BUILDINGS

EIG CRSI

EPOXY INTEREST GROUP

About EIG

History of the Epoxy Interest Group

Since 1973, the use of epoxy-coated reinforcing bars has continued to grow. In response to this growth, in 1982 the industry formed the Fusion Bonded Coaters Association (FBCA). FBCA published the first edition of Anti-Corrosion Times in August 1983.

In 1985, the FBCA merged with the Concrete Reinforcing Steel Institute (CRSI). Founded in 1924, CRSI stands as the authoritative resource for information related to steel reinforced concrete construction. CRSI members are manufacturers, fabricators and placers of steel reinforcing bar and related products, as well as professionals who are involved in the research, design and construction of reinforced concrete.

In March 2008, a new group was formed within CRSI. The Epoxy Interest Group (EIG) of CRSI operates within the charter of CRSI, but promotes and markets epoxy-coated bars and is able to create awareness and interest in epoxy-coated reinforcing steel and its important benefits for transportation agencies, engineering specifiers and contractors.

EIG CRSI
EPOXY INTEREST GROUP

Our Mission

To promote the use and advance the quality of Epoxy-Coated Steel Reinforcing Bars.

Benefits of Epoxy-Coated Steel Reinforcing Bars

- Excellent Corrosion Protection.
- More than 35 Years of Experience.
- Extended Service Life.
- Cost Effective Life-Cycle.
- Nationwide Availability.
- CRSI Certified Plants.
- Sustainable.

Photo: Shutterstock

Cover Photo:
Photo courtesy of Steve Hall © Hedrich Blessing 2009.

Introduction

"In the world there is nothing more submissive and weak than water. Yet for attacking that which is hard and strong nothing can surpass it." Philosopher Lao Tzu

The use of Epoxy-Coated Reinforcment in Buildings

A substantial amount of epoxy-coated bars are used to protect reinforcing bars in buildings. Although epoxy-coated steel was used in bridge decks as early as 1973, it was not until 1980 that epoxy-coated bars were used in parking structures. Every year over 600,000 tons of epoxy-coated reinforcing steel is produced in the US and Canada. As of 2009, over 60,000 bridges and numerous buildings, wharfs and other structures contain Epoxy-Coated Steel Reinforcing Bars.

At least $600 million is spent yearly to repair parking decks in the U.S., typically a result of corrosion from deicing salts carried into the garage by cars. Parking garages without epoxy-coated bars may show deterioration within 10 to 15 years and costs for repairs may exceed $10/sf. In addition, contractors generally need to remove a minimum of 100 spaces from service in order to affect a repair, which affects revenue in pay-to-park structures. Over the past 30 years, the performance of epoxy-coated bars have been studied and found to provide substantially improved durability over the use of black reinforcing.

Many balconies in coastal areas suffer from corrosion due to salt spray and the application of indoor/outdoor carpeting on the balcony may cause corrosion to appear more rapidly as it traps water and chloride ions. Repair of these buildings is complicated by issues relating to ownership and responsibility for repairs and repairs costing $20 – $30/sf are not uncommon. Frequently costs are borne by the individual condominium owners. However in 1999, a condo association in Florida received $5.8 million from the developer for a 23 story building that was built in 1982. Epoxy-coated bars may also be used when balcony repairs are made, reducing future corrosion risks.

Photo courtesy of Steve Hall © Hedrich Blessing 2009.

Sustainability And LEED Credits

Photo courtesy of Shutterstock.

Sustainable development is defined as: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Brundtland Commision, 1997

Epoxy-coated bars are widely used and help achieve the goals of sustainable development in many ways:

Recycled content: Epoxy-coated bars are made using readily available reinforcing bar products. These bars are generally made using over 97 percent of recycled materials from primarily post-consumer sources. They are coated using environmentally friendly coatings in safe operations.

Embodied energy: The embodied energy of epoxy-coated bars during manufacture is lower than that of other corrosion-resistant reinforcing steels.

Shipping: Epoxy-coated bars are made from locally sourced materials available near most major cities. Other products may be produced in limited locations requiring additional shipping.

Durability: Epoxy-coated bars have provided more than 35 years of excellent performance and substantially increase the durability of concrete structures.

Cost: Epoxy-coated bars are less expensive than most of the other corrosion-protection systems.

