DEKRA Rail

Testing of scaffolding anchors for tensile and shear force

4 December 2018

DEKRA

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Testing of scaffolding anchors for tensile and shear force

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Testing of scaffolding anchors for tensile and shear strength, 4-12-2018, finalized 1.0 - 1 / 20 $\,$

Management Summary

Scaffolding anchors from McNetiq are subject to tensile and sliding tests before being released by the Deutsche Institut für Bautechnik (DIBt).

The tests have been carried out in order to be able to assess whether the scaffolding anchors comply with the requirements laid down in NEN-EN 13155:2003+A2:2009. In accordance with the standard, the scaffolding anchors shall be subjected to both tensile and shearing tests under various conditions. The tensile tests were carried out on the 15th of November 2018. Prof. K. Hameyer was present as the representative for DIBT. The slide tests were carried out on 21 November 2018.

Mr. Bas Gravendeel was present for McNetiq on both test days.

This report contains a description of the measurements carried out and the results of the tensile and shear tests.

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1 Introduction

For release by the German DIBt institute, McNetiq scaffolding anchors must be subjected to tensile and shear tests. There is no specific standard (yet) for scaffolding anchors. As a guideline, the standard as it applies to lifting equipment is sought, the NEN-EN 13155:2003+A2:2009. The activities described in this report were commissioned by returning our quotation DR/18/180293/001, signed by the client, by e-mail on 18 July 2018.

2 Set-up of activities

DEKRA Rail has ordered the necessary equipment for carrying out the tests. The list of tools is shown in appendix 1. In accordance with the standards, the plates have a flatness of less than 0.1 mm per 500 mm. The tests were carried out with both, a perpendicular and a shearing force. The tests were also carried out with different starting points. Appendix 2 contains a list of all the tests to be carried out. A scaffolding anchor was heated to 80 degrees Celsius for a number of tests. A blank and a coated plate of 20 mm thickness were tested at a temperature of -20 °C.

3 Methode

The tests were carried out on the MTS test bench with a calibrated load cell. This test bench was last calibrated on 1 October 2018. In terms of accuracy, the machine is in class 0.5 for both tensile and compressive testing. This means that the deviations in both tensile and compressive readings are less than 0.5%.

The boards with the different wall thicknesses are mounted on a wood package of at least 54 mm on the tensile part of the test bench. The plates are pressed onto the wood package by means of two clamping plates. The magnet to be tested is mounted to the fixed frame of the test stand by means of its eyebolt attachment.

After the magnet has been switched on, the plate is pulled down at a speed of 0.5 mm per minute. The movement of the bench is stopped after the magnet comes loose from the plate. Pictures 1 and 2 show the test fixture as used during the tensile tests.



Photo 1 and 2: Installation for tensile tests.

The air gap tests were carried out using copper foil of 0.5 mm, 1 mm and 1 mm respectively. mm and 2 mm thick. The tensile force and displacement of the cylinder are determined by Instron software.

The maximum tensile force is determined per test using the force/displacement diagram made of each measurement. Figure 1 shows an example of a force/displacement diagram. For the measurement in the figure below, the maximum tensile force is determined at 21.3 kN.



Panel 20mm, air gap 0mm, on 54mm wood

Figure 1: Force versus displacement measurement wall thickness 20 mm.

The determination of the shear force was carried out on the same MTS test bench. The plates to be tested were placed vertically. Pictures 3 and 4 show the test setup as used during the sliding tests. In order to avoid having to lift the magnet every time the sheets are changed, the magnet is suspended from the fixed frame of the test bench using the green lashing strap. After switching on the magnet on the plate to be tested, the anchor is loaded by the blue lashing strap attached to the pulling cylinder.



During the tensile test, the green lashing strap is relaxed so that the scaffold anchor can move when the maximum shearing force is reached.



Photo 3 and 4: Test setup for determining the shear force with coated and uncoated plate.

In Annex 3 some pictures of the test set-ups are shown.

