Reconstruction of Mississippi River Bridge at Keokuk

SYNOPSIS—The old single-deck spans are being replaced with double-deck spans having a railway track below and highway and sidewalk above. The reconstruction is of special interest in that the bridge has to be kept open for railway and roadway traffic during the progress of the work.

The reconstruction of the long steel bridge crossing the Mississippi River at Keokuk, Iowa, by placing a new superstructure on the old piers, is complicated by the necessity of keeping the bridge open for railway, street-railway, team and pedestrian traffic.

The bridge has a 380-ft. swing span, two fixed spans of 254½ ft. and eight fixed spans of 149 to 162 ft. The old bridge had a single lower deck for all traffic, teams being excluded while trains were crossing, as there was not room for them to pass. The new bridge has a lower deck, with single track for steam and electric-railway service, and an upper deck, with 18-ft. roadway and a 4½-ft. walk (on the south side only) carried by cantilever brackets. The approaches for the upper deck are 600 ft. long on the Keokuk side and 360 ft. on the Hamilton side. The new bridge was described in *Engineering News*, Aug. 5, 1915. Fig. 1 shows the condition of the work on Dec. 1, 1915.

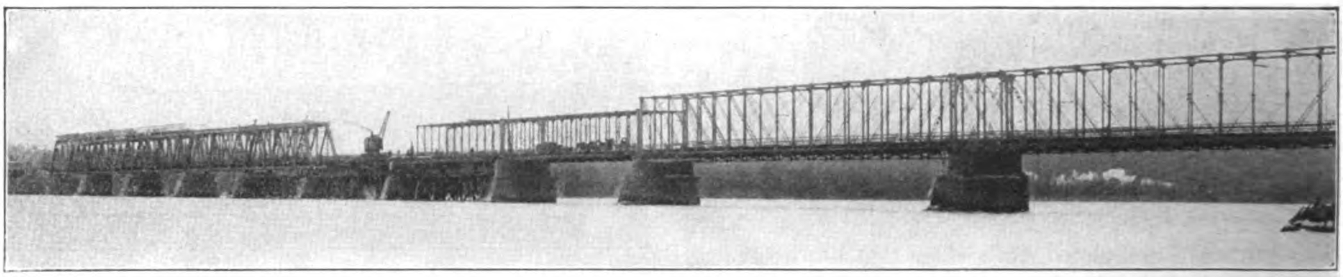

FIG. 1. RECONSTRUCTION OF MISSISSIPPI RIVER BRIDGE AT KEOKUK, IOWA (DEC. 1, 1915)

Five of the new 160-ft. double-deck spans at the east end have been erected. The locomotive crane is standing on the falsework of the sixth span, and the seventh span is partly dismantled. The next short span and the two 254-ft. spans have the old trusses still in place. The drawspan is next to the long span at the right

Alterations to Piers

The piers are of stone masonry, resting on the bedrock that forms the river bottom. Owing to the greater depth of the floor system of the new bridge, with tracks at the original level, the tops of the piers were cut down about 5 ft. and capped with reinforced concrete. This work was done during the erection of the steel, the new shoes being suspended from the trusses (on falsework) just clear of their final elevation and lowered to a bearing as soon as the concrete had set.

A small concrete mixer was run out on the bridge, and the concrete was spouted through the floor. As the trusses of the new bridge are spaced 16 ft. 7 in. c. to c. while those of the old one were spaced 21 ft. 6 in., there was plenty of room to place the mixer on a platform over the end of the pier, the old outside walks having been torn up. One pier is in bad condition and will be rebuilt from above the low-water line. Until the completion of this work, the ends of the spans to be carried by this pier will remain supported on the falsework.

The river bottom is limestone bedrock, with little or no cover, so that no piling can be used. The falsework consists of 6-post bents carrying the working platform. In placing the bents each post was driven to a firm bearing on the rock and then cut off at the proper elevation for the cap.

