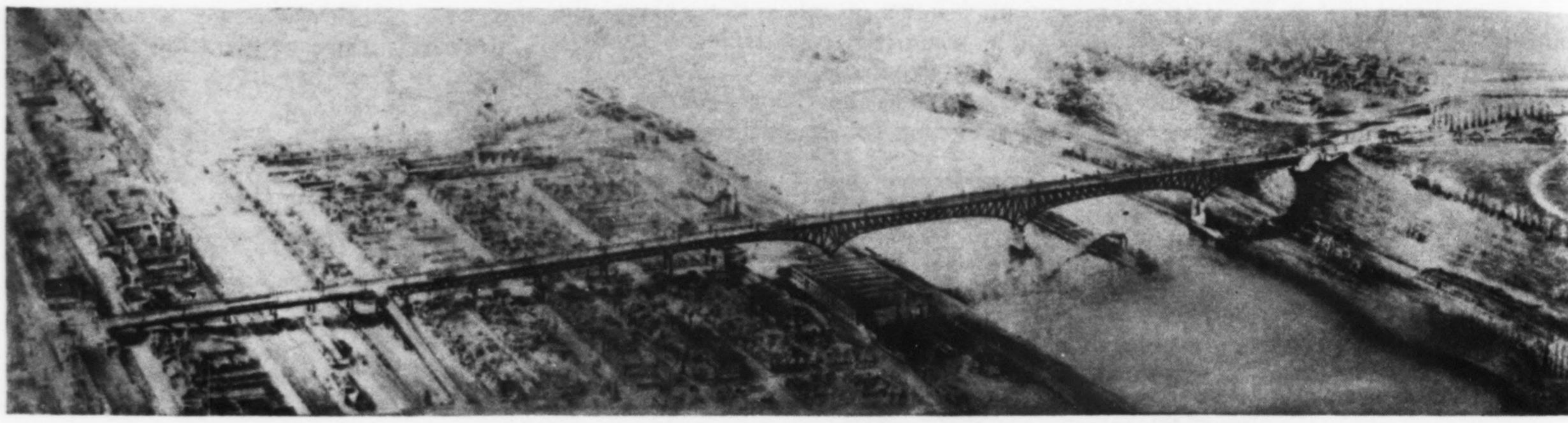

FIG 1—NEW TYPE continuous truss bridge over the Monongahela River between Pittsburgh and Homestead which is statically determinant by virtue of pin jointed rhomboid panels over the intermediate piers. The four span main river bridge comprises one continuous group, while the six spans of trusses in the Homestead approach comprise the second group. Eighth Ave. in Homestead is at the left.

Continuity and Determinacy Combined in New Bridge

Monongahela River crossing between Pittsburgh and Homestead utilizes Wichert trusses in which the panel of members over the piers is a pin-jointed rhomboid instead of the more usual triangle

A UNIQUE TYPE of continuous truss bridge is under construction over the Monongahela River 8 miles above its mouth in downtown Pittsburgh. Having all the advantages of continuity, such as rigidity, economy of material, and smaller foundations, the trusses of the bridge are at the same time statically determinate. As a result, the truss has the special advantage for a continuous structure of ease and directness of analysis and certainty of reactions. Known as the Wichert truss, a name taken from the man who developed it, this special type of structure boasts other claimed advantages—the moment distribution may be accurately controlled, the stresses are unaffected by temperature differences between the chords and are negligibly affected by pier settlement, and the reactions do not need to be adjusted as they do in most continuous structures. These special qualities result solely from the expedient of arranging the panel of members over the intermediate piers in the form of a rhomboid pinned at the corners and oriented so that one corner rests on the pier.

The Homestead Bridge has been designed and is being built under the supervision of the engineers of the Allegheny County Authority with a PWA loan and grant. It is a high level structure in contrast to the nearby Brown's Bridge which it replaces. The old bridge, of simple through truss design, was built in 1894 and its approach roads on both sides of the river have long been a source of trouble and delay to traffic.

As shown in Fig. 1 the new bridge is a long deck structure extending some 3200 ft. from near the top of a bluff on the Pittsburgh side across the river to a junction in Homestead with 8th Ave., a main thoroughfare along the edge of the business district. Two groups of Wichert truss units are included in this length. The main river crossing consists of a four span unit (291-533½-533½-291 ft.) with curved lower chords. (As the bridge is viewed in Fig. 1, these spans are designated as Number 17, 16, 15 and 14 from the right or Pittsburgh abutment to the left.) Adjoining this unit in the Homestead approach is a six span group with 128 ft. end spans and 163 ft. intermediate spans, all with parallel chords. The shoes of the main truss spans rest on sandstone faced concrete piers and abutments, those of the approaches on steel bents. The support between the main and approach spans is also a heavy steel bent resting on a concrete base on piles.

