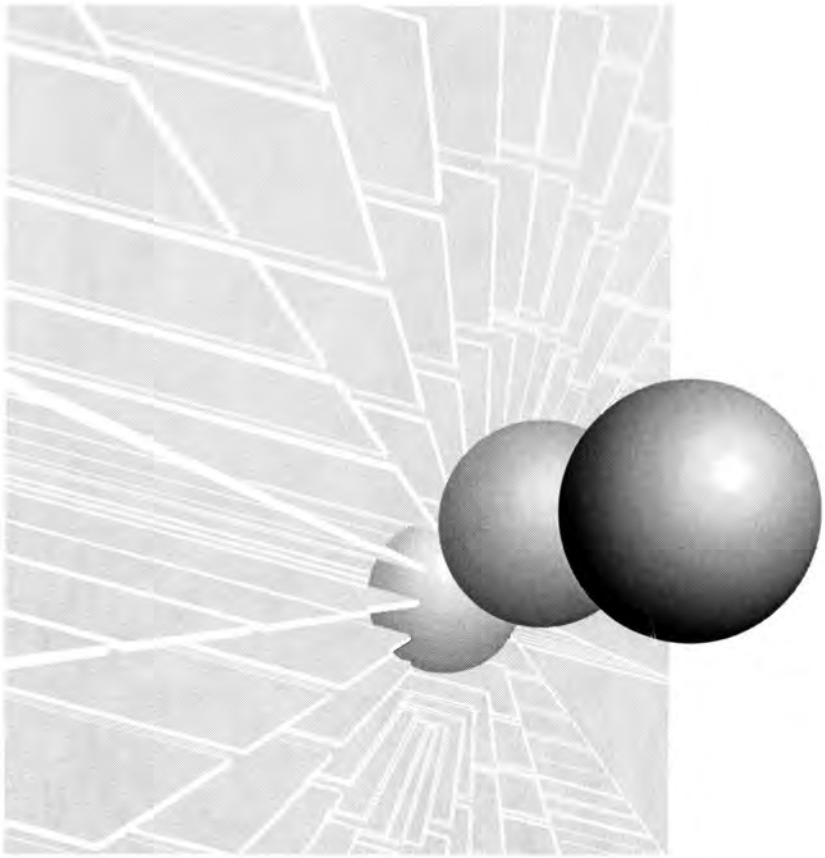
MoDOT

RI96-10

Research, Development and Technology Division

Evaluation of Using a Dissipating Liquid Membrane Curing Compound on Bridge Barrier

Final Report



August, 1997

Evaluation of Using a Dissipating Liquid Membrane Curing Compound on Bridge Barrier

RI96-10

Final Report

Prepared by

Patty L. Brake
Research, Development and Technology Division
Missouri Department of Transportation

August 1997

EXECUTIVE SUMMARY

MoDOT's current specification for curing concrete bridge barrier is limited to moist cure methods, including the most frequently used, wet burlap. The application of curing compounds has most likely never been allowed due to 1) their application would inhibit the proper application of linseed oil, and 2) moist curing has always been considered the most ideal of curing methods. The introduction of curing compounds with the capability of dissipating and concerns regarding the actual effectiveness of current curing procedures implemented in the field (placement of wet burlap) have initiated the consideration of allowing curing compound as an alternative method of curing bridge barrier. The objective of this investigation was to evaluate the method of curing bridge barrier by applying a dissipating type liquid membrane curing compound. This investigation involved evaluations conducted in the both the laboratory and field. The laboratory phase included testing each of three dissipating type liquid membrane curing compounds for compliance with AASHTO M-148, Liquid Membrane-Forming Compounds for Curing Concrete, and for dissipation capabilities. The three types tested were RX Cure, RX Cure 30%, and W.B. Resin Cure all manufactured by Conspec. According to the laboratory testing, all the curing compounds complied with the appropriate requirements of AASHTO M-148 specifications, and they also all dissipated as claimed by the manufacturer. Laboratory test results did indicate that only W.B. Resin Cure produced a lower V.O.C. (volatile organic compound) level which would be more preferable for future policies limiting the use of materials with what is considered high V.O.C. contents. The field phase of this investigation included the actual application of RX Cure and W.B. Resin Cure on bridge barrier constructed on active projects. For each curing compound tested, an equal amount of barrier was cured using the traditional method of placing wet burlap for comparison purposes. Observations were made during application and follow-up observations were made as allowed. The observations noted no significant differences between the barrier cured with the curing compound and that cured with wet burlap except that the section of barrier cured with W.B. Resin Cure had less vertical cracking than its companion section cured with wet burlap. However, the origin of the vertical cracking may possibly have had no relation to the curing methods used. Observations of the procedure of placing wet burlap for curing did emphasize concerns regarding its actual effectiveness in the field. This was due to observing that the burlap did not always contain adequate moisture nor was maintained that way, and that the

draping of the burlap over the barrier does not guarantee that moisture is provided to the surface of the curing barrier. Efforts were also made in the field to compare 28-day compressive strength results between the concrete cured with RX Cure and that cured by wet burlap. A modified section of barrier without reinforcing steel was fabricated to allow a 3 ft. section to be cured with RX Cure and another 3 ft. section to be cured with wet burlap. Drilled 6 in. by 12 in. cores taken and tested for compressive strength at 28-days determined that the concrete cured with curing compound produced a slightly higher average compressive strength than that cured with wet burlap. As a result of the testing and observations made in this study, it appears that the application of a dissipating type liquid membrane curing compound to concrete bridge barrier would be an effective and more economical means of curing bridge barrier.

