Multi-performance hysteretic rheological device.

Priority Number

(ex RM2015A000075).

KEYWORDS □ DAMPER

- □ VIBRATION CONTROL
- □ ISOLATION
- □ ANTISEISMIC DEVICE
- □ SHOCK ABSORBER
- □ HYSTERESIS

ARFA

CIVIL. CONSTRUCTION. **MECHANICAL** ENGINEERING

CONTACTS

> PHONE NUMBERS +39.06.49910888 +39.06.49910855

> EMAIL u brevetti@uniroma1.it n. 102015902332343 20.02.2015

- Patent Type Patent for invention.
- Ownership Sapienza University of Rome 100%.

Inventors Walter Lacarbonara, Biagio Carboni.

Industrial & Commercial Reference

Reducing seismic risk and wind-induced oscillations or dynamic forces in civil and offshore structures; vibration damping or shock absorption in structures, vehicles in the mechanical, aeronautical and aerospace engineering fields.

Time to Market

Lab prototype realized and extensively tested; 1 to 2 years for the design, optimization and development of the product to be launched on the market.

Availability

License, Start-up and Spin-off.



Fig. 1 Frequency responses of the uncontrolled (red dots) and controlled structure (black dots). The sway motion amplitude of the fifth floor versus frequency is reported for a multistory building. Reductions of the order of 70% are achieved both for the sway displacement and acceleration.



Fig. 2 Picture of the prototype realized as a TMD (vibration absorber)



Fig. 3 Flutter control of the Runyang suspension bridge: maximum torsional angle vs. wind speed. The network of TMDs can shift the flutter speed and reduce the limit cycle oscillations due to flutter.

Abstract

The invention deals with a multi-purpose mechanical device capable of providing restoring forces with adjustable nonlinear hysteretic properties.

The device can be used in many different forms including tuned mass damper (TMD), vibration absorber, damper, hysteretic isolator, energy absorber, shock absorber and, more in general, as rheological device with custom-designed hysteretic force-displacement characteristics in compliance with the specific applications. The device can be civil, employed for aeronautical. aerospace and industrial structures for vibration reduction due to dynamic excitations (earthquake, wind, sea waves, etc.), and in mechanical engineering for shock absorption in isolation or machineries.

Publications

- ✤ B. Carboni, W. Lacarbonara, F. Auricchio (2014). Hysteresis of multi-configuration assemblies of NiTiNOL and steel strands: and phenomenological experiments identification. Journal of Engineering Mechanics 141(3). 04014135. doi: 10.1061/(ASCE)EM.1943-7889.0000852.
- B. Carboni, W. Lacarbonara, Nonlinear vibration absorber with pinched hysteresis: Theory and experiments. Journal of Engineering Mechanics 142 (5), 04016023.

ASuRTT _ UFFICIO VALORIZZAZIONE E TRASFERIMENTO TECNOLOGICO SETTORE BREVETTI E TRASFERIMENTO TECNOLOGICO http://uniroma1.it/ricerca/brevetti



Multi-performance hysteretic rheological device.

Technical Description

The invention deals with a mechanical device capable of providing nonlinear restoring forces characterized by hysteresis loops whose shapes can be adjusted. The forces are delivered by strands of wires made of steel and shape memory alloys subject to flexural or tensile/flexural loads.

The possibility of optimizing the hysteresis shape according to the application targets makes the device versatile and capable of high performance. Both stiffness and energy dissipation (damping) are uniquely provided by the wire ropes.

The restoring forces can be applied to an oscillating mass obtaining a TMD or introduced in the base of a structure to achieve isolation from the base excitation. In addition, the hysteretic force can act as a localized damper of kinetic energy for shock/vibration mitigation of different structures.



Fig. 4 Time histories of the uncontrolled (red line) and controlled structure (black line). The sway motion is reported for a multistory building subject to two earthquakes. Reductions of the order of 70% are achieved in the acceleration time history.

Technologies & Advantages

The proposed device can be employed for various applications which exploit the restoring force of an assembly of several ropes and wires made of different materials.

The main advantage of the device is the capability of adjusting the shape of the hysteretic cycles according to the application targets.

The damping and stiffness trends can be suitably designed as function of the displacement along the loading and unloading branches.

In this way, the loss of performance is overcome in mitigating vibrations of structures whose dynamical features depend on the amplitude of the displacements.

The version of the device based on steel wire ropes is designed for civil applications where the large scale of the system does not result in high costs due to the employed low-cost materials.

The version which employs shape memory alloy wire ropes is designed for customized applications where the size of the system is relatively small and a high performance is required.

The proposed device exhibits higher performance than existing devices since it is more robust and, mainly, it is cheaper.

Applications

The device can be used for various applications such as vibration damper, energy dissipator, adaptive structural element, actuator, rheological element capable of providing hysteretic restoring forces according to design specifications that require nonlinear stiffness and damping.

The planar and spherical configurations can be employed as tuned mass damper to be integrated in building floors, in skyscrapers, in towers (including offshore wind turbines), in monumental buildings, to reduce the seismic hazard, to mitigate the oscillations due to wind or to increase the fatigue life of off-shore structures reducing the level of stress due to sea wave motions.

In mechanical engineering, the device can be used as a vibration isolator of machines or mechanical parts.



Fig. 5 Flutter control architecture for a suspension bridge: two arrays of TMDs are positioned on the sides of the deck to control both bending and torsion.

ASuRTT _ UFFICIO VALORIZZAZIONE E TRASFERIMENTO TECNOLOGICO SETTORE BREVETTI E TRASFERIMENTO TECNOLOGICO



http://uniroma1.it/ricerca/brevetti

CONTACTS

PHONE NUMBERS
+39.06.49910888
+39.06.49910855

EMAIL u_brevetti@uniroma1.it