BRIDGES ON THE NORTH COAST RAILWAY.

SOME NOTES ON LOCATION AND ERECTION.

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In locating a line of railway attention is paid to the streams which it must cross to ensure as little expense as possible in dealing with the water.

As regards small watercourses, it is generally sufficient to keep the centre line from following their beds, as the ideal crossing at right angles to the stream, would probably entail heavier expense in earthworks elsewhere, than the alterations to the watercourse which a skew crossing involves.

Choice must be made of the kind of opening which will not only secure the works from damage by floods, but effect that object economically.

It is the usual practice in most countries to adopt standard designs for the less important watercourses, from which a selection would be made for the waterway in question.

When, however, large streams are in question, many factors enter into the problem.

These have then to be reduced, having due regard to efficiency, to the lowest common denominator of expense.

In the first instance, an endeavour would be made to obtain a crossing of a river in a position which would be in the most direct line of the natural, or shortest, route of the railway.

Bearing this in mind, examination would be made of the banks and bed of the river, to find the narrowest place, and best foundation; if all these factors are found in the same locality, the ideal site has been discovered.

More often but one is present, and then it becomes a matter for serious consideration as to which site must be adopted.

Recollecting that extra width of stream means more expense, either in the number of, or larger spans; also that bad foundations run into great cost, the adoption of a more circuitous route is considered: and the extra amount of earthworth, etc., balanced against the better conditions of a site not in the most direct route.

In making choice of a site for an important bridge, many points have to be taken into account, in addition to those mentioned above. It is necessary, for instance:—

(a) To determine whether a crossing at right angles or skew to the course of the river must be adopted.

(b) To obtain if possible a straight run for the flood water, to obviate chance of scour to either abutment of the bridge.

(c) To ascertain the amount of floating timber and height of flood water.

(d) To get borings at the sites of piers to ascertain nature of foundations.

These investigations precede and largely determine the design of the bridge.

The height of floods and quantity of floating timber will decide the level to which the bottom booms must be kept, and this, in conjunction with the results of the borings, will decide whether short or long spans will be most economical.

Having selected the site and designed the bridge, the erection has next to be considered. The general procedure is as follows:—

First. Base lines showing the centre of the bridge and piers are very carefully marked on the ground by pegs, which will not be disturbed during erection.

This is the most important and generally the most difficult part of the setting out.

The banks are usually rough and steep, and as the results of the erection of the superstructure depend entirely upon the accuracy of this work, too much care cannot be taken.

Bench marks are also established in secure positions for handy reference when levels are required.

For timber openings it is advisable to set out by means of small pegs (in addition to the base lines) the precise position of each pile, and as these are nearly all battered, the position at ground level will vary for the differing heights of bridges.

The piles having been driven by means of a 25cwt. monkey—as nearly in position as possible—fresh centres and levels are given, and the superstructure started.

Piles often are not driven in exactly the positions required, but better results are obtained by leaving the piles as driven, and varying the superstructure, than by straining and pulling the piles into the correct places.

For larger bridges the next step is to mark exactly upon the ground—by means of pegs which will not be cut out—the spots where the excavations for the abutments and piers are to be made.

The foregoing relates to the procedure which obtains generally in connection with bridges, and the case of the Hunter River Bridge, which consists of three 157ft. 6in. and six 32ft. steel spans may now be more definitely described.

The system adopted for the erection was that of the travelling cableway, euphoniously termed the flying fox: the method is not new for conveying loads, but has not, it is understood, been used much for putting up bridges.

The length of the Hunter Bridge, approaches included, is about 223 yards, and as the approaches are on flat ground, it was necessary either to build towers of a considerable height to eliminate sag, or else support the rope in the centre.

The latter course was adopted, and three derrick poles were used, one at each end, resting in roughly made sockets, and that at the centre supported on a stage formed on the top of four piles driven in the bed of the river.

Each derrick head was moveable transversely by means of a wire rope worked by a winch, which gave the cableway a range on each side of the centre line of about 10 feet.

With this contrivance all the material excavated, piles in foundations, pile engine, concrete, erection of staging, and steel work were handled.

Two foxes were necessary, one on each side of the centre derrick, and material sent from one side of the river to the other, had to be fleeted past this centre pole, always a troublesome, and often a risky operation.

Borings on the south bank showed that only soft material would be got for a great depth, so on this side piles were driven to a level which could not be interfered with by any probable scour from the river, and concrete piers built over them. The piles used were from 30 to 45 feet long.

The piles were spaced about 2ft. 6in., centres in staggered rows. In the large excavations the pile engine was lowered to the bottom of the hole, and for the narrower trenches, a dolly enabled the piles to be punched down, when below ground level.

