Performance Survey of Silicone-Sealed Concrete Pavement Joints

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PERFORMANCE SURVEY OF SILICONE-SEALED CONCRETE PAVEMENT JOINTS

by

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in cooperation with
Kentucky Transportation Cabinet

and

Federal Highway Administration
U.S. Department of Transportation

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August 1987
February 7, 1989

Mr. Robert E. Johnson  
Division Administrator  
Federal Highway Administration  
330 West Broadway  
Frankfort, Kentucky 40602-0536

SUBJECT: IMPLEMENTATION STATEMENT  
KYHPR 85-107-2, Pavement Joints and Seals  
UKTRP 87-19, "Performance Survey of Silicone-Sealed Concrete Pavement Joints"

Dear Mr. Johnson:

As a result of information gained during the course of work reported in the subject report, the Department of Highways has revised Special Provision No. 63, Silicone Rubber Sealant for Concrete Pavement. It is now required that joints be blastcleaned in two passes in an effort to improve the effectiveness of cleaning and thereby improve the bond of the sealer to the concrete.

Sincerely,

O. G. Newman  
State Highway Engineer
Performance Survey of Silicone-Sealed Concrete Pavement Joints

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This report summarizes field inspections of various silicone-sealed concrete pavement joints. A list of silicone sealant projects was provided by the Kentucky Transportation Cabinet. Observations of performance were subjective and qualitative.
INTRODUCTION

A list of silicone sealant projects was obtained from the Kentucky Department of Highways in August of 1985 (Table 1). All projects were visually inspected; the observations were subjective and qualitative.

SUMMARY

Construction techniques were considered to be the major factor in the success or failure of the silicone-sealed concrete pavement joints. Irregular saw cuts and failure to clean vertical faces of the sawed joint prior to installation led to many failures. Also, several pavement joints had deteriorated to the point where the seal was deemed to be a failure. With proper installation and maintenance, silicone seals performed admirably and their use for effectively sealing concrete pavement joints should be continued.

Following is a brief statement of the findings.

PROJECT NUMBER CF 60-1(6)
The majority of the seals appeared to be in good condition. Many joints had filled with sand and small rocks. Pavement breaking near joint edges contributed to some failures. In one location where water had collected, the seals and backing rods had disappeared completely. A complete description of the visual survey is contained in Appendix A.

PROJECT NUMBER HES 7320(1)
Silicone seals placed longitudinally between the old pavement and the newly constructed traversable median were in very poor condition. Uneven heights were most detrimental. Transverse seals were in very good condition. A complete description of the visual survey is contained in Appendix B.

PROJECT NUMBER EACIR 64-6(31)113
The silicone seals inspected were in excellent condition and performing as expected. A complete description of the visual survey is contained in Appendix C.

PROJECT NUMBER ACIR 64-4(62)53
The majority of the silicone seals were in very good condition. Although the saw cuts were somewhat irregular and the concrete had broken along the edge of the joint in some places, the seals were performing satisfactorily. A complete description of the visual survey is contained in Appendix D.

PROJECT NUMBER SR 5170(1)
Overall, the silicone seals were in fair condition and performing adequately. The seals were not finished properly. The depths of the seals varied and were not as smooth as other silicone sealant projects that were surveyed. A complete description of the visual survey is contained in Appendix E.

PROJECT NUMBER SR 5228(5)
The silicone seals inspected were in excellent condition. This was a very old pavement and many of the joints exhibited some deterioration; however, the seals in those joints were functioning properly. Any anticipated failures of
the silicone seals would be expected to occur at those locations where the joints were showing signs of deterioration. A complete description of the visual survey is contained in Appendix F.

PROJECT NUMBER I 471-4(17)2

The visual inspection revealed that portions of the silicone seal had come out of nearly every joint. It was estimated that 85 percent of the joints had at least an 8-inch section of the sealer missing. Many joints had as much as 25 percent of the sealer missing. One possible reason for these failures is that the faces of the saw cuts were not completely free of dust when the seals were installed. A complete description of the visual survey is contained in Appendix G.