For the shorter fixed spans—149 to 162 ft.—each span had 7 bents connected by longitudinal struts, with diagonal bracing connecting one pair of bents at each end. This construction is shown in Fig. 3. Each of the two longer spans—254 ft.—had 12 bents, with the end bents parallel with the piers and the others at right angles to the bridge. These were spaced about 23½ ft. apart and braced together in pairs to form five braced towers under each span (Fig. 4).

For the drawspan a different arrangement was used (Figs. 2 and 4), owing to the swift current in the navigable channel and the desirability of leaving ample passageway for drifting ice. This precaution is specially necessary in view of the fact that the falsework simply rests on the river bed, so that pressure against it is to be avoided. Under each arm of this span there are 8 bents, braced in pairs to form 16-ft. towers spaced 25 to 28 ft. apart. The longitudinal bracing of the towers is in the plane of the outer vertical posts, as shown in Fig. 2.

In all falsework bents the posts are 10x12 in., the outer posts being battered. The caps are 12x12-in., 28 ft. long, not driftbolted, but secured by splices bolted to the sides of the cap and posts. Along the ends of the caps are stringpieces 12x12 in. The sway-bracing of the bents is of 3x10-in. planks, and the tower struts 6x12 in.

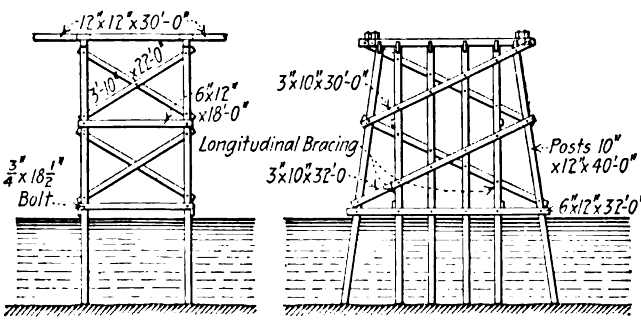

FIG. 2. FALSEWORK TOWERS FOR THE 380-FT. DRAW SPAN

Falsework was built for three spans at a time. As soon as that for the first span was completed, work on the steel was commenced, while at the same time the falsework was being put in under the next span. In each of the eight shorter spans plate-girder stringers for the 254-ft. spans were used as falsework stringers, braced by horizontal and diagonal transverse timbers. The same arrangement was used for one of the longer spans, while for the other there were six lines of the old trussed floor-beams to serve as stringers. For the drawspan falsework the towers had four lines of 15-in. I-beams, from the approach, while between the towers were six of the old floor-beams.

