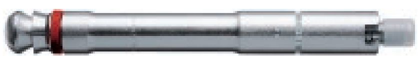
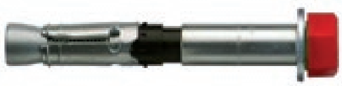
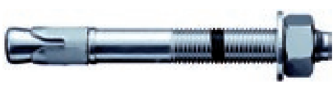
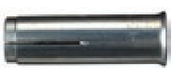
Anchor technology and design.

Hilti. Outperform. Outlast.

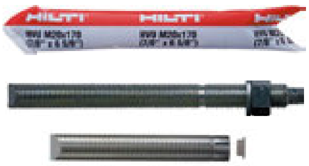
Anchor selector

Anchor type	Base material: Cracked concrete	Uncracked concrete	Solid brick masonry	Hollow brick masonry	Fire tested	Application
Mechanical anchor systems						
Heavy duty anchors						
HDA-T/ -TR/TF/-P/-PR/-PF undercut anchor 	■	■			■	Anchor fastening for high loads e.g. in steel construction and plant construction, suitable for dynamic loading
HSL-3 / 3B heavy duty anchor 	■	■			■	Fastening heavy loads e.g. from structural columns & beams, machines, etc.
Medium and light duty anchors						
HSC-A(R) /-I(R) safety anchor 	■	■			■	Safety relevant fastening at facades, ceilings & balustrades where short embedment depth is required.
HSA/-R/-F stud anchor 		■			■	Fastening through in place parts like wooden beams, metal sections, columns, beams, brackets, etc.
HUS-HR screw anchor 	■	■	■		■	Fastening channels, brackets, racks, seating, temporary and permanent fastenings.
HUS-H screw anchor 	■	■	■		■	Fastening channels, brackets, racks, seating, temporary and permanent fastenings.
HKD push-in anchor 	□	■			■	Fastening with threaded rods for pipe suspensions, air ducts, suspended ceilings.

■ = very suitable □ = redundant fastening

Key Features	Drill bit diameter resp. anchor size	Specification						Setting		Page
		Steel, zinc plated	Steel, sheradised, hot dipped galv.	Stainless steel A4 (1.4401)	HCR steel* (1.4529)	External thread	Internal thread	Pre-setting	Through-fastening	
Automatic undercutting High load capacity Approved for dynamic loads	Drill bit dia.: 20 – 37 mm Anchor size: M10 – M20	■	■	■		■		■	■	244
• Reliable pull-down of part fastened. • Force controlled expansion • Automatic torque control (safety cap)	Drill bit dia.: 12 – 32 mm Anchor size: M8 – M24	■				■			■	265
• Automatic undercutting • Suitable for shallow base material thickness. • Shallow anchorage depth	Drill bit dia.: 14 – 20 mm Anchor size: M8 – M12	■		■		■	■	■		266
• Three setting depths • Setting mark • Extremely ductile steel for high bending capacity	Drill bit dia.: 6 – 20 mm Anchor size: M6 – M20	■	■	■		■		■	■	286
• Screw driven straight into base material • Forged on washer • Matched system of screw anchor and screw driver	Drill bit dia.: 6 – 14 mm			■					■	300
• Screw driven straight into base material • Forged on washer • Matched system of screw anchor and screw driver	Drill bit dia.: 6 – 14 mm	■	■						■	310
• Visual verification of full expansion • Shallow setting depth	Drill bit dia.: 8 – 25 mm Anchor size: M6 – M20	■		■			■	■		318

■ = very suitable
*HCR steel available subject to lead time

Anchor type	Base material					Application
	Cracked concrete	Uncracked concrete	Solid brick masonry	Hollow brick masonry	Fire tested	
Adhesive anchor systems						
Foil capsule systems						
HVU adhesive anchor 		■			■	Heavy duty ‘adhesive capsule’ fastenings with threaded rod and internally threaded sleeves for structural steel columns, beams, brackets, end plate & balustrade fastenings.
Injection mortar systems						
HIT-RE 500-SD 	■	■			■	High performance injection epoxy adhesive system for reinforcement bars and threaded rod applications in cracked and non-cracked concrete. Suitable for dynamic loading.
HIT-RE 500 		■			■	Chemical injection / adhesive anchor. Heavy duty fastenings with rebar & threaded rod fastenings. Concrete member / element extensions “starter bars” or structural steel columns, beams, brackets & end plate fastenings with threaded rod. Suitable for diamond cored and water filled holes.
HIT-HY 200 	■	■			■	Chemical injection / adhesive anchor. Heavy duty fastenings with rebar & threaded rod fastenings. Structural steel columns, beams, brackets & end plate fastenings with threaded rod or shallow embedment concrete member / element extensions “starter bars”.
HIT-HY 70 			■	■	■	Universal chemical injection mortar / adhesive for solid and hollow brick. Fastening wooden or steel elements to masonry.

■ = very suitable

Note: HIT-RE 500 SD for cracked concrete is available subject to lead time

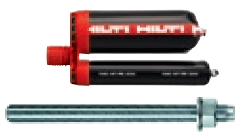
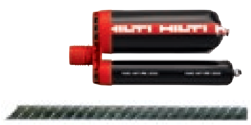
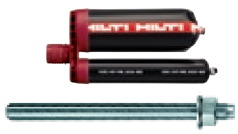
Key Features	Drill bit diameter resp. anchor size	Specification						Setting		Page
		Steel, zinc plated	Steel, sheradised, hot dipped galv.	Stainless steel A4 (1.4401)	HCR steel* (1.4529)	External thread	Internal thread	Pre-setting	Through-fastening	
• A strong and flexible foil capsule • Fast cure, volume controlled adhesive. • Small edge distances and spacing • Flexible foil capsule instead of glass: a robust and safe product for real jobsite conditionss.	HAS M8 – M39 HIS-M8 - M20	■	■	■	■	■	■	■		60
• Small spacing and edge distances. • Slow cure, suitable for shallow & deep embedment • Seismic design and shockproof fastenings. • Low dispensing pressure • No expansion pressure • No styrene content	HAS M8 – M30 HIS-M8 - M20 Rebar dia. 8 – 32 mm HIT-V M8 – M24	■	■	■	■	■	■	■		202
• Small spacing and edge distances. • Slow cure, suitable for shallow & deep embedment • Suitable for diamond cored & hammer drilled holes. • Low dispensing pressure • No expansion pressure • No styrene content	HAS M8 – M39 HIS-M8 - M20 Rebar dia. 8 – 40 mm HIT-V M8 – M24	■	■	■	■	■	■	■		152
• Small spacing and edge distances • Fast cure • No expansion pressure • Low dispensing pressure • No styrene content • No plasticizer content	HAS M8 – M30 HIS-M8 - M20 Rebar dia. 8 – 32 mm HIT-V M8 – M24 HIT-Z M8 – M20	■	■	■	■	■	■	■		84
• Mortar filling control with HIT-SC sleeves • Fast cure • No expansion pressure • Low dispensing pressure • Suitable for solid or hollow masonary.	Drill bit dia. 10 – 22 mm Thread: M6 – M12	■	■	■	■	■	■	■		226

■ = very suitable
*HCR steel available subject to lead time

Note: HIS (internal thread) not available in sheradised, hot dipped galv or HCR steel
HIT Z not available in hot dipped galv.

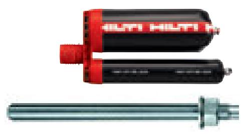
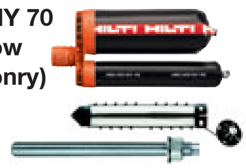
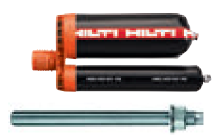
Specifying Hilti SAFEset systems

Chemical anchors

Anchor type	Zinc Plated	Hot dipped galvanised	Stainless steel
HIT-HY 200 + HIT V 	Hilti SAFEset System: HIT HY200 + M16 HIT-V Rod Grade 5.8, embedment 125mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 12/0084	Hilti SAFEset System: HIT HY200 + M16 HIT-V-F Rod Grade 5.8, embedment 125mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 12/0084	Hilti SAFEset System: HIT HY200 + M16 HIT-V-R Rod , embedment 125mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 12/0084
HIT-HY 200 + HIT Z 	Hilti SAFEset System: HIT HY200 + M16 HIT-Z Rod, embedment 100mm, no hole cleaning required (hammer drilled holes) as per ETA report no 12/0028	N/A	Hilti SAFEset System: HIT HY200 + M16 HIT-Z- R Rod, embedment 100mm, no hole cleaning required (hammer drilled holes) as per ETA report no 12/0028
HIT-HY 200 + Rebar 	Hilti SAFEset System: HIT HY200 + N20 rebar, embedment 250mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 12/0084	N/A	N/A
HIT-RE 500 + HIT V 	Hilti SAFEset System: HIT RE500 + M20 HIT-V Rod Grade 5.8, embedment 150mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 04/0027	Hilti SAFEset System: HIT RE500 + M20 HIT-V-F Rod Grade 5.8, embedment 150mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 04/0027	Hilti SAFEset System: HIT RE500 + M20 HIT-V-R Rod, embedment 150mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 04/0027
HIT-RE 500 + Rebar 	Hilti SAFEset System: HIT RE500 + N16 rebar, embedment 200mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 04/0027	N/A	N/A
HIT-RE 500 SD + HIT V 	Hilti SAFEset System: HIT RE500SD + M20 HIT-V Rod Grade 5.8, embedment 190mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 07/0260	Hilti SAFEset System: HIT RE500SD + M20 HIT-V-F Rod Grade 5.8, embedment 190mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 07/0260	Hilti SAFEset System: HIT RE500SD + M20 HIT-V-R Rod, embedment 190mm, automatic cleaning installation with Hilti hollow drill bit & vacuum cleaner as per ETA report no 07/0260
HIT-RE 500 SD + Rebar 	Hilti SAFEset System: HIT RE500SD + N24 rebar, embedment 190mm, automatic cleaning installion with Hilti hollow drill bit & vacuum cleaner as per ETA report no 07/0260	N/A	N/A

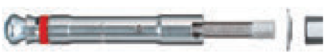
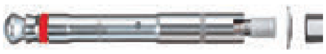
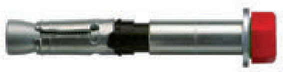
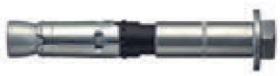
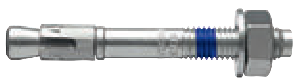
Specifying Hilti anchors

Chemical anchors

Anchor type	Zinc Plated	Hot dipped galvanised	Stainless steel
HVU + HAS-E 	Hilti HVU M16 chemical capsule with HAS-E M16 rod (zinc plated). Standard 125mm embedment.	Hilti HVU M16 chemical capsule with HAS-E-F M16 rod (hot dipped galvanised). Standard 125mm embedment.	Hilti HVU M16 chemical capsule with HAS-E-R M16 rod (stainless steel). Standard 125mm embedment.
HVU + HIS-N 	Hilti HVU M20 chemical capsule with HIS-N M16 sleeve (zinc plated). Standard 170mm embedment.	N/A	Hilti HVU M20 chemical capsule with HIS-RN M16 sleeve (stainless steel). Standard 170mm embedment
HIT-HY 200 + HIT-V 	Hilti HIT-HY 200 chemical injection with HIT-V M16 rod (zinc plated). 125mm embedment.	Hilti HIT-HY 200 chemical injection with HIT-V-F M16 rod (hot dipped galvanised). 125mm embedment.	Hilti HIT-HY 200 chemical injection with HIT-V-R M16 rod (stainless steel). 125mm embedment.
HIT-HY 200 + HIS-N 	Hilti HIT-HY 200 chemical injection with HIS-N M16 sleeve (zinc plated). Standard 170mm embedment.	N/A	Hilti HIT-HY 200 chemical injection with HIS-RN M16 sleeve (stainless steel). Standard 170mm embedment.
HIT-HY 200 + Rebar 	Hilti HIT-HY 200 chemical injection with N16 rebar. 200mm embedment.	N/A	N/A
HIT-RE 500 + HIT-V 	Hilti HIT-RE 500 chemical injection with HIT-V M16 rod (zinc plated). 125mm embedment.	Hilti HIT-RE 500 chemical injection with HIT-V-F M16 rod (hot dipped galvanised). 125mm embedment.	Hilti HIT-RE 500 chemical injection with HIT-V-R M16 rod (stainless steel). 125mm embedment.
HIT-RE 500 + Rebar 	Hilti HIT-RE 500 chemical injection with N24 rebar. 400mm embedment.	N/A	N/A
HIT-HY 70 (hollow masonry) 	Hilti HIT-HY 70 chemical injection with HIT-V M12 rod (zinc plated) using HIT-SC composite sleeve. Standard 85mm embedment.	Hilti HIT-HY 70 chemical injection with HIT-V-F M12 rod (hot dipped galvanised) using HIT-SC composite sleeve. Standard 85mm embedment.	Hilti HIT-HY 70 chemical injection with HIT-V-R M12 rod (stainless steel) using HIT-SC composite sleeve. Standard 85mm embedment.
HIT-HY 70 (solid masonry) 	Hilti HIT-HY 70 chemical injection with HIT-V M12 rod (zinc plated). Standard 85mm embedment.	Hilti HIT-HY 70 chemical injection with HIT-V-F M12 rod (hot dipped galvanised). Standard 85mm embedment	Hilti HIT-HY 70 chemical injection with HIT-V-R M12 rod (stainless steel). Standard 85mm embedment.

