CRSI CONCRETE REINFORCING STEEL INSTITUTE
EPOXY COATING COMMITTEES
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anti-corrosion times

Reporting on industry news, noteworthy applications and new developments of the fusion bonded coating system for corrosion prevention.

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EPOXY COATING PASSES FIRE TESTS WITH FLYING COLORS

The dominant use to date of epoxy-coated reinforcing bars has been in new or replacement deck slabs for highway bridges. As reported often in this newsletter, usage of epoxy-coated bars has spread to many other types of reinforced concrete structures such as parking garages, port and marine structures, wastewater treatment plants, and parts of industrial plants.

Fire rating question

In parking garages, epoxy-coated bars are being used in new construction as well as in the repair and rehabilitation of existing structures. Building codes usually impose fire rating requirements on enclosed parking garages, particularly those which comprise the lower levels of commercial or residential buildings.

When fire-resistive construction is required for parking garages, questions have been raised concerning the structural behavior and performance of components reinforced with epoxy-coated bars. The questions usually focus on the heating of the epoxy coating and its subsequent effect on bond strength of the bars with the concrete. When the epoxy coating on the bars softens or melts, due to heating, do the bars lose their bond with the concrete?

These are certainly valid questions. On the other hand, there are potential safety hazards resulting from premature deterioration of a reinforced concrete structure due to corrosion of the reinforcement. Premature deterioration also places an unnecessary financial burden on owners of parking facilities. Repairs and business interruptions are costly to owners —

Continued on page 4

Underside view of slab in place for fire test

Deicing salts no threat to underground parking ramps in Toronto's newest highrise

An architectural gem will soon shine in Toronto's downtown business district. The 68-story, $430 million Plaza Bank Building is on its way up to become an important new landmark in this fast growing city of three million people.

The striking structure is a composite design with a reinforced concrete slip-formed central core. 8,000 tons of Grade 60 rebar went into its core construction. It's the world's second tallest concrete "tube" building.

To provide its tenants and visitors with ample inside parking, a 4-level underground reinforced concrete ramp was planned. That means hundreds of cars could be tracking in snow mixed with deicing salts every cold winter day. Bad news for concrete. With the acres of underground ramps and parking areas, it was vital to protect the concrete against the intrusion of destructive salts which could cause future rebar corrosion. It's the products of this corrosion which exert tremendous force, causing the concrete to spall. Therefore, all 600 tons of rebar in the parking complex are epoxy-coated.

The designers went all out in providing insurance against possible future corrosion problems. A waterproof membrane topping is placed over the silica fume concrete slabs. This prevents salt from penetrating the concrete.

If salt water should ever get through the membrane barrier, it won't be able to corrode the rebar because the fusion bonded epoxy-coating would prevent corrosive elements from reaching the steel.

Epoxy-coated rebar was specified for both top and bottom reinforcing for 250,000 sq. ft. of floor slabs on the four suspended parking levels, as well as in the ramps and some supporting beams. The structural engineer noted that the extra cost for this added protection amounts to only about one-half of 1% of the total cost of the structural system.

Close-up of the placement of the epoxy-coated rebar on the parking ramp far below street level.

Moving up, concrete on another ramp level is placed over the epoxy-coated rebar around the central core.

Owner: **Campeau Corp. & PCL Constructors, Toronto**
Architect: **Webb Zerafa Menekes Housden, Partnership, Toronto**
Contractor: **PCL, Toronto**
Structural Engineer: **Quinn Dressel Associates, Toronto**

Deicing salts are not the only cause of corrosion! Imagine cars and trucks, as in this 1929 scene, spewing corrosive exhaust every day for 60 years. No wonder the unprotected ceiling gradually began to deteriorate.

After 60 years of corrosive exhaust — Holland Tunnel ceiling says "that's enough"

Epoxy-coated rebar figures in new installation

After 60 years of being subjected to the corrosive exhaust of 5 billion or more cars, the 5" thick concrete ceiling slab in the Holland Tunnel must be replaced. The 1/16" expanded metal reinforcing in the concrete of this granddaddy of all vehicular tunnels was corroded completely through in some areas and required emergency repairs to prevent the danger of falling sections.

