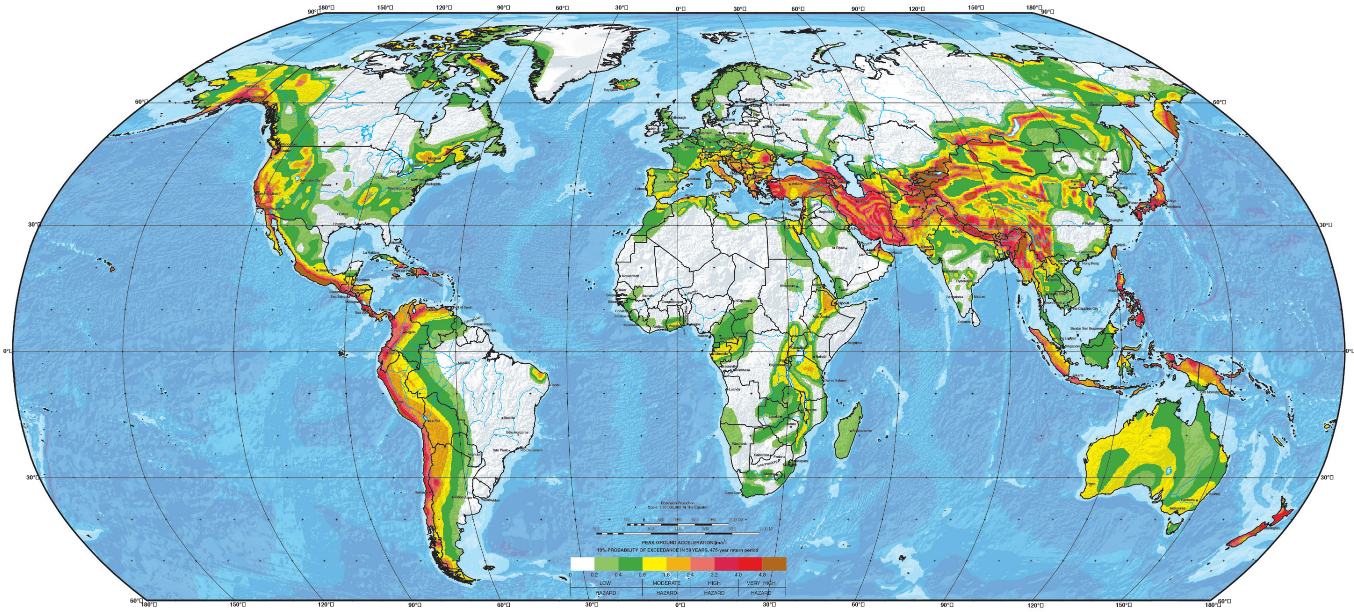
MINIMIZE DAMAGE
MAXIMIZE SAFETY

Hilti seismic anchors

EARTHQUAKES ARE UNAVOIDABLE DISASTERS



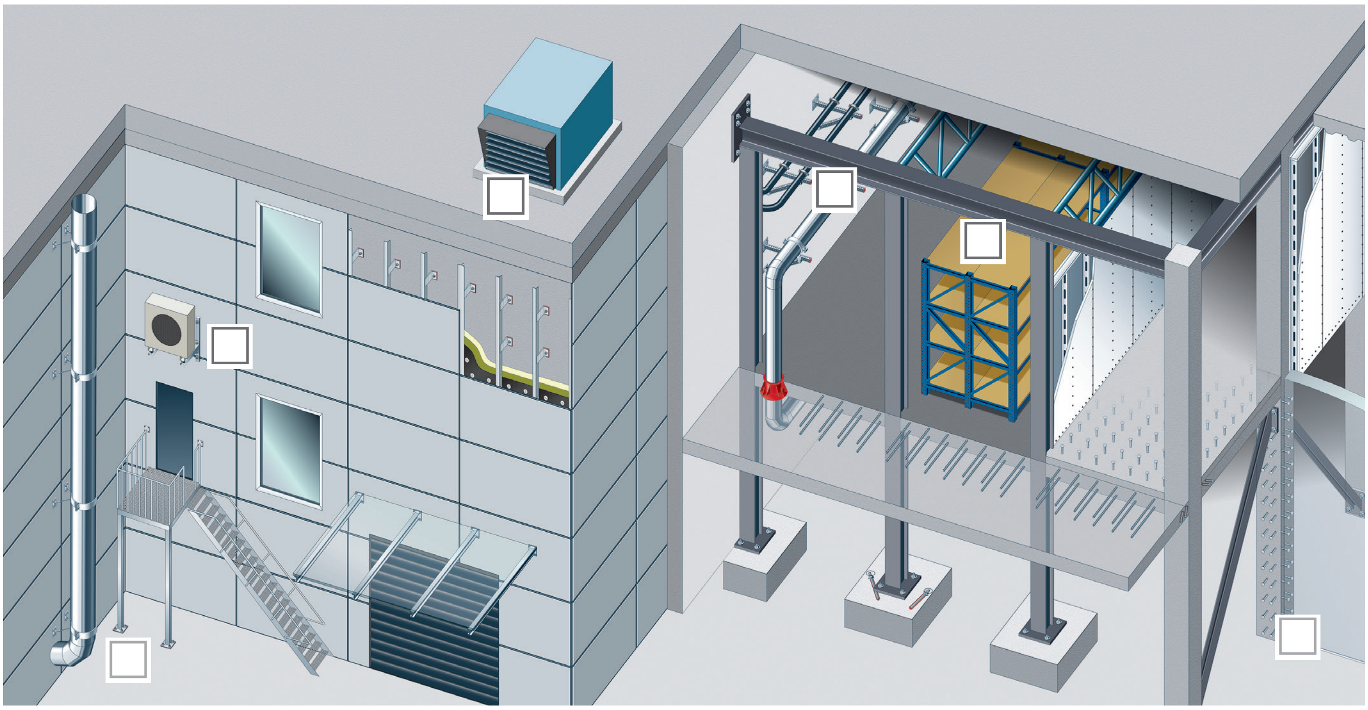
Source: The Global Seismic Hazard Assessment Program (GSHAP)

Damages have far reaching effects – from structural and economic destruction to human casualties.

2013		2014		2015		2016	
Pakistan	D 825 ; M 8.0	China	D 617 ; M 7.8	Nepal	D 9018 ; M 7.8	Ecuador	D 661 ; M 7.8
Philippines	D 222 ; M 7.3	Peru	D 8 ; M 4.9	Malaysia	D 18 ; M 6.0	Taiwan	D 117 ; M 6.4
