Long Concrete-Arch Viaduct Built Near Cleveland

Structure on Brookpark Road in metropolitan park area distinguished by special architectural treatment, cooling of mass concrete in piers and use of railing expansion joints of rubber

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THE MOST RECENT and largest of three open-spandrel arch bridges to be constructed in the Cleveland metropolitan area by the Ohio department of highways is a structure known as the Brookpark Viaduct, located on an extension of Brookpark Road, state route 43, immediately southwest of the city limits of Cleveland. It provides a new high-level crossing of the Rocky River Valley and completes another link in a proposed belt highway around the business section of Cleveland. It is situated just west of the Cleveland Airport, and, with its approaches, was built as a federal-aid project with financial participation by Cuyahoga County.

Although the normal channel of Rocky River is relatively narrow, its valley, like that of other streams that flow into Lake Erie in this section, is very wide and deep, practically making a high-level structure necessary in the interest of economy and to provide appropriate highway gradient. The entire river valley at this location is a part of the metropolitan park system.

The open-spandrel concrete-arch type was selected as fulfilling the requirements of pleasing appearance and economy. As it was to be the third viaduct of this type built in Cuyahoga County by the state highway department, it was considered desirable for the sake of variety to develop a somewhat different style of architecture than had previously been used. The result is a bridge embodying a Gothic motif as shown in some of the accompanying views.

