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ETAG 001

GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL
OF
METAL ANCHORS FOR USE IN CONCRETE

Part two: TORQUE-CONTROLLED EXPANSION ANCHORS

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INTRODUCTORY NOTES

In this Part requirements, criteria and test information additional to Part 1 and applicable only for torque-controlled expansion anchors are given. The same numbering of paragraphs as in Part 1 is used. If a paragraph is not mentioned, then the text in Part 1 applies without modification.

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PART TWO:
TORQUE-CONTROLLED EXPANSION ANCHORS

2 SCOPE

2.1 Anchors

2.1.1 Types and operating principles

This Guideline covers the following types of torque-controlled expansion anchors:

a) Shell type expansion anchors with one cone (Fig. 2.2.a) or more than one cone.
b) Bolt type expansion anchors with one cone (Fig. 2.2b) or more than one cone.
c) A combination of a) and b).

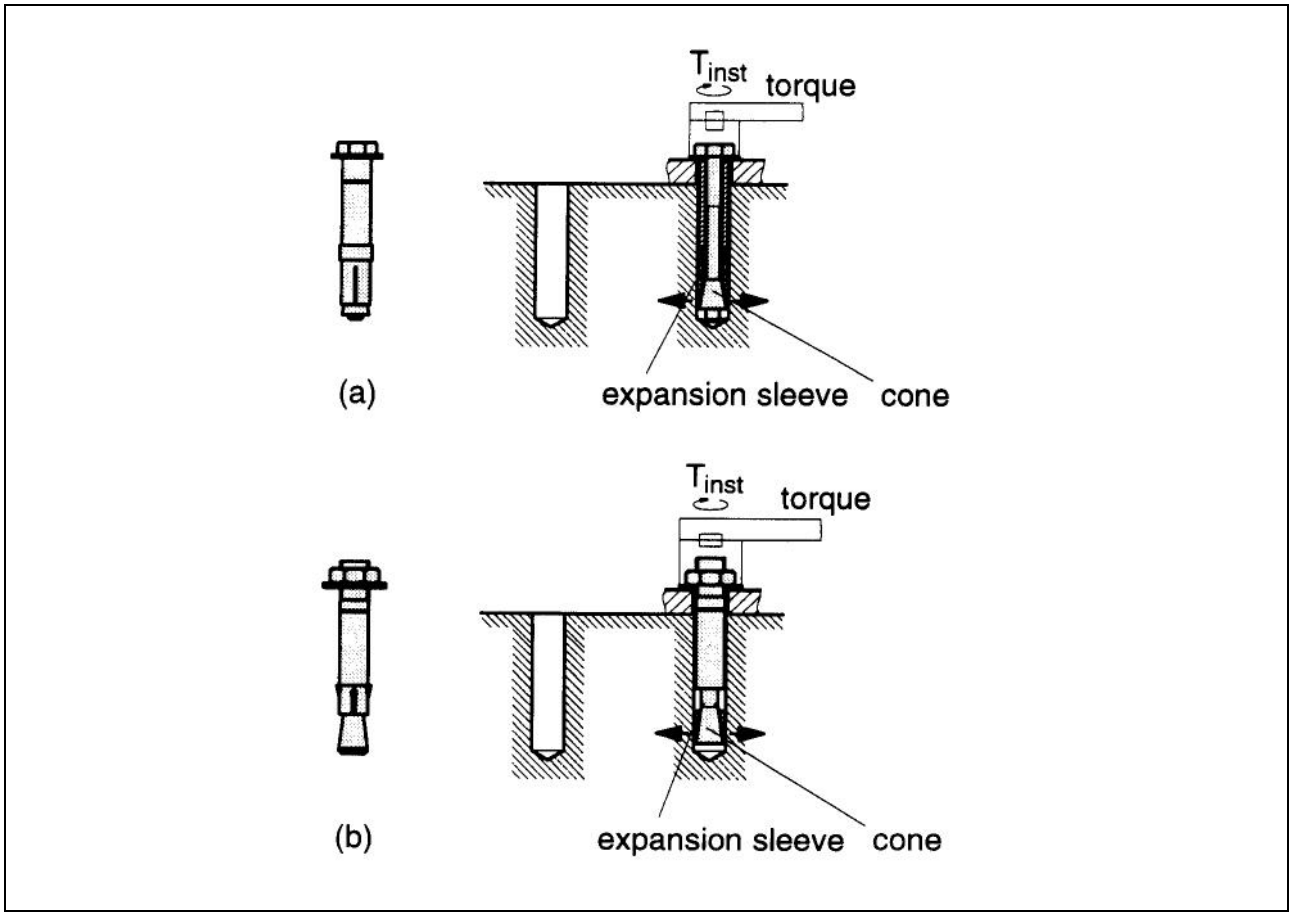

Figure 2.2 Examples of torque-controlled expansion anchors

5 METHODS OF VERIFICATION

5.1 Methods related to 4.1 (Mechanical resistance and stability)

5.1.2 Tests for suitability

The types of tests, additional tests, test conditions and the number of required tests as well as the criteria applied to the results are given in Tables 5.1 (anchors for use in cracked and non-cracked concrete) and 5.2 (anchors for use in non-cracked concrete only). In general, all the tests shall be performed with single anchors without edge and spacing effects under tension loading. For the tests in line 7 of each Table only, the torque moment is increased to at least $T = 1{,}3\ T_{inst}$ (see Annex A).

5.1.3 Tests for admissible service conditions

The test conditions are given in Part 1, 5.1.3 and Annex B. They are summarized in Table 5.4 of Part 1. Table 5.4 applies to anchors to be used in cracked and non-cracked concrete according to Option 1.

Table 5.1 Suitability tests for torque-controlled expansion anchors to be used in cracked and non-cracked concrete

