Cappelen Memorial Bridge Rehabilitation
Franklin Avenue (CSAH 5) Over the Mississippi River
Minneapolis, Minnesota

Minneapolis Heritage Preservation Commission Summary
September 2013

The Cappelen Memorial Bridge is a five-span, open-spandrel, reinforced concrete arch bridge completed in 1923. It carries Franklin Avenue (County State Aid Highway 5) over the Mississippi River in Minneapolis. The bridge is owned and maintained by Hennepin County. It is heavily used by pedestrians, bicycle users, single occupancy vehicles, heavy trucks, emergency vehicles, and transit buses.

The Cappelen Bridge is in need of repair and is eligible for federal rehabilitation and replacement funds. Expansion joints in the concrete deck are leaking and the drainage system below the joints has failed allowing water saturated with road deicing salts to reach the concrete structure below in multiple locations. Concrete elements closest to the joints exhibit widespread deterioration, while elements farther away from the joints are in generally good condition. The concrete exhibits cracks, spalls, and delamination which has exposed the steel reinforcing in some places. The chloride content in the concrete is high enough that continued deterioration of the reinforcing steel is likely. The two outer spans of the bridge also need strengthening to improve their structural capacity. A list of proposed work items is provided below. See also the illustrated PDF document that accompanies this summary.

Bridge Description

The Cappelen Memorial Bridge is 1,011.5' long and spans a gorge 900' wide with limestone banks about 100' tall. The banks are heavily wooded.

The bridge deck is carried by five open spandrel concrete arch spans with a pier or abutment at the end of each arch. The 400' main (central) span is flanked by two side spans of 199' and outer spans of 55.4'. The crown of the main span is 88' above the springing line of the arch. West River Parkway travels under the westernmost span (span 1) of the bridge. There is a narrow bituminous bike/pedestrian trail under the span 4 on the east bank of the river.

The bridge deck is 66.3' wide and carries two traffic lanes, two bike lanes, and two 7'-wide raised sidewalks. Originally, the deck was 60' wide (see alterations below) and carried streetcar tracks down the center flanked by two lanes of traffic and two 8' sidewalks. The sidewalks were originally paved with concrete tiles and the roadway was paved with blocks of granite and wood that were eventually covered with a bituminous overlay. The bridge carried four lanes of traffic from 1940 to 2005 when it was reduced back to two lanes except at the east end where four lanes were retained heading into the complex five-legged interchange with East River Parkway and 27th Avenue SE.

Each span is comprised of a pair of 12' wide arch ribs that are located 25' apart. The arch ribs in the main span 17' thick at the springing line, tapering to 8' thick at the crown. Each rib is built with Melan-style rigid structural steel reinforcement consisting of five parallel longitudinal

lattice-like frames or trusses built of angled steel. The arches support vertical spandrel columns (about 28’ apart) that end in horizontal cap beams that, in turn, support the deck.

The bridge’s four piers are built of reinforced concrete with recessed fluted detailing on the north and south faces. The two river piers (piers 2 and 3) are oblong in cross-section while the outer piers (piers 1 and 4) have a cruciform plan. The face of the river piers projects outward from the arches and deck, creating space for an observation bay at the top of each pier. The floor of each observation bay was originally about 8.7' deep, a distance that was reduced to 3.3' when a new wider deck was installed in 1970.

The bridge’s original railing was a Classically-inspired concrete balustrade. The railing had square posts, 24" by 28" in cross section. The panels between posts were about 12' long, 44" tall, and 5" thick. The railing had 4" wide by 19" tall hexagonal openings.

The railing was mounted above a "frieze" level on the side of the deck. The frieze was ornamented with a faceted rectangular block that "supported" each railing post and was in turn "supported" by one of the bridge’s corbel-like cap beam ends. These elements, together with architrave-like detailing at the tops of the piers, created a Classical Revival entablature and balustrade on the side of the deck. When the deck was replaced in 1970 the classical ornamentation was removed. The 1970 replacement railing is a tubular steel and concrete structure that is 48" tall.

The deck originally had 26 lights mounted on top of the railing posts. The lights had ornamental metal standards and glass fixtures suspended from curved arms. The original lights were replaced by cobra style lights in 1970.

The bridge received only minor alterations until 1970 when deterioration warranted a major reconstruction. Everything above the arches, piers, and abutments was removed and replaced. Bridge alterations are summarized below:

1940
- A 48”-diameter water main was suspended beneath the deck.
- Streetcar tracks were removed, two vehicle lanes were added for a total of four lanes, and an inner rail was added separating the sidewalk from vehicles.

