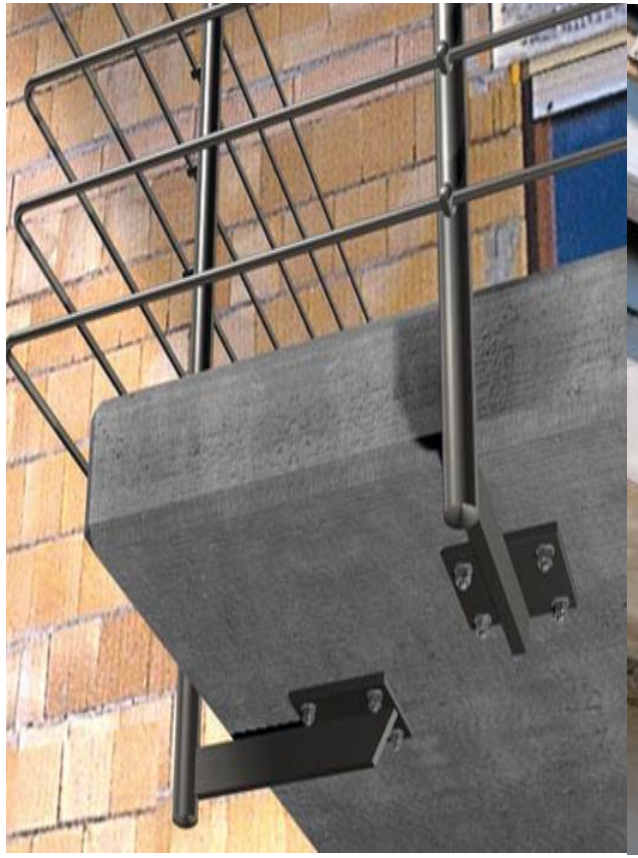
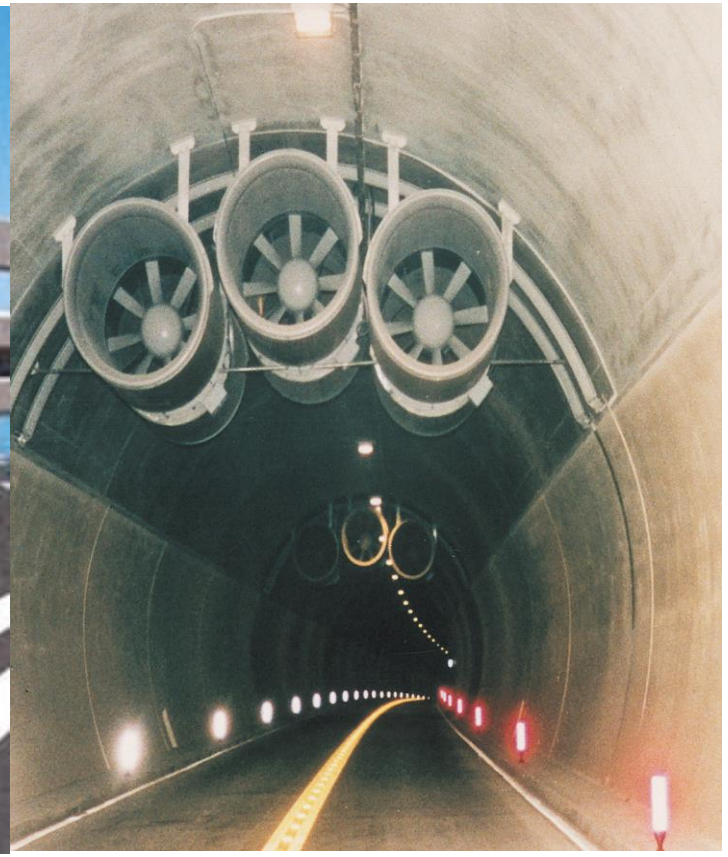
SEISMIC RESEARCH IN FASTENING TECHNOLOGY