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INTRODUCTION

MoDOT's current specification for curing bridge barrier, either cast-in-place or slip formed construction, is limited to the placement of wet burlap or other similar means of moist cure methods. The method of using a liquid membrane curing compound has not been allowed, most likely, because 1) the application of the curing compound would inhibit the proper application of linseed oil, the final step required in the completion of the bridge superstructure, and 2) wet burlap or moist curing has always been considered the most ideal of curing methods.

Moist cure techniques, including the most frequently used placement of wet burlap, do provide the most ideal curing conditions when carried out properly. However, curing compounds have proven to perform sufficiently at achieving desired results. Questions regarding the timely placement of the burlap and the sometimes poor attempt at maintaining adequate moisture have initiated concern over how effective our moist curing methods actually are under routine field conditions.

A recent awareness of curing compounds which claim to have the capability of dissipating (which would allow eventual application linseed oil) and that also comply with MoDOT specifications for liquid membrane-forming compounds has initiated an interest in further investigation of their use as an alternative method for curing bridge barrier. The use of curing compounds would not only be much more economical as opposed to moist cure techniques, but also, the application of curing compound to bridge barrier would potentially help address concerns over the frequently occurring improper and ineffective implementation of current methods used.

The objective of this investigation was to evaluate the method of curing bridge barrier by applying a dissipating type liquid membrane curing compound as an alternative to current moist cure methods.

DISCUSSION OF WORK PERFORMED

This investigation on the proposed use of a dissipating type liquid membrane curing compound involved evaluations conducted in both the laboratory and field. Laboratory evaluations were conducted by the chemical lab of the Materials Division and field evaluations were conducted at two separate bridge locations in the District 6 area by RD&T Division personnel with the assistance and cooperation of district construction personnel and the project contractor. Originally, only one product, RX Cure from Conspec, was going to be included in this investigation. However, data collected during the investigation determined that two additional products with a potentially lower volatile organic compound (V.O.C.) should also be evaluated. These additional products were RX Cure 30% and W.B. Resin Cure also both from Conspec.

The laboratory phase of this investigation included testing each of the three dissipating type liquid membrane curing compound materials for compliance with AASHTO M-148 (ASTM C-309), Liquid Membrane-Forming Compounds for Curing Concrete, and for dissipation capabilities. MoDOT's current standard specifications require that liquid membrane-forming compounds meet AASHTO M-148 requirements as appropriate for the type of curing compound used.

The field phase of this investigation was limited to evaluating the application of RX Cure and W.B. Resin Cure. This included making general observations during the application of the curing compound and documenting any notable effects on the barrier as a result of using curing compound as opposed to wet burlap or moist cure methods. Along with each application of RX Cure and W.B. Resin Cure, curing with wet burlap was also carried out on approximately half of the bridge barrier for the purpose of serving as a control and a means for adequate comparison. As part of the field evaluation, efforts were also made to compare compressive strength results between concrete cured with the RX Cure material and that cured by placement of wet burlap.

LABORATORY EVALUATION RESULTS

The following is a summary of the laboratory evaluation results determined for each of the three dissipating type liquid membrane curing compounds evaluated.

RX Cure: Chemical lab test results indicated that RX Cure complies with AASHTO M-148 specifications. However, chemical lab personnel noted that while it met specifications, the level of volatile organic compound (V.O.C.) for RX Cure was significantly high at 4.62 lbs./gal. With the exception of structural paints, there is currently no law or policy against the use of industrial materials with V.O.C.'s above 3.5 lbs./gal. However, it is prudent to be aware that the proposed Architectural Industrial Maintenance (AIM) Coatings Rule, which is planned to go into effect sometime in 1998, will limit the V.O.C. contents of all industrial coating materials to possibly 2.9 lbs./gal. The date set for implementation, as well as, the established V.O.C. limit for the AIM Rule continues to vary. Once the rule does go into effect, a material such as RX Cure with a V.O.C. content of 4.62 lbs./gal., will not be allowed for application. As a result, this investigation was prompted to consider possible alternatives for a curing compound with a lower V.O.C. content.

Additional tests conducted by the chemical lab to determine RX Cure's dissipation capabilities included accelerated weathering and outdoor exposure evaluations. Both tests indicated that RX Cure dissipated as claimed. A detailed description of each evaluation and its results is located in the appendix.

RX Cure 30%: Chemical lab test results indicated that RX Cure 30% complies with AASHTO M-148 specifications. The V.O.C. level determined was 4.83 lbs./gal., actually higher than that for RX Cure, as well as the anticipated limit of 2.9 lbs./gal. Tests conducted to determine dissipation capabilities indicated that RX Cure 30% dissipated as claimed. Detailed test results are located in the appendix.

W.B. Resin Cure: Chemical lab test results indicated that W.B. Resin Cure complies with AASHTO M-148 specifications. The V.O.C. level determined was 1.44 lbs./gal., a preferable level for V.O.C. compliance. Tests conducted to determine dissipation capabilities indicated that W.B. Resin Cure dissipated as claimed. Detailed test results are located in the appendix.

