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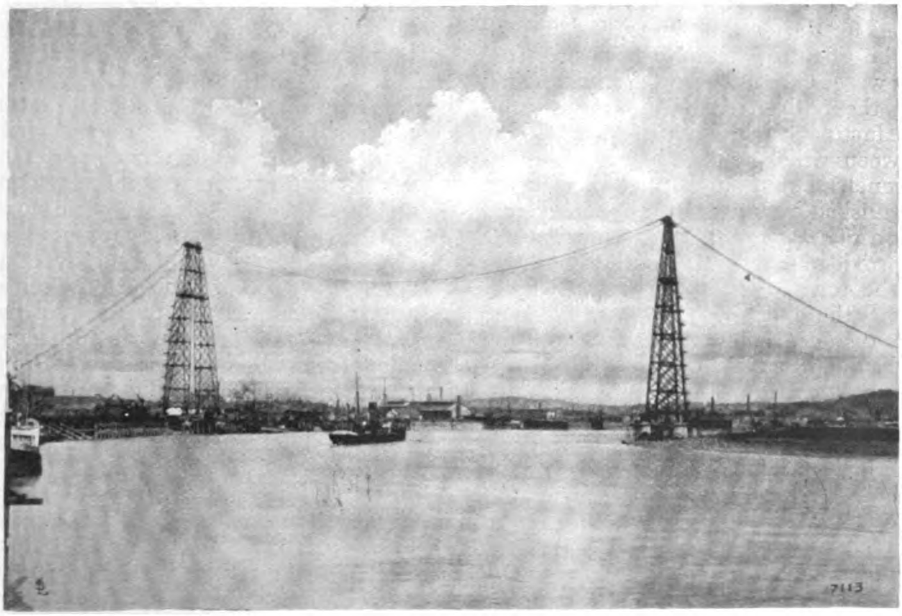
104, HIGH HOLBORN, W.C.

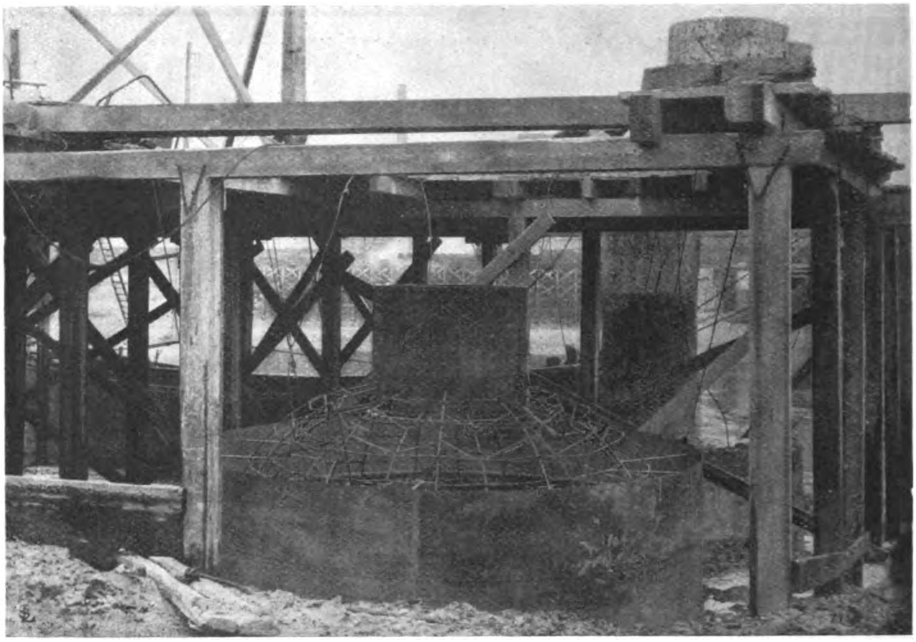
Newport Transporter Bridge.

ALTHOUGH the Widnes and Runcorn bridge across the Mersey and Manchester Ship Canal has the distinction of being the first of the "transporter" type in this country (and outside the Continent), to be opened for public use, the idea of the transporter bridge, which is under construction at Newport, Monmouthshire, was mooted several years earlier than the one connecting the Palatine counties of Lancashire and Cheshire. The problem of crossing the river Usk had long engaged the attention of the Newport authorities before a transporter bridge was accepted as the solution. The borough really consists of two distinct towns, the old occupying the western, and the new the eastern bank of the river, and the latter has for many years been steadily extending in a southerly direction. At present, the only means of access between the old and new towns is a stone bridge of five arches, built in the year 1800, which was widened in 1866, and again widened and otherwise remodelled in 1882-3. These works still left the old bridge in a far from satisfactory condition, in fact, it would be impossible to make a good job of the structure, which dates from a time when Newport comprised a handful of houses, clustered around a castle. With the enormous growth of the town the question of additional cross river communication had to be faced. The inhabitants in the south of the old and new portions respectively, although separated by a channel only 200 yds. in width, have to travel 3½ miles to reach each other.

The Usk is no ordinary river. The



THE NEWPORT TRANSPORTER BRIDGE



NEWPORT TRANSPORTER BRIDGE. FOUNDATION SHOWING METHOD OF FORMING WORKING CHAMBER.

velocity of the current is great; it is noted for the extraordinary rise and fall of the tide, 40 ft. at high springs; the low water channel is extremely shallow; and the nature of the banks very unsatisfactory. Although the exact points between which a new bridge or cross-channel communication should be established was a matter for debate, it was a *sine quâ non* that it would have to be provided to meet the southerly growth of the town, that is, nearly two miles below the existing bridge, and some little distance below the most important docks and quays.

Therefore, from shipping having to be reckoned with, the choice of the authorities was restricted to a ferry, subway, high level bridge, or "movable" bridge scheme. A ferry was deemed impracticable owing to the above-named characteristics of the river, while the estimates furnished for the erection of a high level bridge, and "movable" bridges of varying types revealed that the cost of each would be enormous—as much as £1,250,000 for a high level fixed bridge, and £700,000 for a swing bridge, to give but two examples.

In 1896, Mr. Robert H. Haynes, the Borough Engineer, proposed a transporter bridge, as a result of a visit he had paid to the first transporter ever constructed at Bilbao, which had been opened in 1893. The complete novelty of the proposal earned for it hostile criticism. However, Mr. Haynes persevered. In 1898, owing to the remarkable development on the eastern bank, it became a question of urgency to adopt some definite scheme. Projects of all kinds were again prepared and considered, including a transporter. Eventually, the choice rested between a subway and a transporter. In 1899, Mr. Haynes escorted a party of the Corporation officials and Harbour Commissioners to Rouen, to inspect M. Arnodin's transporter across the Seine. The committee were so impressed by that experience, that they at once and unanimously declared

themselves in favour of Mr. Haynes's project. Mr. Haynes and M. Arnodin were appointed engineers, and the bill for the construction of the bridge received parliamentary sanction in the session of 1900. Tenders for the work were obtained in the summer of 1902, and the works were begun in the early autumn. The chief dimensions are as follows.—

Span, centre to centre of towers, 645 ft.
Span between faces of piers, 592 ft.
Clear height to underside of stiffening girder from high water mark, ordinary spring tides, 177 ft.
Height of tower from pier cap or level of approach road to saddle, 241 ft. 6 in.
Distance between centres of anchorages, 1,545 ft.
Centre of tower to centre of anchorages, 450 ft.

The accompanying photographs give an excellent idea of the construction of the bridge, which it is hoped will be completed five months hence.

