

Inspections & Safe Use of Lifting Equipment



Introduction



Critical Lifting
Applications

Purpose of this information



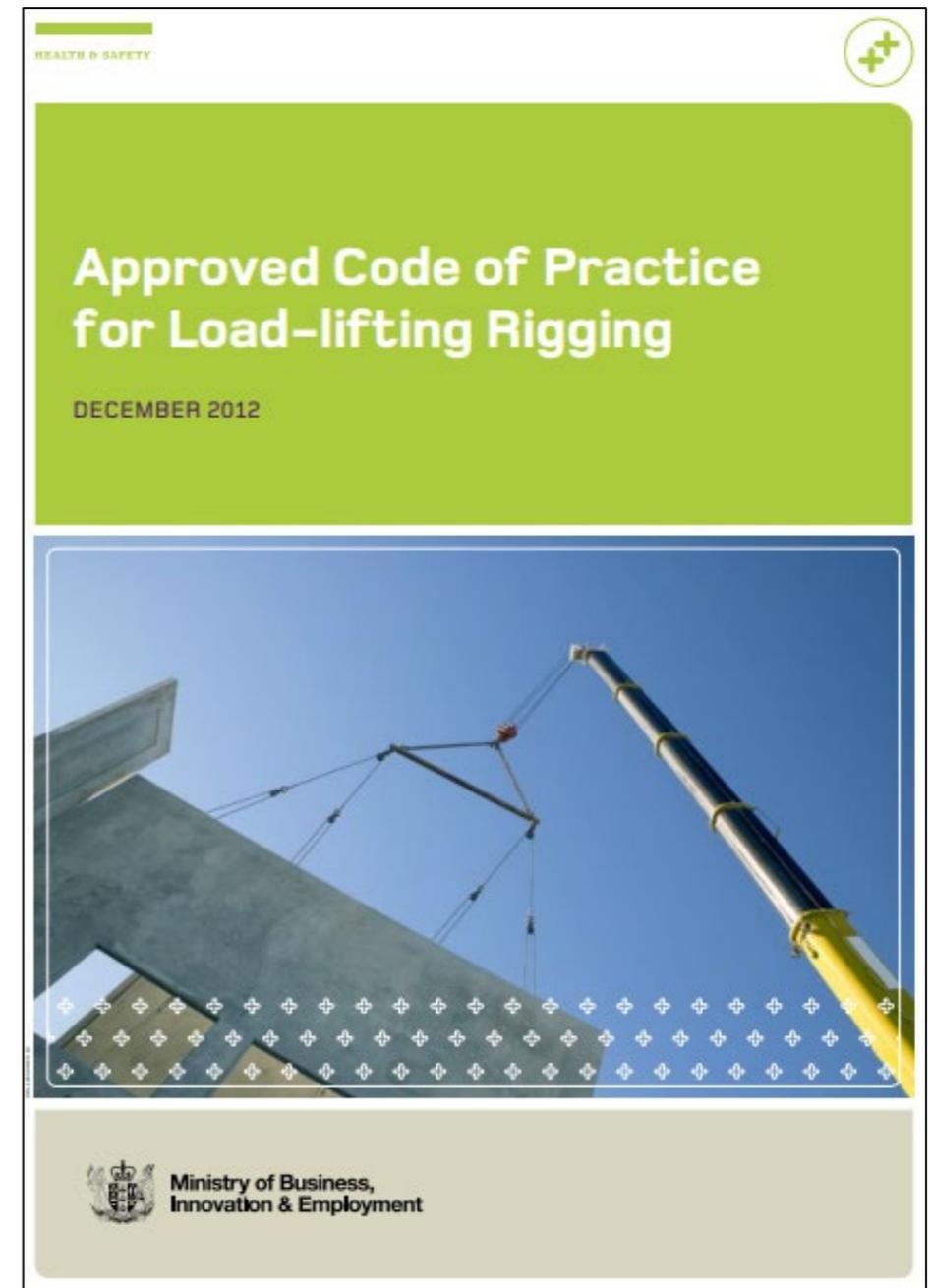
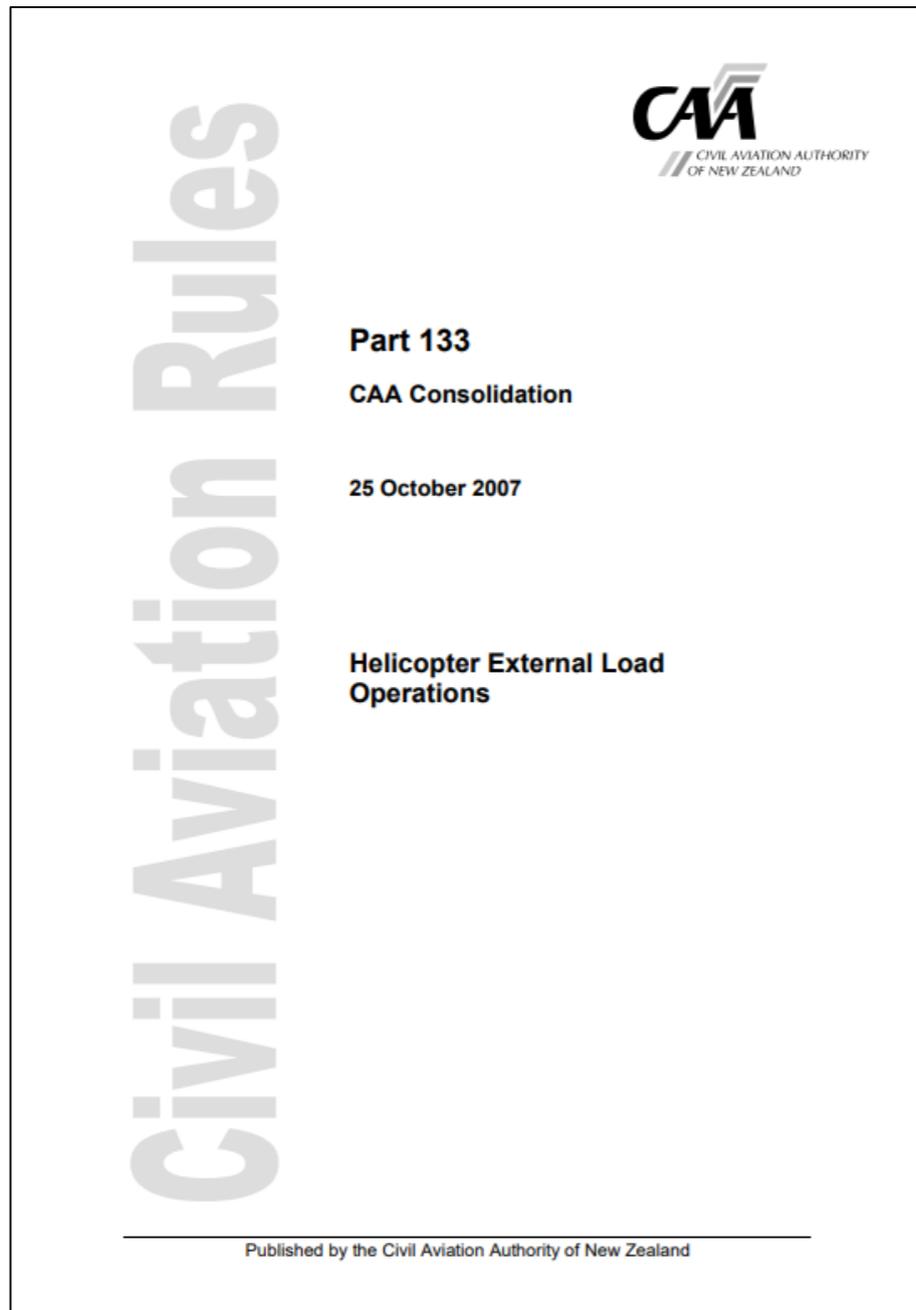
- Understanding what is required of you as an equipment user & inspector.
- Carrying out Pre-Use Inspections on Lifting Equipment.
- Be able to use Equipment Safely

Topics



- The New Zealand Health and Safety at Work Act
- ACoP Load-Lifting Rigging
- Pre-Use Inspections of Lifting Equipment
- Safe Use of Lifting Equipment
- Lifting Equipment Load Limit Charts
- CAA Rule 133 - Helicopter External Load Operations
- Asset registers

Equipment Guidelines



Lifting Equipment - Categories

Long Lines - Synthetic
- Wire Rope

Slings - Synthetic - Web & Round
- Braid & Strand
- Wire Ropes
- Chain Slings

Shackles - Connectors - Hooks

Frames - Spreaders
- Beams
- Cages

Equipment Registers

- Lifting Equipment must be registered in the owner's asset register, it is recommended to register all lifting equipment to maintain traceability.
 - Ref: ACoP Load-Lifting Rigging - Section 5.13 Register
- Health and Safety at Work Act 2015
 - Ensure that machinery and equipment are safe for the user / employees.
 - Ref: Subpart 2, Duties of PCBUs - Section 36, Primary Duty of Care
- Equipment Inspections – Traceability
 - Inspect - Ensure that the equipment is regularly inspected before use.
 - Ref: ACoP Load-Lifting Rigging - Section 5.12 Inspection
 - Periodically - When inspected by a third party, the asset register should be updated.
 - As scheduled - As an equipment owner / user, in accordance with an alternative schedule.
 - As requested - Equipment inspected randomly as requested by the owner or user.
 - Maintain asset registers - Keeping all certificates / periodic asset registers of the equipment.
 - Traceability - Each item clearly identifiable by ID / Serial number
 - Ref: ACoP Load-Lifting Rigging - Section 3.1 Identification

Pre-Use Inspections

Why do Pre-Use Inspections?

