CRSI

ANTI-CORROSION TIMES

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

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. Direct any questions or comments regarding the *Anti-Corrosion Times* to Scott Humphreys.

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Runway 10-28 at Hartsfield-Jackson Atlanta International Airport (ATL) uses 2,033 tons of epoxy-coated steel bars

Hartsfield-Jackson Atlanta International Airport (ATL) is one of the world's busiest airports as it handles over 80 million travelers and 700,000 tons of cargo each year while serving 192 cities in 31 countries. Future demands are predicted to reach 121 million passengers by 2015.

Runway 10-28 opened on May 27, 2006 and is expected to decrease delays at ATL by 50 percent, causing a decrease in delays across the country, saving time for air travelers and money for the airlines—a projected $260 million per year.

The runway is one segment of the largest public works project in the history of the State of Georgia with an overall budget of $6 billion and a 10 year schedule. Known as the "fifth runway," Runway 10-28 is a $1.28 billion dollar part of the project. Designers were faced with many obstacles along the way. One hurdle was determining the optimal runway location due to the position of the existing 3,750-acre, landlocked airport,

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surrounded by highways. Another challenge was site preparation and the need for extra fill. In order to begin building the new runway, a conveyor belt system five miles in length had to be installed to import more than 27 million cubic yards of fill. Soil had to be placed at a rate of 7,000 tons per hour every day.

The runway is 9,000 feet long and located 4,200 feet south of the airport's existing southernmost runway. It includes a full-length parallel taxiway and dual north-south taxiways to connect to the existing airfield. This runway accommodates CAT III operations (take-offs and landings in all weather conditions).

Runway 10-28 crosses over ten lanes of traffic on Interstate 285, with two-thirds of the runway pavement on the west side and the remainder across the road on the east. Although the unique bridge culvert spans 10 lanes, expansion is possible up to 18 lanes. An impressive size, the main runway bridge measures 1,200 feet long by 486 feet wide, and its taxiway bridge is 450 feet long by 450 feet wide. While most aircraft touch down before they cross the bridged section, the bridge is designed to withstand an aircraft load well over the weight of a 1.04 million-pound wide-bodied Boeing 747 or 1.33 million-pound Airbus A380.

Aerial view of Interstate 285 and box culverts

With six construction packages, key elements of the Runway 10-28 program included the relocation of roadways and streams within the runway footprint, construction of taxiway and runway bridge structures over Interstate 285, maintenance of ten lanes of traffic during construction, and relocation under the runway plus importation and placement of 27 million cubic yards of fill. The sequence of construction along the runway was driven by a balance of risks associated with anticipated consolidation of underlying compressible materials, 30- to 80-foot-deep fills, utility relocation constraints and site logistics.

Runway 10-28 program was recognized by the Airports Council International-North America with the 2004 Environmental Achievement Award, in the category of large hub.

Aerial view of box culverts under construction

Runway Facts:

2,033 tons of epoxy-coated rebar
4,260 tons of uncoated rebar
9,000 ft. long x 150 ft. wide
Surface: concrete/grooved
Design capacity:
- Single wheel: 75,000 lbs
- Double wheel: 209,000 lbs
- Double tandem: 600,000 lbs
- Dual double tandem: 900,000 lbs

Project Team:

Owner:
City of Atlanta

Joint Venture:
Hartsfield-Jackson Construction Management

Boris Lend Lease
DMJM Aviation,
Thicker Operating Company,
Louis Burger & Associates
Luster CM Incorporated.

Bridge Contractor:
Archer Western Contractors Limited

Concrete:
Allied RMC, Atlanta, Georgia

Concrete Pumping:
Pioneer Concrete Pumping, Smyrna, Georgia

Earth Moving:
5R Contractors

Epoxy Rebar:
CMC/ABC Coating - North Carolina

Uncoated Rebar:
CMC South Metro Rebar - Georgia

CRSI sponsors visual test for corrosion-resistance in reinforcing bars

The question is often raised as to which type of corrosion-resistant steel reinforcing bar is best. While the question is seemingly simple, the numerous studies completed to date are often difficult to visualize and understand in a physical way. This study addresses this shortcoming by providing side-by-side photographs of various corrosion resistant steel reinforcing bars.

