Instytut Techniki Budowlanej
Group of Testing Laboratories
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Accreditation Certificate No. AB 023

AB 023

TEST REPORT
LZK01-02292/25/Z00NZK

Client:	**Handan Tedun Fastener Group Co., Ltd** **2303 Sunshine Building, Handan City, Hebei Province**
Product name: **(as specified by the Client)**	Wedge anchor
Date of issue:	18.12.2025

Laboratorium Konstrukcji Budowlanych, Geotechniki i Betonu (LZK)
Katowice, ul Korfantego 191, m.wolyniak@itb.pl

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1. Information on the test

Other parties to the agreement:	**Handan Tedun Fastener Group Co., Ltd 2303 Sunshine Building, Handan City, Hebei Province**
Test start date:	08.09.2025
Test completion date:	17.11.2025

Test location:
In the laboratory LZK , in the following location : Katowice, ul Korfantego 191

2. Product

2.1. Information provided by the Client

Product:	Wedge anchor carbon steel
Declared range of application:	Fastening of building structures

3. Test item, sample

3.1. Information provided by the Client

Sample origin:	**Handan Tedun Fastener Group Co., Ltd 2303 Sunshine Building, Handan City, Hebei Province**

3.2. Information obtained based on visual inspection in the Laboratory

Acceptance of the test item into the laboratory:

Date:	08.09.2025
Acceptance protokol:	LZK00-02292/25/Z00NZK

Condition of the test item:

A sample was provided in a condition and quantity suitable for testing.

Description of the test item:

The Tedun wedge anchors was determined in cracked concrete or non-cracked concrete, are designed to make anchorages in reinforced or non reinforced concrete, strength class C20/25 to C50/60. The anchors are made of carbon steel.

Figure No 1: Wedge anchor 8,10,12,16

Table No 1: Technical specification

Parameter	Symbol	Units	M8	M10	M12	M16
Drill bit diameter	d_0	mm	8	10	12	16
Nominal embedment depth	h_{nom}	mm	55	65	75	95
Drill embedment depth	h_1	mm	65	90	100	110
Effective embedment depth	h_{ef}	mm	48	55	63	80
Torque	T_{inst}	Nm	20	40	60	100
Minimum slab of concrete	h_{min}	mm	100	110	126	160
Minimum edge distance	c_{min}	mm	40	40	50	70
Minimum edge distance	s_{min}	mm	40	40	50	70
Edge distance	$c_{cr,sp}$	mm	75	85	94,5	120
Edge distance	$s_{cr,sp}$	mm	150	170	189	240

Table No 2: Concrete base material

Type of concrete	$f_{cm,cube}$	Class	Supplier	Test
[-]	[MP] [psi]	[-]	[-]	[-]
Normal weight concrete	29,9 MPa	C20/25	GORAZDZE BETON	A1,A3,F1,F3,F4,F9,F11,F12,V1
	67,4 MPa	C50/60	GORAZDZE BETON	A2,A4,F2,N2

Table No 3: Program of test

Purpose of test			Number of test			
Test	Concrete	Crack	M8	M10	M12	M16
[-]	[-]	[mm]				
A1	C20/25	0,0	5	5	5	5
A2	C50/60	0,0	5	5	5	5
A3	C20/25	0,3	5	5	5	5
A4	C50/60	0,3	5	5	5	5
F1	C20/25	0,5	5	5	5	5
F2	C50/60	0,5	5	5	5	5
F3	C20/25	01-0,3	5	5	5	5
F4a F4c	C20/25 C50/60	0,0	-	-	3+3	-
F9	C20/25	0,3	5	5	5	5
F11	C20/25	0,0	5	5	5	5
F12	C20/25	0,0	5	5	5	5
V1	C20/25	0,0	5	5	5	5
N1	-	0,0	5	5	5	5
N2	C50/60	0,0	5	5	5	5
C1	C20/25	0,5	-	5	5	5

4. Test results

4.1. Test: Tension test A1

4.1.1. Test method

The A1 test was carried out in compliance with EAD 330232-01-0601, table A1.

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.1.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 4: Result of test A1

Serie [-]	A1	A1	A1	A1
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	13,45	18,98	23,45	50,45
	14,32	19,43	24,12	48,56
$F_{u,m,i}$ [kN]	12,54	19,23	22,65	52,65
	13,76	18,44	25,45	49,52
	14,87	20,65	24,98	50,81
$F_{u,m,t}$ [kN]	13,79	19,35	24,13	50,40
s	0,88	0,82	1,13	1,53
cv_F	6,41	4,23	4,69	3,04
n	5	5	5	5
U-LOKK-145n	±0,20	±0,21	±0,56	±0,58

Table No 5: Evaluation of test A1

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$ / $f_{u,test}$	$f_{ck,cube}$ / f_{uk}	$F_{u,m,20}$ / $F_{u,m,s}$	cv_F	Failure
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[%]	[-]
A1	8	48	5	0,0	13,79	29,9	25	12,61	6,41	p.o.
A1	10	55	5	0,0	19,35	29,9	25	17,69	4,23	p.o.
A1	12	63	5	0,0	24,13	29,9	25	22,06	4,69	p.o.
A1	16	80	5	0,0	50,40	29,9	25	46,08	3,04	p.o.

Table No 6: Evaluation of characteristic value in test A1

Serie	Size	h_{ef}	n	$N_{u,m}$	$N_{u,m,r}$	$N_{u,m,r,min}$	$N_{u,m}$/	$N_{Rk,A1}$	$N_{Rk,p,A1}$
				$N_{u,m,s}$			$N_{u,m,r,min}$		
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[kN]	[-]	[kN]	[kN]
A1	8	48	5	12,61	22,45	20,52	0,61	9,86	9,86
A1	10	55	5	17,69	27,53	25,16	0,70	15,15	15,15
A1	12	63	5	22,06	33,75	30,85	0,72	18,55	18,55
A1	16	80	5	46,08	48,30	44,15	1,04	41,32	41,32

4.2. Test: Tension test A2

4.2.1. Test method

The A2 test was carried out in compliance with EAD 330232-01-0601, table A1.

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.2.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 7: Result of test A2

Serie [-]	A2	A2	A2	A2
$f_{ck,cube}$ [N/mm²]	60	60	60	60
$f_{c,t}$ [N/mm²]	67,4	67,4	67,4	67,4
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	19,43	30,32	34,54	75,43
	18,23	29,43	33,23	76,76
$F_{u,m,i}$ [kN]	19,09	27,88	35,65	73,23
	20,43	28,65	36,87	70,98
	17,34	26,45	32,11	73,91
$F_{u,m,t}$ [kN]	18,90	28,55	34,48	74,06
s	1,18	1,48	1,89	2,20
cv_F	6,23	5,19	5,48	2,97
n	5	5	5	5
U-LOKK-145n	±0,21	±0,56	±0,56	±0,41

Table No 8: Evaluation of test A2

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,50}$	cv_F	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[%]	[-]
A2	8	48	5	0,0	18,90	67,4	60	17,84	6,23	p.o
A2	10	55	5	0,0	28,55	67,4	60	26,93	5,19	p.o
A2	12	63	5	0,0	34,48	67,4	60	32,53	5,48	p.o
A2	16	80	5	0,0	74,06	67,4	60	69,88	2,97	p.o