FIELD DEMONSTRATION, BLUEGRASS PARKWAY BOSTON TOLL PLAZA

On April 11, 1986, silicone seals placed in the longitudinal shoulder-pavement joint at the Boston Toll Plaza on the Bluegrass Parkway were inspected. There was no evidence that there were ever any seals installed at this location. A long-time employee at the toll plaza indicated that someone had indeed installed the seals there some 6 or 7 years ago, but said "the stuff had come right back out." The project was deemed a complete failure.

PROJECT NUMBER ACIR 00243(27)65

The silicone seals were performing satisfactorily in the sections surveyed. Although some transverse saw cuts were 2 to 3 inches wide, the seals were in very good condition. There were no failed seals in the area surveyed. A complete description of the survey is contained in Appendix H.

TABLE 1. SILICONE (DOW-CORNING) SEALANT PROJECTS

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>PROJECT</th>
<th>CONTRACTOR</th>
<th>PROJECT LENGTH (miles)</th>
<th>DATE AWARDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>McCracken</td>
<td>CF 60-1(6)</td>
<td>Jim Smith</td>
<td>2.31</td>
<td>6/20/80</td>
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<tr>
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<td>HES 7320(1)</td>
<td>Shamrock</td>
<td>1.01</td>
<td>6/22/79</td>
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<tr>
<td>Rowan, Bath</td>
<td>EACIR 64-6(31)113</td>
<td>W. L. Harper</td>
<td>33.38</td>
<td>3/01/84</td>
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<tr>
<td>Franklin</td>
<td>ACIR 64-4(62)53</td>
<td>R. L. Carter</td>
<td>4.71</td>
<td>9/12/84</td>
</tr>
<tr>
<td>Owen</td>
<td>SR 5170(1)</td>
<td>Eaton Paving</td>
<td>9.21</td>
<td>3/08/82</td>
</tr>
<tr>
<td>Boone</td>
<td>SR 5228(5)</td>
<td>Eaton Paving</td>
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<td>3/08/82</td>
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<tr>
<td>Campbell</td>
<td>I 471-4(17)2</td>
<td>Pierce Construction</td>
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<tr>
<td>Trigg/Christian ACIR 00243(27)65</td>
<td>Shamrock</td>
<td>45.00</td>
<td>6/26/85</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Included is a field demonstration of 300 feet of shoulder-pavement joint at the Bluegrass Parkway Boston Toll Plaza completed in September 1978 by KYDOH.
APPENDIX A

PROJECT CF 60-1(6)
The majority of the seals appeared to be in good condition; however, most joints were filled with sand and small rocks (Figure 1). This made inspection somewhat difficult as the debris had to be removed to examine the seals.

Pavement breaking near saw cuts contributed to some seal failures (Figures 2 and 3). Debris had collected in the cracks and grass had begun to grow there (Figures 4 and 5). Irregular saw cuts were observed, varying from 3/8 inch to nearly 1 inch wide (Figures 6, 7, and 8). The wider the saw cut, generally, the deeper the seal was in the joint. The depths of seals from the surface varied from 1 inch to nearly flush.

At some locations, seals had parted from the face of the concrete slab (Figures 9 and 10). At other locations, the seal had disappeared and the backing rod was visible (Figures 11, 12, and 13). Near the entrance to Chuck Mullens' Oldsmobile dealership, both the seal and the backing rod had disappeared altogether (Figures 14, 15, and 16). It also was noted that water was ponding in that area.

Longitudinal seals were in very good condition for the most part; however, wide saw cuts contributed to the failure of some seals (Figure 17). Overall, the seals appeared in good condition. Only the few seals in front of the Oldsmobile dealership were deemed complete failures. That was due to the extended presence of water.
Figure 1. Many joints were filled with debris.

Figure 2. Pavement breaking at the joint contributed to some failures.
Figure 3. Sealant was used to repair broken concrete at the joint face.

Figure 4. Debris had collected in the broken pavement and grass had begun to grow through the joint.
Figure 5. Joint failure, silicone seal in good condition.

Figure 6. Irregular transverse saw cut.
Figure 7. Irregular transverse saw cut.