- To identify any obvious defects on the gear
- To make sure the equipment is correctly rated
- To make sure the equipment is certified
- To make sure it is the correct gear for the job

- Ref: ACoP Load-Lifting Rigging - Section 5.12 Inspection

Periodic Inspections

- Required Annually, at intervals not exceeding 12 months
 - Performed by the equipment owner / user / schedule
 - Registered equipment
 - All rated / load bearing equipment to be included.
 - When issued as a new item, added to the register.
 - After any repair or alterations
 - After reinstatement to service after long-term storage
- Ref: ACoP Load-Lifting Rigging - Section 5.12 Inspection

Equipment Markings

- All Lifting Equipment should be clearly and permanently marked with:
 - ID Number / Serial Number
 - Rating – WLL (Working Load Limit) / SWL (Safe Working Load)
 - Grade
 - Length
 - Diameter
 - Date of Manufacture / Retirement
- Once inspected by a third party, a Date of Inspection - Due Date included on a tag



Lifespan of Equipment

Key information – must be retained of certain equipment types:

Many manufacturers supply synthetic equipment with retirement dates on synthetics such as Long Lines and Height Safety Gear. It is important to be aware of this information that should be included within the asset register.

Such information may include:

- Manufacturer's specifications
 - Date of Manufacture
 - Retirement Date (if applicable)
- Purchase Date

Which could be as e.g.

- Expiry ~4, 5 or up to 10 years

Synthetic Material Types

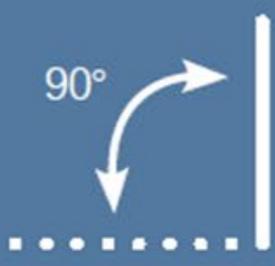
A wide range of material types are available in the industry with Dyneema, Polyester & Nylon being the most used types in certified lifting equipment with the applicable safety factors considered.

The materials can be assembled and presented in several ways such as:

- Ropes – twined, braided
- Netting – fused, knotted
- Webbing – fused, stitched, covered
- Sleeves – zipped, Velcro

Usage – Applied Factors

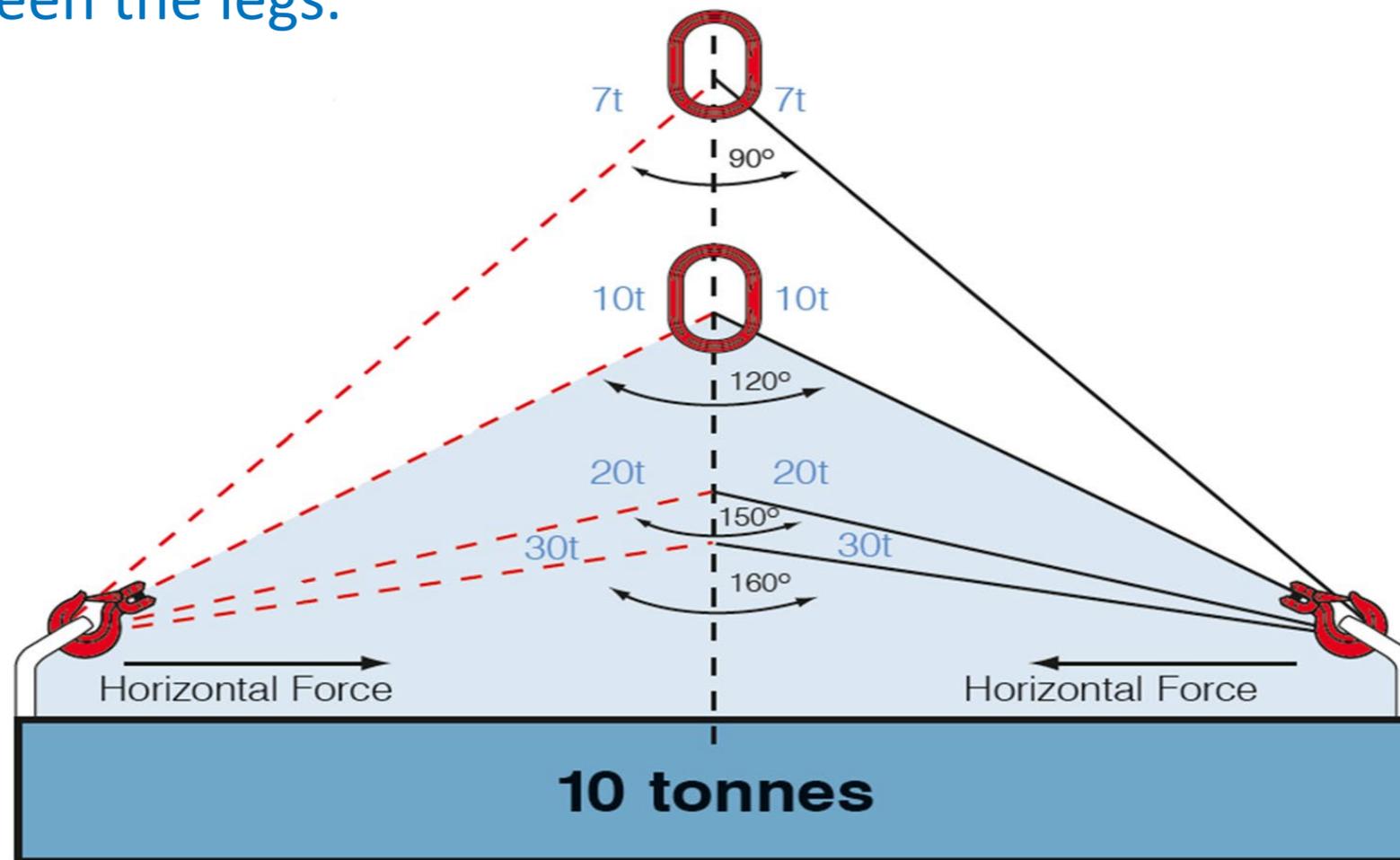
The ratings of lifting equipment includes the respective safety factors which are determined by the equipment type. The ratings can also be affected by varying factors such as when multiple leg configurations are used and / or where used in bespoke applications. In these instances, Rigging Charts are provided as guides that clearly identify the applied factors and the respective Working Load Limits as shown in the example below.

	1 Leg	2 Leg			3 & 4 Leg – Same Ratings		
Lifting Mode							
Chain Ø	Factor 1	Factor 1.7	Factor 1.4	Factor 1	Factor 2.6	Factor 2.1	Factor 1.5
mm	0°	60°	90°	120°	60°	90°	120°

Ref: ACoP Load-Lifting Rigging - Section 3.2 factors of Safety

Forces Applied / Loads

The applied forces on lifting equipment can change significantly when used in multi-leg configurations and is therefore important that the Working Load Limits are not exceeded when rigging. The image below demonstrates the increased forces when the same load is applied, but with differing included angles between the legs.



Synthetics



Synthetics

Synthetic / fibre lifting equipment is becoming increasingly popular due to their attractive attributes:

Commonly Constructed with Internal Fibres and an outer casing with benefits in Strength and that are extremely lightweight in comparison to wire ropes or chains.

There are some downfalls though, and that is that they can be easily damaged by cuts, abrasion, burns etc.