Table No 9: Evaluation of characteristic value in test A2

Serie	Size	h_{ef}	n	$N_{u,m}$	cv_F	$N_{Rk,A2}$
				$N_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[kN]	[%]	[kN]
A2	8	48	5	17,84	6,23	14,06
A2	10	55	5	26,93	5,19	22,18
A2	12	63	5	32,53	5,48	26,47
A2	16	80	5	69,88	2,97	62,82

Table No 10: Evaluation of n factor

Serie	Size	h_{ef}	Temp.	$N_{u,m,50}$	$f_{c,t,50}$	Failure	$N_{u,m,20}$	$f_{c,t,20}$	n[1)]
[-]	[mm]	[mm]	[ºC]	[N/mm²]	[N/mm²]	[-]	[N/mm²]	[N/mm²]	[-]
A2/A1	8	48	20	18,90	67,4	c.c	13,79	29,9	0,39
A2/A1	10	55	20	28,55	67,4	c.c	19,35	29,9	0,48
A2/A1	12	63	20	34,48	67,4	c.c	24,13	29,9	0,44
A2/A1	16	80	20	74,06	67,4	c.c	50,40	29,9	0,47
1) Equation $n = Log(N_{u,m,50}/N_{u,m,20)} / Log(f_{c,t,50}/f_{c,t,20})$									

Table No 11: Evaluation of ψ_c factor

Sizes		8	10	12	16
n		0,39	0,48	0,44	0,47
ψ_c	C30/37	1,17	1,21	1,19	1,21
	C40/50	1,31	1,39	1,36	1,39
	C50/60	1,43	1,55	1,50	1,54

4.3. Test: Tension test A3

4.3.1. Test method

The A3 test was carried out in compliance with EAD 330232-01-0601, table A1.

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.3.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2.

Uncertainty has been estimated on the basis of available data, including: data on the accuracy of

the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 12: Result of test A3

Serie [-]	A3	A3	A3	A3
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	8,54	15,67	20,43	37,65
	8,04	16,24	19,89	38,99
$F_{u,m,i}$ [kN]	9,43	17,87	21,65	36,23
	9,12	15,76	21,34	38,76
	8,56	16,91	20,98	35,37
$F_{u,m,t}$ [kN]	8,74	16,49	20,86	37,40
s	0,54	0,91	0,71	1,58
cv_F	6,22	5,55	3,39	4,21
n	5	5	5	5
U-LOKK-145n	±0,15	±0,20	±0,55	±0,57

Table No 13: Evaluation of test A3

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	cv_F	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[%]	[-]
A3	8	48,0	5	0,3	8,74	29,9	25	7,99	6,22	p.o.
A3	10	55,0	5	0,3	16,49	29,9	25	15,08	5,55	p.o.
A3	12	63,0	5	0,3	20,86	29,9	25	19,07	3,39	p.o.
A3	16	80,0	5	0,3	37,40	29,9	25	34,2	4,21	p.o.

Table No 14: Evaluation of characteristic value in test A3

Serie	Size	h_{ef}	n	$N_{u,m}$	$N_{u,m,r}$	$N_{u,m,r,min}$	$N_{u,m}$/	$N_{Rk,A3}$	$N_{Rk,p,A3}$
				$N_{u,m,s}$			$N_{u,m,r,min}$		
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[kN]	[-]	[kN]	[kN]
A3	8	48,0	5	7,99	15,80	14,44	0,6	6,30	6,30
A3	10	55,0	5	15,08	19,37	17,71	0,9	12,23	12,23
A3	12	63,0	5	19,07	23,75	21,71	0,9	16,88	16,88
A3	16	80,0	5	34,20	33,99	31,1	1,1	29,30	29,30

4.4. Test: Tension test A4

4.4.1. Test method

The A4 test was carried out in compliance with EAD 330232-01-0601, table A1.

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.4.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 15: Result of test A4

Serie [-]	A4	A4	A4	A4
$f_{ck,cube}$ [N/mm²]	60	60	60	60
$f_{c,t}$ [N/mm²]	67,4	67,4	67,4	67,4
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	11,23	22,43	30,56	48,65
	11,54	23,65	32,43	50,67
$F_{u,m,i}$ [kN]	10,56	21,43	28,45	51,23
	12,65	24,54	27,67	53,45
	13,66	23,84	29,12	52,88
$F_{u,m,t}$ [kN]	11,93	23,18	29,65	51,38
s	1,23	1,24	1,88	1,90
cv_F	10,29	5,34	6,35	3,71
n	5	5	5	5
U-LOKK-145n	±0,20	±0,56	±0,56	±0,58

Table No 16: Evaluation of test A4

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,50}$	cv_F	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[%]	[-]
A4	8	48	5	0,3	11,93	67,4	60	11,25	10,29	p.o.
A4	10	55	5	0,3	23,18	67,4	60	21,87	5,34	p.o.
A4	12	63	5	0,3	29,65	67,4	60	27,97	6,35	p.o.
A4	16	80	5	0,3	51,38	67,4	60	48,47	3,71	p.o.

Table No 17: Evaluation of characteristic value in test A4

Serie	Size	h_{ef}	n	$N_{u,m}$	cv_F	$N_{Rk,A4}$
				$N_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[kN]	[%]	[kN]
A4	8	48	5	11,25	10,29	7,32
A4	10	55	5	21,87	5,34	17,90
A4	12	63	5	27,97	6,35	21,93
A4	16	80	5	48,47	3,71	42,36

Table No 18: Evaluation of n factor

Serie	Size	h_{ef}	Temp.	$N_{u,m,50}$	$f_{c,t,50}$	Failure	$N_{u,m,20}$	$f_{c,t,20}$	n[1)]
[-]	[mm]	[mm]	[ºC]	[N/mm²]	[N/mm²]	[-]	[N/mm²]	[N/mm²]	[-]
A4/A3	8	48	20	11,9	67,4	c.c	8,7	29,9	0,38
A4/A3	10	55	20	23,2	67,4	c.c	16,5	29,9	0,42
A4/A3	12	63	20	29,6	67,4	c.c	20,9	29,9	0,43
A4/A3	16	80	20	51,4	67,4	c.c	37,4	29,9	0,39
1) Equation $n = Log(N_{u,m,50}/N_{u,m,20}) / Log(f_{c,t,50}/f_{c,t,20})$									

Table No 19: Evaluation of ψ_c factor

Sizes		8	10	12	16
n		0,38	0,42	0,43	0,39
	C30	1,17	1,19	1,19	1,17
	C40	1,30	1,34	1,35	1,31
	C50	1,42	1,47	1,49	1,43

4.5. Test: Tension test F1

4.5.1. Test method

The F1 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.5.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2.

Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 20: Result of test F1

Serie [-]	F1	F1	F1	F1
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	7,65	-	16,56	30,54
	5,76	-	17,83	32,43
$F_{u,m,i}$ [kN]	6,78	-	15,98	34,32
	7,66	-	17,78	28,45
	7,56	-	16,16	30,38
$F_{u,m,t}$ [kN]	7,08	-	16,86	31,22
s	0,83	-	0,89	2,23
cv_F	11,65	-	5,26	7,15
n	5	-	5	5
U-LOKK-145n	±0,15	-	±0,20	±0,56

Table No 21: Evaluation of test F1

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F1	8	48	5	0,5	7,08	29,9	25	6,48	p.o
F1	10	55	5	-	-	-	-	-	-
F1	12	63	5	0,5	16,86	29,9	25	15,42	p.o
F1	16	80	5	0,5	31,22	29,9	25	28,55	p.o.

Table No 22: Evaluation of characteristic value in test F1

Serie	Size	h_{ef}	n	$N_{u,m}$	cv_F	$N_{Rk,F1}$
				$N_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[kN]	[%]	[kN]
F1	8	48	5	6,48	11,65	3,91
F1	10	55	5	-	-	-
F1	12	63	5	15,42	5,26	12,66
F1	16	80	5	28,55	7,15	21,61

Table No 23: Evaluation of factor α

Serie	Size	h_{ef}	n	$N_{u,m,F1}$	$N_{Rk,F1}$	cv_F	$N_{u,m,A3}$	$N_{Rk,A3}$	cv_F	α	rqd.α	α/ rqdα
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[%]	[kN]	[kN]	[%]	[-]	[-]	[-]
F1	8	48	5	6,48	3,91	11,65	7,99	6,30	6,22	0,81	0,80	>1
F1	10	55	5	-	-	-	-	-	-	-	-	-
F1	12	63	5	15,42	12,66	5,26	19,07	16,88	3,39	0,81	0,80	>1
F1	16	80	5	28,55	21,61	7,15	34,20	29,30	4,21	0,83	0,80	>1

4.6. Test: Tension test F2

4.6.1. Test method

The F2 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.6.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 24: Result of test F2

Serie [-]	F2	F2	F2	F2
$f_{ck,cube}$ [N/mm²]	60	60	60	60
$f_{c,t}$ [N/mm²]	67,4	67,4	67,4	67,4
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	9,34	-	25,43	42,35
	8,54	-	26,19	43,67
$F_{u,m,i}$ [kN]	11,23	-	28,65	44,57
	9,24	-	24,54	39,38
	10,10	-	28,27	40,40
$F_{u,m,t}$ [kN]	9,69	-	26,62	42,07
s	1,02	-	1,79	2,17
cv_F	10,56	-	6,71	5,17
n	5	-	5	5
U-LOKK-145n	±0,15	-	±0,56	±0,57

Table No 25: Evaluation of test F2

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F2	8	48	5	0,5	9,69	67,4	60	9,14	p.o
F2	10	55	5	-	-	-	-	-	-
F2	12	63	5	0,5	26,62	67,4	60	25,11	p.o
F2	16	80	5	0,5	42,07	67,4	60	39,70	p.o.

Table No 26: Evaluation of characteristic value in test F2

Serie	Size	h_{ef}	n	$N_{u,m}$ / $N_{u,m,s}$	cv_F	$N_{Rk,F2}$
[-]	[mm]	[mm]	[-]	[kN]	[%]	[kN]
F2	8	48	5	9,14	10,56	5,86
F2	10	55	5	-	-	-
F2	12	63	5	25,11	6,71	19,38
F2	16	80	5	39,70	5,17	32,72

Table No 27: Evaluation of factor α

Serie	Size	h_{ef}	n	$N_{u,m,F2}$	$N_{Rk,F2}$	cv_F	$N_{u,m,A4}$	$N_{Rk,A4}$	cv_F	α	rqd.α	α/ rqdα
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[%]	[kN]	[kN]	[%]	[-]	[-]	[-]
F2	8	48	5	9,14	5,86	10,56	11,25	7,32	10,29	0,81	0,80	1
F2	10	55	5	-	-	-	-	-	-	-	-	-
F2	12	63	5	25,11	19,38	6,71	27,97	21,93	6,35	0,90	0,80	1
F2	16	80	5	39,70	32,72	5,17	48,47	42,36	3,71	0,82	0,80	1

4.7. Test: Tension test F3

4.7.1. Test method

The F3 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.7.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 28: Result of test F3

Serie [-]	F3	F3	F3	F3
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	7,56	14,35	17,65	33,23
	6,56	15,65	18,34	30,65
$F_{u,m,i}$ [kN]	7,98	13,25	16,04	31,54
	8,34	14,98	18,09	35,67
	7,14	12,12	17,55	28,54
$F_{u,m,t}$ [kN]	7,52	14,07	17,53	31,93
s	0,70	1,40	0,90	2,69
cv_F	9,29	9,97	5,10	8,43
n	5	5	5	5
U-LOKK-145n	±0,15	±0,20	±0,20	±0,56

Table No 29: Evaluation of test F3

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F3	8	48	5	0,1-0,3	7,52	29,9	25	6,87	p.o
F3	10	55	5	0,1-0,3	14,07	29,9	25	12,87	p.o
F3	12	63	5	0,1-0,3	17,53	29,9	25	16,03	p.o
F3	16	80	5	0,1-0,3	31,93	29,9	25	29,19	p.o

Table No 30: Evaluation of characteristic value in test F3

Serie	Size	h_{ef}	n	$N_{u,m}$	cv_F	$N_{Rk,F3}$
				$N_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[kN]	[%]	[kN]
F3	8	48	5	6,87	9,29	4,7
F3	10	55	5	12,87	9,97	8,5
F3	12	63	5	16,03	5,10	13,3
F3	16	80	5	29,19	8,43	20,8

Table No 31: Evaluation of factor α

Serie	Size	h_{ef}	n	$N_{u,m,F3}$	$N_{Rk,F3}$	cv_F	$N_{u,m,A3}$	$N_{Rk,A3}$	cv_F	α	rqd.α	α/ rqdα	δ_{100}
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[%]	[kN]	[kN]	[%]	[-]	[-]	[-]	[mm]
F3	8	48	5	6,87	4,70	9,29	7,99	6,30	6,22	0,86	0,9	0,96	<3
F3	10	55	5	12,87	8,50	9,97	15,08	12,23	5,55	0,85	0,9	0,95	<3
F3	12	63	5	16,03	13,25	5,10	19,07	16,88	3,39	0,84	0,9	0,93	<3
F3	16	80	5	29,19	20,83	8,43	34,20	29,30	4,21	0,85	0,9	0,95	<3

4.8. Test: Tension test F4

4.8.1. Test method

The F4 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.8.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample

Table No 32: Result of test F4a

Serie [-]	F4a
$f_{ck,cube}$ [N/mm²]	25
$f_{c,t}$ [N/mm²]	29,9
f_{uk} [N/mm²]	800
$f_{u,test}$ [N/mm²]	851
Size [mm]	12
h_{ef} [mm]	63
	24,57
	25,43
$F_{u,m,i}$ [kN]	25,98
	-
	-
$F_{u,m,t}$ [kN]	25,33
s	0,71
cv_F	2,81
n	3
U-LOKK-145n	±0,56

Table No 33: Evaluation of test F4a

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F4a	12	63	3	0,0	25,33	29,9	25	23,16	p.o.

