CRSI

ANTI-CORROSION TIMES

REPORTING ON INDUSTRY NEWS, NOTEWORTHY APPLICATIONS & NEW DEVELOPMENTS ON FUSION BONDED EPOXY COATINGS FOR CORROSION PROTECTION OF REINFORCING STEEL.

VOLUME 18, NO. 2 FALL 2001

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In this issue

ANTI-CORROSION TIMES

is a publication of the Concrete Reinforcing Steel Institute, a not-for-profit trade association providing valuable resources for the design and construction of quality cast-in-place reinforced concrete. Published biannually, the Anti-Corrosion Times is produced to help specifiers, engineers, architects, fabricators and end-users receive the most recent information about how and where epoxy-coated reinforcing steel is used, recent technical changes and information resources. Send any questions or comments regarding the Anti-Corrosion Times to John M. Prentice, Manager of Corrosion Protection at CRSI.

Epoxy-coated rebar used in Utah I-15 could reach from Salt Lake City to the Moon

As the entire reconstruction of Interstate 15 through Salt Lake City nears completion, over 61,000 tons of epoxy-coated reinforcing steel and pavement dowels have been used for 17 miles of freeway and 144 bridges. If considering an average bar size to be #5 (5/8 inch in diameter), that tonnage equates to 121,000,000 feet of steel. Put end to end it would form a line of bar from the surface of the Great Salt Lake to the surface of the moon. Other record-breaking material usages included 2,500,000 cubic yards of concrete and over 5,000,000 cubic yards of fill.

Reinforcing steel for seat abutment and backwall of typical bridge

Speedy Delivery

To expedite completion, the Utah Department of Transportation (UDOT) chose design-build contracting for the $1.6 billion project. This surely minimized traveler inconvenience, reducing construction to 4-1/2 years from over 10. Thanks to diligence by both the design-build contractor and the material suppliers, the project is now 5 months ahead of schedule—great news since Salt Lake City will host the 2002 Winter Olympics. It's also great news for the contractor, who has earned $4,996,018.75 to date, out of a possible $5,000,000 bonus for early completion.

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Keeping Utah I-15 on or ahead of schedule, no easy task . . . continued from page 1

Bridge pier cap reinforcing steel

Epoxy Coating Helps In Short-Term

Keeping epoxy coated reinforcing steel supplied to the project was no easy task either. With the tight engineering and field work of design-build, material supply was continually on the critical path of the construction. The CRSI-certified epoxy coating plant met all delivery schedules, did not delay any single concrete placement operation and continually broke its own monthly quantity records for coating and fabrication. The epoxy powder supplier, Dupont Powder Coatings, did their part by providing next day service to the coater. As a final assurance, plant management placed epoxy project managers on site to help maintain proper field handling techniques and for quick problem solving.

Two Steel Types

The required use of two grades of reinforcing steel complicated matters somewhat at the coating plant. Bridge engineers specified ASTM A706 (Grade 75) low-alloy reinforcing steel for longitudinal and spiral reinforcement of columns for the 144 bridges, since the I-15 corridor is located near the Wasatch Front mountains. The Wasatch Front has seen seismic activity of magnitude 7 and higher. ASTM A706 is chosen for seismic zones because it is more ductile than the more commonly used ASTM A615 (Grade 60). No special requirements are needed to coat ASTM A706 versus A615, which made up the majority of the 61,000 tons used. However, plant personnel were required to maintain separate inventories.

