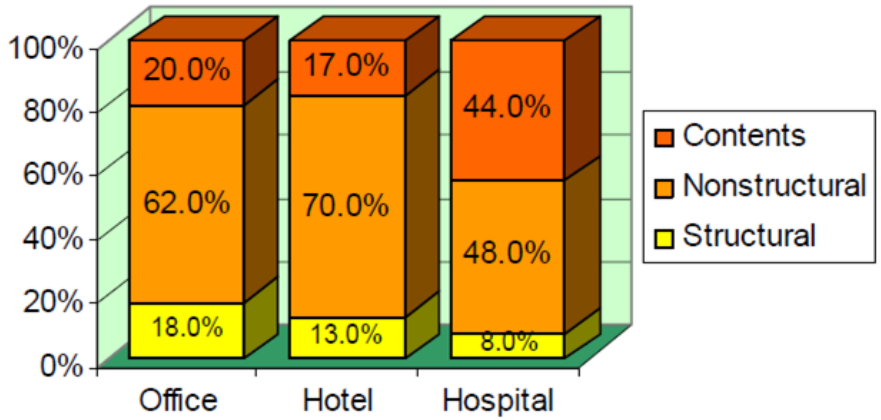
Hilti Innovation process related to Earthquake and Firestop

Nonstructural components can result in major economic loss and a threat to life safety …

In most buildings, the **non-structural** components account for **60 to 80 percent** of the value of the building. Mostly are fragile, easily damaged, and costly to repair or replace.



Typical investments in building construction (after E. Miranda)

**Source: Earthquake effects on buildings. Christopher Arnold. FEMA Library*

… and non-structural elements can increase the potential for fire

- The Applied Technology Council of San Francisco created the CAPSS report*. They suggest 17 important actions to reduce the impact of future earthquakes

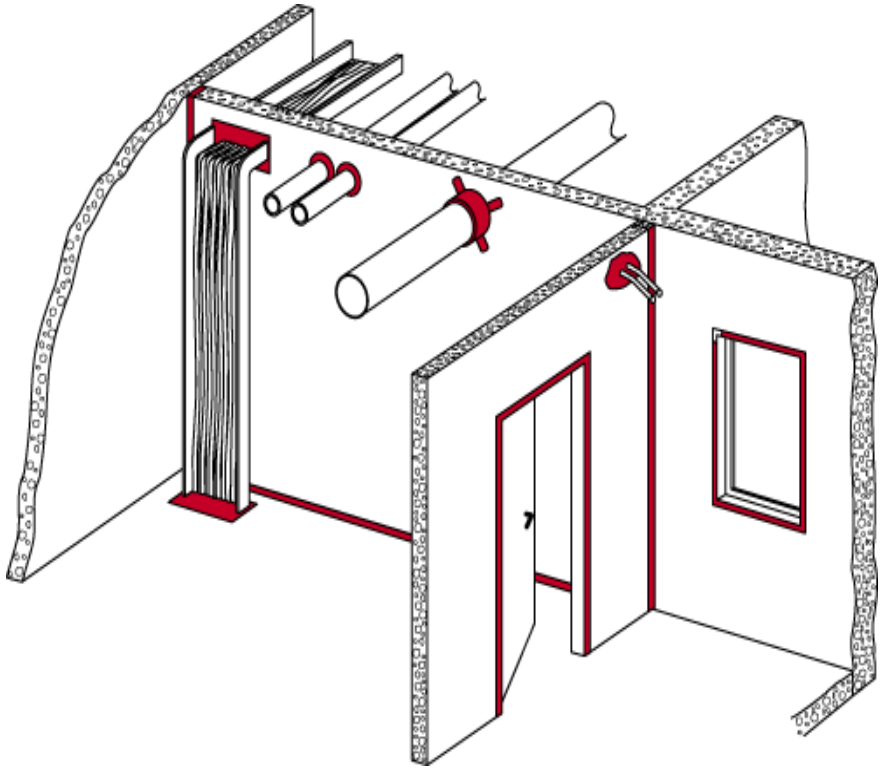
- **<u>6 of them are related to mitigating fire following earthquake</u>**:

  "Address the hazards from damage to building systems, appliances, equipment and ***non-structural building elements****. Damage to building systems, such as fallen ceilings and fixtures, broken pipes, and overturned equipment and appliances,* ***increase the potential for fire ignitions and spread".***

**CAPSS report: a Community Action Plan for Seismic Safety*
Source: After the Shaking Stops: A Communitywide Approach to Managing Post-Quake Fires. Insurance Institute for Business & Home Safety

How can we ensure safety with passive firestop?

