building and structural use were discussed by F. L. Browne (U. S. Forest Products Laboratory), more especially as to the behavior of paints on frame houses. Then the termite problem as affecting railway structures was reviewed by Harry R. Duncan (C., B. & Q. R. R.). In roofs of various materials the troubles and failures are due more to lack of adequate maintenance than to poor materials or workmanship in original construction, according to a committee report (J. S. Hancock, D., T. & I. R. R.).

Subjects for the 1937 meeting include: (1) Developments in timber trestles; (2) deferred maintenance in relation to painting; (3) maintenance of movable bridges; (4) safety in use of power-operated tools and equipment; (5) fire protection of structures; (6) water service developments; (7) insulation of railway buildings. Election of officers resulted as follows: President, E. C. Neville, bridge and building master, Canadian National Railways; secretary, C. A. Lichty, Chicago.

Cantilever Bridge Erected From One End

Wabash Railway Company builds new structure over the Missouri River at St. Charles, eliminating 50-year old bridge

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DESIGNED to be erected from both ends, a cantilever bridge across the Missouri River at St. Charles has just been completed by the Wabash Railway Company, construction having been carried on entirely from one end. When it became evident that a considerable amount of time would be required to dismantle the erecting equipment and re-erect it on the opposite side, the feasibility of erecting the structure all from one end was investigated. It was found that no change in details would be necessary, except for the removal of some splice plates, and a rearrangement of the temporary steel bents. As a result of this change, it was estimated that a month's time in erection could be saved.

The structure, which went into regular service Oct. 13, replaces one of the old historic landmarks in its section of the country, first constructed in 1871 and rebuilt during the Eighties. The old bridge consists of seven spans some 300 and some 315 ft. in length on high masonry piers having a clearance of 70 ft. in ordinary stages of the river. Four of the spans are of the Whipple double intersection type 40 ft. deep, and three are of the double Warren type 33 ft. in depth. The details of the latter trusses gave more or less trouble as the floorbeams were carried on brackets riveted to the inclined web members. The trusses were originally designed to carry 84½-ton locomotives, but with the increase in traffic and in the size of locomotives, they were strengthened to carry one 210-ton locomotive. While the computations showed that the unit stresses allowable had not been exceeded, the increased loading no doubt contributed to the weakening and ultimate renewal of the bridge.

