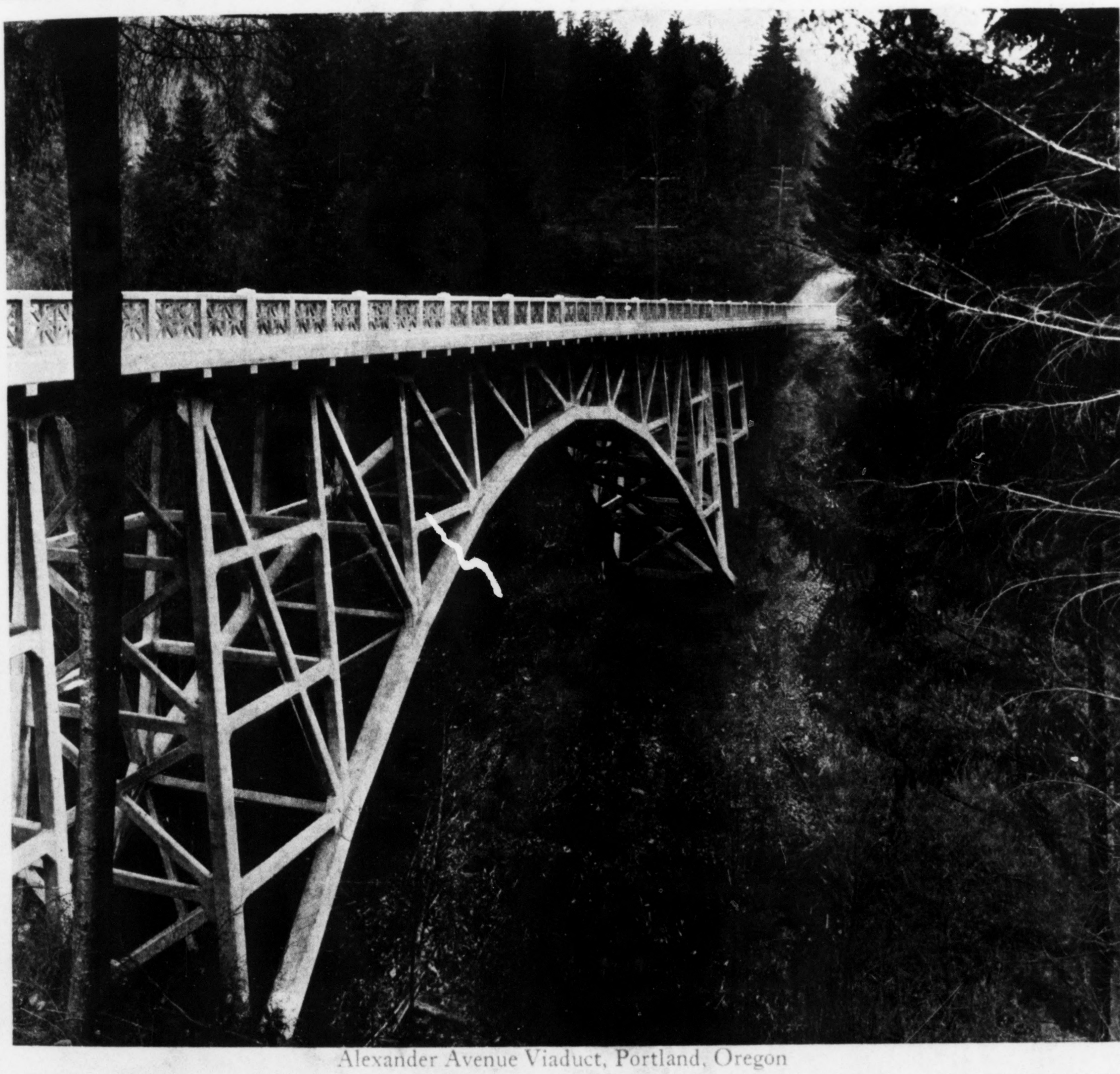
Devoted to Civil Engineering and Contracting.
McGraw-Hill Company, Inc.
August 28, 1924

Engineering News-Record



Alexander Avenue Viaduct, Portland, Oregon

A Return to Checks and Balances and Decentralization
Studies of the new Los Angeles city charter.

Personnel System for an Engineering College
Details of the Purdue University experiment.

