

Securing of Pilot ladders at intermediate lengths

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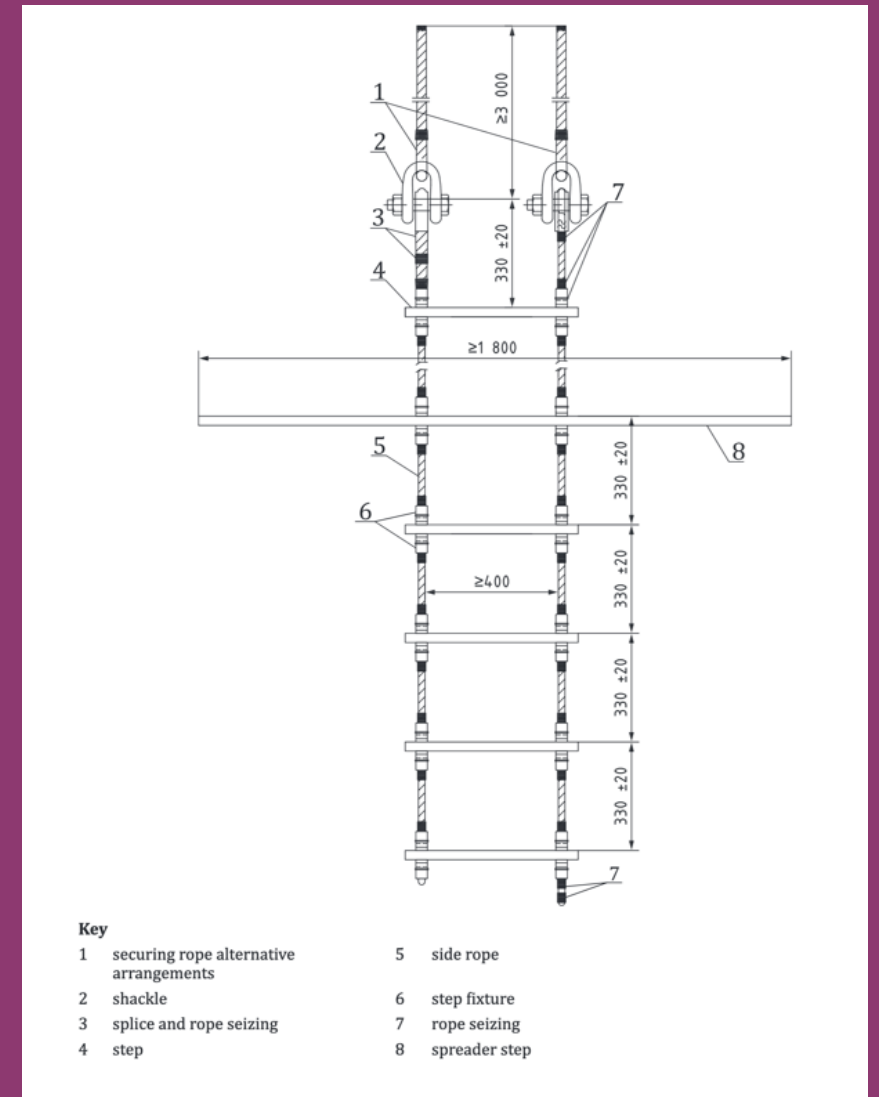
University of Southampton, UK

Contents of talk

- Introduction
 - Securing methods
 - Sample construction
- Testing and results
 - Base line testing
 - Hitch testing
 - ‘D’ shackle testing
- Conclusions



Introduction



Gripping the side rope

- Cow or rolling hitch using rope or straps
- Wear in the system is a concern



Passing the side rope through a shackle

- Metal 'D' shackles
- Damage to step fixings is a concern



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A physical laboratory-based test programme



to investigate the effectiveness and impact of various methods used to secure pilot ladders at intermediate lengths

Ladder construction for tests

- 20 mm natural manila (4 strand)
- 20 mm polypropylene with an inner colour contrast core weaving
- Rope seizings (match rope type)
- Aluminium alloy clips (on both rope types)



Testing: Baseline

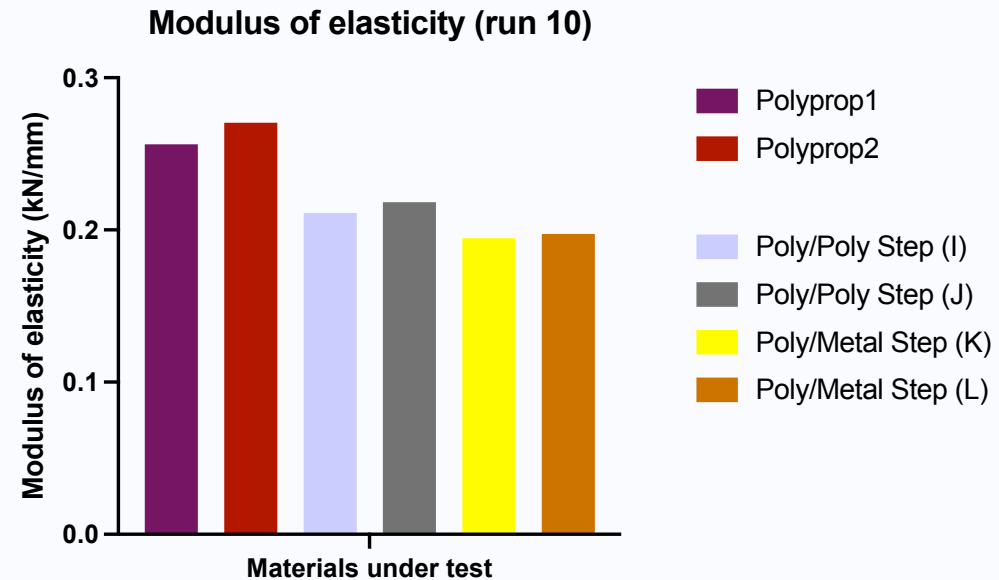
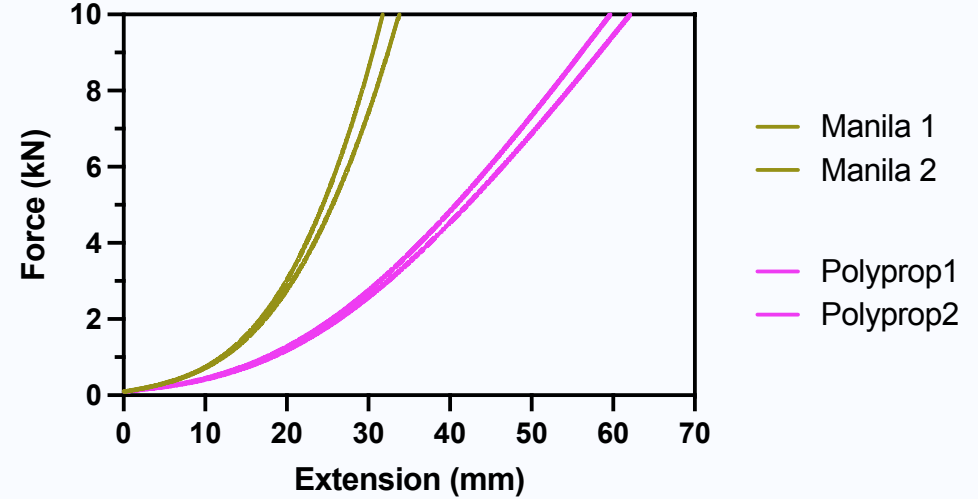
Baseline testing

