2020 AWARD OF EXCELLENCE

LONGEVITY CATEGORY

South Carolina Department of Natural Resources, Marine Resources Research Institute: Concrete Repair and Protection to the Wet Lab Areas—10 Years Later

COLUMBIA, SOUTH CAROLINA

SUBMITTED BY SIKA CORPORATION

South Carolina Department of Natural Resources, Marine Resources Research Institute

The South Carolina Department of Marine Resources Research Institute contains administrative offices, classrooms, a library, an auditorium, "wet labs" for saltwater marine life research, and other research labs. The original building was constructed in 1974 with an addition completed in 1977. The total building is 50,000 sf (4,645 m²); wet lab Area A is approximately 5,600 sf (520 m²) and Wet Lab Area B is about 2,700 sf (250 m²). Refer to Figure 1.

In 1989, the structure survived Hurricane Hugo but flooded because of this event. In the 1990s, the original wet lab showed signs of deterioration at the base of the steel columns and top surface of the concrete. The columns were repaired and the slabs were sealed; thus, relatively little had been done (or appeared to be required) prior to the repairs undertaken in this project.

INSPECTION AND EVALUATION TECHNIQUES

During an evaluation in 2006, some "conditions of concern" in the concrete structure under the wet labs were noted. Numerous locations of corrosion-related spalling within the floor areas of the wet lab locations as well as noticeable steel column corrosion caused concern that led to a more detailed evaluation.

In the summer of 2006, an extensive visual and non-destructive testing (NDT) investigation was conducted on the concrete floor slabs, beams and columns at two locations that house the wet labs. The investigation included visual inspections and rapid chloride testing (Fig. 2), half cell potential, the use of ground penetrating radar and a cover meter.

Further investigations were conducted in the summer of 2008 as part of the overall design/build contract.

The visual investigations in both 2006 and 2008 found several degraded structural conditions, including deteriorated reinforcement, spalled concrete (Fig. 3), cracked concrete, and rust-stained concrete. The 2008 destructive investigation uncovered many areas in which 25-50% section loss of the reinforcing steel had occurred. Some areas had complete section loss of the reinforcing steel. Approximately 20% of the 50,000 sf (46,45.15 m²) building required concrete repair.