3.1 Tested anchor bolts

The tests in which the scaffolding anchor was used at ambient temperature were carried out with the anchor with serial number 2018-023. The tests in which the scaffold anchor was preheated at 80 °C before the test was carried out were carried out with the anchor with serial number 2018-018.

The certificates of both anchors tested are shown in appendices 6 and 7.

3.2 Certification DEKRA rail b.v.

DEKRA Rail has ISO 9001-2015 certification for the entire company and ISO17025 accreditation for parts.

The equipment used to determine the measurement results is calibrated annually. The type numbers and calibration dates are listed in appendix 1.

4 Results

4.1 Results of tensile tests

Airgon[mm]		Wall thickness						
Angap[mm]	20 mm	10mm	8mm	6mm				
0	21,3	16,0	10,4	3,2				
0,5	10,1	8,3	7,5	3,0				
1	6,9	6,1	5,3	2,6				
2	3,0	2,6	3,0	1,6				

Table 1 shows the results of the tensile tests on the blank plates.

Table 1: Perpendicular tensile force [kN] at different wall thicknesses and air gaps.

The ambient temperature during these tests was 24 °C.

Figure 1 shows these results in graphical form.



Figure 2: Results of tensile strength blank plate with different wall thicknesses.

These tests were carried out with anchor 2018-23. Figure 3 shows the measured values as provided by the manufacturer in the manual

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Figure 3: Lead straight force vs. wall thickness according to the manufacturer's specifications.

Table 2 shows the results of the tensile tests on the bare plate 20 mm thick with the preheated magnet on a plate at ambient temperature. And on a plate, that had been cooled to -30 C and the magnet at ambient temperature. The exact temperatures at the time of testing deviated slightly from the prescribed temperature of +80 °C and -20 °C respectively.

Airgap [mm]	Panel 24 °C / magnet 75 °C	panel -16 °C/ magnet 24 °C
0	19,9	21,0
0,5	8,3	10,0
1	5,9	
2	2,6	

Table 2: Perpendicular tensile force [kN] with magnet or plate at different temperatures.

Appendix 4 shows a number of force/displacement diagrams of the tensile tests.

4.2 Results of shear testing

Table 3 shows the results of the measurements to determine the shear forces on the uncoated sheets with different wall thicknesses, wetted, and cooled at -16 °C. The results are shown in the table below. The magnetic temperature at all slide tests was 22 °C.

Airgon/panal condition	Wall thickness					
Aligap/pariel condition	20 mm	10 mm	6 mm	4 mm		
0 mm	3,7	3,5	2,0	1,3		
-16 °C	3,2					
22 °C nat	3,2					

Table 3: Shear strength [kN] bare plate at different wall thicknesses and air gaps.



Table 4 shows the results of the measurements to determine the shear forces on the coated sheets with different wall thicknesses, wetted, and cooled at -16 °C. The results are shown in the table below.

Airgan/nanal condition	Wall thickness				
Aligap/parler condition	20 mm	10 mm	4 mm		
0 mm	3,2	2,9	1,2		
-11 °C	4,0				
22 °C nat	2,7				

Table 4: Shear strength [kN] coated plate at different wall thicknesses and air gaps

Appendix 5 shows a number of force/displacement diagrams for the sliding tests.



Device/	Further	Identification	Last	Next
Instrument	Description		calibration	calibration
MTS Loadcell	100 kN	CTO 5.33.49.6	1-10-2018	01-10-2019
Slide gauge	150 mm	1.6.2053	14-02-2018	14-02-2019
Layer thickness	Fischer			
meter	Deltascope MP3	5.2.70	12-09-2018	12-09-2019
Height meter	Trimos MT1000MA	8.1.34	09-01-2018	09-01-2019
Temperature meter	Keithley 871A	CTO 1.23.7	12-09-2017	12-09-2019
Oven	Hielkema Grenlo GH	IS 12540		
Climate room	Minimum temperatur	re -30 °C		

Annex 1: Used equipment and materials

Table 5: Used equipment/instruments.

