



European Technical Approval ETA-02/0031

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung
Trade name

Würth Hochleistungsanker W-HAZ/S, W-HAZ/A4
Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Zulassungsinhaber
Holder of approval

Adolf Würth GmbH & Co. KG
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DEUTSCHLAND

Zulassungsgegenstand
und Verwendungszweck

Kraftkontrolliert spreizender Dübel zur Verankerung im Beton unter
statischer und quasi-statischer Einwirkung, Erdbeben
Leistungskategorie C1 oder Brandbeanspruchung

*Generic type and use
of construction product*

*Torque controlled expansion anchor for use in concrete under static or
quasi-static action, seismic action performance category C1 and fire
exposure*

Geltungsdauer:
Validity:

vom
from
bis
to
verlängert
extended
vom
from
bis
to

15 December 2011
25 March 2013
26 March 2013
26 March 2018

Herstellwerk
Manufacturing plant

Herstellwerk W1,
Deutschland

Diese Zulassung umfasst
This Approval contains

31 Seiten einschließlich 24 Anhänge
31 pages including 24 annexes

I LEGAL BASES AND GENERAL CONDITIONS

- 1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:
 - Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products¹, modified by Council Directive 93/68/EEC² and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council³;
 - *Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998⁴, as amended by Article 2 of the law of 8 November 2011⁵;*
 - Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC⁶;
 - Guideline for European technical approval of "Metal anchors for use in concrete - Part 2: Torque controlled expansion anchors", ETAG 001-02.
- 2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.
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¹ Official Journal of the European Communities L 40, 11 February 1989, p. 12
² Official Journal of the European Communities L 220, 30 August 1993, p. 1
³ Official Journal of the European Union L 284, 31 October 2003, p. 25
⁴ *Bundesgesetzblatt Teil I 1998*, p. 812
⁵ *Bundesgesetzblatt Teil I 2011*, p. 2178
⁶ Official Journal of the European Communities L 17, 20 January 1994, p. 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of the product and intended use

1.1 Definition of the construction product

The Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4 (type W-HAZ-B, W-HAZ-S and W-HAZ-SK) is an anchor made of galvanised steel (M6, M8, M10, M12, M16 and M20) or stainless steel (M8, M10, M12 and M16), which is placed into a drilled hole and anchored by torque-controlled expansion.

An illustration of the product and intended use is given in Annex 1.

1.2 Intended use

The anchor is intended to be used for anchorages for which requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106 EEC shall be fulfilled and failure of anchorages made with these products would cause risk to human life and/or lead to considerable economic consequences.

The anchor may be used for anchorages with requirements related to resistance to fire.

The anchor is to be used for anchorages subject to static, quasi-static or seismic action (anchor performance category C1 only for anchor sizes specified for in Annex 1) or for anchorages with requirements related to resistance to fire. It may be used in reinforced or unreinforced normal weight concrete of strength classes C20/25 at minimum and C50/60 at most according to EN 206:2000-12. It may be anchored in cracked and non-cracked concrete.

Würth High-Performance-Anchor W-HAZ/S made of zinc-plated steel:

The anchor made of zinc-plated steel may only be used in structures subject to dry internal conditions.

Würth High-Performance-Anchor W-HAZ/A4 made of stainless steel:

The anchor made of stainless steel may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure (including industrial and marine environment), or exposure in permanently damp internal conditions, if no particular aggressive conditions exist. Such particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

The provisions made in this European technical approval are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

2 Characteristics of the product and methods of verification

2.1 Characteristics of the product

The anchor corresponds to the drawings and provisions given in Annex 2. The characteristic material values, dimensions and tolerances of the anchor not given in Annex 2 shall correspond to the respective values laid down in the technical documentation⁷ of this European technical approval.

Regarding the requirements concerning safety in case of fire it is assumed that the anchor meets the requirements of class A1 in relation to reaction to fire in accordance with the stipulations of the Commission decision 96/603/EC, amended by 2000/605/EC.

The characteristic values of anchorages are given in the Annexes.

Each anchor is marked according to Annex 2. In addition, each washer of anchor size 24/M16L has a marking of the letter "L".

The anchor shall only be packaged and supplied as a complete unit.

2.2 Methods of verification

The assessment of fitness of the anchor for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 has been made in accordance with the "Guideline for European technical approval of Metal Anchors for Use in Concrete", Part 1 "Anchors in general" and Part 2 "Torque-controlled expansion anchors", on the basis of Option 1 and ETAG 001 Annex E "Assessment of Metal Anchors under Seismic Action".

The assessment of the anchor for the intended use in relation to the requirements for resistance to fire has been made in accordance with the Technical Report TR 020 "Evaluation of anchorages in concrete concerning resistance to fire".

In addition to the specific clauses relating to dangerous substances contained in this European technical approval, there may be other requirements applicable to the products falling within its scope (e. g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3 Evaluation and attestation of conformity and CE marking

3.1 System of attestation of conformity

According to the decision 96/582/EG of the European Commission⁸ the system 2(i) (referred to as system 1) of attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 1: Certification of the conformity of the product by an approved certification body on the basis of:

(a) Tasks for the manufacturer:

- (1) factory production control;
- (2) further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan;

⁷ The technical documentation of this European Technical Approval is deposited at the Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.

⁸ Official Journal of the European Communities L 254 of 08.10.1996.

(b) Tasks for the approved body:

- (3) initial type-testing of the product;
- (4) initial inspection of factory and of factory production control;
- (5) continuous surveillance, assessment and approval of factory production control.

3.2 Responsibilities

3.2.1 Tasks of the manufacturer

3.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

The manufacturer may only use initial/ raw/ constituent materials stated in the technical documentation of this European technical approval.

The factory production control shall be in accordance with the control plan which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Deutsches Institut für Bautechnik⁹.

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

3.2.1.2 Other tasks of manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of anchors in order to undertake the actions laid down in section 3.2.2. For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of this European technical approval.

3.2.2 Tasks of approved bodies

The approved body shall perform the

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

in accordance with the provisions laid down in the control plan.

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the product stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

⁹ The control plan is a confidential part of the documentation of the European technical approval, but not published together with the ETA and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.

3.3 CE marking

The CE marking shall be affixed on each packaging of the anchor. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- the name and address of the holder of the approval (legal entity responsible for the manufacturer),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate of conformity for the product,
- the number of the European technical approval,
- the number of the guideline for European technical approval,
- use category (ETAG 001-1 Option 1, seismic performance category C1 where applicable),
- size.

4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

The European technical approval is issued for the product on the basis of agreed data/information, deposited with Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to Deutsches Institut für Bautechnik before the changes are introduced. Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

4.2 Design of anchorages

The fitness of the anchor for the intended use is given under the following conditions:

The anchorages are designed either in accordance with

- ETAG 001 "Guideline for European technical approval of Metal Anchors for use in concrete", Annex C, method A

or in accordance with

- CEN/TS 1992-4:2009, design method A

and Technical Report TR 045 "Design of metal Anchors under Seismic Action" under the responsibility of an engineer experienced in anchorages and concrete work.

Verifiable calculation notes and drawings are taking account of the loads to be anchored.

The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports).

The design of anchorages under fire exposure has to consider the conditions given in the Technical Report TR 020 "Evaluation of anchorages in concrete concerning resistance to fire". The design method covers anchors with a fire attack from one side only. If the fire attack is from more than one side, the design method may be taken only, if the edge distance of the anchor is $c \geq 300$ mm.

Anchorage shall be positioned outside of plastic hinges of the concrete structure. Fastenings in stand-off installation or with a grout layer under seismic action are not covered.