Specifying Hilti anchors

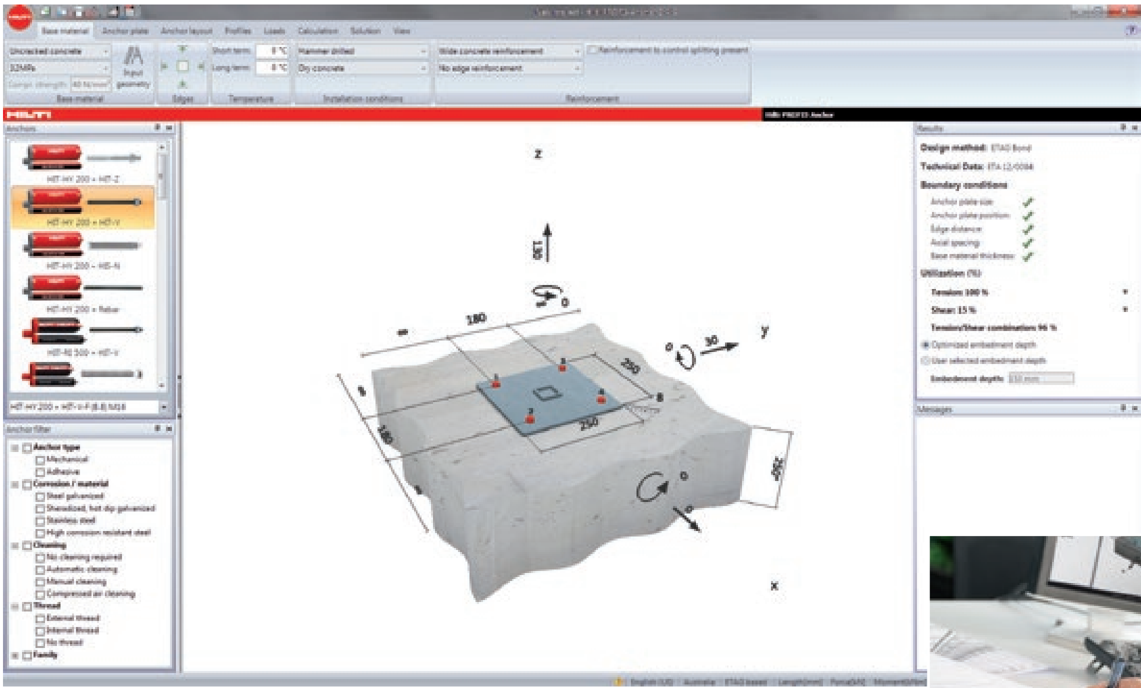
Mechanical anchors

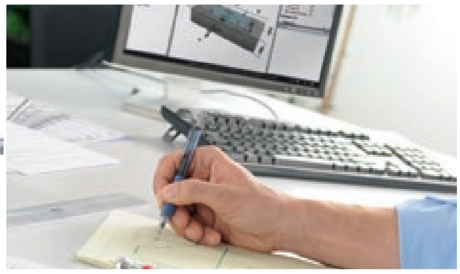
Anchor type	Zinc Plated	Hot dipped galvanised	Stainless steel
HDA-P 	Hilti HDA-P M10 x 100/20 (zinc plated) Note: Max thickness fastened = 20mm ** available subject to leadtime	Hilti HDA-PF M10 x 100/20 (sheradised) Note: Max thickness fastened = 20mm ** available subject to leadtime	Hilti HDA-PR M10 x 100/20 (stainless steel) Note: Max thickness fastened = 20mm ** available subject to leadtime
HDA-T 	Hilti HDA-T M10 x 100/20 (zinc plated) Note: Max thickness fastened = 20mm ** available subject to leadtime	Hilti HDA-TF M10 x 100/20 (sheradised) Note: Max thickness fastened = 20mm ** available subject to leadtime	Hilti HDA-TR M10 x 100/20 (stainless steel) Note: Max thickness fastened = 20mm ** available subject to leadtime
HSL-3-B 	HSL-3-B M12/25 heavy duty anchor (zinc plated) Note: Max thickness fastened = 25mm	N/A	N/A
HSL-3 	HSL-3- M12/25 heavy duty anchor (zinc plated) Note: Max thickness fastened = 25mm	N/A	N/A
HSC-A 	Hilti HSC-A M10 x 40 safety anchor (zinc plated)	N/A	Hilti HSC-AR M10 x 40 safety anchor (stainless steel) ** available subject to leadtime
HSC-I 	Hilti HSC-I M10 x 50 safety anchor (zinc plated)	N/A	Hilti HSC-IR M10 x 50 safety anchor (stainless steel) ** available subject to leadtime
HSA 	Hilti HSA M16 x 140 stud anchor (zinc plated)	Hilti HSA-F M16 x 140 stud anchor (hot dipped galvanised)	Hilti HSA-R M16 x 140 stud anchor (stainless steel)
HUS-H 	Hilti HUS-H 10 x 100 concrete screw anchor (zinc plated) with 70mm embedment	Hilti HUS-HF 10 x 100 concrete screw anchor (hot dipped galvanised) with 70mm embedment	Hilti HUS-HR 10 x 105 concrete screw anchor (stainless steel) with 70mm embedment
HKD 	Hilti HKD M10 x 40 drop-in-anchor (zinc plated)	N/A	Hilti HKD-SR M10 x 40 drop-in-anchor (stainless steel)

Glossary of Hilti anchors

Chemical anchors	
HIT-V	Zinc plated threaded rod, universal anchor rod for use with HIT injectable mortars, enabling flexible embedment depth
HIT-V-F	Hot dipped galvanised threaded rod, universal anchor rod for use with HIT injectable mortars, enabling flexible embedment depth
HIT-V-R	Stainless steel, universal anchor rod for use with HIT injectable mortars, enabling flexible embedment depth
HIT-Z	Zinc plated rod shaped with multiple conical surface used with HIT-HY 200 only
HIT-Z-R	Stainless steel rod shaped with multiple conical surface used with HIT-HY 200 only
HAS-E	Zinc plated threaded rod, standard length, with friction taper for easy setting
HAS-E-F	Hot dipped galvanised threaded rod, standard length, with friction taper for easy setting
HAS-E-R	Stainless steel threaded rod, standard length, with friction taper for easy setting
HIS-N	Zinc plated internally threaded anchor sleeve
HIS-RN	Stainless steel internally threaded anchor sleeve
HIT-SC	Composite mesh sleeve, specifically for use with HIT-HY 70 in hollow masonry base materials.
HVU	Hilti Vinyl Urethane chemical capsule
HIT-RE 500	High performance injection epoxy, ideal for rebar application
HIT-HY 200	High performance two component hybrid mortar injection anchor for use in concrete.
HIT-HY 70	Two component hybrid mortar injection anchor, for use in hollow & solid masonry
Mechanical anchors	
HDA-P	Zinc plated, self undercutting, heavy duty mechanical anchor. ‘P’ for pre-set fastening
HDA-PF	Sheradised, self undercutting, heavy duty mechanical anchor. ‘P’ for pre-set fastening
HDA-PR	Stainless steel, self undercutting, heavy duty mechanical anchor. ‘P’ for pre-set fastening
HDA-T	Zinc plated, self undercutting, heavy duty mechanical anchor. ‘T’ for through set fastening
HDA-TF	Sheradised, self undercutting, heavy duty mechanical anchor. ‘T’ for through set fastening
HDA-TR	Stainless steel, self undercutting, heavy duty mechanical anchor. ‘T’ for through set fastening
HSC-A	Zinc plated, self undercutting mechanical anchor for shallow embedment, external thread
HSC-AR	Stainless steel, self undercutting mechanical anchor for shallow embedment, external thread
HSC-I	Zinc plated, self undercutting mechanical anchor for shallow embedment, internal thread
HSC-IR	Stainless steel, self undercutting mechanical anchor for shallow embedment, internal thread
HSL-3	High tensile steel, heavy duty mechanical expansion anchor
HSL-3-B	High tensile steel, heavy duty mechanical expansion anchor with torque indicator cap
HSA	Hilti stud anchor, zinc plated
HSA-F	Hilti stud anchor, hot dipped galvanised
HSA-R	Hilti stud anchor, stainless steel
HUS-H	Concrete screw anchor, zinc plated
HUS-HF	Concrete screw anchor, hot dipped galvanised
HUS-HR	Concrete screw anchor, stainless steel
HKD-S	Internally threaded drop-in anchor, zinc plated
HKD-SR	Internally threaded drop-in anchor, stainless steel

PROFIS Anchor





Applications

- Calculate your anchoring applications more easily!
- Use the latest codes, regulations and approvals: ETAG, ACI CENT/TS
- Benefits of the Hilti expertise when designing complex applications
- Possibility to design for seismic applications, fatigue loading and dynamics

Functionality

- Intuitive left to right working ribbon for structured input
- Simple 3D graphics with direct input for geometry and loads
- Large selection of pre-defined anchor plates which can be easily customised
- Several filter options
- Easy access to technical library approvals, documents and BIMM/CAD
- Update functions that notifies of any changes available

Advantages

- Fast and reliable anchor design based on the most up to date technical data and approvals such as ETA
- Download free of charge from **www.hilti.com.au**
- For support contact your local Hilti Engineer

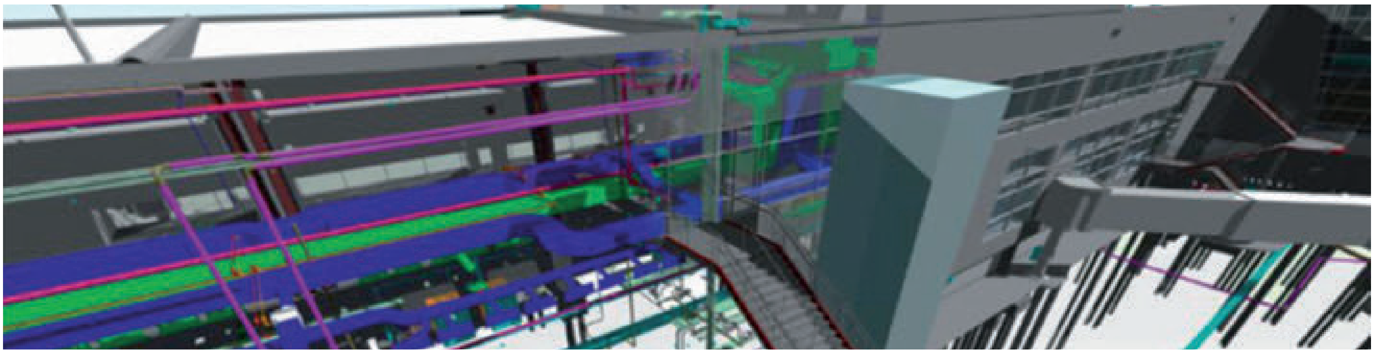
PC System requirements

Microsoft Windows 2000 Professional, Microsoft Windows XP, Microsoft Windows Vista or Microsoft Windows 7 operating system with Microsoft Internet Explorer 6.1 or higher.

CPU: Intel or AMD, 2 GHz or better - Memory: 1024 MB or more - Hard disk: 600 MB free space - CD-ROM: 24x - Hardware accelerated 3D OpenGL video.

Building Information Modelling (BIM)

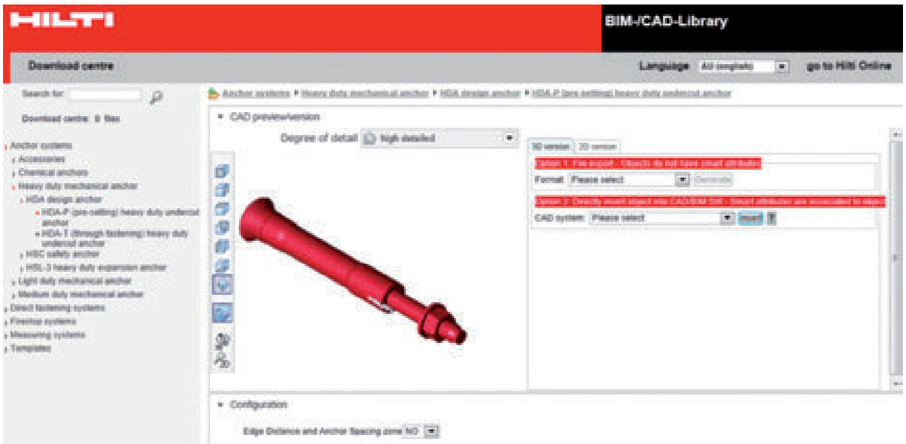
Where virtuality and reality meet innovation.



BIM/CAD Library

With the rapid adoption of Building Information Modelling in the industry, Hilti thrives to provide innovative and state of the art BIM compatible solutions to its customers. These solutions make your modelling and planning more efficient by offering greater flexibility and compatibility.

This is why an extensive range of Hilti products in the form of BIM objects of various kinds is now available on the Hilti BIM/CAD Library.



Hilti BIM/ CAD library

- Many Hilti products are available within our BIM / CAD library for your specification needs.
- 2D and 3D available models of these objects carry BIM information for convenient design.
- The BIM / CAD library supports almost all known specification software and file types.
- If you are missing a Hilti product within the Library, please contact your Hilti Field Engineer on 131 292 or au.engineering@hilti.com.

AutoCAD plugin for Hilti BIM/CAD library

The Hilti BIM/CAD library is also available as an AutoCAD plugin. This plugin allows you to access Hilti BIM/CAD library within AutoCAD and download BIM/CAD objects. This is a fast and convenient way to integrate models of Hilti objects in your project design.

Revit Plugin for Hilti BIM/CAD Library

A fast and convenient way to download Hilti BIM/CAD objects into your Revit software.

Features

- A library of downloadable 2D and 3D models of Hilti products
- Plugin that allows direct import to Revit software

Tekla software

All Hilti anchors are now available as an embedded family in Tekla software platform.

The Hilti BIM/CAD library and plugins can be downloaded from the Hilti website **www.hilti.com.au** in the services/ technical info > engineering and technical support section or through the Profis software in solution tab.

Legal environment

Technical data

The technical data presented in this Anchor Fastening Technology Manual are all based on numerous tests and evaluation according to the state-of-the art. Hilti anchors are tested in our test labs in Kaufering (Germany), Schaan (Principality of Liechtenstein) or Tulsa (USA) and evaluated by our experienced engineers and/or tested and evaluated by independent testing institutes in Europe and the USA. Where national or international regulations do not cover all possible types of applications, additional Hilti data help to find customised solutions.

In addition to the standard tests for admissible service conditions and suitability tests, for safety relevant applications fire resistance, shock, seismic and fatigue tests are performed.

European Technical Approval Guidelines

Approval based data given in this manual are either according to European Technical Approval Guidelines (ETAG) or have been evaluated according to these guidelines and/or national regulations.

The European Technical Approval Guideline ETAG 001 “METAL ANCHORS FOR USE IN CONCRETE” sets out the basis for assessing anchors to be used in concrete (cracked and non-cracked). It consists of:

- Part 1 Anchors in general
- Part 2 Torque-controlled expansion anchors
- Part 3 Undercut anchors
- Part 4 Deformation-controlled expansion anchors
- Part 5 Bonded anchors
- Part 6 Anchors for multiple use for non-structural applications
- Annex A Details of test
- Annex B Tests for admissible service conditions – detailed information
- Annex C Design methods for anchorages

For special anchors for use in concrete, additional Technical Reports (TR) related to ETAG 001 set out additional requirements:

- TR 018 Assessment of torque-controlled bonded anchors
- TR 020 Evaluation of Anchorages in Concrete concerning Resistance to Fire
- TR 029 Design of Bonded Anchors

The European Technical Approval Guideline ETAG 020 “PLASTIC ANCHORS FOR MULTIPLE USE IN CONCRETE AND MASONRY FOR NON-STRUCTURAL APPLICATIONS” sets out the basis for assessing plastic anchors to be used in concrete or masonry for redundant fastenings (multiple use). It consists of:

- Part 1 General
- Part 2 Plastic anchors for use in normal weight concrete
- Part 3 Plastic anchors for use in solid masonry materials
- Part 4 Plastic anchors for use in hollow or perforated masonry
- Part 5 Plastic anchors for use in autoclaved aerated concrete (AAC)
- Annex A Details of tests
- Annex B Recommendations for tests to be carried out on construction works
- Annex C Design methods for anchorages

The European Technical Approval Guidelines including related Technical Reports set out the requirements for anchors and the acceptance criteria they shall meet.

The general assessment approach adopted in the Guideline is based on combining relevant existing knowledge and experience of anchor behaviour with testing. Using this approach, testing is needed to assess the suitability of anchors.

The requirements in European Technical Approval Guidelines are set out in terms of objectives and of relevant actions to be taken into account. ETAGs specify values and characteristics, the conformity with which gives the presumption that the requirements set out are satisfied, whenever the state of art permits to do so. The Guidelines may indicate alternate possibilities for the demonstration of the satisfaction of the requirements.

Post installed rebar connections

The basis for the assessment of post installed rebar connections is in accordance to the model as per the following Australian Standard to determine the concrete capacity:

- AS3600 - 2009 : Concrete Structures

When applied in combination with the development of HIT chemical injection mortar, the load transfer values achieved are comparable to those obtained with cast-in reinforcement.

System of attestation of conformity

For anchors having an approval, the conformity of the product shall be certified by an approved certification body (notified body) on the basis of tasks for the manufacturer and tasks for the approved body.