Seismic Academy
October 24, 2017

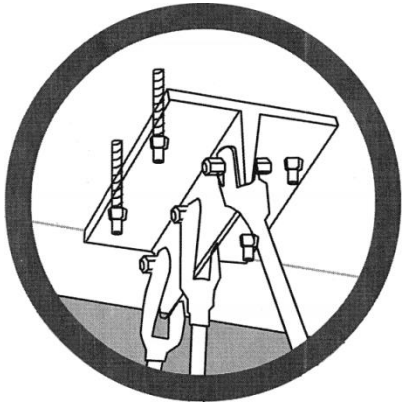
Ted Przybylowicz

FASTENING TECHNOLOGY IS EVERYWHERE



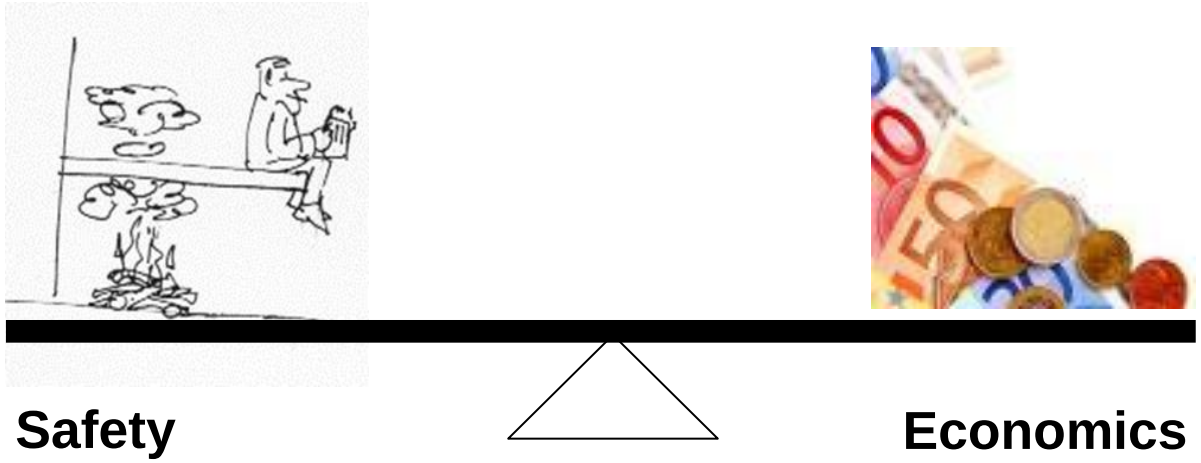


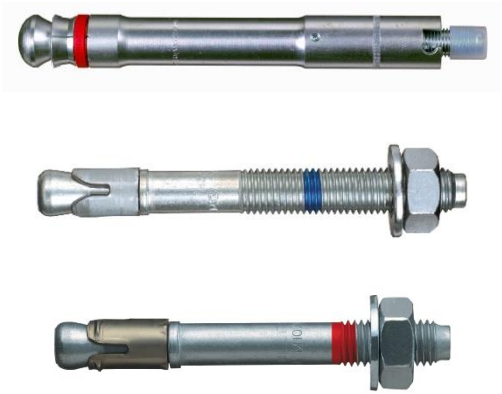
FAILURES OF FASTENINGS HAVE A SIGNIFICANT IMPACT



Failure of a ceiling in an indoor swimming pool
(Uster, 1985)

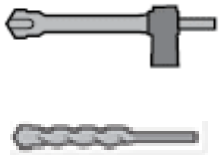
EUROPEAN TECHNICAL APPROVALS / ASSESSMENT PROVIDE TRANSPARENCY TO THE FUNDAMENTAL BALANCE





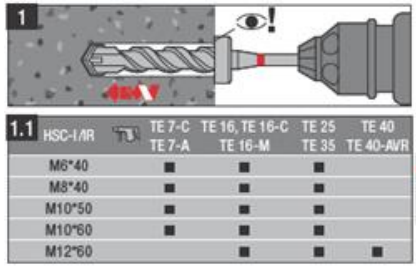
SAFE FASTENING SOLUTIONS ARE PROVIDED BY A FULL SET OF KEY ELEMENTS

1 The drilling hardware



2 The anchor hardware

3 IFU



4 3rd party testing & eval.

5 Design method

6 Design software

7 Installation training

8 On site testing

INVESTMENT OF HILTI INTERNAL RESOURCES - FASTENING SYSTEMS RESEARCH LABORATORY

Static / Quasistatic Loads
200 N - 2 MN

Fatigue Loads
200 N - 500 kN

Seismic Loads
Digital, freely programmable servohydraulic system

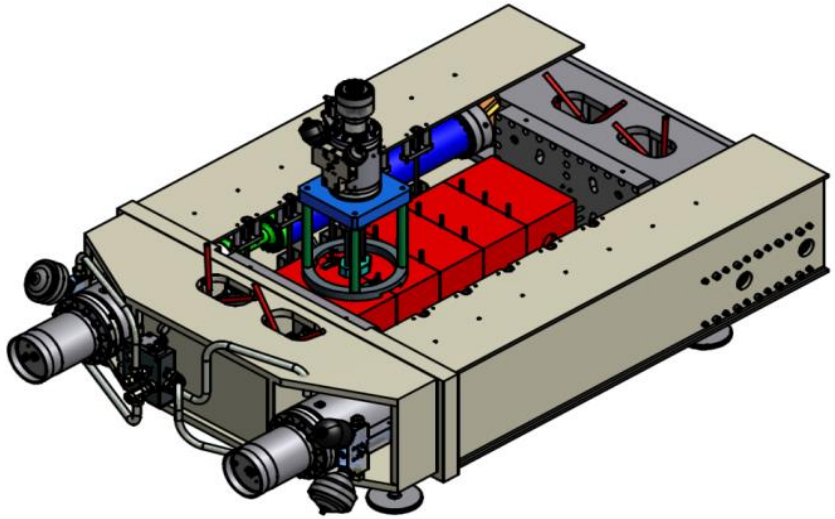
Shock Loads
0.7 m/s - 4 m/s

Fire Resistance
1200°C (ETK) single-point testing (200 N - 63 kN)

Cracked Concrete
Static and dynamic tests using cracked concrete (0.1 mm - 1 mm)

