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Canadian Society of Civil Engineers.
INCORPORATED 1887.
TRANSACTIONS.

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TRANSPORTATION ON OUR INLAND WATERWAYS AND CANALS.

By A. L. Hogg, M. Can. Soc. C E.

(To be read Thursday, 6th December, 1894.)

This is a subject of much importance. Only a few weeks ago, a convention was held at Toronto, to discuss and to forward any practicable scheme to connect our great Inland Lakes with the sea-board. A system of deep waterways was discussed, via the St. Lawrence and Hudson Rivers. The great cost of such a scheme, based upon the customary lockage system, would undoubtedly involve its promoters in ultimate financial disaster *à la* Panama, and there the matter rested, in so far as the convention was concerned, and since then, with the exception of a few casual remarks from an occasional correspondent in the local press, we have heard nothing more of it.

While improvements are constantly being introduced in our methods of transport by land in all its various branches, very little apparently has been accomplished in the meantime to improve our methods of transport in connection with our waterways; methods that were introduced two or more generations back are still in vogue to-day. In this field of engineering we seem inclined to follow too closely, and sometimes blindly, in the footsteps of the early engineers, content to accept their plans and details for our modern works of this class, without question, not presuming, or perhaps fearing to alter designs, which have answered the requirements so well, and have withstood the test of years. It is always prudent to let well enough alone; but in this particular the time has arrived for an advance to keep up with the age we live in. The writer proposes, through the medium of this paper, to suggest for discussion one important innovation to the existing methods in our canal transport. The principal reason for the introduction of this inoovation is the vital one of cost, as compared with the lockage system, and if it can be made to work as efficiently, so much the better, ensuring to the promoters and shareholders a reasonable return for capital invested, by virtue of the immense reduction in the estimates.

At various times in watching the progress of vessels, through a series of locks in our canals, it has occurred to the writer that here might be an opening for improvement, in substituting some other arrangement to overcome summits than that of climbing by an ascending and descending ladder of locks, and now proceed to describe the scheme proposed as an offset to the lockage system in our canals and waterways, for the transfer of vessels, over summits or from one water level to another. The accompanying drawings illustrate a system of skidways, combined with pontoons and slips, applying the principle employed by the French, in their "Chemin de Fer Glessant," between the sliding surfaces of the ways, to eliminate friction as far as possible, when the vessel is being drawn up the incline, or to act as brake power, when being let down the incline as desired. To utilise to greatest advantage this system of skidways, the engineer must secure a suitable site, gently sloping hill side is the most favourable for the purpose, as then the work of grading up the ways, being mostly surface work, gives greatest strength with least expense. There are a variety of ways, in which these skids can be placed according to the nature of ground selected for site, but the simplest form of their use would obviously be up and down in one direction.

A most important consideration in the choice of a site for these skidways is that they should be located near a stream of sufficient volume to operate the hydraulic appliances efficiently, and failing such volume, a storage reservoir can be constructed at a convenient point on the hill side, to be supplied from the nearest streamlet or gathered from springs and surface drainage. It is most essential in a design for these skidways to have an absolute plane surface between the sliding ways.

The utilisation of these ways in connection with dams and weirs, for the improvement of natural water courses, especially in mining or isolated districts, as are found in the Kootenay District of British Columbia, and many other parts of the interior of Canada, would be an economical means of local transport to the highways of trade for the products of these districts, and thereby develop the country, and benefit our mining and other interests which have been sadly neglected—and which are in much need of some encouragement.

Some may doubt the practicability of handling loaded vessels in this manner. Those may be referred to an article by Sir Benj. Baker, on Ship Railways, in the *Nineteenth Century Magazine*, of March, 1891, as to what has been done in that way. The following is an abstract :

"It is very rare in engineering problems to find that what has been
" done successfully on a small scale is impracticable on a large one ;
" but rather the reverse is the truth.

"The same truth, that with modern appliances and increased ex-
" perience, engineers of the present day encounter less difficulty in
" carrying out large works than their predecessors successfully sur-
" mounted in dealing with small ones, holds good of steamboats and
" countless other things, and doubtless will hold good as regards ship
" railways.

