Myton Bridge, Hull, UK

Le pont Myton à Hull, Royaume-Uni

Myton-Brücke, Hull, England

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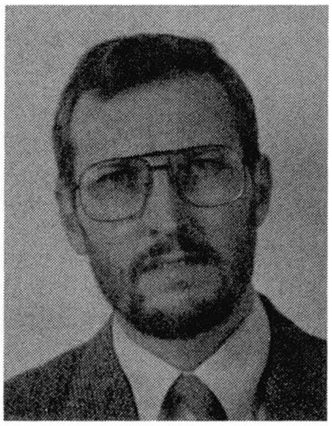

On graduating from the University of Leicester, UK, Chris Davis joined Freeman Fox & Partners and was involved in the design of cable supported and steel long span bridges. Chris Davis is now Technical Director responsible for major bridge projects.

SUMMARY

This paper describes aspects of the design and construction of a steel box girder cable stayed swing bridge.

RESUME

La présente communication décrit les caratéristiques du projet et de la construction d'un pont basculant haubané à poutre-caisson en acier.

ZUSAMMENFASSUNG

Dieser Beitrag beschreibt Entwurf und Erstellung einer Dreh-Schrägseilbrücke mit Stahlkastenträger.

1. GENERAL

The Myton Bridge in Hull, UK, crosses the River Hull 250m north of its confluence with the Humber Estuary. The bridge forms part of the Hull South Orbital Road which provides a direct link for heavy traffic travelling between the dock system East of Hull and the trunk road network to the West.

The River Hull serves as a busy and active port used by vessels up to 1500 t gross weight and 60 m in length. As it was not possible to make the bridge high enough to allow all ships to pass underneath it, a movable bridge was required.

Freeman Fox & Partners designed and supervised construction of the bridge on behalf of the client authority, Humberside County Council.

2. DESIGN REQUIREMENTS

2.1 Alignment

It was a planning requirement that the west approach to the bridge should intersect at grade with an existing junction some 200 m from the river. This requirement ruled out the option of crossing the river by a fixed high level bridge. A low level bridge also had considerable aesthetic and environmental advantages which were important because of its location adjacent to Hull's historic Old Town.

The horizontal alignment was determined by land availability and resulted in a crossing of the river at a skew of 22°.

2.2 Shipping Requirements

It was important to minimise the daily requirement for openings of the bridge to permit shipping movements in order to minimise interruptions to road users. The bridge's vertical alignment was, therefore, to be kept as high as possible, consistent with the constraints already discussed, and its construction depth kept to a minimum. This would permit free passage of barges which form the major part of the river's traffic, something which the existing bridges over the river could not do.

Nevertheless, at least one opening of the bridge to shipping was anticipated at every high tide (i.e. two openings per day). A system which could be operated speedily and with minimum interruption to road traffic remained an important requirement.

2.3 Loading Specification and Design Standards

The loading specification adopted conformed to the current British Standards for trunk road bridges. In addition to the basic HA loading, the abnormal 1800 kN HB vehicle was allowed for.

Design of the bridge steelwork was in accordance with the Interim Design Working Rules (IDWR) which were in force at the time, but have since been superseded by BS 5400.

3. DESCRIPTION

3.1 Bridge Superstructure

The structure is a 32 m wide cable stayed bridge carrying dual three lane carriageways and footways. Its spans are 55.6 m and 28.4 m; a navigation clearance between fenders of 30 m is provided. The nose end of the main span is skewed by 22° so that the landing pier can be set parallel to the navigation channel. The back end is radiussed in plan. Longitudinal and transverse

