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Authorised and notified according to Article 10 of the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products (89/106/EEC)

DIBt

Mitglied der EOTA
Member of EOTA

European Technical Approval ETA-98/0001

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung *Trade name*	Hilti Durchsteckanker HST, HST-R und HST-HCR *Hilti stud anchor HST, HST-R and HST-HCR*
Zulassungsinhaber *Holder of approval*	Hilti Aktiengesellschaft Business Unit Anchors 9494 Schaan FÜRSTENTUM LIECHTENSTEIN
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	Kraftkontrolliert spreizender Dübel in den Größen M8, M10, M12, M16, M20 und M24 zur Verankerung im Beton *Torque controlled expansion anchor of sizes M8, M10, M12, M16, M20 and M24 for use in concrete*
Geltungsdauer: vom *Validity: from*	18 November 2008
bis *to*	19 February 2013
Herstellwerk *Manufacturing plant*	Hilti Aktiengesellschaft Werk 1

Diese Zulassung umfasst *This Approval contains*	22 Seiten einschließlich 14 Anhänge *22 pages including 14 annexes*
Diese Zulassung ersetzt *This Approval replaces*	ETA-98/0001 mit Geltungsdauer vom 12.02.2008 bis 19.02.2013 *ETA-98/0001 with validity from 12.02.2008 to 19.02.2013*

EOTA

Europäische Organisation für Technische Zulassungen
European Organisation for Technical Approvals

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 products[1], modified by Council Directive 93/68/EEC[2] and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council[3];
- 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 1998[4], zuletzt geändert durch Gesetz vom 06.01.2004[5];
- Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC[6];
- 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.

3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.

4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.

5 Reproduction of this European technical approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of Deutsches Institut für Bautechnik. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European technical approval.

6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

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1 Official Journal of the European Communities L 40, 11.02.1989, p. 12
2 Official Journal of the European Communities L 220, 30.08.1993, p. 1
3 Official Journal of the European Union L 284, 31.10.2003, p. 25
4 Bundesgesetzblatt I, p. 812
5 Bundesgesetzblatt I, p.2, 15
6 Official Journal of the European Communities L 17, 20.01.1994, p. 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product and intended use

1.1 Definition of the construction product

The Hilti stud anchor HST, HST-R and HST-HCR is an anchor made of galvanised steel (designated as HST) or stainless steel (designated as HST-R) of sizes M8, M10, M12, M16, M20 and M24 or made of high corrosion resistant steel (designated as HST-HCR) of sizes 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 only for anchorages subject to static or quasi-static loading 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.

Hilti Stud Anchor HST made of galvanised steel:

The anchor may only be used in structures subject to dry internal conditions.

Hilti Stud Anchor HST-R made of stainless steel A4:

The anchor made of stainless steel A4 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).

Hilti Stud Anchor HST-HCR made of high corrosion resistant steel:

The anchor made of high corrosion resistant steel may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure, in permanently damp internal conditions or in other particular aggressive conditions. 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 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 Annexes 2 and 3. The characteristic material values, dimensions and tolerances of the anchor not given in Annexes 2 and 3 shall correspond to the respective values laid down in the technical documentation[7] 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 for the design of anchorages are given in Annexes 4 to 9.

The characteristic values for the design of anchorages regarding resistance to fire are given in the Annexes 10 to 14. They are valid for use in a system that is required to provide a specific fire resistance class.

Each anchor is marked with the identifying mark of the producer, the anchor identity, the size of thread and the maximum thickness of fixture according to Annex 1. In addition, the minimum anchorage depth is marked on the bolt. Each anchor made of stainless steel A4 is marked with the letter "-R" and each anchor made of high corrosion resistant steel is marked with the letters "-HCR".

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.

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.

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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.

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 Commission[8] the system 2(i) (referred to as system 1) of attestation of conformity applies.

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;

(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.

Note: Approved bodies are also referred to as "notified bodies".

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 of February 2008 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 Bautechnik[9].

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.

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

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.

3.2.2 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.

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 producer (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),
- 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 the 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 the 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 Installation

4.2.1 Design of anchorages

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

The anchorages are designed in accordance with the "Guideline for European technical approval of Metal Anchors for Use in Concrete", Annex C, Method A, 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 relevant characteristic anchor values are given in Annexes 10 to 14. 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.

4.2.2 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 spacings 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 torque moment given in Annex 3 using a calibrated torque wrench.

