ADAPTIVE FLUID-DAMPING INTELLIGENT SEISMIC BUILDING CONNECTOR

Specification:

Technical Field

[0001] The present disclosure relates generally to structural engineering and seismic protection, and more particularly to a fluid-damping connector capable of autonomous response to multi-axial vibrational stresses.

Background of the Invention

[0002] Conventional seismic dampers often rely on static mechanical properties. These systems frequently fail to provide optimal damping across a broad spectrum of seismic frequencies, leading to structural fatigue or catastrophic failure during high-magnitude events. There is a need for a "smart" connector that can adapt its damping coefficient in real-time.

Summary of the Invention

[0003] The present invention provides a retractable, fluid-based connector that utilizes a shape-memory alloy (SMA) valve system. By sensing thermal or kinetic changes during a seismic event, the SMA actuator adjusts the flow rate of internal hydraulic fluids, thereby stiffening or loosening the joint to dissipate energy efficiently.

Detailed Description of the Embodiments

[0004] Referring to the drawings, the connector comprises a housing (100) and a piston (200). The interior chamber (110) is filled with a non-Newtonian fluid. During a low-frequency tremor, the fluid flows freely through the bypass (210), allowing for thermal expansion of the building.

[0005] During a high-frequency earthquake, the SMA actuator (300) triggers the closure of the bypass. This forces the fluid through micro-perforations, significantly increasing the damping force ($F_d = -c \cdot v^n$). This transition occurs within milliseconds, providing immediate structural stabilization.

ABSTRACT

An adaptive seismic connector for structural applications is disclosed. The device includes a housing assembly and a dynamic piston defining a hydraulic circuit containing a variable-viscosity fluid. An autonomous valve assembly, utilizing a shape-memory alloy actuator, modulates the flow of the fluid in response to seismic loads. The connector enables real-time adjustment of damping coefficients, significantly reducing kinetic energy transfer from a foundation to a superstructure. The modular design allows for both new construction integration and retrofitting of existing buildings.

Claims

1. An adaptive fluid-damping seismic connector, comprising:
    - a housing assembly defining a primary hydraulic chamber, the housing assembly further comprising a first mounting interface;
    - a dynamic piston disposed within the primary hydraulic chamber and configured to translate along a longitudinal axis, the dynamic piston being coupled to a second mounting interface;
    - a variable-viscosity fluid sealed within the primary hydraulic chamber; and
    - an autonomous valve assembly integrated within the dynamic piston, the autonomous valve assembly comprising a shape-memory alloy (SMA) actuator configured to modulate fluid flow through the piston based on a detected kinetic energy threshold.
2. The seismic connector of claim 1, further comprising a secondary expansion reservoir fluidly coupled to the primary hydraulic chamber via a pressure-relief conduit.
3. The seismic connector of claim 1, wherein the variable-viscosity fluid comprises a magnetorheological fluid.
4. The seismic connector of claim 3, further comprising an electromagnetic coil disposed circumferentially around the primary hydraulic chamber, the electromagnetic coil being configured to generate a magnetic field in response to a signal from a piezoelectric sensor.
5. The seismic connector of claim 1, wherein the first mounting interface is configured to couple to a primary building superstructure and the second mounting interface is configured to couple to a structural foundation.

Figures

Figure 1: A perspective view of the adaptive seismic connector in a neutral state, showing the first and second mounting interfaces.
Figure 2: A longitudinal cross-sectional view of the device, illustrating the internal primary hydraulic chamber and the dynamic piston.
Figure 3: A detailed view of the autonomous valve assembly (Component 300) showing the shape-memory alloy actuator in a deactivated state.
Figure 4: A detailed view of the valve assembly in an activated state, illustrating the restricted fluid flow path during a seismic event.

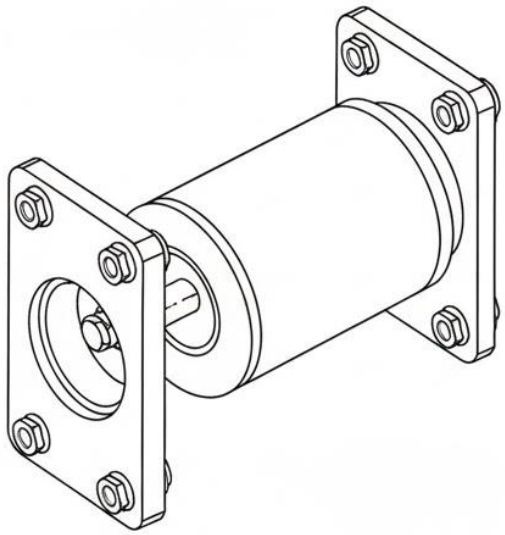

Figure 1

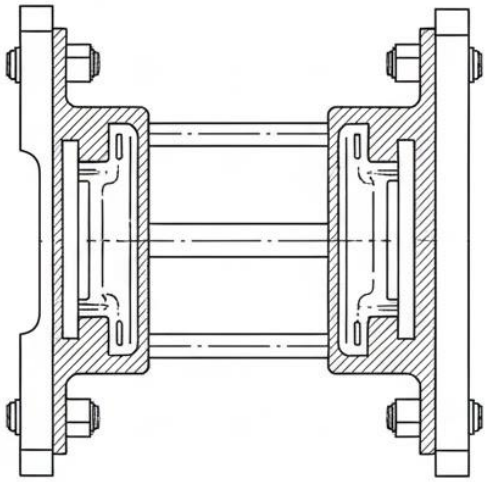

Figure 2

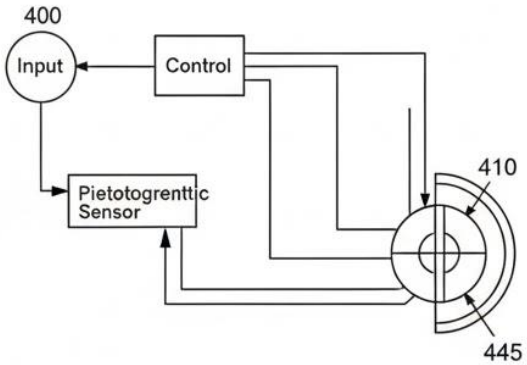

Figure 3

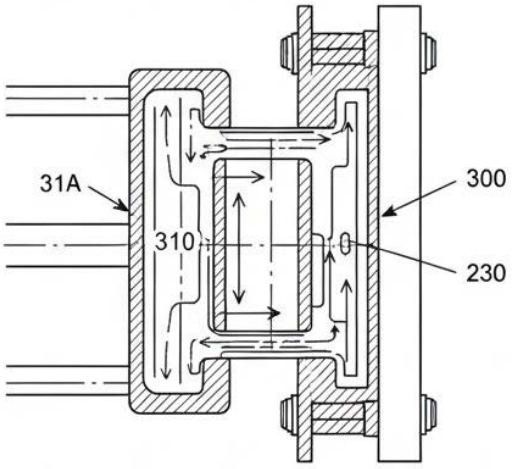

Figure 4