Fire spread within buildings can be reduced by ensuring that passive fire protection systems have sufficient fire and earthquake resistance*.



- Firestop restores the integrity of compartments breached by services and other openings
- Reduces the **spread of fire and smoke**
- Openings in fire-resisting walls & floors are areas of weakness
- Goal of Firestop is to ensure **safe escape** (Time!)

**Acc. to source: Building design for fire after earthquake. Russ Botting and Andy Buchanan*

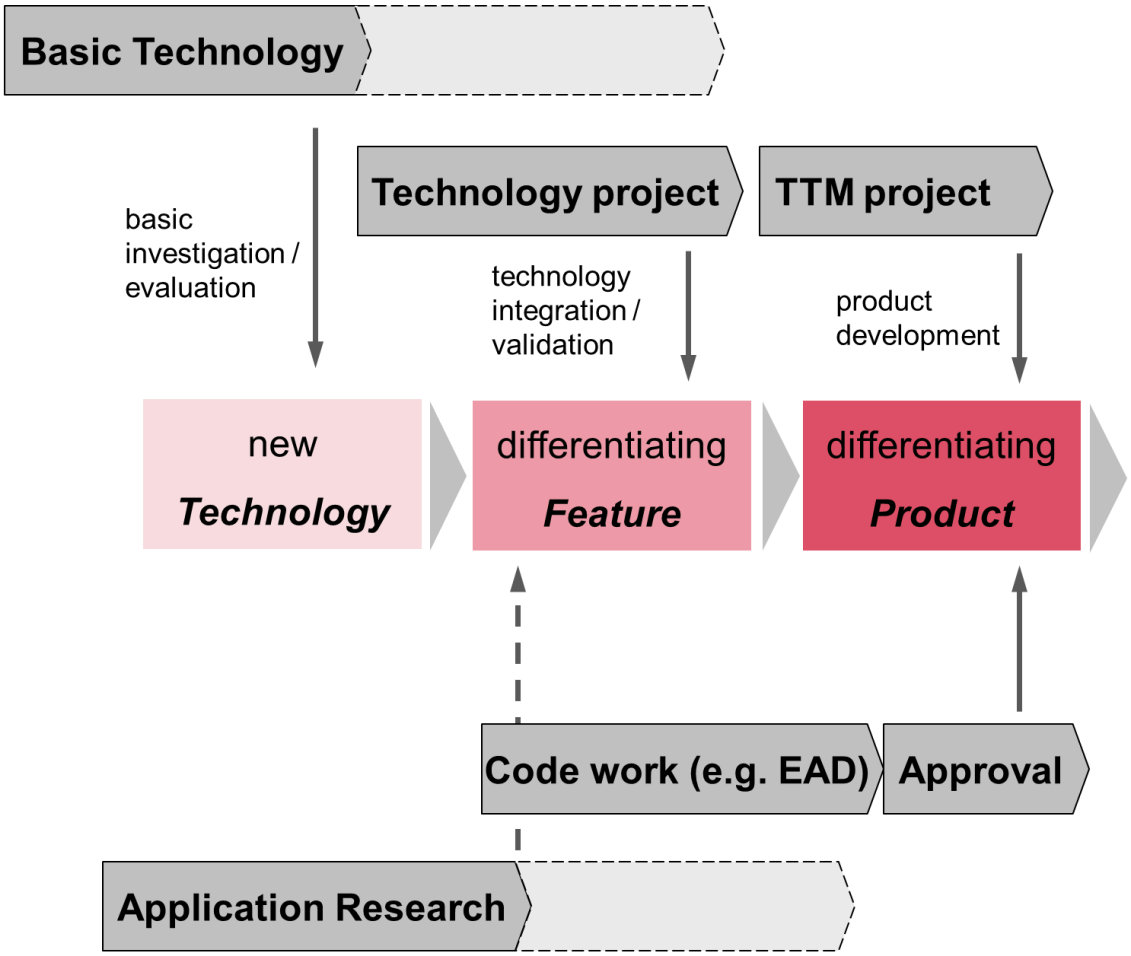
Insurances also consider fires after quakes a major loss trigger and recommend non-combustible firestop material that can deform under seismic loading

