The exceptional bearings of the Tran Thi Ly Bridge, Da Nang, Vietnam

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Summary

The design of the recently constructed Tran Thi Ly Bridge in Da Nang city, Vietnam called for extraordinarily large bearings to support the bridge's pylon. Of the four bearings which fulfil this role, two must each resist a vertical force of 250,000 kN, or 3.5 times the weight of the Eiffel Tower's metal structure, while allowing longitudinal sliding movements and resisting transverse forces. In order to address this great challenge, spherical bearings featuring a special high-grade sliding material (as an alternative to the typically used PTFE) were proposed. This solution enabled the size of the bearings to be minimised; although they still have a diameter of almost 3 metres, they are considerably smaller than they would have been had another type of bearing, or PTFE sliding material, been used. This paper describes the challenge, the features and advantages of the selected solution, and the bridge construction benefits offered by these truly exceptional bearings.

Keywords: Bridges, bearings, loads, movements, rotations, sliding, material, size, constructability

1 Introduction

Exceptional bridge structures require exceptional bearings to optimally and safely transmit loads and accommodate movements and rotations, and to ensure the proper functioning of the structure as a static and dynamic system. The recently constructed Tran Thi Ly Bridge is such a structure, with a cable stayed design which concentrates enormous forces beneath its central pylon – forces which must be carried by bearings which also allow sliding movements. The challenge presented, and the implemented solution, are described below.

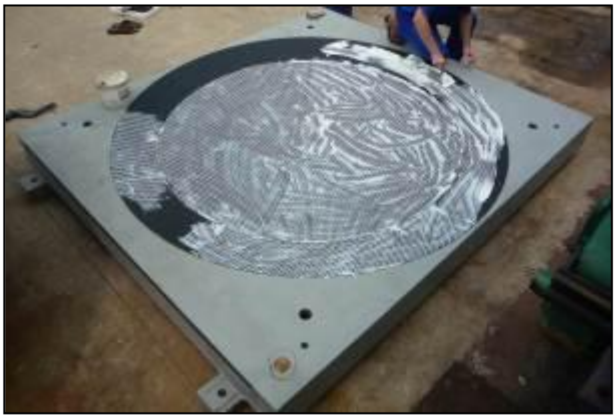

Fig. 1: Lower bearing part during application of special silicone grease to sliding material

Fig. 2: Placing of two enormous guided sliding spherical bearings, side by side to support pylon

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2 The challenge and solution

The Tran Thi Ly Bridge is a cable-stayed bridge across the Han River in Da Nang city, Vietnam. The design of the bridge, with its single pylon and 230-metre main span, results in enormous vertical loads of 586,000 kN which must be carried by bearings beneath the pylon. These bearings must also facilitate longitudinal sliding movements. To minimise the size of the bearings, the supplier proposed a solution with spherical bearings - optimising the use of space and centralising the transfer of forces. Two guided sliding bearings at the centre of the pier would each carry a vertical load of 250,000 kN, or 3.5 times the weight of the Eiffel Tower's metal structure, while allowing longitudinal sliding movements of +/- 160 mm and resisting transverse forces of 8,800 kN. The other two bearings, at the ends of the pier, would each carry 43,000 kN of vertical load while allowing sliding movements in any horizontal direction (free sliding).

Spherical bearings are very strong and durable, consisting entirely of carbon steel, stainless steel and a sliding material such as PTFE above and below the calotte. The weakest part is the sliding material, so the strength and durability of the entire bearing depends on that of the sliding material. The use of an alternative high-grade sliding material can thus substantially increase the load carrying capacity of the bearing. Robo®Slide is a patented sliding material of modified ultra-high-molecular-weight polyethylene, which was specially developed and certified for use in bridge bearings and expansion joints [1]. It offers several advantages over the traditionally used PTFE, including: its high characteristic load capacity of 180 N/mm^2 (double that of PTFE); its far higher resistance to wear and abrasion, with virtually no signs of wear detected in testing after a sliding distance of 50 km; and its lower friction coefficient at high pressures and low temperatures, resulting in lower transverse forces on the connecting structures under such conditions (which are likely to be defining in the design of the bridge). Spherical bearings with such high-strength sliding material thus have a great deal to offer the bridge construction and maintenance industry.

Following detailed design in accordance with the European standard EN 1337, the bearings were fabricated and installed in 2011 (Figure 2), with the guided bearings having a diameter of almost 3 metres – very large by any standard, but somewhat smaller than would have arisen with perhaps any other solution. The use of spherical bearings featuring the selected high-grade sliding material thus benefitted the bridge construction project in several ways. By reducing the number of bearings required and their size to a minimum, the transfer of forces from the bridge's pylon to the pier beneath could be optimised, concentrated in a relatively small area - resulting in enhanced structural efficiency and improved rotation characteristics. The use of smaller bearings also minimised the requirement for materials, in the bearings themselves and potentially in the connecting structures, with benefits for the environment and the construction budget. And the placing of the bearings was also simplified, with less weight to be lifted and smaller bearings to be precisely positioned.

3 Conclusions

The decision to use spherical bearings featuring Robo®Slide high-grade sliding material (as an alternative to the typically used PTFE) was significant for the construction of the Tran Thi Ly Bridge. This sliding material, a modified ultra-high-molecular-weight polyethylene, offers much higher bearing capacity than PTFE, along with other advantages such as far superior resistance to wear and abrasion, and lower friction at critical pressures and temperatures. Although the larger of the bearings are indeed enormous, with a diameter of almost 3 metres, they are considerably smaller than they would have been had another type of bearing been used, or had PTFE been used for the sliding material. This contributed to enhanced constructability and improved structural efficiency, and avoided any need for redesign. If bearings cannot be designed and manufactured to satisfy the onerous demands presented by bold, innovative bridge designs, the bridge designs must be adapted to reduce the demands, perhaps resulting in a relatively standard, less economical and less elegant structure. The importance of key components such as bearings to the development of the bridge construction industry should therefore not be underestimated.

[1] SAVIOZ P., SPULER T., O'SUILLEABHAIN C., "Challenges and solutions for expansion joints on super long span bridges", *Proc. IABSE Congress on Innovative Infrastructures towards human urbanism*, Seoul, Korea, September 2012