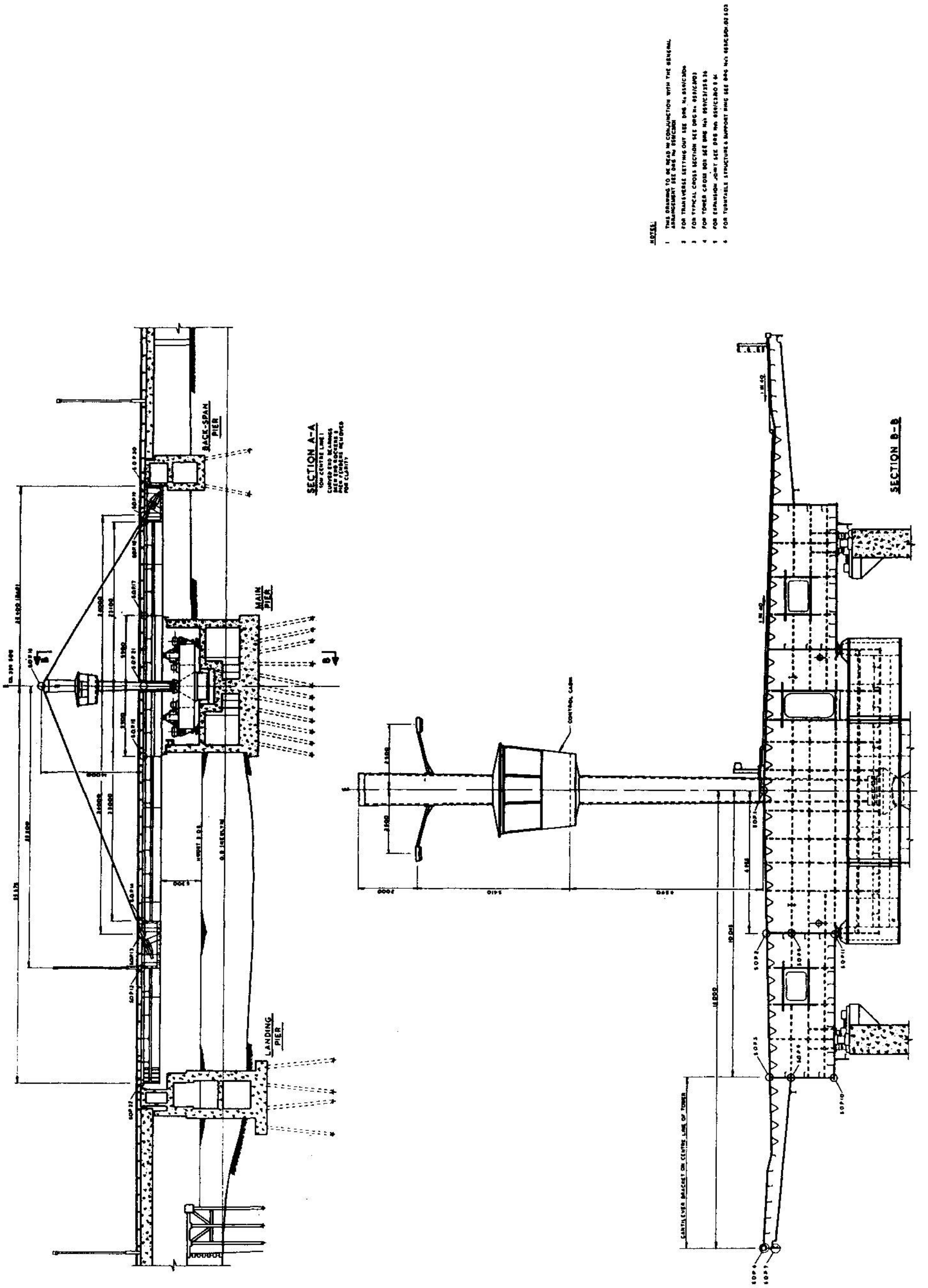

Fig. 1 Longitudinal and Transverse Section

sections are shown in figure 1.

The deck comprises twin steel box girders interconnected by cross girders at 3.3 m centres and surmounted by a steel orthotropic deck plate surfaced with mastic asphalt. Transverse box girders are provided at the main pier and at the anchorages for the cable stays in the main and back span.

The cable stays are formed by six parallel 84 mm diameter spiral strands, each with a minimum breaking load of 6000 kN. These pass over a cast steel saddle which is supported by the hollow steel pylon at the main pier. The socketed stays are anchored within transverse box girders after passing through cast steel splay saddles supported by sliding bearings. The strands are linked by clamps at third points between saddles to present oscillation due to wind excitation. Provision is made in the design for replacement of all stay strands.

Approximately 9000 t of steel is used in the bridge superstructure but, because of the unequal spans, a further 630 t of steel and concrete ballast is required in shorter back span to balance the structure.

3.2 Articulation

At all times, the whole superstructure, including the pylon, rests on a cast steel pivot which is carried by a fabricated steel turntable structure. The turntable is mounted on a 4 m diameter roller bearing slewing ring which is fixed to a drum girder cast into the main pier.

The articulation of the bridge is designed to suit its two operating modes as illustrated in figure 2.