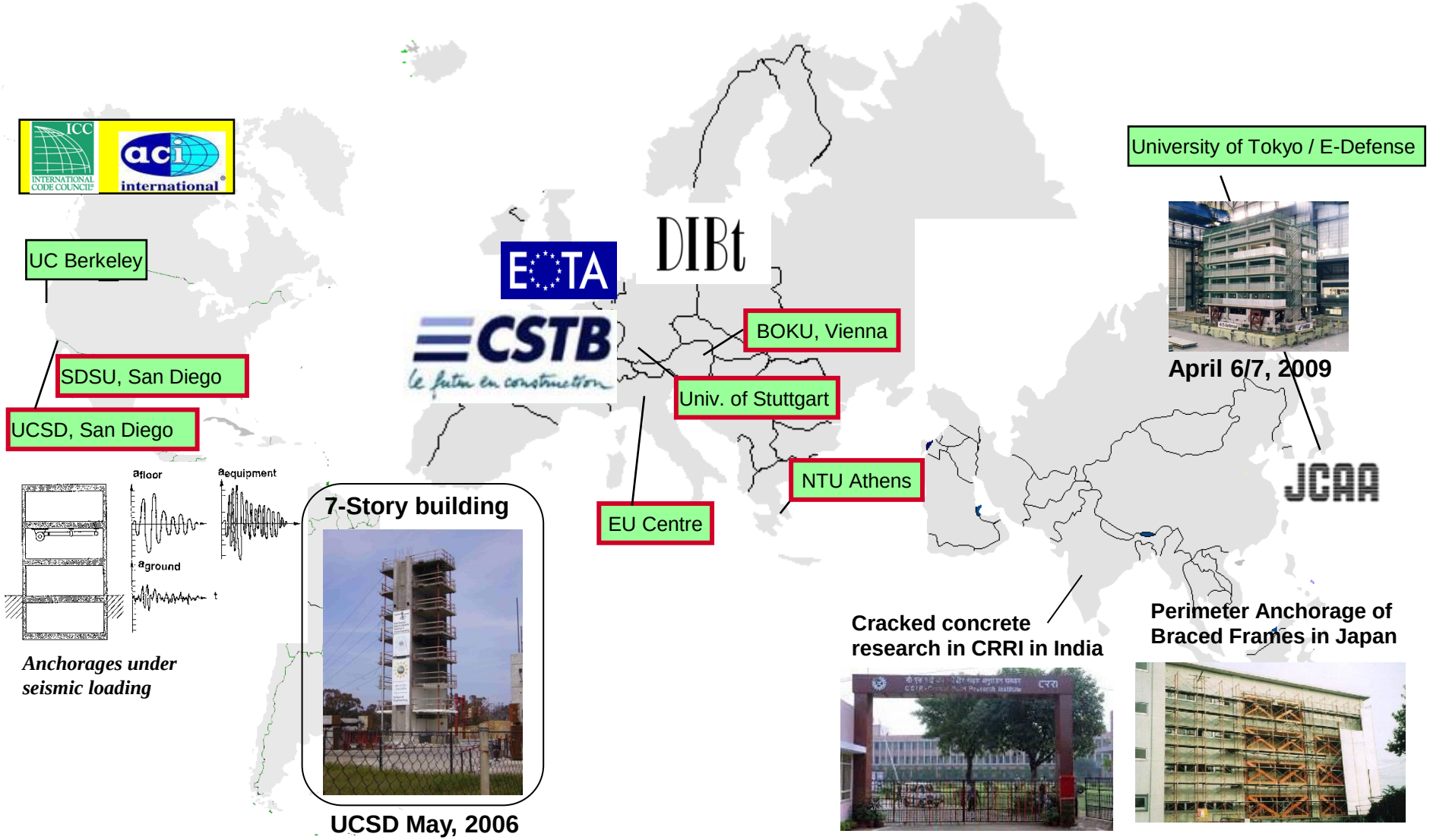
Long-term testing
-20°C - 180°C, variable load level

- Founded in 1979
- Most up-to date test infrastructure
- Conduct fastener tests
- Test full-scale structural systems
- Accredited according ISO/IEC 17025,



HILTI IS NOW OPERATING IN A GLOBAL, DE-CENTRALIZED SETUP IN 8 LOCATIONS

RESEARCH & DEVELOPMENT AS WELL AS THIRD PARTY ASSESSMENT IS THE BASIS FOR SUSTAINABILTY



EXTERNAL RESEARCH ACTIVITIES – FEW EXAMPLES

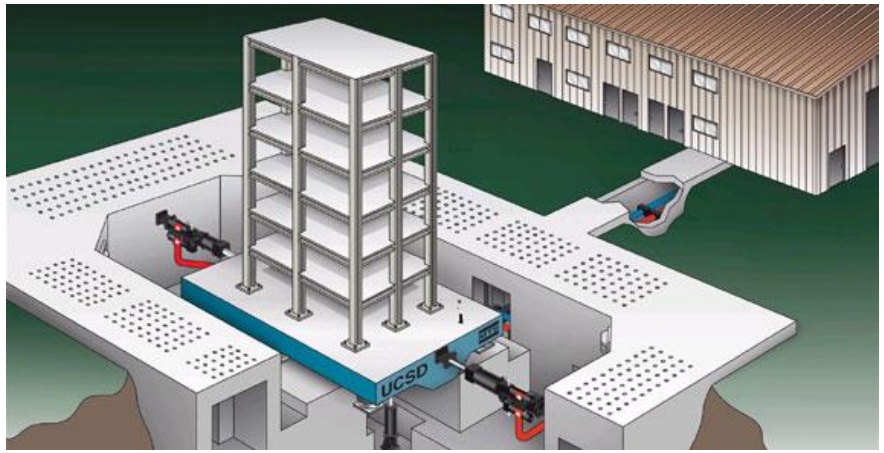
- **BNCS (Building Nonstructural Components and Systems)** – Support to seismic product qualification procedures and anchorage design in EU (e.g., ETAG 001 Annex E)

- **Shear walls and anchors** – Validation of existing assumptions on anchor behavior in cracked concrete and seismic conditions

- **Anchor ductility** – Support to ACI 318/EOTA TR045 ductile anchor design provisions

- **Nonstructural component testing** – Validation of existing design requirements for seismic anchorage of nonstructural components