	Purpose of test	Concrete	Crack width Δw (mm)	Drill bit	Applied torque T/T_{inst}	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Annex A
						s	i	m	i	l	load dis-placement behaviour	ultimate load req. α (3)		
1	Installation safety - (a) anchorage intensity	C50/60	0,3	$d_{cut,m}$	0,5	5	5	5	5	5		≥ 0,8 (4)	(5), (6)	5.2.1
3	Functioning in low strength concrete	C20/25	0,5	$d_{cut,max}$	1,0/0,5 (7)	5	5	5	5	5	Part 1, 6.1.1.1	≥ 0,8	(5), (6)	5.2.1
4	Functioning in high strength concrete	C50/60	0,5	$d_{cut,min}$	1,0/0,5 (7)	5	5	5	5	5		≥ 0,8	(5), (6)	5.2.1
5	Functioning in crack-movements	C20/25	0,1 - 0,3	$d_{cut,max}$	1,0/0,5 (7)	5	5	5	5	5	Part 1, 6.1.1.1 and 6.1.1.2 (a)	≥ 0,9	(5), (6)	5.5
6	Functioning under repeated loads	C20/25	0	$d_{cut,m}$	1,0/0,5 (7)	-	-	3	-	-	Part 1, 6.1.1.1 and 6.1.1.2 (b)	≥ 1,0	(8)	5.6
7	Maximum torque moment	C50/60	0	$d_{cut,m}$	≥ 1,3	5	5	5	5	5	-	(9)	(10)	5.10

Notes: see page 5

Table 5.2 Suitability tests for torque-controlled expansion anchors to be used in non-cracked concrete only

	Purpose of test	Concrete	Drill bit	Applied torque T/T_{inst}	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Annex A
					s	i	m	i	l	load dis-placement behaviour	ultimate load req. α (3)		
1	Installation safety - (a) anchorage intensity	C20/25	$d_{cut,m}$	0,5	5	-	5	-	5		$\geq$ 0,8 (4)	(6), (8)	5.2.1
3	Functioning in low strength concrete	C20/25	$d_{cut,max}$	1,0/0,5 (7)	5	-	5	-	5	Part 1, 6.1.1.1	$\geq$ 0,8	(6), (8)	5.2.1
4	Functioning in high strength concrete	C50/60	$d_{cut,min}$	1,0/0,5 (7)	5	-	5	-	5		$\geq$ 1,0	(6), (8)	5.2.1
5	Functioning under repeated loads	C20/25 C50/60	$d_{cut,m}$	1,0/0,5 (7)	-	-	3 3	-	-	Part 1, 6.1.1.1 and 6.1.1.2 (b)	$\geq$ 1,0	(8)	5.6
7	Maximum torque moment	C50/60	$d_{cut,m}$	$\geq$ 1,3	5	5	5	5	5	-	(9)	(10)	5.10

Notes to Tables 5.1 and 5.2

(1) Anchor size
s = smallest
i = intermediate
m = medium
l = largest

(2) Necessary only for anchors with h_{ef} < 80 mm to be used in concrete members with a reinforcement of spacing < 150 mm.