3.2.1 Traffic Position

In the traffic position, two retractable pedestal bearings provide vertical support to the nose of the bridge at the landing pier; two sliding pot bearings support the backspan end. Folding wedge bearings mounted on the main pier wall provide additional support to each longitudinal girder.

A retractable shear key on the bridge's nose engages in a slot in the landing pier to provide transverse fixity.

3.2.2 Slewing Mode

Support to the superstructure in the shipping position, and during slewing, is provided at three points on the turntable structure. Primary support is by the centre pivot. Steel bearings mounted on outrigger girders on the turntable provide stabilising reactions as well as transmitting the slewing torque to the superstructure.

When the bridge is being made ready for opening to shipping, the sequence of operations is as follows. After the folding wedge bearings at the main pier have been disengaged, the nose of the bridge is lifted by hydraulic rams so that the pedestal bearings can be withdrawn. Then, as the rams lower the nose, the whole superstructure pivots so that it comes to rest on the three point support provided by the turntable structure and the back end lifts off and disengages from the backspan pier bearings. Finally, the nose shear key is withdrawn, and the bridge is ready for slewing.

3.3 Operation and Maintenance

The torque to slew the bridge during all movements is provided by twin hydraulic rams connected to the turntable structure and reacting against the main pier wall. In order to prevent over-slewing of the bridge, a buffer unit is mounted on a plinth on the East bank. A similar unit is also provided on the Landing

Pier.

Bridge operations and movements are controlled from the control cabin which is mounted on the pylon and affords the controller a good view of both road and shipping traffic. Sensors and tansducers linked to display panels ensure that the position and mode of all parts of the bridge are known. Interlocks prevent incorrect and possibly damaging sequences of operations being following. CCTV cameras provide additional visual data.

There is provision for future replacement of all mechanical parts of the bridge, including bearings, the slewing ring, actuating hydraulic rams, power packs etc.

3.4 Bridge Substructure

3.4.1 Main Pier

The main pier is an 18.5 m diameter circular hollow reinforced concrete structure founded on precast concrete driven piles. As well as housing the turntable structure and drive mechanism, it contains the principal and standby power supplies, communications equipment and messing facilities. The main pier also gives access to the inside of the pylon, and thence to the control cabin.

3.4.2 Landing Pier

The landing pier is of a similar form to the main pier. There is a direct link to the main pier for communications and other services by a 1 m diameter services tunnel under the river bed.

3.4.3 Backspan Pier

Also founded on piles, the backspan pier is radiussed in plan. There is a direct link for services to the main pier.

3.4.4 Fendering

In addition to the fendering mounted on the landing pier, substantial greenhart piled fendering is provided along both sides of the navigation channel. Its function is to guide shipping and to protect the bridge superstructure in the shipping position from damage by shipping collision.

