# Shatt-Al-Basrah Bridge A swing bridge with a hydraulic drive

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In the course of the construction of the express road in the vicinity of Basrah a few years ago, a bridge with a total length of some 600 metres was built over the Shatt-Al-Arab waterway.

As a part of this, a swing bridge was built over the shipping channel in order to allow ships to pass. The bridge as a whole with its 14 spans was constructed of prestressed concrete.

It was also decided to build the swing bridge in prestressed concrete. The building authority, the Ministry of works and housing, Directorate general of roads and bridges, Republic of Iraq, placed contracts with a consortium consisting of Polansky and Zöllner civil engineers, Frankfurt am Main; Julius Berger-Bauboag AG, Wiesbaden; and ENKA, Insaat Ve Sanayi, AS Istanbul, for the construction of the bridge.

The above consortium then engaged the company Waagner-Biro of Vienna to design, supply and assemble the mechanical part of the bridge. Under this contract, Waagner-Biro designed the mechanical parts, complete with the drive system.
The hydraulic drive system was supplied by Mannesmann Rexroth.

## 1 A general description of the bridge

The bridge was designed as a swing bridge having two equal arms. It has an overall length of 67 metres and a width of 21 metres. In the open position, this allows two channels open to shipping, each having a width of 23 m.

The overall weight of the swinging portion, as mentioned above a unique prestressed concrete construction, was 2200 tonnes.

## 2 Supporting the bridge

The whole weight of the bridge in the open position, and also the bridge plus the weight of vehicles in the closed position is transmitted by a central pier to the foundations. The bearings for the bridge are mounted on this pier, together with the rotary drive for the bridge with its associated hydraulic power units and electrical controls.

The vertical forces are taken by a special taper roller bearing. This bearing has a diameter of 10 metres, taken to the centre of the bearing track.

The horizontal forces are carried by a rotary axis. This transfers the forces to a fixed shaft via taper roller bearings.

This shaft also carries the drive lever for the cylinders driving the bridge. The rotary movement is transmitted to the bridge via a further hollow shaft and a second lever.

The design of the bearings for the bridge is shown in *figure 1*.

