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Bellaterra: **July 30th, 2015**

File number: **15-10400-1000**

Petitioner's reference **APOLO FIJACIONES**
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CHARACTERISTIC RESISTANCE FOR TENSION LOADING ON DNBOLT ANCHORS ACCORDING TO ETAG 001

SCOPE and REQUESTED TESTS

Characteristic resistance for tension loading not influenced by edge and spacing effects was performed on simple anchors.

Reference standards for tested product and performed tests are:

- ***ETAG 001: METAL ANCHORS FOR USE IN CONCRETE. Part one: ANCHORS IN GENERAL***
- ***ETAG 001: METAL ANCHORS FOR USE IN CONCRETE. Part two: TORQUE – CONTROLLED EXPANSION ANCHORS***
- ***ETAG 001: METAL ANCHORS FOR USE IN CONCRETE. Annex A: DETAILS OF TESTS***
- ***ETAG 001: METAL ANCHORS FOR USE IN CONCRETE. Annex B: TESTS FOR ADMISSIBLE SERVICE CONDITIONS. DETAILED INFORMATION***

PRODUCT TESTED

Technical characteristics of tested products listed below were provided by the petitioner.

Characteristics of tested products		
	**Definition of tested product**	Torque- controlled expansion anchors trademark **DNBOLT** manufactured by the petitioner.
	Tested model designation	**9L / 11L / 14L / 16L / 21 / 26**
	Screw material	6.8 steel according to SO/DIN 989-1
	Sleeve	Soft steel
	Washer	Soft steel
	Cone	Soft steel, quality C6
	Case	HDPE
	Coating	White zinc plated

Tested anchors were selected by the petitioner and delivered at Applus laboratories on 08/07/2015 with its original packaging and properly labeled.

6 different cases were tested (corresponding to 6 different diameters):
Anchors 9L / 11L / 14L / 16L / 21 / 26

For each case were tested 5 tests samples.

Before testing and delivering test material, tests members were prepared (one for each anchor).

Date of tests: July 16th 2015.

TEST PROCEDURE AND TEST CONDITIONS

Characteristic resistance for tension loading not influenced by edge and spacing effects was performed on simple anchors.

This test is included in the group of tests for admissible service conditions indicated in table 5.1, section 5.1.3 of ETAG 001-2 and table 5.4 section 5.1.3 of ETAG 001-1.

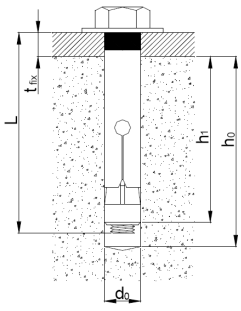
The aim of this group of tests is to achieve the design values of the performance characteristics of the anchors.

Test parameters

Test method described in section 5.2.1 Annex A of ETAG 001.
Condition of concrete member: non-cracked.
Concrete strength at the moment of tests: 23 N/mm^2

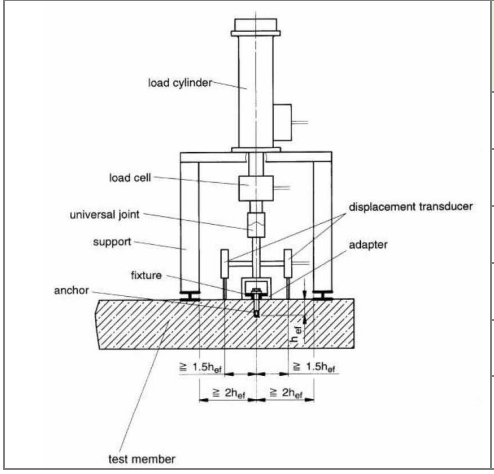
For each single anchor was prepared a test member with a square base and minimum member thickness described in section 2.5 (b), Annex A of ETAG 001.
Following tables show anchor installation parameters and size of test members depending on it.