Unusual Concrete Bridge at Portland, Oregon
A design based on economy, permanence and beauty.

Correcting the "Lean" in Aerial Photographs
Harmonizing aerophotographs and field survey data.

Unusual Spandrel-Braced Arch Bridge Built at Portland

Dead-Loads Reduced by the Use of High-Strength Concrete and Short-Span Floorbeams—Trestle Used as Falsework in Constructing the Arches

By O. Laurgaard
City Engineer, Portland, Ore.

LOCATED in a sparsely settled part of the city of Portland Ore., where the value of the property on which its entire cost was to be assessed was low, the Alexandra Ave. bridge of necessity had to be designed so that it could be built with the utmost economy consistent with the requirements for permanence and pleasing appearance. As the sides of the gulch over which it was to be built provided good foundations for an arch, a type of spandrel-braced arch was used which, it is believed, is a radical departure from ordinary bridge construction. No record of any similar bridge has been found either in this or in foreign countries.

Preliminary Arch Design—The first step in the design of the arch, after an examination of the site showed that sound rock at both sides of the valley made

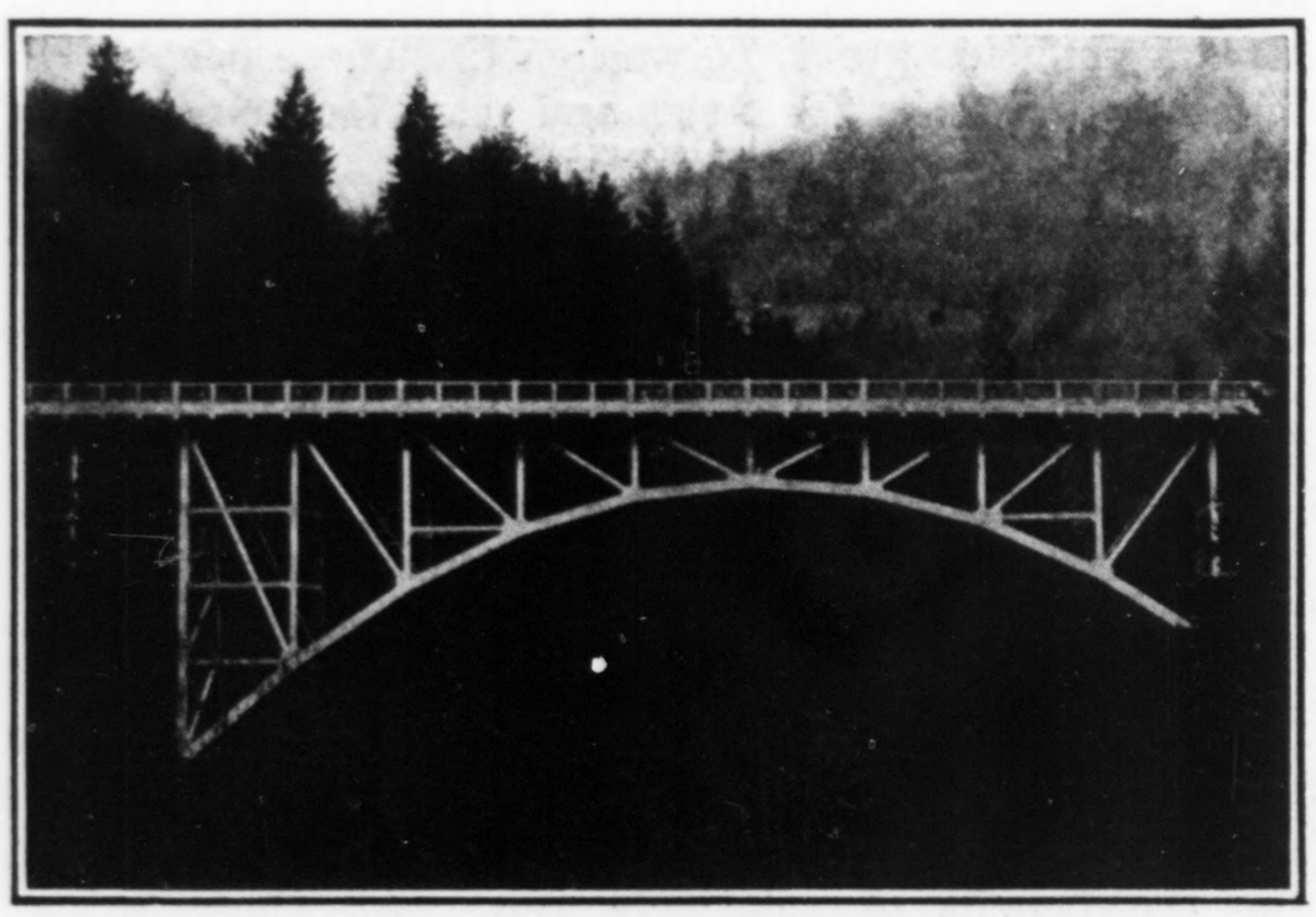


FIG. 1—COMPLETED ALEXANDRA AVE. VIADUCT, PORTLAND, ORE.

such a structure desirable, was the determination of allowable concrete stresses, by actual tests, with the idea of using high stresses in order to reduce the dead-load. For these tests nine cylinders of 1:1:2 concrete, 6 in. in diameter and 12 in. long, were cast, using different sands and gravel. These cylinders were broken at 7- and 28-day periods. The average crushing strength at 7 days was 2,610 lb., while at 28 days it was 4,140 lb. From this it was determined that a working stress of 900 lb. per square inch for concrete was safe. Subsequent tests, made during construction, were even better than the preliminary laboratory tests, the average for 7 days being 3,180 lb. per square inch and for 28 days 5,390 lb. In the 28-day tests some of the samples went beyond the limit of the testing machine without breaking, so that the average was probably considerably greater than the amount given.