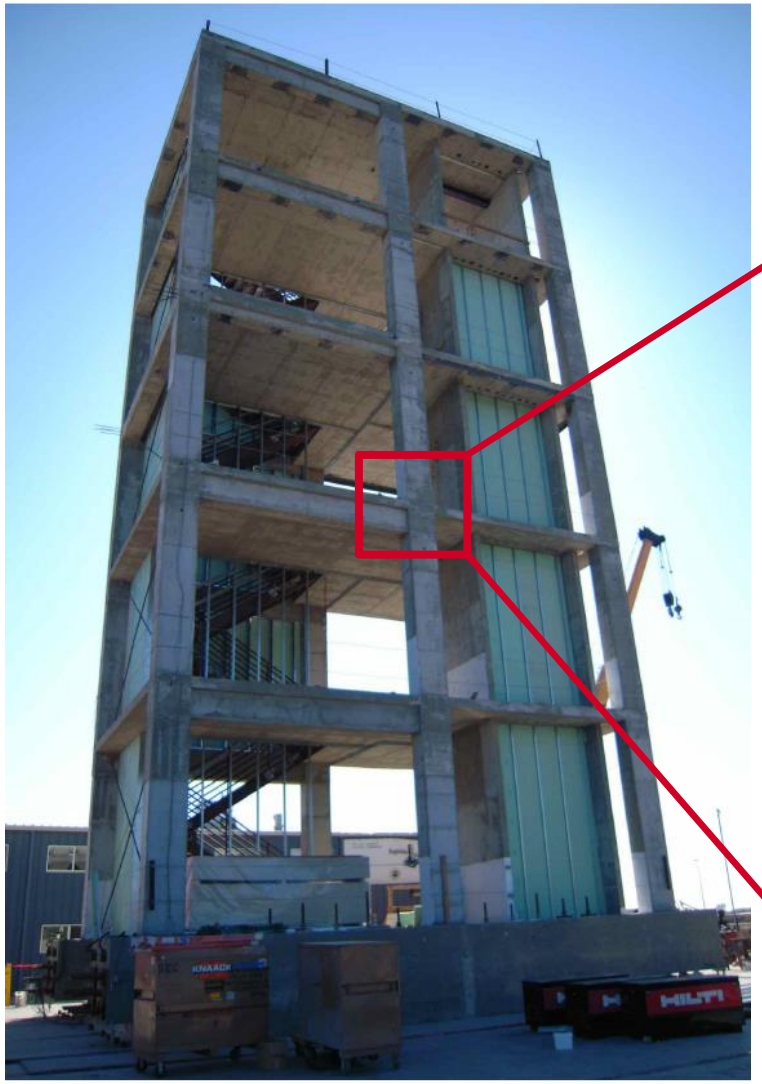
BNCS

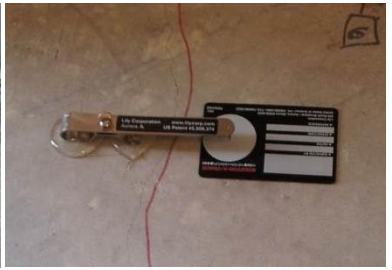


- Multihazard Project
  - UCSD School of Engineering
  - External partners (Consultants, Contractors…) and Hilti Corp.