Anchors DNBOLT*/ Installation parameters



Name	Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Maximum thickness of fixture $t_{fix,\ max}$	Required torque T_{inst} (Nm)
9L	M6	60	9	45	40	20	10
11L	M8	80	11	55	50	30	15
14L	M10	100	14	65	60	40	30
16L	M12	110	16	75	70	40	65
21	M16	110	21	85	80	30	150
26	M20	130	26	105	100	30	300

(*) Installation parameters shown were provided by the petitioner

Installation parameters/ test members characteristics				
	**Name**	**Thickness of test member h (mm) = 2hef (min 100mm)**	**edge L (mm) = 6 hef**	**diameter of clearance hole ** (mm)**
	9L	**100**	**240**	**11**
	11L	**100**	**300**	**13**
	14L	**120**	**360**	**16**
	16L	**140**	**420**	**18**
	21	**160**	**480**	**23**
	26	**200**	**600**	**29**

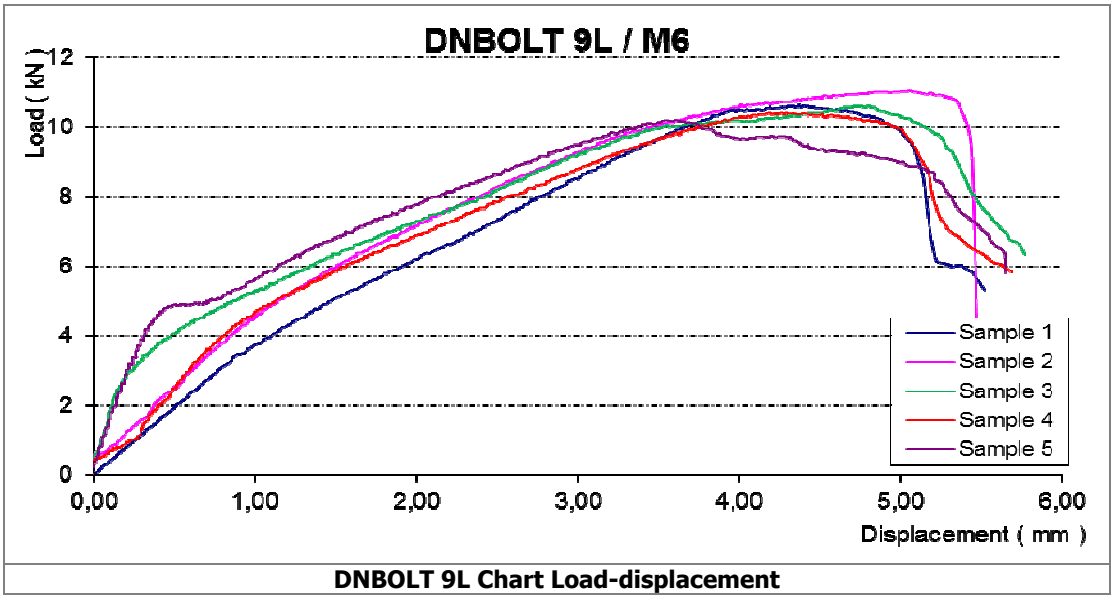
(**) diameter of clearance hole in the fixture according to table 4.1 Annex A ETAG 001

The anchors were installed in accordance with the standard instruction supplied by the manufacturer and taking into account requirements of section 3 Annex A of ETAG 001.
Torque moment (T_{inst}) was applied following the manufacturer instructions.
After about 10 minutes of torquing de anchors, the torque moment was reduced to 0,5 T_{inst} to account for relaxation of the prestressing force with time.
Test equipment was a press trademark INCOTECNIC model 600kN–T/C that meets requirements specified in section 4 Annex A of ETAG 001.
During tension test, load and displacements were recorded continuously.