Table No 34: Evaluation of factor α

Serie	Size	h_{ef}	n	$N_{u,m,F4a}$	$N_{Rk,F4a}$	$N_{u,m,A1}$	$N_{Rk,A1}$	α	rqd.α	α/ rqdα
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[kN]	[kN]	[-]	[-]	[-]
F4a	12	63	3	23,16	-	22,06	-	1,05	1,00	>1

Table No 35: Result of test F4c

Serie [-]	F4c
$f_{ck,cube}$ [N/mm²]	60
$f_{c,t}$ [N/mm²]	67,4
f_{uk} [N/mm²]	800
$f_{u,test}$ [N/mm²]	851
Size [mm]	12
h_{ef} [mm]	63
	33,24
	35,65
$F_{u,m,i}$ [kN]	37,12
	-
	-
$F_{u,m,t}$ [kN]	35,34
s	1,96
cv_F	5,54
n	3
U-LOKK-145n	±0,57

Table No 36: Evaluation of test F4c

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F4c	12	63	3	0,0	35,34	67,4	60	33,34	p.o.

Table No 37: Evaluation of factor α

Serie	Size	h_{ef}	n	$N_{u,m,F4a}$	$N_{Rk,F4a}$	$N_{u,m,A2}$	$N_{Rk,A2}$	α	rqd.α	α/ rqdα
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[kN]	[kN]	[-]	[-]	[-]
F4c	12	63	3	33,34	-	32,53	-	1,02	1,00	>1

4.9. Test: Tension test F9

4.9.1. Test method

The F9 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.9.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample

Table No 38: Result of test F9

Serie [-]	F9	F9	F9	F9
$f_{ck,cube}$ [N/mm²]	60	60	60	60
$f_{c,t}$ [N/mm²]	67,4	67,4	67,4	67,4
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	9,54	18,45	24,56	45,98
	10,36	19,54	26,98	47,88
$F_{u,m,i}$ [kN]	9,43	17,54	29,43	40,99
	8,89	18,98	24,66	42,33
	11,43	20,24	26,28	46,83
$F_{u,m,t}$ [kN]	9,93	18,95	26,38	44,80
s	0,99	1,03	2,00	2,98
cv_F	9,97	5,44	7,57	6,66
n	5	5	5	5
U-LOKK-145n	±0,20	±0,21	±0,56	±0,57

Table No 39: Evaluation of test F9

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,50}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F9	8	48	5	0,3	9,93	67,4	60	9,37	p.o.
F9	10	55	5	0,3	18,95	67,4	60	17,88	p.o.
F9	12	63	5	0,3	26,38	67,4	60	24,89	p.o.
F9	16	80	5	0,3	44,80	67,4	60	42,27	p.o.

Table No 40: Evaluation of characteristic value in test F9

Serie	Size	h_{ef}	n	$N_{u,m}$	cv_F	$N_{Rk,F9}$
				$N_{u,m,s}$		
[-]	[mm]	[mm]	[-]	[kN]	[%]	[kN]
F9	8	48	5	9,37	9,97	6,19
F9	10	55	5	17,88	5,44	14,57
F9	12	63	5	24,89	7,57	18,49
F9	16	80	5	42,27	6,66	32,70

Table No 41: Evaluation of factor α

Serie	Size	h_{ef}	n	$N_{u,m,F9}$	$N_{Rk,F9}$	cv_F	$N_{u,m,A4}$	$N_{Rk,A4}$	cv_F	α	rqd.α	α/ rqdα	γ_2
[-]	[mm]	[mm]	[-]	[kN]	[kN]	[%]	[kN]	[kN]	[%]	[-]	[-]	[-]	[-]
F9	8	48	5	9,37	6,19	9,97	11,25	7,32	10,29	0,83	0,80	1,04	1,2
F9	10	55	5	17,88	14,57	5,44	21,87	17,90	5,34	0,82	0,80	1,02	1,2
F9	12	63	5	24,89	18,49	7,57	27,97	21,93	6,35	0,89	0,80	1,11	1,2
F9	16	80	5	42,27	32,70	6,66	48,47	42,36	3,71	0,87	0,80	1,09	1,2

4.10. Test: Test F11

4.10.1. Test method

The F11 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.10.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample

Table No 42: Result of test F11

Serie [-]	F11	F11	F11	F11
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
T_{inst} [Nm]	20	40	60	100
c_{min} [mm]	40	40	50	70
s_{min} [mm]	40	40	50	70
h_{min} [mm]	100	110	126	160
h_{ef} [mm]	48	55	63	80
	60	130	180	270
	65	135	178	268
$T_{u,m,i}$ [Nm]	68	140	175	285
	70	132	170	284
	65	128	174	290
$T_{u,m,t}$ [Nm]	66	133	175	279
s	3,78	4,69	3,85	9,79
cv_F	5,76	3,53	2,19	3,50
n	5	5	5	5
U-LOKK-151	±3	±4	±4	±5

Table No 43: Evaluation of test F11

Serie	Size	h_{ef}	k	rqd.T_{inst}	n	$T_{u,m,t}$	$f_{ck,cube}$	$f_{c,t}$	$T_{5\%}$	rqd.$T_{inst,test}$	$T_{5\%}$/rqd.$T_{inst,test}$
[-]	[mm]	[mm]	[-]	[Nm]	[-]	[Nm]	[N/mm²]	[N/mm²]	[Nm]	[Nm]	[-]
F11	8	48	2,1	20	5	65,6	25	29,9	53	46	1,1
F11	10	55	2,1	40	5	133,0	25	29,9	117	92	1,3
F11	12	63	2,1	60	5	175,4	25	29,9	162	138	1,2
F11	16	80	2,1	100	5	279,4	25	29,9	246	230	1,1

4.11. Test: Tension test F12

4.11.1. Test method

The F12 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.11.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample

Table No 44: Result of test F12

Serie [-]	F12	F12	F12	F12
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
$c_{cr,sp}$	75	85	95	120
$s_{cr,sp}$	150	170	190	240
h_{min} [mm]	100	110	126	160
h_{ef} [mm]	48	55	63	80
	11,34	16,87	24,22	48,05
	12,54	17,25	22,54	46,92
$F_{u,m,i}$ [kN]	13,65	18,92	23,12	50,66
	10,27	18,55	21,66	47,22
	-	-	-	-
$F_{u,m,t}$ [kN]	11,95	17,90	22,89	48,21
s	1,46	0,99	1,07	1,70
cv_F	12,25	5,54	4,69	3,53
n	4	4	4	4
U-LOKK-145n	±0,20	±0,21	±0,55	±0,58

Table No 45: Evaluation of test F12

Serie	Size	h_{ef}	n	crack	$F_{u,m,t}$	$f_{c,t}$	$f_{ck,cube}$	$F_{u,m,20}$	Failure
						$f_{u,test}$	f_{uk}	$F_{u,m,s}$	
[-]	[mm]	[mm]	[-]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[-]
F12	8	48	4	0,0	12,0	29,9	25	10,9	sp
F12	10	55	4	0,0	17,9	29,9	25	16,4	sp
F12	12	63	4	0,0	22,9	29,9	25	20,9	sp
F12	16	80	4	0,0	48,2	29,9	25	44,1	sp

The statistical test was carried out acc. to one-sides F-test with level of significance a=0,05 and two-sides t-test or t-Welch with level of significance a=0,05 for independent data from test A1 and test F12.

