CONVEYORS

These are gravity or powered equipment commonly used for moving bulk or unit load continuously or intermittently, uni-directionally from one point to another over fixed path, where the primary function is **conveying** of the material by the help of movement of some parts/components of the equipment.

CLASSIFICATION OF CONVEYORS' TYPE

A. Belt Conveyor 1. Flat 2. Trough 3. Closed 4. Metallic 5. Portable 6. Telescoping	**D. Cable Conveyor**
B. Chain Conveyor 1. Apron or pan 2. Slat 3. Cross-bar or arm 4. Car type/pallet 5. En-mass 6. Carrier chain and flat-top 7. Trolley 8. Power and free 9. Suspended tray or swing-tray	**E. Bucket Conveyor** 1. Gravity discharge 2. Pivoted bucket 3. Bucket elevator (also included under III)
C. Haulage Conveyor 1. Drag chain 2. Flight 3.Tow (*a*) over-head (*b*)flush-floor (*c*) under-floor	**F. Roller Conveyor** 1. Gravity 2. Powered/driven 3. Portable **G. Screw Conveyor**

A. BELT CONVEYORS

Definition / Description

A belt conveyor consists of an endless flat and flexible belt of sufficient strength, made of fabric, rubber, plastic, leather or metal, which is laid over two metallic flat pulleys at two ends, and driven in one direction by driving one of the two end pulleys. Material is placed on this moving belt for transportation. The active half of the belt is supported by idler rollers or slider bed. The return half of the belt may or may not be supported, as it generally does not carry any additional load other than its own weight. The endless belt is kept taught by a belt tensioning arrangement.

General Characteristics

(*i*) Belt conveyors operate in one vertical plane, horizontally or with an inclination (up or down) depending on the frictional property of the load conveyed.

(*ii*) For changing direction of the materials being conveyed, in the horizontal plane, more than one belt conveyors are needed.

(*iii*) Conveying capacity of a conveyor can be controlled by changing belt speed.

(*iv*) Belt conveyors are generally employed for continuous flow of materials.

(*v*) Metal/special belts can carry hot, abrasive or reactive materials.

Fig. 6.1.1. A flat belt conveyor with drive control

Types of Belt Conveyors

(*a*) **Flat Belt Conveyor.**

(*b*) **Troughed Belt Conveyor.**

(*c*) **Closed Belt Conveyor.**

(*d*) **Metallic Belt Conveyor.**

(*e*) **Portable Conveyor.**

(*f*) **Chain or Rope Driven Belt Conveyor.**

(*g*) **Submerged Belt Conveyor.**

Parts of a Belt Conveyor

(*a*) **Conveyor Belts.**

(*b*) **Idlers:** The rollers used at certain spacing for supporting the active as well as return side of the belt are called idlers. Accurately made, rigidly installed and well maintained idlers are vital for smooth and efficient running of a belt conveyor.

Idler construction: Idlers are generally made from steel tubes conforming to IS 9295:1983, uniformly machined all over at the outer diameter and at the two ends of the inner diameter. The tubes are mounted on antifriction bearings over a fixed steel spindle. The ends of the spindles are flat machined to standard dimensions for quick fixing in slots of idler structure. The idlers may be made of heavy steel tubes for severe service condition (like in material loading section) or cast iron in corrosive application (handling coke etc.).

Components of Belt conveyor

(*c*) **Conveyor Pulleys:** At each of the two ends of a belt conveyor, one large diameter pulley is installed against which the belt turns and changes direction. These pulleys are called terminal or bend pulley.

(*d*) **Drives for Belt Conveyors:** The belt conveyors are generally driven at the head end pulley, where material is discharged.

(*e*) **Take-ups** or **Belt Tensioning Devices:** Endless conveyor belt after being threaded through the entire length of the conveyor need to be tightened so that sufficient frictional force is developed between the drive pulley and the belt, to make the belt move.

(*f*) **Loading and unloading devices:** Free flowing material may be directly delivered from a hopper, bin or storage pile through a chute, the delivery rate being controlled by a regulating gate at the hopper / bin output.

(*g*) **Belt Cleaners:** For cleaning the outer surface of the belt a wiper or scraper blade is used for dry particles adhering to the belt. A rotary brush type cleaner is used for wet and sticky materials. To clean the inner surface of belt, if warranted, a scraper is placed near the end of return run before the tail end pulley.

(*h*) **Training idlers:** For various reasons like eccentric loading, sticking of material to belt or idlers etc., particularly for a long-centre conveyor, the belt may tend to move out of centre line. To prevent this tendency, belt training idlers are used which automatically maintain belt alignment.

(*i*) **Conveyor structure:** The structure supporting the pulleys and idlers consists of suitable sized channel stringers, with supporting legs to the main structure or floor.

(*j*) **Transfer terminals:** In a long-centre conveyor, direction of the conveyor is changed in a transfer terminal where materials from one conveyor is transferred into another conveyor. The second conveyor is laid out at certain angle (generally 90°) to the first one. The dis-charge from first conveyor takes place at a higher point, and materials is directed to the second conveyor situated at a lower height, through properly shaped and sized transfer chute.