Epoxy Coating Helps In Long-Term

For the long-term, the epoxy coating will protect the reinforcing steel from corrosion due to chlorides from road deicing. UDOT's policy is to maintain a dry pavement at all times, requiring a large amount of deicing salts. This, plus the fact that salts are plentiful in the soils around the Great Salt Lake, necessitates enhanced corrosion control. To ensure a minimum 50-year service life for its structures, UDOT specifies epoxy-coated reinforcing steel in all bridge elements, except piles in certain situations. This requirement includes both top and bottom mat of bridge deck reinforcement. ♦

Epoxy Coating: Western Coating, Inc., Ogden, UT
Design-Build Contractor: Wasatch Front, Salt Lake City, UT
Owner: Utah DOT, Salt Lake City, UT
For more information: www.i-15.com

Pier cap construction

North Carolina lifeline bridge uses epoxy-coated rebar to ensure 100 year life

By November 2001, the Croatan Sound Bridge will bring faster access and egress between Manteo on Roanoke Island and the northeast mainland of North Carolina. The new 5.25-mile-long, 4-lane-wide bridge will be the longest in the state, and joins an existing 2-lane bridge built in 1956 as the only vehicular access to and from the island and the Outer Banks. The new bridge will increase accessibility, improve safety and travel time, and provide a key emergency evacuation route during hurricanes and tropical storms. It was desperately needed since a 1996 study projected traffic would more than double by 2020.

The following material facts were taken from the Croatan Bridge website, www.doh.dot.state.nc.us/operations/division1/soundbridge/facts/

- Enough deck concrete to cover 278 basketball courts to a depth of one foot.
- Enough deck reinforcing steel to go the 2633 miles round trip from Manteo to Wichita, KS.
- Enough deck surface grooves to go the 3680 miles round trip from Manteo to Billings, MT.
- Enough roadway fill for 8000 truck loads.

Sound Bridge Components

The North Carolina Department of Transportation (NCDOT) wanted a bridge that would last for "100 years." Thus, quality design, construction and construction materials are a must for the 268 bridge spans. Typical spans on the low-level crossing sections use 1372 mm (54 in.) standard AASHTO girders that are each 97.5 feet long. Typical spans in the high-rise crossing sections use 1981 mm (78 in.) pre-stressed concrete bulb-tee girders that are each 137.8 feet long. For the 3-span main navigational channel, a set of 7 precast concrete girders were spliced and post-tensioned together to form a continuous unit. The 8.25-inch-thick deck slab is constructed of lightweight concrete with a minimum concrete compressive strength of 4,500 psi. All reinforcing steel in the deck is epoxy-coated.

Seven piles and a pile cap support the low-level crossing superstructure; pile supported footings with dual columns and a hammerhead cap support the high-level crossing superstructure. The maximum column height is 54 feet above top of footing.

Placement of reinforcing steel for barrier; deck concrete in place

The Need for Epoxy-Coated Rebar

Cast-in-place and precast concrete work used a total of 11,329 tons and 965 tons of epoxy-coated reinforcing steel respectively. The NCDOT standard is to use epoxy coating for all steel subjected to a highly corrosive environment such as salt water in coastal areas. Bridge designers chose to specify the coating of both top mat and bottom mat of deck reinforcing steel, as well as the barrier.

Epoxy coating of reinforcing steel has the longest track record of all corrosion protection systems. It has been used on thousands of bridges and many other structures since the 1970s. ◆

Construction of west side approach spans

Epoxy Coating: ABC Coating of North Carolina, Gastonia, NC
Engineer: Wilbur Smith Associates, Raleigh, NC
Contractor: Balfour Beatty Construction, Inc., Atlanta, GA
Owner: North Carolina DOT, Raleigh, NC
For more information: www.doh.dot.state.nc.us/operations/division1/soundbridge/

Automated deicing strategy and epoxy-coated rebar combine for long-lasting, safe Michigan roadway structure

(This article is a continuation of the cover story from the Winter 2001 edition of Anti-Corrosion Times.)

The reconstruction of the one-mile S-curve of U.S. 131 in downtown Grand Rapids, Michigan, is by far the most complex infrastructure project ever seen in the western part of the state. To make it more unique, it is one of the first U.S. roadway/bridge projects to use an innovative point-of-application deicing technology in combination with the industry standard corrosion protection strategy: epoxy coating of reinforcing steel. The Michigan Department of Transportation's (MDOT) two-prong solution will provide an extremely safe and a long-lasting traffic structure.

