Spliced reinforced precast concrete beams facilitate marine construction

On July 19, 2025, former National Basketball Association player and current Carnival Corp. chief fun officer Shaquille O'Neal joined other executives from the world's largest cruise line to welcome their first guests to Celebration Key, Carnival's newest resort in the Bahamas. Spread over 329 acres (133 hectares) just 50 mi (80 km) off Florida on Grand Bahama Island, the $600 million development offers vacationers a plethora of shopping, eating, sleeping, and playing options. By 2028, Carnival expects to host 4 million guests a year.

When their ship docked that day, almost 5000 guests disembarked onto a 1350 ft (412 m) long pier and walked to shore on a 1000 ft (305 m) long trestle built in two years with reinforced precast concrete pile-to-cap connections; transverse pile caps; fender blocks; and precast, prestressed deck panels produced by Island Site Development (ISD) in Nassau on New Providence Island in the Bahamas. The finished components were barged to the site laydown area and then trucked to the jobsite.

Delivering precast concrete structural components rather than forming them onsite minimized the number of trucks, heavy equipment, and material piles on the jobsite. Eliminating the need for a mobile batch plant also eliminated leaks onto the ground or into the water. Because weather can halt cast-in-place concrete production, building with already-cured concrete helped crews meet an aggressive completion deadline necessitated by the jobsite's exposure to long-period waves and hurricanes.

Precast concrete also facilitated top-down construction—starting at the shore and building out into the Atlantic Ocean section by section from above the structure with barge-mounted crews and equipment—by decreasing beam weight to less than 35 tons (32 tonnes). This was particularly critical for trestle pile caps.

Instead of using one beam to form the 55 ft (16.8 m) wide span, ISD fabricated two 26 ft (7.9 m) reinforced precast concrete beams that were spliced together at the jobsite. One end was cast with a custom-fabricated wide-flange steel connector consisting of headed studs welded to steel plates; one end of the other beam was cast to accept the connector.

Crews then poured concrete into the joint to seal the splice, protecting the steel splice from saltwater corrosion and providing the strength required to transfer vertical and lateral loads during construction as well as lateral loads upon completion. ISD fabricated 52 beams.

More than six hundred and twenty 19 in. (483 mm) thick precast, prestressed concrete deck panels overlaid with 8 in. (203 mm) of concrete formed the trestle's primary superstructure. The panels had bottom-projecting reinforcement at ends (over pile bents) to provide capacity to handle the uplift loads induced by hurricane-induced waves.

This process is being repeated to build another two-sided cruise ship pier consisting of a 440 ft (134 m) long trestle extension and 1400 ft (439 m) long berthing structure that are expected to be completed in the second quarter of 2026.

—Stephanie Johnston

Carnival Corp. is building two 2-sided piers to dock four cruise ships at the company's newest Bahamian resort, Celebration Key. The first was delivered in July 2025. The second is under construction. Courtesy of WSP.

Emulative design using proprietary connectors speeds natural gas plant construction

Liquified natural gas is big business for U.S. energy producers. By 2023, the United States was the world's largest exporter. Projects under construction or permitted are expected to double exports by 2027. The owner of a new gas insulated substation facility on the Mississippi River, a U.S.-based liquefied natural gas exporter, is expanding to meet that demand. It's the latest of four liquid natural gas facilities built by the owners along the Gulf Coast.

Turning natural gas into a liquid requires first compressing it and then letting it cool to the cryogenic temperature of -260° F (-162° C). The liquid natural gas is then stored for distribution overseas by ship. Liquid natural gas facilities have substations that house transformers, circuit breakers, disconnectors, busbars, and other equipment to manage the electricity required by each step in the conversion process.

That equipment generates a lot of heat. Some substations use equipment that's cooled with air, some with equipment that's cooled with yet another gas: sulfur hexafluoride. The latter is called a gas-insulated switchgear substation.

The new $12 billion facility has two 720 MW gas-insulated substations to power six pretreatment trains, 36 liquefaction trains, and four 200,000 m^3 (7 million ft^3) storage tanks connected by 27 mi (43.5 km) of pipeline spread over 630 acres (250 hectares). In the unlikely event of an explosion, BakerRisk of San Antonio, Tex., designed the precast concrete substation frame and walls to withstand a 1.5 psi (10 kPa) blast. Louisiana averages 40 tornadoes a year, so the substations are also designed to sustain 193 mph (311 kph) winds and the impact of projectiles created by those winds.

The project team chose precast concrete over steel and cast-in-place concrete to cut construction time. This was an industry first. To further speed delivery, this project's design-build team deployed a novel fabrication framing system employing a patented connection system that cut significant time off the schedule with an erection crew of just 12 workers and 2 cranes while providing a structural framework much less susceptible to fire and corrosion than steel.

Emulative precast concrete framing system employed A frames and link beams to form the outer walls and transverse beams with slab plus topping for the floor and roof. All column/frame-to-beam connections employed the grouted advancing bar connector system. NMB Splice-Sleeves were used with mass grouting from column to foundation pedestal. After grouting the connections, the bracing could be removed as soon as the next day. Courtesy of Cajun Industries LLC.

Tindall Corp.'s advancing bar connector system of custom-engineered structural members spliced together with NMB Splice Sleeves' reinforcing bar coupler greatly accelerated project delivery for new insulated substation buildings on the Gulf Coast by using emulative design concepts. Courtesy of Cajun Industries LLC.

PCI-certified precast concrete producer and precast concrete specialty engineer Tindall Corp.'s Mississippi division and contractor Cajun Industries of Baton Rouge, La., used the American Concrete Institute's (ACI's) *Guide to Emulating Cast-in-Place Detailing for Seismic Design of Precast Concrete Structures* (ACI 550.1R-09) to emulate a cast-in-place moment frame. They provided *Building Code Requirements for Structural Concrete (ACI 318) and Commentary (ACI 318R)* Type 2 mechanical splices Grade 60 (414 Mpa) reinforcing bar across joints. This was achieved using a Tindall patented advancing bar connector grouted coupler system that only requires grouting and no cast-in-place closure pours. Due to the high strength SSM grout used, such the connections and grouted joints reach 4000 psi (27 MPa) in less than 24 hours (approximately 70° F [21° C]). This achieves a yield strength connection and allows the braces and temporary corbels to be removed and construction to continue.

The system saves time and money by using removable haunches instead of scaffolding to set beams. Collar forms for ±2 in. (50 mm) grout joints are significantly faster and lower cost than forms for cast-in-place closure pours, which require much wider formwork and bracing. The grouted couplers and joints allowed for construction tolerances in the structure.

For each substation, Tindall's Moss Point, Miss., plant produced twenty cruciform columns, two 20 by 24 in. (500 by 600 mm) columns, thirty-two 18 in. (460 mm) wide by 48 in. (1200 mm) deep beams, forty-seven 0.06 in. (15 mm) thick flat slabs, forty-four 15 in. (381 mm) thick flat insulated panels, and sixty-six 20 in. wide by 24 in. deep beams.

Precast concrete erection for the first substation ran from October 25 to December 16, 2022. Erection for the second substation ran from May 22 to August 4, 2023. The project was completed November 1, 2024. These time spans included other work required within the structure.

The owner was so impressed by the precast concrete gas-insulated substation buildings that it has enlisted Cajun and Tindall to build two more larger emulative precast concrete gas-insulated substation buildings on its next liquified natural gas project. The first of these buildings is currently being erected.

—Stephanie Johnston