The Port Authority of New York and New Jersey, owner of this vital link between two states, contracted with Morrison-Knudsen Company to install new ceiling panels. Measuring up to 5 x 22 feet and 5-1/2 inches thick and weighing about 4 tons, five different series of panels were required in special trapezoidal shapes. To fit each ceiling panel properly, the contractor conducted a survey to measure precise dimensions at each panel placement point — over 30,000 points in all. Stereo photographs were taken to pinpoint exact dimensions for each of the 1,800 tailor-made panels.

The panels were produced in the Morehead City, North Carolina plant of Morrison-Knudsen under very tight specifications so they will last under the corrosive conditions. Fabrication procedure called for placing concrete over No. 2 and 3 bars and WWF 4 x 4 - W4 x W4. For assurance of lasting protection against future corrosion problems, all rebar and welded wire fabric were epoxy-coated.

Before placing the reinforcing steel in the forms, clay tiles with a moisture resistant glaze are set in a rubber grid followed by a layer of cement slurry.

Concrete is poured over panels reinforced with epoxy-coated rebar.

Closeup of the well-constructed panel. All rebar and welded wire and ties are epoxy-coated.

After the slurry has set, the reinforcing steel is positioned on top and the 4-3/4 inch layer of concrete is poured.

Panels were then trucked to the New Jersey side on flat bed trucks where a specially-designed hoist frame was attached which transferred them onto lifting platforms for installation at their designated location. With epoxy-coated reinforcing steel on the job this time, the panels should more than match the historic performance of the original reinforced concrete slab with the added feature of a ceramic tile finish that provides even greater corrosion protection.

Historic San Francisco highrise reclad with precast panels containing protective epoxy-coated rebars

The well-known Appraisers Building with its original terra-cotta exterior.

The old 16-story Appraisers Building, a landmark federal office building in the prestigious financial district of San Francisco, is going modern.

Built in 1941, its original terra cotta facing was showing the effects of the years and weather. Cracking and fading were increasingly a problem. It was time to reconstruct the exterior.

The Design and Construction Division of Public Buildings of the General Services Administration, San Francisco hired architects Kaplan, McLaughlin, Diaz and Forell/Elsesser, structural engineers to do the job. The challenges were to design new panels for the entire building that would provide a long, maintenance-free life span. And, the panels had to match the original terra cotta appearance to preserve the character of the historic district in which the building is located.

The solution was to go to reinforced concrete panels. The engineers wisely called for epoxy-coated reinforcing steel for all the perimeter "trim bars". This decision in their words was, "due to exposure of the panels to coastal marine environment and help assure the desired longevity of a Federal Building."

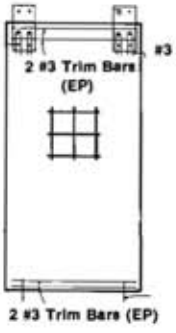


Diagram shows locations of No. 3 epoxy-coated rebars at perimeter of panels. No. 4 uncoated rebars are on 12" centers in the rest of the panels.

WISCONSIN DOES IT AGAIN

Pioneers in CRCP interstate overlay

Completed section of smooth, continuously reinforced concrete pavement.

In the nearly 30 years since it was constructed, Interstate 94 has carried millions of travelers through the rolling hills of Wisconsin. From Wisconsin's southern border with Illinois, I-94 heads northwest for 350 miles into Minnesota.

It's a favorite route for tourists heading to Wisconsin's famed lakes and woods — or on to Minnesota. That's why it is so heavily traveled by motorists — and also preferred by truckers.

This year, after taking decades of pounding by countless cars and trucks and the application of tons of deicing salt, it came time to rehabilitate some sections. The Wisconsin Department of Transportation, Division of Highways earmarked a 14-mile stretch near Eau Claire that had been built in 1967, for reconstruction.

Based on the state's good experience with continuously-reinforced concrete pavement (CRCP), it was a sound decision to call on the proven principle again. Only this time, instead of total reconstruction as has been done on other projects elsewhere in the state, DOT engineers decided to use a CRCP **overlay** on top of the original 9", jointed reinforced concrete pavement.

After preparing the old pavement, a 1-inch nominal asphalt-concrete leveling course was placed. Polyethylene sheeting was applied over this as a bond breaker.

