Strength of Pilot Ladders and Intermediate Securing of Pilot Ladders:

An investigation into actual strength of ladders and intermediate securing methods used.

T Evans

Introduction / Preamble:

I decided to look into pilot ladder strength and intermediate securing arrangements after MNZ put out what I felt was a confusing and unclear document about securing of pilot ladders.

Looking for information about why lashings were preferred got me nowhere; all sources just said they were best.
The discussions went along the line of the following:
Me – "So a piece of rope is not going to damage another piece of rope, but shackles are?"
Expert – "No the shackles put load on the step fixtures, lashings do not"
Me – "But the rope lashings do put load onto the step fixtures"
Expert - "No they do not"
Me – "look at these images"


Expert –"……."
As you can see in the images the lashings are on the step fixtures.

Some of the reasons given against the use of choking shackles:	**Comments:**
Some manufacturers recommend against the use of them,	Why and what testing has been carried out?
Some authorities recommend against them	Why and what testing has been carried out?
Some manufactures claim the choking shackles cause chaff damage.	Why and what testing has been carried out?
Some authorities claim the shackles place load on the crimps / steps fixtures, whereas the lashing using a rolling hitch does not	Have they tested the lashings?
The term "Shackle fatigue" has come into use	What do people mean by this and is there such a thing as lashing fatigue?
Shackles have no give.	True

So Rolling hitch lashings versus …. Choking shackles and other methods, and along with that the strength of ladders – are they as strong as some people think?
Some say traditional seamanship skills are disappearing / gone,
Or is it crew have found a "quicker" way of doing the job with other gear?

How to test?
Load / destruction test.
Where / how can I do that? In the Barn, certified load cell + hydraulic pulling ram system + testbed structure + assorted shackles + time + rope + ladders…. As another pilot says "Easy peasy"

Onto investigating intermediate securing methods and strengths of ladders.

Testing Intermediate Securing of Pilot Ladders:

Methods investigated included the rolling hitch lashing, choking shackles, shackles between sideropes, endless slings, and “deck tongues”

To determine the actual strength of ladders top end securing was tested as well.

The investigation into methods started with assessing the traditional method – rope lashings using rolling hitches.

Rope Lashings[1]

Average breaking strength of Manila rope used for lashings = 2516kg (24.67kN), samples were taken at random from the different parcels received from the supplier. Eyes were spliced in each end then tested to destruction.

Rolling hitch and other assorted knots

First step was to determine if lashings, in particular the rolling hitch, place any load on the crimps / step fixtures.
To determine if lashings would put load onto the fixtures a number of knots where tested on a mock siderope;

- The knots were tied and firmed up manually with block and tackle,
- Then a single 200mm pull using a hydraulic pulling ram was applied,
- The peak reading was taken to determine the best performing knot.

Knot	Avg	min	comments
right hand knot in "how to rig a pilot ladder	384	302	
rolling hitch right left	542	380	
left knot in "how to…	432	392	
rolling hitch right right	**572**	**452**	This is the conventional rolling hitch
Rolling hitch left left	726	510	Caused the most damage to mock side rope
Craig S - knot 4 half hitches	553	520	

All the knots shifted more than 150mm with the manual load placed on them - this mean the knots would have slid onto the step fixtures.

To make it clear - If the knots were tied onto a pilot ladder rather than a mock side rope with no step fixtures every single knot would have come up on the fixtures with less than 200kg load, nearly all with less than 100kg. In all tests using knots on actual ladders this was found to be true.

As a pilot climbs a ladder the load on either side of the ladder will alternate depending upon the climbing technique, so 100kg of force a side is not hard to achieve when including the ladder weight.

Chaff damage - Chaff on the mock side ropes ranged from minor to moderate or worse.

[1] Tests were also done with thinner higher strength synthetics – all results were lower but further testing could be done.

Testing On Ladders:

4 different makes of ladder were tested, 2new, 2 old

As it only takes the failure of one side of a ladder for a pilot to fall the majority of tests were carried out on one side only.