LEED Credits: The Leadership in Energy and Environmental Design (LEED) Green Building Rating System was developed by the U.S. Green Building Council (USGBC) and used by the Canadian Green Building Council (CGBG). Currently it is the most widely used rating system for environmentally sustainable design, construction and operation of buildings and neighborhoods. Epoxy-coated reinforcing steel may assist with credits for recycled content and regional materials. For information on how these may be utilized visit ***www.epoxyinterestgroup.org*** or contact your material supplier regarding your specific project needs.

Certification And Quality

In 1991, CRSI (Concrete Reinforcing Steel Institute) initiated a voluntary certification program for the manufacture of Epoxy-Coated Steel Reinforcing Bars.

EPOXY COATING PLANT CERTIFICATION™
CONCRETE REINFORCING STEEL INSTITUTE

CERTIFIED PLANT

The Epoxy-Coating Plant Certification program continues to ensure products are manufactured to the highest quality. Developed to provide an independent certification, the program outlines the basic requirements for a quality control program to ensure that a plant and its employees are trained, equipped and capable of producing fusion bonded Epoxy-Coated Steel Reinforcing Bars in conformance with the latest industry standards and recommendations. The Program certifies the manufacturing process and is not a guarantee of product quality and is intended to supplement, not to replace, the acceptance testing of materials.

The purpose of the voluntary certification program is:

- To ensure that coating applicator plants have the capabilities and quality control procedures in place to ensure a high level of excellence in materials produced and delivered to the job site.
- To assist plant management in achieving a high level of excellence in the plant and its operations.
- To provide recognition to plants which demonstrate a high degree of excellence.

ASTM INTERNATIONAL
Standards Worldwide

Standard Specifications

The following standard specifications are available to specify epoxy-coated steel reinforcement:

ASTM A775/A775M *Standard Specification for Epoxy-Coated Steel Reinforcing Bars.*