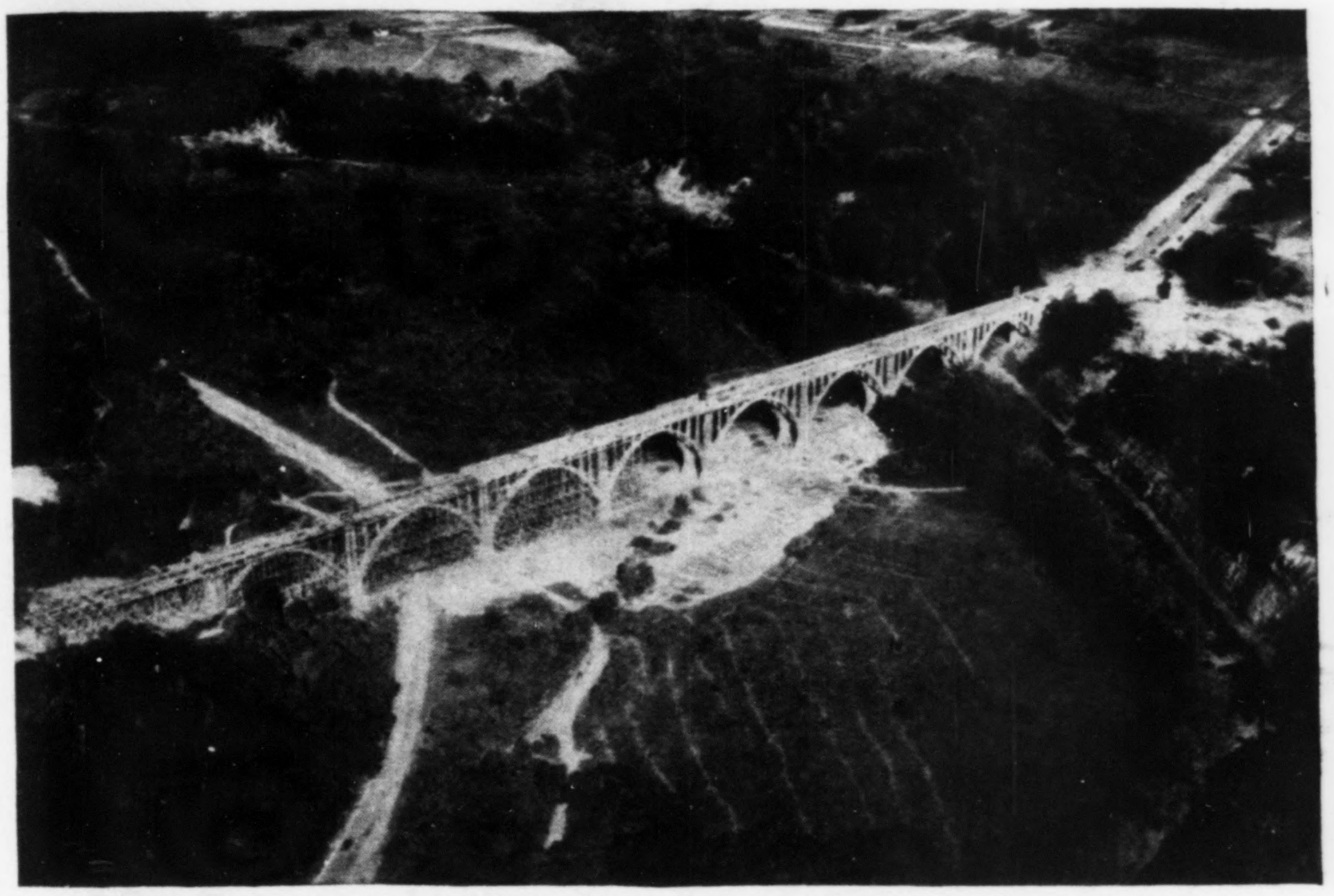


FIG. 1—BROOKPARK VIADUCT in Cleveland's metropolitan park area provides a high-level crossing of the Rocky River Valley.

Springing from the steep shale bank on the east side of the valley, the arch spans cross the river and park to the gentle slope on the west side. This arch portion, of open-spandrel deck construction, consists of eight spans, the two end spans being unsymmetrical, to fit the topography, measuring 176 ft. 10½ in. c. to c. of piers, and the other six symmetrical arches being of 192-ft. 3-in. span c. to c. of piers. Beyond the arches, up the west slope, are six 33-ft. concrete T-beam spans, of continuous type, with the underneath side of the beams arched. East of the arches are three T-beam spans similar to those at the west end, except that the middle one, which spans a small ravine, is 50 ft. long. A U-shaped abutment is provided at each end. The over-all length is 1,918 ft. 7 in., and the greatest height from ground line to road surface is 116 ft.

All piers and abutments are founded on hard shale, some of which is exposed and some as deep as 20 ft. below the ground surface.

The loading used in design was H-20. The maximum unit stress for concrete was 900 lb. per sq.in. in bending, and the maximum tensile stress for reinforcing steel 16,000 lb. per sq.in.

The roadway, 40 ft. wide, is paved with 3-in. brick on a ¾-in. slag cushion, and there are two 5-ft. sidewalks raised 12 in. above the brick pavement. The rather high curbs have decided safety advantages on such a high structure in this region, where deep snow tends to fill the gutters. All drainage water is carried in downspouts to a storm sewer that parallels the bridge. The road ascends from east to west on a 0.3 per cent gradient.

The lighting standards and luminaires are of cast aluminum, deplated and highlighted, which provides both handsome appearance and assurance of freedom from soiling of the supporting concrete members due to corrosion. A balcony at each pylon (situated between the arch portion and the approach spans of the structure), besides adding a touch of ornamentation, affords the sightseer an opportunity for enjoying a view of the side of the bridge as well as the park below. Particular attention was given to the treatment of the arch umbrellas, in order to obtain a pleasing transition from the slender columns to the massive pier pedestals. A projection on the face of the ribs along the extrados was added to enhance appearance.

