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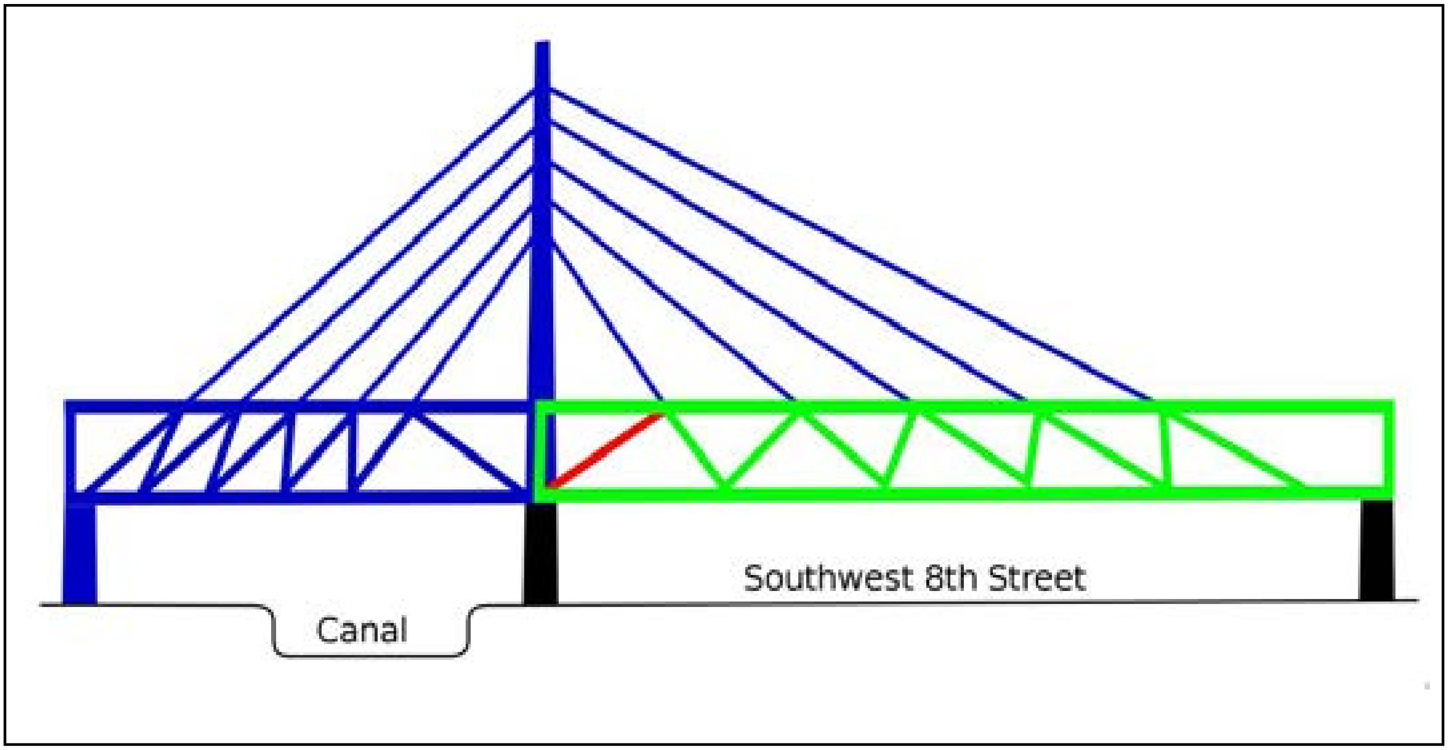

Diagram of the FIU pedestrian bridge with the critical member highlighted in red

Engineering Oops: Florida International University Pedestrian Bridge Collapse

by Austin Crawford, Mechanical Engineering Junior

“Building bridges” is a common metaphor used to describe the action of connecting people, things, places and ideas that are separated by some barrier. The bridges that we build in the literal sense often invoke ambition and aspirations for our communities, states or nations to become more than just an isolated entity, but rather an integral part of the economies and cultures of the surrounding world. As such, bridges are often designed not only with functionality in mind but also with a sense of grandeur and style that reflect these aspirations. This became the case with Florida International University (FIU) located in Miami, Florida, and their desire to build a pedestrian bridge over Southwest 8th Street into the adjacent community of Sweetwater.

