New Vertical Lift Bridge at Middlesbrough

The illustration above shows the new vertical lift bridge at Middlesbrough in position for vehicles to pass over it. The bridge is the first of the vertical lift type to be built in this country, and is claimed to be the largest of its kind in the world. The photographs illustrating this article are published by courtesy of the engineers, Messrs. Mott, Hay and Anderson.

THE vertical lift bridge across the River Tees at Newport, Middlesbrough, opened in February 1934 by the Duke of York, is the first bridge of this type to be erected in this country, and is claimed to be the largest of its kind in the world. It has a span 265 ft. 4 in. between the bearings of the moving portion, and carries a roadway 38 ft. wide between the kerbs, in addition to two footpaths each 9 ft. in width. When the moving portion is raised for ships to pass, the navigable waterway, which is 250 ft. in width, has a clearance of 120 ft. between high water level and the steelwork of the bridge. When the span is down there is a clearance of 21 ft. The bridge took nearly three years to build and the work cost nearly £500,000, including the cost of the land.

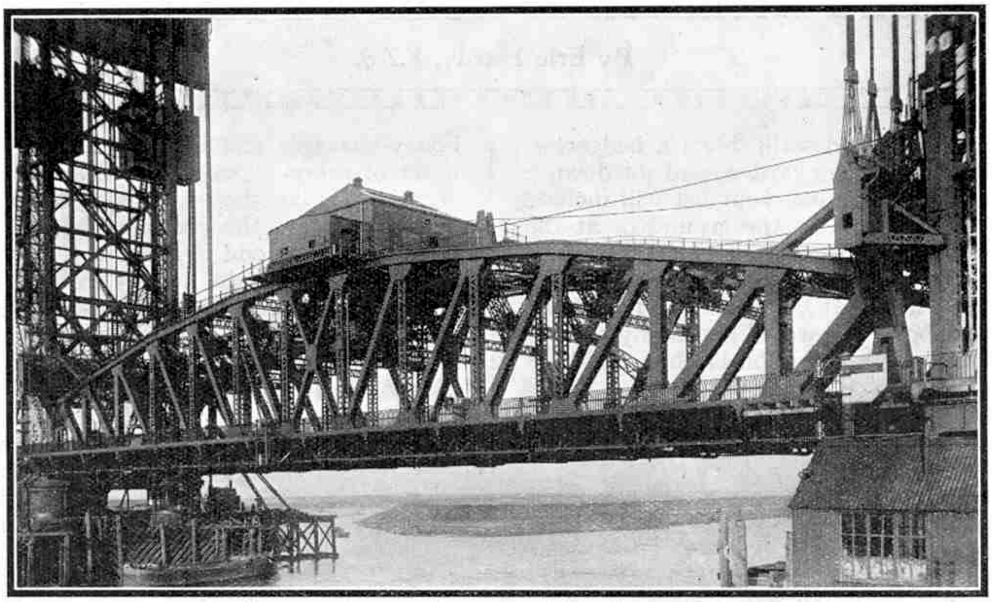
The scheme of which the new bridge forms the principal part has been carried out to the order of a Joint Committee of representatives of the Durham County Council and of the Middlesbrough Corporation, and provides communication between Newport and Haverton Hill Road. This road forms a connection between Stockton-on-Tees and Billingham, and has recently become of increasing importance owing to the industrial development in Billingham and the neighbouring districts.

To effect communication with Haverton Hill Road an approach road was constructed across some low-lying ground on the north side of the river. This approach is carried on an embankment of blast furnace slag for a length of more than 3,000 ft. Half way along the embankment it was found necessary to construct another bridge in order to carry the road across the Billingham Beck branch of the London and North Eastern Railway. This bridge is built of steel, with five spans, and it is the first highway bridge in the country the structural work of which has been erected entirely by welding. On account of the peaty nature of the subsoil, and in order to avoid disturbance of the rail tracks, the five spans of the bridge are supported partly on octagonal reinforced-concrete piles 18 in. in diameter, and partly on 4-in. diameter cylinders, all of which were sunk to a depth of 70 ft. The bridge is 216 ft. in total length, and carries a 38 ft. roadway with a 9 ft. footpath on each side. These widths of roadway and footpath are standard also for the lifting bridge and throughout the approaches.

From the embankment, the lifting span is reached over three approach spans of plate-girder construction, while on the south approach there are two spans of similar construction followed by a 154-ft. span carried on double warren trusses. Continuing along the south approach, there is a reinforced-concrete box abutment, a skew span of 68 ft., and finally a 500-ft. length of embankment on a falling gradient, built between two concrete retaining walls.