(3) α see Part 1, Equation (6.2)

(4) Valid for γ_2 = 1,2, for other values of γ_2 refer to Part 1, 6.1.2.2.2.

(5) If fewer than three anchor sizes are tested together and/or the different anchor sizes are not similar in respect of geometry, friction between cone and sleeve (internal friction) and friction between sleeve and concrete (external friction), then the number of tests shall be increased to 10 for all anchor sizes.

(6) If the coefficient of variation of the failure loads is v $\geq$ 10 % or the coefficient of variation of the anchor displacements at a load F = 0,5 $F_{Ru,m}$ ($F_{Ru,m}$ = mean failure load in a test series) is v $\geq$ 30 %, then the number of tests in this test series shall be increased to n = 10.

(7) 10 minutes after applying the torque moment T_{inst}, the torque moments shall be reduced to $T = 0,5\ T_{inst}$

(8) If anchors are not similar in respect of geometry, friction between cone and sleeve and friction between sleeve and concrete, then other sizes shall also be tested.

(9) See Part 1, 6.1.1.2(d) and for bolt type anchors (Part 2, Figure 2.2b), see also Part 2, 6.1.1.2(d).

(10) With shell type anchors (see Part 2, Figure 2.2a) the number of sizes to be tested may be reduced or these tests may be omitted if it can be shown by experience that the requirement according to Part 1, 6.1.1.2(d) will be fulfilled.

6 ASSESSING AND JUDGING THE FITNESS OF ANCHORS FOR AN INTENDED USE

6.1 Assessing and judging related to 4.1 (Mechanical resistance and stability)

6.1.1.1 Criteria valid for all tests

(a) Load/displacement behaviour
Uncontrolled slip of the anchor occurs if the expansion sleeve is moving in the drilled hole. This can be recognized by a reduction in load and/or a horizontal or nearly horizontal part in the load/displacement curve (compare Part 1, Figure 6.1). If in doubt about the anchor behaviour, the displacement of the expansion sleeve relative to its position in the drilled hole shall be recorded by appropriate means during or after the tension tests. If uncontrolled slip is proved refer to Part 1, 6.1.1.1(a).

6.1.1.2 Criteria valid for specific tests

(d) Torque test, Tables 5.1 and 5.2, line 7
In addition to the requirement given in Part 1, 6.1.1.2(d), for bolt type anchors (see Part 2, Figure 2.2.b) no turning of the anchor shall occur up to a torque moment $T = 1{,}3\ T_{inst}$.

6.7 Identification of the anchor

In addition to the tests mentioned in Part 1, the roughness of the cone surface and the inner surface of the sleeve shall be measured. Furthermore, if the cone and/or the sleeve are coated, this coating shall be identified and its thickness shall be measured. The results shall be compared with the specifications (see Part 1, 6.7).

8 EVALUATION OF CONFORMITY

8.3 Test plan

With torque-controlled expansion anchors the functioning depends significantly on the internal friction between cone and sleeve which is influenced by the geometry as well as the hardness and surface roughness of cone and sleeve. In the suitability tests the influence of the tolerances for these parameters taking into account their possible combinations on the anchor behaviour is not checked. Therefore, tests are performed at regular intervals to measure the internal friction between cone and sleeve. This can be done by measuring the ratio splitting force to tension force. The test results shall fall within the scatter band for the relationship between splitting and tension force measured on anchors used in the approval tests. Because the ratio between splitting and tension force may be influenced by the test set-up and the test procedure, the tests for production control shall be done in the same way as the approval tests.

If these tests are not performed, then tests in high strength concrete according to Part 1, Table 5.1, line 4 are necessary at regular intervals. The test results shall fulfil the requirements of Part 1, 6.1.1.1.