

Webbing in Hangers Testing Report

Version 1.0, 2021

Author: Grant Prattley

Over The Edge Rescue https://overtheedgerescue.com

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Table of Contents

Introduction	5
Methods and Materials	6
Results	8
Analysis	9
Conclusions	9
References	10
Glossary of terms	11
Appendix 1: Aspiring 16mm Tubular Webbing	12
Appendix 2: Aspiring 25mm Tubular Webbing	27

Introduction

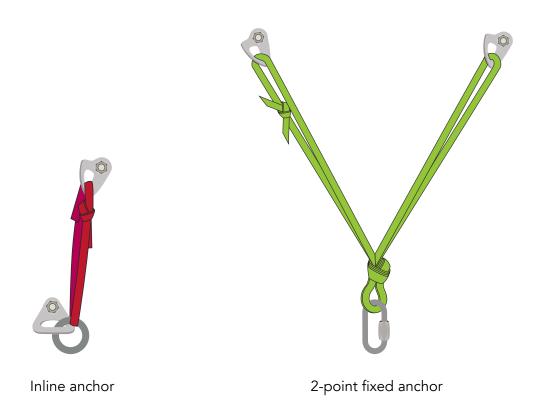
The New Zealand Canyoning Association Bolting Code of Practice states that 15kN should be a minimum construction standard for temporary anchors.

Rigging for both inline anchors and 2-point fixed anchors use tubular webbing (16mm or 25mm) directly into hangers to share the load between 2 bolts.

Therefore, this testing aims to ascertain if joining anchors in this way (with webbing into hangers) meets or exceeds 15kN.

Notes:

- These temporary anchors are for lightweight canyoning first descents where you minimize the heavy hard wear you are carrying.
- Even though multiple future canyoning groups could use the anchors, the anchors are considered temporary for canyoning as the webbing needs replacing regularly.
- If the canyon is going to get multiple descents in the future, upgrading the webbing to metal components is needed as a permanent solution.



Methods and Materials

Methods

General setup methods

- As each test destroyed both webbing and hangers, they were new for every test.
- Rings, carabiners and rapides, where they were undamaged, were reused for multiple tests.
- No testing was done on used hangers, as carabiners or other attachments could create sharp edges.
- All knots and bends had hand tension with all strands pulled tight.

Slow pull tests

- Each testing series records the slow pull tests set up (see Appendix 1-2).
- The slow pull testing was in one location.
 - Aspiring Safety, 1/6 Burdale Street, Riccarton, Christchurch, New Zealand.
 - https://www.aspiring.co.nz/
- Vertical testbed 1.6m Electronic Universal Testing Machine, Model WDW-100
 - Maximum Test Force 100kN, sample rate 60 per second
 - Jinan Chuanbai Instrument Equipment Co Ltd





Anchor joining variations tested

In both 16mm and 25mm tubular webbing

- Loop with tape bend (control)
- Inline: loop with tape bend + hanger (raw webbing)
- Inline: loop with tape bend + hanger (tail padding)
- 2 point fixed: 2 strands + overhand (control)
- 2 point fixed: 2 strands + 2 hangers + overhand (raw webbing)

Materials

CT hangers

• Diameter: 10mm

• Breaking strength: 25kN

• Materials: 316L stainless steel

• Standards: EN 795, EN 959, UIAA

• Manufacturer: CT – www.climbingtechnology.com

Fixe hangers

• Diameter: 10mm

Breaking strength: 25kN

Materials: 316L stainless steel

Standards: EN 795, EN 959, UIAA

• Manufacturer: Fixe – www.fixeclimbing.com

Fixe rappel ring

• Diameter: 10mm

Breaking strength: 35kN

Materials: 316L stainless steel

• Standards: CE/UIAA Certified

• Manufacturer: Fixe – www.fixeclimbing.com

Aspiring 16mm tubular webbing

• Width: 16mm, Weight: 34 g/m

Breaking strength: 12.5kN

Materials: Nylon

Standards: Complies with EN 565

Brand: Aspiring – www.aspiring.co.nz

Aspiring 25mm tubular webbing

Width: 25mm, Weight: 51 g/m

Breaking strength: 21kN

Materials: Nylon

Standards: Certified EN 565

Brand: Aspiring – www.aspiring.co.nz











Results

Aspiring 16mm Tubular Webbing

Slow pull tests (100mm/minute)

