THE TAY BRIDGE.

On the Machinery and Methods for Founding the Pires of the New Tay Bridge.

In the construction of the foundations for large bridges in a tidal river where boisterous weather and strong currents exert their full force, and are seldom long absent, great difficulties have always been experienced, involving serious trouble and expense, as well as loss of time and material in constructing staging sufficient to act as a platform for the execution of the work. Previous experience of these difficulties in other cases, and a careful forecast of their character in the case of the new Tay Bridge, has led to the designing and construction of a peculiar staging or movable platform by Mr. Arrol, the contractor for that structure. These platforms have proved equal to all the work required of them, and have withstood the severity of wind and current without any mishaps. With the design, the construction, and working of these platforms, the present article proposes to deal. The largest will be selected for description, the others being all on the same principle, only varying in size.

In order to form an idea of the work to be done and the methods and appliances for executing it, reference may be made to Fig. 1 this view being a cross elevation of one of the piers of the new structure. The lower part, with which this paper is intended to deal, consists of two cylindrical shafts sunk into the bed of the river, these being carried up the low-water level, while on them are erected brick pillars, which are united in one at high water level to form a continuous cross structure on which the superstructure of the bridge is to rest.

The cylindrical shafts as sunk into the river bed are formed primarily of wrought-iron cylinders built up in annular sections as the work of sinking them proceeds. The first section placed in position is provided with a cutting edge, so that when the material within it is removed, and additional rings are added to it, the superincumbent weight causes it to descend. When these cylinders have been sunk to their proper depth they are filled with concrete, thus forming a cylindrical shaft encircled with an iron tube. To sink those cylinders truly, and to handle easily and safely the materials for the brickwork and concreting, was the work for which the appliances about to be described were designed.

The "movable platforms" (of which there are four at work) vary in sizes from 56 ft. long by 36 ft. 6 in. broad and 6 ft. deep, as in the case of the smallest, to 82 ft. long by 66 ft. broad and 7 ft. deep in the case of the largest. The essential feature in the construction of these platforms is that of uniting in one solid structure five watertight iron tanks, somewhat in the form of the letter H, each member of the letter representing a tank, while one tank is added at each end, thus forming two openings, corresponding to the position which the shafts of the pier occupy in horizontal plan. (See Figs. 1 and 2.) In the large platform these openings are 25 ft. square, and adapted to a pitch of 32 ft. centres of the shafts forming the pier. The two main tanks which form the ends are each constructed of a length equal to the breadth of the platform, and in the case of the largest which is being described are 12 ft. broad by 7 ft. deep.

Near to either extremity of these end tanks are openings 8 ft. 4 in. by 6 ft. 6 in., through which are passed the columns or legs which support the platform the river bed, and on which it is suspended at varying heights by hydraulic gear to clear it from the action of the tides. By this combination of watertight tanks in rectangular form, suspended on four cylindrical columns or "legs," there is formed what is really an amphibious staging, rigid at one time on the bed of the river, ready at another to raise its own "legs" or supports and sail away to another position of action.

On the platform thus constructed the following plant is arranged: On the end tanks are placed the engine and boilers for actuating the hydraulic and other pumps, and a workshop for renewal or repair of tools. The two side tanks which join the end tanks having a breadth of 12 ft. by the common depth 7 ft., carry the cranes, the concrete mixer, a centrifugal pump, etc., an additional breadth of 8 ft. being got on one of these tanks by the arrangement of a girder and planking, etc. On the centre tank, which has a length of 25 ft. by 7 ft. broad and 7 ft. deep, there is fitted a shelter for the men. At the openings in the end tanks through which the "legs" pass there are fitted steel plates in a vertical position, and to these are fixed the hydraulic gear for raising and lowering the platform. These are shown more particularly in plan in Fig. 2.

The "legs" of this platform are 65 ft. long and 6 ft. in diameter, with a conical shaped foot or bottom, 12 ft. in diameter. These "legs" are simply strong tubes open at bottom, so as to exert a cutting tendency when loaded, but fitted inside with a transverse plate at a distance of 30 in. up from the cutting edge to prevent the "leg" from sinking too deep into the sand or gravel of the bed of the river. After many experiments with different shapes of feet this arrangement was found to be the best, as the scour was trifling. It may be mentioned that in the construction of the South Esk Viaduct (a quarter of a mile in length) at Montrose by the same contractor, a "movable platform" was also used which had flat bases on its supports 12 ft. square, as the bed of the river was of a gravelly nature, and there was no chance of scour.

To the supporting "legs" or columns are attached four heavy steel plates in two opposite pairs having a distance of 21 in. between them; in these plates are cut holes 5½ in. in diameter, and spaced at 9 in. centres through which are passed the steel pins by which the platform is suspended. Sliding within these plates are the two plates before mentioned as attached to the platform which carries the hydraulic gear; these having also holes of the same diameter and pitch as the plates on the "legs" and also a slot opposite the crosshead to admit of the vertical travel of the pin. The suspension pins are 5 in. in diameter and 30 in. long, and are provided with a tapered point to facilitate their entrance into the holes.

The hydraulic gears, of which there are two for each "leg," wrought simultaneously, consist of a cylinder, 12 in. in diameter, piston, piston-rod, open crosshead, and the necessary valves for actuating them. (See Figs. 6 and 7.)

The mode of raising or lowering the platform is as follows: Suppose the piston to be at the top of the cylinder, a suspension pin is passed through the two outer plates and the crosshead. Water is then admitted, and the cylinder is forced up because the outer plates are fixed to the supporting column, which in turn rests on the bed of the river. The inner plates with the platform attached, have thus been lifted a distance equal to the travel of the piston; this being 18 in., coincides with the pitch of the holes in both sets of plates, and these are now exactly opposite each other. Another suspension pin is then placed in one of the holes, the pressure in the cylinder is released, enbling the first pin to be withdrawn and leaving the platform suspended on the second, while the crosshead is free to descend and take hold of the holes of the next pitch and to repeat the operation, this being repeated until the platform has been raised as far as desired. To lower the platform this action is simply reversed.

In order to float the platform from one pier to another, it is first lowered down by the hydraulic gear sufficiently to catch the tide two hours before high water. Ropes and chains are attached from one side to the piers of the old bridge (60 ft. centres from the new), and to three heavy anchors on the other side. These attachments are made sufficiently in advance of the platform to allow it to be drawn to the next point of operation. The steam crane is then applied as a winch, and the platform advanced to the position of the next pier. The necessary capstans, steam and hand winches, and fair leads are applied to bring the platform as near as posible to its true position for founding a pier. The supporting columns or legs are now lowered down by the hydraulic gear until they reach the bed of the river, and then the platform is raised up about 2 ft. so as to be clear of the action of the tides. The valves in the bottom of the main tanks are then opened, allowing the water to pass freely into the tanks, and thereby removing any tendency to float at high stream tides. The platform having now become stationary, the work of putting down the piers is proceeded with. The centres are carefully set off by the engineers, and vertical iron guides placed at the four sides of the well-holes and bolted to the top and bottom of the tanks in order to secure the sinking of the cylinder into its true position. Timber blocks are used above the taper portion of the foundation cylinder to maintain it in a perfectly vertical position, and at the same time to allow it to slide down as freely as possible. The foundation cylinders are rivetted together on shore and conveyed in convenient lengths by cargo boats to the platform. The various rings are lifted out of the boat by the 10-ton crane on the platform and placed inside the well-holes. A line of rails is laid on the platform so that the crane can be easily shifted from one well-hole to the other. The first ring is formed of ⅝ in. wrought-iron plate, is 23 ft. in diameter, and 13