January 26, 1869.

CHARLES HUTTON GREGORY, President,
in the Chair.

No. 1,181.—“Description of the New Ferry and the New Brighton Piers and Landing Stages on the River Mersey, near Liverpool.”
By HENRY HOOPER, Assoc. Inst. C.E.

IN the session of 1860-61 the Author submitted a Paper, on the construction of a wrought and cast-iron pier at Southport, on the coast of Lancashire, from the designs of Mr. Brunlees, M. Inst. C.E.¹ The success of that work, in an engineering and commercial point of view, has led to the erection of many similar structures at various points on the coast of Great Britain; and believing that others will hereafter be formed on the same model, it is now proposed to describe two modifications of the principle, as carried out at the New Ferry Pier and Stage, and at the New Brighton Pier, both on the River Mersey, near Liverpool.

The ferry accommodation of the River Mersey comprises, on the west or Cheshire shore, commencing at the mouth of the estuary, first the New Brighton Pier and Landing Stage, forming a portion of the subject of this Paper. Proceeding up the stream, and still on the same shore, there are the Egremont and the Seacombe Landings, each consisting of an inclined way of stone, along which rails are laid, to allow of the passage up and down, according to the state of the tide, of a wrought-iron platform on wheels; the power for raising the platform being supplied by a stationary engine on the shore. These landings will probably soon be replaced by piers and floating stages. The New Brighton, the Egremont, and the Seacombe Landings are under the control of the Wallasey Local Board of Health. The next in position, provided by the Birkenhead Commissioners, is at Woodside. This consists of a wrought-iron floating stage, 800 feet in length, connected with the shore by wrought-iron bridges. Ascending the river, still in a southerly direction, this is succeeded by the inclined way, also of stone, which is used by the Chester and Birkenhead Railway Company as a landing-place for the passengers and luggage crossing by the railway boats from Liverpool. Following this is the inclined way of stone at Rock Ferry, the New Ferry Pier and floating stage, to

¹ *Vide* Minutes of Proceedings Inst. C.E., vol. xx., p. 292 *et seq.*

be described in this Paper, and lastly, the wooden pier at Eastham, distant from New Brighton about 6 miles.

Crossing to the eastern or Lancashire shore, and descending the river towards the north, at a point nearly opposite Rock Ferry, is the South End floating stage, 120 feet long and 30 feet broad, with connecting bridge, all of wrought iron: and lastly, the well-known George's and Prince's stages, the former of which is 500 feet in length by 80 feet in breadth, carried on thirty-five pontoons, and connected with the shore by two bridges, each 150 feet in length; while the latter is 1,000 feet in length by 82 feet in breadth, and is connected with the shore by four bridges, each 113 feet in length.

It has been proposed to construct a pier and stage at Waterloo, at the mouth of the river, opposite to New Brighton. This is still a desideratum as regards the passenger traffic, and by indicating the channel, it would prove useful to vessels entering and leaving the port.

It having become evident that there was a want of communication by water, between the central and the southern portions of Liverpool, and New Ferry on the opposite shore, the Mersey River Steamboat Company was originated to run a line of steamers from the Prince's stage to the south end of the borough, and thence across the estuary to New Ferry, and *vice versa*. Express boats run during the day direct between Liverpool and New Ferry, and others between the south end and New Ferry. This necessitated the erection of a Pier, with landing-stage and connecting bridge at New Ferry, which was constructed from the designs of Mr. Brunlees, by Messrs. W. and J. Galloway and Sons, contractors, under the superintendence of the Author, for Mr. R. A. Macfie, of Liverpool, who leases it to the Mersey River Steamboat Company.

The original slipway was one of the oldest on the river, consisting merely of a bank of clay, raised about 2 feet above the shore, and covered with loose stones. The approach to the new pier, at the shore end, is formed by a curved retaining wall, on which the ends of the first set of girders rest. A wrought-iron railing on the coping of the wall, provided with three carriage gates, each 10 feet wide, and two wicket gates, each 5 feet wide, encloses a space pitched with stone sets, upon which the two pay-boxes and office are placed.