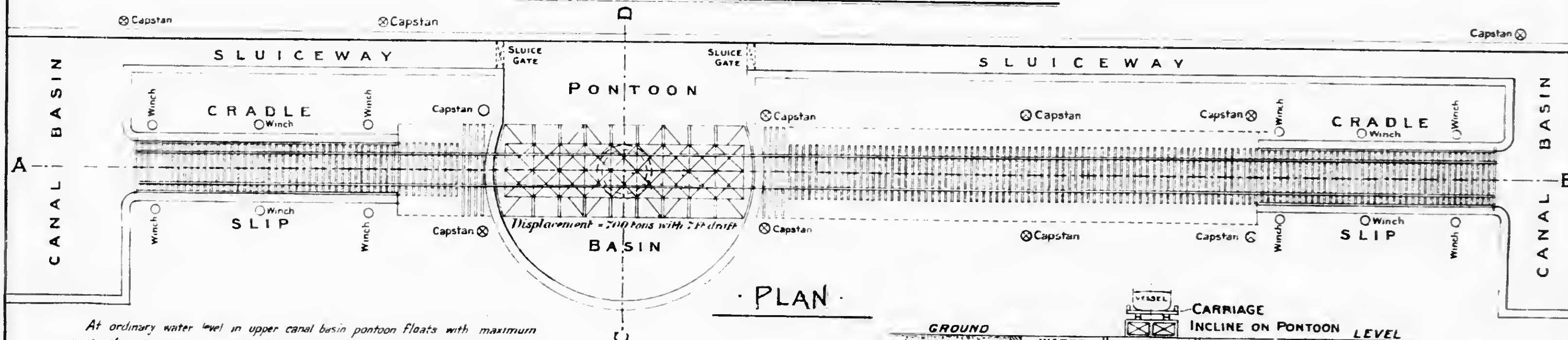
" But, after all, a ship railway adapted to modern vessels is but a
" new combination of mechanical contrivances, every one of which has
" been well tested singly to at least as severe an extent as it would be
" tested in the combination. Thus, in the case of a ship railway the
" vessel has to be lifted out of the water, and it has to be hauled along
" a railway, on a properly constructed car. It is necessary in order to
" prove the above proposition, therefore, to show : (1) That heavy
" vessels can be floated over and blocked on a submerged cradle, and
" that the cradle and blocking will carry the ship safely when moving
" along the railway. (2) That the vessel and cradle can be lifted to
" any required height out of the water to rail level. (3) That the
" rails and sleepers will support the heavy rolling load. These points
" will now be dealt with very briefly in the light of past experience.

" A vessel's home is upon the water, but she is built on land, and
" she has to return there whenever the slightest repairs to her hull
" have to be effected. She must be strong enough, therefore, for both
" conditions—ashore or afloat. It is now seventy years since the first
" great improvement was made, by the introduction of what was known
" as the 'Patent Slip' by Mr. Morton of Leith, where the ship was
" floated over a submerged cradle, blocked thereon, and hauled up an
" inclined railway by mechanical power. During the past seventy
" years thousands of vessels, up to three thousand tons in dead weight,
" have been so hauled out of the water, over a short length of railway,
" without the slightest difficulty or structural injury; and as a result
" of past experience, no reasonable doubt need exist as to practicability
" of constructing a cradle capable of carrying a vessel over any length
" of railway with safety, certainty and despatch. It has been equally
" demonstrated by past experience that heavy vessels can be satisfac-
" torily lifted to any required height out of water. The largest dock
" in existence, known as the 'Bermuda Dock,' was built about twenty
" five years ago, of sufficient power and capacity to lift ironclads weigh-
" ing 10,200 tons clear out of the water. Of more recent design are
" the 'Depositing Docks' of Messrs. Clark & Standfield, where the
" vessels are lifted by pumping out submerged pontoons, and are
" deposited on fixed staging, and it is stated that the operation occu-
" pies only about twenty minutes. As an illustration of the great
" strength of ships, it may be mentioned than at the Nicolaieff Dock.

