BUILDING RESEARCH INSTITUTE
FILTROWA 1, 00-611 WARSZAWA, POLAND
tel.: (4822) 8250471, (4822) 8257655; fax: (4822) 8255286

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TECHNICAL APPROVAL series

TECHNICAL APPROVAL ITB
AT-15-7728/2016

On the grounds of the decree of the Minister of Infrastructure of 8 November 2004 on technical approvals in construction and organizations authorized for their issuing (consolidated text: Polish Journal of Law of 2014, item 1040), following the approval proceedings carried out by the Building Research Institute (ITB) in Warsaw on the application of the company

TRUTEK FASTENERS POLSKA Sp. z o.o
Al. Krakowska 55, Sękocin Nowy, 05-090 Raszyn

it is hereby stated that the products named:

Steel expansion anchors
TT-THROUGHBOLT

are approved for use in construction to the extent and on the terms set forth in the Enclosure which is an integral part of this ITB Technical Approval.

Term of validity:
22 September 2021

Enclosure:
General and Technical Provisions

INSTYTUT TECHNIKI BUDOWLANEJ

DYREKTOR
Instytutu Techniki Budowlanej
dr inż. Marcin M. Kruk

Warsaw, 22 September, 2016

ENCLOSURE

GENERAL AND TECHNICAL PROVISIONS

LIST OF CONTENTS

1. SUBJECT OF THE APPROVAL

The subject of this Technical Approval are steel expansion fasteners type TT-THROUGHBOLT manufactured by the TRUTEK FASTENERS LIMITED company, Trutek House, Brooklands Business Park, Leigh Street, Sheffield S9 2PR, Great Britain.

TT-THROUGHBOLT fasteners are manufactured in four versions: TT-, TT-G, TT-SS and TWH. The TT and TWH fasteners are made of ordinary steel and covered with an electrolytic zinc-coated protective layer, fasteners labeled TT-G are made of ordinary steel and protected with hot dip zinc coating, the TT-SS fasteners are made of stainless steel.

Components of TT-THROUGHBOLT expansion fasteners in the TT, TT-G and TT-SS versions are: a threaded stud ended with an expansion cone, an expansion sleeve, a hex nut and a washer; the TWH version consist o a non-threaded stud with round hole ended with an expansion cone and expansion sleeve (Figure 1). The dimensions of the fasteners are shown in Figures 2 and 3 and specified in Table 1.

The thickness of the protective electrolytic zinc coating of (TT and TWH) is not less than 5 μm, and hot dip zinc coating (TT-G fastener) is not less than 43 μm.

By tightening the nut of a TT-THROUGHBOLT fastener in TT, TT-G and TT-SS versions, or by striking the stud of the TWH version, the expansion sleeve is forced to slide over the expansion cone and expand the sections of the nicked expansion sleeve, thus resulting in a firm anchoring of the fastener. Fastenings made with use of TT-THROUGHBOLT fasteners are shown in Figures 4 and 5.

The required technical characteristics of the TT-THROUGHBOLT fasteners are given in Section 3.

2. PURPOSE, RANGE AND CONDITIONS OF USE

TT-THROUGHBOLT expansion fasteners are used for fastening construction elements with static loading in ordinary or reinforced concrete, non-cracked or cracked, of the C20/25 to C50/60 class according to the PN-EN 206:2014 standard.

For the reason of the corrosive aggressiveness of the environment, the TT and TT-G expansion fasteners shall be used according to the requirements given in the PN-EN ISO 2081:2011, PN-EN ISO 12944-2:2001 and PN-EN ISO 9223:2012 standards, while the TT-SS fasteners made of stainless steel grade 1.4401, 1.4404 or 1.4571 shall be used according to requirements of PN-EN 10088-1:2014 (Section 3.1) specified for the steel grades OH17N12M2T, OH17N14M2T or H17N13M2T respectively.

The calculated tensile load capacity of fastenings made with use of TT-THROUGHBOLT expansion fasteners is given in Tables 2 and 3.

The calculated share load capacity of fastenings made with use of TT-THROUGHBOLT fasteners when the anchoring depth h_{ef} is less or equal to 60 mm shall be assumed equal to their tensile load capacity, given in Tables 2 and 3, divided by a partial safety factor of 1.25.

The calculated shear load capacity for TT-THROUGHBOLT fasteners in the cases when the anchoring depth h_{ef} is more than 60 mm shall be determined as follows:

$$V_{sd} = \frac{0{,}5 \times A_s \times f_{uk}}{\gamma_{Ms}}$$

where:

A_s – stud cross section according to PN-EN-ISO 898-1:2013
f_{uk} – characteristic tensile strength of the stud material acc. to PN-EN-ISO 898-1:2013
γ_{Ms} – partial safety factor, assumed equal to 1.25

The parameters of spacing and installation of TT-THROUGHBOLT fasteners are shown in Figures 6 through 8 and specified in Tables 4 and 5.

A hammer drill should be used to make a hole in base material for fastening. The hole should be drilled perpendicularly to the surface of the base material. It should be possible to insert the fastener into the hole in the base material with light strikes of a hammer.

The installation of TT-THROUGHBOLT fasteners in TT, TT-G and TT-SS versions should be done with use of a torque spanner. Care should be taken that the washer under the nut or screw head be firmly tightened to the element being fastened. The TT-THROUGHBOLT fastener in the TWH version is installed by inserting it in the hole and hammering its stud.

TT-THROUGHBOLT fasteners shall be used according to the design developed with respect to the requirements of the respective Polish standards, construction related regulations and this Technical Approval, as well as manufacturer's instructions concerning the conditions of making fastenings with their use.

3. TECHNICAL FEATURES, REQUIREMENTS

3.1. Materials

TT, TT-G and TWH expansion fasteners shall be made of ordinary carbon steel grade of the mechanical properties class not less than 4.8 according to the PN-EN ISO 898-1:2013 standard. TT and TWH fasteners shall be plated with minimum 5 µm thick zinc coating

complying with the PN-EN ISO 4042:2001/Ap1:2004 standard; TT-G shall be plated with hot dip zinc coating not less than 43 μm complying with the requirements of the PN-EN ISO 1461:2011. TT-SS expansion fasteners shall be made of stainless steel grade 1.4401 (A4-70), 1.4404 (A4-70) or 1.4571 (A4-70) according to PN-EN 10088-1:2014 and PN-EN ISO 3506-1:2009.

