19 MN horizontal forces require vertically installed special bridge bearings

Pelješac Bridge, Croatia: Springs in the bearing core and special materials ensure long service life despite extreme loads through permanent contact of the sliding surfaces.

Munich, Pelješac. **The Pelješac Bridge, situated at the picturesque Croatian coast, will become one of the most impressive cable-stayed bridges, however, it is politically controversial. From 2022, it is supposed to connect northern Croatia with the country's south, in particular the region of Dubrovnik. In bridge construction, however, seismic faults are by far more important than political upheaval: the region is an earthquake zone; thus, the bearings must be capable of accommodating large movements and high horizontal forces. For this reason, half of the bearings have been installed vertically. To this end, MAURER developed a special solution to ensure that no gaps can arise between the sliding surfaces. In this way, wear is reduced and a service life of at least 50 years can be achieved.**

September 2020: View onto the Pelješac peninsula. The bridge is scheduled for inauguration in 2022.
Foto: MAURER

The Pelješac Bridge has been a political issue for years. The south of Croatia can be solely accessed overland via the city of Neum that, however, belongs to Bosnia-Herzegovina. The new bridge featuring a width of a good 22 m will connect the Croatian mainland to the offshore peninsula Pelješac thus opening a complete overland route from the north to Dubrovnik. It is designed as an express highway with two traffic lanes in each direction.

Cable-stayed bridge with twelve pylons

The remarkable length of the bridge of 2,404 m will be subdivided into 13 different areas. The main bridge across the so-called Pelješac Canal is a cable-stayed bridge with twelve pylons. The five central span widths each amount to 285 m (935 foot). The vertical clearance is 55 m.

Spherical bearings instead of pot bearings

Since the entire region is earthquake-prone, the bridge bearings must meet special requirements in terms of movability, durability, and load capacity. The planners envisaged two spherical bearings and two pot bearings each for the abutments and for six of twelve pylons in total. "However, we succeeded in convincing the customer that spherical bearings are the only way to meet the technical requirements," reports project manager Luca Paroli from MAURER. Spherical bearings are sliding bearings capable of accommodating arbitrary rotations in all directions without noticeable resistance via an internal spherical calotte joint and thus can transfer remarkably high forces restraint-free from the bridge deck into the substructure.

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16 vertically installed spherical bearings

In fall 2020, MAURER installed 32 spherical bearings in Croatia. The 16 bearings for bridge guidance in longitudinal direction presented a particular technical challenge. They must accommodate high horizontal loads of up to 19 MN and have to be installed vertically. In the process, it must be ensured that the sliding surfaces stay in close contact at any time. Wherever a gap arises, dust can ingress and compromise the sliding properties such as low friction. Moreover, this would result in wear that reduces the service life to five to ten years instead of at least 50 years as required.

To this end, MAURER developed special bearings featuring disc springs in the core. The springs keep the sliding surfaces in close contact at any time with a force of approx. 500 kN in center position, in addition, they have been designed fatigue resistant – due to often occurring wind forces. "This would not have worked out with pot bearings. In case of rotations, there would have been the risk of a gaping joint, resulting in significant wear and shortened service life due to a too rigid elastomeric element," explains Paroli.

As a basic principle, MAURER uses MSM® (MAURER Sliding Material) as high-performance material on all sliding surfaces. Compared to customary Teflon (PTFE), it can stand at least twice the structural load, in other words: the bearings can be built smaller by approx. 30 % and more economical. In addition, MSM® can bear at least five times the movements without wear. This is particularly important with soft bridges like the Pelješac Bridge in combination with the forces of nature acting on them. According to their technical approval, MSM® Spherical Bearings achieve a service life of 50 years.

Additional 16 MSM® Spherical Bearings, two for each pylon, were installed to accommodate vertical forces up to 33 MN. Since wind and earthquakes can result in uplift forces of up to 2 MN, the upper sections of the bearings are equipped with a cramp to prevent them from uplifting.

Furthermore, all bearings have to accommodate large, fast movements of up to ± 1.3 m in case of an earthquake. That requires a bearing length of up to 3 m. The largest bearings feature a width of 1.2 m and a height of approx. 330 mm.