1954
- West River Parkway was built under span 1.

1970
- Spandrel columns, cap beams, deck, barrier, and lights were removed, leaving only the arches, piers, and abutments.
- The historic arches, piers, and abutments were repaired and covered with a film-forming protective coating.
- The height of the piers was increased by about 3’ and ornamentation at the tops of the piers was removed.
- The new deck was 6’ wider than the original deck; it was 14” rather than 9” thick, and had no ornamentation on the fascia. The deck had a 50’, rather than 40’, roadway and 8’, rather than 7’, sidewalks.

- The new spandrel columns were spaced about 29' apart (instead of 14'), which reduced the number of columns by about 40%. The new columns were 20% to 30% wider but half the thickness (north-south) and set back 3' from each arch face.
- The new cap beams were 20%-30% wider than the original beams, slightly taller, and had square rather than curved ends.
- The wider deck decreased the projection of the river piers and the size of their observation bays. The wider deck also projects farther out over piers 1 and 4.
- A modernistic 48" tall, 1' wide railing was installed, as were cobra style lights.

1984

- A bituminous deck overlay (installed sometime after 1970) was replaced with a 2" low slump concrete overlay.

2005

- Traffic lanes were reduced from four to two.

Historical Background

The Franklin Avenue Bridge, as it was first called, was built in 1920-1923. The bridge was designed by City Engineer Frederick W. Cappelen, assisted by City Bridge Engineer Kristoffer O. Oustad. The bridge approaches were designed in cooperation with the Minneapolis Park Board.

The 1923 concrete arch bridge replaced a steel truss bridge, also designed by Cappelen, that had been built in 1889. To maintain traffic and make use of a ready construction platform, the 1923 bridge was designed to be built around the 1889 truss bridge, which was not demolished until the concrete bridge was completed. (The lower few feet of two limestone piers from the 1889 truss bridge remain in the river today.)

The new bridge provided a wider roadway to serving growing automobile traffic, and allowed expansion of streetcar service: before 1923 the Franklin/11th Street streetcar line terminated on the west bank of the river and did not yet cross to the east bank.

Construction of the new bridge began in July 1920 and took more than three years. In October of 1921, while construction was underway, Frederick W. Cappelen died unexpectedly. Two months later the bridge was named Frederick W. Cappelen Memorial Bridge in his honor.

The *Engineering News-Record* in January 1923 called the bridge, "one of the most important and interesting works of structural engineering now in progress." When the bridge was dedicated in December 1923, the main span was the longest concrete arch in the world and attracted international attention from the engineering community.

The Cappelen Bridge was one of a series of monumental concrete arch bridges built in the Twin Cities in the early 20th century. Six are listed on the National Register: Third Avenue Bridge (1916); Cappelen Bridge (1923); Robert Street Bridge (1926); Fort Snelling-Mendota Bridge (1926); Intercity or Ford Bridge (1927); and Cedar or Tenth Avenue Bridge (1929).

Frederick W. Cappelen was one of an elite group of talented Norwegian-born and European-trained engineers who came to the U.S. between 1880 and 1930. He was born in Norway in 1857, studied in Sweden and Germany, and graduated with honors in 1880 from the Royal Polytechnic Institute in Dresden. He immigrated in 1880 and worked as an engineer for the

Northern Pacific Railroad until 1886. He was then Bridge Engineer for the City of Minneapolis and next served as City Engineer, an elected position, in 1893-1898 and 1913-1921. Between terms as City Engineer, Cappelen was in private practice.

Cappelen worked on at least eight bridges over the Mississippi: Third Avenue and Cappelen Memorial, which are extant, and six that have been razed. He also designed significant portions of Minneapolis' municipal sanitation and water systems, including designing Kenwood Water Tower (1910) and Prospect Park Water Tower (1914, National Register-listed). He died of appendicitis in October 1921 at age 63.

Kristoffer O. Oustad (1857-1943) assisted with the design of the Cappelen Memorial Bridge and took over design responsibility after Cappelen died. Oustad was also a talented Norwegian-born engineer. He graduated from Trondhjem's Technical College in 1882, and was hired by the City of Minneapolis in 1883. He became City Bridge Engineer in 1893. Oustad assisted Cappelen with the design of the Third Avenue Bridge and the Cappelen Bridge. He was lead designer for the Cedar Avenue Bridge and retired when it was completed in 1929.