4.2.3 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 and 4.2.1 and 4.2.2 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,
- Torque moment,
- 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.

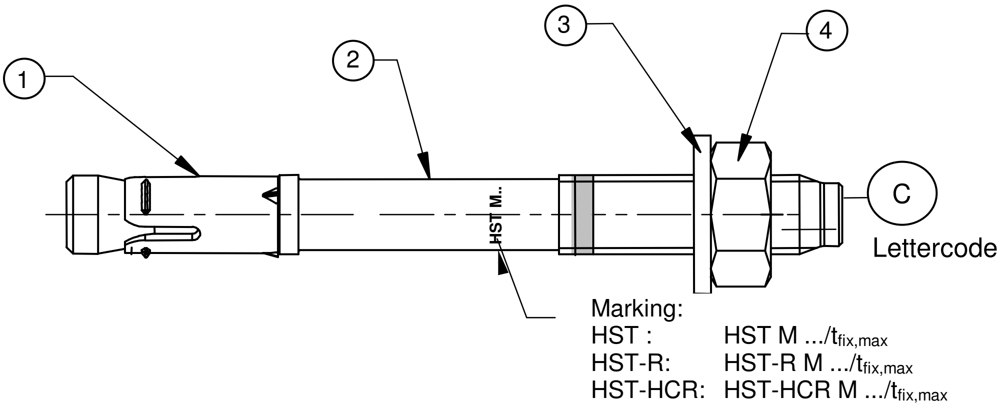
All data shall be presented in a clear and explicit form.

Dipl.-Ing. E. Jasch
President of Deutsches Institut für Bautechnik
Berlin, 18 November 2008

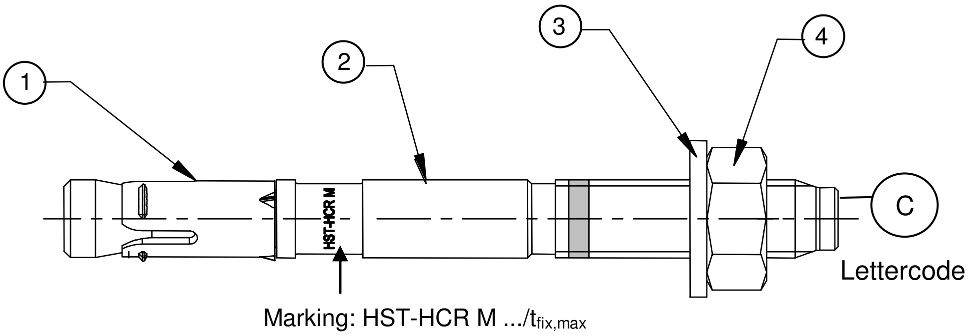
beglaubigt:
Lange

HST (steel galvanised)
HST-R (stainless steel)
HST-HCR (high corrosion resistant steel)

