

more longitudinal tenacity than the toothing bond. As the masonry progressed in height, the cross and diagonal timber bracing of the temporary caissons interfered. It was therefore necessary at such stages to substitute other means of bracing the sides of the caissons against the external pressure of the constantly fluctuating tides of the Thames. For this purpose the horizontal timber frames which supported the metal-plate sides of the caisson were strutted against the masonry. In some cases, where the timber frame came too high to effectively brace against the masonry by reason of too much slope in the struts, longitudinal timber backing the iron-plate caisson sides were put intermediately between the regular original frame timbers. The struts were butted between these temporary timbers and the masonry, where it was solidly backed up with brickwork. When the masonry in the several caissons forming the external of the pier had been completed in a continuous surrounding mass, the external and other remaining sides of the temporary caisson were removed. The piles which closed the intervals between the caissons on the external side were also removed down to the permanent caisson. The similar piles between the internal sides of the caissons were, however, not removed until the central rectangle of the pier had been excavated.

PIER CENTRAL RECTANGLE.

The excavation of this portion of the Tower Bridge piers was not commenced until the encircling masonry, limited by the internal sides of the temporary caissons, were completed. The tide had in the meantime been allowed free access to this central portion through a 12 in. pipe placed in the interval between two adjacent caissons, and passing through the timber piles which formed the water-tight joint between them. This pipe was furnished with a sluice to shut off the water when required. It was found that the greatest difference between the internal and external water levels was never more than 20 in., so that the water pressures nearly balanced each other. The stability of the caissons was therefore not at any time severely tried with this small water head. When the progress of the work had rendered it necessary to exclude the tide, it was considered advisable to place five double-timber struts across the centre between and butting against the surrounding masonry. This was merely done as a precaution against the external water pressure unduly compressing the London clay underneath the inner edge of the concrete foundation surrounding the centre. It was found when the water was pumped out that the bottom of the central rectangle had silted up about 14 ft. above the river bed level in a period of about 13 months as regular

the north pier. The south pier had silted up about 12 3/4 ft. in a somewhat shorter time. The silt was excavated by the grabs. When the excavation had reached the bottom of the temporary caissons the internal sides were removed and a second set of timber struts were butted against the opposite masonry walls in the centre of the pier sides. The excavation over the whole surface of the centre rectangle at once was carried down to a depth of 5 ft. below the top of the permanent caissons. In consequence of the swelling of the freshly exposed London clay, it was only excavated in sections. The divisions of these sections corresponded with the joints between the caissons, and the excavation was done in alternate sections simultaneously. In this way the walls were not opposed to the external pressure of the surrounding clay with its weight of submerging water for a greater length than about 30 ft. at a time. The masonry walls were found to be water-tight, so that no pumping was required after the final exclusion of the tide. There was, however, a slight weeping through some pores in the concrete of about two-thirds of a gallon per minute. This was trivial considering that there was an internal face exposure of about 318 ft. lineal, with an extreme depth of about 22 ft. in the alternate sections as they were excavated until they were filled with concrete, up to within 4 ft. of the general concrete level. As the excavation of the sections was completed

the internal iron sides of the permanent caissons were removed, and the dovetail recesses in the surrounding concrete was cleaned out. The section was then filled with concrete, including the dovetails, up to within 4 ft. of the ultimate concrete level. When the four sections have all been thus filled with concrete, the remaining 4 ft. of the height was laid all over in one mass of concrete together at the same time and finished off level to receive the brickwork. The four sections were thus firmly united, and each was bonded to the surrounding concrete by the vertical dovetails. The brickwork which followed was bonded to the surrounding brickwork by the toothings, which had been left for the purpose. These required careful raking out and fitting in of the bonding bricks in the alternate courses.

The cost of the concrete, brickwork, and granite in both piers up to 4 ft. above Trinity high-water level was about £2. 3s. 7d. per cubic yard.

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