# MICROSILICA MODIFIED CONCRETE FOR BRIDGE DECK OVERLAYS

## Final Report

## FHWA Experimental Features

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16. Abstract

This report summarizes the performance of microsilica concrete (MC) overlays on seven distressed Portland cement concrete bridge decks at three sites in Oregon. This report emphasizes the overlays' condition after four years of use.

After four or five years, there was cracking on all seven overlays and delamination on five overlays. On the two overlays without delaminations, the cracking had not increased during the second year of use. On the five overlays with delaminations, the number and length of the cracks and the number and size of the delaminations increased during the third and/or fourth year of use.

Despite the cracking, all of the overlays had no excessive surface wear or rutting, spalling around the crack edges, potholes, or popouts. All of the overlays had good tire-to-pavement friction numbers.

The only maintenance was the sealing of cracks on one overlay with methacrylate and sand at a cost of $4,000.

The overlays met two of their three design objectives after three or four years' use. They were still adding strength to the deck and providing a smooth and durable wearing surface. However, as they were cracked, it is surmised that they were no longer sealing the underlying deck from the intrusion of chlorides.

The Oregon Department of Transportation (ODOT) is continuing to specify MC as an overlay material. Experience with the material and revision of the MC specifications has reduced construction problems, and consequently, improved the quality of subsequent MC overlays.



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# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

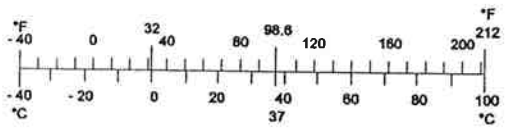
| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.305 | meters | m |
| yd | yards | 0.914 | meters | m |
| mi | miles | 1.61 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 645.2 | millimeters squared | $mm^2$ |
| $ft^2$ | square feet | 0.093 | meters squared | $m^2$ |
| $yd^2$ | square yards | 0.836 | meters squared | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | kilometers squared | $km^2$ |
| | | **VOLUME** | | |
| fl oz | fluid ounces | 29.57 | milliliters | mL |
| gal | gallons | 3.785 | liters | L |
| $ft^3$ | cubic feet | 0.028 | meters cubed | $m^3$ |
| $yd^3$ | cubic yards | 0.765 | meters cubed | $m^3$ |

NOTE: Volumes greater than 1000 L shall be shown in $m^3$.

| | | | | |
|---|---|---|---|---|
| | | **MASS** | | |
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.454 | kilograms | kg |
| T | short tons (2000 lb) | 0.907 | megagrams | Mg |
| | | **TEMPERATURE (exact)** | | |
| °F | Fahrenheit temperature | 5(F-32)/9 | Celsius temperature | °C |

## APPROXIMATE CONVERSIONS FROM SI UNITS

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




* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

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## DISCLAIMER

# MICROSILICA MODIFIED CONCRETE FOR BRIDGE DECK OVERLAYS

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# 1.0 INTRODUCTION

## 1.1 BACKGROUND

Prior to 1989, latex modified concrete (LMC) was almost always used in bridge deck overlays by the Oregon Department of Transportation (ODOT) to add structural strength, to provide a smooth and durable wearing surface, and to seal the deck from the intrusion of chlorides from deicing agents or other sources.

Manufacturers of microsilica admixtures claimed microsilica modified concrete (MC) could be used as a cost-effective alternative to LMC in bridge deck overlays. The manufacturers said MC had the structural strength, resistance to wear, and impermeability to chloride intrusion needed for an overlay concrete. In addition, they claimed the material would be less costly to produce than LMC, as it could be mixed in a conventional concrete batch plant like Portland cement concrete (PCC). LMC, in contrast, usually requires the added expense of mobile mixing plants at the jobsite.

In order to gain experience with this material, ODOT used MC to overlay seven bridge decks in 1989. The specifications for all projects were written to allow the use of MC containing Force 10,000® microsilica slurry made by W.R. Grace, Inc.

## 1.2 OBJECTIVES AND SCOPE

The objective of this study is to see if MC can be a suitable alternative to LMC for structural deck overlays. A construction report for these overlays, covering the pouring, finishing, curing, construction costs, and post-construction inspection results was published in October 1990 (*Miller,* 1990). A first year interim report was published in November 1991 (*Miller, 1991*).

The interim report covered the first two to three years' performance of the overlays, with emphasis on cracking, delamination, and tire-to-pavement friction. A summary of the surface inspection results and maintenance activities since construction is included in Appendix A.

This final report covers the final inspection of the Meacham bridge deck in 1994 and all others bridge decks in 1993. No changes were noted during these inspections. In addition to the inspections, some photographs included herein were taken in the spring of 1994.

# 2.0 SITE DESCRIPTION AND MATERIALS

## 2.1 LOCATION AND LAYOUT

The overlays are listed below in Table 2.1. Their locations are shown in Figure 2.1. The location of the pours on the bridge decks are shown in Figure 2.2.

