

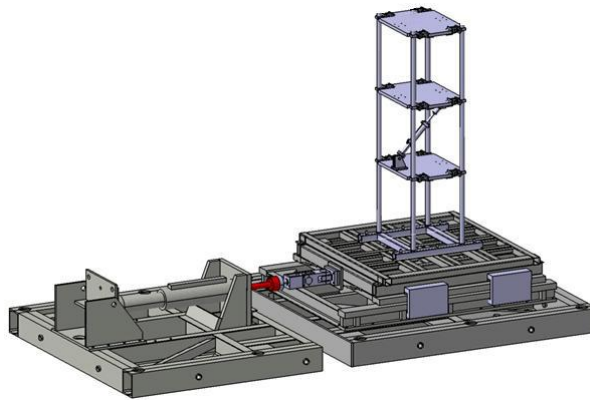
Project: ANTI-SEISMIC BUILDINGS PROTECTION SYSTEM USING MAGNETO-RHEOLOGIC DAMPER

The objective of this project is to develop and manufacture an electro-mechanical system for protecting buildings against earthquakes. The system is based on a semi-active control of vibrations in order to avoid resonance frequencies and stabilize buildings by changing their mechanical characteristics such as stiffnesses and vibration modes.

Within this anti-seismic protection system with semi-active control of vibrations, a key element is the executive component, which is the Magneto-Rheologic (MR) Damper. The system is designed as a system for optimal control, semi-active, with sequential command, and with the possibility of defining new controlling laws for the MR damper. Some specific control algorithms that can be used for controlling the MR damper are:

- distributed bang-bang,
- Liapunov function method,
- clipped-optimal,
- friction modulation.

The anti-seismic protection system with semi-active control of vibrations is manufactured and tested at STRAERO. In the picture below you can see the 3D model of an assembly which includes a seismic testing platform, the structure to be studied, and the anti-seismic protection system.



Below are given some characteristics of systems with semi-active control of vibrations:

- Anti-vibration insulation and anti-seismic protection are based on energy dissipation - similar with passive control systems,
- Ensure total adaptability - similar with active control systems,
- Do not introduce energy into the system,
- Require low power external energy sources - for example batteries or cells,
- Robust,
- Have potential to new and original solutions,
- Opposite to the active control systems, the semi-active control systems avoid the risk of destabilizing the controlled mechanical structure in the sense of bounded input - unbounded output.

MAGNETO-RHEOLOGIC DAMPER

The Magneto-Rheologic Damper was produced and tested by STRAERO in partnership with S.C. HESPER S.A. within the AMTRANS programme and it is a national novelty. Internationally, such dampers are studied since 1990s but only recently they started being used for practical applications.

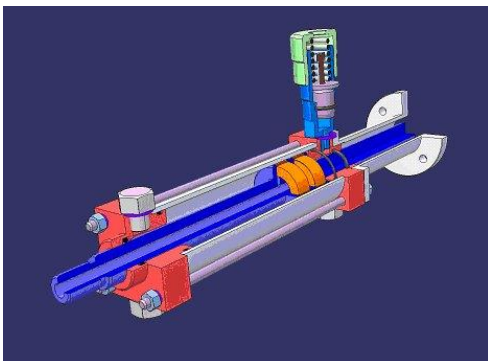
The MR Damper is based on the concept of smart fluid - the magneto-rheologic fluid. The MR fluid is a biphasic fluid made from a mixture of solid particles plunged in a nonmagnetic fluid. When a magnetic field is induced on the MR fluid, its rheologic properties, that is, its effective viscosity, can be dramatically modified. When the magnetic field is applied on the MR fluid, the solid particles suspended in the fluid are reoriented in the form of chains of particles and the MR fluid develops a yield strength and behaves as a Bingham solid. This phenomenon changes the effective viscosity of the fluid proportionally with the intensity of the electric or magnetic field induced and occurs in less than a few milliseconds.

The MR fluid acts as a simple, still and fast interface between the control electronic system and the controlled mechanical system. It is considered that, due to their potential, such controllable MR fluids can make a radical change in the field of electro-mechanic, electro-hydraulic and electro-pneumatic systems. Compared with other dampers, the dampers which use MR fluids have the following advantages:

- good stability,
- low power control,
- quick time response,
- reliability.

The MR Damper developed and manufactured at STRAERO is part of the anti-seismic buildings protection system.

The characteristics of the MR Damper developed and manufactured by STRAERO are experimentally determined as follows:



- Controllable developed force: 10 - 1500 daN,
- Command current necessary for maximum force: 2A,
- Electric power necessary for control: 24 - 30W,
- Response time: approx. 10 ms,
- Course Length: +/- 50 mm,
- Weight: approx. 3 kg.