RIGGING

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1. INTRODUCTION

This Section covers the safe use and care of chain lifting slings, wire role slings, synthetic flat we slings, synthetic round endless slings and associated tackle used for taking loads. For information regarding conductor load calculations see Section 4

2. NATURAL FIBRE ROPES

Although natural fibre ropes are frequently called "hemp" ropes, they are made from manila and/or sisal fibres. First grade rope is made with manila fibre, second grade with a blend of manila/sisal and third grade with sisal only. A sisal rope is whiter and does not have the gloss and smoothness of a manila rope as sisal fibres are stiffer and tend to split. Manila and sisal each have approximately the same mass for equal lengths of rope.

The most common type of natural fibre rope consists of three strands twisted together and this construction is known as plain or hawser laid.

Manila fibre rope

Sisal fibre rope

3. SYNTHETIC FIBRE ROPES

Most ropes used in the Electricity Supply Industry are now made from synthetic fibres. Synthetic ropes generally have greater strength, flexibility and resistance to abrasion with less weight. As they do not absorb water, they handle better when wet. They have a much higher resistance to mildew, rot and chemical attack and deteriorate less due to heat, cold water, age and general exposure.

Their main disadvantage is a smoother, more slippery surface which decreases the reliability of knots and splices. Knots in synthetic ropes

should be made in the same way as for natural fibre ropes however where possible extra turns should be taken. When splicing synthetic rope, use at least two extra tucks per strand when compared to the same size natural fibre rope.

Synthetic fibre ropes can be spun from long threads (filaments) or made up from shredded fibres similar to natural fibre ropes. Filament types are stronger while the shredded fibre type is cheaper and more akin to natural fibre in feel and appearance.

Polypropylene rope

Safe Working Load (SWL) for Ropes

Generally, the safe working load (SWL) of a rope is determined by squaring the diameter of the rope.

eg: SWL for natural fibre12mm rope is 12 x 12 = 144kg

New specialised high strength ropes may have a greater SWL. Refer to manufacturer's specifications.

4. STEEL WIRE ROPES

The manufacture of the strands in wire rope is in some ways similar to the method of making stranded copper or aluminium conductor.

The steel is drawn into wire sizes, the wires are helically laid into strands and the strands (usually six) are laid over a core to form the finished rope. The main core can either be fibre or steel. A fibre core is impregnated with lubricant prior to the manufacture of the rope. The steel core can be either a steel wire strand or an independent wire rope, the latter being usually made of seven strands each of seven wires, one central strand forming the support for the other six.

A rope of "ordinary lay" has the wires laid in one direction and the strand in the opposite direction. A rope of "Langs lay" has the wires and the strands laid in the same direction. Langs lay rope stands greater frictional wear than ordinary lay rope, owing to the greater surface area of wires exposed to friction by the load. But Langs lay rope should never be used where one end of the rope is free to turn.

Safe Working Load (SWL) for Steel Wire Rope

The working load of a steel wire rope is determined by applying a factor of safety or load factor to the minimum breaking load. As there are many different constructions and types of steel wire rope, it is not possible to give a simple formula for calculating the working SWL. Always refer to the manufacturers specifications for the wire rope.

Flexibility of Steel Wire Rope

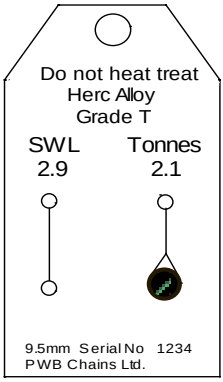
Generally the greater number of wires in a rope, the greater the flexibility. For instance a 6 x 7 rope, (that is a rope made up of 6 strand of 7 wires in each strand), would not have sufficient flexibility for use as a winch rope; however ropes from 6 x 19 up to 6 x 41 could be typically used depending on the application.

5. LIFTING CHAINS

Chain is heavier than steel wire rope of the same lifting capacity but is more durable. It can withstand rougher handling and can be stored without deterioration.