The bridge as finally designed consists of a 150-ft. parabolic arch with a 35-ft. rise and ten 15-ft. panels, two 60-ft. approach trestles of four 15-ft. panels each, and two 11-ft. abutments, a total length of 292 ft. The roadway is 16 ft. wide and the single walk 4 ft. wide. In order to reduce the load of the floor system, the longitudinal trusses were placed 12 ft. apart with a portion of the roadway cantilevered on one side and the sidewalk cantilevered on the other. The floorbeams were spaced 5 ft. apart.

For the floor system design a live-load was used equivalent to a 12-ton truck with 3,000 lb. on each of the front wheels, and 9,000 lb. on each of the rear wheels, and wheelbase 6x12 ft. For the trusses a uniform panel live-load of 12,500 lb. and a snow load of 4,500 lb. was used.

Wind loads are carried along the top chord and down the end posts by a diagonal system in the end panel. In the lower chord the wind loads are carried to the abutments by a system of struts and diagonals between the arches.

The dead-load stresses were computed for three-hinged condition, the center hinge being left open until the span came to rest under dead-load, and being then sealed in. The live-load stresses were computed for two-hinged condition. In constructing the deformation diagrams the entire roadway slab was taken as part of the top chord and ten times the area of the reinforcing steel added to the concrete cross-sectional area. After the first preliminary design was completed, with the necessary changes made in sizes of members and reinforcing steel, a complete recheck was made and stresses were recomputed.

Under stress reversal due to temperature, wind and live-load, the compression in the diagonals was very small. As the tension stresses are taken entirely by the reinforcing steel, care was used to extend the rods into the top chord and the arch ribs far enough to develop their whole strength in bond.

The reinforcing rods in the lower chord were machined on the ends and butted together. In that way they were continuous from hinge to hinge, splice bars and clips being used to hold them in alignment. At the center and abutment hinges the rods fitted tight against the hinge castings. Care was used at the joints of the members to see that they were well reinforced with ties in all directions, so that the stresses would be carried through the joint and transmitted to the other members in the proper manner.

