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Wire Ropes

Wire Ropes

A Rope is a length of thick strong cord made by twisting strands made of wire around a core of suitable material depending upon the suitability of the work.

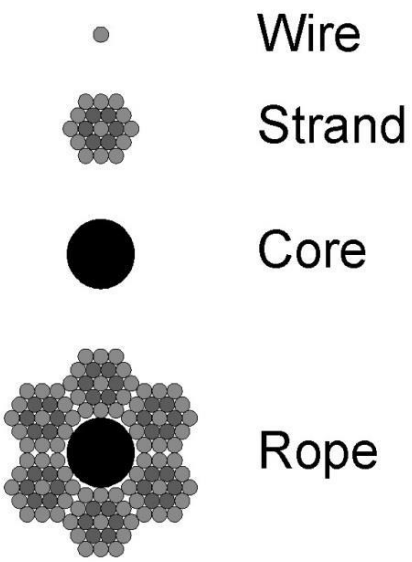


Fig.Components Of Ropes

- **Wire :**It is a metal drawn out into the form of a thin flexible thread or rod made of ductile metal. It is used to make a strand in a rope.

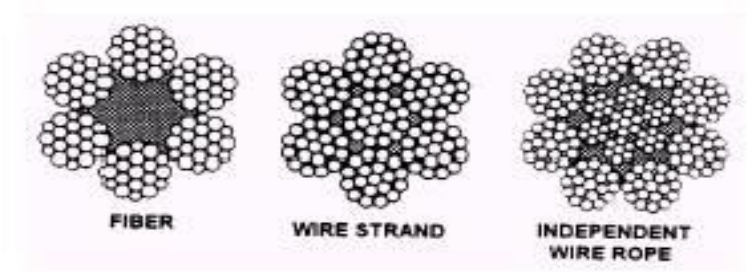
- **Strand**: A strand is formed by laying up one or more layers of wires around a strand core. A strand core is either a single wire or made up of a number of wires.

- **Core:** It is the centre of the wire rope around which the strand of wire is laid or coiled. There 3 types of cores :-

1)Fibre Core: It is made of fibres& generally used as a main core in stranded ropes. It provides more flexibility to the rope.

2)Steel Wire Core: It is a steel wire, which is used as a core. Generally it is used in strands & locked coil ropes.

3)Independent Wire Rope Core (IWRC): If a rope itself is used as a core, it is known as independent wire rope core. It is used when rope is subjected to kinetic shocks.



Fig, Different core constructions

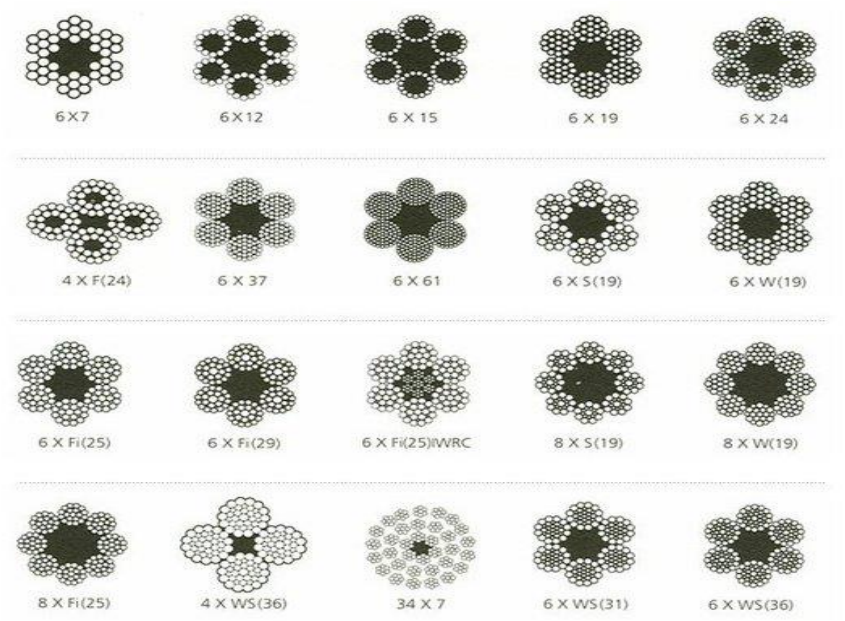
❖ CLASSIFICATION OF WIRE ROPES:-

1. Stranded Wire Ropes

- Round Strand Ropes
- Triangular Strand Ropes
- Multi-Strand Ropes
- Flat Strand Ropes

2. Non-Stranded Wire Ropes

- Full Locked Coil
- Half Locked Coil



❖ TYPES OF ROPE:-

1) Stranded rope
2) Non-stranded rope

1.Stranded Rope:-

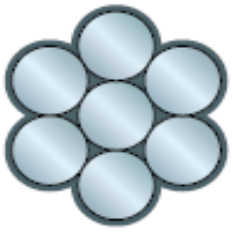
1) A stranded rope is built up of number of strands.
2) The strands are laid around the main core to make a stranded rope.

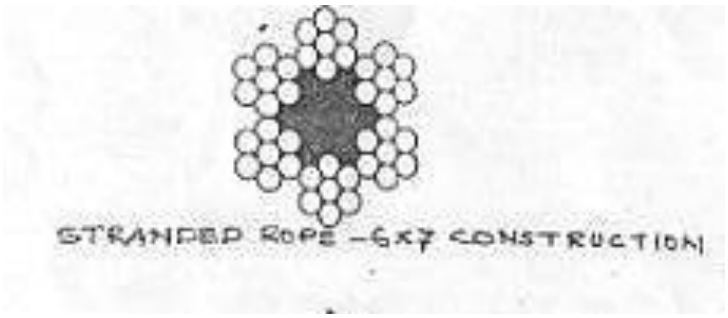
❖ **Types of Stranded Rope:-**

1. Round Stranded Rope:

1) It consists of six round strand laid around a main core.
2) It is known as a simple construction of strands is having only one layer of wire & of the compound construction if strands are having more than one layer of wire. **There are two types of Round Stranded ropes**:-

A. Simple Round Strand:-



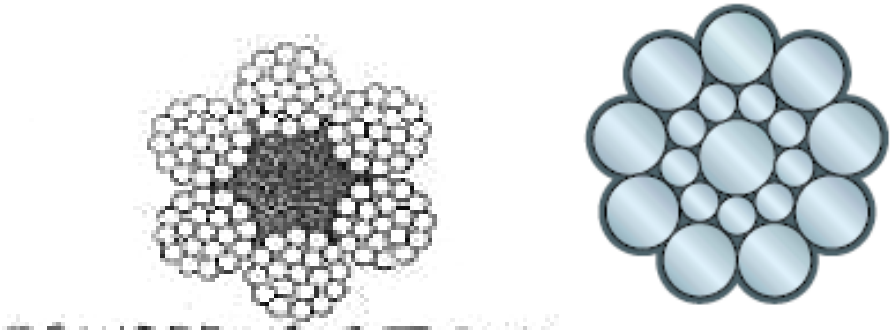


1)Rope usually consists of six similar strands laid around a central core of fiber or soft material each strand consist of six wires around similar central wire.

2) The fiber core as a yielding cushion in which the strands embed thus preventing frictional wear when bending on sheaves or drums.

B. Compound strands:

1)These ropes contain wires commonly of different diameters and may be arranged in different ways. In a 6x8/6/1 (or 6x8-6-1) wire rope, there are eight larger outer wires to give flexibility.
2) The larger outer wires provide for wear.
3) This being common construction for winding ropes.



- **Advantages of Round Stranded Rope**

1) Simple in construction.
2) Cheap.
3) Easy to examine visually.
4) Flexibility is more.

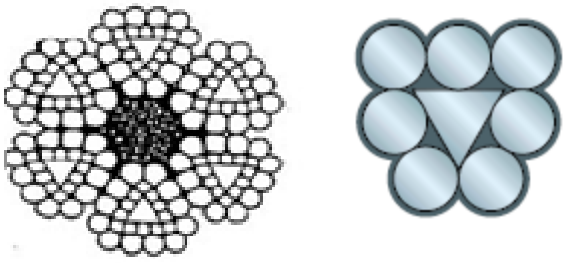
- **Disadvantages of Round Stranded Rope**

1) Turning tendency (rotating tendency as the load change).
2) More external wears.

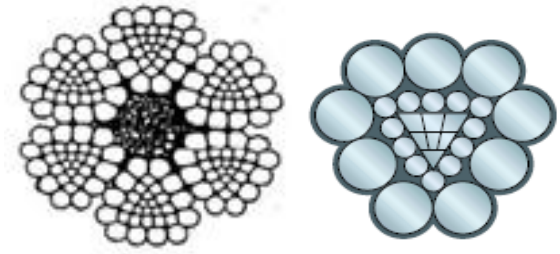
2. <u>Triangular Strand Rope or Flattened Strand Rope</u>:-

1) It consist of six triangular strand laid around a main.
2) It is known as a simple construction of strand is having only one layer of wire & of the compound construction if the strands are having more than one layer of wire. **There are two types of triangular strand**:-

A. Simple triangular strand:-



B. Compound triangular strand :-



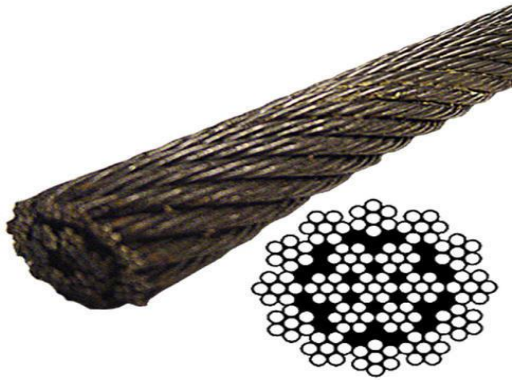
- **Advantages of Triangular Strand Rope**

1) Strength is more (10% more strength than the round strand rope).
2) Life is more.
3) Crushing strength is more.

- **Disadvantages of Triangular Strand Rope**

1) Costly.
2) Less flexible.
3) Rotates as the load changes.

3. Multi-Strand Rope:



1) A multi-strand rope is built up of two or more layers of strand laid around a main core.
2) Each layer of strand may be composed of round strand or triangular strand.
3) It is known as round strand multi strand rope.
4) The two layers of the strand are always laid on the opposite direction to reduce the rotating tendency of the rope.

- **Advantages of Multi-Strand Rope**

1) Non-rotating.
2) More flexible.
3) Strong & more durable.

- **Disadvantages of Multi-Strand Rope**

1) Interior of the rope cannot be examined visually.
2) Costly.

4. Flat Rope:1)It is made up of several strands laid side by side.
2) The strands are stitched together with one stitching strand or wire so as to hold the rope together & equalized the load between the several strands.
3)They have been preferred as a balancing ropes on koepe winding systems.

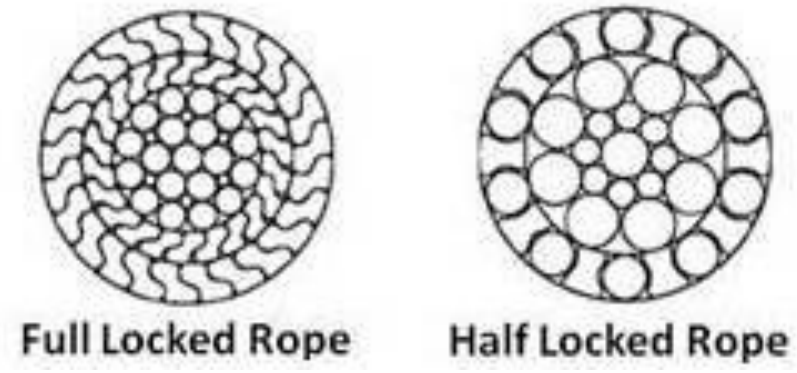
- **Advantages of Flat Rope**

1) Non-rotating.
2) More flexible.
3) More external surface hence easy examined.

- **Disadvantages of Flat Rope**

1) Costly.
2) Life is less.
3) Flexible in only one direction.

2)<u>Types of Non-Stranded Rope</u>:-



1. **Locked Coil Rope or Full Locked Coil Rope:**

1) It consists of one straight strand & containing as many wires necessary to give the required rope strand.
2) Its main core is single wire as present in any round strand.
3) The wires in the rope are laid in the opposite direction to make the rope non-rotating.
4) The outermost layer is always composed of full a locked wire that gives a smooth external surface & a locking action to any rotating tendency of rope.

- **Advantages of Locked Coil Rope**

1) Greater strength.
2) Smooth external surface hence can be used as guide rope.
3) Non-rotating.
4) Permanent stretch is less.
5) External wear is less.
6) Crushing strength is more.

- **Disadvantages of Locked Coil Rope**

1) Inner wire cannot be examined.
2) Less flexibility.
3) External portion of the rope cannot be lubricated.
4) These ropes cannot be splices.

2. Half Locked Coil Rope:

1)It consists of one straight strand containing as many wires as necessary to give the required rope strand.
2) Its main core is a single wire as present in any round strand.
3)The layers of the wire are always laid in the opposite direction to make the rope non-rotating.
4)The outermost layer of the wire consist of the wires consist of the half locked wires to give a smooth external surface & to provide a locking action, if the rope tries to rotate.

- **Advantages of Half Locked Coil Rope**

1) Greater strength.
2) Smooth external surface hence can be used as a guide rope.
3) Non-rotating.
4) Permanent stretch is less.
5) External wear is less.
6) Crushing strength is more.

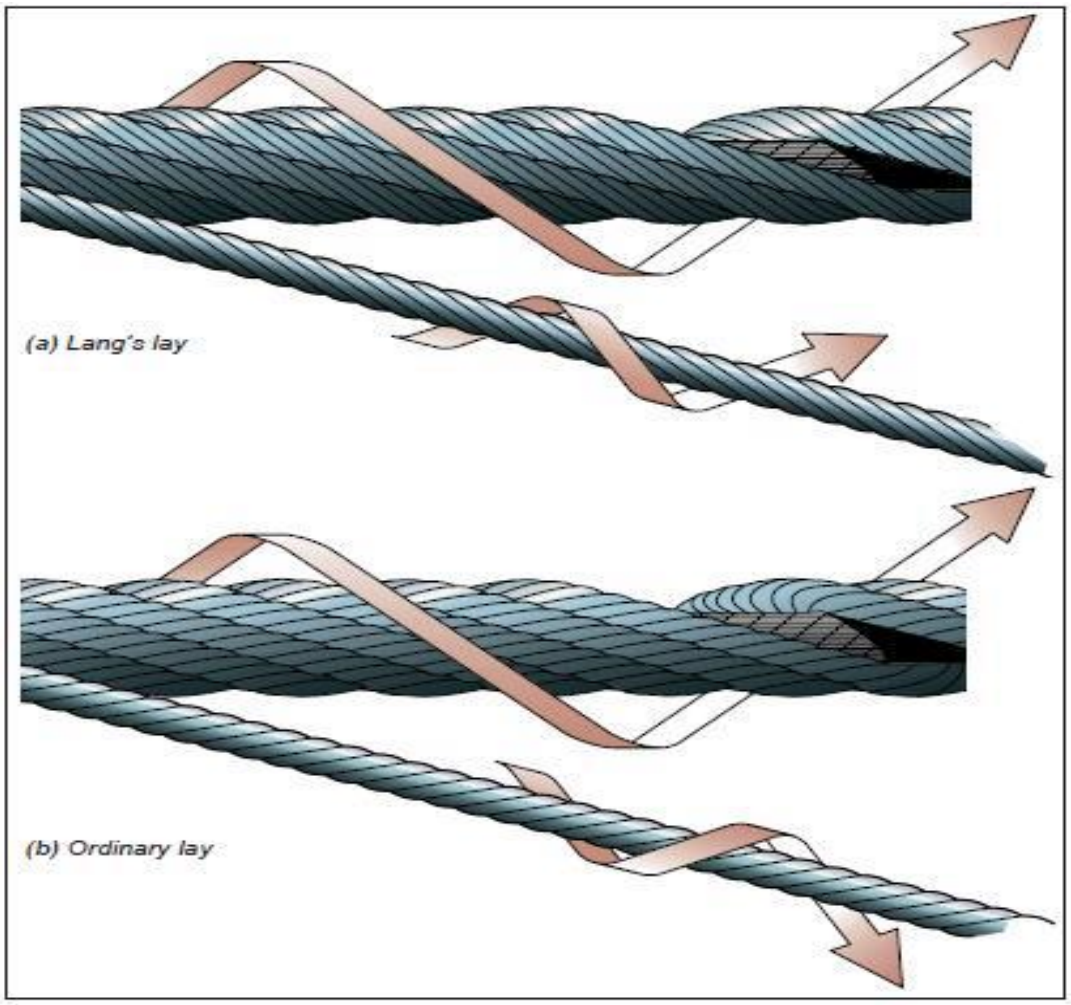
- **Disadvantages of Half Locked Coil Rope**

1) Inner wire cannot be examined.
2) Less flexibility.
3) Inner position of the rope cannot be lubricated.
4) These ropes cannot be spliced.
5) Less costly than full locked coil rope.

❖ Guide ropes: -

1) These ropes are usually made up of mild steel wires or ropes of large diameter, so sometime 12mm in circumference.
2) The ultimate tensile strength ranges between 5.5to13.5 tons /sq.cm.
3) A single strand guide rope is simply 6 around 1.
4) A locked coil rope as a guide rope consists of 6 around 1in the Centre and the outer layer has shaped wires so that they interlock.

❖ Lay of ropes:-



1) The twist or lay of the strands in rope may be either right hand or left hand.
2) In a right hand lay rope, its helix when viewed vertically upwards is directed rightward and in a left hand lays rope, leftward.
3) The right hand lay ropes must be used when there are to be wound up the drum clockwise when viewed from the operator's site and vice-versa.
4) It is a good policy to use alternately right hand and left hand lay type ropes at its change of the ropes to allow uniform wear of the guides.
5) The wires in each strand are laid spirally around the central core and the strands are also laid around the core.
6) Strands and the wires is each strand may be laid either in opposite direction or in the same direction amongst themselves.
7) Types-

a)Ordinary lay
b) Lang's Lay

❖ Ordinary lay:-

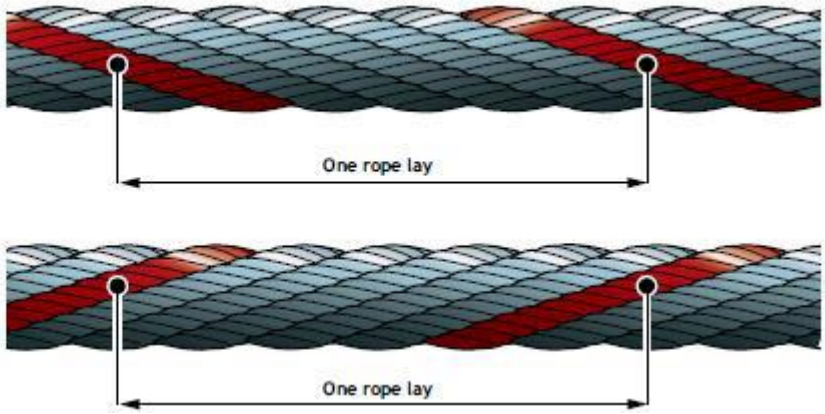
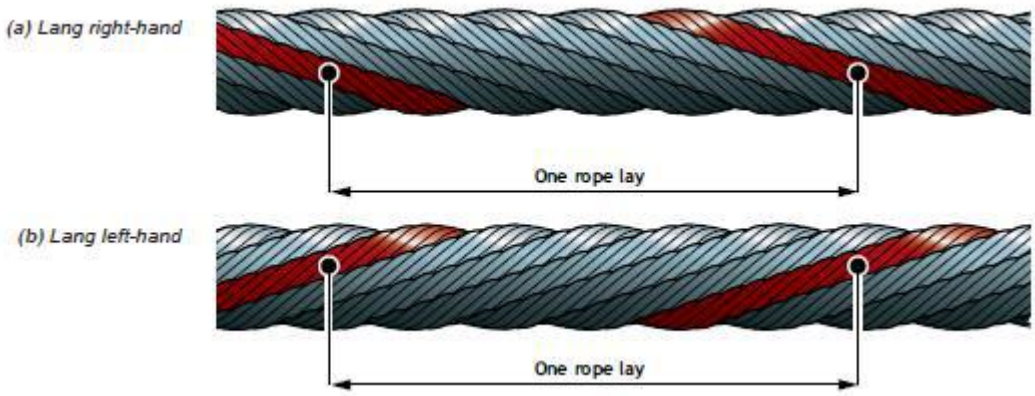


Figure 5: Type, direction and length of lay

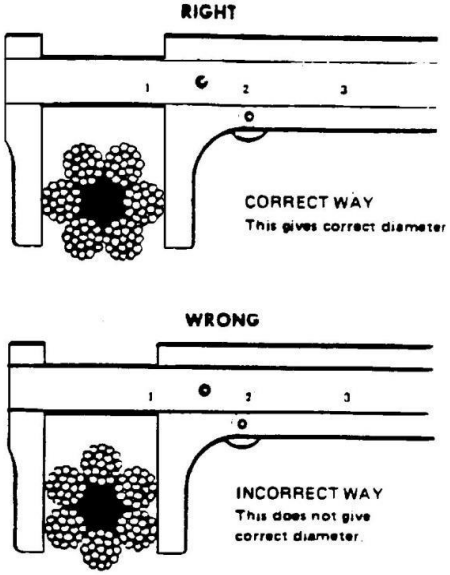
1) A rope is of ordinary lay construction if the wires in the strand and the strands in the rope are laid in opposite direction.
2) Ordinary lay is also known as regular lay.
3) This construction is not satisfactory for winding and haulage because there is uneven wearing on the wires.
4) It have the advantage that they are non-rotating since the strands and wires, being laid in opposite directions, tend to balance each other's rotating tendency.

❖ Lang's Lay:-



1) A rope is of Lang's lay construction if the wires in the strand are laid in same direction as the strands are laid in the ropes.
2) Such construction causes the rope to spin, for this reason Lang's lay rope must never be used if there is free end to rotate.
3) The advantage of these lay is that the rope offer a better working surface than one of ordinary lay but also more resistance to bending fatigue.
4) Lang's lay ropes are favored for winding and haulage purposes.
5) Lang's lay ropes have to be used carefully and are preferably operated with both ends of rope anchored.

❖ **Size (Measurement) :-**



1) The diameter of a wire rope is the diameter of the circle which will just enclose all of the strands.
2)In the case of strands, the diameter is that of the circle which will just enclose all of the wires.
3) The correct diameter is the greatest diameter of the rope or strand shows the correct and incorrect ways of measuring wire rope in the fig.

❖ **<u>Space Factor (Fill Factor)</u>:-**

It is the percentage of steel present in the given cross section of the wire rope.

S. F. = Sum of individual wires cross section/Cross section of wire rope X 100.

Assume,

d= Diameter of wire

n= number of wires used in the rope

D= Diameter of the rope

S.F. = $\{n.\pi d^2/4\}/ \{\pi D^2/4\}$ X100

S.F. = $n.d^2/D^2$ X100

❖ **<u>Static Load</u>:-**

The static load bearing is the weight applied without any builds up of energy, and therefore is to remain motionless.

It includes,

1) The weight of the tub
2) The weight of the cage
3) The weight of coal or mineral

4) The weight of suspension gear
5) The weight of the rope itself

❖ **Dynamic load:-**

1) Force due to acceleration.
2) Force due to retardation.
3) Kinetic shock.
4) Bending of rope.

❖ **Factor of Safety:-**

1) It is the ratio of the maximum static or dead load to nominal breaking strength of the rope.
2) The FOS for a winding rope is usually based on the static load under the worst condition i.e. the loaded cage at the lowest winding level in the shaft.

F.O.S= Maximum static load/Nominal breaking strength of the rope.

➢ ***Factors Affecting the Factor of Safety:-***

1) **Depth:** As the depth increases, the weight of rope itself becomes very excessive hence to control it factor of safety is reduced slightly so that the weight of the rope can be controlled.

2) **Rate of Acceleration:** As the rate of acceleration increased, the factor of safety used for rope also increases.

3) **Rate of Retardation:** As the rate of retardation increases, the factor of safety used for the rope also increases.

4) **Working Conditions:** If a rope is used under adverse working conditions such as on the ground, wet conditions etc. its factor of safety should be more.

5) **Man or Material Transport:** If a rope is used for men transportation it should have higher factor of safety.

6) **Bending of Ropes:** If a rope is subjected to frequent bending it should have higher factor of safety.

7) **Shock Loads:** If a rope is subjected to shock loads, it should have higher factor of safety.

❖ **Selection of Wire Rope:-**

1) **Watery Places or Corrosive Atmosphere:** Under such conditions a galvanized rope should be used to prevent rusting & effect of corrosive water.

2) **Stationary or Running Coiling Rope:** If a rope is used as a working rope etc. it is known as running coiling rope. These types of rope should have more flexibility than it is required for a stationary rope i.e. guide rope.

3) **Rotating Quality:** In a crane one end of the rope is free to rotate hence a rope which is having a non-rotating property should be used. In case of haulages rotating property of the rope is not a problem.

4) **Shock Loads:** If a rope is subjected to frequent shock loads, in that case a rope with steel core should be used.

5) **Resistance to Wears:** Ropes used for haulage & winding should have high resistance to wear, in other words such ropes should have a smooth external surface, under such conditions it is preferred to use a Lang's lay construction.

6) **Factor of Safety (Men/Material Transport):** If a rope is used for men winding it should have higher factor of safety than it is required for material transport.

7) **Crushing Strength:** If a rope is subjected to crushing load, it should have high crushing strength. Under such conditions if flatten strand rope, steel core rope or locked coil rope can be used.

8) **Bending of the Rope:** If a rope is subjected to frequent bending, then a rope used should have more flexibility.

9) **Groove Size:** The rope should not be loose or too tight in the groove of the pulley or drum.

Machine/Place	Rope Used
1. Winding.	A rope of suitable size, round strand fiber core, Lang's lay construction
2. Haulage rope.	A suitable size, round strand fiber core, Lang's lay construction
3. Guide rope.	Suitable size, guide size, full/half locked coil.
4. Shaft sinking.	Suitable size, round strand, ordinary lays, steel core or locked coil rope.
5. Cranes.	Suitable size, regular lay or ordinary lay with steel core.
6. Drag line.	Suitable size, Lang's lay with IWRC (steel core).
7. Shovel.	Suitable size, Lang's lay with IWRC (steel core).

❖ **Care & Maintenance of Wire :-**

1) Buy right construction of rope suitable for the job.

2) Under corrosive atmosphere use the galvanized rope.

3) Do not load the rope beyond its safe working load.

4) Ensure that the rope is strongly tight before it is cut.

5) Fiber core should not be used if the rope is subjected external pressure (crushing load).

6) Flexibility of rope should be suitable to the size of drums & pulleys.

7) Grease the rope & cover properly before starting in a dry ventilated shade.

8) Handle the rope carefully while transporting & uncoiling to avoid kinks.

9) Inspect the rope frequently & lubricate with acid free lubricant.

10) Judge the safe life of the rope for the conditions under which it is used & replace it in proper time.

11) Kinetic shocks to the rope should be avoided.

12) The rope must be recapped after every six months.

❖ **Type of Deterioration in the Ropes :-**

1) **Wear:** Wear in the rope can be classified as external wear & internal wear. Internal wear is due to the movement of the wires which cannot be controlled, but if the external wears become excessive in nature, the cause should be found & it should be corrected.

2) **Corrosion:** The water spray, unsuitable lubricants, acids, salts etc. cause it. Any water will cause corrosion if it gets in contact with the steel surfaces. Corrosion can be denied by using proper lubrication & galvanized ropes.

3) **Water-Corrosion:** Corrosion produces a weak layer of oxides &thislayer of oxides is removed very fast by the wearing action & again a fresh steel surface is present for further corrosion. Hence the joint effect of wears & corrosion is much higher than their individual effect.

4) **Fatigue:** If a rope is subjected to rapid reversal of stresses i.e. loading & unloading of the rope, bending of the rope etc. the rope fails as much lower stress level. This is due the fatigue.

5) **Corrosion-Fatigue:** It occurs when there is a combination of the conditions favouring both corrosion rate increases, which can be reduced by using the sufficient & suitable lubricant.

6) **Accidental Dangers:** It is not a form of deterioration but it is very important that the rope man should realize that any cause may lead to rapid deterioration of the rope.

❖ Testing of Wire Rope :-

1) **Tensile Test:** In this test the tensile strength of one wire which is used in the rope, it obtained by using this tensile strength are approximate tensile strength of the complete rope can be calculated.

2) **Tension Test:** In this test one end of the wire is fixed & the other end is rotated at 1 to 2 revolutions/second until failure occurs. The number of rotations to the failure is noted & by using the torsion strength of the complete rope can be calculated.

3) **Reverse Bend Test:** In this test one end of the wire is fixed & then it is bent backwards & a forward continuously through till the wire fails. The number of bends before failure gives an idea about the flexibility of the rope.

4) **Wrapping Test:** In this test the wire is bent & one end of wire is wrapped tightly around the other, usually for 8 turns. It is then unwrapped & if there is no sign of cracking, it means that the rope is still suitable for the job.

5) **Hand Test:** In this test the operator takes the two ends of the wire, one in each hand & forms a loop in it. Then pulls it out & again repeating the procedure until the wire fails. Based on this experienced operator can decides the approximate strength of the rope.

❖ *Capping* :-

The end of the rope where load is to be attached should be such that it may be attached to load in a simplest way. An attachment is known as cappel& is attached to one end of the rope so that rope can be attached to the load. The attaching to the cappel to the rope is known as capping.

➢ Types of Capping

1) White metal capping (Coned socket type capel)

2) Capping with split capel& rivets (Split capel)

3) Wedge type capping (Reliance rope capping)

1) <u>White Metal Capping (Cone socket type Capel)</u>:-

1) The coned socket type capel is probably the most compact type of rope capel.

2) This can be fitted on the rope used for practically every purpose including winding.

3) Near the rope and where the coned socket is to be used on the rope, wrap a few turns of binding wire tightly at a point equal to 1&1/4 times the length of conical portion of the capel.

4) Open out the end wires beyond the binding wire lashing, clean them with a suitable solvent like kerosene or diesel oil and cut the exposed fiber core.

5) Reassemble the wires so that the rope end resemble a brush with the ends of wires even.

6) Pulled the rope through the capel so that the branch remains inside its conical portion.

7) Clamp the capel and seal the junction of rope and capel with asbestos yarn and moist clay to prevent escape of molten metal (white metal).

8) Heat the capel gradually and evenly all around the outside circumference by a blow lamp (not in U/G mines) avoiding heating the wire rope and undue heating of the capel.

9) Pour molten white metal(temp not exceeding 365^{o} C) to fill up the conical hole of the capel.

10) Allow the metal to cool gradually till the capel cools to atmospheric temp.

(White metal= Lead 80% + Tin 5% + Antimony 15%, melting point: 260^{o} C to 300^{o} C, maximum temperature: 360^{o} C.)

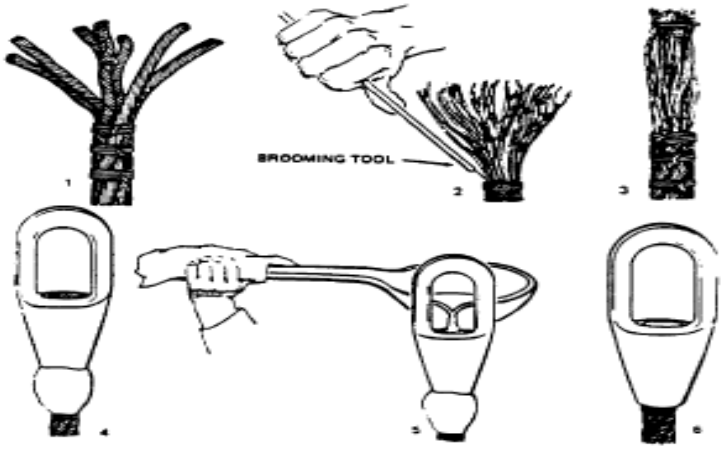


Fig.Coned Socket type Capel

2)Capping with Split & Rivets:-

1) This is normally used in the haulage ropes but not in the winding ropes. It is simple construction i.e. conical portion of capel fits the rope.

2)Near the end of the rope mark two points, one point ‘a’ one cone length away and another point ‘b’, two cone length away from the end.

3) Near ‘a’ gives several wrapping of the wire to make it thick and slightly conical and open out wires between rope end and point ’a’ and clean them.

4) After fanning out the wires cut 1/3rd of them to 1/3rd length & another 1/3rd to 2/3rdlength .

5) Turn back all the wires on the rope position a-b to give a cone & tie them on that rope position with a thin wire & cut the exposed core.

6) Lay a thin layer of white metal on the cone.

7) Hammer a thin wooden wedge into the cone at end B.

8) Push a split capel with its mouth slightly widened onto the cone & hammered the widened arms in position to grip the coned portion of rope.

9) Rivets are then hammered into the capel& through the rope at 3-4 points nearly 20 cm apart. With this capping operation is over.

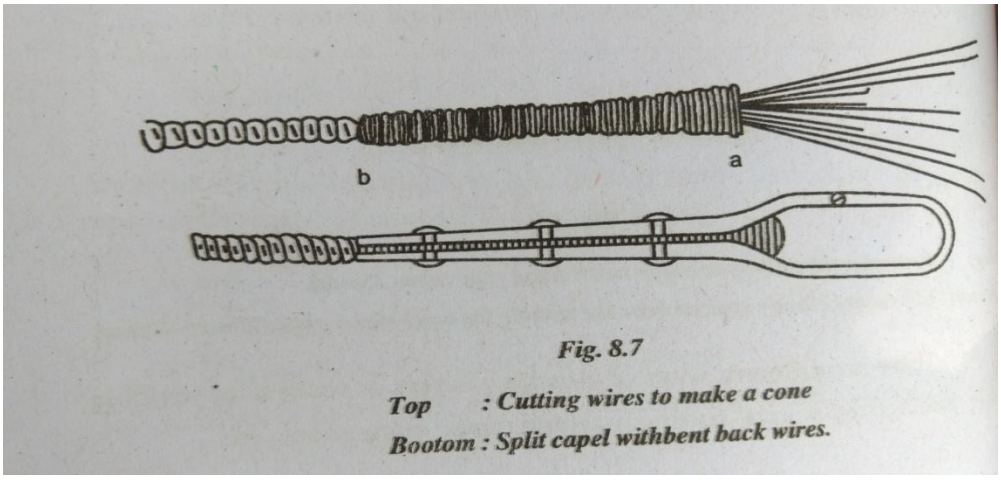


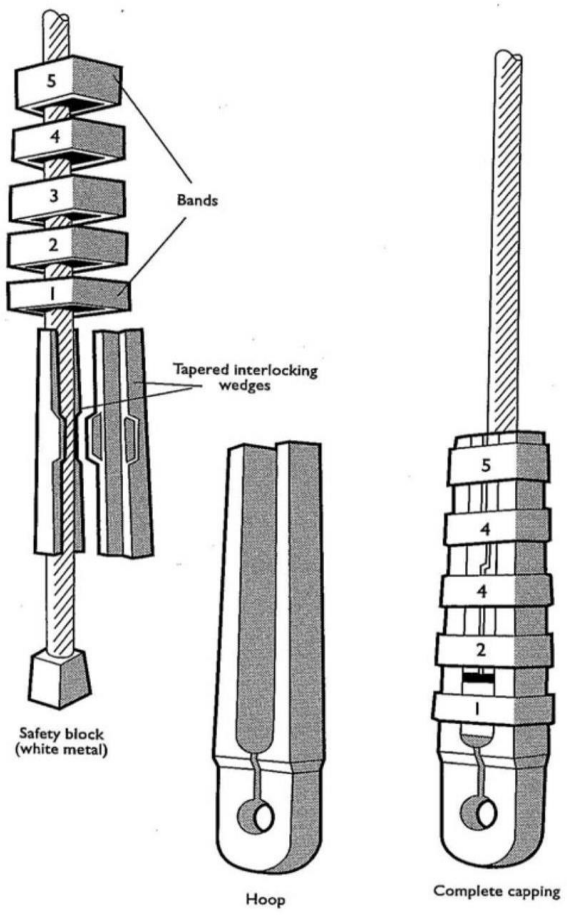
Fig. 8.7

Top : Cutting wires to make a cone

Bootom : Split capel withbent back wires.

Fig.Capping with Split & Rivets

3)Wedge Type Capping (Reliance Rope Capping):-



Wedge Type Rope Capel
Fig 2.8

- ✓ **<u>Introduction</u>:-**

In this capel there are two iron wedges which grip the rope near the required end where a white metal block is prepared. There is U-shaped steel strapped which is placed over the two wedges & on which 4 - 5 iron clamps are fitted by hammering.

- ✓ **<u>Procedure</u>:-**

1)Prepare a white metal block at the required end of the rope.

2)Insert the iron clamps on to the rope in order of numbers (largest number first). The jaws of capel are about 24 times rope diameters in length.

3)Properly clean any grease or lubricant from that portion of the rope, which will be griped by the wedges.

4) Place the two wedges around the rope approximately in the position they will occupy when in capel.

5) Fit the U-shaped strip over the wedges such that the U-shaped strip & wedge top are in one line. Draw the iron clamps over the U-shaped strip.

6) Hammer the iron clamps for proper grip. The ring number one should not be hammered because it is only for the safety of the white metal block. With this capping operation is over.

❖ Recapping:-

1)Every rope should be re-capped at least once in every six month or if necessary at shorten intervals & also after every over wind.
2) Before every such re-capping, at least two meter of rope is cut off & examined properly so that condition of the rope can be judged.
3) If it is found that rope can be used again, the normal capping operation should be done.

❖ Rope Splicing:-

1)Splicing is a method of joining two wire ropes permanently without using special fittings or attachment.
2) Splicing of winding drum is not permitted by DGMS ,after splicing the diameter of rope should not increase & also the joint should have almost original strength of the rope.
3) Splicing length depends on the diameter of the rope.
Let splicing length is 2X.

Procedure

1) Describe the length of splice let it be 2X.
2) Each rope is tied at the half of the splice length i.e. point A & B.
3) Open out strands of the rope up to A & B.
4) Cut the fiber core & remove from both ropes.
5) Bring the two ropes close to each other.

6) Strand 1’ unwound from rope B up to a length approximately equal to x & the space left by strand 1’ is filled by strand 1 from rope A. in a similar manner space left by 2 is replaced by 2’.

7) Next set of strands number (3 - 3’ & 4 - 4’) are spliced for 2/3rdlength & strands 5 - 5’ & 6 - 6’ are spliced for 1/3rdlength only.

8) Cut the strand up to the length required for tucking.

9) Bend the splice back & forth until all strands rest from in their places.

10) Insert a tucker & needle into the rope at the point where the two strands cross, pull out the main core & cut it.

11) Tuck in the other strand tail of the same crossing in a similar manner.

12) Repeat the operation at all other five points & with this splicing operation is over.

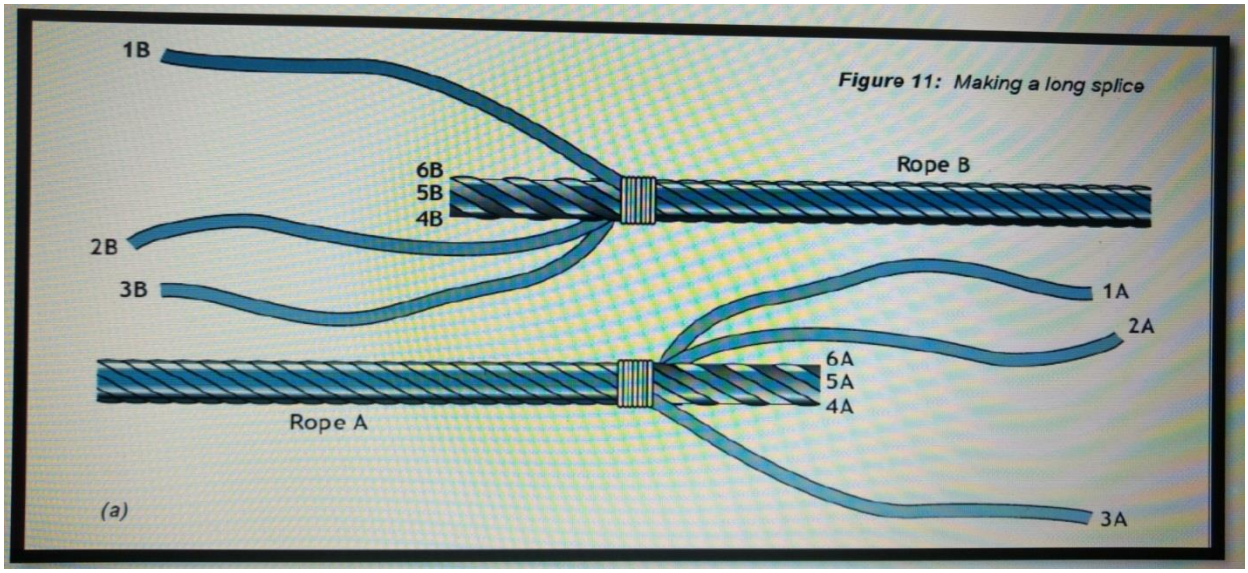
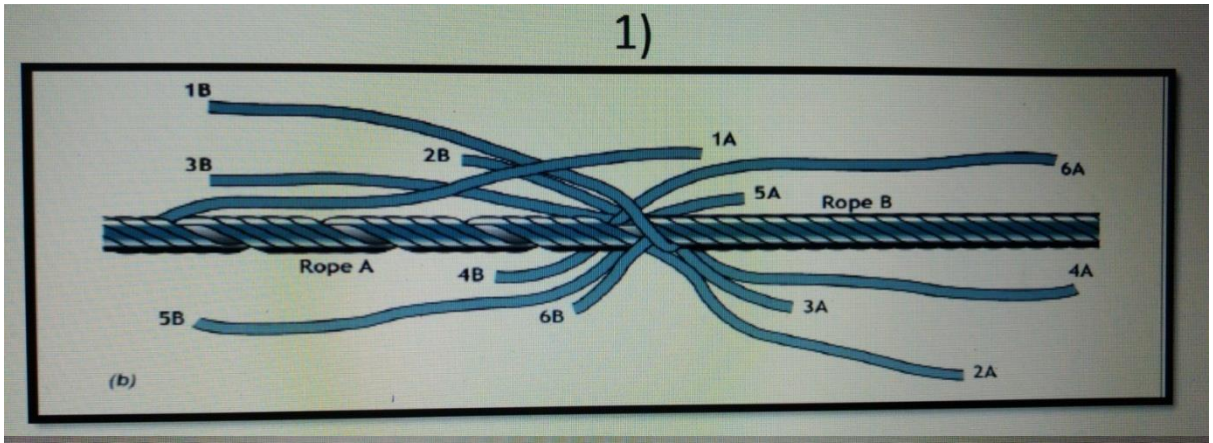
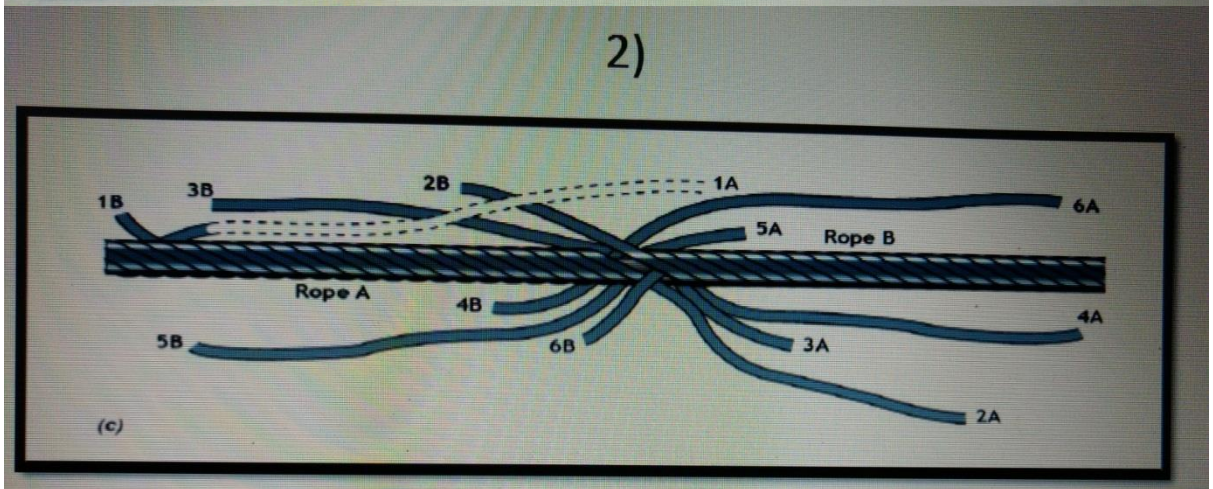


Figure 11: Making a long splice

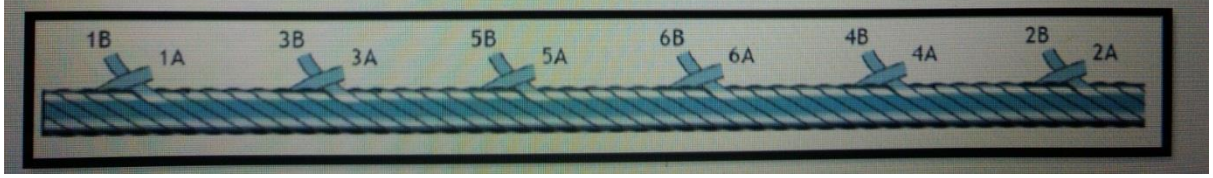
1)


1B
3B
2B
1A
6A
5A
Rope B
Rope A
4B
4A
3A
5B
6B
2A
(b)

2)


1B
3B
2B
1A
6A
5A
Rope B
Rope A
4B
4A
5B
6B
3A
2A
(c)

3)


1B
1A
3B
3A
5B
5A
6B
6A
4B
4A
2B
2A