The following may affect the results:

- Less distortion occurs when one side gets loaded than both (results possibly higher)
- Testing was inline versus uneven setups onboard ship (results possibly higher)
- Unless clearly stated, all rope lashings tied onto actual ladder side ropes have an eye spliced in one end and are used for one test only. (results possibly higher) Many lashings ropes used onboard use a knot to secure to a strong point
- Testing has no deck edge feature (results possibly lower)

Side rope strength testing:

Side rope with no fittings

Thimbles were used to allow for a better D/d_1.

Single part of line

Old crimped avg result = 741kg
Old Seized avg result = 1970kg
New crimped avg result = 2002kg Removing crimps possible damage to the rope.

Doubled part of line

Old Seized avg result = 3592
New crimped avg result = 3269kg Removing crimps possible damage to the rope.

Sideropes with steps crimp / seizings and chocks/widgets

- a section of ladder was modified to have two tops so that the side ropes would be loaded and no load placed on any steps, chocks or crimps except by the sideropes

One side of a ladder loaded;

Old Seized avg result = 2012kg
New crimped avg result = 2755kg

Both sides were loaded;

- Failure of the ladder was deemed to have occurred when one side of a ladder failed
- 3 makes of ladder were tested

Results:

Old Seized = 3020

New crimped =4110

Ratios:

New Crimped

One side	Both sides
2755	4110

One side : both sides 1:1.49

Old Seized

One side	Both sides
2012	3020

One side : both sides 1:1.50

Step testing - wood only:

Strength of timber steps.

Longitudinal pull -

Remove side ropes from step.

Test 1 Fit shackles to side rope holes - one shackle at each end

Test 2 Fit shackles to side rope holes - Two shackles at each end

Result Test 1 Failure occurred at 2600kg

Test 2 Stopped test at 4800kg, after removing shackles noted that the holes had elongation of approx 1mm in all four side rope holes

Step strength – transverse - loading on tread

Remove side ropes from 2 steps - upper step is there as a spreader.

Fit synthetic line in place of sideropes.

Test 1 sling in centre of step - no spreading of load

Test 2 sling in centre of step - timber fitted cross grain to avoid crush damage

Test 3 Block fitted to place load closer to side rope holes

Result Test 1 Failure occurred at 1730kg

Test 2 Failure occurred at 1760kg

Test 3 Failure occurred at 2910kg

Test 1 shows the likely strength of a wooden step if a pilot boat were to come down on one.

Test 3 shows the timber step strength when use on a deck tongue - see results for deck tongue.

Strength of Pilot ladders

I hear people talk about strength of pilot ladders, they refer to the rules which state 24kN for the side rope material, the rules **do not** state the strength for pilot ladders it is the strength of the material for the side ropes.
You may think this means little, but…. A pilot ladder is proof tested to 8.8kN, which means that the load you should safely put on a pilot ladder in use will be less than 8.8kN.

From the testing carried out we can see that the actual strength of pilot ladders is not 48kN and nowhere near 96kN. Testing so far as an average of 40.3kN

SWL / WLL
Looking at safety factors and proof testing to determine a SWL for a pilot ladder with manila sideropes:
Manila rope SF of 12,
48kN = 4kN,
96kn = 8kN

What proof load is required, looking back I found pilot hoists had to have an overload test of 2.2, below is some of the text from the old MNZ Part 53. Dutch rules are similar.

53.20 Testing of pilot hoist

(1) A pilot hoist that is installed on a New Zealand ship on or after the date that Part 53 comes into force must be subjected to an overload test of 2.2 times the working load.

So applying the 2.2 to what Pilot ladders are currently tested to.
Test load / proof load factor = 8.8kN/2.2 = 4kN = 407kg force
Perhaps this is the SWL / WLL of a pilot ladder.

Being practical is a 407kg SWL / WWL acceptable for a pilot ladder:

- What weight does a pilot ladder have to carry?
    - itself….(a 15m long pilot ladder weighs in at 100kg.)
    - A pilot 150kg to allow for wallet(with pilots licence in), radio, small bag, wet weather gear (may be fitted with pockets to carry PPU), PPE (Incl Covid-19 gear).

