

European Technical Approval ETA-03/0039

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung
Trade name

KÖCO-Kopfbolzen
KÖCO Headed Studs

Zulassungsinhaber
Holder of approval

Köster & Co. GmbH
Bolzenschweißtechnik
Spreeler Weg 32
58256 Ennepetal

Zulassungsgegenstand
und Verwendungszweck
*Generic type and use
of construction product*

Stahlplatte mit einbetonierten KÖCO-Kopfbolzen aus Stahl
und aus nichtrostendem Stahl
*Steel plate with cast-in KÖCO-headed studs made of steel
and stainless steel*

Geltungsdauer:
Validity: vom
from
bis
to

1 April 2011
18 November 2013

Herstellwerk
Manufacturing plant

Herstellwerk 1

Diese Zulassung umfasst
This Approval contains

15 Seiten einschließlich 7 Anhänge
15 pages including 7 annexes

Diese Zulassung ersetzt
This Approval replaces

ETA-03/0039 mit Geltungsdauer vom 31.05.2010 bis 18.11.2013
ETA-03/0039 with validity from 31.05.2010 to 18.11.2013

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 law of 31 October 2006⁵;
 - Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC⁶.
- 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.

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 2006, p. 2407, 2416
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 product and intended use

1.1 Definition of the construction product

The steel plate with cast-in KÖCO-headed studs consists of one or more headed studs which are welded-on to a steel plate. The headed studs and the plate consist of steel or stainless steel. The headed studs have a diameter of the shaft of 10, 13, 16, 19, 22 and 25 mm. At one end a head is formed by upsetting. The other end is prepared for drawn arc stud welding with ceramic ferrule or shielding gas (method 783 according to EN ISO 4063:2002-02).

The product is surface-flush anchored in the concrete.

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

1.2 Intended use

The steel plate with welded-on headed studs is intended for uses where requirements concerning mechanical resistance and stability as well as safety in use in the sense of the Essential Requirements ER1 and ER4 of the Directive 89/106/EEC shall be satisfied and where failure of the anchorage may cause risk to human life and health and/or lead to considerable economic consequences.

The steel plate with welded-on headed studs is to be used for the anchorage under static or quasi static actions as well as under not predominantly static actions (fatigue actions) in reinforced normal concrete of the minimum strength class C20/25 according to EN 206-1:2000-07. The construction product may be anchored in cracked and non-cracked concrete. The anchorage is admissible with single studs or groups of studs, which consist of two up to nine headed studs. The construction product can be stressed by a tensile load, shear load or a combination of tensile and shear loads.

Further steel components may be welded-on to the steel plate on the side which is not cast-in.

The intended use of the steel plate with welded-on headed studs concerning corrosion is given in Annex 4, Table 2 and 3 depending on the chosen material.

The provisions made in this European technical approval are based on an assumed working life of the product 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 method of verification

2.1 Characteristics of the product

2.1.1 General

The characteristic material values, dimensions and tolerances of the product not indicated in the Annexes shall correspond to respective values laid down in the technical documentation⁷ of this European technical approval.

⁷ The technical documentation for this European technical approval is deposited at 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.

Regarding the requirements concerning safety in case of fire (ER 2) it is assumed that the construction product 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 200/605/EC.

The characteristic values for the design calculation of the anchorage are given in Annexes 5 to 7.

2.1.2 Headed stud

The headed studs made of steel and stainless steel according to EN ISO 13918:2008 "Studs and ceramic ferrules for arc stud welding" shall correspond to the materials, mechanical properties and dimensions given in Annex 3, Table 1 and Annex 4, Table 2 and 3.

It is also permissible to use two headed studs welded one on top of the other by arc stud welding (see Annex 2). A padded ring is to be placed under the head of the first stud. The padded ring is to be secured in its position to make a permanent compression of ≥ 5 mm possible. The padded ring can be made, for example, of technical felt or cellular rubber. The external diameter of the padded ring shall exceed the head diameter and the inside diameter shall be less than the shaft diameter. The padded ring shall prevent a contact of the lower head at the concrete and a transmission of loads by the lower stud head.

2.1.3 Marking

Each headed stud is marked with the identifying mark of the producer and if applicable with the type of stainless steel according to Annex 3.

