QuakeCoRE
NZ Centre for Earthquake Resilience

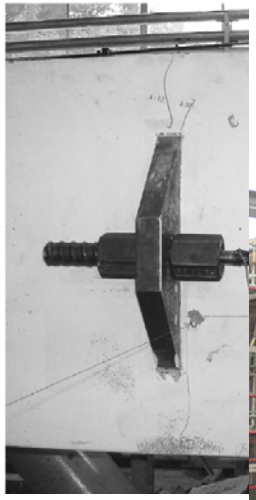
Dissipative and/or braced systems (components and devices)

Why?

- Rocking systems typically have low inherent damping and require a form of supplemental energy dissipation to prevent excessive displacements.
- A multitude of different energy dissipation systems exist within New Zealand and internationally.
- This is only a broad overview of the options available and is not an exhaustive list.

Yielding Steel Dissipaters

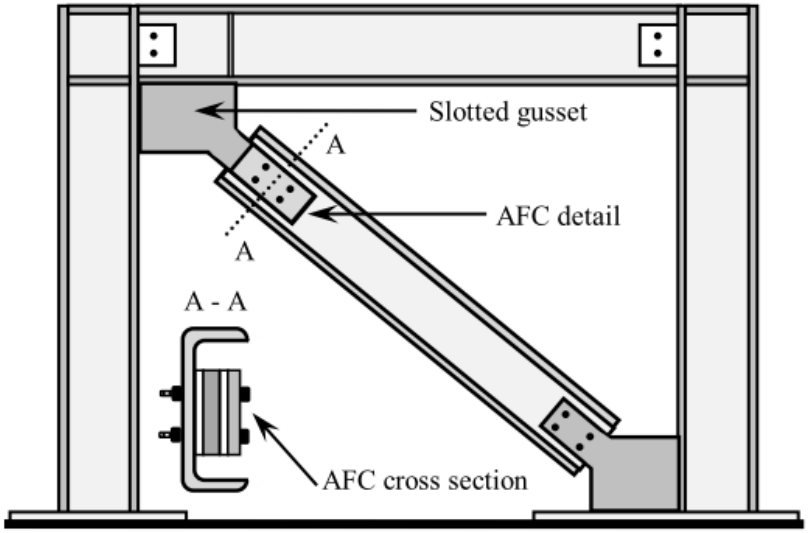
- Simple and generally low-cost
- Vary significantly in size from small “plug and play” devices in individual connections, to full Buckling Restrained Braces (BRBs) for full bays

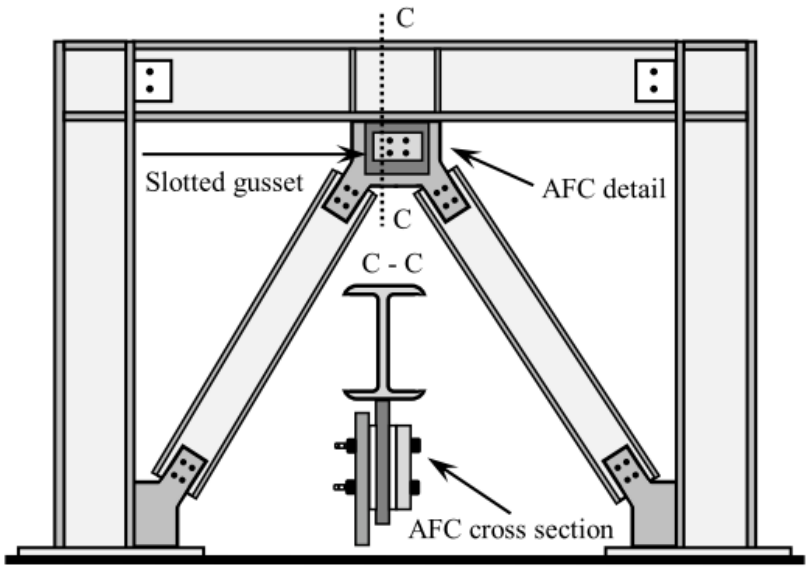


Sol

Friction Connections

- Sliding Hinge Joint, Symmetrical and Asymmetrical Friction Connections (SFC, AFC)
- Similar to conventional moment frame design methodology, but allows low-damage frictional sliding
- A simple, low-damage solution that has been widely adopted





Resilient Slip Friction Joint (RSFJ)

