at all, since the cement was practically washed out of it. Disintegration of the bottoms of such cylinders followed rapidly.

We have mentioned the faulty design, due to not putting the end of the concrete cylinder deep enough into the mud, and we have mentioned the ignorant method of depositing the concrete mixture into water at the bottom of the form, and when we add the fact that probably the mixture itself was often bad or defective in its cement or rock or other ingredient or in the proportions employed, we have accounted for the resulting condition of such cylinders, which for the most part were costly failures.

From these causes about twenty-five per cent. of our piers went out of commission in the past four years, such piers varying in age from six to twelve years.

It was impossible to repair them with concrete and subsequently they had to be rebuilt with creosoted wooden piles driven in and set with considerable difficulty and cost under the existing wharf decks and sheds.

Profiting by the experience of their predecessors, our engineers in the past four years have improved on the old type of concrete cylinder and in the actual work of installing them in several noticeable respects, and have employed what we may designate as our second type of concrete cylinders.

This type is really founded on an entirely different principle.

If wooden piles are used to support the cylinder, as they must be in mud bottoms where there is no bed-rock, the piles are driven to about eight feet below the permanent dredge line, and come up into the concrete cylinder only about five feet, the theory being that the wood supports the cylinder and then the cylinder supports the wharf. This arrangement, we believe, guards sufficiently against the possibility that the wood will, by shifting of the mud, become exposed to teredo attacks.

The method is first to drive a steel shell, or caisson, in cylindrical shape into the bottom, so that it can be sealed. The mud is dredged out of it and the water pumped out, and the wooden form with the steel reinforcement already set in it is lowered into the steel shell. Great care is taken to clean and dry the bottom of the form as thoroughly as possible, and then the concrete mixture is poured in and tamped down by hand.

After the concrete is set, the steel shell is pulled off by the pile-driving apparatus and again used elsewhere.

Steel reinforcing rods are always used, usually three-quarters of an inch square, and from eight to twelve rods in each cylinder. The concrete columns when finished are from three to four feet in diameter.

Spiral wire hooping is also used around the reinforcement, as already described with respect to the concrete piles.

The mixing of the concrete is carefully inspected by competent inspectors of our own selection; the cement, steel and concrete are tested by our own testing engineers; and the cement is bought by us and furnished to the contractor for the work.

It may be of interest to add that in the concrete mixture now used in the harbor of San Francisco, the proportion of cement to the aggregate is 1 to 5 in the pile, and 1 to 6 in the wharf deck and cylinders.

Our experience with cylinders has warranted the deduction that where at all practicable the cylinders should rest on bed-rock, thus avoiding the use of wooden supports below them. By bed-rock, of course, we mean any bottom hard enough to carry the load.

In San Francisco harbor, as far as it has been improved, such bed-rock has been found in only one limited district, and in that stretch seven piers have been built, supported by concrete columns or cylinders of the type last described, and going down to hard-pan and without any wooden supports under them at all. These piers range from 130 to 200 feet wide and from 650 to 800 feet long.

Our pier-head line is limited by the United States government to a distance of 800 feet from the sea-wall, or shore line bulkhead.

Where a greater length of pier than 800 feet is desired, the object is accomplished by inclining the pier at an angle to the sea-wall, thus affording some berths of over 900 or 1,000 feet in length.

The minimum depth of water is 33 feet at the bulkhead line, which depth is enjoined by statute, and the depth at the outer end of the pier averages over 50 feet, and in a number of cases is as much as 70 feet.

It happens that the best bottom is in the district where the water is deepest, and consequently the construction of piers resting on concrete cylinders going down to bed-rock in this district was necessarily very expensive.

Some idea of the quantities involved in building such a pier, 200 feet wide, 800 feet long, in water much of it 50 to 60 feet deep and supported by concrete columns three to four feet in diameter, may be gathered by reflecting that the outer end of the pier would be as high as a five-story building; and with a shed on top of that about 35 feet high.

If the depth of water is not too great and the bottom is of such character as permits us a choice between concrete piles and concrete cylinders as wharf supports, experience with both types has brought us to a decision in favor of the piles. As I have said, we feel better satisfied that we know what we have got.

In short, where bottom conditions permit, we exercise a preference in favor of concrete over wood, however treated or protected; and when it comes to concrete we prefer the driven pile type to the built-up cylinder type.

TORONTO TERMINALS RAILWAYS COMPANY.

At the annual meeting of the Toronto Terminals Railways Company, Mr. Howard G. Kelley, president of the company, reported good progress on the construction of the new station building in Toronto, which will be owned and occupied jointly by the Canadian Pacific and Grand Trunk Railway companies, each of which holds an equal interest in the property. The steel work on the new building was reported as practically all complete, and the stone work is being delivered and cut preparatory to its erection, which it is expected will be commenced during the present month.

The directors and officers of the company were elected as follows: Directors, Messrs. George Bury, I. G. Ogden and E. W. Beatty, K.C., representing the Canadian Pacific Railway Company, and Messrs. E. J. Chamberlin, Howard G. Kelley and J. E. Dalrymple, representing the Grand Trunk Railway Company. Officers, Mr. Howard G. Kelley, President; Mr. Geo. Bury, vice-president; Mr. Henry Philips, secretary; Mr. H. E. Suckling, treasurer; Mr. W. H. Ardley, auditor; Mr. J. W. Leonard, general manager; Mr. W. C. Chisholm, K.C., general solicitor; Mr. J. R. W. Ambrose, chief engineer; Messrs. W. H. Biggar, K.C., E. W. Beatty, K.C., general counsel; Messrs. H. R. Safford and J. M. R. Fairbairn, consulting engineers.