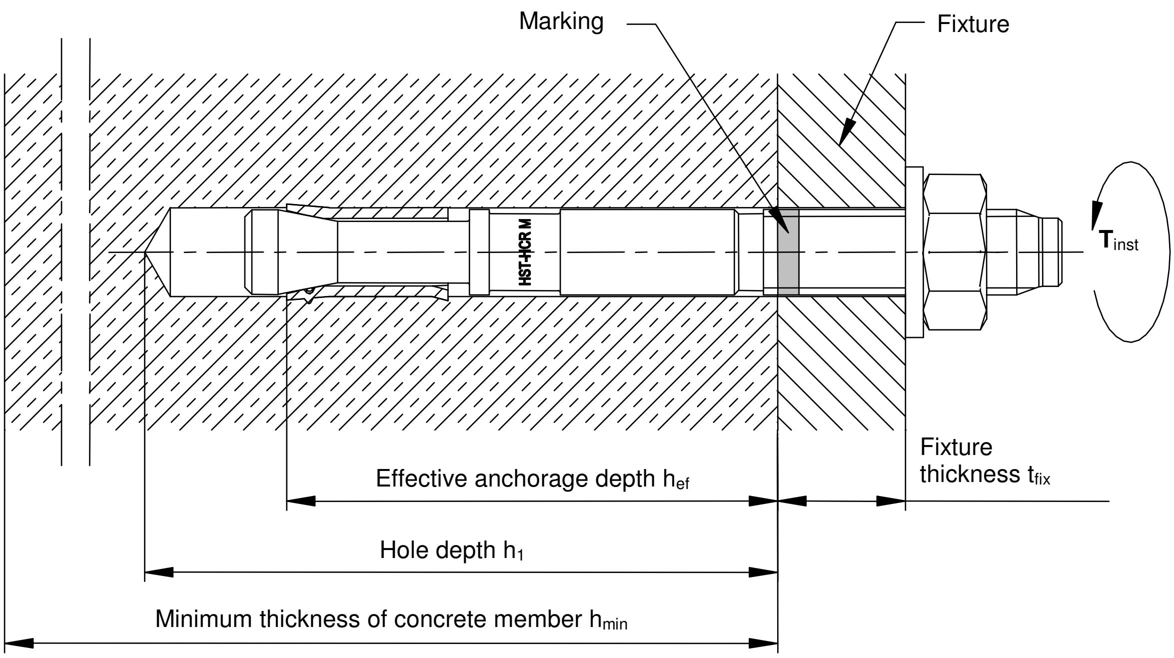
Coldformed version



Machined version



Intended use



Hilti stud anchor HST, HST-R, HST-HCR	**Annex 1**
Product and intended use	of European technical approval **ETA-98/0001**

Table 1: Anchor Materials

Part	Designation	Material
HST (steel galvanised)		
1	Expansion sleeve	Stainless steel A4
2	Bolt	Carbon steel galvanised and coated M8, M10, M12: f_{uk} = 800N/mm^2, f_{yk} = 640N/mm^2 M16 f_{uk} = 720N/mm^2, f_{yk} = 580N/mm^2 M20: f_{uk} = 700N/mm^2, f_{yk} = 560N/mm^2 M24: f_{uk} = 530N/mm^2, f_{yk} = 450N/mm^2
3	Washer	Steel galvanised, EN ISO 4042
4	Hexagon nut	Class 8 EN 20898-2, galvanised

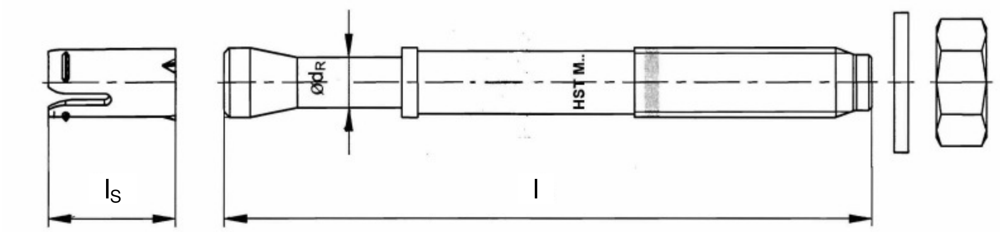
Part	Designation	Material
HST-R (stainless steel)		
1	Expansion sleeve	Stainless steel A4
2	Bolt	Stainless steel A4, cone coated M8: f_{uk} = 720N/mm^2, f_{yk} = 575N/mm^2 M10, M12: f_{uk} = 700N/mm^2, f_{yk} = 560N/mm^2 M16: f_{uk} = 650N/mm^2, f_{yk} = 500N/mm^2 M20, M24: f_{uk} = 650N/mm^2, f_{yk} = 450N/mm^2
3	Washer	Stainless steel A4
4	Hexagon nut	Stainless steel A4, coated

Part	Designation	Material
HST-HCR (high corrosion resistant steel)		
1	Expansion sleeve	Stainless steel A4
2	Bolt	High corrosion resistant steel, cone coated M8, M10, M12, M16: f_{uk} = 800N/mm^2, f_{yk} = 640N/mm^2
3	Washer	High corrosion resistant steel
4	Hexagon nut	High corrosion resistant steel, coated

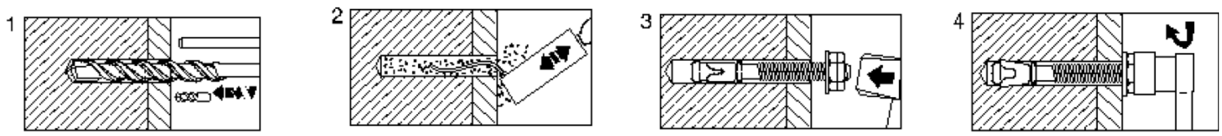
Table 2: Installation data and dimensions

