

## TRANSPORTATION CATEGORY

# Paradise Island East Bridge Repairs and Renovations

NASSAU, BAHAMAS

SUBMITTED BY SIKA CORPORATION



Fig. 1: East Bridge connects Nassau and Paradise Island

**P**aradise Island, a tourist resort, is an island in the Bahamas with an area of 685 acres (277 hectares) located just off the shore of the city of Nassau. It is best known for the sprawling resort Atlantis with its extensive water park rides, pools, beach, restaurants, walk-in aquarium and the Caribbean's largest casino.

Paradise Island is connected to the island of New Providence by two bridges that cross Nassau Harbour. The Paradise Island East Bridge (Fig. 1) is the older of the two bridges, and opened to traffic in 1967. The East Bridge is owned, operated, and maintained by The Bridge Authority, Commonwealth of The Bahamas as a toll facility and provides one-way egress from Paradise Island to New Providence. Millions of tourists and residents traverse the bridge annually to vacation at or visit the Atlantis and other resorts located on the island.

The bridge has an overall width of 36 ft (11 m) and carries two lanes of traffic, along with a sidewalk on each side of the carriageway. It is 1,560 ft (475 m) in overall length and consists of 15 concrete approach spans and 3 high elevation main channel spans.

## PROBLEMS THAT PROMPTED REPAIR

The tropical salt water environment had taken its toll on the reinforced concrete superstructure and substructure causing corrosion-induced cracking and spalling on the various structural elements of the 50-year-old bridge (Fig. 2).

In 2011, a detailed bridge inspection was carried out in accordance with the 2011 AASHTO Manual for Bridge Evaluation (Second Edition), and found that the structure was generally in good condition. However, several of the bridge components exhibited varying levels of deterioration due to corrosion of the embedded steel reinforcement which would require rehabilitation and subsequent regular maintenance.

## REPAIR STRATEGY

The Bridge Authority considered two options regarding the safe operation of the bridge: replace the bridge at an estimated cost of \$40-50 million,

or repair and protect the existing concrete bridge at a cost of approximately 10-15% of the replacement cost.

The Bridge Authority decided to move forward with the concrete repair option and extend the service life of the existing structure. In March 2016, concrete repair work began on the East Bridge. The work took 12 months to complete at a cost of \$5.6 million. While the majority of the work involved concrete repair to the bridge columns (Fig. 3), other work included repairs to cast-in-place and precast concrete elements such as abutments, beams, piers, columns and deck; repairs to bridge railings, lights and signage; repairs and replacement of deck joints; underwater repairs to pile caps; repairs and/or replacement of portions of the fender systems; repairs and/or replacement of drainage system; and supply of maintenance platform and application of protective coatings.

## CHALLENGES FACED DURING THE PROJECT

### Access

Getting access to many of the deteriorated areas on the underside of the bridge presented significant challenges since more than 75% of the spans were over water and at a significant height above the waterline, at up to 55 ft (17 m). A swift tidal current under the bridge also did not allow much space on the water for a work barge to be floating adjacent to a pier while hundreds of recreational and commercial boats passed under the bridge each day.

### Time Constraints

Heavy traffic on the bridge meant that no lanes of traffic could be closed between 7 and 9 am or from 3 to 6 pm. From 9 am to 3 pm, one lane of traffic could be closed to allow for the contractor's equipment. In order to complete the work within the 12-month time frame, the contractor worked two shifts, with most of the work being done at night.

### Load Limitations

Due to weight limits on the bridge deck and limited space on the water beneath the bridge, ready-mixed concrete was not an option. Instead, 12,000 bags (6,000 cf, 170 cm) of self-consolidating concrete (SCC) was placed by hand to encapsulate the columns from the pier caps to the beams.

## VALUE ENGINEERING AND REPAIRS

The original design called for encapsulation of all columns from the pier cap to a height of 20 ft (6 m) and individual spall repairs on deteriorated concrete areas above that height. A spray-applied migrating corrosion inhibitor was also specified to help protect the column areas that were not being repaired. Soon after construction began, it was agreed that more value could be gained by totally encasing the columns above the 20 ft (6 m) height. As a result, most of the trowel-applied column spall repairs and the migrating corrosion inhibitor were eliminated from the project and instead the columns were totally encased with new, corrosion resistant concrete from top to bottom. This revised approach saved time, provided significant strengthening of the columns, and provided full protection for the column against corrosion by increasing concrete cover by 6 in (152 mm)



Fig. 2: Column deterioration during the bridge inspection



Fig. 3: Repair work at one of the columns



Fig. 4: Swinging platform to perform spall repairs and apply coating



Fig. 5: Concrete repairs performed from swinging platform



Fig. 6: Protective coating installation at bridge underside



Fig. 7: Completed repairs at East Bridge

over 100% of the column surface area. In addition to providing corrosion protection by increasing column diameters, the concrete mix also contained corrosion inhibitor, silica fume, and polymer to provide a significantly higher level of corrosion protection than typical ready-mix concrete.

In addition to the column encapsulation work, approximately 2,000 sf (185 sm) of isolated spalls on columns, beams, and piers were repaired utilizing a “trowel-applied” technique with a non-sag, polymer modified repair mortar with integral corrosion inhibitor. To get access to these areas, a trailer-mounted, retractable, self-propelled swinging platform was used and allowed workers to climb from the bridge deck to a secure working platform under the bridge deck (Fig. 4). From the platform, workers were able to perform hand-applied spall repairs (Fig. 5) as well as apply protective coatings.

To defend against chloride and moisture infiltration, a total of 220,000 sf (20,440 sm) of columns, beams, abutments, piers, and the underside of the bridge deck were protected with polymer-modified cementitious coating (Fig. 6). A secondary benefit of the protective coating was that it provided an aesthetically-pleasing finished product by giving the newly repaired bridge a monolithic/uniform appearance that made the bridge look new again.

## CONCLUSION

The Paradise Island East Bridge rehabilitation project was completed on time and for a fraction of the cost of replacement (Fig. 7). By using the right combination of methods and materials, and by choosing to not only repair but also protect the reinforced concrete against the deleterious effects of chloride-induced corrosion, it is expected that the service life of the Paradise Island East Bridge has been extended by 25 years. ■

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SUBMITTED BY  
**Sika Corporation**  
Lyndhurst, NJ

OWNER  
**The Bridge Authority,**  
**Commonwealth of The Bahamas**  
Nassau, Bahamas

PROJECT ENGINEER/DESIGNER  
**ETS**  
Nassau, Bahamas

REPAIR CONTRACTOR  
**ISD**  
Nassau, Bahamas

MATERIALS SUPPLIER/MANUFACTURER  
**Sika Corporation**  
Lyndhurst, NJ