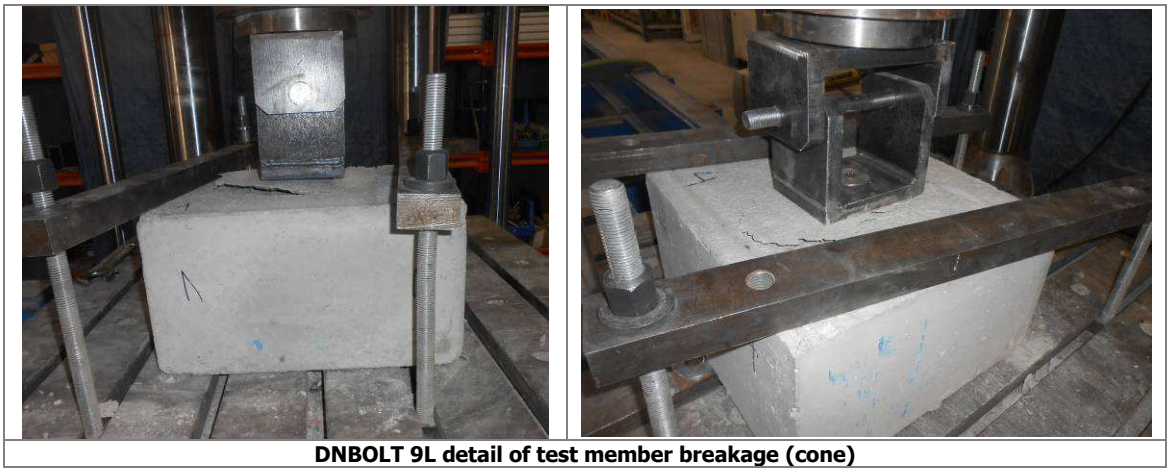
Tests results, load-displacement chart and pictures during tests are shown in next pages.

DNBOLT 9L

Characteristic resistance for tension loading not influenced by edge and spacing effects DNBOLT 9L									
Name Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Required torque T_{inst} (Nm)	Sample nº	Maximum load. (kN)	Displacement at máx. load (mm)	Failure mode
9L M6	60	9	45	40	10	1	10,65	4,37	Breakage of test member (cone) in all cases
						2	11,07	5,05	
						3	10,62	4,80	
						4	10,41	4,29	
						5	10,19	3,60	
					Average value		10,59		