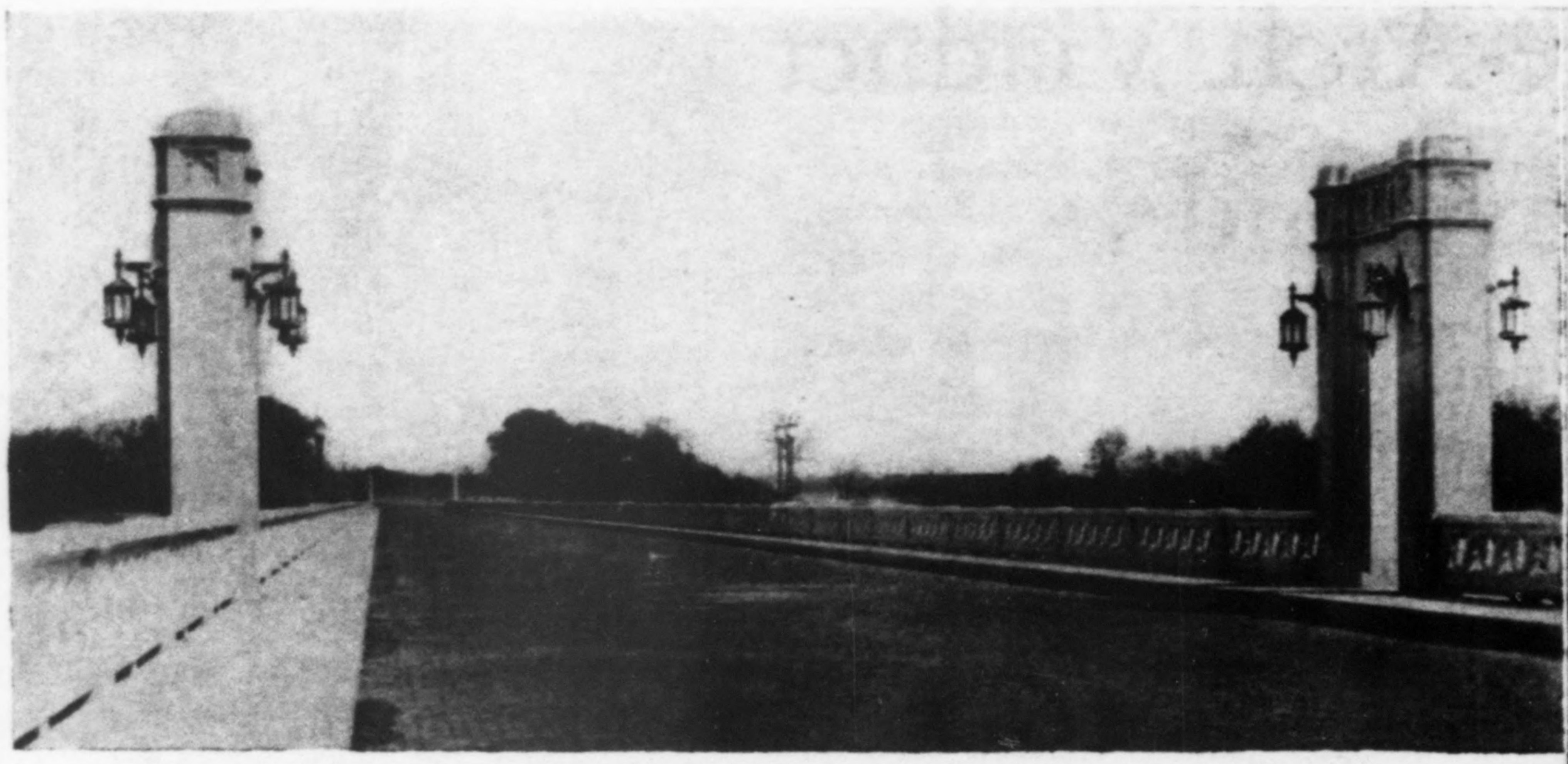
Crack prevention in piers

On several previously built arch viaducts, shrinkage cracks developed in the piers below the umbrellas. On the assumption that such cracks result from the heat generated in the mass concrete, five 24-in. vertical pipes were installed in each pier on the Brookpark Viaduct, to permit the free circulation of air during the curing of the concrete (Fig. 3). The tops of these pipes were later sealed by the umbrella sections, but horizontal vents, placed from the pipe to the surface of the concrete, remained open. So far no cracks are visible.

Rib and deck design

Each arch span is supported by two ribs 7 ft. wide with a thickness of 3 ft. at the crown and 5½ ft. at the skewbacks. Each rib has a rise of 80 ft. 2½ in. It was found possible to make a major portion of each unsymmetrical end arch identical with the symmetrical arches, thereby facilitating construction and adding to the appearance of the structure.