FIELD EVALUATION RESULTS

The following is a summary of the observation made and results determined from the application of RX Cure and W.B. Resin Cure in the field.

RX Cure: On July 30, 1996 approximately 400 feet of bridge barrier was placed by slip-formed method on the east side of bridge #A-10062, a Rte. I-270 bridge over Rte. I-44 currently under rehabilitation and widening. Initially during placement, in the late morning, skies were overcast with a slight breeze. Placement of the of the barrier was completed at approximately 12:30 p.m. By afternoon skies were sunny and temperatures were in the upper 70's with still a slight breeze. The over-all placement of the barrier appeared to go smoothly.

Application of RX Cure was initiated on the first half of the already placed barrier as the final portion of the barrier was slip-formed. The curing compound was applied using a compressor air sprayer at the appropriate rate recommended by the manufacturer. Application appeared to be easy. While most of the application did appear uniform and smooth, there were areas toward the upper portion of the barrier which had a streaking and runny appearance, most likely, as a result of excess application of material. Photo 1 shows a section of barrier after the application of RX Cure.

In order to compare the effects on compressive strength of using curing compound and wet burlap, the contractor was requested to place a modified section of barrier after completing the placement of the actual bridge barrier. This modified barrier was placed shorter and wider, using no reinforcing steel, and long enough for at least 3 ft. to be cured with RX Cure curing compound and an another 3 ft. to be cured with wet burlap. The barrier was designed and placed to allow a minimum of three cylinders to be cored from each section for 28-day compressive strength testing. Photo 2 shows the modified barrier. The full length of the modified barrier was then sawn to produce separate 3 ft. sections for isolated curing conditions. Photo 3 shows barrier sections during curing. The left section was cured using wet burlap and the right section was cured using RX Cure.

The remaining half of the actual bridge barrier was then cured with wet burlap. Burlap, in primarily a dry condition, was placed on the barrier at approximately 1:00 p.m. Although, specifications do require that the burlap shall be sufficiently wet at the time of placement to prevent moisture absorption from the finished surface, burlap is sometimes placed in a dryer condition due to easier handling. Photo 4 shows the burlap in the process of being placed. A soaker hose, used to supply moisture to the burlap, was turned on at approximately 3:00 p.m. Water slowly trickled from the sprayer hose, indicating that it would be some time before the burlap achieved full moisture.

The barrier was again checked at approximately 8:00 p.m. that evening. By this time most of the burlap had achieved full moisture; however, there were areas that were still dry. Closer observation of some of the wet burlapped areas indicated that although the burlap was wet, due to its positioning and draping over the barrier, it may not actually be in contact with the barrier

surface. Therefore, the wet burlap would not be providing the moist cure conditions intended. This is demonstrated at two separate locations in photo 5 and photo 6.

Observation of the barrier cured with RX Cure determined that there was vertical cracking present at mid-span areas. It has not been determined if the cracking was caused by shrinkage or by flexural movement. Since this was a bridge widening project only a portion of the bridge was closed to traffic. Heavy Rte. I-270 traffic continued to be present throughout placement and curing of the barrier and most likely would have been the source of the vertical cracking noted. Investigation of cracking in the wet burlap cured area was prevented due to the presence of the burlap.

Observations the following morning determined that areas of barrier noted earlier to be covered with wet burlap, but not actually wet themselves, were still dry as observed previously.

The barrier was checked approximately two weeks after placement for notable changes and comparison of the section cured with RX Cure to the section cured with wet burlap. At this time it was observed that vertical cracking was apparent in both sections, and the extent of vertical cracking appeared to be the same regardless of the method of curing used.

Prior to 28-days following placement of the barrier, three cores were successfully drilled and removed from each of the separately cured sections of modified barrier. The cores were brought back to the central laboratory and tested for compressive strength. Actual laboratory test results are included in the appendix. The results in Table 1 show that the average compressive strength of the cylinders taken from the concrete cured with wet burlap is 5750 psi, and the average compressive strength of the cylinders taken from the concrete cured with curing compound is 5870 psi. Hence, according to the test results, the curing compound had no adverse effect on the compressive strength of concrete as compared to wet burlap. It should also be noted that the design compressive strength of bridge barrier is 4000 psi, and the strengths determined from all the cored cylinders fall well-above the required design strength.

Follow-up observations to determine the later performance of the bridge barrier and to compare curing methods have been virtually prevented due to the high volume traffic conditions in the area. Unfortunately, any observations must be made from a moving vehicle and do not allow the close view necessary to make adequate and fair determinations between the two curing methods.

W.B. Resin Cure: On Friday, December 6, 1996, approximately 300 feet of bridge barrier was placed by slip form method on each side of the newly constructed Cragwald Road bridge, #85408, over Rte. I-270. Placement started at 9:50 a.m. with the south side barrier. Skies were overcast with a breeze and temperatures were in the 40°'s. Placement of the southern barrier was completed at 12:28 p.m. with an ambient temperature reaching 52°. At approximately 2:30 p.m., placement of the north side barrier began. Skies were again overcast, and temperatures maintained in the lower 50°'s with a breeze. The barrier placement was completed by approximately 5:00 p.m.