4.3 Installation of anchors

The fitness for use of the anchor can only be assumed if the anchor is installed as follows:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site,
- Use of the anchor only as supplied by the manufacturer without exchanging the components of an anchor,
- Anchor installation in accordance with the manufacturer's specifications and drawings and using the appropriate tools,
- Checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range given and is not lower than that of the concrete to which the characteristic loads apply,
- Check of concrete being well compacted, e. g. without significant voids,
- Edge distances and spacing not less than the specified values without minus tolerances,
- Positioning of the drill holes without damaging the reinforcement,
- In case of aborted hole: new drilling at a minimum distance away of twice the depth of the aborted hole or smaller distance if the aborted drill hole is filled with high strength mortar and if under shear or oblique tension load it is not in the direction of load application,
- Cleaning of the hole of drilling dust,
- Anchor installation such that the effective anchorage depth is complied with. This compliance is ensured when the embedment mark of the anchor does no more exceed the concrete surface,
- Application of the installation torque given in the Annexes using a calibrated torque wrench.

5 Responsibility of the manufacturer

The manufacturer is responsible to ensure that the information on the specific conditions according to 1 and 2 including Annexes referred to as well as sections 4.2 and 4.3 is given to those who are concerned. This information may be made by reproduction of the respective parts of the European technical approval. In addition all installation data shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The minimum data required are:

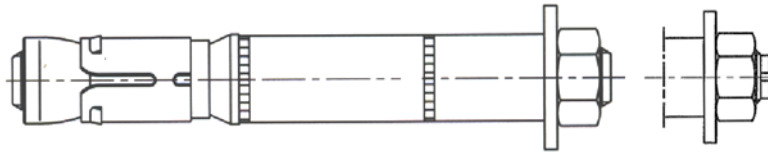
- Diameter of drill bit,
- Thread diameter,
- Maximum thickness of the fixture,
- Minimum effective anchorage depth,
- Minimum hole depth,
- Required installation torque,
- Information on the installation procedure, including cleaning of the hole, preferably by means of an illustration,
- Reference to any special installation equipment needed,
- Identification of the manufacturing batch.

All data shall be presented in a clear and explicit form.

Georg Feistel
Head of Department

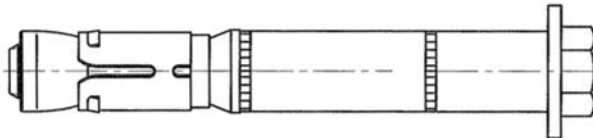
beglaubigt:
Baderschneider

Anchor type with threaded bolt



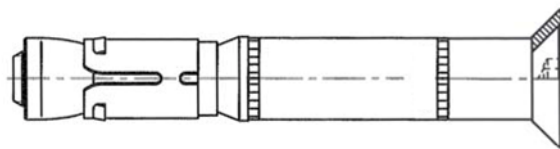
W-HAZ-B (M6-M20)
W-HAZ-B (M8-M16) A4

Anchor type with hexagon head screw

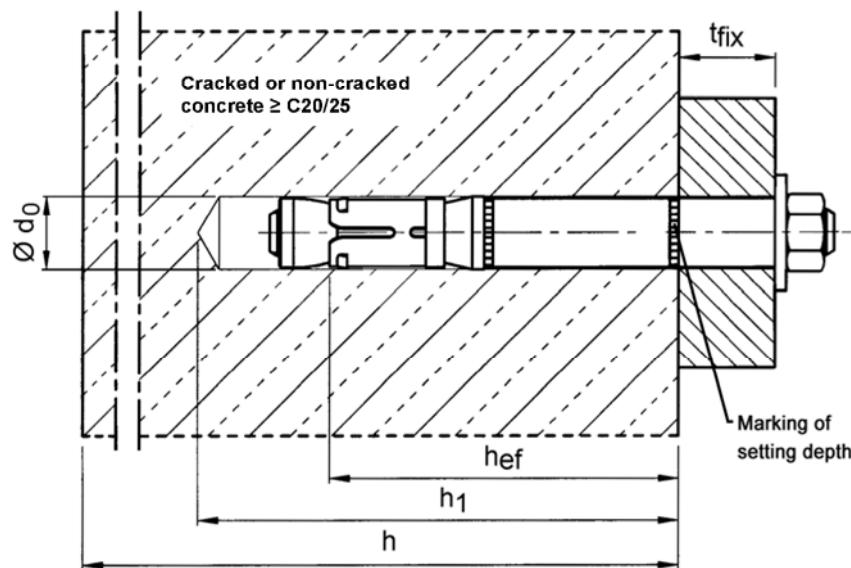


W-HAZ-S (M6-M20)
W-HAZ-S (M8-M16) A4

Anchor type with countersunk washer and countersunk screw



W-HAZ-SK (M6-M12)
W-HAZ-SK (M8-M12) A4

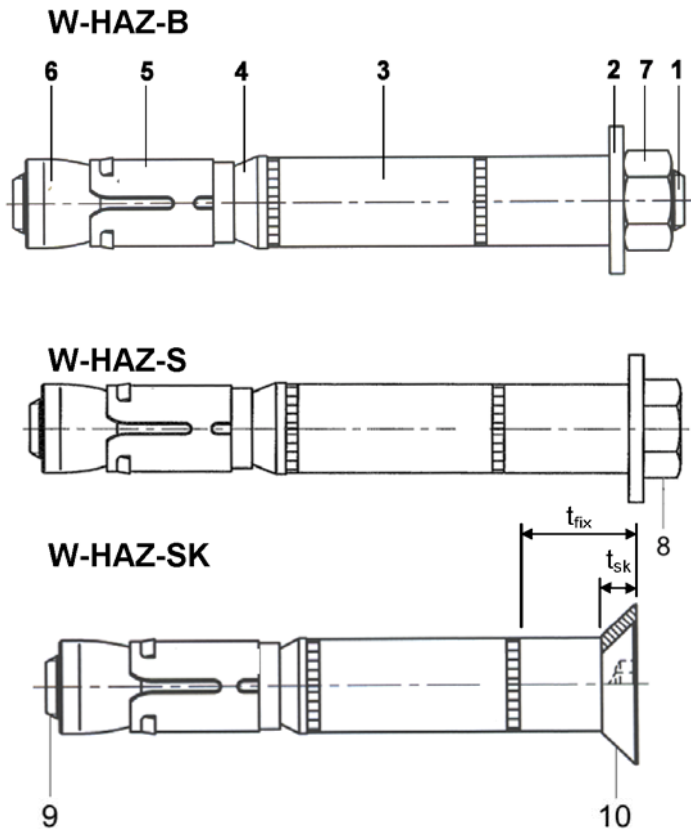


W-HAZ, steel zinc plated	10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Static or quasi-static action	✓						
Seismic action	-				C1		
Resistance to fire	R30 ... R 120						
W-HAZ, stainless steel A4		12/M8	15/M10	18/M12	24/M16		
Static or quasi-static action	✓						
Seismic action	C 1						
Resistance to fire	R30 ... R120						

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Product and intended use

Annex 1



- Marking:
- expansion sleeve:
- Identifying mark of manufacturing plant ◇
 - additional marking of stainless steel A4 A4
 - Trade name (alternatively on distance sleeve) SZ
 - size of thread (alternatively on distance sleeve) M10