Tasks for the manufacturer are:

- Factory production control (permanent internal control of production and documentation according to a prescribed test plan)
- involve a body which is approved for the tasks

Tasks for the approved body are:

- initial type testing of the product
- initial inspection of factory and of factory production control
- continuous surveillance, assessment and approval of factory production control

Base materials

General

Different anchoring conditions

The wide variety of building materials used today provide different anchoring conditions for anchors. There is hardly a base material in or to which a fastening cannot be made with a Hilti product. However, the properties of the base material play a decisive role when selecting a suitable fastener / anchor and determining the load it can hold.

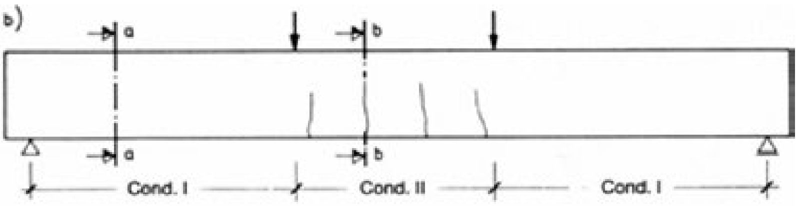
The main building materials suitable for anchor fastenings have been described in the following.

Concrete

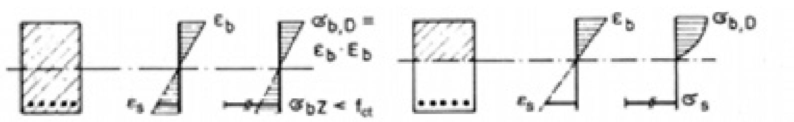
A mixture of cement, aggregates and water

Concrete is synthetic stone, consisting of a mixture of cement, aggregates and water, possibly also additives, which is produced when the cement paste hardens and cures. Concrete has a relatively high compressive strength, but only low tensile strength. Steel reinforcing bars are cast in concrete to take up tensile forces. It is then referred to as reinforced concrete.

Cracking from bending



Stress and strain in sections with conditions I and II



σb, D calculated compressive stress
σb, Z calculated tensile stress
fct concrete tensile strength

If cracks in the tension zone exist, suitable anchor systems are required

If the tensile strength of concrete is exceeded, cracks form, which, as a rule, cannot be seen. Experience has shown that the crack width does not exceed the figure regarded as admissible,i.e. $w \cong 0.3$mm, if the concrete is under a constant load. If it is subjected predominately to forces of constraint, individual cracks might be wider if no additional reinforcement is provided in the concrete to restrict the crack width. If a concrete component is subjected to a bending load, the cracks have a wedge shape across the component cross-section and they end close to the neutral axis. It is recommended that anchors that are suitable in cracked concrete be used in the tension zone of concrete components. Other types of anchors can be used if they are set in the compression zone.

Observe curing of concrete when using expansion anchors

Anchors are set in both low-strength and high-strength concrete. Generally, the range of compressive strength, $f'_{c,cyl}$ is between 20 and 50 MPa. Expansion anchors should not be set in concrete which has not cured for more than seven days. If anchors are loaded immediately after they have been set, the loading capacity can be assumed to be only the actual strength of the concrete at that time. If an anchor is set and the load applied later, the loading capacity can be assumed to be the concrete strength determined at the time of applying the load.

Cutting through reinforcement when drilling anchor holes must be avoided. If this is not possible, the design engineer responsible must be consulted first.

Avoid cutting reinforcement

Masonry

Different types and shapes

Masonry is a heterogeneous base material. The hole being drilled for an anchor can run into mortar joints or cavities. Owing to the relatively low strength of masonry, the loads taken up locally cannot be particularly high. A tremendous variety of types and shapes of masonry bricks are on the market, e.g. clay bricks, sand-lime bricks or concrete bricks, all of different shapes and either solid or with cavities. Hilti offers a range of different fastening solutions for this variety of masonry base material, e.g. the HPS-1, HRD, HUD, HIT, etc.

If there are doubts when selecting a fastener / anchor, your local Hilti sales representative will be pleased to provide assistance.

Plaster coating is not a base material for fastenings

When making a fastening, care must be taken to ensure that a layer of insulation or plaster is not used as the base material. The specified anchorage depth (depth of embedment) must be in the actual base material.

Other base materials

Aerated concrete

Aerated concrete: This is manufactured from fine-grained sand as the aggregate, lime and/or cement as the binding agent, water and aluminium as the gas-forming agent. The density is between 0.4 and 0.8 kg/dm^3 and the compressive strength 2 to 6 N/mm^2. Hilti offers the HGN and HRD-U anchors for this base material.

Lightweight concrete

Lightweight concrete: This is concrete which has a low density, i.e. $\leq$ 1800 kg/m^3, and a porosity that reduces the strength of the concrete and thus the loading capacity of an anchor. Hilti offers the HRD, HUD, HGN, etc anchor systems for this base material.

Drywall / gypsum panels

Drywall (plasterboard/gypsum) panels: These are mostly building components without a supporting function, such as wall and ceiling panels, to which less important, so-called secondary fastenings are made. The Hilti anchors suitable for this material are the HLD, HHD, HSP and HFP.

Variety of base materials

In addition to the previously named building materials, a large variety of others, e.g. natural stone, etc, can be encountered in practice. Furthermore, special building components are also made from the previously mentioned materials which, because of manufacturing method and configuration, result in base materials with peculiarities that must be given careful attention, e.g. hollow ceiling floor components, etc.

Descriptions and explanations of each of these would go beyond the bounds of this manual. Generally though, fastenings can be made to these materials. In some cases, test reports exist for these special materials. It is also recommended that the design engineer, company carrying out the work and Hilti technical staff hold a discussion in each case.

Jobsite tests

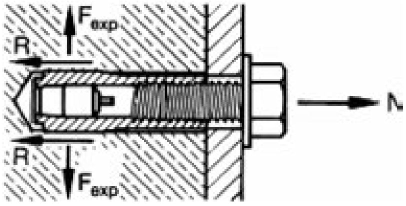
In some cases, testing on the jobsite should be arranged to verify the suitability and the loading capacity of the selected anchor.

Why does an anchor hold in a base material?

Working principles

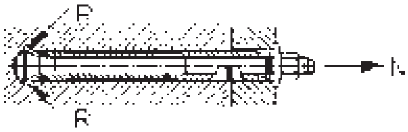
There are three basic working principles which make an anchor hold in a building material:

Friction



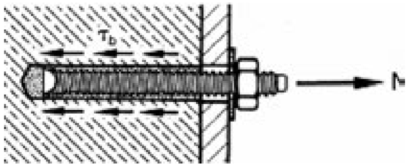
The tensile load, N, is transferred to the base material by friction, R. The expansion force, Fexp, is necessary for this to take place. It is produced, for example, by driving in an expansion plug (HKD).

Keying



The tensile load, N, is in equilibrium with the supporting forces, R, acting on the base material, such as with the HDA anchor.

Bonding



An adhesive bond is produced between the anchor rod and the hole wall by a synthetic resin adhesive, such as with HVU with HAS anchor rods.

Combination of working principles

Many anchors obtain their holding power from a combination of the above mentioned working principles.

For example, an anchor exerts an expansion force against wall of its hole as a result of the displacement of a cone relative to a sleeve. This permits the longitudinal force to be transferred to the anchor by friction. At the same time, this expansion force causes permanent local deformation of the base material, above all in the case of metal anchors. A keying action results which enables the longitudinal force in the anchor to be transferred additionally to the base material

Force-controlled and displacement-controlled expansion anchors

In the case of expansion anchors, a distinction is made between force-controlled and movement-controlled types. The expansion force of force-controlled expansion anchors is dependent on the tensile force in the anchor (HSL-3 heavy-duty anchor). This tensile force is produced, and thus controlled, when a tightening torque is applied to expand the anchor.

In the case of movement-controlled types, expansion takes place over a distance that is predetermined by the geometry of the anchor in the expanded state. Thus an expansion force is produced (HKD anchor) which is governed by the modulus of elasticity of the base material.

Adhesive/resin anchor

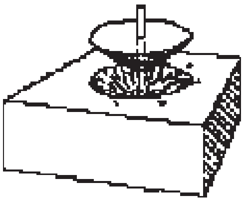
The synthetic resin of an adhesive anchor infiltrates into the pores of the base material and, after it has hardened and cured, achieves a local keying action in addition to the bond.

Failure modes

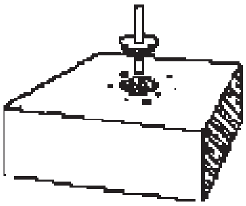
Effects of static loading

Failure patterns

The failure patterns of anchor fastenings subjected to a continually increased load can be depicted as follows:



1.



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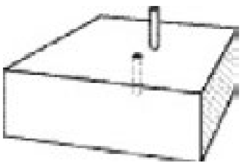

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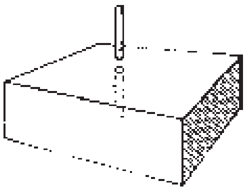
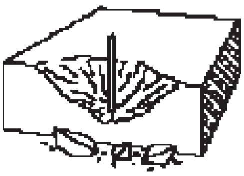


3a.



4.

Causes of failure

The weakest point in an anchor fastening determines the cause of failure. Modes of failure, 1. break-out, 2. anchor pull-away and, 3., 3a., failure of anchor parts, occur mostly when single anchors that are a suitable distance from an edge or the next anchor, are subjected to a pure tensile load. These causes of failure govern the max. loading capacity of anchors. On the other hand, a small edge distance causes mode of failure 4. edge breaking. The ultimate loads are then smaller than those of the previously mentioned modes of failure. The tensile strength of the fastening base material is exceeded in the cases of break-out, edge breaking and splitting.

Combined load

Basically, the same modes of failure take place under a combined load. The mode of failure 1. break-out, becomes more seldom as the angle between the direction of the applied load and the anchor axis increases.

Shear load

Generally, a shear load causes a conchoidal (shell-like) area of spall on one side of the anchor hole and, subsequently, the anchor parts suffer bending tension or shear failure. If the distance from an edge is small and the shear load is towards the free edge of a building component, however, the edge breaks away.

Influence of cracks

Very narrow cracks are not defects in a structure

It is not possible for a reinforced concrete structure to be built which does not have cracks in it under working conditions. Provided that they do not exceed a certain width, however, it is not at all necessary to regard cracks as defects in a structure. With this in mind, the designer of a structure assumes that cracks will exist in the tension zone of reinforced concrete components when carrying out the design work (condition II). Tensile forces from bending are taken up in a composite construction by suitably sized reinforcement in the form of ribbed steel bars, whereas the compressive forces from bending are taken up by the concrete (compression zone).

Efficient utilisation of reinforcement

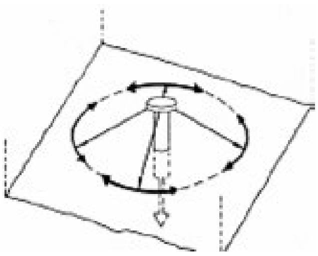
The reinforcement is only utilised efficiently if the concrete in the tension zone is permitted to be stressed (elongated) to such an extent that it cracks under the working load. The position of the tension zone is determined by the static / design system and where the load is applied to the structure. Normally, the cracks run in one direction (line or parallel cracks). Only in rare cases, such as with reinforced concrete slabs stressed in two planes, can cracks also run in two directions.

Testing and application conditions for anchors are currently being drafted internationally based on the research results of anchor manufacturers and universities. These will guarantee the functional reliability and safety of anchor fastenings made in cracked concrete.

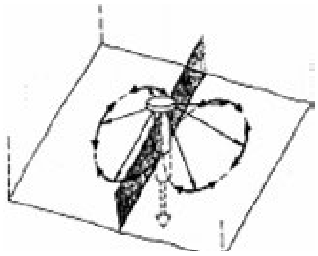
Loadbearing mechanisms

When anchor fastenings are made in non-cracked concrete, equilibrium is established by a tensile stress condition of rotational symmetry around the anchor axis. If a crack exists, the loadbearing mechanisms are seriously disrupted because virtually no annular tensile forces can be taken up beyond the edge of the crack. The disruption caused disrupted by the crack reduces the loadbearing capacity of the anchor system.

Crack plane



a) Non-cracked concrete



b) Cracked concrete

Reduction factor for cracked concrete

The width of a crack in a concrete component has a major influence on the tensile loading capacity of all fasteners, not only anchors, but also cast-in items, such as headed studs. A crack width of about 0.3mm is assumed when designing anchor fastenings. The reduction factor which can be used for the ultimate tensile loads of anchor fastenings made in cracked concrete as opposed to non-cracked concrete may be assumed to be 0.65 to 0.70 for the HSC anchor, for example. Larger reduction factors for ultimate tensile loads must be anticipated (used in calculations) in the case of all those anchors which were set in the past without any consideration of the above-mentioned influence of cracks. In this respect, the safety factor to use to allow for the failure of cracked concrete is not the same as the figure given in product information, i.e. all previous figures in the old anchor manual. This is an unacceptable situation which is being eliminated through specific testing with anchors set in cracked concrete, and adding suitable information to the product description sheets.

Since international testing conditions for anchors are based on the above-mentioned crack widths, no theoretical relationship between ultimate tensile loads and different crack widths has been given.

Pretensioning force in anchor bolts / rods

The statements made above apply primarily to static loading conditions. If the loading is dynamic, the clamping force and pretensioning force in an anchor bolt / rod play a major role. If a crack propagates in a reinforced concrete component after an anchor has been set, it must be assumed that the pretensioning force in the anchor will decrease and, as a result, the clamping force from the fixture (part fastened) will be reduced (lost). The properties of this fastening for dynamic loading will then have deteriorated.

Loss of pretensioning force due to cracks

To ensure that an anchor fastening remains suitable for dynamic loading even after cracks appear in the concrete, the clamping force and pretensioning force in the anchor must be upheld. Suitable measures to achieve this can be sets of springs or similar devices.

Seismic loads and cracked concrete

As a structure responds to earthquake ground motion it experiences displacement and consequently deformation of its individual members. This deformation leads to the formation and opening of cracks in members. Consequently all anchorages intended to transfer earthquake loads should be suitable for use in cracked concrete and their design should be predicted on the assumption that cracks in the concrete will cycle open and closed for the duration of the ground motion.

Parts of the structures may be subjected to extreme inelastic deformation. In the reinforced areas yielding of the reinforcement and cycling of cracks may result in cracks width of several millimetres, particularly in regions of plastic hinges. Qualification procedures for anchors do not currently anticipate such large crack widths. For this reason, anchorages in this region where plastic hinging is expected to occur, such as the base of shear wall and joint regions of frames, should be avoided unless apposite design measures are taken.