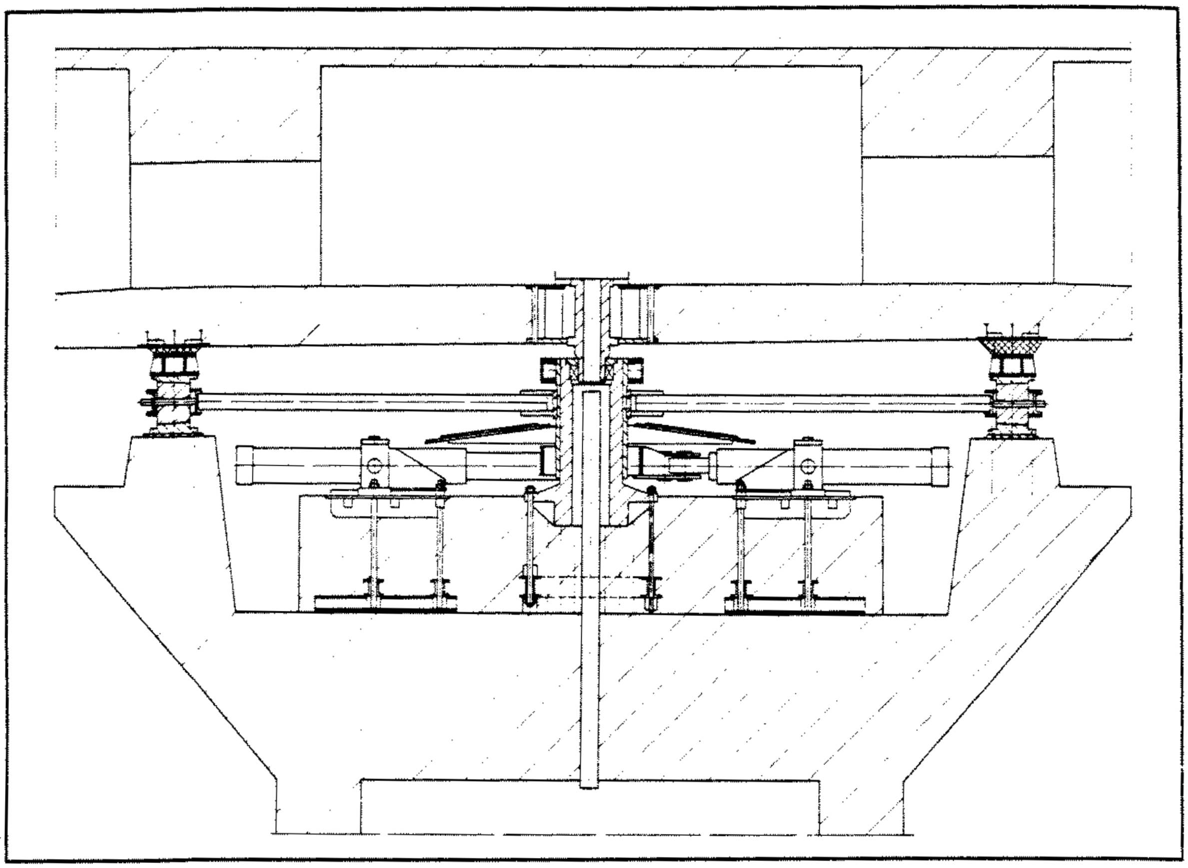

Fig. 1: *Shatt-Al-Basrah bridge, bridge bearing*

*Figure 2* shows a detail of the taper roller bearings. From this diagram, it can be seen that the 480 mm diameter rollers are carried in an annular cage. Each roller is individually adjustable, so that all 42 rollers carry an equal share of the weight. All rollers are equipped with an automatic lubrication system in order to minimise the servicing requirements of this large bearing.