Application of W.B. Resin Cure, a water based curing compound, on the north side bridge barrier was initiated at 3:20 p.m. and was completed by 5:45 p.m. The curing compound was applied using a compressor air sprayer at the rate recommended by the manufacturer. Rather than a preferred mist spray, the sprayer applied the curing compound in more of a stream, as shown in photo 7. However, it appeared that full coverage of the barrier was achieved as shown in photo 8.

For comparison of curing methods, the south side bridge barrier was cured with wet burlap. Burlap, in primarily a wet condition, was then placed on the southern barrier at approximately 2:00 p.m. A soaker hose was used to supply moisture to the burlap.

Follow-up observations were made on Monday, December 9, to inspect and compare each side of barrier. The north barrier cured with W.B.Resin Cure had only one visible vertical crack. During the inspection, the wet burlap on the south side was in the process of being removed. Upon removal, it was noted that the burlap was in a damp condition, but the barrier itself was dry except for some areas on the top surface and the very bottom surface. This again appears to be a consequence of the positioning and draping of the burlap over the barrier. Photo 9 shows the barrier after the burlap has been removed. The primarily dry condition of the barrier, re-questions the true effectiveness of this curing method. Approximately eight vertical cracks were noted in the southern barrier or the barrier cured with wet burlap.

Although traffic flow was kept to a minimum during construction to minimize movement of the bridge, any traffic on the old bridge, which was located directly next to the new bridge, created movement in the new bridge. This most likely could have been the source, along with any construction traffic, of the vertical cracking in the barrier on the new bridge. Also, a sidewalk previously constructed on the north side of the new bridge may have provided additional stability for the northern barrier which would have minimized movement and, hence, cracking of the barrier cured with W.B. Resin Cure. Photo 10 shows the sidewalk on the new bridge and the original Cragwald Road bridge located directly next to and north of the new bridge.

Further follow-up observations were made approximately 5 1/2 months later on May 23, 1997. These observations were made simply to compare and make note of anything significant as a result of the two curing methods used. While vertical cracking was evident in both sides of barrier, the barrier cured with W.B. Resin Cure had significantly less cracking. The southern barrier, cured with wet burlap, had more cracking with the presence of efflorescence. The barrier cured with curing compound and the barrier cured with wet burlap can be seen in photos 11 and 12, respectively.

COST COMPARISON OF CURING COMPOUND VS. MOIST CURE METHODS

Depending on the size of project or length of bridge barrier placed, the cost savings for bridge barrier placed and cured with a dissipating type curing compound could range from $0.50 per linear foot, on projects placing extensive amounts of barrier, to $1.50 to $3.00 per linear foot on more typical projects placing lesser amounts of barrier. Records show that on average, approximately 62,000 linear feet of bridge barrier is constructed each year. This would calculate

to an annual cost savings of anywhere from $31,000 up to $186,000 per year. As a result, over a 20 year period, our department could anticipate a present worth savings of $421,300 to $2,527,700.

CONCLUSIONS

1. According to the results in this study, the application of a dissipating type liquid membrane curing compound had no detrimental effects on the compressive strength of concrete as compared to concrete cured with wet burlap.

2. The actual effectivess of the current method of applying wet burlap for curing bridge barrier should be re-evaluated.

3. Application of a dissipating type liquid membrane curing compound to concrete bridge barrier appears to be an effective means of curing bridge barrier.

4. The dissipating type liquid membrane curing compounds evaluated in this study successfully dissipated as claimed by the manufacturer.

5. Allowing the application of a dissipating type liquid membrane curing compound for curing bridge barrier would produce a significant cost savings to the department as compared to current methods specified.

RECOMMENDATIONS

1. As a result of this study, it is recommended that the department allow the application of a dissipating type liquid membrane curing compound as an alternative method to curing concrete bridge barrier. Specifying a dissipating type curing compound would allow the essential application of linseed oil to the completed bridge barrier.

2. In preparation of the institution of the AIMS Coating Rule, curing compounds with minimal V.O.C. levels should be considered if the application of curing compound is approved as recommended in this study.

TABLES

TABLE 1

COMPRESSIVE STRENGTH TEST RESULTS

Sample Ident	PSI
C-1	5890
C-2	5820
C-3	5890
Average	**5870**
W-1	5870
W-2	5300
W-3	6080
Average	**5750**

Note: Specimens cured with RX Cure curing compound are C-1, C-2, and C-3. Specimens cured with wet burlap are W-1, W-2, and W-3.

APPENDIX A

PHOTOGRAPHS

Photo 1. Section of barrier where RX Cure curing compound has been applied.

Photo 2. Modified barrier constructed for compressive strength testing.

Photo 3. Modified barrier during curing.

Photo 4. Burlap being placed on section at opposite end of section cured with RX Cure.

Photo 5. Wet burlap providing inadequate moisture to bridge barrier during curing.