Items tested	Avg. kN	# Tests	Comment	Аррх. 1
Loop 16mm webbing	17.71	3	Broke at the bend	pg. 10
Inline: loop webbing hanger	8.85	3	Cut webbing at the hanger	pg. 13
Inline: loop webbing hanger + tail padding	15.16	3	Cut webbing at the hanger, cut through both sling and tail padding.	pg. 16
2-point fixed: 2 strand	22.32	3	Broke at fixed overhand, top side, 1 strand, leg without bend	pg. 19
2-point fixed: 2 strands 2 hangers	17.96	3	Cut webbing at hanger, side without tape bend, other side almost cut through	pg. 22

Aspiring 25mm Tubular Webbing

Slow pull tests (100mm/minute)

Items tested	Avg. kN	# Tests	Comment	Аррх. 2
Loop webbing	31.13	3	Broke at the bend	pg. 25
Inline: loop webbing + hanger	15.42	3	Cut webbing at the hanger, hanger bent flat	pg. 28
Inline: loop webbing + hanger + tail padding	22.06	3	Cut sling at the hanger, damage to the tail pad at the edges, hanger bent flat	<u>pg. 31</u>
2-point fixed: 2 strands	46.09	3	Broke the loops under overhand knot, broke leg without bend top side overhand knot, broke steel carabiner	pg. 34
2-point fixed: 2 strands 2 hangers	32.76	3	Cut webbingat the hanger, side without bend, slight damage to side with bend, hangers bent flat.	pg. 37

Analysis

Aspiring 16mm Tubular Webbing

Recommendations

- When joining an inline anchor (ring and a hanger) with a piece of 16mm tubular webbing, it's not suitable to use a raw sling against the hanger (av. 8kN); however, it is appropriate when a tail pad is in place (av. 15kN).
- **Note:** You could argue that the back anchor and webbing loop would only take 50% of the force if load sharing were equal for an inline anchor. If this were the case, the back anchor sling would only need to take 7.5kN and therefore be suitable to use with raw webbing. However, it can be difficult to rig the front and back bolt in a load sharing way. On the other hand, it's simple to rig with a tail pad and achieve a full strength connection of 15kN, so do it.
- When joining side by side anchors with a piece of 16mm tubular webbing directly into the hangers, it is over the minimum of 15kN (av. 17kN).

Aspiring 25mm Tubular Webbing

Recommendations

- When joining an inline anchor (ring and a hanger) with a piece of 25mm tubular webbing, it is appropriate to have a raw webbing against the hanger (av. 15kN) however is highly recommended to have a tail pad in place (av. 22kN).
- When joining side by side anchors with 25mm tubular webbing directly into the hangers, it is over double the minimum of 15kN (av. 32kN).

Conclusions

- In the context of use, the current combination of new 16mm or 25mm tubular webbing into new hangers (with tail pads for 16mm inline anchors) without any metal connections is suitable for temporary canyoning anchors.
- On average, over three tests, all but one series (inline 16mm webbing into a hanger) tested over 15kN, which is the standard in the New Zealand Canyoning Association Bolting Code of Practice.

References

- 1. NZCA. Bolting Code of Practice. http://nzcanyoningassociation.org/resources/#boltingcode
- 2. CT Climbing Technology. https://www.climbingtechnology.com/
- 3. Fixe. https://www.fixeclimbing.com/
- 4. Aspiring Safety. https://www.aspiring.co.nz/
- 5. Prattley, Grant. **Webbing in Hangers.** Over the Edge Rescue. Version 1.0, 2021. https://overtheedgerescue.com/canyoning/webbing-in-hangers/

Glossary of terms

Bends: Where two pieces of rope or webbing are tied together usually at their ends, with both playing an integral part. The load is pulling in line through the bend. An example is a double fisherman's bend.