ASTM A884/A884M *Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.*

ASTM A934/A934M *Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.*

ASTM D3963/D3963M *Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.*

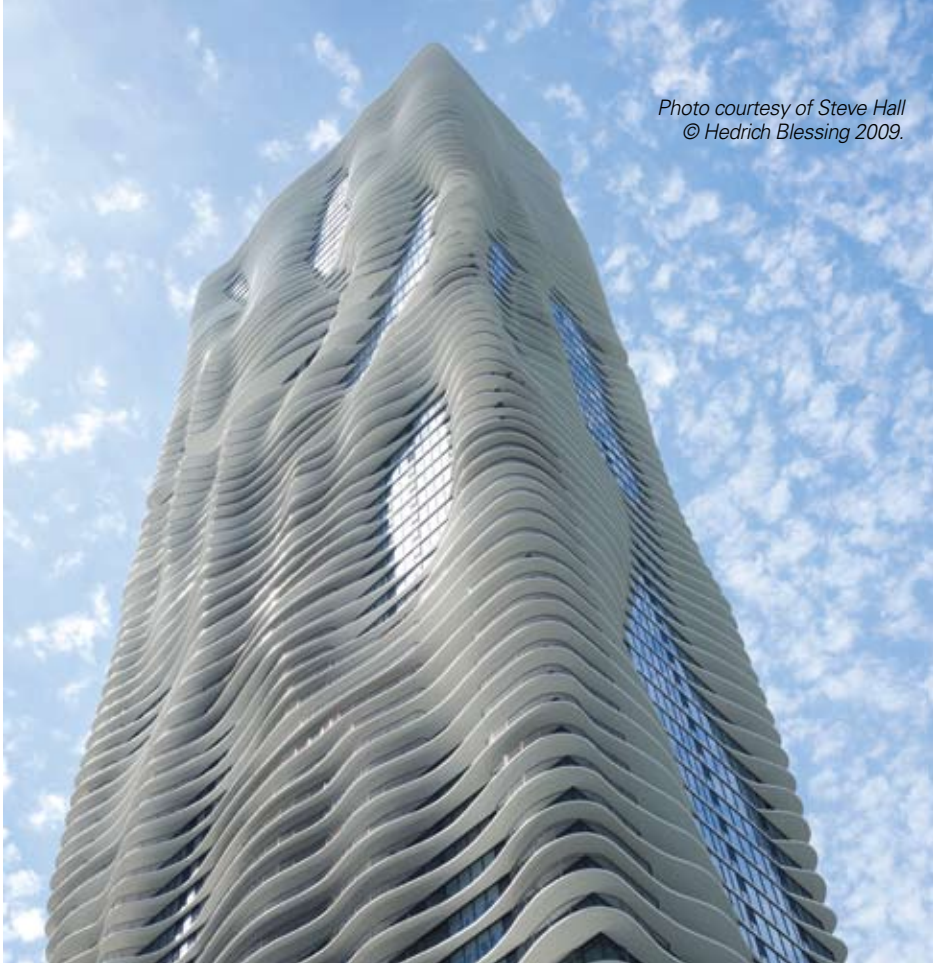

Photo courtesy of Steve Hall
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Aqua Building

Chicago, Illinois

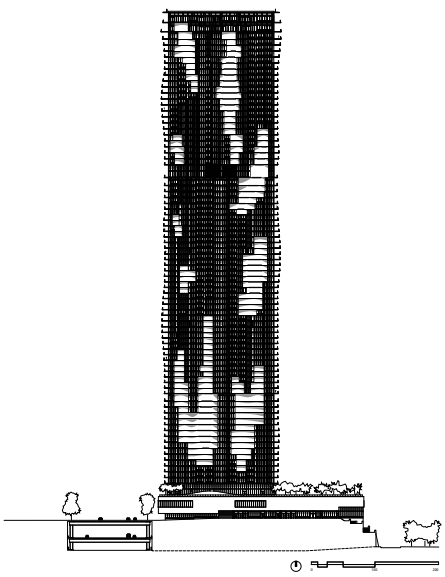
The 82-story Aqua Tower, a mixed-use building in downtown Chicago, was named to fit the nautical theme of the owner's other structures in the development complex. Enhancing that imagery are wave-like reinforced concrete balconies with unique, irregular shapes that make the skyscraper's façade appear to undulate. The balconies were created by combining concrete and epoxy-coated reinforcing bar in customized, reusable concrete forms.

The outdoor terraces on the 819-foot-tall building cantilever from 2 to 12 feet and differ in shape from floor to floor in response to the view, solar shading, and size and type of dwelling. They resemble the striated limestone outcroppings that are common to the

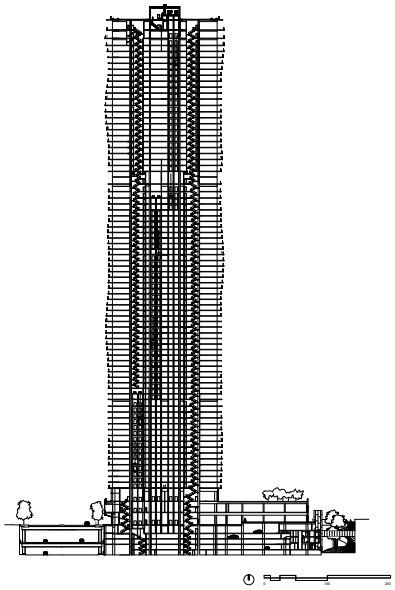
Photo courtesy of Steve Hall © Hedrich Blessing 2009.

Design Criteria

- Create a distinctive look for an urban mixed-use development with no two floors alike.
- Produce a design that is shaped by climate and landscape, weaving it into its surroundings and interconnecting the building and its environment.
- Maximize environmental friendliness, including solar shading, green building materials and other sustainable-design concepts.
- Create reinforced concrete balconies unique to each dwelling that provide an undulating appearance that aids solar shading and wind flow.



South Façade Elevation
Drawing courtesy of Studio Gang Architects.



East West Section
Drawing courtesy of Studio Gang Architects.

Photo courtesy of MKA.

Great Lakes region and also suggest the wave-like motion produced by bodies of water. Computer modeling determined the shape of each balcony, but because each level's footprint varies, the calculations were performed floor by floor.

The tower's east-west orientation maximizes its winter solar performance. The reinforced concrete balconies extend further on the southern façade to increase shading and reduce solar exposure in the summer while allowing passive warming in the winter. To accommodate the balcony cantilever, the structure features 28-foot column spacing and a slightly larger column with 9-inch reinforced concrete slabs for each floor.