Construction—An old timber trestle on the site of the new viaduct was used as falsework for the arches. The old posts were cut off at the bottoms, where rotted, and cribbing constructed to obtain a solid foundation. A few new bents had to be built at the ends on account

TABLE—COST DATA OF CONSTRUCTION OF VIADUCT

	Amount	Unit Price	Total
Excavation, common	49 cu.yd.	$3.86	$189.20
Excavation, rock	56.1 cu.yd.	6.30	353.60
Embankment and backfill	70 cu.yd.	1.14	79.75
Falsework	.....	.....	1,774.87
Arch abutments and footings	68.7 cu.yd.	14.83	1,018.82
End abutments	56 cu.yd.	14.82	829.92
Arches, columns, struts and diagonals	113 cu.yd.	48.95	5,531.35
Deck and girders	160 cu.yd.	19.90	3,184.00
Handrail	610 l n.ft.	3.84	2,342.40
Miscellaneous	.....	.....	1,290.90
Reinforcing steel in place	75,500 lb.	.456	3,442.80
Steel castings in place	6,500 lb.	.15	975.00
Total cost from data		.....	21,712.61
Total of engineer's estimate		.....	24,845.00
Total of contractor's bid		.....	21,200.00
Total of final estimate		.....	23,265.20

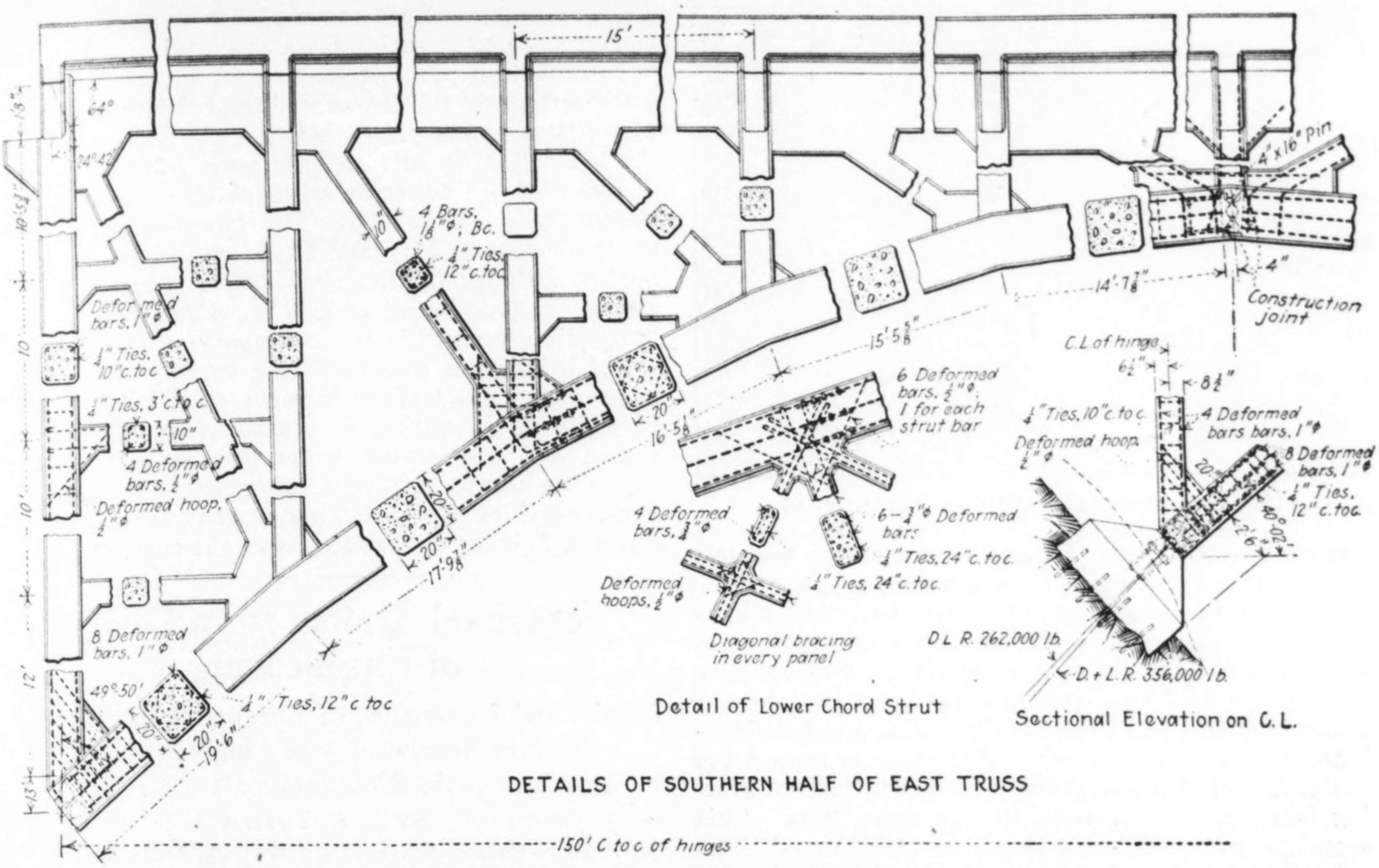


FIG. 2—DETAILS OF ARCH AND SPANDRELS

of the spacing of the old bents. This method made a considerable saving in cost to the contractor. The stability of the falsework was demonstrated by the small settlement which occurred during the pouring of the concrete.