The foundation piers, eight in number, are placed in groups of four on each bank. On the west shore their foundations are carried down 78 ft. below the river bank, and on the east shore to a depth of 86 ft., owing to the upper surface of the marl, reached at a depth of 68 ft. below high water mark, proving somewhat softer than the borings revealed. The central spacing between piers is 78 ft. 9 ins. on the riverward faces, and 36 ft. on the faces at right angles thereto. Although some of the tenderers suggested steel cylinders in preference, each pier consists of a monolith mounted on a steel shoe 20 ft. in diameter. The monoliths were sunk by compressed air working. The towers are of open steel construction, and their general outline looking in the direction of the stream is an even taper from base to summit, while viewed from across the stream the legs are spindle shaped. The upper part of the tower above the platform is rigidly connected together by three tiers of lattice girders and heavy bracing, the ordinary bracing in each leg being carried up in addition, so as to make the whole head of the tower thoroughly

EAST ANCHORAGE, NEWPORT TRANSPORTER BRIDGE.

firm; the extreme top is heavily reinforced by joist sections, in order to take and distribute the weight transmitted to the saddles and their expansion carriages; and below the platform level the legs, though well stiffened by gussets and brackets, are not connected in any way, the space between being required for the passage of the car and parts of its suspension ropes. On the top of each masonry pier a heavy cast-iron saddle is fixed, carrying a rocker, on which rests an inverted saddle connected to the tower leg itself. This arrangement ensures perfect elasticity, together with direct vertical reaction through the monolith. Each leg is secured to its spindle by steel shackles, and each spindle to the masonry pier by steel bolts and clips. Each tower is fitted with an easy stairway from the ground to the platform level, and it is proposed to net in the stairways, and allow the public to ascend to the platforms for a small fee.

The estimated weight of a tower is 277 tons, and in their erection a very simple electrical crane has been employed. Equipped with one motor, rotating in but one direction, the various motions of lifting the load, canting and rotating the jib, and traversing the crane, can be obtained simultaneously. Further, the crane has this unique feature—it can be rotated through a whole circle. The capacity is three tons at 25 ft. radius. In addition to the 277 tons of steel work in a tower, there are about 100 to 150 tons of timber used in staging and scaffolding. The actual expenditure of current used in Board of Trade units for lifting the whole of this material is 598.

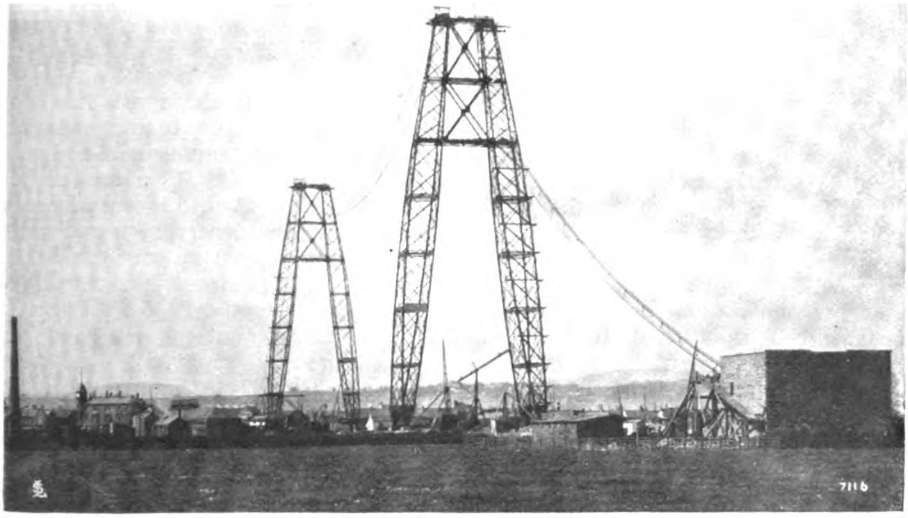
The anchorages are of rubble masonry on a pile and lime concrete foundation, and galleries are provided for the passage of the cables, which thus can be inspected throughout their length. The reaction is taken through granite bed blocks, having armoured cement concrete blocks on their inner faces.

There are sixteen suspension cables, each cable being composed of 127 wires of 20 millimetres in area; and sixteen anchor cables, each composed of 127 wires 21·7 millimetres in area. These cables are secured at their ends to cast steel sockets, which are in turn connected to the main saddle pins of the expansion carriages by shackles of high resistance steel, and a similar arrangement holds good at each anchorage. Consequently, it is possible to renew cables in detail without suspending the working of the bridge.

A portion of the span is carried by diagonal cables, and the horizontal force developed by these is taken by the parabolic cables attached to the ends of the rail-carrying girder. Each of these latter cables is built up of ninety-one wires of 18·54 millimetres sectional area. The stiffening girders run the whole length of the platform, and are placed 26 ft. 3 in. apart axis from axis, their depth being 16 ft. The bottom boom is the rail carrying girder on which the traveller runs. Both top and bottom boom are provided with a series of cleats and steel shackles, threaded by steel pins, which are suspended from the parabolic cables by iron rods, pins, and stirrups, and connected to the diagonal cables by shackles. The pins form articulations, on which the verticals merely rest and the diagonals engage. This arrangement eliminates any distortion or strain, and renders the whole structure solid though flexible. In order to prevent the compression of the top boom (under either the influence of a load or great variation of temperature), exceeding the calculated tension, it is fitted in three places with elastic joints, which allows the girder to follow the movement of the suspension cables.

The travelling frame, running under the bottom boom of the stiffening girders, measures 104 ft. in length by 26 ft. in width. It is furnished with sixty cast-steel wheels, carried in steel brackets fixed to the longitudinal members of the frame, and arranged as follows:—fifteen inside and fifteen outside the web of each of the rail carrying members, and fifteen pairs of horizontal wheels engaging on the edge of the flange plate.

The transporter car is suspended from the traveller by thirty ropes, set in



A VIEW OF THE NEWPORT TRANSPORTER BRIDGE LOOKING N.W.

triangulation, to prevent any excess of swaying during high winds.

The car is 33 ft. in length by 40 ft. in width, and weighs 31·5 tons. It is divided into a central roadway space, which can take six two-horse vehicles, and covered footways on either side, accommodating three hundred passengers. The motorman's cabin, containing the controlling apparatus, is on one side.

Electricity is the propelling power, but the motors are not geared to the traveller as at Runcorn. The principle is that of a winding engine, *i.e.*, the frame is propelled by steel wire ropes wound on a drum, worked by motors fixed on the shore at the western end.

The car at rest does not project into the river, but is housed in a dock at the base of the tower; the riverward face of each dock being furnished with an elastic buffer, which will absorb the momentum of an incoming car, and accelerate the start of an outgoing one. The rate of travel will be 10 ft. per second, so that the crossing will occupy little more than a minute.

The following contracts have been let to Mr. Alfred Thorne, of Westminster: —foundation piers and anchorages, £23,897; shore abutments, eastern pier, and lattice girder span, £4,588; steel superstructure and travelling apparatus, £35,165.

Supplement to THE SURVEYOR AND MUNICIPAL AND COUNTY ENGINEER, *January 11, 1907.*

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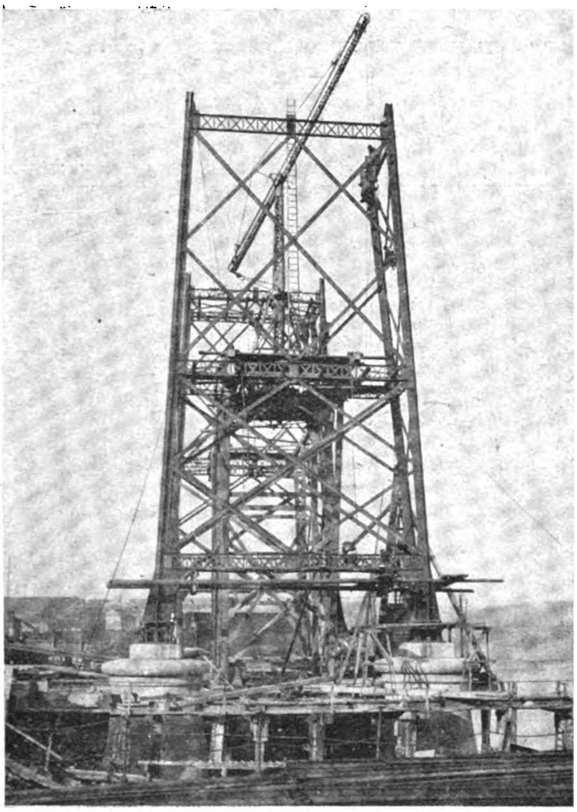
Newport Transporter Bridge Opened.