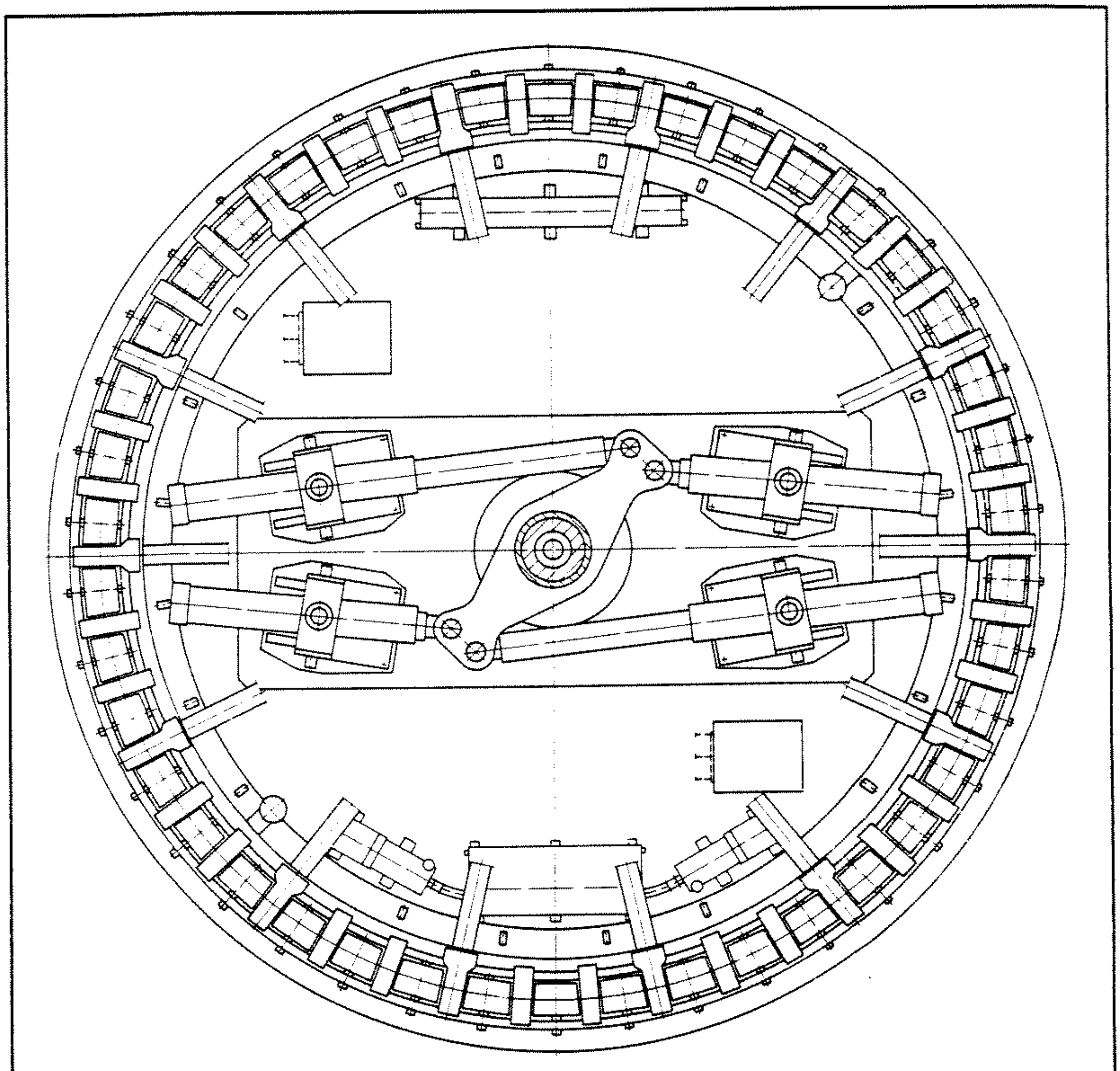

Fig. 2: *Shatt-Al-Basrah bridge, bridge bearing and drive system*

## 3 The rotary drive

The rotary drive to the bridge is via four plunger cylinders working in opposed pairs so that two are active (extending), and two passive (retracting), in each direction of rotation. The cylinders and the drive system are both designed so that should a failure occur, the bridge may be operated by one cylinder.

Due to the opposed hydraulic cylinders, the bridge is always hydraulically restrained to ensure that in no circumstances can it run away.

*Figure 3* shows the drive cylinders. Also in figure 3, the arrangement of the 42 tapered rollers can once more be seen.

