ANTI-CORROSION TIMES

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

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In this edition

Chicago Union Station selects epoxy-coated rebar for its long service life

The rebuilding of the Harrison and Lake Street Interlockings that serve Chicago's Union Station is the largest individual rehabilitation project ever initiated by Amtrak outside of the Northeast Corridor. This $55-million project, financed by Metra and Amtrak, involved the complete replacement of all tracks, switches and signals that feed the south end of the station as well as selected track and signal work at the north end.

Included in the project was the total replacement of track slabs and over 12 miles of railroad that access the 16 track stations. The Milord Company of Bridgeview, Illinois replaced 15 South Station track slabs and all 15 South and North platforms. Each area was completed as an individual segment over a three year period while the station remained fully operational.

The project was done in two phases—track slabs and then platforms. Each slab or platform was completed separately to maintain sufficient station operations for both passenger and commuter trains. While the project was not difficult to plan, it was massive in scale. A great deal of coordination was necessary to handle construction along with the heavy passenger volume during rush-hour traffic periods.

The tracks were in a state of obsolescence and disrepair, creating constant maintenance problems. Originally installed in 1915 as stub ties set in concrete, the track could not be replaced as it deteriorated. This lead to serious track structural problems including trains sitting at 5° off plumb.

Platforms were replaced because they were in a poor and obsolete condition. In addition, they needed to conform with the Americans with Disabilities Act (ADA) and the revised railroad clearances. The ADA standards included adding tactile tiles two feet out from the edge of the platform to warn blind passengers that they are approaching the track.

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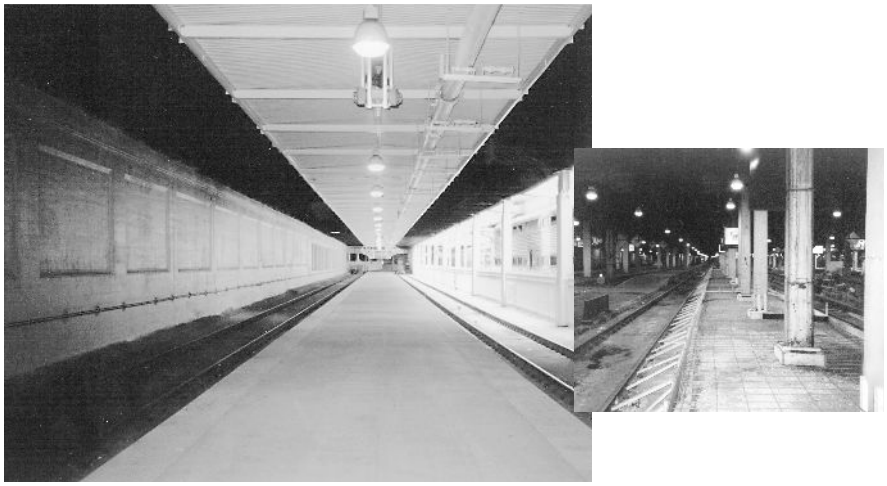
Chicago Union Station selects . . . continued from page 1



Union Station is the first station to use track slabs for station inverts and station works, technology previously used only for transit systems. With this renovation, Union Station is the leader in embedded track technology, an advanced anchoring system with continuous rails and no slab joints. Union Station was also one of the first to use direct fixation for a smoother ride.

Construction Techniques

Because the station was in use during the entire life of the project, there was a need for innovative scheduling, material use and project management.

Working conditions were difficult because of height restrictions, rubble removal and passenger traffic. During the three years of rehabilitation, crews often worked at night or on weekends for increased safety and work area efficiency to take advantage of minimal passenger traffic.

The project included tear up and removal of all track and platform slabs as individual projects. In this demolition phase, concrete and ties were separated for recycling.

With seventy percent of the station under existing buildings, restricted height clearances of 16 feet added to the complicated reconstruction process. Cranes and other heavy equipment had little space to maneuver.