Excavation for abutments and footings had to be carried to a considerably greater depth than originally estimated on account of the broken structure of the rock. The abutments and footings were enlarged to fill the openings made in reaching sound rock.

Forms for the arch ribs with their struts and diagonal braces were first built upon the falsework. After this was completed the reinforcing steel for the arch ribs was placed. This reinforcing was built up in units for each panel length and then placed in position.

Next the reinforcing steel for the arch struts and diagonals was placed. This steel, owing to difficulty in placing in units, was placed one bar at a time.

Due to the fact that the reinforcement in the verticals and diagonals was continuous and extended a considerable distance into the arch ribs, this reinforcement had to be placed in position before any concrete was poured. The forms for these verticals and diagonals were constructed in units and placed in position to act as a support for the reinforcing steel. These forms were, in some cases, only skeleton forms and

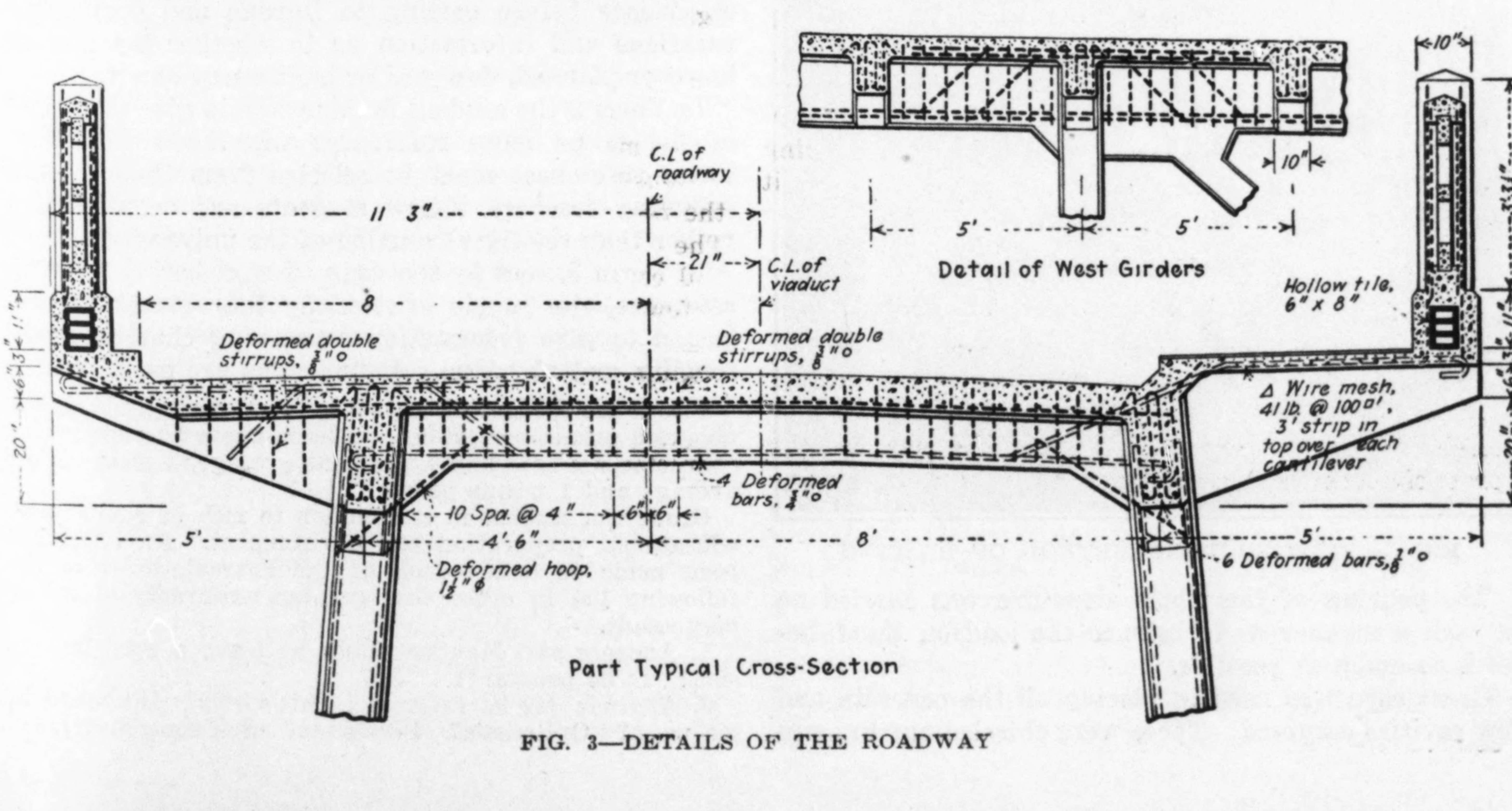


FIG. 3—DETAILS OF THE ROADWAY