China	D 193 ; M 6.6	Chile	D 6 ; M 8.2	Chile	D 20 ; M 8.3	Japan	D 40 ; M 7.0
				China	D 3 ; M 6.4	India	D 11 ; M 6.7
						Italy	D 291 ; M 6.2

Note: D = death ; M = magnitude

STRUCTURAL AND NON-STRUCTURAL APPLICATIONS WILL BE AFFECTED



Seismic-relevant structural applications

☐ Seismic retrofitting

☐ Structural steel connections to concrete

Seismic-relevant non-structural applications

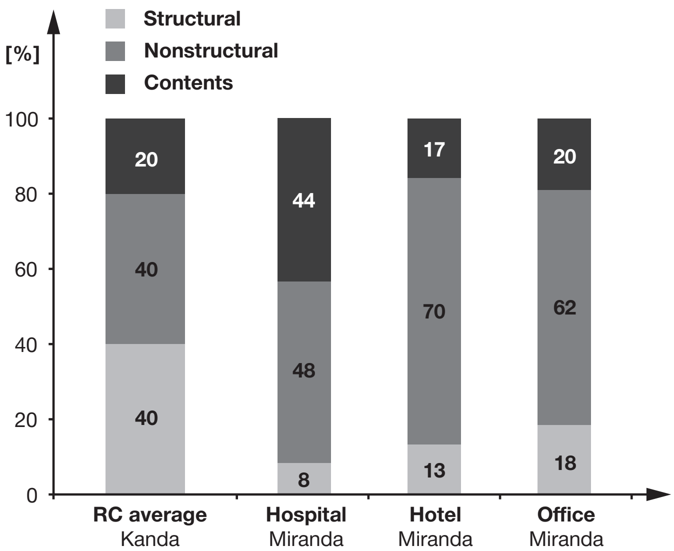
☐ Mechanical, electrical and industrial supports