- 100 N pre-tension, 10 kN loading
- Extension (under load & residual)
- 10 repeat loadings (bedding in)



Baseline Results

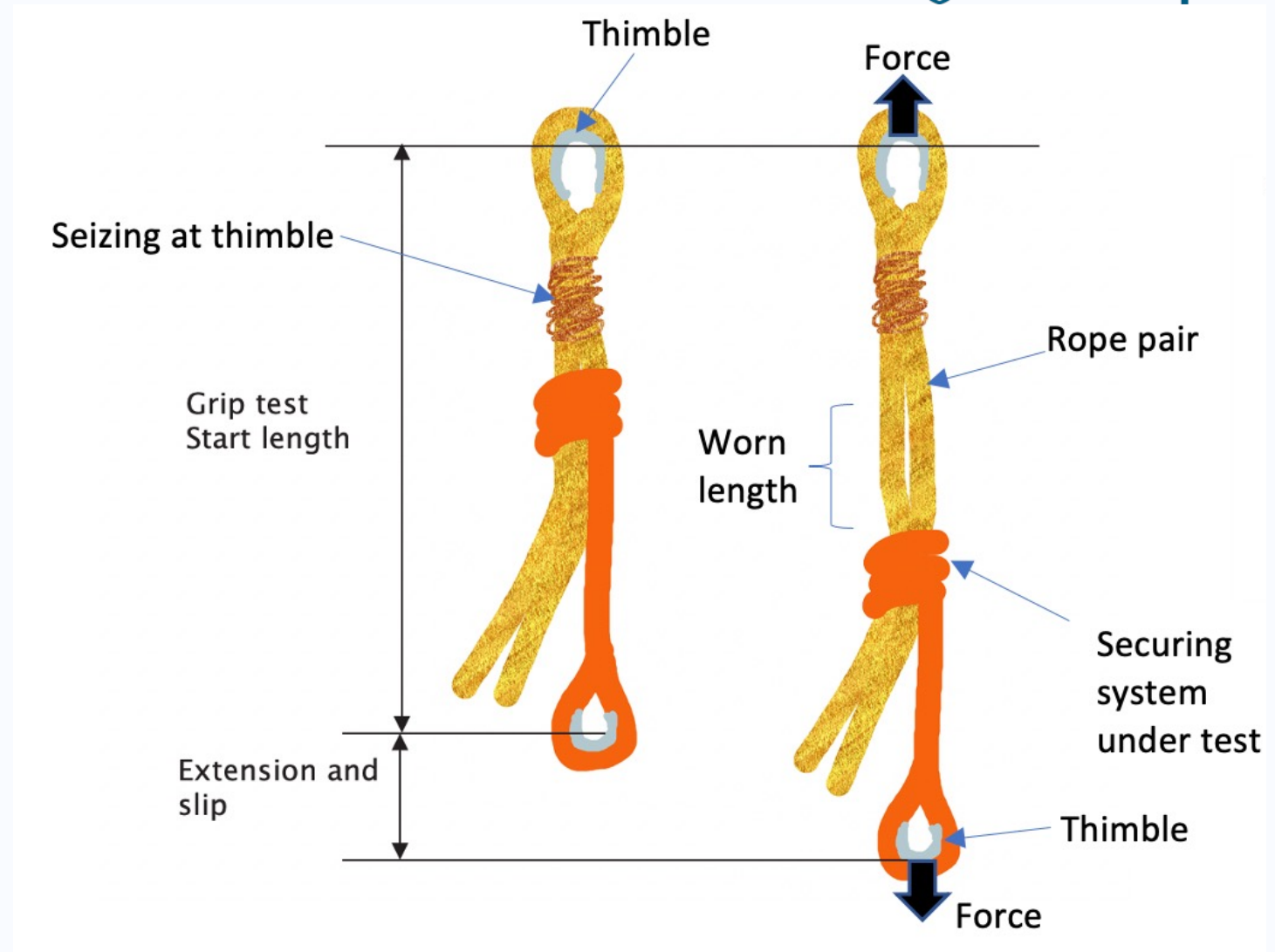
- Consistent test results
- All ropes required bedding in
- Under 10 kN tension:
 - Polypropylene extended by 8-9%,
 - Manila extended by 4-5%,
 - Adding steps made them slightly more ‘stretchy’ (less stiff)
 - No measurable influence from rope seizing or metal clip

