Heavy Movable Structures, Inc.

SIXTH BIENNIAL SYMPOSIUM

October 30 - November 1, 1996

Doubletree Resort Surfside
Clearwater Beach, Florida

106th Street Bascule Bridge - Emergency Repairs

by

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106TH STREET BASCULE EMERGENCY REPAIRS

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INCIDENT

The 106th Street Bascule bridge is a 250-foot dual-leaf "Chicago-Style" bascule carrying four lanes of traffic and two sidewalks. Built in 1928, the bridge replaced an old swing span over the Calumet River. The positioning of the bridge in relationship to the river is less than ideal for navigation, with a horizontal clear channel of 192 feet and a bend in the river just south of the bridge. River traffic is extremely heavy at this location, and this bridge is listed as the most frequently opened bridge in the city of Chicago.

On the evening of November 4, 1993, a 660-foot-long Polish freighter, Ziema Zamojska, was bound for Montreal fully loaded with corn. The ship apparently made too wide a turn at the river bend, and despite the frantic effort of the tow boats, the ship slammed into the east leaf of the bridge. The ship then backed away and continued toward Lake Michigan, where it was detained by the United States Coast Guard.

Damage to the ship was not threatening, but the structure had suffered the worse end of the deal. The east leaf was in the full upright position when struck and had sustained major damage to the lower chord of the north truss. The bridge was immediately closed to vehicle and navigational traffic.

By morning, the city recognized that the damage to the lower chord was extensive enough that the upright leaf was in danger of collapse. The city mobilized a team of engineers and contractors to assess the damage, develop and implement a plan to immediately stabilize the structure, and to get the structure back in service as soon as possible.

STABILIZING

In the initial assessment of the collision damage, it was noted that the two-inch-diameter trunnion bearing anchor bolts had sheared off, and the north side of the east leaf had shifted nine inches to the east. The lower chord of the east leaf had been entirely smashed in with the distance between panel points shortened by as much as four inches. The immediate concern was to safely stabilize the east leaf in the up position. The danger was two-fold: one, the bottom chord had lost its axial load capacity and the entire truss could collapse; and two, since the north rack and rack-and-pinion had become disengaged, the leaf may not have adequate control to maintain an upright position, and could rapidly crash downward.

To maintain the truss in an upright position, a bracing system was immediately sized and installed between the back wall of the pit and the counterweight. This system consisted of two steel wide flange sections at each truss end and laterally braced off the pit walls.

Concurrently, a strut system was designed and installed to brace the damaged chord. The strut system consisted of a steel wide flange section bolted to the gusset plates and spanning the damaged chord section. The design and installation of the strut system was the first of many cooperative efforts between the City, the designer, general contractor, specialty contractor, steel fabricator, and steel erector.