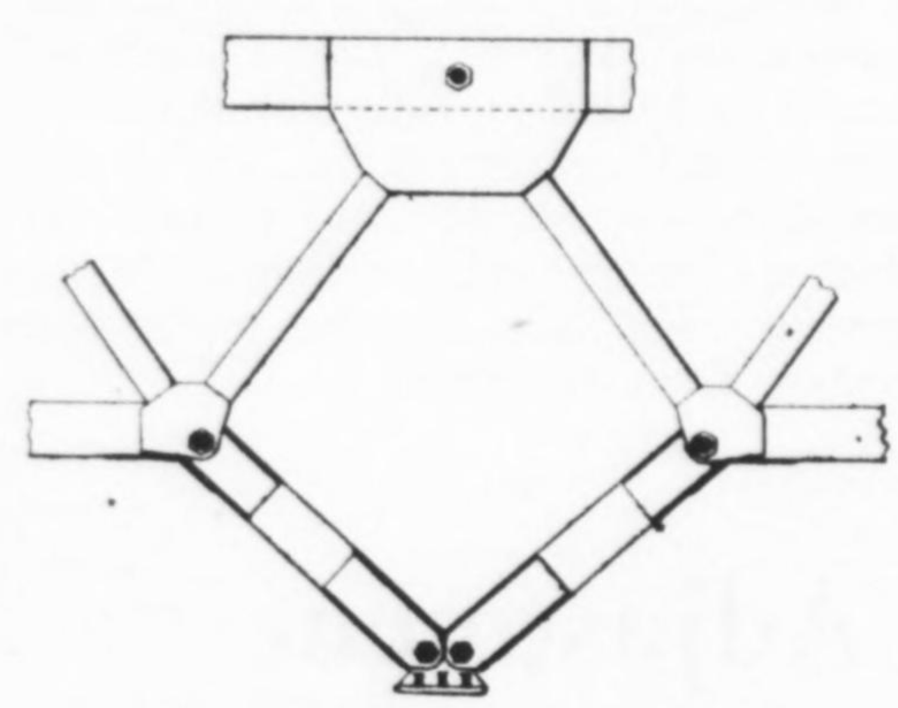

FIG. 2—TYPICAL RHOMBOID PANEL of a Wichert truss.

The remainder of the length is made up of six plate girder spans over the tracks of the Pennsylvania and Pittsburgh & Lake Erie railroads and a 65-ft. steel rigid frame over 7th Ave. A grade of 3.5 per cent was necessary over the first 2½ spans in order to cross 7th Ave. without requiring it to be depressed more than 3½ ft. This grade is followed by a 218 ft. parabolic curve over the railroad tracks. A break in grade to 0.5 per cent is then made, to keep the structure as low as possible at the point where the 5th Ave. ramp connects in the first truss span. A 240 ft. parabolic curve then gives transition to the 3 per cent grade that is used on the balance of the structure.

The bridge carries a 40-ft. roadway and two 8-ft. cantilevered sidewalks. The girders in the first five spans are 44 ft. center to center as a result of the through girders required in span 5 to maintain the minimum clearance over the P.R.R. tracks. On the remainder of the bridge the girders and trusses are 40 ft. on centers.

The roadway pavement is a concrete filled steel I-grid, about 4¼ in. deep with a maximum weight of 60 lb. per sq.ft. Sidewalk slabs are made of burned clay aggregate concrete with a unit weight of 100 lb. per cu.ft.

The bridge was designed for a live load on each truss consisting of one lane of trucks, one lane of street cars, and a 6 ft. width of loading on the sidewalk, giving 1.13 kips per lin.ft. for uniform load (moment and shear) and 115 kips for moment and 128 kips for shear under concentrated loads. In no case did the specified combination that included wind stresses govern the design of the trusses and they therefore were omitted.

