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.

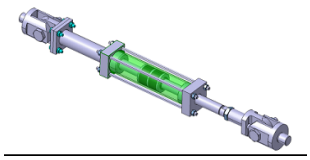
Short description of the project:

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.

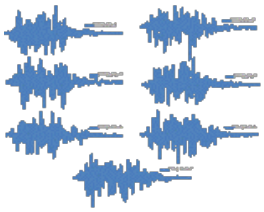


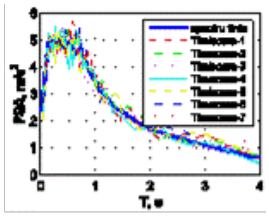
Implementation period:

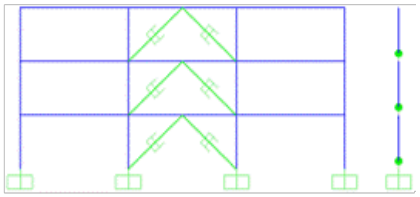
01.07.2014 – 30.06.2016

Main activities:

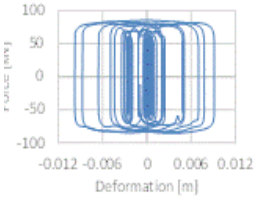
The activities of the project are divided in three stages (I/2014, II/2015, III/2016), of which the first was completed. The particular activities covered the establishment of the seismic action for two locations (Timișoara, București), and the estimation of the functional parameters corresponding to the MR damper.

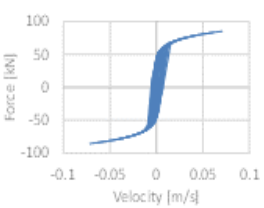




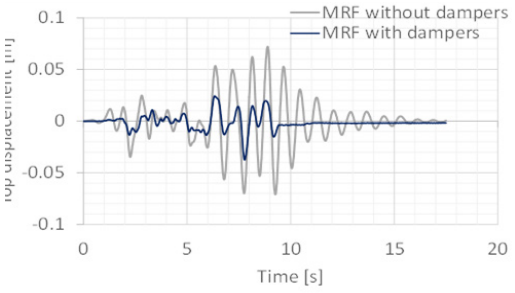


Response of the damper (3rd floor)





Response of the frames



Further, a MR damper of 10 tons capacity will be designed, 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 first stage comprise two sets of artificial accelerograms (stiff and soft soil) and the estimated functional parameters of the MR damper (i.e. force, deformation, velocity). It can be highlighted that the calibration procedure of the functional parameters was established, and the dependence of the parameters was identified in relation to the nature of the seismic motion. Besides, the main outcomes of the project will be:

- Nano-micro composite MR fluid recipes for seismic semi-active dampers;
- The technical solution for the MR damper;
- 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:

- 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 neighbouring 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

- UPT - Politehnica University of Timișoara
- S.C. ROSEAL S.A.
- IMS-AR, Institute of Solid Mechanics of the Romanian Academy
- AR-FT, Timișoara Branch of the Romanian Academy
- S.C. TITAN S.A.

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

Contact information

Prof. Dr. H. C. Dan DUBINĂ, PhD
Corresponding Member of Romanian Academy
Department of Steel Structures and Structural Mechanics
Address: Str. Ioan Curea, No. 1, RO300224, Timisoara
Phone: (+40) 256 403 920
Fax: (+40) 256 403 917
E-mail: dan.dubina@upt.ro