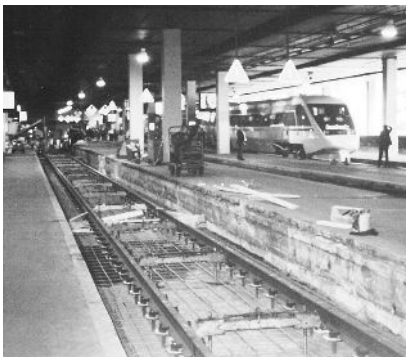
The solution—a cast-in-place concrete system reinforced with epoxy-coated rebar.

In an environment that included high humidity, wide temperature variations and heavy salt transfer, a construction system with a proven long life-cycle was necessary. Both Milord Construction and an independent structural engineering consultant chose epoxy-coated rebar for its corrosion protection and extended life-cycle qualities. Approximately 300 tons of #4 and #5 epoxy-coated rebar were used.

The height restrictions, the lack of roads and because pumping proved to be too expensive, an alternative approach was necessary to facilitate the concrete pour. Two 10 yard trucks were placed "piggy-back" on flat rail cars and brought into the station. In-station work was also time restricted from 9:30 am to 1:30 pm daily. This limited each pour to about 40-60 yards of placed concrete. To ensure the specified results, a three inch concrete cover mix with an increased portland content was used. Curing required seven to fourteen days.

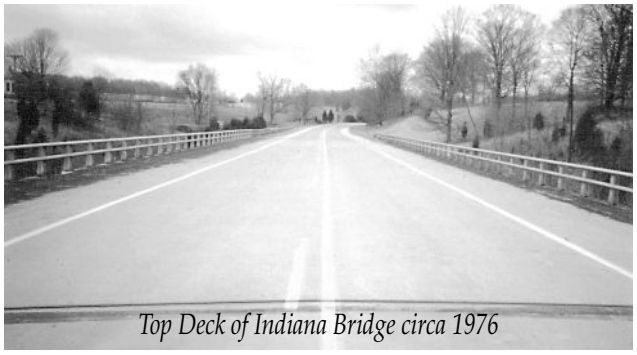
Inspection of the first installed track slab after more than three years showed no sign of stress cracking, no sign of stress on the rail and no movement. The slab looked as good as new.

Completed in December 1995, the rehabilitated track and platform at Union Station continues to perform



with little or no maintenance and is easy to clean. More importantly, the total costs were less than other construction systems. In fact, the embedded track system cost one-third less than rebuilding using the old stub-tie system it replaced. ♦

Survey updates epoxy success in bridge decks



Top Deck of Indiana Bridge circa 1976

Top Deck of Pennsylvania Bridge circa 1973

A recent inspection and survey of 18 bridge decks in 14 states has documented the success of epoxy-coated rebar as a protection system for bridge decks. Included in the survey are 13 bridge decks examined in 1993. No apparent change has been noted in these decks since their last inspections.

All of the inspected decks first used epoxy-coated rebar (ECR) in the 1970s, and each is the first known installation of ECR in its state. All are located in freeze/thaw regions where ECR has become the norm for almost every state where deicing chemicals are used. Each bridge deck has required little maintenance since installation. This has been verified by bridge engineers responsible for the bridge design or maintenance records.

This overview of 18 bridges completed in 1993 and again in 1995-1996 provides evidence of the excellent performance ECR has demonstrated during the initial 20 years of installation. With approximately 27,000 bridge decks using ECR in the United States today, performance speaks for itself.

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Conclusion

Epoxy coating on reinforcing steel provides a barrier against the corrosive effects of chlorides that permeate concrete. It prevents reinforcing steel corrosion and the deterioration of concrete that results.

BRIDGE HISTORY

STATE	Mat	Year Opened	Initial Grade—Year	Latest Grade—Year	Rebar Deck Maintenance
IOWA	Top	1975	8—1975	7—06/19/95	0
ILLINOIS	Top	1977		7—12/01/95	0
INDIANA	Top & Bottom	1976	7—1976	6—01/17/96	0
MICHIGAN	Top & Bottom	1976	8—1980	7—10/31/95	0
	Top & Bottom	1976	8—1980	7—08/10/94	0
	Top & Bottom	1976	8—1980	7—08/30/94	0
KANSAS	Top	1977	8—1977	7—1995	0
MINNESOTA	Top	1973	8—1973	8—08/17/95	0
NEBRASKA	Top	1976	n/a*	8—1996	0
	Top	1975	9—1975	7—1996	0
WISCONSIN	Top	1976	9—1976	8—08/95	0
	Top	1976	9—1976	8—08/95	0
MARYLAND	Top & Bottom	1974	9—1974	7—07/96	0
KENTUCKY	Top	1975	7—1981*	7—06/95	0
PENNSYLVANIA	Top	1973	6—1989*	5—07/95	0
MISSOURI	Top	1974	9—1973	7—12/14/95	n/a
OHIO	Top	1974	8—1985*	7—03/19/96	0
WEST VIRGINIA	Top	1973	9—1973	6—02/02/96	0