Synthetics

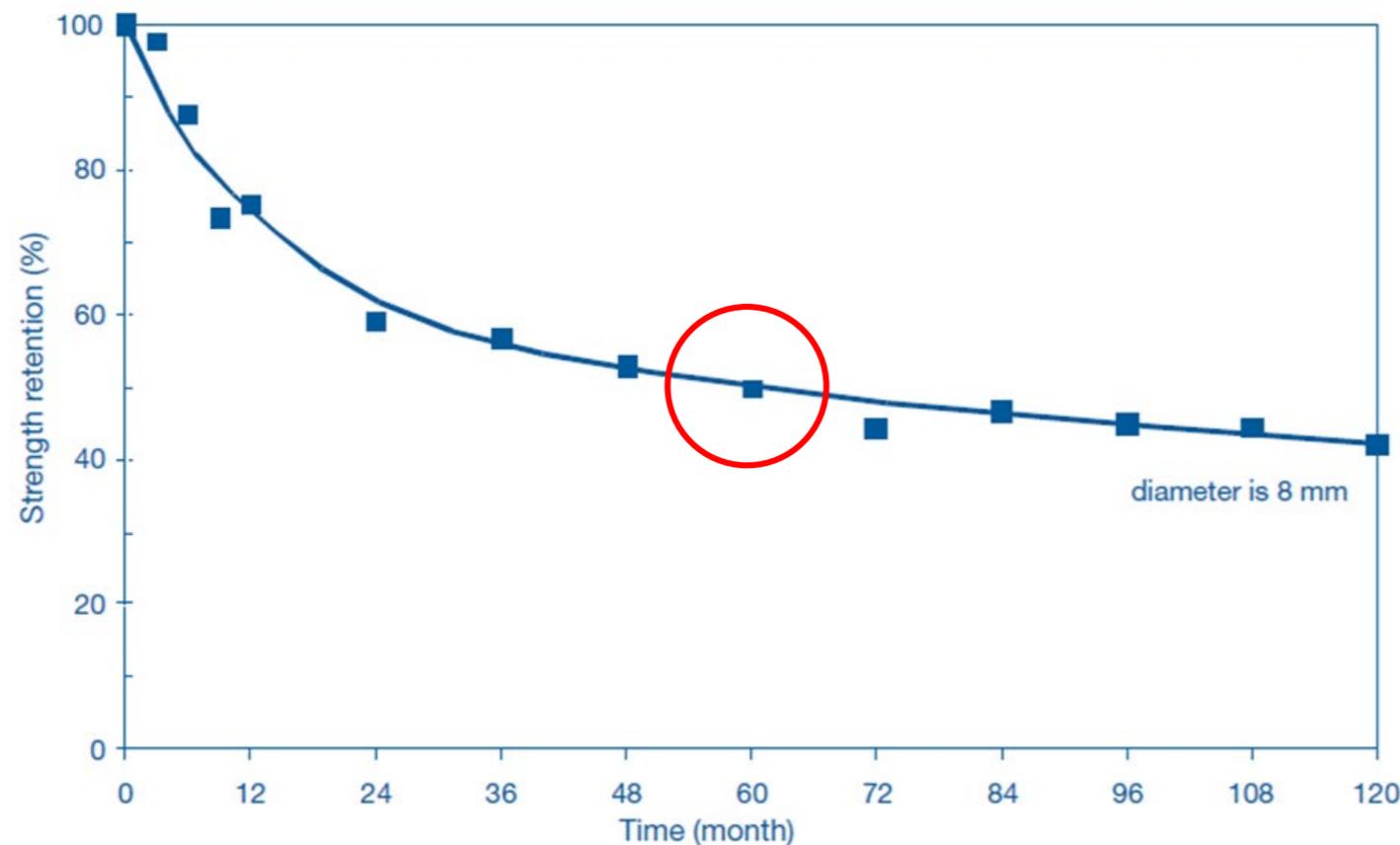
– Inspection Guidelines

Some key points to look for when inspecting synthetic lifting equipment include:

- Label / ID tag legible (rating, length, date of manufacture...)
- Damaged splices / terminations
- Creep / elongation in the lines
- Cuts / external abrasions
- Mechanical damage
- Inconsistent diameter
- Rope construction damage
- Heat damage
- Glossy / glazed areas
- Chemical damage / discoloration
- Damage to braided cover
- Fittings

Degradation - Synthetics

Synthetic materials are susceptible to degradation, by various factors, where UV Degradation is found to be a common, unknown and dangerous defect. Degradation reduces the capacity of the equipment by unmeasurable values over time, to demonstrate this, below is a case study that demonstrates the affects of UV degradation on the tensile strength of the materials.



Case Study

– *Dynamica Ropes*

- 8mm Braided Rope

- Circa 50% / 5yrs

Label / ID tag - Illegible

The image below is an example of a longline ID tag that is damaged and, in some places, illegible. Where the item becomes no longer identifiable or the rating cannot be seen, the unit should be withdrawn from service.



Terminations



Terminations

It is essential that the ends of lifting equipment items are properly secured as per the certified manufacturers specifications and as per standard. Where terminations are substandard or not to spec, the likelihood of failure is high.

The images below are clear demonstrations of equipment that has been identified as being unsafe for use and removed from services. Note the terminations that are substandard.



Terminations

This image demonstrates a non-specified splice that is terminated with a zip-tie. Withdrawn from service due to the unknown rating or capacity - this item could fail at any point.

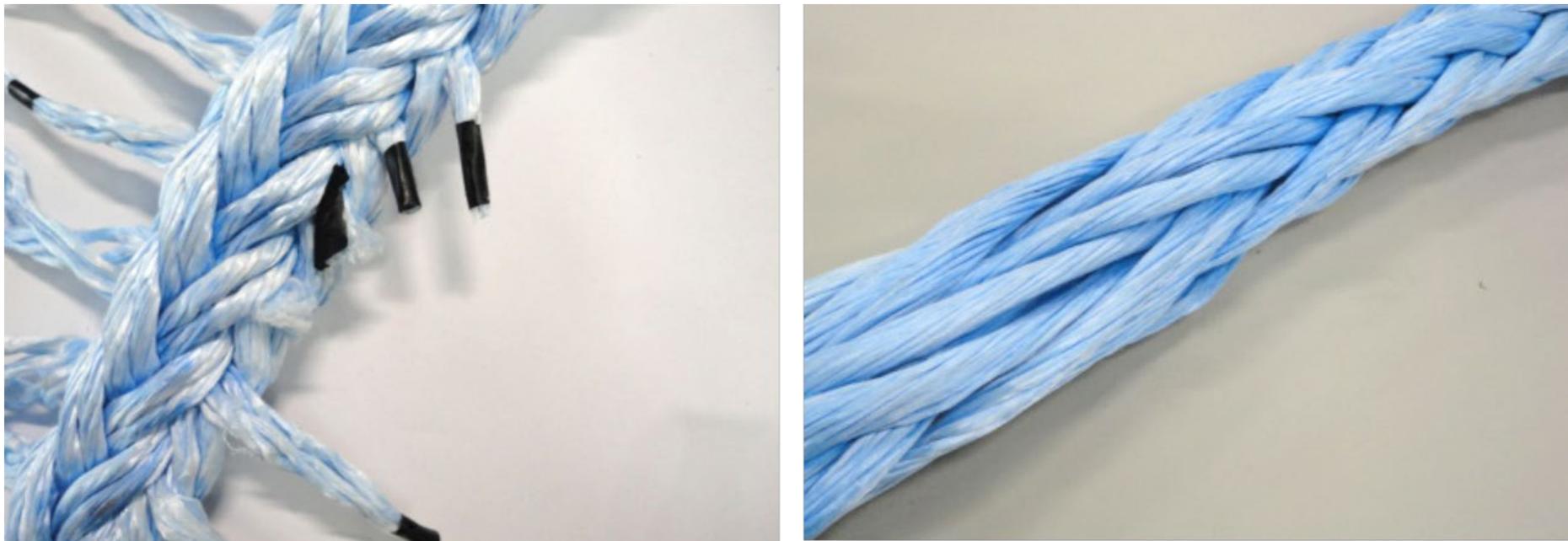
Also note that there is no traceability of this item, it appears to be homemade and is not fit for purpose – furthermore, there is no thimble in the eye which leaves the rope in direct contact with the shackle which will have likely abrasion and cutting effects.



Splices

Note: It is Essential to have a manufacturers specified splices in lifting equipment, the splices are proven and rated with the respective safety factors being applied.

- Ref: ACoP Load-Lifting Rigging – Part 4. Rope Splices



Cuts / External Abrasions

Any damage found on lifting equipment has the potential to cause failure. Where such defects are identified, as per example in the images below, the item should be withdrawn from service.