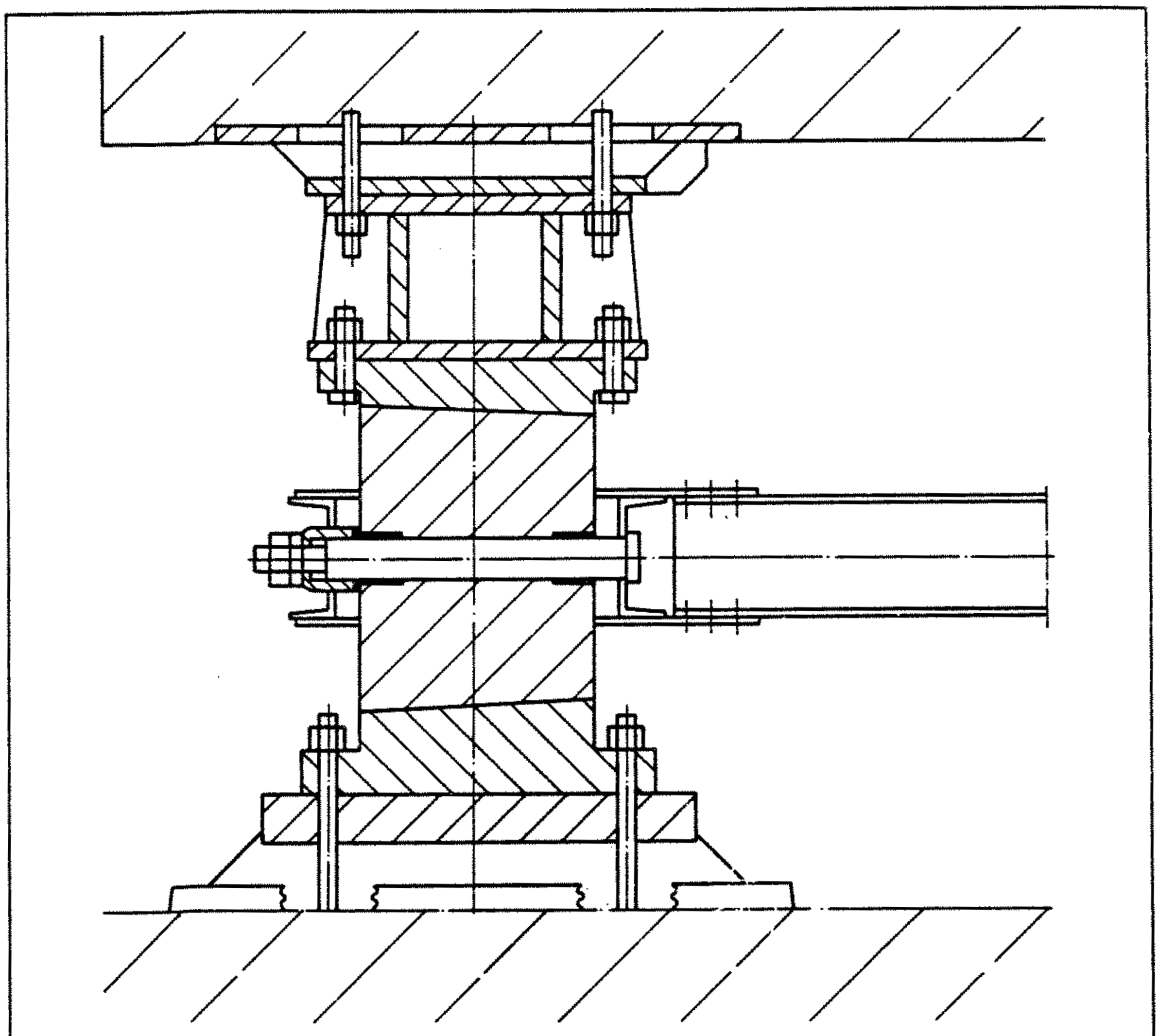

Fig. 3: *Shatt-Al-Basrah bridge, detail bridge bearing*

# 4 The locking system

In the closed (traffic) position, the bridge is locked at 4 points, with two separate systems at the ends of the bridge. In view of the unusual weight of the bridge, a special design of lifting/locking system had to be produced by *Waagner Biro*.

As mentioned earlier, the bridge is of hollow section prestressed concrete. The locking device for the bridge is fitted within these hollow sections. The lifting section of the locks, and also the mating parts for the locking devices are mounted in the fixed sections of the bridge. This separate arrangement of the locking and lifting mechanisms was necessary due to the bridge bending some 150 mm during the opening phase. Such a large bending movement cannot be accepted by a specially formed locking device, and must be taken up by the separate lifting mechanism.

The locking mechanism mounted in the moving bridge consists of two locks 5700 mm apart at each end of the bridge, mounted in a steel framework. The bolts are of rectangular section 400 x 550 mm. Both vertical and horizontal guides have roller bearings, thus permitting the locking forces to be relatively low. The drive to the locks is via a direct coupled hydraulic cylinder. The design can be seen in *figure 4*.