H0 (Null Hypothesis) is the hypothesis assuming that results of tests F12 do not differ from results of tests A1.

Table No 46: Evaluation of test F12 and A1, statistical test F

Serie	Size	n_{F12}-1	n_{A1}-1	s_{F12}	s_{A1}	F(test F)	f Critical one-tail	p-value (test F)	Null Hypothesis (H_0:T)
[-]	[mm]	[-]	[-]	[kN	[kN]	[-]	[-]	[-]	[-]
F12/A1	8	3	4	1,46	0,88	2,74	4,19	0,18	Accepted
F12/A1	10	3	4	0,99	0,82	1,47	4,19	0,35	Accepted
F12/A1	12	3	4	1,07	1,13	1,11	4,19	0,44	Accepted
F12/A1	16	3	4	1,70	1,53	1,23	4,19	0,41	Accepted

Table No 47: Evaluation of test F12 and A1, statistical test t

Serie	Size	n_{F12}-1	n_{A1}-1	s_{F12}	s_{A1}	$N_{u,m,F12}$	$N_{u,m,A1}$	T (t-test)	T (t-Welch)	t Critical two-tail	p-value (t-test)	Null Hypothesis (H_0:T)
[-]	[mm]	[-]	[-]	[kN	[kN]	[kN]	[kN]	[-]	[-]	[-]	[-]	[-]
F12/A1	8	3	4	1,46	0,88	10,9	12,6	2,14		2,36	0,07	Accepted
F12/A1	10	3	4	0,99	0,82	16,4	17,7	2,20	-	2,36	0,06	Accepted
F12/A1	12	3	4	1,07	1,13	20,9	22,1	1,53	-	2,36	0,17	Accepted
F12/A1	16	3	4	1,70	1,53	44,1	46,1	1,85	-	2,36	0,11	Accepted

4.12. Test: Shear test V1

4.12.1. Test method

The V1 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.12.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2.

Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 48: Result of test V1

Serie [-]	V1	V1	V1	V1
$f_{ck,cube}$ [N/mm²]	25	25	25	25
$f_{c,t}$ [N/mm²]	29,9	29,9	29,9	29,9
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
h_{ef} [mm]	48	55	63	80
	18,43	26,87	38,22	70,65
	19,23	26,98	38,54	72,23
$F_{u,m,i}$ [kN]	18,56	27,23	37,44	71,54
	18,34	26,55	37,73	73,98
	19,04	26,02	37,66	72,44
$F_{u,m,t}$ [kN]	18,72	26,73	37,92	72,17
s	0,39	0,47	0,45	1,23
cv_F	2,10	1,74	1,19	1,71
n	5	5	5	5
U-LOKK-31g	±0,08	±0,12	±0,15	±0,23

Table No 49: Evaluation of test V1

Serie	Size	h_{ef}	$V_{u,m}$	$f_{u,test}$	f_{uk}	$V_{u,m,20}/V_{um,s}$	cv_F	V_{Rk}	A_s	f_{uk}	$V_{Rk,s}$	$V_{Rk}/V_{Rk,s}$	$V_{Rk,ETA}$
[-]	[mm]	[mm]	[kN]	[N/mm²]	[N/mm²]	[kN]	[%]	[kN]	[mm²]	[N/mm²]	[kN]	[-]	[kN]
V1	8	48	18,7	815	800	18,4	2,10	17,1	36,6	800	14,6	1,17	14,6
V1	10	55	26,7	856	800	25,0	1,74	23,5	58,0	800	23,2	1,01	23,2
V1	12	63	37,9	851	800	35,6	1,19	34,2	84,3	800	33,7	1,01	33,7
V1	16	80	72,2	827	800	69,8	1,71	65,8	157,0	800	62,8	1,05	62,8

4.13. Test: Tension test N1

4.13.1. Test method

The N1 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.13.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 50: Result of test N1

Serie [-]	N1	N1	N1	N1
Size [mm]	8	10	12	16
	22	51	65	89
	23	52	65	90
$F_{u,m,i}$ [kN]	21	51	65	91
	20	51	67	92
	21	52	67	93
	20	52	64	92
$F_{u,m,t}$ [kN]	21,17	51,50	65,50	91,17
s	1,17	0,55	1,22	1,47
cv_F	5,52	1,06	1,87	1,61
U=LOKK-033	±1	±1	±1	±1

Table No 51: Evaluation of test N1

Serie	Size	$F_{u,m,t}$	A_s,neck	$f_{u,test}$	$N_{Rk,s,ETA}$
[-]	[mm]	[kN]	[mm²]	[N/mm²]	[kN]
N1	8	21,2	25,97	815	20,8
N1	10	51,5	60,13	856	48,1
N1	12	65,5	76,98	851	61,6
N1	16	91,2	110,29	827	88,2

4.14. Test: Tension test N2

4.14.1. Test method

The N2 test was carried out in compliance with EAD 330232-01-0601, table A1

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

4.14.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 52: Result of test N2

Serie [-]	N2	N2	N2	N2
$f_{ck,cube}$ [N/mm²]	60	60	60	60
$f_{c,t}$ [N/mm²]	67,4	67,4	67,4	67,4
f_{uk} [N/mm²]	800	800	800	800
$f_{u,test}$ [N/mm²]	815	856	851	827
Size [mm]	8	10	12	16
T_{inst} [Nm]	20	40	60	100
h_{ef} [mm]	48	55	63	80
	8,56	10,43	14,35	28,56
	8,34	11,23	15,46	30,54
$F_{u,m,i}$ [kN]	7,98	10,65	16,54	32,00
	8,45	11,11	14,76	31,87
	8,22	10,76	17,87	25,78
$F_{u,m,t}$ [kN]	8,31	10,84	15,80	29,75
s	0,22	0,33	1,43	2,62
cv_F	2,69	3,05	9,03	8,79
n	5	5	5	5
U-LOKK-145n	±0,15	±0,20	±0,20	±0,56

Table No 53: Evaluation of test N2

Serie	Size	h_{ef}	n	1.3 xT_{inst}	$N_{1,3Tinst}$	cv_F	$N_{1,3Tinst,95\%}$
[-]	[mm]	[mm]	[-]	[Nm]	[kN]	[%]	[kN]
N2	8	48	5	26	8,31	2,69	9,07
N2	10	55	5	52	10,84	3,05	11,96
N2	12	63	5	78	15,80	9,03	20,64
N2	16	80	5	130	29,75	8,79	38,64

Table No 54: Evaluation of test critieria

Serie	Size	h_{ef}	$N_{1,3Tinst}$	$N_{1,3Tinst,95\%}$	A_s	f_{yk}	F= A_s x f_{yk}	$N_{Rk,c}$	F/ $N_{1,3Tinst,95\%}$ [1)]	$N_{Rk,c}$/ $N_{1,3Tinst}$ [2)]	Anchor
[-]	[mm]	[mm]	[kN]	[kN]	[mm²]	[N/mm²]	[kN]	[kN]	[-]	[-]	[-]
N2	8	48	8,31	9,07	25,97	640	16,6	16,4	1,83	1,97	no turn
N2	10	55	10,84	11,96	60,13	640	38,5	20,1	3,22	1,85	no turn
N2	12	63	15,80	20,64	76,98	640	49,3	24,6	2,39	1,56	no turn
N2	16	80	29,75	38,64	110,29	640	70,6	35,2	1,83	1,18	no turn

4.15. Tension test C1

4.15.1. Test method

The C1.1 and C1.2 test was carried out in compliance with EAD 330232-01-0601.