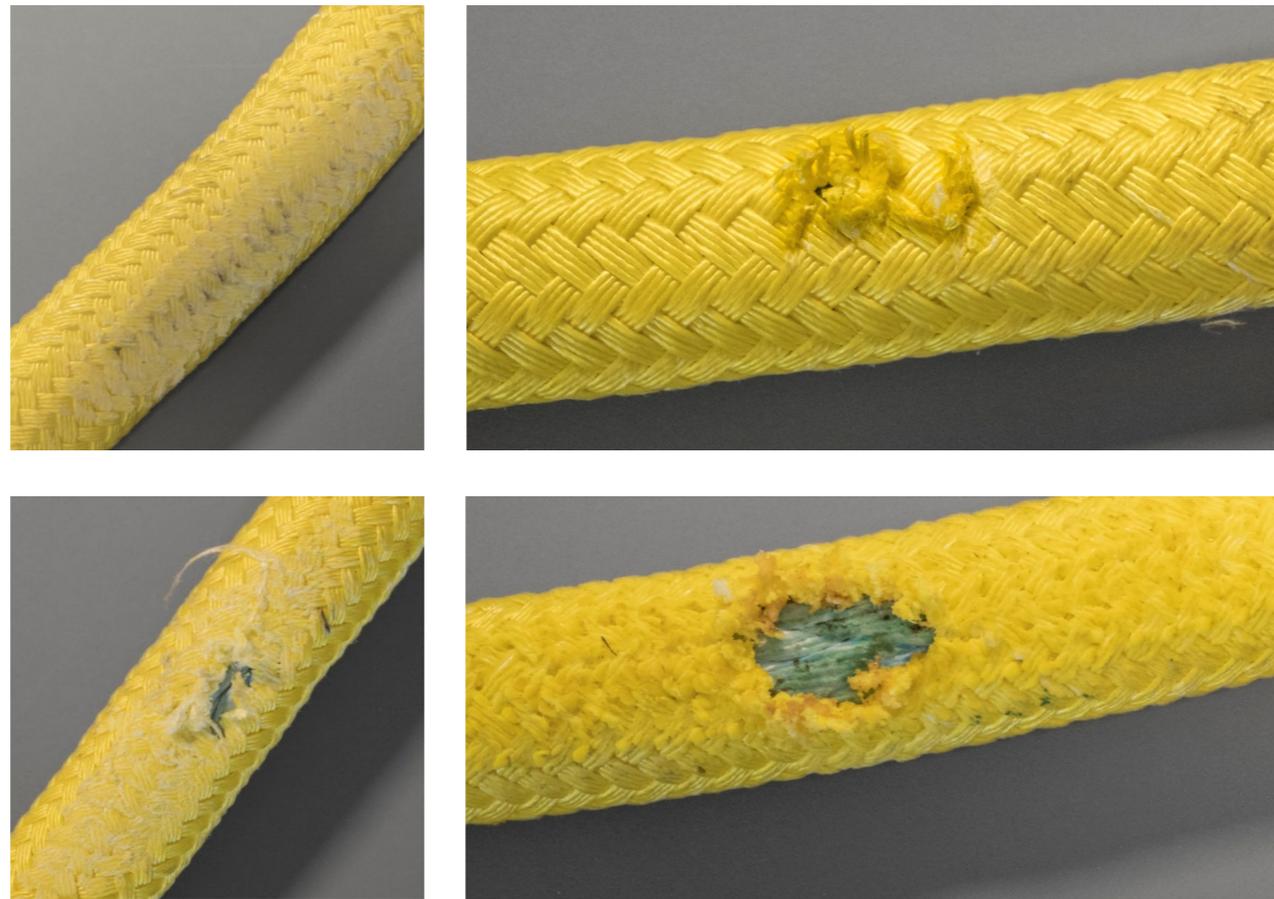
Damage to covers

Where damage is identified on casings, most commonly on long-line casings, the internal core / load bearing rope should be inspected for damage as well. The casings in most cases are non load bearing, they are merely covers to protect the inner core.



Casing Damage / Wear

Any damage found on lifting equipment has the potential to cause failure. Where such defects are identified, as per example in the images below, the item should be withdrawn from service.



Mechanical damage

Any damage found on lifting equipment has the potential to cause failure. Where such defects are identified, as per example in the images below, the item should be withdrawn from service.



Chemical Attack & Heat Damage

Any damage found on lifting equipment has the potential to cause failure. Where such defects are identified, as per example in the images below, the item should be withdrawn from service.



Braided Ropes – Inspections?

A common query regarding braided or covered synthetic lifting equipment is – can it be inspected and certified?

Some braided ropes are supplied with rating and breaking loads which meets the basic requirements to have rated equipment, but the difficult part is that the inner load bearing core cannot be inspected for damage and deterioration. It is therefore common practice to use uncovered lines that allow for full inspections to take place.



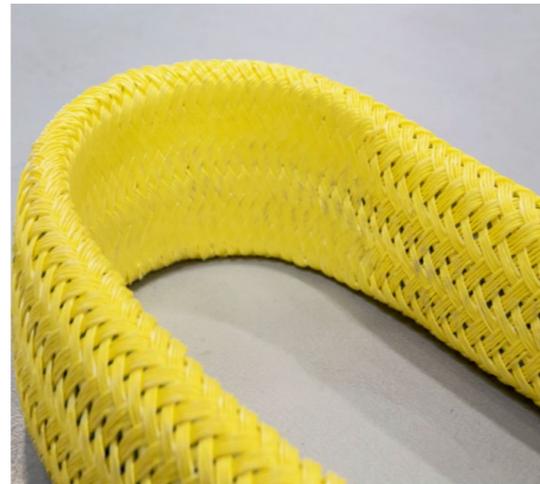
Bearing Point Wear / Damage



Direct Load Bearing

It is important to ensure that the correct rigging equipment is always used.

Noting that rigging assemblies comprise of several components, one should be aware that load bearing wear takes place between components especially where synthetics are connected to metallic lifting devices as seen in the image below.



Cargo Nets

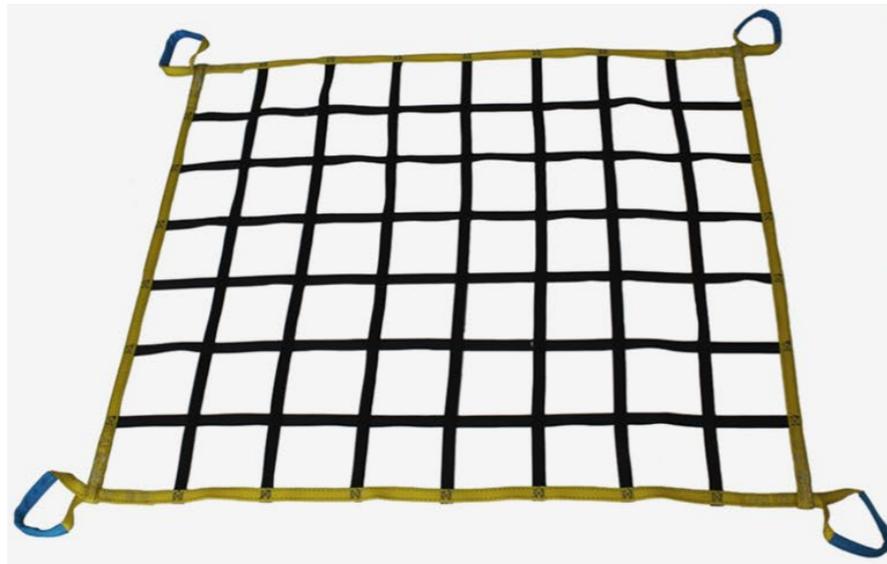
Cargo carrying nets are load bearing and should be traceable and certified assemblies. Where nets are not certified, seek certification or manufacturers ratings that can be applied. As the cargo carrying net is a lifting device, the basic discard criteria applies as listed under Web and Round Slings.



Cargo Nets

Examples of different net types.

Flat Webbing



Fiber Rope



Effects of Knots



Knots are not permitted in lifting equipment as they can significantly reduce the tensile strength of the load bearing device. As per case studies, common knots can have a 40 to 80% efficiency on rope tensile strengths.

Common Damage

The next suite of slides and images are examples of damage found on synthetic lifting equipment, nominally flat webbing.