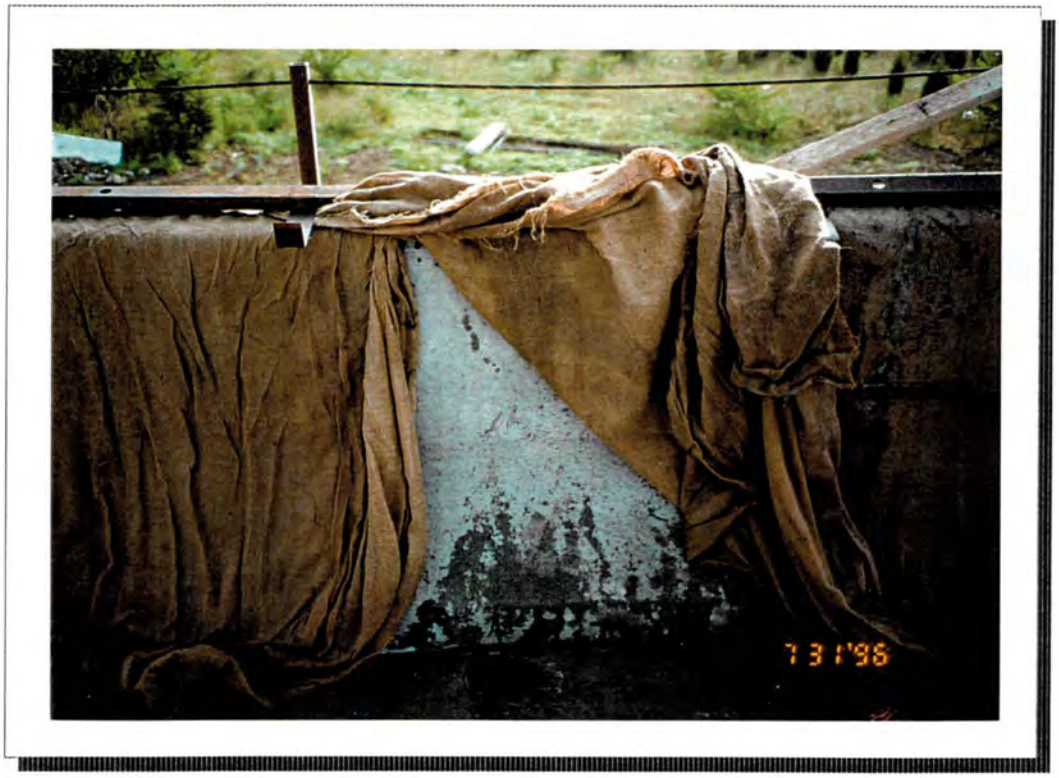

Photo 6. Another photo of inadequate moisture provided during curing.

Photo 7. Application of W.B. Resin Cure curing compound.

Photo 8. Bridge barrier after complete application of W.B. Resin Cure.

Photo 9. Cragwald Road bridge barrier after removal of burlap.

Photo 10. Sidewalk adjacent to barrier slip-formed on new Cragwald Road bridge.

Photo 11. Bridge barrier 5 1/2 months after cured with W.B. Resin Cure.

Photo 12. Bridge barrier 5 1/2 months after cured with wet burlap.

APPENDIX B

TEST RESULTS

..Form T634 Rev 1/90

CORRECTED REPORT

MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

Product Name **RX CURE - CLEAR CONC. CURING COMPOUND**

Product No **3099XX** ID No **PB-96-01** Lab No **96-08373**

Project Route County

Source/Formation Location/Ledge

Mfg/Fab/Producer **CONSPEC MARKETING & MFG.** Location **KANSAS CITY, KS**

Contractor Destination

Sampled From For Use In **GENERAL RESEARCH INVESTIGATION**

Lot Quantity **1 QT.**

Inspector **PATTY BRAKE** Reported By **HAROLD SCHWARTZ/ET**

Sampled **07-11-96** Received **07-11-96** Completed **07-16-96** Reported **07-27-96**

TEST RESULTS

Color.....Transparent

Weight per gallon, 77°F.....5.80 lbs/gal

Total Solids by weight.....20.3%

Volatile Matter by weight.....79.7%

Volatile Organic compoun.....4.62 lbs/gal ✓

Water Retention test.....*0.53 kg/m^2

Drying Time, moist mortar block.....½ hour

Drying Time, metal panel.....½ hour

Status : [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks: **Sample complies with specifications except that it contains no red dye. Results of laboratory testing to check for dissipation will be forwarded when complete (approx. 50 days).**

***Report corrected to show true water rentention loss and to attach results of long-term exposure tests.**

Copies: **PATTY BRAKE**
FILE

Gary Chegwidden

Division Engineer, Materials

Inter-Office Correspondence

MISSOURI DEPARTMENT OF TRANSPORTATION

DATE: October 1, 1996

TO: Harold Schwartz
Chemical Laboratory Director

FROM: Todd Bennett TB
Analytical Chemist

SUBJECT: Materials
Weathering of Rx Cure

The following tests were performed on Conspecs product Rx Cure.

Accelerated weathering: Rx Cure was applied to a glass panel and placed in the QUV accelerated weathering instrument. The panel showed yellowing and cracking of the product within the first week. After two weeks the product flaked off on parts of the panel. The panel was tested for fifty days in the QUV. It was tested at a UV level of 0.80 nm. After the test was concluded the product could be rubbed off easily with the finger.