BNCS

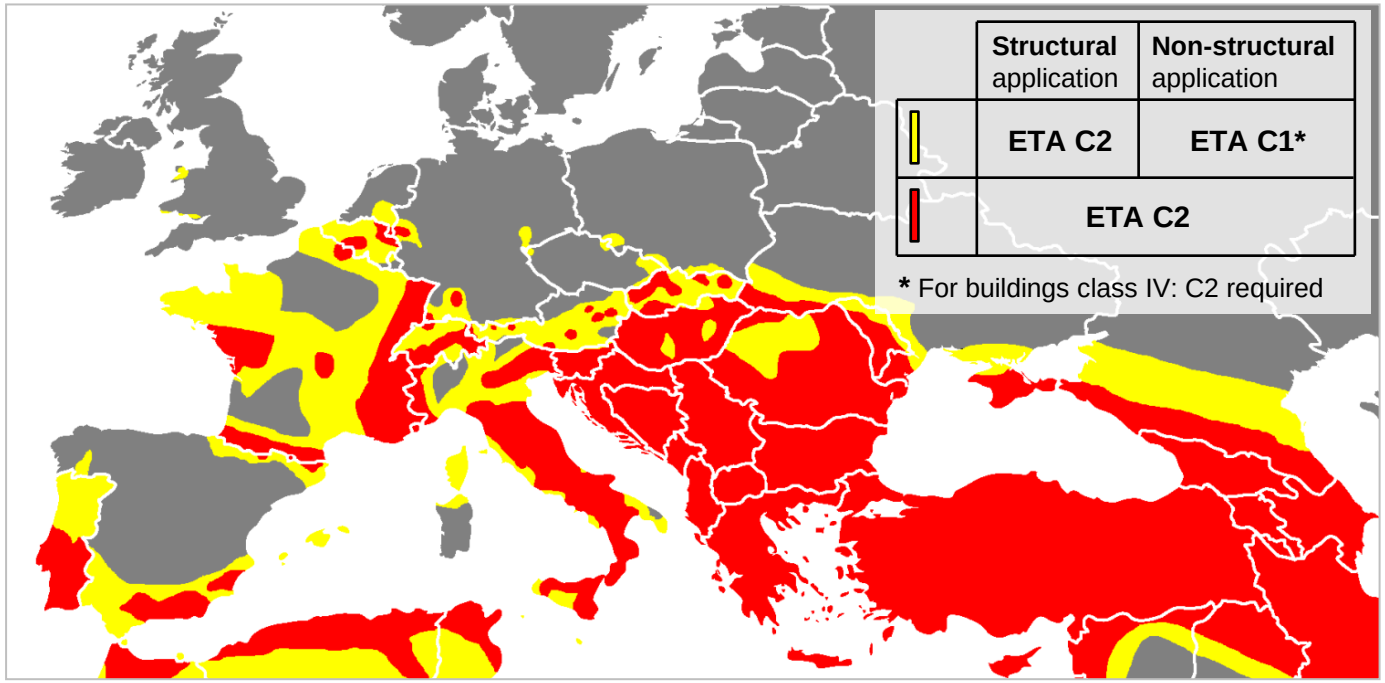
Denali, Alaska, Magnitude 7.9





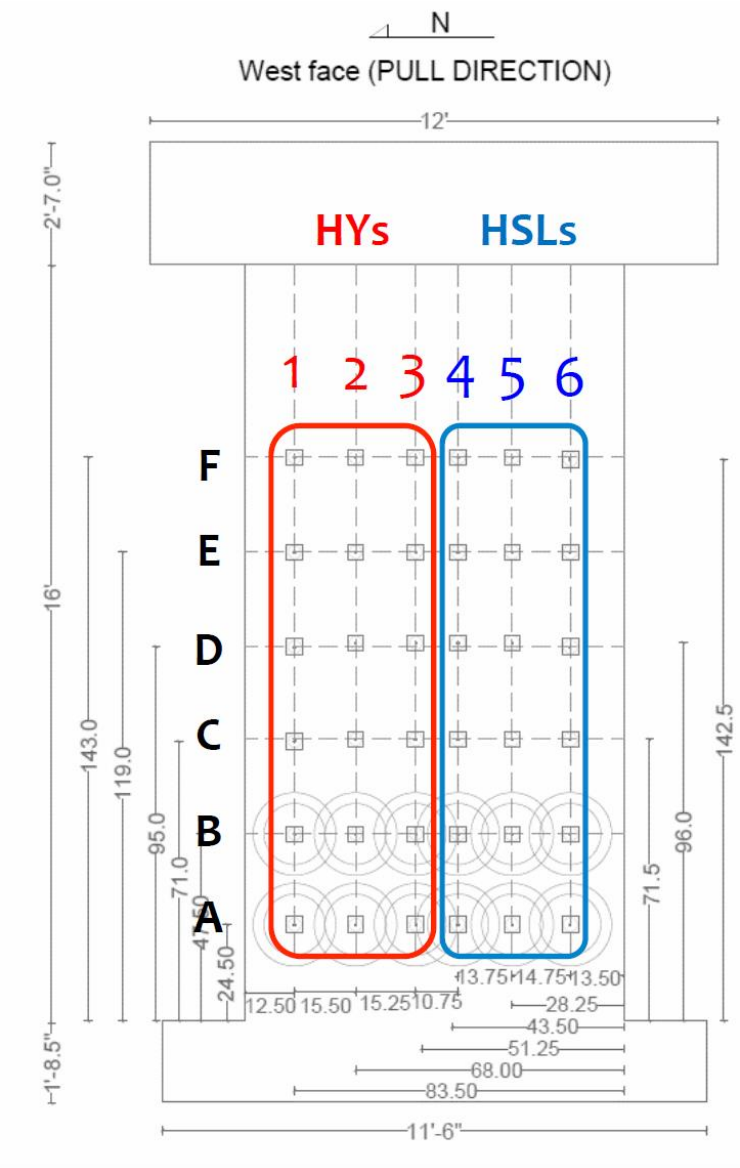
RESULT OF THIS EXTENSIVE EXERCISE: TRANSPARENT APPROPRIATE LEVEL OF SAFETY FOR RELEVANT SEISMICITY LEVEL IN EUROPE

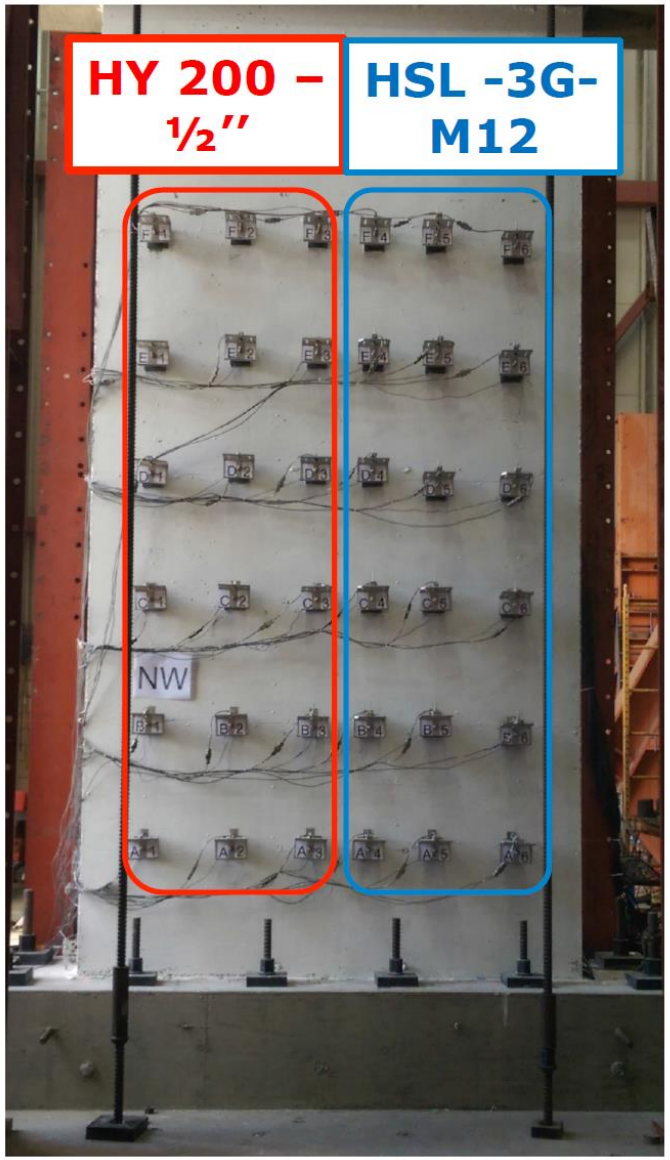