HST (steel galvanised) **HST-R (stainless steel)** **HST-HCR (high corrosion resistant steel)**			**M8**	**M10**	**M12**	**M16**	**M20[1)]**	**M24[1)]**
Nominal diameter of drill bit	d_0	[mm]	8	10	12	16	20	24
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	8,45	10,45	12,50	16,50	20,55	24,55
Depth of drill hole	$h_1 \geq$	[mm]	65	80	95	115	140	170
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	9	12	14	18	22	26
Effective anchorage depth	h_{ef}	[mm]	47	60	70	82	101	125
Torque moment	T_{inst}	[Nm]	20	45	60	110	240	300
Maximum thickness of fixture	$t_{fix,max}$	[mm]	195	200	200	235	305	330
Maximum length of anchor	l_{max}	[mm]	260	280	295	350	450	500
Shaft diameter at the cone	d_R	[mm]	5,5	7,2	8,5	11,6	14,6	17,4
Length of expansion sleeve	l_S	[mm]	14,8	18,2	22,7	24,3	28,3	36,0
Width across flats	S_W	[mm]	13	17	19	24	30	36

1) Anchor size only for anchor types HST and HST-R



Setting instruction



Drill hole with drill bit

Blow out dust and fragments

Install anchor

Apply tightening torque

Table 3: Minimum thickness of concrete member, minimum spacing and minimum edge distances

HST (steel galvanised)			M8	M10	M12	M16	M20	M24
Minimum thickness of concrete member	h_{min}	[mm]	100	120	140	160	200	250
Cracked concrete								
Minimum spacing	s_{min}	[mm]	40	55	60	70	100	125
	für c ≥	[mm]	50	70	75	100	160	180
Minimum edge distance	c_{min}	[mm]	45	55	55	70	100	125
	für s ≥	[mm]	50	90	120	150	225	240
Non-cracked concrete								
Minimum spacing	s_{min}	[mm]	60	55	60	70	100	125
	für c ≥	[mm]	50	80	85	110	225	255
Minimum edge distance	c_{min}	[mm]	50	55	55	85	140	170
	für s ≥	[mm]	60	115	145	150	270	295

HST-R (stainless steel)			M8	M10	M12	M16	M20	M24
Minimum thickness of concrete member	h_{min}	[mm]	100	120	140	160	200	250
Cracked concrete								
Minimum spacing	s_{min}	[mm]	40	55	60	70	100	125
	für c ≥	[mm]	50	65	75	100	130	130
Minimum edge distance	c_{min}	[mm]	45	50	55	60	100	125
	für s ≥	[mm]	50	90	110	160	160	140
Non-cracked concrete								
Minimum spacing	s_{min}	[mm]	60	55	60	70	100	125
	für c ≥	[mm]	60	70	80	110	195	205
Minimum edge distance	c_{min}	[mm]	60	50	55	70	140	150
	für s ≥	[mm]	60	115	145	160	210	235

HST-HCR (high corrosion resistant steel)			M8	M10	M12	M16
Minimum thickness of concrete member	h_{min}	[mm]	100	120	140	160
Cracked concrete						
Minimum spacing	s_{min}	[mm]	40	55	60	70
	für c ≥	[mm]	50	70	75	100
Minimum edge distance	c_{min}	[mm]	45	50	55	60
	für s ≥	[mm]	50	90	110	160
Non-cracked concrete						
Minimum spacing	s_{min}	[mm]	60	55	60	70
	für c ≥	[mm]	50	70	80	110
Minimum edge distance	c_{min}	[mm]	60	55	55	70
	für s ≥	[mm]	60	115	145	160

Table 4: Design method A
Characteristic values for tension loads

HST (steel galvanised)			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure								
Characteristic resistance	$N_{Rk,s}$	[kN]	19	32	43	75	75	127
Partial safety factor	γ_{Ms} 1)	[-]	1,5					1,41
Pullout failure								
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	5	9	12	20	30	40
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	9	16	20	35	50	60
Increasing factors for $N_{Rk,p}$ for cracked and non-cracked concrete	ψ_c	C30/37	1,22					
	ψ_c	C40/50	1,41					
	ψ_c	C50/60	1,55					
Partial safety factor	γ_{Mp} 1)	[-]	1,8 2)	1,5 3)				
Concrete cone failure and splitting failure								
Effective anchorage depth	h_{ef}	[mm]	47	60	70	82	101	125
Spacing	$s_{cr,N} = s_{cr,sp}$	[mm]	3 x h_{ef}					
Edge distance	$c_{cr,N} = c_{cr,sp}$	[mm]	1,5 x h_{ef}					
Partial safety factor	$\gamma_{Mc} = \gamma_{M,sp}$ 1)	[-]	1,8 2)	1,5 3)				