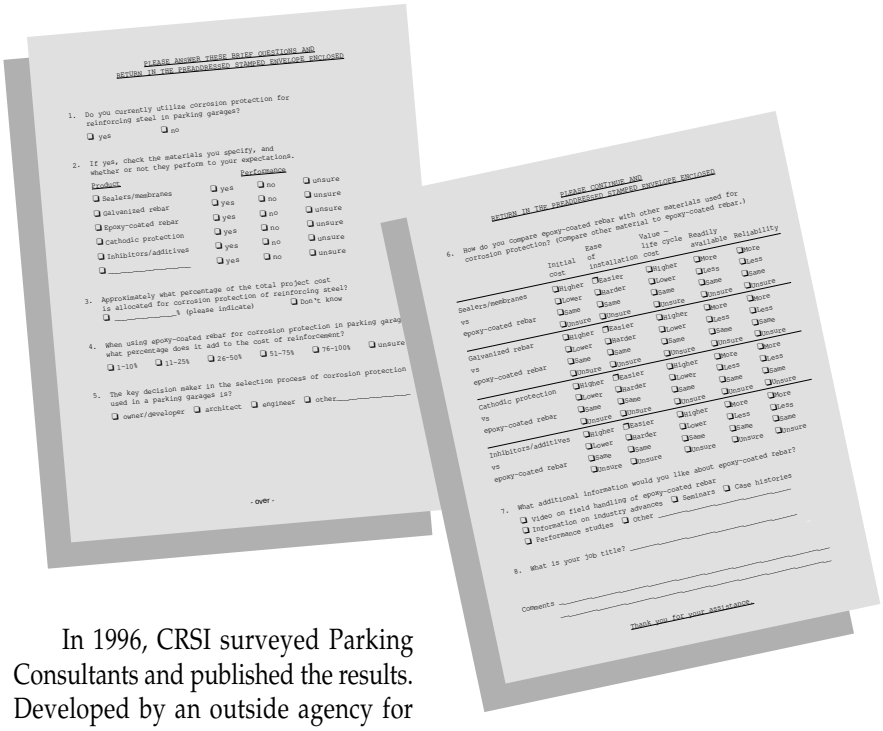
*Initial Grade Unknown n/a = not available Data compiled 11/26/96

IOWA Ratings 0 to 9.9

Ratings of 9 = new condition

Ratings of 8, 7, 6, and 5 = very good to satisfactory

Corrosion Product Survey to parking consultants leads to life-cycle evaluation



In 1996, CRSI surveyed Parking Consultants and published the results. Developed by an outside agency for CRSI, the survey was multi-purpose with five primary objectives:

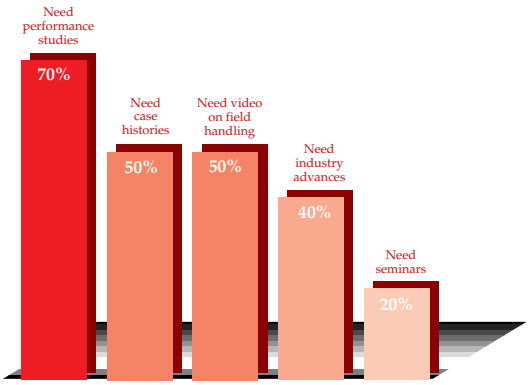
1. To determine the perceptions of parking garage developers towards epoxy coating.
2. To determine if corrosion protection materials were used in the construction of parking garages, what types were used and the users' perceptions of the products.
3. To determine how the users compared other corrosion protection material to epoxy-coated rebar.
4. To determine who decides what type of corrosion protection products are used, if any.
5. To determine if users know what additional costs are involved when adding epoxy coating to rebar.

