMPRESSIVE STRENGTH:**

3 Day: 2,000 psi

7 Day: 4,000 psi

**BATCH QUANTITIES: Pounds Per Cubic Yard**

ITEM	BATCHING WEIGHTS	ABSOLUTE VOLUME
Cement, Tilbury Type I - II	660 Lbs.	3.36
Water (10.0 gallons)	83 Lbs.	1.34
Concrete Sand (SSD)	1,476 Lbs.	9.06
5/8" - 3/8" Coarse Aggregate (SSD)	1,467 Lbs.	8.74
Reichhold Chemical Silica Fume (25.9 gal./cy)	238 Lbs.	3.43
Entrained Air	0.0 Lbs.	1.07
<b>TOTAL</b>	<hr/> 3,924 Lbs.	<hr/> 27.00

Mix may need to be field adjusted to provide the desired air content &amp; slump.

## Trial Batch Data Batch #1- MTC 93 - 11

<b>PROPERTIES:</b>		Fly	Admix	#2	#1	#2		
	Cement	Ash	Latex	Sand	Coarse	Coarse		
Sp. Gr.	3.15		1.11	2.61	2.69			
Absorption	-	-		3.2%	1.4%			
Moisture	-	-		7.3%	1.4%			
Soild Volume Unit Weight	196.6		3.4	162.9	167.9			
Batch Size:	0.111	cubic yd	3.000 cubic feet					
Design % Air:	3.0%					Sand Ratio:	50.1 %	
Sack Content:	7.02					W/C Ratio:	0.33	
% Fly Ash:			Theoretical Air Free Unit Weight:	149.80	lbs/cubic ft		Design Water	10.0 gals.
			Design Unit Weight:	145.33	lbs/cubic ft			

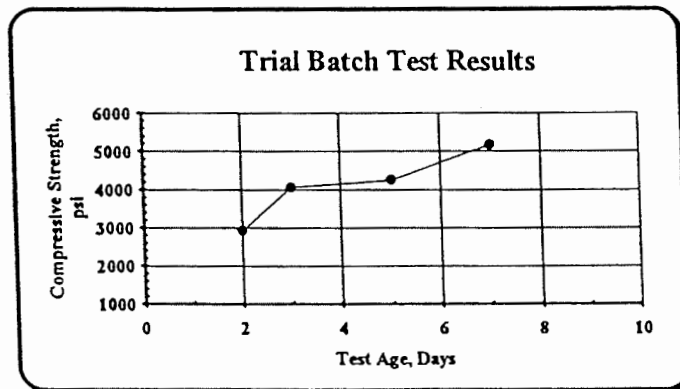
<b>PROPORTIONS:</b>		Fly	Admix	#2	#1	#2	Total	Air	Yield
	Cement	Ash	Latex	Sand	Coarse	Coarse	Water	Content	Totals
SSD Weights per yard:	660		238	1,476	1,467		83	3.0%	3,924 lbs.
Absolute Volume:	3.36		3.43	9.06	8.74		1.33	0.81	26.73 cu.ft.
Estimated Batch Weights (lbs):	73.30		26.44	164.00	163.00		11.10		437.8 lbs.
Estimated Batch Weights (grams):									
Actual Batch Weights (lbs):	73.30		26.44	170.70	163.00		9.26		442.7 lbs.
Actual Absolute Volumes:	0.37			1.00	0.97		0.15		

<b>ADMIXTURES:</b>	Dosage	Batch	Batch
	Gal/cu. yd.	Dosage (ml)	Dosage (fl oz)
Reichhold Silica Fume	25.94		

\*NOTE: Silica Fume is 45% Solids and 55% Water

<b>TEST RESULTS:</b>				
Unit Weight Bucket Weight:	lbs.	Weight of Bucket & Concrete:	34.77 lbs.	
Unit Weight Bucket Volume:	0.2490 cubic foot	Unit Weight of Concrete:	139.8 lbs/cubic feet	
Concrete Slump:	7.00 inches	Yield:	1.0420 cubic feet	
Air Content (Pressure Method):	8.0 %	Relative Yield:		
Air Content (Gravimetric):		Concrete Temperature:	76.3 Degrees Farenheit	