Working closely with the contractor and mechanical contractor, Studio Gang Architects found the high number of shape variations in the floor slabs could be achieved without increasing the building's construction timetable. The balconies' shapes also provide protection against wind loading, minimizing the amount of damping required to ensure stability even in high winds.

The 1.9-million-square-foot project features epoxy-coated reinforcing bar in all of the balconies as well as in the five-level, 500,000-square-foot below-grade parking structure. Epoxy-coated reinforcing bar was used in these strategic areas to ensure no corrosion induced damage

Photo courtesy of Steve Hall
© Hedrich Blessing 2009.

Owner: **Magellan Development Group, Chicago**
Architect: **Studio Gang Architects, Chicago**
Engineer: **Magnusson Klemencic Associates, Chicago**
General Contractor: **James McHugh Construction Co., Chicago**
Total Cost: **$350 million**
Date opened: **Spring 2010**
Epoxy-Coated Bars: **2445 tons**

Photo courtesy of MKA.

would occur. Approximately 2445 tons of epoxy-coated reinforcing bar was used.

To accommodate the fluid nature of the balconies' designs, the contractor ordered reinforcing bar in three different lengths rather than fabricate bar to custom lengths in the field. The savings in labor costs and field adjustments easily compensated for the cost of the added steel.

Flexible steel edge-forms were sculpted into the prescribed shape for each balcony and reused on each floor to minimize formwork material waste.

The balcony slabs, averaging about 2,600 square feet each, are 9 inches thick along the façade and become thinner as they cantilever further from the facade, aiding drainage.

The project features retail and office space on the lowest three floors, hotel rooms on the fourth through 18th floors, luxury rental residences on floors 19 through 52 and condominiums on floors 53 and up. A green roof, one of the largest in Chicago at 80,000 square feet, includes various plantings as well as an outdoor pool, running track, gardens, fire pits and a yoga terrace. ■

45 Province Street

Boston, Massachusetts

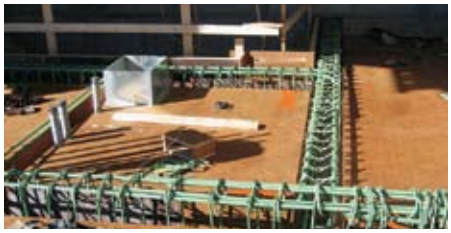
Elegant residences have returned to Province Street, where prominent Bostonians first strolled the streets two centuries ago. Running along the foot of Beacon Hill and within a short walk of the Boston Common, the new 31-floor reinforced concrete mixed-use residential tower provides high-quality amenities while fitting into its historic neighborhood. Designers achieved this goal with a highly articulated façade that features a structural system made entirely of cast-in-place concrete.

The building offers features 37 levels, including four levels of below-grade parking, 31 stories of luxury condominiums and amenities, including retail space on the first two floors, and two mechanical levels below the roof. Amenities include a spa, a four-season pool, spa treatment rooms and a fitness studio. Also offered is a dining room with a catering kitchen, a screening room and a roof terrace.

Photo courtesy of Richard Mandelkorn.

Design Criteria

- Design a 31-story residential building in the heart of Boston's historic district that complements the existing structures.
- Offer parking on six below-grade parking levels with immediate access to grade level via car elevators.
- Provide reinforced concrete balconies for each residence that offer sweeping views of the city's historic neighborhoods.



Photos courtesy of Barker Steel LLC, a Harris Rebar Company.

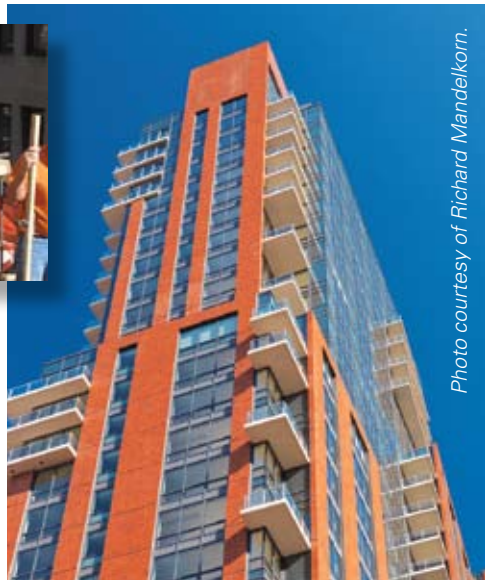
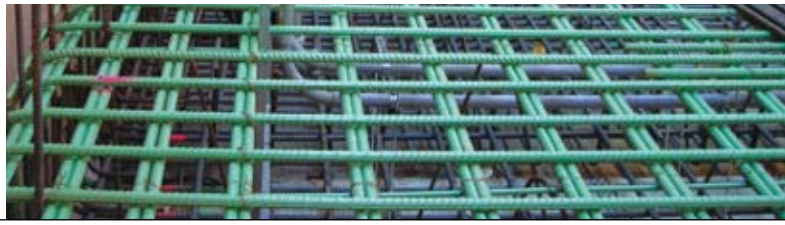