Anchor design

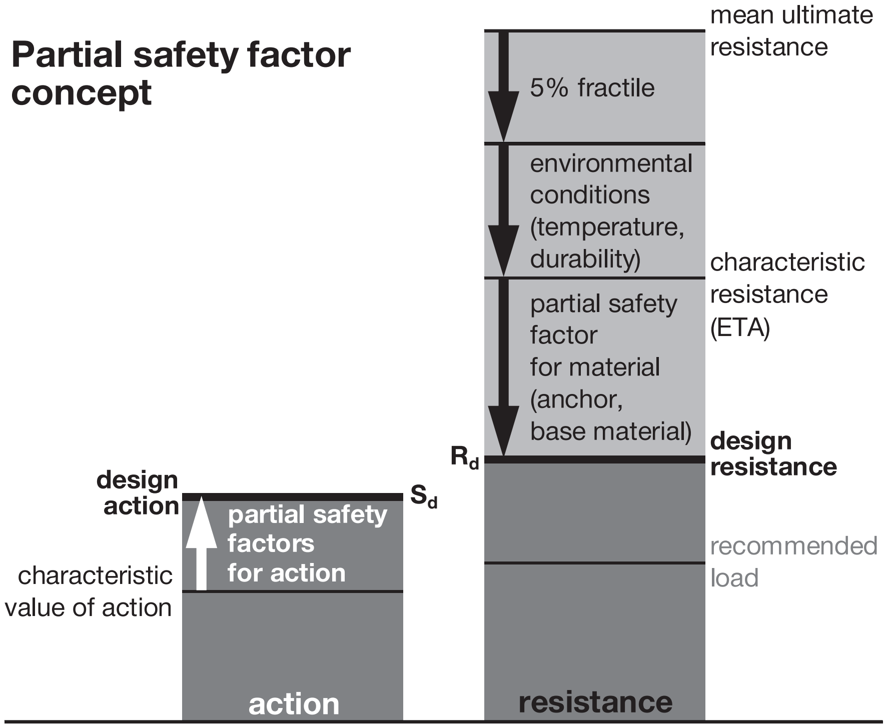
Safety concept

Depending on the application and the anchor type one of the following two concepts can be applied:

For anchors for use in concrete having an European Technical Approval (ETA) the partial safety factor concept according to the European Technical Approval Guidelines ETAG 001 or ETAG 020 shall be applied. It has to be shown, that the value of design actions does not exceed the value of the design resistance: Sd ≤ Rd.

For the characteristic resistance given in the respective ETA, reduction factors due to e.g. freeze/thaw, service temperature, durability, creep behaviour and other environmental or application conditions are already considered.

In addition to the design resistance, in this manual recommended loads are given, using an overall partial safety factor for action γ = 1,4.



Design methods

Metal anchors for use in concrete according ETAG 001

The design methods for metal anchors for use in concrete are described in detail in Annex C of the European Technical Approval guideline ETAG 001 and for bonded anchors with variable embedment depth in EOTA Technical Report TR 029. Additional design rules for redundant fastenings are given in Part 6 of ETAG 001.

The design method and Tables given in this Anchor Fastening Technology Manual is based on these guidelines.

Resistance to fire

When resistance to fire has to be considered, the load values given in the section “resistance to fire” should be observed. The values are valid for a single anchor.

Hilti design software PROFIS Anchor

For a more complex and accurate design according to international and national guidelines and for applications beyond the guidelines, e.g. group of anchors with more than four anchors close to the edge or more than eight anchors far away from the edge, the Hilti design software PROFIS Anchor yields customised fastening solutions. The results can be different from the calculations according to this manual.

The following methods can be used for design using PROFIS Anchor:

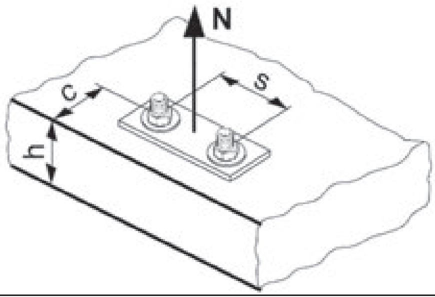
- ETAG
- CEN/TS
- ACI 318-08
- CSA

Annex C of ETAG 001 and EOTA TR 029

Design tensile resistance

The design tensile resistance is the lower value of

- Design steel resistance $N_{Rd,s}$
- Design pull-out resistance (Design combined pull-out and concrete cone resistance for bonded anchors) $N_{Rd,p}$
- Design concrete cone resistance $N_{Rd,c}$
- Design splitting resistance $N_{Rd,sp}$



Design steel resistance $N_{Rd,s}$

Annex C of ETAG 001 / EOTA TR 029 and relevant ETA

$N_{Rd,s} = N_{Rk,s} / \gamma_{Ms}$

* $N_{Rk,s}$: characteristic steel resistance

* γ_{Ms}: partial safety factor for steel failure

* Values given in the relevant ETA

Design pull-out resistance $N_{Rd,p}$ for mechanical anchors according Annex C of ETAG 001

Annex C of ETAG 001 and relevant ETA

$N_{Rd,p} = (N_{Rk,p} / \gamma_{Mp}) \cdot \Psi_c$

* $N_{Rk,p}$: characteristic pull-out resistance

* γ_{Mp}: partial safety factor for pull-out failure

* Ψ_c: influence of concrete strength

* Values given in the relevant ETA

Design combined pull-out and concrete cone resistance $N_{Rd,p}$ for bonded anchors designed according EOTA TR 029

EOTA TR 029 and relevant ETA

$$N_{Rd,p} = (N^0_{Rk,p} / \gamma_{Mp}) \cdot (A_{p,N} / A^0_{p,N}) \cdot \Psi_{s,Np} \cdot \Psi_{g,Np} \cdot \Psi_{ec,Np} \cdot \Psi_{re,Np} \cdot \Psi_c$$

where $N^0_{Rk,p} = \pi \cdot d \cdot h_{ef} \cdot \tau_{Rk}$

$$\Psi_{g,Np} = \Psi^0_{g,Np} - (s / s_{cr,Np})^{0,5} \cdot (\Psi^0_{g,Np} - 1) \geq 1$$

$$\Psi^0_{g,Np} = n^{0,5} - (n^{0,5} - 1) \cdot \{(d \cdot \tau_{Rk})/[k \cdot (h_{ef} \cdot f_{ck,cube})^{0,5}]\}^{1,5} \geq 1$$

$$s_{cr,Np} = 20 \cdot d \cdot (\tau_{Rk,ucr} / 7,5)^{0,5} \leq 3 \cdot h_{ef}$$

- * γ_{Mp}: partial safety factor for combined pull-out and concrete cone failure
- \+ $A^0_{p,N}$: influence area of an individual anchor with large spacing and edge distance at the concrete surface (idealised)
- \+ $A_{p,N}$: actual influence area of the anchorage at the concrete surface,limited by overlapping areas of adjoining anchors and by edges of the concrete member
- \+ $\Psi_{s,Np}$: influence of the disturbance of the distribution of stresses due to edges
- \+ $\Psi_{ec,Np}$: influence of excentricity
- \+ $\Psi_{re,Np}$: influence of dense reinforcement
- * Ψ_c: influence of concrete strength
- * d: anchor diameter
- * h_{ef}: (variable) embedment depth
- * τ_{Rk}: characteristic bond resistance
- s: anchor spacing
- \+ $s_{cr,Np}$: critical anchor spacing
- n: number of anchors in a anchor group
- k: = 2,3 in cracked cocrete
= 3,2 in non-cracked cocrete
- $f_{ck,cube}$: concrete compressive strength
- * $\tau_{Rk,ucr}$: characteristic bond resistance for non-cracked concrete

* Values given in the relevant ETA

\+ Values have to be calculated according data given in the relavant ETA (details of calculation see TR 029. The basis of the calculations may depend on the critical anchor spacing).

Design concrete cone resistance $N_{Rd,c}$

Annex C of ETAG 001 / EOTA TR 029 and relevant ETA

$N_{Rd,c} = (N^0_{Rk,c} / \gamma_{Mc}) \cdot (A_{c,N} / A^0_{c,N}) \cdot \Psi_{s,N} \cdot \Psi_{re,N} \cdot$

$\Psi_{ec,N}$

where $N^0_{Rk,c} = k_1 \cdot f_{ck,cube}^{0,5} \cdot h_{ef}^{1,5}$

* γ_{Mc}: partial safety factor for concrete cone failure

\+ $A^0_{c,N}$: area of concrete cone of an individual anchor with large spacing and edge distance at the concrete surface (idealised)

\+ $A_{c,N}$: actual area of concrete cone of the anchorage at the concrete surface, limited by overlapping concrete cones of adjoining anchors and by edges of the concrete member

\+ $\Psi_{s,N}$: influence of the disturbance of the distribution of stresses due to edges

\+ $\Psi_{re,N}$: influence of dense reinforcement

\+ $\Psi_{ec,N}$: influence of excentricity

k_1: = 7,2 for anchorages in cracked concrete

= 10,1 for anchorages in non-cracked concrete

$f_{ck,cube}$: concrete compressive strength

* h_{ef}: effective anchorage depth

* Values given in the relevant ETA

\+ Values have to be calculated according data given in the relavant ETA (details of calculation see Annex C of ETAG 001 or EOTA TR 029)

Design concrete splitting resistance $N_{Rd,sp}$

Annex C of ETAG 001 / EOTA TR 029 and relevant ETA

$$N_{Rd,sp} = (N^0_{Rk,c} / \gamma_{Mc}) \cdot (A_{c,N} / A^0_{c,N}) \cdot \Psi_{s,N} \cdot \Psi_{re,N} \cdot \Psi_{ec,N} \cdot \Psi_{h,sp}$$

where $N^0_{Rk,c} = k_1 \cdot f_{ck,cube}{}^{0,5} \cdot h_{ef}{}^{1,5}$

- * γ_{Mc}: partial safety factor for concrete cone failure
- ++ $A^0_{c,N}$: area of concrete cone of an individual anchor with large spacing and edge distance at the concrete surface (idealised)
- ++ $A_{c,N}$: actual area of concrete cone of the anchorage at the concrete surface, limited by overlapping concrete cones of adjoining anchors and by edges of the concrete member
- \+ $\Psi_{s,N}$: influence of the disturbance of the distribution of stresses due to edges
- \+ $\Psi_{re,N}$: influence of dense reinforcement
- \+ $\Psi_{ec,N}$: influence of excentricity
- k_1: = 7,2 for anchorages in cracked concrete
  = 10,1 for anchorages in non-cracked concrete
- \+ $\Psi_{h,sp}$: influence of the actual member depth
- $f_{ck,cube}$: concrete compressive strength
- * h_{ef}: embedment depth

* Values given in the relevant ETA

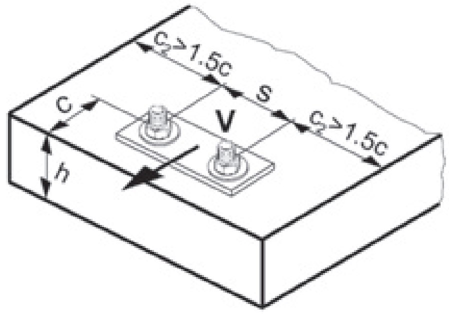
\+ Values have to be calculated according data given in the relavant ETA (details of calculation see Annex C of ETAG 001 or EOTA TR 029)

++ Values of $A^0_{c,N}$ and $A_{c,N}$ for splitting failure may be different from those for concrete cone failure, due to different values for the critical edge distance and critical anchor spacing

Design shear resistance

The design shear resistance is the lower value of

- Design steel resistance — $V_{Rd,s}$
- Design concrete pryout resistance — $V_{Rd,cp}$
- Design concrete edge resistance — $V_{Rd,c}$



Design steel resistance $V_{Rd,s}$ (without lever arm)

Annex C of ETAG 001 / EOTA TR 029 and relevant ETA

$V_{Rd,s} = V_{Rk,s} / \gamma_{Ms}$

* $V_{Rk,s}$: characteristic steel resistance

* γ_{Ms}: partial safety factor for steel failure

* Values given in the relevant ETA

For steel failure with lever arm see Annex C of ETAG 001 or EOTA TR 029

Design concrete pryout resistance $V_{Rd,cp}$ for mechanical anchors according Annex C of ETAG 001

Annex C of ETAG 001 and relevant ETA

$V_{Rd,cp} = (V_{Rk,cp} / \gamma_{Mp/Mc}) = k \cdot N_{Rd,c}$

$N_{Rd,c} = N_{Rk,c} / \gamma_{Mc}$

$N_{Rk,c}$: characteristic tension resistance for concrete cone failure (see design concrete cone failure)

* γ_{Mc}: partial safety factor for concrete cone failure (see design concrete cone failure)

* k: influence of embedment depth

* Values given in the relevant ETA

Design concrete pryout resistance $V_{Rd,cp}$ for bonded anchors designed according EOTA TR 029

EOTA TR 029
and relevant ETA

$V_{Rd,cp} = (V_{Rk,cp} / \gamma_{Mp/Mc}) = k \cdot$ lower value of $N_{Rd,p}$ and $N_{Rd,c}$

$N_{Rd,p} = N_{Rk,p} / \gamma_{Mp}$

$N_{Rd,c} = N_{Rk,c} / \gamma_{Mc}$

$N_{Rd,p}$: characteristic tension resistancefor combined pull-out and concrete cone failure (see design combined pull-out and concrete cone failure)

$N_{Rk,c}$: characteristic tension resistance for concrete cone failure (see design concrete cone failure)

* γ_{Mp}: partial safety factor for combined pull-out and concrete cone failure (see design combined pull-out and concrete cone failure)

* γ_{Mc}: partial safety factor for concrete cone failure (see design concrete cone failure)

* **k**: influence of embedment depth

* Values given in the relevant ETA

Corrosion

Material recommendations to counteract corrosion

Application	General conditions		Recommendations
Initial/carcass construction			
Temporary fastening: Forming, site fixtures, scaffolding	Outside and inside applications		Galvanised or coated
Structural fastening: Brackets, columns, beams	Dry inside rooms, no condensation		Galvanised 5-10 microns
	Damp inside rooms with occasional condensation due to high humidity and temperature fluctuations		Hot-dipped galvanised /sherardized min. 45 microns
	Frequent and long-lasting condensation (greenhouses), open inside rooms or open halls / sheds		A4 (316) steels, possibly hot-dipped galvanised
Composite construction	Protection due to alkalinity of concrete		Galvanised 5-10 microns
Interior finishing			
Drywalls, suspended ceilings, windows, doors, railings / fences, elevators, fire escapes	Dry inside rooms, no condensation		Galvanised 5-10 microns
Facades / roofing			
Profiled metal sheets, curtain wall cladding, insulation fastenings, facade support framing	Rural atmosphere (without emissions)	Inside application	Galvanised 5-10 microns
		Outside application	Hot-dipped galvanised / sherardized min. 45 microns
		Insulating materials	Dacromet / plastic, A4 (316) steels
	Town / city atmosphere: High SO_2 and NOx contents, chlorides from road salt can accumulate/ concentration on parts not weathered directly	Inside application	Galvanised 5-10 microns
		Outside application	Hot-dipped galvanised /sherardized min. 45 microns, Hilti-HCR if chlorides exist
		Insulating materials	A4 (316) steels
	Industrial atmosphere: High SO2 content and other corrosive substances (without halides)	Inside application	Galvanised 5-10 microns
		Outside application	A4 (316) steels
		Insulating materials	A4 (316) steels
	Coastal atmosphere: High content of chlorides, combined with industrial atmosphere	Inside application	Galvanised 5-10 microns
		Outside application	Hilti-HCR
		Insulating materials	Hilti-HCR