3.2. Expansion fasteners

3.2.1. Shape and dimensions. The shape and dimensions of TT-THROUGHBOLT expansion fasteners shall conform to Figures 1 through 3 and the parameters given in Table 1, observing the dimension tolerances in compliance with the PN-EN 22768-1:1999 standard, tolerance class *m*.

3.2.2. Characteristic load capacities of fastenings. The characteristic load capacities of fastenings made with use of TT-THROUGHBOLT expansion fasteners shall not be less than given in Tables 7 and 8.

4. PACKING, STORING AND SHIPPING

TT-THROUGHBOLT expansion fasteners shall be supplied in manufacturer's packaging and shipped and stored in a way ensuring stability of their properties. An information card shall be attached to each package, including at least the following data:

- product name,
- manufacturer name and address,
- technical approval number, ITB AT-15-7728/2016,
- number and date of the national conformity statement,
- name of the certifying entity that participated in the assessment of conformity,
- type of material,
- basic conditions of use and storing,
- construction conformity mark.

The way of construction conformity marking shall be in accordance with the decree of the Minister of Infrastructure of 11 August 2004 on declaring the conformity of construction products and the manner of their marking with a construction conformity mark (Polish Journal of Law No. 198/2004, item 2041, with later amendments).

In addition, if other regulations impose an obligation to mark the product according to the decree of the Minister of Health of 20 April 2012 on the marking of the packages of

dangerous substances and mixtures and specific mixtures (consolidated text: Polish Journal of Law of 2015, item 450) and Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC and amending Regulation (EC) No 1907/2006 (CLP), and to attach information describing the risks to life and health as resulting from the characteristics card conforming to the Regulation (EC) No 1907/2006 (with amendments) of the European Parliament and of the Council, concerning the registration, evaluation, authorization and restriction of chemicals (REACH), documentation in suitable form shall be attached to the product, including the marking and information required by the respective legal regulations.

5. CONFORMITY ASSESSMENT

5.1. General Rules

According to articles 4 and 5, paragraph 1, item 3, and article 8, paragraph 1, of the act of 16 April 2004 on construction products (Polish Journal of Law No. 92/2004, item 881, with later amendments), the products to which this Technical Approval applies can be put on the market and used in construction works in the range corresponding to their usable properties and purpose, provided their Manufacturer has conducted conformity assessment, issued the statement of conformity with the Technical Approval ITB AT-15-7728/2016 and marked the products with a construction conformity mark as required by the legally binding regulations.

According to the decree of the Minister of Infrastructure of 11 August 2004, on declaring the conformity of construction products and the manner of their marking with the construction conformity mark (Polish Journal of Law No. 198/2004, item 2041, with later amendments), conformity assessment for the products to which the Technical Approval ITB AT-15-7728/2016 is applicable shall be carried out by the Manufacturer (or their authorized representative based on the territory of the Republic of Poland) using assessment system 1.

Using assessment system 1, the Manufacturer can issue a national statement of conformity with the Technical Approval ITB AT-15-7728/2016 if an accredited certifying entity has issued a conformity certificate of the product on the basis of:

a) Manufacturer's obligations:
   - factory production process inspection,
   - supplementary inspection tests of finished products (samples) at the production

plant, carried out by the Manufacturer according to an agreed test plan, including tests according to section 5.4.3;

b) Accredited certifying entity obligations:
   - preliminary tests of product type,
   - preliminary inspection of the production plant and its production control system,
   - continuous supervision, assessment and approval of the factory production control system.

5.2. Preliminary Tests of the Product Type

Preliminary tests of product types are carried out to confirm the required technical and functional properties of a product prior to placing it on the market.

Preliminary tests of TT-THROUGHBOLT expansion fasteners include the calculated load capacities of fastenings made with their use and the thickness of their zinc coating.

The tests conducted in the approval procedure as the basis for the determination of the technical and functional properties of the product are considered the preliminary tests of the product type in its conformity assessment.

5.3. Factory Production Process Inspection

Factory production process inspection includes:

1) specification and checking of product components and materials,
2) inspection and tests in the manufacturing process and tests of finished products (Section 5.4.2) carried out by the Manufacturer according to an agreed test plan and in conformity with the principles and procedures stipulated in the documents of the factory quality control system, adjusted to the particular production technology and aimed at obtaining products of required properties.

Production process inspection should ensure that the product conforms to the Technical Approval ITB AT-15-7728/2016. The results of production inspection should be registered on a regular basis, the register confirming that the products meet the conformity criteria. Individual products or product batches and related production details should be unambiguously identifiable and reconstructible.

5.4. Tests of Finished Products

5.4.1. Test Plan. The test plan includes:

a) current tests,

b) supplementary tests.

5.4.2. Current Tests. The current tests include:

a) checking of the shape and dimensions,

b) checking of the zinc coating.

5.4.3. Supplementary Tests. Supplementary tests include checking of the characteristic load capacities of fastenings made with fasteners under test.

5.5. Frequency of Tests

Tests shall be conducted according to an agreed test plan, but at least for each batch of products. The volume of the product batch to be tested shall be specified in the respective documentation of the factory production inspection system.

Supplementary tests shall be conducted at least once in three years.

5.6. Test Procedures

5.6.1. Checking the shape and dimensions of fasteners. The shape and dimensions of fasteners shall be checked with use of measuring instruments that provide the required measurement accuracy.

5.6.2. Checking the thickness of zinc coating. The thickness of the zinc coating of fasteners shall be checked according to the PN-EN ISO 2178:1998 standard.

5.6.3. Checking the characteristic load capacities of seated fasteners. Checking of the characteristic load capacities of seated fasteners shall be carried out according to the Guidelines for European Technical Approvals ETAG 001:2013, parts 1 and 2, option 1, on fasteners seated in the base materials specified in Tables 7 and 8. Measurements of force shall be made with use of an instrument having a measurement range adequate to the expected destructive force and featuring continuous and slow increase of the test force until it becomes destructive. The measurement error shall not exceed 3% in the whole measurement range.