Maximum Force (kN): Maximum amount of tensile stress that the material can withstand before failure (rupture), such as breaking or permanent deformation. Tensile strength specifies the point when a material goes from elastic to plastic deformation.

Force (kN): In physics, force is the push or pull on an object with mass that causes it to change velocity (to accelerate). Force represents as a vector, which means it has both magnitude and direction. The SI unit of force is the newton (N).

Knots: 'If it's not a bend or a hitch then it's a knot'. In the widest sense a generic name for all types of rope and cord entanglements but specifically where a connection is tied that is self-sustaining in rope or webbing.

Appendix 1: Aspiring 16mm Tubular Webbing

16mm Loop

Slow Pull Test Friction Test Drop Test
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Materials

• Aspiring 16mm tubular webbing (12.5kN)

Test setup

• Tied a tape bend to form a loop

Test parameters

- Slow pull speed 100mm/minute
- Tested between 12mm pins

Date	#	Max force (kN)	Comments
12/11/19	5*	18.75	Broke at the bend
12/11/19	6	17.26	Broke at the bend
12/11/19	7	17.11	Broke at the bend
Ave	rage	17.71	



^{*} Sample 12/11/19 #5 of the testing shown on the following pages.



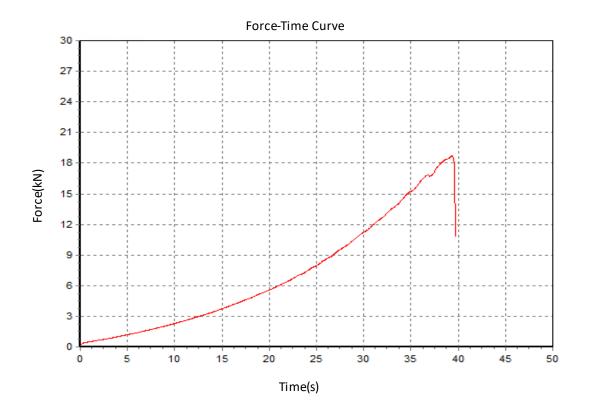
Test Date: Tuesday, 12 November 2019

Max Force (kN): 18.75

Product Name: Loop Tape Bend

Batch #: 5

Material: 16mm Aspiring Tubular Webbing



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Inline 16mm Loop + Hanger

Slow Pull Test	Friction Test	Drop Test
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Materials

- Aspiring 16mm tubular webbing (12.5kN)
- CT 10mm Stainless Steel Hanger (25kN)

Test setup

- Tied a tape bend to form a loop through the hanger
- Raw tape on the hanger

Test parameters

- Slow pull speed 100mm/minute
- Tested between a 12mm pin and hanger mounted onto a rigging plate



Date	#	Max force (kN)	Comments
24/01/20	5*	8.59	Cut webbing at the hanger
24/01/20	6	8.53	Cut webbing at the hanger
24/01/20	7	9.43	Cut webbing at the hanger
Ave	rage	8.85	

^{*} Sample 24/01/20 #5 of the testing shown on the following pages.

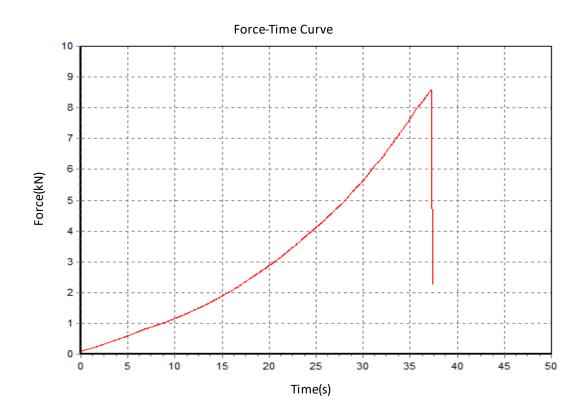


Test Date: Friday, 24 January 2020

Peak Load (kN): 8.59
Product Name: CT hanger

Batch #: 5

Material: 16mm aspiring webbing



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Appendix 1: Aspiring 16mm Tubular Webbing