HST-R (stainless steel)			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure								
Characteristic resistance	$N_{Rk,s}$	[kN]	17	28	40	69	109	156
Partial safety factor	γ_{Ms} 1)	[-]	1,5			1,56	1,73	
Pullout failure								
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	5	9	12	25	30	40
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	9	16	20	35	50	60
Increasing factors for $N_{Rk,p}$ for cracked and non-cracked concrete	ψ_c	C30/37	1,22					
	ψ_c	C40/50	1,41					
	ψ_c	C50/60	1,55					
Partial safety factor	γ_{Mp} 1)	[-]	1,5 3)					
Concrete cone failure and splitting failure								
Effective anchorage depth	h_{ef}	[mm]	47	60	70	82	101	125
Spacing	$s_{cr,N} = s_{cr,sp}$	[mm]	3 x h_{ef}					
Edge distance	$c_{cr,N} = c_{cr,sp}$	[mm]	1,5 x h_{ef}					
Partial safety factor	$\gamma_{Mc} = \gamma_{M,sp}$ 1)	[-]	1,5 3)					

1) In absence of other national regulations.
2) The partial safety factor γ_2 = 1,2 is included.
3) The partial safety factor γ_2 = 1,0 is included.

Hilti stud anchor HST, HST-R, HST-HCR	**Annex 5**
Design method A, Characteristic values for tension loads	of European technical approval **ETA-98/0001**

Table 5: Design method A
Characteristic values for tension loads (continued)

HST-HCR (high corrosion resistant steel)			M8	M10	M12	M16
Steel failure						
Characteristic resistance	$N_{Rk,s}$	[kN]	19,4	32,3	45,7	84,5
Partial safety factor	γ_{Ms} [1)]	[-]	1,5			
Pullout failure						
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	5	9	12	25
Characteristic resistance in non-cracked concrete C20/25	$N_{Rk,p}$	[kN]	9	16	20	35
Increasing factors for $N_{Rk,p}$ for cracked and non-cracked concrete	ψ_c	C30/37	1,22			
	ψ_c	C40/50	1,41			
	ψ_c	C50/60	1,55			
Partial safety factor	γ_{Mp} [1)]	[-]	1,5 [2)]			
Concrete cone failure and splitting failure						
Effective anchorage depth	h_{ef}	[mm]	47	60	70	82
Spacing	$s_{cr,N} = s_{cr,sp}$	[mm]	3 x h_{ef}			
Edge distance	$c_{cr,N} = c_{cr,sp}$	[mm]	1,5 x h_{ef}			
Partial safety factor	$\gamma_{Mc} = \gamma_{M,sp}$ [1)]	[-]	1,5 [2)]			

[1)] In absence of other national regulations.
[2)] The partial safety factor $\gamma_2 = 1,0$ is included.

Table 6: Displacements under tension loads

HST (steel galvanised)			M8	M10	M12	M16	M20	M24
Tension load in cracked concrete	N	[kN]	2	4,3	5,7	9,5	14,3	19,0
Corresponding displacement	δ_{N0}	[mm]	1,3	0,2	0,1	0,5	1,9	2,2
	$\delta_{N\infty}$	[mm]	1,2	1,0	1,2	1,2	2,3	2,5
Tension load in non-cracked concrete	N	[kN]	3,6	7,6	9,5	16,7	23,8	28,6
Corresponding displacement	δ_{N0}	[mm]	0,2	0,1	0,1	0,4	0,6	0,5
	$\delta_{N\infty}$	[mm]	1,1	1,1	1,1	1,1	1,4	1,4

HST-R (stainless steel)			M8	M10	M12	M16	M20	M24
Tension load in cracked concrete	N	[kN]	2,4	4,36	5,7	11,9	14,30	19,0
Corresponding displacement	δ_{N0}	[mm]	0,6	0,2	0,8	1,0	1,1	0,8
	$\delta_{N\infty}$	[mm]	1,5	1,2	1,4	1,2	1,2	1,7
Tension load in non-cracked concrete	N	[kN]	4,3	7,6	9,5	16,7	23,8	28,6
Corresponding displacement	δ_{N0}	[mm]	0,1	0,1	0,1	0,1	0,5	0,8
	$\delta_{N\infty}$	[mm]	1,5	1,2	1,4	1,2	1,2	1,7