- Distance sleeve:
- Diameter 15
 - max. thickness of fixture 25
 - additional marking for countersunk version SK

additional marking on the washer of anchor size SZ 24/M16L L

Table 1: Designation of anchor parts and materials

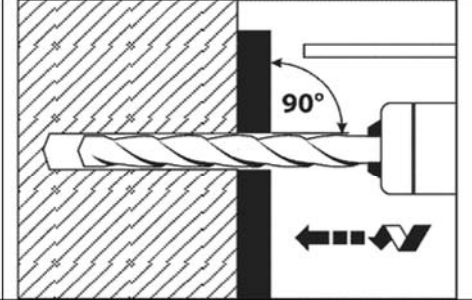
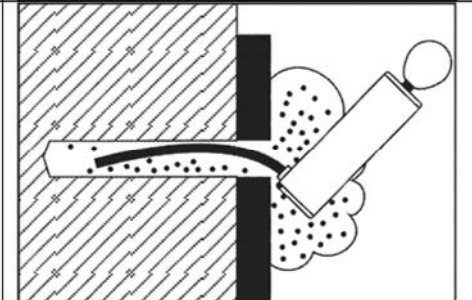
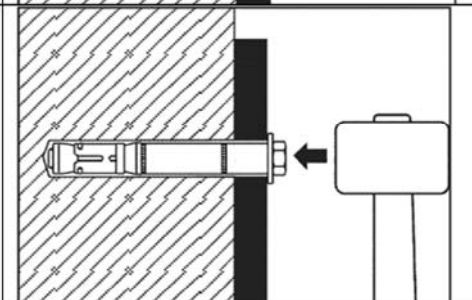
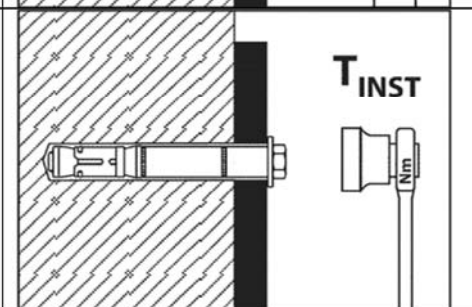
Part	Designation	Materials galvanised $\geq 5 \mu\text{m}$, acc. to EN ISO 4042	Stainless steel A4
1	Threaded bolt	Steel, Strength class 8.8, EN ISO 898-1	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
2	Washer	Steel, EN 10139	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
3	Distance sleeve	Precision steel tubes DIN 2394/2393	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
4	Ring	Polyethylene	Polyethylene
5	Expansion sleeve	Steel, EN 10139	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
6	Threaded cone	Steel, Strength class 8, EN ISO 898-2	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
7	Hexagon nut	Steel, Strength class 8, EN ISO 898-2	ISO 3506, strength class 70, stainless steel 1.4401 or 1.4571, EN 10088
8	Hexagon head screw	Steel, Strength class 8.8, EN ISO 898-1	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
9	Countersunk screw	Steel, Strength class 8.8, EN ISO 898-1	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088
10	Countersunk washer	Steel, EN 10083-2	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Designation of anchor parts and Materials

Annex 2

Installation instructions

1		Drill hole perpendicular to concrete surface.
2		Blow out dust.
3		Drive in anchor.
4		Apply tightening torque T_{inst} by using torque wrench.

Technical data for stainless steel A4 version starting from Annex 14

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Installation instructions

Annex 3

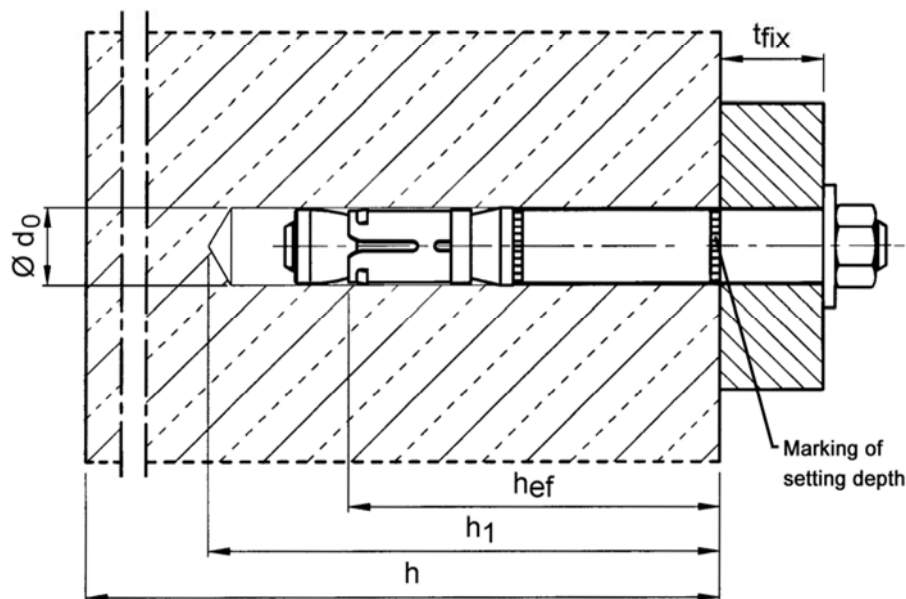
Table 2: Installation parameters, steel zinc plated

Anchor size		10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Size of thread	[-]	M6	M8	M10	M12	M16	M16	M20
Effective anchorage depth	h_{ef} [mm]	50	60	71	80	100	115	125
Nominal diameter of drill bit	$d_0 =$ [mm]	10	12	15	18	24	24	28
Cutting diameter of drill bit	$d_{cut} \leq$ [mm]	10.45	12.5	15.5	18.5	24.55	24.55	28.55
Depth of drill hole	$h_1 \geq$ [mm]	65	80	95	105	130	145	160
Diameter of clearance hole in the fixture	$d_f \leq$ [mm]	12	14	17	20	26	26	31
Minimum thickness of member	h_{min} [mm]	100	120	140	160	200	230	250
Minimum spacing ¹⁾	s_{min} [mm]	50	60	70	80	100	100	125
	for $c \geq$ [mm]	80	100	120	160	180	180	300
Minimum edge distance ¹⁾	c_{min} [mm]	50	60	70	80	100	100	180
	for $s \geq$ [mm]	100	120	175	200	220	220	540
Thickness of fixture	$t_{fix\ min}$ [mm]	0	0	0	0	0	0	0
W-HAZ-B and W-HAZ-S	$t_{fix\ max}$ [mm]	200	200	200	250	300	300	300
Thickness of fixture	$t_{fix\ min}^{2)}$ [mm]	8	10	14	18	-	-	-
W-HAZ-SK	$t_{fix\ max}$ [mm]	200	200	200	250	-	-	-
Thickness of countersunk washer W-HAZ-SK	t_{sk} [mm]	4	5	6	7	-	-	-
Required setting torque	$T_{inst} =$ [Nm]	15/10 ³⁾	30/25 ³⁾	50/55 ³⁾	80/70 ³⁾	160	160	280

¹⁾ Intermediate values by linear interpolation

²⁾ Depending on the existing shear load, the thickness of the fixture may be reduced to the thickness of the countersunk washer t_{sk} . It must be verified that the present shear load can be transferred completely into the distance sleeve (bearing of hole).

³⁾ Values for anchor type W-HAZ-SK



Würth High-Performance-Anchör W-HAZ/S, W-HAZ/A4

Installation parameters, steel zinc plated

Annex 4

Table 3: Characteristic values for tension load under static or quasi static action, ETAG 001, Annex C, design method A, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20	
Steel failure										
Characteristic resistance	$N_{Rk,s}$	[kN]	16	29	46	67	126	126	196	
Partial safety factor	γ_{Ms}	[-]	1.5							
Pullout failure										
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	5	12	16	25	36	44	50	
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	18	20	30	35	50	78	72	
Splitting failure (The higher resistance of Case 1 and Case 2 may be applied.)										
Case 1										
Characteristic resistance in concrete C20/25	$N^0_{Rk,sp}$	[kN]	12 ¹⁾	16 ¹⁾	25 ¹⁾	30 ¹⁾	40 ¹⁾	70	50 ¹⁾	
Respective spacing	$s_{cr,sp}$	[mm]	3 h_{ef}							
Respective edge distance	$c_{cr,sp}$	[mm]	1.5 h_{ef}							
Case 2										
Spacing	$s_{cr,sp}$	[mm]	5 h_{ef}					3 h_{ef}	5 h_{ef}	
Edge distance	$c_{cr,sp}$	[mm]	2.5 h_{ef}					1.5 h_{ef}	2.5 h_{ef}	
Increasing factors for $N_{Rk,p}$ and $N^0_{Rk,sp}$	ψ_C	C30/37	[-]							1.22
		C40/50	[-]							1.41
		C50/60	[-]							1.55
Concrete cone failure										
Effective Anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125	
Spacing	$s_{cr,N}$	[mm]	3 h_{ef}							
Edge distance	$c_{cr,N}$	[mm]	1.5 h_{ef}							
Partial safety factor	$\gamma_{Mp} = \gamma_{Msp} = \gamma_{Mc}$	[-]	1.5							