Historic Designation

The Cappelen Memorial Bridge was listed on the National Register in 1978. It was evaluated within the statewide historic context entitled "Reinforced-Concrete Highway Bridges in Minnesota, 1900-1945." The bridge is eligible for the National Register under Criterion C (type, period, or method of construction) in the area of Engineering as the most prominent of a nationally-renowned series of concrete arch bridges constructed in the Twin Cities in the 1920s and for having, at the time of completion, the longest concrete arch in the world. The level of significance is National and the period of significance is 1923, the year the bridge was completed.

The bridge is also a Contributing element within the Grand Rounds, a historic district eligible for the National Register and in the process of being formally nominated. The Grand Rounds is eligible under Criterion A (broad patterns of history) and Criterion C (type, period, or method of construction) in the areas of Community Planning and Development and Landscape Architecture. The period of significance is 1887-1942.

The Cappelen Memorial Bridge was named a Minneapolis Landmark in 1985.

Proposed Bridge Rehabilitation: List of Work Items

Deck

- replace 1970 deck with similar deck of similar width except widen at east end by 10' (beginning east of Pier 3) with 1:15 taper

Sidewalk

- replace 1970 raised sidewalk with 17'-wide bike/ped trail (12' at east end)

Inner Rail

- add an inner rail separating the bike/ped trail from vehicular traffic; use simple visually-neutral design (compatible in scale) consisting of concrete parapet with metal tube on

top; use of an inner rail that meets modern crash-test standards frees up the outer rail to be a close reproduction of the original

Outer Rail

- replace 1970 rail with 48" tall concrete rail that is a close reproduction of the 44" original

Lights

- replace 1970 lights with close reproduction of original lights; place in original locations on railing posts; use LED dark-sky compliant fixtures

Observation Bays

- extend observation bays on river piers about 40" out over the pier face to recover about 2/3 of original overlook depth (floor of observation bays was originally 8'8", now 3'4")

Deck Fascia

- on new deck, create two-level entablature with faceted blocks at "frieze" level

Spandrel Columns

- repair concrete (dates from 1970)
- cover with film-forming coating (except in Span 1) to blend repairs and protect concrete

Cap Beams

- replace cap beams (date from 1970) with beams slightly larger in dimension; shape the ends of the new beams with curves similar to historic curve
- cover with film-forming coating (except in Span 1) to protect concrete

River Piers (Piers 2-3)

- remove loose 1970s coating
- repair concrete (which dates from 1923)
- add architrave-like coping at top of piers similar to historic detail (observation bays will be extended out over pier)
- finish repairs with standard concrete finish (using plywood forms)
- cover with film-forming coating to blend repairs and protect concrete

Pier 1 (at West River Pkwy)

- remove loose 1970s coating
- repair concrete (which dates from 1923)
- shape the beam structure at the top of the pier to match curve of new cap beams
- finish repairs with special board-form finish
- stain to blend repairs
- protect with clear silane coating

Pier 4 (east bank, less accessible to public)

Same as Pier 1 except:

- beam structure at top will extend further out over the pier because of east end deck widening
- finish repairs with standard concrete finish (using plywood forms)
- cover with film-forming coating to blend repairs and protect concrete

River Arches (Spans 2-4)

- remove loose 1970s coating
- repair concrete (which dates from 1923)
- embed hidden cathodic protection anodes
- finish repairs with standard concrete finish (using plywood forms)
- cover with film-forming coating to blend repairs and protect concrete

Span 1 Arch (at West River Parkway)

- remove loose 1970s coating
- repair concrete (which dates from 1923)
- embed hidden cathodic protection anodes
- reconstruct two missing spandrel columns to increase strength
- finish repairs with special board-form finish
- stain to blend repairs
- protect with clear silane coating

Span 5 Arch (east bank, less accessible to public)

Same as Span 1 arch except:

- finish repairs with standard concrete finish (using plywood forms)
- cover with film-forming coating to blend repairs and protect concrete

West Abutment

- remove loose 1970s coating
- repair concrete (which dates from 1923)
- finish repairs with special board-form finish
- stain to blend repairs
- protect with clear silane coating

East Abutment (less accessible to public)

Same as west abutment except:

- finish repairs with standard concrete finish (using plywood forms)
- cover with film-forming coating to blend repairs and protect concrete

Old Bridge Piers

- remove piers from 1889 bridge