HST-HCR (high corrosion resistant steel)			M8	M10	M12	M16
Tension load in cracked concrete	N	[kN]	2,4	4,3	5,7	11,9
Corresponding displacement	δ_{N0}	[mm]	0,6	0,2	0,8	1,0
	$\delta_{N\infty}$	[mm]	1,5	1,2	1,4	1,2
Tension load in non-cracked concrete	N	[kN]	4,3	7,6	9,5	16,7
Corresponding displacement	δ_{N0}	[mm]	0,1	0,1	0,1	0,1
	$\delta_{N\infty}$	[mm]	1,5	1,2	1,4	1,2

Table 7: Design method A
Characteristic values for shear loads

HST (steel galvanised)			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure without lever arm								
Characteristic resistance	$V_{Rk,s}$	[kN]	14	23,5	35	55	84	94
Partial safety factor	γ_{Ms} [1]	[-]	1,25					1,5
Steel failure with lever arm								
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	240	454	595
Partial safety factor	γ_{Ms} [1]	[-]	1,25					1,5
Concrete pryout failure								
Factor in equation (5.6) of ETAG 001 Annex C, 5.2.3.3	k	[-]	2,0		2,2	2,5	2,5	2,5
Partial safety factor	γ_{Mcp} [1]	[-]	1,5 [2]					
Concrete edge failure								
Effective length of anchor in shear loading	l_f	[mm]	47	60	70	82	101	125
Diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24
Partial safety factor	γ_{Mc} [1]	[-]	1,5 [2]					

HST-R (stainless steel)			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure without lever arm								
Characteristic resistance	$V_{Rk,s}$	[kN]	13	20	30	50	60	80
Partial safety factor	γ_{Ms} [1]	[-]	1,25			1,3	1,44	
Steel failure with lever arm								
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	27	53	92	216	422	730
Partial safety factor	γ_{Ms} [1]	[-]	1,25			1,3	1,44	
Concrete pryout failure								
Factor in equation (5.6) of ETAG 001 Annex C, 5.2.3.3	k	[-]	2,0					
Partial safety factor	γ_{Mcp} [1]	[-]	1,5 [2]					
Concrete edge failure								
Effective length of anchor in shear loading	l_f	[mm]	47	60	70	82	101	125
Diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24
Partial safety factor	γ_{Mc} [1]	[-]	1,5 [2]					

[1] In absence of other national regulations.
[2] The partial safety factor γ_2 = 1,0 is included.

Table 8: Design method A
Characteristic values for shear loads (continued)

HST-HCR (high corrosion resistant steel)			M8	M10	M12	M16
Steel failure without lever arm						
Characteristic resistance	$V_{Rk,s}$	[kN]	13	20	30	55
Partial safety factor	γ_{Ms} 1)	[-]	1,25			
Steel failure with lever arm						
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	266
Partial safety factor	γ_{Ms} 1)	[-]	1,25			
Concrete pryout failure						
Factor in equation (5.6) of ETAG 001 Annex C, 5.2.3.3	k	[-]	2,0			
Partial safety factor	γ_{Mcp} 1)	[-]	1,5 2)			
Concrete edge failure						
Effective length of anchor in shear loading	l_f	[mm]	47	60	70	82
Diameter of anchor	d_{nom}	[mm]	8	10	12	16
Partial safety factor	γ_{Mc} 1)	[-]	1,5 2)			

1) In absence of other national regulations.
2) The partial safety factor γ_2 = 1,0 is included.

Table 9: Displacement under shear loads

HST (steel galvanised)			M8	M10	M12	M16	M20	M24
Shear load in cracked and non-cracked concrete	V	[kN]	8,0	13,4	20,0	31,4	48,0	45,0
Corresponding displacement	δ_{V0}	[mm]	2,5	2,5	3,7	4,0	2,7	2,0
	$\delta_{V\infty}$	[mm]	3,8	3,7	5,5	6,0	4,1	3,0

HST-R (stainless steel)			M8	M10	M12	M16	M20	M24
Shear load in cracked and non-cracked concrete	V	[kN]	7,4	11,0	17,0	27,5	40,0	57,0
Corresponding displacement	δ_{V0}	[mm]	1,6	3,3	4,9	2,2	2,5	2,5
	$\delta_{V\infty}$	[mm]	2,4	4,9	7,4	3,3	3,7	3,7