A response rate of 21% provided a valid survey and helped CRSI gather information about the perceptions of materials used for corrosion protection in parking garages. While epoxy coating usually adds only about 1-1/2% to the cost of a parking garage project, the survey revealed that most specifiers and non-specifiers are not aware of initial costs. Consultants know that epoxy coating will enhance service life, but generally, have no supporting life-cycle cost data.

Survey results were positive regarding the use of epoxy-coated rebar.

- 83% of respondents used some type of corrosion protection, and all of these respondents have specified epoxy-coated rebar, either as the sole protection system or in conjunction with other materials, i.e., sealers/membranes or inhibitors/additives.
- 60% of the respondents indicated performance to expectations,
- 26% were unsure about performance, basically because material had not been installed long enough to realize life-cycle performance.

Other products used for corrosion protection included cathodic protection, galvanized rebar, and to a lesser extent, concrete cover, low water to concrete ratio, and concrete mix design.



Results of surveys such as this 1996 Parking Consultant Survey and the 1995 Epoxy Research Survey help CRSI produce materials necessary to educate the industry about epoxy-coated rebar. ♦

CRSI assesses performance of epoxy-coated reinforcing steel in parking decks built between 1980-1985

A new study of 19 parking ramps built with epoxy-coated reinforcing steel from 1980 to 1985 in Wisconsin, Minnesota, Michigan, Nebraska and South Dakota are "performing adequately." That is the term generally applied to ramps that have little or no damage since construction.

For the study, CRSI found the earliest parking ramps built with epoxy-coated reinforcing steel. The study included visual inspection of 12 ramps plus interviews with ramp owners and engineers and supporting documentation for all 19 ramps.

Even though epoxy-coated reinforcing steel was used in bridge decks during the 1970s, it was not used in parking ramps until 1980. The owners and engineers of the 19 parking ramps studied here all specified epoxy-coated bars. Today, these same people are still satisfied with the performance of the epoxy-coated protection system. In fact, all owners and engineers interviewed continue to use epoxy-coated reinforcing steel for their new parking construction.

Wisconsin . . .
Minnesota . . . Michigan
Nebraska . . . South Dakota

Epoxy-coated reinforcement was found to be effective in preventing chloride corrosion in areas that have severe freeze-thaw cycles and where vehicles carry deicing salts onto the ramps.

Minnesota . . . University of Minnesota, Washington Avenue

Several of the owners interviewed have not had the same success with uncoated steel used in the 1960s and 70s. They have had to finance extensive repairs caused by chloride damage.

Of the 19 parking ramps studied, only one had limited epoxy disbonding, which has been attributed to inadequate concrete cover and construction errors.

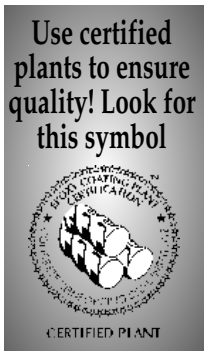
Only used since the early 1980s, owners and engineers are unable to predict how much time epoxy coating can add to the life-cycle of parking garages. But generally, industry users feel that epoxy coating in parking garages adds at least 10 to 15 years of protection before corrosion even has a chance to start developing. With uncoated bar, corrosion can begin in year one.

Later in 1997, CRSI will publish the complete findings on these parking ramps, including information about each individual ramp. ◆

Wisconsin . . . LaCrosse Civic Center Garage Top Deck

Minnesota . . . St. Cloud Grand Central

CRSI Plant Certification Program a resounding success



Instituted in 1991, the CRSI Voluntary Plant Certification Program for Epoxy Coating Applicators has been extremely effective at improving quality of epoxy-coated rebar. The Program's goal is to ensure that coating applicator plants have the capabilities and quality control procedures in place to assure that the highest quality material is produced and delivered to the job site.

The success of the Program can be measured in several ways. Participation in the program has grown, with 30 of the 34 plants in North America either certified or pending inspection. These plants produce over 95% of epoxy-coated rebar supplied.

