strength by extra iron girders. The nineteen piles which carry the pier head are of a similar construction to those in the body of the structure, but only 2 ft. in diameter. The crane is carried upon a cylinder 7 ft. in diameter as far as the first tier of horizontal iron braces, see Fig. 5. It is of cast iron, lowered into the gravel, and filled with hydraulic concrete. From the level of this tier the cylinder is continued with a diameter reduced to 3 ft., and coincident with the axis of the crane post above. From the top of the 7 ft. cylinder springs a cluster of cast-iron struts, cruciform in section (see the lower part of Fig. 6), and raking upwards and outwards to the platform level, where they are bolted to a circular girder, forming the bed of the crane, as shown in Figs. 4 and 5.

A system of tie bolts disposed around this bedplate, and secured to the cap of the large cylinder below (see Fig. 6), serves to steady the structure and secure it against vibration during the raising or lowering of heavy guns by the crane, and the pier head is well stiffened by a series of diagonal cast-iron struts and a horizontal bracing.

THE KISTNA VIADUCT.

PLATE LXXXVII.

The Kistna Viaduct, illustrated by Plate LXXXVII., is a work of considerable magnitude, upon the Great Indian Peninsula Railway. It occurs on the south-eastern section of that line, which at present runs from Bombay to Sholapore, and is being further extended to Raichore, where it will join a branch of the Madras Railway. Near to Raichore is the River Kistna, over which the railway is carried by means of the viaduct.

In the drawings Fig. 1 is a general elevation of the viaduct; Fig. 2 is a distorted plan of the diagonal struts and ties of one span; Fig. 3 is a part side elevation of one span; Fig. 4 is a transverse section; Figs. 5 and 6 are half-transverse sections over piers, the former showing roller bearings, and the latter a fixed bearing; Figs. 7 and 8 are detail views showing the method of securing the longitudinal timbers to transverse girders; Fig. 9 is a part side elevation, showing the ends of two girders resting on fixed bearings; Fig. 10 is a part side elevation, showing roller bearing for girders; Fig. 11 is a cross section of a transverse girder; Fig. 12 is a detail view of rollers; Figs. 13 and 14 are detail views of bottom of pier cylinders; Figs. 15 and 16 are details of one of the fixed bedplates for girders; Fig. 17 is an elevation of one of the piers; while the figure on the next page is a view showing the arrangement of scaffolding, &c., for erecting the piers.

The structure consists of thirty-six openings of 100 ft. clear span at the top of the columns, and is 3848 ft. long from centre to centre of the end columns, which are built into the abutments. The piers are arranged for carrying a double line of railway, although at present girders for a single line only are erected, the intention being to widen for a double line when circumstances demand it. The section of the river is irregular, the height of the piers varying from 34 ft. to 76 ft. 6 in. from base of pier to rail level. The river bottom is hard rock, into which, in all cases, the cylinders of the piers are sunk, and to which they are securely bolted. The piers each consist of two columns formed of wrought-iron cylinders averaging 10 ft. in diameter at the base, and tapering to 7 ft. in diameter at the top. The vertical joints are formed internally of T-irons, which are continuous from top to bottom, and which are rivetted through to outside vertical strips. For the horizontal joints the ends of the cylinders are planed, the joints being butt joints with strips inside and out. The cylinders are filled in with cement concrete, and finished with stone caps, which form the bases on which the bed girders rest, the caps being placed directly on the concrete.

The bottom lengths of the cylinders are held down to the rock by eight bolts, each 2 ft. 1 in. long, and 1½ in. in diameter in the shank, and having a square head. Holes are drilled in the rock, into which the bolts are let head downwards, the screwed ends being attached to