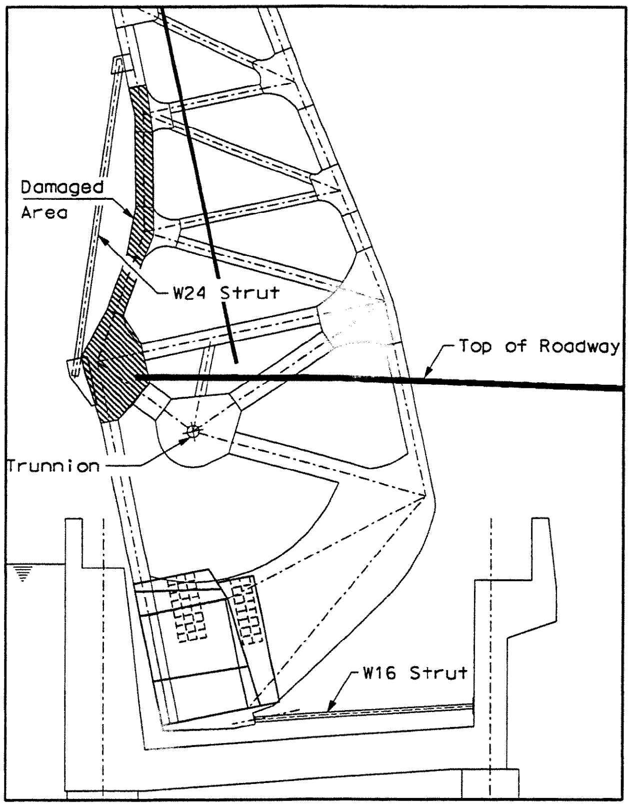

Figure 1.
TRUSS STABILIZATION

DAMAGE REPAIR

After the truss was stabilized and the river open to navigation, the next step was to further assess the damage and develop a plan to repair the structure and get the bridge back into service. After assessment of the repair scope, a schedule was jointly developed for implementing the repairs and placing the structure back in service by February 15, 1994, a duration of only three months. Since the 106th Street bridge is a vital link across the Calumet River, and since the adjacent bridge on 100th Street was under construction, the city desired to get 106th Street bridge back in service as soon as possible. This deadline placed an extreme challenge ahead for the team, given the degree of the damage, the extreme displacement of the entire leaf, and the upcoming winter weather.

The winter weather turned out to present more of a challenge than anyone had anticipated, with several days in January as cold as 30 degrees below zero.

The critical member to be replaced was the damaged section of the lower chord. To facilitate the removal and replacement of this member, the team developed a strut system consisting of wide flange beams attached at the truss gusset plates and spread open with two 200-ton hydraulic jacks. Since the deformation was so severe, a system that would simultaneously jack upward on the bridge deck was also installed. This system consisted of three 100-ton jacks and two 12-inch-diameter columns that transferred the upward jacking force on the bridge deck down through the fixed span deck and to the top of the counterweight.

During the week of December 27, the jacking of the lower chord began. While carefully monitoring the jack pressures, the truss was spread open to the dimension from the original shop drawings. A three-dimensional survey was performed on the top of the truss to verify that the leaf was reasonable plumb. When the dimensions and elevations seemed acceptable, the new chord was installed and bolted up.

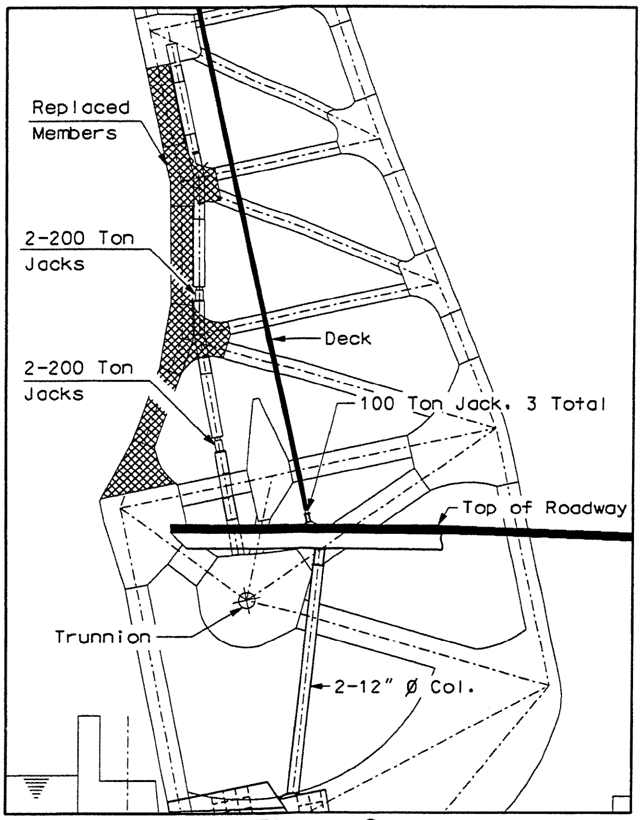

Figure 2.
DAMAGE REPAIR

Repositioning Truss

With the truss stabilized and steel repair in progress, the team worked on developing a plan to shift the entire leaf nine inches back into position. After considerable analysis and discussion, a detailed approach was developed and approved to reposition the leaf. The basic steps to this procedure were:

1. Releasing the north side counterweight blocking.
2. Overcoming friction by jacking up the leaf with four 200-ton jacks.
3. Simultaneously pushing the leaf back into position by jacking upward and outward on the north truss with two 200-ton jacks located against the pit back wall.