Design considerations

In the analysis of the Wichert truss, the moment about the upper hinge point of the rhomboid is a controlling factor. This moment, resisted by the thrust of the rhomboid struts, is determined by the product of the reaction at the pier times a constant that reflects the dimensions of the rhomboid. As a consequence, the reactions are obtained simply by taking moments about the upper hinge points and solving the several equations simultaneously. The rhomboid constant is expressed in feet. Its value is one-half the base of a right triangle whose altitude is a line joining the upper and lower hinge points and whose hypotenuse is one of the rhomboid struts extended to an intersection with a horizontal line drawn through the upper hinge point.

As in other continuous trusses, the so-called "fixed points" are of prime importance and form the basis of all analyses connected with the truss. These points, whose positions are fixed by the dimensions of the truss and are independent of the loading, are two in number in each span, one near the left end and one near the right end.

Once the fixed points are determined, all influence lines are readily determined; the influence line for the end reaction may in fact be drawn by inspection. The influence lines consist of straight lines, those for the reactions connecting the upper hinge points of the rhomboids. Since the lines are based solely upon the dimensions of the truss, stresses obtained from them are final and do not have to be corrected for factors which depend upon the sections chosen for the members.

Since the dimensions of the rhomboid and consequently the rhomboid constant may be varied at will, the moment distribution is thus under control, permitting the truss outline to be varied to suit requirements of economics or esthetics. For purposes of economy, the dead load moment curve is made to correspond as closely as practicable to the truss outline. This moment curve is obtained by sketching the simple span bending moment and then adding a closing line that gives the proper value for the negative moments over the piers. These latter moments are of course obtained from the reactions and the rhomboid constants.

The rhomboid constants at piers 15 and 17 are 47.8641 ft. and at pier 16 (in the center of the river) 54.6887 ft. Using these values the dead load moment at these three piers was selected so as to give the most economical distribution. This required a higher moment at the center pier than at the two others.

Although a complete examination of secondary stresses in the trusses of the Homestead bridge was not made, the maximum secondary stress found for the several conditions of loading investigated was about 20 per cent of the primary stress. Low secondary stresses are a particular advantage claimed for the Wichert truss over a cantilever or a conventional continuous truss although the designers of the Homestead bridge believe that low secondaries are a minor consideration in the comparative economy of the Wichert truss. Friction in the joints of the rhomboid affect the secondary stresses in the adjacent members and for this reason extra precautions were taken to reduce this friction to a minimum, principally by using the smallest possible pins.

Details of one of the rhomboid panels in the four span main river group of trusses are shown in Fig. 3. The shoe is typical of that at piers 15 and 17; at pier 16 a fixed shoe is used. It will be noted that two pins are used in the shoe. Such an arrangement was chosen as giving a more simple detail than a single large pin. Also the two small pins were estimated to cause less friction than a single large pin.

Another element of the rhomboid make-up, chosen to reduce the size of the pins and therefore pin friction, is the forged billet bearing at the pins. Although the members are 30 in. deep, only 8 in. diameter pins are required. These billets are attached to the members by four 1-in. diameter tap bolts and by welds of both the plug and fillet type. Extra care is used to prevent corrosion or rusting in the vicinity of the pins; the lower ends of the rhomboid struts are filled with concrete and all openings where water might enter are sealed with asphalt cement.

In addition to the rhomboid panels, the trusses have other structural features. The top chords are utilized as stringers. No lacing bars are used on any member in the bridge; rolled sections are utilized wherever possible. Otherwise built-up sections with cover plates are used; from the lower cover plates of these members manholes, 12x18 in. at the joints and 10x18 in. elsewhere are cut at intervals of 3 ft. as an aid to riveting, inspection and painting. The diagonal and vertical members in the trusses are generally 27 in. wide flange beams.

The floor steel consists of 60-in. plate girders spanning between the trusses and two lines of 30-in. 116-lb. stringers placed 6 ft. either side of the bridge centerline. In addition the top chords of the trusses serve as stringers, as mentioned above. The stringer span is 24 ft. 3 in. In each such span length there are four lines of 21-in. cross beams framed into the chords and resting on the stringers.

The rhomboid struts are the heaviest bottom chord members in the bridge, carrying a load (dead plus live) of 3,113 kips. This is resisted by an effective section of 154.81 sq.in. The center panels of the top chords carry a load of 3,014 kips. All main bridge steel is copper-bearing. Of the 2,800 tons of steel in the trusses of the main river crossing, 2,400 are silicon steel and 400 carbon steel. Most of the steel in the approaches is copper-bearing, carbon steel. All rivets in the truss joints are $1\frac{1}{8}$ in. in diameter, the shop rivets being of copper bearing carbon steel, and the field rivets of copper bearing manganese steel.