SOME DETAILS OF THE STRUCTURE.

A new and striking landmark in the shape of a transporter bridge has sprung up in the past three or four years in South Wales, and the town of Newport, which has hitherto been divided into two portions by a wide and swiftly flowing river, the Usk, is at last in possession of adequate means of communication for its vehicular and pedestrian traffic. The opening ceremony, which was performed by Viscount Tredegar, Lord-Lieutenant of Monmouthshire, took place on Wednesday, and was witnessed by large numbers of people.



Newport Transporter Bridge: Western Tower, showing Mode of Erection.

Until the erection of the bridge the river Usk was spanned within the borough by only one road bridge, which was erected as far back as 1800. This, although widened in 1866 and partly reconstructed in 1892-3, had long proved inadequate for the traffic, and its situation near the northern end of the borough made access from the eastern to the western side of the river at the southern end of the town a matter of difficulty only to be overcome by a wide detour.

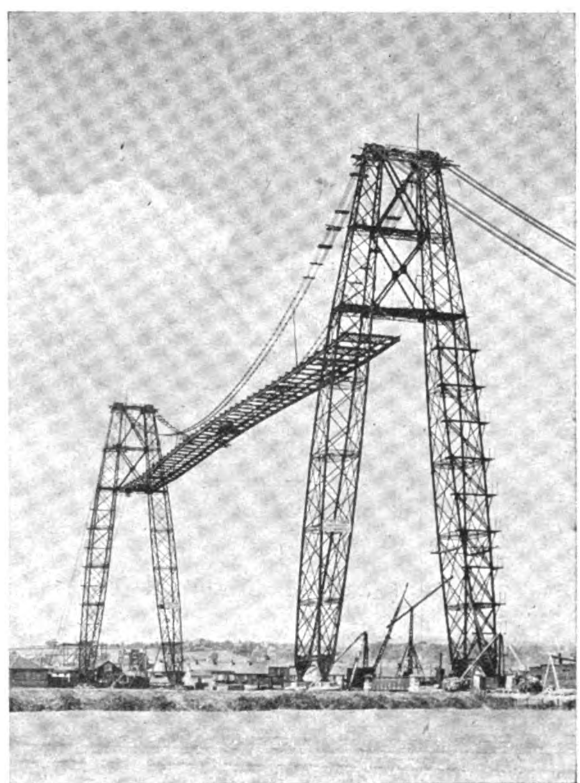
Between the years 1869 and 1889 various schemes were proposed for joining up the opposite banks, and a ferry and foot-passenger subway were authorised, but nothing tangible resulted.

In 1898 the subject was tackled in earnest. Many proposals—including ferries, high-level, bascule, swing, lifting, and rolling bridges, subways, and movable or traversing bridges—were considered, but the choice ultimately fell on a transporter bridge. A scheme for a subway of sufficient capacity to deal with vehicular traffic was abandoned on the score of cost; high-level bridges with sloping approaches were out of the question for financial reasons; swing bridges were rejected owing to the obstruction they offer to the free use of the waterway, and for the further reason that complications were not unlikely to arise owing to the reduction in the section of the channel due to the large piers required. The contracts for the erection of a transporter bridge were finally entered into in the early autumn of 1902.

The chief dimensions of the bridge are as under: Span—centre to centre of towers, 645 ft.; clear opening between faces of piers, 592 ft.; clear headway from high water to underside of span, 177 ft.; height of towers above level of approach roads, 242 ft.

The foundation piers are placed in groups of four on each bank, and from centre to centre the distance is 78 ft. 9 in. on the riverward faces, and 36 ft. on the faces at right angles thereto. These piers are masonry wells or monoliths, mounted on steel shoes or curbs, and were sunk by means of pneumatic pressure to the hard marl underlying the alluvial deposit in the river, the actual foundation depth varying from 78 ft. to 86 ft. below the river banks. A curb was first placed in position on the river bank, and a working chamber composed of reinforced or armoured concrete formed over it. On the outer part of the chamber a wall, 2 ft. 3 in. thick, was built. This was carried up as the shoe sank, and kept at all times of sufficient height to prevent the ingress of tidal water. Men were sent into the working chamber (at first in the open), and as they excavated from under the edges of the curb the well sank. When a depth of about 10 ft. was reached an air shaft and air lock were added, and air was pumped in to keep back the water. The men then continued the excavation under air pressure, and passed all material up through the air shaft and lock. The air pressure was reduced at the end of each day's work to allow the well to move downwards, and the operations were continued until a satisfactory bottom was reached. It is believed that this is the first instance in Great Britain where masonry wells have been sunk under air pressure. When sunk to its proper level the well was filled in with concrete, and as soon as this had set the false wall was taken down, and the masonry portion of the pier above ground-line proceeded with. Each pier contains on an average 19,500 cub. ft. of masonry and concrete. The total load transmitted to the foundation is 5½ tons per superficial foot.

The anchorages are large blocks of masonry, resting on pile and concrete foundations. Galleries through which the anchoring cables pass are formed in each limb, the pull of the anchor castings being taken on granite blocks placed at the rear of the masonry. Each anchorage contains 35,800 cub. ft. of masonry, and weighs over 2,200 tons. The total force exerted by each series of cables is 920 tons. The weight of masonry in front of and opposed to the anchor castings is 1,300 tons.



Newport Transporter Bridge: Later Stage of Work.

The towers are of open lattice steel construction. The main members of the legs are formed of angles and plates rivetted together in the form of a cross, the bottom being stiffened by gussets and brackets. The

legs are mounted at their feet on articulations, or joints, constructed of cast-iron saddles and steel rocking pins, an arrangement which provides flexibility and vertical loading through the piers when the towers are subjected to heavy wind pressures. The weight of steel in each tower is 277 tons, and the surface to be painted 36,000 sq. ft.—substantially, four-fifths of an acre.

The suspension cables are sixteen in number, four inside and four outside of each of the stiffening girders. Each is composed of twenty-seven wires of 20 millimetres in area, giving a sectional area of 3·945 sq. in. per cable. Under the maximum load the tension in each cable is nearly 48¼ tons, but as the breaking weight of the cable approaches 254 tons the margin of safety should be sufficient to satisfy the most nervous. The total loads and breaking weights are 776 and 4,064 tons respectively. Each cable weighs nearly 4 tons.

The anchor cables or back stays are also sixteen in number, each composed of 127 wires of 21·7 millimetres in area, giving a total section of 4·27 sq. in. per cable. The maximum load in each is nearly 54¼ tons and the breaking weight about 277 tons; the total loads and breaking weights, therefore, represent 868 and 4,432 tons respectively. These cables weigh nearly 3¼ tons each. A portion of the span is carried by diagonal cables proportioned to the work they have to perform, and the ends of each of the stiffening girders are moored or held by two cables of ninety-one wires, having a total section of 2·61 sq. in. The weight of suspension and anchorage cables is 196 tons, and of the diagonal cables 19 tons, exclusive of sockets and shackles.