Application	General conditions	Recommendations
Installations		
Conduit installation, cable runs, air ducts Electrical systems: Runs, lighting, aerials Industrial equipment: Crane rails, barriers, conveyors, machine fastening	Dry inside rooms, no condensation	Galvanised 5-10 microns
	Damp inside rooms, poorly ventilated rooms, cellar / basement shafts, occasional condensation due to high humidity and temperature fluctuations	Hot-dipped galvanised / sherardized min. 45 microns
	Frequent and long-lasting condensation (greenhouses), non enclosed inside rooms or open sheds / buildings	A4 (316) steels, possibly hot-dipped galvanised
Road and bridge construction		
Conduit installation, cable runs, traffic signs, noise-insulating walls, crash barriers / guard rails, connecting structures	Directly weathered (chlorides are regularly washed off)	Hot-dipped galvanised / sherardized min. 45 microns, A4 (316) steels, Duplex steel or austenitic steel with approx. 4-5% Mo
	Frequently heavy exposure to road salt, highly relevant to safety	Hilti HCR
Tunnel construction		
Tunnel foils / sheeting, reinforcing mesh, traffic signs, lighting, tunnel wall cladding / lining, air ducts, ceiling suspensions, etc.	Secondary relevance for safety	Duplex steel, poss. A4 (316) steels
	Highly relevant to safety	Hilti HCR
Dock/harbour/port facilities /off-shore rigs		
Fastenings to quaysides, dock / harbour	Secondary relevance for safety, temporary fastenings	Hot-dipped galvanised
	High humidity, chlorides, often a superimposed "industrial atmosphere" or changes of oil / sea water	Hilti HCR
	On the platform / rig	A4 (316) steels
Industry / chemical industry		
Conduit installation, cable runs, connecting structures, lighting	Dry inside rooms	Galvanised 5-10 microns
	Corrosive inside rooms, e.g. fastenings in laboratories, galvanising / plating plants etc.,very corrosive vapours	A4 (316) steels, Hilti-HCR
	Outside applications, very heavy exposure to SO2 and additional corrosive substances (only acidic surroundings)	A4 (316) steels
Power plants		
Fastenings relevant to safety	Dry inside rooms	Galvanised 5-10 microns
	Outside applications, very heavy exposure to SO2	A4 (316) steels

Application	General conditions	Recommendations
Smokestacks of waste incineration plants		
Fastening of, for example, service ladders, lightening conductors	In lower section of stack	Hot-dipped galvanised/sherardized min. 45 microns A4 (316) steels
	In top section of stack, condensation of acids and often high chloride and other halide concentrations	Hilti-HCR
Sewage / waste water treatment		
Conduit installation, cable runs, connecting structures etc	In the atmosphere, high humidity, sewage / digester gases etc.	Hot-dipped galvanised/sherardized min. 45 microns A4 (316) steels
	Underwater applications, municipal sewage / waste water, industrial waste water	Hilti HCR
Multi-storey car parks		
Fastening of, for example, guard rails, handrails, balustrades	Large amounts of chlorides (road salt) carried in by vehicles, many wet and dry cycles	Hilti HCR
Indoor swimming pools		
Fastening of, for example, service ladders, handrails, suspended ceilings	Fastenings relevant to safety	Hilti HCR
Sports grounds / facilities / stadiums		
Fastening of, for example, seats, handrails, fences	In rural atmosphere	Hot-dipped galvanised / sherardized min. 45 microns
	In town / city atmosphere	Hot-dipped galvanised / sherardized min. 45 microns A4 (316) steels
	Inaccessible fastenings	A4 (316) steels

The following table shows the suitability of the respective metal couple. It also shows which two metals in contact are permissible in field practice and which should rather be avoided.

Fastened part \ Fastener	El.-chem. galvanised	Hot-dipped galvanised	Aluminium alloy	Structural steel	Stainless steel	Brass
Zinc	○	○	○	○	○	○
Hot-dipped galv. steel	○	○	○	○	○	○
Aluminium alloy	●	■	○	○	○	○
Cadmium coating	●	■	○	○	○	○
Structural steel	●	●	●	○	○	○
Cast steel	●	●	●	●	○	○
Chromium steel	●	●	●	●	○	■
CrNi(Mo) steel	●	●	●	●	○	●
Tin	●	●	●	●	○	■
Copper	●	●	●	●	●	●
Brass	●	●	●	●	●	○

○ Slight or no corrosion of fastener

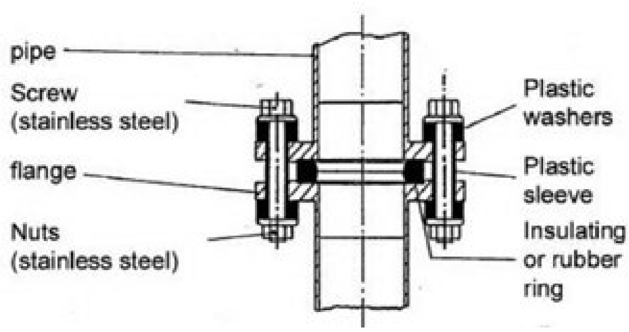
● Heavy corrosion of fastener

■ Moderate corrosion of fastener

If two or more metals are combined and these are linked conductively with direct contact or contact through a medium, attention must be paid to their electrochemical compatibility.

The ratio of surface areas of the linked metals is of crucial importance for the corrosion rate. Here it should be remembered that from an electrochemical point of view the less noble metal should always have a much larger surface area. In view of the fact that a fastener is normally always the smaller component and thus has a smaller surface area, the fastener should be made of the same material as the part fastened or if not possible of a nobler material.

If an " unfavourable" combination of different materials cannot be avoided, suitable measures can be taken to avoid contact corrosion, for example electrical insulation using plastic parts, like washers, sleeves, etc.



Galvanic separation using plastic and rubber

Dynamic loads (fatigue, shock, seismic)

Dynamic design for anchors

Actions

Common engineering design usually focuses around static loads. This chapter is intended to point out those cases, where static simplification may cause severe misjudgement and usually under-design of important structures.

Static loads

Static loads can be segregated as follows:

- Own (dead) weight
- Permanent actions
  Loads of non-loadbearing components, e.g. floor covering, screed, or from constraint (due to temperature change or sinking of supports / columns)
- Changing actions
  working loads (fitting / furnishing , machines, “normal” wear) Snow, Wind, Temperature

Dynamic actions

The main difference between static and dynamic loads is the effectiveness of inertia and damping forces. These forces result from induced acceleration and must be taken into account when determining section forces and anchoring forces.

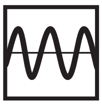
Typical Dynamic Actions

Dynamic actions can generally be classified into 3 different groups:

- Fatigue loads
- Shock loads
- Seismic loads

Fatigue loads

Fatigue



If an anchor is subjected to a sustained load that changes with respect to time, it can fail after a certain number of load cycles even though the upper limit of the load withstood up to this time is clearly lower than the ultimate tensile strength under static loading. This loss of strength is referred to as material fatigue. When evaluating actions causing fatigue also the planned or anticipated fastening life expectancy is of major importance.

Material behaviour under fatigue impact

The grade and quality of steel has a considerable influence on the alternating strength. In the case of structural and heat-treatable steels, the final strength (i.e. after 2 million load cycles or more) is approx. 25-35% of the static strength.

In the non-loaded state, concrete already has micro-cracks in the zone of contact of the aggregates and the cement paste, which are attributable to the aggregates hindering shrinkage of the cement paste. The fatigue strength of concrete is directly dependent on the grade of concrete. Concrete strength is reduced to about 55 – 65% of the initial strength after 2’000’000 load cycles.

Examples for Fatigue Loads

Two main groups of fatigue type loading can be identified:

- Vibration type loading of fasteners with very high recurrence and usually low amplitude (e.g. ventilators, production machinery,etc.).
- Repeated loading and unloading of structures with high loads and frequent recurrence (cranes, elevators, robots, etc.).

Shock loads

Shock

Shock-like phenomena have a very short duration and generally tremendously high forces which, however, only occur as individual peaks. As the probability of such a phenomenon to occur during the life expectancy of the building components concerned is comparably small, plastic deformations of fasteners and structural members are permitted according to the pre-qualification criteria.

Examples of Shock Loading

Shock loads are mostly unusual loading situations, even though sometimes they are the only loading case a structure is designed for (e.g. crash barriers, protection nets, ship or aeroplane impacts and falling rocks, avalanches and explosions, etc.).

Shock Testing

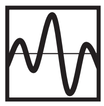
Load increase times in the range of milliseconds can be simulated during tests on servo-hydraulic testing equipment. The following main effects can then be observed:

- Deformation is greater when the breaking load is reached
- The energy absorbed by an anchor is also much higher
- Breaking loads are of roughly the same magnitude during static loading and shock-loading tests

In this respect, more recent investigations show that the base material (cracked or non-cracked concrete), has no direct effect on the loadbearing behaviour.

Seismic loads

Earthquakes



An increasing population density, the concentration of valuable assets in urban centers and society's dependence on a functioning infrastructure demand a better understanding of the risks posed by earthquakes. In several areas around the globe, these risks have been reduced through appropriate building codes and state of the art construction practices. The development of pre-qualification methods to evaluate building products for seismic conditions additionally contributes to safer buildings for generations to come.

Anchors suitability under seismic loading

For a properly designed fastening, anchors subjected to seismic loading shall be designed and additionally pre-qualified for seismic load scenarios. In view of this, suitability tests for tension and shear are carried out according to ACI 355.2 with the ICC acceptance criteria AC193 and AC308. As a consequence of this procedure, for the suitable anchors, technical data is published and an evaluation technical report (ESR) is released.

Additionally, Hilti's seismic research includes detailed investigation of product performance under simulated seismic conditions and full-scale system testing. This multilevel approach helps to capture the complexity of anchored system behaviour under seismic conditions.

Typical seismic applications

Seismic anchorage applications can include strengthening or retrofitting an existing structure, as well as standard anchorage applications that exist both in seismic and non-seismic geographies. In addition to an engineers focus on the anchoring of structural elements, it is crucial for an adequate seismic design to attend to non-load bearing and non-structural elements. These elements failure can severely compromise the building/structure functionality or repair costs after a seismic event.

Seismic loads (cont'd)

Seismic anchor design regulations landscape

For a sound seismic design of a post-installed anchorage the first step begins with the correct definition of the acting loads. In the United States ASCE/SEI 7-05 establishes the provisions for the definition of the seismic action, and the anchor performance shall be evaluated in accordance with ACI 318-08, Appendix D. Pre-qualification reports, created in accordance with published testing procedures and acceptance criteria, (ACI 355.2 with ICC-ES AC193 and AC308) provide sound data in a proper format for design.

Following the same design flow, in Europe the action definition is available through the EN 1998:2004 (Eurocode 8) and the resistance evaluation can be defined by the CEN/TS 1992-4:2009. Hilti anchors can be designed with the recently introduced European requirements outlined in the EOTA report TR045 for anchors pre-qualified according to ETAG-001, Annex E (refer Seismic section p42 for more information).

Under seismic loading the performance of an anchored connection is crucial either to the stability of a structure or in order to avoid major casualties and/or economical impacts consequence of non-structural elements collapse. Therefore, to consent in Europe the design of anchors subjected to seismic action, the resistance evaluation may utilize the provisions and technical reports existing in the United States

Engineering judgment on the design procedure

By an in-depth analysis and comparison of the code regulations on both continents it is possible to establish a plain harmonization. A comparison of ASCE/SEI 7-05 and Eurocode 8 in terms of the design spectrum, seismic base shear force and also the load combinations concept to account for earthquake action allows for a sound recommendation of this approach.

The above mentioned design exercise is presently the only available and fully operational code based procedure in Europe and can as such be considered state-of-the-art. Upon the development of pre-qualification criteria and technical data for the seismic design of anchors in Europe, a designer will be recommended to reference to most recent published design approach.

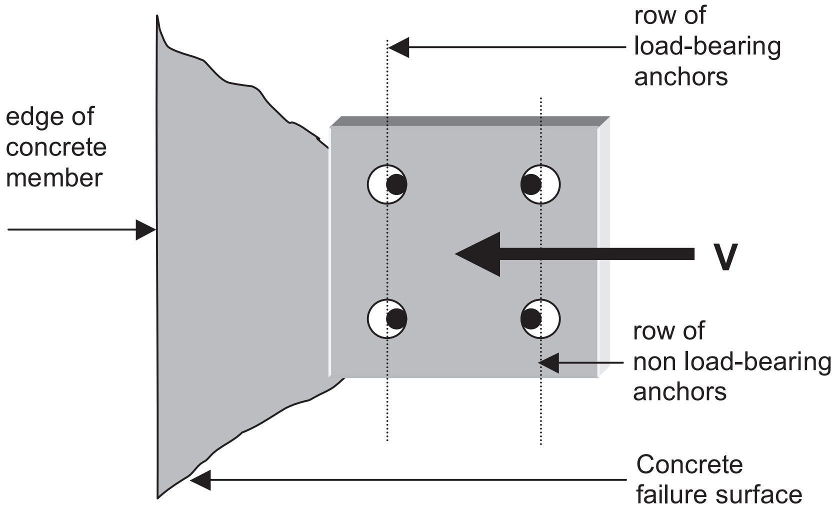
After an earthquake

After a strong or design earthquake occasion, the ultimate loading capacity of an anchor is considerably reduced (30 to 80% of the original resistance). Proper inspection shall then be carried to ensure the level of performance not only for a future earthquake but also to guarantee the load combinations for static loading.

Dynamic set for shear resistance upgrade

Uneven shear load distribution

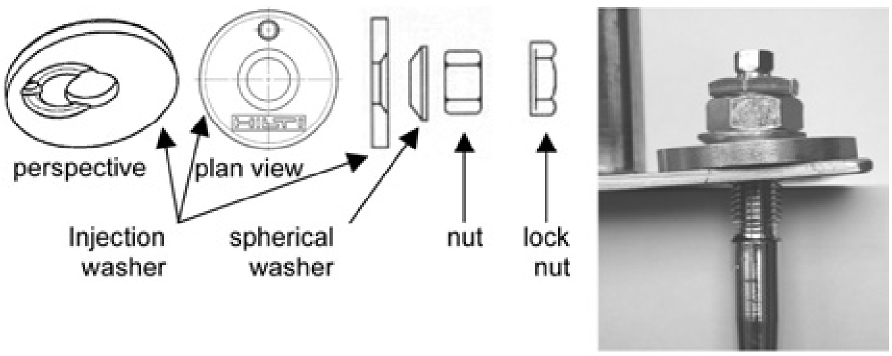
If a multiple-anchor fastening is loaded towards the edge of a concrete member (shear load), the gap between anchor shaft and clearance hole has an important role. An uneven shear load distribution within the anchors in the fastening is the result as the clearance hole is always larger than the anchor diameter to ensure an easy installation. Design methods take this fact into account by assuming that only the row of anchors nearest to the concrete edge takes up all shear load.



Activating the second row of anchors

The second row of anchors can be activated only after a considerable slip of the anchoring plate. This slip normally takes place after the edge failure of the outside row. The effect of the clearance hole gap on the internal load distribution increases if the shear load direction changes during the service life. To make anchors suitable for alternating shear loads, Hilti developed the so called Dynamic Set. This consists of a special washer, which permits HIT injection adhesive to be dispensed into the clearance hole, a spherical washer, a nut and a lock nut.

Dynamic Set



Improvements with Dynamic Set

Injection washer: Fills clearance hole and thus guarantees that the load is uniformly distributed among all anchors.

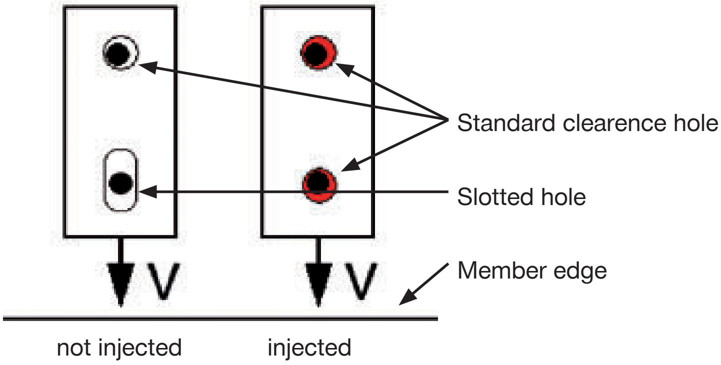
Spherical washer: Reduces bending moment acting on anchor shaft not set at right angles and thus increases the tensile loading capacity.