Common Damage



Burn Marks



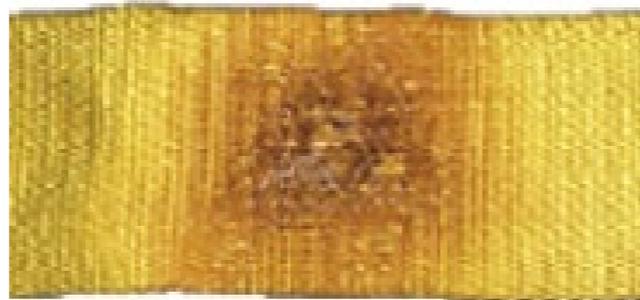
Cuts



General Wear



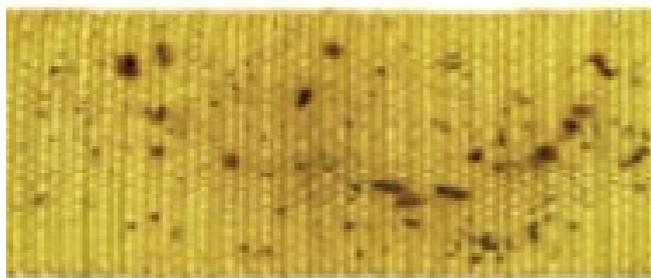
Edge Cuts



Burn Marks



Snags



Welding Splatter

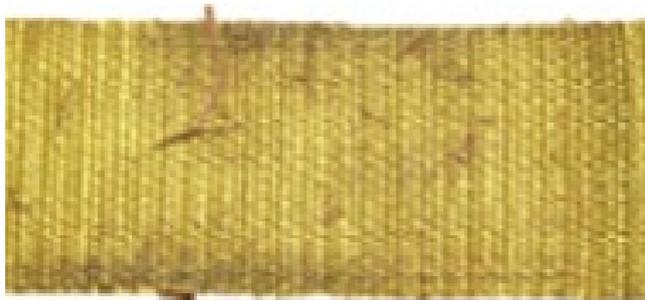


Damaged Stitching



Eye Damage

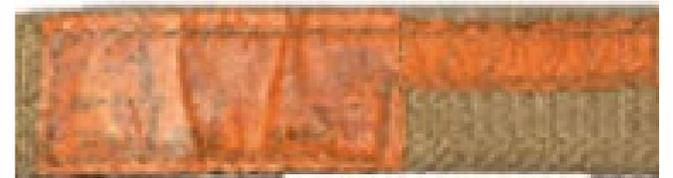
Common Damage



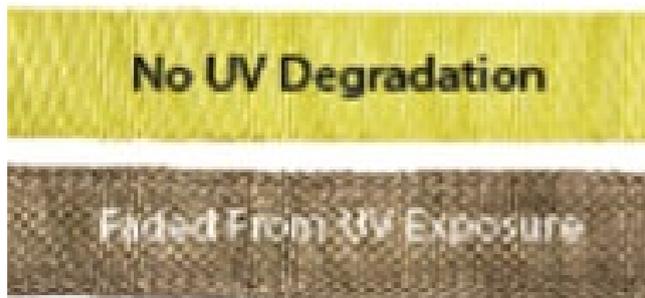
Fragments



Cut Edges



Illegible Label



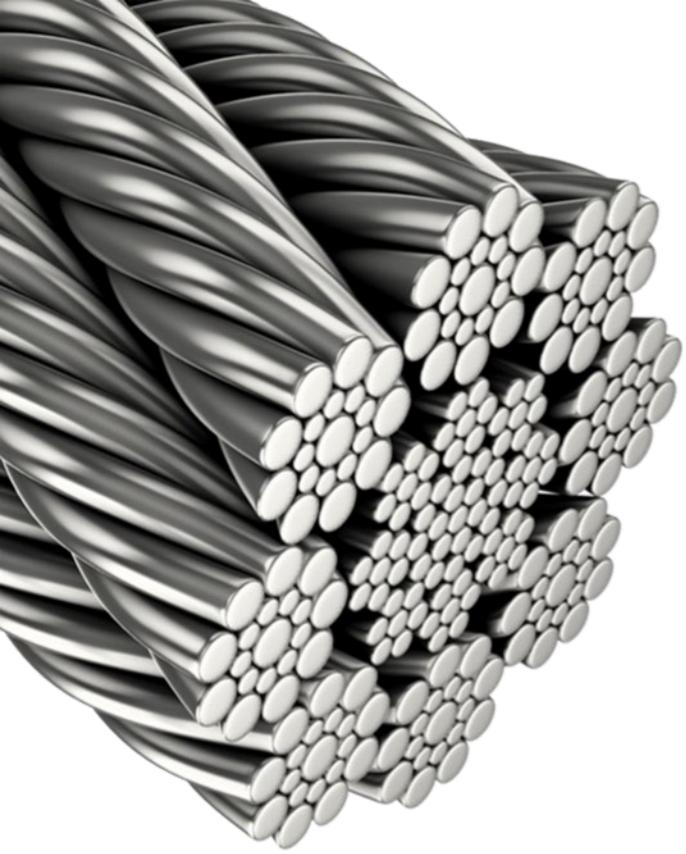
UV Degradation



Knots



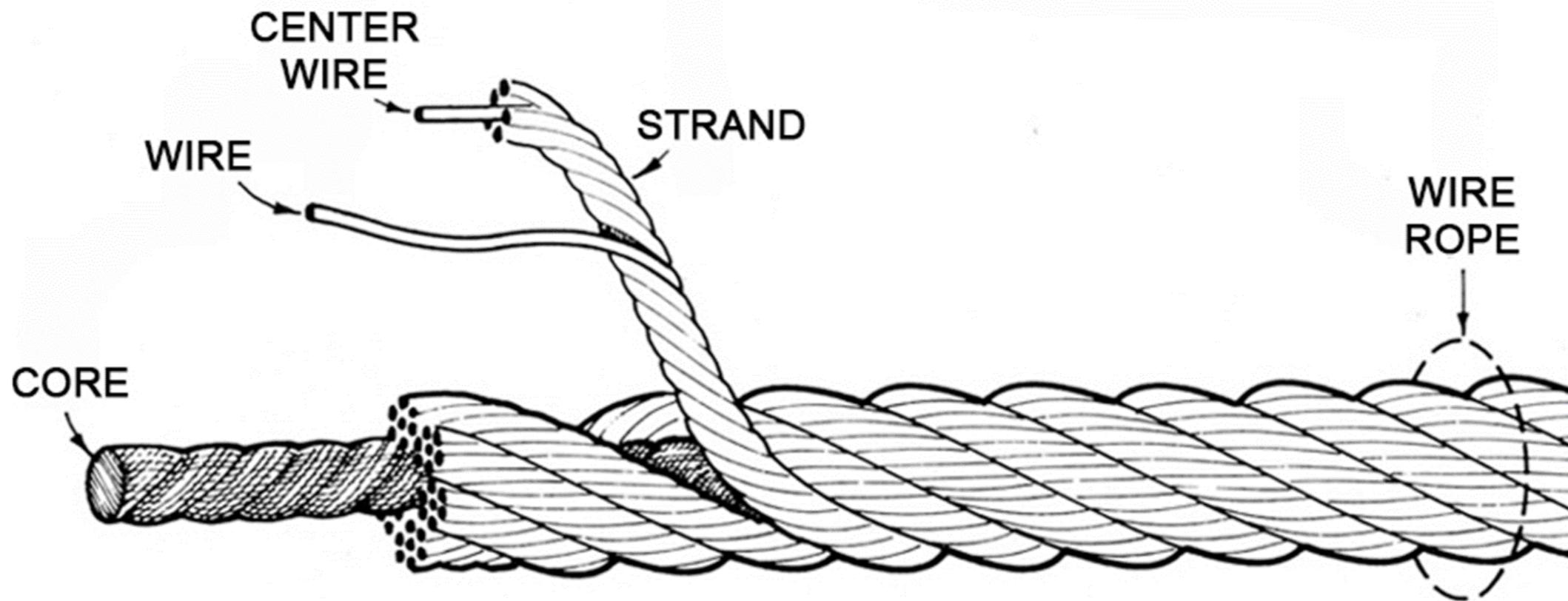
Edge Nicks



Wire Ropes



Assembly of a wire rope



Inspection Guidelines

There are several defects on wire ropes that can deem the units as unsafe / unfit for use, below are some basic guidelines of common defects that can be identified. Where such defects are identified, the rope should be withdrawn from service.

- Randomly distributed or grouped broken wires that are visible – as a norm, where there are 3 x or more broken wires over 6 x the rope diameter.
- Visible broken wires in the immediate vicinity of the rope termination or thimble eye (ferrule).
- Decrease in diameter (core failure, crushing, localised wear) – reduction of 10%.
- Internal and/or External corrosion where there is pitting.
- Deformations in the rope.
- Kinks in the rope.

The following slides are examples of common defects.