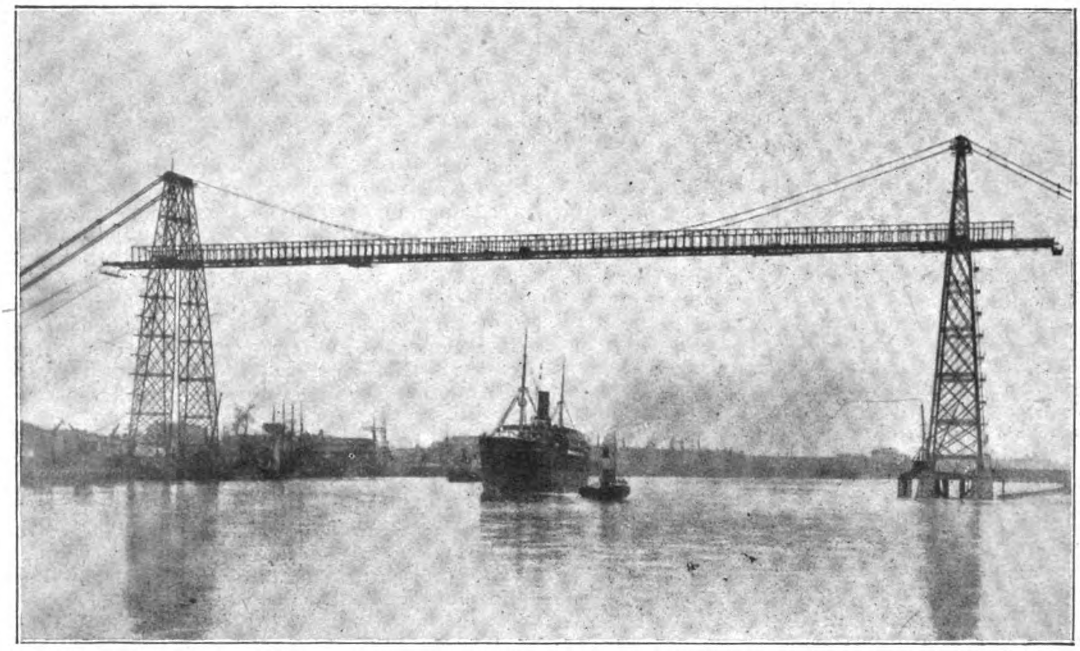
The bridge has been designed to resist a wind pressure of 56 lb. to the superficial foot, corresponding to a velocity of 110 miles per hour, on the windward faces; with 28 lb. to the foot on one-half the area of the faces to leeward. In the girders two faces are taken into account, one windward, one leeward; in the towers four faces are taken, one windward, three leeward. The total weight of girders, suspension rods and attachments, gangways, platforms and service footways is 539 tons. This does not include the weight of the cables. The surface to be painted is 74,000 sq. ft., equal to one and seven-tenths acres.

The travelling frame or truck (104 ft. in length) is built up of joist, channel, and angle steel. It is fitted with sixty wheels, fifteen inside and fifteen outside the web of the bottom members of each stiffening girder. The wheels are of steel, carried in steel brackets; each bracket is fitted in addition with two horizontal guide wheels, engaging on the edges of the girder flanges. From this frame is suspended the platform or car, 33 ft. in length by 40 ft. wide. The car is divided into a central roadway space and two footways, the latter being roofed in. The car beams and deck are designed for the simultaneous passage of two four-wheeled vehicles, each carrying 15 tons. The car is electrically lighted. The travelling truck weighs 16·3 tons, the suspension cables 2·9 tons, car 31·5 tons, a total of 50·7 tons. There are thirty suspension cables of a total length of 1,620 yards; these are crossed to form triangular trussing in order to prevent swaying motion during high winds. These cables have a breaking load of 550 tons.

The car is propelled to and fro by what is in effect a continuous rope of flexible steel wire (in reality, for convenience of erection and maintenance, two ropes), driven by an electrically-worked drum erected in the motor-house near the eastern end of the bridge. The first rope passes up from the drum to a guide pulley at the eastern end of the bridge, then along supporting pulleys on the upper part of the platform to a main return pulley at the western end. Then it comes back under the platform, where it is supported by further pulleys fixed underneath, to a swan-neck in the centre of the frame, to which it is secured. The second rope is attached to the swan-neck, passes under the bridge, over the pulleys, to a second guide pulley at the eastern end, and thence descends to the drum.

The motors, two in number, are each of 35 horsepower, and may be used together or singly.

The engineers were Messrs. F. Arnodin and R. H. Haynes, the latter of whom is the borough engineer of Newport; the contractor, Mr. Alfred Thorne. Mr. V. J. Kérihuel acted as resident engineer and Mr. A. John P. Thorne as contractor's engineer.



Newport Transporter Bridge: Structure Practically Complete.

Newport Sanatorium.—The Newport (Mon.) Sanitary Committee have decided to open a sanatorium in connection with the Allt-yr-yn Infectious Diseases Hospital on October 15th.

Irish Congested Districts.—The Royal Commission, of which the Earl of Dudley is chairman, appointed to inquire into the problem of congested districts in Ireland, and to suggest means of remedying their condition, held its first sitting in Dublin last Friday.

Water Supply at Scunthorpe: New Works.—The inauguration took place on Friday of new water supply works at Scunthorpe. After expending about £5,000 to obtain a supply at the foot of the cliff hills, by means of a deep bore, the water turned out to be salty and unfit for domestic use. The council had, therefore, to seek another source, and this was found on the oolites at the north-east of the town, where 2 acres of land were obtained, including the site of the reservoir at the top of Sawcliffe Hill, 2 miles away. At the pumping station a catchment was built 150 ft. long, 22 ft. deep, and 11 ft. wide, with two bores in it. A plentiful supply of water was found. Two sets of engines were put down, each capable of pumping 25,000 gallons per hour into the reservoir, which has a capacity of 750,000 gallons. The power station for generating the electricity for pumping is at the gas-house, Scunthorpe, and the electricity is conveyed to the pumps, 5 miles away, by means of armoured cables. The service reservoir is a covered one, and is 100 ft. above the town. The cost of the scheme is £17,013.

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EVERY SATURDAY

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NUMBERS 1—27

July 1—December 30, 1905

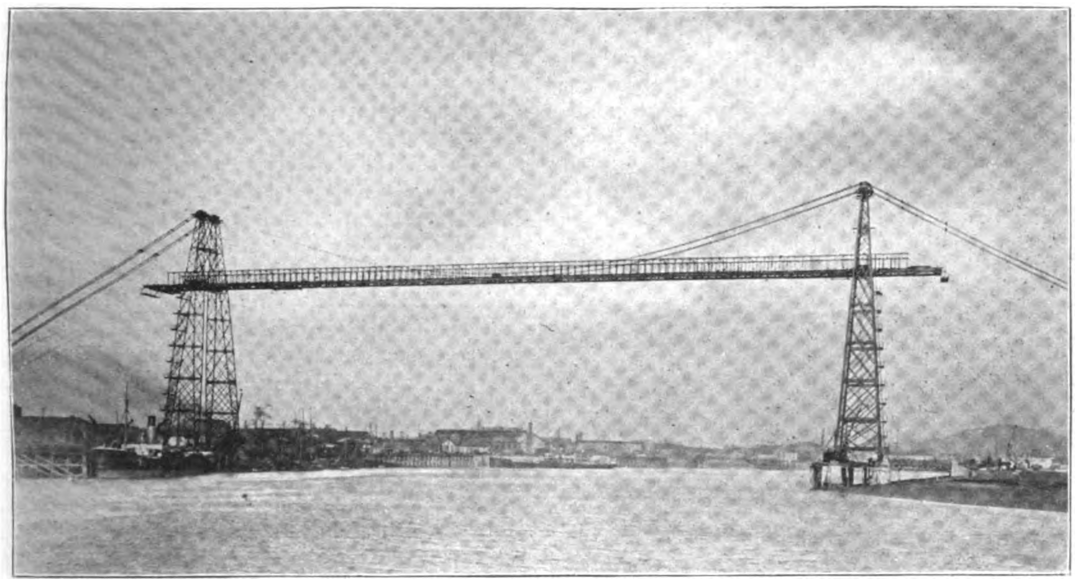
ELECTRICIAN PUBLISHING COMPANY

CHICAGO

The Newport (England) Electric Transporter Bridge.

[From the London correspondent of the Western Electrician.]