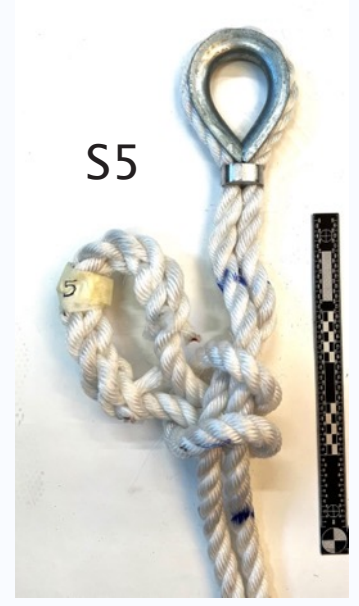
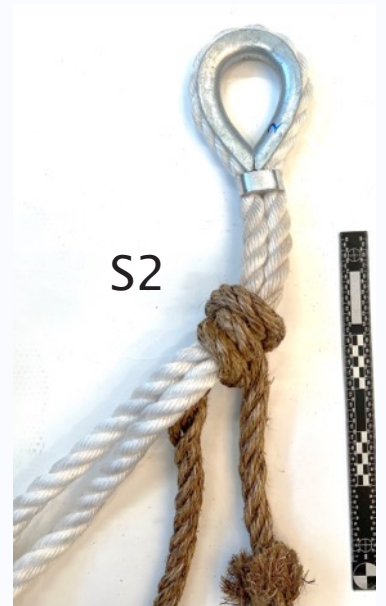


Testing: Hitches

Hitch testing

- Hitch types
 - Cow hitch
 - Rolling hitch - tugged
- Securing systems
 - Ropes
 - Manila rope
 - Polypropylene rope
 - Cargo straps: 1000 kg 1m circular endless web slings
 - Purple sleeve
 - White stitched
- **50 repeat tests each**

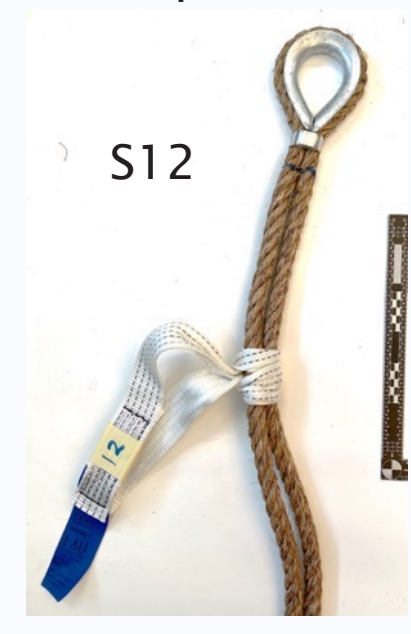




Rolling hitch

Cow hitch - ropes

Cow hitch - straps



S3

S4

S7

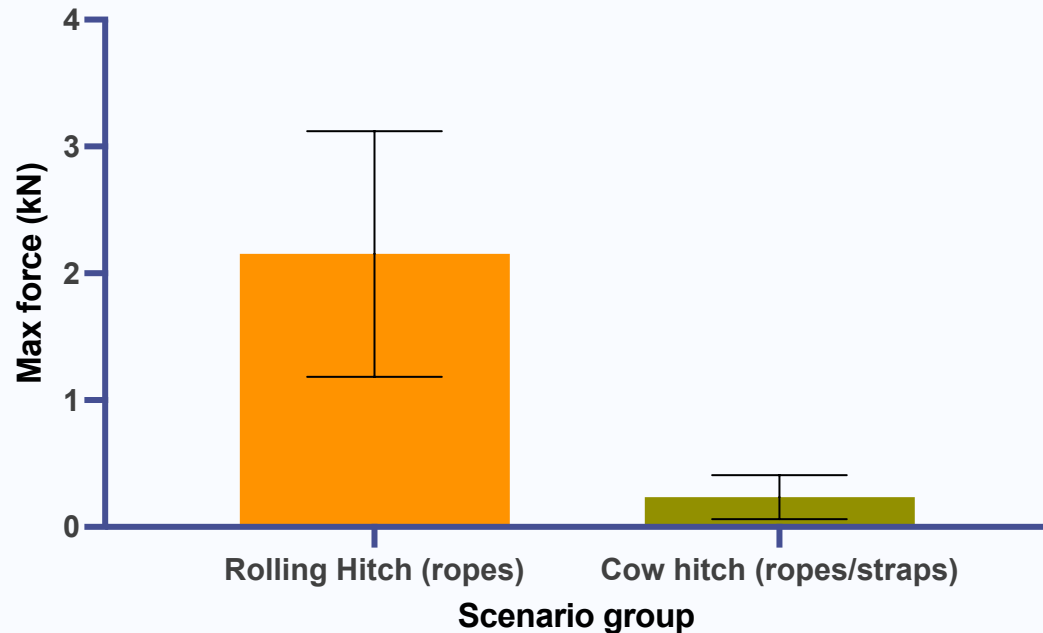
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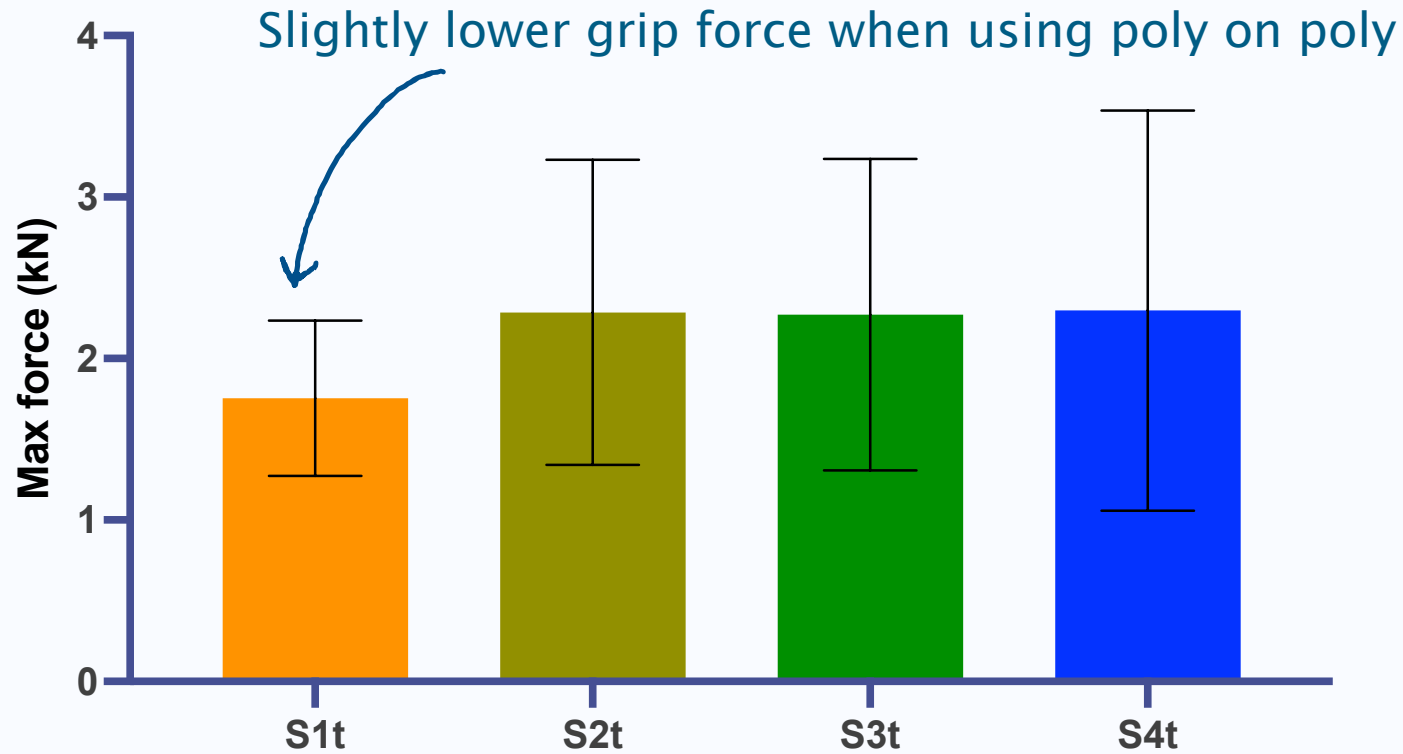
S12