Outdoor Exposure: Rx Cure was applied to two concrete blocks and placed on the roof of the Central Laboratory. The blocks were exposed to weather at all times. The blocks were left on the roof for fifty days. At the end of the period there were no noticeable signs of the product left on the blocks. One block was completely covered with the above product, while the other was partially covered. The partially covered block was then tested to see if some of the Rx cure still remained. Concrete surface sealer was applied to the block. The sealer penetrated the block uniformly on both the area that contained no product and the portion with the Rx Cure.

db

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Form T434 Rev 1/90

MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

Product Name **RX CURE 30% - DISSIPATING LIQUID CURING COMPOUND**

Product No **3099XX** ID No **PB-96-67** Lab No **96-14490**

Project Route County

Source/Formation Location/Ledge

Mfg/Fab/Producer **CONSPEC MARKETING & MFG.** Location **KANSAS CITY, KS**

Contractor Destination

Sampled From For Use In **CONCRETE**

Lot Quantity **1 QUART**

Inspector **PATTY BRAKE** Reported By **Harold Schwartz/rb**

Sampled **11-07-96** Received **11-07-96** Completed **1/27/97** Reported **1/27/97**

TEST RESULTS

VOC ≤ 4.83 #/gal

% Solids.....31.3%
lbs.per gallon.....7.00 lbs/gal
Water Retention.....0.49 kg/m²

RX CURE 30%.

Accelerated Weathering: ~~W.B. Mesh Cure~~ was applied to a glass panel and placed in the QUV accelerated weathering instrument. The panel showed yellowing and cracking of the product within the first two days. The test was conducted for fifty days in the QUV at 0.80nm of light. At the end of this period of time 85% of the product had fallen off the glass panel. The remainder of the product was very brittle and was easily wiped off.

RX CURE 30%.

Outdoor Exposure: ~~W.B. Cure~~ was applied to two concrete blocks and placed on the roof of the Central Laboratory. The blocks were exposed to the outdoor climate for fifty straight days. At the end of this test period no signs of the product remained. A penetrating sealer was applied to the concrete blocks. The sealer penetrated the surface of the block uniformly.

Status : [X] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional
Remarks: **Results of testing indicate compliance with AASHTO M148.**

Copies: **Patty Brake**
File

Harry Cheyne

Division Engineer, Materials

Form T634 Rev 1/90

MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

Product Name **W.B. RESIN CURE - DISSIPATING LIQUID CURING COMPOUND**

Product No **3099XX** ID No **PB-96-66** Lab No **96-14489**

Project Route County

Source/Formation Location/Ledge

Mfg/Fab/Producer **CONSPEC MARKETING & MFG.** Location **KANSAS CITY, KS**

Contractor ~~Destination~~

Sampled From [redacted] For Use In **CONCRETE**

Lot ~~Quantity~~ **1 QUART**

Inspector **PATTY BRAKE** Reported By **Harold Schwartz/rb**

Sampled **11-07-96** Received **11-07-96** Completed **1/27/97** Reported **1/27/97**

TEST RESULTS

VOC > 1.44 H/GN/

% Solids.....20.6%

Weight per gallon, lbs.....8.19 lbs/gal

Water Retention.....0.55 Kg/m^2

Accelerated Weathering: W.B. RESIN CURE ~~Rx Cure 30%~~ **was applied to a glass panel and placed in the QUV accelerated weather instrument. The panel showed yellowing and cracking of the product within the first two days. The test was conducted for fifth days in the QUV at 0.80nm of light. At the end of this period of time 65% of the product had fallen off the glass panel. The remainder of the product was very brittle and was easily wiped off.**

Outdoor Exposure: W.B. RESIN CURE ~~Rx Cure~~ **was applied to two concrete blocks and placed on the roof of the Central Laboratory. The blocks were exposed to the outdoor climate for fifty straight days. At the end of this test period no signs of the product remained. A penetrating sealer was applied to the concrete blocks. The sealer penetrated the surface of the block uniformly.**

Status : [X] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks: **Results of testing indicates compliance with AASHTO M148.**

Copies: **Patty Brake**
File

Gary C. Gardner

Division Engineer, Materials

Form T634 Rev 03/91
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MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

1617 Missouri Blvd., Jefferson City, MO 65109

Product Name **SAFETY BARRIER CURB (B-1)** (General Research Investigative)

Product No **3099XX** ID No **PB-96-07** Lab No **96-11089**

Project **GENERAL CONSTRUCTION** Route County

Source/Formation

Mfg/Fab/Producer **Breckenridge #2, Hwy 21**
3004900236

Contractor

Sampled From

Lot **C-1**

Inspector **PATTY BRAKE**

Sampled **08/27/96** Received **08/27/96**

Location/Ledge

Location **St. Louis, Missouri**

Destination

For Use In

Quantity **0**

Reported By **Dale Payne**

Completed **08/29/96** Reported **08/29/96**

TEST RESULTS

Test Description	Result	Units	Tester	Test Date	Test No.
Compressive Strength	5890	psi	DAVISJB	08/29/96	

Sample submitted for the above determinations.