Materials used

Steel panel	Amount
845 x 250 x 20 mm S235 vlgs EN13155 flat-edged	2
845 x 250 x 10 mm S235 vlgs EN13155 flat-edged	1
845 x 250 x 8 mm S235 vlgs EN13155 flat-edged	1
845 x 250 x 6 mm S235 vlgs EN13155 flat-edged	1
845 x 250 x 4 mm S235 vlgs EN13155 flat-edged	1
845 x 250 x 20 mm S235 vlgs EN13155 100 μm coating	2
845 x 250 x 10 mm S235 vlgs EN13155 100 μm coating	1
845 x 250 x 4 mm S235 vlgs EN13155 100 μm coating	1
Ground panel 850x350x30 v.v. threaded holes and	
threaded ends	1
strip 700x100x10 v.v. sleufgaten	2

Copper foil				
140 x 10 x 0.5 mm	2			
140 x 10 x 1 mm	2			
140 x 10 x 2 mm	2			

Table 6: Materials purchased

Annex 2: Pull tests carried out

			Temp.	Used	Test file	Measured
Test- number		Tensile testing	Magnet / panel [°C]	anchor	number	Force [kN]
	P1.	Temperature meter (10 < T < 30)		2018-23		
	,	Temperature meter				
		Magnet at				
		room temperature (measuring)				
	20 mm	steel panel 845 x 250 x 20 mm S235				
		vlgs EN13155 flat-edged				
1		airgap 0 mm	24		15	21,3
		Copper foil 0,5 mm, 140 mm long				
2		and	24		16	10,1
		10 mm wide				
3		Copper foil 1 mm, 140 mm long and	24		17/18	6,8/6,9
		10 mm wide				
4		Copper foil 2 mm, 140 mm long and	24		19/20	3,0/3,0
		10 mm wide				
	Р2,	Temperature meter (10 < T < 30)		2018-18		
		Temperature meter				
		Magnet at 80 degrees C (measuring)				
	20 mm	Steel panel 845 x 250 x 20 mm S235				
_		vigs EN13155 flat-edged	75		24	10.0
5		airgap 0 mm	/5		21	19,9
6		Copper foll 0,5 mm, 140 mm long and	74		22	8,3
7		Conner foil 1 mm 140 mm long and	70		22	5.0
/		10 mm wide	12		23	5,9
8		Copper foil 2 mm 140 mm long and	70		24	2.6
0		10 mm wide	10		27	2,0
	P3.	Temperature meter $(10 < T < 30)$		2018-23		
	- /	Temperature meter				
		Magnet at				
		Room temperature(measuring)				
	10 mm	Steel panel 845 x 250 x 10 mm S235				
		vlgs EN13155 flat-edged				
9		airgap 0 mm	24		25/59/60	17,0/15,3/15,8
10		Copper foil 0,5 mm, 140 mm long and	24		26/61/62	-8,3/8,2
		10 mm wide				
11		Copper foil 1 mm, 140 mm long and	24		27/63/64	6,1/5,6/6,7
		10 mm wide			00/07/05	
12		Copper toil 2 mm, 140 mm long and	24		28/65/66	3,0/2,4/2,5
		10 mm wide				



-						
	РЗ,	Temperature meter (10 < T < 30)		2018-23		
		Temperature meter				
		Magnet at				
		room temperature (measuring)				
	8 mm	Steel panel 845 x 250 x 8 mm S235				
		vlgs EN13155 flat-edged				
13		airgap 0 mm	24		29	10,4
		Copper foil 0,5 mm, 140 mm long				
14		and	24		30	7,5
		10 mm wide				
15		Copper foil 1 mm, 140 mm long and	24		31	5,3
		10 mm wide				
16		Copper foil 2 mm, 140 mm long and	24		32	3,0
		10 mm wide				
	РЗ,	Temperature meter (10 < T < 30)		2018-23		
		Temperature meter				
		Magnet at				
		room temperature (measuring)				
	6 mm	Steel panel 845 x 250 x 6 mm S235				
		vlgs EN13155 flat-edged			_	_
17		airgap 0 mm	24		33/34	3,3/3,1
		Copper foil 0,5 mm, 140 mm long				
18		and	24		35	3,0
		10 mm wide				
19		Copper foil 1 mm, 140 mm long and	24		36	2,6
		10 mm wide			07/00	
20		Copper foil 2 mm, 140 mm long and	24		37/38	1,6/1,6
		10 mm wide				
	extra	Temperature meter $(10 < T < 30)$		2018-23		
		Temperature meter	22			
		Magnet at	22			
		room temperature (measuring)				
	20 mm	Steel panel 845 x 250 x 20 mm S235	VIgs EN13155			
41		Flat-edged			40	24
L.		Airgap U mm	Plaat – 16 °C		40	21
24		copper foil 0,5 mm, 140 mm long				
Ľ		and 10 mm wide			20	10
		10 mm wide	Plaat – 16 °C		39	10