**Table 2.1: Overlay Listing**

| ODOT Bridge No. | Bridge Name | Dates of Pouring | Highway | Milepoint | No. of Pours | Average Pour Thickness in inches |
|---|---|---|---|---|---|---|
| 9260B | Northbound Colestin Road Overcrossing Bridge | 4/27/89 | Pacific (OR #1 or US #I-5) | 4.61 | 1 | 1.9 |
| 9260B | Southbound Colestin Road Overcrossing Bridge | 8/31/89<br>9/6/89 | Pacific (OR #1 or US #I-5) | 4.61 | 2 | 1.9 |
| 9184A | Northbound Neil Creek Road Overcrossing Bridge | 5/11/89 | Pacific (OR #1 or US #I-5) | 10.34 | 1 | 1.9 |
| 9184A | Southbound Neil Creek Road Overcrossing Bridge | 9/14/89 | Pacific (OR #1 or US #I-5) | 10.34 | 1 | 1.9 |
| 7036 | Holladay Street Ramp Bridge | 4/29/89<br>5/6/89 | Columbia River (OR #2 or US #I-84) | 1.32 | 2 | 2.5** |
| 7040AA | Grand Avenue Ramp Bridge | 9/9/89 | Columbia River (OR #2 or US #I-84) | 0.52 | 1 | 2.0 |
| 8498W | Westbound Meacham Overcrossing Bridge | 8/3/89<br>8/9/89<br>8/10/89 | Old Oregon Trail (OR #6 or US #I-84) | 237.95 | 3 | 1.7 |