The pier proper consists of fourteen spans, each 58 feet in the clear. It is formed of three lines of wrought-iron girders, placed 9 feet apart from centre to centre, and resting on cast-iron columns. The pier is thus divided into two distinct ways, one of which is used for the up and the other for the down traffic, the girders themselves forming the parapets. The openings are arranged in three groups; the first, from the re-

taining wall towards the river, comprising five bays, then two rows of columns, three in each row, and 4 feet apart from centre to centre measured along the platform; next, four bays, and again two rows of columns; and lastly, five bays, terminated by a platform, 18 feet by 16 feet, supported on a cluster of eighteen columns, securely braced horizontally and vertically, by means of angle irons 3 inches by 3 inches and $\frac{1}{2}$ inch thick. The girders are each 60 feet in length, and 4 feet 9 inches in depth. The top member of the girder is composed of two half round bulb irons, forming, when riveted together through the flanges, a tube of 8 inches external diameter. The remainder of the girder is of the ordinary lattice form. The two footways, each 8 feet 4 inches wide, formed of Memel planking 4 inches thick, are carried on the bottom flanges of the girders, the planks being secured at the ends by bolts $1\frac{1}{2}$ inch in diameter. The two outside girders are each calculated to bear a load of 120 lbs. per superficial foot of platform, and the centre girder is nearly twice the strength of the others. The supporting columns are 12 inches external diameter, the metal being $\frac{3}{4}$ inch thick. They are generally cast in lengths of 10 feet, and are connected by flange joints, excepting the junction of the columns with the piles, which is of the socket form. The piles were cast in variable lengths, to suit the contour of the ground, and are furnished with one turn of a screw at the bottom, 2 feet 6 inches in diameter, the metal being $1\frac{1}{4}$ inch thick at the root. The bottom of each pile is of a plain spigot form. The piles were screwed down to depths of from 6 feet to 10 feet, by means of a capstan head of cast iron, with eight bars 9 feet in length, worked by about thirty men, until an exceedingly hard bed of clay was reached, on entering which about 2 feet, it was found impossible to screw the piles further by hand power. The tops of the piles of each pier were then cut off to a level of about 2 feet above the surface of the shore, and a double false socket was fixed on, by means of a rust joint. Variable lengths of the columns were then cast, in order that the remainder might be used in lengths of 10 feet, and thus insure uniformity in the work. Each pier consists of a line of three cast-iron columns and piles transversely to the footway, and on the top of each column there is a cast-iron bearing plate, 2 feet long, to which the ends of the girders are secured by two bolts, each 1 inch in diameter, the holes in the girders being of an oval form to allow of expansion and contraction. A space of $\frac{1}{2}$ inch is left between the ends of the girders, which is concealed by a light, ornamental iron casting, so arranged as not to interfere with the motion of the girders. In the case of the centre girders, a cast iron lamp standard is added on the top of these coverings. The outside girders are stiffened at the ends over the piers by gusset pieces, bearing on cast-iron brackets, bolted to the heads of the columns on

the outside. Similar brackets are used under the ends of the girders where they bear on the heads of the columns. The gussets are formed of two angle irons, each 2 inches by 2 inches and $\frac{3}{8}$ inch thick, filled in with a $\frac{1}{4}$ inch plate, of a triangular form, the base being 1 foot 9 inches, and the height 4 feet. Throughout the length of the pier, and at intervals of 7 feet 6 inches, the girders are kept apart by transom bars of T iron, 4 inches by 3 inches and $\frac{1}{2}$ inch thick, bolted to the underside of the bottom plates of the girders, by four bolts $\frac{3}{4}$ inch in diameter to each girder.

The outer edge of the platform, at the head of the pier, forms a bearing for the moveable joint at the upper end of the Bridge, connecting the pier with the floating stage (Fig. 2, p. 221). This joint admits of a horizontal and vertical motion of the bridge, and consists of a strong wrought-iron girder, having a radial motion round a steel pin, 4 inches in diameter, fixed to a girder forming a portion of the framework on the top of the columns. The vertical motion is obtained by means of a hinge under each girder of the bridge, composed of a wrought-iron forging, bolted to a rotating girder, and a steel pin, 2 inches in diameter passed through it and the two forged straps riveted round the end of the bridge. The underside of the rotating girder immediately under these hinges is supplied with two sheaves, or rollers, bearing on segments fixed to the heads of the columns.