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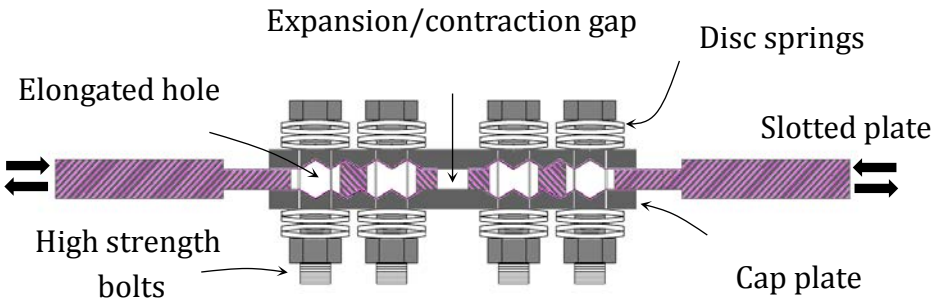
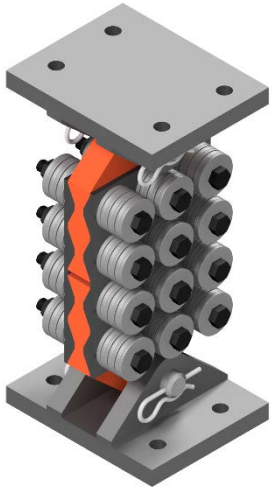
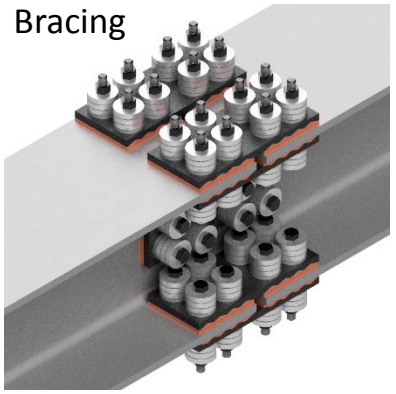
- Damping and self-centring in one joint.

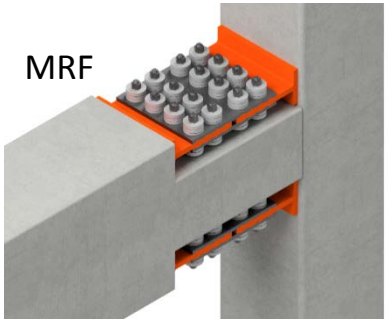




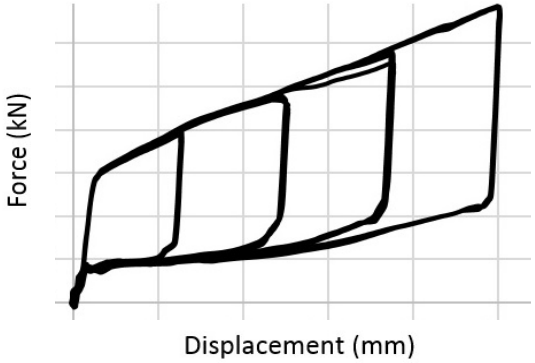
Bracing



MRF



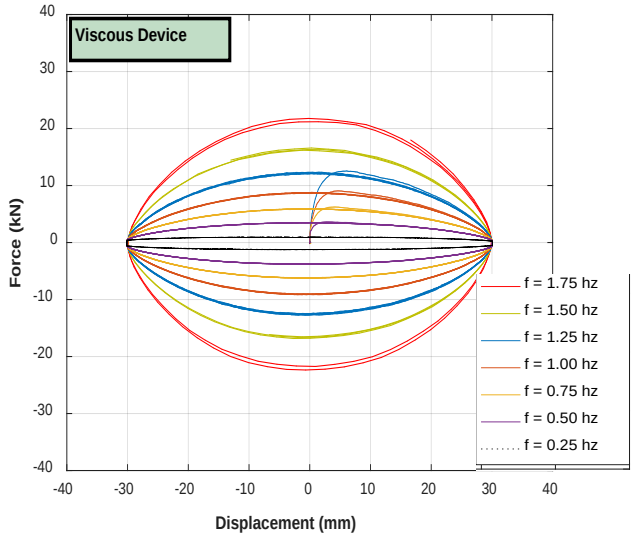
To be implemented in the new Nelson Airport Terminal