** Some sections were built up to six inches: These sections cracked badly.

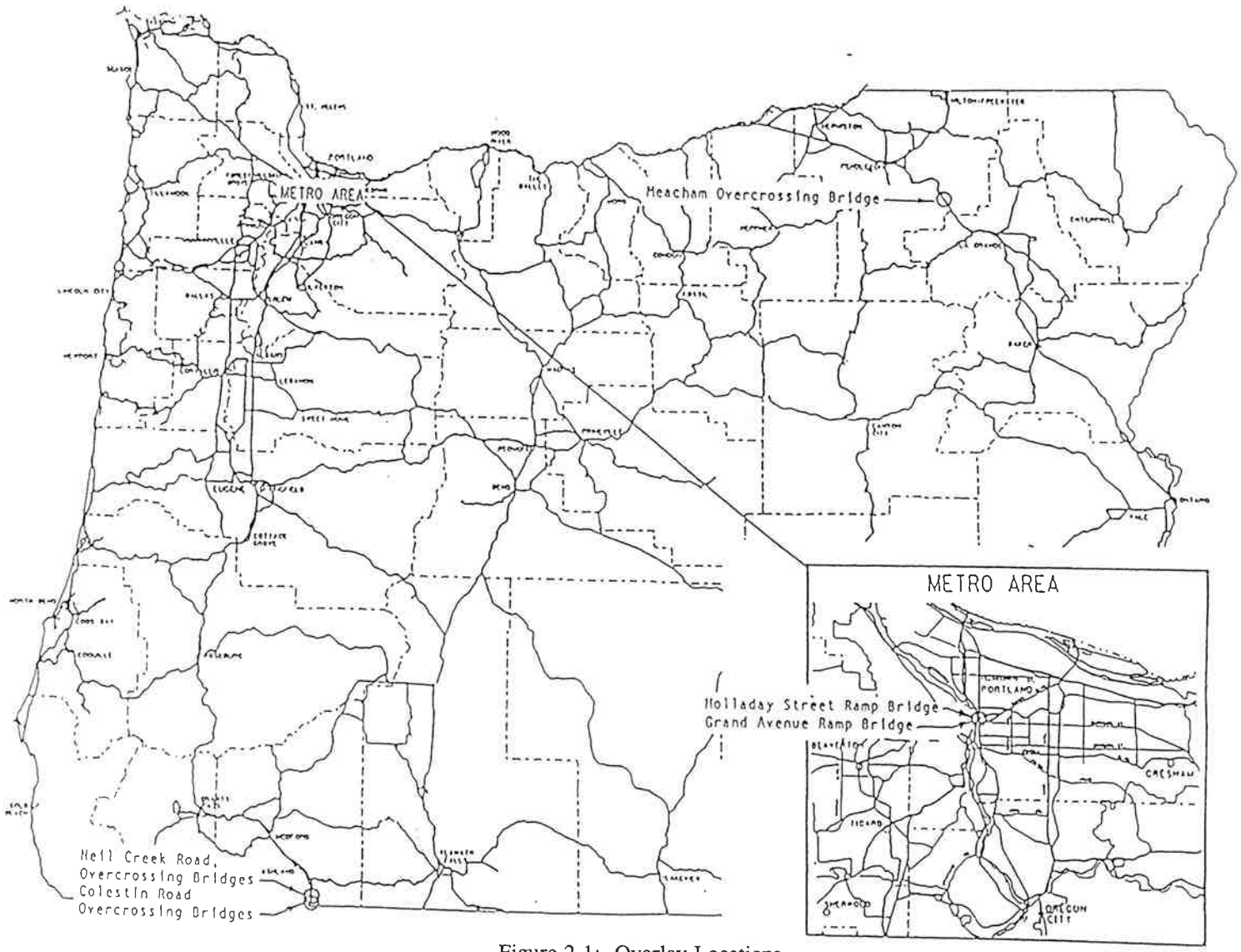


Figure 2.1: Overlay Locations

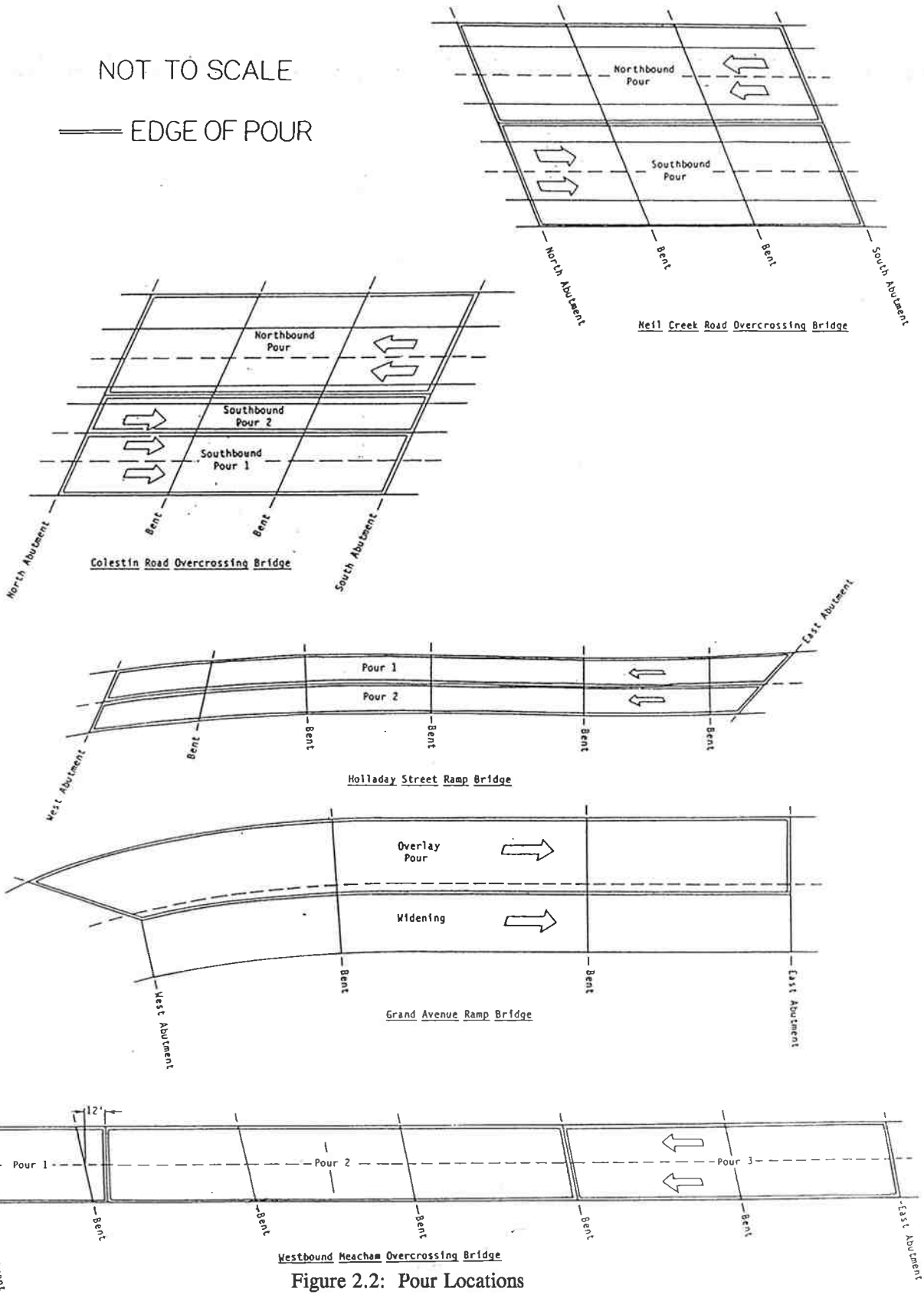


Figure 2.2: Pour Locations

## 2.2 ENVIRONMENT AND TRAFFIC

Climate and traffic data are summarized in Table 2.2 (*Loy et al, 1976 and ODOT, 1992*).

