Forced Vibration Testing and Seismic Fragility Assessment of Instrumented Structures

Reporting

Project Information

FORAGAINST

Grant agreement ID: 268428

Status
Closed project

Start date
8 February 2012

End date
7 February 2016

Funded under
FP7-PEOPLE

Overall budget
€ 100 000

EU contribution
€ 100 000

Coordinated by
MIDDLE EAST TECHNICAL UNIVERSITY
Turkey

Final Report Summary - FORAGAINST (Forced Vibration Testing and Seismic Fragility Assessment of Instrumented Structures)

Earthquakes are paramount among the natural hazards impacting civil infrastructure worldwide. Large losses incurred in recent earthquakes have prompted an interest in performance assessment of the built environment to future seismic events. Performance evaluations of buildings and other structures are required at multiple levels, beyond the traditional goal of life safety under rare events, to estimate expected losses to civil infrastructure. These evaluations require improved building performance and seismic risk assessment tools.

FORAGAINST project aims to perform forced vibration tests on existing European buildings that have been permanently instrumented for recording their dynamic responses in the case of future earthquakes, and to develop probabilistic seismic risk assessment tools in the form of fragility curves for these structures to evaluate their seismic vulnerability.

In forced vibration testing, structural vibrations due to the sinusoidal excitation of a vibration generator, which is typically mounted on one of the top floors, are recorded. Generally, acceleration-frequency responses are obtained upon digital signal processing of the records, which involves extracting the steady-state acceleration responses at each operated frequency during the frequency sweep. Structural system dynamic properties are then identified by well-established methods in structural dynamics, which do not require sophisticated system identification algorithms as in analyses of data from ambient vibration and seismic monitoring. Such tests on existing structures are limited in number and help us improve our understanding of the dynamic behavior of structural systems.

Today, buildings have been densely instrumented with ever-increasing number of accelerometers in forced vibration tests to examine the response characteristics in detail. Individually extracting the steady-state amplitude for each response measure from the recorded accelerations throughout the building at each operated frequency of the vibration generator is a demanding task. To facilitate the signal processing for determining the acceleration-frequency response curves in forced vibration tests, a technique that uses the analytical signal, an application of the Hilbert transform, was introduced.

Within the scope of this project, forced and ambient vibration tests were performed on a four-story reinforced concrete dormitory/school building in Bolu, a six-story steel residential building in Antakya, a four-story reinforced concrete office building in Istanbul, and a six-story precast concrete dormitory building in Ankara, Turkey. Structural system dynamic properties identified from these forced and ambient vibration tests were used in validating or calibrating the-state-of-the-art finite element models of these structures. These structural models were then used in deriving reliable seismic fragilities for these permanently instrumented structures. The end product of this project, seismic fragilities, will serve the building owners and local authorities in pre-earthquake planning to mitigate probable losses and in post-earthquake planning to develop emergency response and recovery strategies in earthquake prone regions of Europe.

Structural responses of the tested buildings in this project to future earthquakes will be recorded as they are all instrumented. Therefore, this project will continue to contribute to our knowledge in the earthquake engineering area and the future contribution will be three-fold: (1) the identified structural system dynamic properties from this project will enable to make comparisons with the properties that will be identified from the recorded earthquake structural responses; (2) similar comparisons can be made if forced vibration tests are performed after future earthquakes; and (3) recorded responses will enable to validate the fragilities derived in this project.

The project website is at the following address: http://users.metu.edu.tr/occelik/foragainst/.

During this project, the fellow has led the efforts to use the resources of the Structures Lab of METU Civil Engineering Department to perform forced and ambient vibration testing of existing structures. Now, the state-of-the-art vibration recording system is up and running.

The fellow has fulfilled the requirements for the associate professor title and started the application process. He is getting a permanent position at METU at the end of this academic semester.

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