5.7. Drawing Samples for Tests

Samples for tests shall be drawn according to the PN-/N-03010:1983 standard.

5.8. Test Result Evaluation

Manufactured products shall be considered as conforming to this ITB Technical Approval if the results of all the tests are positive.

6. FORMAL AND LEGAL STATEMENTS

6.1. The Technical Approval ITB AT-15-7728/2016 substitutes the Technical Approval ITB AT-15-7728/2015.

6.2. The Technical Approval ITB AT-15-7728/2016 is a document that confirms the suitability of TT-THROUGHBOLT expansion fasteners for use in construction in the extent following from the provisions of this Technical Approval.

According to articles 4 and 5, paragraph 1, item 3, and article 8, paragraph 1, of the act of 16 April 2004 on construction products (Polish Journal of Law No. 92/2004, item 881) the products to which this Technical Approval applies can be put on the market and used in construction works in the range corresponding to their usable properties and purpose, provided their Manufacturer has conducted conformity assessment, issued a national statement of conformity with the Technical Approval ITB AT-15-7728/2016 and marked the products with a construction conformity mark required by the legally binding regulations.

6.3. This ITB Technical Approval does not breach the rights resulting from the respective industrial property regulations, in particular those resulting from the act of 30 June 2000 – Industrial Property Law (Polish Journal of Law of 2013, item 1410, with later amendments). The provision of those rights is legal obligation of the users of this ITB Technical Approval.

6.4. The Building Research Institute (ITB), issuing this Technical Approval, does not take responsibility for possible violation of exclusive or acquired rights.

6.5. This Technical Approval does not release the Manufacturer from responsibility for the proper quality of products, and the executors of construction works – from responsibility for their proper use.

6.6. Information about the Technical Approval ITB AT-15-7728/2016 granted to TT-THROUGHBOLT expansion fasteners should be provided in leaflets, announcements and other documents related to their marketing and use in construction.

7. VALIDITY PERIOD

The ITB Technical Approval AT-15-7728/2016 is valid till 22 September 202. Its validity can be extended for successive periods if the applying entity or its legal successor apply again to the Building Research Institute not later than 3 months prior to the expiry date of the document.

End

8. ADDITIONAL INFORMATION

Related Standards and Documents

PN-EN 206-1:2014	*Concrete. Requirements, properties, production and conformity*
PN-EN ISO 2081:2011	*Metals and other non-organic coating. Electrolytic zinc coating with additional processing on iron and steel*
PN-EN ISO 12944-2:2001	*Paints and lacquers. Corrosion protection of steel constructions by means of protective painting systems. Part 2: Classification of environments*
PN-EN ISO 9223:2012	*Corrosion of metals an alloys. Corrosivity of atmospheres, classification, definitions and evaluation*
PN-EN 10088-1-2014	*Stainless steels. Part 1: List of stainless steels*
PN-H-86020:1971	*Corrosion resistant steel (stainless, acid proof). Brands*
PN-EN ISO 898-1:2013	*Mechanical properties of fasteners made of carbon steel and alloy steel. Bolts, and double-nutted bolts*
PN-EN 4042:2001/ Ap1:2004	*Fasteners. Electrolytic coating*
PN-EN ISO 1461-2011	*Hot dip galvanized coatings on fabricated iron and steel articles – specifications and test methods*
PN-EN ISO 3506-1:2000	*Mechanical properties of fasteners made of corrosion resistant stainless steel. Bolts, and double-nutted bolts*
PN-EN 10277-3:2009	*Bright steel products. Delivery Technical Conditions. Part 3: free-cutting steels*
PN-EN ISO 2178:1998	*Non-magnetic coating on magnetic materials. Measurement of coating thickness. Magnetic method*
PN-N-03010:1983	*Statistical quality control. Random selection of product samples*
PN-EN 22768-1:1999	*General tolerances. Linear and angular dimension tolerances without individual tolerance indications*
TR 020	*Evaluation of anchorages in concrete concerning resistance to fire*
ETAG 001:2013, part 1	*Guideline for European Technical Approval of metal anchors for use in concrete. Part 1: Anchors in general*

ETAG 001:2013, part 2	*Guideline for European Technical Approval of metal anchors for use in concrete. Part 2: Torque-controlled expansion anchors*

Tests and Assessments

1) LOK-905/A/07. *Report of the tests and technical evaluation of TT steel expansion fasteners with ring sleeve. Building Research Institute, Silesian Division, Katowice, 2008*
2) LOK-02844/14/R11OSK. *Report of the tests and supplementary information concerning TT-THROUGHBOLT expansion fasteners. Building Research Institute, Department of Construction Elements and Construction for Mining Industry, Katowice, 2014*
3) NZK-01711R:09/DD/15. *Supplementary opinion on TT-THROUGHBOLT expansion fasteners. Building Research Institute, Department of Construction Structures and Geotechnics, Katowice, 2016*