¹⁾ For the proof against splitting failure according to ETAG 001 Annex C, $N^0_{Rk,c}$ in equation (5.3) has to be replaced by $N^0_{Rk,sp}$ with consideration of the member thickness ($\psi_{ucr,sp} = 1,0$)

Table 4: Displacements under tension load, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Tension load in cracked concrete	N	[kN]	2.4	5.7	7.6	12.3	17.1	21.1	24
Displacement	δ_{N0}	[mm]	0.5	0.5	0.5	0.7	0.8	0.7	0.9
	$\delta_{N\infty}$	[mm]	2.0	2.0	1.3	1.3	1.3	1.3	1.4
Tension load in non-cracked concrete	N	[kN]	8.5	9.5	14.3	17.2	24	29.6	34
Displacement	δ_{N0}	[mm]	0.8	1.0	1.1		1.3		0.3
	$\delta_{N\infty}$	[mm]	3.4		1.7		2.3		1.4

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**Characteristic values for tension load under static or quasi static action, ETAG 001, Annex C, design method A
Displacements under tension load, steel zinc plated**

Annex 5

Table 5: Characteristic values for shear load under static or quasi static action, ETAG 001, Annex C, design method A, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Steel failure without lever arm									
W-HAZ-B									
Characteristic resistance	$V_{Rk,s}$	[kN]	16	25	36	63	91	91	122
Partial safety factor	γ_{Ms}	[-]	1.25						
W-HAZ-S and W-HAZ-SK									
Characteristic resistance	$V_{Rk,s}$	[kN]	18	30	48	73	126	126	150
Partial safety factor	γ_{Ms}	[-]	1.25						
Steel failure with lever arm									
Characteristic resistance	$M_{Rk,s}^0$	[Nm]	12	30	60	105	266	266	519
Partial safety factor	γ_{Ms}	[-]	1.25						
Concrete pryout failure									
Factor in equation (5.6) ETAG 001, Annex C, 5.2.3.3	k	[-]	1.8	2	2	2	2	2	2
Partial safety factor	γ_{Mcp}	[-]	1.5						
Concrete edge failure									
Effective length of anchor in shear loading	l_f	[mm]	50	60	71	80	100	115	125
Outside diameter of anchor	d_{nom}	[mm]	10	12	15	18	24	24	28
Partial safety factor	γ_{Mc}	[-]	1.5						

Table 6: Displacements under shear load, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
W-HAZ-B									
Shear load in cracked and non-cracked concrete	V	[kN]	9.1	14	20.7	35.1	52.1	52.1	77
Displacement	δ_{V0}	[mm]	2.5	2.1	2.7	3.0	5.1	5.1	4.3
	$\delta_{V\infty}$	[mm]	3.8	3.1	4.1	4.5	7.6	7.6	6.5
W-HAZ-S and W-HAZ-SK									
Shear load in cracked and non-cracked concrete	V	[kN]	10.1	17.1	27.5	41.5	72	72	77
Displacement	δ_{V0}	[mm]	2.9	2.5	3.6	3.5	7.0	7.0	4.3
	$\delta_{V\infty}$	[mm]	4.4	3.8	5.4	5.3	10.5	10.5	6.5

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

**Characteristic values for shear load under static or quasi static action,
ETAG 001, Annex C, design method A,
Displacements under shear load, steel zinc plated**

Annex 6

Table 7: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M6 – M10, steel zinc plated, ETAG 001, Annex C, design method A

Anchor size			10/M6				12/M8				15/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure														
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	1.0	0.8	0.6	0.4	1.9	1.5	1.0	0.8	4.3	3.2	2.1	1.5
Pullout failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	1.3		1.0		3.0		2.4		4.0		3.2	
Concrete cone failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,c,fi}^0$	[kN]	3.1		2.5		5.0		4.0		7.6		6.1	
Spacing	$S_{cr,N,fi}$	[mm]	4 h_{ef}											
Edge distance	$C_{cr,N,fi}$	[mm]	2 h_{ef}											
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 4, Table 2											
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 4, Table 2; $c_{min} > 300mm$											

Table 8: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M20, steel zinc plated, ETAG 001, Annex C, design method A

Anchor size			18/M12				24/M16; 24/M16L				28/M20			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure														
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	6.3	4.6	3.0	2.0	11.6	8.6	5.0	3.1	18.3	13.5	7.7	4.9
Pullout failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	6.3		5.0		8.8		7.0		15.9		12.7	
Concrete cone failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,c,fi}^0$	[kN]	10.3		8.3		18.0		14.4		31.4		25.1	
Spacing	$S_{cr,N,fi}$	[mm]	4 h_{ef}											
Edge distance	$C_{cr,N,fi}$	[mm]	2 h_{ef}											
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 4, Table 2											
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 4, Table 2; $c_{min} > 300mm$											

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under fire exposure, steel zinc plated, ETAG 001, Annex C, design method A

Annex 7

Table 9: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M6 – M10, steel zinc plated, ETAG 001, Annex C, design method A

Anchor size			10/M6				12/M8				15/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure without lever arm														
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	1.0	0.8	0.6	0.4	1.9	1.5	1.0	0.8	4.3	3.2	2.1	1.5
Steel failure with lever arm														
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	0.8	0.6	0.4	0.3	2.0	1.5	1.0	0.8	5.6	4.1	2.7	1.9

Table 10: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M20, steel zinc plated, ETAG 001, Annex C, design method A

Anchor size			18/M12				24/M16; 24/M16L				28/M20			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure without lever arm														
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	6.3	4.6	3.0	2.0	11.6	8.6	5.0	3.1	18.3	13.5	7.7	4.9
Steel failure with lever arm														
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	9.7	7.2	4.7	3.1	24.8	18.3	11.9	6.6	42.4	29.8	17.1	10.7

Concrete pryout failure

The initial value $V_{Rk,cp,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V_{Rk,cp,fi} = k \times N_{Rk,c,fi}$$

with $k=2.0$ (1.8 for M6) of ETAG 001, Annex C, 5.2.3.3, Equation (5.6) and the relevant values of $N^0_{Rk,c,fi}$ of Table 7 and Table 8.

Concrete edge failure

The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V^0_{Rk,c,fi} = 0.25 \times V^0_{Rk,c} \text{ (R30, R 60, R90)}$$

$$V^0_{Rk,c,fi} = 0.20 \times V^0_{Rk,c} \text{ (R120)}$$

with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for shear load under fire exposure, steel zinc plated, ETAG 001, Annex C, design method A

Annex 8

Table 11: Characteristic values for tension load under static or quasi static action, steel zinc plated, CEN/TS 1992-4, design method A

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Steel failure									
Characteristic resistance	$N_{Rk,s}$	[kN]	16	29	46	67	126	126	196
Partial safety factor	γ_{Ms}	[-]	1.5						
Pullout failure									
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	5	12	16	25	36	44	50
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	18	20	30	35	50	78	72
Splitting failure (The higher resistance of Case 1 and Case 2 may be applied.)									
Case 1									
Characteristic resistance in concrete C20/25	$N_{Rk,sp}^0$	[kN]	12 ¹⁾	16 ¹⁾	25 ¹⁾	30 ¹⁾	40 ¹⁾	70	50 ¹⁾
Respective spacing	$s_{cr,sp}$	[mm]	3 h_{ef}						
Respective edge distance	$c_{cr,sp}$	[mm]	1.5 h_{ef}						
Case 2									
Spacing	$s_{cr,sp}$	[mm]	5 h_{ef}					3 h_{ef}	5 h_{ef}
Edge distance	$c_{cr,sp}$	[mm]	2.5 h_{ef}					1.5 h_{ef}	2.5 h_{ef}
Increasing factors for $N_{Rk,p}$ and $N_{Rk,sp}^0$	ψ_C								
		C30/37	[-]						
		C40/50	[-]						
		C50/60	[-]						
			1.22						
			1.41						
			1.55						
Concrete cone failure									
Effective Anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125
Factor for cracked concrete	k_{cr}	[-]	7.2						
Factor for uncracked concrete	k_{ucr}	[-]	10.1						
Spacing	$s_{cr,N}$	[mm]	3 h_{ef}						
Edge distance	$c_{cr,N}$	[mm]	1.5 h_{ef}						
Partial safety factor	$\gamma_{Mp} = \gamma_{Msp} = \gamma_{Mc}$	[-]	1.5						