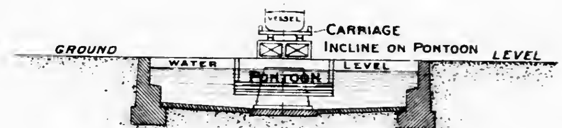
No 2

· Sketch · for · SKIDWAYS · with · PONTOON · TURNTABLE ·
· proposed · as · an · alternative · for ·
· Locks · in · Canals ·

A. L. Hogg, C.E.



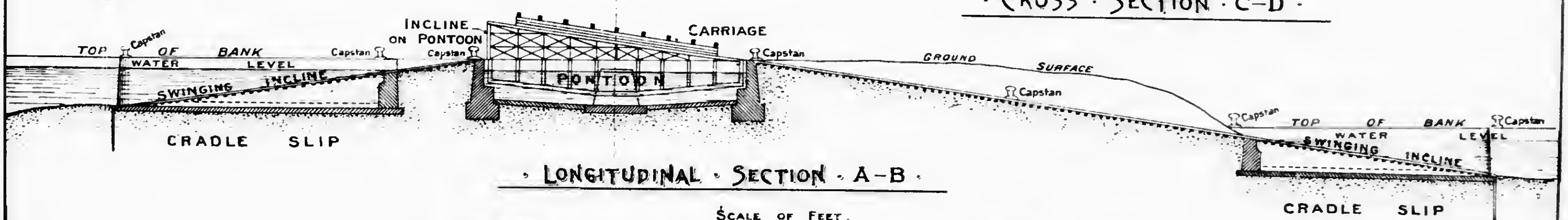
· PLAN ·



· CROSS · SECTION · C–D ·

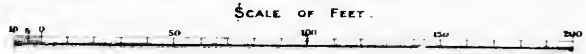
At ordinary water level in upper canal basin pontoon floats with maximum load 1½ inches above seats. Draw off 3 inches water from pontoon basin: this will distribute 10 tons pressure on the supports provided to lock the pontoon in position to receive carriage with load.

For the operation of turning admit sufficient water to float pontoon off supports.