The deck is a continuous slab, crowned on top and bottom and placed mono-



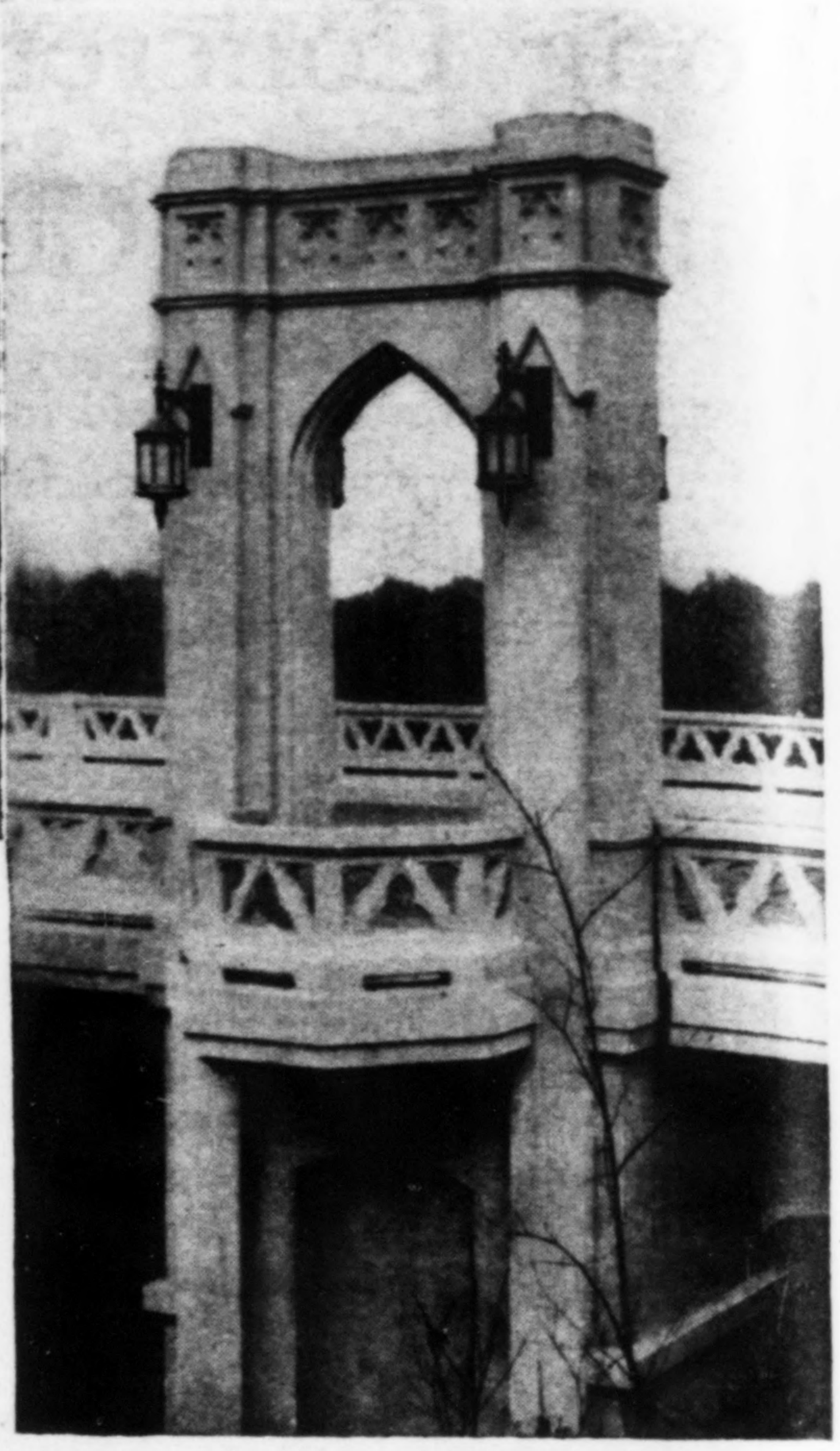


FIG. 2—ARCHITECTURAL TREATMENT of railings and pylons on Brookpark Viaduct. Balconies at pylons permit a view along the side of the structure.

lithic with the floor beams which are supported by the spandrel columns. Columns and beams are reinforced for full frame action. The only longitudinal joints permitted in the deck are at the junction of roadway and sidewalks. This curb construction joint permitted the sidewalks to be placed after the roadway slab, thereby minimizing stresses due to deflection and transverse shrinkage. In addition, such joints permit a true alignment of curb forms, since they may be rigidly supported upon the finished roadway slab.

