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KnowRISK

Know your city, Reduce seISmic risK through non-structural elements

Prevention and preparedness projects in civil protection and marine pollution. Prevention Priorities

Deliverable Report

Deliverable C3 – Shake table tests: wall shelves and equipment

Task C – Non-structural seismic risk reduction

Deliverable/Task Leader: EERC Revision:

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Project co-funded by the European Commission - Civil Protection Financial Instrument		
Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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LIST OF SYMBOLS AND ABBREVIATIONS

k = Stiffness

m = Mass

T = Period of Vibration

π = Pi

1. DESCRIPTION OF THE DELIVERABLE

1.1 INTRODUCTION

The objective of the KnowRISK Action C.3 is to carry out earthquake simulations in the large LNEC 3D shake table with different types of non-structural components in order to assess their seismic performance, with and without complementary restraining devices.

1.2 PREPARATION OF THE SHAKE TABLE TESTS WITH WALLS AND SHELVES

1.2.1. Introduction

In the following sections will be described the works carried out in the scope of this task towards the shake table tests with walls and shelves.

1.2.2. Time history selection

The shaking table tests will simulate the effects of earthquakes on non-structural components located inside dwellings. For that purpose, a bed room will be setup on top of the shaking table with several familiar objects that can be found in such an environment. The purpose of these simulations is to demonstrate to the target audience the different outcome that can be achieved when simple non-structural protective measures are used to prevent human and material damages.

These simulations also have a strong scientific interest since there has not been much research on the seismic behaviour of non-structural components. These components will be instrumented in order to assess their rocking behaviour, the level of floor motion that triggers that behaviour and relate it to the ground motion.

Several time histories from the Iceland and Nepal seismic catalogues were analysed taking into account the following aspects:

a) Frequency content;
b) PGA;
c) Response spectrum;
d) Building type;
e) Pulse like motion;
f) Magnitude;
g) Epicentral distance.

In the end only four records from the Iceland seismic catalogue were taken into consideration because there were available also the floor time histories in buildings where they caused extensive non-structural damages. These records are the following:

- 2000-06-17, Selfoss City Hall
- 2000-06-21, Selfoss City Hall
- 2000-06-17, Reykjavik Hus Verslunarinnar

- 2000-06-21, Reykjavik Hus Verslunarinnar

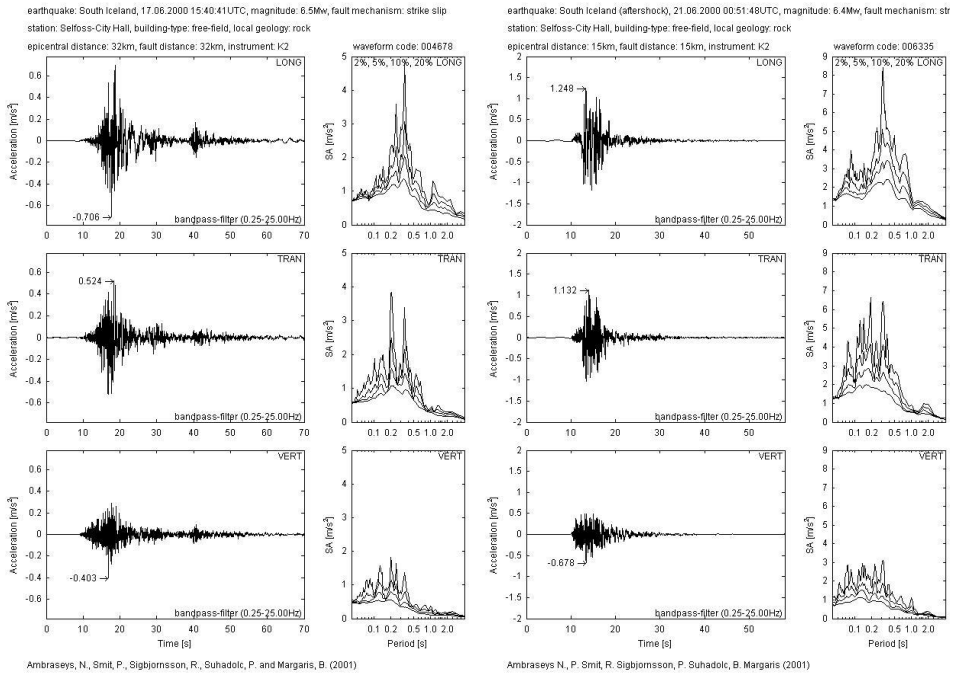

Figure 1. Selfoss City Hall events: 2000-06-17 (left) and 2000-06-21 (right).