Extraction procedure of 15 year old epoxy-coated rebar used in this study

The Fog Test

Eight different bar material samples were exposed to a 5% NaCl fog at 35°C for a total of 672 hours. The corresponding corrosion was documented by weight and visual inspection.

Several bars were tested in the as-received condition (mill scale) and sandblasted conditions. In total there were fourteen different specimens, each of which were tested in triplicate. All the bars were No. 5 (16 mm) except the sandblasted low carbon, chromium ASTM A 1035/A 1035M which was a No. 4 (13 mm).

The epoxy-coated bars and galvanized bars were tested as-received and with 1/16-inch drill holes. Recently produced epoxy-coated reinforcing (ECR) and ECR retrieved from a bridge deck about 15 years old were used. Chloride analysis of the concrete indicated that the chloride level was twice the threshold level.

All the bars were degreased with solvent, rinsed with deionized water, air-dried and then exposed in a Q-fog chamber. During testing bars were visually inspected, removed from the chamber, cleaned and then weighed to obtain weight loss data. From each of the specimens one bar was removed at 174 hours, the second bar at 440 hours, and the last bar at 672 hours. This data was then used to calculate corrosion rates.

The complete study with before and after photos of each time slot is available on line at www.crsi.org

Bar Materials Tested

Eight types of steel reinforcing bars were studied:

1. Uncoated ASTM A615/A615M
2. Low carbon, chromium ASTM A1035/A1035M
3. Old galvanized ASTM A767/A767M
4. New galvanized ASTM A767/A767M
5. Grade Cr12 stainless steel ASTM A240/A240M (a lean stainless steel—proprietary)
6. Grades 2201, 2205, 316LN stainless steel ASTM A955/A955M
7. 15-year old epoxy-coated ASTM A775/A775M
8. New epoxy-coated ASTM A775/A775M

Concrete core sample with smooth, unstained rebar impression

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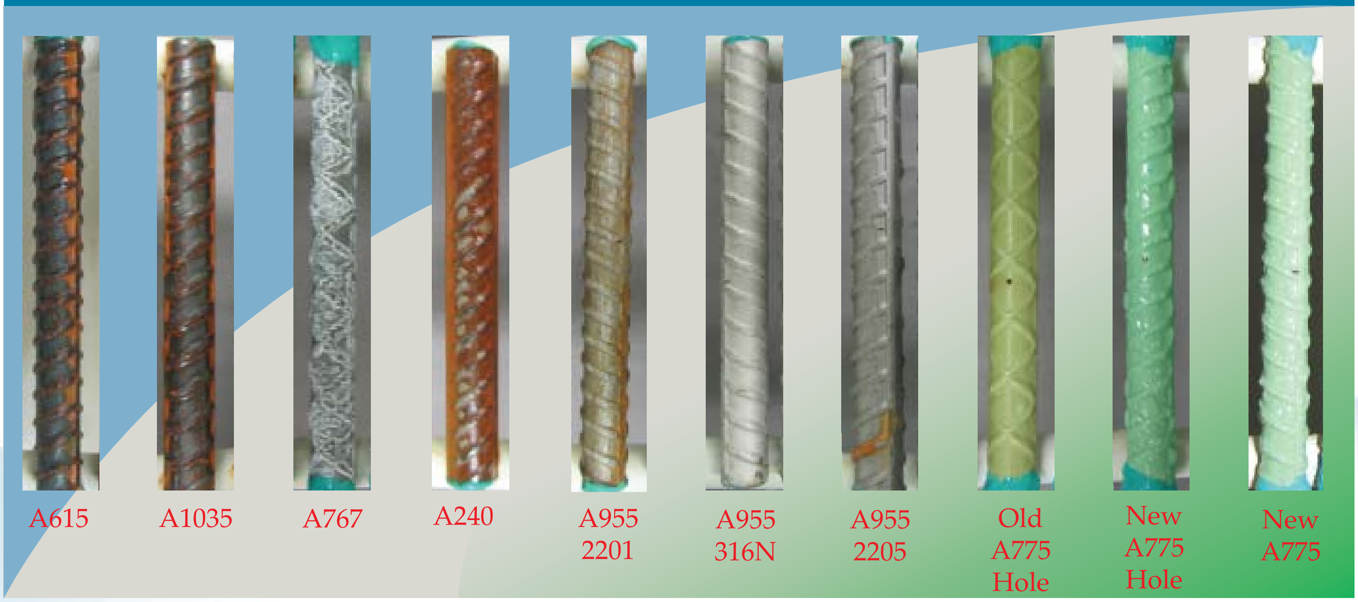
Bars at 12 hours of exposure in 5% NaCl fog



