(*b*) When the supply of ballast is limited and subgrade sunken on the banks, it is better to be satisfied with a track having local depressions below the theoretical grade line, rather than to rob the sides by building up a high, narrow track to the true grade, as such a track will soon sink and get out of line—being deficient in lateral support.

(*c*) Each tie should be tamped equally well, because even one tie, without support, acts like a force pump: each passing truck, by suddenly depressing it, compresses the air under it, forces out more ballast, until there is a cavity formed, a lodging place for water and a permanent sag in the rail.

(*d*) Ballast should be tamped more firmly under the rails than under the centre of the track, because a centre bearing will cause a rocking motion which will increase rapidly, especially on banks, where the sides are apt to sink more than the centre anyway.

(*e*) Surface is rather more important than alignment, although not so easily obtained or seen by a track foreman.

(*To be continued*).

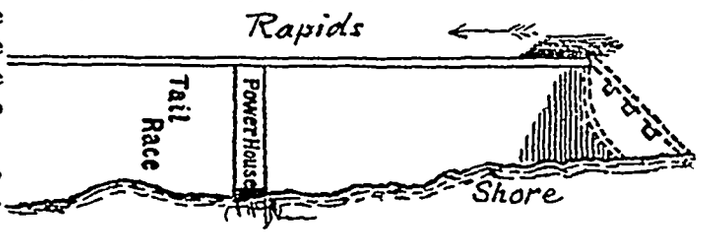
FRAZIL ICE IN THE LACHINE RAPIDS.

The Lachine Rapids Land and Hydraulic Company has been supplying electric current steadily to Montreal since last winter and has had four dynamos running, delivering 3,000 h.p. Some difficulty was again experienced, during the severe weather early last month, in obtaining a sufficient head of water to keep the plant in operation. The lighting companies subsidiary to the Lachine Rapids and Hydraulic Co., the Imperial and the Temple Cos., had to start up their steam plant, and the Imperial borrowed a dynamo from the Royal Electric Co.

The two chief difficulties in the problem of maintaining the head which the engineers of the Lachine rapids development had to contend with in winter were the sudden and very great fluctuations in the river level below the rapids, caused by ice jams in the river and the formation of frazil ice. It has been found that the changes in the river level at the city are not so important as was anticipated, but a great deal of trouble has been found through the formation of an ice dam on the rock bottom of the shallow stretches immediately below the tail-race. On the occasion referred to, we are informed, the level of the water in the tail-race rose ten feet owing to this cause and for a time the head was reduced to three feet. The removal of the rock in the shallows below the tail-race will probably remedy this defect, and it becomes only a question of how much the company is prepared to expend in securing itself against similar occurrences.

The second difficulty, that caused by frazil, is as yet unsolved, and if the report is true that the company intends to install a steam plant in Montreal as an auxiliary, capable of running all the arc lights in the city, it would suggest that the final solution was believed by the company to be still remote.

The recent obstruction of the intake which reduced the level of the water in the head race from nine to five feet, as we are informed, was due to the existence of frazil. The construction of the intake will be seen at the top of the accompanying rough diagram, which we reproduce from the Montreal Witness. Between the pier head and the shore are placed in a slanting line three rock-filled caissons, and along the upper side of these represented in the illustration by double dotted lines is stretched a boom thirty inches deep. A little lower down is a second boom represented by the lower pair of dotted lines. This latter is four feet deep. Between these two booms is maintained an open sheet of comparatively still water. These were constructed so that the frazil floating down the current would be stopped by the first boom and carried away by the current which sweeps along it. Should any get past this boom the clear space of quiet water was maintained for it to rise in, and the second boom constructed to catch it. The vertical shading in the illustration shows where a part of the construction dam has been left. Though this does not come up to the surface, it is so near it that pieces of ice catch in floating over it. This obstruction lessened the current sweeping the outer boom and also caused a large eddy. In this way the frazil was not carried off as it



should have been. The snow also, which fell heavily at the time, drifted into the open space between the two booms, formed slush, and this getting under the boom rose again immediately and froze to the underside of the ice. Thus between snow and frazil the intake became frozen solid from top to bottom over the area shown by the horizontal shading. This had to be blasted out. To prevent a recurrence of the snow difficulty, a snow fence has been constructed across the ice below the intake. The Witness states that, to prevent the frazil coming in, a few feet will be removed from the top of the old construction dam so that ice may pass over it freely and the outer boom be continually washed by a swift current.

There can be very little doubt that if any solution of he difficulty can be reached, the engineering staff of the company will arrive at it. It has been established that frazil does not form in ice-covered water that is warmer than the open stretches, and frazil is only formed in water whose temperature is below freezing. The vast amount of the St. Lawrence which is kept open by the rapids and swift currents materially cools a large body of water, and this is especially true of the river at Lachine, where for a distance of about six miles above the company's works the river is almost entirely open. In these open rapids frazil is formed in great quantities, and it is yet to be shown that at the bottom of such an extensive stretch of rough open water there can be maintained a sufficient area of still water by which the turbines may be driven and from which the frazil coming down the river can be excluded.

ROPE TESTING.*

BY GEO. A. M'CARTHY AND ERNEST G. MATHESON.

Almost all departments of engineering have been so thoroughly exploited that wherever you may carry your researches you find that you are by no means the pioneers. If this leaves less room for originality, yet it furnishes many useful hints in regard to methods to be pursued in order to obtain the best results with the least effort and in the most satisfactory manner. In our investigation of the strength and other qualities of ropes, it was assuredly not in the multitude of data, but in their absence, where lay our chief difficulty, or if these data existed we failed to get them within our reach, therefore, in so far as we are concerned, this thesis is almost wholly original.

Before entering on the subject of rope testing it might

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