FIGURES AND TABLES

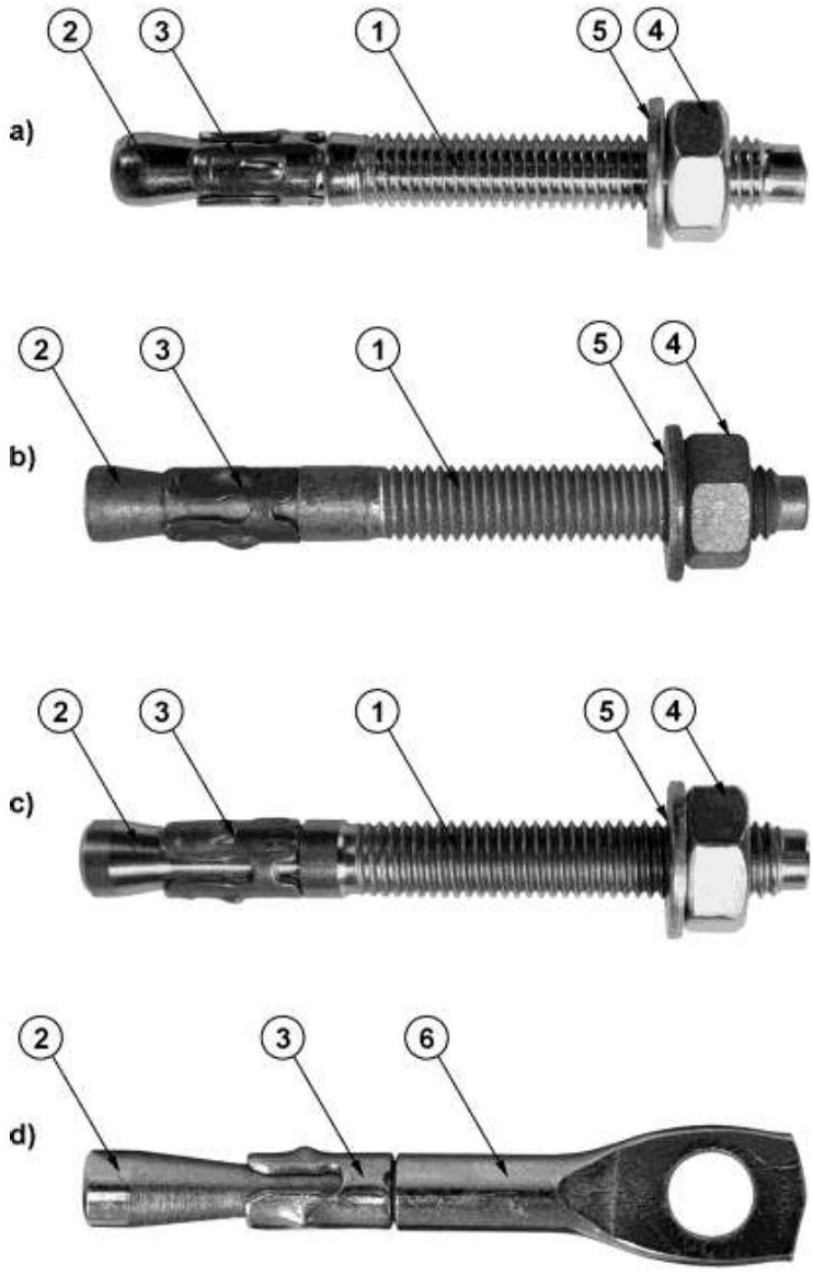

Figure 1. TT-THROUGHBOLT steel expansion fasteners

a) TT fastener made of electrolytically zinc coated ordinary carbon steel,

b) TT-G fastener made of hot dip zinc coated ordinary carbon steel,

c) TT-SS fastener made of stainless steel

d) TWH fastener made of electrolytically zinc coated ordinary carbon steel

1 – threaded stud, 2 – expansion cone, 3 – expansion sleeve,
4 – hex nut, 5 – washer, 6 – plain stud with eye

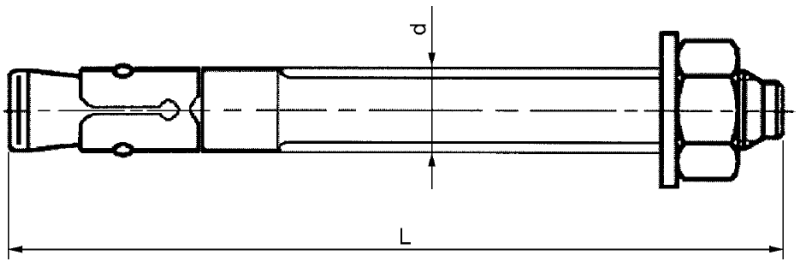

Figure 2. TT-THROUGHBOLT steel expansion fasteners dimensions, versions TT, TT-G and TT-SS

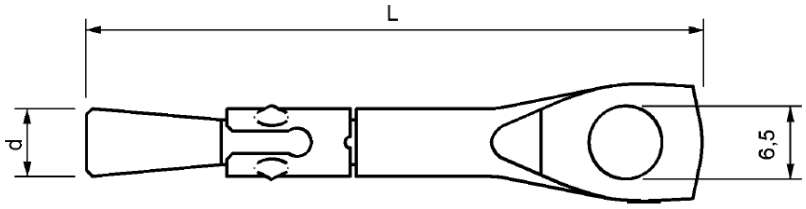

Figure 3. TT-THROUGHBOLT steel expansion fasteners dimensions, version TWH

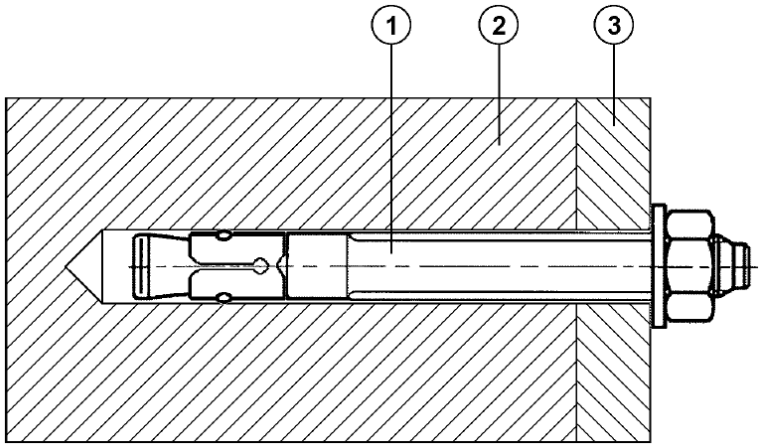

Figure 4. Fastening made with use of a TT-THROUGHBOLT steel expansion fastener of TT, TT-G and TT-SS versions

1 – expansion fastener, 2 – base material, 3 – fastened element

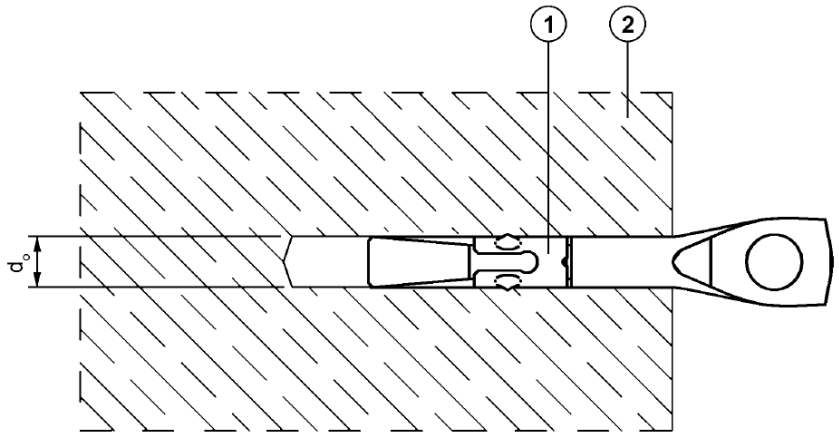

Figure 5. Fastening made with use of a TT-THROUGHBOLT steel expansion fastener of TWH version
1 – expansion fastener, 2 – base material