2.2 Methods of verification

2.2.1 General

The assessment of the fitness of the product for the intended use with regard to the requirements of mechanical resistance and stability as well as safety in use in the sense of the Essential Requirements 1 and 4 was performed based on the following verifications:

Verifications for tension loads for

- | | |
|--|-----------------------|
| 1. Steel failure - headed stud | $N_{Rk,s}$ |
| 2. Concrete failure - pullout | $N_{Rk,p}$ |
| 3. Concrete failure - concrete cone | $N_{Rk,c}$ |
| 4. Concrete failure - splitting due to loading | $N_{Rk,sp}$ |
| 5. Concrete failure - blow-out | $N_{Rk,cb}$ |
| 6. Reinforcement | $N_{Rk,re}, N_{Rd,a}$ |
| 7. Displacement under tension loads | δ_N |

Verifications for shear loads for

- | | |
|-------------------------------------|-----------------------|
| 1. Steel failure without lever arm | $V_{Rk,s}$ |
| 2. Concrete failure - pry-out | $V_{Rk,cp}$ |
| 3. Concrete failure - concrete edge | $V_{Rk,c}$ |
| 4. Reinforcement | $N_{Rk,re}, N_{Rd,a}$ |
| 5. Displacement under shear loads | δ_V |

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/EEC of the European Commission⁸ system 2(i) (referred to as System 1) of the 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 control 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 Responsibility

3.2.1 Tasks for 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 relating to this European technical approval 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 with 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 for the 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.

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

⁹ The control plan is a confidential part of the European technical approval 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 for the 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 the packaging. 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 manufacture),
- the last two digits of the year in which the CE marking was affixed,
- number of the EC certificate of conformity for the product,
- number of the European technical approval,
- name of the product.

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

The fitness of the product for the intended use is given under the following condition:

The design of the anchorage is based on CEN/TS 1992-4:2009 "Design of fastenings for use in concrete", part 1 and 2 under the responsibility of an engineer experienced in anchorages and concrete building.

It is generally assumed that the concrete is cracked and that the occurring splitting forces are resisted by the reinforcement. The required cross section of the minimum reinforcement is determined according CEN/TS 1992-4-2:2009 section 6.2.6.2 b).

Taking into account the loads to be anchored verifiable calculation notes and drawings are prepared.

The position of the product is indicated on the design drawings (e.g. position of the headed studs towards the reinforcement or the supports).

On the anchorage of not predominantly static action the following characteristic range of steel stresses may not be exceeded:

- tensile load $\Delta\sigma$ = 100 N/mm²
- shear load $\Delta\tau$ = 35 N/mm²
- hanger reinforcement $\Delta\sigma$ = 60 N/mm²

The partial safety factor for fatigue strength $\gamma_{Ms, fat} = 1.35$ shall be applied.

4.3 Installation

4.3.1 Welding of the headed studs on the steel plate

4.3.1.1 General

For the safeguarding of the quality assurance of the welded connection the provisions of EN ISO 14555:2006 "Welding - Arc stud welding of metallic materials" and EN ISO 3834:2005 "Quality requirements for fusion welding of metallic materials" shall apply for the executing company. The level of quality requirements shall correspond to EN ISO 3834-2:2005 "Part 2: Comprehensive quality requirements".

4.3.1.2 Steel plates

The steel plates, on which headed studs of steel S235J2+C470 according to Annex 4, Table 2 will be welded, shall consist of the materials S235JR, S235JO, S235J2, S355JO or S355J2 according to Annex 4, Table 2.

The steel plates, on which headed studs of stainless steel (1.4301; 1.4303) according to Annex 4, Table 3 will be welded, shall consist of the stainless steel 1.4571 or 1.4401 according to Annex 4, Table 3.

Because of the stress of the steel plate in the direction of the thickness a possibly not homogeneous structure of the steel plate in this direction shall be taken into account. At the same time the risk of lamellar tearing as well as lamellar imperfections in the steel plate shall be paid attention to.

For not predominantly static loads ultrasonic tested steel plates shall be used.

The material and dimensions of the steel plate shall be according the design drawings.