**Table 2.2: Environment and Traffic**

| | Colestin Road Bridge | Neil Creek Bridge | Holladay Street Ramp Bridge | Grand Avenue Ramp Bridge | Westbound Meacham Overcrossing Bridge |
|---|---|---|---|---|---|
| Elevation, Feet (m) | 4,275 (1,303) | 2,565 (782) | 125 (38) | 65 (20) | 3,740 (1,140) |
| Avg. Daily Temp. of Coldest Month, °F (°C) (January) | 30 (-1) | 32 (0) | 41 (5) | 41 (5) | 28 (-2) |
| Mean Daily Temp. Swing in January, °F (°C) | 14 (8) | 14 (8) | 11 (6) | 11 (6) | 14 (8) |
| Avg. Daily Temp. of Hottest Month, °F (°C) (July) | 63 (17) | 64 (18) | 66 (19) | 66 (19) | 63 (17) |
| Mean Daily Temp. Swing in July, °F (°C) | 31 (17) | 32 (18) | 23 (13) | 23 (13) | 32 (18) |
| Average Annual Precipitation, Inches (cm) | 25 (63) | 20 (51) | 39 (99) | 39 (99) | 30 (76) |
| 1991 Avg. Daily Two-Way Traffic (Vehicles/Day)[a] | 13,025 | 13,150 | - | - | 6,450 |
| Heavy Trucks (% of ADT)[b] | 30 | 30 | - | - | 43 |

[a]These bridge decks carry one-way traffic. Consequently, they carry about ½ of the two-way traffic loading.
[b]Single unit, 2 axle, 6 tire or larger vehicles are classified as "heavy trucks".

## 2.3 MATERIALS

The MC for the Colestin Road Overcrossing Bridge and Neil Creek Road Overcrossing Bridge overlays contained:

**Cement -** Calaveras Type II.
**Aggregates -** ¾" - #4 (19 - 4.75 mm) crushed river gravel and natural sand from Kendall Bar on the Rogue River.
**Additives -** "Force 10,000" microsilica, "WRDA 19" high range water reducer (superplasticizer), "Daratard 17" set retarder, and "Daravair" air entrainment agent.

The MC for the Holladay Street Ramp Bridge and Grand Avenue Ramp Bridge contained:

**Cement -** Ashgrove Type I.
**Aggregates -** ¾" - #4 (19 - 4.75 mm) crushed river gravel and natural sand dredged from the Willamette River near Ross Island.
**Additives -** "Force 10,000" microsilica, "WRDA 19" high range water reducer (superplasticizer), "WRDA 79" Type A water reducer, and "Darex" air entrainment agent.

The MC for the Westbound Meacham Overcrossing Bridge contained:

**Cement -** Ashgrove Type I.
**Aggregates -** ¾" - #4 (19 - 4.75 mm) crushed river gravel and natural sand from the R.D. Mac pit on the Grande Ronde River near Island City.
**Additives -** "Force 10,000" microsilica, "WRDA 19" high range water reducer (superplasticizer), "WRDA 79" Type A water reducer, and "Daravair" air entrainment agent.

The microsilica and all other additives were made by:

W.R. Grace & Co.
Construction Products Division
62 Whittemore Avenue
Cambridge, Massachusetts 02140
(617) 876-1400

The Force 10,000® microsilica was supplied in a water based slurry. The primary ingredient was finely powdered microsilica produced as a by-product from the manufacture of metallic silicon. For all project's mix designs, the percentage of microsilica powder was 7.9% of the cement weight.

# 3.0 OVERLAY PERFORMANCE

This chapter describes the condition of the overlays at the time of the latest inspections and deck repair since construction. Summaries of the individual overlays' condition since construction are in Appendix A.

## 3.1 PERFORMANCE OF COLESTIN ROAD OVERCROSSING BRIDGE AND NEIL CREEK ROAD OVERCROSSING BRIDGE OVERLAYS

The latest inspection was performed in June 1993, and the inspection for the first year interim report was done in September 1990. During the 33 month period between these inspections, all of these overlays had:

1) **No excessive rutting or surface wear.**

2) **No potholes, spalling, or popouts.**

3) **A slight increase in surface crack length, width, and frequency.** In 1993, all four of the overlays had areas of highly visible surface cracking. Most of these cracks were in a map or alligator pattern, they were 1/16 inches or less in width, and their edges were not spalled. The deck around the edges of many of these cracks was stained with a fine white powder. Typically, these stains indicate water is pumping in and out of the cracks when traffic moves across the span. Many of the alligator patterned cracks were over delaminated areas. Outside of the areas with more visible cracking, all of the decks had fine cracking over their entire surface.

   Cracking increased from 1990 to 1993. Figure 3.1 shows a typical crack pattern. This photo was taken in the spring of 1994 on the Neil Creek Overcrossing Bridge. Cracks had interconnected into an alligator or map pattern. The interconnected, "map pattern", cracking was typical of many cracked areas on these overlays.