Table 7: Measurements made for the determination of the tensile strength.

Annex 3: Sliding tests carried out

Test - nummer	Slide test		Temp. Magnet / panel [°C]	Used anchor	Test file number	Measured Force [kN]
21	P4, 20 mm	Temperature meter (10 < T < 30) Temperature meter Magnet at room temperature (measuring) Steel panel 845 x 250 x 20 mm S235 vlgs EN13155 flat- edged airgap 0 mm	22	2018-23	45	3,7
22	20 mm	Temperature meter (10 < T < 30) Temperature meter Magnet at room temperature (measuring) Steel panel 845 x 250 x 20 mm S235 vlgs EN13155 100 μm coating airgap 0 mm	22	2018-23	46	3,2
23	P5, 10 mm	Temperature meter (10 < T < 30) Temperature meter Magnet at room temperature (measuring) Steel panel 845 x 250 x 10 mm S235 vlgs EN13155 flat- edged Airgap 0 mm	22	2018-23	51	3,5
24	10 mm	Temperature meter (10 < T < 30) Temperature meter Magnet at room temperature (measuring) Steel panel 845 x 250 x 10 mm S2 EN13155 100 μm coating Airgap 0 mm	35 vlgs 22	2018-23	47	2,9
	P5, 4 mm	Temperature meter (10 < T < 30) Temperature meter Magnet at room temperature (measuring) Steel panel 845 x 250 x 4 mm S235 vlgs EN13155 flat- edged	22	2018-23	50	1,3
25		Airgap 0 mm Steel panel 845 x 250 x 6 mm S235 vlgs EN13155 flat-edged	22		49	2,0



26	4 mm	Temperature meter (10 < T < 30) Temperature meter Magnet at room temperature (measuring) Steel panel 845 x 250 x 4 mm S235 vlgs EN13155 100 μm coating airgap 0 mm	22	2018-23	48	1,2
	P6,	Temperature meter (10 < T <				
		30) Temperature meter				
		Magnet at	22	2018-23		
		room temperature (measuring)				
	20 mm	Steel panel 845 x 250 x 20 mm	Plaat – 16 °C		53	2,0
		S235 vlgs EN13155 flat-				
27		edged, -20 degrees C			50	2.6
27		airgap 0 mm	Plaat – 16 °C		56	2,6
		1 emperature meter (10 < 1 <				
		Magnet at	22	2018-22		
		room temperature (measuring)	22	2010-23		
		Steel panel 845 x 250 x 20 mm				
		S235 vlgs EN13155 100 um				
		coating20				
		degrees C				
28		airgap 0 mm	Plaat – 16 °C		52	4,0
	Р7,	Temperature meter (10 < T <				
		30) Temperature meter				
		Magnet at		2018-23		
		room temperature (measuring)				
	20 mm	Steel panel 845 x 250 x 20 mm S2	35 vlgs			
		EN13155 flat-edged				
29		airgap 0 mm	22		54	3,2
		Water spray bottle				
		Temperature meter (10 < T <				
		30) Temperature meter				
		Magnet at		2018-23		
		room temperature (measuring)				
	20 mm	Steel panel 845 x 250 x 20 mm S2	35 vigs			
20		LINISISS 100 µm coating	22		FF	20
30		angap U mini Ie	22		55 E C	2,8
1	I	water splay buille Ze			50	2,0

Table 8: Measurements made for the purpose of determining the shear strength.



