and on examination were found to have suffered no material damage either at their points or any part of their length. Test loads of from 90 to 120 tons were applied to individual piles with no resultant settlement where the pile had been driven to refusal.

The piles, after being driven, were extended up to deck level and the reinforced concrete deck system was built on them. This consists of transverse girders along the heads of the piles in each bent, and longitudinal beams spanning from bent to bent, carrying the floor beams and slab, which was designed for a safe live load of 1,000 lbs. per square foot.

Sheathed With Creosoted Plank

In order to protect the concrete against the action of frost and ice, all surfaces between low water of spring tides and 18 ins. above high water of spring tides were sheathed with 4 ins. of creosoted plank.

The pier carries a two-story reinforced concrete shed 676 ft. long by 200 ft. wide and four railway tracks, one on each side of the shed and two down the centre inside the shed.

By the kind permission of R. H. Smith, resident engineer at Halifax for the Canadian Government Railways, the writer was given an opportunity last month of examining the condition of the structure below deck level. In a few places only did there appear to be corrosion taking place in the reinforcing steel above high water, and in these cases the reinforcing steel had been evidently misplaced during construction.

This was particularly noticeable on the underside of the deck slab, where the placing of reinforcing steel and holding it in correct position during the placing of the concrete is liable to be less carefully attended to than in the beams, but where a good covering of concrete is just as necessary and should always be allowed for and insisted upon. An extra one inch of concrete on the underside of the deck not only gives additional protection to the steel but it adds to the stability of the structure by increasing its inertia, which is an important point in these days of 40,000 and 50,000-ton vessels. In no place was any sign of corrosion discovered where the steel had been properly covered with 2 ins. of sound concrete. The greater port of the structure was five years old when the examination was made and the whole pier had been completed four years.

Collisions Cause No Damage

The frost protection sheathing, where it had been undisturbed by vessels, was in good condition. In a few places this sheathing had been knocked off by vessels, and where this had occurred previous to last winter and had not been repaired, the action of frost and ice on the concrete below high water could be seen. At one of the outer corners of the pier the lower part of one of the stiffening gusset walls had been attacked by frost until the concrete had been entirely removed from around the reinforcing rods. The concrete in this gusset wall had been poured in place at low water, and as a contrast to its lack of durability when unprotected was the case of a pile which, having been broken while being placed, had been discarded and allowed to remain standing free and unprotected under the pier. This pile, made of 1 : 1½ : 3 concrete, had seasoned for nearly twelve months before being placed in the water and after five winters only a slight amount of abrasion had taken place between tide levels, and this was little more than a rounding off of the corners. In no place was the steel exposed nor had any rust stains appeared; succeeding winters, however, will have a greater effect, as part of the hard outer skin has now been removed.

Since the pier has been in use it has received several severe blows from vessels of all sizes, but in no case has there been any but local damage suffered by the structure. A few months ago a vessel with a displacement of over 40,000 tons collided with the pier while docking, and although several of the side plates of the vessel were bent, the concrete was damaged for a distance of not more than five feet in from the fender beam.

The work was designed by Sir John Kennedy of Montreal, for whom the writer acted as assistant and resident engineer. The contractors were the Nova Scotia Construction Company, of Halifax and Sydney, and the cost of the structure was about $1,000,000, exclusive of the interior fittings of the shed.

The Furness Withy Pier

The Furness Withy Pier at Halifax, completed last year, has a length of 590 ft. and a width of 90 ft. It is supported on 76 reinforced concrete cylinders in 19 rows of four cylinders each, and a solid concrete retaining wall under the shore end. The depth of water alongside ranges from 13 feet to 46 feet below low water of spring tides. One-quarter inch steel plate cylinders rivetted together were used as forms for the concrete supports and were left in place as a protection to the concrete.

The contract plans called for the driving of reinforced concrete piles within the steel cylinders except where the steel cylinders could be sunk to solid rock, in which cases the piles were naturally to be omitted. The contractors decided that they would excavate to rock in every case and so eliminate the need of pile driving.

In shallow water a Harris excavator, operating a Hayward orange peel bucket, was used for excavating the cylinder foundations.

For about 200 feet out from the bulkhead this excavation had to be carried through old timber cribwork and a very tough boulder clay, which it was found necessary to blast. Towards the outer end of the pier, silt and stone filling only were found overlying the rock, and these were easily removed by an orange peel bucket.

The two side cylinders in each bent are six feet in diameter and the two interior ones seven feet, and they are spaced 25 ft. 9 in., 30 ft. 0 in. and 25 ft. 9 in., centre to centre. The bents are placed 30 ft. 3 in. apart, centre to centre.

Probings to rock were taken at the location of each cylinder and the required length of cylinder sent to the bridge company, who made up the cylinders and shipped them by rail to Halifax.

Placing the Cylinders

The foundations for a bent of cylinders having been excavated to rock, guiding timbers fastened to the pier falsework were placed so as to hold the cylinders in correct position when being set. The cylinders, as required, were then tipped endwise into the water and raised into a vertical position by a floating derrick, which set each in its location as marked by the timber frames.

A helmet diver was then sent down each cylinder to thoroughly scrape and clean the foundation, and also to close up any apertures which might exist around the bottom edge of the cylinder.

Owing to the distance of 30 ft. 3 in. between the bents of cylinders, it was necessary to drive temporary wooden piles to support the formwork for the pier deck. Two rows of piles at ten feet centres were driven between