☐ Utilitiesfastening:mechanical equipment attachment

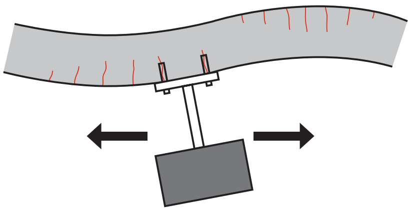
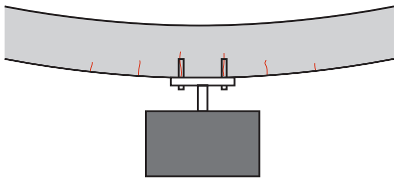
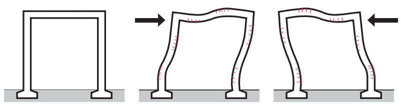
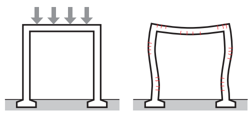
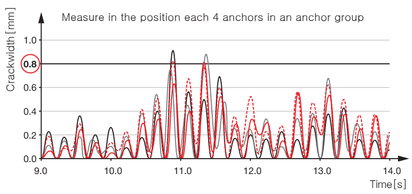
Structural connections ensure that a structure will respond to a seismic event in a predictable manner.
Detailed connections during the design phase are essential so that contractors and building inspectors alike have a clear understanding of project specifications.
Furthermore, detailed engineering specifications ensure that only designed products are used during the construction and installation phases.

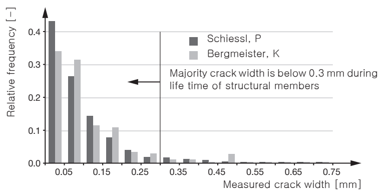
Source:
Taghavi S. and Miranda E.: "Seismic Performance and Loss Assessment of Nonstructural Building Components," Proceedings of 7th National Conference on Earthquake Engineering, Boston, 2002.

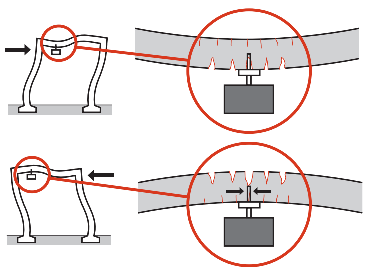
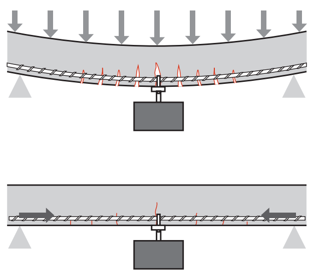
Extensive research shows that the costliest repairs in most commercial buildings following a seismic event are found in nonstructural systems, such as mechanical or electrical supports or utilities fastening. Many non-structural installations must be designed properly to meet safety requirements.