In so far as its continuous truss features are concerned, the 6-span group in the Homstead approach is similar to the main river crossing. The shorter spans, however, permit the use of a single-pin shoe. The principal other point of in-

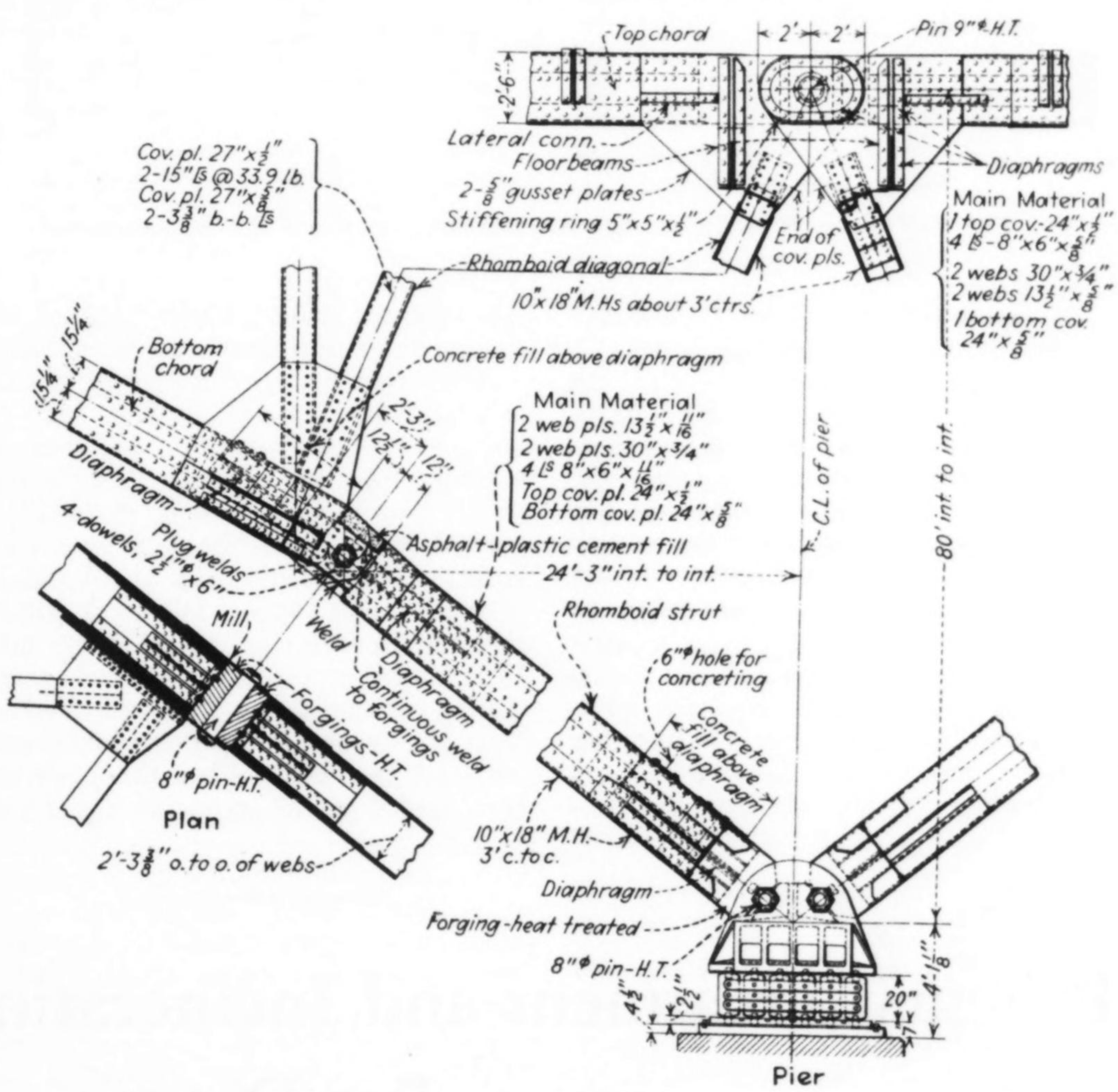

FIG. 3—RHOMBOID panel details at the two shore piers of the new Monongahela River crossing at Homestead, Pa. Details at center river pier same except for use of a fixed shoe which is similar but deeper because of the absence of rockers.