Annex 3: Photographs of the test setup



Position of copper foil 0.5 mm for testing

Cooled plate after testing





Slide test wetted plate



Annex 4: Force versus displacement tensile force determination





Annex 5: Force versus displacement shear force determination





Annex 6: Certificate scaffold anchor 2018-0018

TEST CERTIFICATE PRÜFZERTIFIKAT TESTCERTIFICAAT CERTIFICAT D'ESSAIS		TCERTIFIKAT VECERTIFIKAT TSERTIFIKAT KASTUSTODISTUS	CERTIFICADO DE ENSAYO CERTIFICATO DI CONTROLLO CERTIFICADO DE AFERIÇÃO Πιστοποιητικό δοκιμών		
iff mannet model	Luftmagnet two	I mán elevador, modelo	CERTYFIK/ Magnes podnoszący	AT TESTU	
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io. de série Ireak-away force Urwißkraft Osbraekkracht	Sarjanumero Lesrivelsekraft Trækkraft Draokraft	Fuerza de arranque Forza di distacco Forca de arranque	Siła oderwania	2.240	
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This is to certify the brea Our test equipment is ca Hiermit bascheinigen wi Unser Pröfstand wird pe Hierme documenteren Orze testbank wordt pe Nous certifions la force Note band de best est o Vi erklærer at denne le Vores testudstyr er kalls Vi erklærer at denne le Vores testudstyr er kalls Vi torsaker harmed at Vi forsaker harmed at vakuutamme, esta fam Testaustabileistomme o Certificamos que este in Anesto sparatos de Si dichiara che questo r I nostri dispositivi di test Declaramos que este it Ansasa aparethagend Ansaz, sprzet testowy je Deklanjeme, že etektro pravidelnoù kalibraci o	kaway force indicated above of th librated periodicatly by a carkled ir die oben eingetragene Abreitker riddisch von einer offiziellen Prüfa wij de losbreekkracht van deze m indisk door een offiziellen Prüfa diarachement de os portsur mage abregendigverment par un orga temagneten har oppnäöd ovenstå rert med jevne mellomnom av et o fremagnet har nået ovenstående i b inreret periodisk af et officiet organ enna lyfimagnet uppnäid ovenstå ibrerad regelbundet av et officiet biserad regelbundet av et officiet i nostomagneetti on saavuttanut yd n vikallisen tahon tarksstama mån elevador ha alcanizade la fuer magnete di sollevamento ha raggis t sono sottoposti al controllo da pa man elevador alcançou a forca de te testes esta sob controllo de um si evekazana povyzej sile oderwi st ovestowo kaloroweny przez oe pragnet dosahi behem testování v d certifikovaného subjektu.	is litting magnet according to the pr body. It dieses Lasthebernagneten gemäl instalt kaltoriert agneet volgens de aan de ommezij gekaltereerd rittige oortlie. ende tegsweisekraft under den testi fisielt organ esrivningskraft vid det på andra sida torgan. Itamainitum inrotusvoiman kääntöpur ogan ansimo oortficado. into ta forza 6 distacco sopra indigi ret 6 organo competente autorizza arrangue acima mencionada duran i instância certificada. arrangue acima mencionada duran i instância certificada.	rocedure described overleaf. & der auf der Rücksole beschr de beschreven procedure. I au verso weisestesten som er beskrevet e, der er beskrevet på bagsider in beskrivna dragtestet ofelfa kuvatussa irrobuskokeess durante el ensayo descrito al d als, durante il collaudo relativo to to ensalo descrito no verso nie z procedura opisana na odv estovaci zalizeni prochàzi	iebenen Prozedur, på baksiden, h. a aurso. descritto suf retro.	