DIFFERENCES BETWEEN SEISMIC AND STATIC CONDITIONS

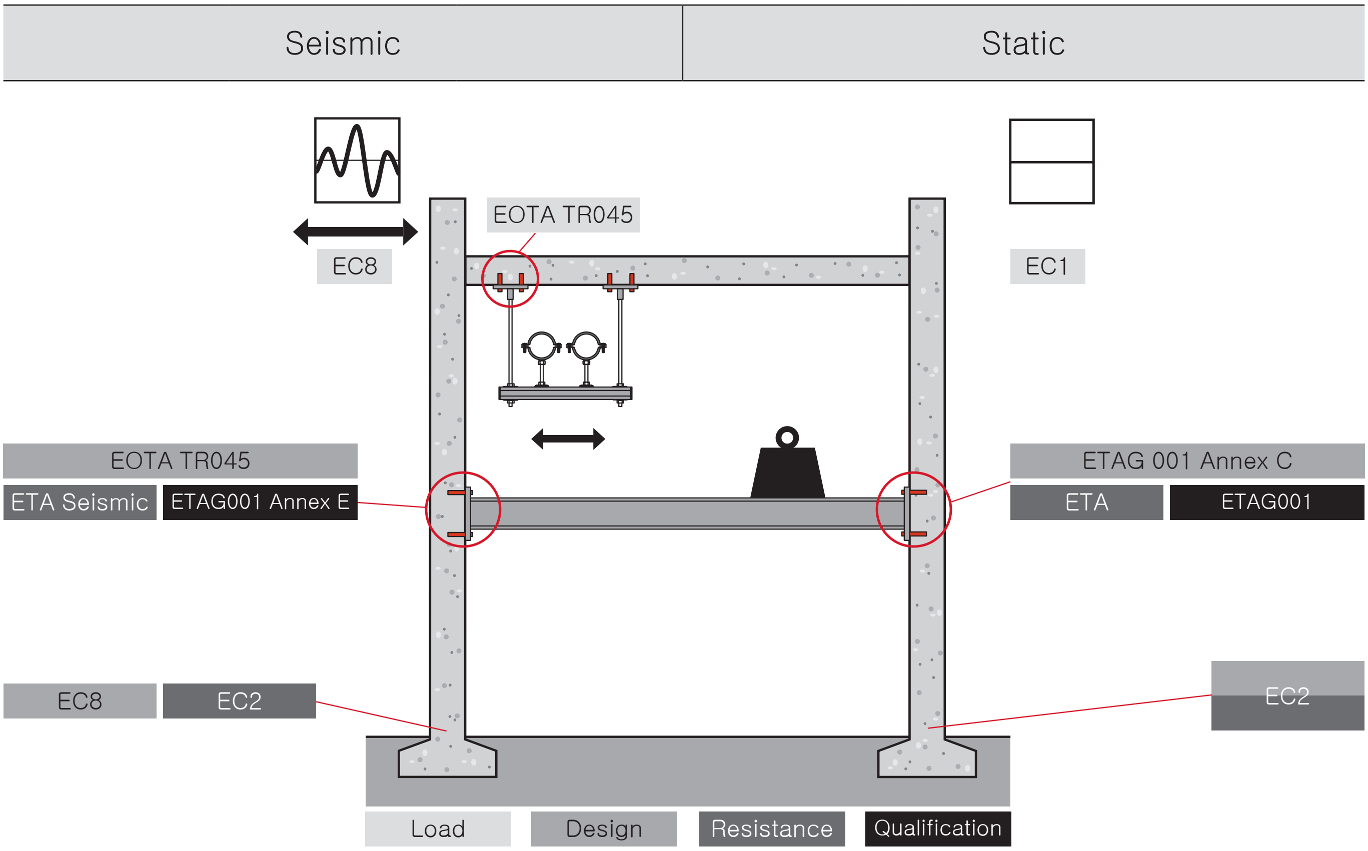
<table>
<tr><th></th><th>Seismic</th><th>Static</th></tr>
<tr><td>Load</td><td>Large load cycling with inertia force in multi-direction.
</td><td>No large cyclic load with inertia.
</td></tr>
<tr><td>Crack position</td><td>Cracks occur almost everywhere in concrete members – the base of anchorage.
</td><td>Cracks occur in tension zones which may be predicated positions.
</td></tr>
<tr><td>Crack width</td><td>Crack width can be up to 0.8 mm during seismic according to ETAG001, supported by extensive research.


Source: Hoehler, M. S. (2006) Behavior and Testing of Fastenings to Concrete for Use in Seismic Applications</td><td>Crack width no more than 0.3 mm under ser-vice condition design limits can already fulfill the requirements of EC2.