The bridge is 158 feet in length, and is formed of two bowstring girders, on the lattice principle, 10 feet in depth at the centre. The vertical web consists, for a length of 16 feet from each end, of plates $\frac{1}{4}$ inch thick, the rest of the girder being of the ordinary lattice form. The girders are 9 feet 8 inches apart from centre to centre, leaving a roadway of 8 feet 4 inches in the clear. They are kept apart at the bottom by transoms of T iron, 4 inches by 3 inches and $\frac{1}{2}$ inch thick, at intervals of 16 feet throughout the bridge, each intermediate space being filled in diagonally with two angle irons, 3 inches by 3 inches and $\frac{1}{2}$ inch thick.

The upper members of the girders are kept in place by an arch of wrought iron, 16 inches in depth, the top and bottom being each formed of two angle irons, 4 inches by 3 inches and $\frac{1}{2}$ inch thick, with a vertical plate between them $\frac{1}{2}$ inch thick. The headway from the level of the platform to the underside of this arch at the centre is 13 feet.

The platform of the bridge is composed of planking, 4 inches thick, laid transversely, and secured to the upper side of the bottom plates of the girders by an angle iron, 4 inches by 4 inches and $\frac{1}{2}$ inch thick, running longitudinally and crossing the ends of the planks. This angle iron is bolted at intervals to the flange of the girder, and forms a kerb on each side of the bridge. The surface of the planking is covered with teak, $1\frac{1}{2}$ inch in thickness, grooved

Fig. 3.

Fig. 2.

Fig. 1.

10 5 0 10 20 feet

Attachment of Moveable Girder to Pier and to Pontoon.

at intervals of about 6 inches throughout, and spiked to the planking. Two longitudinal grooves, with copper scupper holes, allow of the escape of water down the bridge. Hinged flaps of teak are fixed at the top and bottom of the bridge. The lower end of the bridge is suspended by chains 2 inches in diameter from a cradle, formed of wrought-iron plates and angle irons, fixed on the floating stage (Fig. 3). This was considered necessary, to reduce the strain on the pier and bridge, caused by the rolling of the stage, and is found to answer very well. The upper surface of the platform of the pier is 12 feet above high water of ordinary spring tides, or 7 feet above an extraordinary tide of 21 feet above the Old Dock Cill, the datum from which the tides are reckoned in the Mersey.

The Floating Stage is 100 feet in length by 22 feet in breadth, tapering for a length of 19 feet to 19 feet at each end. A spur, 22 feet by 11 feet, projects at the back under the bridge. The depth of the iron pontoon is 7 feet 3 inches, and from the top of the platform to the bottom of the pontoon it is 8 feet 6 inches. The sides have a 'batter' inwards of 1 foot. The pontoon is built of ribs of T iron, 4 inches by 2 inches and $\frac{3}{8}$ inch thick, 1 foot 9 inches apart from centre to centre, fixed transversely to the stage. It is divided into five compartments by four watertight bulkheads, each formed of a frame of two angle irons, 3 inches by 3 inches and $\frac{1}{2}$ inch thick, filled in with plates $\frac{1}{4}$ inch thick, stiffened vertically at intervals of 3 feet by T irons, 4 inches by $2\frac{1}{2}$ inches and $\frac{1}{2}$ inch thick. To increase the stiffness, there is a longitudinal bulkhead of the same construction through the centre of the pontoon, and there are also smaller bulkheads under the cradle supporting the bridge. The skin forming the sides and bottom of the pontoon is of plates $\frac{1}{4}$ inch thick. The deck of the stage is formed of planking 2 inches thick, laid transversely, and spiked to longitudinal timbers, 9 inches by 9 inches, and 3 feet apart from centre to centre, bolted to the ribs of the pontoon; the joints of the planking being caulked to render them water-tight. A nosing of timber, 11 inches by 6 inches, is run round the front and edge of the stage, and below this, along the front, there is hung a timber fender 2 feet by 6 inches. The front of the pontoon is supplied with nine cast-iron mooring studs, each secured to the ironwork of the pontoon by four bolts. Two similar studs are fixed at the back of the stage. A fence runs entirely round the stage, consisting of two lines of chain, $\frac{3}{8}$ inch in diameter, supported by forged wrought-iron stanchions. At the back of the stage there are two landing-places or gangways, one on each side of the bridge, for small boats, approached by means of wooden steps. On the stage two waiting sheds are provided, each 20 feet by 6 feet 6 inches, with all necessary conveniences.