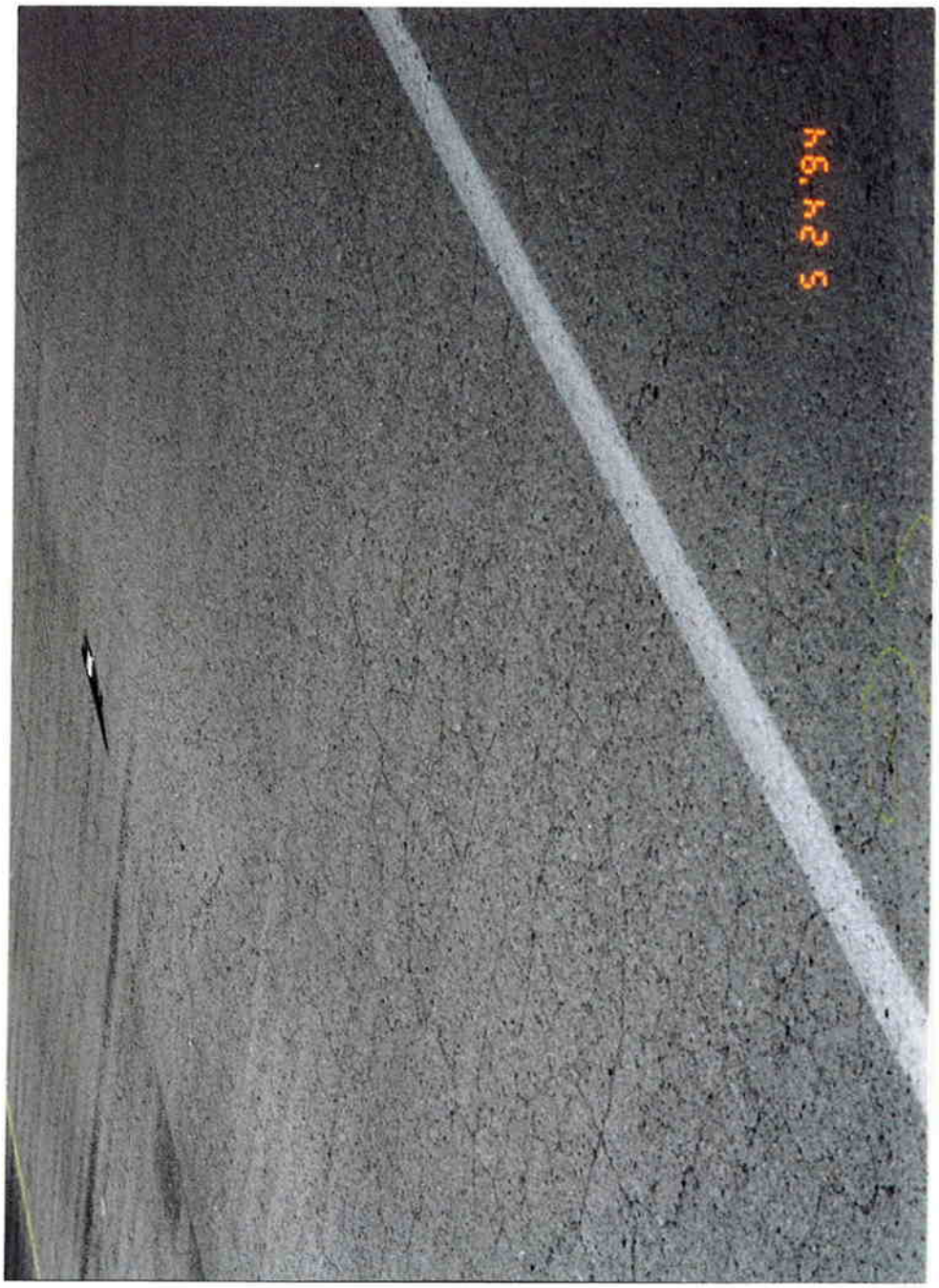


Figure 3.1: Typical Crack Pattern on Neil Creek Overcrossing.

a) Cracking and delamination on the south end of the overlay in September 1990. (Red line outline the delaminated areas)

b) Delaminated areas in June 1992 (approximately same location as Figure 3.1a). The cracking and delamination had increased.

Figure 3.1: Cracking and Delamination on the Northbound Colestin Road Overcrossing Bridge Overlay

4) **An increase in the number and size of delaminations.** In 1993, all four of these overlays had delaminated areas. Between 1990 and 1993, the percentage of the deck area which was delaminated increased from an average of 1.25% to an average of 3.75%. Figure 3.2 shows typical delaminations in 1990, and again in 1993. As shown in the Figure, the delaminations increased in size during the three year period.