Status [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks

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Division Engineer, Materials Bill Turner

Form T634 Rev 03/91
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MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

1617 Missouri Blvd., Jefferson City, MO 65109

Product Name **SAFETY BARRIER CURB (B-1)** (General Research Investigative)

Product No **3099XX** ID No **PB-96-08** Lab No **96-11090**

Project **GENERAL CONSTRUCTION** Route County

Source/Formation

Mfg/Fab/Producer **Breckenridge #2, Hwy 21**
3004900236

Contractor

Sampled From

Lot **C-2**

Inspector **PATTY BRAKE**

Sampled **08/27/96** Received **08/27/96**

Location/Ledge

Location **St. Louis, Missouri**

Destination

For Use In

Quantity **0**

Reported By **Dale Payne**

Completed **08/29/96** Reported **08/29/96**

TEST RESULTS

Test Description	Result	Units	Tester	Test Date	Test No.
Compressive Strength	5820	psi	DAVISJB	08/29/96	

Sample submitted for the above determinations.

Status [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks

Copies **PATTY BRAKE** ✓
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Division Engineer, Materials Bill Trimm

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MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

1617 Missouri Blvd., Jefferson City, MO 65109

Product Name **SAFETY BARRIER CURB (B-1)** (General Research Investigative)

Product No **3099XX** ID No **PB-96-09** Lab No **96-11091**

Project **GENERAL CONSTRUCTION** Route County

Source/Formation

Mfg/Fab/Producer **Breckenridge #2, Hwy 21**
3004900236

Contractor

Sampled From

Lot **C-3**

Inspector **PATTY BRAKE**

Sampled **08/27/96** Received **08/27/96**

Location/Ledge

Location **St. Louis, Missouri**

Destination

For Use In

Quantity **0**

Reported By **Dale Payne**

Completed **08/29/96** Reported **08/29/96**

TEST RESULTS

Test Description	Result	Units	Tester	Test Date	Test No.
Compressive Strength	5890	psi	DAVISJB	08/29/96	

Sample submitted for the above determinations.

Status [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks

Copies **PATTY BRAKE**
LAB
FILE

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Division Engineer, Materials Bill Turner

Form T634 Rev 03/91
LA11107
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MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

1617 Missouri Blvd., Jefferson City, MO 65109

Product Name **SAFETY BARRIER CURB (B-1)** (General Research Investigative)

Product No **3099XX** ID No **PB-96-10** Lab No **96-11092**

Project **GENERAL CONSTRUCTION** Route County

Source/Formation

Mfg/Fab/Producer **Breckenridge #2, Hwy 21**
3004900236

Contractor

Sampled From

Lot **W-1**

Inspector **PATTY BRAKE**

Sampled **08/27/96** Received **08/27/96**

Location/Ledge

Location **St. Louis, Missouri**

Destination

For Use In

Quantity **0**

Reported By **Dale Payne**

Completed **08/29/96** Reported **08/29/96**

TEST RESULTS

Test Description	Result	Units	Tester	Test Date	Test No.
Compressive Strength	5870	psi	DAVISJB	08/29/96	

Sample submitted for the above determinations.

Status [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks

Copies **PATTY BRAKE**
LAB
FILE

6
3
4

Division Engineer, Materials Bill Turner

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MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

1617 Missouri Blvd., Jefferson City, MO 65109

Product Name **SAFETY BARRIER CURB (B-1)** (General Research Investigative)

Product No **3099XX** ID No **PB-96-11** Lab No **96-11093**

Project **GENERAL CONSTRUCTION** Route County

Source/Formation

Mfg/Fab/Producer **Breckenridge #2, Hwy 21**
3004900236

Contractor

Sampled From

Lot **w-2**

Inspector **PATTY BRAKE**

Sampled **08/27/96** Received **08/27/96**

Location/Ledge

Location **St. Louis, Missouri**

Destination

For Use In

Quantity **0**

Reported By **Dale Payne**

Completed **08/29/96** Reported **08/29/96**

TEST RESULTS

Test Description	Result	Units	Tester	Test Date	Test No.
Compressive Strength	5300	psi	DAVISJB	08/29/96	

Sample submitted for the above determinations.

Status [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks

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Division Engineer, Materials Bill Turner

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MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT
DIVISION OF MATERIALS

1617 Missouri Blvd., Jefferson City, MO 65109

Product Name **SAFETY BARRIER CURB (B-1)** (General Research Investigative)

Product No **3099XX** ID No **PB-96-12** Lab No **96-11094**

Project **GENERAL CONSTRUCTION** Route County

Source/Formation

Mfg/Fab/Producer **Breckenridge #2, Hwy 21**
3004900236

Contractor

Sampled From

Lot **W-3**

Inspector **PATTY BRAKE**

Sampled **08/27/96** Received **08/27/96**

Location/Ledge

Location **St. Louis, Missouri**

Destination

For Use In

Quantity **0**

Reported By **Dale Payne**

Completed **08/29/96** Reported **08/29/96**

TEST RESULTS

Test Description	Result	Units	Tester	Test Date	Test No.
Compressive Strength	6080	psi	DAVISJB	08/29/96	

Sample submitted for the above determinations.