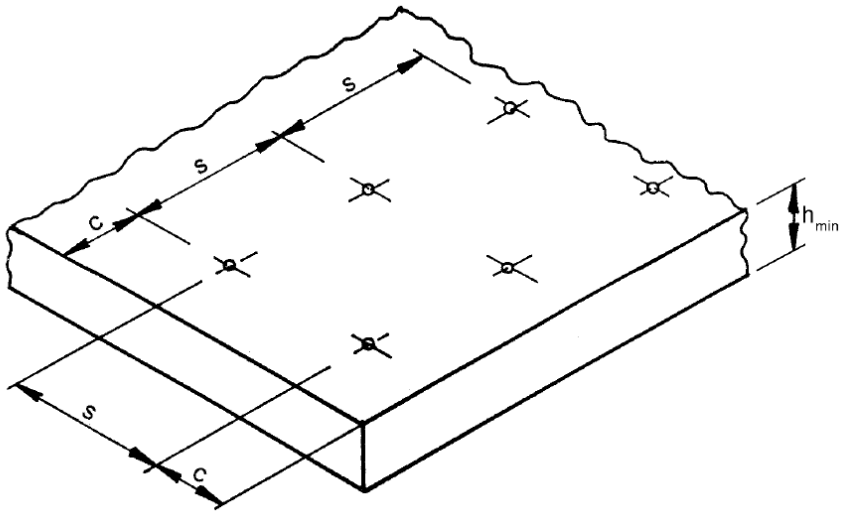

Figure 6. Spacing of TT-THROUGHBOLT fasteners in base material

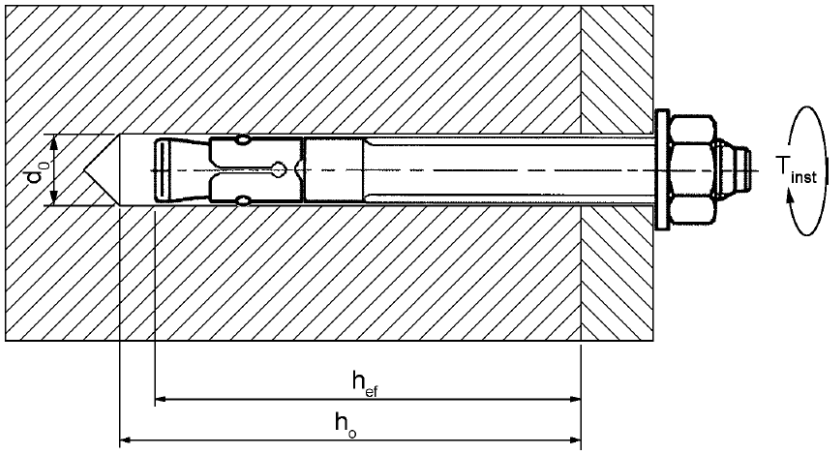

Figure 7. Installation parameters of TT-THROUGHBOLT steel expansion fasteners, versions TT, TT-G and TT-SS

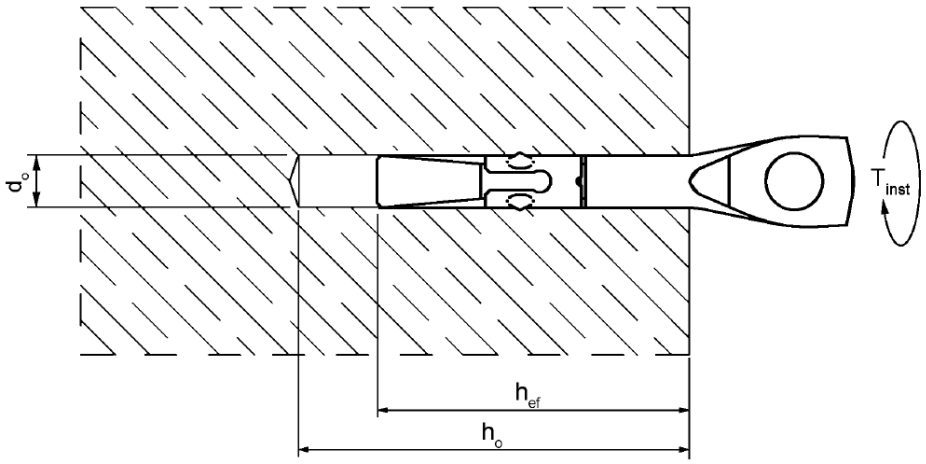

Figure 8. Installation parameters of TT-THROUGHBOLT steel expansion fasteners, version TWH