- Seismically designed structures along with all construction elements (e.g. anchor) ensure a (more) predictable earthquake response.



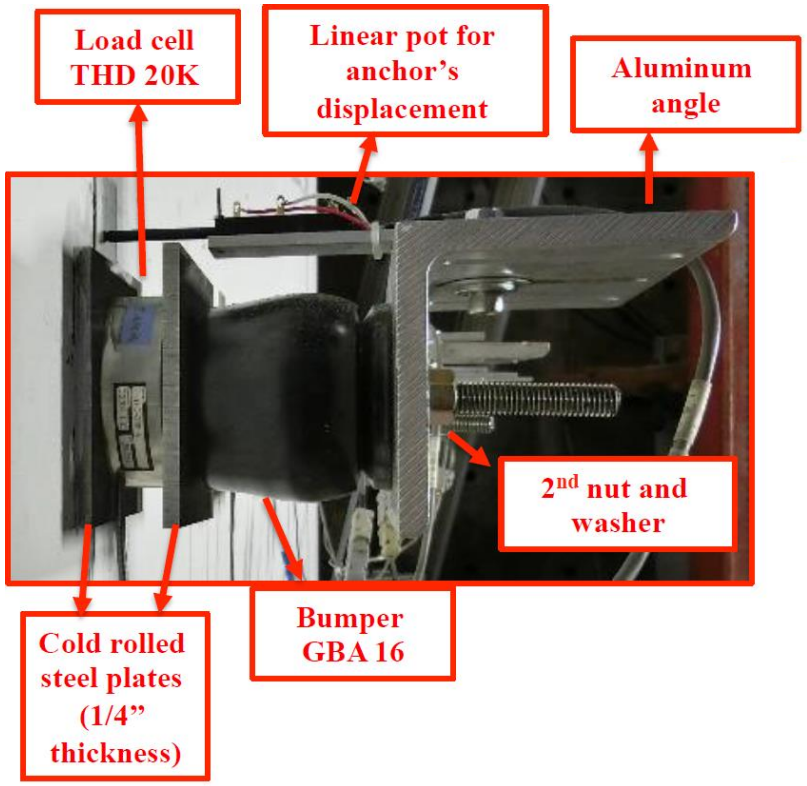
Source: Countries seismic acceleration maps ; ETAG 001 Annex E and EOTA TR045 recommendations