Figure 8. Overall view of transverse saw cut.
Figure 9. Seal parted from joint face.

Figure 10. Seal parted from joint face.
Figure 11. Backing rod visible under missing seal.

Figure 12. Backing rod sticking up through joint.
Figure 13. Seal missing, backing rod visible.

Figure 14. Seal missing, backing rod missing.
Figure 15. Seal missing, backing rod visible.

Figure 16. Seal missing, backing rod missing.
Figure 17. Failed longitudinal seal.
APPENDIX B

PROJECT HES 7320(1)
A flush, paved median was constructed between the eastbound and westbound lanes for approximately 1 mile. Silicone seals were placed longitudinally between the old pavement and the new median and transversely at regular intervals in the median. Silicone seals were placed around existing drainage structures located at the pavement-median interface (Figure 18).

Longitudinal saw cuts were very narrow, averaging nearly 1/4 inch. Depths of the seals ranged from nearly flush to 1/4 inch. Transverse saw cuts averaged 3/4 inch in width. Depths of transverse seals from the surface averaged 5/16 inch.

Debris had collected in some joints and the seals were not adhering to faces of the joints (Figure 19). Some seals were twisted and disfigured (Figures 20 and 21).

Uneven heights between the old and new pavements may have caused problems during installation of the seals. Longitudinal seals were in very poor condition. There also may have been dust on the faces of the joints during installation of the seals. In some places, the older pavement was breaking at the pavement-median interface and was the cause for some seal failures (Figures 22 and 23).

There was a complete failure of the longitudinal seal along the north edge of the median near the entrance to Juniper Hills Park (Figures 24 and 25). Failure began approximately at Station 1575+00 and extended to the end of the project, a distance of about 800 feet.

One failure of a transverse seal was observed. It was near the entrance to Frankfort Plaza Shopping Center and Juniper Hills Park at approximately Station 1578+00 (Figure 26).

Overall, installation of the seals was probably not as good as it could have been; that is, conditions were not ideal. Uneven heights of adjacent slabs were most detrimental. Sealed transverse joints were in good shape, while the sealed longitudinal joints were in poor condition at best. Additional problems with the seals may be anticipated where the older pavement is deteriorating.
Figure 18. Seal between old and new pavement.

Figure 19. Seal not adhering to joint face.
Figure 20. Twisted seal.

Figure 21. Twisted seal, backing rod sticking up through joint.
Figure 22. Older pavement breaking.

Figure 23. Older pavement breaking.
Figure 24. Failed longitudinal seal, sealer missing.
Figure 25. Failed longitudinal seal.

Figure 26. Failed transverse seal, backing rod and seal visible.
PROJECT: EACIR 64-6(31)113
COUNTIES: Rowan, Bath
CONTRACTOR: W. L. Harper
YEAR INSTALLED: 1984
PRODUCER: The Dow-Corning Company
DATE SURVEYED: March 11, 1986
AREA SURVEYED: I-64, Milepost 119 to the Montgomery County line; approximately 5 miles was covered in the survey

Silicone seals inspected were in excellent condition and performing as expected. There was a small amount of debris near the pavement edge. The eastbound and westbound lanes were very similar in appearance with respect to the condition of silicone seals.

For both the eastbound and westbound lanes, the average width of the longitudinal saw cuts was 7/16 inch. The average depth to the tops of longitudinal seals was 7/16 inch. The average width of transverse saw cuts was 7/8 inch with a bevel on both concrete faces. The average depth to the tops of transverse seals was 7/16 inch. Longitudinal and transverse seals were smooth in appearance; and overall, it appeared that the installation of the seals was very good.

Two failures were observed in the westbound lanes. One was a puncture of the seal about 4 inches long. The backing rod was visible underneath the hole (Figure 27). The other failure was similar; however, the backing rod was sticking up through the joint (Figure 28).

There was some evidence of irregular saw cuts (Figures 29 and 30); however, the seals were still functioning properly. The major problem was debris had collected in the joints at the pavement-shoulder interface (Figure 31). This was limited to a small area where the shoulder was slightly higher than the traveled lanes. Traffic would run over the debris and push it down into the joint, causing the seal to separate from the face of the joint. This will eventually lead to failure of the seal.
Figure 27. Seal punctured.