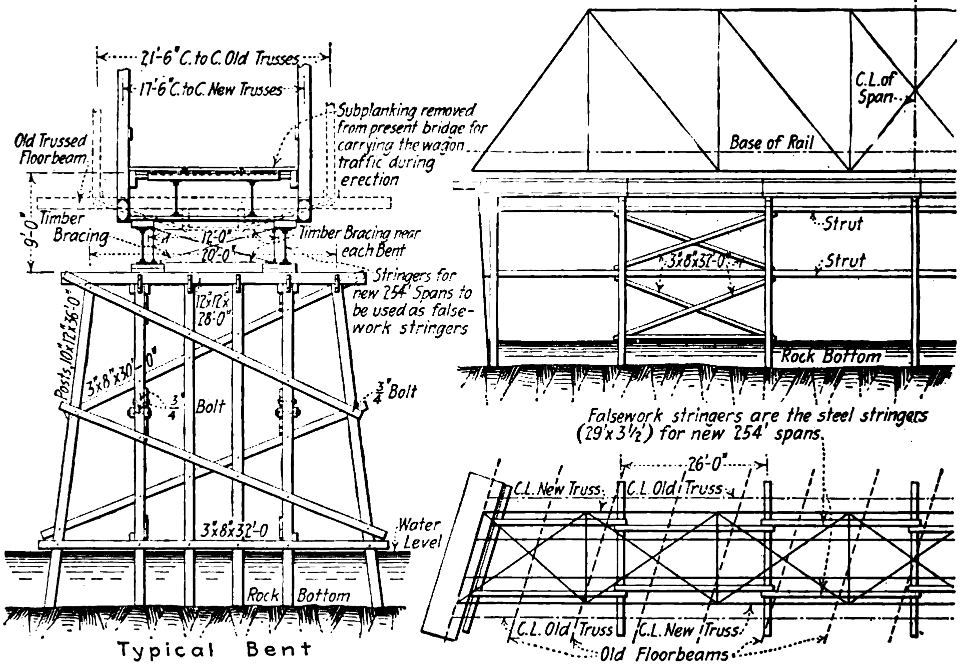

FIG. 3. FALSEWORK AND METHOD OF ERECTION FOR THE 160-FT. SPANS

With the falsework in place the first work was the renewal of the floor system. The old floor construction consisted of trussed floor-beams spaced about 12 ft. c. to c. and carrying wooden stringers to which the deck planking was spiked. The rails rested directly upon two of these stringers. The two sidewalks, outside of the trusses, were carried by extensions of the floor-beams.

The new steel stringers, mentioned before as being used for falsework, are placed in elevation somewhat below the new floor-beams, and the old stringers are supported on them. The old trusses and overhead bracing are then dismantled. The old floor, consisting of paving, subplanking and ties, is left until all the spans are erected.

In erecting the new floor system slots are first cut crosswise in the floor, to allow the new floor-beams to be slipped in place; then the old wooden stringers are removed and the new steel stringers inserted under the old ties. This work is done piecemeal, or panel by panel, the floor-beams and stringers being removed as the replacement work reaches them.

When all the spans are erected and the roadway on the upper deck is finished, the team traffic will be diverted to this roadway. In the intervals between trains the old deck will be torn up and replaced with an ordinary railway deck with rails and guard timbers on crossties.

