## Correspondence.

Mr. JOHN S. BRODIE observed that the different methods employed in reclaiming the site of the docks and basins from tidal influence afforded an interesting study, the value of which would have been enhanced by a return showing the comparative cost of each method. Presumably, the three types of dam adopted were intended to meet the changes in the geological formation of the foreshore. The timber coffer-dam was a good example of heavy timber work, but probably the clay filling between the two lines of close whole-timber piling would have been much better if it had been previously puddled, and then deposited and rammed in layers. The use of old steel rails in fortifying that part of the concrete culvert which was subject to great pressure during the reclamation works appeared to be open to serious objection, as the same end could have been attained by much less expensive methods. It was not clear why the half-timber sheeting used on one section of the sewer was not driven low enough to obviate the necessity of driving internal runners by hand and strengthening the gantry. Dressing the sandstone to profile in the graving-docks must have effected a considerable saving, but the advisability of this course must depend upon the geological formation, and the quality of the sandstone. It was rather surprising that electricity had not been adopted as the motive power for the pumps, seeing that a generating-station was in close proximity to the works. It might have been better, when piling the foundations of the basin-walls, to cross-cap each line of piles, and to introduce either longitudinal rails or girders of a suitable section, dogged to the cross caps, and fished together. Probably also a row of whole-timber close piling, driven as toe-piles to the face of the wall, and projecting up the face 4 or 5 feet, with longitudinal walings bolted to the sheeting, would have been the means of preventing the forward creep of the wall. The sandstone displacers appeared to have been fixed closer together than was usually found in good work. The Simplex concrete piling for the workshop-foundations appeared to have been very successful, and its cost moderate. Mr. Brodie.

Mr. A. E. CAREY observed that it was somewhat difficult to discuss the merits of different methods of construction without a comparison of the actual costs involved, and the absence of such Mr. Carey.

Mr. Carey. information detracted materially from the value of a Paper. With regard to the alignment of the graving-docks at an angle of 64° with the line of the river-wall and pointing up-stream, perhaps the Author would state whether in actual use the design had been found entirely satisfactory, and whether it ensured vessels being manipulated with the minimum of risk. No. 1 dock appeared to have been hewn almost entirely out of the solid rock. There was a precedent for this operation at Panama, where Mr. Eiffel had built a canal-lock, about 650 feet in length, excavated in the same way out of the solid rock, and lined, where necessary, with masonry. With regard to the construction of the outer basin-walls, a considerable length of these appeared to be carried on a foundation of sand, the wall being supported on pitch-pine piling. The West Pier at Newhaven was similarly founded on Baltic timber piling, creosoted, the work having been carried out in 1881–2. The timber work was now so much destroyed by the teredo, that the underpinning of the concrete wall had been taken in hand, and was being carried out in reinforced concrete. He had recently carried out, at Southwold, a river quay-wall about 1,200 feet long and approximately similar in section to the walls of the outer basin at Tranmere. The Southwold wall was vertical down to low-water level and below this battered, being 14 feet wide at the base. The base of the wall was inclined, and along its bottom edge a toe had been carried down to arrest lateral movement. The wall stood on alluvial deposits of a silty character, and tie-rods were carried from the wall to concrete piers at the rear. In the test which the Author detailed for the raw material for concrete, he appeared to have considered as sand everything that would pass a $\frac{1}{8}$-inch mesh. A large proportion of material passing through this mesh must have been small beach gravel. The ingredients which passed a $\frac{1}{8}$-inch mesh were to the larger ingredients as 1 to 2·4. Two of coarse sand to one of cement made a mortar which resulted in water-tight concrete when mixed with a suitable proportion of gravel, but Mr. Carey doubted whether water-tightness would be obtained by the mixture indicated by the Author, and probably the admixture of a further quantity of sand would have been advantageous. The weight per cubic foot of the concrete used on this work was 7 to 8 per cent. higher than would have resulted from the use of an aggregate of ordinary sand and gravel. The Author's remarks as to workshop-foundations carried on Simplex concrete piling were of much interest, as there had been hitherto so little experience of this method of construction. The objection which naturally suggested itself was the possibility that

voids in the concrete might be left when the tube was withdrawn, and that thus there would not be absolute certainty of securing the full value of the normal bearing-area of the piles. That this objection was not entirely unfounded was borne out by the Author's experience, which went to show that, in plastic ground, the driving of adjacent piles tended to deform concrete recently deposited by this method in their vicinity. The cheapness of this type of piling was notable, and for passing grout into a foundation some modification of the system might prove a valuable expedient. Mr. Carey.

Mr. A. R. ELLISON stated that since he succeeded to the position of Resident Engineer, previously held by the Author, several alterations had been made, the details of which might be of interest. In the later foundations the method of filling the form of the concrete piles had been considerably altered. By the new method the whole quantity of concrete necessary for making the pile was first deposited in the form, the latter being then withdrawn with one movement, instead of, as formerly, being partially withdrawn after each bucketful of concrete had been tipped into the form. A considerable head of concrete was always necessary inside the form, to compensate for the difference in the inside and outside diameters of the form, and also to cause any interstices in the ground to be filled. The piles formed by this method (particularly in soft ground) had proved to be superior to those formed when intermittent drawing was resorted to; and a considerable saving of time was also effected. Owing to the graving-docks having direct connection with the river, some serious difficulty was experienced at first in replacing a caisson in rough weather. In order to obviate this, on the south side of each entrance a timber stop had been fixed on the inside caisson quoins 6 feet below coping-level; each of these stops projected 6 inches off the face of the quoins and was 3 feet deep, with a slight bevel towards the caisson-chase. The method of replacing the caisson was the following:—One of the greenheart stems was guided into the north caisson-chase and securely held there by rope tackles, the other stem was then moored approximately opposite the south caisson-chase. The sinking of the caisson then proceeded until the caisson had sunk to such a level that the free stem could take a bearing against the timber stop, the filling-valves were closed until the free stem had been fastened securely against the stop, and the sinking of the caisson was resumed, the timber stop guiding the free stem into the caisson-chase. No difficulty had been experienced in replacing the caissons since this method was adopted. In the case of the 1000-foot slipways the slope had been altered from $\frac{1}{2}$ inch to $\frac{7}{16}$ inch per foot. Mr. Ellison.

The Author. The AUTHOR, in reply, observed with reference to Mr. John S. Brodie's remarks as to the construction of the concrete sewer-culvert, that his more recent experience in reinforced-concrete work had tended to confirm his opinion that the rough system of fortifying employed was, under the circumstances, safer than any more elaborate and scientific method, though admittedly not as economical. The first point for consideration had been that the culvert should be absolutely water-tight, the second that the time of construction should be as short as possible; and under these essential conditions —working at low-tide only, and under the difficulties mentioned in the Paper—any ordinary system of reinforced-concrete construction would have been at a great disadvantage. The half-timber sheet-piling had been driven from the surface, as low as it would go, a bed of sand stopping any further penetration. When the trench was opened out and timbered, the weight on the back would have prevented the piles from being driven any deeper, even if it had been considered advisable to attempt it. He regretted to be unable to answer Mr. Carey's question as to the angle of the graving-docks with the line of the river-wall, but the presence of a strong eddy towards high water at this side of the Mersey would render comparison with any other locality misleading. In the particular beach-gravel used in these works, the proportion of sharp sand was unusually high, averaging, at a rough estimate, 75 per cent. of what would pass through a $\frac{1}{8}$-inch mesh.