of concrete. But works of such magnitude as this are not common, and it is in retaining walls, piers, docks and such structures that most engineers are familiar with and interested in.

One of the greatest sources of damage to dock and approach walls to canal locks is from blows from vessels, due either to poor handling by the crews or to winds and currents. Protection must in some way be provided, as concrete walls, even when well reinforced, will not long withstand these blows unless adequate protection is given. The writer knows of one instance where, as a protection, the face of the wall was six inches back from the face of the cribs on which it was built. This did not prove sufficient, as the curved sides of the boats was more than the set-back for the same height, and chips were frequently broken from the wall. A 1-foot set back would have been better.

A good waling should be provided above water and also one below would be an advantage. Objection may be made to the difficulty of renewing this waling as it is damaged or worn, as it will be in course of time, often a short time. Fig. 1 is suggested as one way of fastening the waling so as to allow of renewal. Another method of protecting a wall would be a series of rolling wooden fenders loosely suspended over the edge, as shown in Fig. 2. These would often be torn loose but would be easily replaced, and the cost smaller than replacing broken walings.

In the Lachine Canal, part, if not all, of the approach walls to the locks are concrete, and as a protection to the coping of these walls steel plates about three-eighths of an inch thick, about a foot wide and any convenient length are bent longitudinally to fit the arris of the wall and fastened to the wall with bolts with countersunk heads. It apparently answers the end in view. As a further protection to the walls in places, a timber float from four to six feet wide is fastened to the wall. This is not in all places permissible owing to the space taken up.

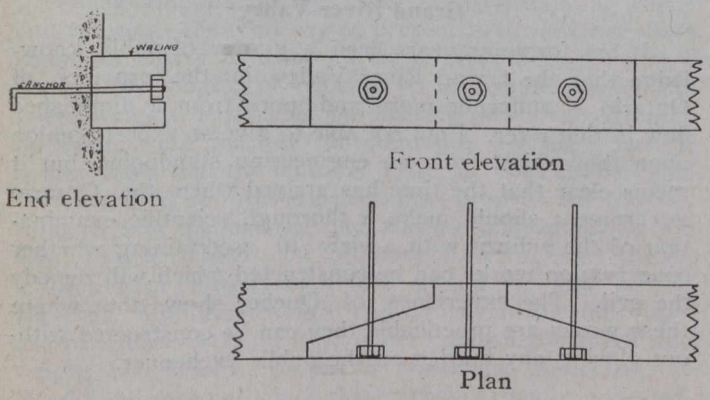

Fig. 1.—Suggested Method of Fastening Waling to a Wall

But the writer has often thought that for such walls as approaches to canal locks or small docks of some kinds, it would be an advantage to have the top foot of the wall a course of good quality cut stone, instead of concrete. The first cost would be somewhat greater than concrete but there would be advantages to offset this. The stone would withstand as heavy, if not heavier, blows than concrete without damage, and if by repeated blows one stone should be damaged enough to need replacing, a new stone of the same size would make the work as good as new, whereas, patched concrete is never as good, either in appearance or strength, as the original wall. Patching concrete is neither easy nor satisfactory.

Another disadvantage to the use of concrete, especially for docks and piers for bridges in our climate, is the effect that ice has upon it. This effect is particularly shown in at least two forms. In many places there is little or no current and the ice once formed remains practically stationary till it thaws in the spring. Here the danger is from the filling of cracks in the concrete with water, the freezing of the water with its resulting expansion, and the slow but sure disintegration of the concrete. Careful

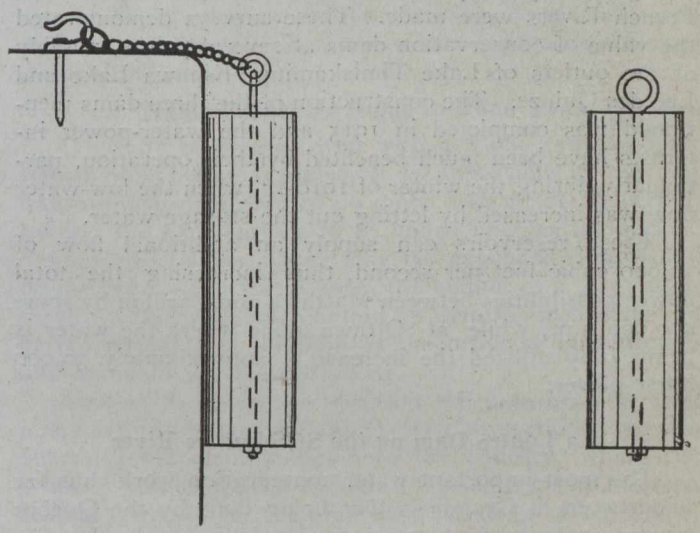

Fig. 2.—Rolling Fender for Wall Protection

construction will, in a large measure, do away with this danger to walls.

But it is in rivers and harbors where there is more or less current that the effect of ice is more marked, in the wearing away of the concrete by rubbing and grinding of the ice cakes. In such cases the best protection is a timber sheathing which is comparatively easy to renew. The writer recalls an instance on a river flowing into the Bay of Fundy where at low tide there was but a foot or so of water in the river, but at high tide upward of thirty feet. Here ice formed in huge masses, and while there was very little movement of ice up or down river, yet the rising and falling with consequent grinding twice a day, wore away masonry bridge piers to such an extent that completely encasing them in timber was the only thing that could be done to save them from complete destruction. Piers of concrete in such circumstances would be no better than—if as good as—the masonry.

While all admit the great advantages and adaptability of concrete, yet it cannot be claimed that its use is a cure-all for every engineering problem. There are many occasions where something else may be substituted to advantage.

One use to which concrete could be put more generally, and to advantage, than at present is in shore protection, or rip-rap to river banks, or where currents are cutting away valuable lands. On the St. Lawrence canals some ten or eleven years ago concrete was laid as rip-rap in place of the usual hand-laid stone. It was partly an experiment and partly to finish a certain piece of work that season. It was a stiff mix of ordinary proportions, laid on a 1½ to 1 slope with an expansion joint every forty feet or so. It is in good condition to-day; in fact the only

(Concluded on page 519)