Broken Wires



Broken Wires



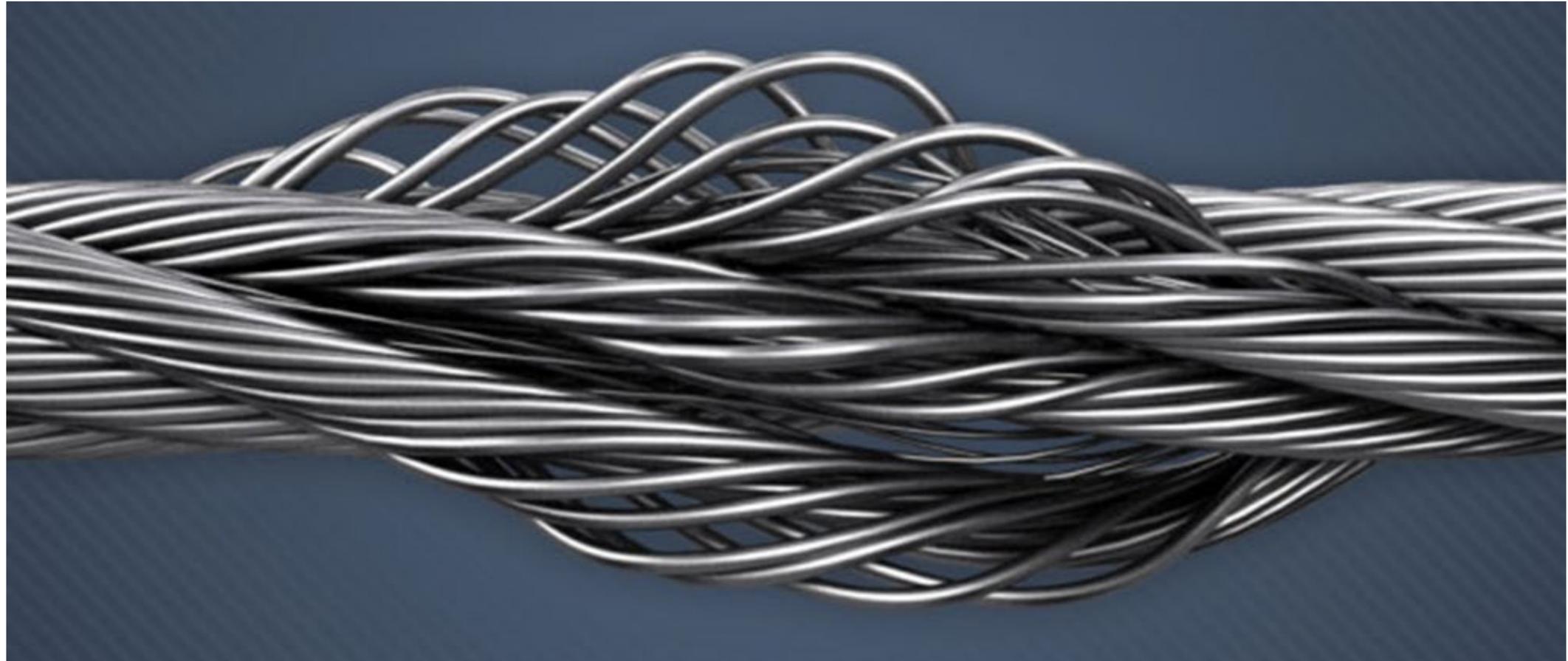
Dog Legs & Kinks



Deformation



Bird Cage



Surface Damage



Corrosion



Type of Corrosion	Condition	Severity Rating
Internal Corrosion	Obvious visible signs: corrosion debris exuding from valleys between outer strands	Discard 100% Or carry out internal examination if practical
Fretting Corrosion	Removing of fine particles of steel from the wires due to dry wires and strands constantly rubbing and then oxidizing – red rouge	Investigate further and if there is any doubt about its severity – Discard 100%

Terminations



Chain Slings



Chain Slings - Components

Chain slings for lifting can be made up of several configurations; they all however need to be specifically rated with the respective safety factors and certified safe for use. The chain and components need to be of grades no less than G80. Chain slings may have other types of lifting equipment incorporated however they do still need to be certified and the ratings applied to the lowest rated part.

Chain slings typically consists of the following components:

- Master Links (Rings)
- Connectors (Hammerlocks)
- Chain (Rated for lifting G80 or G100)
- Grab Hooks or Shorteners
- Hooks

The same inspection criteria applies to all components!

Rated for lifting

- Chain



Chains must be rated for Lifting
- G80, G100 or G120



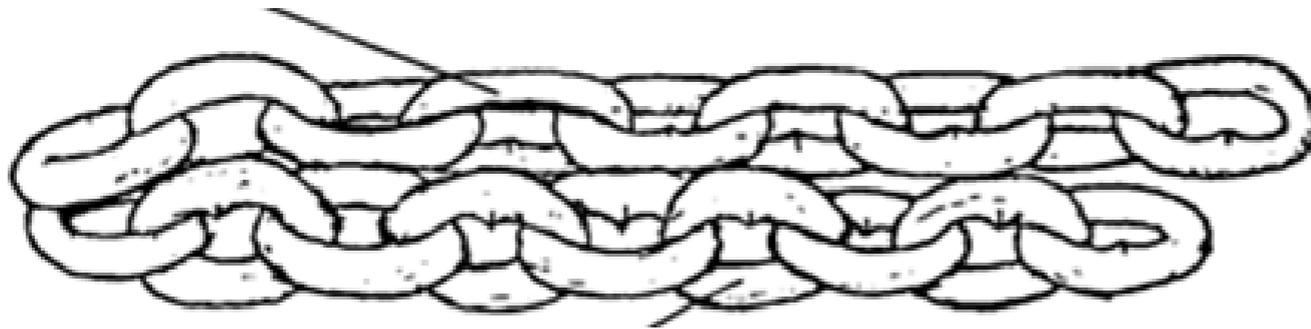
Chain NOT rated for lifting (G70)
- Used for lashing equipment
Must not be used for lifting!



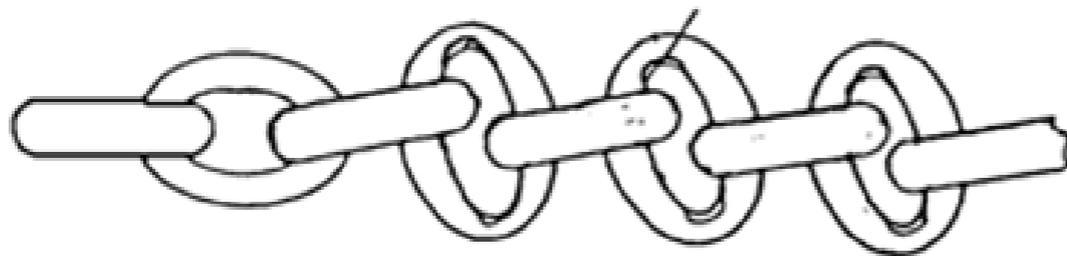
Chain rated for trailers – common use chain
Must not be used for lifting!

Common Defects on Chains

The following images are examples of common defects found on lifting chains, noting also, that the primary requirement is to have all chain sling assemblies tagged with the respective Rating and Identification.



Rusted (Corroded) chain links



Worn chain links

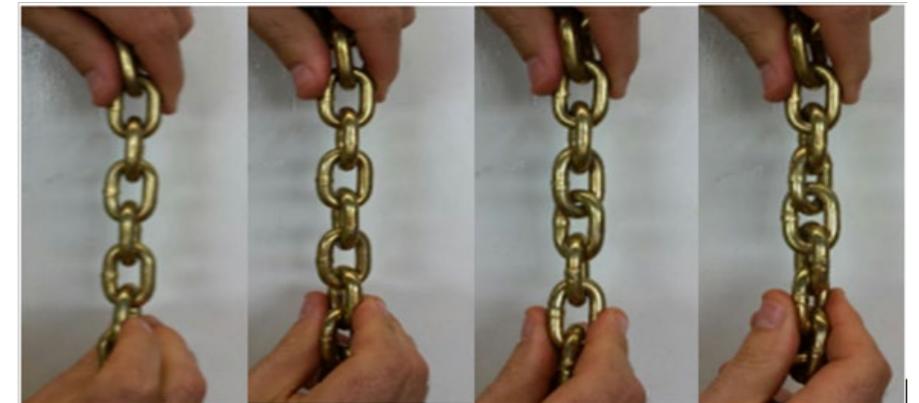
Checking Chain - Stretch

Always check the chain links for wear in the load bearing sections. Nicks, gouges, stretch, bent / distorted links and corrosion are common defects that can deem the chain and components as unsafe / unfit for use.

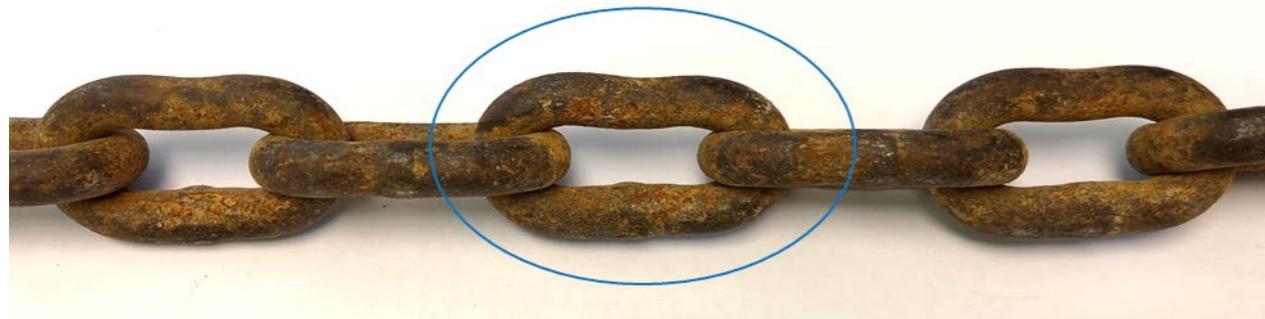


A quick reference check for identifying if a chain is worn or stretched is to “twist” the chain links together.