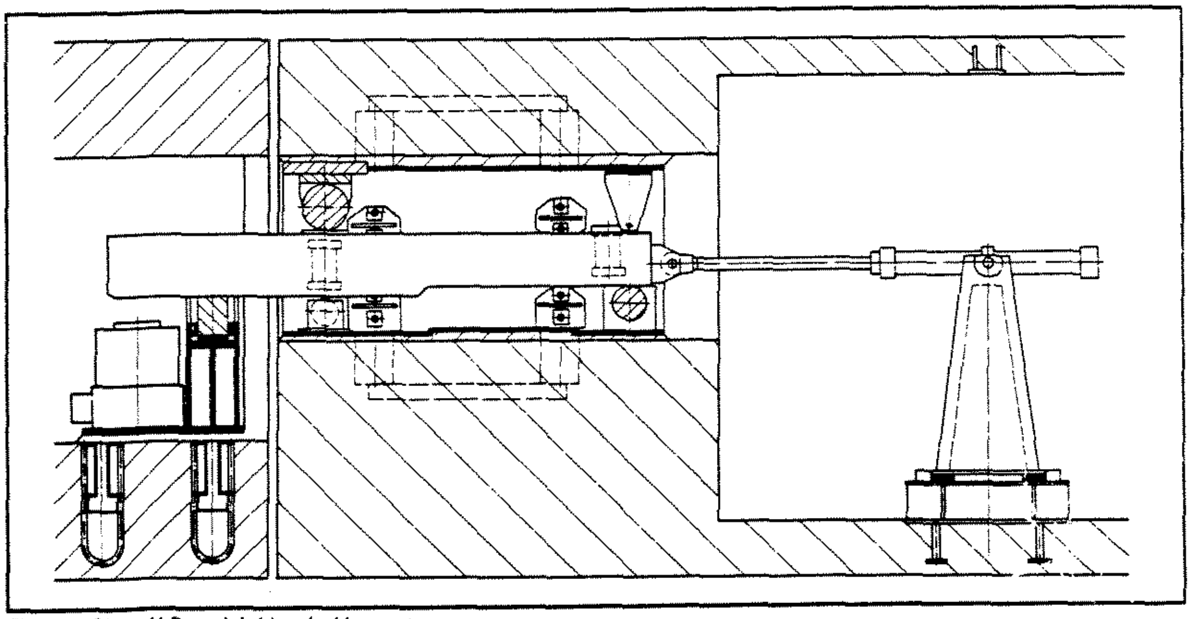

Fig. 4: *Shatt-Al-Basrah bridge, locking system*

The lifting mechanism fitted into the fixed sections of the bridge are also equipped with extending locking pins. When the bridge has been swung into the traffic position, the locking pins extend from the moving portion in order to engage in the fixed sections. In order to centralise the bridge, one of the four locking pins is designed as a locating pin. When the bridge has been centralised, the lifting cylinders lift the ends of the bridge via the extended locking pins until the surface of the moving and fixed sections are at the same height. When this has been achieved the four horizontal locking pins are then entered under the previously extended locking pins from the moving section, in order to hold the bridge at the correct height. Finally, the lifting mechanism is lowered, lowering the bridge onto the fixed supports. The lifting mechanism is thus unloaded.

The hydraulic drive to the lifting device can be seen in *figure 5.*

When opening the bridge, the above process is reversed. The lifting cylinders are extended, the horizontal locks withdrawn, the bridge lowered, and the extending locks retracted, allowing the bridge to bend to its free position. The bridge is then once more only supported on the taper roller bearing on the centre pier.

## 5 The hydraulic drive

The bridge has now been working for a number of years to the entire satisfaction of the specifying authority. The hydraulics operate perfectly in spite of the adverse environmental conditions (frequent sand storms).

At this point, we would particularly like to thank Waagner Biro for their cooperation and kindness in passing information to us, thus allowing this presentation to be produced.