4.3.1.3 Welded connection

The headed studs shall be welded to the steel plate by means of drawn arc stud welding with ceramic ferrules or shielding gas in accordance with EN ISO 14555:2006. Welding of the headed studs via arc stud welding may be performed in the manufacturing plant or on the construction site

For the welding of headed studs on the steel plate the executing company shall have a valid acceptance for arc stud welding according EN ISO 14555.

The material, the size and position of the headed studs shall be according to the design drawings.

4.3.2 Setting steel plates with headed studs in concrete

The fitness of the anchorage for the intended use can be assumed only, if the following installation conditions are kept:

- Installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters on site.
- Use of the product only as supplied by the manufacturer.
- Installation in accordance with the manufacturer's specifications and the design drawings with exact position of the steel plate.
- The anchorage is fixed to the formwork or auxiliary constructions in a way that no movement of the product will occur during placing of reinforcement or during placing and compacting of the concrete.
- The concrete under the head of the headed stud is properly compacted (no significant voids). For large fixtures (steel plate > 400 mm x 400 mm) vent openings are provided. These are specified in the installation instructions.
- Compliance with the installation parameters.

Welding-on of the intended and designed steel components to the cast-in construction product may only be performed by companies meeting the corresponding quality requirements for welding according to EN ISO 3834:2005 "Quality requirements for fusion welding of metallic materials ". The quality level shall be according EN ISO 3834-2:2005 "Part 2: Comprehensive quality requirements".

5 Responsibility of the manufacturer

It is in the responsibility of the manufacturer to ensure that the information on the specific conditions according to 1 and 2 including Annexes referred to and 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).

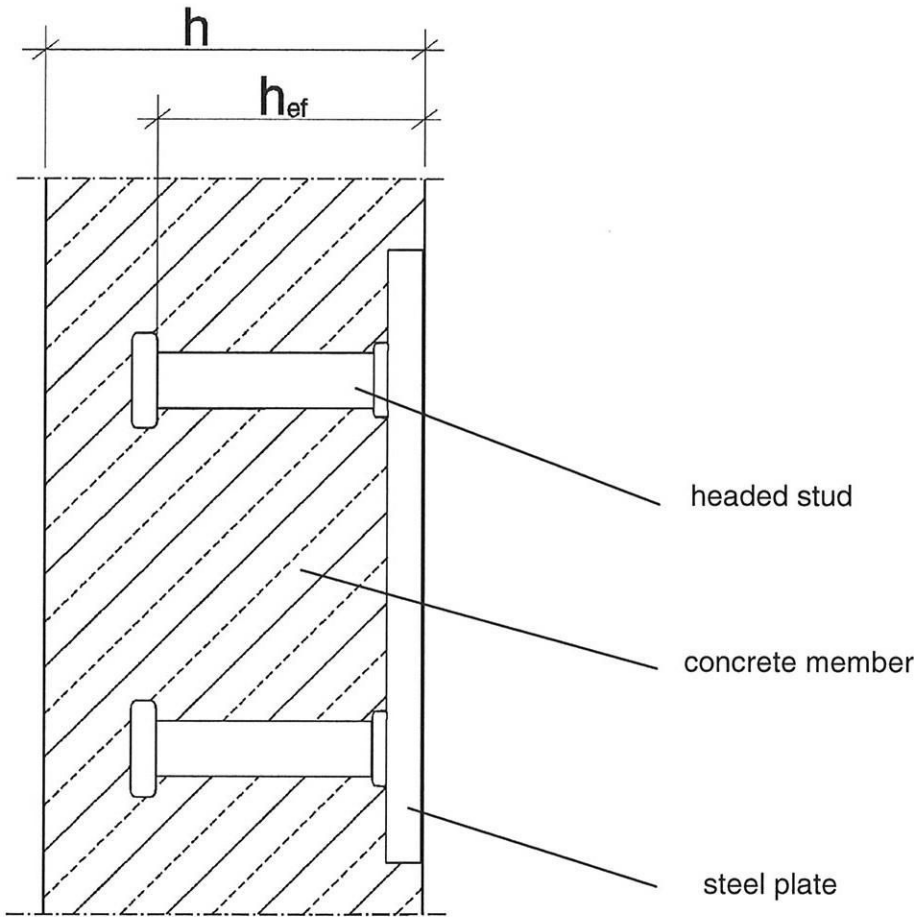
The minimum data required are:

- diameter of the headed studs,
- length of the headed studs,
- material of the headed studs.

