MSM®-Spherical Bearings 200 m (656 ft) above Singapur

Marina Bay Sands – Skypark Hotel: Maurer Söhne delivers 17 sliding bearings catering for a movement of up to ±1 m and dampens the vibrations of the garden platform.

München/Singapur. **In front of the skyline of Singapore, a new landmark is being erected. With 3 towers and 55 storeys high, the hotel "Marina Bay Sands" which opened in June aims to reach the sky. In a height of 200 m (565 ft), these towers have been given a roof structure that consists of a garden of an area of 1 hectare, including a 150 m (492 ft) long pool and 250 trees. In order to rely this garden the essential horizontal "freedom of displacement", it rests on 17 spherical bearings. A tuned mass damper system takes care of the vertically acting vibrations of the cantilevered part of the garden. Bearings and tuned mass dampers are being manufactured in Munich, at Maurer Söhne, the technological world market leader of all kinds of bearings in civil engineering.**

The "Marina Bay Sands" is the new tourist magnet of Singapore. Next to the luxury hotel with over 2,600 rooms, the owners from the "Las Vegas Sands Corporation" built a casino in Las-Vegas-Style, an art museum, a theatre, a shopping centre, congress facilities of up to 45,000 guests, as well as restaurants and night clubs. An absolute highlight is the so called sky park which rests over the 3 hotel towers. The garden including the embedded restaurants, bars and swimming pool takes an area of 345 x 36 m (1,132 x 118 ft), and provides a 360° view onto the port and Singapore's skyline.

In technical respect, the garden rests on 3 large steel platforms, which rests each at one hotel tower. Two invisible joints separate these steel platforms. This design poses high challenges for the bearings as well as for the tuned mass dampers. Maurer was being awarded the contract from the Japanese contractor JFE, which already acknowledged the technological and manufacturing know how of the Munich based steel construction company from an earlier project.

Challenges for the Bearing Design

MSM®-Spherical Bearings distinguish themselves by way of their long service life and high safety against failure, which is a deciding criteria given the extraordinarily exposed position of the Sky Park. That is, a replacement of the bearings would correspond to a extremely high effort. To that end, a guarantee of 5 years had to be issued, and the life time is designed to last at least 50 years. This high challenge on the design of the bearings ist justified by 4 factors: the high vertical loads, the high temperatures, the high sliding displacements and the conditions of installations during construction.

High Vertical Loads

The earlier mentioned 3 steel platforms including garden, trees, restaurants and

Marina Bay Sands, Singapore: The 3 hotel towers of a height of 55 storeys support a roof garden with swimming pool, restaurants, and bars. The skypark rests on 17 spherical bearings. The vibrations which are caused by the cantilevering tip of the platform are reduced with a damper mass of 5,000 kg.

Foto: Maurer Söhne

Download of the picture for print (1772 x 1181 px):
http://www.maurer-soehne.de/files/bauwerkschutzsysteme/presse/MarinaBaySandsHotel.jpg

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swimming pool – in short, the luxury to enjoy the skyline of Singapore – create high vertical loads between 15,100 and 87,100 kN. For this end, the sliding material MSM® (Maurer Sliding Material) is the material of choice, which like no other comparable material can bear extremely high loads, and thus the bearings can be designed in a very compact way. This lends the bearings to an economical aspect, and due to the relatively small space it takes, allows the architect creative degrees of freedom.

Up to 70° C

Furthermore, MSM® deals with the very high temperatures and the high moisture at Marina Bay. The sliding material is approved until temperatures of 70°C, and so is ideally suited for use in Singapore.

High sliding displacements

The deciding criteria for the use of MSM® however was the high sliding displacements and their accumulated displacements over time. The bearings have to accommodate displacements of up to ±1,000 mm (39 inch). Main cause for these high displacements is wind, which displaces hotel towers and sky park or creates vibrations. But the bearings are designed to even accommodate displacements caused by earth quake. In this respect it is important to know that MSM® not only accommodates high sliding displacements and vertical loads, but also high sliding velocities, as they occur in case of earth quake.

Some bearings are laterally guided, some allow free displacements. The range of diameter of the spherical bearings goes up to 1,110 mm (43 inch), and the dimensions of the sliding plates above go up to 2,850 mm (111 inch).

Time saving Installation

A further challenge consists in the installation of the spherical bearings. Maurer Söhne developed an installation unit which allows to position the bearings in the course of the progress of construction onto the 3 hotel towers, however to only install them by a 90° horizontal rotation when the scaffolding was taken away. Because a part of the sliding plates of the bearings is so long that they reach into the sliding joints – however there was no space as long as the scaffolding was required. The installation in their final position after the removal of scaffolding would have been very time consuming. „By way of our rotational installation unit we could contribute to save several weeks of construction time", explains Peter Huber, project manager of Maurer Söhne

Tuned mass dampers at the tip of the garden

The garden platform cantilevers by around 65 m (213 ft) over the Northern hotel tower. In order to reduce the vibrations caused by wind, rain, or humans, a tuned

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mass damper system with a mass of 5,000 kg is being integrated into the steel plates. Because the frequency of vibration could not be easily predetermined – assumed is a range between 0.8 Hz to 1.2 Hz, the system will be delivered to Singapore with a variety of spring sets. Already before delivery, extensive tests at the completely assembled tuned mass damper were conducted at the University of the Armed Forces in Munich, in order to proof the specified perfomance characteristics at 0° C, 22° C, and 40° C.

After installation, measurements were conducted, and the tuned mass damper was adapted to the measured structural frequency of 1.0742 Hz. This was achieved by way of replacement of individual steel springs.

In addition, rubber plates above and below limit extreme movements of the tuned mass damper – also they were adjusted on site.

This way, the damping of the structure could be improved at least by the factor of 4, and so the system requirements could be met, or even exceeded.

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