Inline 16mm Loop + Hanger + Tail pad

Slow Pull Test	Friction Test	Drop Test
Slow I all lest	i ilction lest	Diop lest

Materials

- Aspiring 16mm tubular webbing (12.5kN)
- CT 10mm Stainless Steel Hanger (25kN)

Test setup

- Tied a tape bend to form a loop through the hanger
- Longer tail to form a second layer of tape on the inside of the hanger (tail pad)

Test parameters

- Slow pull speed 100mm/minute
- Tested between a 12mm pin and hanger mounted onto a rigging plate



Date	#	Max force (kN)	Comments
24/01/20	8*	14.52	Cut webbing at the hanger, through both sling and tail padding
24/01/20	9	15.01	Cut webbing at the hanger, through both sling and tail padding
24/01/20	10	15.96	Cut webbing at the hanger, through both sling and tail padding
Ave	rage	15.16	

^{*} Sample 24/01/20 #8 of the testing shown on the following pages.

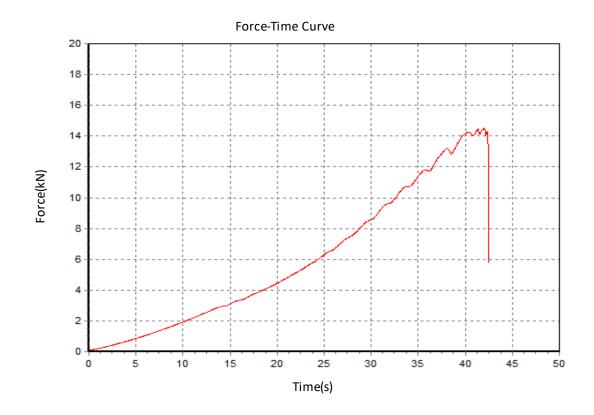


Test Date: Friday, 24 January 2020

Peak Load (kN): 14.52 Product Name: CT hanger

Batch #: 8

Material: 16mm aspiring webbing + padding



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Appendix 1: Aspiring 16mm Tubular Webbing





2 point fixed 16mm 2 strand anchor

Slow Pull Test Friction Test Drop Test

Materials

- Aspiring 16mm tubular webbing (12.5kN)
- CT 10mm Stainless Steel Hanger (25kN)

Test setup

- Tied a tape bend to form a loop
- Two stand anchor legs
- Tied with an overhand at the focal point
- Anchor angle approx 25 degrees

Test parameters

- Slow pull speed 100mm/minute
- Tested between a 12mm pin and 10mm rapides attached to the outside holes of a rigging plate



Date	#	Max force (kN)	Comments
1/10/20	7*	21.19	Broke at fixed overhand, top side, 1 strand, leg without bend
1/10/20	8	24.39	Broke at fixed overhand, top side, 1 strand, leg without bend
1/10/20	9	21.37	Broke at fixed overhand, top side, 1 strand, leg without bend
Ave	rage	22.32	

^{*} Sample 1/10/20 #7 of the testing shown on the following pages.



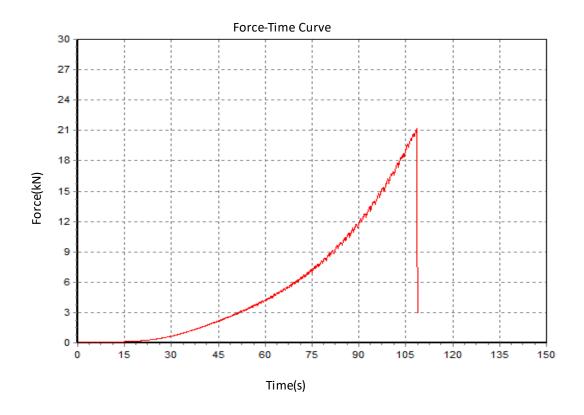
Test Date: Thursday, 1 October, 2020

Max Force (kN): 21.19

Product Name: 2 point fixed anchor overhand knot

Batch #: 7

Material: Aspiring 16mm Tubular Webbing



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Appendix 1: Aspiring 16mm Tubular Webbing