Annex 7: Certificate scaffold anchor 2018-0023

TEST CERTIFIC PRÜFZERTIFIK TESTCERTIFIC CERTIFICAT D	ATE TES AT PRØ AAT TES 'ESSAIS TAR	TCERTIFIKAT VECERTIFIKAT TSERTIFIKAT KASTUSTODISTUS	CERTIFICA CERTIFICA CERTIFICA Πιστοποιητ CERTYFIK	DO DE ENSAYO TO DI CONTROLLO DO DE AFERIÇÃO Ικό δοκιμών ΑΤ TESTU
Hebemagnet Typ Hijsmagneet type Almant, modèle	Leftemagnet typ Leftemagnet type Nostomagneetil typpi	Magnete di sollevamento tipo Iman elevador modelo	Typové označení magnetu	Controlock Magnetic Anchor
Code number Kodenummer Codenummer	Kodenummer Kodenummer Kodnummer	Numèto de código Numeto di codice Numéto de código Kód číslo	Numer kodu	551.01-1400.1
Serial no. Serienn. Serienr.	Serienummer Serienummer Serienummer	Número de serie Número di serie0 Número de série	Numer seryiny Výrobní číslo	2018-0023
Break-away force Abreiškraft Lostreekkracht	Løsrivelsekraft Trækkraft Dragkraft	Fuerza de arranque Forza di distacco Força de arranque Odthout or	Sita oderwania:	2.195
Porce de decollement Date Datum	Dato Pálväys	Fecha Data	Datum	12-9-2018
Tested by: Geprüft von: Getest door:	Testet av: Afprøvet af: Testad av:	Ensayado por: Controllato da: Testado por:	Testoval	RS
Airgap: Luftspalt: Luchtspleet: Entrefer:	Luftspalte: Luftspalte: Luftspringa: Ilmarako:	Abertura Spazio. Folga	Szczelina powietrzna: Vzduchová mezera:	0 mm
Hiermit bescheinigen w Unser Prüfstand wird pr Hiermee documenteren Orze testbank wordt pr Nous certifions la force Notre banc de test est i Vi erklærer at denne la	r die oben eingetragene Abreißkra triodisch von einer offiziellen Prüfe wij de losbreekkracht van deze m rhodiek door een officiële instantie d'arrachement de ce porteur magr zalbre periodiquement par un orga hemagneten har oppnådd ovenstå preri med jevne mellomrom av et o stjemagnet har njet ovenstående i	It desses Lasthebernagneten gemäl instati kalbriert. agneet volgens de aan de ommezijd gekalbreerd. hétique suivant la procédure décrite nisme certifié. ende lastivetsekraft under den lessi fisielt organ.) der auf der Rückseite beschri Se beschreven procedure au verso. relasstesten som er beskrevet j n, der er beskrevet på bagsiden	ebenen Prozedur. på baksiden
Vár test utstyret er kalk Vi erkiærer, al denne la Vores testudistyr er kalk Vi försäkar härmed at o Vår testurusning är ka Valkutamme, että täm Testauslariteistomme o Cersificamos que este i Nuestros aparatos de e Si dichara che questo. I nosti dispositivi di test Declaramos que este i Ninejszym zašwadcza Nasz sprzet testowy je Deklarujeme, že etektor pravidelnou kalkoracio	breret periodisk af et officielt organ tenna lyftmagnet uppnätt ovenstiel ikbrenad regelbundet av ett officiel a nostomagneett on stavuttanut y man elevador ha alcanzado ta fuet trisayo estan bajo control de un or magnete di sollevamento ha raggio it sono sottoposti al controllo de pa man elevador alcanzu a forca de de testes está sob control de umo st oktesovo kalibrowany przez cel vmagnet dosáhl behem testování.	nde dragkraft vid det på andra sidar torgan. Ilamainitum irrotusvoiman kääntöpuo rza de arranque arriba mentionada o ganismo certificado unto la forza si distacco sopre indica rite di organo competente autorizzat arranque acima mencionada durant i instância oetificada. ania magnesu podnoszącego zgodn tyfikowany podmiot ryše uvedených garametrů. Naše ter	i beskrivna dragtestet. Ielia kuvatussa irrotuskokeessi surante ol ensayo desorito al do ta, durante il collaudo relativo (o. e o ensaio desorito no verso. ie z procedurą opisaną na odw stovaci zafizeni procházi	a descritto sul retro. rocie