INVESTIGATIVE UPDATE

Collapse of Pedestrian Bridge Under Construction Miami, Florida (HWY18MH009)

The information in this report is preliminary and will be supplemented or corrected during the course of the investigation.

This report provides an update to the preliminary report issued by the NTSB on May 23, 2018, concerning the March 15, 2018, collapse of a pedestrian bridge under construction in Miami, Florida. Investigative activities addressing the forensic examination of several bridge structural components and destructive testing of multiple concrete core and steel samples have taken place since the preliminary report was issued in May.

Tests Conducted by the Turner-Fairbank Highway Research Center (TFHRC)

The Federal Highway Administration (FHWA) is a party to the NTSB investigation and has provided resources and expertise to evaluate materials used in the construction of the bridge. Personnel from the FHWA TFHRC, with NTSB investigators, have conducted various tests and examinations to evaluate multiple concrete core and steel samples taken from the bridge following the collapse. Additionally, one of the steel post-tensioning rods from diagonal member 11 involved in the re-tensioning activity that took place on March 15 and the hydraulic jack used to tension the rods have been evaluated.[1] The initial results from these tests and examinations have, thus far, not indicated any notable material issues. Although the jack was damaged during the collapse, tests were conducted to determine whether the jack could have applied its maximum specified force. Additional testing will be conducted.

Post-tensioning rod tests:

- A tension test to failure was conducted on one of the 1 3/4-inch-diameter post-tensioning rods removed from diagonal member 11 to check the rod's conformance to ASTM International (ASTM) A722.[2]

- Standard round-bar tension-testing specimens were sampled from the 1 3/4-inch-diameter post-tensioning rod removed from diagonal member 11 and from an exemplar 1 3/4-inch-diameter tensioning rod obtained from the collapse site. The specimens were tested in accordance with ASTM A370.

[1] The hydraulic jack is a piece of equipment used to apply the force necessary to adjust (stress or de-stress) the tensioning rods.

[2] ASTM International is a globally recognized developer of voluntary industry consensus standards. ASTM International creates test methods, specifications, classifications, guides, and practices that support industries and governments worldwide.

- Rockwell C hardness measurements were performed on a cross-section of the 1 3/4-inch-diameter post-tensioning rod taken from diagonal member 11 and on a cross-section of the previously mentioned exemplar 1 3/4-inch-diameter tensioning rod obtained from the collapse site. The testing was performed in accordance with ASTM E23.

Post-tensioning jack tests:

- The post-tensioning jack used to tension diagonal member 11 was assessed. The system consisting of the jack, hoses, hydraulic pump, and pressure gauges was installed within a self-reacting test frame with a calibrated load standard. In this test, the jack system was actuated so that the pressure readings on four pressure gauges recovered from the collapse site could be compared to the calibrated load standard. The jack was also tested for its maximum capability.

Concrete tests:

- Six concrete compression tests were conducted; three samples from the bridge deck and three samples from the canopy were tested. These samples were extracted from the bridge structure by means of core drilling. These tests were conducted to determine the compressive strength, compressive elastic modulus, Poisson ratio, and compressive stress-versus-strain behavior of the concrete samples. The tests were conducted according to ASTM C39 (compression), C469 (elastic modulus and Poisson ratio), and C42 (standard for drilled cores).

- Two concrete tension tests were conducted.[3] Both concrete test samples were collected from the bridge deck. These samples were extracted from the bridge structure by core drilling and were tested to determine their tensile strength, tensile elastic modulus, Poisson ratio, and tensile stress-versus-strain behavior. The tests were conducted according to US Bureau of Reclamation (USBR) 4914 (standard for tension testing) and ASTM C42 (standard for drilled cores).[4]

- Six additional concrete samples—three from the bridge deck and three from the canopy—were evaluated to determine the entrained and entrapped air contents, aggregate content, and cement paste content. The tests were conducted in accordance with ASTM C457.

[3] Within the structure, concrete was sometimes subjected to tensile stresses. When an applied tensile stress exceeds the concrete tensile resistance, the concrete will crack. Knowledge of in-place concrete tensile resistance can assist investigators in assessing structural performance.
[4] The USBR is a federal agency within the US Department of the Interior.

