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Dynamic Interaction between the Shaking Table and the Specimen during Earthquake Tests

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1 ABSTRACT

The boundary conditions between the tested structures and the platform of a large shaking table are a major parameter for the design and numerical analyses of shaking table tests. A foremost attention is given to the design of the foundation and anchorage of the structure. All analyses are made considering a completely rigid shaking table: rigid actuators and rigid platform. However, since quite a long time, the shaking table / structure interaction has been clearly observed (Blondet and Esparza, 1988) when analysing the shaking table / actuators interaction, depending on the control tuning. In CEA Saclay, during the last 15 years, decreases of mock-up frequencies between calculations and experimental tests of massive structures have been observed: CASSBA, CAMUS 1 to 4, CAMUS 2000 (Combescure and Ragueneau, 2002) and more recently SMART. For a long time it has been calculated, after tests, the global stiffness that the "Azalée" shaking table should have to explain those decreases.

This paper describes and validates the finite-element model of this shaking table platform, presents the mock-up used and finally deals with and concludes on the shaking table / mock-up interaction.

2 INTRODUCTION

Much advancement is on progress among the members of the European consortia of earthquake engineering laboratories (Bairrao et al., 2006) and the more important needs of the experimental facilities were already identified in detail (Taucer et al., 2005). The optimisation of leading experimental tools like shaking tables is one of the main fields of research as, for example, control systems, hybrid tests, high-speed data transfer and sub-structuring.

The improvement of shaking table technologies is clearly of paramount importance to reduce the seismic vulnerability of the building stock and also to mitigate the consequences of future, and inevitable, seismic events by contributing significantly to the amelioration of new construction techniques.

The global capacities of the biggest European shaking tables are very moderate when compared with the ones of the more recent Japanese laboratories. Therefore the shaking table test of real and very large structures is not foreseen in Europe for the near future. Consequently, the use of sub-structuring techniques must be developed in order to fix to the simulator platform just a part of the structure while all the remainder will be tested on computer, like in the pseudo-dynamic testing procedure (Bairrao, 2008).

To use this technique in shaking table tests it will be need a real-time control and an indeed very high speed of the data transfer between the control system of the shaking table and the computer system modelling the numerical part of the experiment.

Another very important need in shaking table testing, in order to improve its performance, is a comprehensive study on the interaction between the dynamic characteristics of the facilities (the platforms and all the hydraulics systems) and the specimens during the experiments.