CRSI's independent inspection agency, Wiss Janney Elstner Associates, has noted dramatic quality improvements in all of the participating plants. And, the improvement has been at little or no additional cost to the product delivered. In 1991 prior to the initiation of the program, the added cost of epoxy coating was $0.127 per pound according to a 20-city average published in Engineering News Record magazine. In 1997, the average added cost differential was $0.087. The final indication of the programs effectiveness is the fact that many specifiers now require CRSI Plant Certification for all epoxy coating suppliers. As of January 1, 1997, ten State Departments of Transportation and two Canadian Ministries of Transportation require CRSI certification.

What is the CRSI Plant Certification Program?

The program is intended to complement––not replace an owner's quality assurance efforts. All significant aspects of the coating application process are evaluated. These areas include: quality control policies, handling, storage, surface preparation, curing, holiday testing, thickness measurement and adhesion testing.

Several new tests (not required by most standard specifications) have been introduced as part of the program such as:

NEW TESTS

- ✔ BACKSIDE CONTAMINATION
  to measure the amount of dirt, dust and other contamination that is between the coating and steel.
- ✔ CHLORIDE DETECTION
  to ensure that the steel being coated is not contaminated with salt before the coating is applied.
- ✔ COPPER SULFATE TEST
  to identify mill scale on the steel surface that has not been removed by blast cleaning.
- ✔ CATHODIC DISBONDMENT TEST
  to more effectively evaluate coating adhesion.

The Certification Program is constantly being reviewed and updated in an effort to improve product quality even further and to more fully satisfy specifiers' needs. In fact, since the program's inception, the quality control standards have been revised and tightened seven times. This has been accompanied by a change in the coater's attitude toward quality. Now, as a direct result of the CRSI Certification Program, most coaters strive to do the best job possible, even if not required by the specification. As an example, the average of inspection scores in the Certification Program is 90%, even though only a score of 75% is needed for certification.

The result, as noted earlier, has been a dramatic improvement in product quality over the past six years. Highlights include:

- ▲ Certified plants now average 0.23 holidays per foot of bar. (ASTM now requires not more than an average of 1 holiday per foot; in 1991, the limit was 2 per foot)
- ▲ Average backside contamination is 15%. Prior to 1991, the industry averaged between 40% and 50% by best estimates.
- ▲ Based on recent CRSI surveys, certified plants now average less than 4mm disbondment in the cathodic disbondment test. This test was not performed on a routine basis in 1991; however, research indicates that coated bars produced prior to that time, typically, had much poorer results in this test.

To find out more about this program and how you can benefit from it on your next project, contact CRSI.

For an immediate list of the CRSI Certified Plants, visit our Website: http://www.crsi.org ◆

Survey updates epoxy success in bridge decks . . . continued from page 3

Top Deck of Kentucky Bridge circa 1975

Underdeck of above Kentucky Bridge in 1993

The service life of all bridge decks is documented in federally mandated inspection reports. Biennial inspections provide a detailed description of the structure's condition according to a uniform rating system. The FHWA rating is based on a scale from 0 to 9.9, with the top grade reserved for new condition. Ratings of 8, 7, 6, and 5 represent deck conditions from very good to satisfactory, in descending order. Lower ratings signal trouble.

The ratings shown are the most recent available from each state inspection. All were rated from satisfactory to very good, as shown in the Bridge History Chart on page 3.

The positive results of the survey provides evidence of a successful technology at work. Even though most of the bridges built in the 70s used a single mat of epoxy-coated reinforcing steel (most use a double mat today) and had less stringent standards for concrete cover and strength than today, they are still performing successfully.

Continually improving standards of quality ensure a bright future for ECR. With the addition of CRSI's Epoxy Certification Program and when materials are produced to specifications, fabricated and handled correctly before installation, epoxy-coated rebar proves to be an effective long term bridge deck product. ♦

ASTM Standard Specifications follow certification program

The CRSI Certification Program has served as a proving ground for many of the recent changes and improvements to ASTM standard specifications for epoxy-coated reinforcement. Requirements for holiday testing, bend testing, anchor profile and powder prequalification have all been tightened based on the performance of coating applicators in the certification program.