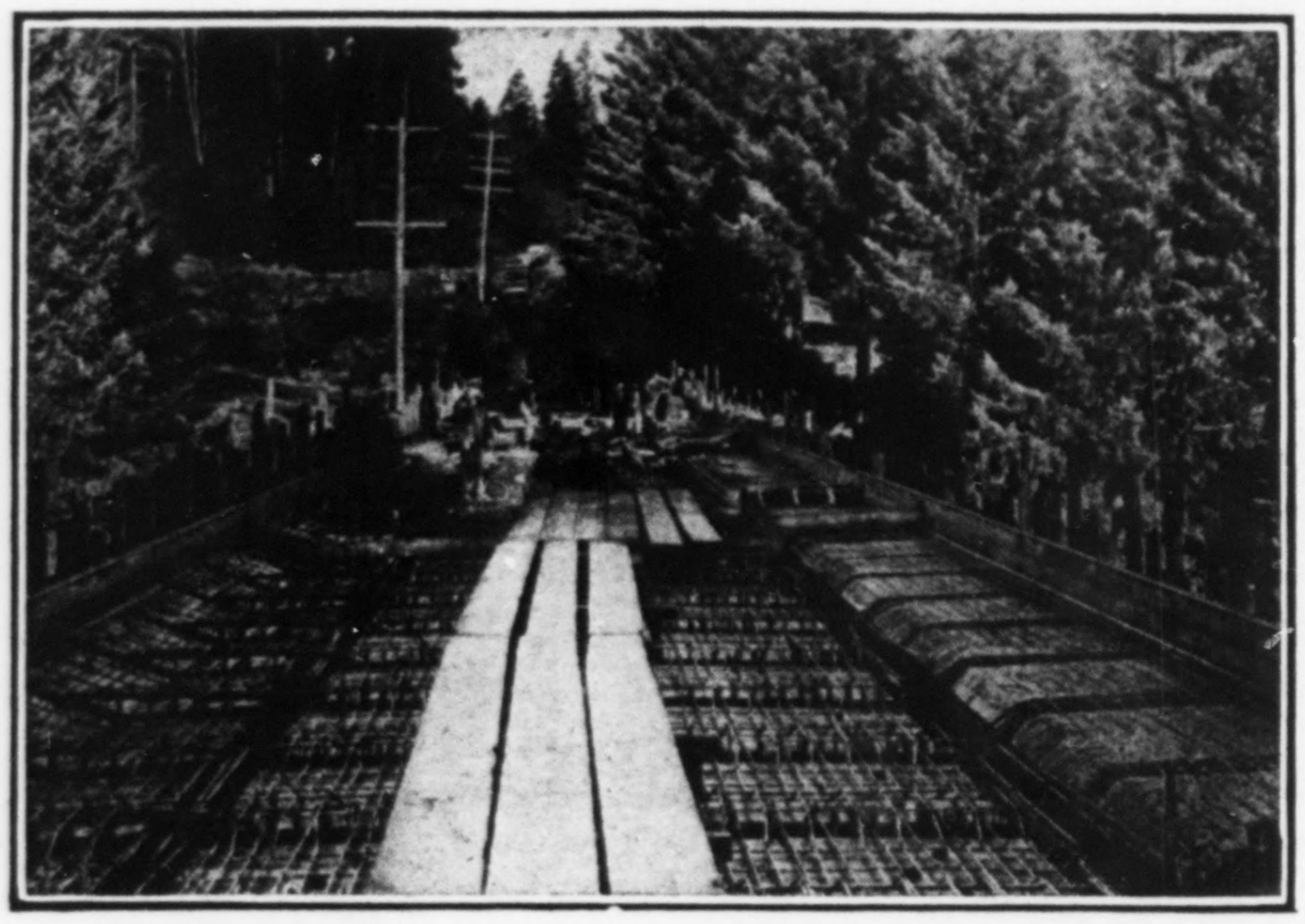


FIG. 4—ROADWAY DURING CONSTRUCTION

were completed later. In all cases one side was left open to be boarded up as the concreting progressed.

After all necessary forms had been built and all the reinforcing steel placed that in any way affected the arch ribs, the concreting was started. Two one-sack mixers were used but as the mix was 1:1:2 two sacks of cement were used to a batch. Concreting started simultaneously at each abutment and progressed toward the center hinges; the pouring of struts and diagonal bracing being carried forward at the same time. This operation was continuous, requiring eight hours' time; a total of 601 sacks of cement was used, which with a 1:1:2 mix gave a volume of 167 cu.yd. The verticals and diagonals were poured up to the top of the gussets at the same time as the arch ribs.

The vertical and diagonal members and the deck were poured at a later date. Construction joints were bulkheaded where vertical, and, in the roadway slab, were placed where the least shear would occur. The concrete at horizontal joints was roughened and sprinkled with neat cement before fresh concrete was poured.