Hold the chain with 5 x links between to hands, in a vertical state, slowly twist the chain – if the chain twists with no resistance, it can be assumed safe for use and where there is resistance, further investigation should take place as there may be wear or stretch in the links.



Common Findings



Used Chain – Severely stretched

Hooks

Common defects to look for on Hooks:

- Safety Catches – they must be fitted to hooks.
- Original shape – no distortion allowed.
- Triggers working correctly – on safety latch lock hooks – the trigger must be functional.
- Correct hook for the application (ratings).





Safety & Correct Use

Ratings (WLL – SWL – MBL)

There are several types of rating methods and abbreviations, the following are commonly found in our industry noting that WLL is mostly used in New Zealand.

WLL - Working Load Limit

Maximum inline mass or force a product can support

SWL - Safe Working Load

WLL can be reduced and replaced by SWL

MBL - Minimum Breaking Load

Lowest fracture point

UL - Ultimate Load

Commonly associated with Breaking Load of a material

RC - Rated Capacity

Same as WLL

LC - Lashing Capacity

Equipment used to secure equipment – not for lifting

Safety Factors & Load Testing

All lifting equipment is rated with a Safety Factor, equipment type dependant, the WLL includes the SF. Load tests are required periodically by the CAA and is the norm under several guidelines. In some instances, it is not practical to load test an item and where this is the case, alternative means of certification are applied. To give an idea of the common Safety Factors applied to lifting equipment types, the following accordingly.

SF - Safety Factors

- Chain slings 4:1
- Wire ropes 5:1
- Synthetic Slings 7:1
- Long lines 8:1 and 10:1 (People Carrying)

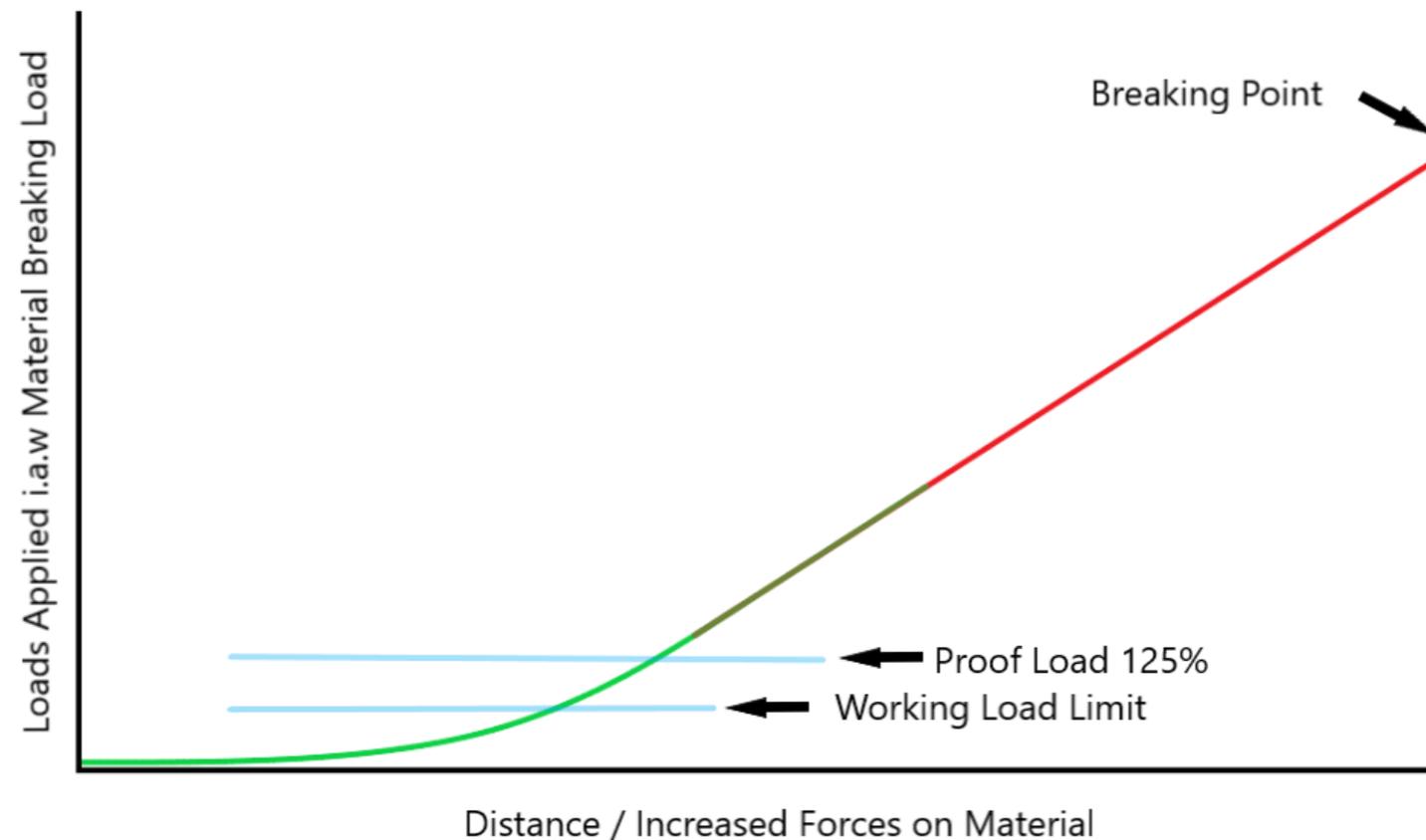
Load Testing - CAA Rule 133

- Proof Loaded to 1.25 x rated strength

Load Testing

The requirement for load testing equipment and the concern that it may damage the equipment is often raised. The below graph of applied forces during a load test is explained. With having the respective safety factors in place, a load test of $1.25 \times \text{WLL}$ will not damage the equipment being tested.

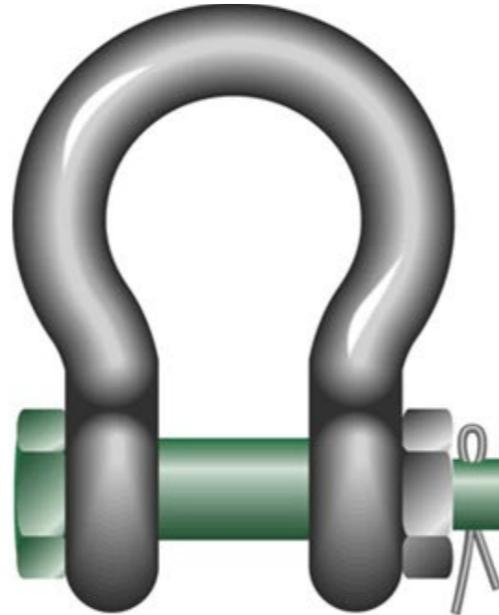
Note in the graph below, the applied load test is 25% on top of the WLL and well within the safety factor range meaning that the actual breaking load or point of destruction of that material or equipment type is well away from any point of deformation.