The stage is moored by four chains, $1\frac{1}{4}$ inch in diameter, two at

each end of the pontoon. Each chain is 50 fathoms in length, and at right angles to the adjoining one, the end of each being secured to an anchor with one fluke. Provision is made for taking in the slack of the chains by two sets of gearing fixed on the stage, one at each end, consisting of a worm and worm wheel; one set of gearing taking in the slack of two contiguous chains. The gearing is worked by levers, provided with stoppers, the whole being boxed in with wood to prevent accidents.

A dioptric light, by Messrs. Chance Brothers, of Birmingham, is fixed on the top of the arch forming part of the cradle used for suspending the bridge, access to which is obtained by means of a light wrought-iron gallery and ladder.

Gas and water are supplied from the mains on the shore, by means of pipes laid on the bottom flanges of the outside girders, one on each side of the pier, the water being used for the shipping, and the gas for lighting the pier and stage.

The pontoon draws about 2 feet of water, and at low water of spring tides, there is never less than from 7 feet to 8 feet of water at the front of the stage.

The dimensions of the various parts of the structure are then given in detail; and with regard to the expenditure on the works, it is stated that, the approaches had cost £1,063, the pier (including the bridge) £7,740, and the stage £2,674, making a total of £11,477.

The design for the New Brighton Pier and Landing Stage was of a similar character to that of the New Ferry Pier, and was likewise furnished by Mr. Brunlees, the original contractors being Messrs. Rothwell and Co. The works in the first instance were under the superintendence of the Engineer to the Wallasey Local Board of Health; but an accident having occurred, in the attempt to place the bridge in position, which rendered the construction of a new bridge necessary, the Author was placed in charge. As the Wallasey Board was not satisfied with the state of the works, their completion was finally intrusted to Messrs. Bowdler and Chaffer.

The Pier consists of three lines of wrought-iron girders, each girder being 60 feet in length. There are twelve bays, or spans, divided into three groups of four spans each, by two intermediate rows of three columns, placed $\frac{1}{4}$ feet apart from centre to centre, measured along the pier. The enlarged platform at the river end of the pier, on the outside face of which the upper end of the bridge rests, is 33 feet 6 inches by 16 feet. It is supported by short wrought-iron girders resting upon a cluster of twenty vertical and thirteen raking cast-iron columns, 12 inches external diameter, the metal being $\frac{3}{4}$ inch thick, with screws 2 feet 6 inches in diameter. The cluster of columns

is strengthened by horizontal bracing of angle iron, 3 inches by 3 inches and $\frac{1}{2}$ inch thick, and by vertical bracing of bars, 3 inches by $\frac{1}{2}$ inch, keyed at one end, and the three adjoining piers towards the land are braced vertically by two tiers of the same iron. The fourth double pier from the cluster is braced in the same manner, but in the upper length of 10 feet of the columns only. The other piers are kept apart by transoms of cast iron, 9 inches in depth, fixed in sockets cast on the heads of the columns, and transversely to the line of the pier. The foundations of the cluster of columns and of the two adjoining piers are formed by screw piles, with blades 2 feet in diameter, and having a pitch of 7 inches; they passed through variable depths of from 5 feet to 8 feet of sand and gravel to the surface of the rock underneath. In the case of the remaining piers, discs were cast at the foot of the columns, 2 feet 6 inches in diameter, which are bedded in the rock close to the surface. The width of the pier from centre to centre of the outside girders is 21 feet 4 inches, the centre girder dividing the platform into two footways, each 10 feet in the clear, the girders themselves forming the parapets. The planking of the pier is 3 inches in thickness, supported in the middle under each footway by a longitudinal T iron, 4 inches by $3\frac{1}{2}$ inches and $\frac{1}{2}$ inch thick, bearing on transoms of T iron, connecting the bottoms of the girders at intervals of 7 feet 6 inches throughout the length of the pier. The lamp standards and castings over the ends of the girders are similar to those used at New Ferry.