Photo courtesy of Richard Mandelkorn.



Photos courtesy of Barker Steel LLC, a Harris Rebar Company.

A glass and terra-cotta rain-screen façade, supported by concrete shear walls, columns and floors, helps bridge old and new Boston. The terra cotta reflects the color and scale of the surrounding historic buildings, while the glass complements the newer structures.

Windows, cladding and canopy were scaled to resonate with the existing streetscape. Despite its height, the building avoids overshadowing its neighbors thanks to close cooperation between the Boston Redevelopment Authority and designers at Bruner/Cott. They explored 119 historic views and determined that the new building could be built at twice the size allowed by the underlying zoning without overshadowing nearby structures. The narrow streets ensure the building's true height is seen only from a distance as part of the skyline view.

To aid this scaling, the building's façade is highly articulated and was studied for massing, daylighting, reflection, shadows and wind. Features include private balconies for each residence. The streetscape likewise is highly articulated to aid the pedestrian scale, with the entrance marked by a curving glass canopy in intentional opposition to the linear, angular façade.

Epoxy-coated reinforcing bar was used on the six below-grade levels of parking. These levels require no space for traditional ramping, as cars are raised to grade level via elevators. Epoxy-coated reinforcing bar also was used in structuring the private exterior balconies for each residence, to ensure they provided superior protection against the harsh Boston winters.

Owner: **Abbey Group, Cambridge, Mass.**
Architect: **Bruner/Cott & Associates Inc., Cambridge, Mass.**
Engineer: **McNamara/Salvia Inc., Boston**
General Contractor: **Suffolk Construction Co., Boston**
Total Cost: **$110 million**
Completion Date: **Spring 2009**
Epoxy-Coated Bars: **421 tons**

Photo courtesy of Richard Mandelkorn.

Approximately 25,000 cu yds of concrete were used in the project, with a total of 2,728 tons of reinforcing bar used. ■

Richmond Olympic Speed Skating Oval

Richmond, British Columbia

Creating the world's best long-track speed-skating rink required engineers to devise special systems to create a super-flat slab inside a structure resting on more than 700 feet of soft, compressible soil. To achieve this goal, designers used a reinforced concrete structural system and foundation to create an Olympic-grade athletic complex that is LEED Silver certified. Some 6850 tons of black and epoxy-coated reinforcing bar were used in the concrete components.

The challenges of the project were daunting. Nearby project sites were known to settle as much as 8 inches, yet the Richmond Speed Skating Oval could not vary from level any more than 0.6 inch over its full length—a distance of 4½ times the length of a football field. The project also included space for 450 cars, athletic services, retail and a rowing-training facility at no significant additional cost.

A two-level structure was devised to provide parking on the lowest level and the Oval on the upper level. Designed on a combination raft and pile foundation in densified soil, the two-level structure anchored buttresses that support the arch roof. The raft foundation is located in the infill areas between buttresses and has the dual purpose of supporting the suspended ice slab above and serving as the parking-slab surface at grade. The raft foundation system features epoxy-coated steel reinforcing bar to reduce potential corrosion caused by salt penetration brought into the structure by cars.

Pile caps located on the building's north and south sides support decorative buttresses and in turn are supported on 460 reinforced concrete expanded base (Franki) piles.

The concrete composition allowed the visually exposed buttresses to create dramatic focal points on each end. Epoxy-coated reinforcing bar was used in these buttresses and columns to ensure a excellent appearance over their lifetime. ■

Photos courtesy of Art & Architecture Photography.