The program of the tests is given in the table below:

Table No : Test program

Code	Description	Concrete	Δw [mm]
C1.1	Functioning under pulsation tension load	C20/25	0.5
C1.2	Functioning under alternating shear load	C20/25	0.5

Tests under pulsating tension load (test series C1.1)

The maximum tension load to be applied in the seismic tension test series C1.1 is calculated according to the following equation ([2], equation C.1):

$$N_{C1} = 0{,}5 \cdot N_{u,m} \cdot \left(\frac{f_{c,C1.1}}{f_{c,3}}\right)^{m}$$

where:

- $N_{u,m}$: mean ultimate tensile load of the tests in concrete on test series A3.
- $f_{c,C1.1}$: mean compressive strength of concrete used for the test series C1.1 at the time of testing.
- $f_{c,3}$: mean compressive strength of concrete used for the “Basic tension tests" at the time of testing.
- m: normalization exponent.

Tests under alternating shear load cycling (test series C1.2)

These tests are intended to evaluate the performance of the fasterners under simulated seismic shear loading, including the effects of concrete cracking.

The maximum shear load to be applied in the seismic shear test series C1.2 is calculated according to the following equation ([2], equation C.5):

$$V_{C1} = 0{,}5 \cdot V_{u,m} \cdot \left(\frac{f_{u,C1.2}}{f_{u,5}}\right)$$

where:

- $V_{u,m}$: mean ultimate shear load of the tests in concrete.
- $f_{u,C1.2}$: mean ultimate tensile strength of steel fastener element used in the test series C1.1.
- $f_{u,5}$: mean ultimate tensile strength of steel fastener elements used in tests for “characteristic resistance to steel failure under shear load” in uncracked concrete C20/25.

The test implementation, environmental conditions and accuracy of the measuring devices used are in accordance with the requirements of the above-mentioned standard.

The C.1.1 and C.1.2 test was carried out for THE concrete screw in compliance with EAD 330232-01-0601:2019, table A.1, test C.1.1 and C.1.2

Concrete base material in C.1.1 and C.1.2.test - normal weight non-cracked concrete C20/25

4.15.2. Results

Uncertainty of the measurement is for a confidence level of 95 % and uncertainty factor 2. Uncertainty has been estimated on the basis of available data, including: data on the accuracy of the measurement system. The uncertainty value refers to the individual test results. The value of uncertainty can not be assigned directly to the characteristics of a given product, because the laboratory does not have knowledge about the variability of product population, but only about the tested sample.

Table No 55: Results of C1.1. test

Serie	Anchor	h_{nom}	N_{C1}	Ultimate load					Mean value	s	C_{oV}
[-]	[-]	[mm]	[kN]	[kN]					[kN]	[kN]	[%]
C.1.1	10	65	7,9	-	-	-	-	-	-		-
			4	14,32	15,64	13,27	14,65	11,65	13,9	1,5	11

Table No 56: Seismic tension loads calculated

Serie	Anchor	h_{nom}	$f_{c,C1.1}$	$f_{c,A3}$	$F_{u,test,A3}$	N_{C1}	$N_{C1,red}$	$N_{C1,red} / N_{C1}$ ($\alpha_{N,C1}$)
[-]	[-]	[mm]	[N/mm²]	[N/mm²]	[kN]	[kN]	[kN]	[-]
C.1.1	10	65	29,9	32,6	16,49	7,9	4	0,5

Table No 57: Seismic tension test results

Serie	Anchor	h_{nom}	Failure	$N_{Ru,20,mean,C1.1}$	C_{oV} (C1.1)	160% $N_{C1,red}$	min(1; R_m)
[-]	[-]	[mm]	[-]	[kN]	[%]	[kN]	[-]
C.1.1	10	65	concrete	13,9	11	6,4	1

Table No 58: Results of C1.2. test

Serie	Anchor	h_{nom}	V_{C1}	Ultimate load					Mean value	s	C_{oV}
[-]	[-]	[mm]	[kN]	[kN]					[kN]	[kN]	[%]
C.1.2	10	65	13,35	-					-	-	-
			8	25,45	24,54	25,12	25,76	24,12	25,0	0,7	3

Table No 59: Seismic shear loads calculated

Serie	Anchor	h_{nom}	$f_{c,test,i}$	$f_{u,C1.2}$	$f_{u,5}$	$V_{u,m}$	V_{C1}	$V_{C1,red}$	$V_{C1,red}/V_{C1}$ ($\alpha_{C1.2}$)
[-]	[-]	[mm]	[N/mm²]	[MPa]	[MPa]	[kN]	[kN]	[kN]	[-]
C.1.2	10	65	29,9	856	856	26,7	13,35	8	0,60

Table No 60: Seismic shear test results

Serie	Anchor	h_{nom}	Failure	$V_{Ru,20,mean,C1.1}$	$C_{oV\ (C1.2)}$	160% $V_{C1,red}$	min(1; R_m)
[-]	[-]	[mm]	[-]	[kN]	[%]	[kN]	[-]
C.1.2	10	65	steel	25,0	3	12,8	1

Table No 61: Results of C1.1. test

Serie	Anchor	h_{nom}	N_{C1}	Ultimate load					Mean value	s	C_{oV}
[-]	[-]	[mm]	[kN]	[kN]					[kN]	[kN]	[%]
C.1.1	12	75	10,9	-	-	-	-	-	-		-
			8	19,32	18,43	20,35	18,22	17,61	18,8	1,1	6

Table No 62: Seismic tension loads calculated

Serie	Anchor	h_{nom}	$f_{c,C1.1}$	$f_{c,A3}$	$F_{u,test,A3}$	N_{C1}	$N_{C1,red}$	$N_{C1,red}$ / N_{C1} ($\alpha_{N,C1}$)
[-]	[-]	[mm]	[N/mm²]	[N/mm²]	[kN]	[kN]	[kN]	[-]
C.1.1	12	75	32,6	29,9	20,86	10,9	8	0,7

Table No 63: Seismic tension test results

Serie	Anchor	h_{nom}	Failure	$N_{Ru,20,mean,C1.1}$	C_{oV} (C1.1)	160% $N_{C1,red}$	min(1; R_m)
[-]	[-]	[mm]	[-]	[kN]	[%]	[kN]	[-]
C.1.1	12	75	concrete	18,8	6	12,8	1

Table No 64: Results of C1.2. test

Serie	Anchor	h_{nom}	V_{C1}	Ultimate load					Mean value	s	C_{oV}
[-]	[-]	[mm]	[kN]	[kN]					[kN]	[kN]	[%]
C.1.2	12	75	18,95	-					-	-	-
			11	36,56	37,98	34,65	35,12	37,13	36,3	1,4	4