Results

After just 12 hours of exposure, A615, A1035, A767 and A240 bars showed progressive corrosion

The complete study with before and after photos of each time slot is available on line at www.crsi.org

Uncoated ASTM A615/A615M Bars

Both as-received and sandblasted bars corroded extensively and the corrosion aggressively progressed with time. Weight analysis shows that the bars experienced significant corrosion.

Low Carbon Chromium ASTM A1035/A1035M Bars

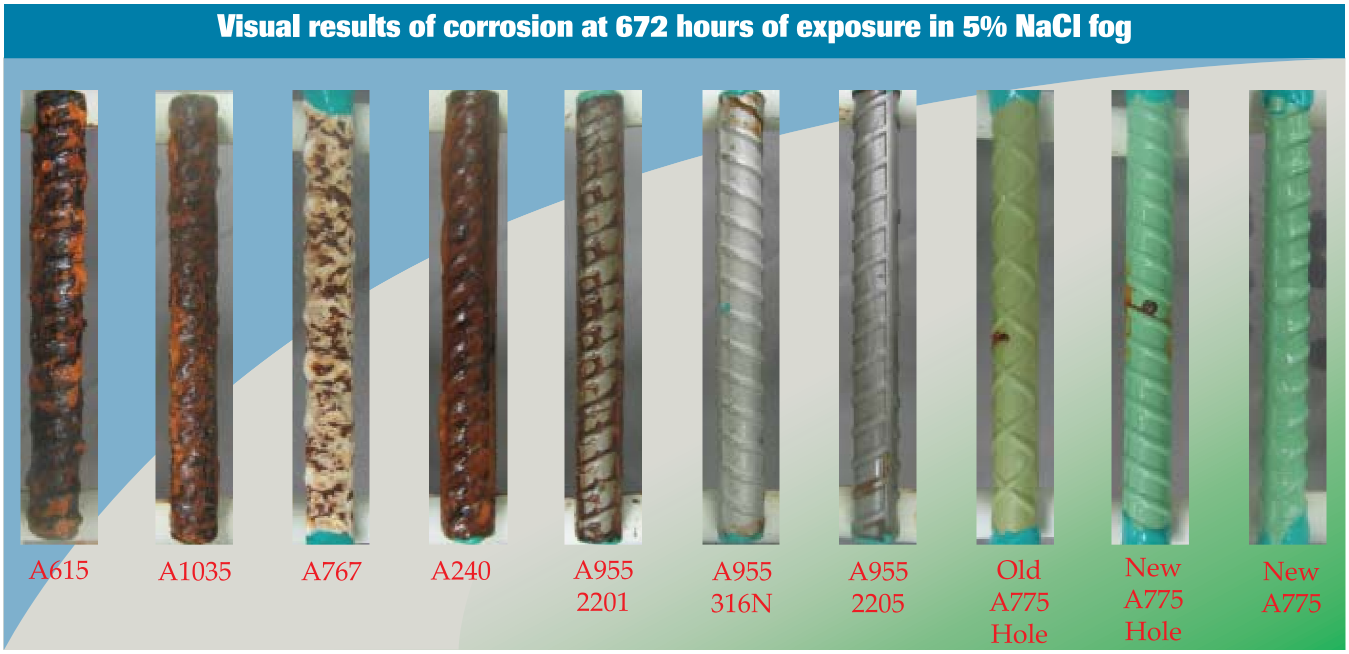
Both as-received and sandblasted bars corroded significantly and the corrosion aggressively progressed with time.