The practice of omitting expansion joints in the arch deck, except at piers, was followed on this structure because there is always the risk of water leakage and concrete deterioration at a joint and because tests conducted by the designers on paper and celluloid models of previously designed structures indicated that intermediate joints are unnecessary. The spandrel columns and the unusually slender pier columns were designed for flexure from expansion and contraction of deck, assuming the columns as fixed top and bottom. The expansion at the large-end pylons was provided by means of cast leaded-bronze plates. Copper gutters leading to the downspouts were installed under all expansion joints.

Rubber railing joints

Expansion joints were also provided between all railing panels and posts, the posts and panels being anchored independently to the deck. At piers and abutments where there are expansion joints in the floor system, the joints in the railing were left open with a 2-in. space. All intermediate panels and posts were separated with a sheet of light-gray sponge rubber $\frac{1}{4}$ in. thick. This material proved to be very satisfactory both in ease of handling and in finished appearance, as it is quite pliable, does not extrude when compressed and matches substantially the color of the concrete.

The rubber was cemented to the ends of the finished concrete panels, which were placed first, and the post concrete was then deposited in direct contact with the rubber. Open joints between railing panels and posts require more difficult form building and, as the joints

FIG. 3—STRUCTURAL DETAILS and sections of open-spandrel arches and T-beam spans comprising the new Brookpark Viaduct near Cleveland.

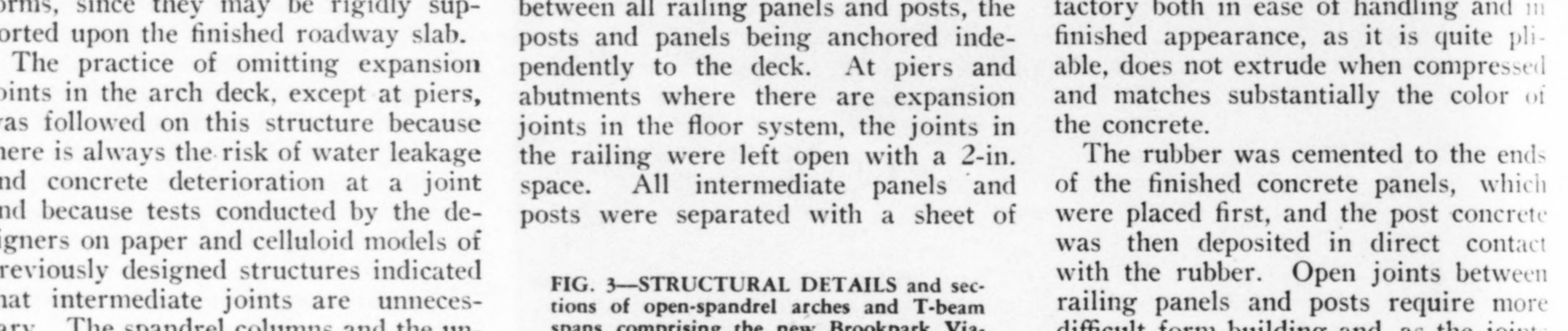


FIG. 4—SPONGE-RUBBER expansion joint being cemented to railing, ready for post to be concreted in.

must necessarily have an opening of ½ in. or more, they are more conspicuous in appearance. If the life of the rubber proves to be relatively short, it will merely result in open joints of smaller size and better appearance than the preformed open type.