## 3.2 PERFORMANCE OF HOLLADAY STREET RAMP BRIDGE AND GRAND AVENUE RAMP BRIDGE OVERLAYS

The first inspection was done in October 1990, and the latest inspection was done in June 1993. During the 32 months between the inspections, the overlays had:

1) **No excessive rutting or surface wear.**

2) **No potholes, spalling, or popouts.**

3) **A slight increase in cracking since the 1990 inspection.** In 1990, The Holladay overlay had cracking on 50% of the right lane and 30% of the left lane. The cracks were deeper and connected into a map pattern near the ends of the bridge. The Grand Avenue overlay had short hairline alligator cracking on 34% of its deck area. None of these cracks had spalled edges. In 1993, a few new cracks were found.

4) **A few scattered delaminations.**

## 3.3 PERFORMANCE OF THE WESTBOUND MEACHAM OVERCROSSING BRIDGE OVERLAY

The inspection for the first year interim report was done in November 1990, and the last inspection was done in July 1994. During the 43 month period between the inspections, the overlays had:

1) **No excessive rutting or surface wear.**

2) **No popouts or spalling.**

3) **A slight increase in cracking.** Between 1990 and 1991, the amount of cracking increased from approximately 3.4 to 4.3 lineal feet per square yard of deck surface. These cracks were very fine and their edges were not spalled. A typical square yard of the overlay in 1994 is shown in Figure 3.3.


Figure 3.2: A typical view of the Meacham Overcrossing Bridge overlay. In this 1994 picture, cracking is sparse and difficult to see.

## 3.4 PAVEMENT FRICTION

In 1993 pavement friction testing was done at speeds near 40 mph on every overlay using a K.J. Law trailer. The test methods, calibration techniques, and equipment conformed to AASHTO standards.

All MC overlays had adequate friction numbers. Also, the average friction numbers for the MC overlays were higher than typical values for PCC pavements. In addition, the MC overlay's average friction number was substantially higher than the average friction number from 34 tests on 2-year-old LMC overlays on two typical Oregon bridges

## 3.5 MAINTENANCE

Some delamination repair and crack sealing was done after the curing blankets were removed and before the decks were opened to traffic. The contractor paid for these repairs. The only other repair or maintenance was the sealing of the Northbound Colestin Road Overcrossing Bridge deck with methacrylate seal and sand in November 1989 (*Miller* 1990). This repair cost ODOT about $4,000. Details on maintenance are in Appendix A.

# 4.0 ADDITIONAL ODOT EXPERIENCE WITH MICROSILICA

Although there were problems with the MC overlays in this study, ODOT continues to specify MC as an overlay material. The agency feels the newer MC overlays may be more successful than the overlays in this study because:

1) Contractors and ODOT field personnel are gaining experience with the material.

2) MC is specified as an alternative to LMC on projects where the agency anticipates that MC can be placed within 90 minutes of initial mixing. On remote projects or other jobs where the agency feels this requirement cannot be met, LMC is specified as the sole overlay material. On the overlays in this study, the duration between batching and placing some loads often exceeded 90 minutes. Usually these loads were hard to place and finish, and often they would crack shortly after placement.

3) The MC specifications were revised to allow the use of densified microsilica as well as slurried microsilica (*ODOT, 1993*). Contractors in Oregon have found this form of microsilica is easier to handle than the slurry, and it is used most often. The specifications for the MC in this study allowed slurry only.

4) Changes in the specifications for air content, slump, deck preparation, finishing, tining, and environment during placement (*Miller, 1990*).

These changes have improved the short-term performance of MC overlays. For example, adherence to the batch-to-placement time limits and the environment during placement appears to be lowering the instances when the overlays have plastic or drying shrinkage cracks. The effect of these changes on long-term performance remains to be seen, as overlays constructed with the various versions of revised specifications are only three years old.

# 5.0 CONCLUSIONS AND RECOMMENDATIONS

## 5.1 CONCLUSIONS

After four or, in some cases, five years, the overlays were still meeting their design goal of adding structural strength. None of the cracking and delamination was severe enough to weaken the overlays. In addition, the overlays were satisfying their design goal of giving a smooth and durable surface. The cracked and delaminated areas were still intact. However, the overlays were not meeting their design objective of sealing the underlying deck from chlorides. Water can contact the underlying deck through cracks in the overlays, delaminations under cracked sections of the overlay, and delaminations adjacent to construction and/or expansion joints.

Aside from cracking and delamination, MC appears to be a hard and durable overlay material. The Colestin Road Overcrossing Bridge and the Neil Creek Road Overcrossing Bridge are good examples. These decks are on a heavily traveled freeway in a snow zone where vehicles often use tire studs, cables, or chains. In these hostile conditions, these overlays have been excellent at resisting abrasion damage.

The MC overlays appear to have better surface friction properties than PCC and LMC. Friction test results from 1994 show that the overlays have higher friction numbers than typical LMC or PCC overlays.