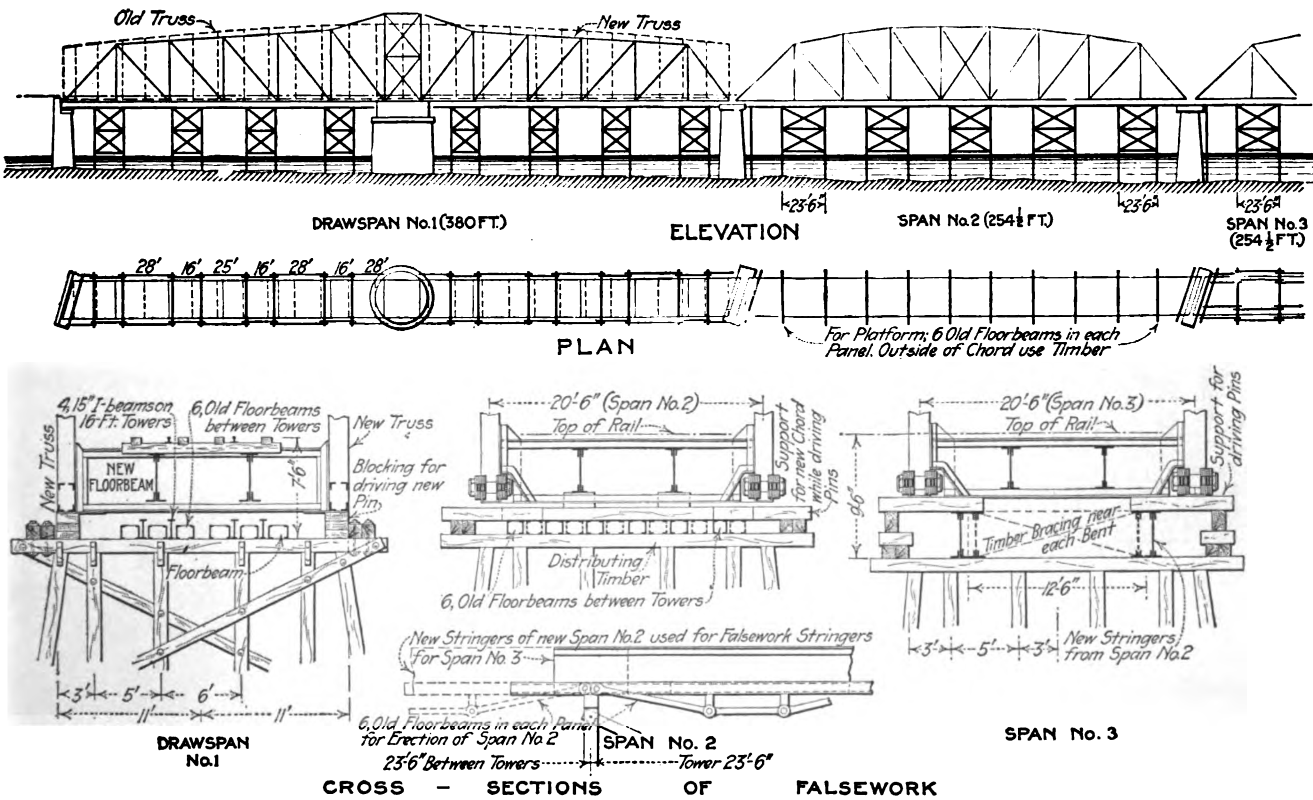

FIG. 4. FALSEWORK AND PLATFORMS FOR THE 380-FT. DRAWSPAN AND TWO 254½-FT. FIXED SPANS

After the completion of the falsework the old trusses were dismantled, commencing with the span at the east end. This work was done with a 25-ton four-wheel locomotive crane standing upon the railway track (Fig. 1). The material was loaded upon flat-cars that were handled by a dinkey locomotive. The steel for the new trusses was delivered and erected in the same way, the posts being riveted to the floor-beams already in place. The material yard is at the east end of the bridge.

In the two longer spans, with eye-bar members for the bottom chords, blocking was built up on the falsework to support the ends of the chord members while the pins were driven. The entire span was riveted up complete upon the falsework, which was then removed to another span.

Fig. 5 is a view of the work in progress. In the background is a train on one of the new spans. An old span is in the foreground, and between this and the new one is a dismantled span with track carried on falsework. The brackets extending out to the right on top of the new span are for the sidewalk on the upper deck. These are also shown in Fig. 6.

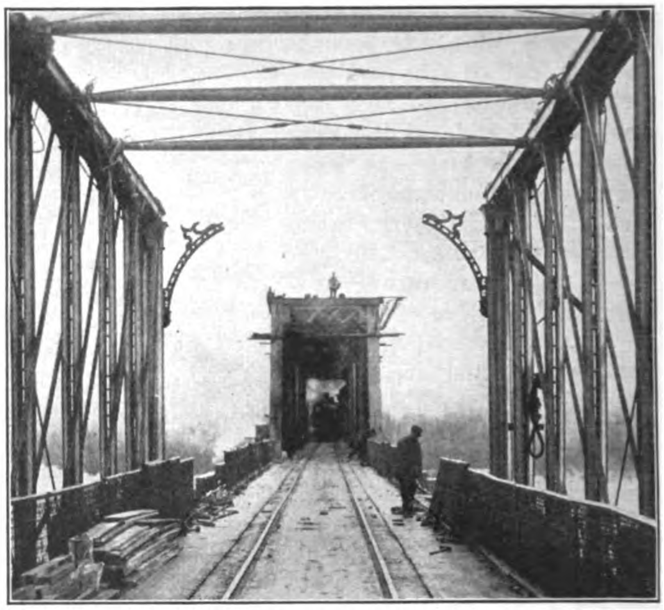

FIG. 5. DISMANTLING ONE OF THE SPANS

Handling Traffic Over the Bridge

While there are not many steam trains crossing the bridge, there is a half-hourly service of electric cars. To provide for their passage, the contractors remove the locomotive crane to a siding at the material yard and clear the bridge every half-hour. The cars and any waiting teams then cross, first in one direction and then in the other. This arrangement involves a delay averaging 10 min. from the time of stopping work until its resumption. As electric wires cannot be maintained across the bridge, the cars are hauled across the bridge by the contractor's dinkey locomotive.