Epoxy-coated Rebar — Good Insurance

Paving of the 10" CRCP overlay started in mid-summer in the middle of the project and proceeded northwesterly in the westbound direction from the concrete plant site. After completing the first 7-mile section, the remaining 7 miles were paved southeasterly in the same manner.

The longitudinal steel is comprised of forty-four No. 6 epoxy-coated bars placed on 6-1/2 inch centers. Transverse epoxy-coated bars and chairs were prefabricated with the chairs tackwelded to the transverse steel. This aided in faster set up. Altogether, approximately 2,700 tons of epoxy-coated rebar were used. The total 28-lane miles were scheduled for completion in less than a season.

Typical condition of existing jointed concrete pavement.

Longitudinal epoxy-coated rebars were set on transverse epoxy-coated rebars with prefabricated epoxy-coated chairs.

The contractor, James Cape and Sons Co., Racine, Wisconsin reported smooth going on this 28-lane mile overlay project; often achieving 6,000 feet a day with their 24-foot slipform paver. The mainline overlay paving was completed ahead of schedule in late August. A smart paving project smartly executed.

While CRCP has been used by this and many other states for new highway construction, Wisconsin acted in its traditional innovative manner and for the first time anywhere in an overlay project, specified that all reinforcing steel be **epoxy-coated**. The benefits of this decision include lasting protection against rebar corrosion caused by deicing salts and the promise of longer pavement life with less future maintenance. A better deal for taxpaying motorists.

Navy fights corrosion battle in new ship docks with epoxy-coated rebar

There's a huge new, double-deck concrete structure taking shape on the waterfront in Charleston, South Carolina. Sometime in early 1987, it will be ready to accommodate U.S. Navy ships up to 600 ft. long. It's a twin double deck pier complex that will be equipped to service Navy ships and keep them in fighting trim.

Designed by Gee & Jenson, Engineers-Architects-Planners, Inc., West Palm Beach, Florida under jurisdiction of Naval Facilities Engineering Command, Charleston, it has many unusual design features for its specialized role. Not so unusual, however, was the specification that all concrete in the massive structure, up to 10 feet elevation above sea level, include epoxy-coated reinforcing steel.

The designers are taking no chances in this harsh marine environment. They wanted maximum protection against future deterioration of the concrete from both salt water and salt air exposure. Their specification of epoxy-coated bar in the lower portion of the hefty double deck berthing facility is low-cost insurance against any rebar corrosion problem.

The 1245-foot long double deck berthing facility.

Attending ASCE in Boston? Meet the Epoxy-Coated Rebar Experts

Here's an opportunity to update yourself on the latest thinking in the design and use of epoxy-coated rebars for all types of projects.

Bring your questions to the specialists who will staff the CRSI booth in Boston, October 27-31. Get the latest reports on this most cost-effective method of protecting steel in concrete against corrosion problems. You'll find your time well invested. Look for us in booth 91.

FIRE TESTS *Continued from page 1*

extra costs which could be minimized if coated bars were used as a corrosion-protection system.

Thus, the construction industry is faced with a dilemma! Epoxy-coated reinforcing bars are a proven and cost-effective corrosion-protection system. But are epoxy-coated bars suitable for fire rated construction?

Fire testing

To resolve the dilemma, the Construction Technology Laboratories, a Division of the Portland Cement Association, has fire-tested a large two-way slab reinforced with Grade 60 epoxy-coated bars. The objective of the fire test was to determine the fire endurance of the slab and to compare its structural performance to a companion slab, reinforced with uncoated Grade 60 bars, that had been fire tested in a previous fire test program.

The test specimen was a two-way flat slab approximately 18 by 14 ft. in plan and 7-in. thick. Aggregate for the normal weight concrete was predominantly a mixture of dolomite and chert. The slab was subjected to a 138 psf uniformly distributed service live load throughout the fire test. Moderate in-plane restraining forces were applied to the slab to simulate an edge bay in a nine-bay floor system. Clear concrete cover on the reinforcing bars was 3/4 in. The fire test was conducted in accordance with the fire test standard ASTM E 119 and for practical reasons limited to approximately 4-1/2 hours.

