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

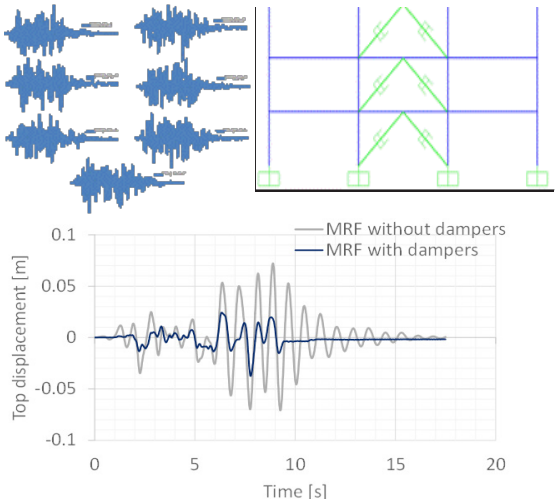
- The Research Centre for Mechanics of Materials and Structural Safety – CEMSIG, Politehnica University of Timişoara.

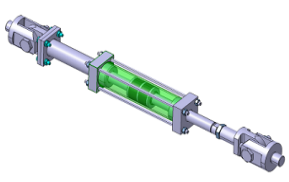
Implementation period:

01.07.2014 – 30.06.2016

Main activities:

The activities of the project are divided in three stages (I/2014, II/2015, III/2016), of which the first was completed. The second stage is in progress, covering several main activities: (i) preparation and characterization of nano-micro composite magneto-rheological (MR) fluid for seismic semi-active dampers, (ii) testing of a MR damper model containing the MR fluid, (iii) development of the technical solution for the 10t MR damper.





Further, the MR damper will be fabricated and 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:

The results of the second stage comprise nano-micro composite MR fluid recipes for seismic semi-active dampers, and the technical solution for the MR damper.
Besides, the main outcomes of the project will be:

- The prototype of the MR damper;
- Validation tests of brace-damper systems;
- Numerical evaluation of effectiveness of MR dampers in reducing seismic effects in structural applications.
- Design and numerical testing of the control algorithm on single degree of freedom systems

Applicability and transferability of the results:

- The target of the project is the pilot solution for the MR damper, which will represent the basis for the mass production by the industrial partners.
- 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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Fields of interest:

Seismic resistant structures for multi-storey building frames

Research Center

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

Research team

- Politehnica University of Timişoara
  CMMC – Department of Steel Structures and Structural Mechanics
  CNISFC – Research Centre for Complex Fluid Systems Engineering
- S.C. ROSEAL S.A.
- IMS-AR - Institute of Solid Mechanics of the Romanian Academy
- AR-FT - Timişoara Branch of the Romanian Academy
- S.C. TITAN S.A.

Based on the above listed research team, the interdisciplinary character should be emphasized, as well as the cooperation between the Civil Engineering branch, the Mechanics branch, the Romanian Academy, and the industrial partners.

There are no secrets to success. It is the result of preparation, hard work, and learning from failure.
Colin Powell

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