structure carrying the bin is built of piles driven about 10 feet to refusal. The trestle is built on the bottom of the canal below Lock No. 2.

The work being carried on at Lock No. 2 is part of section 2, of which Messrs. Baldry, Yerburgh and Hutchinson are the contractors and Mr. H. M. Balfour the resident engineer under Mr. J. L. Weller, C.E., engineer-in-charge for the Department of Railways and Canals.

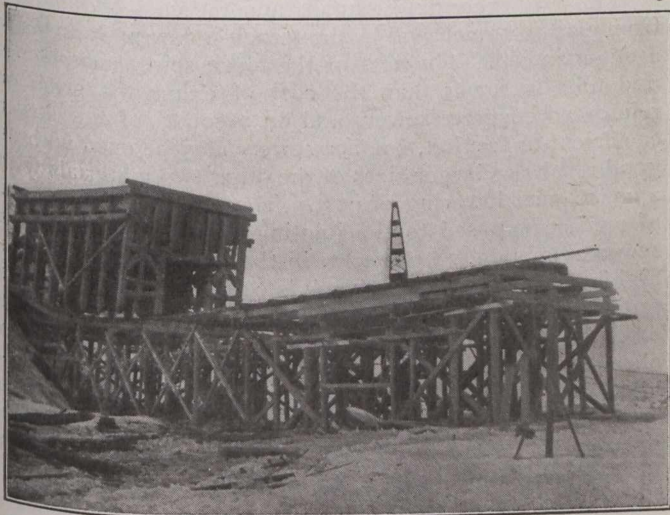

Fig. 4.—Showing Steepness of Incline onto Trestle, which is the Final Location of the Bin.

THE USE OF DREDGES IN EXCAVATING OPEN DRAINAGE DITCHES.

SOME practical notes from a paper read before the Iowa State Drainage Association by A. L. Goldenstar, of Mankato, Minn., will be of interest to engineers in this country inasmuch as the employment of dredges for the work has received very little attention here. The use of dredges has influenced the design of the ditch to some extent. Engineers have specified a cross-section which can be efficiently handled by the machine. It usually has been a section with rather wide bottom and steep side slopes. Side slopes of ½ to 1 have been very common and some have been even steeper. The arguments in favor of such a section have been that the sides were expected to cave down and the ditch would finally assume a section of its own that would stand, and second, that there would be little trouble in getting a contractor to dig the required section, because it is the easiest and most natural one to cut with a dipper dredge. But instead of the channel becoming an ideal one the sides are always rough and ragged, never cease caving in and the ditch fills up above grade clogging up the tile outlets that may be in it. The argument that nature will form the proper form of channel seldom holds good.

For the ordinary soils of northern Iowa and southern Minnesota, 1 to 1 should be the minimum slope and 1½ to 1 is often better. For loose, sandy soils even flatter slopes than these should be used. In order to avoid excessive top widths with these flatter slopes the bottom may be kept comparatively narrow. This will aid in making the ditch self-cleaning. In standard railroad and highway construction the slopes for excavation in cuts are never less than 1 to 1 and 1½ to 1 is now commonly specified. The slopes of railroad and highway cuts are exposed to even less erosive forces than the sides of open ditches.

But the proper construction of an open drainage ditch does not begin and end in specifying the right cross-section. Means must be taken to create absolutely the form that is desired. Where teams and scrapers can be used it is comparatively easy to secure smooth sides and bottoms without much hand labor. But teams and scrapers can be used in very few places so we must reckon with the dipper dredge or the dragline machine. Dipper dredges cannot cut a smooth enough or true enough side slope or bottom without the help of hand labor. Then, also, these machines are usually started at the upper end of a ditch and proceed down stream. There are only two arguments in favor of this method of procedure. The first is that it insures a good supply of water that will lubricate the dipper and make dumping easy, and the other is that it provides the necessary amount of water to float a floating type of machine. From all other points of view this method is detrimental to the job. The machine is always digging under water so that the operator can never see what kind of slope he is digging. When the dipper full of material is raised up through the water all the loose particles will wash off to remain suspended in the agitated water until the machine has moved on. Then this matter settles to the bottom in the form of silt. The author has seen from 2 to 4 ft. of this silt in a semi-liquid condition behind a dredge. It is usually assumed that this will all wash out with first flood, but it never does. Keeping the ditch full of water makes trimming of the sides by hand or any other means impossible. The wet plastic material dropped on the spoil banks settles so firm and tough as to make subsequent spreading very difficult.

The dragline machine seems to be coming into more general use now for wide open channels. Greater care can be taken with this type of machine in cutting the true cross-section channel. The sides can be left smoother since a wide flat bucket is used. Also, the spoil can be dumped over a wider area which reduces the amount of spreading.

Other types of excavator are being used, but only in a few cases. The so-called "template" excavators are made but experience with them is very limited in this territory. They still seem best adapted to dry land work.

In the light of the experience we have had with the various dredging machines, we can say that there is room for much improvement. The dredging machine is still to be invented that will by its own work, without assistance, make a first-class open drainage ditch. The kind of ditch needed is the common sized channel with from 4 to 16-ft. bottom. For the larger channels the present machines may suffice, but for the smaller ones they are not satisfactory.

The first logical step to be taken in handling this problem is to specify exactly the section that is desired and then insist that it be built that way. This will foster the designing of machinery that will build this section. Whether the dipper dredge and dragline machine can be improved to do this or whether some sort of a template excavator must be invented that will move cheaply all kinds of earth remains to be seen. At any rate, a change must be made or we will continue making open ditches that are a continual expense to maintain and never permanent. Instead of designing ditches that the present machinery can build we should try to develop machinery that can build the ditch that will stand.