Waterproof seismic protection for the Cayirhan Bridge

MAURER protects huge sliding isolation pendulums in Turkey against inundation by means of a rubber ring.

Munich, Cayirhan. **The Cayirhan Bridge crosses the Sariyar reservoir west of Ankara. Its pillars are periodically subjected to inundation. For the new bridge construction, large sliding isolation pendulums (SIP®) were designed, which have to fulfill three core tasks: ensuring full functionality at any time by preventing intrusion of dirt particles, accommodation of high loads exceeding 10,000 t as well as enabling service and seismic movements with a corresponding reduction of horizontal forces. As a specialist for seismic devices and bearings, MAURER has been chosen to deliver these SIP® bearings as well as all other bearings for the bridge.**

The new Cayirhan Bridge is part of the expansion of the D140 Ankara-Nallihan-Yolu towards the highway. It is built next to the existing bridge and is situated at the upper end of the Sariyar reservoir where the River Sakarya temporarily becomes a lake due to backwater in the reservoir.

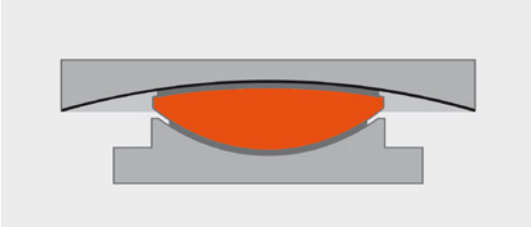
The new construction is a double bridge featuring a width of 13.5 m and a length of 270 m per driving direction. Each bridge has two base points with a distance of 176 m. From each base point, two concrete struts run with an upward incline and form a pedestal shaped like an inclined triangle. The heart of the bearing system is large SIP® bearings at the base points that may be inundated. In addition, flat sliding pendulum bearings are installed in the struts area and spherical bearings at the two abutments.

High loads and inundation

The framework conditions for the SIP® bearings at the base points of the Cayirhan Bridge are defined by three aspects:

- Inundation
- Earthquake risk
- High structural load

For the earthquake load case, a structural load of 45 MN had to be considered and 101 MN for the ultimate load case (ULS).



Schematic representation of a cross section of a sliding isolation pendulum. The inner red calotte can slide against the upper concave sliding plate with a pendulum move.

Graphics: MAURER

The old Cayirhan Bridge with the building site for the new double bridge with tunnel connections on the right.

Photo: MAURER

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To protect these bearings against pollution in case of inundation, they were equipped with a sophisticated circumferential protection ring made of 10 mm thick special chloroprene rubber. The rubber protection is a custom-built component from a company manufacturing such movable and watertight sheathings for use in the port area. The rubber ring features a curvature ensuring the mobility of the bearing.

Inundation also imposes special requirements on corrosion protection, since running water always carries small sand particles nibbling at the corrosion protection. This is why all bearing components not protected by the rubber sheathing were manufactured from stainless steel. The selected steel features the same solidity and load capacity but is corrosion-resistant.

The SIP® bearing before delivery to Turkey. The rubber ring protects the bearing against intrusion of dirt particles in case of inundation.

Photo: MAURER

Quadruple function in case of an earthquake

The SIP® bearings are designed to enable movements in all directions in case of an earthquake. Further specifications were free twisting capability of the bearings, 5.5 % friction and a 3.5 m radius.

This resulted in very large bearings with a diameter of 1.90 m, capable of accommodating the ultimate load of 101 MN.

The sliding bearings type SIP® (MAURER Sliding Isolation Pendulum) fulfill four tasks in case of an earthquake:

- They transfer vertical loads of up to 56 MN.
- They isolate the bridge deck from the foundation and allow for horizontal displacements of ±157 mm.
- They dissipate seismic energy through friction.
- They re-center the bridge superstructure to the center position after an earthquake thanks to the concavely curved sliding plate.

The single-sided movable sliding pendulum bearings contain a „calotte" as a tilting element with the upper surface slightly curved. This calotte is manufactured from MSA®, a particularly corrosion-resistant metal alloy (MSA® – MAURER Sliding Alloy) developed by MAURER. In case of bridge movements, this calotte slides horizontally in the concave sliding plate with a pendulum motion, whereby the bearing automatically re-centers to the center position in an earthquake by storing potential energy.

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The occurring sliding friction of 5.5 % acts like sort of a brake and ensures that the projected seismic movements of the superstructure are not exceeded. This horizontally flexible bearing function enables the reduction of the horizontal seismic loads by approx. factor 4 compared with a rigid retention.

Eight MAURER SIP® bearings have been installed, two at each base point. Due to the ultimate load all of them have been designed for a bearing load of 101,857 kN.

Flat sliding bearings for longitudinal movements

In addition, the bearing system includes flat sliding bearings and spherical bearings. Both types are not subjected to inundation.

The eight flat sliding bearings allow for horizontal displacements on all sides and consist of a polyethylene disc (MSM®) sliding against polished stainless steel sheet. They are installed at the outer struts half way up. They are designed for a structural load of 36,690 kN and feature a diameter of about 1 m.

Spherical bearings for vertical forces

A special construction protects the bridge against uplifting forces. The bridge deck is connected to the abutment structure through a concrete cantilever. The abutment encircles the bridge cantilever like a claw.

In between, i. e. above and below the bridge cantilever, one spherical bearing each is installed. A total of 16 bearings accommodate the arising traction and pressure forces. They are designed for 21,654 kN each. In addition, they compensate for displacements of the bridge deck by means of an inner joint called calotte.

The large SIP® sliding isolation pendulums were installed in March 2018, further bearings are to follow, depending on construction progress, until the end of 2018. The Cayirhan Bridge with subsequent tunnel work is scheduled to be completed in spring 2019. Building contractor is the regional highway direction section 4 Ankara.

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Quick facts about MAURER SE

The MAURER Group is a leading specialist in mechanical engineering and steel construction with over 1,000 employees worldwide. The company is market leader in the area of structural protection systems (bridge bearings, expansion joints, seismic devices, tuned mass dampers, monitoring systems). It also develops and produces vibration isolation of structures and machines, roller coasters and ferris wheels as well as special structures in steel.

Maurer participates at many spectacular projects world wide, like for example the world's biggest structural bearings for the Signature Bridge in Wazirabad, Delhi, earthquake resistant expansion joints for the Bosporus bridges in Turkey, semi-active tuned mass dampers for the Danube City tower in Vienna, or uplift bearings for the Zenit-Football-Arena in St. Petersburg. As for steel structures, the BMW World in Munich or the Terminal 2 of Munich Airport count among the reputed projects. In terms of spectacular amusement rides, to be mentioned are the world's biggest transportable Ferris Wheel R80 in Mexico, the Rip Ride Rockit Roller Coaster in the Universal Studios Orlando or the Fiorano GT Challenge in Abu Dhabi.

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