Most chain manufactured today for lifting is Grade (T) short-link lifting chain or 80 alloy steel. It is stamped (T), 80, 800 HA, CM a Polar Bear or various combinations of them.

Each chain sling must have a tag attached showing its manufacturer, grade, SWL, serial №, link size and different applications and uses.



Safe Working Load Chains

The SWL for chains is stamped onto the mandatory tag. Never exceed the manufacturers SWL.

6. SYNTHETIC FIBRE SLINGS

Synthetic slings are made from nylon, polyester, polypropylene or aramid polyamide.

7. SLINGING AND TYPICAL SLING APPLICATIONS

Slings are normally made from natural or synthetic fibre rope, chain, steel wire rope or synthetic webbing. Very few slings actually wear out; the principle abuse, apart from overload is to pass them around too sharp a radius when under load. This can be avoided by packing corners with soft wood or tyres. A wire rope sling that refuses to lie flat has been overstrained or bent around too small a radius.

The most positive and safest connection of a sling to a load is by hooking or shackling direct to eye bolts or specially prepared connections; this is invariably a feature of all transformers, from the smallest to the largest.

Chain Slings

These are for general use, where applications require versatility, flexibility and resistance to abrasion and cutting.

Wire Rope Slings

The use of wire rope slings for lifting provides several advantages over other types of slings. While not as strong as chain, wire rope has good flexibility with minimum weight; this is an advantage, particularly when long and large capacity slings are required for heavy lifts.

Synthetic Flat Web Slings

Synthetic flat web slings offer a number of advantages for rigging purposes. Their relative softness and width create much less tendency to mark or scratch finely machined, highly polished or painted surfaces and have less tendency to crush fragile objects than wire or chain slings. Because of their flexibility, they tend to mould themselves to the shape of the load.

Synthetic Endless Round Slings

Light and extremely easy to handle, they are ideal for difficult loads where surface damage is a concern. Because load contact points can be changed with every lift, wear is evenly distributed prolonging the life of the sling.

Safe Working Load (SWL) for Slings

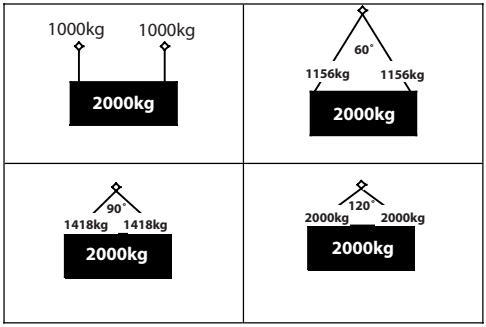
The SWL for slings is established by the manufacturer and must not be exceeded under any circumstances.

Slingtech round and Flat Slings – Working Load Limits

ROUND SLINGS										
FLAT SLINGS										
L = LOAD FACTOR		L = 1.0	L = 0.8	L = 2.0	L = 1.9	L = 1.7	L = 1.4	L = 1.0	L = 1.7	L = 1.38
COLOUR CODE	W.L.L. Tonnes	VERTICAL W.L.L Tonnes	CHOKE S.W.L. Tonnes	BASKET S.W.L. Tonnes	30° S.W.L. Tonnes	60° S.W.L. Tonnes	90° S.W.L. Tonnes	120° S.W.L. Tonnes	60° S.W.L. Tonnes	60° CHOKE S.W.L. Tonnes
VIOLET	1.0	1.0	0.8	2.0	1.9	1.7	1.4	1.0	1.7	1.3
GREEN	2.0	2.0	1.6	4.0	3.8	3.4	2.8	2.0	3.4	2.7
YELLOW	3.0	3.0	2.4	6.0	5.7	5.1	4.2	3.0	5.1	4.1
GREY	4.0	4.0	3.2	8.0	7.6	6.9	5.6	4.0	6.9	5.5
RED	5.0	5.0	4.0	10.0	9.5	8.6	7.0	5.0	8.6	6.9
BROWN	6.0	6.0	4.8	12.0	11.4	10.3	8.4	6.0	10.3	8.2
BLUE	8.0	8.0	6.4	16.0	15.2	13.8	11.2	8.0	13.8	11.0
ORANGE	10.0	10.0	8.0	20.0	19.0	17.3	14.1	10.0	17.3	13.8