The work of renewing the first span was commenced in September, 1915. On Dec. 6 five spans had been completed, the new sixth span was partly erected and the old seventh span partly dismantled, while falsework was being placed under the eighth span. Falsework was also being placed under the drawspan. Fig. 1 shows the condition on Dec. 1, and Fig. 6 shows some of the completed double-deck spans.

Navigation was closed officially on Nov. 18, but boats were allowed to pass until Dec. 4. The new drawspan must be ready for the opening of navigation this season. The weight of the new spans is about 190 tons for each 160-ft. span, 400 tons for each 254-ft. span and 680 tons

FIG. 6. NEW DOUBLE-DECK SPANS OF THE KEOKUK BRIDGE

for the drawspan, as compared with 120, 240 and 400 tons for the corresponding old spans.

The new bridge was designed by Ralph Modjeski, consulting engineer, of Chicago. The Strobel Steel Construction Co., of Chicago, has the contract for the entire work of removal and reconstruction.

Interlocking Wood Sheet Piles

In the wood sheet piling shown herewith each pile is made up of three planks that are easily shaped at the mill and may be spiked together at the site. When assembled, the pile has a T-head tongue and a slotted groove to receive the tongue of the next pile. Fig. 2 shows the construction of the pile and also the method of making an interlocked corner. The piles are of yellow pine and may be wholly or partly creosoted.

This sheet piling has been used extensively to form cutoff walls to prevent leakage under levees, also for bulkheads, foundations and caissons for bridge piers. Fig. 1 shows (at the left) the top of a line of sheeting in the Fairfield levee (with waling pieces bolted along each side); at the right is a caisson for a bridge pier in the New Basin canal at New Orleans. This caisson was made of piles 30 ft. long and was removed after completion of the pier.

For making a water-tight cutoff under levee embankments it has been employed on about 20 mi. of levee work in Louisiana, including the Fairfield levee, built by the Mississippi River Commission and described in *Engineering News*, Oct. 8, 1914. Major Sherrill, United States Corps of Engineers, reported that of various kinds of steel and wood sheet piling used this was "the only one that was entirely satisfactory."