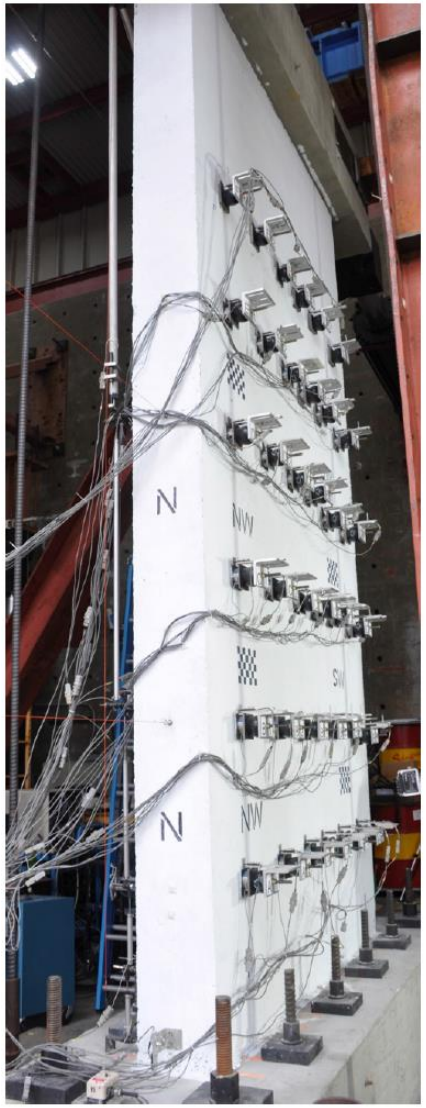
SHEAR WALLS AND ANCHORS

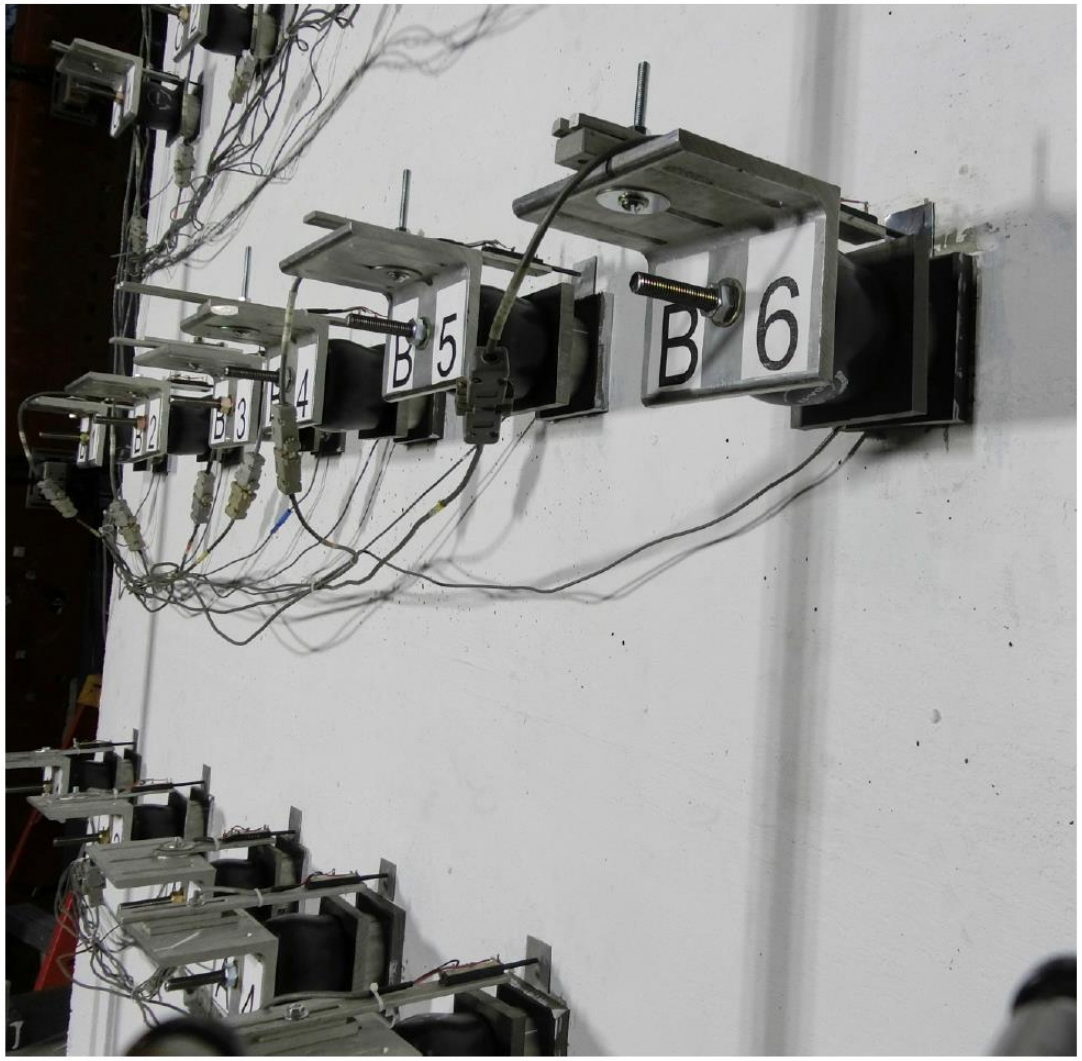




SHEAR WALLS AND ANCHORS







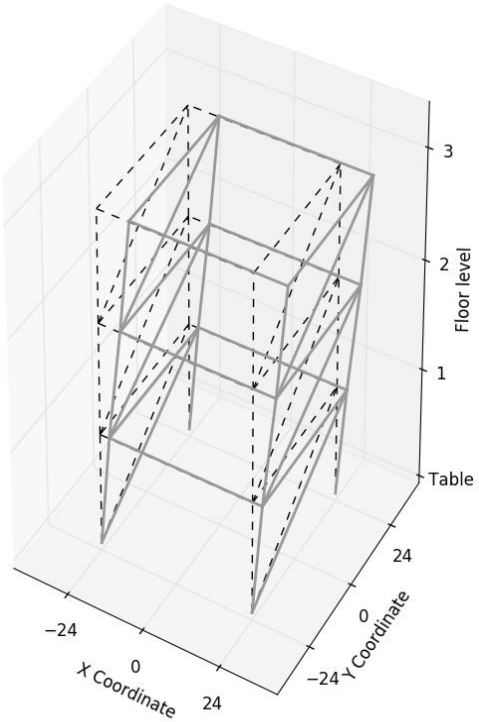
SHEAR WALLS AND ANCHORS

UC San Diego
Jacobs School of Engineering

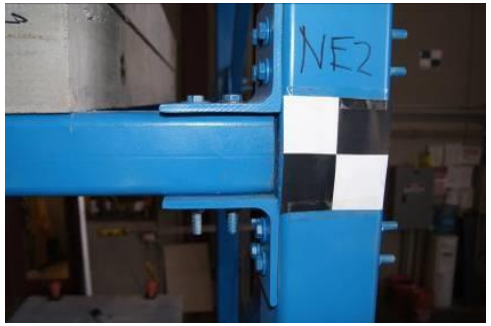
Hilti Seismic Project:
Full-Scale Shear Wall-Anchorage Tests

June 5, 2017
West face

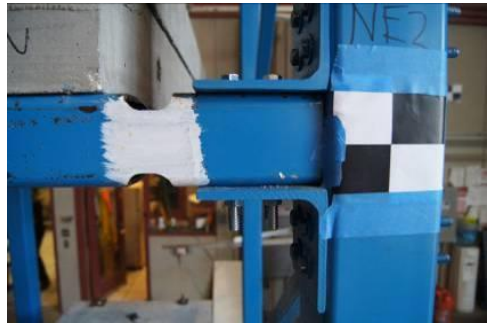
ANCHOR DUCTILITY



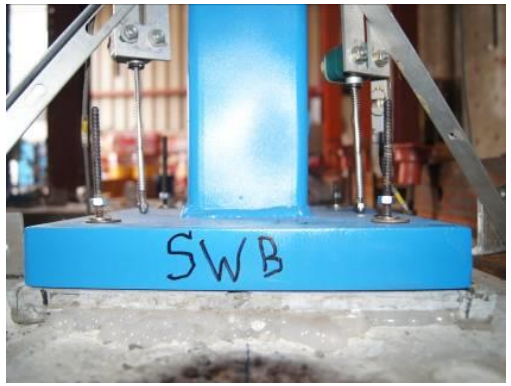
Mode 1: Fundamental x-dir. (T_1=0.30s)