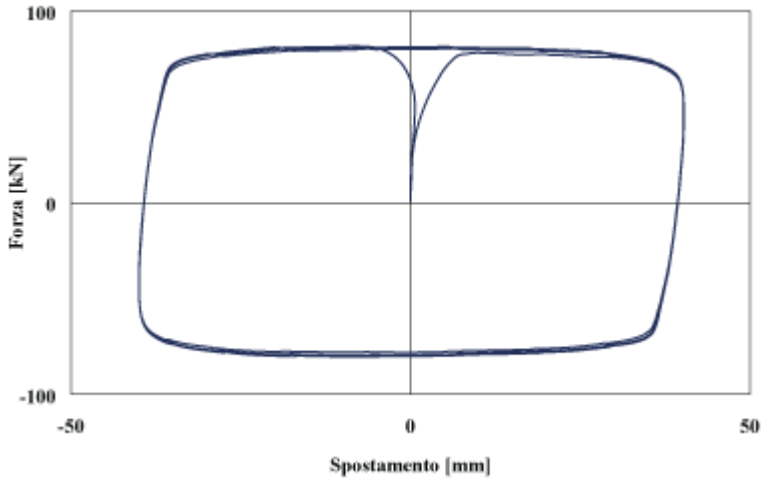
Shearwall

Viscous Dampers

- Various options available including Fip, Taylor Devices, and locally produced.
- Linear and non-linear velocity response behaviour (α = 0.15-1.0)
- No post-event repair or maintenance required and potential for reduced residual displacements