Figure 28. Seal punctured, backing rod sticking up through the joint.
Figure 29. Irregular transverse saw cut.

Figure 30. Sealant used to repair broken concrete at the joint face.
Figure 31. Irregular saw cut, debris in joint at the pavement edge.
APPENDIX D

PROJECT ACIR 64-4(62)53
New concrete joints had been constructed on this section of I 64. Silicone seals had been installed in the pavement joints. For the westbound lanes, the average width of the longitudinal saw cut was 3/8 inch. The average depth to the tops of longitudinal seals was 3/8 inch. Transverse saw cuts averaged 7/8 inch and had beveled edges. Depths to the top of the transverse seals averaged 3/8 inch.

Three seal failures were observed in the westbound lanes. All three were punctures of the seal 1 to 2 inches in length (Figure 32). The backing rod was visible under the seals.

For the eastbound lanes, the average width of longitudinal saw cuts was 7/16 inch while the average depth to the tops of the silicone seals was 3/8 inch. The average width of transverse saw cuts was 7/8 inch while the average depth was 7/16 inch from the surface.

There was only one failure of the silicone seal observed in the eastbound lanes. The seal had become dislodged at the shoulder edge on the median side for approximately 1 foot (Figure 33).

The majority of the silicone seals were in very good condition (Figure 34). Even though the saw cuts were somewhat irregular (Figures 35 and 36) and the concrete had broken along the edge of the joint in some places (Figure 37), the seals were performing satisfactorily and appeared to be in very good condition.
Figure 32. Seal punctured.

Figure 33. Seal at shoulder edge became dislodged.
Figure 34. Good seal.

Figure 35. Irregular longitudinal joint.
Figure 36. Irregular transverse joint.

Figure 37. Concrete broken along edge of joint.
APPENDIX E

PROJECT SR 5170(1)
US 127 is a two-lane highway. Silicone seals were in fair condition for the section surveyed. The average width of longitudinal saw cuts was 3/8 inch. Depths to the tops of the seals varied from 3/8 to 1 inch. Widths of transverse saw cuts were 3/4 inch. Again, depths of the seals varied from 3/8 to 1 inch. The biggest variation occurred in the northbound lanes (Figure 38).

Dirt and small gravel had collected in some joints and some saw cuts were irregular (Figure 39). Three seal failures were observed. One of the failures involved a puncture of the seal about 2 to 3 inches long (Figure 40). Another failure was where the seal had pulled away from the face of the joint (Figure 41). The largest failure involved the longitudinally sealed joint near the intersection of KY 845. This was primarily due to the deterioration of the joint itself (Figures 42 and 43).

Overall, the silicone seals were in fair condition and performing adequately. The seals were not finished smoothly and depths of the seals from the surface varied more than other silicone sealant projects that were surveyed.
Figure 38. The seal depth varied.

Figure 39. Irregular transverse saw cut.
Figure 40. Seal punctured and twisted.

Figure 41. Seal pulled away from the joint face.
Figure 42. Failed longitudinal seal.

Figure 43. Backing rod exposed in longitudinal joint.
APPENDIX F

PROJECT SR 5228(5)
PROJECT: SR 5228(5)
COUNTY: Boone
CONTRACTOR: Eaton Paving
YEAR INSTALLED: 1982
PRODUCER: The Dow-Corning Company
DATE SURVEYED: April 10, 1986

AREA SURVEYED: KY 18, at the beginning of the four-lane highway just east of Burlington eastward toward Florence; approximately 2 miles in each direction were covered by the survey.

There were no mile markers located on this highway; therefore, four 1/2-mile sections were surveyed in each direction.

Silicone seals on KY 18 were in excellent condition (Figure 44). The average longitudinal saw cut was 3/8 inch in width. Depths of longitudinal seals from the surface ranged from 1/4 to 1/2 inch. The average transverse saw cut was 1/2 inch wide and had a bevel on each concrete face. Depths of transverse seals ranged from 1/4 to 1/2 inch.