Galvanized ASTM A767/A767M Bars

While galvanized bars with two different types of deformation were tested, all the bars experienced extensive corrosion of similar pattern. The zinc (Zn) coating corroded first, producing a white-color corrosion product. Then the underlying carbon steel started to corrode, producing a rusty color. Rust color was prominent after 2 weeks of exposure. The exposed carbon steel at drilled holes was protected until the adjacent zinc coating was consumed. Weight loss analysis showed that these galvanized bars experienced extensive corrosion with very high corrosion rates. Average corrosion weight loss of the undamaged galvanized bars was about 30 percent higher than that of the as-received A615 bars.

3Cr12 Solid Stainless Steel ASTM A240/A240M Bars (a proprietary grade)

The sandblasted bars corroded extensively. After cleaning, it was observed that the bars experienced general corrosion attack at most areas and also some deep pitting corrosion near the ribs. While corrosion of 3Cr12 appeared to be extensive, its average corrosion was about half of the A1035 and about 1/3 the rate of the as-received A615 steel bars.



Results

Grade 2201 Stainless Steel ASTM A955/A955M Bars

After 12 hours of exposure, corrosion products were already visible on most of the bar surfaces and corrosion appeared to progress with time. However, the cleaned bar showed that corrosion was rather superficial and no obvious pits were observed. Weight loss analysis yielded a very low average corrosion of about 3% of as-received A615 bars.

Grades: 2205 & 316LN Stainless Steel ASTM A955/A955M Bars

These stainless steel bars experienced some localized corrosion and such corrosion apparently progressed with time. However, the total amount of corrosion was trivial and such corrosion was speculated to have been induced by local contamination or crevices generated by the coating used to seal cut ends.

Old Epoxy-coated ASTM A775/A775M Bars

The bars extracted from a 15-year-old bridge deck performed very well. For the first 174 hours of exposure entire test, corrosion only occurred at the drilled holes where carbon steel was exposed. A small weight loss value and visual observation indicates that corrosion of the bars was minor. For all the ECR specimens, weight loss was so minor that it was not possible to effectively estimate actual corrosion rates.

New Epoxy-coated ASTM A775/A775M Bars

The new ECR bars with no defects had no corrosion throughout the testing program. The specimens with a drilled hole only corroded at the holes.

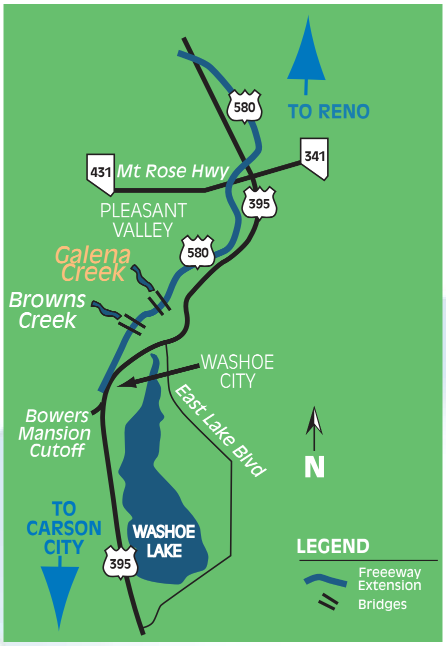
Conclusions

The bars can be divided into four groups based on their corrosion rates:

