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INVESTIGATION OF POLYURETHANE TOP-COAT DELAMINATION ON STRUCTURAL STEEL

Introduction

This article summarizes the results of a recently completed study by the M&T Research Laboratory into the causes of top-coat delamination affecting 10 bridges coated in 1991 (see Research Report R-138 for details). In early 1992, Michigan Department of Transportation (MDOT) field personnel discovered delaminated top coats on three bridges. During bridge paint warranty inspections in May 1992, the inspection team discovered several more bridges with the same problem. The Department added these structures, along with two others, to the study, bringing the total number of bridges to 10, four of which were under a warranty specification. The list of structures with top-coat delamination may not be complete; however, we discovered no new delamination problems since July 1993. These 10 bridges comprise about two percent of the structures painted after converting to a three-coat system in 1985.

Discussion

With one exception, Contractors painted all structures in the study in September and October 1991; the exception was painted in July 1991. Three different contractors coated the 10 structures, and all used the same manufacturer's coating system. The investigators did not find a satisfactory explanation why nine structures completed in a two-month period all developed the same failure. Weather conditions, coating materials, and contractor practices could all be causes, but were not unique to the subjects of this study. The perplexing part was that not all structures coated during the end of the 1991 season exhibited peeling, and those that did were affected in a random fashion.

Late in the season, conditions are conducive to moisture formation, but there is no indication that 1991 was different from previous years. Also, the coating was a proven system used successfully for several years. All three contractors had the same problem, which seems to rule out faulty procedures. A possible explanation is that for some reason the urethane formulation that year was unusually sensitive to ambient moisture, and the contractors, anxious to complete projects, did not consider top-coat application critical to performance.

Findings

The inspection team found that peeling on each structure appeared only on one or two spans over traffic lanes. Each beam within the affected span showed delamination, with the top of the bottom flange frequently being the starting point for peeling. Contractors usually paint one span in a day, which supports the hypothesis that weather conditions on a given day contributed to delamination. Two structures will need extensive or complete repair of entire spans or sections, while the rest will require zone or spot repairs.

A microscopic examination of samples collected from the field verified the observation that the top coat separated cleanly from the intermediate coat. Painting over foreign material, such as dirt, oil, or moisture will cause intercoat delamination, but as inspectors did not observe any dirt or other foreign material between the intermediate and top coats, moisture on the previously painted intermediate coat is likely the cause of delamination. Examining a coating after it is cured, however, will not reveal whether the contractor painted over a thin layer of moisture.

Investigators obtained copies of the field inspector's Interim Daily Report (IDR) to check if conditions were favorable for moisture formation at the time of painting. They found that temperature and humidity readings are frequently missing from the IDRs (Table 1), but in cases where temperatures were recorded, there is no indication of where or at what time inspectors took the readings. Our specification requires that the steel temperature be at least five degrees above the dew point before painting can begin. With Michigan's climate, the steel or surface temperature is frequently only seven degrees above the dew point during much of the painting season, creating the potential for localized areas to be at or near the dew point and collect moisture. When possible, field inspectors should take temperature and dew-point readings close to the areas being painted to ensure that localized areas

TABLE 1

Bridge		Peeling	Date	Steel	Dew	Diff.	Air
1	tailspan,abut A	N	9-5	N/A	52	N/A	56
1	tailspan,abut B	N	9-5	N/A	63	N/A	78
2	tailspan,abut A	N	9-5	80	65	15	80
2	median	N	9-10	78	71	7	78
2	NB lanes	N	10-1	N/A	N/A	N/A	N/A
2	SB lanes	Y	10-1	N/A	N/A	N/A	N/A
3	tailspan	N	5-31	79	73	6	80
3	tailspan,abut A	N	7-30	70	63	7	71
3	median/lt.sh'ldr	N	7-31	N/A	72	N/A	82
3	SB rt. 2 lanes	Y	9-12	57	51	6	58
3	NB rt. 2 lanes	N	9-19	59	47	12	58
4	Span 4	N	7-3	N/A	N/A	N/A	N/A
4	Span 1	N	7-30	N/A	59	N/A	N/A
4	15' of Span 3	Y	7-30	N/A	59	N/A	N/A
4	Span 2	N	7-31	N/A	59	N/A	N/A
4	Span 3	Y	7-31	N/A	59	N/A	N/A
5	N. tailspan	N	10-3	N/A	N/A	N/A	N/A
5	Span 1	Y	10-3	N/A	N/A	N/A	N/A
5	Span 2	N	10-3	N/A	N/A	N/A	N/A

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meet specification requirements. MDOT specifications hold the contractor responsible for not painting over moisture, but pressure to finish a project may take precedence over painting within specifications.

Repair Procedures

The general repair procedure, used satisfactorily to repair two structures in 1992, is to power clean the affected areas without damaging the underlying coats, then recoat with 1 mil of polyurethane. The original contractor will repair bridges in this study that are under a warranty contract at the end of the two-year warranty period, and maintenance forces will repair the remaining bridges at MDOT's expense.

Conclusions and Recommendations

The opinion of the investigators is that such delamination is not widespread and results from an unique set of conditions that existed in 1991. To reduce moisture-related delamination of this type would require specification changes, including raising the dew-point and steel-temperature differential, requiring total enclosures during coating for painting, and verifying environmental conditions throughout the structure. Other than encouraging the field inspectors to take dew-point readings close to the areas being painted, the investigators recommend making no specification changes. Revising the steel-temperature and dew-point specification is impractical, because it would severely limit the number of days contractors could paint. With only two percent of the bridges painted since 1985 exhibiting delamination, the cost of requiring total enclosure is not justified at this time. If delamination continues to be a problem, the department should re-evaluate the cost of specification changes. The most cost-effective solution is to hold the contractor accountable for performance by expanding the warranty program.

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Technology Transfer Unit
Materials and Technology Division
Michigan DOT
P.O. Box 30049
Lansing, Michigan 48909
Telephone (517) 322-5688