Evaluation of Recovered Bridge Deck in the Vicinity of Node 11 and 12

On June 13 and 14, NTSB investigators and parties to the investigation performed a limited internal examination of the section of bridge deck in the vicinity of node 11 and 12. An approximately 5-foot-wide section of the bridge deck was cut on either side of node 11 and 12 and was photographed and subsequently documented using 3-D laser scanning. The internal areas of the specimen were evaluated to determine if the size and location of the reinforcement bars were in accordance with the design plans. The preliminary evaluation of the saw-cut surfaces that were internal to the bridge deck and diaphragm II revealed sound concrete in the undamaged surface areas and embedded reinforcing steel consistent with the reinforcing prescribed in the final design plans.[5]

Interviews

NTSB investigators have interviewed employees affiliated with the following firms and organizations involved with the pedestrian bridge's design, inspection, and construction:

- FIGG Bridge Engineers, Inc.
- Munilla Construction Management
- Bolton, Perez & Associates Consulting Engineers
- Structural Technologies LLC
- Louis Berger Engineers
- Florida Department of Transportation
- The Corradino Group, Inc.
- George's Crane Service, Inc.

Investigators have completed the majority of the interviews, and the NTSB anticipates that the remaining interviews will take place in early August.

Photographs of Cracks

The NTSB's preliminary report included photographs taken on February 24, 2018, that documented cracks in the bridge in the region of diagonal member 11. These photographs illustrated the condition of the cracks before the relocation of the bridge's main span from the casting yard, where the span had been built. On March 10, 2018, the 174-foot-long bridge span was transported from the casting yard and set into place on permanent bridge piers so that it was elevated over SW 8th Street.

NTSB investigators have obtained additional photographs showing the condition of the cracks after the March 10, 2018, move. Figures 1–4 are photographs of the cracks with brief descriptions of their locations and the date and time that each photograph was taken. Figure 5 is a photograph of the span taken during the process of moving it.

[5] A diaphragm is a structural element that transmits lateral loads to the vertical resisting elements of a structure.

Figure 1. Location: Diaphragm II, west side directly adjacent to vertical member 12, top deck view of crack, looking to the north. Time stamp: March 13, 2018, at 11:16:50 a.m., labels added by the NTSB. (Source: Munilla Construction Management)

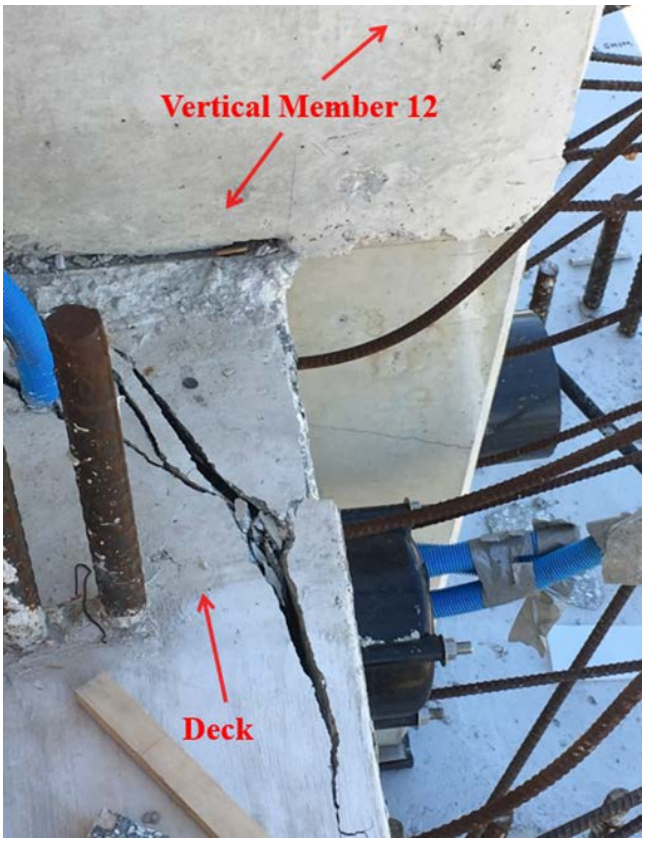

Figure 2. Location: Diaphragm II, east side directly adjacent to vertical member 12, top of deck looking down view of crack. Time stamp: March 14, 2018, at 1:50 p.m., labels added by the NTSB. (Source: Bolton, Perez & Associates Consulting Engineers)