Spherical bearing with a length of 3 m on the concrete base, the white steel deck has still to be lowered. The bearings accommodate vertical forces of up to 33 MN. Clearly visible: the cramp shape of the upper sliding plate that prevents the bridge from uplifting for forces up to 2 MN.

Photo: MAURER

Attention, mirror image! The bearing (lower half) is reflecting in the mirror-bright sliding plate made of stainless steel (top). This is why the cramps preventing uplift forces appear double at top and bottom.

Photo: MAURER

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Important issue for bearings and joints: corrosion protection

For reasons of corrosion protection (aggressive sea air), the steel components of the spherical bearings are not only equipped with a suitable C5-m coating; the important inner calotte joint is completely manufactured from one single material: MSA® – MAURER Sliding Alloy. Compared to a chrome-plated surface, this mirror-bright, extremely smooth and highly corrosion-resistant material allows for a reduction of tolerances by at least 50 % while featuring better accuracy of fit in the joint and a three to four times longer service life.

The required corrosion protection also affects the design of the expansion joints. These flexible structural elements balance the temperature and seismic movements of the bridge deck of up to 1,400 mm versus the mainland. Concurrently, it is ensured that traffic can pass these expansion joints without restriction, irrespective of their displacement condition. The expansion joints are installed right-angled to the direction of traffic.

The two joints, type swivel joist expansion joint DS1400 with 14 profiles, will be built by MAURER in hybrid design. In this case, hybrid means that the upper section of the steel profiles consists of stainless steel whereas the bottom section is made of structural steel, which provides high corrosion protection. The expansion joint will be delivered to Croatia in one piece since no welding work on the joint was allowed at the jobsite. This means the expansion joint must only be lifted in position as one component by means of a crane and fastened to the structure, which will take no more than one to two days per joint.

The construction work at the current Pelješac Bridge – a first project was discontinued ten years ago – started mid of 2018 and is scheduled to be completed by the end of 2022. Building contractor is CRBC (China Road and Bridge Corporation).

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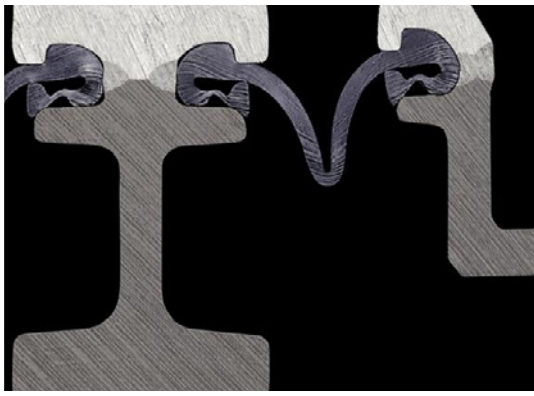
One of the two expansion joints with a length of 23.6 m, type swivel-joist expansion joint DS1400 with 14 profiles; picture taken in the production hall in Munich prior to delivery to Croatia.

Photo: MAURER



Cross section of a hybrid profile: the upper part made of stainless steel features an outstanding corrosion resistance, exactly in the area of highest impact by traffic and weather conditions.

Graphic: MAURER

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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, roadway expansion joints, seismic devices, tuned mass dampers, and monitoring systems). It also develops and produces vibration isolation of structures and machines, roller coasters and observation wheels as well as special structures in steel construction.

MAURER participates in many spectacular large-scale projects worldwide, like, for example, the world's biggest bridge bearings in Wazirabad, earthquake-resistant expansion joints for the Bosporus bridges, tuned mass dampers in the Baku and Socar Tower, or uplift bearings for the Zenit Arena in St. Petersburg. Complete structural isolations range from the Acropolis Museum in Athens to the new major airport in Mexico. Spectacular amusement rides include, for example, umadum – the Munich observation wheel, the Rip Ride Rockit Roller Coaster in the Universal Studios Orlando, or the worldwide first duelling roller coaster at the Mirabilandia Park in Ravenna.

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