Table No 65: Seismic shear loads calculated

Serie	Anchor	h_{nom}	$f_{c,test,i}$	$f_{u,C1.2}$	$f_{u,5}$	$V_{u,m}$	V_{C1}	$V_{C1,red}$	$V_{C1,red}/V_{C1}$ ($\alpha_{C1.2}$)
[-]	[-]	[mm]	[N/mm²]	[MPa]	[MPa]	[kN]	[kN]	[kN]	[-]
C.1.2	12	75	32,6	851	851	37,9	18,95	11	0,58

Table No 66: Seismic shear test results

Serie	Anchor	h_{nom}	Failure	$V_{Ru,20,mean,C1.1}$	C_{oV} (C1.2)	160% $V_{C1,red}$	min(1; R_m)
[-]	[-]	[mm]	[-]	[kN]	[%]	[kN]	[-]
C.1.2	12	75	steel	36,3	4	17,6	1

Table No 67: Results of C1.1. test

Serie	Anchor	h_{nom}	N_{C1}	Ultimate load					Mean value	s	C_{oV}
[-]	[-]	[mm]	[kN]	[kN]					[kN]	[kN]	[%]
C.1.1	16	95	19,5	-	-	-	-	-	-		-
			14	33,41	32,95	30,55	32,16	29,87	31,8	1,5	5

Table No 68: Seismic tension loads calculated

Serie	Anchor	h_{nom}	$f_{c,C1.1}$	$f_{c,A3}$	$F_{u,test,A3}$	N_{C1}	$N_{C1,red}$	$N_{C1,red}$ / N_{C1} ($\alpha_{N,C1}$)
[-]	[-]	[mm]	[N/mm²]	[N/mm²]	[kN]	[kN]	[kN]	[-]
C.1.1	16	95	32,6	29,9	37,4	19,5	14	0,7

Table No 69: Seismic tension test results

Serie	Anchor	h_{nom}	Failure	$N_{Ru,20,mean,C1.1}$	C_{oV} (C1.1)	160% $N_{C1,red}$	min(1; R_m)
[-]	[-]	[mm]	[-]	[kN]	[%]	[kN]	[-]
C.1.1	16	95	concrete	31,8	5	22,4	1

Table No 70: Results of C1.2. test

Serie	Anchor	h_{nom}	V_{C1}	Ultimate load					Mean value	s	C_{oV}
[-]	[-]	[mm]	[kN]	[kN]					[kN]	[kN]	[%]
C.1.2	16	95	36,10	-					-	-	-
			22	70,43	72,55	69,65	71,35	70,78	71,0	1,1	2

Table No 71: Seismic shear loads calculated

Serie	Anchor	h_{nom}	$f_{c,test,i}$	$f_{u,C1.2}$	$f_{u,5}$	$V_{u,m}$	V_{C1}	$V_{C1,red}$	$V_{C1,red}/V_{C1}$ ($\alpha_{C1.2}$)
[-]	[-]	[mm]	[N/mm²]	[MPa]	[MPa]	[kN]	[kN]	[kN]	[-]
C.1.2	16	95	32,6	827	827	72,2	36,10	22	0,61

Table No 72: Seismic shear test results

Serie	Anchor	h_{nom}	Failure	$V_{Ru,20,mean,C1.1}$	C_{oV} (C1.2)	160% $V_{C1,red}$	min(1; R_m)
[-]	[-]	[mm]	[-]	[kN]	[%]	[kN]	[-]
C.1.2	16	95	steel	71,0	2	35,2	1

5. Disclamers

The Testing Laboratory declares that the test results relate only to the sample received.

The Laboratory is responsible for all information presented in this test report and for all stages of the test process, except for information provided by the Ordering Party and process stages performed by or under the responsibility of the Ordering Party (e.g. sample assembly). These are clearly identified in this report as information provided by the Ordering Party or activities performed by the Ordering Party.

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6. Annex

END OF THE REPORT

Annex

1. Assessment of steel resistance

Considering a uniform section and steel hardness along the full anchor length, and according to drawings supplied by the manufacturer, following steel properties apply as per EAD 330232-01-060:2019 sections 2.2.1.1 and 2.2.7.1:

Table No 73: Assessment of steel resistance

Size	f_{uk}	f_{yk}	f_{yk}/f_{uk}	$N_{Rk,s,ETA}$	$V_{Rk,s,ETA}$	$M^0_{Rk,s}$ [1)]	$\gamma_{M,s}$ (tension) [2)]	$\gamma_{M,s}$ (shear) [3)]
	[MPa]	[MPa]	[MPa]	[kN]	[kN]	[Nm]	[--]	[--]
8	800	640	0,80	20,8	14,6	44,7	1,50	1,25
10	800	640	0,80	48,1	23,2	88,7	1,50	1,25
12	800	640	0,80	61,6	33,7	154,9	1,50	1,25
16	800	640	0,80	88,2	62,8	371,7	1,50	1,25

Note:
1) Equation $M^0_{Rk,s} = 1,2 \times W_{el} \times f_{uk}$, when $W_{el} = \pi \times d^3/32$, $d = ((4 \times A_s)/\pi)^{0,5}$, A_s from test N1
2) Equation $\gamma_{M,s} = 1,2 / f_{yk}/f_{uk} \geq 1,4$
3) Equation $\gamma_{M,s} = f_{uk}/f_{yk} \geq 1,25$, when $f_{uk} \leq 800$ N/mm² and $f_{yk}/f_{uk} \leq 0,8$ or $\gamma_{M,s} = 1,5$, when $f_{uk} > 800$ N/mm² or $f_{yk}/f_{uk} > 0,8$

2. Assessment of pull out resistance

Pull out failure resistance has been assessed according to EAD 330232-01-0601:2019 section 2.2.2.10.

Table No 74: Assessment of pull out resistance, uncracked concrete

Value to the evaluation	Unit/Size	**M8**	**M10**	**M12**	**M16**
$N_{Rk,p,\ A1}$	[kN]	9,86	15,15	18,55	41,32
$(\alpha_p/\text{req}\ \alpha_p)$ F4	[-]	1	1	1	1
min $(\alpha_1/\text{req}\ \alpha_1)$	[-]	1	1	1	1
min $(\alpha/\text{req}\ \alpha)$ F1	[-]	1	1	1	1
min $(\alpha/\text{req}\ \alpha)$ F2	[-]	1	1	1	1
min $(\alpha/\text{req}\ \alpha)$ F4	[-]	1	1	1	1
min (βcv)	[-]	1	1	1	1
$N_{RK,p}$	[kN]	9,86	15,15	18,55	41,32
h_{ef}	[mm]	48	55	63	80
$N_{Rk,c}$	[kN]	16,36	20,07	24,60	35,20
Governs	[-]	Pull out	Pull out	Pull out	Concrete cone
ETA	[kN]	9,5	15	18	-

Table No 75: Assessment of pull out resistance, cracked concrete

Value to the evaluation	Unit/Size	M8	M10	M12	M16
$N_{Rk,p,A3}$	[kN]	6,30	12,23	16,88	29,30
min (α_p/req α_p) F3	[-]	1	1	1	1
min (α_1/req α_1)	[-]	1	1	1	1
min (α/req α) F1	[-]	1	1	1	1
min (α/req α) F2	[-]	1	1	1	1
min (α/req α) F3	[-]	0,96	0,95	0,93	0,95
min (α/req α) F4	[-]	1	1	1	1
min (βcv)	[-]	1	1	1	1
$N_{RK,p}$	[kN]	6,02	11,60	15,76	27,79
h_{ef}	[mm]	48	55	63	80
$N_{Rk,c}$	[kN]	11,45	14,05	17,22	24,64
Governs	[-]	Pull out	Pull out	Pull out	Concrete cone
ETA	[kN]	6	11	15	-

3. Displacements under service loads

Displacement under service loads have been taken from test series A1, A3 and V1.