Anti-icing disk dispenser and control box

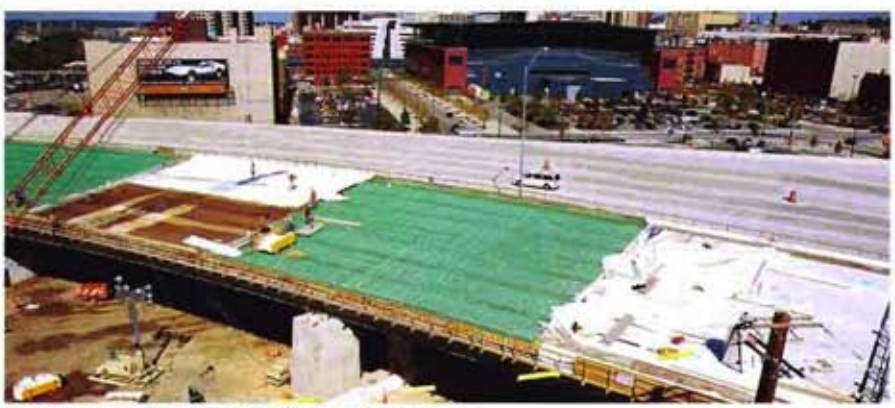
New S-Curve

The original S-curve consisted of 6 bridges that carried over 120,000 vehicles per day. Although only 36 years old, continual traffic increases and substandard roadway alignments for high-speed traffic necessitated reconstruction. The entire structure from piers to superstructure were replaced. The S-curve shape is retained but alignments are revised to allow 50 mph traffic movement; a fourth driving lane was added as a merging/weaving lane. Also, some ramps are reconfigured to improve traffic flow and safety.

Safety First

The latest technology in anti-icing systems is being used. The point-of-application system consists of disks (shaped like over-sized hockey pucks) that are embedded flush into the roadway surface (bridge deck) during cast-in-place concrete construction. Disks, installed on both sides of the roadway in both directions, are wired to sensors imbedded elsewhere in the roadway. Sensors automatically trigger the disks to spray three narrow streams of anti-icing liquid across two lanes of traffic when weather conditions warrant. The streams never shoot higher than six inches above the deck surface. Vehicle tires actually help spread the liquid evenly across the pavement. When one sensor triggers a disk, all other disks fire in sequence. As a backup, the disks can be fired manually from a control box located at the bridge or even remotely by telephone.

Installation of anti-icing system in bridge deck



Construction of southbound S-curve bridge deck

Long-Term Solution

Not only is this anti-icing system more to-the-point than the commonly used spreading of road salt, but is also said to be environmentally safe and non-corrosive, which is good news for the long-term performance of the reinforced concrete bridge deck and the structural steel girders. None the less, the MDOT thought it prudent to rely

on epoxy coating of the reinforcing steel for corrosion protection. After all, vehicles entering the S-Curve will most likely be carrying road salt from adjacent roadway stretches and local streets. ◆

Epoxy Coating/Rebar Fabricator: ABC Coating of Michigan, Inc.
Contractor: Kiewit Western, Inc., Chicago, IL, and Whaley Steel, Detroit, MI, in joint venture
Owner: Michigan DOT, Lansing, MI

For more information:
www.mdot.state.mi.us

Roster requiring CRSI plant certification grows

On January 8, 2001, the New Mexico State Highway and Transportation Department (NMSHTD) became the fourteenth highway agency in the United States to require that epoxy-coated rebar come from plants certified under the Concrete Reinforcing Steel Institute Epoxy Plant Coating Certification program. The special provision by the NMSHTD became effective immediately for projects in design and for all future projects.