8. LIFTING OF EQUIPMENT

Sling Angles



If a load is lifted by a pair of equal length sling legs inclined to each other, there is an increasing load in each of the sling legs as the angle between them increases. It is vital that this is understood and that the necessary allowance is always made to the SWL of each sling.

For example, if a load weights 2000kg the weight carried by two vertical slings of the same length is equal, ie 1000kg on each leg.

However, if the same load is lifted with the slings not vertical but at an angle to the load, the load in each sling increases as the angle between the slings increases:

a) At 120° the load on each sling doubles;

b) At 140° the load on each sling trebles.

These load increases are described as the loading factor and demonstrate how critical sling angles are. The loading factors for common sling angles are as follows:

Angle	30°	45°	60°	90°	120°
Loading factor	1.93	1.85	1.73	1.41	1.0

To establish the load on a sling leg, divide the weight of the load by the loading factor for that particular angle, eg:

a) Load weight = 3500kg, sling angle is 60°

3500 ÷ 1.73 = 2023kg on each sling leg

b) Load weight = 7300kg, sling angle is 45°

7300 ÷ 1.85 = 3946kg on each sling leg

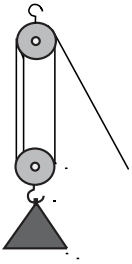
Use of Spreaders

When lifting a load which is fitted with lifting lugs, it is essential that care be taken that the lugs are not bent inwards by the pull of the sling. To prevent this, a "spreader" can be fitted between the two legs of the sling so that the direction of the pull of the sling on the lugs is vertical and not sideways. When using a spreader it is important that it is fitted as close as possible to the lugs so that the angle between the legs is as small as possible.

9. ROPE TACKLES

A tackle (or block and tackle) is a system of two or more pulleys with a rope or cable threaded between them, usually used to lift or pull heavy loads; they are however also commonly used as a temporary stay during construction work.

To determine the mechanical advantage of a set of tackle blocks, the number of rope parts coming from the moving (running) block is counted.



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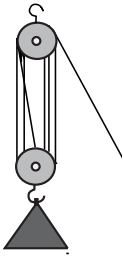

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Like all machines, blocks are not 100% efficient due to the effects of friction and this needs to be accounted for when determining the overall mechanical advantage and SWL of the block and tackle. For practical purposes, the sheave friction losses on well maintained sheaves are approximately 10% of the load to be lifted for each sheave.

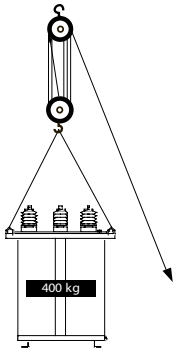
Example

To use a set of three sheave blocks to raise a 400kg transformer how much weight must be applied to the fall of line to begin the move?

Weight of transformer	400kg
Friction loss (6 x 10% of 400kg)	240kg
Total weight	640kg

Mechanical advantage of blocks 6:1

Pull on fall line 640 ÷ 6 = 107kg



10. CARE AND HANDLING OF RIGGING EQUIPMENT

General

Care and maintenance:

a) Storage should be under and off the ground, in a cool, dry building where temperatures are reasonably constant to avoid condensation. The rope and its wrappings should not touch the floor. The rope should be clear of dust, acid fumes, salt and other corrosive factors;

b) The care and preservation of synthetic ropes is very much the same as for natural fibre ropes except it is not recommended to scrub synthetic ropes to free them from mud and dirt. Hang the ropes up to dry thoroughly and then work the fibres to allow the dirt to fall out;

c) When under load, ropes in use must not rub together or cross sharp edges or corners; falling objects can cur and bruise them internally as well as externally;

d) Ropes must not be subjected to shock loading; loads should be applied gently and braking equally gently. Shock loading not only damages ropes, it can hazardous to people nearby;

e) Every sling and rope should be thoroughly examined at regular intervals by a competent person and such examination should also be made at any time there is doubt about the condition.