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

Georg Feistel
Head of Department

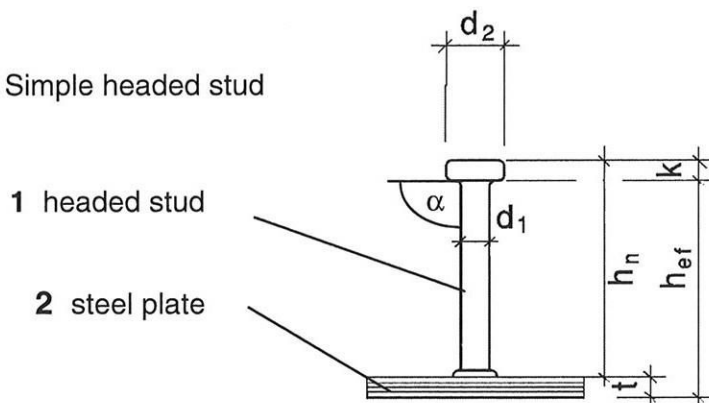
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h_{ef} = effective anchorage depth
 h = thickness of concrete member

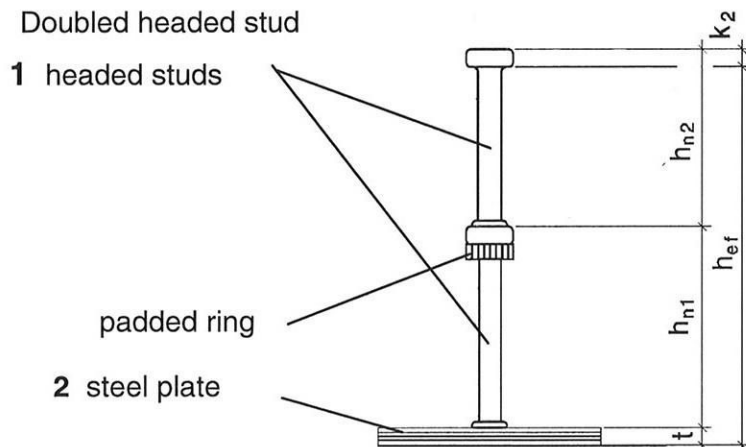
Steel plate with cast-in KÖCO headed studs made of steel and stainless steel	Annex 1 of the European technical Approval ETA-03/0039
Product and intended use	

Fig. 1: Simple headed stud

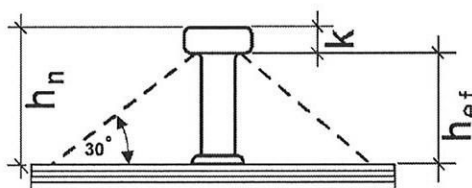


$$h_{ef} = h_n - k + t \quad (1)$$

Fig. 2: Doubled headed stud



$$h_{ef} = h_{n1} + h_{n2} - k_2 + t \quad (2)$$

Fig. 3: Short headed stud, if the theoretic cone meets the steel plate at an angle of $\sim 30^\circ$ 

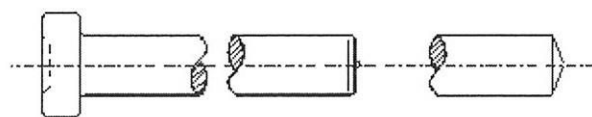
$$h_{ef} = h_n - k \quad (3)$$

- d_1 = diameter of shaft
 d_2 = diameter of head
 h_{ef} = effective anchorage depth
 h_n = nominal length of the headed stud (after welding)
 k = thickness of the head
 t = thickness of the steel plate
 α = 90°

**Steel plate with cast-in KÖCO headed studs
made of steel and stainless steel**

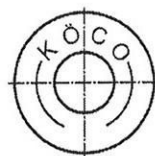
Details of the welded-on construction product

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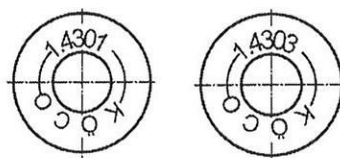
Marking