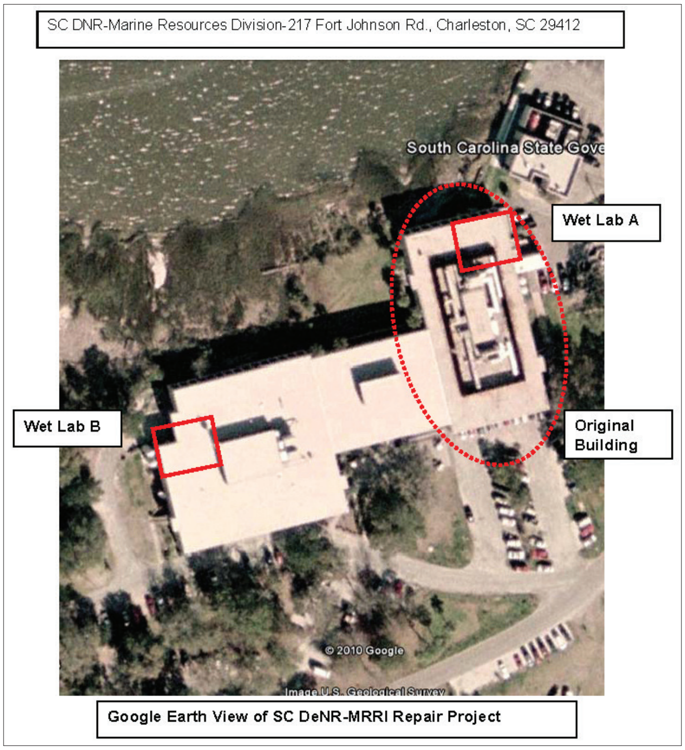

Fig. 1: Google Earth View of SC DeNR-MRRI Repair Project

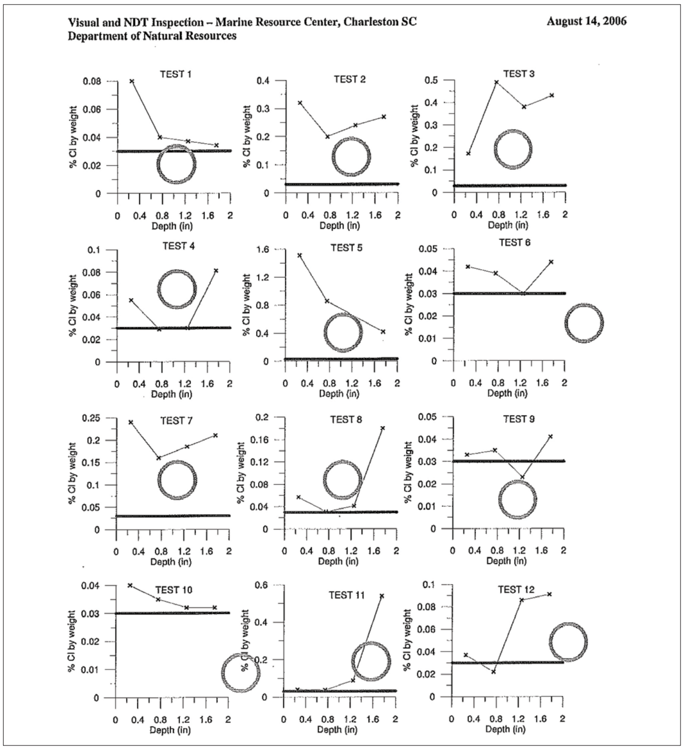

Fig. 2: Chloride profiles for test locations 1-12 (the circle indicates the location of the first layer of reinforcement—the vertical scale varies between the plots)

The top surfaces of the floor slab in the wet labs were found to have been coated with an epoxy floor coating that had failed, allowing saturation from the saltwater tanks. These wet labs remain constantly wet as routine washing down of the floors and tanks occur.

It was determined that the root cause of the steel corrosion and resulting spalling was high chlorides and, in some cases, insufficient concrete cover. This situation was exacerbated by the marine environment in which the building is situated, as well as the saltwater tanks within the building and the routine washing of various areas throughout the lab.

REPAIR SYSTEM SELECTED

The goals of the owner and design/build team were to address the root cause of corrosion, repair the damaged concrete, coatings and cracks, and extend the service life of the building.

Wet Lab Area A required complete removal of the concrete slab and the upper 5 in (125 mm) of the beams and girders (Fig. 4 and 5). Due to the connection of the new floor slab reinforcing being tied to the existing beam reinforcing, 100 sacrificial galvanic anodes were installed to reduce the effects of incipient anode corrosion. The new ready-mix concrete (approximately 50 cy [38 m³]) design included a corrosion-


Fig. 3: Underside spalling and steel corrosion


Fig. 4: Demolition at Lab A

inhibiting admixture to provide additional protection for reducing the incipient anode effect throughout the entire slab replacement areas.

It was determined that Wet Lab Area B did not require complete floor slab removal, but long-term corrosion protection was required. Due to the high levels of chlorides in the concrete, another system of sacrificial anodes was installed. Six hundred and thirty-four (634) anodes were installed by laying out the steel reinforcement grid, core drilling 2 ¼ in (57 mm) diameter holes approximately 3 in (75 mm) deep connecting them, 10 to a run, with a connection to the reinforcing steel made at the start and end of each run (Fig. 6).

To provide complete global protection of the entire underside of the exposed concrete, a surface-applied, penetrating corrosion inhibitor was applied to the beams and underside of the slabs. The shallow, smaller areas were repaired by means of hand applying the repair mortar. There were over 800 of these repair type locations. The structural strengthening of different beam locations was accomplished using an 18 oz (510 g), unidirectional carbon fiber fabric that was saturated in epoxy then wrapped around the sides and undersides of four beams comprising approximately 60 ft (18 m) of beam strengthening. Wet Lab Area B received a cementitious overlay to provide better pitch to drains and improve the floor finish. Finally, all wet lab floor slabs (8,000 sf [745 m²]) were coated with a high-build epoxy floor coating system.

Fig. 5: New slab formed with new reinforcing steel

Fig. 6: Core holes and slots for galvanic protection in Lab B, 2010

Fig. 7: Lab A in 2020

SUMMARY

The project consisted of a complete concrete repair scope that included conventional repair techniques of remove and replace, hand-applied spall repairs, form and pour repairs, epoxy rebar protective coatings, epoxy crack injection, high-build epoxy floor coatings as well as state-of-the-art systems. The project began in December 2008 and was substantially complete by October 2009. An average crew size of six worked six to seven days per week throughout the project. The service life extension will allow for the continued study of marine wildlife for many years to come.

It has been over 10 years since this project was completed (Fig. 7). A recent visit to the site and discussion with the owner confirm the repairs are still performing. This project is an excellent testimony that when industry-proven practices are implemented, long-term durability is not only possible but probable!

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