SHAKING TABLE EXPERIMENTAL STUDY ON STRUCTURAL POUNDING DURING EARTHQUAKES

R. Jankowski
Gdańsk University of Technology, Gdańsk, Poland

1. Introduction

Earthquake-induced pounding between insufficiently separated buildings or bridge segments may result in some local damage at the contact points during moderate earthquakes [1] or may lead to collapse of structures during severe ground motions [2]. Structural pounding has been recently intensively studied numerically (see, for example, [3,4]). On the contrary to numerical analyses, only few experimental studies have been conducted concerning mainly the validation of the numerical models (see [5]). Therefore, the aim of the present paper is to show the results of more extensive experimental study performed on a shaking table using models of two towers equipped with colliding elements made of different building materials.

2. Setup of the experiment

A small shaking table (see Figure 1) located at the Gdańsk University of Technology was used in the experimental study. It is a unidirectional device with the platform dimensions of 0.75×0.6 m excited by the linear actuator with the stroke of 0.5 m and maximum acceleration of 10 m/s^2. Two 1 m high model towers with different dynamic properties (see Figure 1) were built to be tested during the experiment. Each of them was constructed from four steel columns with the mid-height horizontal connections and additional skew bracings to prevent transverse as well as torsional vibrations. All elements used in the left tower had the rectangular cross section of 6×6 mm, whereas the right tower was constructed from members with the section of 8×8 mm. Additional plates made of different building materials, i.e. concrete, steel and timber were fixed at the top of each tower in order to study the pounding-involved structural response due to impacts between various materials. The top mass of the towers was kept constant for all experimental tests, apart from the material used.

3. Results of the study

The experimental study was conducted under the NS component of the El Centro earthquake (18 May 1940) for different gap size values between the towers. In this paper, the examples of the results for the gap size of 0.04 m are presented. The displacement time histories of the towers for concrete-to-concrete, steel-to-steel and timber-to-timber pounding are shown in Figure 2a, 2b and 2c, respectively. For the purposes of comparison, the displacement time histories for the independent vibrations of the towers are also presented in Figure 2d.

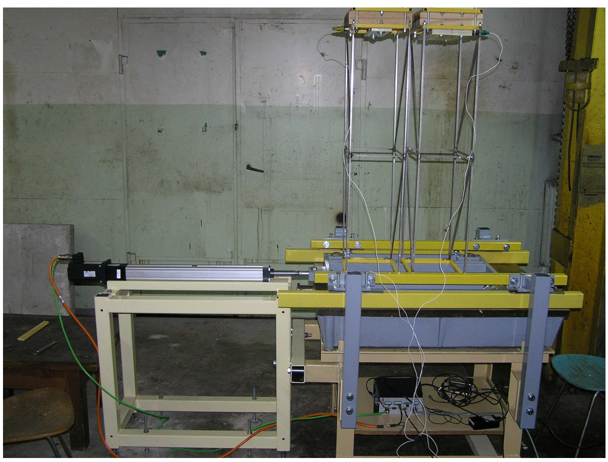

Figure 1. Setup of the shaking table experiment.

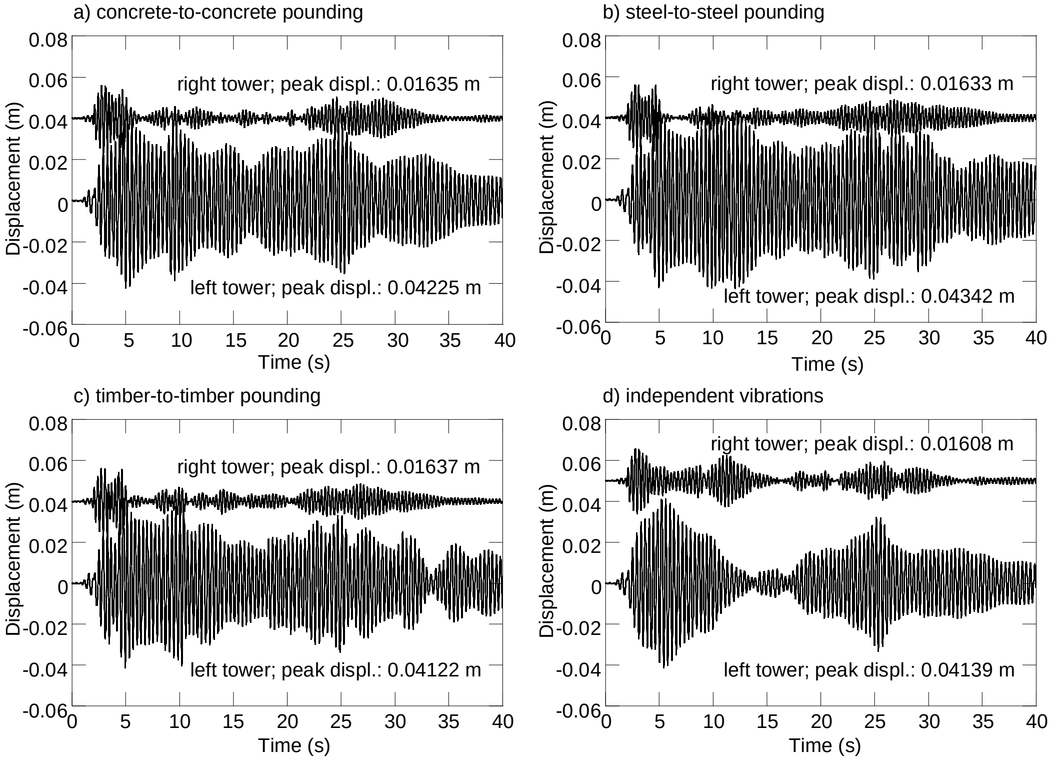

Figure 2. Displacement time histories of towers under the El Centro earthquake.

4. Conclusions

The results of the experimental study show that pounding may result in substantial increase of the structural response; however, it can also play a positive role by reducing vibrations (see reduction of the peak displacement for the left tower on Figure 2c). Moreover, the results show the considerable influence of the type of material used for colliding elements on the behaviour of structures during earthquakes.

The study described in this paper was performed using relatively small structural models. Therefore, further experimental study is planned to be conducted on larger models of real structures in order to verify the results obtained.

5. References

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