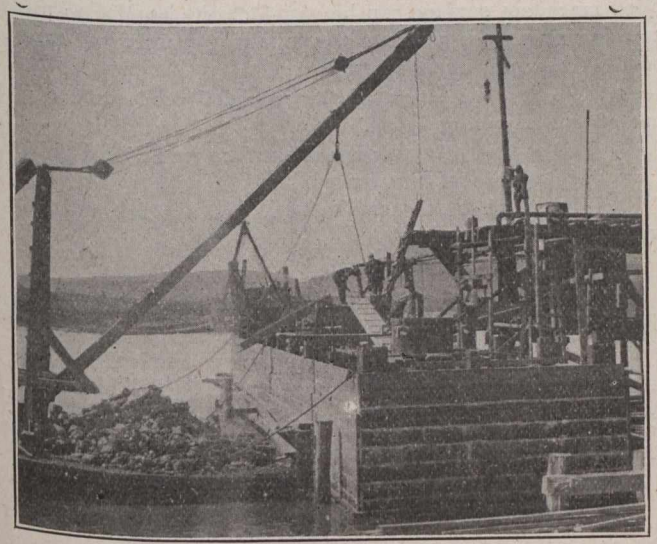
settle down on to the hard bench below the shoe. Clay was then used to "mud-up" underneath the shoe, to prevent the leakage of air; and excavation commenced again.

About 900 cubic yards of material was excavated from No. 1 caisson, including about 50 cubic yards of bed rock which had to be blasted out in one end of the caisson to get a level bearing for the pier.

When the excavation was completed, the work of concreting the caisson began. The concrete was poured on to the bottom door of the material locks and then dropped into the caisson. Wet concrete was used until the caisson was filled to within four feet of the deck. It was then sent down very dry; and benched and packed tight against the deck, leaving a narrow passage down the centre. This passage



6. Excavating Stone.

was then packed full, up to the locks and the air taken off. Six weeks was the average length of time required to excavate and concrete each caisson.

Two other caissons of the same construction were sunk for the McKellar bridge. These caissons, however, went down 45 feet and required 18 lb. pressure.

Mr. A. C. Stewart was in charge of the work; the writer was contractor's engineer; and G. N. W. Otty, B.Sc., resident engineer for the Canadian Pacific Railway.

NEW OCEAN DOCKS.

Messrs. Harland and Wolff, the famous Belfast shipbuilding firm, intend to establish ship repairing works at Liverpool.

At a meeting of the Mersey Docks and Harbor Board, it was recommended by a committee that the North dock yard at Bootle should be let to Messrs. Harland and Wolff, and the motion was adopted. The site has been taken on a sixty years' lease. It will not be necessary to construct a new dock in connection with the scheme.

Lord Pirrie, head of Harland and Wolff, is largely concerned with the White Star, American, Leyland, and Dominion lines, and with Elder Dempster and Company, Lamport and Holt, and the Pacific Steam Navigation Company, which have all been managed from Liverpool. Their tonnage aggregates over two million. The new works will employ nearly 1,000 hands.

STEAM ROLLING OF WATER-BOUND MACADAM ROADS.

General directions for the steam rolling of water-bound macadam roads are given the Road Board (Great Britain) specification No. 7. This was issued in December last, and will be of interest to all municipal and good roads engineers. We publish it in full.

1. General.—These general directions are intended for use in cases where a new surface coating is to be laid with steam-rolled water-bound macadam on any road which has a proper foundation or sub-crust of adequate thickness.

2. Trial Trenches.—Before laying the new surface the thickness of the old crust, including the foundation, should be ascertained by opening trial trenches at intervals averaging about 150 yards apart, extending from the side to the centre of the road, such trenches to be made alternately on opposite sides of the road. A careful record of the facts disclosed by these trenches should be kept, with plans and sections, for future reference.

3. If a proper foundation or sub-crust of adequate thickness does not exist, or if the road is weak at the haunches, the following steps should be taken:—

In the case of heavily trafficked roads the haunches should be strengthened and the crust thickened either with stone of any kind suitable for bottoming work, broken to a gauge of from 3 in. to 4 in., or with hard core, clinkers, or other suitable materials, according to the nature of the subsoil. In some cases, where the surface of the broken stone, after being steam-rolled, is sufficiently smooth for the purpose of traffic, it may be possible to allow the bottoming material to be used as the wearing surface of the road for a short period, not exceeding twelve months, if it is important for financial reasons to postpone for that period the laying down of the final surface coating in accordance with the other provisions contained in these general directions.

4. Total Thickness of Crust.—Even when there exists a good natural foundation, the total thickness of the road crust, including the old and the new macadam after consolidation by rolling, should not be less than 4 in. In the case of well-drained sub-soil, which cannot be materially softened by the infiltration of surface water, the total thickness, including the new consolidated surface coating as well as the sub-crust and foundations (if any), should not under ordinary circumstances be less than 5 in. In the case of fairly hard clay or other yielding sub-soils the total thickness, including foundations, should not be less than 9 in. In the case of soft wet clay or bog or marshy sub-soil, foundations of a special character may be required. (See No. 10, Appendix.)

5. Thickness of New Surface Coating.—The thickness of the new surface coating of macadam when consolidated by rolling should be from 2 in. to 3 in., according to the traffic requirements. If it is desired that the new coating should have a greater thickness than 3 in. when consolidated the stone should be applied in two coatings separately rolled.

6. Cross-fall.—The finished surface should have a cross-fall of 1 in 24, or ½ in. to the foot. If the old crust is not sufficiently thick at the crown to enable this cross-fall to be obtained when a new coating of the thickness above mentioned is super-added, the old surface should be left intact and unscarified, and the thickness of the new coating of macadam should be increased as far as may be necessary. If the crust is of ample thickness, but the cross-fall excessive, it should be reduced by scarifying the surface and removing material from the crown to the sides previous to the application of the new coating. The material so loosened by scarifying should be screened, and all material finer than ½ in. should be put on one side to be used for top dressing during rolling operations.