¹⁾ For the proof against splitting failure according to CEN/TS 1992-4-4, $N_{Rk,c}^0$ in equation (12) has to be replaced by $N_{Rk,sp}^0$ with consideration of the member thickness ($\psi_{ucr,sp} = 1,0$)

Table 12: Displacements under tension load, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Tension load in cracked concrete	N	[kN]	2.4	5.7	7.6	12.3	17.1	21.1	24
Displacement	δ_{N0}	[mm]	0.5	0.5	0.5	0.7	0.8	0.7	0.9
	$\delta_{N\infty}$	[mm]	2.0	2.0	1.3	1.3	1.3	1.3	1.4
Tension load in non-cracked concrete	N	[kN]	8.5	9.5	14.3	17.2	24	29.6	34
Displacement	δ_{N0}	[mm]	0.8	1.0	1.1		1.3		0.3
	$\delta_{N\infty}$	[mm]	3.4		1.7		2.3		1.4

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under static or quasi static action, CEN/TS 1992-4, design method A
Displacements under tension load, steel zinc plated

Annex 9

Table 13: Characteristic values for shear load under static or quasi static action, steel zinc plated, CEN/TS 1992-4, design method A

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Steel failure without lever arm									
W-HAZ-B									
Characteristic resistance	$V_{Rk,s}$	[kN]	16	25	36	63	91	91	122
Ductility factor	k_2	[-]	1.0						
Partial safety factor	γ_{Ms}	[-]	1.25						
W-HAZ-S and W-HAZ-SK									
Characteristic resistance	$V_{Rk,s}$	[kN]	18	30	48	73	126	126	150
Ductility factor	k_2	[-]	0.8						
Partial safety factor	γ_{Ms}	[-]	1.25						
Steel failure with lever arm									
Characteristic resistance	$M_{Rk,s}^0$	[Nm]	12	30	60	105	266	266	519
Partial safety factor	γ_{Ms}	[-]	1.25						
Concrete pryout failure									
Factor in equation (16) CEN/TS 1992-4-4, 6.2.2.3	k_3	[-]	1,8	2,0	2,0	2,0	2,0	2,0	2,0
Partial safety factor	γ_{Mcp}	[-]	1.5						
Concrete edge failure									
Effective length of anchor in shear loading	l_f	[mm]	50	60	71	80	100	115	125
Outside diameter of anchor	d_{nom}	[mm]	10	12	15	18	24	24	28
Partial safety factor	γ_{Mc}	[-]	1.5						

Table 14: Displacements under shear load, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
W-HAZ-B									
Shear load in cracked and non-cracked concrete	V	[kN]	9.1	14	20.7	35.1	52.1	52.1	77
Displacement	δ_{v0}	[mm]	2.5	2.1	2.7	3.0	5.1	5.1	4.3
	$\delta_{v\infty}$	[mm]	3.8	3.1	4.1	4.5	7.6	7.6	6.5
W-HAZ-S and W-HAZ-SK									
Shear load in cracked and non-cracked concrete	V	[kN]	10.1	17.1	27.5	41.5	72	72	77
Displacement	δ_{v0}	[mm]	2.9	2.5	3.6	3.5	7.0	7.0	4.3
	$\delta_{v\infty}$	[mm]	4.4	3.8	5.4	5.3	10.5	10.5	6.5

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

**Characteristic values for shear load under static or quasi static action,
CEN/TS 1992-4, design method A
Displacements under shear load, steel zinc plated**

Annex 10

Table 15: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M6 – M10, steel zinc plated, CEN/TS 1992-4, design method A

Anchor size			10/M6				12/M8				15/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure														
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	1.0	0.8	0.6	0.4	1.9	1.5	1.0	0.8	4.3	3.2	2.1	1.5
Pullout failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	1.3		1.0		3.0		2.4		4.0		3.2	
Concrete cone failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,c,fi}^0$	[kN]	3.1		2.5		5.0		4.0		7.6		6.1	
Spacing	$S_{cr,N,fi}$	[mm]	4 h_{ef}											
Edge distance	$C_{cr,N,fi}$	[mm]	2 h_{ef}											
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 4, Table 2											
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 4, Table 2; $c_{min} > 300mm$											

Table 16: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M20, steel zinc plated, CEN/TS 1992-4, design method A

Anchor size			18/M12				24/M16; 24/M16L				28/M20			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure														
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	6.3	4.6	3.0	2.0	11.6	8.6	5.0	3.1	18.3	13.5	7.7	4.9
Pullout failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	6.3		5.0		8.8		7.0		15.9		12.7	
Concrete cone failure														
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,c,fi}^0$	[kN]	10.3		8.3		18.0		14.4		31.4		25.1	
Spacing	$S_{cr,N,fi}$	[mm]	4 h_{ef}											
Edge distance	$C_{cr,N,fi}$	[mm]	2 h_{ef}											
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 4, Table 2											
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 4, Table 2; $c_{min} > 300mm$											

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under fire exposure, steel zinc plated, CEN/TS 1992-4, design method A

Annex 11

Table 17: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M6 – M10, steel zinc plated, CEN/TS 1992-4, design method A

Anchor size			10/M6				12/M8				15/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure without lever arm														
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	1.0	0.8	0.6	0.4	1.9	1.5	1.0	0.8	4.3	3.2	2.1	1.5
Steel failure with lever arm														
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	0.8	0.6	0.4	0.3	2.0	1.5	1.0	0.8	5.6	4.1	2.7	1.9

Table 18: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M20, steel zinc plated, CEN/TS 1992-4, design method A

Anchor size			18/M12				24/M16; 24/M16L				28/M20			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120	30	60	90	120
Steel failure without lever arm														
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	6.3	4.6	3.0	2.0	11.6	8.6	5.0	3.1	18.3	13.5	7.7	4.9
Steel failure with lever arm														
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	9.7	7.2	4.7	3.1	24.8	18.3	11.9	6.6	42.4	29.8	17.1	10.7

Concrete pryout failure

The initial value $V_{Rk,cp,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V_{Rk,cp,fi} = k \times N_{Rk,c,fi}$$

According to the equations (D.6 and D.7) of CEN/TS 1992-4-1 Annex D, D.1.3.3.2 the k-value is to equalise with the k_3 -value for normal temperature. The controlling value $N^0_{Rk,c,fi}$ in Table 15 and Table 16 respectively has to be observed.

