SEISMIC PROTECTION OF ENGINEERING STRUCTURES THROUGH DISSIPATIVE BRACES OF NANO-MICRO MAGNETO-RHEOLOGICAL FLUID DAMPERS – SEMNAL-MRD

Goal of the project:

The goal of the project is to develop a seismic protection system, which uses magneto-rheological fluid (MRF) dampers, acting as semi-active structural control system. Particular objectives are:

- To develop nano-micro MRF compatible with application in seismic MR dampers;
- To design and built a 10tf capacity MR damper;
- To provide type tests, based on EN 15129-2009: Anti-seismic devices, aimed to validate, calibrate and model the damper;
- To design, execute and test a brace-damper assembly in order to validate the integration of damper and brace, including connections;
- To propose structural application schemes for implementation in practice of semi-active control brace-MRD systems.

Short description of the project:

There are three strategies for the seismic protection of structures:
(i) reduce seismic demands,
(ii) enhance structural damping,
(iii) use active or semi-active structural control.
The current project involves the third approach focusing on semi-active systems. Semi-active devices have properties that can be adjusted in real time but cannot inject energy into the controlled system. Many of them can operate on battery power alone, proving advantageous during seismic events when the main power source to the structure may fail. The most promising devices suitable for implementation into a semi-active control appear to be magneto-rheological (MR) dampers, which succeed in overcoming many of the expenses and technical difficulties associated with other types of semi-active devices.

Response characteristics of MR devices can be changed by varying the magnetic field through different current inputs. In addition to its small power requirement, the MR damper can transfer large forces at low velocities. Currently there are MR dampers with capacities up to 200 kN and research results proved the possibility to obtain capacities up to 400-500 kN.

Project implemented by

The Research Centre for Mechanics of Materials and Structural Safety – CEMSIG, Politehnica University of Timişoara.

Implementation period:

01.07.2014 – 30.09.2017

Main activities:

The activities of the project were divided in four stages (I/2014, II/2015, III/2016, IV/2017). All stages are completed.

As part of stage IV/2017, the main activities were:

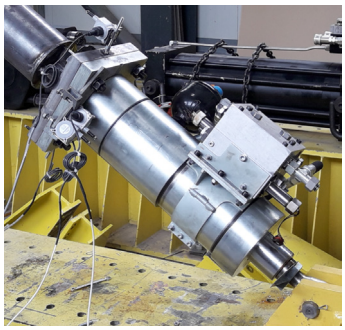
(i) testing of MR damper of 10tf capacity,
(ii) testing of the brace-damper assembly,
(iii) numerical modelling of single- and multi-degree of freedom systems.

The MR damper was tested under different loading conditions. Experimental investigations were performed on two buckling restrained braces (BRBs), under both monotonic and cyclic loading conditions. In addition, tests were performed also on the brace-damper assembly, since the dampers in structural systems will be coupled with braces. A control unit was used for the control of the magneto-rheological damper.

Results:

The results of the fourth stage (IV/2017) comprised:

(i) several testing phases of the MR damper and adjustments for the improvement of the response;
(ii) experimental and numerical investigations of the buckling restrained braces;
(iii) experimental investigation of the brace-damper assembly.



The experimental tests have demonstrated the functionality of this system, but in order to optimize the way it works - there are several aspects of detail to be solved. The functionality of the hybrid system has been demonstrated in the sense that it has highlighted how the dampers work in a first phase, then by electronical control at the work capacity, the damper was blocked and the buckling restrained brace was operating.

Applicability and transferability of the results:

Considering the seismicity of Romanian territory and the effectiveness of the dissipative devices targeted in the project (once under fabrication, the implementation in new and existing structures would be quite easy), the national market potential is very large. On the other hand, this market can comprise all the Balkan's area, including Turkey and Greece, with development potential towards neighboring Asian Countries.

Financed through/by

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Research Center

The Research Centre for Mechanics of Materials and Structural Safety – CEMSIG, Politehnica University of Timisoara.

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