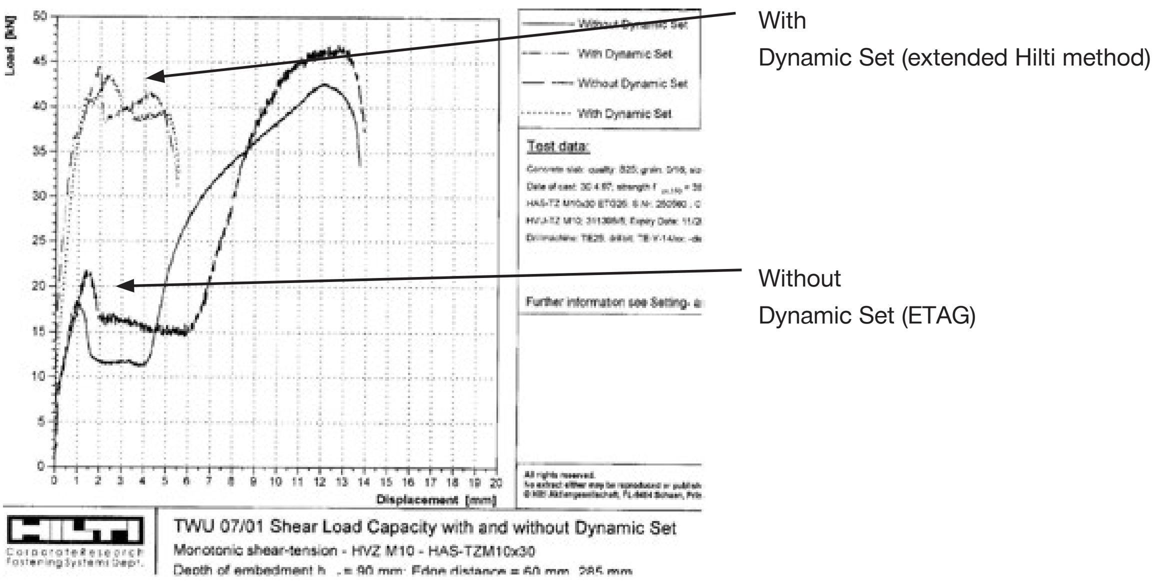
Lock nut: Prevents loosening of the nut and thus lifting of the anchoring plate away from the concrete in case of cyclic loading.

Delivery programme Dynamic Set: M10, M12, M16, M20

Shear resistance improvement with Dynamic Set

By using the dynamic set for static fastenings, the shear resistance is improved significantly. The unfavourable situation that only one row of anchors takes up all loads no longer exists and the load is distributed uniformly among all anchors.
A series of experiments has verified this assumption. An example from this test programme, double fastenings with HVZ M10 anchors with and without the Dynamic Set are shown to compare resulting shear resistance and stiffness.





The test results show clearly that according to the current practice the second row of anchors takes up the load only after significant deformation of the plate, when the concrete edge has already failed. The injection and the Dynamic Set resulted in a continuous load increase until the whole multiple fastening fails.

When carrying out a simple fastening design, it may be assumed if the Dynamic Set is used the overall load bearing capacity of the multiple fastening is equal to the resistance of the first row of anchors multiplied by the number of rows in the fastening. In addition to that it must be checked whether the concrete edge resistance of the furthest row is smaller than the above metioned resistance. If injection with the Dynamic Set is used, the ETAG restrictions on more than 6 anchor fastenings can be overcome.

Hilti post-installed anchors in Seismic

Hilti has a range of post-installed mechanical and chemical anchors that have passed the ACI355.2.

In addition to the requirements of ACI355.2, Hilti anchors can be designed with the recently introduced European requirements outlined in the EOTA report TR045 for anchors pre-qualified according to ETAG-001, Annex E.

EOTA TR045, which was first introduced in 2013, distinguishes between two performance categories depending on the seismicity of the area.

- Performance category C1: Similar to the ACI355.2 seismic pre-qualification test.
- Performance category C2: Very demanding seismic crack movement tests. More stringent than C1 and ACI 355.2.

Tests for qualification of anchors under categories C1 and C2 are defined in ETAG-001, Annex E.

Please refer to the table below for further information on our range of seismic qualified anchors.

Anchor Type	Product	Description	Picture	Size	Seismic Pre-qualification criteria		
					ACI 355.2*[1]	EOTA C1	EOTA C2
Mechanical Anchor	HDA	Undercut		M10 – M20	✓ ICC-ES	Pending	
	HSL-3	Expansion		M8 – M24	✓ ICC-ES	Pending	
	HST	Stud		M10 – M16	✓	✓ ETA	✓ ETA
	HUS-H	Screw		Drill bit size: 8-10mm*[2]	✓	✓ ETA	-
Chemical Anchor	HIT-RE500-SD	Slow cure Epoxy		HIT-V: M8 – M30	✓ ICC-ES	✓ ETA	Pending
	HIT-HY200	Fast cure Hybrid mortar		HIT-V: M8 – M30	✓ ICC-ES	✓ ETA	-
				HIT-Z: M8 – M20	✓ ICC-ES	✓ ETA	✓*3 ETA

1. A requirement to satisfy NZS4219 & NZS3101
2. HUS-HR 8-14 (s/s) is in compliance with ACI355.2 & EOTA C1
3. M12 and M16 are the only sizes that comply with ETA C2 at this stage

Hilti manufacture and supply top quality products, giving designers and end users the utmost trust and confidence with full technical support (e.g. approvals & technical data) available on request.

Both design methods, the ACI and EOTA TR 45 are incorporated in the PROFIS software.

ETAG-001, Annex E rating classifications for anchor under performance category C1 and C2

New European testing procedure for determining the seismic suitability of fastenings
The seismic pre-qualification of anchors has been regulated in Europe since the release of ETAG 001 Annex E in early 2013. Anchors subject to this new test procedure must now incorporate in the ETA all the required seismic design technical data .

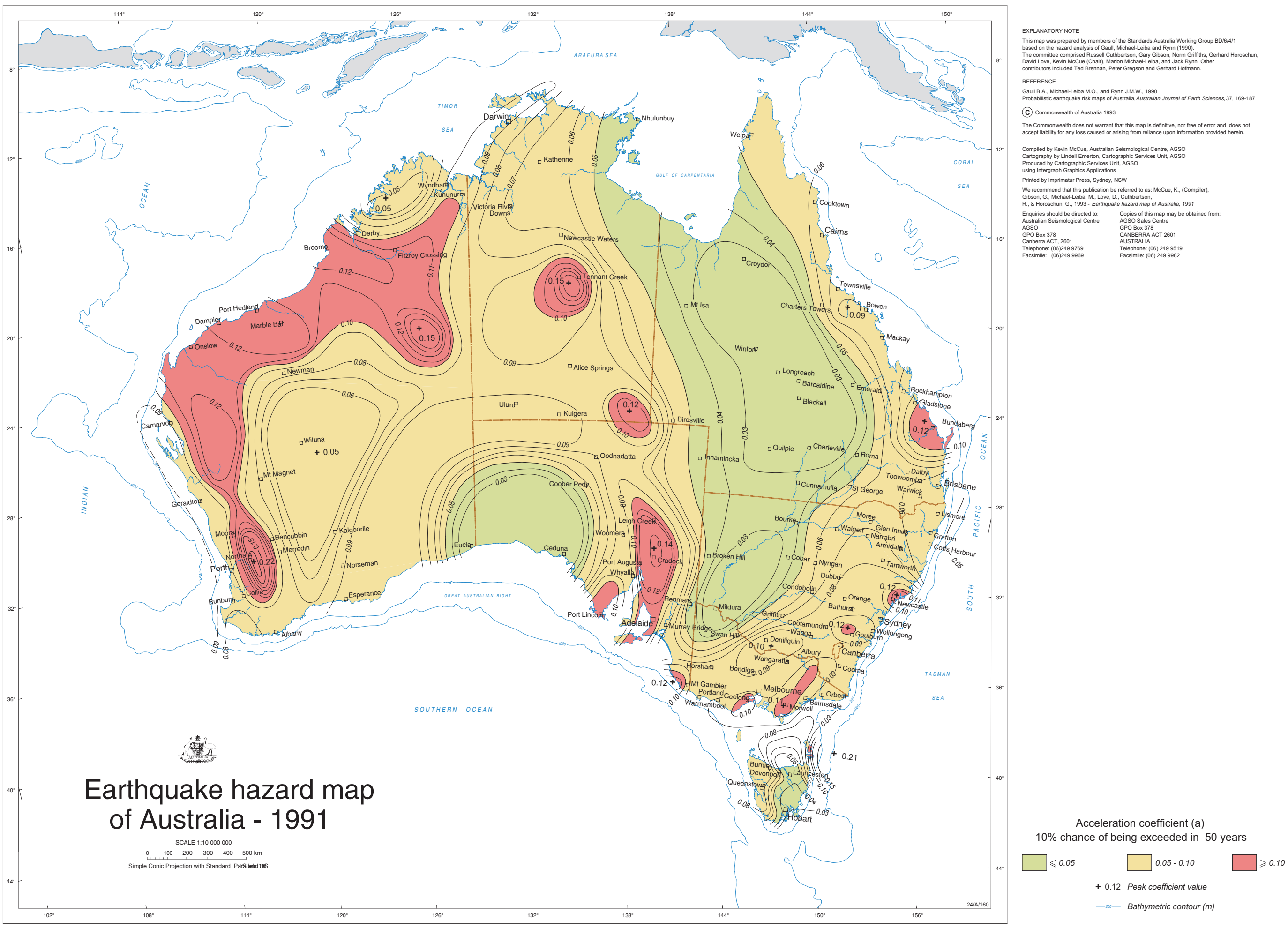
Minimum recommendation performance categories for anchors under seismic actions as per table 1.1 of ETAG-001, Annex E

Structural applications

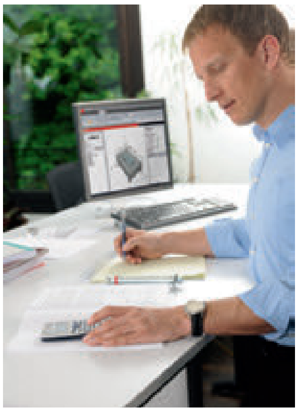
Acceleration ($a_g \cdot S$)	Building importance II, III, IV
< 0.05g	non-seismic
0.05g to 0.1g	ETA C2
> 0.1g	

Non-structural applications

Acceleration ($a_g \cdot S$)	Building importance II, III	Building importance IV
< 0.05g	non-seismic	
0.05g to 0.1g	ETA C1	ETA C2
> 0.1g	ETA C2	

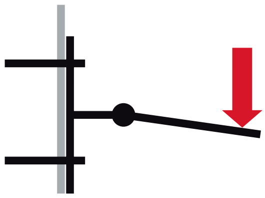


Post-installed anchor seismic design

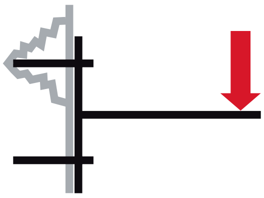


Three design options

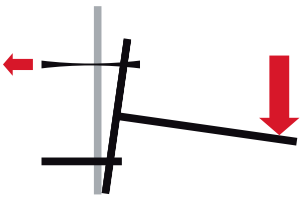
Both EOTA TR045 and ACI 318/AC192, AC308 provide three design approaches which are described below. Note that all three of these approaches are acceptable within their application conditions.



1) 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.



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



3) Design with requirements on the ductility of the anchors
This design for ductile steel failure requires an anchor classified as ductile. Additionally, this approach is applicable only for the tension component and some provisions require to be observed in order to ensure that the cause of failure is steel failure.

Hilti engineering services

A team of qualified and experienced engineers is available to provide you with more detailed information and to help you determine and design the best solution for your particular project.

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E: au.engineering@hilti.com

Resistance to fire

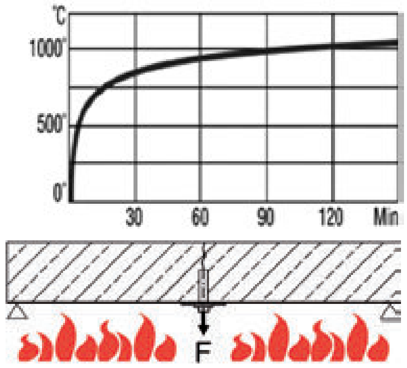
Tested fasteners
for passive structural fire prevention

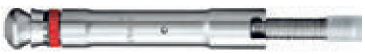
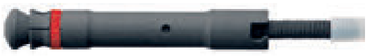
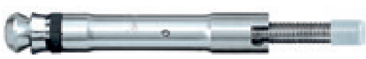
Tested according to the international standard temperature curve

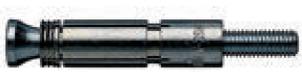
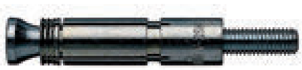
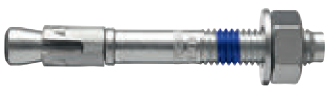
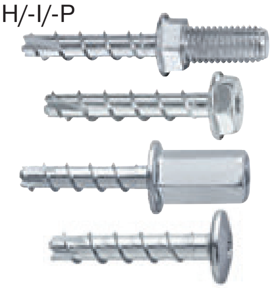
MFPA Leipzig GmbH

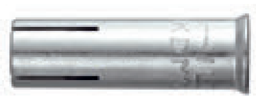
Tested according to the international standard temperature curve (ISO 834. DIN 4102 T.2) and/or to EOTA Technical Report TR 020 (Evaluation of Anchorages in Concrete concerning Resistance to Fire)

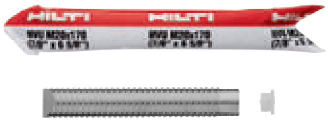
Tested when set in cracked concrete and exposed to flames without insulating or protective measures.