Form A

Form B

Steel

Marking:
 Manufacturer = KÖCO
 steel = without

Stainless steel

Marking:
 Manufacturer = KÖCO
 Stainless steel = 1.4301/ 1.4303

Table 1: Dimensions

Headed stud type	Shaft \varnothing d1-0,4 mm	Head \varnothing d2 mm	Nominal length		thickness of the head k mm
			min h _N mm	max h _N mm	
10	10	19	50	200	7.1
13	13	25	50	400	8
16	16	32	50	525	8
19	19	32	75	525	10
22	22	35	75	525	10
25 ¹⁾	25	40	75	525	12

¹⁾ Headed stud size 25 only of material S235J2 or S355

**Steel plate with cast-in KÖCO headed studs
 made of steel and stainless steel**

Marking,
 dimensions

Annex 3
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Table 2: Materials steel

Part	Denomination	Material	Mechanical properties	Intended use
1	Headed stud according to EN ISO 13918:2008, Type: SD1	S235J2+C470 or S355 acc. EN 10025:2005 (Conforms to material group 1 ISO/TR 15608 within the limits: $C \leq 0,2\%$ $AL \geq 0,02\%$)	$f_{uk} \geq 470 \text{ N/mm}^2$ $f_{yk} \geq 375 \text{ N/mm}^2$	Steel plates with welded on headed studs may only be used in structures subject to dry internal conditions
2	Steel plate	Steel S235JR; S235JO; S235J2 according to EN 10025:2005	$f_{uk} = 340-470 \text{ N/mm}^2$, $f_{yk} = 225 \text{ N/mm}^2$	
		S355JO; S355J2 according to EN 10025:2005	$f_{uk} = 510-680 \text{ N/mm}^2$, $f_{yk} = 345 \text{ N/mm}^2$	

Table 3: Materials stainless steel

Part	Denomination	Material	Mechanical properties	Intended use
1	Headed stud according to EN ISO 13918:2008, Type:SD3	Stainless steel 1.4301; 1.4303 according to EN 10088:2005	$f_{uk} \geq 540-780 \text{ N/mm}^2$, $f_{yk} \geq 350 \text{ N/mm}^2$	Steel plates with welded on headed studs may also be used 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).
2	Steel plate	Stainless steel 1.4571; 1.4401 according to EN 10088:2005	$f_{uk} = 530-680 \text{ N/mm}^2$, $f_{yk} = 220 \text{ N/mm}^2$	

**Steel plate with cast-in KÖCO headed studs
made of steel and stainless steel**

Materials
Intended use

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Table 4: Installation parameters for headed studs made of steel and stainless steel

Nominal size (mm)		10	13	16	19	22	25 ¹⁾
anchorage depth	$\min h_{ef}$ [mm]	50	50	50	75	75	75
minimum spacing	s_{min} [mm]	50	70	80	100	100	100
minimum edge distance	c_{min} [mm]	50	50	50	70	70	100
minimum thickness of concrete member	h_{min} [mm]	$h_{ef} + k + c_{nom}$ ²⁾					

¹⁾ Headed stud size 25 only of material S235J2 or S355

²⁾ c_{nom} = required concrete cover according to national regulations

Arrangement of the headed studs

Regulations for the arrangement of the headed studs on the plate are given in CEN/TS 1992-4-1:2009, section 1.2.3.

**Steel plate with cast-in KÖCO headed studs
made of steel and stainless steel**

Installation parameters,
Arrangement of the headed studs

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Table 5: Characteristic values of resistance to tensile load for headed studs of steel and stainless steel