Table 1

Dimensions of TT-THROUGHBOLT steel expansion fasteners

Ref.	Fastener marking	d, mm	L (1), mm
1	2	3	4
1	TT ϕ6 x 45	6	45
2	TT ϕ6 x 55	6	55
3	TT ϕ6 x 85	6	85
4	TT ϕ8 x 50	8	50
5	TT ϕ8 x 65	8	65
6	TT ϕ8 x 80	8	80
7	TT ϕ8 x 90	8	90
8	TT ϕ8 x 100	8	100
9	TT ϕ10 x 115	8	115
10	TT ϕ10 x 130	8	130
11	TT ϕ10 x 65	10	65
12	TT ϕ10 x 75	10	75
13	TT ϕ10 x 90	10	90
14	TT ϕ12 x 105	10	105
15	TT ϕ12 x 120	10	120
16	TT ϕ12 x 140	10	140
17	TT ϕ12 x 80	12	80
18	TT ϕ12 x 100	12	100
19	TT ϕ12 x 130	12	120
20	TT ϕ12 x 140	12	140
21	TT ϕ12 x 180	12	180
22	TT ϕ12 x 200	12	200
23	TT ϕ12 x 220	12	220
24	TT ϕ12 x 240	12	240
25	TT ϕ16 x 100	16	100
26	TT ϕ16 x 105	16	105
27	TT ϕ16 x 125	16	125
28	TT ϕ16 x 150	16	150
29	TT ϕ16 x 175	16	175
30	TT ϕ16 x 200	16	200
31	TT ϕ16 x 220	16	220
32	TT ϕ16 x 240	16	240
33	TT ϕ20 x 130	20	130
34	TT ϕ20 x 160	20	160
35	TT ϕ20 x 220	20	220
36	TT ϕ20 x 240	20	240
37	TT ϕ20 x 260	20	260
38	TT ϕ24 x 180	24	180
39	TT ϕ24 x 200	24	200
40	TT ϕ24 x 220	24	220
41	TT ϕ24 x 240	24	240
42	TT ϕ24 x 260	24	260

Table 1
continued

Ref.	Fastener marking	d, mm	L (1), mm
43	TT-G ϕ8 x 50	8	50
44	TT-G ϕ8 x 65	8	65
45	TT-G ϕ8 x 80	8	80
46	TT-G ϕ8 x 90	8	90
47	TT-G ϕ8 x 115	8	100
48	TT-G ϕ8 x 130	8	115
49	TT-G ϕ10 x 65	8	130
50	TT-G ϕ10 x 75	10	75
51	TT-G ϕ10 x 90	10	90
52	TT-G ϕ10 x 105	10	105
53	TT-G ϕ10 x 120	10	120
54	TT-G ϕ10 x 140	10	140
55	TT-G ϕ12 x 80	10	80
56	TT-G ϕ12 x 100	12	100
57	TT-G ϕ12 x 120	12	120
58	TT-G ϕ12 x 140	12	140
59	TT-G ϕ12 x 180	12	180
60	TT-G ϕ16 x 105	16	105
61	TT-G ϕ16 x 125	16	125
62	TT-G ϕ16 x 150	16	150
63	TT-G ϕ12 x 175	16	175
64	TT-G ϕ16 x 200	16	200
65	TT-G ϕ16 x 220	16	220
66	TT-G ϕ16 x 240	16	240
67	TT-G ϕ20 x 130	20	130
68	TT-G ϕ20 x 160	20	160
69	TT-G ϕ20 x 200	20	200
70	TT-G ϕ20 x 220	20	220
71	TT-G ϕ20 x 240	20	240

Table 1
continued

Ref.	Fastener marking	d, mm	L [(1)], mm
72	TT-SS ϕ6 x 45	6	45
73	TT-SS ϕ6 x 55	6	55
74	TT-SS ϕ6 x 85	6	85
75	TT-SS ϕ8 x 50	8	50
76	TT-SS ϕ8 x 65	8	65
77	TT-SS ϕ8 x 80	8	80
78	TT-SS ϕ8 x 90	8	90
79	TT-SS ϕ8 x 100	8	100
80	TT-SS ϕ8 x 115	8	115
81	TT-SS ϕ8 x 130	8	130
82	TT-SS ϕ10 x 50	10	50
83	TT-SS ϕ10 x 65	10	65
84	TT-SS ϕ10 x 75	10	75
85	TT-SS ϕ10 x 90	10	90
86	TT-SS ϕ10 x 105	10	105
87	TT-SS ϕ10 x 120	10	120
88	TT-SS ϕ10 x 140	10	140
89	TT-SS ϕ12 x 80	12	80
90	TT-SS ϕ12 x 100	12	100
91	TT-SS ϕ12 x 120	12	120
92	TT-SS ϕ12 x 140	12	140
93	TT-SS ϕ12 x 160	12	160
94	TT-SS ϕ12 x 180	12	180
95	TT-SS ϕ12 x 200	12	200
96	TT-SS ϕ16 x 90	16	90
97	TT-SS ϕ16 x 105	16	105
98	TT-SS ϕ16 x 125	16	125
99	TT-SS ϕ16 x 150	16	150
100	TT-SS ϕ16 x 175	16	175
101	TT-SS ϕ16 x 200	16	200
102	TT-SS ϕ16 x 220	16	220
103	TT-SS ϕ20 x 130	20	130
104	TT-SS ϕ20 x 160	20	160
105	TT-SS ϕ20 x 220	20	220
106	TT-SS ϕ20 x 240	20	240
107	TT-SS ϕ24 x 160	24	160
108	TT-SS ϕ20 x 180	24	180
109	TT-SS ϕ24 x 200	24	200
110	TT-SS ϕ24 x 220	24	220
111	TT-SS ϕ24 x 260	24	260
112	TT-SS ϕ24 x 310	24	310
113	TWH ϕ6 x 55	6	55

(1) – Fasteners of other lengths than specified in the table are also available on request, their use is depending on the required effective depth of anchorage h_{ef}.

Table 2

Calculated tensile load capacities of fastenings made with use of TT-THROUGHBOLT steel expansion fasteners in non-cracked concrete

Ref.	Fastener marking	Base material type	Effective anchoring depth h_{ef}, mm	Calculated capacity $N_{R,d}$, kN
1	2	4	5	6
1	TT ϕ6	Ordinary concrete class C20/25 (1), non cracked Increase factor ψ_c (2): C30/37 – 1.22; C40/50 – 1.41; C50/60 – 1.55	40	2.4
2	TT ϕ8		50	3.6
3	TT ϕ10		55	4.8
4	TT ϕ12		70	9.9
5	TT ϕ16		85	13.9
6	TT ϕ20		100	19.8
7	TT ϕ24		130	23.8
8	TWH ϕ6		40	1.0
9	TT-G ϕ8		50	4.8
10	TT-G ϕ10		55	6.3
11	TT-G ϕ12		70	7.9
12	TT-G ϕ16		85	11.9
13	TT-G ϕ20		100	15.9
14	TT-SS ϕ6		40	3.6
15	TT-SS ϕ8		50	4.8
16	TT-SS ϕ10		55	4.8
17	TT-SS ϕ12		70	7.9
18	TT-SS ϕ16		85	11.9
19	TT-SS ϕ20		100	19.8
20	TT-SS ϕ24		130	19.8

