FOUNDATIONS OF BRIDGE OVER THE RIVER TET, AT PERPIGNAN.

Plate XC.

The branch line of the Southern Railway of France from Narbonne to Perpignan includes amongst its works two of the most important brickwork structures connected with the Southern Railway system. These are two bridges, each consisting of five elliptical openings of 82 ft. 2½ in. span, the one crossing the River Agly at Rivesaltes, and the other the River Tet, at Perpignan. The two bridges are similar in their general design and dimensions, but that last mentioned is a skew bridge, whilst that at Rivesaltes crosses the River Agly at right angles. It is not, however, of the superstructure of the bridges that we intend to speak here, but of the means employed in putting in the foundations, which possess some points of interest.

According to the plans prepared by the engineer-in-chief, M. Carvallo, the bridge piers were to be carried on hollow shafts of brickwork, sunk, by dredging out materials from the interior, through beds of sand and gravel from 23 ft. to 26 ft. in thickness. The site of the piers was almost always dry on the surface during eight months of the year, but the substrata contained large quantities of water. Each pier was to be formed of three of these hollow brickwork shafts, each shaft being 13 ft. 1½ in. in diameter outside, and the three being arranged in a line perpendicular to the centre line of the bridge. Each of the abutments was to be carried on nine similar shafts, these being arranged three in each row. The shafts, after being sunk down to a firm substratum, were to be filled in with cement concrete up to about one metre below the level of the surface of the ground, and on the foundation thus formed the brickwork of the piers was to be commenced.

At Rivesaltes this programme was carried out without much difficulty, the substrata consisting of sand and stones of small size lying loosely. At Perpignan the case was different, the borings showing that the substrata were very compact, consisting of granite and quartz stones mixed with blocks of 12 in. to 14 in. in diameter. Under these circumstances, the thickness of the shafts was increased to 1 metre (3 ft. 3½ in.), or double the thickness which was adopted at Rivesaltes, and instead of being built of bricks they were constructed of stones taken from the bed of the River Tet, and set in Spanish cement. The manner in which the shafts were constructed was as follows: Referring to Fig. 2 of Plate XC, it will be seen that each shaft was founded on a sill, B, of sheet iron, ⅛ in. thick, this sill consisting of inner and outer vertical sides united by a bottom plate inclined at an angle of 20°. The sides and bottom were connected by 2 in. angle irons, C, and the lower angle was strengthened by a ring of 2 in. by ⅛ in. iron rivetted to it. The upper parts of the sides of the sill were stayed by the crossbars, D, which were ⅛ in. in diameter, and were placed at intervals of about half a metre (19¼ in.). The lower part of the sill was filled in with oak blocks, E, and on these the shaft was built. The brickwork was carried up with a perpendicular interior face; but the external face was built with the slight batter of 1 in 100 in order to diminish the frictional resistance to the sinking of the shaft, and to prevent as far as possible the chance of the shaft "hanging" on one side as it descended. The shafts forming each pier were pitched only 2 ft. apart at their bases, the spaces between them increasing, owing to their batter, to 6 in. or 8 in. at the top.

The shafts were sunk without much trouble to depths of from 5 ft. to 7 ft., according to their position, but below these depths serious difficulties were met with. The substrata was found to be so hard and compact, and the stones contained in it of such large size, that all the dredging appliances which had been used with success at Rivesaltes, were found to be ineffectual, and it was only by a special apparatus designed by M. Carrière, the engineer in charge of the plant employed, that any success was attained. This apparatus consisted of four curved shovels or blades, so mounted at the lower end of a strong central wooden beam, that, when this beam was lowered in the shaft, the shovels were made to penetrate the ground, and could then be raised so as to break up the latter. After several trials this apparatus was got into good working order, and was found capable of excavating from 35 to 52 cubic feet per day of ten hours.

The operation of dredging, however, was so difficult that the engineers in charge of the work resolved to render the shafts dry, and carry on the excavation by hand labour. Here, however, another difficulty had to be overcome. The quantity of water contained in the substrata was so great that it would have been impos-