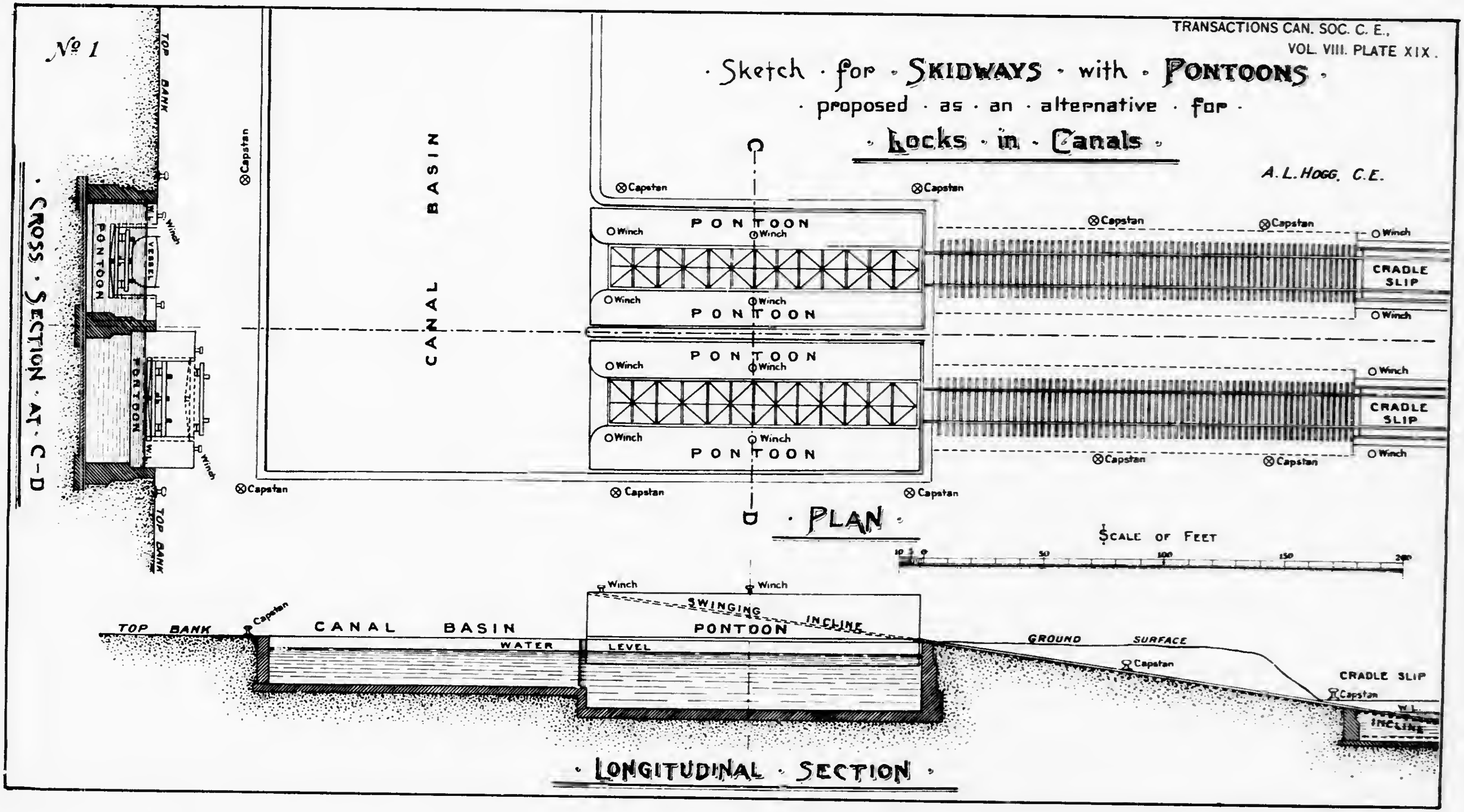


· LONGITUDINAL · SECTION · A–B ·

SCALE OF FEET.



TRANSACTIONS CAN. SOC. C. E.,
VOL. VIII. PLATE XIX.



"the steamship 'Russia,' about 3,000 tons in weight, and 334 feet in "length, was lifted out of the water by pontoons extending only for a "length of 174 feet under her keel, thus leaving both ends of the "vessel unsupported, and that, notwithstanding this great overhang, no "sign of structural weakness was exhibited.

"As regards the ability of the ways and sleepers to carry the load of "a ship and cradle, in the manner proposed, little need be said in this "age of advanced mechanical appliances."

Having thus, by an appeal to past experience in connection with the raising of ships and the haulage of heavy loads, justified the statement that, after all, these skidways are but a new combination of old contrivances, we may proceed to consider briefly the application of those methods in the case now under consideration as an alternative for locks in our canals and waterways.

The object of the proposed innovation is to cheapen the cost of works of this class, and so place enterprises of the kind in the first rank, as paying concerns, and thereby secure the confidence of the investing community to demonstrate that the capital required for its construction could not be better employed. There are many places in Canada, where the natural topography of the country would permit of these skidways being constructed in connection with dams and weirs, connecting the natural water stretches at a comparatively small cost, considering the great advantages derived to the country at large, in the development of these otherwise waste places where minerals abound, as phosphate, iron, stone and lumber and valuable ores of all descriptions that are awaiting transport to the markets of the world, and which at present lie buried and unproductive. The accompanying drawings show two methods of handling vessels on these inclines.

In No. 1 it is proposed to raise the vessel to the incline by means of pontoons, to which is attached a swinging gridiron, consisting of a very stiff combination of longitudinal and cross girders made of steel and firmly riveted together, and which when lifted to the angle of the incline is supported at intervals by iron chock-blocks and stays underneath worked by hydraulic power, so that the gridiron then in effect constitutes a solid part of the main skidway.

Hydraulic power is also to be provided for pumping pontoons, capstans and winches for manœuvring the vessels on the ways; at the ends of the incline, cradle slips are provided to expedite the work of placing the vessel on cradle, over ways, and properly securing it before being hauled up incline. These slips have also attached a swinging gridiron, similar to these in the pontoons described above. The cradles, like the gridirons, are formed of a rigid combination of steel girders carrying keel-blocks and sliding bilge blocks of the usual lifting dock type.