Source: Eligehausen, R.; Bozenhardt, A. (1989): Crack widths as measured in actual structures and conclusions for the testing of fastening elements</td></tr>
<tr><td>Crack open / close cycling pattern</td><td>The crack opens and closes dramatically. Anchors tend to slip out under this crack cycling pattern.
</td><td>The crack opens and closes slightly with the changing of live load. The crack closes natural-ly by rebar restrain. Anchor is less likely to slip out.
</td></tr>
</table>

Safety cannot be guaranteed if the resistance of the anchor is used without taking seismic conditions into account.

CODES AND REGULATIONS FOR ANCHOR CONNECTIONS



Eurocode 1, Eurocode 2 and Eurocode 8 (EC1, EC2 and EC8) set the frame of design of concrete structures, while for anchors, European Technical Approval Guideline (ETAG) 001 defines the qualification and design requirement for anchor fastenings. Under seismic conditions, EC8 provides the method to calculate seismic action and structural response while EC2 gives the design method and resistance of concrete components.

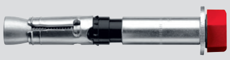
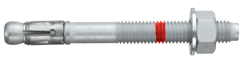
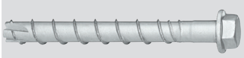
The design method for anchors is defined by EOTA TR045 Design of Metal Anchors For Use In Concrete Under Seismic Actions. The resistance is provided in European Technical Assessment (ETA) of the specific product based on ETAG 001 Annex E Assessment of metal anchors under seismic.

The qualification requirement or assessment of anchor performance is the key difference between the structural member design and the anchor design code system.

Performance classified in 2 categories: most apllications require C2

$a_g \times s$	Structural applications		Non-structural applications	
	Building IV	Building II, III	Building IV	Building II, III
0.05 – 0.1 g	ETA C2			ETA C1
>0.1 g	ETA C2			

ANCHORS WITH ULTIMATE SEISMIC C2 PERFORMANCE

Anchor system	Design value	Approval	Highlight
HIT-HY 200 + HIT-Z/HIT-V anchor rod  M12 / M16 / M20 / M24	kN Tension: 33 / 20 Shear: 22 / 18 M12, h_{ef} = 144mm (HIT-Z)	ETA 12/0006	SAFESET Delivers ultimate performance, reliability and productivity without hole cleaning.
HIT-RE 500 V3 + HIT-V anchor rod  M16 / M20 / M24	kN Tension: 39 / 20 Shear: 50 / 37 M16, h_{ef} = 144mm	ETA 16/0143	SAFESET Works in all condition even in bellow freeze temperature; Drives productivity and reliability with reduced curing time and roughening tool.
HDA self-undercut anchor  M10 / M12 / M16 / M20	kN Tension: 23 / 23 Shear: 24 / 19 M12, h_{ef} = 125mm (HDA-P)	ETA 99/0009	The HDA self-undercut anchor works as a “cast in” with proof of k-factor of concrete cone failure greater than 8.0 according to EOTA TR045.
HSL-3 expansion anchor  M10 / M12 / M16 / M20	kN Tension: 17 / 15 Shear: 34 / 11 M12, h_{ef} = 80mm	ETA 02/0042	A wide range of sizes and configurations for multiple applications.
HST3 expansion anchor  M8 / M10 / M12 / M16 / M20	kN Tension: 13 / 12 Shear: 31 / 23 M12, h_{ef} = 70mm	ETA 98/0001	Delivers ultimate resistance in wide range concrete strength from C12/15 to C80/95 with various drilling technique. Low minimal edge and spacing distance requirement.
HUS3  M10 / M14	kN Tension: 13 / 6 Shear: 23 / 17 M10, h_{nom} = 85mm (HUS3-H)	ETA 13/1038	Driven straight into concrete base material. High productivity

Note: Seismic | Static (cracked concrete)

Values listed above are under following conditions:

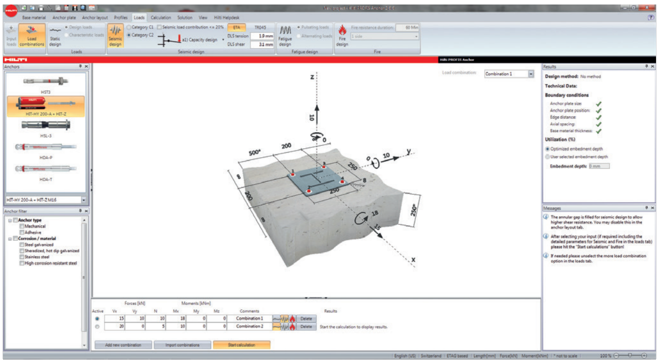
- With Hilti filling set (except HSL-3); - Concrete strength C20/C25; - Room temperature
- Single anchor without edge and spacing influence; - Galvanized steel version; - Hammer drilling.

For more comprehensive or detailed data, please refer to Hilti's Fastening Technical Manual or relevant ETA.

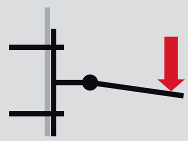
Hilti filling set	
	Doubles the shear resistance under seismic loading without changing the number of anchors.

RELIABLE PARTNER FOR BASE PLATE SOLUTIONS

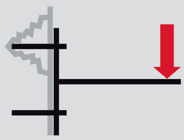
Hilti PROFIS Anchor –
The most reliable design software solution for post-installed anchors in seismic.



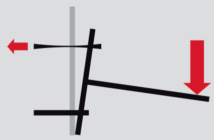
Profis Anchor performs seismic calculations according to EOTA TR 045, which allows three options for base plate connection solutions.



a1) Capacity design
The anchorage is designed for the force corresponding to the yield of a ductile component or, if lower, the maximum force that can be transferred by the fixture or the attached element.



a2) Elastic design
The fastening is designed for the maximum load assuming an elastic behavior of the fastening and of the structure.



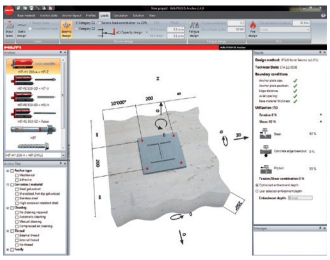
b) Design with requirements on the ductility of the anchors
This design for ductile steel failure requires an anchor classified as ductile.

In many cases, more than 4 anchors per base plate under seismic conditions are needed. Due to insufficient test results, the scope of EOTA TR 045 only covers 4 anchors when close edges are a factor. Thanks to extensive testing and stringent research, Hilti offers reliable base plate solutions for up to 8 anchors and in close edges for large load requirements under seismic conditions.

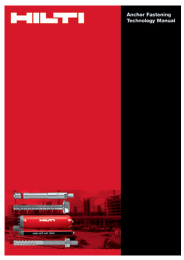
Hilti PROFIS Anchor is embedded with seismic approved products under EOTA TR 045 design method as well as research data based on SOFA seismic. With Hilti PROFIS Anchor, designers are given the most reliable, comprehensive solutions for base plate design under seismic conditions.

Design resources
PROFIS software solutions offer a simple, effective way of calculating fastening systems and rebar connections in accordance to the latest seismic design codes and practices.

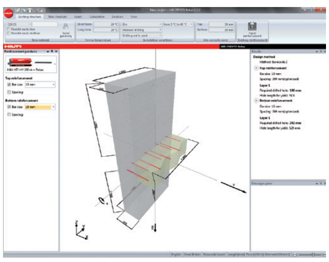
Additionally, the Hilti Fastening Technical Manual (FTM) provides all technical data information available on Hilti.com. For more information, contact your local Hilti Field Engineer.



PROFIS Anchor



FTM



PROFIS Rebar

Hilti Online

Hilti Corporation
9494 Schaan, Liechtenstein
P +423-234 2965

www.facebook.com/hiltigroup
www.hilti.group