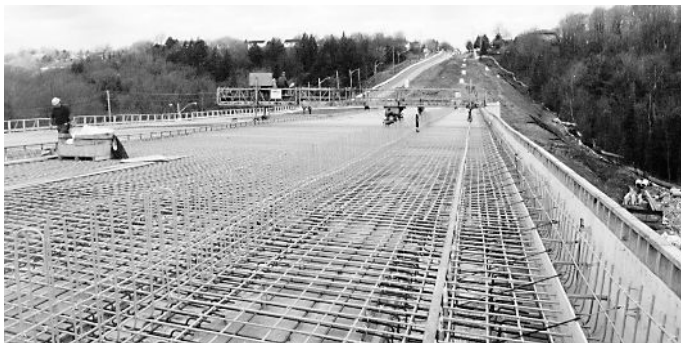
The following are the most current versions of ASTM standards for epoxy-coated reinforcement and are recommended for use on most projects where corrosion of reinforced concrete is a concern:

ASTM A775-96	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A934-96	Standard Specification for Prefabricated Epoxy-Coated Reinforcing Steel Bars
ASTM D3963-96a	Standard Specification for the Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars
ASTM A884-96	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
ASTM A994-95	Standard Test Method for Comparing Bond Strength of Steel Reinforcing Bar to Concrete Using Beam-End Specimens

For more information regarding these specifications, contact ASTM at 610-832-9500. ♦

Epoxy-coated rebar used for bridge expansion

Completed in late 1996, the Mountainview Road Bridge on the outskirts of Georgetown, Ontario, Canada (West of Toronto) and owned by the municipality of Halton was built to handle increased traffic in the area. The bridge and roadway required expansion to four lanes to allow uncongested traffic flow.



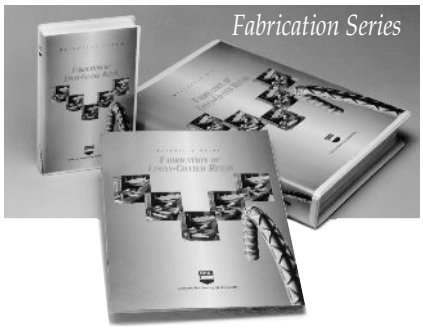
Improved visibility was also required for the roadway in the Silver Creek Valley. The new roadway design corrected a dangerous downhill blindspot.

With a construction budget of $4,000,000 (Canadian) for the bridge structure, it was important that the construction method provide a long service life. This was accomplished by using 165 tons of epoxy-coated rebar in the top reinforcing mat. The cost to add epoxy coating to the top mat reinforcement was only 1.4% over the original construction budget. Epoxy-coated reinforcing steel was supplied by Raymond Steel Limited, Ontario. They also supplied an additional 213 tons of black rebar for use in other areas of the bridge.

The structural engineering firm responsible for the design of the bridge was McCormick Rankin & Associates Limited. ♦

New epoxy videos and guides available

The newest series available from CRSI include a video and a reference guide on the fabrication of epoxy-coated rebar.



The series was developed for use by inspectors, manufacturers, consultants and others involved in the fabrication of epoxy-coated rebar. The video is approximately 7-1/2 minutes long. The reference guide is fully illustrated in 12-pages. Both show the approved method of receiving, storing, shearing, bending, repairing, handling and shipping epoxy-coated rebar.

These materials were developed to help those involved in the manufacturing and fabrication of epoxy-coated rebar produce an end product that assures high quality and increases the life-cycle of concrete structures.

Introduced in 1996, the CRSI field handling techniques for epoxy-coated rebar series also include video and reference guide.

This series was developed for industry users including contractors, inspectors and others involved in construction. Both the 8-1/2 minute video and 12-page reference guide give the most current information about field handling procedures. Subject matter includes receiving, inspection, long and short term storage, placing with use of accessories, inspection, field repair and guidelines for the concrete pour.

The CRSI Epoxy Coating Technical Committee produced both video and reference guide series. You can order either series.

- ❑ Reference guide .....$10 each
- ❑ Video .....$25 each

Kits are also available at a reduced rate:

- ❑ Fabrication of Epoxy-Coated Rebar Kit, video and guide.....$30
- ❑ Field Handling Techniques for Epoxy Coated Rebar at the Jobsite Kit, video and guide.....$30

Call, fax or write to CRSI for these new, colorfully illustrated reference materials. ♦