The Bridge connecting the pier and stage is 160 feet in length. The two girders are 11 feet apart from centre to centre, leaving a clear footway of 10 feet 3 inches. The planking is 4 inches in thickness, and is laid transversely, and this is covered with teak, grooved, $1\frac{1}{2}$ inch in thickness. The upper end of the bridge has a similar motion to, and the lower end is hung from a cradle on the same principle as, that at New Ferry.

The Floating Stage is 200 feet in length by 30 feet in breadth, and consists of a series of twelve pontoons, connected by three lines of lattice girders, each 2 feet 3 inches in depth, and two lines of box keelsons, each 3 feet in depth and 2 feet 9 inches in width, formed of two angle irons at the top, each 6 inches by 6 inches and $\frac{5}{8}$ inch thick, the vertical plates being $\frac{5}{16}$ inch thick. The horizontal plates are two in number throughout, both at the top and bottom, the two lengths of 43 feet 6 inches from each end being $\frac{3}{8}$ inch thick; the next two lengths of 32 feet 6 inches being $\frac{5}{8}$ inch thick, and the centre length of 31 feet being $\frac{3}{4}$ inch thick. Wrought-iron bars, formed of angle iron, 6 inches by 6 inches and $\frac{3}{4}$ inch thick, are riveted to the top edge of the pontoons, and the bottom flanges of the longitudinal keelsons are bolted to them. The end pontoons are pointed so as to act as cutwaters, and are

each 29 feet by 18 feet; the ten intermediate pontoons are 29 feet by 11 feet 6 inches, and the depth of all the pontoons is 6 feet 3 inches. The pontoons are formed of a framework of ribs of T iron, $3\frac{1}{2}$ inches by 2 inches and $\frac{3}{8}$ inch thick, and 1 foot 7 inches apart from centre to centre, with a bulkhead at the centre; the top plates are $\frac{3}{16}$ inch thick, and the sides and bottom $\frac{1}{4}$ inch thick. Each pontoon is provided with an oval manhole, with water-tight cover. On the top of the longitudinal girders, timber joists are laid transversely, 2 feet apart from centre to centre, the scantling being 9 inches by 6 inches at each end, and 12 inches by 6 inches in the centre, thus giving a camber of 3 inches from the centre of the deck to the edges. The deck is formed of planking, $2\frac{1}{2}$ inches thick, running lengthways of the stage, the joints being caulked and run with pitch. Round the edge of the stage, on the top of and flush with the sides of the pontoons, are two timbers, 12 inches by 12 inches; and planking 6 inches in thickness, sheathed with wrought-iron plates $\frac{3}{16}$ inch thick, is fixed vertically to these timbers, by spikes 10 inches long. In front of the stage there is a hanging fender, 2 feet by 9 inches, suspended by chains from the mooring studs. A fence formed of two lines of $\frac{3}{8}$ inch chain runs round the stage, the stanchions being of forged iron, 6 feet 6 inches apart, and the whole galvanized. There are two waiting sheds of timber on the stage, each 40 feet by 10 feet, provided with all necessary conveniences. The stage is moored at the ends by two chains, 50 fathoms in length and $1\frac{3}{4}$ inch in diameter, at right angles to each other, and in the river they are attached to cast-iron mushrooms, 5 feet in diameter. At the back of the stage are four breast chains, $1\frac{1}{2}$ inch in diameter, fixed to mushrooms on the shore.

The dimensions of the several parts of the structure are then given in detail; and in conclusion it is stated that the total cost of the pier, bridge, stage and subsidiary works, has amounted to £23,906.

The communication is accompanied by a series of diagrams, from which the woodcuts, Figs. 1, 2, and 3, have been engraved.

[Mr. BRUNLEES

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[1868-69. N.S.]