Two seal failures were observed in the westbound lanes. The first was a small 1-inch puncture. The second was a 7-inch puncture of the seal.

Very little debris had collected in the joints. This was a very old pavement and many of the joints exhibited some deterioration; however, the seals in those joints were functioning properly (Figures 45, 46, and 47). Any anticipated failures of the silicone seals would be expected to occur at locations where the joint is deteriorating.
Figure 44. A good seal.
Figure 45. Deteriorated joint.
Figure 46. Broken concrete at joint face.

Figure 47. Sealer used to repair broken concrete.
PROJECT: I 471-4(17)2
COUNTY: Campbell
CONTRACTOR: Pierce Construction
YEAR INSTALLED: 1980
PRODUCER: The Dow-Corning Company
DATE SURVEYED: April 10, 1986
AREA SURVEYED: I 471, both eastbound and westbound lanes from Milepoint 4.0 to the end of the project; the survey covered approximately 1.3 miles

I 471 is a three-lane limited access highway. This project was a bit unusual as the longitudinally sealed joints had been filled with hot-poured asphalt. Longitudinal saw cuts averaged 3/8 inch in width. Transverse cuts averaged 1/2 inch in width for both the northbound and southbound directions. Depths of transverse seals ranged from 1/4 to 1/2 inch from the surface for both directions.

When these seals were installed, it was felt that it was an exceptionally good job; however, visual inspection revealed that some of the silicone sealant had come out of almost every joint. The traveled lanes and shoulders were littered with remains of the seals (Figures 48 and 49). In some places, traffic had not yet whipped the backing rod from the joint (Figure 50).

It was estimated that about 85 percent of the joints had at least an 8-inch section of the sealer missing. Many joints had as much as 25 percent of the sealer missing (Figure 51).

It would be hard to determine what caused the seals to come out of the joints, since it was thought that the contractor had done such a good job. It is theorized that the faces of the sawed joints were not completely free of dust when the seals were installed. Another reason could be the amount of traffic on this section. It was noted that the silicone seals in shoulder joints were functioning properly.
Figure 48. Remains of loose backing rod.

Figure 49. Remains of backing rod.
Figure 50. Failed transverse seal.
Figure 51. Transverse seal failure across all three lanes.
PROJECT: ACIR 00243(27)65

COUNTIES: Trigg, Christian

CONTRACTOR: Shamrock Construction

YEAR INSTALLED: 1985/1986

PRODUCER: The Dow-Corning Company

DATE SURVEYED: December 12, 1986

AREA SURVEYED: I-24, eastbound lanes from US 68 to KY 117, and both eastbound and westbound lanes from US 41A to the Tennessee state line; the survey covered approximately 22 miles.

Overall the seals observed were in excellent condition. There were no failed seals observed. The worst conditions were crooked saw cuts and several wide joints. Although several saw cuts as wide as 2 to 3 inches were observed, the seals were performing as expected (see Figure 52). There were no loose seals in these wide saw cuts.

The average width of the transverse saw cuts was 1 inch. Most cuts were fairly uniform. However, some cuts were bottle shaped with wide and narrow areas (see Figure 53). Transverse saw cuts in the section from US 41A to the Tennessee state line were slightly wider, averaging approximately 1-1/8 inches.

Longitudinal saw cuts were noticeably wider on the western end compared to the eastern end. Longitudinal saw cuts on the west end, from US 68 to KY 117, averaged 1/2 inch or larger, with many measuring nearly 3/4 inch. On the east end, US 41A to the Tennessee state line, longitudinal saw cuts averaged 1/2 inch or less, with many measuring 3/8 to 1/4 inch.

Depths of transverse seals in both sections surveyed averaged 1/2 inch. Many places were higher than this, but few were deeper. Even where the seal was flush with the surface, it appeared to be well sealed. Longitudinal seals varied more in depth. Generally, depths of the seals averaged less than 1/2 inch. The depth of the seal was more uniform for the wider saw cuts.
Figure 52. Some Saw Cuts 2 to 3 Inches Wide

Figure 53. Saw Cuts Varied in Width.