Results of hitch testing: Cow hitch

- Cow hitch did not grip and carry as much load as rolling hitch
- Cow hitch slid when loaded
- No ladder pair wear noted after 50 runs



Results of hitch testing: Rolling hitch



Results of hitch testing: Rolling hitch

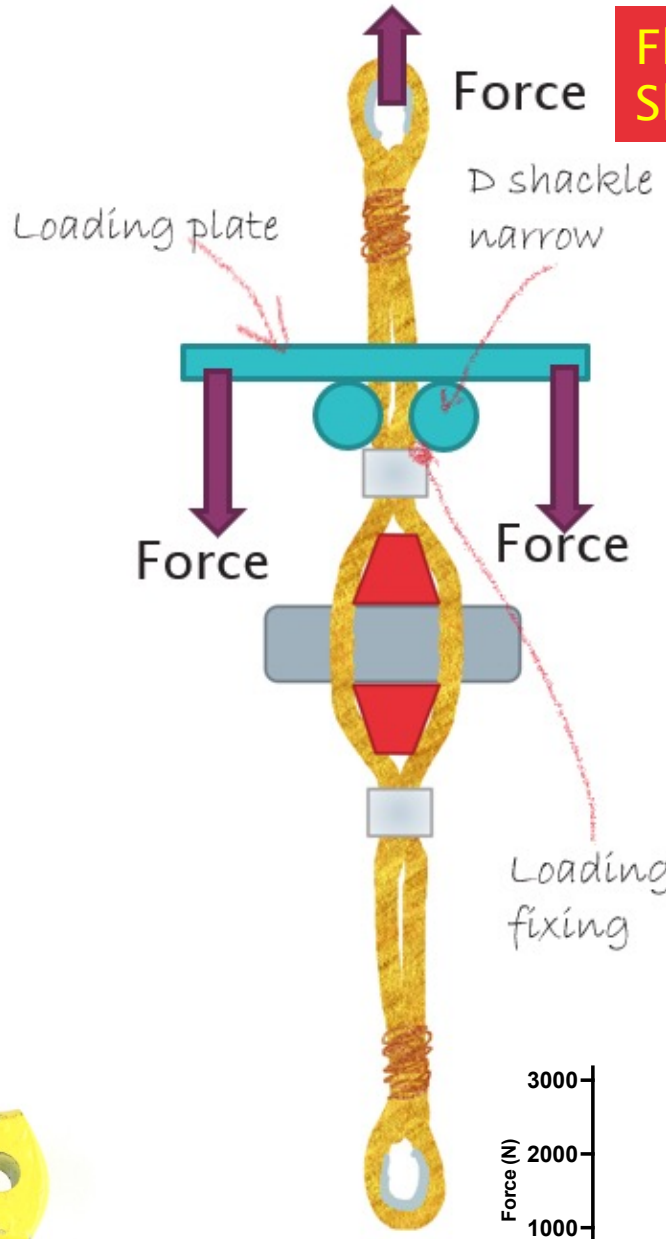
Deformation and discolouration of side ladder rope pair after x50 cycles in one location