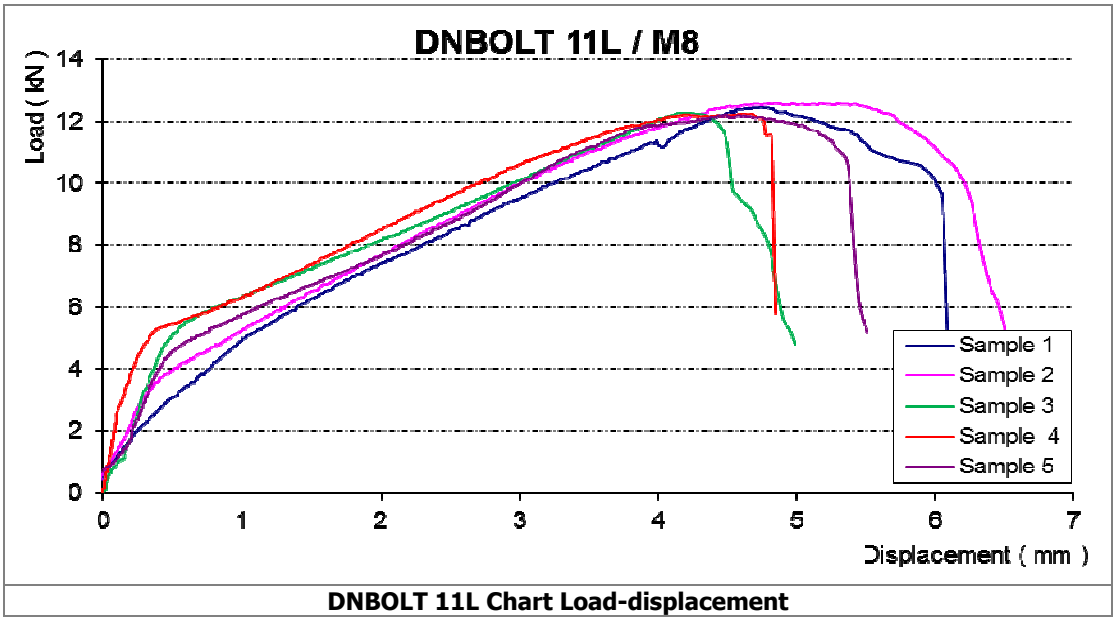
DNBOLT 9L Chart Load-displacement



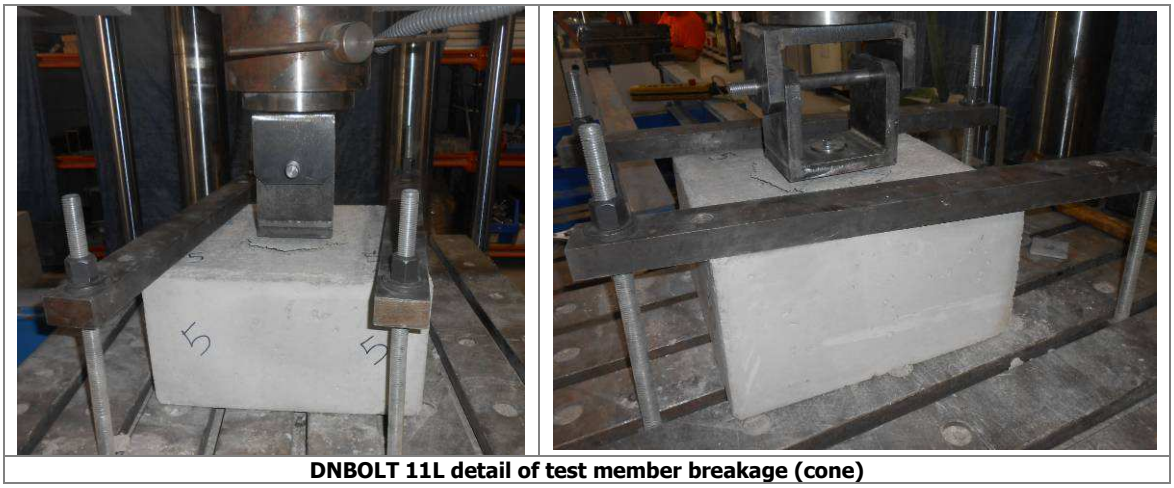
DNBOLT 9L detail of test member breakage (cone)

DNBOLT 11L

Characteristic resistance for tension loading not influenced by edge and spacing effects DNBOLT 11L									
Name Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Required torque T_{inst} (Nm)	Sample nº	Maximum load. (kN)	Displacement at máx. load (mm)	Failure mode
11L M8	80	11	55	50	15	1	12,46	4,74	Breakage of test member (cone) in all cases
						2	12,60	5,17	
						3	12,27	4,14	
						4	12,25	4,67	
						5	12,20	4,48	
						Average value	12,35		



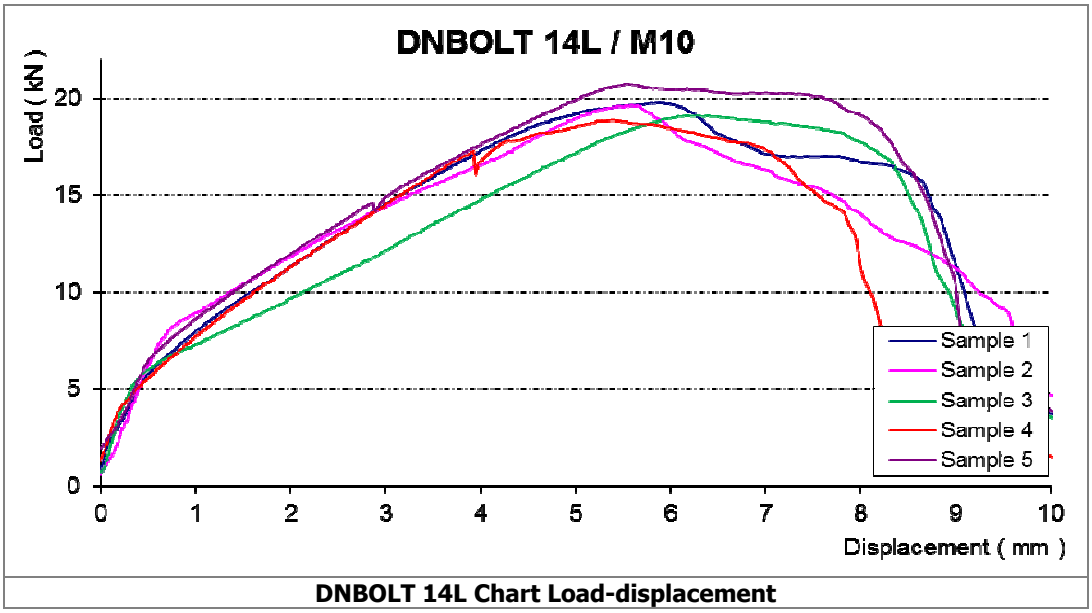
DNBOLT 11L Chart Load-displacement



DNBOLT 11L detail of test member breakage (cone)