The order of procedure in raising a vessel and transferring it across the skidways would be as follows: for plan No. 1:—The vessel is floated into the pontoon or cradle slip, "as the case may be," over the submerged, swinging incline and cradle, then sufficient water is pumped out of the pontoon to bring it to the level of the incline where it is secured, and the vessel with cradle on gridiron properly blocked, the whole is mechanically swung to the angle of the incline. The ship and cradle would then be in position to be hauled along the ways, on to the incline, in the cradle slip at the foot of incline, and there placed in the water to resume her voyage by a converse operation to that used when being raised to the incline at the other side of the way.

Plan No. 2, in so far as regards the ways and cradle slips at foot of inclines, is similar to that in plan No. 1, as to design and operation, the only difference being the introduction of a floating turntable at the top of inclines, which removes the necessity for expensive pumping machinery required in pumping the pontoons used in plan No. 1.

Sir Benjamin Baker states that various plans have been proposed from time to time for the quick and efficient blocking of the curved surface of a vessel's hull to the flat top of the cradle. Hinged bilge-blocks, hydraulic rams, elastic bags filled with air or water, and many other such contrivances have been suggested, but the present universal practice in docking, or in launching a ship, is to use simple wooden keel and bilge blocks. In docking a vessel, nearly the whole of the weight comes on the keel blocks, and the bilge blocks are few in number, and extend only for about the middle third of the ship's length. In launching a vessel, the weight is transferred from the keel-blocks on to the launching ways on each side of the same, by means of a couple of narrow cradles or bilge logs of hard wood, packed up to the hull of the vessel by soft wood filling. These cradles carry the ships down the too often imperfectly bedded inclined launching ways at a speed of some twelve miles an hour. As the vessel is leaving the launching way, her stern is waterborne, whilst the bow is pressing hard on the shore, but yet it is the rarest thing for any mishap to occur to a vessel even under this singularly rough treatment.

The best way of blocking a vessel on the cradles will be quickly determined after a few weeks' experience, but in the first instance, the well tried one, of timber keel and bilge blocks, cannot be far astray.

The following extracts from Trautwine, relating to the laws governing moving bodies on inclined planes, will assist to an understanding of the subject:

Sliding force	(parallel to surface of plane)	= W, × Sin M N O.
Pressure	(perp. " " ")	= W, × Cos M N O.
Friction	(parallel " " ")	= W, " " co-eff. of fric.

Friction does not vary as the angle of the plane, but as the cosine of that angle, or in the same manner as the perpendicular pressure varies. Suppose we desire to slide a vessel of say 600 tons, in the manner proposed, up an inclined plane, sloping 8° or 14 feet in 100 feet, we have to overcome the parallel sliding force and the friction.

Sliding force = 600 tons (W) × nat sine 8°.
= 83.5 tons.

Friction = 600 tons (W) × nat. cosin 8° x co-eff. of friction.
= 600 × .9903 × .14 prop. of friction to pres.
= 81.79 tons (angle of fric 7° 59').

combined force to overcome = 81.79 + 83.52 = 165.31 tons.

This force but balances the downward tendency of the load together with its friction, and in this condition, it is plain, that to impart motion to the now unresisting load we must apply some additional force; we desire again to slide the load down the plane, what force have we to employ? Here nothing resists but the friction, viz.: 81.79 tons, and the sliding parallel force helps to the extent of 83.5 tons, therefore in this case we would have to apply about 1.73 tons of break power to keep load from sliding down the plane.

It has been stated that the main object of the author in bringing forward these skidways was the vital one of cost, as compared with the lockage system. In the first place, where a series of locks would be necessary, these ways could be put in at half the cost of locks. Secondly, the greatest saving would be effected in the reduced quantities in excavation, and earthwork in the canal as a whole. The skidways can be lengthened with very little additional expense, for the purpose of placing the centre line of the canal proper on the contour of minimum excavation, by this means the quantities can be considerably reduced, which, taken with the saving effected in dispensing with locks, together would make quite a respectable showing.

Where one lock only is required to overcome a summit, these skidways can offer no advantages over the lockage system.

In conclusion, the writer hopes that this important subject will meet with some consideration from the members of the Society, and draw out such discussion as the subject deserves, although an innovation, it may be the means (through discussion) of bringing to light some practicable scheme to accomplish the object in view. In which case this paper will not have been written in vain, nor love's labour lost.