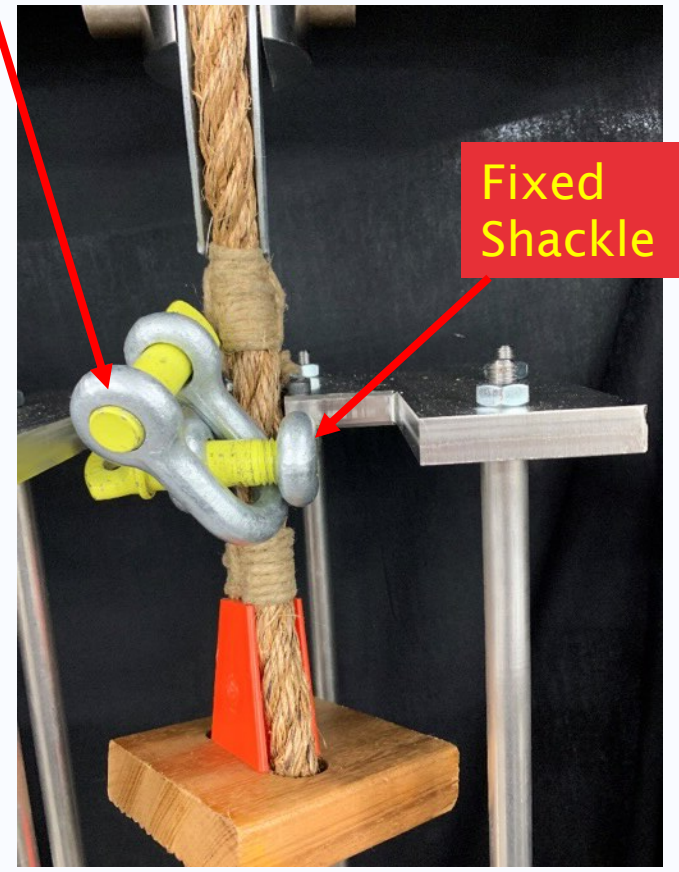
Testing: 'D' Shackles

'D' Shackle testing

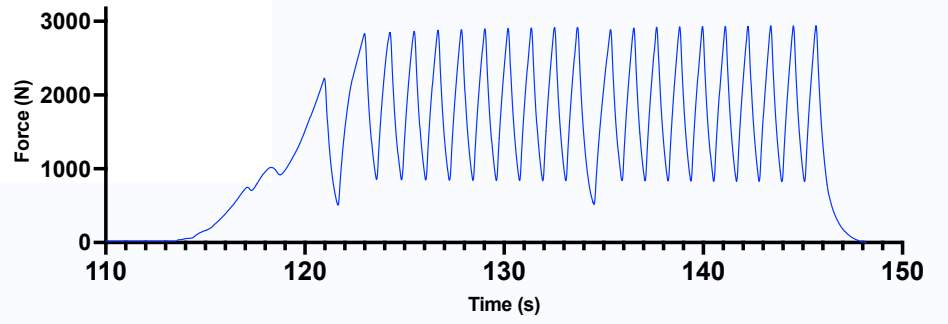
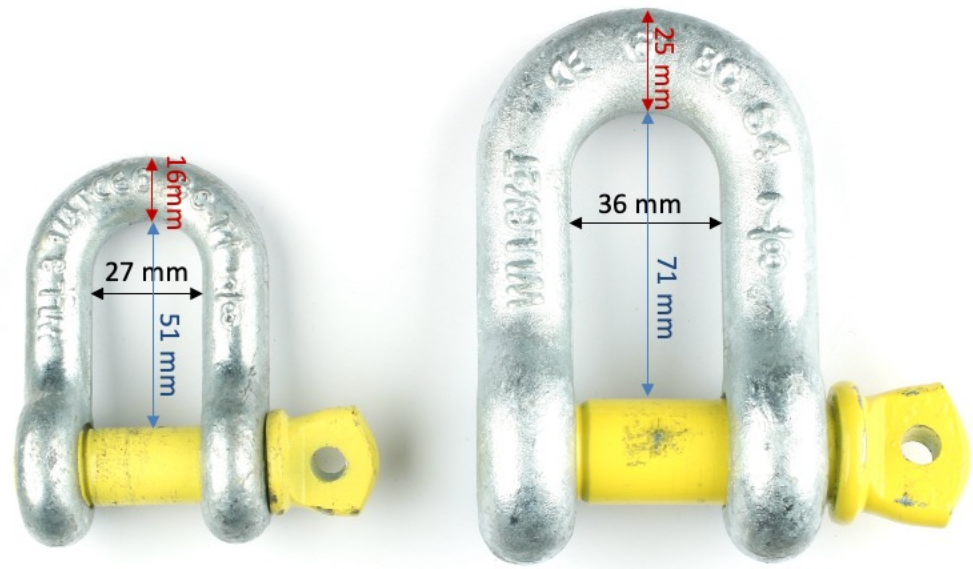
- Ladder system pulled through/against a 'D' shackle
- Two shackle sizes
- Loading sequence applied 1500 times