DNBOLT 14L

Characteristic resistance for tension loading not influenced by edge and spacing effects DNBOLT 14L									
Name Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Required torque T_{inst} (Nm)	Sample nº	Maximum load. (kN)	Displacement at máx. load (mm)	Failure mode
14L M10	100	14	65	60	30	1	19,79	6,25	Breakage of test member (cone) in all cases
						2	19,65	5,59	
						3	19,11	6,38	
						4	18,85	5,36	
						5	20,75	5,52	
					Average value		19,63		



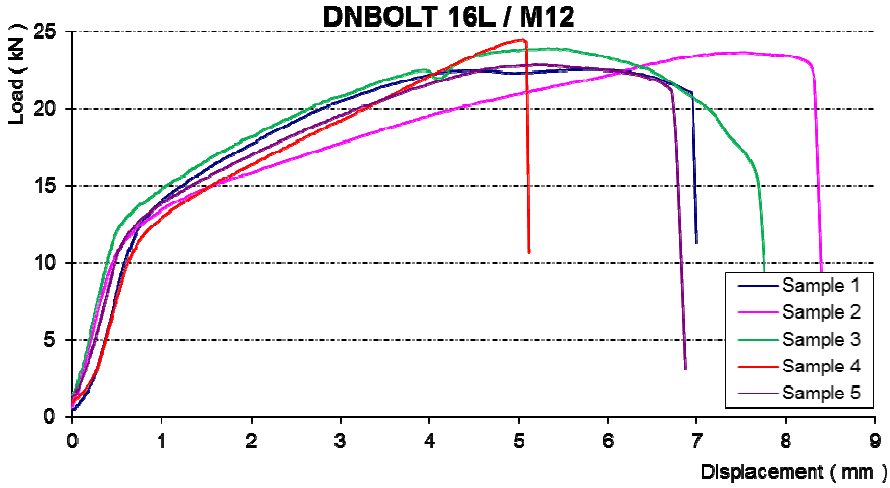
DNBOLT 14L Chart Load-displacement

DNBOLT 14L detail of test member breakage (cone)

DNBOLT 16L

Characteristic resistance for tension loading not influenced by edge and spacing effects DNBOLT 16L									
Name Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Required torque T_{inst} (Nm)	Sample nº	Maximum load. (kN)	Displacement at máx. load (mm)	Failure mode
16L M12	110	16	75	70	65	1	22,56	5,73	Breakage of test member
						2	23,67	7,36	
						3	23,93	5,52	Breakage of test member (cone)***
						4	24,51	5,05	Breakage of test member
						5	22,87	5,19	
						Average value	23,51		

*** Remark: the cone of breakage only appears in sample nº 3*



DNBOLT 16L Chart Load-displacement

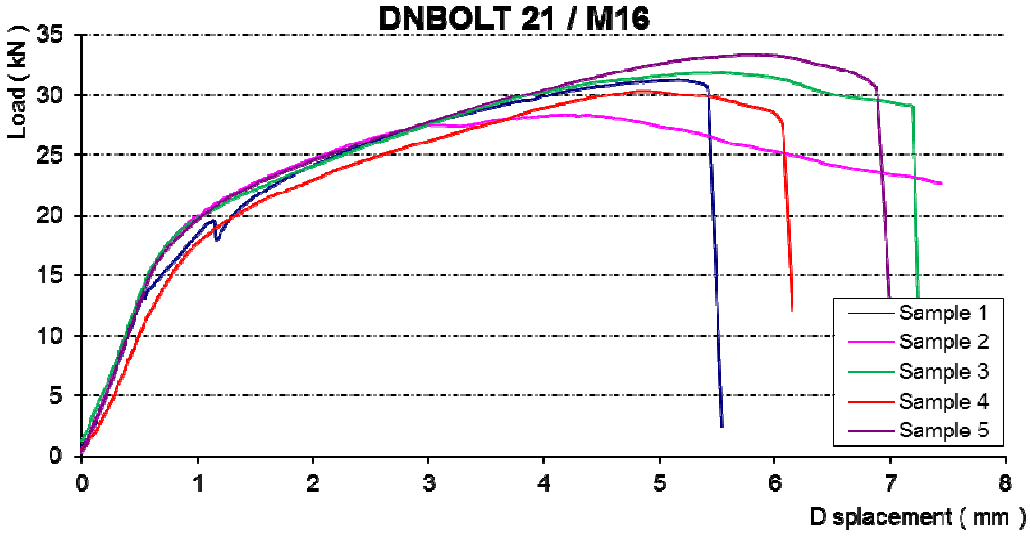
DNBOLT 16L: Breakage of test member Samples nº 1, 2, 4, 5 y 6