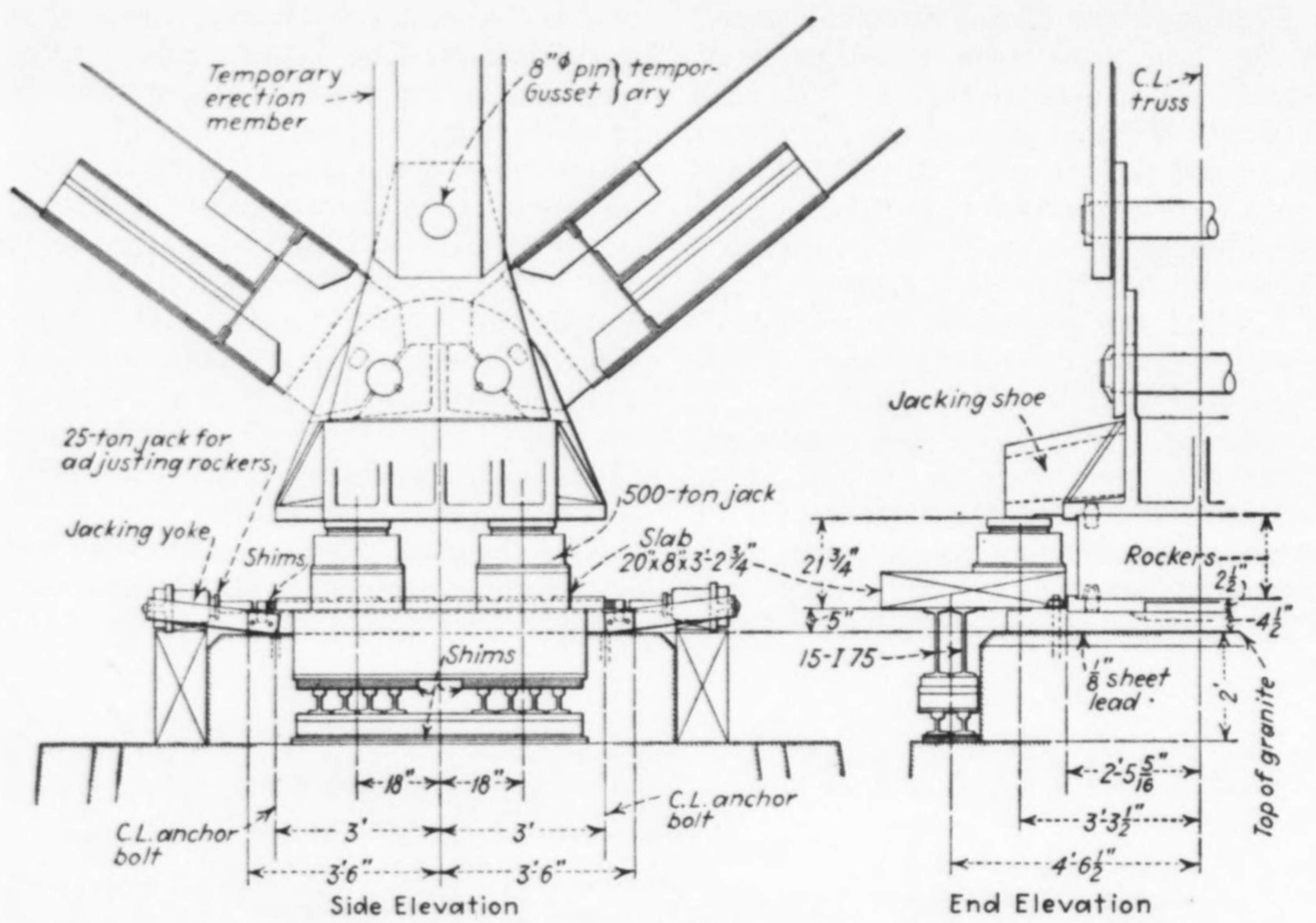

FIG. 5—JACKING details required at expansion shoes on piers 15 and 17 during erection.

terest lies in the method used to take care of expansion and longitudinal forces.

These spans, as shown in Fig. 1, are supported on steel portal braced bents. Beginning at the river end, the first three bents are slender two-column assemblies braced together by a truss near the top. The next two bents are of A-frame construction and relatively shorter.