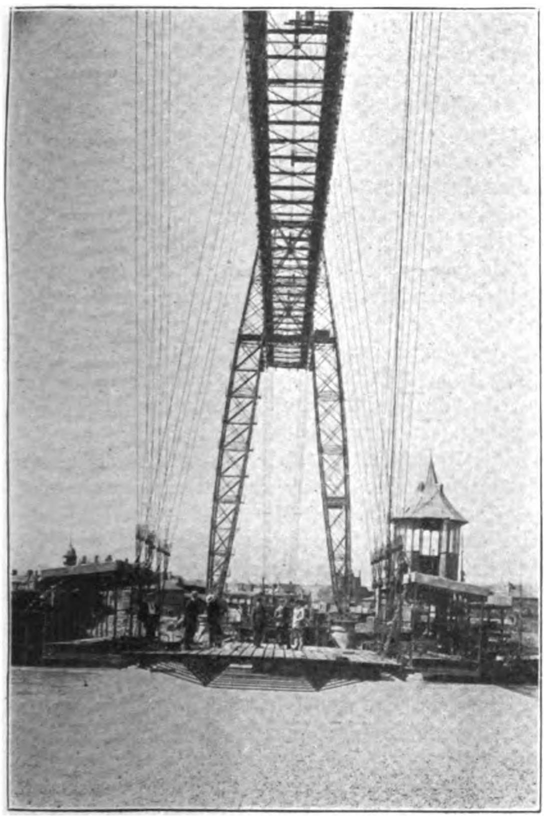
The electrically operated transporter bridge which has been erected by the Newport Corporation across the River Usk in Wales is an interesting structure, although the electrical features are mainly confined to the driving of the car. The inception of the idea was brought about by the fact that Newport is divided into two portions by a wide and swiftly flowing tidal river, navigable for a distance of about five miles from its mouth by large ships. Only one bridge existed hitherto, and that at the northern end of the borough. At the southern end of the town a ferry was the only means of transport across the river at this point. Various schemes were proposed for joining up the opposite banks here, and these included ferries, high-level, bascule, swing, lifting and rolling bridges, subways and movable or traversing bridges. The choice, however, ultimately fell upon a transporter bridge, each one of the other proposals having one or more insuperable objections to them, such as cost, obstruction to shipping, and so on. Parliamentary sanction was granted in the year 1900, and detailed calculations were made, designs prepared and contracts for the work entered into in the early autumn of 1902.



THE NEWPORT (ENGLAND) ELECTRIC TRANSPORTER BRIDGE (WITHOUT CAR).

The photographic views give a good indication of the structure, of which the following are the chief dimensions: Span, center to center of towers, 645 feet; clear opening between faces of piers, 592 feet; clear headway from high water to underside of span, 177 feet; height of towers above level of approach roads, 242 feet.

Foundations are placed in groups of four on each bank, and from center to center the distance is 78 feet nine inches on the riverward faces, and 36 feet on the faces at right angles thereto. These piers are masonry wells or monoliths, mounted on steel shoes or curbs, and were sunk by pneumatic pressure to the hard marl underlying the alluvial deposit in the river, the actual foundation depth varying from 78 feet to 86 feet below the river banks. It is believed that this is the first instance in Great Britain where masonry wells have been sunk under air pressure. The greatest pressure used during sinking was 36 pounds to the square inch, and no illness or compressed-air trouble was experienced. Each pier contains on an average 19,500 cubic feet of masonry and concrete, the total load transmitted to the foundation being 5½ tons per superficial foot.



END VIEW OF NEWPORT TRANSPORTER BRIDGE, SHOWING CAR.

Large blocks of masonry, resting on pile and concrete foundations, form the anchorages. Galleries, through which the anchoring cables pass, are formed in each limb, the pull of the anchor castings being taken on granite blocks placed at the rear of the masonry. Each anchorage weighs over 2,200 tons, the total force exerted by each series of cables being 920 tons.

As seen in the pictures, the towers are of open lattice steel construction. The main members of the legs are of angles and plates riveted together in the form of a cross. The general outline, looking in the direction of the stream, is an even taper from the base to the summit, but viewed from across the stream the legs are of spindle form. The extreme summit of the legs is heavily reinforced by steel girders. The legs are mounted at their feet on articulations or joints, constructed of cast-iron saddles and steel rocking pins, an arrangement which provides flexibility and vertical loading through the piers when the towers are subjected to heavy wind pressures. There is a stairway up each of the towers to the platform level.

An electrically driven crane was used for the erection, and less than 1,000 kilowatt-hours of electricity, costing about $45, was sufficient to lift and place in position the whole of the temporary scaffolding and staging, as well as the permanent structural steelwork in both towers, a total weight of some 800 tons.

Suspension cables are 16 in number, four inside and four outside of each of the stiffening girders, each cable being composed of 127 wires, giving a sectional area of 3.945 square inches. The breaking weight of each cable is nearly 254 tons, but the maximum load is only 48½ tons, so that there is an ample margin of safety. The total loads and breaking weights are 776 tons and 4,064 tons, respectively.

There are 16 anchor cables or backstays, each having 127 wires and a total section of 4.27 square inches. The total load on these is 868 tons, and the breaking weight 4,432 tons.

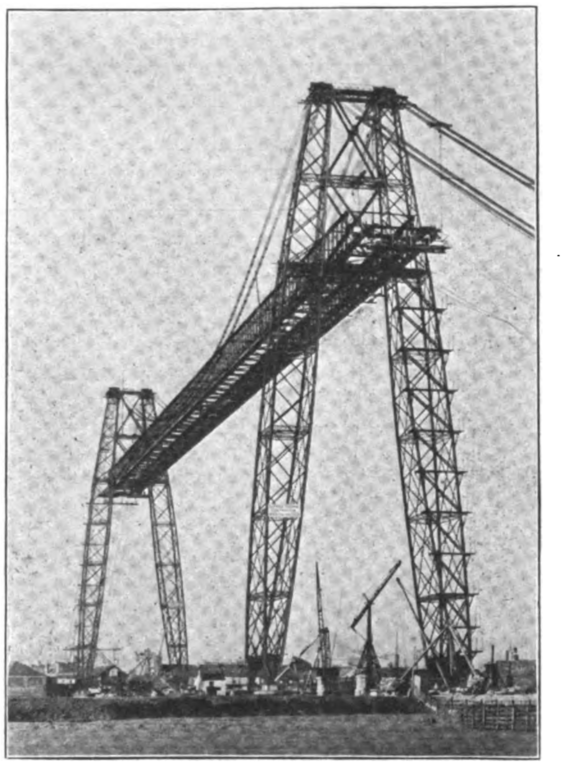
A portion of the span is carried by diagonal cables, and the weight of the suspension and anchorage cables is 196 tons, that of the diagonal cables 19 tons, exclusive of sockets and shackles.

Stiffening girders have been placed the whole length of the upper platform and act as stiffening beams and distribute the moving load over the suspension parts, while at the same time providing sufficient flexibility to allow of the compound structure giving to the movement of the suspension and for the necessary alteration of form due to temperature changes. They are placed at central distances of 26 feet three inches, and their depth is 16 feet overall. The bottom member is built up as an ordinary plate girder, each lower flange carrying the rails on which the wheels of the traveling truck run.

This truck is 104 feet in length and it is fitted with 60 wheels, 15 inside and 15 outside the web of the bottom members of each stiffening girder. The wheels are of steel, carried in steel brackets; each bracket is fitted in addition with two horizontal guide wheels, engaging on the edges of the girder flanges. From this frame is suspended the platform or car, 33 feet in length by 40 feet wide. The car is divided into a central roadway space, as seen in the illustration, and two footways, the latter being roofed in. The car beams and deck are designed for the simultaneous passage of two four-wheeled vehicles, each carrying 15 tons. The car is electrically lighted. The traveling truck weighs 16.3 tons, the suspension cables 2.9 tons, and the car 31.5 tons, making a total of 50.7 tons. There are 30 suspension cables of a total length of 1,620 yards, which are crossed to form triangular trussing, in order to prevent swaying motion during high winds. These suspension cables have a breaking load of 550 tons.

The car is propelled to and fro by what is in effect a continuous rope of flexible steel wire (in reality, for convenience of erection and maintenance, two ropes) driven by an electrically worked drum erected in the motor house near the eastern end of the bridge. The first rope passes up from the drum to a guide pulley at the eastern end of the bridge, then along supporting pulleys on the upper part of the platform to a main return pulley at the western end. Then it comes back under the platform (where it is supported by further pulleys fixed underneath) to a swan-neck in the center of the frame to which it is secured. The second rope is attached to the swan-neck, passes under the bridge, over the pulleys, to a second guide pulley at the eastern end and thence descends to the drum.