DNBOLT 16L: Breakage of test member (cone) Sample nº3

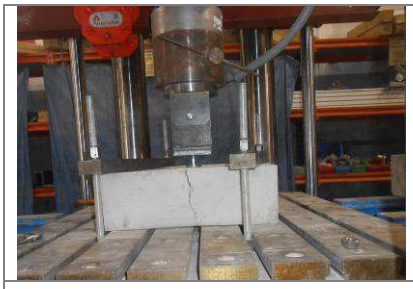
DNBOLT 21

Characteristic resistance for tension loading not influenced by edge and spacing effects DNBOLT 21									
Name Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Required torque T_{inst} (Nm)	Sample nº	Maximum load. (kN)	Displacement at máx. load (mm)	Failure mode
21 M16	110	21	85	80	150	1	31,24	5,17	Breakage of test member
						2	28,35	4,38	Breakage of test member (cone)***
						3	31,82	5,52	Breakage of test member
						4	30,32	4,89	
						5	33,33	5,72	
						Average value	31,01		

*** Remark: the cone of breakage only appears in sample nº2*

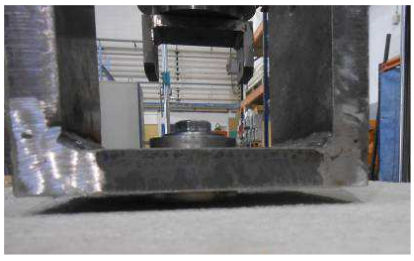


DNBOLT 21 Chart Load-displacement



DNBOLT 21: Breakage of test member Samples nº 1, 3, 4, 5 y 6

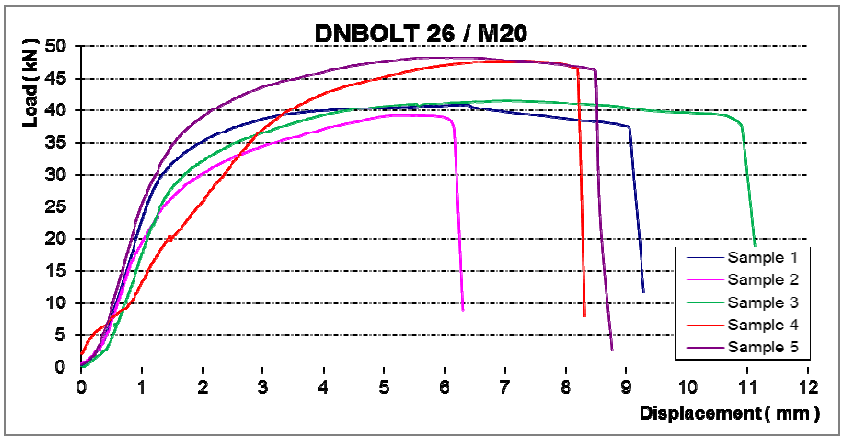
DNBOLT 21: Breakage of test member (cone) Sample nº2



DNBOLT 21: Detail of tension test

DNBOLT 26

Characteristic resistance for tension loading not influenced by edge and spacing effects DNBOLT 26									
Name Thread	Length L (mm)	Hole dimensions do (mm)	Hole dimensions ho (mm)	Embedment depth h_1 (mm)	Required torque T_{inst} (Nm)	Sample nº	Maximum load. (kN)	Displacement at máx. load (mm)	Failure mode
26 M20	130	26	105	100	300	1	40,90	6,39	Breakage of test member in all cases
						2	39,23	5,18	
						3	41,58	7,10	
						4	47,69	7,32	
						5	48,30	5,76	
						Average value	43,54		



DNBOLT 26 Chart Load-displacement

DNBOLT 26 detail of breakage / end of test

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