HIGHWAY BRIDGE OVER THE MIAMI RIVER AT ELIZABETHTOWN, OHIO, THAT RESISTED THE RECENT FLOOD.

This bridge is remarkable in being the longest simple-truss span in existence. It has a span of 586 feet between centres of end pins and surpasses in length by 36 feet the longest other span, which is one in the bridge crossing the Ohio River at Cincinnati, known as the Cincinnati and Covington railway and highway bridge.

On the site of the present new steel bridge, there had been for many years an old covered wooden bridge, known locally as "Lost Bridge." It consisted of three spans, 195 feet long each, supported on stone piers and abutments. The old piers were unusually heavy, and yet, notwithstanding this fact, the foundation beneath them was badly scoured, so much so that one had fallen several feet out of plumb at the top. The superstructure of the old wooden bridge was also rapidly failing, the spans showed excessive sag, a condition frequently developing in old wooden bridges before failure. In the summer or autumn of 1903 the superstructure of the old bridge was destroyed by fire, and the need of replacing it at once became apparent.

In selecting the most suitable type of bridge for replacing the old one, there were numerous important considerations. The rise and fall of the water in the Miami River is very uncertain. At flood seasons it rises rapidly, sometimes 20 feet or more in a few days. The greatest difference between high and low water is about 30 feet. At such times the last ten feet or more of rise is back water from the Ohio River. For this reason all bridges in this district are built at about the same elevation of 30 feet above low water of the Ohio River. The railroads and many of the highways are likewise built on banks at the same elevation, for at flood seasons the entire country around is liable to be covered with water.

At another river crossing, about a mile distant from Elizabethtown, the conditions had been met in previous years by building a suspension bridge of 500 feet clear span, spanning the entire width of the water course. The suspension bridge is quite an imposing structure and an ornament to the district, but is lacking in the more important requirement of rigidity. It has a clear roadway of 20 feet and the stone towers at either end are placed 36 feet apart, so the cables have a considerable cradle. It has, also, six sets of stay cables from the towers to the floor, and is braced laterally by three sets of rod guys at each end, fastened to stone blocks on the river bank, yet the passage of ordinary loads, such as farm wagons, causes excessive vibrations. In high, or even moderate winds, the swaying of the bridge is also considerable.

At New Baltimore, Ohio, in the same county, similar conditions had been overcome by building a single truss span 465 feet in length.

The railroads were also having difficulty with their bridges in the same region, and some such bridges were destroyed by having their piers undermined by the scour and wash of the uncertain currents and soil. At the time when the rebuilding of the Elizabethtown bridge was being considered, a railroad bridge in the vicinity was being strengthened and the piers protected at great expense, by having large quantities of broken stone and loose rock deposited around the piers and abutments. It was found, however, that notwithstanding the dumping in of many carloads of rock, and the strengthening of piers with additional concrete, the river piers were still in an uncertain condition and frequently exposed to the damaging influences of scour and the shifting of the channel.

For these reasons it was decided to avoid the use of river piers in rebuilding the bridge at Elizabethtown, and to bridge the entire waterway with a single span. Having thus decided on the use of a single span, approximating 600 feet in length, it then became necessary to select the most suitable type of bridge.

The suspension bridge described above is in some respects very desirable, but on account of its lack of stiffness was not seriously considered as a type for Elizabethtown. The underneath clearance would not permit the use of a deck arch of so long a span, and a through arch, such as those used at Bonn or Dusseldorf, or more recently at Bellows Falls, Vermont, are lacking in lateral stiffness. In through arches such as those mentioned above, it is necessary, in order to maintain the required clearance through the bridge, to omit top lateral bracing between the arch ribs for some considerable distance back from the springs. This is more serious than in truss bridges, where the end posts incline at an angle of 45 degrees or more with the horizontal. With the through arch the slope of the ribs is so gradual that a large part of the most effective lateral bracing between the ribs must necessarily be omitted.

Some forms of stiffened suspension bridge, and a cantilever design of 600 feet span between piers, with back stays similar to the back stays of a suspension bridge, were also considered. None of these forms were favored, chiefly because of their lack of stiffness. Of the alternate forms considered, the cantilever above referred to would doubtless have given the best results. It would leave the waterway entirely free of piers and would permit the use of a narrower roadway, by placing the trusses further apart at the shore, than at the end of the cantilever arms. It is interesting to note that a bridge of this type has since been built at Long Lake, N.Y.

After due consideration of various types, it was decided to use a through, pin connected, simple-truss bridge.

The foundation work consisted chiefly in repairing the old stone abutments by building up new material in reinforced concrete in front of the old stone work, carrying up the retaining walls and parapets, and rebuilding the bridge seats with lines of steel beams embedded in concrete.

The type of truss is the subdivided Pratt, with main panels 65 feet long. The depth of truss varies from 80 feet at the centre to 40 feet at the first panel point. The curve of the top chord is a parabola, in straight sections of two panel length. Stiff laterals and sway bracing are used throughout. This is a very essential feature of the design, and one upon which much of the stiffness of the bridge depends. Lateral and other light struts are built in box form, latticed on all four sides. The first panel of diagonals in the top lateral system are built in the same way. Each of the 32-feet-6-inch panels of the floor system are again subdivided by carrying an intermediate floor beam on two longitudinal beams, one at each side of the bridge. In addition to the benefit of economy in floor framing, the two side beams serve also as chords for the lower lateral system. The longitudinal and cross floor beams are of the same size, and diagonal laterals are rigidly connected by plates, which fasten to the bottom flanges of both cross and longitudinal beams. The floor joist consist of 6-inch steel beams, spaced 2 feet 6 inches apart, elevated on 9-inch beam corbels. On the steel joist is laid the 2½-inch oak flooring, spiked to six lines of 3 x 7 oak spiking pieces, with 60d nails. The wheel guards are 6 x 6-inch oak, beveled on the inner edge and elevated on 4 inch blocks, spaced 2 feet apart for drainage. The bridge was given an initial camber at the centre