As evidenced by the test results shown, the fire endurance, or fire rating, of the slab reinforced with epoxy-coated bars is at least 4-1/2 hours. This is more than satisfactory for use in parking garages where regulations generally require a 1-1/2 to 3 hour fire rating, and is comparable to the performance of the slab reinforced with uncoated bars. The somewhat higher deflection obtained for the slab reinforced with epoxy-coated bars is at least partially due to the fact that, for practical reasons during testing, the restraining forces applied to the slab with coated bars were on average, about 15% lower than those applied to the slab reinforced with uncoated bars. Also, the aggregate for the slab reinforced with epoxy-coated bars had a higher coefficient of thermal expansion than that of the slab with uncoated bars.

Acknowledgment

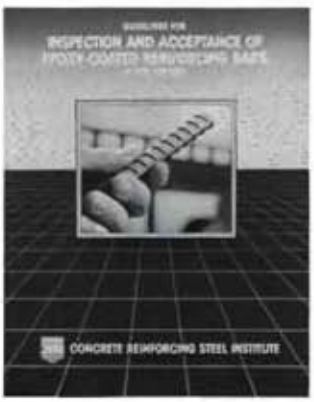
We acknowledge the Construction Technology Laboratories' cooperation in permitting us to disseminate this information before they complete the preparation and publishing of their detailed report on the fire test. We have received numerous inquiries from design professionals regarding the use of epoxy-coated bars in fire rated construction. Hence, our sole purpose in presenting the basic fire test results here is to respond to those questions and concerns. The fire test of the slab reinforced with epoxy-coated bars was funded by the Portland Cement Association, the Concrete Reinforcing Steel Institute, and by ten companies that manufacture or apply epoxy coating materials.

COMPARISON OF TEST RESULTS

	Slab With Epoxy-Coated Bars	Slab With Uncoated Bars
Duration of test	4 hr. 30 min.*	4 hr. 20 min.*
Structural end point	Not reached	Not reached
Heat transmission end point	Not reached	Not reached
Measured center point deflection at end of test	4.8 in.	3.7 in.

**Test stopped at arbitrary time after exceeding 4 hr. duration, the maximum fire rating required in codes, but before any end point was reached.*

Just published:



Here's a brand-new aid for users of epoxy-coated reinforcing bars. For the first time, contractors, field inspectors, project engineers and ironworkers have a practical reference guide for the inspection and handling of epoxy-coated rebar at the jobsite.

Illustrated with full color photos, the 16 page manual gives recommended construction practices for the handling, storage, inspection and placing of epoxy-coated reinforcing bars.

Priced at $8.00, copies are available from the Concrete Reinforcing Steel Institute.

Brad McFadden Thomas Edgell Herbert Schmidt

EPOXY-COATED REBAR GROUP ELECTS NEW LEADERS

The Epoxy Coating Committees (ECC) of the Concrete Reinforcing Steel Institute elected new chairmen at its 1986 annual spring convention at Innisbrook, Tarpon Springs, Florida. Named as Chairman of the ECC Advisory Committee was Brad J. McFadden, Epoxicote Rebar, Inc., Stoney Creek, Ontario, Canada. Herbert J. Schmidt, Jr., P.E., MCP Facilities Corporation, Glen Head, New York was appointed Chairman of the ECC Technical Committee. Thomas W. Edgell, 3M Company, St. Paul, Minnesota was named Chairman of the ECC Marketing Committee.

Members of the Epoxy Coating Committees of the Concrete Reinforcing Steel Institute include epoxy powder manufacturers and coating applicators and producers and fabricators of reinforcing bars. ECC is increasing its range of technical services to design professionals and contractors who specify this system of protection of steel against corrosion in concrete.

Epoxy-Coating Committees Retiring Director Honored

Robert T. Stafford, who recently retired as Director of the Epoxy-Coating Committees of the Concrete Reinforcing Steel Institute was honored by the CRSI Board of Directors and all attending CRSI members at its May 7 meeting.

Bob caps off a long career of service to the reinforcing steel industry with the last several years as the Director of the Epoxy-Coating Committees, which represents powder producers and fabricators of epoxy-coated reinforcing steel.

The staff functions of the Epoxy-Coating Committees are now shared by Ted Neff, CRSI Transportation Engineer, Peter Steiner, Marketing Manager and David Gustafson, Technical Director, under the direction of Victor A. Walther, Jr., Executive Vice President.