MAURER SÖHNE
forces in motion

Press Release – May 2009

Exceptional Uplift Spherical Bearings

Maurer Söhne handles uplift forces at 2 railway crossings at the Central Railway Station in Hamburg

Munich/Hamburg. **Compression forces, displacements and rotations are usual with bridge bearings. Unusual is however the case that at 2 railway bridges at the Central Railway Station in Hamburg, also uplift forces have to be dealt with. The specialist on sliding bearings, Maurer Söhne, solved this problem with newly developed uplift bearings. At the core of the system is a calotte-in-calotte design, in which the upper tension spherical calotte is connected through the main spherical calotte to the substructure of the bearing.**

The railway bridges located in Amsinckstrasse and Oberhafen are just 200 m apart, located near the Central Station in Hamburg. They were constructed in 2007, however on the old substructure. For both bridges there was the special case that in the course of the train passing the bridges, uplift forces occurred. Only a complete new construction of the bridges would have achieved to get rid of this loading case. This was however not envisaged.

The uplift forces occur during passing of the bridge. The train brings loads onto the track, and the track acts like a lever with its base on the next bearing point, causing uplift forces on the following bearing. Tension bearings must prevent this lift-off. Uplift bearings must be able to cope with the alternate state tension-compression-tension.

Maurer Söhne received the order to solve this challenge for both railway bridges. Background displaying the competence was the successful installation of uplift bearings at the Lehrter Bahnhof in 2001 in Berlin. Due to the fact that uplift bearings at bridges are a special case, which are not covered by standard regulations, like in 2001 an intra-corporate approval issued by German Railways as well as a special approval in the individual case of the Federal Railway Authority were required. In cooperation

with the expert Prof. Dr. Ing. Gerhard Hanswille of the Wuppertal University and the Material Testing Institute of Stuttgart University, all the calculations were provided by the Technical Office in Lünen.

Calotte-in-Calotte-System

The design of an uplift spherical bearing can be distinguished from the one of an ordinary spherical bearing by the fact that at the upper side of the calotte a second calotte is embedded. This small tension calotte is connected through the main calotte to the base plate of the bearing. The connection consists of up to 5 HV-Bolts of type M36 of class 10.9. In addition, the main calotte is connected to the sliding plate by way of lateral clamps. When tension forces act on the bearing, this was will be transferred by way of the lateral clamps into the main calotte and from there via the embedded calotte into the base of the bearing. This very extensive mode of lode transfer is necessary because in the same time with compression or tension also rotations and displacements can occur.

In addition very comprehensive calculations (FEM) were carried out to correctly model and examine the displacement behaviour of the bearing components. It was the objective to calculate all sliding surfaces and contact surfaces in a way that they can transfer each of the manifold and quickly alternating loading cases without cant.

Adaptive and long service life

As sliding material in the uplift bearings, for the first time MSM® was employed. Thus, this new sliding material once more proves that it displays a broad scope of application. It can accommodate high contact stresses, sliding displacements and displacement velocities, it is adaptive, which means that the various structural elements can very well keep contact next to each other, and yet it displays a long service life.

Although the 2 bridges located in Amsinckstrasse and Oberhafen are mentioned in connection with the bridge bearings in the same breath, the 2

bridges are fundamentally different. Oberhafen bridge stands for a big truss bridge over water plus 2 approach bridges with high loads. This bridge required 7 uplift bearings as well as 21 normal spherical bearings. In addition, 2 uplift bearings had to be designed in an especially flat shape, because otherwise the horizontal forces could not have been transferred.

In contrast, the beam-and-slab bridge over Amsinckstrasse rests on many piers and required a total of 48 bearings, of which 42 had to be designed as uplift bearings.

High traffic density

Construction and installation of the bearings was accomplished under special documentary and control requirements.

For each bearing, comprehensive work instructions had to be written for the workshop, and during installation an expert of the Material Testing Institute (MPA) Stuttgart was present.

As if the bearings themselves would not already pose enough challenge, also the installation of the bearings had to be accomplished under tight conditions. Hamburg is an ICE High Speed Railway junction, and train traffic is correspondingly dense. The bridges could only be blocked for installation over the Christmas period. This break was used in 2007 for the launch of the new bridge deck. Thereby, over the course of 1 year provisional elastomeric bearings were employed, which however could only be passed in slow speed. In Christmas of 2008, the installation of the final uplift bearings was carried out. Since this time, the railway line can be used again without restrictions.

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Railway Bridge Oberhafen: Technical challenge were passing trains which caused uplift forces. The problem was solved by way of special uplift spherical bearings.