Early in 1929, surveys were started for a new bridge. The height of the

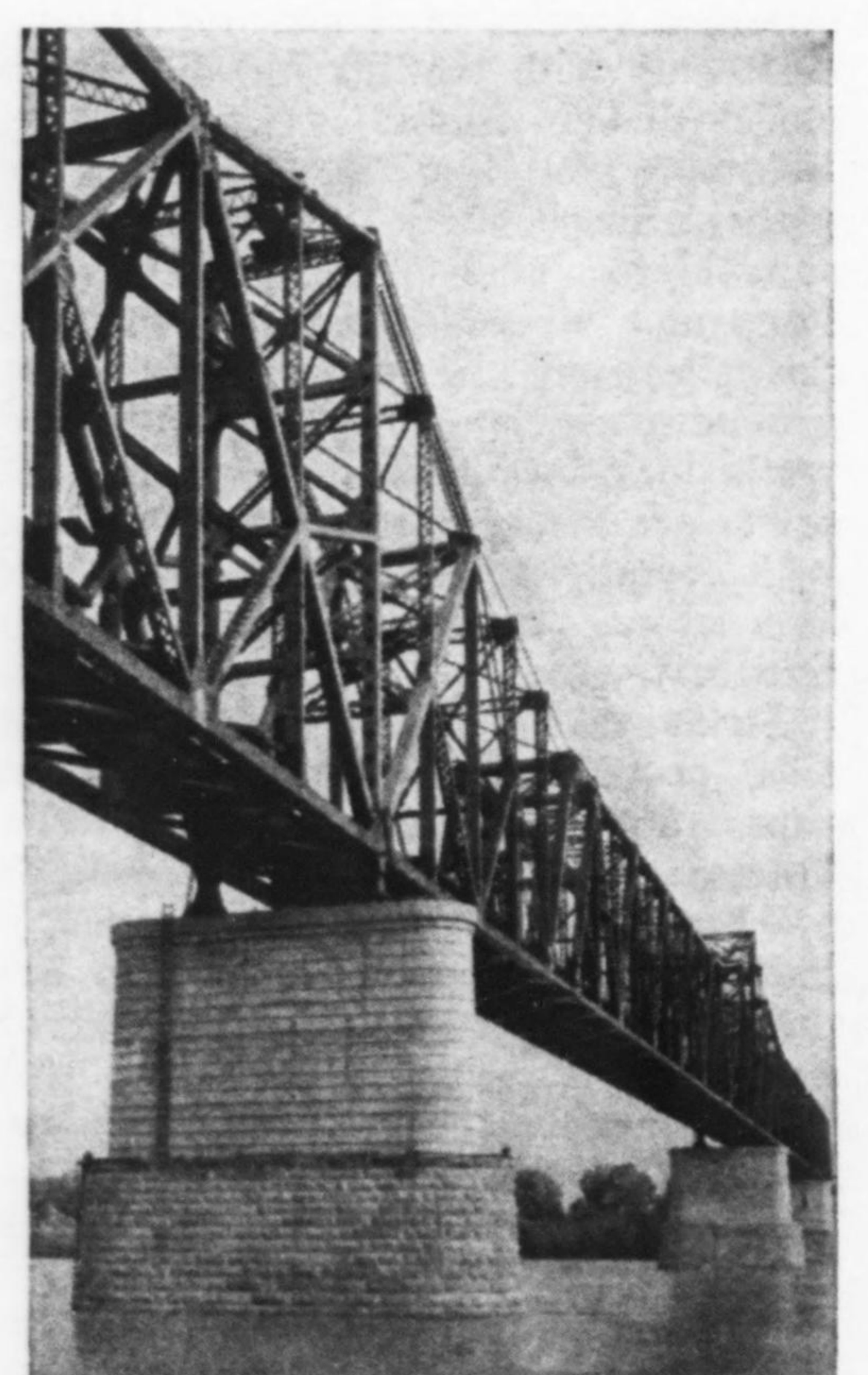


FIG 1—MAIN CANTILEVER span of the new Missouri River crossing of the Wabash Ry. provides a 600 x 45.5 ft. shipping opening.

piers of the old bridge and the irregular alignment of the approaches made a relocation advisable. A new crossing was located about one-half mile downstream from the existing line. At the same time it was decided to reduce the ruling grade between St. Louis and Kansas City, located just east of the bridge, necessitating a change of line between Robertson and St. Charles, a distance of 7.2 miles. The line selected shortened the distance about 0.7 miles and eliminated 234 degs. of curvature.

The War Department required that the railroad company provide a vertical clearance of 45.5 ft. above the 1903 high water mark, one 600 ft. clear main channel and one 406 ft. auxiliary channel, locating the westerly main channel pier about 250 ft. from the west bank. With these restrictions, it was impossible to obtain a symmetrical structure. A cantilevel structure with unequal anchor arms was selected which met all of the requirements, and a simple span was inserted at the east end, to fill out the waterway. The suspended span was made identical with the simple span, thereby obtaining a small amount of duplication in the details. The simple span was made 312 ft. in length, the east anchor arm 429 ft., the channel span 624 ft. and the west anchor arm 273 ft.

Main bridge details

The structure is designed for single track, using a special loading of two 401-ton locomotives, the equivalent of about Cooper's E-75. The basic unit stresses used were 18,000 lb. per sq. in. for carbon steel and 24,000 lb. per sq. in. for silicon and heat-treated steel. The floor system and all main truss members except one in the simple span are of silicon steel. In detailing the structure, the back-to-back of chord angles was held constant instead of the inside-to-inside of gusset plates as is usual. This simplified the riveting in the chords and enabled the gussets to be cut into the webs of the chords, thus shortening the length of the connecting rivets in addition to saving material. Split H-sections were used wherever possible in the bracing. A star section—two angles with equal legs arranged in the