Table No 76: Displacements under tension service loads in uncracked concrete

Size		M8	M10	M12	M16
h_{ef}	[mm]	48	55	63	80
$N_{Rk,p,A1}$	[kN]	9,86	15,15	18,55	41,32
$\gamma_{inst,F9}$	[-]	1	1	1	1
γ_c	[-]	1,5	1,5	1,5	1,5
$\gamma_{Mc}=\gamma_{inst,F9}$ x γ_c	[-]	1,5	1,5	1,5	1,5
γ_F	[-]	1,4	1,4	1,4	1,4
$N_s=N_{Rk,p,A1}$ / γ_F x γ_{Mc}	[kN]	4,69	7,21	8,83	19,68
$\delta_{N,0}$	[mm]	0,26	0,45	0,62	0,78
$\delta_{F4,100000}$	[mm]	1,50	1,50	1,50	1,50
$\delta_{N,F4,\infty}=\delta_{F4,100000}/2$	[mm]	0,75	0,75	0,75	0,75

Table No 77: Displacements under tension service loads in cracked concrete

Size		M8	M10	M12	M16
h_{ef}	[mm]	48	55	63	80
$N_{Rk,p,A3}$	[kN]	6,30	12,23	16,88	29,30
$\gamma_{inst,F9}$	[-]	1	1	1	1
γ_c	[-]	1,5	1,5	1,5	1,5
$\gamma_{Mc}=\gamma_{inst,F9}$ x γ_c	[-]	1,5	1,5	1,5	1,5
γ_F	[-]	1,4	1,4	1,4	1,4
$N_s=N_{Rk,p,A3}$ / γ_F x γ_{Mc}	[kN]	3,00	5,83	8,04	13,95
$\delta_{N,0}$	[mm]	0,30	0,50	0,70	0,80
$\delta_{F3,1000}$	[mm]	3,00	3,00	3,00	3,00
$\delta_{N,\infty} = \delta_{F3,1000}/1,5$	[mm]	2,00	2,00	2,00	2,00

Table No 78: Displacements under shear service loads in uncracked concrete

Size		M8	M10	M12	M16
$V_{Rk,s}$	[kN]	14,64	23,2	33,72	62,80
γ_C	[-]	1,5	1,5	1,5	1,5
γ_F	[-]	1,4	1,4	1,4	1,4
V_s	[kN]	6,97	11,05	16,06	29,90
$\delta_{V,0}$	[mm]	0,62	0,74	0,82	0,92
$\delta_{V,\infty}=1,5 \times \delta_{V,0}$	[mm]	0,93	1,11	1,23	1,38

Table No 79 : Displacements under shear service loads in cracked concrete

Size		M8	M10	M12	M16
$V_{Rk,s}$	[kN]	14,64	23,2	33,72	62,80
γ_C	[-]	1,5	1,5	1,5	1,5
γ_F	[-]	1,4	1,4	1,4	1,4
V_s	[kN]	6,97	11,05	16,06	29,90
$\delta_{V,0}$	[mm]	0,62	0,74	0,82	0,92
$\delta_{V,\infty}=1,5 \times \delta_{V,0}$	[mm]	0,93	1,11	1,23	1,38

4. Proposed ETA values

EAD 330232-01-0601:2019 and EN 1992-4

Table No 80: Characteristic values to tension loads of design method A according to EN 1992-4

Characteristic values of resistance to tension loads according to design method A				**Performances**			
Anchor size				8	10	12	16
h_{nom}	Nominal embedment depth:		[mm]	55	65	75	95
Tension loads: steel failure							
$N_{Rk,s}$	Characteristic resistance:		[kN]	20	48	61	88
γ_{Ms}	Partial safety factor [1]:		[-]	1,5			
Tension loads: pull-out failure in concrete							
$N_{Rk,p}$	Characteristic resistance in C20/25 uncracked concrete:		[kN]	9,5	15	18	-1)
$N_{Rk,p}$	Characteristic resistance in C20/25 cracked concrete:		[kN]	6	11	15	-1)
Ψ_c	Increasing factor for concrete	C30/37	[--]	1,17	1,19	1,19	1,17
		C40/45	[--]	1,30	1,34	1,35	1,31
		C50/60	[--]	1,42	1,47	1,49	1,43
Tension loads: concrete cone and splitting failure							
h_{ef}	Effective anchorage depth:		[mm]	48	55	63	80
$k_{ucr,N}$	Factor for uncracked concrete:		[-]	11,0	11,0	11,0	11,0
$k_{cr,N}$	Factor for cracked concrete:		[-]	7,7	7,7	7,7	7,7
$s_{cr,N}$	**Concrete cone failure**	Spacing	[mm]	3 x h_{ef}	3 x h_{ef}	3 x h_{ef}	3 x h_{ef}
$c_{cr,N}$		edge distance	[mm]	1,5 x h_{ef}	1,5 x h_{ef}	1,5 x h_{ef}	1,5 x h_{ef}
$s_{cr,sp}$	Spitting failure	Spacing	[mm]	150	170	190	240
$c_{cr,sp}$		edge distance	[mm]	75	85	95	120
γ_{inst}	Robustness		[-]	1,2			

1) *Pull-out doesn't decide. Characteristic resistances based on the formula from EN 1992-4, section 7.2.1.4, formula 7.2*

Table No 81: Characteristic values to shear loads of design method A according to EN 1992-4

Characteristic values of resistance to tension loads according to design method A			Performances			
	Anchor size		8	10	12	16
h_{nom}	Nominal embedment depth:	[mm]	55	65	75	95
Shear loads: steel failure without lever arm						
$V_{Rk,s}$	Characteristic resistance:	[kN]	14	23	33	62
k_7	Ductility factor:	[--]	1,0			
γ_{Ms}	Partial safety factor [1]:	[--]	1,25			
Shear loads: steel failure with lever arm						
$M^0_{Rk,s}$	Characteristic bending moment:	[Nm]	44,7	88,7	154,9	371,7
γ_{Ms}	Partial safety factor [1]:	[-]	1,25			
Shear loads: concrete pryout failure						
k_8	Pryout factor:	[mm]	1	1	2	2
γ_{ins}	Installation safety factor:	[--]	1,2			
Shear loads: concrete edge failure						
l_f	Effective length of fastener under shear loads:	[mm]	48	55	63	80
d_{nom}	Outside fastener diameter:	[mm]	8	10	12	16
γ_{ins}	Installation safety factor:	[--]	1,2			