Floating Shackle

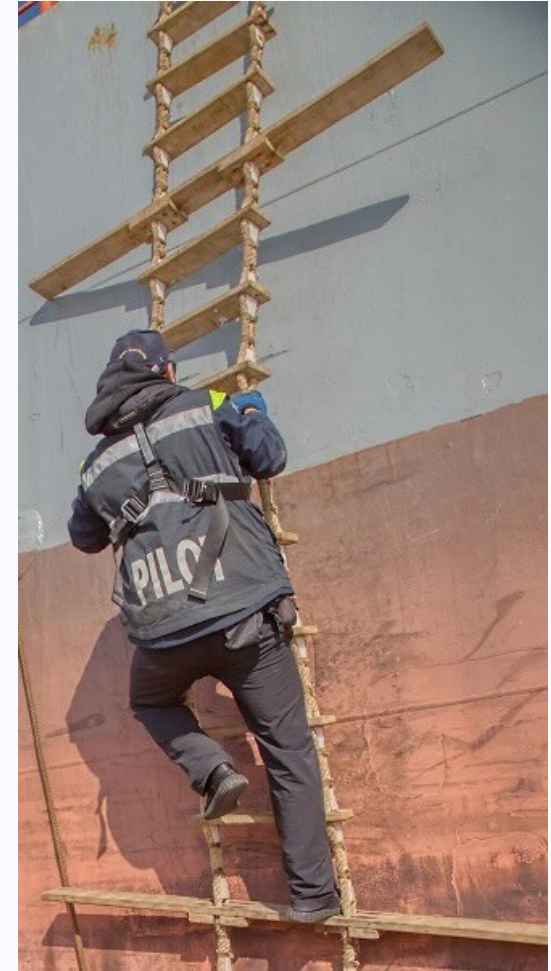
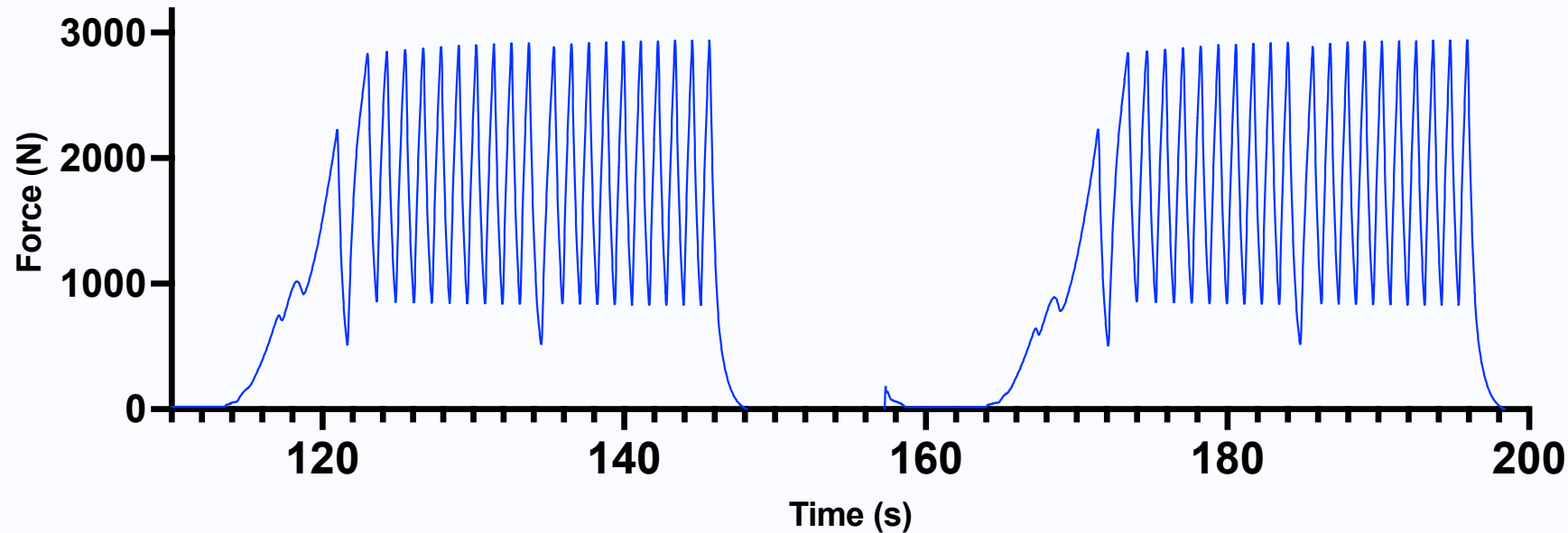


Fixed Shackle



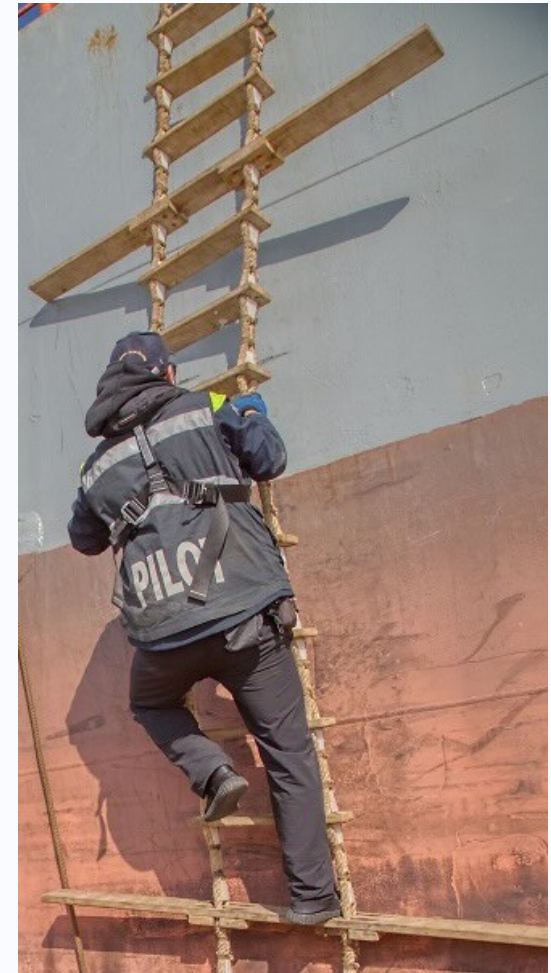
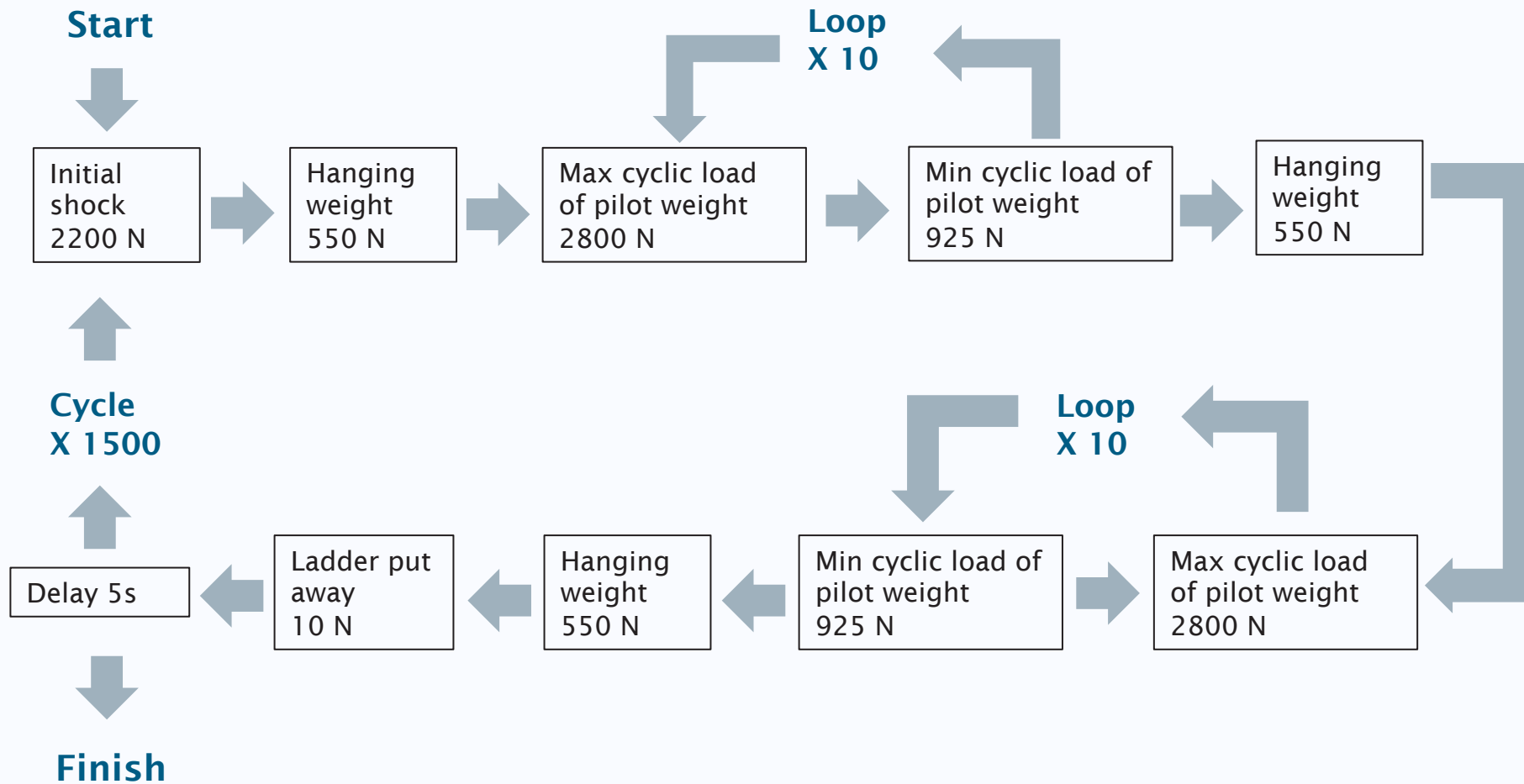
'D' Shackle testing – loading sequence