Currently more than 90% of epoxy coating plants in the U.S. and Canada participate in the program. ◆

State/Province Highway Agencies Requiring Certified Plants as of August 2001

Arkansas	North Carolina
Idaho	Oregon
Indiana	Utah
Kansas	Virginia
Minnesota	West Virginia
Nevada	Wisconsin
New Hampshire	Alberta
New Mexico	Ontario

CRSI Epoxy Coating Plants Certification Program Certified Plants in the U.S. and Canada*

Alberta
HARRIS REBAR
Leduc, 780-986-7055

Colorado
ABC COATING CO. OF COLORADO
Brighton, 303-654-0098

Illinois
AMERICAN HIGHWAY TECHNOLOGY
Kankakee, 888-745-3751

TOLTEC
Mokena, 972-937-9841

Indiana
BLOCK HEAVY AND HIGHWAY PRODUCTS, CO.
Valparaiso, 219-476-4106

MIDWEST PIPE COATING, INC.
Schererville, 219-322-4564

RJ REBAR, INC.
Muncie, 765-286-5454

Iowa
SIOUX CITY FOUNDRY COMPANY
Sioux City, 712-252-4181

WADY INDUSTRIES, INC.
Maquoketa, 563-652-5136

Kansas
AMERICAN HIGHWAY TECHNOLOGY
Parsons, 800-745-3709

Michigan
ABC COATING OF MICHIGAN, INC.
Wyoming, 616-245-4626

Minnesota
SIMCOTE, INC.
St. Paul, 651-735-9660

Missouri
SHEFFIELD STEEL CORP.
Kansas City, 816-231-3110

New Jersey
CO-STEEL SAYREVILLE
Sayreville, 732-721-6600

North Carolina
ABC COATING OF NO. CAROLINA
Gastonia, 704-865-9171

Ohio
SIMCOTE, INC.
Marion, 740-382-5000

Oklahoma
ABC COATING CO. OF OKLAHOMA
Tulsa, 918-585-2587

STEEL COATING, INC.
Muskogee, 918-682-2600

Ontario
HARRIS REBAR
Stoney Creek, 905-662-5700

TEME INC.
Stoney Creek, 905-643-0045

Pennsylvania
AMERISTEEL
Milton, 570-742-2350

HARRIS REBAR ATLANTIC, INC.
Bethlehem, 610-882-1401

LANE ENTERPRISES, INC.
Carlisle, 717-249-8342

TITUSVILLE FABRICATORS, INC.
Franklin, 814-432-2551

Tennessee
AMERISTEEL
Knoxville, 865-546-0102

Texas
ABC COATINGS CO. OF TEXAS
Waxahachie, 972-937-9841

Utah
WESTERN COATING, INC.
Ogden, 800-835-3039

FARWEST STEEL CORP.
Salt Lake City, 800-364-8030

Washington
WESTERN COATING, INC.
Auburn, 800-835-0576

*As of September, 2001

Epoxy-coated rebar saves billions of dollars

The report, "Corrosion Protection: Concrete Bridges"[1], from the Federal Highway Administration (FHWA), includes a chart that shows the latest grade-year condition of bridges constructed between 1973 and 1977. These bridges were some of the first built with epoxy coated reinforcement. An excerpt from that report states:

The preferred primary corrosion-protection systems in many states has been fusion-bonded epoxy-coated rebars (ECR), which have been used in approximately 20,000 reinforced concrete bridge decks. This rebar has performed very well in alleviating the problem of corrosion-induced deterioration of concrete bridge decks. It is estimated that its use in the last 25 years has saved the tax payers billions of dollars so far.

With continuing improvements in the American Association of State Highway and Transportation Officials (AASHTO) and American Society for Testing and Materials (ASTM) specifications for ECR, this corrosion-protection system will become even better.

The table below shows that when studied in 1998, all 18 bridges were judged to be in very good to good quality condition and none of the bridge decks required maintenance because of reinforcing steel corrosion. The following chart indicates performance of each bridge, showing why epoxy-coated reinforcing steel gets a strong recommendation from the FHWA.

Since its first use in 1973, epoxy coating of reinforcement has become the primary corrosion protection system for many state highway departments. Low initial cost and documented longer performance has made it a sound value and a proven protection strategy.

