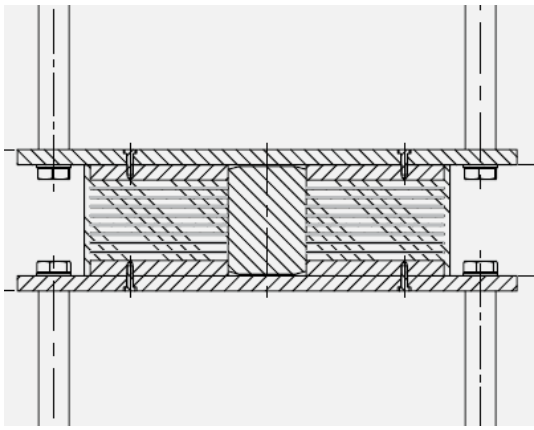
First hospital with seismic isolation in Mexico City

243 isolators from Brazil, Turkey, and Germany protect the Hospital de Tláhuac.

Mexico City. **The subsoil underneath Mexico City can be imagined as a giant piece of Jell-O: it magnifies seismic shocks. For this reason, a hospital in the 9-million metropolis was equipped with a special seismic isolation made of elastomeric bearings for the first time. With its extensive know-how, MAURER was already involved in the planning phase and supplied 243 isolators, mainly lead rubber bearings.**

The main hospital in the southeastern district of Tláhuac was officially inaugurated on December 19, 2020 and immediately admitted 120 Covid-19 patients. It features five stories with 250 beds on a floor area of 33,000 m². Due to the special, rather soft subsoil, the building could not be built any higher.

Mexico City is not located in the immediate vicinity of a seismic focus; however, it was built on a former lake. The subsoil consists of clay with very high water content, which magnifies the shockwaves. Even mid-level earthquakes cause damages in the city, which are more severe than those in the surroundings.



Elastomeric lead rubber bearing with inner lead core and anchor plates with shear dowels for anchoring in the concrete.

Graphic: MAURER

Huge concrete trough as a base

The new hospital was built in the outskirts of the city in an area where the subsoil is slightly more solid than in the city center but nonetheless required special foundation efforts. The hospital was inserted into a huge rigid concrete trough in order to prevent subsidence of the structure. Inside the trough, 243 seismic isolators were installed. On top of them, a concrete platform was built which forms the base on which the hospital with its three individual buildings was erected. The entire structure rests on the spherical isolators. They allow for horizontal movements thus ensuring the isolation of the building complex from the moving subsoil.

One of the 243 lead rubber bearings between the upper concrete platform and the lower concrete trough. Clearly visible are the ring-shaped deformations of the elastomer-steel plate layering.

Photo: MAURER

Elaborate analyses and calculations

This isolation system with one single platform is rather rare and was designed by the local engineering office Gallegos Consultores. MAURER as a specialist for seismic isolation systems was involved in the conception already at an early stage to analyze different variants and design options for a seismic protection system jointly with the engineering office. "Our strength is that we offer different types of isolators and can calculate them together with the entire structure," reports Dr. Luís Pinto Carvalho, who works with MAURER SPS GmbH in Mexico. "That enabled us to assist the engineering office in the search for the most efficient system."

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The analyses were complicated by the fact that the subsoil transmits a broad bandwidth of frequencies during an earthquake. This leads to severe damages at many different types of buildings. Considering the specified local seismic accelerations, the calculation showed horizontal displacements of ± 1 to 1.2 m inside the seismic isolators – too much for a building.

Optimization of the design

The solution was a combination of several measures. The isolator system accommodates a large share of the seismic energy through elastic displacement of the isolators, and a further share through plastic deformation of the inner bearing cores. In case of an earthquake, the buildings do not move by ± 1 m and beyond, but "only" by ± 400 mm. They are subjected to restrained isolation which reduces horizontal vibrations. "Ultimately, this approach insignificantly increases the accelerations in the building, however, we are able to better control the displacements which otherwise would be enormous," explains Dr. Pinto. "Eventually, every seismic isolation of a building from the subsoil is a compromise between incoming seismic accelerations and the maximum occurring horizontal movement of the building."

Lead rubber bearings as isolators

The majority of the 243 isolators are so-called MLRBs (MAURER Lead Rubber Bearings) consisting of a steel-reinforced elastomeric body and an inner lead core. The elastomeric body transmits the vertical loads of the building featuring a weight of approx. 50,000 t, allows for horizontal displacements, and recenters the structure to its initial position during and after the earthquake. The lead core inside the elastomeric bearings converts kinetic energy into heat through plastic deformation. In this way, the subsoil underneath the hospital can move without the horizontal seismic accelerations affecting the building.

The bearings are designed for seismic movements of up to ± 400 mm. They feature a height of 420 mm and an outline with a diameter of 850 mm. The vertical lead core is located in the center, surrounded by horizontally placed natural rubber layers with a thickness of 11 mm each, which are alternately vulcanized onto 3 mm thick steel plates.

The Hospital de Tláhuac shortly before commissioning.
Photo: MAURER

Rear view of the Hospital de Tláhuac: clearly discernible are the three buildings sharing one platform. The seismic isolators are installed underneath the platform.
Photo: MAURER

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208 lead rubber bearings were installed for a structural load of max. 5,100 kN, and 24 with a diameter of 600 mm for a structural load of max. 1,200 kN. In addition, underneath the hospital there are 11 spherical bearings for 1,000 kN structural load, which only accommodate vertical forces and are freely movable in all directions.

First earthquake in summer

In summer 2020, the Hospital de Tláhuac passed a first test during a 7.5-magnitude earthquake when the structure of the building was already completed. The inspection after the earthquake showed that isolators and building responded precisely as anticipated. There were no damages, neither to the building nor to its interior.

Split production

The narrow 3-month timeline presented an additional challenge for production, testing, and delivery of the isolators. Hence, MAURER split the production on three works for parallel manufacture. 162 lead rubber bearings came from Torbali in Turkey, 70 from São Paulo in Brazil, and the 11 spherical bearings from the company headquarters in Munich. The bearings were installed from October to December 2018.

The municipal hospital was built in a public-private partnership model. Planning, construction, and operation will be the responsibility of Sacyr Concesiones S.A. for a period of 25 years: from 2017 to 2042. Building contractor was the Spanish company Sacyr S.A., an internationally renowned company in the construction of hospitals.

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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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