HST-HCR (high corrosion resistant steel)			M8	M10	M12	M16
Shear load in cracked and non-cracked concrete	V	[kN]	7,4	11,0	17,0	27,5
Corresponding displacement	δ_{V0}	[mm]	1,6	3,3	4,9	2,2
	$\delta_{V\infty}$	[mm]	2,4	4,9	7,4	3,3

Table 10: Design method A
Characteristic tension resistance in cracked and non-cracked concrete C20/25 to C50/60 under fire exposure

HST (steel galvanised)				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure									
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	0,9	2,5	5	9	15	20
	R60	$N_{Rk,s,fi}$	[kN]	0,7	1,5	3,5	6	10	15
	R90	$N_{Rk,s,fi}$	[kN]	0,6	1	2	3,5	6	8
	R120	$N_{Rk,s,fi}$	[kN]	0,5	0,7	1	2	3,5	5
Pullout failure									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N_{Rk,p,fi}$	[kN]	1,3	2,3	3	5	7,5	10
	R120	$N_{Rk,p,fi}$	[kN]	1,0	1,8	2,4	4	6	8
Concrete cone failure and splitting failure									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N^0_{Rk,c,fi}$	[kN]	2,7	5	7,3	10,9	18,3	31,3
	R120	$N^0_{Rk,c,fi}$	[kN]	2,2	4	5,9	8,7	14,7	25
Spacing		$s_{cr,N}$	[mm]	4 x h_{ef}					
		s_{min}	[mm]	40	55	60	70	100	125
Edge distance		$c_{cr,N}$	[mm]	2 x h_{ef}					
		c_{min}	[mm]	Fire attack from one side: 2 x h_{ef}					
				Fire attack from more than one side: ≥ 300					

HST-R (stainless steel)				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure									
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	4,9	11,8	17,2	32	49,9	71,9
	R60	$N_{Rk,s,fi}$	[kN]	3,6	8,4	12,2	22,8	35,5	51,2
	R90	$N_{Rk,s,fi}$	[kN]	2,4	5	7,3	13,5	21,1	30,4
	R120	$N_{Rk,s,fi}$	[kN]	1,7	3,3	4,8	8,9	13,9	20
Pullout failure									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N_{Rk,p,fi}$	[kN]	1,3	2,3	3	6,3	7,5	10
	R120	$N_{Rk,p,fi}$	[kN]	1	1,8	2,4	5	6	8
Concrete cone failure and splitting failure									
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N^0_{Rk,c,fi}$	[kN]	2,7	5	7,4	11	18,5	31,4
	R120	$N^0_{Rk,c,fi}$	[kN]	2,2	4	5,9	8,8	14,8	25,2
Spacing		$s_{cr,N}$	[mm]	4 x h_{ef}					
		s_{min}	[mm]	40	55	60	70	100	125
Edge distance		$c_{cr,N}$	[mm]	2 x h_{ef}					
		c_{min}	[mm]	Fire attack from one side: 2 x h_{ef}					
				Fire attack from more than one side: ≥ 300					

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi}$ = 1,0 is recommended.

Table 11: Design method A
Characteristic tension resistance in cracked and non-cracked concrete C20/25 to C50/60 under fire exposure (continued)

HST-HCR (high corrosion resistant steel)				M8	M10	M12	M16
Steel failure							
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	4,9	11,8	17,2	32
	R60	$N_{Rk,s,fi}$	[kN]	3,6	8,4	12,2	22,8
	R90	$N_{Rk,s,fi}$	[kN]	2,4	5	7,3	13,5
	R120	$N_{Rk,s,fi}$	[kN]	1,7	3,3	4,8	8,9
Pullout failure							
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N_{Rk,p,fi}$	[kN]	1,3	2,3	3	6,3
	R120	$N_{Rk,p,fi}$	[kN]	1	1,8	2,4	5
Concrete cone failure and splitting failure							
Characteristic resistance in concrete ≥ C20/25	R30 R60 R90	$N^0_{Rk,c,fi}$	[kN]	2,7	5	7,4	11
	R120	$N^0_{Rk,c,fi}$	[kN]	2,2	4	5,9	8,8
Spacing		$s_{cr,N}$	[mm]	4 x h_{ef}			
		s_{min}	[mm]	40	55	60	70
Edge distance		$c_{cr,N}$	[mm]	2 x h_{ef}			
		c_{min}	[mm]	Fire attack from one side: 2 x h_{ef}			
				Fire attack from more than one side: ≥ 300			

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi}$ = 1,0 is recommended.