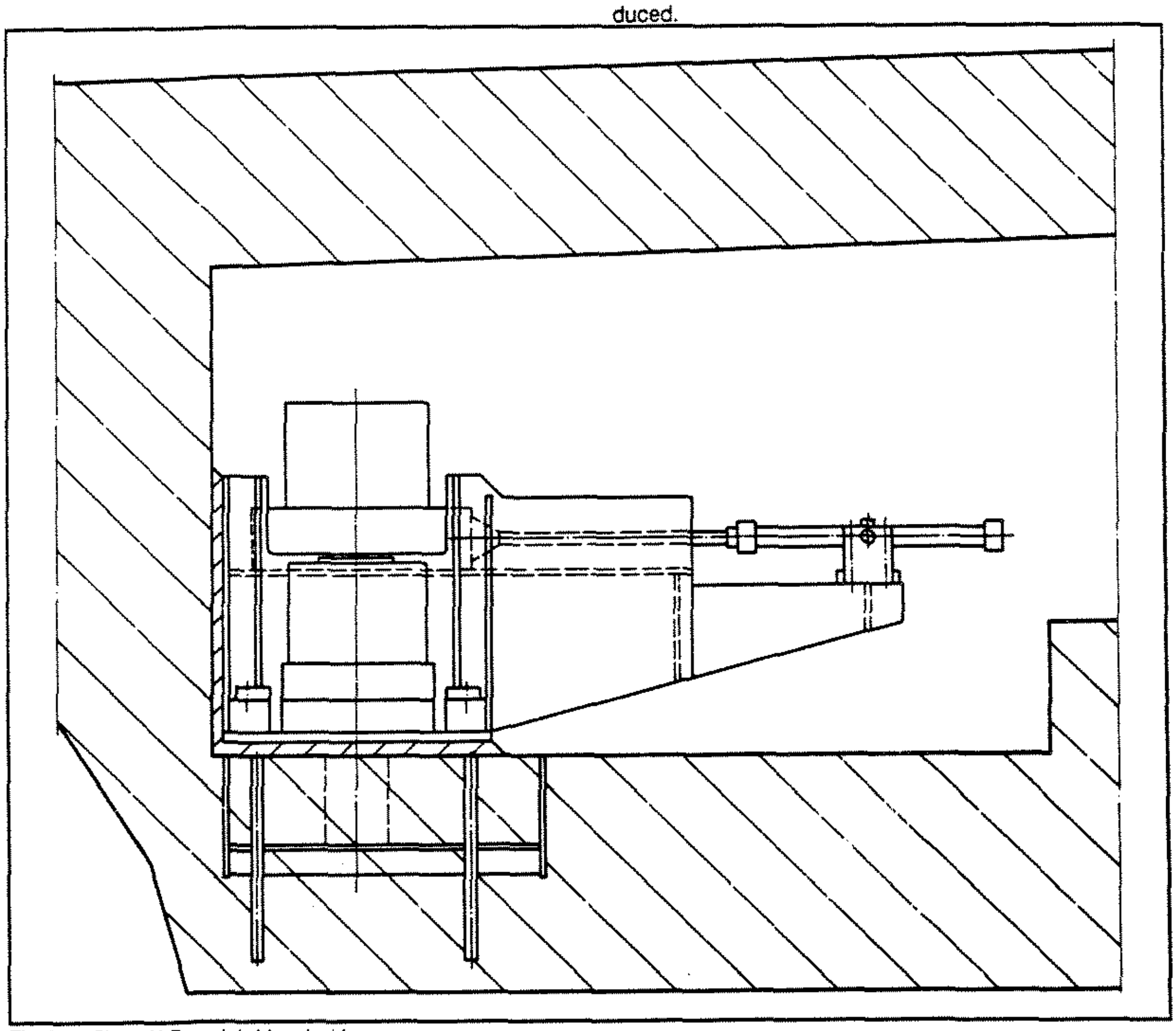

Fig. 5: *Shatt-Al-Basrah bridge, locking sysem*

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