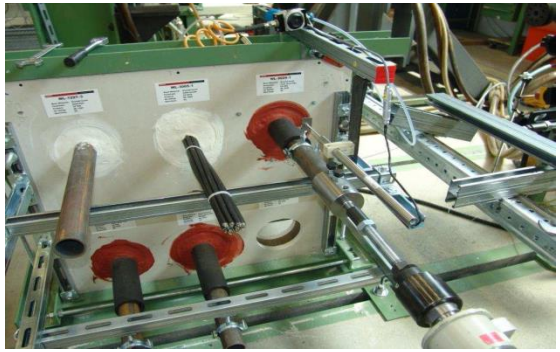
*"An earthquake can not only cause a fire by releasing combustible material but also impair **passive** or active **fire fighting systems**".*

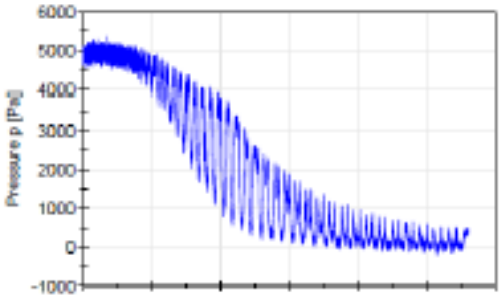
Controls

- ✔ Critical piping to be braced from swaying by means of supporting frames, tensioned wires, etc. Attention is to be given to the connection of the bracing to the pipes. Refer to Federal Emergency Agency document FEMA P-414 for best practice guidance.
- ✔ Provide an adequate gap around critical piping at penetrations of walls. Gaps are to be filled with suitable non-combustible fire stopping material that can deform under seismic loading, eg. acrylic sealants.
- ✔ All production critical equipment, including fire-fighting pumps, to be properly anchored to the foundations. Anchor bolt configuration and foundation design are to be checked by qualified structural engineer.

Innovation process @ Hilti





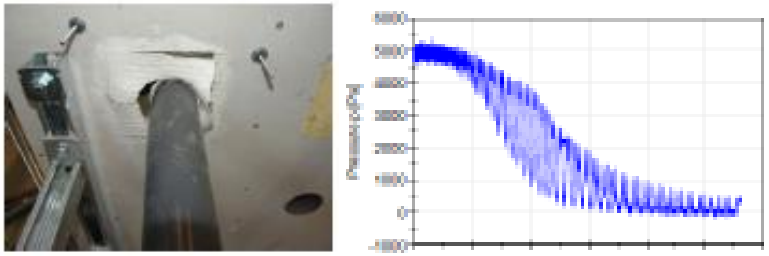


Extensive tests drive our innovation

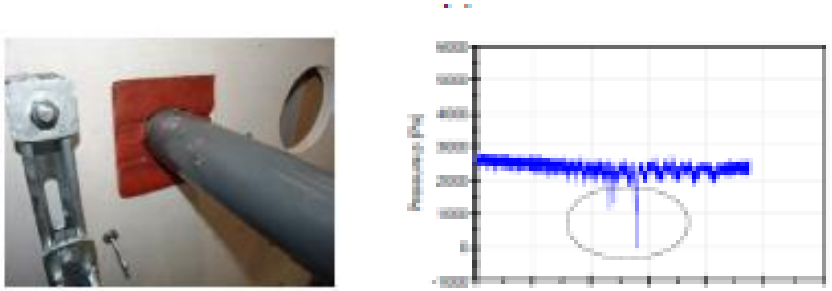
Hilti have conducted several tests to determine the behavior of firestop products in a seismic event while taking fire integrity and smoke tightness issues in a post-earthquake environment into consideration.