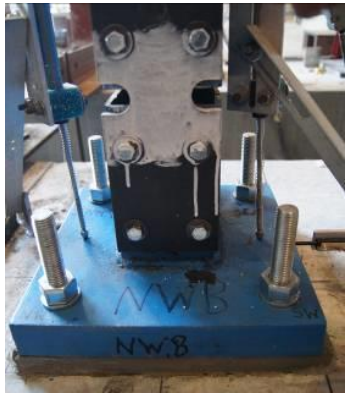
Moment connection



Reduced-beam connection



Ductile anchors



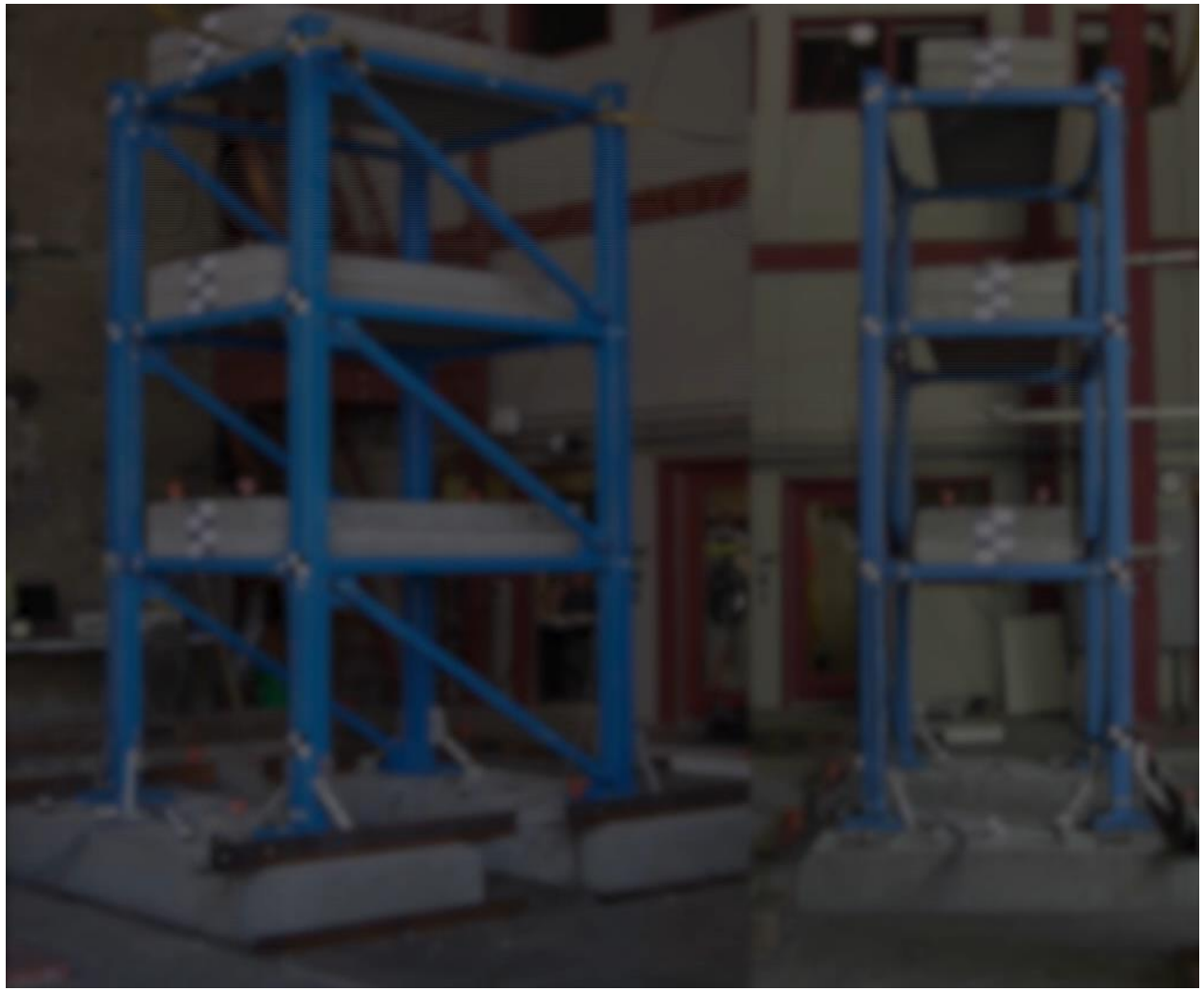
Strong anchors & column fuse

Ductile anchor-baseplate dominated (BD)

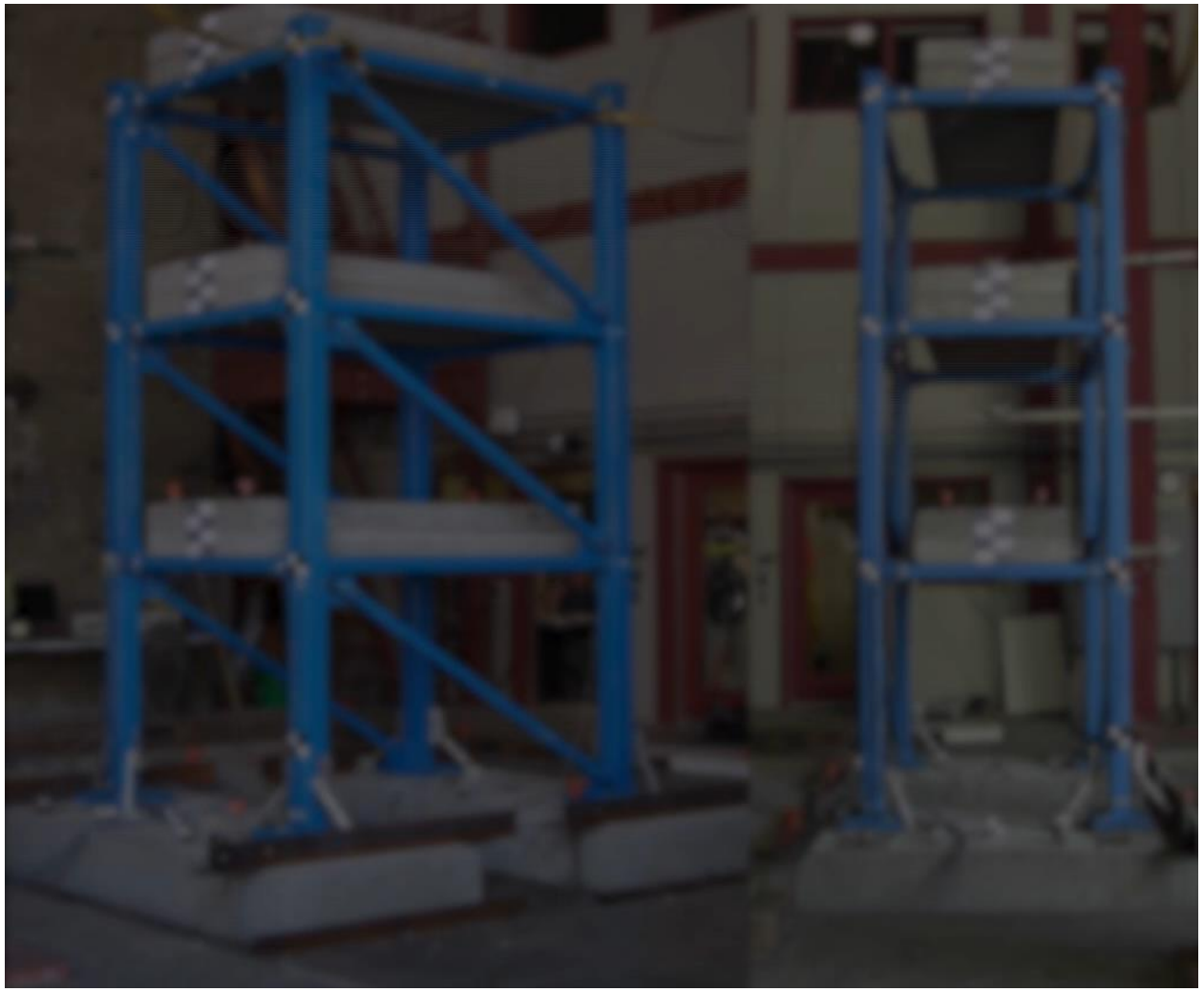
Superstructure-plasticity dominated (SD)

ANCHOR DUCTILITY

Ductile anchors



Ductile anchors



SEISMIC DESIGN OF ANCHORAGE OF NON-STRUCTURAL COMPONENTS

SUMMARY

- Hilti is concerned about the safety of fastenings and fastening applications (structural and non-structural)

- Safe fastenings means:
  - Using suitable anchors for the right application
  - Follow and understand design procedures

- Research activities allow:
  - Full understanding and information on anchors and their safe use
  - Proper understanding of design requirements and product qualification

THANK YOU