The FHWA report highlights bridges which were constructed with some of the first epoxy-coated reinforcement used for this application. Epoxy-coated reinforcing steel continues to add years to the life of these bridge decks, particularly important in structures affected by use of deicing chemicals. ♦

[1]FHWA-RD-98-088, September 1998

First Use of Epoxy-Coated Reinforcing Bars in Bridge Decks—Deck Condition and Grading[1]

State DOT	Coated Bars in Top or in Top and Bottom Mats[2]	Bridge Opened	Initial Grade-Year	Latest Grade-Year	Deck Maintenance Caused by Rebar
Illinois	Top	1977	N/A	7-1997	0
Indiana	Top & Bottom	1976	7-1976	6-1997	0
Iowa	Top	1975	8-1975	7-1997	0
Kansas	Top	1977	8-1977	8-1997	0
Kentucky	Top	1975	7-1981*	7-1997	0
Maryland	Top & Bottom	1974	9-1974	7-1996	0
Michigan	Top & Bottom	1976	8-1980	7-1997	0
Michigan	Top & Bottom	1976	8-1980	6-1996	0
Michigan	Top & Bottom	1976	8-1980	7-1997	0
Minnesota	Top	1973	8-1973	7-1996	0
Missouri	Top	1974	9-1974	7-1996	0
Nebraska	Top	1975	9-1975	7-1997	0
Nebraska	Top	1976	N/A	8-1997	0
Ohio	Top	1974	8-1985*	7-1997	0
Pennsylvania[3]	Top	1973	6-1989*	6-1997	0
West Virginia	Top	1973	9-1973	6-1997	0
Wisconsin	Top	1975	9-1975	7-1996	0
Wisconsin	Top	1976	9-1976	8-1996	0

1. Data compiled in January 1998. 2. "Mat" refers to the layers of reinforcing bars; "Top" for the orthogonal grid of bars near top surface of deck and "Bottom" for the grid near bottom surface of deck. 3. Acknowledged as the first use of epoxy-coated reinforcing bars in a bridge deck.

N/A = not available *Initial grade unknown
FHWA Grade 0 to 9.9; Grade of 9 = new condition; Grade of 8, 7, 6 and 5 = very good to satisfactory

The best gets better with epoxy-coated rebar in Minnesota

Construction of airport tunnel's base slab

Already voted the "best large airport in North America" for 2000 and 2001 by the International Air Transport Association, Minneapolis/St. Paul International Airport (MSP) is in the midst of a $2.6 billion expansion project. The Minnesota Legislature decided in 1996 to expand MSP at its present site rather than build a new airport and pay for it with user fees, not new taxes. According to MSP, in 1999 the

Placement of reinforcing steel for tunnel base and wall

average airport user fee was $3.77 per passenger versus a national average of $8.06. The 2010 Plan includes improvements to the airfield, terminal, parking and roads. Also, a light rail transit line is being extended from the Twin Cities downtown areas directly into MSP.

Roadway Under Runway

One phase of expansion involves the construction of a tunnel under a new 8,000-foot-long runway—North/South (17/35)—to open in 2003. The tunnel will be used as an access roadway to a new state-of-the-art cargo terminal that is being built between two existing runways (South Parallel and Crosswind) and runway 17/35. The cargo terminal's location necessitated the need for safe and efficient underground vehicular movement. The tunnel is being built using cut-and-cover technology, with part of its roof supporting the new runway.

Water Stops Work

Although started three years ago, concerns of groundwater draw-down due to excavation dewatering held up tunnel work for eight months. The engineering solution called for jet grouting to form a cement wall to surround the entire tunnel excavation. With the wall in place, state agencies reissued permits for construction and water control activities, and the project restarted. The majority of construction will be finished by late summer 2001.