I. Uncoated ASTM A615/A615M and A767/A767M galvanized bars – **very high corrosion rate**
II. ASTM A1035/A1035M Low Carbon, Chromium and ASTM A240 3Cr12 – **moderate corrosion rate**
III. ASTM A955/A955M 2201 – **low corrosion rate**
IV. New and 15-year old ASTM A775/A775M ECR, ASTM A955/A955M 316LN and 2205 – **minor corrosion rate.**

These results are consistent with other published research. One of the most recently released, extended laboratory tests was Long-Term Performance of Epoxy-Coated Reinforcing Steel in Heavy Salt Contaminated Concrete, (FHWA Publication No. FHWA-HRT-04-090). This report ranked uncoated steel at a very high corrosion rate and ECR and stainless steel at a minor corrosion rate. ■

I-580 Extension—Galena Creek Bridge, longest concrete arch bridge in U.S.



In January 2003, construction of the 8.5 mile, six lane I-580 Freeway Extension between Reno and Carson City was approved. In 2004, the total project construction cost was estimated at approximately $310 million. A combination of federal and state funding was secured for this project. Currently the actual completion cost may be closer to $440 million.

After Nevada Department of Transportation (NDOT)created the detailed design drawings and specifications, the Project Team developed a plan for construction. To accommodate the complexity of the project NDOT split the 8.5 mile project into two separate contracts, or packages—"Package A" and "Package B".

Package A

Included in this package are specifications for two big bridges, Galena Creek Bridge and Brown's Creek Bridge and small bridges crossing over St. James's Parkway and Parker Ranch Road. The package also includes portions of the retaining walls around the bridge abutments and construction of several access roads.

A sneak preview of some of the aesthetic treatments and revegetation methods to be used on the project were also built into Package A. This included contour grading and revegetation of the slope above Kelly Canyon Road and coloring of the bridge concrete to blend in with the terrain.

Galena Creek Bridge design, a landmark structure

The Galena Creek Crossing was an opportunity to construct a bridge that was strong and aesthetically pleasing. NDOT initiated consideration for twelve different bridge types ranging from a standard concrete box girder bridge to a more elaborate cable stay bridge. Final recommendation was a concrete arch bridge. The sloping walls of the deep canyon makes the site conducive to an arch bridge.

Originally, the arch was to be constructed using segmental construction. However, after considerable thought, a less customary option, a pilot truss arch bridge, was chosen since it would be easier and more economical to build. Pilot truss arch construction is characterized by erecting a steel truss (a web-like assembly of smaller beams that makes it stronger and lighter than a single beam or girder) in the shape of an arch first, then using this to support the formwork, reinforcing steel and concrete.


Galena Creek Bridge

Research uncovered the pilot truss method to:

1. Decrease time of construction by approximately six months
2. Increase safety and stability during construction, especially during winter and high winds
3. The pilot truss method is significantly less expensive and more efficient to construct by over $4 million or about 10 percent
4. Fewer construction crews and less man hours are required
5. Use of more standard construction techniques require a less specialized contractor

All three contractors bidding chose to bid on the pilot truss form work method for approximately $45 million.

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Retaining the Natural Beauty

The entire bridge structure was designed to be as slender as possible, so the bridge blends into the background and complements the natural setting.Visually, the curves of the neighboring hillsides mirror the shape of an arch. This bridge is different than most arches because there are no columns between the bridge superstructure (the portion of a bridge structure which carries the traffic load) and the arch itself. Columns are placed at the ends of the bridge. Most arch bridges have 3 or 4 columns supported by the arch itself. This was an aesthetic choice the team concluded would make the space under the bridge appear more open and less obtrusive within the natural setting. In addition, the bridge and retaining walls incorporate native colors and texture, all disturbed areas were creatively re-vegetated along with rock sculpting and rock treatments to replace the natural setting within the Galena Forest and surrounding drainage areas.