The motors, two in number, are each of 35 horsepower, and may be used together or singly. Two power cables are led from the corporation street mains to the switchboard, one being connected to the tramway circuit, and the other to the power and lighting circuit. The current is controlled by switch apparatus on the motor-house switchboard, whence insulated leads are taken up to the bridge platform, thence along bare wires through contact trolleys and insulated conductors down to the controlling gear in the pilot house on the car. The controllers on the car are duplicated, and under normal conditions the working will be performed from this position, but in order to provide for emergencies a third controller is fitted in the motor house from which the car can be operated in case of necessity.



ANOTHER VIEW OF NEWPORT TRANSPORTER BRIDGE (WITHOUT CAR), SHOWING TYPE OF CONSTRUCTION.

The motor-house board contains the change-over switch for connecting either to the tramway or lighting circuit. The controllers are arranged for starting, increasing or reducing speed, stopping and reversing the motion of the car. Braking can also be done by them in case of need. Special care has been taken to duplicate the electrical apparatus, in order to provide against the possibility of stoppage.

A sliding buffer worked by a counterweight is arranged at each abutment to absorb the momentum of the car and prevent shock. The journey is performed at the rate of 10 feet a second, and the distance to be traveled is some 600 feet.

I am indebted to Mr. R. H. Haynes, the borough engineer at Newport, for the information and photographs contained in this article.

THE

TRAMWAY AND RAILWAY WORLD

AN ILLUSTRATED REVIEW OF PROGRESS IN

ELECTRIC AND OTHER TRACTION

Established in 1892.

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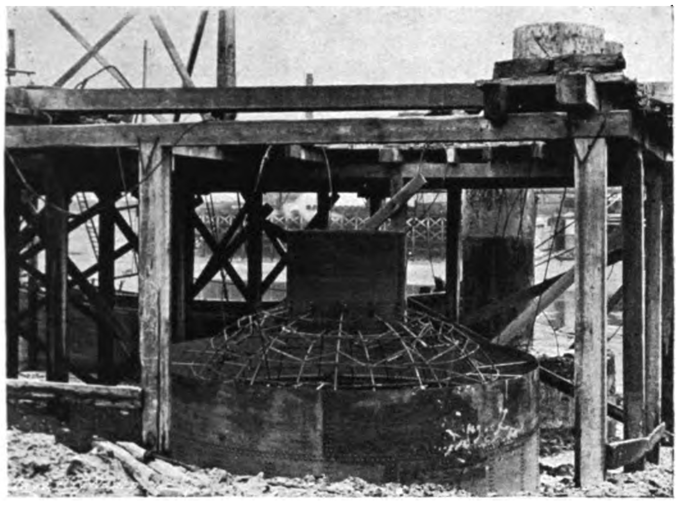
NEWPORT TRANSPORTER BRIDGE.

In 1899 the Corporation of Newport, Mon., decided to construct a transporter bridge over the River Usk, to connect the new and old parts of the town, and the structure will be opened on the 12th inst. The growth of the town on the eastern bank of the river, in the years 1890 to 1898, made it highly desirable that something



Eastern Foundation Caissons (October. 1903)

should be done speedily to improve the facilities for communication. Higher up the river, towards the north, the old and the new parts of the town were united by Newport Bridge. On the east side, the town was extending towards the south, farther and farther from the bridge, and it was consequently desirable to connect the two sides of the river at a point well to the south of the existing bridge.

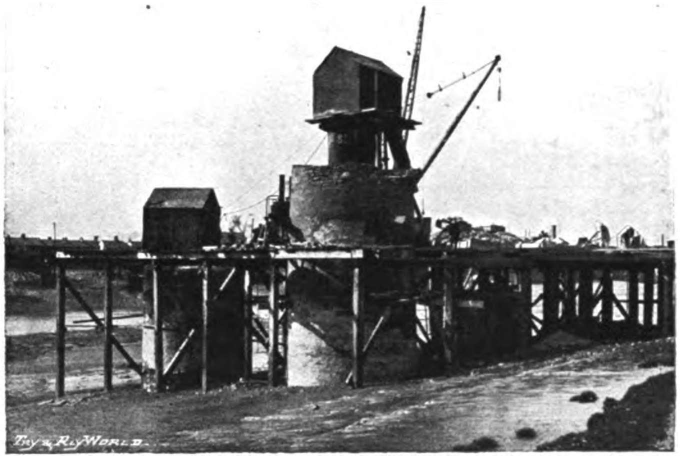
After a special inspection had been made of the Rouen transporter bridge in 1899, the Corporation decided that a bridge similar in principle should be constructed. Parliamentary sanction was obtained in 1900. M. Arnodin, the designer and engineer of the Rouen bridge, and Mr. R. H. Haynes, borough engineer of Newport, were appointed joint engineers of the undertaking. Contracts for carrying out the work were entered into between the Corporation and Mr. Alfred Thorne, of Westminster, on the following basis: For the construction of the piers and anchorages, at a cost of £23,897; for the construction of the steel superstructure and the travelling apparatus, at a cost of £35,165; and for the construction of the shore abutments, eastern pier and lattice girder span, at a cost of £4,588. The specifications required a tensile strength of 8 tons per sq. in. in cast iron used, and a minimum tensile strength of 28 tons per sq. in., and a maximum tensile strength of 31·75 tons per sq. in. in the cast steel used. Wrought iron was to have a tensile strength of 22·75 tons per sq. in., an elongation of 12 per cent. in a length of 4 inches, and of 6 per cent. in a length of 4 inches under a load of 17·75 tons; and a contraction of area at fracture of 23 per cent. Rolled and profiled steel was to be of open-hearth production, to have a tensile strength of 26·65 tons per sq. in., a limit of elasticity of 15·25 tons per sq. in., and an elongation of 22 per cent. in a length of 4 inches. Special steel used for shackles and pins was to have a tensile strength of 35·5 tons per sq. in., an elastic limit of 19 tons per sq. in., and an elongation of 18 per cent. in a length of 4 inches. The steel wire for the cables was to have a tensile strength of 63·5 tons per sq. in. Four bends, twice backwards and forwards through an arc of 180 degrees; also wires to be looped, bent back, and tightly wound four turns on their own diameter, were specified for, and, as regards torsion, six complete turns to be made in a length of 10 inches.

The principal dimensions of the bridge were to be as follows:

Span from centre to centre of towers	645 ft.
Span between faces of piers	592 ft.
Clear height to under side of stiffening girder from high-water mark, ordinary spring tides..	177 ft.
Height of tower from pier cap or level of approach road, to saddle	241 ft. 6 in.
Distance between centres of anchorages.. ..	1,545 ft.
Centre of tower to centre of anchorage	450 ft.

The foundation stone of the anchorage on the west side of the river, that on which the old town stands, was laid by the late Alderman H. J. Davis, then Mayor of Newport, on November 8, 1902.