Safety Points:

a) Never handle running ropes;

b) Use leather gloves when handling wire ropes;

c) Use a few recognised knots rather than large numbers of uncertain knots;

d) Too high a safety factor for steel ropes is unadvisable because of the heavier sheaves, drums etc required.

Natural and Synthetic Fibre Ropes

a) Never use metal clamps or splices on fibre ropes that are under load; such devices will damage the rope and can also be extremely dangerous if the rope breaks;

b) When using synthetic rope for winch work around a capstan, take extra turns round the drum to counteract slipping; on no account let synthetic ropes surge off the drum or the resultant heat will melt and weaken the rope;

c) New fibre ropes are usually supplied in coils wrapped in hessian or other suitable material. To uncoil the rope, lay the coil on end with the inner end on top; cut the holding bands of the coil but do not remove the hessian or cover, as they help to hold the coil in shape; uncoil the inner end of the rope upwards from the coil in an anti-clockwise direction.

Steel Wire Rope

Wire rope can deteriorate due to many factors including; abrasion, corrosion, stretching or mechanical damage. When inspecting check the construction of the rope, for signs of stretching and damage and broken wires.

When wire rope is manufactured it is filled with lubricant to minimise frictional wear and to keep moisture out. Therefore wire ropes should never be exposed to heat which will melt the lubricant.

Points to remember:

- Never overload
- Do not shock load
- Protect the rope from sharp corners
- Avoid dragging the rope from under loads
- Don't roll loads with wire ropes
- Don't store ropes in wet areas
- Keep wire ropes lubricated

Annual Inspection and Colour Codes

- All lifting tackle, i.e. slings, pulleys, chains hoists etc, shall be subject to annual inspection.
- Where the equipment passes inspection it shall be colour coded for the year of inspection per TABLE 1.
- Where equipment fails inspection it shall be immediately removed from service.
- Where tackle is found to be out of inspection date, or where tackle is not in use and not inspected it shall be clearly identified as such and shall not be used.

TABLE 1

BLUE	GREEN	WHITE	BRONZE
2000	2001	2002	2003
2004	2005	2006	2007
2008	2009	2010	2011
2012	2013	2014	2015
2016	2017	2018	2019
2020	2021	2022	2023

Rope Tackles

a) Keep as clean and dry as possible;

b) Keep sheave bearings lubricated with appropriate grease. Do not use oil;

c) When not in use, blocks should be hung up in the truck or store room;

d) Do not leave blocks where heavy material can be placed on them, which may damage the blocks or rope;

e) Do not drag block on the ground as dirt may get in around the sheave bearing or other moving parts.

The block components should be inspected periodically for the following defects:

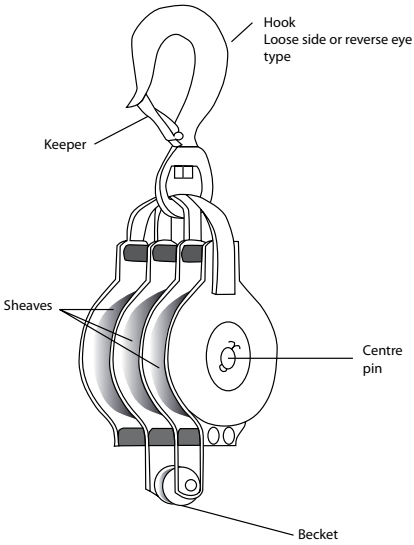
Hook Broken, bent out of shape, safety catch in working order.

Shell Broken, bent out of shape, sharp edges that will damage the rope.

Sheaves Broken, sharp edges that will damage the rope, worn bearings, sheave not turning freely in the shell.

Centre Pin Cotter key or split pin missing or excessive movement due to wear.

Becket Out of shape or worn condition of bolt or pin and thimble for the rope.



11. ERECTING ELECTRICAL EQUIPMENT

General

A common task in line construction and maintenance activities is the erection of electrical equipment such as transformers, capacitor banks, and gas switches etc.

When such equipment is being installed manually or by mechanical equipment, care shall be exercised to prevent personnel, the object or lifting equipment infringing the Safe Approach Distances.

For mechanical handling where there is a risk of infringing the Safe Approach Distances to electrical conductors, the movement of loads shall be controlled by means of non-conducting ropes or other approved means. No person shall contact the load, mobile plant or any attached conducting objects.

Lifting devices used as pole mounted lifting equipment, e.g. rope tackles and handlines shall be attached to pole structures by lineworkers or other suitably trained personnel.

For these tasks, suitable work methods and an appropriate number of persons shall be used to maintain Safe Approach Distances and these controls shall be recorded in the risk assessment completed by the work party.

Control measures to be considered within a risk assessment should include:

- Isolating and earthing electrical apparatus.
- Positioning the mobile plant such that the Safe Approach Distance can be maintained in all circumstances.
- The use of Safety Observers and barriers and signs.
- The use of other precautions such as physical restrictions or control devices in conjunction with barriers.
- The suppression of auto-reclose.
- The alteration of protection and control settings.
- De-energising the electrical apparatus.
- The use of non-conductive ropes.

When mobile plant may come near live electrical apparatus, the mobile plant shall be earthed.

When mobile plant is operated from outside the mobile plant, precautions such as the use of equipotential mats shall be taken to protect the operator from hazardous step and touch potentials.

Erecting equipment using a truck mounted winch

Due to environmental conditions or access restrictions, it is common in rural situations for a work party to have to erect equipment by the use of a truck mounted winch.

Figure 1 shows the proper set-up to use an approved truck mounted winch for this task.

- Always remember to maintain Safe Approach Distances
- Secure covers in place on LV conductors before rigging to raise or lower equipment
- Use guide ropes or tackle to guide equipment into place
- Do not attached guide ropes to bushings
- Pad HV & LV bushings to prevent damage when necessary
- Chock wheels of vehicle
- Make initial lift approximately 100mm and check all of the attachments and anchorages and proceed with the lift only after you are satisfied that it can be safely completed.

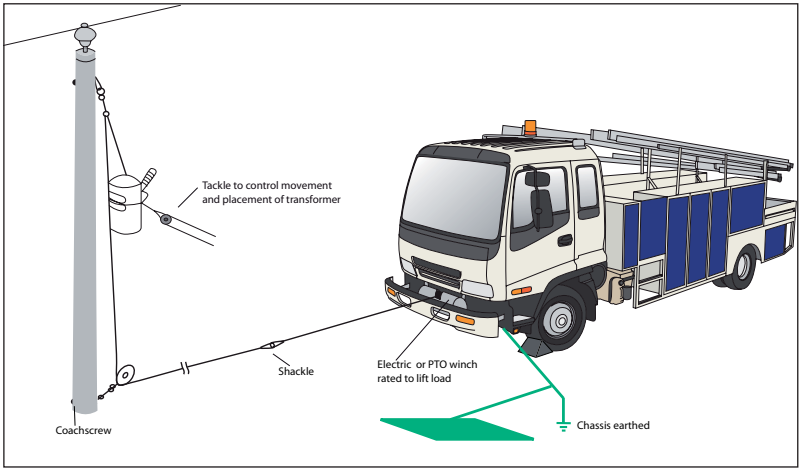


Figure 1. Proper set-up to use an approved truck mounted winch.