- Representing forces on one side of the ladder (single rope pair) for a climb up and then down



'D' Shackle testing – loading sequence

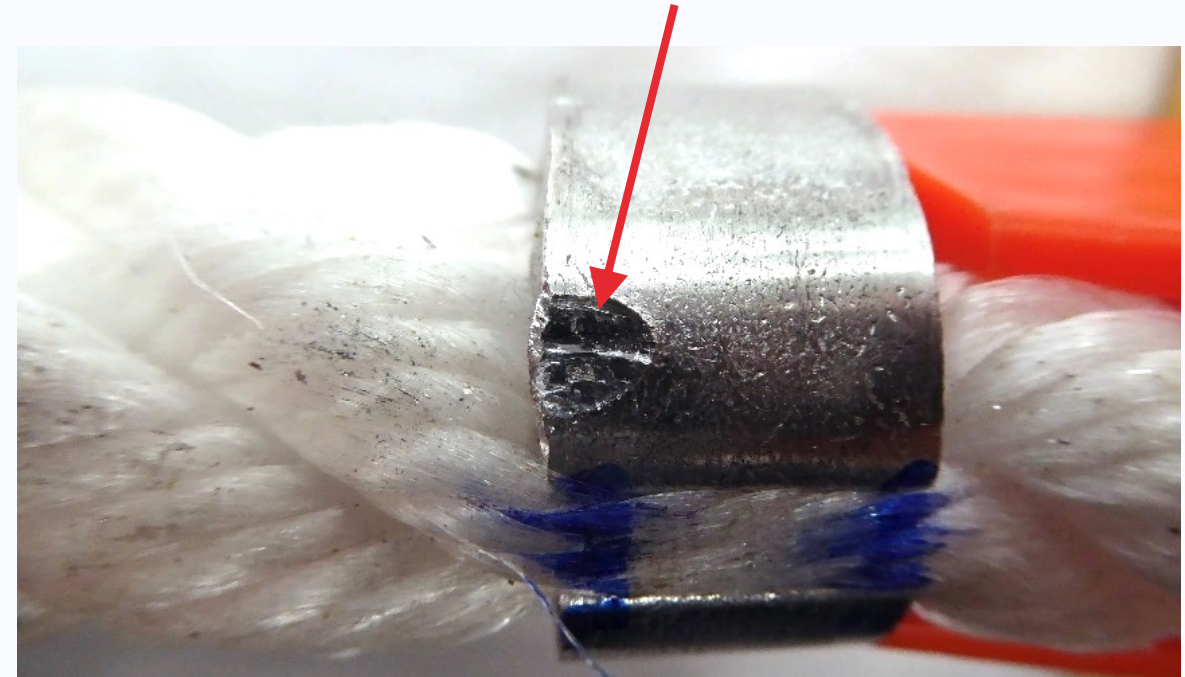
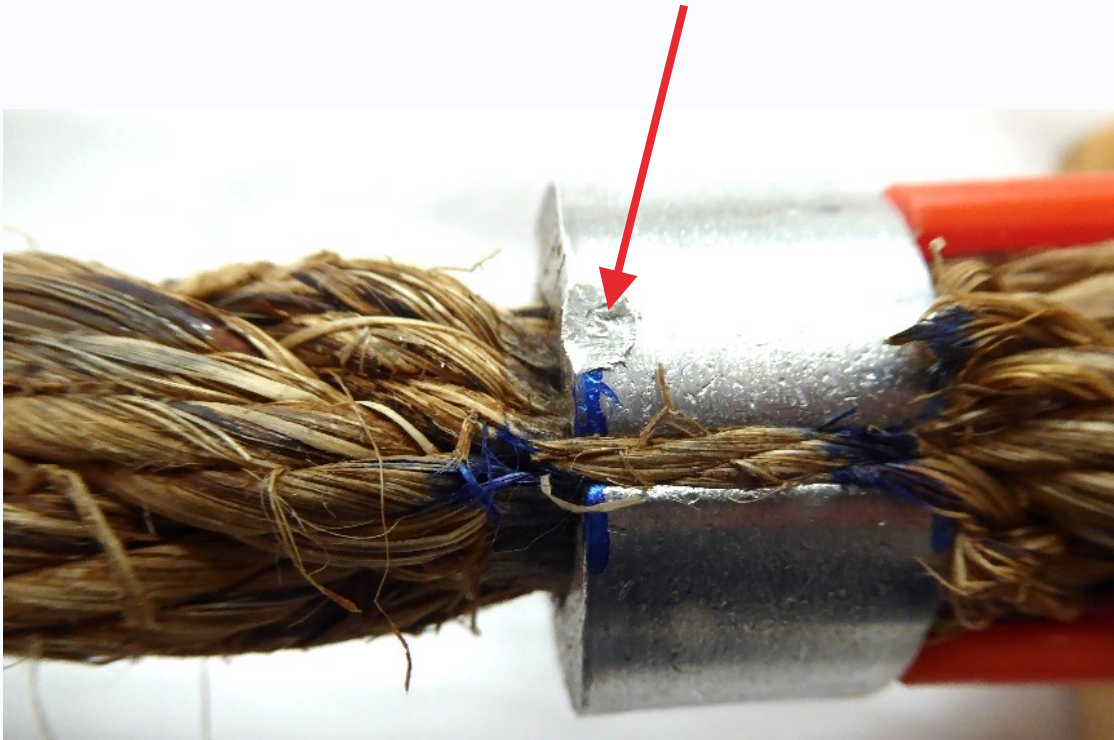
- Representing forces on one side of the ladder (single rope pair) for a climb up and then down