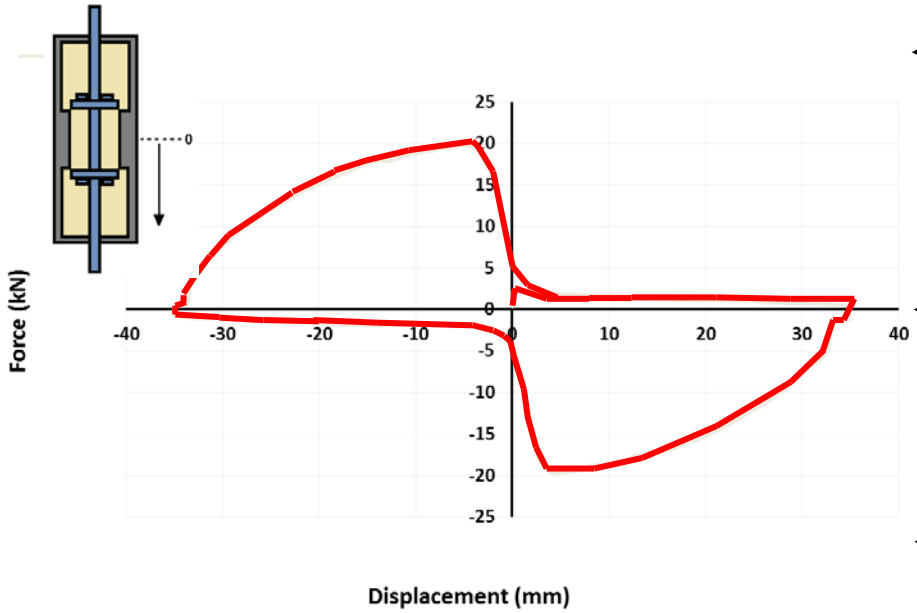
Linear Force-Velocity Response

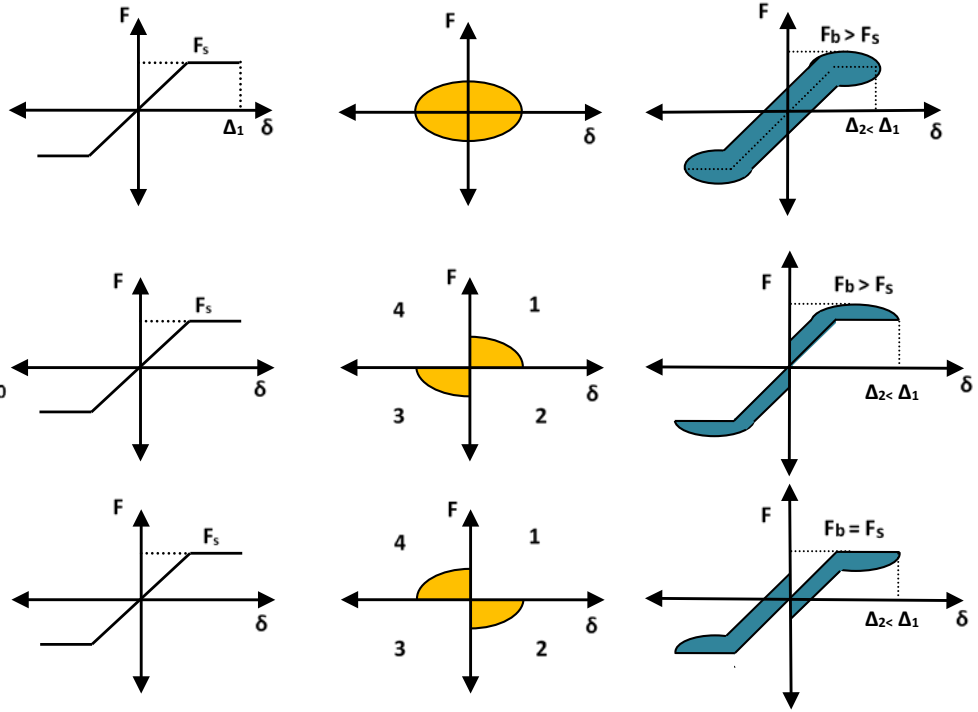


Non-Linear Force-Velocity Response

Viscous Dampers

- Passive quadrant-specific (displacement and direction dependent) viscous damping device designs based on multiple pistons.
- Potential reduction in total force transferred (reduce overall base-shear of reduce toe compression forces on rocking walls)

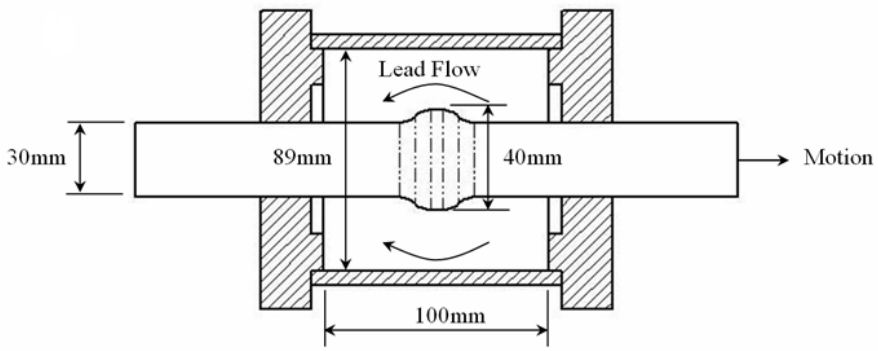




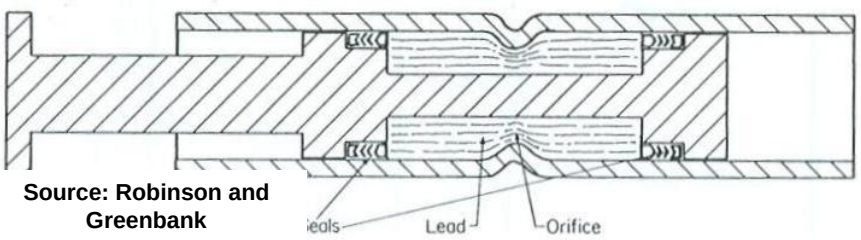
Lead Extrusion Devices

- Energy absorbed through plastic extrusion of lead
- Elasto-plastic hysteresis loop with weak velocity dependence (α=0.12)
- No fatigue issues, but strictly dissipative (no restoring stiffness)