Anchor / fastener	Size	Max. loading (kN) for specified fire resistance time (fire resistance time in minutes)				Authority / No.
		F30	F60	F90	F120	
HDA 	M10	4.5	2.2	1.3	1.0	IBMB Braunschweig UB 3039/8151 Warringtonfire WF Report No 166402
	M12	10.0	3.5	1.8	1.2	
	M16	15.0	7.0	4.0	3.0	
Fire resistance data for F 180 please refer to the test reports	M20	25.0	9.0	7.0	5.0	
HDA-F 	M10	4.5	2.2	1.3	1.0	IBMB Braunschweig UB 3039/8151 Warringtonfire WF Report No 166402
	M12	10.0	3.5	1.8	1.2	
	M16	15.0	7.0	4.0	3.0	
HDA-R 	M10	20.0	9.0	4.0	2.0	IBMB Braunschweig UB 3039/8151 Warringtonfire WF Report No 166402
	M12	30.0	12.0	5.0	3.0	
	M16	50.0	15.0	7.5	6.0	
HSL-3 	M8	3.0	1.1	0.6	0.4	IBMB Braunschweig UB 3041/1663-CM Warringtonfire WF Report No 166402
	M10	7.0	2.0	1.3	0.8	
	M12	10.0	3.5	2.0	1.2	
	M16	19.4	6.6	3.5	2.2	
	M20	30.0	10.3	5.4	3.5	
	M24	43.0	14.8	7.9	5.0	
HSL-3-B 	M12	10.0	3.5	2.0	1.2	IBMB Braunschweig report No. 3041/1663-CM Warringtonfire WF Report No 166402
	M16	19.4	6.6	3.5	2.2	
	M20	30.0	10.3	5.4	3.5	
	M24	43.0	14.8	7.9	5.0	

Anchor / fastener	Size	Max. loading (kN) for specified fire resistance time (fire resistance time in minutes)				Authority / No.
		F30	F60	F90	F120	
HSC-A 	M8x40	1.5	1.5	1.5	-	IBMB Braunschweig UB 3177/1722-1
	M8x50	1.5	1.5	1.5	-	Warringtonfire WF Report No 166402
	M10x40	1.5	1.5	1.5	-	
	M12x60	3.5	3.5	2.0	-	
HSC-I 	M8x40	1.5	1.5	1.5	-	IBMB Braunschweig UB 3177/1722-1
	M10x50	2.5	2.5	2.5	-	Warringtonfire WF Report No 166402
	M10x60	2.5	2.5	2.5	-	
	M12x60	2.0	2.0	2.0	-	
HSC-AR 	M8x40	1.5	1.5	1.5	-	IBMB Braunschweig UB 3177/1722-1
	M8x50	1.5	1.5	1.5	-	Warringtonfire WF Report No 166402
	M10x40	1.5	1.5	1.5	-	
	M12x60	3.5	3.5	3.5	3.0	
HSC-IR 	M8x40	1.5	1.5	1.5	-	IBMB Braunschweig UB 3177/1722-1
	M10x50	2.5	2.5	2.5	-	Warringtonfire WF Report No 166402
	M10x60	2.5	2.5	2.5	-	
	M12x60	3.5	3.5	3.5	3.0	
HSA / HSA-R 	M6	0.20	0.18	0.14	0.10	IBMB Braunschweig 3215/229/12
	M8	0.37	0.33	0.26	0.18	Data valid for steel failure. for other failure modes see report 3215/229/12
	M10	0.87	0.75	0.58	0.46	
	M12	1.69	1.26	1.10	0.84	
	M16	3.14	2.36	2.04	1.57	
	M20	4.90	3.68	3.19	2.45	
HUS-HR 	6x30	0.5	0.5	0.5	0.4	Hilti Tech. data
	6x35	0.7	0.7	0.7	0.5	DIBt Berlin / ETA-10/0005 acc. Part 6
	6x55	1.3	1.3	1.3	1.0	DIBt Berlin ETA-08/0307
	8x60	1.5	1.5	1.5	1.2	
	8x80	3.0	3.0	3.0	1.7	
	10x70	2.3	2.3	2.3	1.8	
	10x90	4.0	4.0	4.0	2.4	
	14x70	3.0	3.0	3.0	2.4	
	14x90	6.3	6.3	6.3	5.0	
HUS-A/-H/-I/-P 	6x35	0.5	0.5	0.5	0.4	DIBt Berlin / ETA-10/0005 acc. Part 6
	6x55	1.5	1.2	0.8	0.7	DIBt Berlin ETA-08/0307
	8x60	1.5	1.5	1.3	0.8	
	8x75	2.3	2.2	1.3	0.8	
	10x70	1.9	1.9	1.9	1.5	
	10x85	4.0	3.6	2.2	1.5	

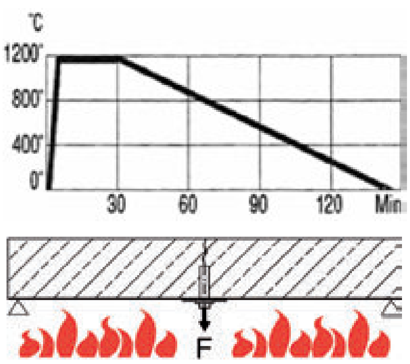
Anchor / fastener	Size	Max. loading (kN) for specified fire resistance time (fire resistance time in minutes)				Authority / No.
		F30	F60	F90	F120	
HKD 	M6x25	0.5	0.4	0.3	0.2	DIBt Berlin ETA-06/0047 acc. Part 6
	M8x25	0.6	0.6	0.6	0.5	
	M8x30	0.9	0.9	0.9	0.7	
	M8x40	1.3	1.3	1.3	0.7	
	M10x25	0.6	0.6	0.6	0.5	
	M10x30	0.9	0.9	0.9	0.7	
	M10x40	1.8	1.8	1.8	1.5	
	M12x25	0.6	0.6	0.6	0.5	
	M12x50	2.3	2.3	2.3	1.8	
	M16x65	4.0	4.0	4.0	3.2	
HKD-SR 	M6x30	0.5	0.5	0.4	0.3	DIBt Berlin ETA-06/0047 acc. Part 6 Warringtonfire WF Report No 166402
	M8x30	0.9	0.9	0.9	0.7	
	M10x40	1.8	1.8	1.8	1.5	
	M12x50	2.3	2.3	2.3	1.8	
HVU + HAS 	M8	1.5	0.8	0.5	0.4	IBMB Braunschweig UB- 3333/0891-1 Warringtonfire WF Report No 166402
	M10	4.5	2.2	1.3	0.9	
	M12	10.0	3.5	1.8	1.0	
	M16	15.0	5.0	4.0	3.0	
	M20	25.0	9.0	7.0	5.0	
	M24	35.0	12.0	9.5	8.0	
	M27	40.0	13.5	11.0	9.0	
	M30	50.0	17.0	14.0	11.0	
	M33	60.0	20.0	16.5	13.5	
	M36	70.0	24.0	19.5	16.0	
	M39	85.0	29.0	23.5	19.5	
HVU + HAS-R/HAS-E-R + HVU + HAS-HCR/HAS-E-HCR 	M8	2.0	0.8	0.5	0.4	IBMB Braunschweig UB- 3333/0891-1 Warringtonfire WF Report No 166402
	M10	6.0	3.5	1.5	1.0	
	M12	10.0	6.0	3.0	2.5	
	M16	20.0	13.5	7.5	6.0	
	M20	36.0	25.5	15.0	10.0	
	M24	56.0	38.0	24.0	16.0	
	M27	65.0	44.0	27.0	18.0	
	M30	85.0	58.0	36.0	24.0	
	M33	100.0	68.0	42.0	28.0	
	M36	120.0	82.0	51.0	34.0	
	M39	140.0	96.0	60.0	40.0	
HVU + HIS-N 	M8	1.5	0.8	0.5	0.4	IBMB Braunschweig UB- 3333/0891-1 Warringtonfire WF Report No 166402
	M10	4.5	2.2	1.3	0.9	
	M12	10.0	3.5	1.8	1.0	
	M16	15.0	5.0	4.0	3.0	
	M20	25.0	9.0	7.0	5.0	

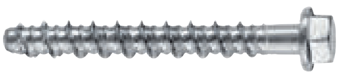
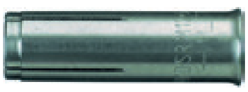
Anchor / fastener	Size	Max. loading (kN) for specified fire resistance time (fire resistance time in minutes)				Authority / No.
		F30	F60	F90	F120	
HVU + HIS-RN 	M8	10.0	5.0	1.8	1.0	IBMB Braunschweig UB- 3333/0891-1 Warringtonfire WF Report No 166402
	M10	20.0	9.0	4.0	2.0	
	M12	30.0	12.0	5.0	3.0	
	M16	50.0	15.0	7.5	6.0	
	M20	65.0	35.0	15.0	10.0	
HIT-RE 500 + HAS/HAS-E/HIT-V 	M8	2.3	1.26	0.73	0.46	IBMB Braunschweig Test Report 3565 / 4595. & supplement letter 414/2008 Warringtonfire WF Report No 166402 & WF Report No 172920
	M10	3.7	2.0	1.15	0.73	
	M12	5.3	2.9	1.68	1.06	
	M16	10.0	5.4	3.1	1.97	
	M20	15.6	8.4	4.8	3.08	
	M24	22.5	12.1	7.0	4.4	
	M27	29.2	15.8	9.1	5.7	
	M30	35.7	19.3	11.1	7.0	
	M33	44.2	23.9	13.8	8.7	
	M36	58.5	31.6	18.2	11.5	
	M39	62.2	33.6	19.4	12.2	
HIT-RE 500 + HAS-R/HAS-ER/ HAS-HCR/HIT-V-R/HIT-V-HCR 	M8	2.4	1.88	1.34	1.07	IBMB Braunschweig Test Report 3565 / 4595. & supplement letter 414/2008 Warringtonfire WF Report No 166402 & WF Report No 172920
	M10	3.8	2.98	2.1	1.69	
	M12	6.5	5.5	4.5	4.0	
	M16	12.1	10.2	8.3	7.4	
	M20	18.8	15.9	13.0	11.6	
	M24	27.2	23.0	18.8	16.7	
	M27	35.3	29.9	24.4	21.7	
	M30	43.2	36.5	29.9	26.5	
	M33	53.4	45.2	37.0	32.8	
	M36	70.6	59.7	48.9	43.4	
	M39	75.2	63.6	52.0	46.2	
HIT-RE 500-SD + HIT-V 	M8	2.3	1.08	0.5	0.28	MFPA Leipzig GS-III/B-07-070 Warringtonfire WF Report No 172920 Loads for standard embedment depth. for variable embedment depth see test report.
	M10	3.7	1.9	0.96	0.59	
	M12	5.3	2.76	1.59	1.0	
	M16	10.0	5.4	3.1	1.97	
	M20	15.6	8.46	4.5	2.79	
	M24	22.5	12.19	7.0	4.4	
	M27	29.2	15.8	9.1	5.7	
	M30	35.7	19.3	11.1	7.0	
HIT-RE 500-SD + HIT-VR/HIT-V-HCR 	M8	2.42	1.08	0.5	0.28	MFPA Leipzig GS-III/B-07-070 Warringtonfire WF Report No 172920 Loads for standard embedment depth. for variable embedment depth see test report.
	M10	3.8	1.9	0.96	0.59	
	M12	6.5	4.2	2.3	1.5	
	M16	12.1	8.6	4.8	3.2	
	M20	18.8	15.9	12.2	10.5	
	M24	27.2	23.0	18.8	16.7	
	M27	35.3	29.9	24.4	21.7	
	M30	43.2	36.5	29.9	26.5	

Anchor / fastener	Size	Max. loading (kN) for specified fire resistance time (fire resistance time in minutes)				Authority / No.
		F30	F60	F90	F120	
HIT-RE 500-SD + HIS-N 	M8	2.3	1.26	0.73	0.46	IBMB Braunschweig PB 3588/4825-CM Brunswick Warringtonfire WF Report No 166402 & WF Report No 172920
	M10	3.7	2.0	1.15	0.73	
	M12	5.3	2.9	1.68	1.06	
	M16	10.0	5.4	3.1	1.97	
	M20	15.6	8.4	4.87	3.08	
HIT-RE 500-SD + HIS-RN 	M8	2.4	1.88	1.3	1.07	MFPA Leipzig GS-III/B-07-070 Warringtonfire WF Report No 172920
	M10	3.8	2.98	2.1	1.69	
	M12	6.5	5.5	4.5	4.0	
	M16	12.1	10.2	8.3	7.4	
	M20	18.8	15.9	13.0	11.6	
HIT-HY 200 + HIT-Z 	M8	1.64	0.45	0.24	0.17	
	M10	2.75	0.75	0.40	0.28	
	M12	4.90	1.80	0.89	0.59	
	M16	10.5	6.07	2.95	1.83	
	M20	16.4	12.3	7.70	4.72	
HIT-HY 200 + HIT-V 5.8 	M8	1.20	0.45	0.24	0.17	
	M10	2.00	0.75	0.40	0.28	
	M12	3.00	1.80	0.89	0.59	
	M16	6.20	2.55	1.29	0.86	
	M20	9.70	7.80	5.85	3.61	
	M24	14.0	11.3	8.60	7.20	
	M27	18.3	14.7	11.2	9.40	
	M30	22.3	17.9	13.6	11.5	
HIT-HY 70 h_{ef} = 80 mm (HLz. MVz. KSL. KSV) 	M8	2.0	0.4	0.2	-	MFPA Leipzig PB 3.2/12-055-1 Warringtonfire WF Report No 166402
	M10	2.0	0.4	0.2	-	
	M12	2.0	0.4	0.2	-	
HIT-HY 70 h_{ef} = 130 mm (HLz. MVz. KSL. KSV) 	M8	2.0	1.2	0.7	-	
	M10	3.6	1.9	1.1	-	
	M12	5.9	3.0	1.5	-	

Tested fasteners
for passive structural fire prevention

Tested according to the German tunnel temperature curve

MFPA Leipzig GmbH	Tested according to the German tunnel temperature curve (ZTV-ING. part 5).	
	Tested when set in cracked concrete and exposed to flames without insulating or protective measures.	

Anchor / fastener	Size	Max. loading (kN) for specified fire resistance time (fire resistance time in minutes)	Authority / No.
HUS-HR 	6	0.20 a)	MFPA Leipzig PB III/08-354
	8	0.30 a)	
	10	0.50 a)	
	14	1.10 a)	
HKD-SR 	M8	0.5	IBMB Braunschweig UB 3027/0274-4 & supplement letter 133/00-Nau- Warringtonfire WF-Report No 166402
	M10	0.8	
	M12	2.5	
	M16	5.0	
	M20	6.0	
HVU + HAS-HCR 	M8	0.5	IBMB Braunschweig UB 3333/0891-2 Warringtonfire WF-Report No 166402
	M10	1.5	
	M12	1.5	
	M16	5.0	

a) Tested according tunnel temperature curve EBA

Introducing Hilti SAFEset Technology

Once in a blue moon, something comes along with the power to change the way you work.

1 No cleaning required.

HIT-Z anchor rods

Designed for use with HIT-HY 200 injectable adhesive, the new Hilti HIT-Z anchor rod, with its cone-shaped helix, works as a torque-contolled bonded anchor. This means that because of their shape, HIT-Z anchor rods are not affected by uncleaned hammer drilled holes. Whether used in dry or water saturated concrete, in base materials above 5°C, the benefits are clear: fewer steps and extremely reliable anchoring.

2 Holes that clean themselves.

Hollow drill bits

Hilti TE-CD and TE-YD hollow drill bits, used in conjunction with HIT-HY 200 or HIT-RE 500, make subsequent hole cleaning completely unnecessary.
Dust is removed by the Hilti vacuum system while drilling is in progress for more reliability and a virtually dustless working environment.

3 The traditional method.

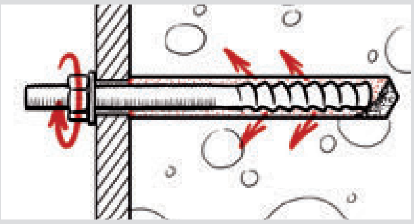
Brush and blow

The current industry standard installation method, uses compressed air and a wire brush to clean the drill hole. Like all Hilti adhesive anchors, HIT-HY 200 and HIT-RE 500 can be installed using the traditional blow-brush-blow method. When using the traditional method, the Hilti HIT system only requires two blows of compressed air, two brushes, and two more blows of compressed air – making it faster to install than many other adhesives on the market.

SAFEset

SAFEset is a registered trade mark of Hilti.