Description	Result
Weight of Ladder	110 kg (1100 N)
Weight of Pilot	125 kg (1250 N)
Weight of kit	25 kg (250 N)
Length of ladder	9 metres

Results – Metal fastener

The hard shackles were able to damage the, relatively soft, metal fasteners
– causing potential sharp edges



Hardness Testing	Large Shackle	Metal Fastener
Average (HV)	92	47

Results – Shackle wedging

The small shackle travels past the rope seizing and gets wedged in the chock for both rope materials.

- The small shackle becomes wedged in the chock for both rope materials.
- This wedging means the chock becomes stuck and during unloading the chock can separate from the wooden step.
- The chock is damaged and permanent deformation of the plastic can be seen.



Results – Rope Wear / material transfer

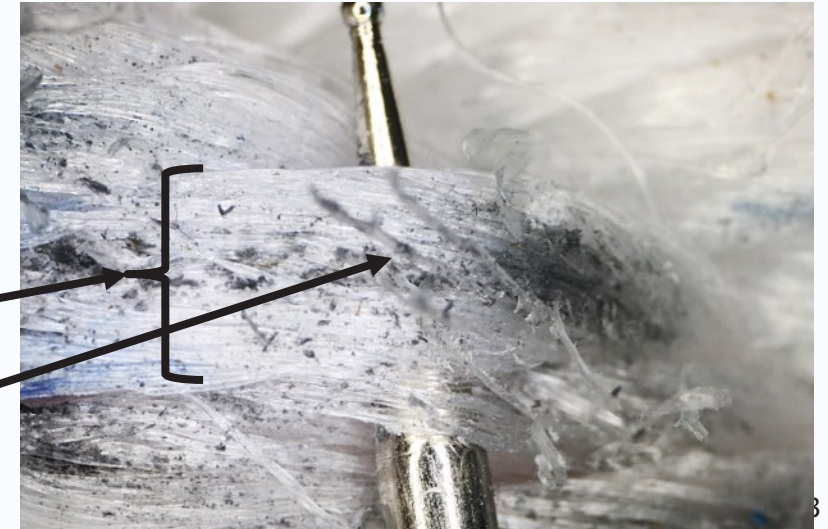


- The small and large shackles rubbed against the ropes and caused some level of wear
- Greater wear on manila rope than polypropylene
- Grey colouring was coating transfer



Strand

Broken fibres



Conclusions

Method		Force achieved without slippage	Damage	Ease of use	Special considerations	Recommendations
D-shackle	27mm	2.8kN (maximum applied force)	Yes: to critical components of the pilot ladder	Very easy and quick	D-shackles may be considered an attractive securing option for personnel charged with rigging pilot ladders due to their ease of use. However, D-shackle use was demonstrated to transfer loading to the components of the step assembly resulting in damage to the structure and critical components of the pilot ladder.	Not recommended for use due to impact on ladder structure
	36mm					
Cow Hitch	Manilla, Polypropylene securing rope	<0.5kN (average)	No damage to the structure and critical components of the pilot ladder	Simple knot, low skill level	The cow hitch method did not damage the structure and critical components of the pilot ladder. However, the cow hitch method was demonstrated to deliver the worst holding performance of the three securing methods. The cow hitch always slipped, coming to rest on the step assembly – resulting in the undesirable situation where all the forces are concentrated on the step assembly.	Not recommended for use due to poor holding performance
	Lifting strap					
Rolling Hitch	Manilla, Polypropylene securing rope	2.2kN (average)	Signs of squashing and discolouration on side ropes, but no material damage was observed	Complex knot, high skill level. Requires a pre-load before use to ensure superior grip force	The rolling hitch method resulted in signs of squashing and discolouration on side ropes, but no material damage was observed. The rolling hitch demonstrated holding performance which was at least 77% better than a cow hitch. However, the superior performance of the rolling hitch is conditional on the knot being tied correctly and being pre-loaded before use. If either of these pre-conditions is not met, the rolling hitch has the holding performance of a cow hitch. Of the material combinations tested, the least effective holding performance (rolling hitch) occurs when both side ropes and secure ropes are made from polypropylene.	Recommended for use but holding performance is conditional

In summary

- Methods of securing Pilot ladders at intermediate lengths have been investigated
- A large physical laboratory-based test programme has been completed at the University of Southampton.
- A matrix of methods and materials were tested.
- The forces, damage and ease of use were all investigated and reported
- With the support of the IMPA recommendations were made.



Thanks for listening