Concrete edge failure

The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V^0_{Rk,c,fi} = 0.25 \times V^0_{Rk,c} \quad (R30, R60, R90)$$

$$V^0_{Rk,c,fi} = 0.20 \times V^0_{Rk,c} \quad (R120)$$

with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for shear load under fire exposure, steel zinc plated, CEN/TS 1992-4, design method A

Annex 12

Table 19: Characteristic values for seismic action, steel zinc plated, Category C1, design method A

Anchor size			24/M16	24/M16L	28/M20
Tension load					
Steel failure					
Characteristic tension resistance	$N_{Rk,s,seis}^0$	[kN]	126	126	196
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.5		
Pullout failure					
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p,seis}^0$	[kN]	36	44	50
Increasing factor for $N_{Rk,p,seis}^0$	ψ_C	[-]	1.0		
Partial safety factor	$\gamma_{Mp,seis}$	[-]	1.5		
Shear load					
Steel failure without lever arm					
W-HAZ-B					
Characteristic shear resistance	$V_{Rk,s,seis}^0$	[kN]	51.9	51.9	96.4
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.25		
W-HAZ-S					
Characteristic shear resistance	$V_{Rk,s,seis}^0$	[kN]	36.3	36.3	67.5
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.25		
Steel failure with lever arm					
Characteristic resistance	$M_{Rk,s,seis}^0$	[Nm]	no performance determined		
<p>The characteristic seismic resistance $F_{k,seis}$ of a fastening shall be determined as</p> $F_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot F_{Rk,seis}^0$ <p>where α_{gap} reduction factor to take into account inertia effects due to an annular gap between fastener and fixture in case of shear loading.</p> <p>= 1.0 no hole clearance between fastener and fixture</p> <p>= 0.5 connections with hole clearance according to Table 1, CEN/TS 1992-4-1 or to Table 4.1, ETAG 001, Annex C</p> <p>α_{seis} reduction factor to take into account the influence of large cracks and scatter of load-displacement curves, see Table 39.</p> <p>$F_{Rk,seis}^0$ basic characteristic seismic resistance to the failure modes given in Table 19, for all other failure modes, the values for static or quasi static action may be applied.</p> <p>$\gamma_{Ms,seis}, \gamma_{Mp,seis}$ partial safety factor for seismic action for the failure modes given in Table 19, for all other failure modes, the values for static or quasi static action may be applied.</p>					

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for seismic action, steel zinc plated, Category C1

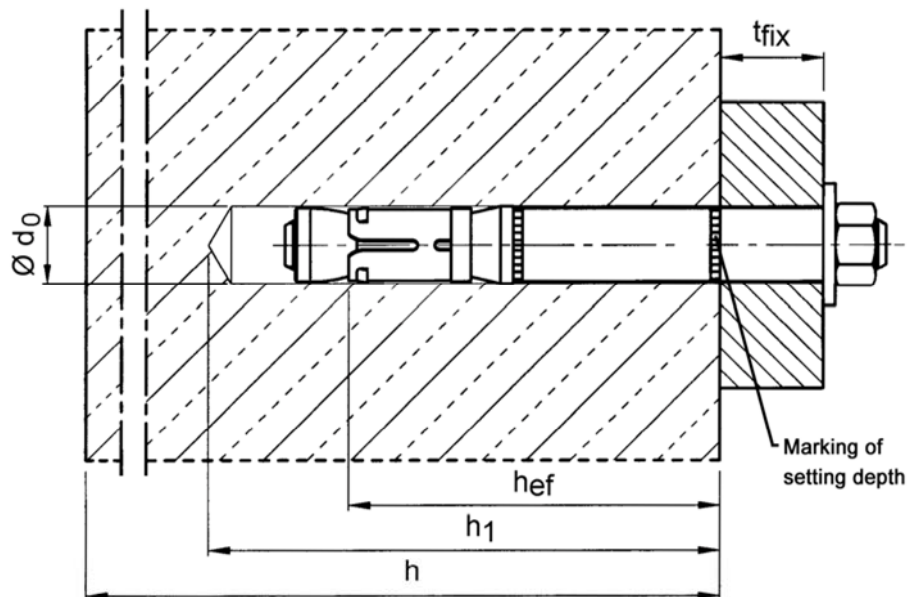
Annex 13

Table 20: Installation parameters, stainless steel A4

Anchor size			12/M8	15/M10	18/M12	24/M16
Size of thread		[-]	M8	M10	M12	M16
Effective anchorage depth	h_{ef}	[mm]	60	71	80	100
Nominal diameter of drill bit	$d_0 =$	[mm]	12	15	18	24
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	12.5	15.5	18.5	24.55
Depth of drill hole	$h_1 \geq$	[mm]	80	95	105	130
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	14	17	20	26
Minimum thickness of member	h_{min}	[mm]	120	140	160	200
Minimum spacing ¹⁾	s_{min}	[mm]	70	85	100	180
	for $c \geq$	[mm]	100	130	170	180
Minimum edge distance ¹⁾	c_{min}	[mm]	75	85	100	180
	for $s \geq$	[mm]	135	185	210	180
Thickness of fixture W-HAZ-B and W-HAZ-S	$t_{fix\ min}$	[mm]	0	0	0	0
	$t_{fix\ max}$	[mm]	200	200	250	300
Thickness of fixture W-HAZ-SK	$t_{fix\ min}^{2)}$	[mm]	10	14	18	-
	$t_{fix\ max}$	[mm]	200	200	250	-
Thickness of countersunk washer W-HAZ-SK	t_{sk}	[mm]	5	6	7	-
Required setting torque	T_{inst} (W-HAZ-B)	[Nm]	35	55	90	170
	T_{inst} (W-HAZ-S)	[Nm]	30	50	80	170
	T_{inst} (W-HAZ-SK)	[Nm]	17,5	42,5	50	-

¹⁾ Intermediate values by linear interpolation

²⁾ Depending on the existing shear load, the thickness of the fixture may be reduced to the thickness of the countersunk washer t_{sk} . It must be verified that the present shear load can be transferred completely into the distance sleeve (bearing of hole).



Würth High-Performance-Anchör W-HAZ/S, W-HAZ/A4

Installation parameters, stainless steel A4

Annex 14

Table 21: Characteristic values for tension load under static or quasi static action, stainless steel A4, ETAG 001, Annex C, design method A

Anchor size			12/M8	15/M10	18/M12	24/M16
Steel failure						
W-HAZ-B						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1.5			
W-HAZ-S and W-HAZ-SK						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1.87			
Pullout failure						
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	9	16	26	36
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	16	25	35	53
Increasing factor for $N_{Rk,p}$	ψ_c	C30/37	1.22			
		C40/50	1.41			
		C50/60	1.55			
Splitting failure						
Spacing	$s_{cr,sp}$	[mm]	360	470	530	600
Edge distance	$c_{cr,sp}$	[mm]	180	235	265	300
Concrete cone failure						
Effective anchorage depth	h_{ef}	[mm]	60	71	80	100
Spacing	$s_{cr,N}$	[mm]	$3 h_{ef}$			
Edge distance	$c_{cr,N}$	[mm]	$1.5 h_{ef}$			
Partial safety factor	$\gamma_{Mp} = \gamma_{Msp} = \gamma_{Mc}$	[-]	1.5			

Table 22: Displacements under tension loads, stainless steel A4

Anchor size			12/M8	15/M10	18/M12	24/M16
Tension load in cracked concrete	N	[kN]	4.3	7.6	12.1	17.0
Displacement	δ_{N0}	[mm]	0.5	0.5	1.3	0.5
	$\delta_{N\infty}$	[mm]	1.2	1.6	1.8	1.6
Tension load in non-cracked concrete	N	[kN]	7.6	11.9	16.7	24.1
Displacement	δ_{N0}	[mm]	0.2	0.3	1.2	1.5
	$\delta_{N\infty}$	[mm]	1.1			

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under static or quasi static action, ETAG 001, Annex C, design method A
Displacements under tension load, stainless steel A4

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Table 23: Characteristic values for shear load under static or quasi static action, stainless steel A4, ETAG 001, Annex C, design method A

Anchor size			12/M8	15/M10	18/M12	24/M16
Steel failure without lever arm						
W-HAZ-B						
Characteristic resistance	$V_{Rk,s}$	[kN]	24	37	62	92
Partial safety factor	γ_{Ms}	[-]	1.25			
W-HAZ-S and W-HAZ-SK						
Characteristic resistance	$V_{Rk,s}$	[kN]	24	37	62	92
Partial safety factor	γ_{Ms}	[-]	1.36			
Steel failure with lever arm						
W-HAZ-B						
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	232
Partial safety factor	γ_{Ms}	[-]	1.25			
W-HAZ-S and W-HAZ-SK						
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	232
Partial safety factor	γ_{Ms}	[-]	1.56			
Concrete pryout failure						
Factor in equation (5.6) ETAG 001, Annex C, 5.2.3.3	k	[-]	2	2	2	2
Partial safety factor	γ_{Mcp}	[-]	1.5			
Concrete edge failure						
Effective length of anchor in shear loading	l_f	[mm]	60	71	80	100
Outside diameter of anchor	d_{nom}	[mm]	12	15	18	24
Partial safety factor	γ_{Mc}	[-]	1.5			