On the west side, the foundations of the piers were carried well down into the marl, the mean depth being 78 ft. below the river bank. On the east side the piers were carried to a depth of 86 ft. below the river bank. The plan of working with compressed air was followed when constructing the foundations of the piers, the maximum air pressure reached being 36 lbs. per square inch. The foundation piers were formed in two groups of four each, the piers next to the river being 78 ft. 9 in. apart, and those on the land side being 36 ft. distant from the piers fronting the river. Each pier consists of a masonry well or monolith, resting on a steel curb or shoe, 20 ft. in diameter. The walling is of local stone set in cement mortar, and at the base of the well was 2 ft. 9 in. in thickness, in the first piers sunk. Steel cables $1\frac{1}{2}$ in. in circumference were secured to the shoe and carried up in the walling as it proceeded. The outer face of the wall was worked with neat cement to minimise surface friction, and the inside face left rough to afford a better grip for the concrete with which the interior was filled. As the work proceeded the thickness of the walls was increased by one foot, to obtain additional sinking weight. False or temporary walls forming coffer dams were carried



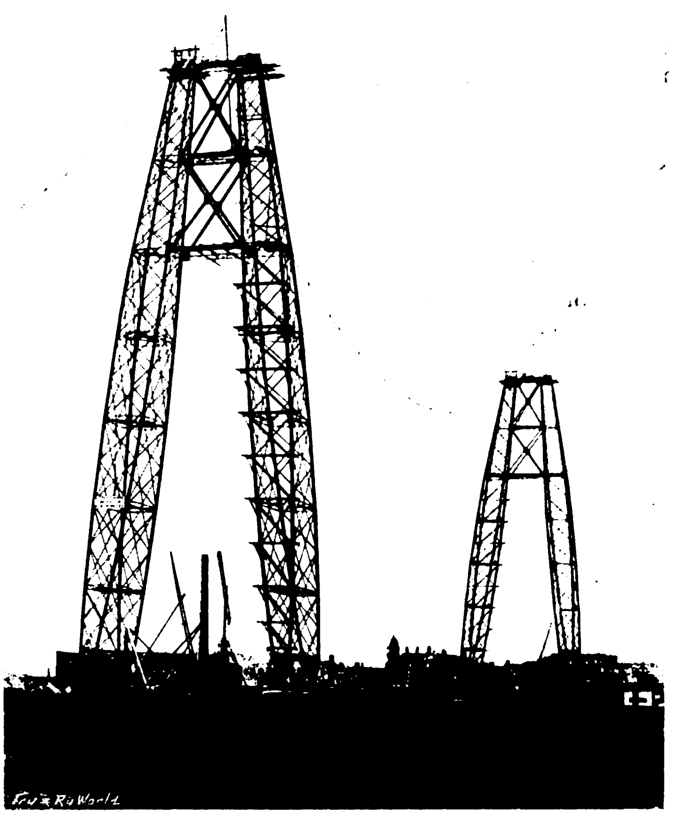
Eastern Foundation Works (May. 1904).

to a point well above high water mark for use during the construction of each pier. When a satisfactory foundation had been obtained the chamber was filled with Portland cement of 6 to 1 composition. Time was allowed for this filling to settle, and then the air lock and shaft were removed and the filling up was done, Aberthaw ground lime concrete of 1 to 4 composition being used. The false wall was then removed and the dressed masonry work proceeded

with. The bed blocks of this work are of Penrhyn granite, and the remainder of local Pennant grit stone, the whole being set in cement mortar. The method of constructing the piers is considered to have been an economical one. The cost of the piers has been £2,200 each, in round figures. The load per square foot of foundation is 5½ tons.

Anchorages consisting of rubble masonry on a pile and lime concrete foundation, each weighing approximately 2,000 tons, were formed for the cables. The reaction is taken through granite bed blocks having armoured cement concrete blocks on their inner faces. The weight of the portion of the anchorage in front of and above the granite blocks is 1,200 tons, the calculated effort being 911 tons.

The two towers are of steel and are of open or lattice construction, the legs of each being of spindle shape, this form giving most stiffness. The legs are

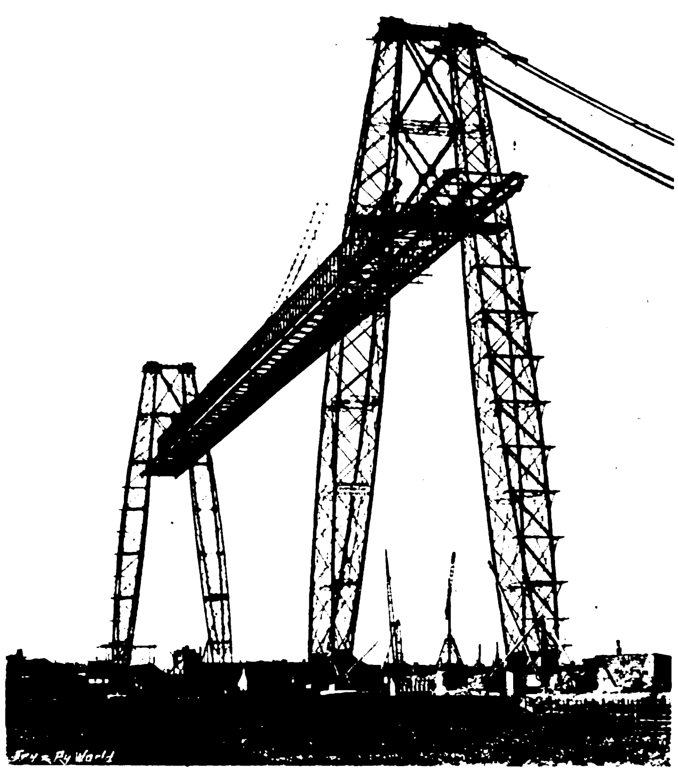


Steel Towers in Position (April, 1900).

formed of angle irons and plates riveted together, with light cross-bracings. Above the level of the track on which the transporter will run the legs of each tower are braced together. Below the level of the track there are no bracings of the legs parallel with the river front, the space being left quite free to allow of the butting of the transporter car, at each side. There are, however, to each leg, five tiers of horizontal lattice girders by which the main limbs of the legs are bound together. Above the platform, in addition to the diagonal cross-bracing of the legs, there is a strong horizontal cross-bracing midway between the platform and the top of the tower. The extreme top is heavily strengthened by joist sections, to bear the full load which will be carried by the saddles.

At the base, each leg has been treated in a special manner. The limbs of each leg taper downwards and inwards towards the points of actual support. At the bottom of each pair of main limbs of the leg there is fixed an inverted saddle in which is worked a deep semi-circular groove, to form a seat for a strong horizontal pin. This pin is carried by a strong rocker which is fixed at the top of the masonry pier, to form the point of support and contact. The pin is held in its bed horizontally by steel bolts and clips, and serves as an articulated joint between leg and pier. A convenient stairway from the ground level to the platform of the bridge has been provided at each tower.

Sixteen suspension cables are used, and are fixed in two sets of four each on each side of the structure. The cables are not "bunched," but laid side by side, though hanging clear of one another. Each cable consists of 127 wires, with an area of 20 millimetres, giving a total section of 3·945 sq. in. for the cable. Sixteen anchor cables have been used, each being composed of 127 wires, having an area of 21·7 millimetres, the sections of each cable being 4·273 sq. in. Under the



The Span.

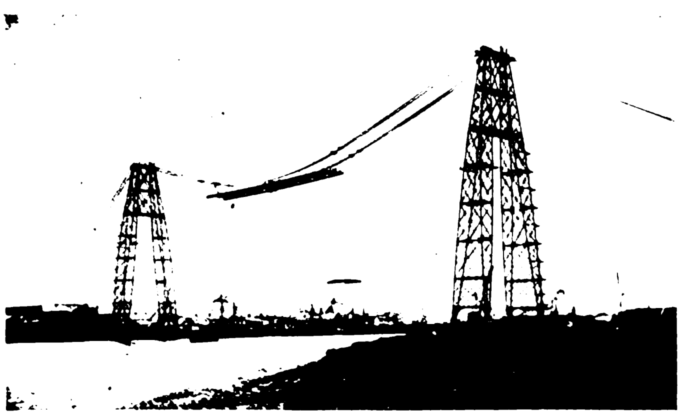
maximum load, the tension in the parabolic main cables is 12·27 tons, and in the anchor cables 12·69 tons per sq. in. The cables are secured at each end to sockets of cast steel, which are connected to the main saddle pins of expansion carriages by steel shackles of high resistance. Each anchorage is furnished with sockets and bolts of high-grade steel. The tension in the shackles and bolts is 6·4 tons per sq. in. The suspensory plan which has been adopted will allow of the renewal of a cable without interfering with the working of the bridge.

A number of diagonal cables are used, and bear part of the weight of the span. The maximum tension in any of these cables under a possible load is 12·7 tons per sq. in. The estimated weight of the suspension and anchorage cables is 196 tons, and of the diagonal cables 19 tons, exclusive of sockets and shackles.

Stiffening girders having a depth of 16 ft. over all, have been placed at central intervals of 26 ft. 3 in., along

the full length of the platform. The arrangement of these girders is such as to distribute the strain of the load, while imparting considerable strength to the suspended portion of the structure, and insuring, at the same time, a required degree of flexibility in the whole.