2 point fixed 16mm 2 strand 2 hanger anchor

Slow Pull Test Friction Test Drop Test

Materials

- Aspiring 16mm tubular webbing (12.5kN)
- CT 10mm Stainless Steel Hanger (25kN)

Test setup

- Tied a tape bend to form a loop
- Raw webbing on the hangers
- Two stand anchor legs
- Tied with an overhand at the focal point
- Anchor angle approx 25 degrees

Test parameters

- Slow pull speed 100mm/minute
- Tested between a 12mm pin and hangers mounted on the outside holes of a rigging plate



Date	#	Max force (kN)	Comments
24/01/20	11*	17.41	Cut webbing at the hanger on the side without the tape bend initially then broke the other side
24/01/20	12	19.13	Cut webbing at the hanger on the side without the tape bend initially then testing stopped, the tape under the hanger on the tape bend side was almost cut through.
24/01/20	13	17.33	Cut webbing at the hanger on the side without the tape bend initially then testing stopped, the tape under the hanger on the tape bend side was almost cut through
Ave	erage	17.96	

^{*} Sample 24/01/20 #11 of the testing shown on the following pages.



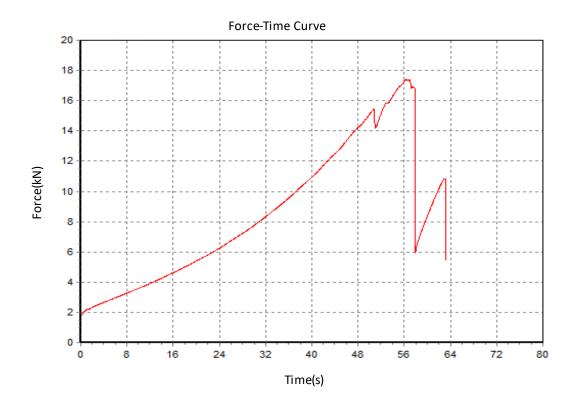
Test Date: Friday, 24 January 2020

Peak Load (kN): 17.41

Product Name: CT hanger 2pt anchor

Batch #: 11

Material: 16mm aspiring webbing



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Appendix 1: Aspiring 16mm Tubular Webbing





Appendix 2: Aspiring 25mm Tubular Webbing

25mm Loop

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Materials

• Aspiring 25mm tubular webbing (21kN)

Test setup

• Tied a tape bend to form a loop

Test parameters

- Slow pull speed 100mm/minute
- Tested between 12mm pins

Date	#	Max force (kN)	Comments
9/04/21	6*	30.04	Broke at the bend
9/04/21	7	32.80	Broke at the bend
9/04/21	8	30.55	Broke at the bend
Average		31.13	



^{*} Sample 9/04/21 #6 of the testing shown on the following pages.



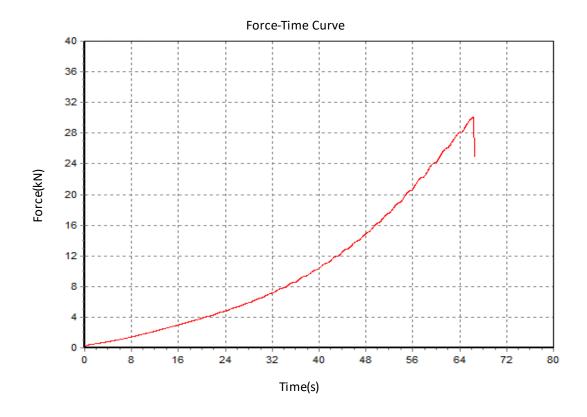
Test Date: Friday, 9 April 2021

Max Force (kN): 30.04

Product Name: Loop tape bend

Batch #:

Material: 25mm Aspiring Webbing



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Appendix 2: Aspiring 25mm Tubular Webbing





Inline 25mm Loop + Hanger

Slow Pull Test	Friction Test	Drop Test
Slow Pull Test	Friction lest	Drop lest

Materials

- Aspiring 25mm tubular webbing (21kN)
- Fixe 10mm stainless steel hanger (25kN)
- Fixe 10mm stainless steel rappel ring (35kN)

