Final Report

Experimental Features Project

MEMBRANE PROTECTION FOR STEEL STRINGER TOPS

Yaquina Bay Bridge
Newport, Oregon

Project No. OR-79-01

by

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F I N A L R E P O R T

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Introduction

Direct coastal exposure imposes serious problems to structural and reinforcing steel in bridges. Corrosion causes expansion of the steel resulting in a variety of problems including spalling of reinforced concrete. This problem can become especially severe under the deck where salt-laden moisture condenses and is not washed away by the rain.

The Yaquina Bay Bridge in Newport, Oregon suffered from severe corrosion problems making it necessary to replace the deck and sidewalk sections throughout the three steel arch spans. With the new deck in place, the tops of the steel deck stringers are inaccessible for sandblasting and painting and are thus subject to corrosion. The purpose of this experimental features study was to determine the effectiveness and suitability of the Chevron Industrial Membrane (CIM) for providing permanent corrosion protection on the tops of steel deck stringers and other similar members in conjunction with the deck replacement project on this structure.

Construction

The application of the Chevron Industrial Membrane was intended as a permanent solution to corrosion on steel members that would not be accessible for sandblasting and painting after the new filled steel grid deck was in place. This included the tops and edges of deck stringers, diaphragm beams and sidewalk supports.

All surfaces to be coated were prepared with a "commercial sandblast" conforming to Pictorial Standard SA2 of ASTM D 2200 or cleaner. Much of the blast was "near white." After sandblasting, the surfaces were wiped with Chevron Bonding Agent.

Temperatures at the time of application ranged from 40°F to 70°F. During inclement weather the membrane was applied under a plywood shed. Space heaters were used to warm the shed during weather having temperatures of 45°F or colder. The shed remained over the fresh membrane until it "skinned over" or became tack-free to prevent rain damage, normally one to two hours.

The membrane material is a two component, extended urethane consisting of Chevron Premix CIM and Chevron Activator CIM. Under the working conditions on this project, it was found there was very little latitude for error in the handling and mixing of the material. The material varied from not curing or setting up, to curing hard and brittle, but for

the most part, the Chevron Industrial Membrane (CIM) cured to a solid while remaining flexible and rubber-like. Material that did not cure properly was later removed and replaced.

Membrane cure time varied with temperature and the ratio of activator to premix. When ambient temperatures or shelter temperatures were in the 60's, initial curing generally took four to five hours. Temperatures in the 40's increased initial cure time to eight to twelve hours. When excess activator was used to reduce cure times, the mixture would sometimes set up too quickly to allow time for application. The manufacturer's literature indicates the material will cure in 24 hours to form a tough, resilient membrane. However, it was found complete curing of the membrane could take from several hours to several months, depending on temperature and mix variables.

The manufacturer's recommended thickness of application was 0.050 inch. To achieve the correct thickness, the wet membrane was checked with a wire having a diameter of 0.050 inch. The dry membrane was checked with a Nordson dry film thickness gage. The Chevron Industrial Membrane was difficult to place to a precisely uniform thickness, but in this application minor thickness variation would be of no consequence.

Trowel and spray grades of Chevron Industrial Membrane were used on this project. Both grades were applied with steel concrete trowels. The trowel grade was used exclusively on the east half of the deck and interchangeably with the spray grade on the west half. Unless problems associated with its application can be solved, the trowel grade is not recommended for use on projects of this nature for several reasons, including the following:

(1) The quick set-up time (10 mins.±) allowed little time for application and limited mix batches to one gallon.

(2) Material was very sticky and messy to handle.

(3) It was very difficult to apply uniformly, impossible around rivet clusters, because the material would not flow. There were always thin spots to be patched thick spots to be trimmed. It would sag and drip from vertical edges.

(4) Because of these problems, there was excessive waste. The calculated job quantity was approximately 300 gallons. Over 800 gallons were used.

The primary advantage of the trowel grade for the type of project is that it cured sufficiently in four to five hours to allow for placement of the grid decking, whereas the spray grade required five to six hours for curing. The steel grid deck was selected as a replacement for the original concrete deck on this project because of the need to keep the bridge open to traffic during construction. Time was very critical in the contractor's operation and the extra hour or so of cure time required for the spray grade was a major factor.

The spray grade was easier to apply. It had the consistency of a thick paint and would flow into a uniform coating. A disadvantage of the spray grade was the tendency to run down to surfaces that were not to be coated and to "string" down from the edges of the deck stringers. However, these strings were easily trimmed after the membrane had cured.

Most of the problems encountered during application of the Chevron Industrial Membrane on this project can be attributed to the lack of trained and experienced personnel. For instance:

(1) The activator was allowed to cool to the point of crystallization during storage (60°F) which reduced its effectiveness.

(2) The protective warming shed was moved too soon on occasion, resulting in some rain damage to the membrane.

(3) Carelessness, inaccurate proportioning and inadequate mixing time were probably the reasons for most of the curing and end result variations.

(4) During the early stages of the project, lacquer thinner and diesel oil were used for tool clean-up. The diesel oil use was discontinued when it was suspected to be a source of contamination, causing a delay in the membrane curing.

(5) Small sags from the edges of the deck stringers were initially left untrimmed. These later interfered with the painter's sandblasting and had to be cut back to the edge of the flange.

Adequate training for those applying the material and for those inspecting its application should be a requisite for the use of the Chevron Industrial Membrane. The manufacturer's instructions must be strictly adhered to.

Performance Appraisal

Inspections made prior to the placement of the grid deck indicate that adhesion to the steel was generally good, although there were a few areas on the edges of the deck stringers where the membrane could be pulled free. These areas may have been the result of delayed application or of surface contamination. There was no visible pinholing of the membrane. Membrane extrusion occurred after placement of the grid deck in areas where curing was slow; however, the membrane subsequently hardened. When the membrane was cured, there was no indication that placement of the grid deck and concrete caused any extrusion.

Subsequent visual inspections at one year and at three years indicate that the material is performing well, with no visible changes. Some rusting has occurred at the interface of the membrane and steel where the combination of sags or runs and the sandblasting during paint-

ing have created a flap effect with the sagged material. The area under this flap generally did not get painted and some rust staining has occurred. Very little rust staining is evident where the transition from the membrane to the steel is a clearly defined line.

Cost

The crew used to apply the Chevron Industrial Membrane generally consisted of one half-time foreman and four full-time laborers. Generally one laborer would be sandblasting, one mixing and two applying the membrane. Costs were as follows:

Labor	$44,900
Materials	$14,894
	$59,794

Conclusion and Recommendations

Evaluation of the Chevron Industrial Membrane in this application is difficult because of the inaccessibility for inspection. After three years in service there have been no changes in the physical appearance of the membrane. Inspections indicate that CIM satisfactorily protects inaccessible steel members from corrosion.

There are, however, several disadvantages with its use. Curing time is very difficult to control under variable temperature and moisture conditions. The membrane is difficult to apply uniformly and often would not flow enough to allow uniform placement on rivet clusters. Difficulties in handling and placing resulted in a great deal of material waste and high placement costs. The tendency for the membrane to run and sag along the edges interferes with sandblasting and painting operations. Failure to trim the flaps and sags results in rusting along the interface of the membrane with the steel. In areas where a clearly defined line between the membrane and the steel exists, very little rust staining has occurred.

It is recommended that, prior to future use of this material or similar materials for this purpose, laboratory testing be undertaken within the range of temperature and moisture conditions expected at the job site to optimize use of the membrane and to reduce waste and handling costs.

If proper care is taken in applying and trimming the material, this evaluation indicates the Chevron Industrial Membrane will provide the intended long-term protection from corrosion for inaccessible steel members.