	Compressive Strength					Average
Test Age, Days:	#1	#2	#3	#4	#5	
2	2920					2920
3	4060					4060
5	4250					4250
7	5350	5160	5180	5070	5100	5170





# LABORATORY RECORD

## REVIEW OF CONTRACTOR MIX DESIGN

MATERIALS SECTION  
800 AIRPORT RD  
SALEM OR 97310

M. Merrigan

BJ #20

PROJECT TUALATIN RIVER BRIDGE NO. 1417n		LABORATORY NO. <b>9309287</b>	
HIGHWAY Pacific Highway West		COUNTY Washington	DATA SHEET NO. 11349
CONTRACTOR Hamilton Construction Co.		FA PROJECT NO. X-STP-S01W(3)	BID ITEM NO.
PROJECT MANAGER Dennis Carlson		AGY. - ORG. UNIT 1802	DATE RECEIVED 8-27-93
SUBMITTED BY Mike Merrigan		AGY. - ORG. UNIT 1802	DATE REPORTED
MIX PRODUCER Hamilton Construction		SOURCE NUMBER(S) 5-001-1	TEST NO.      VAR.      LAB CHARGE
CONTRACTOR MIX DESIGN NO. MTC-93-11		CLASS 3300-1/2	TO BE USED Silica Fume Latex Overlay

The Contractor's mix design for the Silica Fume Latex Modified Concrete Overlay was reviewed according to Section 557.13 of the Contract Special Provisions.

Based on the trial batch test results and other information submitted by the Contractor we have determined that the mix design does comply with requirements of 557.13 for new mix designs.

Mix Proportions as submitted by Hamilton Construction are:

Cement	660 lbs.	Tilbury Type 1-2
Coarse Agg.	1467 lbs.(SSD)	Absorption: 1.4%
Sand	1476 lbs.(SSD)	Absorption: 3.2%
SF Latex	238 lbs.	Reichhold Silica Fume Latex
Water	83 lbs.	WC Ratio: 0.33
Air Content:	4.0%	

Air Entraining Agent: None  
Water Reducer: None

Mix design lab number:

9309287

Our review of this mix design does not relieve the Contractor of his responsibility to produce satisfactory concrete.

NOTE: THIS MIX DESIGN  DOES,  DOES NOT COMPLY WITH SPECIFICATIONS

**APPENDIX B**  
**CONSTRUCTION TESTING**

SAMPLE DATA AND LABORATORY TEST REPORT  
FOR  
CONCRETE CYLINDERS

LABORATORY NO. <b>9310598</b>
DATA SHEET NO. <b>C 89913</b>
E. A. SUB JOB <b>C 11349</b>
FA PROJECT NO. <b>State</b>
BID ITEM NO. <b>20</b>

PROJECT <b>Tualatin River Bridge (No 1417)</b>	COUNTY <b>Washington</b>
HIGHWAY <b>Pacific (West)</b>	CONTRACTOR <b>Hamilton Const.</b>
PROJECT MANAGER <b>Dennis Carlson</b>	AGY. ORG. UNIT <b>73-1802</b>
SUBMITTED BY <b>Richard Thomas</b>	AGY. ORG. UNIT <b>73 1801</b>

SAMPLE DATA

CONCRETE FOR USE IN (LOCATION OR PLACEMENT) <b>S. Lica Fume Latex Deck Overlay</b>	BRIDGE NO. <b>1417</b>	STRENGTH REQUIRED <b>3300</b> PSI <b>7</b> DAYS
CONCRETE SUPPLIER <b>Hamilton Const.</b>	TYPE OF SAMPLE <input type="checkbox"/> CONTROL <input checked="" type="checkbox"/> RECORD <b>9RB</b>	SAMPLED BY (PRINT NAME) <b>H. Timzen Materials Test Corp</b>
REPRESENTED BY <b>(3,6x12) (2,4x6)</b>	SET NO. <b>(2)</b>	DATE CAST <b>9-23-93</b>
NO. OF CYLS.	DATE SHIPPED <b>9-27-93</b>	WITNESSED BY (SIGNATURE) <b>J. Hargreaves</b>
TEST CONCRETE CYLINDER OR BEAM IN DAYS A <b>7</b> DAYS B <b>7</b> DAYS C <b>7</b> DAYS D _____ DAYS E _____ DAYS F _____ DAYS G _____ DAYS H _____ DAYS		
CEMENT: BRAND <b>Tilbury</b>	TYPE <b>I-II</b>	LAB OR MILL ANALYSIS NO.
MIX DESIGN: LAB DR I.D. NO. <b>93-09287</b>	DESIGN STRENGTH <b>3300</b>	AGGREGATE SOURCE NO. CEMENT CONTENT <b>660</b> lbs/cu yd
FIELD TEST RESULTS	TOTAL FIELD MOISTURE CONTENT % <b>1-1/2-3/4 1/2-0 - FA 5.2</b>	SLUMP <b>3-7</b> IN.
ADDITIVES <b>15728</b> oz	CEMENT <b>593.3</b> lbs	SLUMP <b>3-7</b> IN.
PRESTRESS CONCRETE: STEAM HOURS	MAX TEMP	REQ. REL. STR.