Test setup

- Tied a tape bend to form a loop through the hanger and ring
- Raw tape on the hanger

Test parameters

- Slow pull speed 100mm/minute
- Tested between the rappel ring and hanger mounted onto a rigging plate

Date	#	Max force (kN)	Comments
9/04/21	9*	14.89	Cut webbing at the hanger. Hanger flattened out.
9/04/21	10	14.20	Cut webbing at the hanger. Hanger flattened out.
9/04/21	11	17.16	Cut webbing at the hanger. Hanger flattened out.
Ave	rage	15.42	

^{*} Sample 9/04/21 #9 of the testing shown on the following pages.





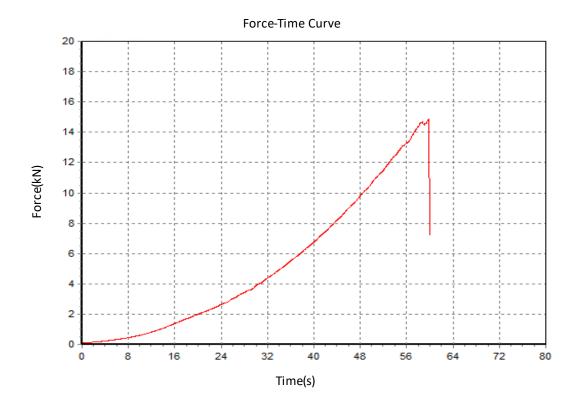
Test Date: Friday, 9 April 2021

Max Force (kN): 14.89

Product Name: Loop tape bend fixe hanger 10mm ring

Batch #: 9

Material: 25mm Aspiring Webbing



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Appendix 2: Aspiring 25mm Tubular Webbing





Inline 25mm Loop + Hanger + Tail Pad

Slow Pull Test Friction Test Drop Test

Materials

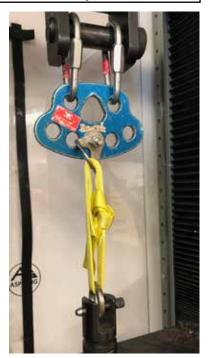
- Aspiring 25mm tubular webbing (21kN)
- Fixe 10mm stainless steel hanger (25kN)
- Fixe 10mm stainless steel rappel ring (35kN)

Test setup

- Tied a tape bend to form a loop through the hanger and ring
- Longer tail to form a second layer of tape on the inside of the hanger (tail pad)

Test parameters

- Slow pull speed 100mm/minute
- Tested between the rappel ring and hanger mounted onto a rigging plate



Date	#	Max force (kN)	Comments
9/04/21	12*	23.60	Cut webbing at the hanger, damage to the tail pad at the edges. Hanger flattened out.
9/04/21	13	21.11	Cut webbing at the hanger, damage to the tail pad at the edges. Hanger flattened out.
9/04/21	14	21.47	Cut webbing at the hanger, damage to the tail pad at the edges. Hanger flattened out.
Ave	rage	22.06	

^{*} Sample 9/04/21 #12 of the testing shown on the following pages.



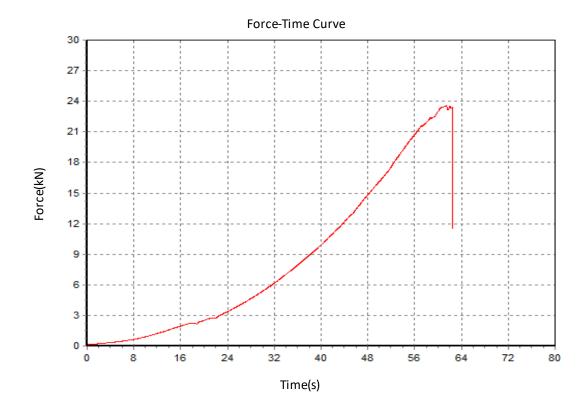
Test Date: Friday, 9 April 2021

Max Force (kN):

Product Name: Loop tape bend fixe hanger 10mm ring tail pad

Batch #:

Material: 25mm Aspiring Webbing



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Appendix 3: PMI 10mm Classic Sport – Drop Tests