Status [ ] Accepted [ ] Rejected [ ] Quality Only [ ] Conditional

Remarks

Copies **PATTY BRAKE**
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Division Engineer, Materials Bill Farmer

APPENDIX C

WORKPLAN

EVALUATION OF USING A DISSIPATING LIQUID MEMBRANE CURING COMPOUND ON BRIDGE BARRIER

RI 96-10

Work Plan

July 1996

Overview

The application of a dissipating type, liquid membrane curing compound as opposed to current, moist cure procedures for curing bridge barrier appears to be a more cost-effective method worth investigating. This project, as a coordinated effort with the RD&T Division and District 6, will evaluate the method of curing bridge barrier by applying a dissipating liquid membrane curing compound. The product used in this research investigation will be RX Cure by Conspec.

Background

MHTD's current specification for curing bridge barrier, either cast-in-place or slip formed construction, is limited to the placement of wet burlap or other similar means of moist cure methods. The method of using a liquid membrane curing compound has not been allowed, most likely, because 1) the application of the curing compound would inhibit the proper application of linseed oil, the final step in the completion of the bridge superstructure and 2) wet burlap or moist curing has always been considered the most ideal of curing methods.

Moist cure techniques, including the most frequently used placement of wet burlap, do provide the most ideal curing conditions when carried out properly. However, curing compounds have proven to perform sufficiently at achieving desired results. Questions regarding the timely placement of the burlap and the sometimes poor attempt at maintaining its wetness have initiated concern over how effective our moist curing methods actually are under field conditions.

With the recent awareness of curing compounds which claim to have the capability of dissipating and that comply with MHTD specifications for liquid membrane-forming compounds, there has been an interest in further investigating their use as an alternative method for curing bridge barrier. The use of curing compounds has not only been found to be much more economical as opposed to moist cure techniques, but also, the application of curing compounds to bridge barrier would potentially help address concerns over the sometimes improper and ineffective implementation of current methods used.

Procedure

The investigation of the proposed use of a dissipating type liquid membrane curing compound will involve evaluation in both the laboratory and field.

Initially, a sample of the dissipating curing compound, RX Cure, will be submitted to the Materials Division for laboratory testing for compliance with AASHTO M-148 (ASTM C-309), Liquid Membrane-Forming Compounds for Curing Concrete. If the product meets the designated requirements, the investigation will proceed to the field for further evaluation. If the product does not test within compliance, no field evaluation will be conducted.

Evaluation in the field will include the application of RX Cure to freshly placed slip formed bridge barrier on a select project under construction in the District 6 area. District 6 construction personnel will prepare a specification to be included in the project contract which will specify the use and application of RX Cure as part of a research investigation.

Slip formed barrier on half of one side of the bridge will receive application of the RX Cure curing compound. Slip formed barrier on the remaining half will be cured by wet burlap. The wet burlap cured barrier will serve as a control to help in the evaluation of the proposed method of curing.

During the application of the RX Cure and the time following, several items will be observed and noted as part of the evaluation. The following is a summary of these items:

- condition of slip formed barrier before application of RX Cure (good consolidation, texture, etc.)
- ambient conditions during placement and after placement
- equipment used for application of RX Cure
- time of application of RX Cure after barrier placement (also time of placement of wet burlap on control side)
- uniform application, coverage, etc. (especially to vertical surfaces; note any streaking, etc. or ponding of material on the deck surface)
- rate of application
- development of shrinkage cracking (make comparison observations with control side)
- dissipation capabilities (indication of complete dissipation and time required)

As part of the field evaluation, copies of the mix design and the plant inspector's daily reports on the concrete placed will also be requested.

During the field evaluation, efforts will be made to compare compressive strength results between the concrete cured by application of the curing compound and that cured by placement of wet burlap. During construction, the contractor will be requested to place two partial sections of bridge barrier strictly for sampling purposes. Each section will be cured separately to simulate curing conditions of the actual bridge barrier. After 28 days, 3 cores, each 6" x 12", will be taken from each section and tested for compressive strength. Results will then be compared to help in determining the curing capability of the curing compound.

Observation of the barrier cured with the dissipating curing compound will continue until complete dissipation of the curing compound takes place. Dissipation will be confirmed by 1) no evidence of a yellow-amber curing compound residue present and 2) capability of water to be absorbed into the concrete.

Material

The material to be used in this research investigation will be RX Cure by Conspec, a dissipating liquid membrane curing compound. RX Cure is formulated to completely dissipate, under normal conditions, in 28 to 45 days after application. When applied, RX Cure should appear to be a yellow-amber color and will eventually turn into a powder residue as part of the dissipating process. Complete dissipation would then allow for proper application of linseed oil to the bridge barrier, as required by specification.

Reporting

A final report on the evaluation of using a dissipating curing compound as an alternative to moist cure methods will be prepared after the completion of the field evaluation. Reporting will be the responsibility of the RD&T Division.

Summary of Tasks & Activities

1) Submit sample of RX Cure by Conspec to Materials Division for laboratory testing.
   (RD&T Division)
2) Select bridge project for field evaluation.
   (District 6 Construction)
3) Write specification for use of RX Cure on bridge project.
   (District 6 Construction)
4) Observe application of RX Cure on bridge barrier vs. placement of wet burlap.
   (RD&T Division)
5) Core cylinders from barrier sample sections and test for compressive strength.
   (RD&T Division)
6) Continue observation of treated bridge barrier for dissipation of curing compound.
   (RD&T Division)
7) Prepare final report.
   (RD&T Division)

pb

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