Tests	Purpose	How
Lab movement tests	Characterise sytem performance	Cyclic test in 2 directions + air leakage
Research project with UCSD	Understand how nonstructural components and systems interact with a building and with each other during an earthquake. Evaluate the post-earthquake fire performance of systems.	Phase 1 - Base isolator tests Phase 2 – Fixed foundation tests Phase 3 – Post earthquake fire performance
According to ASTM standards on movement	Assess systems' individual performance	Cyclic test in 2 directions + Fire test + Hose Stream

Lab movement tests



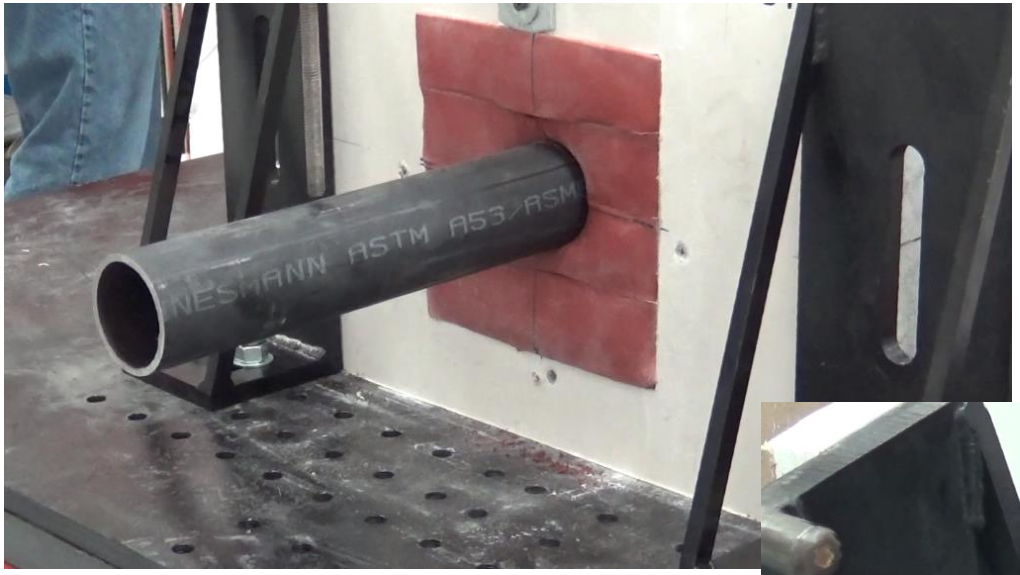
Inflexible Coated Board, high air leakage