Table 12: Design method A
Characteristic shear resistance in cracked and non-cracked concrete C20/25 to C50/60 under fire exposure

HST (steel galvanised)				M8	M10	M12	M16	M20	M24
Steel failure without lever arm									
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	0,9	2,5	5	9	15	20
	R60	$V_{Rk,s,fi}$	[kN]	0,7	1,5	3,5	6	10	15
	R90	$V_{Rk,s,fi}$	[kN]	0,6	1	2	3,5	6	8
	R120	$V_{Rk,s,fi}$	[kN]	0,5	0,7	1	2	3,5	5
Steel failure with lever arm									
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	1	3,3	8,1	20,6	40,2	69,5
	R60	$M^0_{Rk,s,fi}$	[Nm]	0,8	2,4	5,7	14,4	28,1	48,6
	R90	$M^0_{Rk,s,fi}$	[Nm]	0,7	1,6	3,2	8,2	16	27,7
	R120	$M^0_{Rk,s,fi}$	[Nm]	0,6	1,2	2	5,1	9,9	17,2
Concrete pryout failure									
Factor in equation (5.6) of ETAG 001 Annex C, 5.2.3.3		k	[-]	2,0	2,0	2,2	2,5	2,5	2,5
Characteristic resistance	R30 R60 R90	$V_{Rk,cp,fi}$	[kN]	5,4	10	16	27,2	49,4	84,5
	R120	$V_{Rk,cp,fi}$	[kN]	4,4	8	12,9	21,7	39,6	67,5
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: $V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ (≤ R90) $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120) with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.									

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

Table 13: Design method A
Characteristic shear resistance in cracked and non-cracked concrete C20/25 to C50/60 under fire exposure (continued)

HST-R (stainless steel)				M8	M10	M12	M16	M20	M24
Steel failure without lever arm									
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	4,9	11,8	17,2	32	49,9	71,9
	R60	$V_{Rk,s,fi}$	[kN]	3,6	8,4	12,2	22,8	35,5	51,2
	R90	$V_{Rk,s,fi}$	[kN]	2,4	5	7,3	13,5	21,1	30,4
	R120	$V_{Rk,s,fi}$	[kN]	1,7	3,3	4,8	8,9	13,9	20
Steel failure with lever arm									
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	5	15,2	26,6	67,7	132,3	228,6
	R60	$M^0_{Rk,s,fi}$	[Nm]	3,7	10,8	19	48,2	94,1	162,6
	R90	$M^0_{Rk,s,fi}$	[Nm]	2,4	6,4	11,3	28,6	55,9	96,6
	R120	$M^0_{Rk,s,fi}$	[Nm]	1,8	4,2	7,4	18,9	36,8	63,7
Concrete pryout failure									
In equation (5.6) of ETAG 001, Annex C, 5.2.3.3 the k-factor 2,0 and the relevant values $N^0_{Rk,c,fi}$ of Table 9 have to be considered.									
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: $V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ (≤ R90) $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120) with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.									

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

Table 14: Design method A Characteristic shear resistance in cracked and non-cracked concrete C20/25 to C50/60 under fire exposure (continued)

HST-HCR (high corrosion resistant steel)				M8	M10	M12	M16
Steel failure without lever arm							
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	4,9	11,8	17,2	32
	R60	$V_{Rk,s,fi}$	[kN]	3,6	8,4	12,2	22,8
	R90	$V_{Rk,s,fi}$	[kN]	2,4	5	7,3	13,5
	R120	$V_{Rk,s,fi}$	[kN]	1,7	3,3	4,8	8,9
Steel failure with lever arm							
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	5	15,2	26,6	67,7
	R60	$M^0_{Rk,s,fi}$	[Nm]	3,7	10,8	19	48,2
	R90	$M^0_{Rk,s,fi}$	[Nm]	2,4	6,4	11,3	28,6
	R120	$M^0_{Rk,s,fi}$	[Nm]	1,8	4,2	7,4	18,9
Concrete pryout failure							
In equation (5.6) of ETAG 001, Annex C, 5.2.3.3 the k-factor 2,0 and the relevant values $N^0_{Rk,c,fi}$ of Table 9 have to be considered.							
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: $V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ (≤ R90) $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120) with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.							

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.