## 5.2 RECOMMENDATIONS

It is recommended that MC continue to be used on ODOT bridge overlays. The latest approved practices for placing and curing microsilica concrete must be used on all overlays. Much of the earlier cracking due to plastic and drying shrinkage can be eliminated by following approved construction practices. Cracks which occur after two, three or four years may be caused by other sources, such as cracking in the underlying deck reflecting through the overlay, or excessive structural deflections. If the MC overlays are prone or resistant to reflective cracking or cracking due to excess deflections, these properties may need to be considered in the overlays structural design.

# 6.0 REFERENCES

Bo Miller, Microsilica Modified Concrete for Bridge Deck Overlays, Construction Report (Salem, Oregon: Oregon Department of Transportation, October 1990).

Bo Miller, Microsilica Modified Concrete for Bridge Deck Overlays, First Interim Report (Salem, Oregon: Oregon Dept. of Transportation, November 1991).

William Loy et al, Atlas of Oregon (Eugene, Oregon: University of Oregon Books, 1976), pp. 130-32, 135.

Oregon Department of Transportation, 1993 Traffic Volume Tables, (Salem, Oregon: Oregon Department of Transportation, June 1994).

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# APPENDIX A

# SURFACE CONDITION AND MAINTENANCE

**Table A-1a: Surface Condition and Maintenance**

## Northbound Colestin Road Overcrossing Bridge Overlay

| Date of Inspection or Repair | Comments |
|---|---|
| April, '89 | Poured. |
| May, '89 | Isolated cracks were found when the deck was uncovered after the cure. The cracks were sealed with methacrylate sealer.<br><br>Isolated delaminations were chipped out and repaired with MC. |
| November, '89 | Extensive map cracking was found. The deck was flooded with Concresive 2075 methacrylate sealer and covered with #30 grit sand. 1.9% of the surface was delaminated. The delaminations were scattered throughout the deck, and most were 1 to 3 square feet in area. |
| September, '90 | Severe alligator cracks were found on 2% of the surface. Alligator cracking was starting on 1% of the surface. Severe cracking was found between the inside fog line and face of the inside bridge rail. Random transverse and longitudinal cracks up to 6 feet long were found on the right lane. Cracking was found on the strip of MC between the expansion joint and the poured filler on the ends of the bridge. Little cracking was seen on the left lane. |
| August, '91 | New cracks were seen throughout deck. Many of these cracks were perpendicular to the bridge centerline. The old cracks which were sealed with the methacrylate sealer were still sealed. |
| April, '92 | Open map and alligator cracking was seen throughout the deck surface. The methacrylate sealer was no longer visible in many of the previously sealed cracks. |
| June, '92 | Highly visible cracks were found on 60% of the right lane's surface. Fine cracks were seen on the remainder of the deck. 2.6% of the deck surface area was delaminated. Surface wear was minimal and no rutting was found. |
| June, '93 | Visible cracking increased to cover 30% of the deck surface. Delaminated areas increased to 5.2%. No rutting was found, although wheelpath wear was visable. |

**Table A-1b: Surface Condition and Maintenance**

**Southbound Colestin Road Overcrossing Bridge Overlay**

| Date of Inspection or Repair | Comments |
|---|---|
| August and September, '89 | Poured. |
| September, '89 | No cracking or delaminations were found when deck was uncovered after the cure. |
| September, 90 | .7% of the surface was delaminated. Most delaminations were on the right edge of Pour 2 where it abutted Pour 1. Several cracks 20 to 30 feet long were found in Pour 1, the climbing lane, near the leading edge of the bridge. Scattered cracks up to 12 feet long were found throughout the rest of Pour 1 and Pour 2. Cracking was found on the strip of MC between the expansion joints and the poured filler on both ends of bridge. |
| June, '93 | Visible cracking increased to cover 30% of the deck surface. Delaminated areas increased to 5.2%. No rutting was found, although wheelpath wear was visible. |

**Table A-1c: Surface Condition and Maintenance**

**Northbound Neil Creek Road Overcrossing Bridge Overlay**

| Date of Inspection or Repair | Comments |
|---|---|
| May, '89 | Poured. |
| May, '89 | No cracks were found when the deck was uncovered after the cure.<br><br>A few delaminations were found. They were chipped out and repaired with MC. |
| November, '89 | No cracks were found. 1.4% of the surface was delaminated. 0.3 to 1.0 feet of the leading edge of the deck was delaminated. There were scattered small delaminations throughout the rest of the deck. |
| September, '90 | Random cracks up to 9 feet long were found on both travel lanes. 1 foot long cracks extended from the outside bridge rail into the deck at 1 to 1½-foot intervals. 2.2% of the surface was delaminated. These delaminations were scattered, as noted in the November '89 inspection. |
| June, '92 | Highly visible cracks were seen on 30% of the deck area. Fine cracks were found on the remainder of the deck. 6.8% of the surface was delaminated. Surface wear was minimal, and no rutting was found. |
| June, '93 | Visible cracking increased to include 35% of the deck surface. Reported delaminations changed from 5.1% in 1992 to 1.9% in 1993. Although surface wear was visible, rutting remained less than 0.01 feet. |