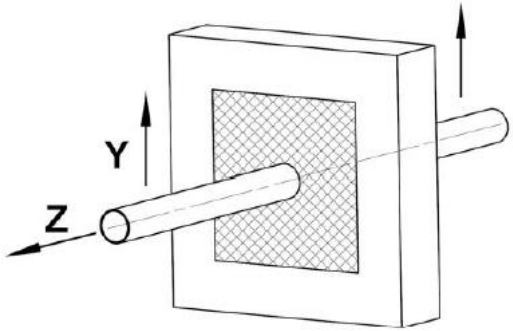


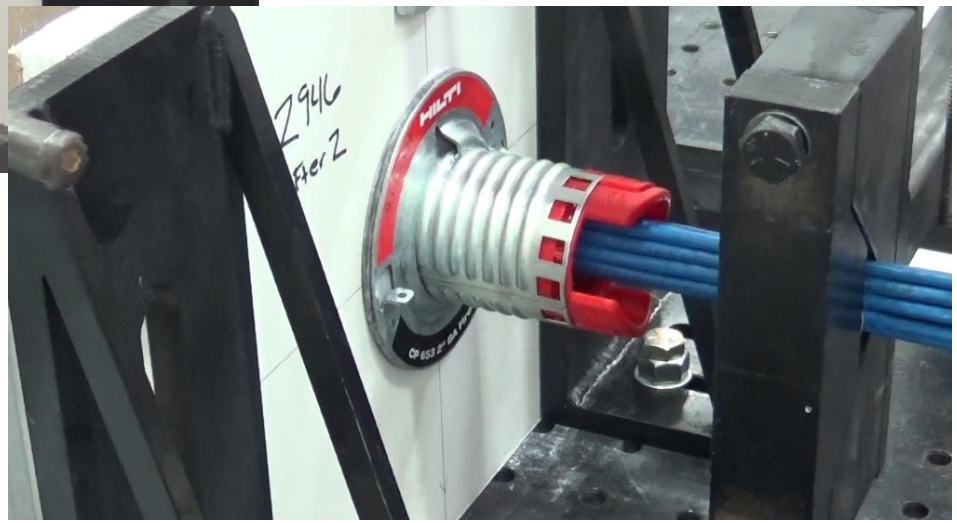
Flexible Blocks, limted air leakage

Fire test shows considerable smoke through coated board, blocks passed fire test

Individual tests acc. to ASTM standards



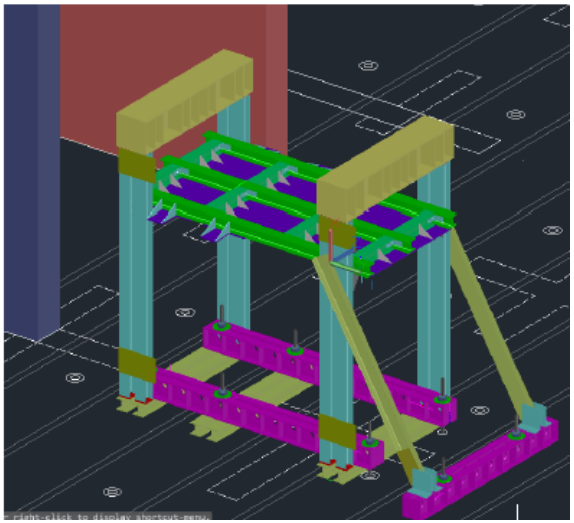


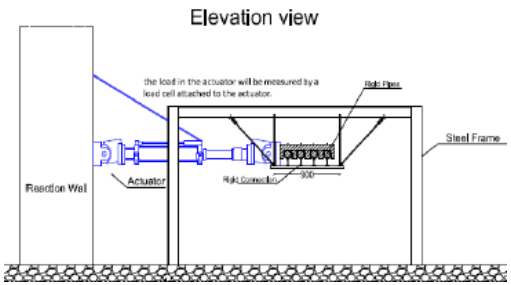


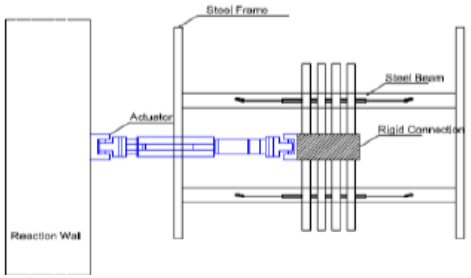
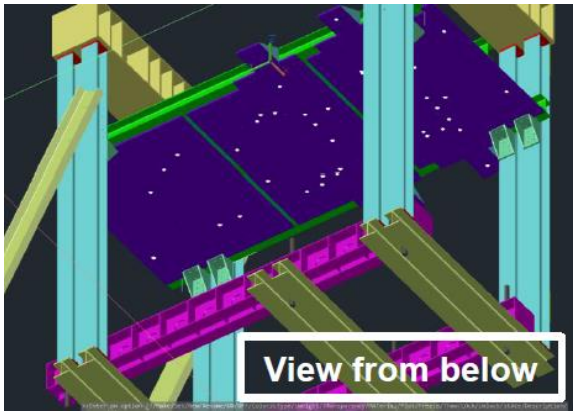
Class A*: Best performance!

Performance is assessed acc. to 3 classes: A, B and C (best: A)

Next step is to quantify the movement experienced in system tests







Experimental design to determine the movement at a wall interface of penetrating items depending on differing designs of supports