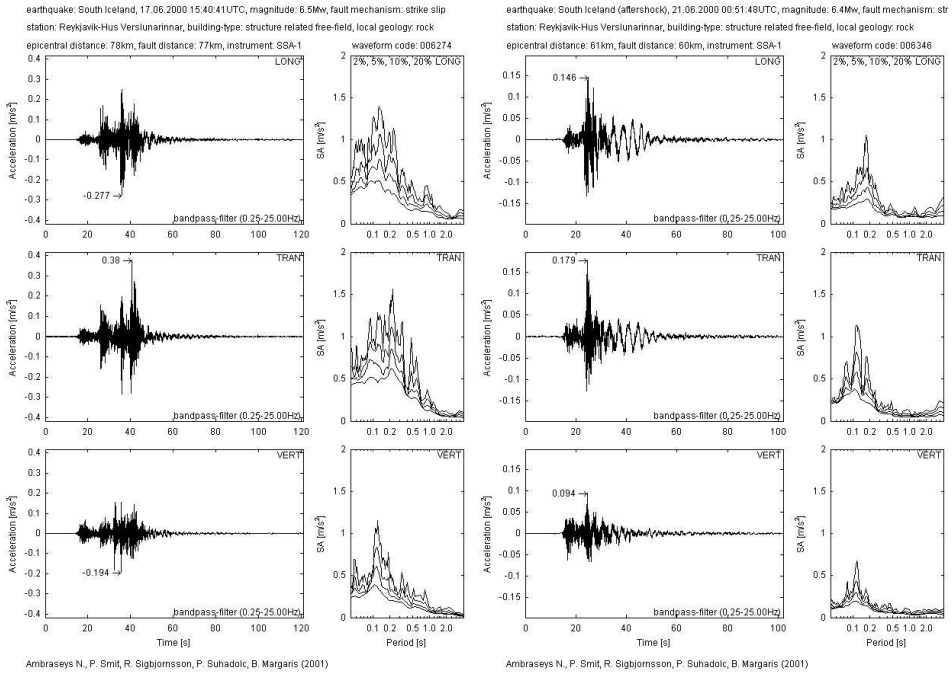

Figure 2. Reykjavik Hus Verslunarinnar events: 2000-06-17 (left) and 2000-06-21 (right).

The interest in these particular events resides on the fact that both ground level and floor level acceleration time histories were recorded, giving the corresponding structural response. Furthermore, the non-structural damages they caused are known and therefore are expected to occur in the shake table simulations.

Figure 3. View of the Selfoss City Hall.

In what accounts for the floor time histories, the following were selected to be imposed on the shaking table:

1. Selfoss City Hall (ground level and 2nd floor) where toppling of the cabinets was observed on both the ground floor and the 2nd floor in the 2000-06-21 earthquake event;
2. Reykjavik Reykjavik Hus Verslunarinnar 14 stories RC building (basement level, 8th floor and 14th floor), although the 8th floor record in the NS direction seems better suited for the shake table than the 14th floor records.

1.2.3. Time history processing

The raw data time series were processed in order to prepare them for the LNEC shake table:

1. Offset remove;
2. High pass Fourier filter at 0,05Hz;
3. Double integration in the Fourier domain to obtain displacements;
4. Apply a cosine taper to displacements;
5. Single differentiation in the Fourier domain to obtain compatible velocity;
6. Single differentiation in the Fourier domain to obtain compatible acceleration.

The compatible displacement and acceleration floor level time series will be imposed in the shake table whereas the ground level acceleration time series will be used to compare the scaling factors with the EC8 response spectrum and seismic hazard (return period).

The floor time histories will be scaled up during the tests in the LNEC shake table until the toppling of the furniture is observed or the limits of shake table are reached.

1.2.4. Test sequence and schedule

Three different proposals were discussed concerning the tests sequence:

1. Start with the anchored furniture (ML);
2. Start with the unanchored furniture to identify the seismic motion that topples the furniture and then test the anchored furniture (PC);
3. Start with unanchored furniture until toppling is observed for the high building representative of Portugal and Italy, then replace any damaged furniture and carry out the anchored test. Lastly, carry out the unanchored test with the low building representative of Iceland until toppling of the furniture is observed (RR).

A final decision on which sequence will be carried out has not been made so far but will be taken prior to the tests.

A tentative test schedule is set for the end of 2016, which is compatible with the remaining tasks of the project.

REFERENCES

Housner, G.W. [1963]. *The behavior of inverted pendulum structures during earthquakes*. Bulletin of Seismological Society of Amarica, Vol. 53, No. 2, pp. 403-417, February, 1963.