(1) – According to the PN-EN 206:2014 standard

(2) – Multiply by this factor the capacities given in the table, to get capacities for concrete class higher than C20/C25

Table 3

Calculated tensile load capacities of fastenings made with use of TT-THROUGHBOLT steel expansion fasteners in cracked concrete

Ref.	Fastener marking	Base material type	Effective anchoring depth h_{ef}, mm	Calculated capacity $N_{R,d}$, kN
1	2	4	5	6
1	TT ϕ6	Ordinary concrete class C20/25 [(1)], non cracked	40	1.6
2	TT ϕ8		50	2.4
3	TT ϕ10		55	3.0
4	TT ϕ12		70	4.8
5	TT ϕ16		85	7.9
6	TT ϕ20		100	11.9
7	TT ϕ24		130	15.9
8	TWH ϕ6		40	1.0
9	TT-G ϕ8		50	3.0
10	TT-G ϕ10		55	3.6
11	TT-G ϕ12		70	4.8
12	TT-G ϕ16		85	7.9
13	TT-G ϕ20		100	9.9
14	TT-SS ϕ6		40	1.2
15	TT-SS ϕ8		50	2.4
16	TT-SS ϕ10		55	3.0
17	TT-SS ϕ12		70	3.6
18	TT-SS ϕ16		85	6.3
19	TT-SS ϕ20		100	9.9
20	TT-SS ϕ24		130	9.9

Increase factor ψ_c [(2)]

Concrete class [(1)]	ψ_c
C30/37	1.22
C40/50	1.41
C50/60	1.55

[(1)] – According to the PN-EN 206:2014 standard

[(2)] – Multiply by this factor the capacities given in the table, to get capacities for concrete class higher than C20/C25

Table 4

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary non-cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[(1)] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
1	TT ϕ6	M6	Ordinary concrete class C20/25 to C50/60 [(6)], non cracked	40	30	0.2
					60	0.2
					90	0.1
					120	0.1
2	TT ϕ8	M8		50	30	0.4
					60	0.3
					90	0.3
					120	0.2
3	TT ϕ10	M10		55	30	0.9
					60	0.8
					90	0.6
					120	0.5
4	TT ϕ12	M12		70	30	1.7
					60	1.3
					90	1.1
					120	0.8
5	TT ϕ16	M16		85	30	3.1
					60	2.4
					90	2.0
					120	1.6
6	TT ϕ20	M20		100	30	4.9
					60	3.7
					90	3.2
					120	2.5
7	TT ϕ10	M24		130	30	7.1
					60	5.3
					90	4.6
					120	3.5
8	TWH ϕ6	M6		40	30	0.2
					60	0.2
					90	0.1
					120	0.1

Table 4
continued

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary non-cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[1] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
9	TT-G ϕ8	M8	Ordinary concrete class C20/25 to C50/60 [6], non cracked	50	30	0.4
					60	0.3
					90	0.3
					120	0.2
10	TT-G ϕ10	M10		55	30	0.9
					60	0.8
					90	0.6
					120	0.5
11	TT-G ϕ12	M12		70	30	1.7
					60	1.3
					90	1.1
					120	0.8
12	TT-G ϕ16	M16		85	30	3.1
					60	2.4
					90	2.0
					120	1.6
13	TT-G ϕ20	M20		100	30	4.9
					60	3.7
					90	3.2
					120	2.5
14	TT-SS ϕ6	M6		40	30	0.2
					60	0.2
					90	0.1
					120	0.1
15	TT-SS ϕ8	M8		50	30	0.4
					60	0.3
					90	0.3
					120	0.2
16	TT-SS ϕ10	M10		55	30	0.9
					60	0.8
					90	0.6
					120	0.5
17	TT-SS ϕ12	M12		70	30	1.7
					60	1.3
					90	1.1
					120	0.8

Table 4
continued

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary non-cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[1] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
18	TT-SS ϕ16	M16	Ordinary concrete class C20/25 to C50/60 [6], non cracked	85	30	3.1
					60	2.4
					90	2.0
					120	1.6
19	TT-SS ϕ20	M20		100	30	4.9
					60	3.7
					90	3.2
					120	2.5
20	TT-SS ϕ24	M24		130	30	7.1
					60	5.3
					90	4.6
					120	3.5

[1] Load capacity for the case of fire influencing from one side
[2] Anchor spacing $s_{cr,fi}$ not less than $4 \cdot h_{ef}$
[3] Anchor edge distance $c_{cr,fi}$ not less than $2 \cdot h_{ef}$
[4] With fire influencing from more than one side, the anchor edge distance $c_{cr,fi}$ – not less than 300 mm
[5] Calculated load capacity corresponding to the most adverse form of destruction
[6] According to the PN-EN 206:2014 standard

Table 5

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[1] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
18	TT ϕ6	M6	Ordinary concrete class C20/25 to C50/60 [6], cracked	40	30	0.2
					60	0.2
					90	0.1
					120	0.1
19	TTϕ8	M8		50	30	0.4
					60	0.3
					90	0.3
					120	0.2

Table 5
continued

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[(1)] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
3	TT ϕ10	M10	Ordinary concrete class C20/25 to C50/60 [(6)], cracked	55	30	0.9
					60	0.8
					90	0.6
					120	0.5
4	TT ϕ12	M12		70	30	1.7
					60	1.3
					90	1.1
					120	0.8
5	TT ϕ16	M16		85	30	3.1
					60	2.4
					90	2.0
					120	1.6
6	TT ϕ20	M20		100	30	4.9
					60	3.7
					90	3.2
					120	2.5
7	TT ϕ24	M24		130	30	7.1
					60	5.3
					90	4.6
					120	3.5
8	TWH ϕ6	M6		40	30	0.2
					60	0.2
					90	0.1
					120	0.1
9	TT-G ϕ8	M8		50	30	0.4
					60	0.3
					90	0.3
					120	0.2
10	TT-G ϕ10	M10		55	30	0.9
					60	0.8
					90	0.6
					120	0.5