The bridge would allow students to cross the road onto campus more safely, especially considering the tragic death of a student hit by a passing vehicle the prior year. It would also promote more travel between campus and the community, offering students a convenient area to socialize outside of classes while increasing FIU’s influence in the community. Being the physical manifestation of FIU’s culture, the bridge required an innovative and aesthetically pleasing design. FIGG Bridge Engineers offered a design that fit those criteria, so they won the $14.2 million bridge contract. Unfortunately, due to key design errors, the bridge collapsed while under construction on March 15, 2018. The incident killed six people, including construction personnel and motorists caught driving underneath the bridge at the time. It is a sobering tragedy for anyone in the engineering field, and it shows that even in modern times with advanced techniques and designs, the fundamentals must always be accounted for when working on important projects.

Overview of Project

The bridge in question consisted of two spans: one over the highway and one over a parallel canal. Both spans met in the middle above a main support column. FIGG employed the accelerated bridge construction (ABC) method to build and place the 175-foot main span traversing the highway. The ABC method involved the onsite prefabrication of segments to be installed onto existing support columns. The ABC method proved desirable for this project due to its cost-effectiveness and the dramatic decrease in time required to construct the bridge. The latter reason became necessary given the desire to avoid the blockage of the busy eight-lane highway for too long. Although ABC provided reliability in other instances, the design of the bridge had to take portability into account which may have caused engineers to overlook key structural features.

The university originally called for an iconic-looking cable-stay design where the main deck is supported by tension cables connected to a main support tower, not unlike the Golden Gate Bridge. However, cable-stay bridges must be constructed on-site and would have resulted in long-term road closures. Attempting to reconcile the convenience of the ABC method with the aesthetic of a cable-stay bridge, the engineering firm proposed an unorthodox truss-style bridge in which there would be a single row of concrete members in the center of the bridge connecting the walking-platform and a canopy on top. To incorporate the cable-stay aesthetic, metal pipes would connect the top of the canopy to the main support column, but they would do little in terms of load bearing.

Design Flaws

Trusses are common structural elements in bridges. They are very effective at distributing loads evenly throughout the structure and preventing any one member from bearing too much stress. However, multiple factors rendered the proposed truss design as unorthodox. First, the truss consisted primarily of concrete, instead of the more commonly used steel for trusses. Concrete is relatively weak in tension, meaning the members had to be made very thick to compensate for the weakness. This approach in turn dramatically increased the weight of the bridge. Second, the truss employed a single row of members down the center as opposed to two rows of members on either side of the bridge. This decision effectively doubled the load on each member of the truss, further increasing the need for thicker, heavier members. Finally, while at first seeming like a minute detail, the angles of the truss members had to be adjusted to line up with "cables" to make the bridge seem more appealing visually, due to the asymmetry of the bridge and the faux cable-stay design. Adjusting the angles of members within a truss changes the load distribution throughout the structure. Because of that, the bridge's load distribution efficiency diminished. These combined factors likely compromised the structural integrity of the bridge.

Several independent structural engineers performed their own analyses of the bridge design and reached the same conclusion on the design. They determined the bridge's design to be unsound, particularly at the member connecting the support column on the main span opposite from the main support column in between the two spans to the upper canopy. They deemed this member to be critical since failure in that member would cause the support column to fail, and, subsequently, cause the entire bridge to collapse. Based off the engineers' calculations, it appears the bridge design firm made the member too thin to support the required load. The likely reason for this error fell to a miscalculation in the original design plans, since the truss contained thicker members elsewhere, but they bore less of a load than the critical member in question.

Catastrophe

Even before the collapse, reports came in that cracks formed within the truss structure near the critical member, but the head engineer of FIGG brushed these reports off, claiming that they held no major concern. Repairs would be made to the cracks later. The day of the collapse, workers for MCM Construction, the company contracted with constructing the pedestrian bridge, began tightening internal support rods within the bridge, possibly as a method to prevent the cracking from spreading further. It is highly speculated that this tensioning increased the load within the critical member of the truss past its breaking point, causing the joint at the member and the vertical support column to fail "explosively," in turn collapsing the entire main span of the bridge onto the highway below.

Aftermath

The National Transportation Safety Board (NTSB) commenced a thorough investigation into the cause of the collapse. The only details about the cause of the collapse at the current moment came from speculation from outside engineers not associated with NTSB or FIU. However, the consensus from these structural experts points to a design issue that led to the fatal catastrophe. While ingenuity, convenience and aesthetics are important aspects of any engineering project, functionality and safety should never be compromised as a result. While there may have been unpredictable circumstances that led to the bridge collapse, a simple increase of the critical member's width from two feet to three feet may have prevented the failure and increased the reliability of the structure. One of the important responsibilities of engineers is to account for unforeseen scenarios and to create designs that are functional while also displaying ingenuity and creativity. In doing so, they ensure the safety of their workers, and more importantly, the public.

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