The boom, or main support, which carries the rails



Lifting a Section of Girder (July, 1905).

on which the travelling frame of the transporter will move to and fro, is of ordinary plate-girder construction, the girder having a central web and a flange on each side at the bottom. A rail is fixed on each flange and is held in position by set screws. The boom is supported by iron suspension rods secured to the main cables, special stirrups and shackles being used to form the connections.

An upper boom, formed of double-channel section girders with a top cover plate, is also used. This boom is fitted with elastic joints at three places in the length, to relieve the strain in the case of excessive compression, and to allow the girder to follow the movements of the main cables. Horizontal braces of H and T sections are used to stiffen the girders so that these may be able to resist a wind pressure of 56 lb. per sq. ft. on the windward side, and 28 lb. per sq. ft. on the leeward side. The construction as a whole imparts to the span, and its constituents of booms, girders, and bracings, the form of a huge girder of box-section. The maximum stress on the structure has been calculated as 6·34 tons per sq. in., the suspension rods working at 3·8 tons per sq. in. The total weight of the girders, suspension rods, and attachments, platform and service footways, is 539 tons.

The Bridge on August 12, 1905.

The transporter proper consists of two main parts; a trolley or truck which moves on wheels over rails fixed on the lower flanges of the track girders of the bridge, and the platform on which passengers, vehicles, and goods will rest while being carried across the river. The truck is formed of iron joists of channel and angle sections, its frame being 104 ft. long over all, and is furnished with four sets of wheels $14\frac{1}{2}$ in. in diameter, at the centre of the tread, there being 15 wheels in each set, making 60 in all. Thirty of the wheels rest on rails on the outer flanges of the two track girders, and thirty on rails on the inner flange of the girders. The rails have a head of the flat-round pattern, and a double flange sole-plate which rests on the girder.

The platform or car is 33 ft. long by 40 ft. wide, and is formed on the surface in three compartments, the two outer ones being for passengers, and the space in the centre for vehicles. The car is undertrussed with steel wire cables, to minimise the weight, and will accommodate about 100 persons in each of the side compartments, and the equivalent of four four-wheeled vehicles, each carrying $7\frac{1}{2}$ tons, on an axle in the centre compartment. The space for passengers, as will be seen from one of the views, is roofed in.

The car is suspended from the travelling truck on the bridge by 30 cables, having a tensional load of 12·7 tons per sq. in. The cables are fixed triangularly, both longitudinally and transversely, so as to prevent swaying. The total weight of the travelling frame, car, and suspension cables, is 50·7 tons: the car weighing 31·5 tons, the platform 16·3 tons, and the cables 2·9 tons. The whole has been designed for a proof load of 66 tons in addition to the weight of the structure. The movement of the trolley and car across the river will be effected by rope haulage, the ropes being worked by electrical power. Two 35 H.P. motors are provided in a power-house near the foot of the towers at the east end of the bridge. Friction gear will transmit power from the main shaft to winding drums. From the drums ropes pass upwards to the platform of the bridge, and are carried over and round the necessary pulley-wheels, and are attached to the frame of the truck to admit of haulage to and fro. The movements of the car will be directed from a pilot house on the car. To admit of control, electrical conductors are fixed below the bridge, which will serve as trolley wires, and from the pilot house other conductors pass upwards and are in connection with these wires through the media of running-trolleys. These conductors will maintain electrical connection between the pilot-house and the power-house on shore. The electric leads for this system of communication from the power-house are carried up one of the legs of the bridge. A

The Bridge as seen from the Bank.

double trolley is provided for each necessary contact, so as to minimise the risk of stoppage through a temporary loss of contact. A system of controlling the movements of the car will also be provided, by which, in the unlikely event of a complete failure of the ordinary means of control from the pilot house of the car, the service may be worked from the motor house. The

Bridge Completed with Transporter Hanging above River.

scheme of electrical transmission and contact which has been adopted requires six trolley wires, one trolley having contact-wheels engaging with each wire. The rate of travel will be 10 ft. per second. This will mean that about one minute will be occupied by the car in passing from side to side of the river.

The outer face of the fixed structure at which the car

Transporter Car Suspended from Bridge.

will berth, on each side of the river, is provided with an elastic buffer, to absorb the momentum of actual contact of the car with the structure.

The cables for the bridge were manufactured by by Messrs. W. B. Brown and Company, Limited, Bankhall Street, Liverpool.

The work of erecting the bridge was greatly facilitated, and the cost kept low, by the use of an electric crane designed by M. Arnodin. The crane may be seen in the photographs on page 248, between the legs of the towers. The upper part of the crane consists of a jib lightly trussed on the back and at the sides, which has a radius of 25 ft., and will lift weights up to 3 tons. Power is derived from an electric motor worked with a resistance control. The platform of the crane is provided with strong vertical screws, and with gear which admits of the crane raising or lowering itself independently of the lift of the jib, as the work proceeds. As proof of the economic working of the crane, it may be stated that the cost of current used in erecting the west tower, at a charge of 2d. per B.T. unit, was £4 19s. 8d., and of the east tower, £4. The weight of the steel, scaffolding, and staging of a tower, when constructed, was approximately 440 tons.

Nothing appears to have been left undone which could add to the fitness of the new bridge, for the work which will be required of it. The construction has been carried out under the constant supervision of Mr. R. H. Haynes, as resident engineer.

LIFEGUARDS AND JACKS.

At a meeting of West Bromwich Trades Council on August 15, the report of Colonel Yorke, the inspector of the Board of Trade in connection with the recent tramway fatality at Handsworth, was received. Colonel Yorke stated that an unfortunate delay of half an hour occurred before the body of the child could be removed, which was due to the fact that no jacks were carried. He added, however, that it was doubtful whether lifting jacks would have had the effect of saving the child's life. The report continued: It transpired during the inquiry that the height of the triggers of the guards of this Company's system above the rails varies from six to four inches. It is correct, as stated at the inquiry, that the Board of Trade has laid down no standard height for the triggers of these guards, for the reason that the minimum height varies with different types of cars, some of which pitch more than others. The height of the trigger should be such as not to permit of the trigger striking the surface of the road under ordinary conditions. With four-wheeled cars, such as the one in this instance, a height of four inches should be sufficient, and should not be exceeded, while with bogie cars the height might be reduced to three or, perhaps, two and a half inches. It would also be advisible if a spring were attached to the back end of the tray of the guard so as to hold the front edge of the tray down to the surface of the roadway when released, and overcome the tendency to vertical oscillation. During the discussion a delegate stated that the lifeguards were frequently rendered useless by the overcrowding of the cars at football matches. The following resolution was carried: "That a letter be sent to the Board of Trade stating that in the opinion of this Council it is absolutely necessary to carry jacks on all cars, and also that the Board of Trade be asked to get an explanation from Colonel Yorke for not allowing their representative to sit after communicating with him regarding the enquiry."

The Use of Jacks in Manchester.

On August 27 an inquest was held on the body of a two-year-old child (son of a tramcar driver) who was knocked down by a car in Dickinson Road, Rusholme, Manchester. A witness named Sydney Gibson said the tramway men brought jacks from different cars, but three were quite useless, because the ratchets would not work. The child had become wedged under the pilot board at the back of the safety cradle beneath the driver's platform. After 18 minutes the car was raised and the body released.—Mr. F. E. Handley, car shed superintendent, said the drivers should know how to use a jack, but in the excitement they might have forgotten to push a catch back.—The witness Gibson said he knew how to use a jack, but two of those that were brought were immovable, being covered with rust. The car was raised by a jack that was new. Mr. Jordon, on behalf of the Corporation, said they had made the fullest inquiry, but had not been able to discover a defective jack.—The jury returned a verdict of accidental death, and added that in their opinion the jacks were not in order, or else the drivers were not instructed how to use them. They wished the matter to be brought before the Corporation with a view to having the jacks kept in readiness to be used freely, and also with a view to proper instructions being given to the men.