SHAKING TABLE TESTS ON SEMI-ACTIVE TUNED MASS AND TUNED LIQUID DAMPERS

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ABSTRACT :

One of the goals of the COVICOCEPAD project is to develop a mathematical model of tuned liquid dampers (TLD) devices. This new model will take into account the damping forces resisting the actions resulting from the viscous interactions between the liquid and its rigid container, the hydrodynamic head losses subsequent to orifices passing and the internal viscosity of the liquid. To calibrate the mathematical models full scale tests on shaking table are being performed. A performance evaluation of the TLD devices will be accomplished by the comparison between the behaviour of a specific structure with and without passive protection. This work addresses on the possibility of exploiting the liquid sloshing motion in tanks for specific vibration control purposes of civil engineering structures. Analytical, numerical and experimental issues are referred and the test steel frame is presented.

KEYWORDS: TLD, shaking table, passive control, vibration, damper

1. INTRODUCTION

The activities presented in this paper are being developed in the aim of the project COVICOCEPAD (Comparison of Vibration Control in Civil Engineering Using Passive and Active Dampers). Its leading purpose is to model the behaviour of semi-active devices of the TMD type (tuned mass dampers), developing also control algorithms for the optimisation of a complete structure including those semi-active devices. Additionally, this project intends to develop also a mathematical model of TLD type devices (tuned liquid dampers).

This new model will take into account the damping forces resisting the actions resulting from: (a) the viscous interactions between the liquid and its rigid container, (b) the hydrodynamic head losses subsequent to orifices passing and (c) the internal viscosity of the liquid.

In fact, the use of such alternative methodologies can be an indeed adequate solution to increase significantly a structure capacity to resist a strong earthquake. Passive protection devices, whose properties can be modified during their movements, are the main composition of these protection systems. The capacity of such devices to improve the dynamic behaviour of a structure being strongly dependent on the potential of their control algorithms.

Two partners of the COVICOCEPAD project are running important experimental dynamic equipment in Europe – the ELSA laboratory reaction wall, at the Ispra Joint Research Centre, in Italy, and the LNEC shaking tables testing hall, in Lisbon, Portugal. Hence, a performance evaluation of those devices will be also accomplished by comparing experimentally the behaviour of a specific structure with and without protection. It is a full-scale steel structure that will be also analysed to check its behaviour alterations when protected by different kinds of devices. This test specimen has a specific upper concrete slab, increasing its total weight up to about 10 tons, and was conceived for a previous benchmarking testing activity on the same shaking table and reaction wall being consequently suitable for both facilities.