Headed stud – nominal size		10	13	16	19	22	25 ²⁾	
Steel failure for headed studs made of steel								
Characteristic resistance		N _{Rk,s} [kN]	37	62	94	133	179	231
Partial safety factor		γ _{Ms} ¹⁾	1.5					
Steel failure for headed studs made of stainless steel								
Characteristic resistance		N _{Rk,s} [kN]	42	72	109	153	205	--
Partial safety factor		γ _{Ms} ¹⁾	1.85					
Pull-out failure for cracked concrete								
Characteristic resistance		N _{Rk,p} [kN]	30	50	90	75	85	115
Increasing factors ψ for the characteristic resistance		C25/30	1.20					
		C30/37	1.48					
		C35/45	1.80					
		C40/50	2.00					
		C45/55	2.20					
		C50/60	2.40					
Partial safety factor		γ _{Mp} ¹⁾	1.5					
Concrete cone failure								
Effective anchorage depth		h _{ef} [mm]	h _n – k + t ³⁾					
factor to take into account the influence of load transfer mechanisms	cracked concrete	k _{cr} [-]	8.5					
	uncracked concrete	k _{ucr} [-]	11.9					
Characteristic spacing		s _{cr,N} = s _{cr,sp} ⁴⁾ [mm]	3h _{ef}					
Characteristic edge distance		c _{cr,N} = c _{cr,sp} ⁴⁾ [mm]	1.5h _{ef}					
Partial safety factor		γ _{Mc} ¹⁾	1.5					
Blow-out failure								
Partial safety factor		γ _{Mcb} ¹⁾	1.5					

¹⁾ In absence of other national regulations.

²⁾ Headed stud size 25 only of material S235J2 or S355

³⁾ For simple headed studs (For doubled headed studs resp. short headed studs see Fig. 2 resp. 3, Annex 2)

⁴⁾ Reinforcement resists the splitting forces and limits the crack width to $w_w \leq 0.3$ mm.

Table 6: Displacement under tensile load

Headed stud – nominal size	10	13	16	19	22	25 ²⁾
Displacements ¹⁾ to 0.7 mm under following loads in [kN]	14	20	25	30	35	45

¹⁾ The indicated displacements are valid for short term loading, the displacements can be increased under long term loading to 1.8 mm.

²⁾ Headed stud size 25 only of material S235J2 or S355

**Steel plate with cast-in KÖCO headed studs
made of steel and stainless steel**

Characteristic values of resistance to tensile load,
displacement

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Table 7: Characteristic values of resistance to shear load for headed studs of steel and stainless steel

Headed stud – nominal size		10	13	16	19	22	25 ²
Steel failure for headed studs made of steel							
Characteristic resistance	$V_{Rk,s}$ [kN]	22	37	57	80	107	138
Partial safety factor	γ_{Ms} ¹⁾	1.25					
Steel failure for headed studs made of stainless steel							
Characteristic resistance	$V_{Rk,s}$ [kN]	25	43	65	92	123	--
Partial safety factor	γ_{Ms} ¹⁾	1.54					
Concrete pry-out failure							
Factor in equation (5.6) to Annex C section 5.2.3.3 of ETAG 001, $N_{Rk,c}$ according to Annex 7, section 3.3	k_3 ³⁾	2.0					
Partial safety factor	γ_{Mcp} ¹⁾	1.5					
Concrete edge failure							
Effective length of the headed stud	$l_f = h_{ef}$ [mm]	$h_n - k + t$ ⁴⁾					
Effective outside diameter	$d_{nom} = d_1$ [mm]	10	13	16	19	22	25
Partial safety factor	γ_{Mc} ¹⁾	1.5					

¹⁾ In absence of other national regulations.²⁾ Headed stud size 25 only of material S235J2 or S355³⁾ In case of supplementary reinforcement the factor k_3 shall be multiplied with 0.75⁴⁾ For simple headed studs (For doubled headed studs resp. short headed studs see Fig. 2 resp. 3, Annex 2)**Table 8: Displacements under shear load**

Headed stud – nominal size	10	13	16	19	22	25 ²
Displacements ¹⁾ to 1.5 mm under following loads in [kN]	15	20	30	45	60	75

¹⁾ The indicated displacements are valid for short term loading, the displacements can be increased under long term loading to 2.0 mm.²⁾ Headed stud size 25 only of material S235J2 or S355**Combined tension and shear load**The factor k_7 is for combined tension and shear load according CEN/TS 1992-4-2:2009, section 6.4.1.3

$$k_7 = \frac{2}{3}$$

Steel plate with cast-in KÖCO headed studs made of steel and stainless steel

Characteristic values of resistance to shear load, displacements, combined tension and shear load

Annex 7
of the European
technical approval
ETA-03/0039