Choosing Wire Ropes

The subject of wire ropes is a large one and covers hundreds of industies requiring a lifetime of study. This is a short introduction to small diameter wire ropes typically used for flying scenery, display, handrailing and small yacht rigging.

The four main criteria that determine the choice of the correct wire rope are:

1) The material
2) The construction
3) The lay
4) The size (or strength).

For lifting purposes, documentation is also a consideration.

Material

1) Galvanised Steel

Notes Most galvanised rope for general purposes is Class B galvanised. It provides a sacrificial corrosion coating suitable for most uses. For salt water evironments Class A galvanising should be chosen however this heavy weight galvanising means the wire will loose some of its physical properties. Ungalvanised wire rope is also referred to as black, bright or self colour. The symbol "U" is usually used to denote uncoated wires. Strength of of Grade 1770 is from 1570N/mm^2 - 1960/mm^2 and Grade 1960 is from 1770N/mm^2 - 2160/mm^2. These are the only grades suitable for lifting.

Advantages The main advantage of galvanised wire rope is that it is economically priced for a wire with reasonable resistance to corrosion. Once the protective zinc coating has worn away tell tale rust weeps will start to show giving the user a good indication of the age of the wire rope.

Disadvantages Unless the galvanising is of Class A standard it is not ideally suited to salt water environments. The bright colour of the galvanising will dull over a period making the wire less attractive if used for modern display purposes.

Principle uses The most widely used wire rope. Used in theatres for flying scenery especially when the wires will never be seen. Wire with Class A galvanising is used as rigging on traditional craft.

2) Stainless Steel

Notes AISI 316 Grade Stainless steel is very resistant to salt water corrosion provided the surface is exposed to oxygen. Strength 1570N/mm^2

Advantages Excellent resistance to salt water corrosion. Good bright attractive modern finish. Non magnetic.

Disadvantages Maintains an "as new" appearance despite being potentially very old which neccessitates keeping good documentation.

Principle uses Used widely for architectural, display and handrailing puposes. The standard wire rope for use on yachts.

3) Blacked Steel

Notes The wire has a special black coating.

Advantages The wires do not show up when used against black masking in theatres. The fibres of the cable are still visable so inspection is possible.

Disadvantages Sometimes has a slightly greasy feel due to the protective coating.

Principle uses Used widely for theatre and opera flying.

4) PVC or Nylon Coated Wire Ropes

Notes The wire may be stainless or galvanised. The thickness of the coating depends on its final use with guard rail wires needing a thick very durable coating whereas flying wire can have a thin coating. The coating must be stripped back before applying terminations.

Advantages If black coated the wires do not show up when used against black masking in theatres. Thick white coating can be used for the top wire in guard rails making the wire more pleasant to lean against and easier to tie items to. Can be ordered white as well as black.

Disadvantages It is not possible to inspect the actual wire for broken strands. Can not be used over pulley sheaves.

Principle uses Used for theatre and opera flying although the blacked steel is now more popular. Widely used as yacht guardrail wires.

Construction

Wire ropes are made up from laying wire strands around a core sometimes refered to as the king wire. The core may be a steel core or a fibre core. A fibre core allows more flexibility and the fibre can hold a lubricant to help prolong the life of the rope. A steel core provides extra strength and helps to prevent the rope from mis-forming. The strands which coil around the core normally consist of a bundle of small wires but non flexible wire ropes may have strands consisting of a single wire. The wires should be preformed so when the wire is cut it retains its shape. Just occassionally you will come across wire rope that has not been preformed, you can tell as soon as you cut it as it flies apart in all directions.

1) Flexible Wire Ropes - FSWR

Notes The more wires per strand the more flexible the wire will be. Theatre wire ropes are virtually always flexible because the usual means of termination is by turning back the wire and securing it with a compressed ferrule. For wires from 3mm to 8mm diameter the usual construction is 6x19 (six strands of nineteen wires, plus a fibre core) or 7x19 (six strands of nineteen wires around a core strand of nineteen wires). Smaller wires are often 7x7 construction.

Typical Uses Any wire with a ferrule secured eye or a termination requiring a turnback such as a wedge socket. Any wire needing to run around a sheave. Running rigging on yachts.

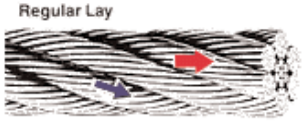
2) Non Flexible Wire Ropes

Notes Typically 1x19 with 19 strands consisting of one wire. The wires are arranged as 12 wires wrapped around 6 wires around a single wire core. Sometimes the wires are compacted which increases the strength by providing fewer air gaps. These wires can be formed into large coils for transport but they are not suitable for running over pulleys, winches etc.

Typical Uses Standing rigging on yachts and handrailing and display applications - nearly always in 316 grade stainless steel. These wire ropes have a slightly smarter more chrome like appearance. Terminating non-flexible wire ropes is generally done by roll swaging or with Sta-lok terminals. It is much easier to use Sta-lok terminals on 1x19 wire rope rather than flexible wire ropes.

Lay

Notes Virtually always the small wire ropes used in theatres and on yachts will be right hand regular (ordinary) lay. To tell if a wire or rope is left or right hand lay, place the rope along your right hand and the strands of right hand lay rope will point towards your thumb.



1) Right Hand Regular Lay - RHRL

Notes This is the lay most often used where the wires wind in one direction and the strands are wound in the other direction.

Advantages This type of rope is less liable to untwist or kink. It is easier to handle and has good crush resistance.

Disadvantages The direction of rotation of a right hand lay rope has the tendency to undo threaded fittings.

2) Lang Lay - RHLL

Notes The wires and the strands are wound in the same direction.

Advantages This type of rope is more flexible and has greater resistance to fatigue.

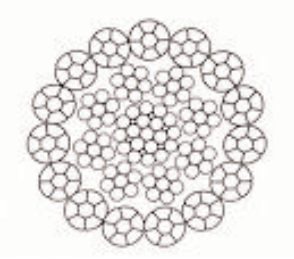
Disadvantages Prone to kninking and untwisting. Needs large diameter sheaves.

3) Left Hand Lay - LHRL

Notes The wires and the strands are wound in opposite directions but the strands are left hand lay.

Advantages This type of rope is mainly used in the drilling industries where its rotation direction tends to tighten fittings.

Disadvantages Rare and would normally be a special order.



4) Low Rotation Wire Rope

Notes There is normally some tendancy for wire rope to rotate slightly when under load. Often this is of no significance but occassionally can cause a problem such as lowering a chandelier on a single line with a power supply. Low rotation wire rope consists of the inner layer of strands being wound in one direction and the outer layer being wound in the opposite direction. This kind of rope is often used on large cranes.

Size

To choose the correct wire rope you need to know the weight of the object being lifted. This assumes a vertical lift.
The Safe Working Load of wire rope is generally based on a factor of safety of 5 to 1 but in certain applications greater safety factors may be requested.

Notes
New ferrule secured wire rope slings to EN 13414-1 do not require proof testing. There is some good logic here. They are basically saying that if the ferrule is correct and is correctly applied (and dimensionally checked) according to EN 13414-1 then proof loading is not relevant. In fact, an incorrectly applied ferrule (which would have been spotted with a dimensional check) may well pass a proof load test. However, proof loading is required for ferrule secured terminations that do not comply with EN 13414-1.
Care needs to be taken when high factors of safety are used to ensure that proof loading is correctly carried out. There are tables which specify the correct proof load to be applied for various items which are based on the WLL of the item being tested. Wire rope slings, for instance should be proof loaded to 1.8x the WLL of the rope. If a theatre specifies a safety of ten times for wire rope, lets say a small wire rope with a mean breaking load of 1000kgs it will give a SWL of 100kgs. Proof loads on wire rope slings are 1.8 x therefore you might think the proof load should be 100 x 1.8 = 180kgs however the correct proof load would be 360kg because the normal safety factor on wire ropes is 5 to 1 giving a SWL of 200kg (200 x 1.8 = 360kgs).
In effect the higher safety factor would have potentially halved the proof load unless the accepted working load limits of 5:1 (EN 13414-1) are used when proof tests are carried out.

Proof loads are designed to ensure the product does not become permanently deformed so that it can still be used in service. Applying higher proof loads may weaken the product whereas a low proof load will not provide a thorough test.