All longitudinal forces are taken by the A-frame bent at pier 10. This bent is ony about 17 ft. high and has a base width of some 10 ft. The truss is attached to it by a fixed shoe. On the other A-frame bent a rocker bearing is used. Fixed shoes are also used on the two-column bents whose slender columns are designed to flex under longitudinal loads.

Steel erection began at pier 15 (on the left river bank in Fig. 1) with span 14 being erected on falsework with a crane working from the ground. After a few panels had been erected on span 14, a traveler working on the deck proceeded with the erection of spans 15, 16 and 17 in order. Two bents of falsework will be required for each main span. When span 15 is landed on the first bent, the bridge will be converted to a two-span Wichert truss and the next few panels cantilevered out from the bent. When this span has been landed on the second bent, the first bent will be removed and again the bridge will be, temporarily, a two-span Wichert layout. The erection will proceed in this manner until the north abutment is reached, no falsework being required for span 17.

In certain stages of the erection, temporary adjustable verticals will be used in the rhomboids for stability of the structure and for lowering the successive spans onto the bents.

Administration

The personnel of the Allegheny County Authority consists of J. F. Laboon, chairman; Henry Hornbostel, vice chairman; Park H. Martin, secretary, and Harry T. Aufderheide, treasurer. When the work was begun the chairman was Press C. Dowler who was succeeded by Samuel Eckels and the vice chairman and chief engineer was E. N. Hunting who was succeeded by John M. Rice. William McK. Reed was secretary-treasurer. George S. Richardson is bridge engineer.

The authority has retained since the beginning an advisory board of consulting engineers, consisting of J. E. Greiner and H. H. Allen, of the J. E. Greiner Co.; W. J. Douglas of Parsons, Klapp, Brinckerhoff & Douglas; Shortridge Hardesty of Waddel & Hardesty, and two local members, Robert A. Cummings and E. K. Morse.

The substructure contract for the Pittsburgh - Homestead Bridge was awarded last fall to the Holmes Construction Co., Wooster, Ohio, for $308,017. This work was completed on July 20. The erection of the superstructure by the American Bridge Co. which was awarded the contract for $1,080,802 was begun on July 6.

Primary Treatment and Incineration For Detroit's New Sewage Plant

IN CONNECTION with the Detroit, Mich. sewage treatment program certain basic plans have been decided upon by the engineers and are reported by L. G. Lenhardt, commissioner of public works, as follows:

The degree of purification has been fixed at 55 per cent removal of total suspended solids by the treatment works which are to consist of grit chambers, primary settling tanks with chemical precipitation provisions and chlorination equipment. Sludge will be digested and then dewatered on vacuum filters; sludge gas will be used only for heating the tanks. Incinerators are to burn the 427 tons estimated daily production of sludge cake which will have a moisture content of 70 per cent when it leaves the filters.

Of the 96 acres of site provided 26 acres will now be covered by plant which is designed to treat the wastes from a population of 2,400,000 anticipated in 1950. Six pumps lifting the sewage 26 ft. will have capacities as follows: two at 200 sec.-ft.; two at 250 sec.-ft. and two at 300 sec.-ft. Provision will be made to install additional pumps at a later date.

The grit chambers, eight in number, are to be 150 ft. long, 15 ft. deep and of an average width of 16 ft. The eight primary settling tanks will be either of the circular type, 200 ft. in diameter, or rectangular chambers 270 ft. long by 120 ft. wide with the width divided into seven 16 ft. compartments. Eight vacuum filters, each 11½ ft. in diameter and 14 ft. long will be used.

Interceptors collecting the 58.5 m.g.d. of sewage from 140 sq. miles of drainage area will have a total length of 14 miles when complete of which 10 miles is new work. The diameters range from 9 to 16 ft. and the depth below Detroit River level is 20 ft. at average water surface in the interceptors. Velocity for average flow at the plant is 6.2 ft. per second which is accomplished by gradients of 0.032 to 0.047 ft. per 100 ft. Forty regulating chambers will be installed.

Discharge of effluent is in the Detroit River through an 18-ft. outfall 5,780 ft. long.

The work of both plant and sewers is being carried out with a $20,000,000 PWA loan and grant under the general direction of L. G. Lenhardt, commissioner of public works. J. S. Stringham, city engineer is in direct charge with Harrison P. Eddy, John H. Gregory and Clarence W. Hubbell as consulting engineers.