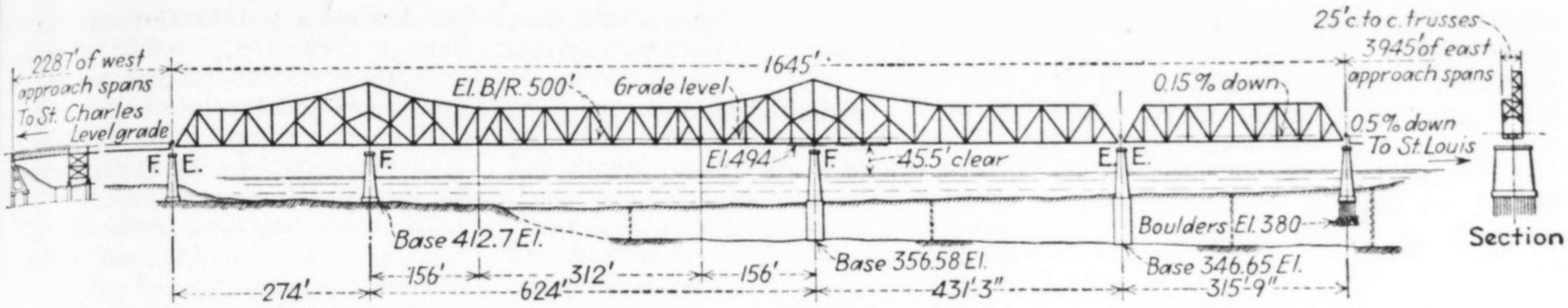


FIG. 2—UNSYMMETRICAL anchor spans and a suspended span that is a duplicate of the simple approach span characterize the new Wabash Ry. bridge over the Missouri River at St. Charles, Mo.

