Experimental Investigation on Fibre Reinforced Elastomeric Bearings

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Summary

Seismic base isolation by introducing a flexible horizontal layer at the foundation of a structure can significantly reduce the seismic demand. Bearings consisting of elastomeric layers reinforced by thin steel plates or fibre sheets have been used in the past as isolation devises. In the present paper, the common practice of bearings bonded at the upper and lower support layers through steel end plates is compared to the innovative unbonded fibre reinforced elastomeric isolators. Results of an experimental research on both bonded and unbonded carbon fibre reinforced bearings are presented. Three different types of bearings are examined varying in height, as a result of different number and thickness of elastomer layers. The influence of the vertical stress, the horizontal deflection, the number of the carbon fibre layers and the number and thickness of the elastomer layers on the effective shear modulus, stiffness and damping coefficient of elastomeric bearings is investigated. As far as the type of bonding is concerned, the damping coefficient and shear modulus values of unbonded bearings seem to be further influenced by the bearing height and the horizontal deflection state. It was also found that the magnitude of the vertical stress and the horizontal deflection influence significantly the above mentioned mechanical characteristics of the bearings. Worth mentioning that European Standards do not take into account any influence of the above parameters, as far as the shear modulus is concerned.

Keywords: elastomeric bearings; shear modulus; damping coefficient.

1. Introduction

In the last few decades, multilayer elastomeric bearings, which are produced by the vulcanisation bonding of rubber layers with thin steel sheets, have been introduced as seismic isolation devices in structural systems. Such seismic isolators are vertically very stiff, so they can carry the structure's high vertical loads, but at the same time they are flexible in the horizontal direction, enabling the structure to perform large lateral deformations caused by strong ground motions. Elastomeric bearings are most commonly applied in bridge engineering, but their use has also been extended for the damping of vibrations induced by machines [1], [2]. Recently, new types of elastomeric bearing reinforcement have been developed through experimental and theoretical studies [3], [4]. The previously applied reinforcement of thin steel sheets has been replaced by carbon or glass fibre fabrics, resulting to a much lower total weight and cost of the bearing, through a much less labour intensive procedure. According to [5], fibre fabrics are more flexible compared to steel reinforcement and the individual fibres that constitute them can be orientated in different directions, enabling the bearing to have an improved performance under various loading directions.

The current study includes an experimental procedure carried out on three different types of square FREBs. The presented results focus on the comparison of the common production practice of fibre reinforced elastomeric bearings (FREBs), involving the bonding of the upper and lower elastomeric layer with thick steel end plates, with the most recently introduced concept of unbonded FREBs. The influence of the vertical stress, the horizontal deflection, the number of the carbon fibre layers and the number and thickness of the elastomer layers on the effective shear modulus and damping coefficient of elastomeric bearings is also presented and discussed.

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