2 point fixed 25mm 2 strand anchor

Slow Pull Test Friction Test Drop Test

Materials

- Aspiring 25mm tubular webbing (21kN)
- Fixe 10mm stainless steel hanger (25kN)

Test setup

- Tied a tape bend to form a loop
- Two stand anchor legs
- Tied with an overhand at the focal point

Test parameters

- Slow pull speed 100mm/minute
- Tested between a 12mm pin and 10mm steel carabiners attached to the outside holes of a rigging plate



Date	#	Max force (kN)	Comments
9/04/21	15	44.29	Broke the loops under overhand knot
9/04/21	16*	46.26	Broke leg without bend top side of overhand knot
9/04/21	17	47.73	Failed leg without bend sling two thirds through then failed 10mm steel carabiner (30kN)
Ave	erage	46.09	

^{*} Sample 9/04/21 #16 of the testing shown on the following pages.



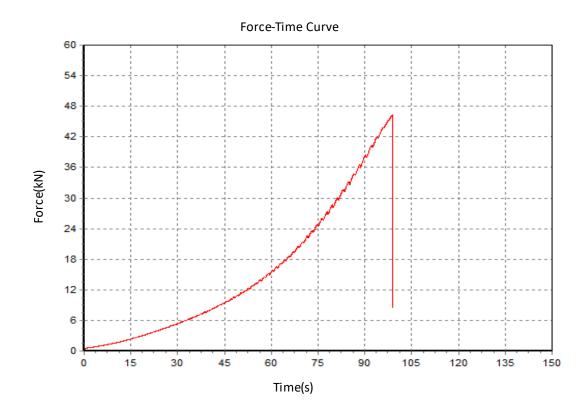
Test Date: Friday, 9 April 2021

Max Force (kN):

Product Name: 2-point anchor overhand knot

> Batch #: 16

Material: 25mm Aspiring Webbing



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Appendix 3: PMI 10mm Classic Sport – Drop Tests





2 point fixed 25mm 2 strand 2 hanger anchor

Slow Pull Test Friction Test Drop Test

Materials

- Aspiring 25mm tubular webbing (21kN)
- Fixe 10mm stainless steel hanger (25kN)

Test setup

- Tied a tape bend to form a loop
- Raw webbing on the hangers
- Two stand anchor legs
- Tied with an overhand at the focal point
- Anchor angle approx 25 degrees

Test parameters

- Slow pull speed 100mm/minute
- Tested between a 12mm pin and hangers mounted on the outside holes of a rigging plate



Date	#	Max force (kN)	Comments
16/04/21	28*	34.25	Cut webbing at the hanger, side without bend, slight damage to side with bend. Hangers flattened out.
16/04/21	29	30.71	Cut webbing at the hanger, side without bend, slight damage to side with bend. Hangers flattened out.
16/04/21	30	33.31	Cut webbing at the hanger, side without bend, slight damage to side with bend. Hangers flattened out.
Average		32.76	

^{*} Sample 16/04/21 #28 of the testing shown on the following pages.



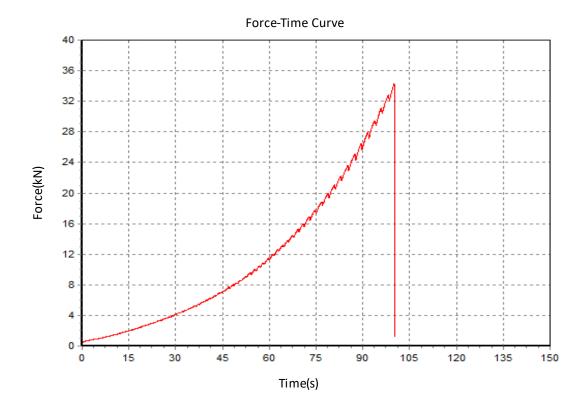
Test Date: Friday, 16 April 2021

Max Force (kN): 34.25

Product Name: 2 pt anchor hangers overhand

Batch #: 28

Material: 25mm Aspiring Webbing



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Appendix 3: PMI 10mm Classic Sport – Drop Tests