A monkey weighing 3 tons was used, and the penetration of the piles with a drop of 3 feet, did not average more than ½in. for the last four or five blows.

In the bed of the river it was necessary to sink cylinders on which to found the pier.

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The contractors were allowed to substitute concrete for oregon in the cylinders, which were made 2 feet thick, and prepared to take an air lock; numerous screwed ends being built into the concrete for that purpose.

This concrete, composed of 4 bags of cement to 24 c.f. of an aggregate of gravel and sand, was not airtight, and had to be plastered, and then stopped with clay.

To sink the cylinders in their correct position the following steps were taken:—

First the centre line of the pier was set out by means of stakes (the river being low), and 8 piles—four to enclose each cylinder—driven to rock in the bed of the river.

Two sets of walings were bolted on these piles, making a frame round each cylinder.

Fresh centres were carefully marked on these frames, and the shoes of the cylinders set in the correct position.

The moulds for the concrete portion of the cylinders were placed on top of the shoes, and the concrete mixed and put in place.

About 6 inches clearance was left between these walings and the sides of the cylinders, and any eccentric movement was adjusted by means of hardwood wedges, and excavation inside the cylinders.

Very little trouble was experienced in sinking the cylinders, and they finished up not more than an inch or two out of the correct position. The air lock was fitted with telephone and electric light.

The foundations for the pier on the north bank had to be carried down through boulders to a level of 10 feet below the bed of the river; this was done in open shafts without air pressure.

At various depths, apparently solid rock was uncovered, which extended right through both shafts, but holes jumped proved it to be only shelves or boulders; even at the foundation adopted, solid rock has not been obtained, but the depth renders it safe from scour.

The staging adopted for the support of the superstructure consisted of trestles under each joint, made of saplings 6in. to 9in. diameter, and framed as double triangles with headstocks on top, and sills at the ground level.

Planks 9in. x 3in. were laid from trestle to trestle, and over each trestle wedges for use as camber blocks were placed.

The steel work was made by the Clyde Engineering Co., and sent by rail to Darling Harbour, and thence by boat to Morpeth, arriving at its destination finally by team.

Foundation Plates. The holding-down bolts were built in as the piers were being finished, and by means of a wire supplied by the manufacturers, the distance apart of the cast-steel foundation plates was determined, and they were set in an accurate position to receive the ends of the trusses.

In erection, the first members lifted, were the bottom chords, which were lined out in their proper positions on the camber blocks. Then the cross girders and posts were put in place, and fastened as each piece came together, with service bolts of good fit, and plugs.

Next the top booms and batter braces, and then the lateral, portal, and other braces.

When erecting any truss supported by temporary staging, it is a matter of great importance to get the permanent work together and fastened by means of service bolts and plugs as quickly as possible, so that if floods carry away the staging, the structure will support itself until rivetting can be done.

During the progress of these works, only on one occasion was trouble threatened by flood, and the danger passed without materialising.

After all the members were bolted up, and the joints (in the top boom more especially) made close-fitting by means of drawholes, the camber was adjusted, and rivetting commenced upon the bottom chords.

The field rivetting was done by hand, no machinery being employed by the contractors for erection, Messrs. Carson, Carey and Simpson.

After rivetting was completed, the ends of the girders were jacked up, and the expansion rollers set upright at a temperature of about 70 degrees, so that the movement may not be all in one direction.

The flying fox proved equal to the task of fixing the different members of the trusses, in whatever position they came, quickly and accurately; but great care was exercised by the winchman in holding the weight.

One or two of the posts proved rather tight fitting, but the work came together well, and reflects great credit on the manufacturers.

After completion of all rivetting, etc., the camber was again tested, and levels taken at the different points shown on the camber diagram.

The camber blocks were then struck, and after a day or two, fresh levels were taken over the same points.

Comparison of the two sets of levels showed that the spans dropped from ¼in. at the first post, to ½in. at the centres of the spans.

The erection of the Paterson Bridge was very similar to that of the Hunter.

The foundations of the north pier of the 200ft. span had to be carried down 50ft. below water level by means of an air lock, with, of course, increased pressure to that used at the Hunter Bridge.

The steel work was delivered at the site of the bridge by drogher, transhipped from the deep sea boats at Morpeth.

The same results were observed from swinging this bridge as at the Hunter, viz., an initial deflection or set of from ¼ to ½in. at the same points.

Many of the smaller spans at the Paterson were hoisted by derrick, as the wire rope did not extend over the whole site of the bridge.

At the Wallarobba and Tabbit Creek bridges—each spanned by 66ft. plate girders carried on concrete piers, with timber approaches—the flying fox was used, but although very handy, it was probably more expensive than the old-fashioned methods.