High performance materials for pendulum sliding bearings

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Summary

At Politecnico di Milano a novel thermoplastic material for pendulum bearings operating in seismic isolation of buildings and structures has been recently developed. The material properties were characterized in small scale tests, and the dependence of the coefficient of friction on operating conditions like pressure, temperature and velocity was determined at speeds and durations typical of seismic events. The effect of extended durations of excitation on the stability of friction was assessed. Two prototypes of pendulum bearing operating with the new material were manufactured and tested. The results confirmed the good performance of real scale isolators in terms of low horizontal stiffness, high damping and good stability of the dynamic properties.

Keywords: pendulum bearing; sliding material; friction; dissipation; stiffness; damping; seismic isolation; experiments.

1. Introduction

Among the modern hardware developed for seismic isolation of buildings and structures there are pendulum sliding bearings, so called because they use the motion of a physical pendulum to lengthen the natural period of the isolated structure [1, 2].

The cross-section of a pendulum bearing is sketched in Figure 1. The main element of the bearing (item A) consists of a pair of curved surfaces which slide one over the other to accommodate the horizontal movements of the superstructure induced by the earthquake, and provide at the same time a restoring effect through the action of gravity, and the dissipation of seismic energy through friction. The relative rotation between the superstructure and the base induced by sliding between the curved surfaces is permitted by the spherical hinge joint (item B).

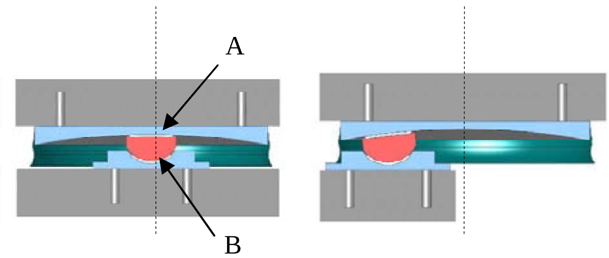

Fig. 1: Typical cross-section of a pendulum bearing

According to the law of motion of the pendulum, the oscillation period is independent of the mass of the suspended structure, with considerable advantage for the isolation of lightweight buildings. Pendulum isolators are generally employed to achieve oscillation periods between 2 and 5 seconds and permit horizontal displacements even larger than 1 meter.

The dynamic properties of pendulum bearings are governed by the characteristics of the main sliding surfaces, precisely by the radius of curvature and the coefficient of friction. The static friction determines the resistance to be overcome at the breakaway and is a key parameter for dimensioning the size of the isolator, of the anchorage system and of the adjacent parts of the

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