FIELD REMARKS: Ambient Temp 64° F  
Mix Temp 72° F  
Silica Fume Latex Emulsion is 55% to water  
Cooler Temp H. 73° Lo 64°  
RW AIR 6.8% BY **J. Hargreaves**

LAB USE ONLY BELOW

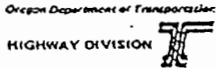
LABORATORY REPORT	DATE DATA SHEET RECEIVED <b>9-28-93</b>	DATE CYLINDERS RECEIVED <b>9-28-93</b>
CYL NO.	DATE OF BREAK	AGE DAYS
A	9-30	7
B	9-30	7
C	9-30	7
D		
E		
F		
G		
H		
STRENGTH PSI	DATE REPORTED	LAB REMARKS: INCLUDE MAX. LOAD, AVG. DIAM., AREA, AND OBSERVED DEFECTS FOR FAILING CYLINDERS.
5470	10-1-93	RECEIVED
5390		OCT 04 1993
5340		PM APM OM
AVE. STR: <b>5400</b>	28 DAYS	TEST TYPE

- DISTRIBUTION
- FILES
- FHWA
- CSL
- PROJECT MANAGER **DENNIS CARLSON**
- REGION GEOLOGIST **SUE D'AGNESE**
- MATERIALS - PORTLAND **RAS I**
- MATERIALS - EUGENE **HAMILTON CONSTRUCTION**
- CONTRACTOR **HAL BAIRD**

TEST TYPE  
 NON-STATISTICAL  STATISTICAL  OTHER (Describe)  
RESULT  
 PASS  FAIL

**Wayne Flavin**  
ENGINEER OF MATERIALS





**SAMP DATA AND LABORATORY TEST REPORT  
FOR  
CONCRETE CYLINDERS**

LABORATORY NO. **9310196**

PROJECT <b>Tualatin River Bridge</b>		DATA SHEET NO. <b>C 89912</b>	
HIGHWAY <b>Pacific (west)</b>	COUNTY <b>Washington</b>	E. A. SUB JOB <b>C 11349</b>	
CONTRACTOR <b>Hamilton Const</b>		FA PROJECT NO. <b>state</b>	BID ITEM NO.
PROJECT MANAGER <b>Dennis Carlson</b>	AGY.-ORG. UNIT <b>73-8002</b>	QTY <b>3</b>	TEST NUMBER <b>719</b>
SUBMITTED BY <b>Richard Thomas</b>	AGY.-ORG. UNIT <b>73 1801</b>	VAR	LAB CHARGE <b>54.00</b>
			<b>500</b>