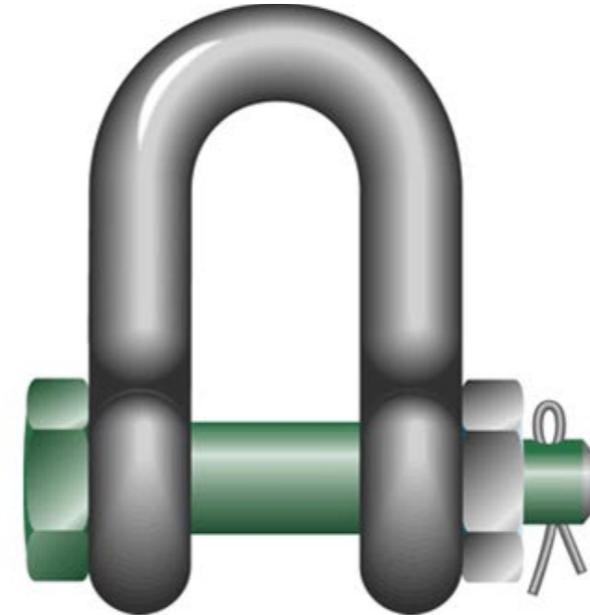
Shackles



Screw Pin Bow



Safety Bow



Safety Dee

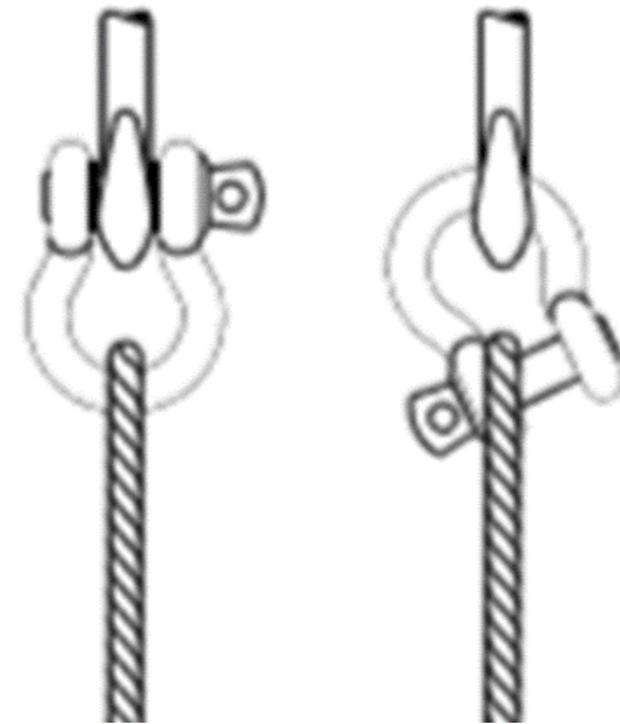
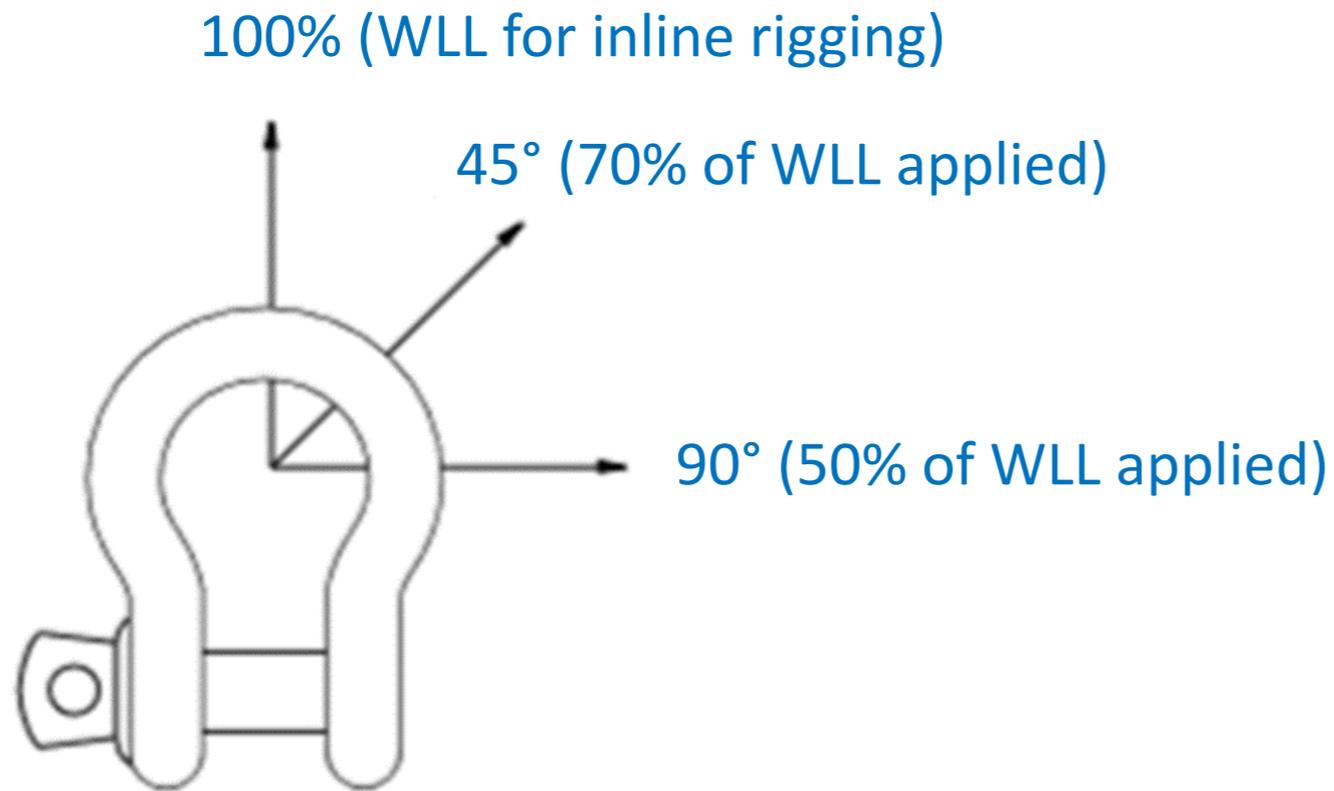
Pre-Use Inspection

There are several defects on shackles that can deem the units as unsafe / unfit for use, below are some basic guidelines of common defects that can be identified. Where such defects are identified, the shackle should be withdrawn from service.

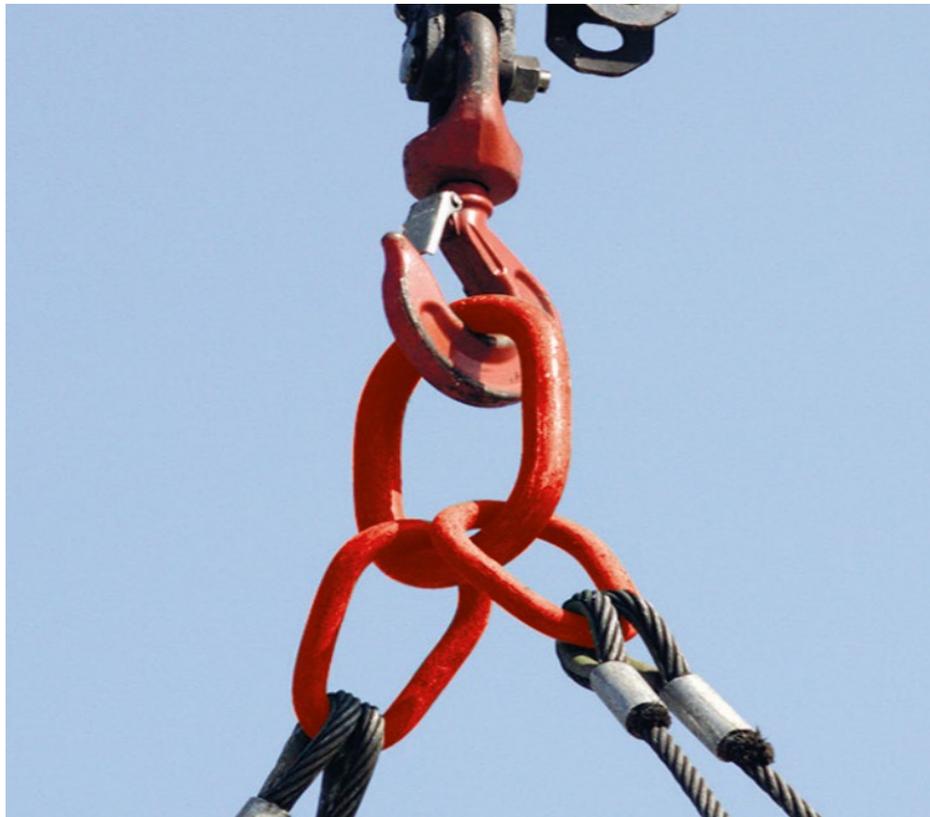
- Is the shackle rated for lifting - Working Load Limit (WLL)
- Worn areas on the body – No more than 10%
- Nicks and Gouges
- Twists or Distortion
- Incorrect Pin
- Damaged thread on the pin
- Certified / Rated Assembly
- Correct gear for the job

Did You Know

There are load bearing effects on shackles when forces are applied in varying angles to the common inline rigging configuration. Below, note the reduced working load limits applied at the varying rigging angles – it is important to be aware of these reductions and care should be taken to ensure that shackles are not overloaded.



Correct Assembly



The correct assembly of lifting equipment is of utmost importance, also that the ultimate rating is as per the lowest rated component within that configuration.

Where there is concern about rigging practices or equipment assemblies, please consult a lifting equipment expert who can guide you accordingly.

House Keeping

Good housekeeping is important especially with lifting and height safety equipment. Equipment stowed after use should be clean and dry, where used in wet weather, the gear should be hung to dry before being stored.

Storing wet synthetic / fibre equipment can cause mould to grow which in turn can create material issues that may affect the life of the gear. When equipment is cared for, it makes it easier to identify obvious defects when doing pre-use inspections. It also makes traceability of the gear easier and in cases where the details are on labels, they tend to last longer.



Recap

All Lifting Equipment:

- Must be rated for use - Working Load Limit (WLL).
- Must be in good condition – within inspection criteria.
- The correct gear must be selected for the job.
- The correct WLL must be selected for the job – nothing less!
- Ensure you do a Pre-Use Inspection on the equipment you will use.
- If you identify a defect on lifting equipment – get it inspected.
- Don't use defective gear.
- Good Housekeeping is important.

If you identify Bad Practice – **Raise the Alarm – Report it!**



Thank you for joining us today