charged engines. The turbocharger contains bearings and seals that are subject to the high heat of combustion exhaust gases. While the engine is running, this heat is carried away by oil circulation, but if the engine is stopped suddenly, the turbo-charger temperature may rise as much as 56° C. The results of extreme heat may be seized bearings or loose oil seals.

For rotary internal combustion engines, see appendix.

LOCOMOTIVE TRANSPORT :

A locomotive haulage can be used in a mine :

1. Where the gradient of the road-way is mild. Nearly flat gradient is preferred. A gradient of 1 in 15 against the loads is considered to be limit though locos are generally employed on gradients milder than 1 in 25.
2. Where the loco track is in settled ground not subjected to movement by mining operations.
3. In the intake air-ways, where air velocity is adequate to keep fire-damp percentage apriciably low. If diesel locos are used the exhaust gases of the loco should be diluted by the air current sufficiently well so as to be unharmful to the workers.
4. Where roads are reasonably wide and high.
5. Where the transport of mine cars involves long haul distances. Small locos for shunting and marshalling in the pit bottom are not uncommon.

Locomotives used in mines range from light weight type (2 tef to $4\frac{1}{2}$ tef weight) to heavy duty types (8 to 13 tef weight). Units of 30 to 75-kW are considered as heavy duty locos and are used for main haul roads. A 75-kw diesel loco weighs nearly 15 tef. The designs of locos are such that the total weight supported by each axle is 5 te or less. Two 75-kW locomotives can be coupled in tandem to provide one 150-kW unit.

Every loco consists of :

1. a chassis which is a rigid frame work of rolled steel sections.
2. Driving wheels (traction wheels) on axles, springs, and brake blocks mounted underneath the chassis.
3. A power unit. This is a diesel engine, electric D. C.motor or compressed air motor, mounted on the chassis. Petrol engines are not permitted by alaw in underground mines as they produce a large amount of carbon monoxide.
4. Operator's cabin equipped with controls, brake operating system, sand boxes, horn.
5. On medium and large size locos, an air compressor for powered brakes.
6. Lights at both ends.
7. A hand screw brake for emergency, as required by law.

All locos are provided with brakes on each of the wheels and these are operated by the loco driver by a lever in his cabin. The wheels are of cast steel. The tyres of the wheels are of steel and are removeable to allow renewal. The brake blocks are of cast iron and act on the tread or the wheel. To improve braking effort, sanding (*i.e.*, spreading of sand) of rails of the leading wheels in either direction of travel is a standard provision on all locos. Sand boxes and feeding arrangements are provided for the purpose on a loco and the arrangement is controlled by the loco operator by a pedal from his cabin. Brakes are power hand operated brake is always required under the regulations as a parking brake.

Before describing different types of locos principle governing traction by locomotives need to be appreciated.

In the case of rope haulages and conveyor transport, the power to move the load is available from fixed motors external to the haulage or conveyor. The sizes of these motors can be varied to match the duty requirements. In the case of a locomotive haulage, however, the driving unit i.e. the locomotive provides the tractive effort and such loco moves along with the train of mine cars to which it is coupled.

Tractive force or tractive effort is the force required to cause movement, and the tractive effort depends on the weight of the loco and also on the frictional adhesion between the locomotive's driving wheels and the rail track. The hauling or tractive effort generated by the engine/moror of the loco is therefore limited and is used up partly in moving and accelerating the loco itself and only the remainder is available for pulling the train of mine cars through the medium of draw bar and accelerating them. The *co-efficient of adhesion* is the co-efficient of *static* friction, μ, between the wheels of a loco and the rails. If W is the total weight of the loco bearing on the driving wheels, μW is the total tractive effort exerted at the driving wheel treads. The value of μ depends on the condition of the two surfaces in contact, *i.e.* the rails and the wheels. When the surfaces are dry the value is higher than the when wet, or covered with oil or slime. Sand or grit increases the value. Some average values of co-efficient of static friction are as follows

Surface Condition	Free of sand	Sanded
Dry	0.25	0.28–0.35
Wet	0.20	0.25–0.30
Slimy	0.15	0.22–0.25

Usually the value of co-efficient of adhesion (co-efficient of static friction) is taken as 0.2 to 0.25 but a lower value, about 0.16, is used when braking is considered as co-efficient of friction is less when the loco is running.

It will be seen that the theoretical maximum tractive effort is only $\frac{1}{4}$ or1/5th of the total weight of loco. Moreover, this is possible only if the weight of the loco is distributed equally over all the wheels and if the drive is transmitted through all those wheels . The tractive effort varies with the speed of the train ; it is more with low speeds and less with high speeds.

Example :

A locomotives weighs 15 tonnef and the adhesion to the tracks is 2246 N per tonnef. (a) What is the co-efficient of adhesion, and (b) what is the draw-bar pull which the locomotive is capable of exerting on (i) a level track, (ii) an adverse gradient of 1 in 100, and (iii) an adverse gradient of 1 in 5. Assume that the running resistance of the locomotive is 67 N per tonnefe.

Ans. :

(a) Coefficient of adhesion $= \frac{2246 \text{ N}}{9810 \text{ N}} = 0.229$

$$f = \frac{84,000}{600,000} = 0.14 \text{ m}/\text{s}^2$$

For a body starting from rest , $v = f t$ or $t = \frac{v}{f}$

$$t = \frac{210}{9 \times 0.14} \frac{\text{m}}{\text{s}} \times \frac{\text{s}^2}{\text{m}} = \frac{500}{3} = 166.7 \text{ s}$$

Ans. Time to accelerate = 167s.

The resistance of the locomotive itself (and of the mine cars, if any, attached to it) for running arises out of the friction caused at the wheel bearings (and friction against wind which is considered negligible). At starting the co-efficient of friction on this count is taken as 0.01 for the loco and the attached train ; when the locomotive is running, the value is taken as 0.0025. This running co-efficient of friction at the wheel bearings assists the loco to slow down and therefore its value its to be considered during braking. The resistance to motion of the loco itself when *in motion* is called its rolling resistance.

Optimum gradient for a locomotive haulage :

A realistic gradient to use for the full effectiveness of locomotives is the gradient at which the same size of train can be started and safety stopped under emergency braking conditions. The braking duty required is usually specified as a stopping distance at a particular speed, the full stopping distance being the distance ahead of the locomotive driver which can be seen without obstructions. Some allowance for "thinking time" and delay in applying brakes must also be made. The gradient is about 1 in 200 to 1 in 400 against the load trains and only the loaded train need be considered as braking and starting duties are not as severe with empty wagons/cars as those for the loaded train.

Diesel locomotives :

These are commonly used in a number of mines. Their weight ranges from 3 te to 15 te and the power from 15 kW to 75 kW. The power unit is a diesel engine with 2, 3 or 4 cylinders of 4-stroke cycle, compression-ignition type. Heavy duty locos are of six cylinders. Locos used in underground coal mines have the power unit in a flame proof enclosure as a safeguard against ignition of fire damp. The intake air going to the engine passes first through a filter and then through a flame trap. Similar flame trap is fitted on the exhaust side of a diesel engine. A flame trap consists of a number of stainless steel plates contained within a stainless steel housing. The plates are 50 mm wide and welded into position with gaps of $\frac{1}{2}$ mm between adjacent plates. The exhaust flame trap can be easily removed from its housing and it has to be throughly cleaned everyday. On the exhaust side the hot exhaust gases of the engine pass through an exhaust conditioner before entering the flame trap..These exhaust gases should have very low percentage of CO and other noxious and poisonous fumes before they enter the mine atmosphere of restricted airways. The diesel combustion has therefore to be satisfactory, and diesel oil should have a flash point of not less than 65 °C. The maximum permitted percentage of CO in the exhaust gases before they enter the mine atmosphere is 0.2 % but usually it is between 0.02 and 0.04 %. In coal mines diesel locomotives are not allowed to be used where the percentage of inflammable gases is more than 1.25 in the general body of the air. Their use is, therefore, confined to intake airways where large volume of air flows .The other gases contained in the exhaust include oxygen, nitrogen, carbon dioxide and small quantities of the oxides of sulphur and nitrogen mixed with certain organic compounds known as aldehydes which smell abominably and cause irritation of the nose, throat, and eyes. To remove these last-mentioned oxides and aldehydes, mine locomotives are fitted with an exhaust conditioner.

Exhaust conditioner : The principle of this is shown in Fig. 16.7 but the details of design vary with different makes and are subject from the engine development as time goes on. The exhaust gases from the engine, amounting in all to about 0.085 m^3 per B. H. P. per minute, are conducted to the bottom of the conditioning chamber, A, and impinge on the surface of the water in the base. This traps hot particles and washes out the sulphur and nitrogen oxides and aldehydes.

The gases then rise through a flame-proof slag wool filtering medium kept moist by the evaportaion of the water, and thereafter pass into a second similar chamber, B, where they are further cooled and filtered before passing through the flame arrester. This consists, as at the inlet, of a grill of removable stainless steel plates, $\frac{1}{2}$ mm apart. Finally, the gases are mixed with about 30 to 40 times their volume of fresh air before being exhausted into the ventilating current.

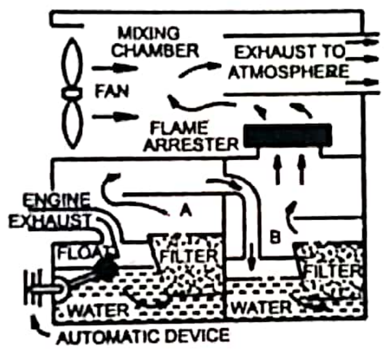

Fig. 16.7. Exhaust conditioner and flame trap used in u/g diesel locos

The filtering material and the flame grids are readily removable and must be replaced by a clean set every-24 hours. If the water is allowed to fall below a certain level, the fuel is automatically cut off from the engine and the brake applied.

The exhaust smell may mask the odour of spontaneous combustion and in mines where the coal is liable to spontaneous heating, the diesel locomotives should be avoided.

Electric battery locomotive :

The power unit of an electric battery locomotive is a D. C. electric motor receiving its current from a storage battery carried in a casing on the upper part of the chassis. Such locomotives are for light and medium duties as they are generally less powerful than diesel or trolley wire locomotives, though battery locos of even 13 tonnes weight are available in the country. Range of battery locomotives is from 4 to 70 kW continuous rating. The battery locomotive is relatively quiet in operation and produces no objectionable fumes. Compared with the diesel locomotive it generates much less heat. An important advantage of battery locomotive is that it can meet an appreciable overload of short duration. The battery constitutes a major portion (nearly 60 %) of the weight of the locomotive. Usually there are two batteries on a loco. The batteries are of lead acid type and each battery consists of a number of 2 - volt cells, their number varying from40-70. The battery cannot be made flamproof and its container has to be well ventilated. A fully charged battery gives service for nearly 8 hours i. e. one shift of regular traction duty. At the end of the shift, the battery has to be placed on a charging rack and it takes nearly 8 hours to fully charge. It should be borne in mind that a fully charged battery can be discharged in a few hours only by overload or battery can be discharged in a few hours only by overload or mis-use. But to replanish the charge, it takes nearly 8 hours. The battery charging station layout is given in Fig.16.8. By a lifting tackle the nearly discharged battery of a loco is removed and placed on the charging bays at the end of the shift and a fully charged battery from the charging station replaces it. The direct current for charging at the station may be available from a motor generator set or by the use of mercury arc rectifier. The latter has the advantage that it has no moving or rubbing parts. The battery charging station should be close to an intake airway.

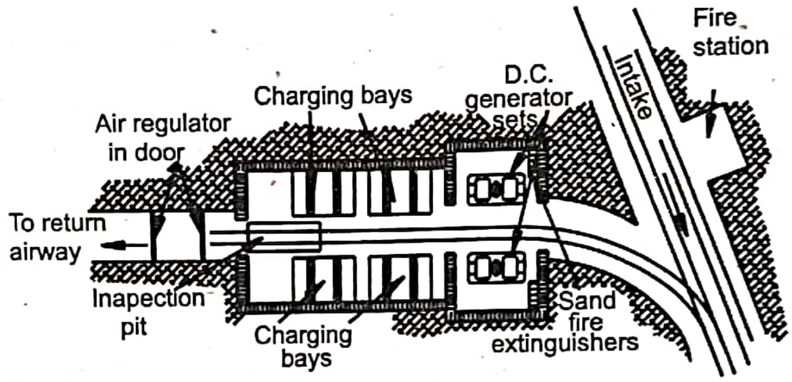

Fig. 16.8. Battery charging room layout.

*Travelling crane supported from roof gi *der changes the batteries.*

Overhead wire locomotive (or trolley wire locomotive) :

The trolley wire locomotive is equipped with electric motor fed with current from overhead electric wire through a pantagraph or through a long pole which is kept pressed against the overhead conductor by spring tension. Only direct current is supplied to the overhead wires though in some foreign countries A. C. is permitted. The main advantage of A. C. is that conversion equipment is not required between the supply mains and the overhead wires. The shock hazards are, however, much more serious with A. C. An important advantage of D. C. for traction is that the D. C. series motor is unrivalled for traction duty. The D. C. supply to overhead wires is at 250 volts. Trolley wire locomotives are used in a number of coal mines near Kurasia colliery and a few other coal mines of degree-I gassiness though the D. G. M. S. office is generally conservative in granting permission for their introduction in underground coal mine.

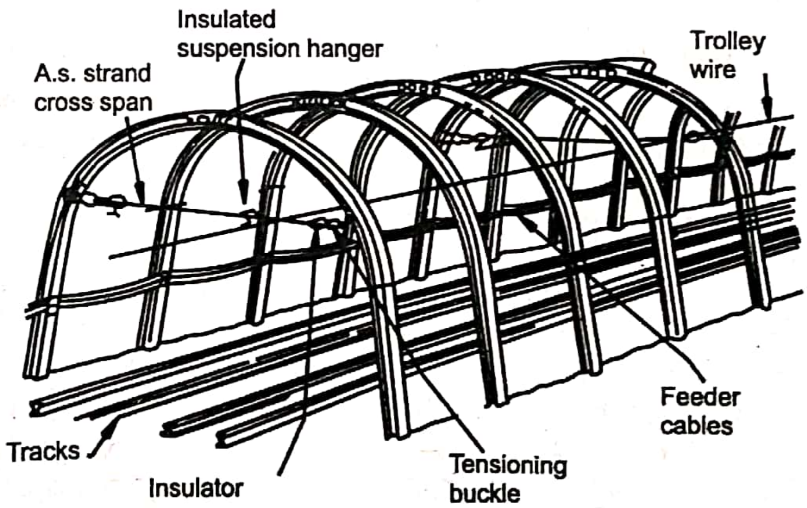

Fig. 16.9. Trolley wire for trolley wire loco.

The bare overhead conductors are of hard drawn copper wire suspended centrally over the track at a height of more than 2 m. The conductors are suspended through insulators from short cross wires of mild steel. An earth leakage wire is connected to each cross-wire. The rail track forms the return path for electric supply circuit and therefore the former must be suitably bridge at each rail joint by copper conductors. Section isolation switches for isolating parts of roadways have to be sited in easily accessible positons in the roadsides. The roadways for trolley wire locomotive should be sufficiently high and wide to provide safe clearances, and the ground free from any movement arising out of mining operations. The roadways have to be equipped with overhead wires and their support system. Branch roads cannot be negotiated unless they are also so equipped. These requirements, therfore, impose some restrictions on the flexibility trolley wire loco. Locos are taken to the face by feeding power through a cable reel from the terminus of the trolley wire line. The hazards of shock to workers through contact with bare wires and the possibility of explosion of fire damp in gassy coal mines due to sparking should not be ignored, though mining regulations are quite stringent in this respect. Such locomotives are used on a wide scale in Ruhr Coalfields (West Germany) in deep gassy mines and also in American underground coal mines.

The trolley wire loco system has the folllowing **advantages :**

1. High efficiency : Of all the different types of locomotives used in mines, trolley wire loco is the most efficient.
2. High overload capacity : For short periods, specially during peak loading activity, overloading of the motors do not pose any problem.
3. Simple maintenance : Most of the skilled work is to be done in the power house.
4. High power/weight ratio : The motor speed can be easily increased to give more tractive effort.
5. Reliability : It is robust in construction and not liable to breakdown.
6. Good control : It gives smooth acceleration and high torque.

Cable reels :

Cable reels are used (1) to enable a trolley loco to operate over a short distance beyond the terminal point of overhead conductors, (2) in the case of battery locomotives, for use at points where there is a lot of starting, stopping, shunting and collection of load. The cable reel is carried on the loco and the cable end is brought in contact with overhead wires by a long insulated hook, or alternatively, the cable end is plugged into a special socket of mains supply. As loco travels forward it uncoils the cable which then rests in the middle of the track; when returning, the reel is rotated by power and the cable is wound up on it.

Traction characteristics of D. C. motors :

It is a standard practice to provide two electric motors on storage battery locomotives as well as on trolley wire locomotives. As the current is D. C. ,series motors are preferred (field winding in series with armature or rotor winding) for the following advantages :

1. Series motor has a high starting torque. The armature current is large at the start and so also is the field current, being in series :
2. Current taken by the motor adjusts itself to the external load and the torque rises as the speed decreases.
3. Speed falls off as the torque for traction increases due to train load or adverse gradient.

A clutch or release mechanism is not provided on an electric locomotives as the load of mine cars should generally be kept attached to the locomotive, a typical condition of traction duty. If the load is not kept attached, *i.e.* if the torque decreases the rotor tends to race up and may develope dangerous centrifugal force.

The back e. m. f. of a motor depends on speed and field current. It is nil at the start and varies with the speed. At start the supply current can, therefore be kept within reasonable limits by inserting resistors in the circuit of the armature and the resistance is reduced in steps as the motor speeds up. At the normal working speed of the motor, full voltage is applied across the field and armature winding.

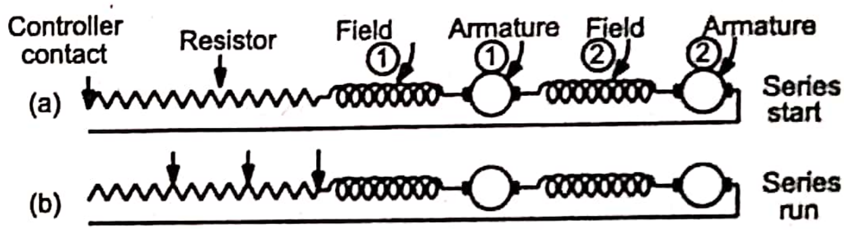

Fig. 16.10. Different electrical connections in a series wound D. C. motor of an electric trolley or battery loco having two motors.

In a series motor, however, reversal cannot be obtained by merely changing the direction of current in the armature since the relationship between the field and the armature remains the same and the direction of rotation is not affected. For purposes of reversal the armature is generally provided with two sets of windings. Changing the direction of current unchanged, causes reversal of the rotor. Fig. 16.10 shows the arrangements of speed control on twin motors. Use of resistors of control the full battery current is wasteful of electrical energy and wastage is more pronounced with frequent starting and stopping. The wastage appears as heat and it is, therefore, important to remember that with battery locomotives the motors should not be run with the resistors in the circuit except during speed changes which should not be sudden. The slowest economic speed is obtained with the battery paths in parallel and the motors in series.

Underground compressed air locomotives are not used in any of the coal mines in this country.

Diesel locos are not used at the face in this c ountry and their use on branch roadways is also rare. In inclined seams locomotives are used in the shaft levels or near the pit bottoms.

A loco can negotiate a right angle bend in 4.3 m wide gallery if track gauge is 0.60 m, the common gauge in most of our mines. If track gauge is wider, rhombus pillars with 120° angle are to be formed.

Example :

What is the maximum tractive effort that can be developed by a 15-tonne diesel locomotive of 75 kW assuming a coefficient of adhension of 0.25 ? At what speed will it haul a train when developing its fullpower and maximum tractive effort, assuming the mechanical efficiency to be 84 % ?

Ans. :

(a) Maximum tractive effort = Tm $= 0.25 \times 15 \times 9810$ N

$= 36787$ N

(b) Power (kW) $= \dfrac{\textit{Tractive effort}\ (N) \times \textit{speed}\ (m/s)}{\textit{gear efficiency}\ (e)}$

Wire Ropes

By- Deepak kumar
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→ A wire rope is an important item of engineering materials in mining and many other engineering industry.

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

→ Carbon 0.5, silicon 0.11, manganese 0.48, sulphur, 0.033, Phosphorous 0.014, iron rest. According to I.S specification No. 1835 of 1961 neither sulphur nor phosphorus content in the steel for wire rope should exceed 0.050 percent

→ The ultimate tensile (breaking strength) of wires used for haulage /winding ropes is generally between 140 kgf/mm² and 170 kg/mm²

→ If the wire rope is to be used in a wet shaft the wires are galvanised, i.e, coated with molten zinc. Ropes of stainless steel are not used as the material has low tensile strength.

→ The wire is subjected to the following tests carried out according to the standards prescribed by I.S specificati-ons.

1. Tensile test.
2. Torsion test
3. Bending test
4. Wrapping test
5. Looping test

Types and Construction of wire ropes

→ Some wire ropes are required to carry the burden or load but are more or less stationary e.g guy ropes, guide ropes in shafts bucket-supporting ropes in bicable aerials ropeways. Such ropes are classified as standing ropes.

→ Other types of ropes are, running ropes have to undergo frequent movement, running or coiling often with varying loads and they have, therefore, to be flexible.

Example:- The ropes used for winding, Haulage, Coal cutting machines winches, excavators, cranes, are running ropes.

→ On the basis of construction wire ropes are classified as:-

(a) stranded ropes, and

(b) non-stranded ropes.

(a) Stranded rope :- A stranded rope is built up of strands and each strand consists of a number of cocentrically twisted wires laid in the form of a helix round a central steel wire.

→ A seven wire strand consists of a single centre wire, called king wire, covered by 6 concentrically laid wires and is common in the ropes used for haulages.

→ Wire ropes are designated usually by stating the number of strands, followed by the number of wires in each strand. For instance 6×7 wire rope means that it is made up of 6 strands, and each strand is made up of 7 wires.

Such rope is the simplest construction and is used mainly for haulage purposes.
For winding and hoisting 6x19 or 6 x 37 construction is preferred.

→ The flexibility of a strand depends ~~on~~ upon,

(a) type of core:- A strand with a flexible core is more flexible than one with steel wire at the centre.

(b) thickness of individual wires:- thinner the wires, more is the flexibility.

(c) number of wires:- larger the number of wires, more is the flexibility.

In a wire rope of the stranded type the strands are laid concentrically round a core which may be of the ~~fl~~ following type.

1. fibre Core.

2. Steel strand Core

3. Independent wire rope (I.W.R.C)

↓

This itself is a small wire rope consisting of 7 strands, each with 7 wires e.g., ropes used for Coal cutting machines have ~~and~~ an independent wire rope core.

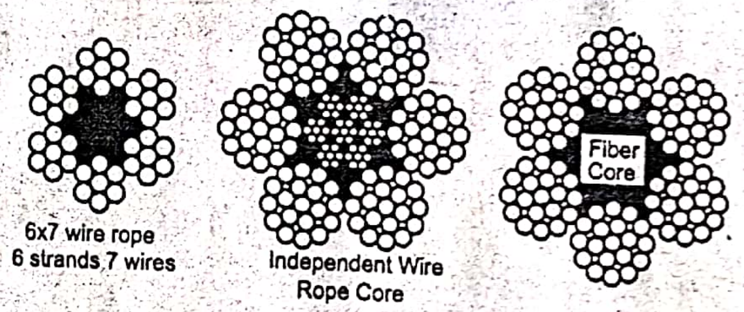

Fig. 8.1 A cross-section of round strand ropes.
Typical use : Left – for haulage; middle – for coal cutting machine; right – for winding.

→ Ropes for winding and haulage purposes have a central Core of fibre which forms a soft bed for the strands and preserves the shape of rope under strain. During manufacture the fibre Core is heavily lubricated.

→ A steel wire stranded core is preferred in ropes operating in conditions of high temperature (e.g in steel melting shop of a steel plant) or in ropes subjected to shock loads (e.g. Coal-Cutting machines).

Wire rope lays:-

→ The term lay used in relation to a Strand ~~indicates~~ indicates the direction of laying of wires in the Strand.

→ There are two types of lays, the right hand lay, and, the left hand lay.

→ In a right hand lay the wires spiral round the core in the same direction as the threads of a right hand screw. the opposite is known as the left hand lay

→ The left hand lay Construction is not Common for haulage ropes or winding ropes used on drum winders but is sometimes adopted for ropes on multi-rope koepe winders, where adjacent ropes are of opposite lays, i.e one rope with right hand lay and the adjacent rope of left hand lay. This prevent untwisting of strands.

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Lang's lay and Ordinary lay :-

→ A rope is of ordinary lay construction if the wires in the strand and the strands in the rope are laid in opposite directions. Ordinary lay is also known as Regular lay.

→ A rope is of langs lay construction if the wires in the strand are laid in the same direction as the strands are laid in the rope.

- Such construction causes the rope to spin. for this reason Lang's Lay rope must never be used if there is a free end to rotate.

- The advantages of this lay is that the rope offers a better wearing surface than one of ordinary lay and it is also more resistant to bending fatigue.

→ Regular lay ropes have the advantage that they are non-rotating since

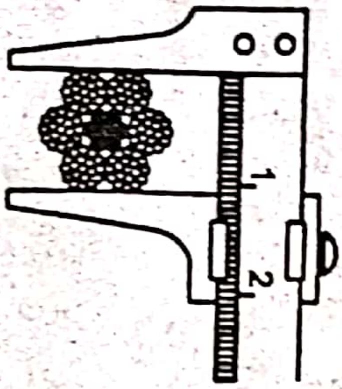

Fig. 8.2.

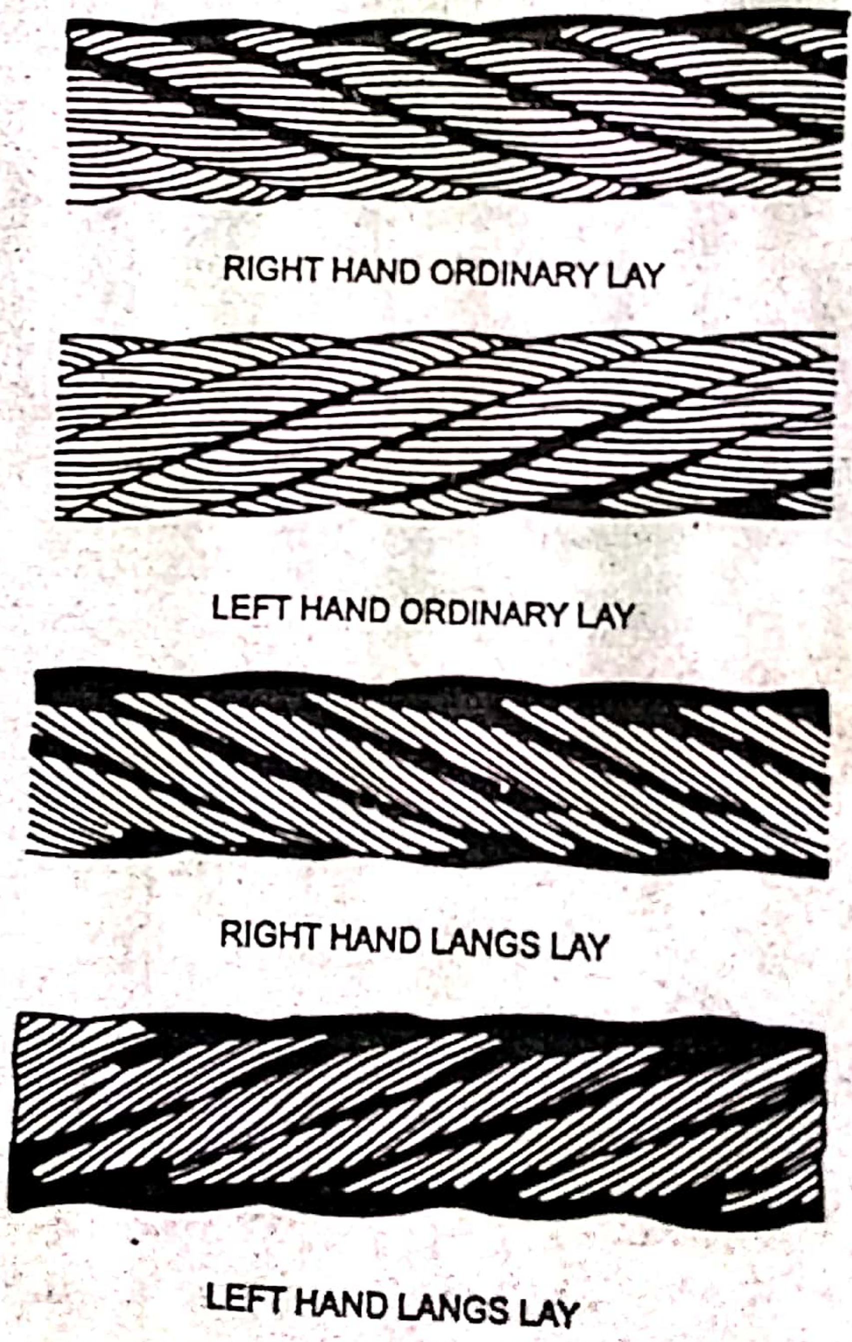

Fig. 8.3 Different lays of stranded ropes.

the strands and wires, being laid in opposite directions, tend to balance each other's rotating tendency.

- They are ideal for use in places where they are freely suspended, such as in cranes.

Preformed wire ropes

→ Draw a number of wire through a die giving them a helical or spiral pattern thus forming a strand.

→ strands are then laid together in a spiral form to produce a complete rope.

→ pre-forming a wire rope is the process of pre-shaping the wires and strands into the exact helical positions they ass assume in the finished rope, thus relieveing the rope of the internal stresses.

→ In a preformed wire rope the strands or wires do not spread out when it is cut without binding with wire at the point of cutting. It is therefore easier to handle.

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→ Ropes used for haulage, winding, Coal cutting machines, cranes, excavators etc. are now-a-day's of preformed construction and they are available with Lang's lay or Regular lay.

Use of preformed wire ropes is recommended for the following reasons :-

(1) Easy to handle.
(2) Longer life.
(3) Balanced load on strands.
(4) Broken wires lie flat.
(5) More easily spliced.
(6) Less liable to kink.

Non-Stranded Ropes

→ An example of this category is the locked coil ropes.

→ The cross-section of lock-coil rope shows that the central portion consists of strands of thick round wires.

→ Only the outer layer (or two outer layers) consists of round wires placed between specially shaped wire of I section, rail section or trapezoidal section so that the wires lock with one another and the rope surface is smooth and plane compared to stranded ropes.

→ The ropes are of full-lock or half-lock construction.

→ The locked coil ropes are heavier and stronger but less flexible than the stranded ropes of the same dia.

→ for winding and hoisting purposes a locked coil rope is sometimes preferred because of its high capacity factor which permits a high factor of safety.

→ The disadvantages of locked coil ropes are:

(1) its construction is some what difficult

(2) its interior cannot be lubricated from outside.

(3) it cannot be spliced.

(4) it is not so flexible.

(5) It is somewhat difficult to cap as compared with the stranded ropes.

... compared with the stranded ropes.

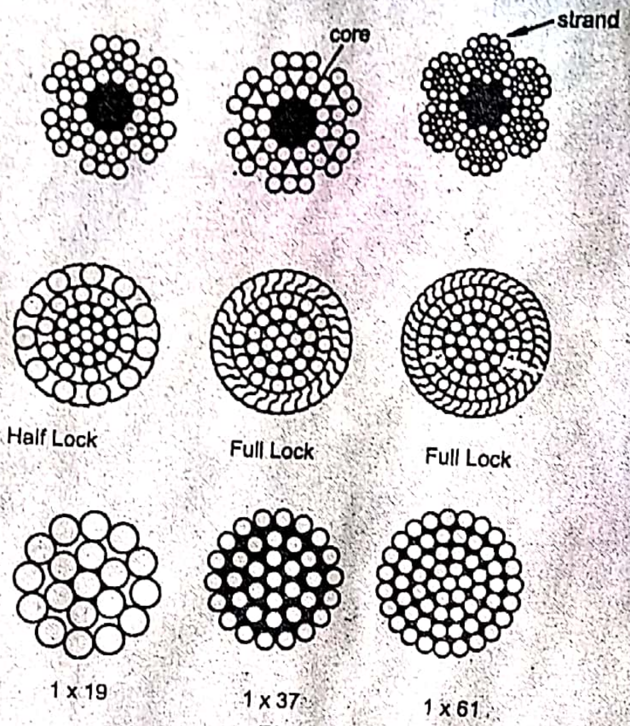

Fig. 8.4

Selection of wire ropes :-

A wire rope is to be selected on the following considerations.

(1.) Watery place and corrosive atmosphere :- A galvanised rope should be used in such places to prevent rusting and effect of corrosive fumes.

(2) High temperature :- Rope with fibre core should be avoided in such places, in foundaries, steel melting shops.

3) Stationary or running Coiling rope:- Stationary ropes can be of large diameter rods or strands e.g. guide ropes in a shaft. Running or coiling ropes require flexibility and smaller the drum/pulley more is the ~~fle~~ flexibility required.

Example:- Rope of a coal cutting machine which has to coil on a small drum should consists of a large number of thin wires and the lay of rope should be "regular" as it give more flexibility.

(4) Spinning or rotating quality:- In a Crane rope, one end is free to rotate and a non spinning rope or one with ordinary lay should be used.

- In a sinking shaft, the sinking bucket is not travelling on guides; therefore a non-spinning rope of locked coil construction or a rope with ordinary lay should be used.

(5) Shock-loads:- Where a rope has to withstand shock loads, the core should be of steel, e.g. coal cutting machine rope.

(6) Resistance to wear:- Ropes for ~~haul~~ haulages and winders have to be flexible and resistance to abrasive wear. Such ropes should be of Lang's lay construction as they offer more wearing surface.

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(7.) Tensile strength and factor of safety:— Ropes used for winding of men should have high tensile strength and high factor of safety than those used for winding of of materials only. Rope of Lang's lay construction streches under load more than the rope of regular lay construction

(8) Bending fatigue:- Repeated bending of a wire rope over sheaves or drums cases fatigue failure of the wires. The rope should be flexible which is possible in a rope having large number of smaller wires.

7. **Tensile strength and factor of safety :** Ropes used for winding of men shoı tensile strength and high factor of safety than those used for winding of materials the Lang's lay construction stretches under load more than the rope of regular lay

8. **Bending fatigue :** Repeated bending of a wire rope over sheaves or drums ca: failure of the wires. The rope should be flexible which is possible in a rope havi number of smaller wires.

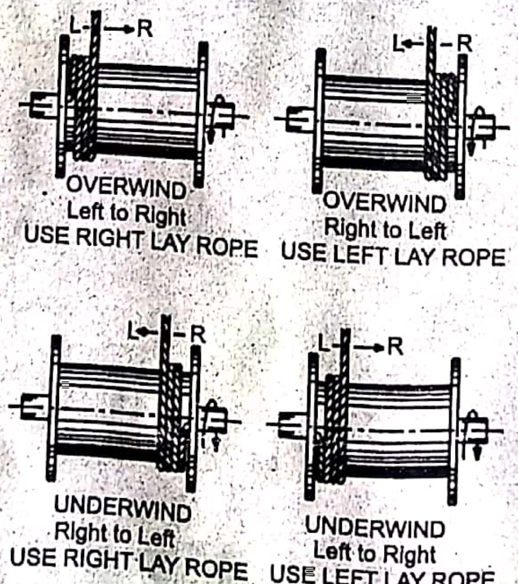


Fig. 8.5 Winding on drum

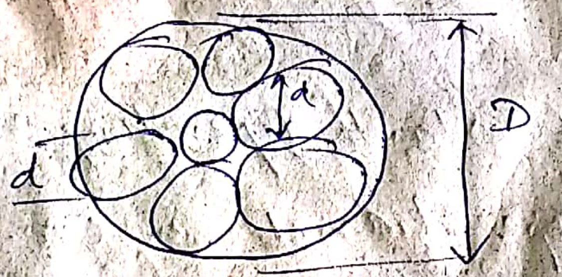
9. **Groove size :** The rope should not be loose or too tight in the groove of the pı

(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.

Mass and Strength of wire ropes

→ The Space factor of a rope is the ratio of aggregate cross sectional area of the wires to the area of a circle drawn around the rope.



$$\text{Space factor (SF)} = \frac{7 \times \pi \left(\frac{d}{2}\right)^2}{\pi \times \left(\frac{D}{2}\right)^2} = 7 \times \frac{d^2}{D^2}$$

Where, d = diameter of the individual wire
D = diameter of the rope.

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→ The mass of a rope depends upon the quantity of steel in it.

- the space factor
- factor and
- Design of the rope

mass of rope $= kd^2$

where k is a constant depending on rope design, d is diameter of rope in cm and mass in kg/m

Strength (Breaking strength) $= Sd^2$

where

S = constant depending on rope design.

d = rope diameter in cm.

(Breaking Strength is in kN)

When d is mm

mass $= K\left(\frac{d}{10}\right)^2$ in kg/m

d in mm

Breaking strength $= S\left(\frac{d}{10}\right)^2$ in kN

d = in mm

Numerical

8. A wire rope, round strand with fibre core, has a diameter of 2.54 cm. If the steel has a tensile strength of 160 kg/mm^2, find out the mass of the rope and the breaking strength in S.I. units. $(K = 0.36)$ $S = 52$

Ans Using the formula

mass of rope in kg/m $= Kd^2$ (d in cm)

and using the value of K as 0.36 from the tables,

Mass of rope $= 0.36 \times (2.54)^2 = 2.32$

Breaking Strength $= Sd^2$ (d in cm)

$= 52 \times (2.54)^2$

$= 335$ KN

Socketting or Capping a rope :

→ The end of a rope where the load is to be attached should be a good portion of the rope free from worn, rusted, bent or broken wires and free from effects of bending and corrosion.

→ There are different ways of attaching Capels or sockets on winding ropes, haulage ropes, Coal cutting machine ropes, crane ropes etc.

(a) Split capel with rivets:-

→ This is normally used on haulage ropes in mines but not permitted on winding ropes. Conical portion of capel fits the rope. (See the figure)

→ 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.

→ Once rope between points a, and b, Wrap a number of ~~turns~~ of turns of binding wire tightly to form a layer.

→ Near a gives severeal wrappings of

the wire to make it thick and slightly conical.

→ Open out wires between rope end and point a and clean them with petrol, kerosene oil or diesel oil to remove grease, oil or rust.

→ After fanning out the wires cut $\frac{1}{3}$rd of them to $\frac{1}{3}$rd length and another $\frac{1}{3}$rd to $\frac{2}{3}$rd length.

→ Turn back all the wires on the rope portion ab to give a cone and tie them on that rope portion with binding wire.

→ Cut the exposed fibre core. Lay a thin layer of molten white metal on the cone with the help of a blow lamp.

→ Hammer a thin wooden wedge into the core at the end a.

→ push a of split capel with its mouth slightly widened onto the cone and hammer the widened arms in position to grip the coned portion of the rope. Reivets are then hammered into the capel and through the rope at 3-4 points nearly 200m apart.

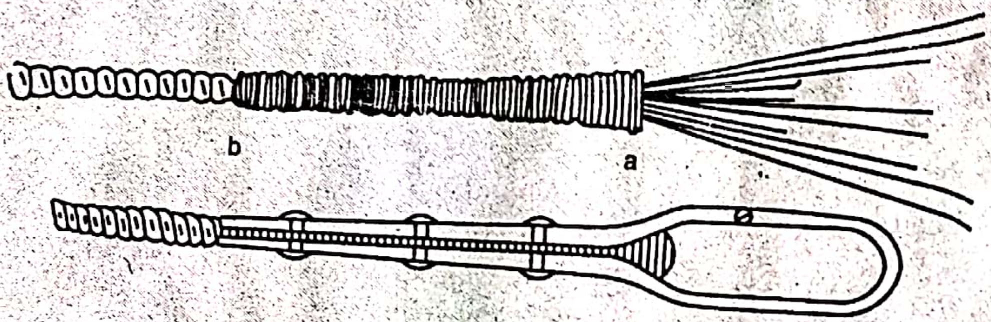

Fig. 8.7

Top : Cutting wires to make a cone

Bootom : Split capel withbent back wires.

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(b) Coned – Socket type Capel :-

→ The Coned Socket type Caped is probably the most compact type of rope Capping. ~~This~~

→ This can be fitted on the rope used for practically every purpose, including winding.

→ Near the rope and where the ~~coned~~ coned socket is to be used on the rope, wrap a few turns of binding wire tightly at a point equal to $1\frac{1}{4}$ times the length of conical portion of the the Canel.

→ Thread the rope and through the capel.

→ 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 ~~fib~~ fibre core.

→ Reassemble the wires so that rope end resembles a brush with the ends of the wires even.

→ pull the rope through the capel so that the branch remains inside its conical clamp.

→ Clamp the capel complete with the rope in place, ~~co~~ in a vertical position with the large end of capel.

pointing up.

→ Seal the Junction of the rope and capel with asbestos yarn and moist clay to prevent escape of molten metal.

→ Heat the capel gradually and evenly all round the outside circumference by a blow lamp.

→ Such heating is essential for free flow of molten metal. Immediately before pouring molten metal.

→ pour molten white metal (temperature not exceeding 365°c) to fill up the conical hole of the capel.

→ Allow the metal to cool gradually till the capel cools to atmospheric temperature.

the rope end resembles a brush with the ends of the wires even. Pull the rope through the c
the branch remains inside its conical portion. Clamp the capel, complete with the rope in
vertical position with the large end of capel pointing up, in readiness to receive molten w
(Fig. 8.9).

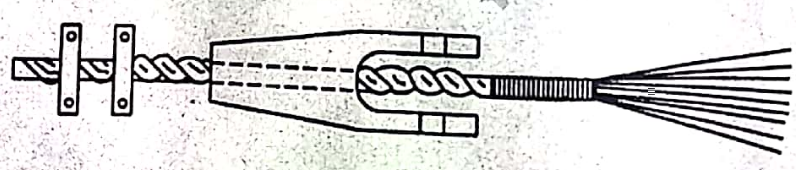

Fig. 8.8
Top:preparing "brush" for coned socket
Left:Capel fixed vertical for pouring white metal

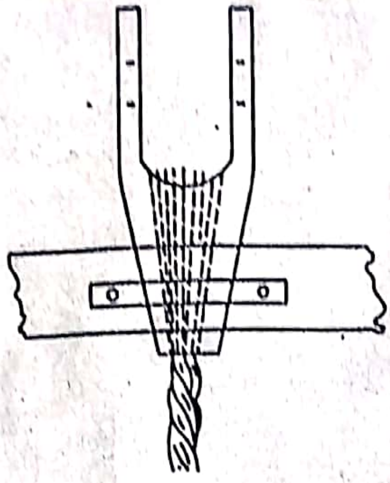

Fig. 8.9

Left : Open coned socket;

Right : Closed coned socket.

Seal the junction of rope and capel with asbestos yarn and moist clay to preve

© Interlocking wedge type Capel
(Reliance Capel):-

→ In this Capel there are 2 tapered iron wedges which grip the rope.

→ The end of the rope is embedded in a block of white metal and the wedges are placed in a U-shaped steel strap on which 4-5 wrought iron hoops or clamps are fitted by hammering.

→ The wedges have a machined groove curved to fit the rope surface and a taper of approximately 1 in 20 upon which the U-shaped strap is held. The Jaws of the capel are about 24 times rope diameter in length.

Procedure :-

1. Keep at hand 3-6 sets of rope clamps to prevent slipping of the wires while mounting.

2. Near the end of the rope, at a distance equal to the tapered length of the capel, lash a layers of binding wire on the rope.

3. Similarly, lash a layer of binding wire on the rope at about 200mm from the end.

4. Thread the wrought iron hoops, C, on the rope in the correct order which they will occupy on the capel. then thread the metallic cone ~~D~~ D on the rope.

5. Fix a set of clamps to the rope portion which will, at the end of the operation, remain inside the wedges.

6. Open up the end wires for a length equal to the length of cone D, clean them, cut out the exposed fibre core, if any, and slide the metallic cone on the cleaned wires made as brush.

(7) warm up the cone with a blow lamp and pour white metal into the core. When the metal solidified, the wires, the metal, and the cone become one solid ~~mass~~ mass.

(8) After removing the rope clamps and the remaining binding wires clean the rope for a length slightly in excess of the tapered-wedges length.

(9) Make sure that the wedge grooves are completely free from lubricant. Place the interlocking wedges on the rope and the whole assembly into the U-shaped strap after greasing the back of the wedges.

10. Slide the wrought iron hoops on to the U-strap and ~~~~ hammer them lightly in position. The capel is placed on a hard floor and the hoops are hammered hard with a shaped set in conjunction with a sledge hammer.

(11) The end cone D should not touch the interlocking wedges and when the capel will be in use the slight gap between the wedges and the cone will indicate that the rope is not sliding up the capel.

Rope Splicing

→ Splicing is a method of joining two wire ropes permanently without using special fittings or attachements.

→ Splicing of winding ropes, by which men are raised or lowered is not permitted under mining regulations, but haulage, power transmission and aerial ropes can be used after splicing and the splice can be made nearly as strong as the original rope.

→ Strength of the spliced rope depends on the length of the splice and on the friction between the interlocked strands.

→ The length of splice will depend upon the diameter of the rope, the lay and the work it will have to do.

→ It is nearly 6–9 m for 13mm diameter rope and 10–15 m for 25 mm diameter rope.

Method of splicing round ropes (Lang's or ordinary lay)

1. Decide the Length of splice.
2. Bring the two ends of the rope to be spliced side by side for the Length of splice. (In the fig. It is 6m.)
3. Open out strands of the two ropes upto the twine binding and cut fibre core
4. Cut out alternate strands of each rope about 30 cm from the twine binding.
5. Bring the two ropes face to face so that the cut out cores meet. Temporarily lash the separated strands of left hand rope to the strands of right hand rope. The strands of RH rope are now ready for "running in" into LH Rope
6. Gradually unwind or unlay strand A of LH rope which will be a short strand and in its bed insert the meshing strand No. 1 from RH Rope which will be a long strand.

This must be laid firmly and lightly into the bed until all but 0.3m of strand 1 is laid in.

7. Cut off strand A to keep an equal length i.e. 0.3m and tie the strands temporarily in place.

8. In a similar manner lay strand 3 of RH rope rope into the groove formed by unlaying strand C of LH rope, but stopping the pair about $\frac{1}{5}$ of the length of splice short of the preceding pair.

(9) Repeat the process for the pair, E strand of LH rope and corresponding meshing strand 5 of RH rope.

(10) All the long strands of RH rope are now laid into LH rope leaving the shortened strands only of RH rope for treatment.

11. The above operations of removing the short strands and replacing the short strands and replacing them by long strands are then repeated with the long strands of LH rope going into the beds of corresponding short strands of RH rope.

12. The length of spliced rope will now have an appearance as in fig 8.11 (iv) with 6 pairs of tails emerging at 6 crossing along the spliced portion.

13. Bend the splice back and forth until all strands rest firmly in their places. This also puts them under nearly equal tension.

14. Straighten each tail by removing any spiral formation.

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

16. Shift the vice and clamps to the next crossing and hammer the strands with a wooden mallet to fix them securely in their place.

15. Repeat the operations at the other five crossing and the splicing job is completed.

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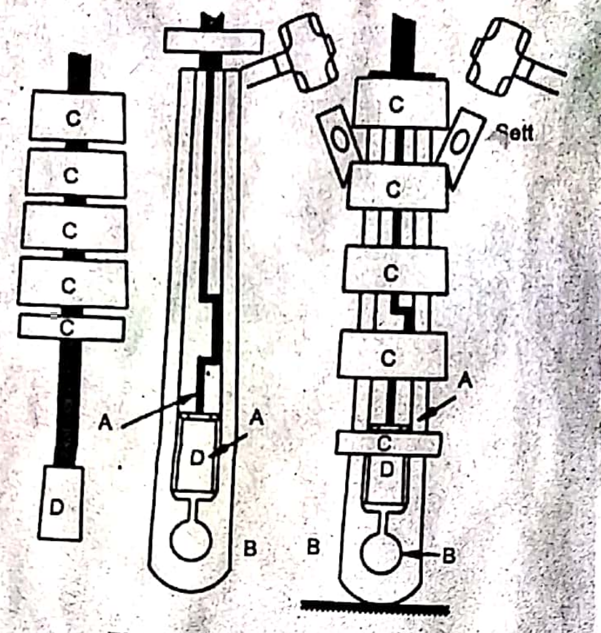

Fig. 8.10 Attaching reliance capel

iii.)

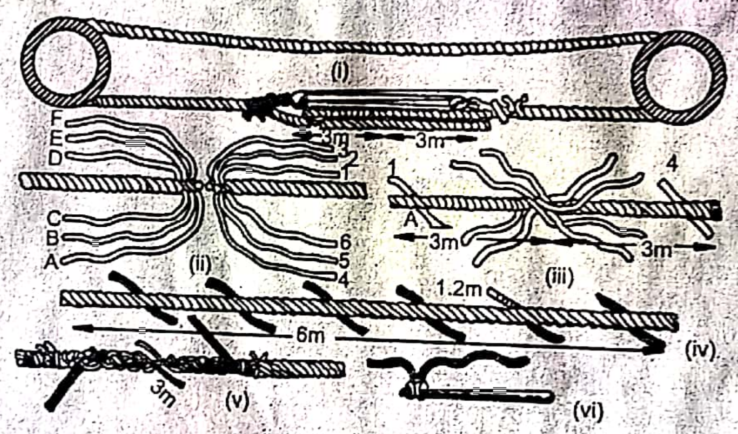

Fig. 8.11 Splicing a wire rope

Care of wire ropes during Storage and use: -

The following points should be kept in mind during the storage and use of wire rope.

1. Avoid use of rope with fibre core, when the rope is subject to heat, fumes, and extreme pressure.

(2) Buy right construction of rope suitable for the Job.

(3) Corrosion can be delayed by using galvanised rope.

(4) Don't load the rope beyond its safe working load.

(5) Ensure that the rope is strongly seized before it is cut.

(6) Flexibility of rope should be suitable to the size of drums and pulleys, and diameter of rope to grooves.

(7) Grease the rope and cover properly before storing in a dry ventilated shed.

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

(9) Inspect the rope periodically and lubricate with acid free lubricant.

(10) Judge the safe life of the rope for the conditions under which it has to work and replace it in proper time.

Module-2

By- Deepak Kr.
Asst. prof. (MRBS)

Transport : Rope Haulages & Tracks

* The main methods of transport are as follows.

(A) Rope Haulage

(i) Direct rope haulage
(a) Tail rope haulage.
(ii) Endless rope haulage.
(a) Over-rope
(b) Under-rope
(iii) Main and tail rope haulage.
(iv) Gravity rope haulage.

(B) Conveyor system of haulage.

(i) Belt Conveyors.
(ii) Cable belt Conveyors.
(iii) Chain Conveyors.
(a) Scraper chain Conveyors
(b) Armoured Chain Conveyors
(c) Gate end Loader
(d) Mobile stage loader.
(e) Pickaback Conveyor.

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(iv) plate Conveyor.
(v) Disc Conveyor.

(c) Locomotive haulage.

(i) Diesel Locomotive
(ii) Electric battery Locomotive
(iii) Trolley wire Locomotive.
(iv) Cable reel Locomotive.
(v) Compressed air Locomotive.
(vi) Electro-gyro Locomotive.

→ Shuttle Cars.

Underground transport arrangements are generally divided into 2 Categories.

1. Main haulage.
2. Gathering haulage.

1. Main haulage :- The main haulage arrangement is that which operates between winding shaft / Incline and the main Underground Loading points

→ At the main Loading point the loads are collected from one, two or more districts.

2. Gathering haulage:-

→ The gathering haulage arrangement is that which operates between the working faces and the main Loading points.

→ In a large mine, where the working faces are far from the main Loading points an intermediate transport arrangement operates and it is known as secondary haulage

→ The main, secondary or gathering haulage may be by ropes, Conveyors, Locomotives or a combination of these.

Rope Haulage

The rope system covers the following types of haulages

1. Direct rope haulage.
2. Endless rope haulage
3. Main and tail rope haulage
4. Gravity haulage.

Module-2

By - Deepak Km
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Transport ; Rope Haulages & Tracks.

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Rope Haulage

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1. Direct rope haulage.
2. Endless rope haulage.
3. Main and tail rope haulage
4. Gravity haulage.

Direct rope haulage

→ This is the simplest system employing one pulling rope and one haulage drum for hauling mineral in tubs or mine cars. up a gradient which is generally steeper than 1 in 10.

→ The haulage engine is situated at the top of an Incline roadway.

→ The train of tubs is attached to one end of the rope, the other end being fixed to the haulage drum.

→ The empty tubs attached to the end of the haulage rope travel on the down gradient by their own weight and do not require power from the haulage engine. The drum shaft is therefore provided with a Jaw clutch to disengage it from the engine. A slip ring motor with drum controller is used.

Advantages:-

1. The rope speed is generally 8-12 km/h and the system can operate between any point of the haulage plane and the haulage engine.

(2) It can, therefore, cope with the haulage requirements of an advancing working face.

(3.) Only one haulage track is required.

(4.) The system can also serve branch roads if the gradient is suitable for down-the-gradient movement of empties by gravity. For this reason, the branch road deviating at an angle of not more than 40° off the main road is convenient.

<u>Disadvantages:-</u>

1. High peak power demand as load starts its journey up the gradient.
2. Severe breaking duty on the downward run.
3. High haulage speed demanding high standard of track maintenance
4. Not suitable for mild inclination of roads.
5. A derailment is associated with heavy damage because of high speed.

Direct rope, double drum balanced haulage

→ It is the modification of direct rope haulage. two drums are provided so that when a train of full tubs is being hauled outbye, a set of empty tubs is lowered inbye.

→ Both the drums are fitted with clutches and are mounted on the same shaft.

→ Weights of the rope and the tubs are balanced and only the unbalanced load for the engine is mineral.

→ This results in a reduced peak power demand and easier braking.

→ The system gives higher output in each trip of the rope brings the loads and there is regular delivery of the ~~lad~~ loaded tubs.

→ The System requires wider roads for the haulage tracks.

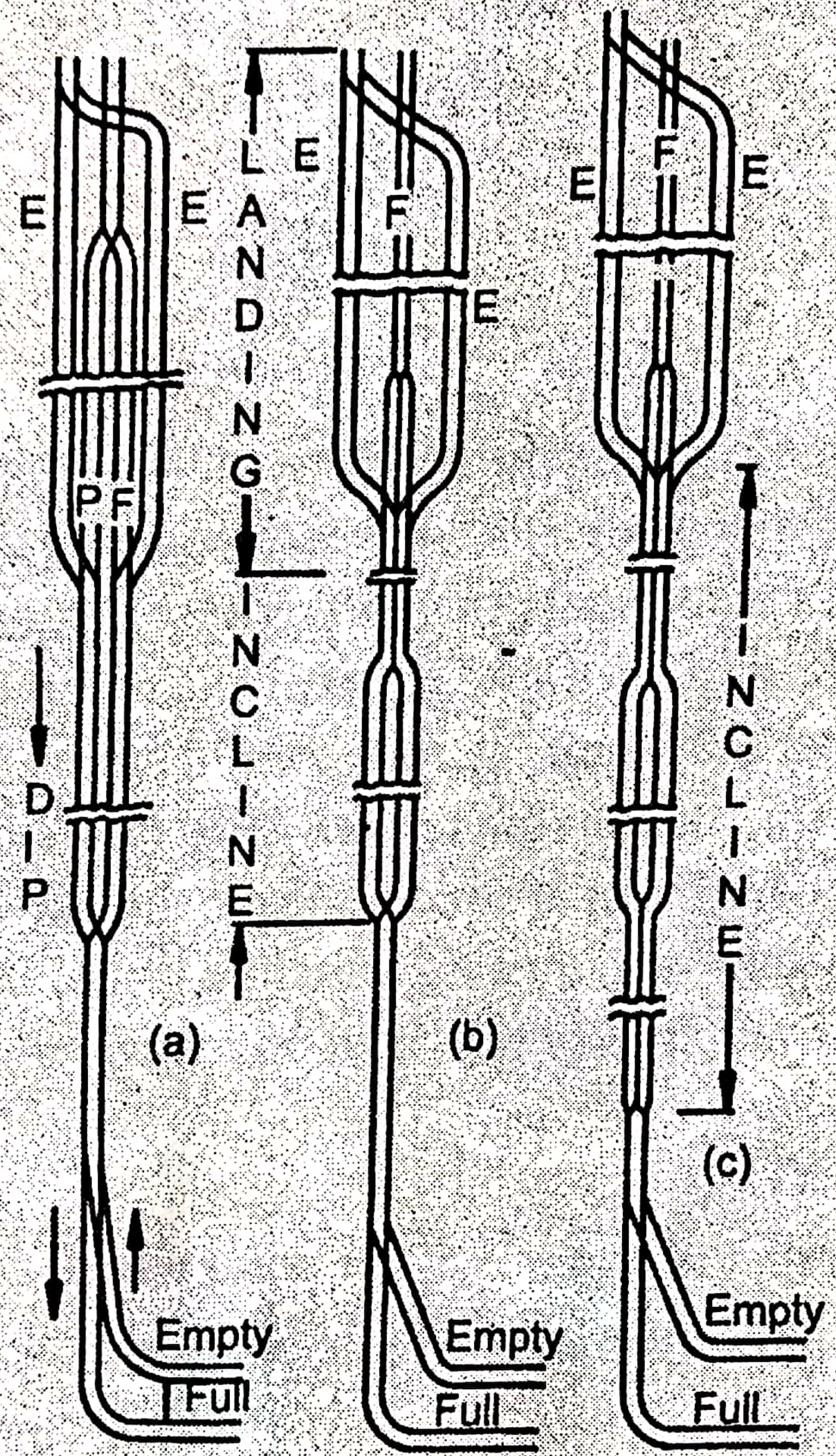

Fig. 15.1 Track layout of balanced double-drum haulage.
E - track of empties; F - track of fulls i.e. loads

Endless rope haulage

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→ In this system there are two parallel tracks side by side.

→ One for loaded tubs and another for empty tubs and the endless rope passing from the driving drum located at out bye end of the haulage road to the in bye end and back again via - a tension bogey.

→ The tubs loaded as well as empties are attached to the rope with regular interval with the help of clips so that the entire rope length has tubs on it at intervals.

→ Only one end of the tub is attached to the rope at a time. But where lashing chain is used for attachment the normal practice is to attach a set of tubs and the attachment or detachment is performed by stopping the rope if however clips are used for single tubs they can be attached or detached when the rope is in motion.

→ The gradient of haulage road is mild and rarely exceeds 1 in 6.

→ The rope speed ranges between 3 km/h and 7 kmh and the haulage is slow moving.

→ The rope moves in one direction only.

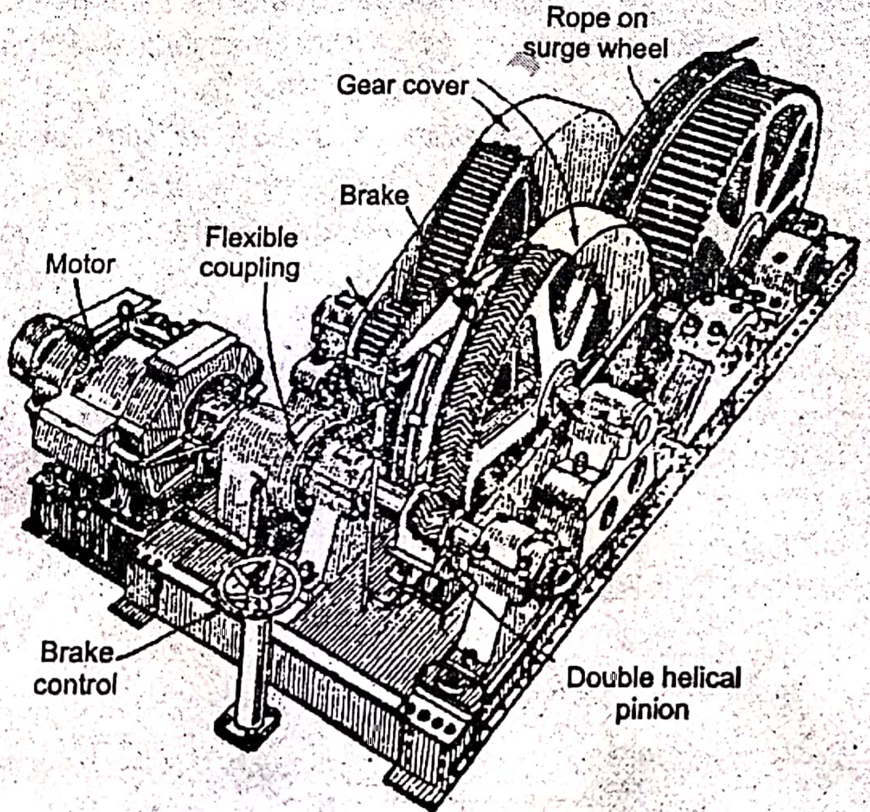

Fig. 15.3 An endless haulage engine

Endless haulages are of over-rope type or under-rope type, the latter being very [illegible]

~~Typeof~~

<u>Clifton pulley</u>:- The driving pulley of an endless haulage is clifton pulley, C-pulley or surge wheel and is of a special shape.

→ To protect the main driving wheel from wear the pulley is fitted with renewable lining of C.I. or soft steel segments having a taper of about 1 in 8.

→ These segments are fixed on the rim of the driving wheel by counter-~~sun~~ sunk bolts and have side flanges.

→ The incoming rope pulling loads enter the segments, leaves them at the smaller diameter.

→ The rope should not be loose on the pulley and in order to keep it in proper tension, due to fluctuation of the load.

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Types

There are two types of endless rope haulage:

1. Over Rope type:- In over rope type the haulage rope passes over the tub or set of tubs.

2. Under Rope type:- In under rope type it passes beneath the tubs or set of tubs.

Advantages:-

1. Because of slow speed, less wear and tear.

2. Accident from derailed tubs does not cause much damage due to slow speed.

3. Motor of less power required

4. It does not place heavy demand on the power-supply.

Disadvantages:-

1. It requires wide roads for two tracks.
2. It is not suitable for steep gradient.

3. Load on the rope is large and a rope of larger cross-section is required.

4. Large number of tubs and clips are required as rolling stock.

5. If a breakdown of any tub occurs the whole system comes to a standstill.

6. It cannot serve a main road and a branch road simultaneously unless elaborate arrangements are made to curve the rope to the branch line with the help of deflection pulleys. The tubs of main road rope have to be detached and ~~reatt~~ reattached at the branch line.

Rope clips used in Endless haulage

→ The tubs, loaded as well as empties, are attached to the rope at regular intervals with the help of clips, so that the entire rope length has tubs on it at intervals. When the clips are used for single tubs they can be attached or detached when the rope is in motion.

Types of rope clips:-

The design of endless haulage rope clips depends on whether the haulage is of over rope type type or of under rope type. Some of the clips used in the endless haulage as follows.

1. Screw clip.
2. Smallman clip.
3. Cam clip
4. Lashing chain

Screw clip:-

→ This clip is tightened on the rope by a handle and screw and the handle is coupled to the drawbar of the tub by a long steel rod hinged to the clip.

Smallman clip:-

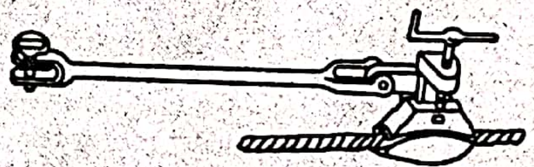
→ Consists of a ~~pear~~ pair of steel cheeks or side plates, loosely held together by the adjustable central bolt which has a spring surrounding it to keep the plates apart and

The design of endless haulage rope clips depends whether the haulage is of over-rope type or of under rope type. Some of the clips used are screw clips, smallman clips and cam clips (Fig. 15.6 and 15.7)

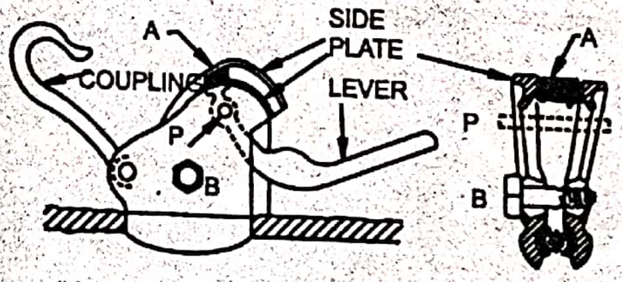
i. ***Screw clip*** : This clip is tightened on the rope by a handle and screw and the handle is coupled to the drawbar of the tub by a long steel rod hinged to the clip.

ii. ***Smallman clip*** : This consists of a pair of stee-cheeks or side-plates, loosely held together by the adjustable central bolt B which has a spring surrounding it to keep the plates apart, and kept in position by the pins supporting the lever and the coupling hook.

The bent lever is pivoted at P and carries at its upper end a wedge. A which works between curved surfaces on the inside of the cheeks. When the lever is depressed, the wedge A enters the narrower part of the space between the cheeks, so forcing them apart at the top, and at the same time causing the bottom jaws to grip the rope. The jaws are about 15 cm long and are lined with renewable soft iron bushes. When the lever is raised, the wedge A moves towards the wider part of the space between the cheeks, so releasing the rope from the jaws.



(a)



(b)

Fig. 15.6 (a) Screw clip (b) Smallman clip

The clip can be detached automatically from the rope by fixing a bridge-piece or trip-bar to a sleeper at such a height and in such a way that the rope passes underneath whilst the lever of the clip strikes against it and is thereby raised. At detaching points, the gradient should be in favour of the tubs.

iii. ***Cam clip*** : This consists of a plate C and a cam-shaped lever L which is pivoted at P and is connected by a small chain to the tub to be hauled.

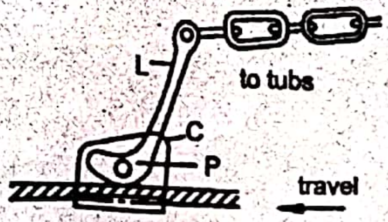


Fig. 15.7 A Cam Clip.

kept in posission by pins supporting the lever ~~and~~ and the coupling hook.

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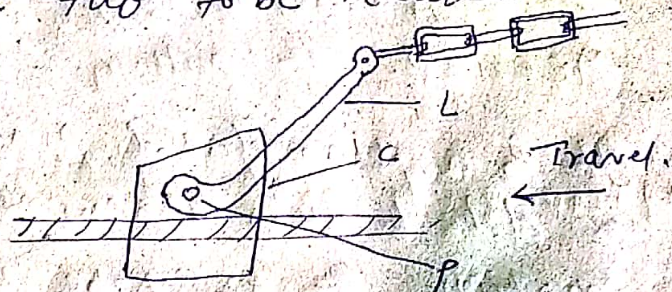


cam clip.

→ The pull of the tub turns the lever around the pivot P so that grip of the clip on the rope is proportional to the load, On undulating roadways a clip must be provided at each end of the tub.

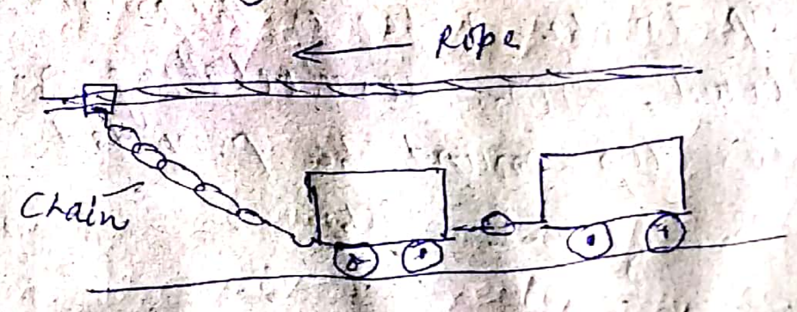
(iv) <u>Lashing chain:-</u>

→ The Lashing chain is usually 2.5 to 3 m long with a hook is attached to the tub draw bar.

→ Other end of the chain is coiled 3 to 4 times around the haulage rope and the second hook is linked to the chain.

→ On undulating roads, one chain is attached in the front and another chain behind the set of tubs but on a gradient only one chain is needed.

→ It is a standard practice to attach or detach tubs when the rope is in motion. If the rope is to be stopped when attaching or detaching tubs, the total timing of rope running is only a small proportion of the shift timing.

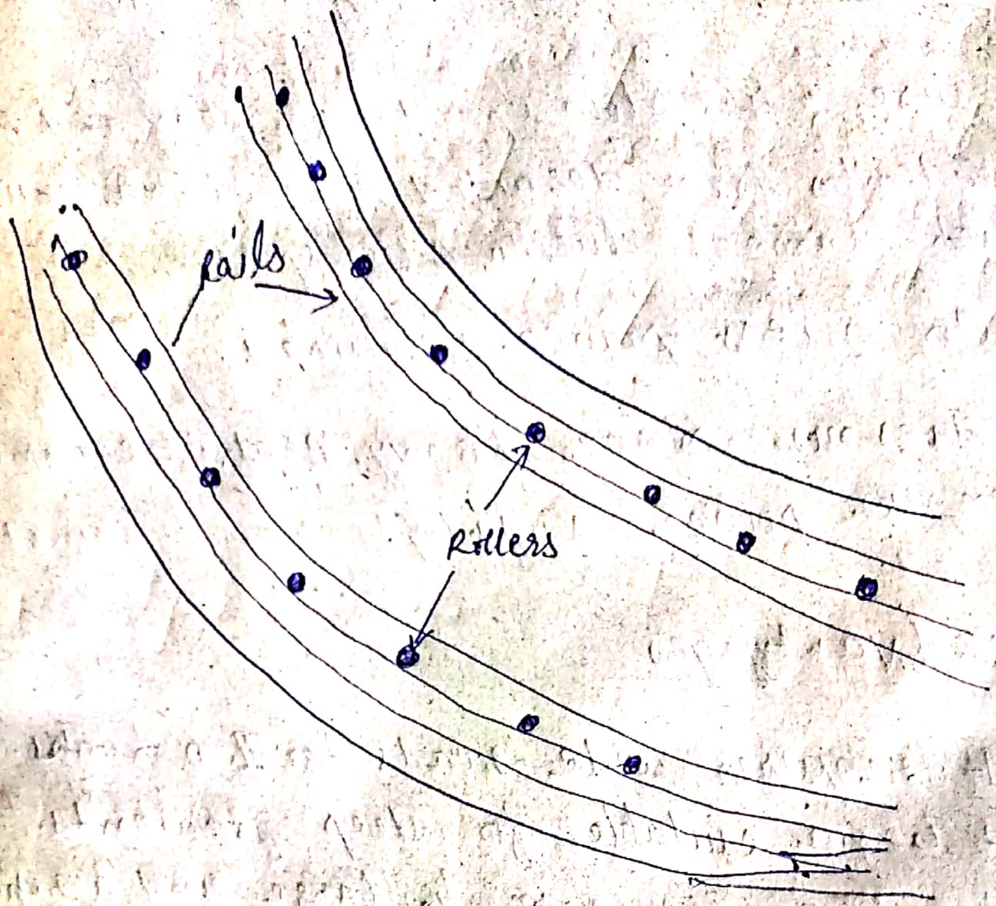


Advantages of Endless haulage

1. Because of the slow speed, less wear and tear.
2. Accidents from derailed tubs do not cause much damage due to slow speed.
3. Motor of less power required.
4. It does not place heavy peak demand on the power supply.

Disadvantages

1. It requires wide roads for two tracks.
2. It is not suitable for steep gradients.
3. Load on the rope is large and a rope of larger cross-section is required.
4. Large number of tubs and clips are required as rolling stock.
5. If a breakdown of any tub occurs the whole system comes to a stand still.
6. It cannot serve a main road and a branch road simultaneously unless elaborate arrangements are made to course the rope to the branch line with the help of deflection pulleys. The tubs of main-road rope have to be detached and re-attached at the branch line.



Curve of an endless haulage showing curve pulleys.

Main and tail rope haulage

→ In this system hauling engine is provided with two separate drums.

→ One for the main rope which hauls the full train out and one for the tail rope which hauls the empty trains in.

→ When one drum is in gear, the other revolves freely on the shaft but controlled, when necessary.

by the brakes to keep the ropes taut.

→ The main rope is approximately equal to the length of the plane, and the tail rope twice this length. Only one track is required.

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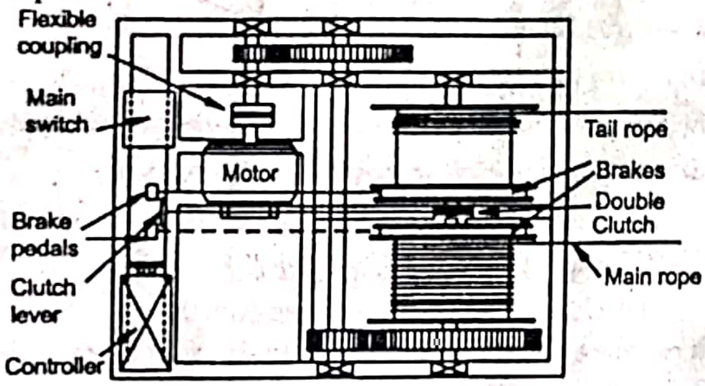

Fig. 15.10 Main and tail rope haulage

This system of haulage is suitable for undulating roadways. Where it is impossible orundesira to maintain the double track required for endless rope haulage; it can readily negotiate curves, and i convenient for working branches.

On the other hand, it operates at fairly high speeds and with long trains, and if a derailm occurs, the resulting damage and delay are likely to be considerable.

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→ It operates at fairly high speeds. and with long trains, and if a derailment occurs, the resulting damage and delay are likely to be considerable.

Gravity haulage or Self Acting incline

→ This is a haulage without any motor or external sources of power and consists of a cast iron pulley 1.3 m – 2 m diameter, having a brake path on one side and a Strap brake.

→ It is located at the top of an inclined roadway and is employed to lower by gravity loads attached to one end of the rope while simultaneously hoisting empties attached to another end of the rope which passes round the Jig pulley.

→ The Jig Pulley is vertical. Only single track is required for its operation but at the mid-way of the road where the loads and empties meet, double track or a bye-pass is essential.

…their descent is controlled by the haulage driver.

Gravity haulage or self acting incline :

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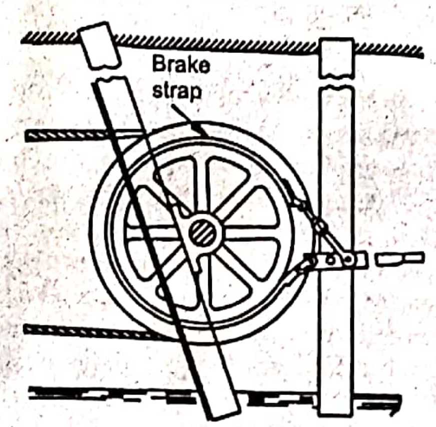

Fig. 15.11 Jig pulley of gravity haulage

It is located at the top of an inclined roadway and is employed to lower by gravity loads attached to one end of the rope while simultaneously hoisting empties attached to another end of the rope which passes round the jig pulley. The jig pulley is vertical. Only single track is required for its operation but at the mid-way of the road where the loads and empties meet, double track or a bye-pass is essential. Fig 15.12 shows the lay-out of the track and the jig pulley.

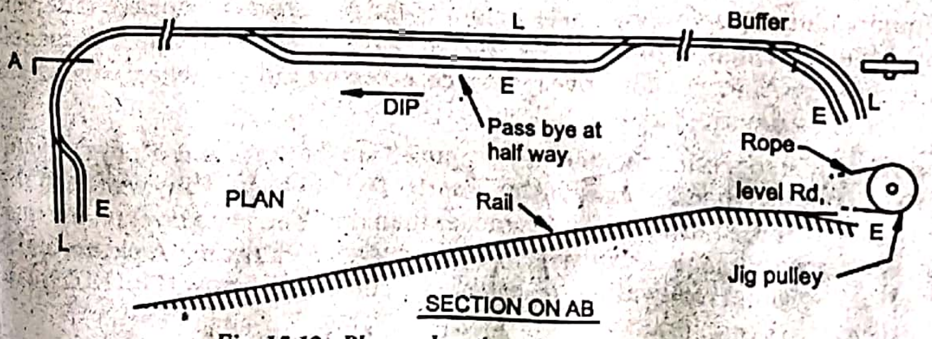

Fig. 15.12. Plan and section of layout of gravity haulage

Essentials of a good haulage track :

A haulage track underground, specially on a main roads, must be capable of carrying the loads imposed upon it with safety and security over a long period of time, with no risk of derailment and a minimum cost of maintenance and repair. The essentials are :

1. Rails of adequate weight and cross-section to carry the load.

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A haulage track underground, specially on a main roads, must be capable of carrying the loads imposed upon it with safety and security over a long period of time, with no risk of derailment and a minimum cost of maintenance and repair.

The essentials are:-

(1) Rails of adequate weight and cross-section to carry the load.

(2) Fish-plated joints with lock washers and bolts, the joint being squares, ~~are~~ across the tracks, except on curves, where they should be stag red.

(3.) Sleepers of adequate length and cross-section, preferably with steel channel sleepers at intervals to give rigidly and maintain the gauge.

(4) Well-rammed ballest (broken rock, gravel, slag or clinke) to provide

a cushioned bearing surface.

(5) Good drainage to maintain the track in a dry condition.

(6) Careful alignment (If necessary with a dial or theodolite) before and after ballasting.

(7) Careful grading (by a grade board and mason's spirit level for Locomotive track only)

(8.) Curves of adequate radius.

→ Track gauge for tubs of 1.1 m^3 capacity is generally 0.6m but for Locomotive haulage it is usually 1m - 1.2m in our mines.

→ A Jim Crow is a handy device for bending the rail to suitable curvature.

Super-elevation:-

→ On a curve, centrifugal action creates a tendency for the train to leave the track and proceed along a course tangential to the curve.

→ This throws the wheel flanges hard against the inner edge of the outer rail, causing excessive wear on the wheels and rails.

→ To counteract this the outer rail should be raised above all rope haulages e.g. with the main and tail rope system the forces in the two ropes pulling in the opposite directions tend to pull the train into the inner rail.

→ The amount of super elevation or cant required is dependent on the radius of the curve, the speed at which the train is travelling and the gauge of the track.

Super-elevation is given by the formula.

$$\text{super elevation} = \frac{Av^2}{gr}$$

Where A is gauge of track, metres

v is velocity of train, m/s

g is 9.81 m/s²

r is radius of curve, metres.

Numerical

Q. A locomotive weighing 15 tef travels round a curve of 80 m radius at a speed of 30 kmh. If the gague 1 metre what should be super-elevation of outer rail over the inner rail so that there is no thrust between the flanges of the outer wheels and the outer rail?

$$v = 30\,kmh = \frac{30 \times 1000}{60 \times 60} = 8.33\ m/sec$$

$$\text{Super-elevation} = \frac{Av^2}{gr}$$

$$\text{Super elevation} = \frac{1 \times 8.33 \times 8.33}{9.8 \times 80}$$

$$= 0.0885\,m$$

$$= 88.5\,mm \quad \text{Ans}$$

Thank you !!

Safety devices on haulage roads:

(a) Monkey or back Catch

→ This consists of (i) a pivoted piece of steel rail placed between the track rails so as to catch the axle of a backward runway or

(ii) a wooden block pivoted at one end and pressed over the rail by a strong spring.

→ It is used for endless haulage track for tubs moving up-~~grad~~ gradient.

Safety devices on haulage roads :

Monkey or back catch :

This consists of (i) a pivoted piece of steel rail placed between the track rails so as to catch the axle of a backward runway, or (ii) a wooden block pivoted at one end and pressed over the rail by a strong spring. It is used for endless haulage track for tubs moving up-gradient. (Fig.15.18)

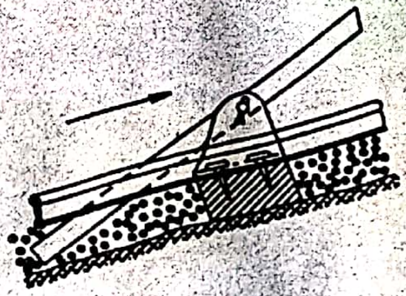

Fig. 15.18 A back catch

(b) <u>Stop-block</u> :- This consists of a wooden beam or block lying across the rails, pivoted at one end and held against pivoted side block at the other. It is a good plan to have two stop-blocks some distance apart, the one forming a reserve for the other.

(c) <u>Backstay</u> :-

→ This is used behind an ascending set of tubs on a direct haulage road or on endless haulage.

→ It is attached to the tub axle and in the event of runaway of tubs, the pointed end of the backstay stops against ~~st~~ sleeper of the track and the travel of the tub or train of tubs is arrested.

Drop Warwick :-

→ This is intended for arresting forward runaways, being placed below the brow of an incline and also near the bottom and below intermediate levels.

→ It consists of a heavy-bulk or girdar hinged at one end to a specially set roof grider and held up at the other by an eye-bolt and pin

→ The warwick is ~~reales~~ released when required in emergency by a haulage worker pulling the wirewick is released when required in emergency by a haulage worker pulling the wire to withdraw the pin.

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Drop Warwick :

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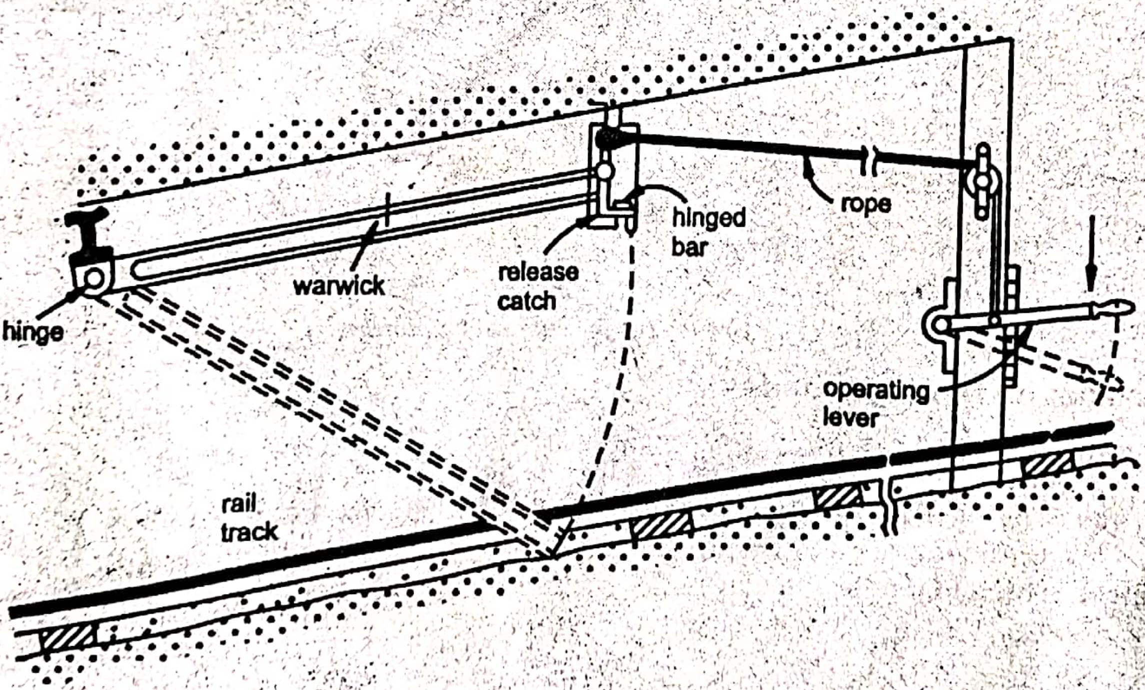

Fig. 15.19. Drop warwick.