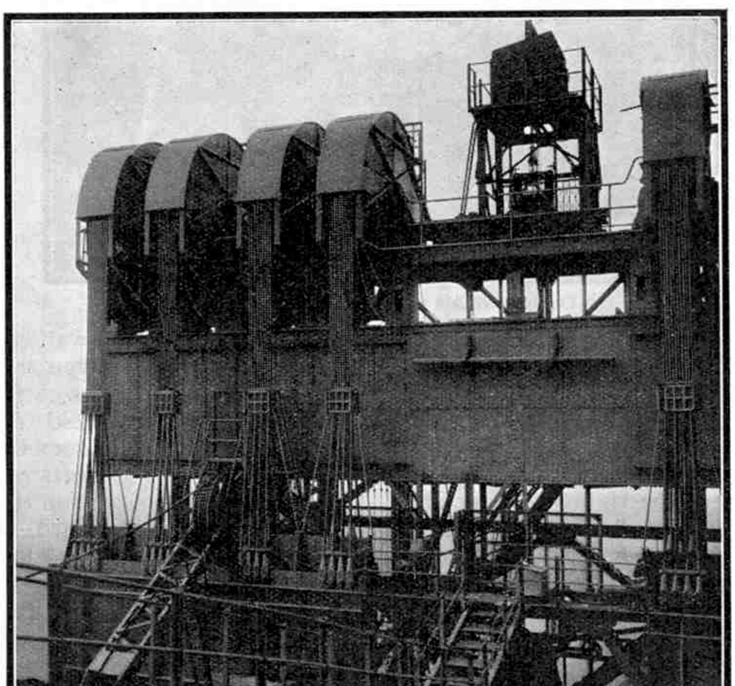
The lift span, which weighs 2,700 tons, is suspended from two supporting towers, and is arranged so that it can be lifted and lowered vertically between them to allow boats to pass. To enable the span to be lifted in this way without the necessity for extremely powerful engines, it is provided with four steel counterweight boxes, to which it is connected by means of 80 wire ropes that pass over eight pulley sheaves arranged at the top of the towers. These sheaves are steel castings 15 ft. in diameter, and are mounted on roller bearings and protected against the weather by a number of hoods. The counterweight boxes, which hang vertically, are partly filled with burr concrete, a material in which the customary stone aggregate is replaced by steel punchings ; and the remaining part of the weight required is made up of cast iron blocks to enable final adjustments in weight to be made.

The two towers that support the lift span are each 156 ft. in height. As the counterweights exactly balance the span, the towers have to carry a combined moving weight, or load, of 5,400 tons, half of which is taken by each tower. This load is a vertical one and therefore it is borne by the vertical front legs of the towers, which form guiding surfaces for the ends of the lifting span. The remaining portions of the towers are merely bracing supports for the front legs, and transverse and longitudinal wind bracing.



A close-up of the lift span showing the machinery house, below which the operator's cabin is situated.

Each of the towers is supported on a foundation that consists of four cylinders, arranged in two pairs, that have been sunk into the bed of the river to depths varying between 75 ft. and 90 ft. below high water level. The front pair support the two vertical legs just referred to and are of massive construction. The bottom 24 ft. of each of these front cylinders is a steel caisson of 27 ft. diameter that was sunk into position under compressed air. The remainder, or upper portion, consists of a series of cast iron cylindrical segments bolted together and filled with concrete as they were being sunk. The rear pair of cylinders support the curved rear legs of the tower, and as the weight imposed upon them is much less they are smaller, being only 10 ft. in diameter above the bed of the river and 14 ft. in diameter below. The four cylinders are protected from damage by shipping by what are known as "dolphins." These are made of timber and consist of piles sunk into the river, joined by crossbracing and covered with special sheeting.



The top of one of the bridge towers, showing the pulleys, which are 15 ft. in diameter, and the hoods to protect them from the weather.

The bridge is electrically operated from a control cabin slung beneath the machinery cabin which is situated centrally on top of the lift span. The necessary power is obtained from the high-voltage A.C. mains of the Middlesbrough Electricity Department, and is fed to a sub-station built near the south approach to the bridge, where it is transformed to low-voltage current. It is then passed to vertical conductors that extend up the face of the south tower, and collector shoes engaging with them convey the current to the machinery cabin. Inside this cabin it is converted into direct current and is then led to the two motors that, through geared shafts, operate the four winding drums. Emergency operating plant for use in the event of a failure of the electricity supply consists of a Thornycroft petrol engine in the machinery cabin, that can drive the drums, and windlasses and gearing for raising and lowering the lift span by hand.

The construction of the vertical lift bridge and its approaches was begun in March 1931, the engineers being Messrs. Mott, Hay and Anderson, of London, S.W.1, and the constructors, Dorman, Long and Co. Ltd.

It is not known when the first vertical lift bridge was built, but during the 19th century several short span bridges of this type were erected across canals in Europe and America. It is interesting to note that one of the earliest really important vertical lift bridges to be planned was intended to span the River Tees near the site of the present structure, but the design was rejected. This proposed bridge had a lifting span 200 ft. long that could be raised 40 ft. and was to be moved up and down by withdrawing water from and adding it to a tank that formed part of the counterweight of the bridge. The first large vertical lift bridge was erected over the South Chicago River at Chicago in 1894. It had a lifting span 130 ft. long which, when raised, provided a vertical clearance of 155 ft.

Some excellent examples of modern vertical lift bridges span the reconstructed Welland Canal in Canada. The height of lift of the bridges ranges from 108 ft. 2 in. to 115 ft. 2 in., and the combined weight of lifting span and counterweight is from 1,036 to 2,054 tons. The width of the lifting span of some of the bridges is 20 ft. and that of others 30 ft. The bridges vary in minor details, but in general design each consists of two vertical towers and a horizontal span that is moved up and down between them by cables worked from the machinery house at the centre of the span, as is the case with the Middlesbrough bridge.