Photo: Eiffel Deutschland Stahltechnologie

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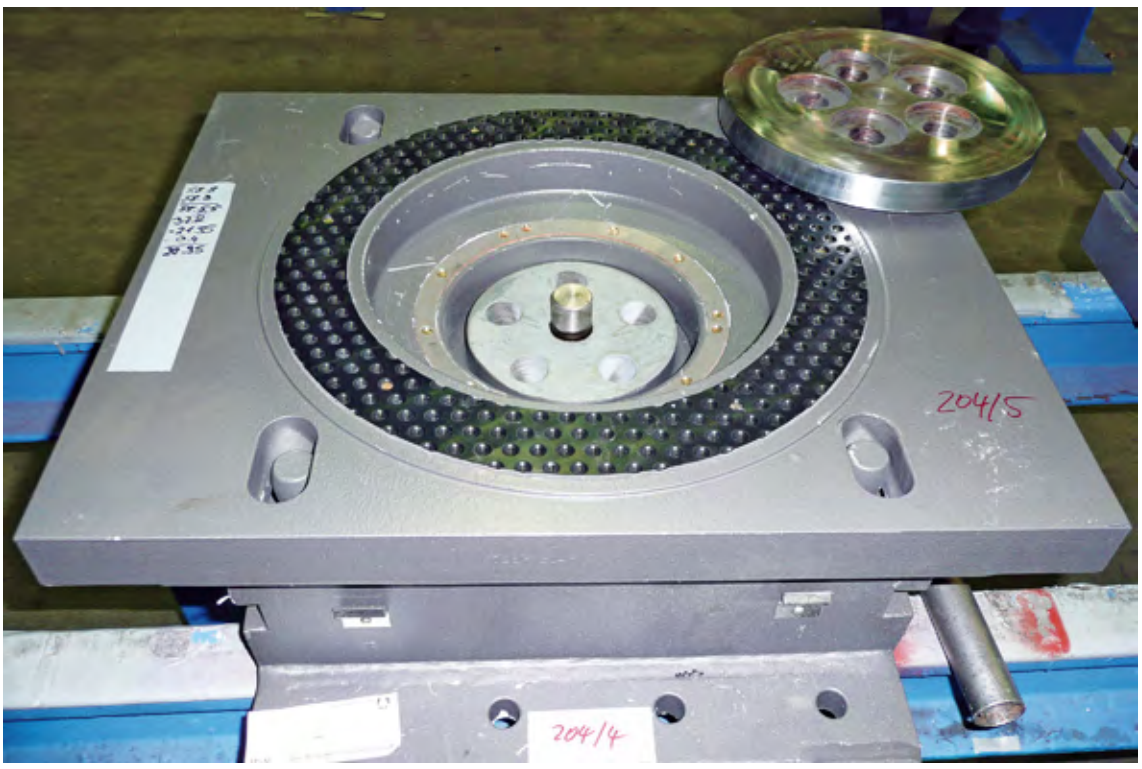

Uplift Bearing with MSM® sliding ring and separate inner calotte.

Photo: Maurer Söhne

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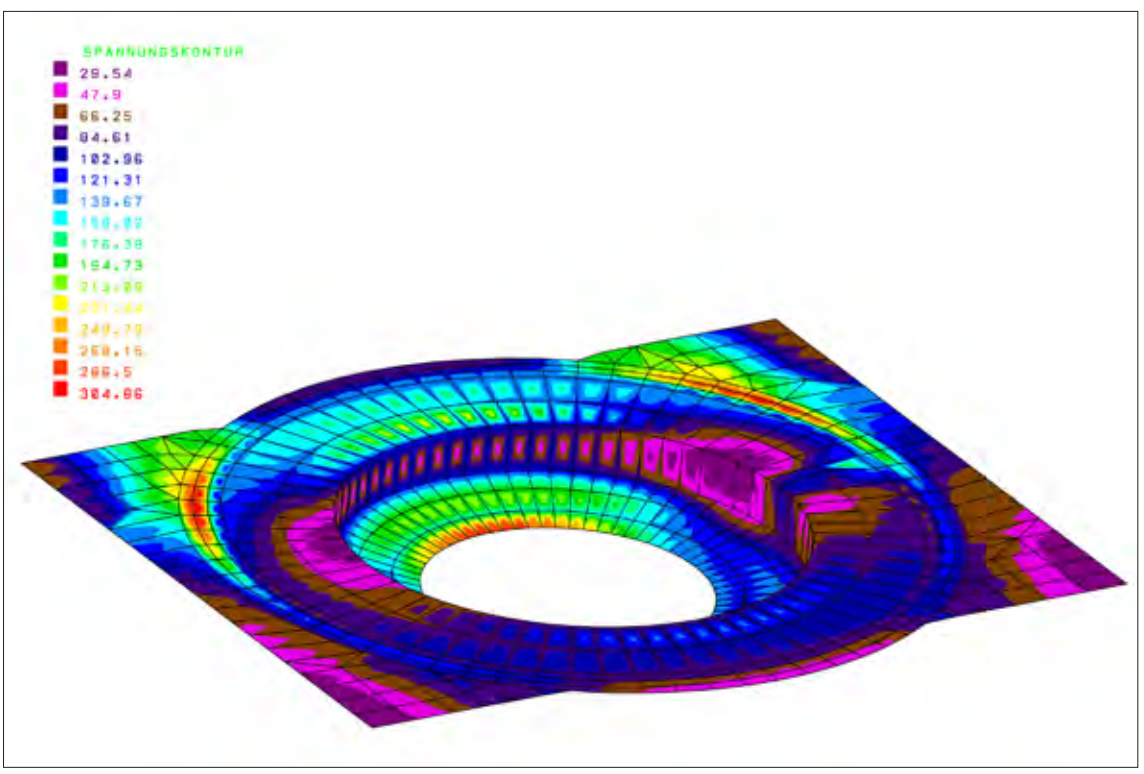

Display of the comprehensive calculations and investigations (FEM) in respect to the deformation behaviour of the bearing components.

Graphics: Maurer Söhne