**SAMPLE DATA**

CONCRETE FOR USE IN (LOCATION OR PLACEMENT) <b>Silica Latex Deck Overlay NB Bridge Rt. 1417N</b>		BRIDGE NO. <b>3300</b>	STRENGTH REQUIRED <b>3300 PSI</b>		
CONCRETE SUPPLIER <b>Hamilton</b>		TYPE OF SAMPLE <input checked="" type="checkbox"/> CONTROL <input type="checkbox"/> RECORD		SAMPLED BY (PRINT NAME) <b>Materials Testing Com</b>	
REPRESENTED BY <b>375*</b>	SET NO. <b>1</b>	DATE CAST <b>9-3-93</b>	DATE SHIPPED <b>9-6-93</b>	WITNESSED BY (SIGNATURE) <b>T. Carlson</b>	
NO. OF CYLS. <b>375*</b>	TEST CONCRETE CYLINDER OR BEAM IN DAYS A <b>7</b> DAYS B <b>28</b> DAYS C <b>28</b> DAYS D _____ DAYS E _____ DAYS F _____ DAYS G _____ DAYS H _____ DAYS				
CEMENT: <b>Tilbury</b>	BRAND <b>Tilbury</b>	TYPE <b>I-II</b>	LAB OR MILL ANALYSIS NO.	ADDITIVES: <b>Reichold</b>	TYPE <b>Silica Fume Latex</b>
MIX DESIGN: <b>93 09287</b>	LAB OR I.D. NO.	DESIGN STRENGTH <b>3300</b>	AGGREGATE SOURCE NO.	CEMENT CONTENT <b>660</b> lbs/cu yd	SLUMP <b>3-7</b> IN.
				AIR CONTENT <b>4</b> %	MAX W/C RATIO <b>.35</b> BY WT.
FIELD TEST RESULTS	TOTAL FIELD MOISTURE CONTENT % <b>1-1/2-3/4</b>	UNIT WT <b>145.2</b> lbs/cu ft	CEMENT CONTENT <b>678</b> lbs/cu yd	SLUMP <b>3/4</b> IN.	AIR CONTENT <b>4.5</b> %
				FIELD W/C RATIO <b>.32</b> BY	
ADDITIVES <b>2071 16</b>	CEMENT	FLYASH	CONCRETE MIX PROPORTIONS AS BATCHED 1-1/2-3/4 AGG <b>12063</b> lbs		SAND <b>12525</b> lbs
				WATER <b>28.7</b> gal	WATER AT JOB SITE
PRESTRESS CONCRETE:	STEAM HOURS	MAX TEMP	REQ. REL. STR.	ACT. REL. STR.	CYLINDER CURE STO _____ DAYS FIELD _____ C.

FIELD REMARKS: **AIR Temp 59° \* 2 SMALL CYLINDERS FOR BRUCE PATTERSON. Concrete 81°**

\* **Silica Fume Latex Emulsion is 55% water**

**LAB USE ONLY BELOW**

LABORATORY REPORT					DATE DATA SHEET RECEIVED	DATE CYLINDERS RECEIVED <b>9-08-93</b>
CYL NO.	DATE OF BREAK	AGE DAYS	STRENGTH PSI	DATE REPORTED	LAB REMARKS: INCLUDE MAX. LOAD, AVG. DIAM., AREA, AND OBSERVED DEFECTS FOR FAILING CYLINDERS.	
A	<b>9-10</b>	<b>7</b>	<b>6630</b>	<b>9-21-93</b>		
B	<b>10-1 9-10</b>	<b>28 7</b>	<b>6680</b>	<b>11</b>		
C	<b>12-1 9-10</b>	<b>28 7</b>	<b>6600</b>	<b>1</b>		
D						
E						
F						
G						
H						

AVG = **6640 PSI** **7** **30 DAYS**  
**RECEIVED**

- 2X FILES
- X DENNIS CARLSON
- X BOB VANVICKLE
- X RAS I
- X HAMILTON CONSTRUCTION
- X HAL BAIRD
- X FRED LUCHT

SEP 22 1993

PM APM OM

TEST TYPE  
 STATISTICAL  STATISTICAL  
HER (Describe):

RESULT  
 PASS  
 FAIL

**CTL** CYLINDERS CAST FROM FRESH SFMC

Client: Oregon Department of Transportation  
 Project: Rapid Chloride Permeability Testing  
 Contact: Mr. Keith Johnston  
 Submitter: Mr. Bruce Patterson

CTL Proj. No.: 105295  
 CTL Proj. Mgr.: M. Morrison  
 Technician: W. Hummerich  
 Approved: R. G. Burg  
 Date: January 24, 1994

**RAPID CHLORIDE PERMEABILITY RESULTS**  
 AASHTO T-277

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
9-3-93 < #1	01-21-94 } 140 DAYS	346	Very Low
< #2	01-21-94	298	Very Low
9-17-93 < #3	01-21-94 } 126 DAYS	367	Very Low
< #4	01-21-94	313	Very Low

*These look negative  
 from reports -  
 results -  
 140 Coulombs -  
 are they correct?*

Sample Type: 4x8-in. concrete cylinders.  
 Age Since Casting: Specimens #1 and #2 140 days, Specimens #3 and #4 126 days.  
 Specimen History: Specimens were received in dry condition. The specimens were placed in lime-saturated water maintained at 73±3° F, until prepared for test.

See Table below for interpretation of results.

Chloride Permeability	Charged Passed Coulombs	Representative Concrete Type
High	>4000	High water-cement ratio (0.6)
Moderate	2000-4000	Moderate water-cement ratio (0.4-0.5)
Low	1000-2000	Low water-cement ratio "Iowa" dense concrete
Very low	100-1000	Latex-modified concrete Internally sealed concrete Microsilica concrete
Negligible	<100	Polymer-impregnated concrete Polymer concrete

**CTL**

CYLINDERS CAST FROM FRESH SFMC

Client: Oregon Department of Transportation  
 Project: Rapid Chloride Permeability Testing  
 Contact: Mr. Keith Johnston  
 Submitter: Mr. Bruce Patterson

CTL Proj. No.: 105295  
 CTL Proj. Mgr.: M. Morrison  
 Technician: W. Hummerich  
 Approved: R. G. Burg  
 Date: January 24, 1994

**RAPID CHLORIDE PERMEABILITY RESULTS  
 AASHTO T-277**

Sample No. (Client ID)	Test Date	Charge Passed (Coulombs)	Relative Chloride Permeability
9-3-93 < #1	01-21-94 } 140 DAYS	346	Very Low
< #2	01-21-94	298	Very Low
9-17-93 < #3	01-21-94 } 126 DAYS	367	Very Low
< #4	01-21-94	313	Very Low

*These  
 look  
 negative  
 from  
 these  
 results -  
 140 Coulombs -  
 are they  
 acceptable?*

Sample Type: 4x8-in. concrete cylinders.  
 Age Since Casting: Specimens #1 and #2 140 days, Specimens #3 and #4 126 days.  
 Specimen History: Specimens were received in dry condition. The specimens were placed in lime-saturated water maintained at 73±3° F, until prepared for test.

See Table below for interpretation of results.

Chloride Permeability	Charged Passed Coulombs	Representative Concrete Type
High	>4000	High water-cement ratio (0.6)
Moderate	2000-4000	Moderate water-cement ratio (0.4-0.5)
Low	1000-2000	Low water-cement ratio "Iowa" dense concrete
Very low	100-1000	Latex-modified concrete Internally sealed concrete Microsilica concrete
Negligible	<100	Polymer-impregnated concrete Polymer concrete

**APPENDIX C**

**CONSTRUCTION NARRATIVE**

NEW EXPERIMENTAL FEATURES PROJECT  
"SILICA FUME LATEX MODIFIED CONCRETE BRIDGE DECK OVERLAY STUDY"  
TUALATIN RIVER BRIDGE (NO. 1417N)  
PACIFIC HIGHWAY WEST  
WASHINGTON COUNTY

SUMMARY OF CONSTRUCTION INSPECTORS' OBSERVATIONS:

The deck overlay was done in two stages in September 1993. Right from the start of the project there were some concerns that the two end spans on the north end of the bridge were not structurally sound. This was because this section had spalled in some areas to expose the rebar, and the rebar did not seem to have had much cover initially. Removal of the old rail on the left hand side of the bridge prior to construction of a new rail also created some transverse cracks in the longitudinal edge beams at this end.

During class one preparation of the deck, minimal hydroblasting in these same areas exposed several portions of rebar by more than half the bar diameter for more than twelve inches, so hydroblasting was done to 3/4 inch below these rebars as per specification (see picture album for the project).

The following is a summary of some pour data. For more details see attached lab reports.

	<u>STAGE 1 - RIGHT</u>	<u>STAGE 2 - LEFT</u>
Date	9-3-93	9-23-93
Start time	12:15 am	8:07 pm
End time	6:00 am	1:05 am
Air temp (°F)	59	64
Mix temp (°F)	81	72
Wind velo. (mph)	2 approx	2 approx
Precipitation (in)	0	0
Humidity (%)	70 approx	40 approx
Vol (Cu. yd)	43.75	44.1
Cure time (hr)	per specs	per specs

BOND TESTS ON OVERLAY:

Right lane : Chain dragging the deck detected no delaminations, and there were no cracks after cure. Tensile test results were 168 psi, 344 psi and 283 psi all for failure at the epoxy on the pull cap, and not in the deck. One pull at approximately midspan resulted in a 16 psi value with failing surface being 1/2 at new deck-old deck interface, and 1/2 the surface at about 1/4 inch into the old deck. The break surface suggested a little delamination in the old deck at this location.