The Need for Epoxy-Coated Rebar

The reinforcing steel used in the concrete tunnel will be subjected to possible corrosion due to roadway deicing salts carried by vehicles entering the tunnel and sprayed by airplanes using the runway above. Therefore, epoxy coating was specified to protect vulnerable surfaces, such as the roadway (tunnel floor). A total of 1,650 tons of epoxy-coated reinforcing steel is used in this tunnel. Two additional tunnels with epoxy-coated reinforcement are also planned. ◆

Bottom slab construction

Epoxy Coating: Simcote, Inc., St. Paul, MN
Tunnel Engineer: various
Tunnel Contractor: various
Owner: Metropolitan Airports Commission (MAC), Minneapolis, MN
For more information: www.mspairport.com

Illinois to Double Pavement Life

The Illinois Department of Transportation (IDOT) may be setting a new example when it comes to state-of-the-art pavement technology. IDOT is exploring ways to increase the projected life of highway pavements, lower maintenance and repair costs and reduce costs and impacts to users—even if it means higher initial costs.

Most Illinois highways are currently designed for a service life of 20 years based on traffic projections. However, with ever increasing traffic volume and loads and Illinois' extreme environmental conditions, service life has been shorter than 20 years in some cases.

That hasn't been the case for the Edens Expressway, which links Chicago with its northern suburbs. Now over 20 years old, the Edens has carried much more traffic than projected and remains in excellent condition, without any major repairs. Pavement on the Edens consists of 10 inches of concrete continuously reinforced with epoxy-coated steel. (IDOT uses epoxy coating for all continuously reinforced concrete pavement in the Chicago area, as well as for bridge structures throughout the state.)

IDOT is investigating ways to achieve a 40-year service life by fine-tuning the design, material specifications and construction methods used on the Edens. The proposed 40-year pavement consists of a compacted subgrade covered with a minimum of 12 inches of crushed stone, followed by a 6 inch layer of asphalt, and capped with 12 to 13 inches of high quality concrete, also continuously reinforced with epoxy-coated steel.

Pavement construction will cost more initially, but will be more economical in the long run by providing a 40-year service life. IDOT is expected to build its 40-year pavement on Interstate highway projects in the Chicago area and around northern Illinois within the next several years. ♦

Update to CRSI Webpage on Epoxy-Coated Reinforcement

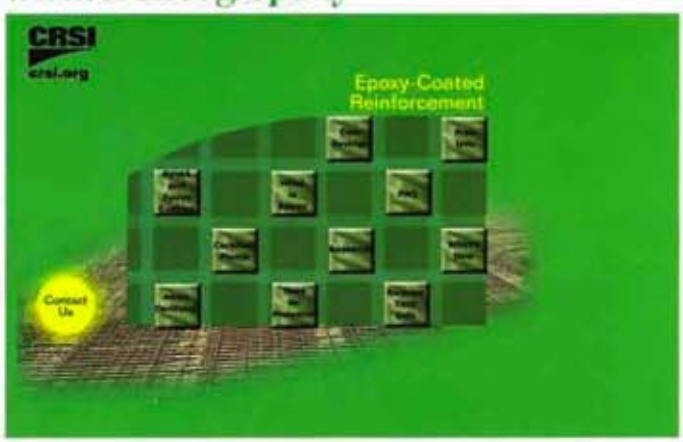
The epoxy webpage sports its first new look since its early 2000 launch.

The New Look:

- Streamlined groupings
- Easier access to downloadable literature
- CRSI certified plants listed with improved contact information

Coming soon, videos on epoxy coated reinforcing steel manufacturing, fabrication and field handling.

www.crsi.org/epoxy



Acknowledgments . . . Special thanks to the following for their help with information and photos for articles in this issue.

Utah I-15: Robert Anderson, URS Corporation; William J. Semioli, Concrete International.

N.C. Croatan Bridge: Marshall Bonds, ABC Coating of North Carolina.

Mpls-St. Paul Airport: John Simmet, Simcote; James Riemenschneider, 3M; Brent Wilber, Lunda Corp.

Grand Rapids S-curve: Daniel Acuna, ABC Michigan; William Phillips, MDOT Photo Lab.