BASCULE BRIDGE "STADE"

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In order to direct traffic away from the city of Stade (which is located at the Lower Elbe, to the Northwest of Hamburg) a road was built, and this road required a bascule bridge to cross the river Schwinge. Traffic on the Schwinge consists mostly of coastal motor boats. The bridge has the following dimensions:

Support width of the bridge: 24.65 m

Clear passage opening between the supports: 16.1 m

Road surface width: total 13.0 m out of this the walkway is 3.25 wide

2-lane road for vehicles: 8.0 m

Right-hand walkway: 1.75 m

To avoid expensive and time-consuming foundation and underground structure work, the bridge was designed as a balance beam bridge. Each of the bridge abutments was put on 3 concrete poles with a 1.7 m diameter.

On these posts rests a concrete plate which carries the pylons and the engine cabin with the control cabin. See drawing sheet 1 through 3 for the design of the bridge. The bridge is located in a picturesque landscape, therefore, the steel construction of the bridge had to look good. For example, each pylon consists of 4 steel pipes; also, the balance beam consists of steel pipes and the counter weights at the balance beam are of a round design, also.

Bridge Drive

The bridge is driven by 2 hydraulic cylinders. These hydraulic cylinders are located at the two pylons and engage at a special beam which is located parallel to the left and right of the road. The balance beam system is connected with this beam, also. This engineering design guarantees that the drive system and the counter weight system are not affected by forces of distortion of the bridge through a) heavy traffic and b) heavy winds. The cylinders are supported at the pylons by means of trunnions. The connection at the beam of the bridge is done via a swivel bearing (spherical bearing) to prevent shearing forces from affecting the piston rod.

Oil Hydraulic Drive System

The entire drive system is designed to allow for a maximum of operating safety and feasibility.

The bridge is operated with 2 different speeds. With a wind load of 0.5 kN per square meter which corresponds with a wind speed of 2 km/h the bridge moves at the following speeds:

open bridge: 120 seconds
close bridge: 130 seconds

With wind loads above 0.5 Kn/square meter up to 1.25 kN/square meter which corresponds with a wind speed of 161 km/h the bridge moves with the following speeds:

open: 240 seconds
close: 240 seconds

This makes the operation extremely economical. The electric motors and the entire electric supply are designed for normal operation only.

The preselection of the moving speeds is done via wind meters. These determine the speed of the wind and pass the correct drive diagram on to the bridge control.

As mentioned before, the bridge is driven via hydraulic cylinders with the following dimensions:

piston diameter: 300 mm
piston rod diameter-160 mm
stroke: 4870 mm

The max. traction is 800 kN per each cylinder and
the max. thrust is 775 kN

Since the wind forces, in accordance with the kinematics of the bridge, are not the same over the entire stroke, the cylinder is operated with various operating pressures. This made it possible to keep the cylinder and piston rod dimensions relatively small. An appropriate monitor makes sure that the permissible buckling load is not exceeded at any point of the cylinder stroke.

A manifold block is flanged to the cylinder both at the piston rod side and the piston side. This manifold block carries pressure relief valves which protect the cylinder against loads, i.e. wind loads above 1.25 kN/square meter. The following is mounted to the manifold blocks:

Brake valves which clamp the cylinder hydraulically.
By means of these special valves, a load change can easily be done without causing the bridge to vibrate. In order to balance differing cylinder loads due to torsion of the bridge with winds hitting at an angle, both cylinders are connected with one another through so-called pressure compensating lines which prevents differing bridge torsions.

The pressure oil supply of the cylinder is done via 2 axial piston units with pilot oil pumps flanged onto the system. The pumps have hydraulic controls via an appropriate pilot piston.

The pilot piston is controlled via a proportional valve. The pumps swivel out slowly via this proportional valve so that the max. drive speed is reached after approx. 15 seconds.

The pump swivels back in inching drive before the final 'open' or 'closed' positions have been reached. A ramp was installed for this purpose which lets the bridge decelerate from full speed in approx. 15 seconds. Acceleration and deceleration speeds can be set via the control electronics of the pumps. The speeds at the construction site can be optimized, also, as well as the inching speed with which the bridge sets down on the trunnion.

The direction is controlled via a hydraulically pilot controlled 4/3 directional valve. The cylinder chamber (which operated 3 pressure stages) at the piston side is connected via a triple pressure relief valve with 3 pressure ranges to be called up. There are pressure switches analog with these 3-range pressure relief valves which monitor the pressure in the cylinder chambers accordingly.

Another monitor is installed for the permissible wind loads in both cases of operation. The entire pipe system is checked for pipe damage via additional pressure switches. The pilot pressure for the entire pilot control of the valves is monitored through pressure switches.

Additional monitoring is provided through float level switches to monitor the oil level in the tank and to monitor the contamination level of the system.

An important monitor device is installed in the electronics for the pump station. This monitoring system prevents the bridge from going into the end position with full speed. If the pump is given the command to swivel back, i.e. it is told to go to inching drive in accordance with the drive diagram, this process is checked in the electronics system through corresponding potentiometers and monitoring devices. If the pump fails to carry out the command to swivel back, an emergency stop takes place so that the bridge is decelerated appropriately until it comes to a full stop in 'open' or 'closed' position before it reaches the trunnions.

Due to the limited space in the engine compartment which is located under the control stand, the entire power unit was designed as compact power unit. The following is mounted to the reservoir which has a usable volume of 2,000 1 - the reservoir volume is designed in such a way that a complete cylinder can be emptied into the reservoir in case of service work - the complete valve control, filters, and all monitoring systems. The two axial piston units with the coupled control units are flanged to the side.

To ensure trouble-free function, a return line filter is installed in the oil circuit, as well as 2 filters in the pilot control system after the pilot oil pumps. This ensures that the proportional valves always have clean oil.

Taking the ocean climate in consideration, all pipes are done in stainless steel, including all fittings and connections. For safety reasons, all pipes were done with flange connections and o-ring seals to guarantee a leakage free system.