Left lane: Two pulls came at 185 psi and 193 psi. Cracks were detected in the northern end spans after cure. The contractor claimed this was due to exposure of the adjacent lane to fast moving rush hour traffic without adequate set of the overlay. The cracks were sealed with methacrylate as per specifications.

Bob Fynn (Inspector)



# PRICE AGREEMENT

APPLYING TO ALTERATIONS, EXTRA WORK OR CLAIMS FOR EXTRA COMPENSATION

011

HIGHWAY DIVISION

PROJECT NAME (SECTION) Tualatin River Bridge #1417N		CONTRACT NO. C11349
HIGHWAY Pacific Hwy West	COUNTY Washington	
CONTRACTOR'S NAME AND ADDRESS Hamilton Construction PO BOX 659 SPRINGFIELD OR 97447		F. A. PROJECT NO. X-STP-S01W(3)
		PRICE AGREEMENT NO. 1

DESCRIPTION AND LOCATION OF WORK OR ITEMS COVERED BY THIS AGREEMENT:

Add to Special Provisions Sec. 02690.20(a):

Coarse Aggregate can be crushed.

PAY ITEM NO.	ITEM DESCRIPTION	EST. QUANTITY	UNIT	AGREED UNIT PRICE	AMOUNT
4001	Aggregate Spec. Change			N/C	

ESTIMATED NET COST EFFECT OF THIS AGREEMENT ON THE CONTRACT: INCREASE \$ -0-  
DECREASE

SPECIFICATIONS AND PROVISIONS — THE WORK TO BE DONE UNDER THIS AGREEMENT IS TO BE PERFORMED, MEASURED AND PAID FOR IN ACCORDANCE WITH THE TERMS FOR THE ABOVE CONTRACT EXCEPT AS MODIFIED AS FOLLOWS:

Allow the use of crushed aggregate in the Silica Latex Modified Concrete.  
See Sec. 02690.20(a)

8-9-93 Robert Stevens

PLEASE INDICATE YOUR AGREEMENT BY SIGNING, DATING AND RETURNING THE ORIGINAL TO THE PROJECT MANAGER. WORK SHALL NOT BEGIN UNTIL YOU ARE NOTIFIED THAT THE PRICE AGREEMENT HAS EITHER BEEN APPROVED OR THAT WORK MAY COMMENCE UNDER ADVANCE APPROVAL. YOUR SIGNATURE FURTHER INDICATES AGREEMENT THAT PAYMENTS IN ACCORDANCE WITH THIS PRICE AGREEMENT CONSTITUTE FULL AND COMPLETE COMPENSATION FOR ALL COSTS, BOTH DIRECT AND INDIRECT, ARISING OUT OF THE DESCRIBED ALTERATIONS, EXTRA WORK OR CLAIMS FOR ADDITIONAL COMPENSATION COVERED BY THIS PRICE AGREEMENT, AND RELEASES AND DISCHARGES THE STATE FROM ALL SUCH COSTS EXCEPT AS PROVIDED HEREIN.

SUBMITTED BY PROJECT MANAGER DATE  
*Robert Stevens* July 26, 1993

APPROVAL RECOMMENDED OR APPROVED DATE  
BY REGION  
*Art Lamine* 8/3/93

NOTED OR APPROVED BY CONSTRUCTION DATE  
*John W. Skulldice*

SIGNED: *[Signature]* 7/21/93  
CONTRACTOR DATE

APPROVAL RECOMMENDED BY LOCAL AGENCY DATE

INSTRUCTIONS — AFTER THE CONTRACTOR HAS SIGNED, THE PROJECT MANAGER SUBMITS THE ORIGINAL THROUGH REGION TO CONSTRUCTION. THE ORIGINAL SHALL BE RETURNED TO THE CONTRACTOR REGION PRO-