**Table A-1d: Surface Condition and Maintenance**

**Southbound Neil Creek Road Overcrossing Bridge Overlay**

| Date of Inspection or Repair | Comments |
|---|---|
| September, '89 | Poured. |
| September, '89 | No cracks or delaminations were found when the deck was uncovered after the cure. |
| September, '90 | Alligator pattern cracking was found on 22% of the deck, and scattered cracks up to 36 inches long were seen on the rest of the span. .2% of the deck was delaminated. There were two delaminations, and both were under sections of the deck that were alligator cracked. |
| June, '92 | Highly visible cracks were found on 30% of the deck area. Fine cracks were found on the remainder of the deck. Less than 1% of the deck was delaminated. Surface wear was minimal and no rutting was found. |
| June, '93 | Slight increase in cracking and delaminations was found. |

**Table A-1e: Surface Condition and Maintenance**

**Holladay Street Ramp Bridge Overlay**

| Date of Inspection or Repair | Comments |
|---|---|
| April-May, '89 | Poured. |
| May, '89 | On Pour 1, the right lane, four 1-inch long shrinkage cracks were found immediately after the curing blankets were removed. Three short longitudinal cracks appeared in the deep (5 to 7 inches) section of the overlay at the west end of the bridge after the cure blankets were off for 24 hours. The cracks were sealed. Diamond grinding was used to smooth the rough surface of Pour 1. No cracks were seen on Pour 2, the left lane, and no grinding was needed.<br><br>No delaminations were found. |
| October, '90 | Cracking was found on 50% of the right lane and 30% of the left lane. Near both ends of the bridge, the cracks appeared to be deeper and were alligatored. The cracking was most severe on the deep section of the overlay at the west end of the right lane. Alligator cracking was also noted on a short section of standard PCC mix located at the east end of the right lane. This PCC was used in the last truckload of mix for the right lane, as the concrete supplier ran out of MC mix. No delaminations were found. |
| October, '91 | No delaminations were found. No changes were reported since the last inspection. Overall condition appeared to be stable and no maintenance has been required. There was no excessive surface wear or rutting |
| June, '93 | Small delaminations and a few new cracks were found. |

**Table A-1f: Surface Condition and Maintenance**

**Grand Avenue Ramp Bridge Overlay**

| Date of Inspection or Repair | Comments |
|---|---|
| September, '89 | Poured. |
| September, '89 | No cracks were seen when the curing blankets were removed.<br><br>Grinding was done on a small section of the overlay to correct the deck profile. No delaminations were found. |
| October, '90 | Short hairline alligator cracking was noted on 34% of the MC overlay. Short transverse cracks were noted on 24% of the widened PCC deck near the right bridge rail. No delaminations were detected. |
| October, '91 | No delaminations were found. No changes since the last inspection. Overall condition appeared to be stable and no maintenance has been required. There was no excessive surface wear or rutting. |
| June, '93 | Minor increases in cracking and a few small delaminations were found. |

**Table A-1g: Surface Condition and Maintenance**

**Westbound Meacham Overcrossing Bridge Overlay**

| Date of Inspection or Repair | Comments |
|---|---|
| August, '89 | Poured. |
| September, '89 | Three cracks 1 to 1½ feet long were found and sealed on Pour 1. Construction personnel feel that these cracks may be tears from tinning. No cracks were found on any other spans. .3% of Pour 1 and .1% of Pours 2 and 3 were delaminated. Almost all delaminations were on the west edges of the pours adjacent to the expansion joints. All delaminations were chipped out and repaired with MC. |
| November, '90 | Isolated scattered cracks were found on Pours 1 and 3, with the heaviest cracking on Pour 1. Little or no cracking was found on Pour 2. The crack intensity was estimated to be 3.4 lineal feet per square yard of deck area. .1% of Pour 1, .01% of Pour 2, and .04% of Pour 3 were delaminated. Almost all delaminations were under or next to patches made on delaminations found in September, 1990. |
| July, '91 | Isolated scattered cracks were found on all pours. There was less cracking on Pour 2 than on Pours 1 and 3. The cracks were fine, randomly oriented, and they did not connect into a map or alligator pattern. The crack intensity was estimated to be 3.9 lineal feet of cracks per square yard of deck area. .4% of Pour 1, .06% of Pour 2, and .2% of Pour 3 were delaminated. There was no excessive surface wear or rutting. |
| April, '94 | Cracking increased from 4868 linear ft. in 1990 to 5368 linear feet in 1994. No change in delaminated areas was found since the 1990 inspection. |