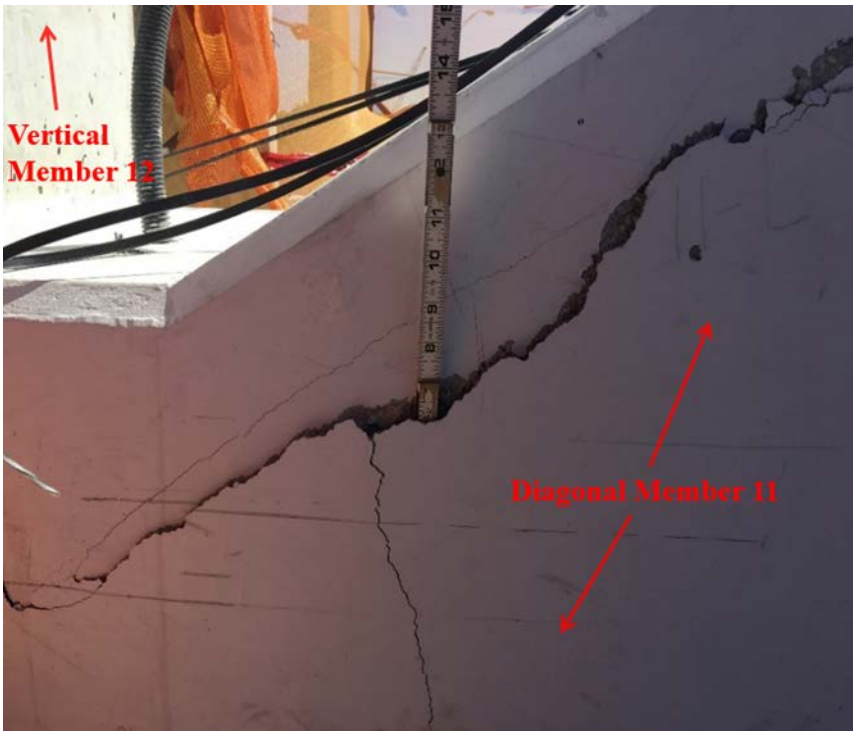

Figure 3. Location: Bottom of diagonal member 11 west face, looking to the east. Time stamp: March 13, 2018, at 11:18:50 a.m., labels added by the NTSB. (Source: Munilla Construction Management)

Figure 4. Location: Bottom of diagonal member 11 east face, looking to the west. Time stamp: March 13, 2018, at 1:29:15 p.m., labels added by the NTSB. (Source: Munilla Construction Management)

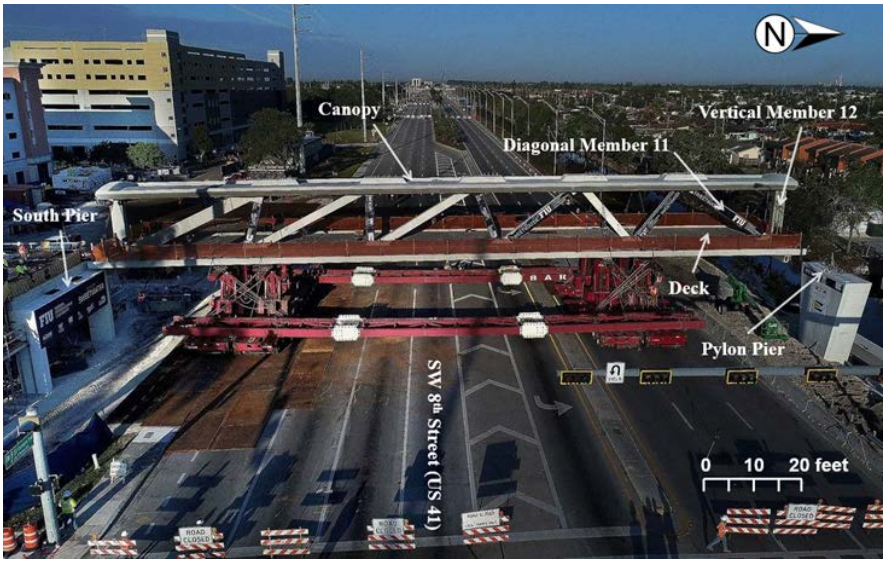

Figure 5. Main span being moved on March 10, 2018, prior to placement on the south pier and north pylon pier, looking to the west, labels added by the NTSB. (Source: Internet)

Other

The following organization has been added as a party to the investigation:

- Bolton, Perez & Associates Consulting Engineers

All aspects of the collapse remain under investigation while the NTSB determines the probable cause, with the intent of issuing safety recommendations to prevent similar events.