a) Traffic Position

b) Slewing Mode

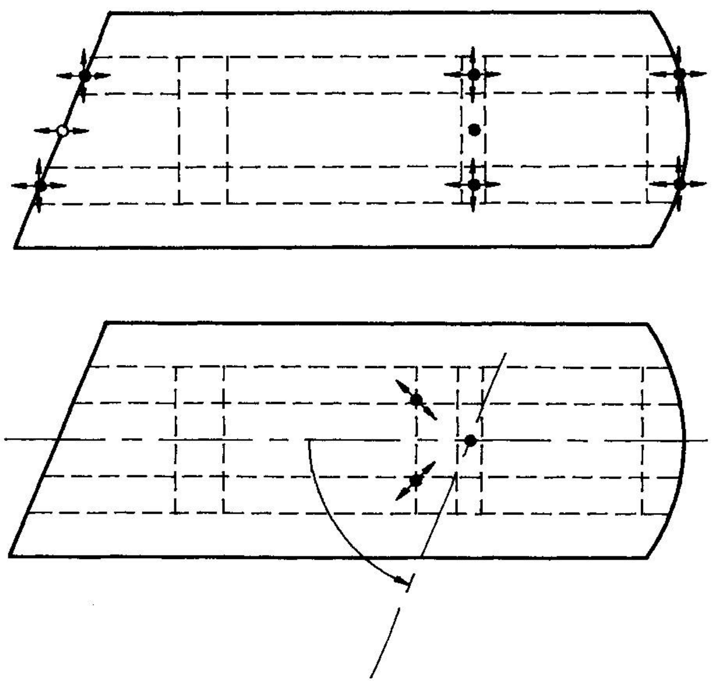

Fig. 2 Articulation

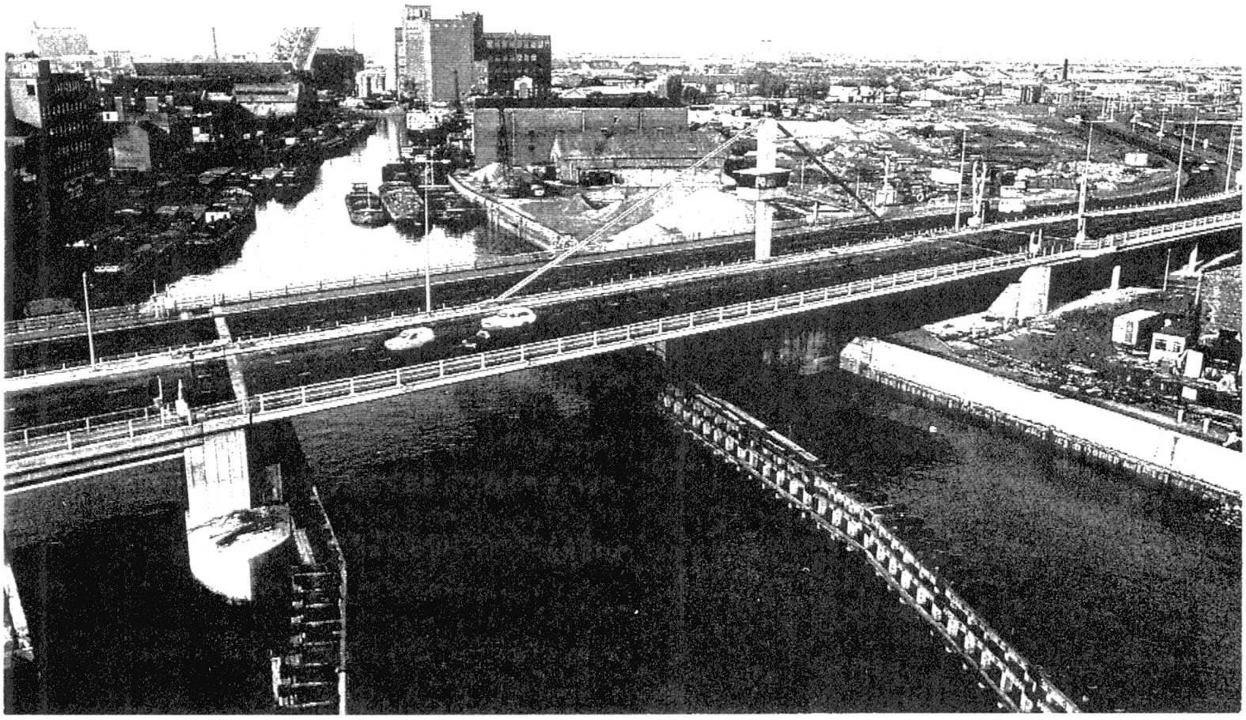

Fig. 3 Myton Bridge, Hull

4. CONSTRUCTION

The steelwork was fabricated and erected the Cleveland Bridge & Engineering Co. Ltd in Darlington, acting as sub-contractor to RDL Contracting Ltd.

The main pier transverse box girder, the turntable box, the pylon and lengths of the longitudinal box girders were assembled at works. All other parts of bridge were assembled at site during erection. The fabricated panels were transported by road to Hartlepool from where they were transported to Hull by ship. The journey from Hull docks to site was completed by road.

The bridge was erected on temporary supports on a line parallel to the shipping position. Site connections between fabricated panels were by welding.

Initially the structure was offset from its final position so that the longitudinal girders were wholly over land and so could be propped by simple trestles. As soon as the whole length of the deck was complete, it was slid into the shipping position, temporary supports continuing to be provided at the nose and back end. The deck was then lowered onto the turntable structure which had already been installed in the main pier. The counterbalancing concrete was then placed in the backspan and the cable stays installed and set to their final length.

After checks of the longitudinal out-of-balance moments by direct measurement with load cells, the whole weight of the structure was transferred to the turntable structure alone. The bridge could then be slewed into the traffic position for final setting of joints and bearings and the temporary supports removed.

The bridge, shown in figure 3, was opened to traffic in December 1980.