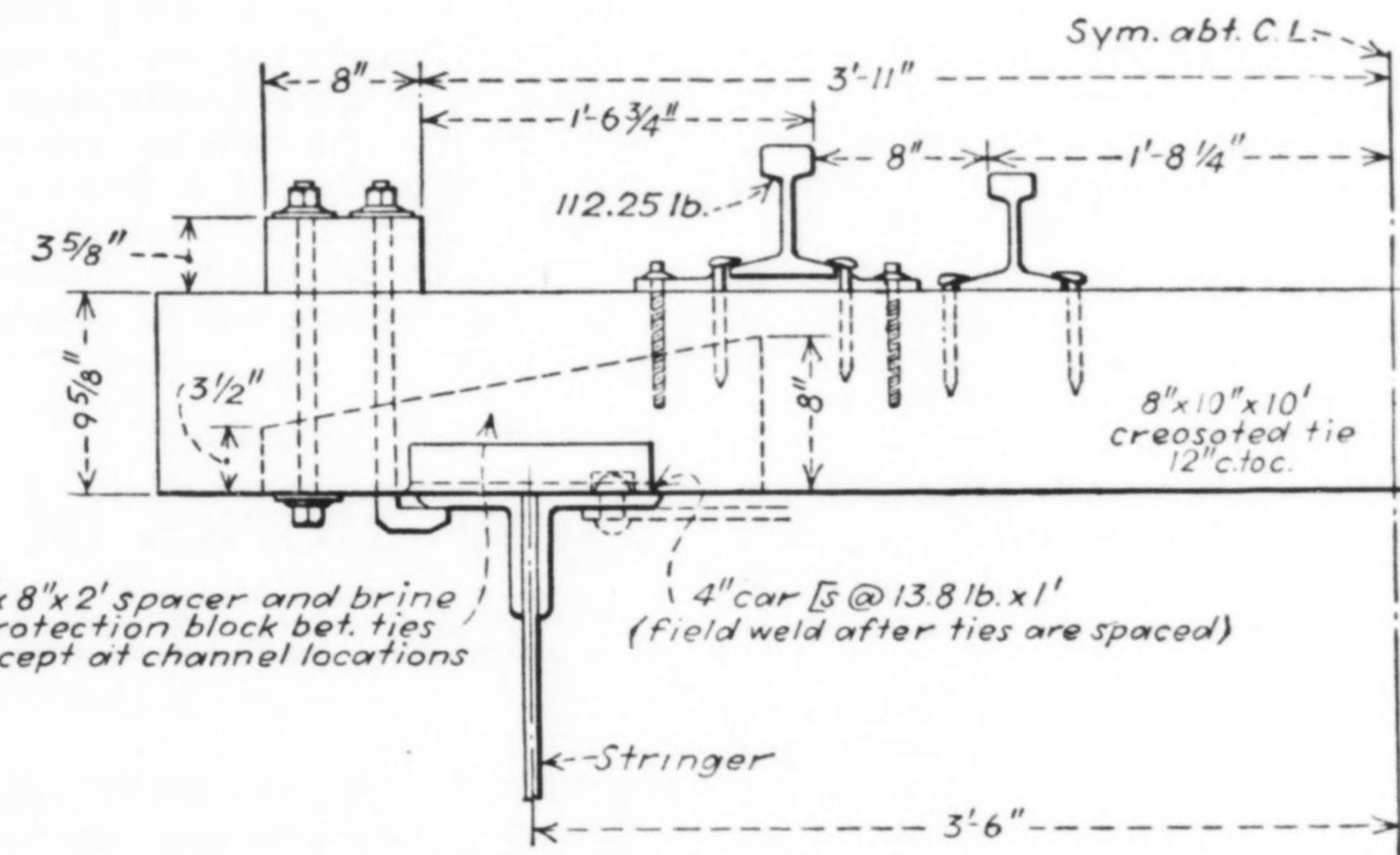


FIG. 3—DECK SECTION in which spacer blocks between the ties protects the stringers from brine drippings. Steel channels welded to the stringers replace the blocks at intervals in the main span, serving to fix the ties in position.

shape of a cross or an X—are used in the diagonal bracing of the intermediate portals. The expansion shoes at the end of the anchor arms are designed with segmental rollers and adjustable wedges which permits of ample adjustment. In the short anchor arm, the uplift is taken by eight 4-in. round rods extending 30 ft. down into the pier. The shoes are set on a bush-hammered surface on alternate layers of canvas and red lead paste. The expansion in the 624 ft. span is taken at the east end of the suspended span, the west end being fixed to the west cantilever arm.

The five main piers were constructed during the winter of 1930-31 by the Missouri Valley Bridge and Iron Co. The three intermediate piers are faced with Indiana limestone from the base to a few feet above the high water line. All of the piers rest on bed rock except the easterly one, which is supported on a foundation of concrete piles. On the completion of the piers, no further work was done on the bridge for several years. However, some 1,000,000 cu. yd. of earth were moved on the change of line before all work was suspended.

Long approaches

The substructure of the east approach consists of 154 concrete pedestals supported on creosoted wood piles. The tops of the pedestals are on the average about 4½ ft. square and are built so that the elevation of the tops are above the high water level, and at the same time parallel to the 0.5 per cent grade in steps, as it were, to produce as much duplication in the superstructure as possible. The east abutment is 38 ft. in height, and is of the spill-through type. It consists of two posts with a beam across the top and is supported against overturning by two inclined members acting as braces. The volume of concrete for an abutment of this height was only 103 cu. yd.

In the west approach substructure, there are 82 concrete pedestals. Elevation of bedrock being only about 30 ft. below the surface of the ground, it was thought that the wood piles used in the east approach would broom in driving. Consideration was then given to the use of steel H-sections, but owing to the irregularity of the surface of the bed rock, these were abandoned as it would be impossible to determine the unit pressure on the rock due to the small area of the pile section. To obviate these difficulties, concrete cylinders were adopted as meeting all of the objections to both the wood and steel piling. The diameters of the cylinders used are 4, 4½ and 5 ft. The west abutment is similar in construction to the east abutment, except that it is 55 ft. high. It is supported on four 5-ft. cylinders and contains 201 cu. yd. of concrete, exclusive of the cylinders.

The superstructure of both approaches is similar in construction, except that the east approach is on a 0.5 per cent grade and the west approach is on a level grade. It consists of a series of a 60-60-30 spans on towers and rocker bents alternately. The columns are all rolled sections, silicon steel, either 24 or 27 in. in depth. All columns are provided with cast iron pedestals, which rest in a bed of iron filings, salamoniac and sulphur. In the rocker bents, the columns are fixed to the bases, being designed to overcome the stresses due to traction and expansion. Silicon steel is used in all girders 60 ft. in length or over. For the sake of appearance and also economy, the 30 ft. spans in the towers were made the same depth as the adjacent 60 ft. spans. To reduce the friction in the expansion bearings at the top of the rocker bents, bearing blocks of structural steel fitted with phosphor-bronze are provided, which can be lubricated from the track level with a pressure gun.