Owner: **City of Richmond, Richmond, B.C.**

Architect: **Cannon Design, Vancouver, B.C.**

Structural Engineer: **Glotman Simpson Consulting Engineers, Vancouver, B.C.**

General Contractor: **Dominion Fairmile Construction Ltd., Vancouver, B.C.**

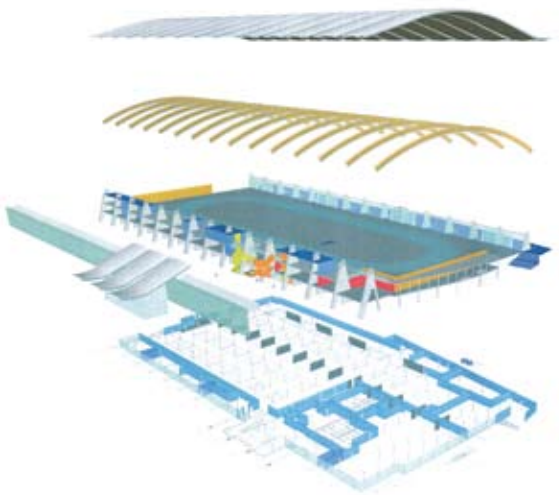
Total Cost: **$178 million**

Size: **355,209 square feet**

Completion Date: **December 2008**

Design Criteria

- Design the world's flattest Olympic-quality speed-skating oval.
- Avoid any differential settling to maintain competition flatness specification.
- Create a first-floor parking deck to provide space for 450 cars and athletic facilities.
- Produce an aesthetically pleasing exterior via concrete buttresses.
- Include concrete aesthetic features, such as two elegant wrap-around stairs and native art impressions.



Kauffman Center for the Performing Arts

Kansas City, Missouri

The design for the Kauffman Center, due to open in the fall of 2011, encourages the enrichment of the lives of people in the community through extraordinary performing-arts experiences. To emphasize that mission, architects created a dramatic sloped-roof design that uses innovative techniques to produce the final shape in precast reinforced concrete, glass and stainless steel.

The center contains two performance spaces along the ridgeline of the site, facing south, fronted by a glazed foyer. As a result, patrons enter to a dramatic view and terraced gardens and proceed to a grand staircase in the lobby.

The envelope consists of a series of undulating, vertical segments of a circle forming the northern container of the theater's stage and concert hall. As these elements ascend, they create the building's segmented, gently curving crown.

From the crest, the roof descends in a curve following a geometric design of light cables, metal and glass toward the south. The roof intersects with an outwardly inclined and curved glass wall, which contains the foyer. The curved, segmented northern walls are sheathed in silvery stainless steel and punctuated by acid-etched, limestone-colored precast reinforced concrete perpendicular walls.

The tensile forces of the suspended glass foyer roof are counteracted by a series of cables securing the structure to anchors at the entrance terrace. The anchors are attached to 24- by 36-inch beams that form a wall separated from the building by a 12-inch-thick concrete driveway slab reinforced with epoxy-coated reinforcing bar. The roadway acts as a brace for the grade-beam system, to ensure the building remains secured.

Use of epoxy-coated reinforcing bar alleviated concerns that long-term effects of traffic loads would erode the surface, allowing moisture and salt to penetrate and cause corrosion. Approximately 872 tons of epoxy-coated bar were used in the project. ■

Owner: **Kauffman Center for the Performing Arts**
Architect: **Moshe Safdie & Associates, Somerville, Mass.**
Associate Architect: **BNIM Architects, Kansas City**
Engineer: **Structural Engineering Associates Inc., Kansas City**
General Contractor: **J.E. Dunn Construction Co., Kansas City**
Total Cost: **$413 million**
Opening Date: **Fall 2011**
Epoxy-Coated Bars: **872 tons**

Design Criteria

- Design two performance spaces with excellent acoustics.
- Provide an exterior design that reflects the mission of providing extraordinary performances.
- Ensure the unique structural tension that creates the sloping roof is secured and will be durable throughout the center's service life.
- Create a 1,000-car parking structure adjacent to the center (under separate contract).

Providing Corrosion Protection

High Performance at a low cost – Epoxy-Coated Reinforcing

EPOXY INTEREST GROUP

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