In theory, the whole procedure seemed feasible, but actually moving a 1,800-ton damaged structure presented a number of concerns. Would the upward lift reduce the friction enough to allow the truss to be pushed horizontally? Would the horizontal jack force be enough to move the truss into position? And would the drive machinery properly re-engage while moving the truss back?

To help address these concerns, a plan was developed to station personnel throughout the bridge to monitor various items during the repositioning operation. Aided by radio contact with one another, the personnel monitored and recorded:

- Jacking pressures
- Movement of the truss at the north trunnion bearing
- Movement of the truss at the counterweight
- Interface of the rack and rack-and-pinion at both east and west trusses.

The plan was to initially jack the leaf up with 400 tons and to push the leaf horizontally. If the leaf did not move horizontally, the vertical jack load would be increased to further help overcome the friction force.

On a cold morning of January 25, 1994, at 10:30 a.m., everyone held their breath as 240 tons were applied vertically and 120 tons horizontally. The entire team was greatly relieved when the truss moved one inch under this load. For the next four hours, the leaf was gradually pushed back into position. The jack loads increased as the structure neared its final position, but still remained well within the maximum capacities. The final position of the truss was determined by the interface at the rack and rack-and-pinion. It was interesting that upon release of the horizontal loads, the truss actually moved back an eighth of an inch, so the truss was pushed further to allow for this "rebound" effect.

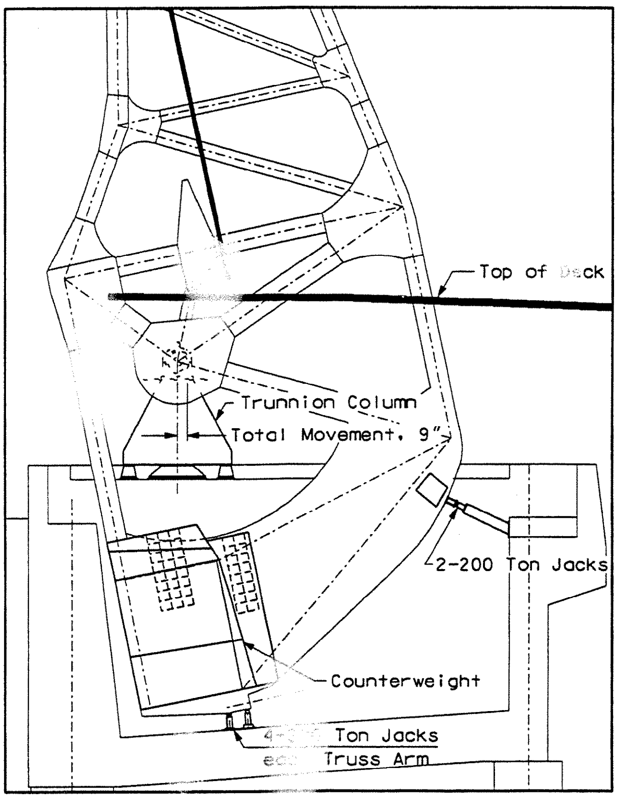

Figure 3.
SPAN JACKING

Restoring Service

Now that the damaged members of the truss were repaired or replaced and the leaf was moved back into position, the next step was to get the span back in operation.

Although the drive mechanics appeared satisfactory, there was concern that the bridge would not be able to operate under its own power. Since the drive mechanism and brake mechanism were questionable, it was decided to develop an approach to manually lower the span. A system was devised using pulleys, cables, and a two-drum cable winch positioned on the fixed span deck. The system was designed to pull upward on the back of the counterweight, thus pulling the leaf back down into position.

The team had concerns over the actual implementation of the plan, and again, to address these concerns, personnel were stationed to monitor critical items during the span pull-down.

On another cold morning, 7:30 a.m. on Friday, February 5, the pull-down operation commenced. The decision to manually pull down proved to be fortunate because ice and debris in the pit caused the initial force to move the span to greatly exceed the torque capacity of the electrical drive system. After the counterweight broke free from the ice and debris in the pit, the pull-down procedure carefully proceeded until the span was fully down at about noon.

Now that the span was down, other challenges occurred in getting the bridge operational within the next ten days. The force and damage that the bridge had undergone was such that the center of the spans still did not match up and the center locks would not engage. This was solved by removing the centerlock mechanism, machining down one side, and shimming and adjusting the centerlock.