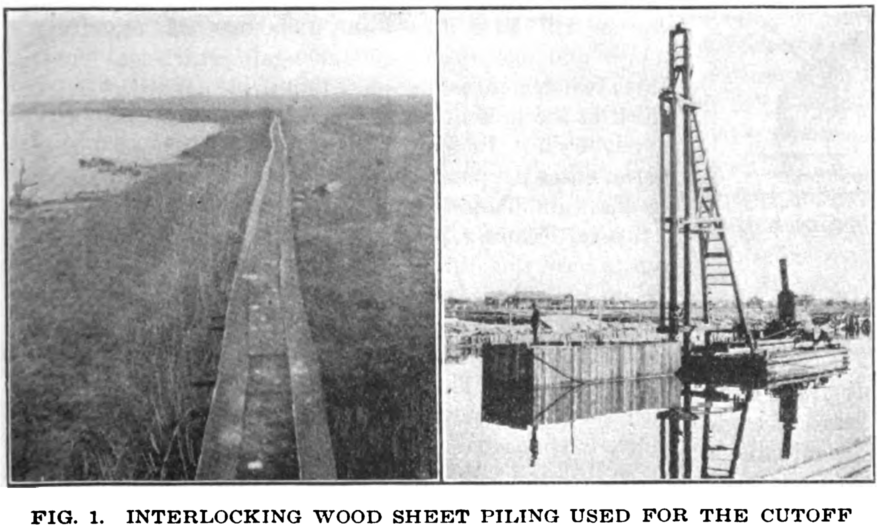

FIG. 1. INTERLOCKING WOOD SHEET PILING USED FOR THE CUTOFF UNDER A LEVEE AND FOR A BRIDGE CAISSON

According to a report of one of the engineers as made to Major Sherrill, the first 857 ft. (17,140 ft. in all) cost $4,309, of which sum $1,378 was for the driving. The direct cost to the contractor was $1.10 per lin.ft., 23c. of which was for assembling, but it was considered that with proper methods this item should not exceed 15c. The soil was "buckshot" and gumbo for the first 8 ft. and then blue clay. With a 2,350-lb. hammer and an average drop of 12 ft. an average of 80 blows was required to drive a 12-in. pile. Very close joints were obtained.

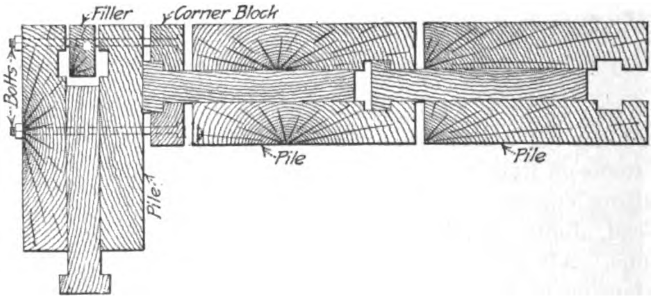

FIG. 2. INTERLOCKING WOOD SHEET PILING

This piling is designed by Albert A. Martinez, 908 Perrin Building, New Orleans, La. It is manufactured by the J. J. Newman Lumber Co., Hattiesburg, Miss.

Emergency Water-Supply at Danville, Ill.

An emergency pipe-laying job was done last year at Danville, Ill., by the Interstate Water Co., to remedy flood damages. In the past two years the company has increased its water-supply by means of a new dam in the Vermilion River. A temporary dam was built to provide for a possible drought in 1914 (as severe droughts had been experienced in the summers of 1911 and 1913), and it was intended to replace this structure with a larger concrete dam.

On July 31, 1915, there occurred a rainfall of 3 in. in 2½ hr., which caused a temporary levee to wash out. This flood caused a jam of driftwood to form against the falsework under the new Oaklawn Ave. concrete bridge, and the jam in turn caused the scouring out of the river bed, washing out four lengths of pipe in the 12-in. water main extending from the city proper to Vermilion Heights. As this was the only line supplying that district and as the break could not be repaired for some little time, it was necessary to lay a 12-in. emergency main, about 2,600 ft. long, on top of the ground and around the bridge site. Service was resumed in three days.

After the flood the temporary dam was replaced with one of timber and concrete construction, made 200 ft. longer and 6 ft. higher. It provides a pondage of 400,000,000 gal. in addition to that obtained by the older concrete dam at the pumping station, 4 mi. downstream. For water treatment hypochlorite has given way to liquid chlorine. The chlorine plant has been in operation only about a month and a half, but is giving satisfactory results as to bacterial reduction and cost of operation. H. M. Ely is Superintendent of the Interstate Water Co.

Causes of Forest Fires in National Forest Reservations are summarized in a bulletin issued by the Forest Service of the Department of Agriculture. There were reported on such reservations in 1915, 6,324 fires, but only 346, or 5½%, did damage in excess of $100. Lightning was the most prominent cause of forest fires, 28½% being of such origin. Other causes are reported as follows: Campers, 18%; brush burning, 11%; incendiary, 11%; railroads, 9%; lumbering, less than 3%; unknown, 15%.