Table 24: Displacements under shear load, stainless steel A4

Anchor size			12/M8	15/M10	18/M12	24/M16
Shear load in cracked and non-cracked concrete	V	[kN]	13.9	21.1	34.7	50.8
Displacement	δ_{v0}	[mm]	3.4	4.9	4.8	6.7
	$\delta_{v\infty}$	[mm]	5.1	7.4	7.1	10.1

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for shear load under static or quasi static action, ETAG 001, Annex C, design method A
Displacements under shear load, stainless steel A4

Annex 16

Table 25: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M8 – M10, stainless steel A4, ETAG 001, Annex C, design method A

Anchor size			12/M8				18/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure										
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	6.1	4.4	2.6	1.8	10.2	7.3	4.3	2.8
Pullout failure										
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	2.3		1.8		4.0		3.2	
Concrete cone failure										
Characteristic resistance in concrete C20/25 to C50/60	$N^0_{Rk,c,fi}$	[kN]	5.0		4.0		7.6		6.1	
Spacing	$s_{cr,N,fi}$	[mm]	4 h_{ef}							
Edge distance	$c_{cr,N,fi}$	[mm]	2 h_{ef}							
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 14, Table 20							
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 14, Table 20; $c_{min} > 300mm$							

Table 26: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M16, stainless steel A4, ETAG 001, Annex C, design method A

Anchor size			18/M12				24/M16			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure										
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	15.7	11.1	6.4	4.1	29.2	20.6	12.0	7.7
Pullout failure										
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	6.4		5.2		9.0		7.2	
Concrete cone failure										
Characteristic resistance in concrete C20/25 to C50/60	$N^0_{Rk,c,fi}$	[kN]	10.3		8.2		18.0		14.4	
Spacing	$s_{cr,N,fi}$	[mm]	4 h_{ef}							
Edge distance	$c_{cr,N,fi}$	[mm]	2 h_{ef}							
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 14, Table 20							
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 14, Table 20; $c_{min} > 300mm$							

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under fire exposure, stainless steel A4, ETAG 001, Annex C, design method A

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Table 27: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M8 – M10, stainless steel A4, ETAG 001, Annex C, design method A

Anchor size			12/M8				15/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure without lever arm										
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	14.3	11.1	7.9	6.3	22.7	17.6	12.6	10.0
Steel failure with lever arm										
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	6.2	4.5	2.7	1.8	13.2	9.4	5.6	3.6

Table 28: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M16, stainless steel A4, ETAG 001, Annex C, design method A

Anchor size			18/M12				24/M16			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure without lever arm										
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	32.8	25.5	18.3	14.6	61.0	47.5	34.0	27.2
Steel failure with lever arm										
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	24.4	17.2	10.0	6.4	61.8	43.6	25.3	16.2

Concrete pryout failure

The initial value $V_{Rk,cp,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V_{Rk,cp,fi} = k \times N_{Rk,c,fi}$$

with $k=2.0$ of ETAG 001, Annex C, 5.2.3.3, Equation (5.6) and the relevant values of $N^0_{Rk,c,fi}$ of Table 25 and Table 26.

Concrete edge failure

The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V^0_{Rk,c,fi} = 0.25 \times V^0_{Rk,c} \text{ (R30, R60, R90)}$$

$$V^0_{Rk,c,fi} = 0.20 \times V^0_{Rk,c} \text{ (R120)}$$

with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for shear load under fire exposure, stainless steel A4, ETAG 001, Annex C, design method A

Annex 18

Table 29: Characteristic values for tension load under static or quasi static action, stainless steel A4, CEN/TS 1992-4, design method A

Anchor size			12/M8	15/M10	18/M12	24/M16
Steel failure						
W-HAZ-B						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1.5			
W-HAZ-S and W-HAZ-SK						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1.87			
Pullout failure						
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	9	16	26	36
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	16	25	35	53
Increasing factor for $N_{Rk,p}$	ψ_c	C30/37	1.22			
		C40/50	1.41			
		C50/60	1.55			
Splitting failure						
Spacing	$S_{cr,sp}$	[mm]	360	470	530	600
Edge distance	$C_{cr,sp}$	[mm]	180	235	265	300
Concrete cone failure						
Effective anchorage depth	h_{ef}	[mm]	60	71	80	100
Factor for cracked concrete	k_{cr}	[-]	7.2			
Factor for uncracked concrete	k_{ucr}	[-]	10.1			
Spacing	$S_{cr,N}$	[mm]	3 h_{ef}			
Edge distance	$C_{cr,N}$	[mm]	1.5 h_{ef}			
Partial safety factor	$\gamma_{Mp} = \gamma_{Msp} = \gamma_{Mc}$	[-]	1.5			

Table 30: Displacements under tension loads, stainless steel A4

Anchor size			12/M8	15/M10	18/M12	24/M16
Tension load in cracked concrete	N	[kN]	4.3	7.6	12.1	17.0
Displacement	δ_{N0}	[mm]	0.5	0.5	1.3	0.5
	$\delta_{N\infty}$	[mm]	1.2	1.6	1.8	1.6
Tension load in non-cracked concrete	N	[kN]	7.6	11.9	16.7	24.1
Displacement	δ_{N0}	[mm]	0.2	0.3	1.2	1.5
	$\delta_{N\infty}$	[mm]	1.1			

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under static or quasi static action, CEN/TS 1992-4, design method A
Displacements under tension load, stainless steel A4

Annex 19

Table 31: Characteristic values for shear load under static or quasi static action, stainless steel A4, CEN/TS 1992-4, design method A

Anchor size			12/M8	15/M10	18/M12	24/M16
Steel failure without lever arm						
W-HAZ-B						
Characteristic resistance	$V_{Rk,s}$	[kN]	24	37	62	92
Ductility factor	k_2	[-]	1.0			
Partial safety factor	γ_{Ms}	[-]	1.25			
W-HAZ-S and W-HAZ-SK						
Characteristic resistance	$V_{Rk,s}$	[kN]	24	37	62	92
Ductility factor	k_2	[-]	0.8			
Partial safety factor	γ_{Ms}	[-]	1.36			
Steel failure with lever arm						
W-HAZ-B						
Characteristic resistance	$M_{Rk,s}^0$	[Nm]	26	52	92	232
Ductility factor	k_2	[-]	1.0			
Partial safety factor	γ_{Ms}	[-]	1.25			
W-HAZ-S and W-HAZ-SK						
Characteristic resistance	$M_{Rk,s}^0$	[Nm]	26	52	92	232
Ductility factor	k_2	[-]	0.8			
Partial safety factor	γ_{Ms}	[-]	1.56			
Concrete pryout failure						
Factor in equation (16) CEN/TS 1992-4-4, 6.2.2.3	k_3	[-]	2.0	2.0	2.0	2.0
Partial safety factor	γ_{Mcp}	[-]	1.5			
Concrete edge failure						
Effective length of anchor in shear loading	l_f	[mm]	60	71	80	100
Outside diameter of anchor	d_{nom}	[mm]	12	15	18	24
Partial safety factor	γ_{Mc}	[-]	1.5			

Table 32: Displacements under shear load, stainless steel A4

Anchor size			12/M8	15/M10	18/M12	24/M16
Shear load in cracked and non-cracked concrete	V	[kN]	13.9	21.1	34.7	50.8
Displacement	δ_{V0}	[mm]	3.4	4.9	4.8	6.7
	$\delta_{V\infty}$	[mm]	5.1	7.4	7.1	10.1

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for shear load under static or quasi static action, CEN/TS 1992-4, design method A
Displacements under shear load, stainless steel A4

Annex 20

Table 33: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M8 – M10, stainless steel A4, CEN/TS 1992-4, design method A