Anchor diameter range	M8 to M20
Material	Carbon or stainless steel (A4)
Embedment depth	Up to 12 times rod diameter
Concrete compressive strengths	C20/25 to C50/60
Installation temperature range	5°C to 40°C

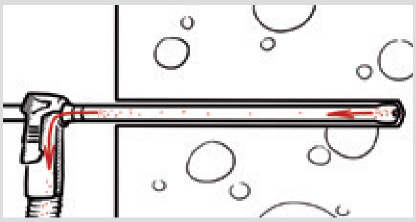


SAFEset Technology

with HIT-HY 200

Drill → Install

Rebar diameter range	N10 to N26
Threaded rod diameters	M10 to M24
Embedment depths	Up to 400 mm
Concrete compressive strengths	C20/25 to C50/60
Installation temperature range	-10°C to 40°C



SAFEset Technology

with HIT-HY 200 or HIT-RE 500

Drill → Install

Rebar diameter range	N8 to N36
Threaded rod diameters	M8 to M36
Embedment depth	Up to 20 times element diameter
Concrete compressive strengths	C20/25 to C50/60
Installation temperature range	-10°C to 40°C

Traditional installation method with all Hilti HIT injectable adhesive anchors.

Drill → 2x2x2 → Install

Applications

- Post-installed rebar connections for concrete slab, column or wall extensions
- Heavy-duty anchoring with threaded rod in cracked or uncracked concrete, e.g. for steel beams, columns, manufacturing equipment or ledger angles
- Facade installation, steel and metal construction, installation of railings and safety barriers

What does SAFEset mean?

Hilti SAFEset Technology eliminates the most load-affecting and time-consuming step in the installation process: cleaning the hole before injection of the adhesive. The system improves reliability because the specified application is being performed on the jobsite just as it has been designed to in the plans.

A small step for engineers.

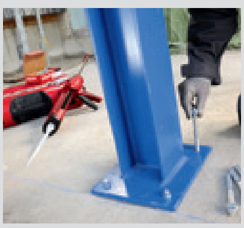
And a giant leap forward for your next design.

Now you can design anchor rod and post-installed rebar connections with more confidence. Inadequately cleaning holes during installation can reduce the performance of conventional chemical anchor systems significantly. Hilti SAFEset Technology eliminates this factor almost entirely – in both cracked and uncracked concrete, and with anchor rods or post-installed rebar.

Hilti proudly presents Hilti SAFEset Technology with the industry-leading, injectable adhesive anchors - HIT-HY 200 and HIT-RE 500.

Application Ranges

Anchoring

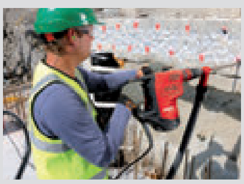


HIT-HY 200 and HIT-Z rod
(no cleaning)

HIT-HY 200/HIT RE-500, TE-CD/TE-YD hollow drill bits and HIT-V rod
(self-cleaning)

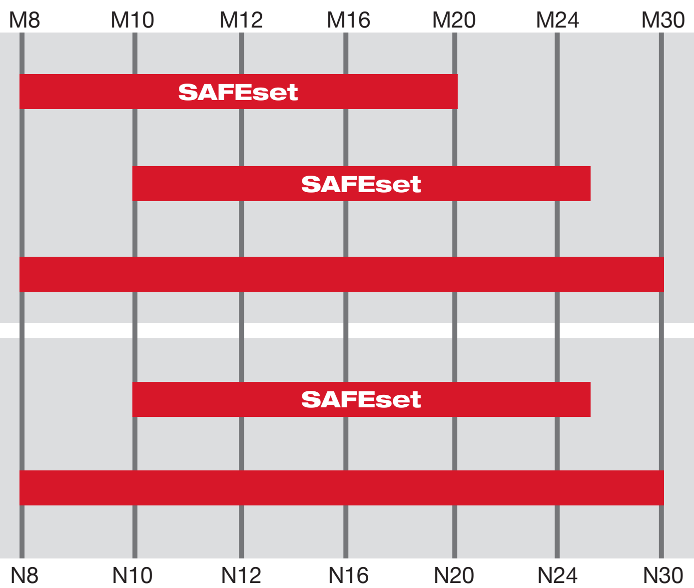
HIT-HY 200/HIT RE-500, standard drill bits and HIT-V rod
(traditional cleaning)

Rebar



HIT-HY 200/HIT RE-500, TE-CD/ TE-YD hollow drill bits and rebar
(self-cleaning)

HIT-HY 200/HIT RE-500, standard drill bits and rebar
(traditional cleaning)

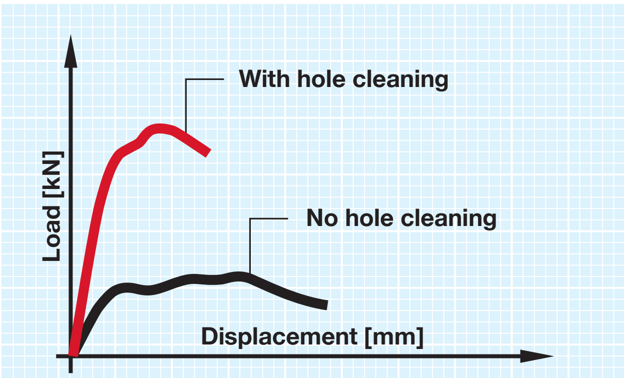


No cleaning required.

Set anchors and rebar reliably.

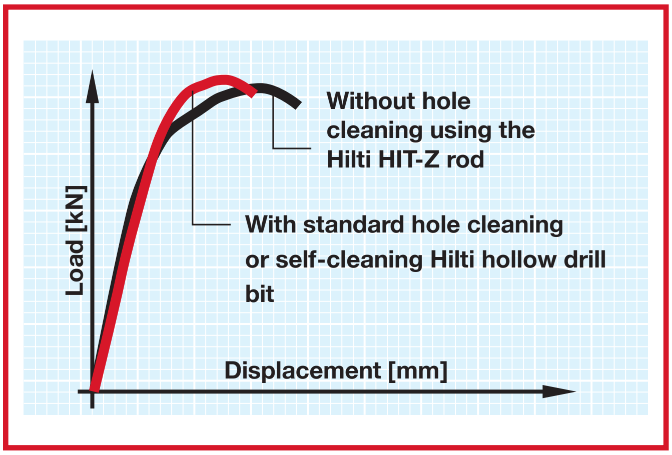
It's no secret that adhesive anchors encounter varying jobsite conditions. Hilti HIT injection technology, reliably and safely, combats this issue. Now Hilti SAFEset Technology, which offers the choice of either hollow drill bits with a Hilti vacuum system or HIT-Z anchor rods, takes a giant leap forward, by removing a step in the installation process entirely.

Potential effects of no hole cleaning



When a threaded rod or rebar is set with conventional injection adhesive, the load it can hold may be significantly reduced, if the hole is inadequately cleaned after drilling. The Hilti SAFEset system eliminates a cleaning step while still providing excellent load values.

Hilti HIT injectable adhesive with SAFEset Technology

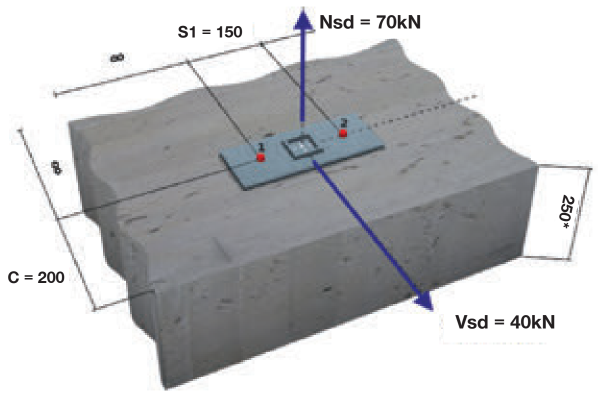


The new SAFEset system featuring HIT-HY 200 or HIT-RE 500 allows a fastening point to take high loads, as though the hole was cleaned using traditional installation methods.

Design examples

HIT-HY 200 + HIT-V-R M20 rods

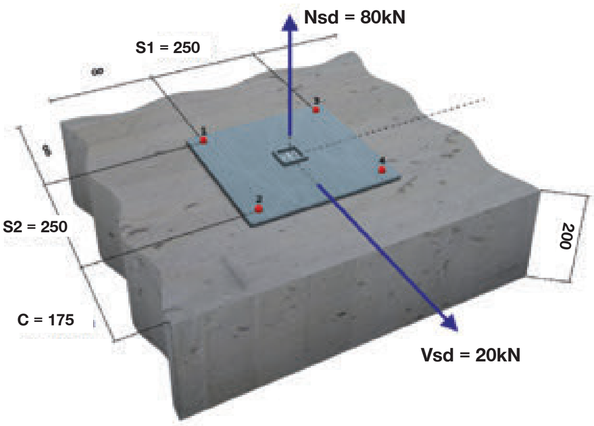
Design Input	
Base Material	
Description Thickness Concrete strength $f'_{c,cyl}$	Non-cracked concrete ≥ 250mm 40MPa
Anchors layout	
Number of anchors Edge distance - c Spacing - s_1	2 x M20 200mm 150mm
Applied loads	
Tension - N_{Sd} Shear - V_{Sd}	70kN 40kN



Design Process	
Step 1 - Design Tensile Resistance N_{Rd} (see page 85)	
Steel - $N_{Rd,s}$ per single anchor Steel - $N_{Rd,s}$ per 2 anchors	92.0kN 184.0kN
Combined pullout and concrete cone resistance $N_{Rd,p}$ $f_{B,p}$ - Influence of concrete strength $N^*_{Rd,p}$ - from the relevant table **(refer page 91)** $N_{Rd,p} = f_{B,p} \bullet N^*_{Rd,p}$	 1.00 128.2kN 128.2kN
Concrete cone or splitting resistance $N_{Rd,c}$ f_B - Influence of concrete strength $N^*_{Rd,c}$ - from the relevant table **(refer page 91)** $N_{Rd,c} = f_B \bullet N^*_{Rd,c}$	 1.11 75.5kN 83.8kN
$N_{Rd} = \min\{N_{Rd,s};N_{Rd,p};N_{Rd,c}\}$	**83.8kN**
Design check - Tension $N_{Rd} > N_{Sd}$	 Safe
Step 2 - Design Shear Resistance V_{Rd} (see page 86)	
Steel - $V_{Rd,s}$ per single anchor Steel - $V_{Rd,s}$ per 2 anchors	55.1kN 110.2kN
Design concrete edge resistance $V_{Rd,c}$ f_B - Influence of concrete strength $V^*_{Rd,c}$ - from the relevant table **(refer page 91)** $V_{Rd,c} = f_B \bullet V^*_{Rd,c}$	 1.11 59.5kN 66kN
$V_{Rd} = \min\{V_{Rd,s};V_{Rd,c}\}$	**66kN**
Design check - Shear $V_{Rd} > V_{Sd}$	 Safe
Step 3 - Design check under combined loads (see page 87)	
$N_{Sd} / N_{Rd} + V_{Sd} / V_{Rd} \leq 1.2$ 1.44 > 1.2	1.44 Unsafe

M16 HSL-3

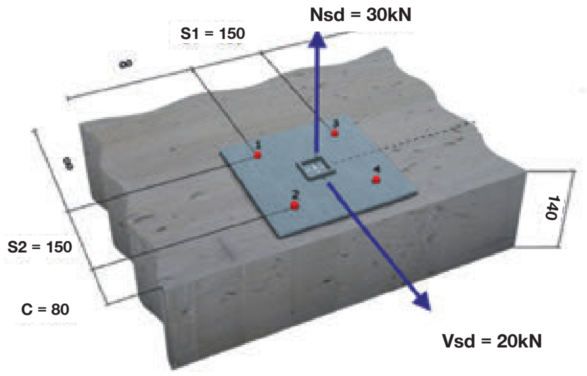
Design Input	
Base Material	
Description Thickness Concrete strength $f'_{c,cyl}$	Non-cracked concrete ≥ 200mm 25MPa
Anchors layout	
Number of anchors Edge distance - c Spacing - s_1=s_2	4 x M16 175mm 250mm
Applied loads	
Tension - N_{Sd} Shear - V_{Sd}	80kN 20kN



Design Process	
Step 1 - Design Tensile Resistance N_{Rd} (see page 257)	
Steel - $N_{Rd,s}$ per single anchor Steel - $N_{Rd,s}$ per 4 anchors	83.7kN 334.8kN
Concrete cone or splitting resistance $N_{Rd,c}$ f_B - Influence of concrete strength $N^*_{Rd,c}$ - from the relevant table **(refer page 263)** $N_{Rd,c} = f_B \bullet N^*_{Rd,c}$	 0.87 111.6kN 97.1kN
N_{Rd} = min {$N_{Rd,s}$;$N_{Rd,c}$}	**97.1kN**
Design check - Tension $N_{Rd} > N_{Sd}$	Safe
Step 2 - Design Shear Resistance V_{Rd} (see page 258)	
Steel - $V_{Rd,s}$ per single anchor Steel - $V_{Rd,s}$ per 4 anchors	80.9kN 323.6kN
Design concrete edge resistance $V_{Rd,c}$ f_B - Influence of concrete strength $V^*_{Rd,c}$ - from the relevant table **(refer page 263)** $V_{Rd,c} = f_B \bullet V^*_{Rd,c}$	 0.87 89.9kN 78.2kN
V_{Rd} = min {$V_{Rd,s}$;$V_{Rd,c}$}	**78.2kN**
Design check - Shear $V_{Rd} > V_{Sd}$	Safe
Step 3 - Design check under combined loads (see page 258)	
N_{Sd} / N_{Rd} + V_{Sd} / V_{Rd} 1.08 < 1.2	1.08 Safe

HVU + M12 HAS-E- Grade 5.8

Design Input	
Base Material	
Description Thickness Concrete strength $f'_{c,cyl}$	Non-cracked concrete ≥ 140mm 32MPa
Anchors layout	
Number of anchors Edge distance - c Spacing - s_1=s_2	4 x M12 80mm 150mm
Applied loads	
Tension - N_{Sd} Shear - V_{Sd}	30kN 20kN



Design Process	
Step 1 - Design Tensile Resistance N_{Rd} (see page 61)	
Steel - $N_{Rd,s}$ per single anchor Steel - $N_{Rd,s}$ per 4 anchors	25.3kN 101.2kN
Combined pullout and concrete cone resistance $N_{Rd,p}$ $f_{B,p}$ - Influence of concrete strength $N^*_{Rd,p}$ - from the relevant table **(refer page 66)** $N_{Rd,p} = f_{B,p} \bullet N^*_{Rd,p} \bullet 4$	 1.00 63.9kN 63.9kN
Concrete cone or splitting resistance $N_{Rd,c}$ f_B - Influence of concrete strength $N^*_{Rd,c}$ - from the relevant table **(refer page 66)** $N_{Rd,c} = f_B \bullet N^*_{Rd,c}$	 1.00 49.0kN 49.0kN
N_{Rd} = min {$N_{Rd,s}$;$N_{Rd,p}$;$N_{Rd,c}$}	**49.0kN**
Design check - Tension $N_{Rd} > N_{Sd}$	 Safe
Step 2 - Design Shear Resistance V_{Rd} (see page 62)	
Steel - $V_{Rd,s}$ per single anchor Steel - $V_{Rd,s}$ per 4 anchors	15.2kN 60.8kN
Design concrete edge resistance $V_{Rd,c}$ f_B - Influence of concrete strength $V^*_{Rd,c}$ - from the relevant table **(refer page 66)** $V_{Rd,c} = f_B \bullet V^*_{Rd,c}$	 1.00 43.4kN 43.4kN
V_{Rd} = min {$V_{Rd,s}$;$V_{Rd,c}$}	**43.4kN**
Design check - Shear $V_{Rd} > V_{Sd}$	 Safe
Step 3 - Design check under combined loads (see page 62)	
$N_{Sd} / N_{Rd} + V_{Sd} / V_{Rd} \leq 1.2$ 1.07 < 1.2	1.07 Safe