Table 5
continued

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[(1)] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
11	TT-G ϕ12	M10	Ordinary concrete class C20/25 to C50/60 [(6)], cracked	70	30	1,7
					60	1,3
					90	1,1
					120	0,8
12	TT-G ϕ16	M12		85	30	3,1
					60	2,4
					90	2,0
					120	1,6
13	TT-G ϕ20	M16		100	30	4,9
					60	3,7
					90	3.2
					120	2.5
14	TT-SS ϕ6	M6		40	30	0.2
					60	0.2
					90	0.1
					120	0.1
15	TT-SS ϕ8	M8		50	30	0.4
					60	0.3
					90	0.3
					120	0.2
16	TT-SS ϕ10	M10		55	30	0.9
					60	0.8
					90	0.6
					120	0.5
17	TT-SS ϕ12	M12		70	30	1.7
					60	1.3
					90	1.1
					120	0.8

Table 5
continued

Calculated load capacities of fastenings with use of TT-THROUGHBOLT expansion fasteners in ordinary cracked concrete for any direction of load under the influence of fire

Ref.	Fastener marking	Stud thread size	Base material type	Effective anchoring depth h_{ef}, mm	Max. fire influence time, min	Calculated capacity[1] $N_{R,d,fi}$[(1),(2),(3),(4),(5)] kN
1	2	3	4	5	6	7
18	TT-SS ϕ16	M16	Ordinary concrete class C20/25 to C50/60 [6], cracked	85	30	3,1
					60	2,4
					90	2,0
					120	1,6
19	TT-SS ϕ20	M20		100	30	4,9
					60	3,7
					90	3.2
					120	2.5
20	TT-SS ϕ24	M24		130	30	7.1
					60	5.3
					90	4.6
					120	3.2

[1] Load capacity for the case of fire influencing from one side
[2] Anchor spacing $s_{cr,fi}$ not less than $4 \cdot h_{ef}$
[3] Anchor edge distance $c_{cr,fi}$ not less than $2 \cdot h_{ef}$
[4] With fire influencing from more than one side, the anchor edge distance $c_{cr,fi}$ – not less than 300 mm
[5] Calculated load capacity corresponding to the most adverse form of destruction
[6] According to the PN-EN 206:2014 standard

Table 6

Installation and spacing parameters of TT-THROUGHBOLT expansion fasteners

Ref	Parameter		Fastener diameter					
		ϕ6	ϕ8	ϕ10	ϕ12	ϕ16	ϕ20	ϕ24
1	2	3	4	5	6	7	8	9
1	Maximum hole diameter d_o, mm	6	8	10	12	16	20	24
2	Minimum hole depth h_o, mm	50	60	70	90	11	130	145
3	Minimum anchoring depth h_{ef}, mm	40	50	55	70	85	100	130
4	Tightening moment T_{ins}, Nm	10	20	45	65	150	250	300
5	Minimum thickness of base material h_{min}, mm	$2\ h_{ef}$; ≥ 100 mm						
6	Minimum spacing between fasteners $s_{cr,N}$, mm	$3\ h_{ef}$; ≥ 100 mm						
7	Minimum edge distance $c_{cr,N}$, mm	$2\ h_{ef}$; ≥ 100 mm						

Table 7

Characteristic tensile load capacities of fastenings made with use of TT-THROUGHBOLT steel expansion fasteners in non-cracked concrete

Ref.	Fastener marking	Base material type	Effective anchoring depth h_{ef}, mm	Calculated capacity $N_{R,d}$, kN
1	2	4	5	6
1	TT ϕ6	Ordinary concrete class C20/25 (1), non cracked Increase factor ψ_c (2): C30/37 – 1.22; C40/50 – 1.41; C50/60 – 1.55	40	6.0
2	TT ϕ8		50	9.0
3	TT ϕ10		55	12.0
4	TT ϕ12		70	25.0
5	TT ϕ16		85	35.0
6	TT ϕ20		100	50.0
7	TT ϕ24		130	60.0
8	TWH ϕ6		40	2.5
9	TT-G ϕ8		50	12.0
10	TT-G ϕ10		55	16.0
11	TT-G ϕ12		70	20.0
12	TT-G ϕ16		85	30.0
13	TT-G ϕ20		100	40.0
14	TT-SS ϕ6		40	9.0
15	TT-SS ϕ8		50	12.0
16	TT-SS ϕ10		55	12.0
17	TT-SS ϕ12		70	20.0
18	TT-SS ϕ16		85	30.0
19	TT-SS ϕ20		100	50.0
20	TT-SS ϕ24		130	50.0

(1) – According to the PN-EN 206:2014 standard

(2) – Multiply by this factor the capacities given in the table, to get respective capacities for concrete class higher than C20/C25

Table 8

Characteristic tensile load capacities of fastenings made with use of TT-THROUGHBOLT steel expansion fasteners in cracked concrete

Ref.	Fastener marking	Base material type	Effective anchoring depth h_{ef}, mm	Calculated capacity $N_{R,d}$, kN
1	2	4	5	6
1	TT ϕ6	Ordinary concrete class C20/25 (1), non cracked	40	4.0
2	TT ϕ8		50	6.0
3	TT ϕ10		55	7.5
4	TT ϕ12		70	12.0
5	TT ϕ16		85	20.0
6	TT ϕ20		100	30.0
7	TT ϕ24		130	40.0
8	TWH ϕ6		40	2.5
9	TT-G ϕ8		50	7.5
10	TT-G ϕ10		55	9.0
11	TT-G ϕ12		70	12.0
12	TT-G ϕ16		85	20.0
13	TT-G ϕ20		100	25.0
14	TT-SS ϕ6		40	3.0
15	TT-SS ϕ8		50	6.0
16	TT-SS ϕ10		55	7.5
17	TT-SS ϕ12		70	9.0
18	TT-SS ϕ16		85	16.0
19	TT-SS ϕ20		100	25.0
20	TT-SS ϕ24		130	25.0

Increase factor ψ_c (2)

Concrete class (1)	ψ_c
C30/37	1.22
C40/50	1.41
C50/60	1.55

(1) – According to the PN-EN 206:2014 standard

(2) – Multiply by this factor the capacities given in the table, to get respective capacities for concrete class higher than C20/C25