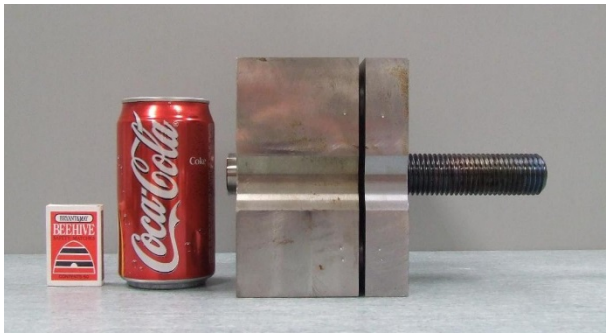
Bulged-shaft type extrusion damper

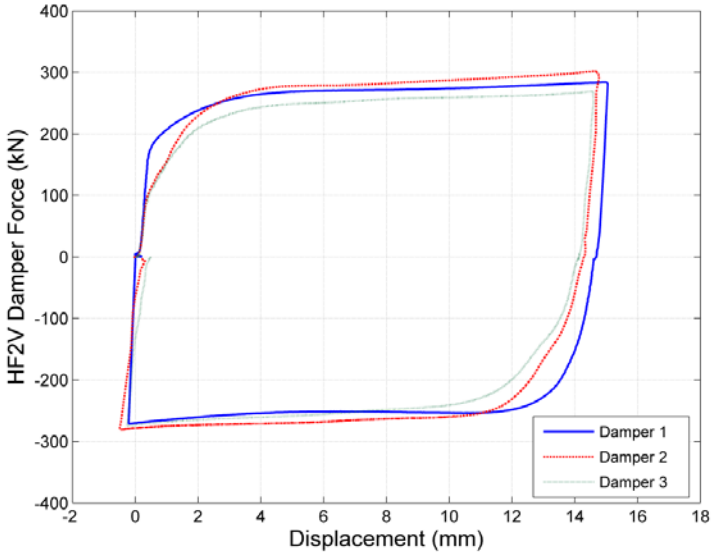


Constricted-tube type extrusion damper



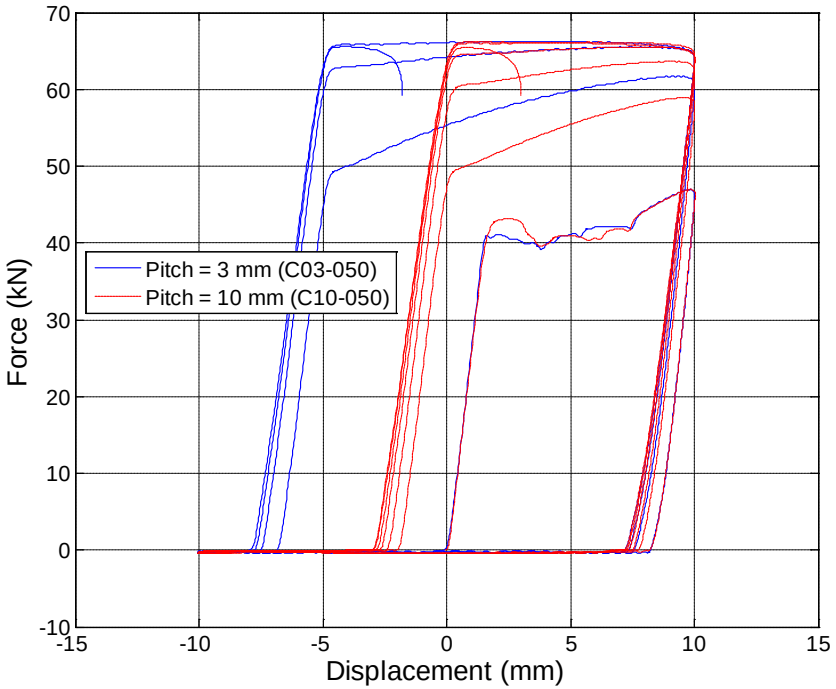
Source: Robinson and Greenbank

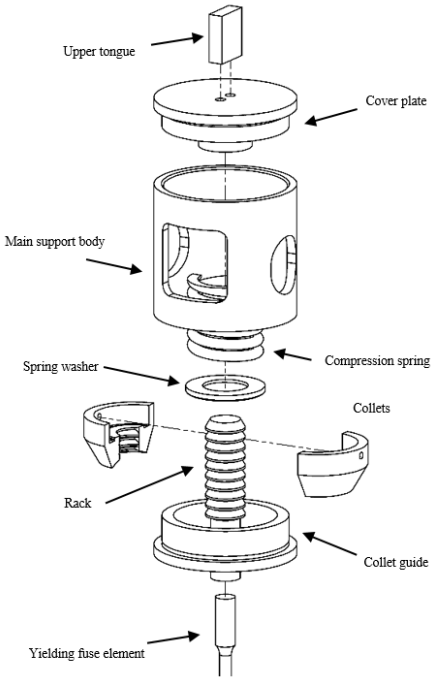




Tension-Only Bracing

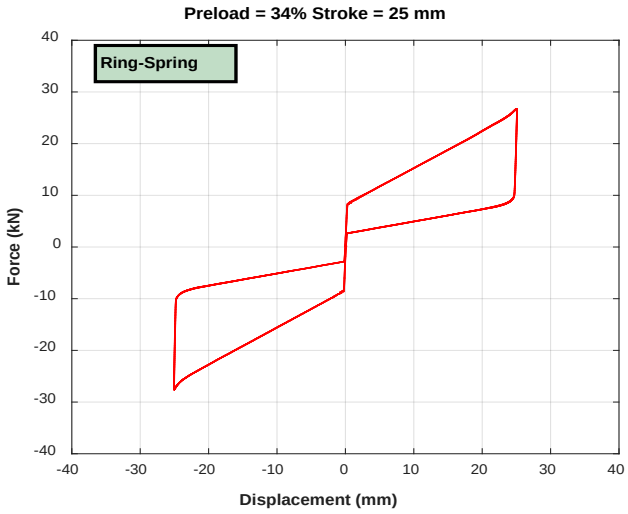
- Several different systems have been investigated by researchers worldwide
- Tension-engagement with minimal compressive forces
- Removes the requirement for large buckling restraint.
- Can be used with any chosen dissipative element