Erection from one end

The erection of the main spans was started at the east end of the bridge with the simple span, and was carried on by means of an inside traveller supported on the stringers and bottom chords of the trusses. The simple span was erected on four steel bents, each bent being supported on eight steel H-piles.

The east six panels of the east anchor arm were cantilevered out from the simple span to an erection bent, a strut being placed between the bottom chords and a tie between the top chords the latter consisting of eyebars later used in the permanent structure. The channel span was cantilevered out to the mid-point of the suspended span and the four erection bents used on the simple span were re-erected under the west half of the suspended span and the west cantilever arm. In erecting the west anchor arm, only one erection bent was required; when the erection of the west anchor arm had progressed two panels beyond the pier, the westerly bent of the four bents in the channel span was dismantled and re-erected at the third panel point west of the pier. The erection bents in the channel span were erected above the final grade so that when a landing was made on the westerly pier, the end floorbeam would be about 1 ft. low. This was done to facilitate the erection of the final top chord member. The end floorbeam was temporarily carried on timber blocking and finally jacked to the proper elevation, at the same time lowering the remaining bents in the channel. Then the shoes and the anchorages were placed in the proper position.

Special deck construction

The details adopted for the deck construction are a modification of the Wabash standard deck, introducing some of the features of the German track construction in an attempt to prevent the creeping of the rails and at the same time to provide some protection against brine drippings on the top flanges of the stringers and the girders. The ties, which are 8 x 10 in. and 10 ft. long, creosoted and prebored, are spaced on 1 ft. centers and are separated by brine blocks, 2 ft. long, 4 in. thick, 4 inches wide at one end and 8 in. at the other. The brine blocks are spiked to the ties with one 8 in. boat spike with the wide end toward the center of the track so that they will drain to the outside. These brine blocks also function as spacer blocks to prevent bunching in the case of a derailment. In each panel in the main spans, six of the brine blocks have been replaced with 4-in. car channels 12 in. long, welded to the stringer. The ties are thus fixed to the stringers and the rail is prevented from running in either direction by rail anchors inserted on the rails between the ties held by the channels. In the approaches, the rail is fixed to the tower spans in the same manner.

Track characteristics

The main running rail is the new *A.R.E.A.* 112-lb. section, using double shouldered tie plates. The tie plates are attached to the ties by two screw spikes. The inside guard rail is of the same section as the running rail. The outside guard rail is a 4 x 8 in. timber laid flat and not dapped. The deck is held in position by hook bolts in every second tie, the alternate ties being held by a bolt through the guard rail. The ties are not dapped as the top cover plates are run full length, but in the girder spans with rivet heads in the upper flanges, the ties were grooved before treating. All holes in the ties were prebored except those for the hook bolts. After the track was lined into position, these holes were drilled in the field. The outside guard rails were not prebored. It was the original intention to attach the tie plates to the ties before placing, using the template described in the A.R.E.A. Manual, but it was found that any slight irregularity in the location of the tie plates prevented the rail from entering between the shoulders on the plate. The procedure finally adopted was simply to lay the tie plates in position, lay the rail, then spike and finally apply the screw spikes.