Anchor size			12/M8				18/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure										
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	6.1	4.4	2.6	1.8	10.2	7.3	4.3	2.8
Pullout failure										
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	2.3			1.8	4.0			3.2
Concrete cone failure										
Characteristic resistance in concrete C20/25 to C50/60	$N^0_{Rk,c,fi}$	[kN]	5.0		4.0	7.6			6.1	
Spacing	$s_{cr,N,fi}$	[mm]	4 h_{ef}							
Edge distance	$c_{cr,N,fi}$	[mm]	2 h_{ef}							
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 14, Table 20							
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 14, Table 20; $c_{min} > 300mm$							

Table 34: Characteristic values for tension load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M16, stainless steel A4, CEN/TS 1992-4, design method A

Anchor size			18/M12				24/M16			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure										
Characteristic resistance	$N_{Rk,s,fi}$	[kN]	15.7	11.1	6.4	4.1	29.2	20.6	12.0	7.7
Pullout failure										
Characteristic resistance in concrete C20/25 to C50/60	$N_{Rk,p,fi}$	[kN]	6.4			5.2	9.0			7.2
Concrete cone failure										
Characteristic resistance in concrete C20/25 to C50/60	$N^0_{Rk,c,fi}$	[kN]	10.3		8.2	18.0			14.4	
Spacing	$s_{cr,N,fi}$	[mm]	4 h_{ef}							
Edge distance	$c_{cr,N,fi}$	[mm]	2 h_{ef}							
Minimum spacing and edge distance under fire exposure from one side			acc. to Annex 14, Table 20							
Minimum spacing and edge distance under fire exposure from more than one side			s_{min} acc. to Annex 14, Table 20; $c_{min} > 300mm$							

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for tension load under fire exposure, stainless steel A4, CEN/TS 1992-4, design method A

Annex 21

Table 35: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M8 – M10, stainless steel A4, CEN/TS 1992-4, design method A

Anchor size			12/M8				15/M10			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure without lever arm										
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	14.3	11.1	7.9	6.3	22.7	17.6	12.6	10.0
Steel failure with lever arm										
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	6.2	4.5	2.7	1.8	13.2	9.4	5.6	3.6

Table 36: Characteristic values for shear load under fire exposure in cracked and non-cracked concrete C20/25 to C50/60 for M12 – M16, stainless steel A4, CEN/TS 1992-4, design method A

Anchor size			18/M12				24/M16			
Fire resistance duration	R...	[min]	30	60	90	120	30	60	90	120
Steel failure without lever arm										
Characteristic resistance	$V_{Rk,s,fi}$	[kN]	32.8	25.5	18.3	14.6	61.0	47.5	34.0	27.2
Steel failure with lever arm										
Characteristic resistance	$M^0_{Rk,s,fi}$	[Nm]	24.4	17.2	10.0	6.4	61.8	43.6	25.3	16.2

Concrete pryout failure

The initial value $V_{Rk,cp,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V_{Rk,cp,fi} = k \times N_{Rk,c,fi}$$

According to the equations (D.6 and D.7) of CEN/TS 1992-4-1 Annex D, D.1.3.3.2 the k-value is to equalise with the k_3 -value for normal temperature. The controlling value $N^0_{Rk,c,fi}$ in Table 33 and Table 34 respectively has to be observed.

Concrete edge failure

The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$$V^0_{Rk,c,fi} = 0.25 \times V^0_{Rk,c} \quad (R30, R60, R90)$$

$$V^0_{Rk,c,fi} = 0.20 \times V^0_{Rk,c} \quad (R120)$$

with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for shear load under fire exposure, stainless steel A4, CEN/TS 1992-4, design method A

Annex 22

Table 37: Characteristic values for seismic action, stainless steel A4, Category C1, design method A

Anchor size			12/M8	15/M10	18/M12	24/M16
Tension load						
Steel failure						
W-HAZ-B						
Characteristic tension resistance	$N_{Rk,s,seis}^0$	[kN]	26	41	60	110
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.5			
W-HAZ-S and W-HAZ-SK						
Characteristic tension resistance	$N_{Rk,s,seis}^0$	[kN]	26	41	60	110
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.87			
Pullout failure						
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p,seis}^0$	[kN]	9	16	26	36
Increasing factor for $N_{Rk,p,seis}^0$	ψ_C	[-]	1.0			
Partial safety factor	$\gamma_{Mp,seis}$	[-]	1.5			
Shear load						
Steel failure without lever arm						
W-HAZ-B						
Characteristic shear resistance	$V_{Rk,s,seis}^0$	[kN]	9.6	13.3	25.4	75.4
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.25			
W-HAZ-S and W-HAZ-SK						
Characteristic shear resistance	$V_{Rk,s,seis}^0$	[kN]	6.7	9.3	17.8	52.8
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1.36			
Steel failure with lever arm						
Characteristic resistance	$M_{Rk,s,seis}^0$	[Nm]	no performance determined			
<p>The characteristic seismic resistance $F_{k,seis}$ of a fastening shall be determined as</p> $F_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot F_{Rk,seis}^0$ <p>with α_{gap} reduction factor to take into account inertia effects due to an annular gap between fastener and fixture in case of shear loading.</p> <p>= 1.0 no hole clearance between fastener and fixture</p> <p>= 0.5 connections with hole clearance according to Table 1, CEN/TS 1992-4-1 or to Table 4.1, ETAG 001, Annex C</p> <p>α_{seis} reduction factor to take into account the influence of large cracks and scatter of load-displacement curves, see Table 39.</p> <p>$F_{Rk,seis}^0$ basic characteristic seismic resistance to the failure modes given in Table 37, for all other failure modes, the values for static or quasi static action may be applied.</p> <p>$\gamma_{Ms,seis}, \gamma_{Mp,seis}$ partial safety factor for seismic action for the failure modes given in Table 37, for all other failure modes, the values for static or quasi static action may be applied.</p>						

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

Characteristic values for seismic action, stainless steel A4, Category C1

Annex 23

The decision of the selection of a higher seismic performance category than given in Table 38 is the responsibility of each individual Member State.

Furthermore, the values of $a_g \cdot S$ assigned to the seismicity may be different in the National Annexes to EN 1998-1:2004 (EC8) compared to the values given in Table 38.

The recommended categories C1 and C2 given in Table 38 are given in the case that no national requirements are specified.

Table 38: Recommended seismic performance categories for anchors

Seismicity level		Importance Class acc. to EN 1998-1:2004, 4.2.5			
Class	$a_g \cdot S$ ²⁾	I	II	III	IV
very low ¹⁾	$a_g \cdot S \leq 0.05 \text{ g}$	No additional requirement			
low ¹⁾	$0.05 \text{ g} < a_g \cdot S \leq 0.1 \text{ g}$	C1	C1 ³⁾ or C2 ⁴⁾		C2
> low	$a_g \cdot S > 0.1 \text{ g}$	C1	C2		

¹⁾ Definition according to EN 1998-1:2004, 3.2.1

²⁾ $a_g = \gamma_1 \cdot a_{gR}$ Design ground acceleration on type A ground (Ground types as defined in EN 1998-1:2004, Table 3.1);

$\gamma_1 =$ importance factor (see EN 1998-1:2004, 4.2.5);

$a_{gR} =$ reference peak ground acceleration on type A ground (see EN 1998-1:2004, 3.2.1);

$S =$ Soil factor (see e.g. EN 1998-1:2004, 3.2.2).

³⁾ C1 for fixing non-structural elements to structures

⁴⁾ C2 for fixing structural elements to structures

Table 39: Reduction factor α_{seis}

Loading	Failure mode	Single fastener	Fastener group
Tension	Steel failure	1.0	1.0
	Pull-out failure	1.0	0.85
	Concrete cone failure	0.85	0.75
	Splitting failure	1.0	0.85
Shear	Steel failure	1.0	0.85
	Concrete edge failure	1.0	0.85
	Concrete pry-out failure	0.85	0.75

Würth High-Performance-Anchor W-HAZ/S, W-HAZ/A4

**Recommended seismic performance categories for anchors,
Reduction factor α_{eq}**

Annex 24