Heating and Thermal Conductivity Effect Inside High Damping Rubber Bearing at Low Temperature

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Abstract

The temperature dependence and heating effect during cyclic loading of high damping rubber (HDR) make the seismic design of HDR bearings included isolated bridge quite complicated, particularly at low ambient temperature. To elaborate the hysteretic behaviour of HDR bearings, past researchers considered the temperature dependant effect, the thermo-mechanical coupling. However due to the newest pseudo dynamic and real time hybrid loading tests, it seems need to further consideration about thermal conductivity inside the laminated rubber layers and the redistribution of deformation due to the difference of the inner temperature. The heating effect and thermal conduction are investigated in this research to illustrate the heat transfer mechanism within the bearings. A new numerical model involving the temperature dependence of the stress-strain relationship of the rubber was incorporated to simulate how the heating and thermal conductivity effects works together inside each layer of the bearings. The numerical model is validated by the tests of quasi-static cyclic loading and real-time hybrid simulation at −20°C, 0°C and 23°C.

Keywords: high damping rubber bearing; hysteretic model; heat transfer; heating effect; thermal coupling; low temperature.

1 Introduction

Rubber bearings have been widely employed as highly effective isolation devices worldwide for buildings, bridges and other structures [1,2]. The high damping rubber (HDR) bearing is regarded as the promising cost-effective device for application due to its effective and stable isolation properties. However, the HDR bearing shows significant temperature sensitivity, exhibiting not only the temperature dependence leading to higher stiffness at low ambient temperature, but also the heating effect due to the energy dissipation. These factors complicate the time evolution of the device

https://doi.org/10.2749/manchester.2024.0904
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