Administration

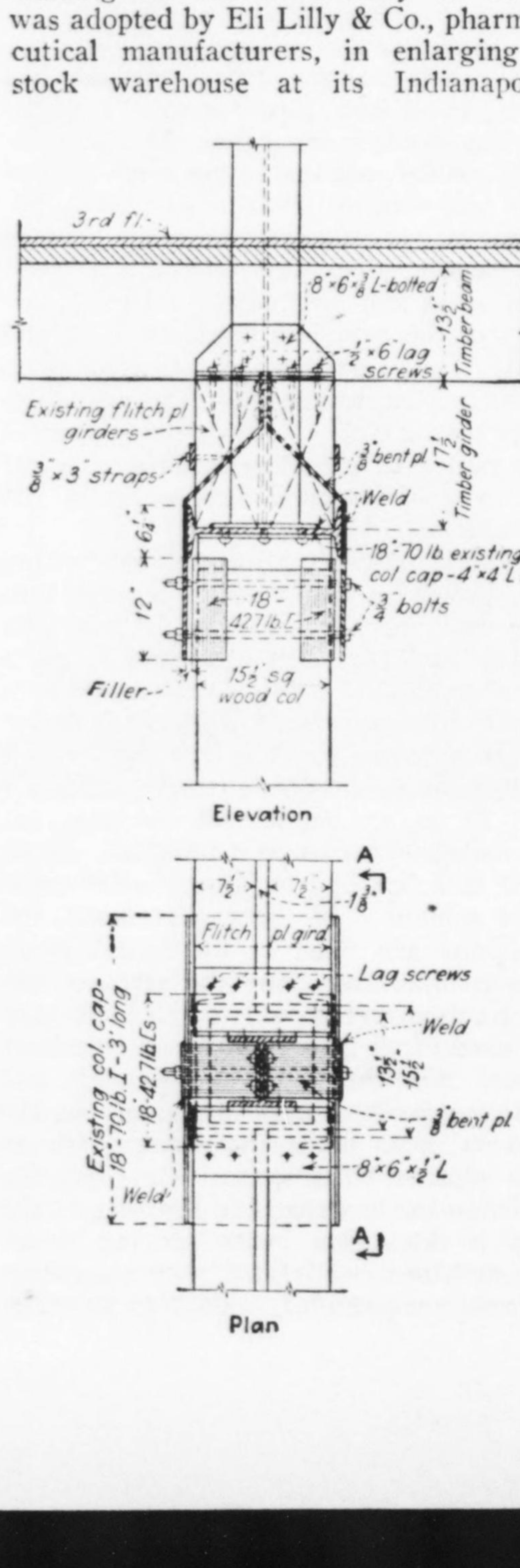
The bridge is 7876 ft. in length and contains 8800 tons of structural steel, 155 tons of reinforcing bars, 5860 yards of concrete, 4061 lin. feet of concrete piles and 64228 lin. ft. of wood piles, exclusive of the five main piers. The total cost of the structure was $1,720,000 of which $1,065,000 was for the superstructure. The Inland Construction Co. was the contractor for the east approach substructure, and Bates & Rogers for the west approach substructure. The contract for the fabrication and erection of the superstructure was let jointly to the American Bridge Co. and the Mt. Vernon Bridge Co. The American Bridge Co. fabricated and erected the approaches and the Mt. Vernon Bridge Co. the main spans. John T. Ellis and Walter Smith were the superintendents for the respective companies.

The work was done under the direction of E. L. Crugar, chief engineer, Wabash Railway Co. and C. S. Johnson, bridge engineer. The structure was designed by the writer, who prepared plans for both the substructure and the superstructure. R. S. Stephens was the resident engineer in charge of the field work. Modjeski, Masters & Case were the consulting engineers, and C. T. Duncan the resident engineer-inspector for the Public Works Administration.

New Stories of Steel Framing Added to Timber Building

THE UNUSUAL EXPEDIENT of adding two new stories of steel framing to an old three-story timber building (and also reframing the old third story in steel) was adopted by Eli Lilly & Co., pharmaceutical manufacturers, in enlarging a stock warehouse at its Indianapolis plant. The two new stories provide expanded facilities for the office forces and are air conditioned, requiring double wall construction to provide space for air ducts. Operations in the stock house in the lower stories could not be interrupted during the alteration, and this affected the construction plan to the extent that the new fourth floor was built inside the building before the old roof was removed, so that the new floor could serve as a roof during the construction. The most novel single element in the reconstruction is the splice between the old timber columns and the new steel columns.

The decision to use steel for the added stories was based upon a study which indicated that the remaining useful life in the timber structure could be equated



SPLICE DETAIL between timber and steel column. Original timber girders and beams were retained on this third floor. Two new upper floors utilize a cellular steel plate design with concrete slab surfacing.