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, and
(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:

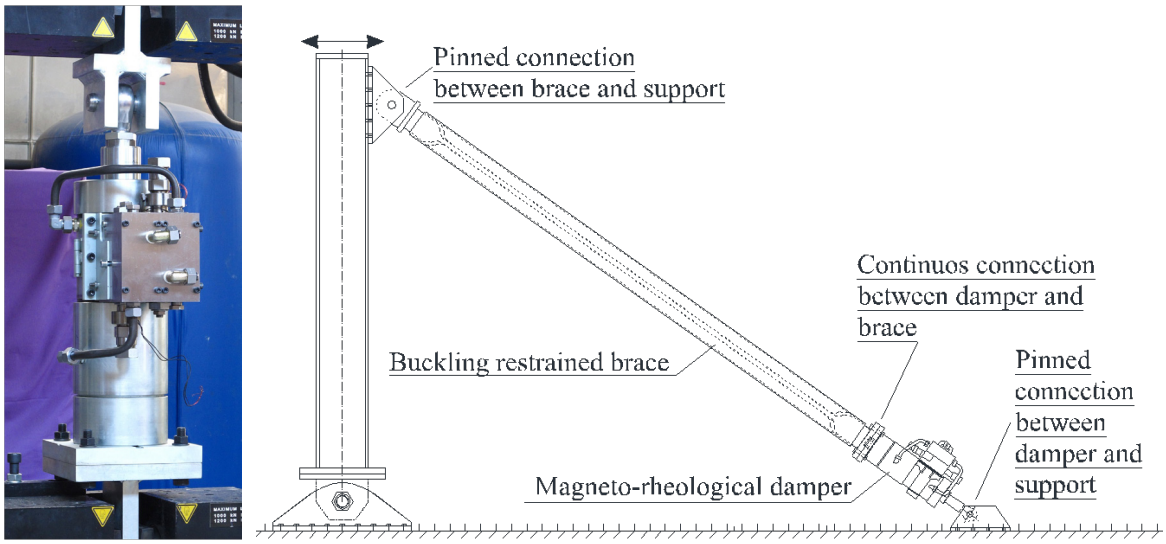
01.07.2014 – 30.09.2017

Main activities:

The activities of the project are divided in four stages (I/2014, II/2015, III/2016, IV/2017). The first three stages are completed. The fourth stage is in progress, covering several main activities:
(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 will be tested under different loading conditions (triangular, sinusoidal, random excitations). In addition, numerical hysteretic models will be calibrated based on the tested MR damper enabling the modeling of structural response. Since the dampers in structural systems will be coupled with braces, both single damper and brace-damper assembly tests will be performed. With a numerically simulated control unit, structural systems equipped with brace-damper assemblies will be numerically tested in order to observe and characterize their behavior.

Results:

TThe results of the third stage (III/2016) comprise the fabrication of the MR damper prototype, development of the testing protocol and control parameters for the MR fluid, design and fabrication of the brace-damper assembly. In the current research phase, besides the testing of the damper and brace-damper assembly, the following activities will be performed:
(i) numerical evaluation of effectiveness of MR dampers in reducing seismic effects in structural applications;
(ii) design and numerical testing of the control algorithm on single degree of freedom systems.



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.

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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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