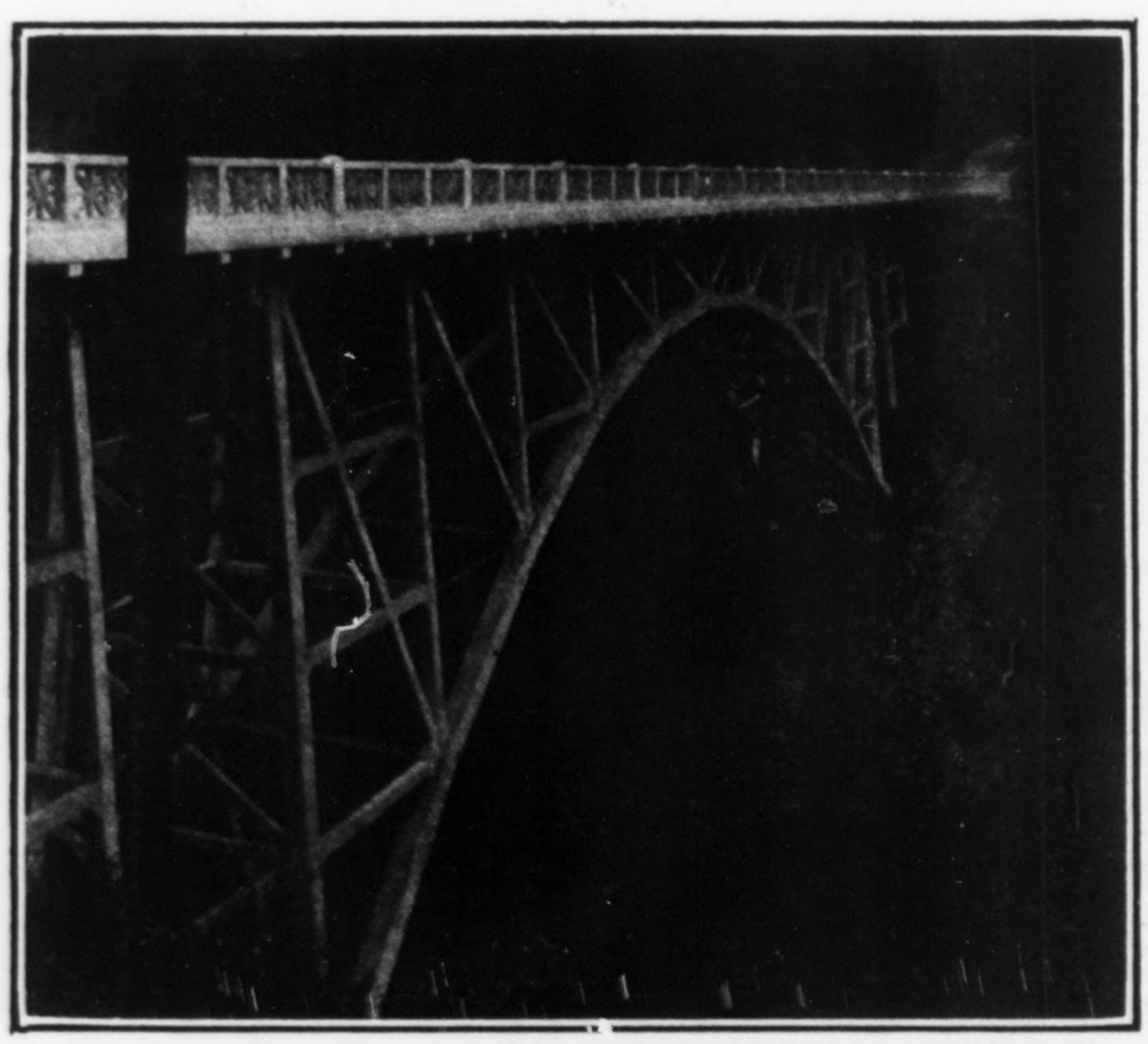


FIG. 5—VIEW SHOWING METHOD OF BRACING

The pouring of the whole structure was carried on in such a manner as to balance the load on the falsework as much as possible.

Great care was used in placing all the concrete and few cavities occurred. These were chiseled out to leave a clean opening and were then filled with a dry mix 1:2 mortar pounded in with a block and maul.

The handrail panels were precast with 1:2 mortar, using a dry mix which was well tamped into the forms. These panels were placed between the main posts and the top rail, with intermediate posts poured in place.

Cost Data—Unit costs were obtained from actual checks made by the city. The following units were used: Cement $3.30; sand $2.45; gravel $2.70; form lumber $20; reinforcing steel $0.03½; laborers $5.40; carpenters $7.20; steel men $7.20. Complete construction costs are given in the accompanying table.

The bridge was constructed by the city of Portland, under management of the Department of Public Works, of which A. L. Barbur is commissioner. It was designed and constructed under the author's general supervision by F. T. Fowler, bridge engineer, and R. E. Kremers, chief of the bureau of construction. Lindstrom & Feigenson, Portland, were the contractors.

Personnel System for a College of Engineering

Details and Experience of Purdue University with System Developed with Funds Provided by Manufacturers

By A. A. Potter

Dean of Engineering, Purdue University, Lafayette, Ind.

A PERSONNEL system for the benefit of engineering students has been in use at Purdue University for several years. The most conclusive proof of the importance attached by industry to this system is that the initial funds for carrying on this work were donated by the Indiana Manufacturer's Association, which has contributed during the past three years $6,000 to develop it. Details of the system follow.

To freshman engineering students are explained the aims and workings of the system early in the year. Early in March of their freshman and junior years the engineering students are requested to fill out two forms. Form 1 includes data concerning the date and place of birth of the student, what studies he enjoys most, part taken in student activities, hobbies, if any, practical experience before coming to Purdue and during the vacations and information as to whether the student has ever planned, designed or built a new object.

In Form 2 the student is requested to give the names of fifteen or more references who know him best. These references must be selected from three groups, including teachers, fellow students and acquaintances (other than relatives) outside of the university.

In Form 3, sent by the dean of engineering to every reference, the people selected by the student are requsted to give information concerning character, personality and physique. Instructions are as follows:

Please use the scale 5 to 1; 5 is the highest grade obtainable and means perfection. If he is above average in any characteristic rate him 4, 3 means average, 2 means below average and 1 means poor.

Grade the student in comparison to men of similar age, educational preparation and environment. An effort has been made to define each of the characteristics in the following list in order that greater uniformity of rating may result.

1. Address and Manner (Does he leave a good impression? Is he popular?) . . . . . .
2. Attitude (Is he rational in his views? Interested in his work? Optimistic? Persistent? Self-controlled?). .