Friction/Ring Springs

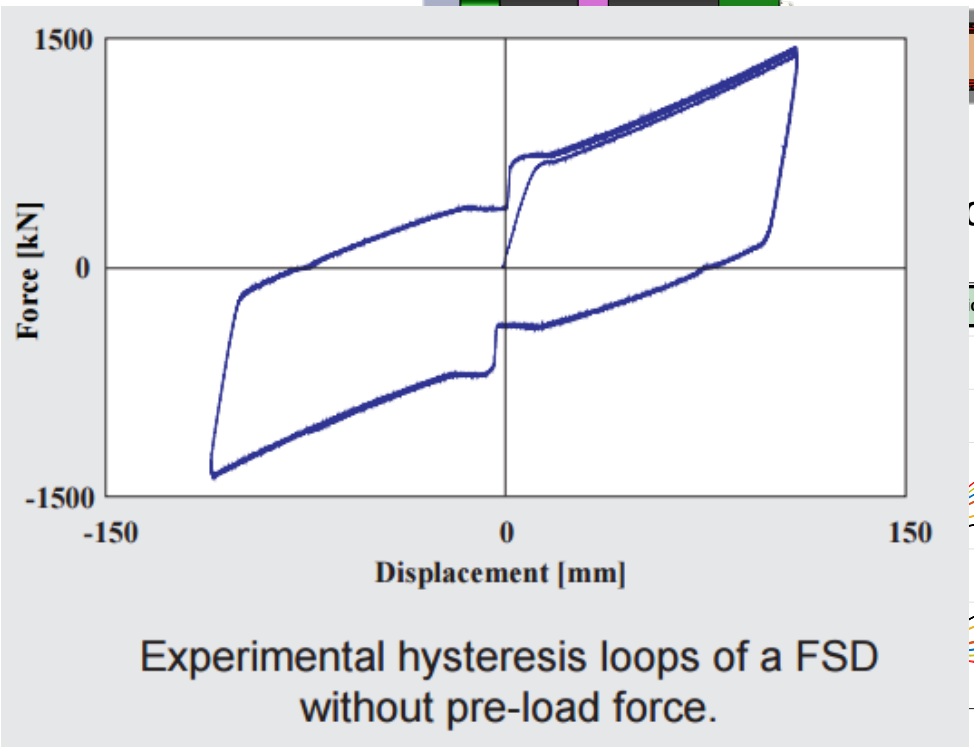
- Commercial product from Ringfeder used extensively in heavy industry over several decades and more recently in seismic applications (including Te Puni Student Village and in Christchurch)
- Re-centering and energy dissipation combined in one unit.
- Can be pre-loaded to prevent initial uplift, similar to post-tensioning of tendons in rocking walls



Hybrid systems

- Any number of possible combinations of individual dissipative elements
- Added complexity in the hybrid device (and probably associated higher cost), but potential advantages in response

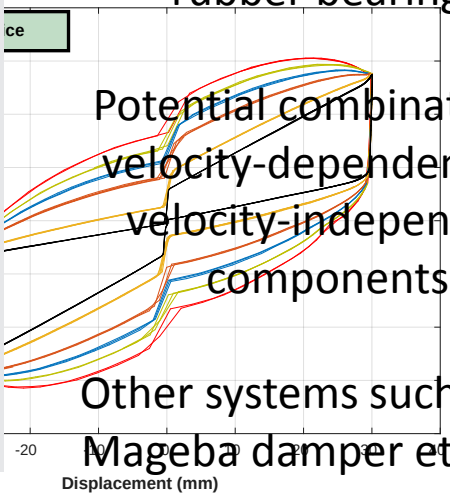
Fip Fluid-Spring-Damper



Experimental hysteresis loops of a FSD without pre-load force.

damper

Hysteresis loops combined re-centering stiffness with energy dissipation (similar to elastomeric or lead-rubber bearings)



Potential combination of velocity-dependent and velocity-independent components.

Other systems such as the Mageba damper etc exist.