250kg/407kg = 61% of the SWL adequate?

~~But the ladder strength is 24kN x 4….~~

Intermediate Securing Methods

Methods tested:

- Deck tongue

- Rolling Hitch lashing

- Shackles between siderope parts

- Choking shackles – D shackles

  - 20mm pin diameter – more common size
  - 15mm pin diameter

- Endless soft sling

Deck Tongue

Tests were conducted inline without a deck edge turn

- Old crimped: 815kg
- Old Seized: 2669kg, note between 300 - 1000kg seizings slid

- New crimped – 1 - New: 2316
- New crimped - 2 – New: 1506* crimps slid at ~1000kg, load increased, ladder badly distorted

THE FOLLOWING TESTS WERE CONDUCTED ON ONE SIDE OF A LADDER

Rolling hitch lashing:

- Old Crimped ladder -857kg
- Old Seized – 1280kg
- New crimped - 1s – 1043kg
- New crimped - 2n – 1145kg

Shackle between the side ropes:

- Old Crimped ladder - 898kg – crimps kept sliding
- Old Seized – 1469kg
- New crimped - 1s – 1091kg
- New crimped - 2n – 1422kg

Choking Shackles:

Choking Shackle 20mm pin dia D shackle:

- Old Crimped ladder -692kg – crimps kept sliding
- Old Seized – 1857kg
- New crimped - 1s – 1492kg
- New crimped - 2n – 1421kg

Choking Shackle 15mm pin dia D shackle:

- Old Crimped ladder -1000kg
- Old Seized – 1822kg
- New crimped - 1s – 1480kg
- New crimped - 2n – 1522kg

Choking Shackle – all types tested:

- Old Crimped ladder -888kg
- Old Seized – 1827kg
- New crimped - 1s – 1481kg
- New crimped - 2n – 1472kg

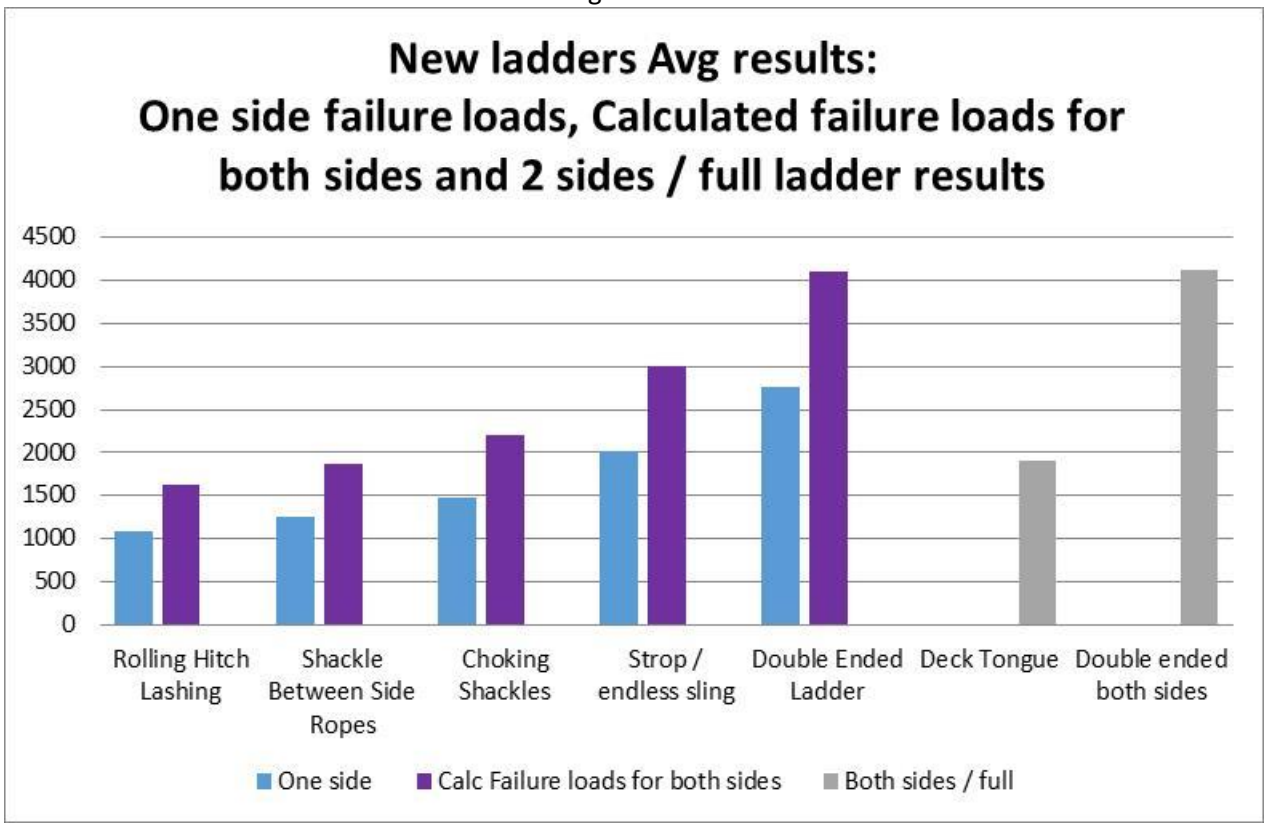
Endless Soft Round Sling 2T WLL and Shackle 6.5T WLL:

- Old Crimped ladder - 1025kg
- Old Seized – 2184kg
- New crimped - 1s – 2094kg
- New crimped - 2n – 1925kg

Summary, Comments & Observations

Results so far…

The following graph uses a factor of 1.49 to convert one side results (light blue), into a calculated failure load for both sides (Purple), it also shows the avg for tests conducted with both sides at the same time (Grey).
The 1.49 comes from the ratios found with testing.



Sometimes the lashings using rolling hitches failed before the ladder did. All the other methods the side ropes failed before the securing gear did.
The lashing either cut itself or it caused the side ropes to fail.

Strongest method?

Currently the strongest intermediate securing arrangement available that I have tested is to use soft round endless slings cow-hitched to the sideropes and shackled to strong points using tested shackles. See last page for photos.
2T WLL slings(14T MBL) with 6.5T WLL (MBL over 30T) green pin shackles were used in testing. The strength of these exceeds the strength requirements under the rules.

Strength of ladders –

Average strength of ladders tested – 4110kg / 40.3kN,
Would having a SWL make a difference?
Perhaps - it might mean that after a pilot boat snags a ladder it would have to be thoroughly inspected or tested?
Or maybe if ladders had a SWL of 407kg ship's crew might take better care, pilot transfer vessels might just might get designed and driven with that in mind, after all a ladder is tested to 8.8kN, what insurance company would pay out on an equipment failure that occurs at a load beyond that which the equipment has been tested to?

Another possible intermediate securing method:

There is presently a device under development, initial tests show that it is as strong as using slings, but it has the added benefit that it leaves a mark on the side ropes to show that over half a tonne

has been applied to the side of the ladder it is securing – in other words if the side ropes have both got the marks then the ladder has been subjected to more than it has been tested to (8.8kN).

Last say

With limited resources and limited testing carried out, less than 300tests on 4 different makes of ladders, further testing may show differences.
Very early testing showed choking shackles and lashings to be similar in strength, yet with further testing this has been found to be false.

Fatigue testing should be carried out – I currently do not have the time or resources to do this though I do intend to continue testing methods that are currently in use and investigate alternatives, any assistance is appreciated.

Gear used for the intermediate securing of pilot ladders should be tested and certified.

Random knots tied with random offcuts of line - you would not secure cargo with them.

Soft Endless Sling Method

Slings cow-hitched to sideropes:

Sling cow-hitched to siderope with turns taken around shackle to shorten the sling: