

## What is wire rope?

Wire Rope is an important engineering material which is being used in Mining & other engineering industries. It is used for holding, lifting, moving and pulling various things.

Wire ropes are made from steel wires of plain carbon steel having high tensile strength.

Composition of wire rope:

Carbon — 0.5

Silicon — 0.11

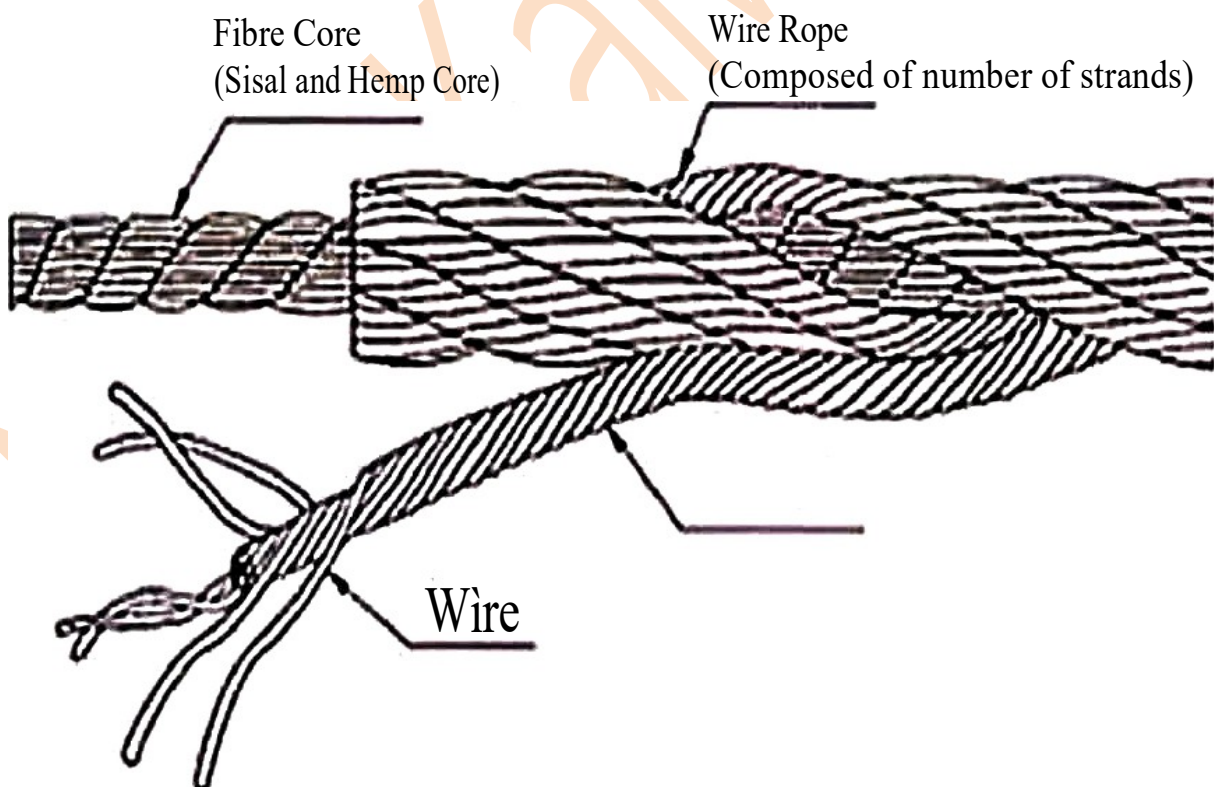
Manganese — 0.48

Sulphur — 0.033

Phosphorous — 0.014 and

Iron — rest

### WIRE ROPE



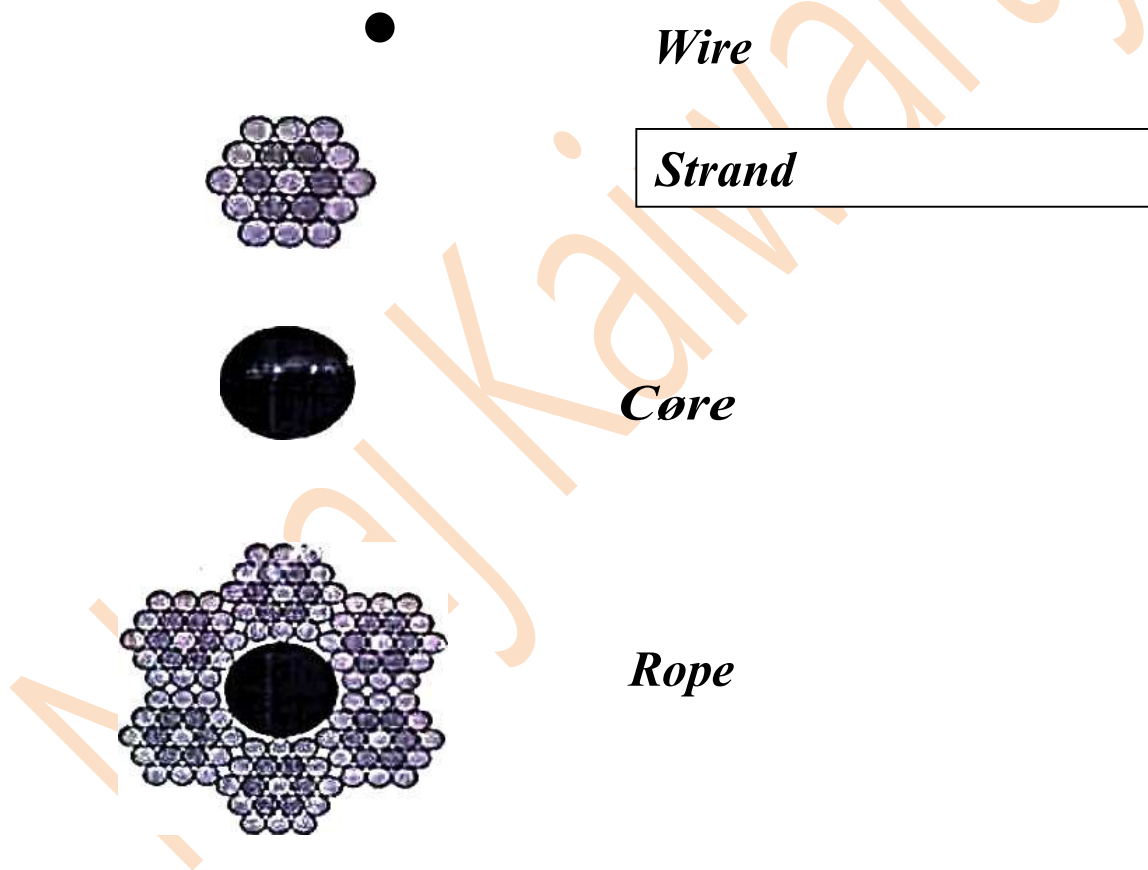
## Components of wire Ropes:

**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.

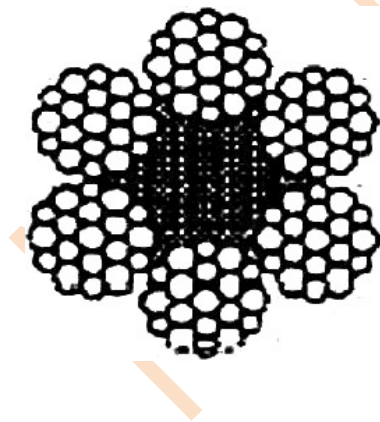
## Components of wire Ropes:



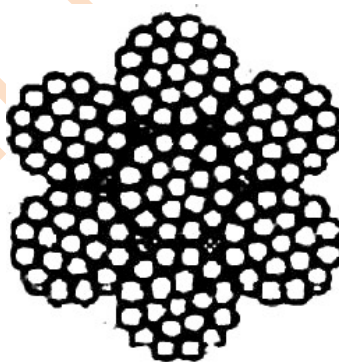
## **TYPES OF CORE**

- 1) Fiber Core:** It is made of fibers & generally used as a **main** core in stranded ropes. It provides more flexibility to the rope. It also serves as a cushion to reduce the effects of sudden strain and acts as an oil reservoir to lubricate the wire and strands (to reduce friction). Wire rope with a fiber core is used when flexibility of the rope is important.
- 2) Steel Wire Core:** It is a steel **wire**, which is used as a core. Generally it is used in strands & locked coil ropes. A wire strand core resists more heat than a fiber core and also adds about 15 percent to the strength of the rope; however, the wire strand core makes the wire less flexible than a fiber core.
- 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. This core strengthens the rope, provides support against crushing, and supplies maximum resistance to heat.

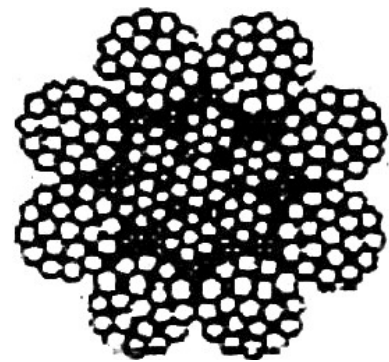
## **TYPES OF CORE**



**Fiber Core**



**Steel Wire Core**

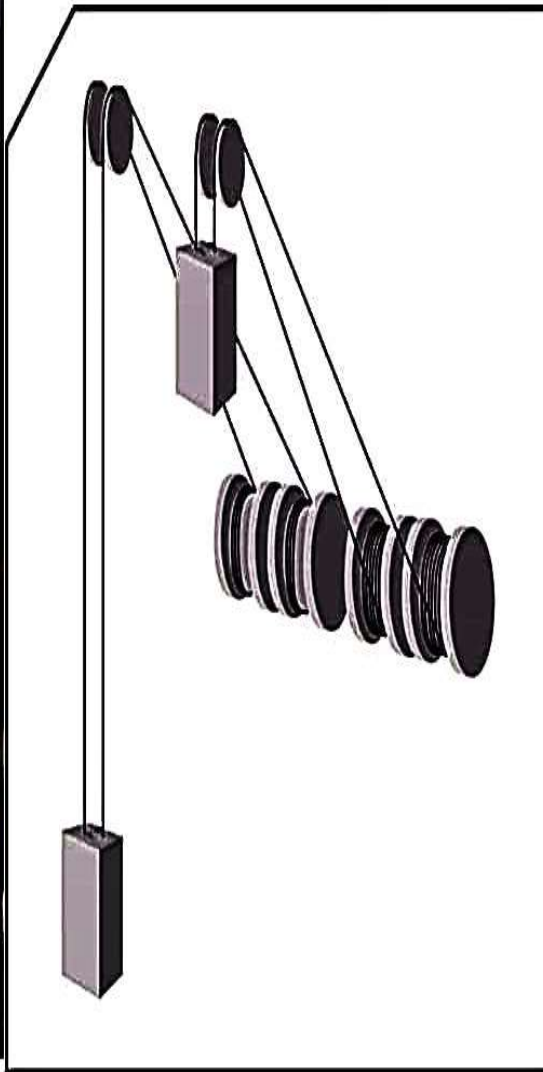
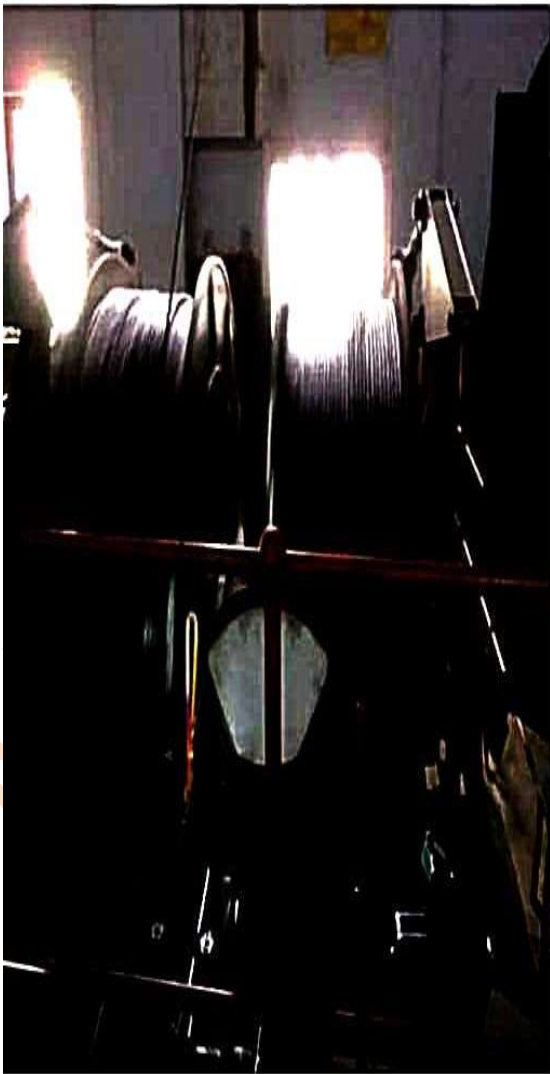


**Independent Wire Rope Core (IWRC)**

## ROPE USED FOR DIFFERENT PURPOSE

1. Winding ropes
2. Guide ropes
3. Haulage ropes
4. Coal cutting machines
5. Diamond drill ropes

## WINDING SYSTEM



## GUIDE ROPE



## HAULAGE ROPE



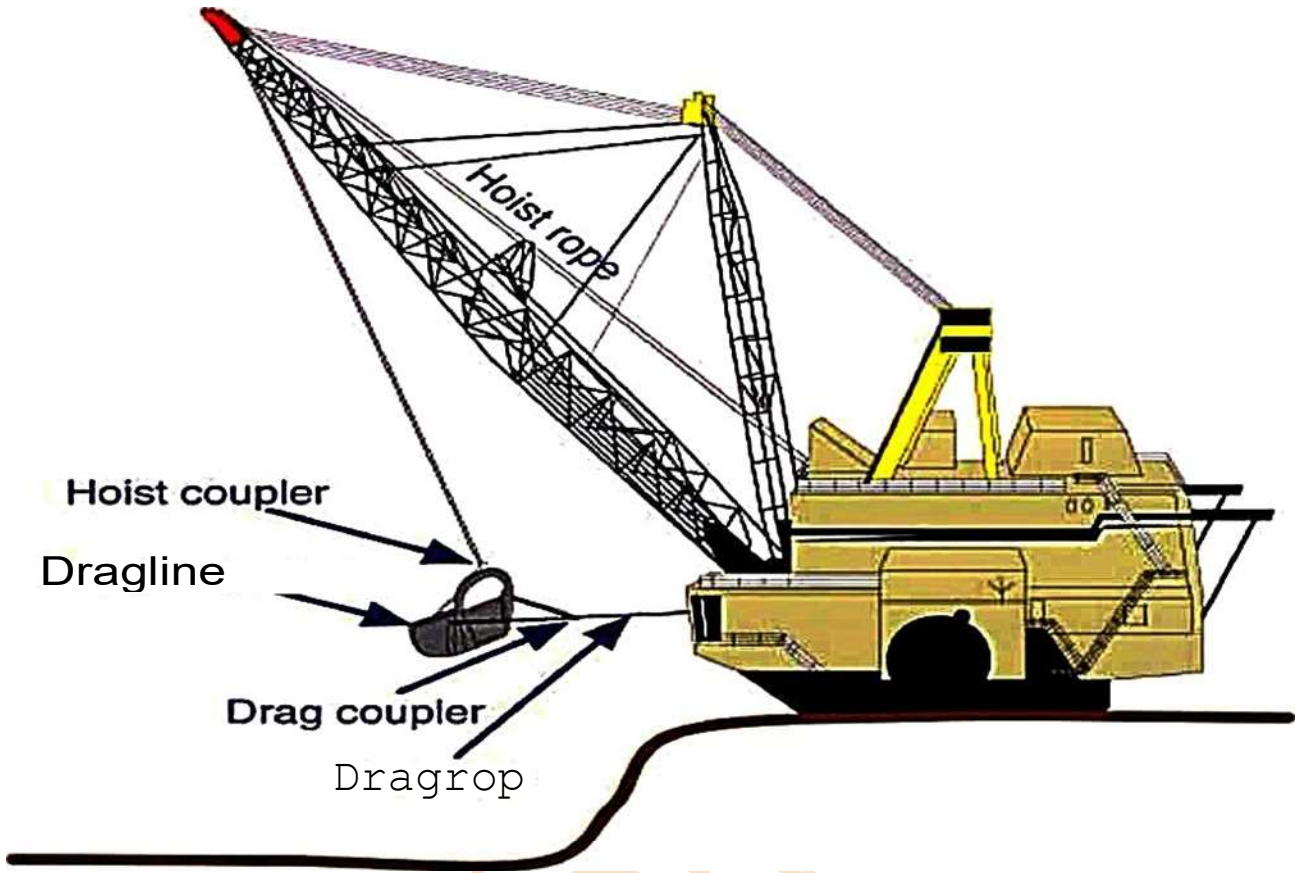
# ROPE SHOVEL

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Niraj Kaiwartya



## CRANE

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# ARIAL ROPEWAY



Niraj K.

## FIELD TEST FOR WIRE ROPE

Wire rope is subjected to the following tests carried out according to the standards provided by I.S. specifications:

1. **Tensile Test**-The specified length of wire is subjected to a stretching force in a testing machine until the rope may break.
2. **Torsion Test**- A specified length of wire rope is stretched and its both ends are gripped into vice. One of each is twisted until it is break.
3. **Bending Test**- One of the wire is fixed in vice with specially rounded jaws and the wire bend towards and backward through 180° over the jaws until break.
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. **Looping Test**- The end of short piece are taken one on each hand & stress generate on the rope by rounding in forward & backward direction. Repeat this process until the wire break.

## TYPES OF WIRE ROPE

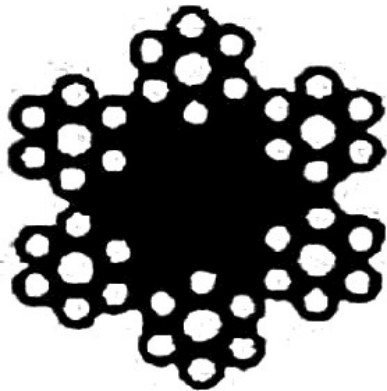
On the basis of use, wire ropes are classified as:

1. **Standing Ropes**: Required to carry the burden or load but are more or less stationary. i. e. guide ropes, track ropes etc.
2. **Running Ropes**: Undergo frequent movement, running or coiling often with varying loads and are flexible e. g. ropes used for winding, haulage coal cutting machine etc.

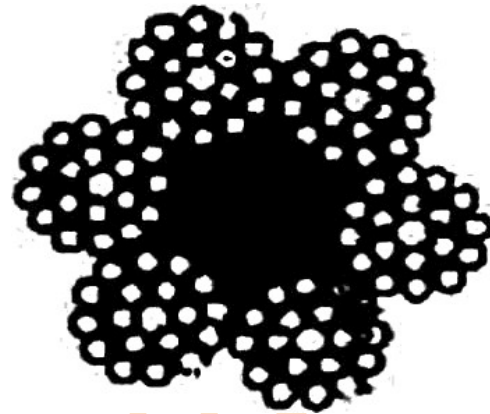
## TYPES OF WIRE ROPE

On the basis of construction, wire ropes are classified as:

- 1. Stranded ropes:** These ropes are made of strands and each strand consists of number of concentrically twisted wires laid in the form of helix round a central steel wire.



6 x 7



6 x 19

**FIG.:- STRANDED ROPE**

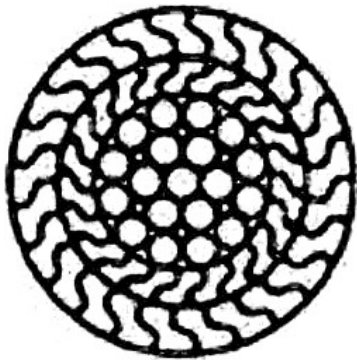
### Advantages of Stranded Rope

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

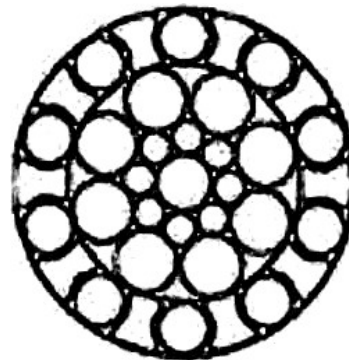
### Disadvantages of Stranded Rope

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

**2. Non-stranded ropes:** A rope in which the wires are not laid up in strands but in concentric sheaths, and in opposite directions in the different sheaths, which gives the rope non-spinning properties. The outer sheaths are composed of specially shaped interlocking wires, and there is no hemp core in the rope. They include locked coil ropes.



Full locked Rope



Half locked Rope

#### ADVANTAGES OF LOCKED COIL ROPE

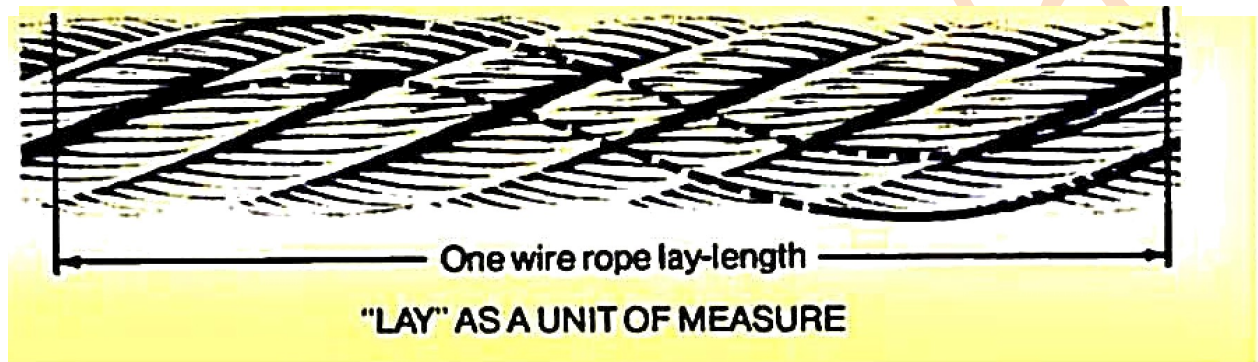
- 1) Greater strength.
- 2) Smooth external surface hence can be used as guide rope.
- 3) Non-rotating.
- 4) Permanent stretch is less.
- 5) External wear is less.
- 6) Crushing strength is more.

#### DISADVANTAGES OF LOCKED COIL ROPE

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

## WIRE ROPE LAY

- «•The lay of a wire rope describes the manner in which either the wires in a strand, or the strands in the rope, are laid in a helix.



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## TYPES OF WIRE ROPE LAY

- Right hand Lay: wires spiral round the core in the same direction as the threads of a right hand screw.
- : Left hand Lay: wires spiral round the core in the opposite direction as the threads of a right hand screw.

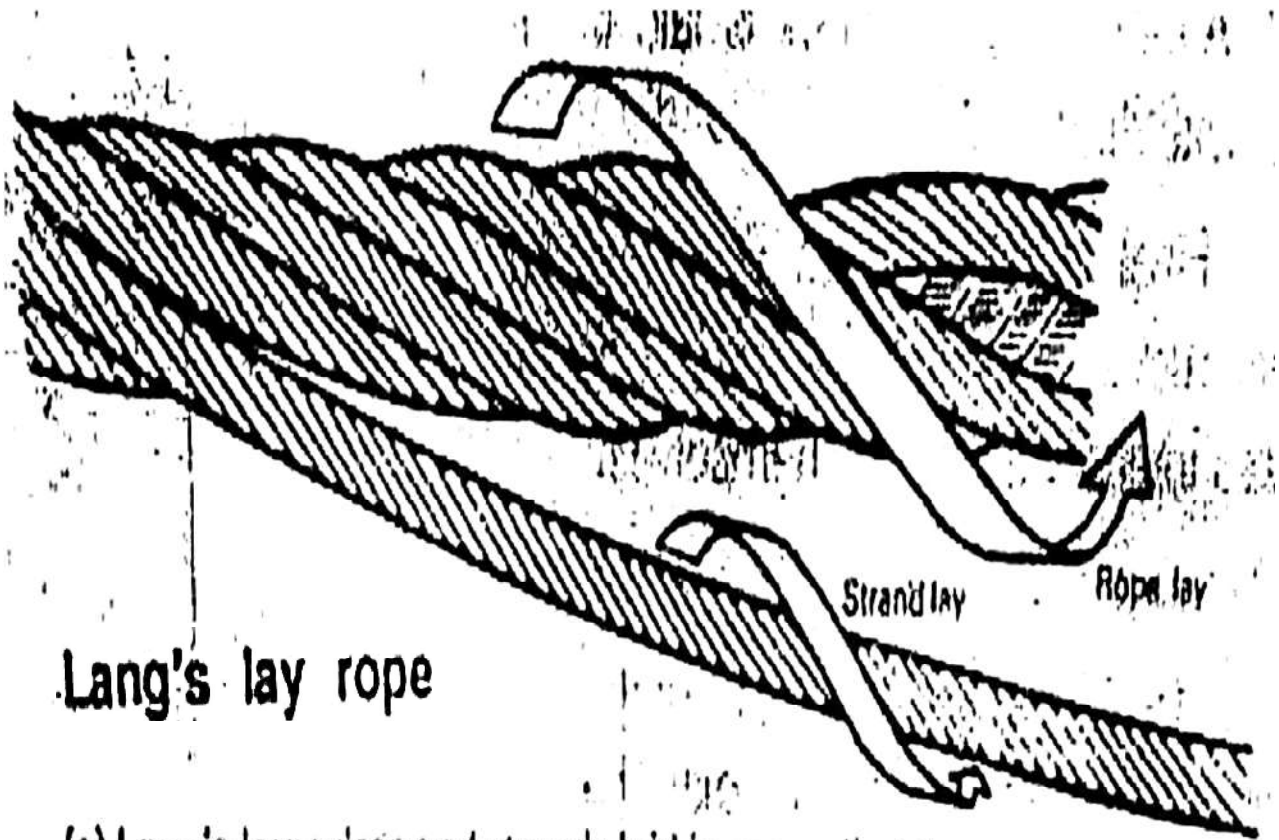
## TYPES OF WIRE ROPE LAY

- : **Regular Lay / Ordinary Lay:** In this type of rope individual wire in the strand and strand itself laid in opposite direction. Because of this opposite constructional characteristics, the rope does not spin. This type of rope is used in shaft sinking operations.
- : **Langs Lay:** In this type of rope, individual wire in the strand and strand itself laid in same direction. Because of this same constructional

characteristics, the rope is more compact This rope can be used in rope haulages. The wear due to friction is even and therefore the rope is durable. This rope has a spinning tendency so it is not used in shaft sinking, hoist drums.

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## LAND'S LAY



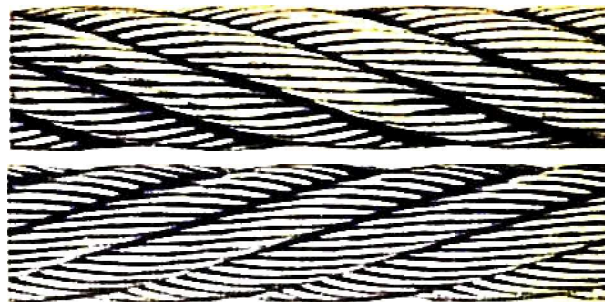
### Lang's lay rope

(a) Lang's lay: wires and strands laid in same direction

## TYPES OF WIRE ROPE LAY

RIGHT  
REGULAR  
LAY

LEFT  
REGULAR  
LAY



RIGHT  
LANG'S LAY



LEFT  
LANG  
LAY



LEFT LANG'S LAY

### FLEXIBILITY OF WIRE ROPE

Flexibility of wire rope depends on the following factors.

- -: Types of core:- a strand with a flexible core is more flexible than one with steel core at the centre.
- -: Thickness of individual wire:- Thinner the wires, more is the flexibility. And
- -: No. of wire:- Larger the number of wires, more is the flexibility.

# ROPE USED FOR DIFFERENT PURPOSE

MACHINE/PLACE	ROPE USED
1.Winding	A rope of suitable size,round strand fibre core; Lang's lay
2.Haulage rope	A rope of suitable size,round strand fibre core; Lang's lay
3.Guide rope	Suitable size, guide size, full/half locked coil.
4. Shaft sinking	Suitable size, round strand, ordinary lay, steel core or locked coil rope
5.Crane	Suitable size, Regular lay/ ordinary lay with steel core
6.Dragline	Suitable size, Lang's lay with IWRC/Steel core
7.Shovel	Suitable size, Lang's lay with IWRC/Steel core

## SELECTION OF WIRE ROPE

The following factors should be consider during selection of wire rope.

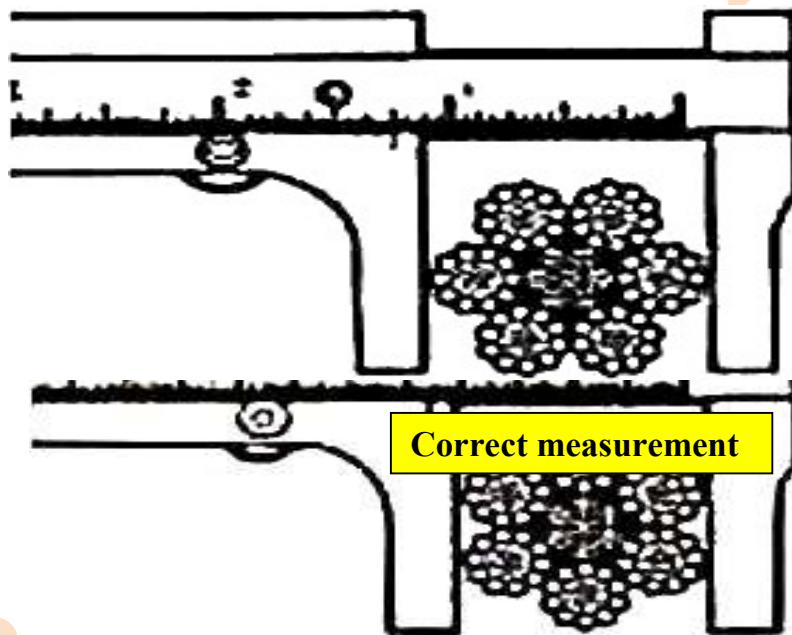
- 1) **Watery Places or Corrosive Atmosphere:** Under such conditions a galvanized rope should be used to prevent rusting & effect of corrosive water.
- 2) **Stationary or Running Coiling Rope:** If a rope is used as a working rope etc. it is known as running coiling rope. These types of rope should 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.

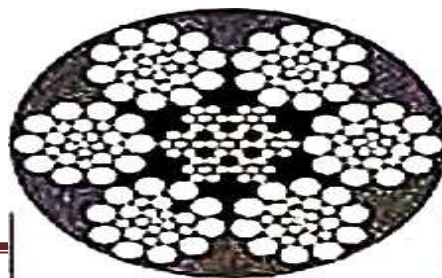
- 6) Factor of Safety (Men/Material Transport): If a rope is used for men winding it should have higher factor of safety than it is required for material transport.
- 7) Crushing Strength: If a rope is subjected to crushing load, it should have high crushing strength. Under such conditions if flatten 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.
- 10) Crushing and Distortion: a flattened strand rope and locked coil rope is better able to withstand crushing than a round strand rope. The core should be of steel wire.

## Size (Measurement)

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



Incorrect measurement



## SPACE FACTOR OF WIRE ROPE

### *Space Factor (Fill Factor)*

The space factor of a rope is the ratio of aggregate cross sectional area of the wires or wire strands to the area of circle drawn around the rope.

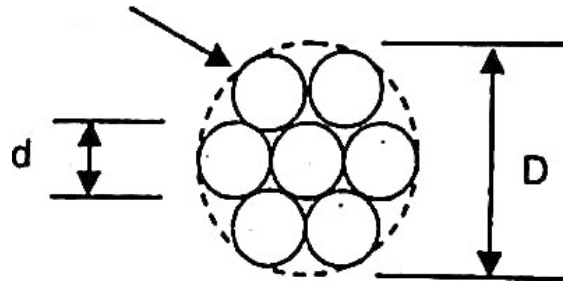


Figure : Space Factor in Rope

$$S.F. = \frac{\text{Sum of individual wires strand cross section}}{\text{Cross section of wire rope}} \times 100$$

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### Space Factor

-: A stranded wire rope having 7 strands including core, the diameter of each strand is 5cm and diameter of circle drawn around the rope is 15 cm. Find out the space factor of that rope.

Solution:-

Here  $d = 5\text{cm}$ ,  $D = 15\text{cm}$

$$\text{Space factor} = \left\{ \frac{7 * 5^2}{15^2} \right\} * 100 = 77.7$$

## MASS AND STRENGTH OF WIRE ROPE

Mass and strength of wire ropes:

-: The mass of a rope depends upon the quantity of steel in it i.e. the space factor and the design of the rope.

$$\text{Mass of rope (kg/m length)} = kd^2$$

Where k is a constant depending on rope design and d is diameter of rope in cm.

Strength (Breaking strength) (KN) =  $sd^2$  Where k is a constant depending on rope design and steel and d is diameter of rope in cm.

## WIRE ROPE CAPPING

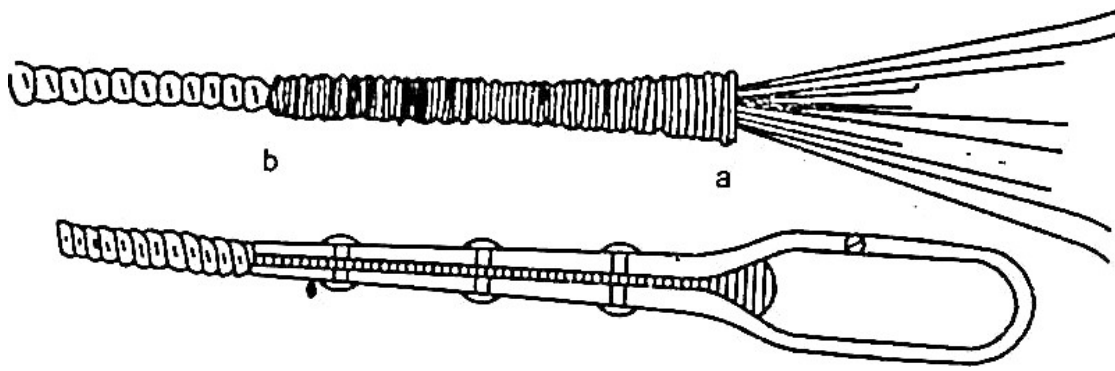
The process of making wire rope end suitable for attachment of load is known as wire rope capping. The end of a rope where the load is to be attached should be a good portion of the rope, free from worn, msted, bent or broken wires and free from the effects of bending and corrosion.

### TYPES OF ROPE CAPEL

1. Split capel with rivets
2. Coned socket type capel (White Metal capping)
3. Interlocking wedge type capel (Reliance capel)

#### 1. Split capel with rivets

- › This is normally used on haulage ropes in mines but not penritted on winding ropes.
- › Conical portion of capel fits the rope. Near the end of the rope mark two points, one point one cone length away and another point, two cone lengths away from the end.
- › On the rope between points, wrap a number of turns of binding wire tightly to form a layer. Near give several wrappings of the wire to make it thick and slightly conical.
- › Open out wires between rope end and point and clean their with petrol, kei•osene oil or diesel oil to remove grease, oil or rust. After fanning out thC wlrres cut  $1/3'^{\wedge}$  of them to  $1/3^{\text{rd}}$  length and another  $1/3'^{\text{d}}$  to  $2/3'^{\text{d}}$  length. Turn back all the wires on the rope portion to give a cone and tie them on that rope portion with binding wire.
- ▶ Cut the exposed fiber core. Hammer a thin wooden wedge into the cone at the end. Push a split capel with ils mouth slightly widened on to the cone and hammer the widened **arms** in position to grip the coned portion of the rope. Rivets are then hai+lmered into the capel and through the rope at 3-4 points nearly 200min apart.



**Fig.:- Top:** Cutting wire to make a cone.

**Bottom:** Split capel with bent back wires.

## 2. Coned socket type capel (White metal capping)

- ▶ The coned socket type capel is probably the most compact type of rope capping. This can be fitted on the rope used for practically every purpose, including winding.
- ▶ A place is marked on the rope.
- ▶ The rope is seized at a length of twice diameter of the rope at this determined place.
- ▶ The socket is now pushed over the rope and the rope beyond the seizing is opened.
- ▶ The central hemp rope is cut. The wires are opened individually and made to form a brush shape.
  - › These wires are cleaned with the help of kerosene or diesel oil or petrol. (Water soluble degreasing fluid or non inflammable organic solvent is preferred. Paraffin is not recommended).
  - › The wires are now cleaned with dry cotton.
  - › Pull the brush through the capel such that the brush remains inside its conical portion.
  - › Clamp the capel complete with the rope in place such that the rope is vertical for a length of at least 24 times of its diameter.

- › Seal the junction of the rope and capel with asbestos yarn or moist clay to prevent escape of molten metal.
- › Heat the socket evenly up to 100 degree centigrade with the help of blow lamp (not pennitted in underground coal mines). When the socket is hot, powdered resin is sprinkled over the rope brush in the capel.
- › White metal is heated up to 365°C and is poured in the molten form in the conical hole of the capel.
- › The metal is allowed to cool gradually till the capel cools down to the atmospheric temperature.

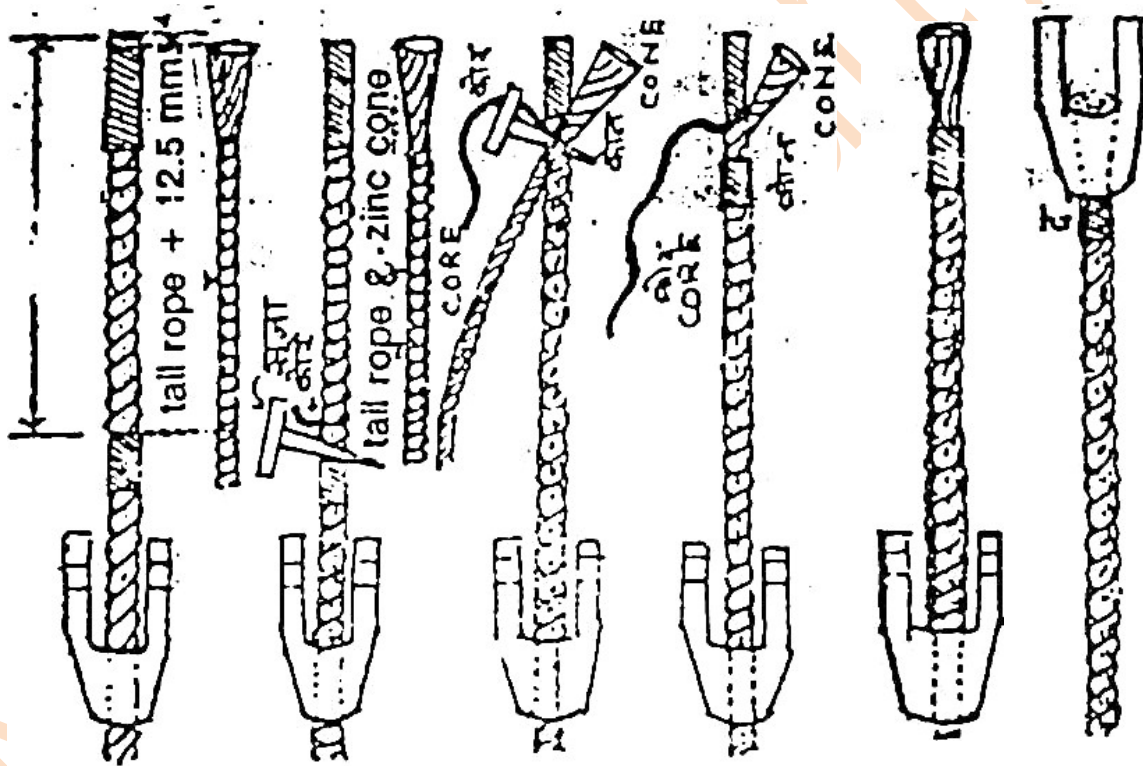
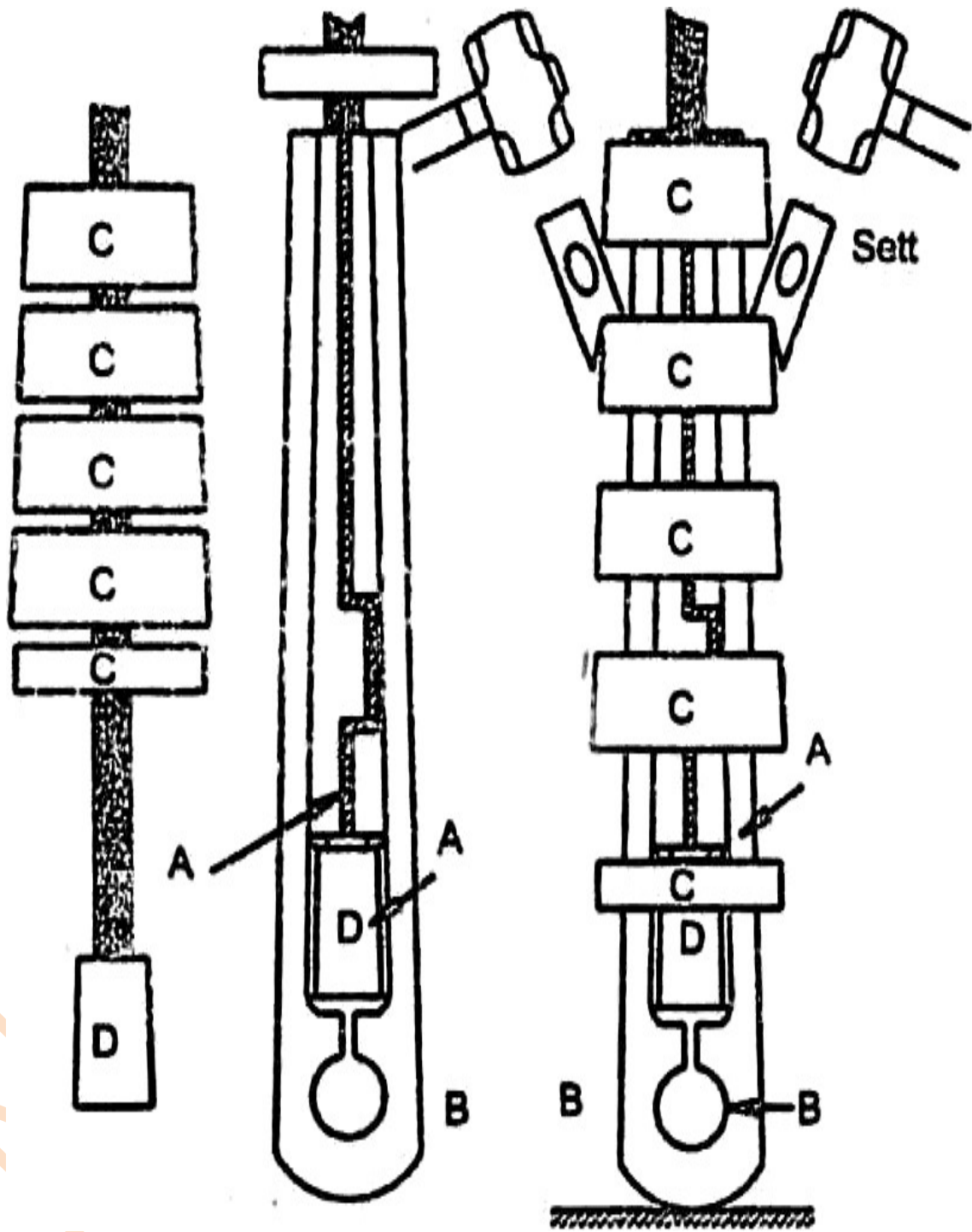


Fig.:- CAPPEL WITH ZINC CONE AND TAIL STRAND

### **3. Interlocking wedge type capel (Reliance capel)**

› 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.

- 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 more diameters.
- 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.



**Fig.:- Interlocking wedge type capel (Reliance capel)**

## ❖ ROPE SPLICING

- : Splicing is a method of joining two wire ropes permanently without using special fittings or attachment.
- : Splicing of winding dmm rope 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.
- : Splicing length depends on the diameter of the rope.

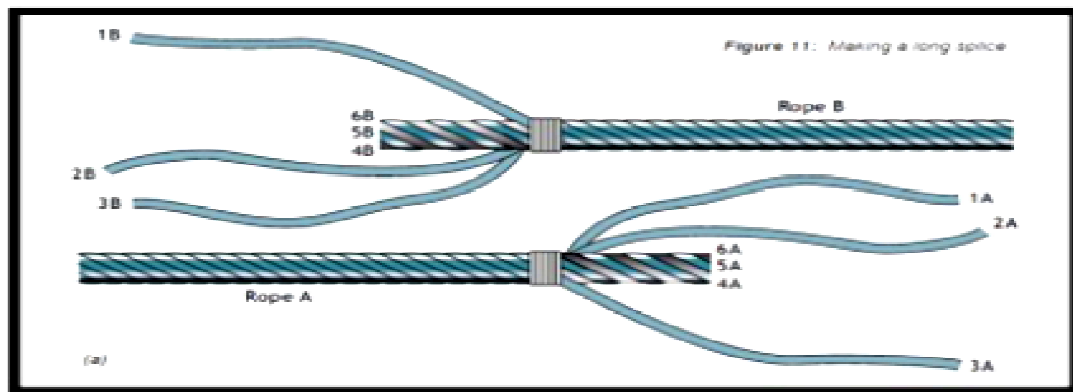
### METHOD OF SPLICING

- Decide the length for splicing of Rope.
- After deciding the length of the splice, the ends of the rope are brought nearer and overlapped for the length of the splice.
- Beyond the overlapping length, the thin binding wire is lightly coiled and the rope is seized.
- The strands are now opened out up to the place of binding and the core of rope is cut. The alternate strands near the binding are cut such that 0.3m length are cut out, from the binding.
- The places of both binding of ropes are brought face to face and the strands are arranged in such that the long strand of one rope are opposite the short/cut strand of the other rope.
- The opened out strands of left hand rope are tied temporarily to the strand of the right hand rope.
  - Strand of one rope is run over the place vacated by the out-coming strand of the other rope. The strands are laid in correct bed till all except 0.3 m of the strand is remaining.

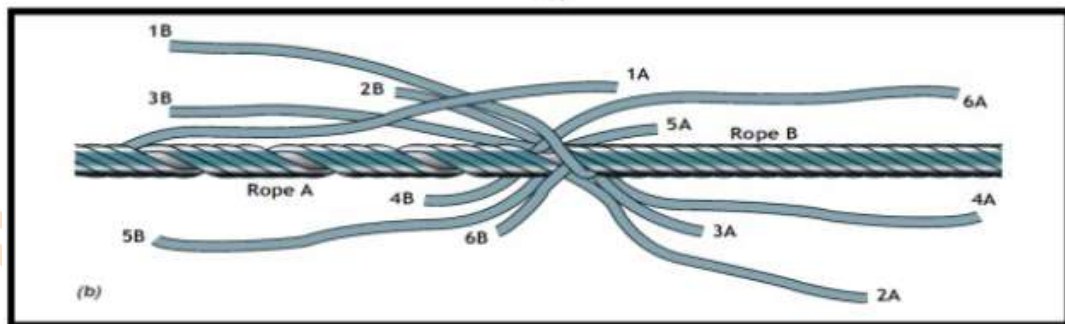
- Cut off the extra strand (came out) to keep an equal length & tie the strands temporarily in its place.

This process is repeated for the balance 2 pair of strands but stopping the pair at predetermined equidistance places.

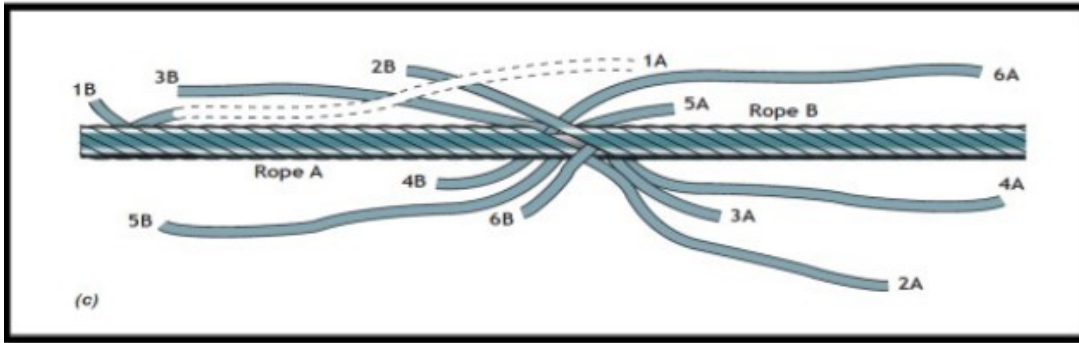
Repeat the process for the other rope strands till the spliced length, gives an appearance of 6 pairs of tails coming out at crossing.



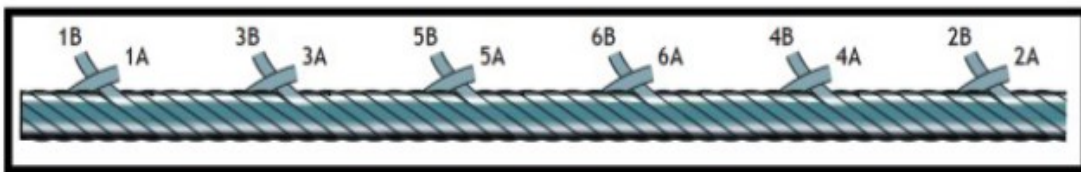
1)



2)



3)



## **CARE & MAINTENANCE OF WIRE ROPE**

- 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 sized 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 storing 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.