The Galena Creek Bridge, when completed, will become the longest concrete arch bridge in Nevada and the longest and most significant concrete arch bridge in the country. Statistics include:

~ Twin bridge structures
~ Total length of 1,719 feet
~ One arch span and six side spans

Reinforcing cage for Galena Creek Bridge Arch

~ Maximum height of bridge is 302 feet
~ Arch span of 663 feet
~ Arch section nearly 20 feet by 12 feet
~ Constructed with pilot truss rather than the typical segmental method

Some notable aspects of the entire project:

~ 8.5 miles of freeway with six lanes
~ Large portion of project is on the side of two mountains
~ 4.8 million yards of soil to be moved
~ 90 percent of the site materials will be reused
~ Hot acidic soil reported near 100°F
~ 10.6 miles of drainage pipe to control surface water run-off
~ Built-in, automatic anti-icing spray system on four bridges
~ Relatively high seismic area with several fault lines
~ Relatively high wind speed with little ground cover throughout site
~ Retaining walls up to 60 foot in height
~ Cast-in-place box girders

Package A Rebid — *Package A (Contract 3148) construction began in November 2003. Completion was originally scheduled to take 44 months with the southbound Galena Creek Bridge completed in August 2006. Completion dates will now be changing due to a disagreement on the construction methods to be used on the Galena Creek Bridge. NDOT & Edward Kraemer & Sons (EKS) mutually agreed to terminate Package A. EKS was to leave the project site by July 15, 2006. On November 6, 2006, Fisher Sand & Gravel Co. of Dickinson, N.D. was awarded the contract to complete the project.*

CRSI appoints Bob Risser as President

Robert J. Risser, Jr.

The Concrete Reinforcing Steel Institute announces the appointment of Robert J. Risser Jr., to the position of President. In his new position, Risser is responsible for the daily operations of CRSI as well as directing its future growth.

In announcing Risser's appointment, CRSI Chairman J. Neal McCullohs stated that in Risser's previous position as Executive Director and CEO of the Michigan Concrete Paving Association (MCPA), "…the concrete paving contractor's market share grew from the high teens to nearly 50%."

Before MCPA, Risser was the Engineering Editor for the Aberdeen Group, Addison, IL where he helped plan and direct editorial content for Concrete Construction Magazine.

Previously Risser was Director of Market Development for the American Concrete Paving Association, Skokie, IL, with responsibilities for airports and industrial roads and training.

Risser is a registered Professional Engineer in Illinois and Michigan. He obtained both bachelors and masters degrees in Civil Engineering at the University of Illinois. ■

The four tenets of fabrication and field handling for epoxy-coated steel reinforcing bars

1. Repair

Material used to patch ends and damaged portions of the coated bars is to be compatible with the epoxy coating and capable of providing an acceptable level of protection from corrosion. In practice, this means that patch material is applied in accordance with manufacturer's instructions.

2. Fabrication

Contact areas of the fabrication equipment are to be covered with material so that coating damage is minimized. In practice, this means that drive rolls, mandrels and back-up barrels are covered with high density plastic.

3. Handling

Coated bars are to be handled in a manner that minimizes the likelihood of damage. This means that contact points are to be padded and coated bars bundled in such a manner that the strapping will not damage or cut the coating. In addition, coated bars and bundles are to be lifted in a manner that minimizes bar-to-bar abrasion. Coated bars must not be dropped or dragged.

4. Storage

Coated bars are to be stored in a manner that minimizes the likelihood of damage. This means that coated bars or bundles are to be stored above ground on wooden or padded supports with timbers placed between bundles. Coated and uncoated steel reinforcing bars are to be stored separately. Coated bar delivery should be scheduled in accordance with construction progress to eliminate the possibility of long-term storage. Uncovered outdoor storage time greater than two months requires coated bars to be covered with opaque polyethylene or other suitable ultraviolet light protective material and provisions made to minimize condensation under that cover. ■

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