In constructing the viaduct a concrete mixing plant was set up in a small ravine on the east bank and operated as a gravity unit with a three-level arrangement. The bins for the slag, sand and cement were on the upper level and were filled by trucks. The proportioning of aggregates was controlled by weighing devices below the bins; and, by means of a chute under these batch weighers, the aggregates were conducted into the mixer, 1 cu.yd. of concrete being mixed at one time. The plant had a capacity of 30 to 35 cu.yd. of concrete per hour and included a 250-hp. boiler to steam-heat materials during winter operations.

The contractor used timber falsework throughout, both to support the forms and to carry an industrial railway by means of which the concrete was transported from the mixing plant to various portions of the structure. The industrial tracks were laid at three levels. From the lower level the pier masses and footings were placed, from the intermediate level the arch rings and columns, and from the upper level the deck concrete. Precast concrete blocks, concreted in the deck, supported the railway on the deck.

Metal forms were used for the piers and arch columns, and a combination wood and metal form was used for the umbrellas. Elsewhere the forms were of wood. Three-ply wood lining was used for surfaces that were to be exposed, with the result that a pleasing texture was obtained with a minimum of rubbing.

The railing, although distinctly ornamental, involved simple form construction and, because of the extensive repetition of identical panels, its cost was rather low.

Cost and personnel

The contract price for the bridge was $378,980, which amounts to only $3.72 per sq.ft. of total deck area. The bridge was built by the Highway Construction Co., Cleveland, whose contract also included 0.657 miles of brick paving on the approaches, with considerable grading, at a price of $65,982.

The work was done under the direction of O. W. Merrell, director of highways; H. P. Chapman, assistant director; J. R. Burkey, chief engineer of bridges; and Elmer Hilty, chief engineer of construction. The design work was supervised by the writers with Mr. Overman in immediate active charge, assisted chiefly by C. P. Smith and A. J. Friemoth. Richard Orth was field engineer, and John Jaster, Jr., division engineer.

Two Public Power Projects Get Under Way in Nebraska

Financed by the PWA, work on the Loup River power project and on the Sutherland combined power and irrigation water-supply project has reached the stage where detailed plans are being made and some construction contracts have been let

AMONG the large allotments of funds made by the Public Works Administration are two totaling nearly $15,000,000 for public power and irrigation projects in Nebraska. One loan is to the Loup River Public Power District at Columbia for a power-development scheme, and the other is to the Platte Valley Public Power and Irrigation District for a combined project for the storage of water for irrigation use and for the development of power near North Platte. Both projects are being constructed under a law passed by the state legislature in 1933, a law that authorizes the creation of public power and irrigation districts managed by directors elected by popular vote and paid at a basis "not exceeding $6 per day." The districts are permitted to build and own irrigation and power works, to store and sell water and to generate and sell power. They have no powers of taxation but may pledge their revenues and physical property as security for loans from federal agencies. The districts may engage in any enterprise incident to the electric business. All profits are to go to water users and electric consumers.

The original estimates of the cost of the Loup River project were $5,734,000, and the approved PWA loan is for $7,300,000; the original estimate of the Sutherland project was $4,806,000, and the PWA has approved a loan up to $7,500,000. Applications for the loans were made, and the loans were granted upon the preliminary estimates. Work now is in progress on the detailed surveys, test borings and estimates. A considerable amount of land has been purchased, and contracts have been let for some of the work.

In both instances the preliminary estimates were prepared by local engineers, but on both projects outside engineering firms experienced in hydroelectric power-development work have been engaged to direct the design and construction work, the engineers who made the original estimates also being retained. In so far as is practical, the employment of engineers from Nebraska is required.

An outline of the work proposed and a review of the special conditions affecting each project are given below.

Loup River Project

THE LOCATION and general arrangement of the project of the Loup River Public Power District are shown in Fig. 1. It consists of a diversion dam on the Loup River about 9 miles southwest of Genoa and a system of canals to divert, normally, 2,500 sec.-ft. of water, first to a power house about 1 mile north of Monroe and thence to a power house 2½ miles north of Columbus, whence the water is delivered to the Platte River 3 miles below the mouth of the Loup River. Storage and regulating reservoirs along the line of the canal are included, but whether all will be built at the present time has not been decided definitely. The project is entirely for the development of power.