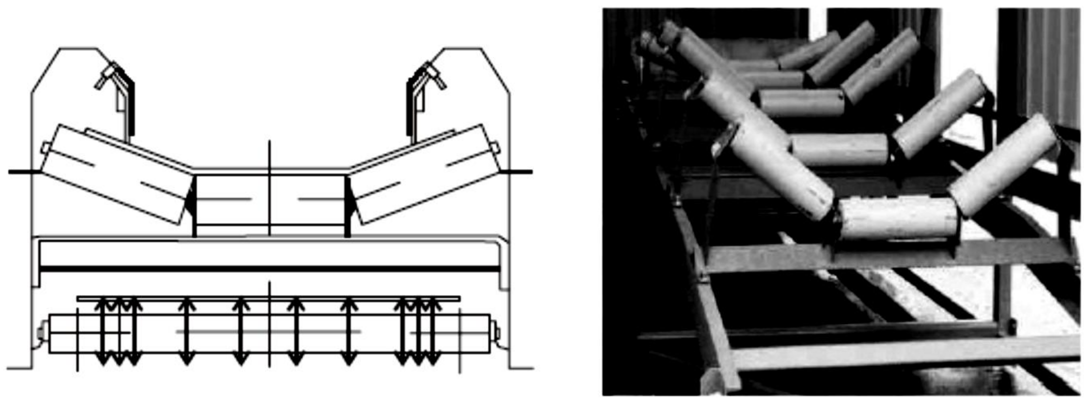


Fig. 6.1.7. Three roll idler : Sketch shows three roll carrying idler with straight return idler in same frame, and photograph shows set of assembled idlers

Aspects of Belt Conveyor Design

The major points in selection and design of a belt conveyor are:

(*a*) Checking/determining capacity of a conveyor.

(*b*) Calculating maximum belt tension required to convey the load and selection of belt.

(*c*) Selection of driving pulley.

(*d*) Determining motor power.

(*e*) Selection of idlers and its spacing.

(*a*) **Checking/Determining Conveyor Capacity**

This basically means to check at what rate (tons/hrs. or units/min) a belt conveyor of a given belt width and speed can convey a particular bulk material or unit loads. Conversely, it is to find out the size and speed of the conveyor to achieve a given conveying rate.

Belt Width: (*i*) On a flat belt, free flowing materials will assume the shape of an isosceles triangle (Fig. 6.1.12 [*a*]). The angle of dynamic repose ''ϕ1'' may be considered to be equal to 0.35ϕ, where ''ϕ'' is the static angle of repose for the material. To avoid spillage, the belt width ''B'' is taken at least 25% more than the base of triangle ''*b*''. Thus b = 0.8B. As per table 7 and 8 of IS 11592, b = 0.9B- 0.05 m for B ≤ 2 m. Therefore, the assumption b = 0.8B is more conservative for B > 500 mm. Referring to Fig. 6.1.12(*a*), the cross sectional area of the load on a flat belt is :

$$F_1 = \frac{bh}{2} = \frac{1}{2}\,(0.8B \times 0.4B \tan\varphi_1) = 0.16B^2 \tan(.35\varphi) \qquad ...(i)$$

Therefore, the conveying capacity "Q_f" of a flat belt conveyor is given by

$$Q_f = 3600F_1 \times V \times \gamma = 576B^2 V\gamma \tan(0.35\varphi), \text{ tons / hr} \qquad ...(ii)$$

where,
γ = bulk density of material in tons /m3, and
V = velocity of belt in m/sec.
B = Belt width in meters

(*a*)

(*b*)

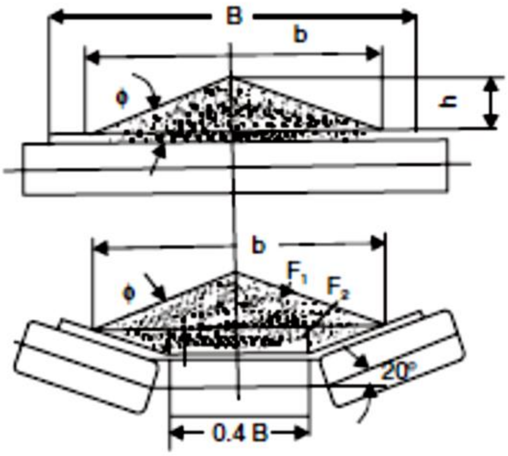


Fig. 6.1.12. Bulk load on flat and troughed belt conveyor

(*ii*) For a three roller troughed belt conveyor (Fig. 6.1.12 [*b*]), where the length of the carrier rollers are equal, the length of each roller lr can be taken as a lr = 0.4B. Let the trough angle be ''λ''. Then, cross sectional area of the load, F = F1 + F2.
The trapezoidal area:

$$F_2 = \frac{1}{2}(0.4B+0.8B) \times 0.2B \tan\lambda = 0.12B^2 \tan\lambda \qquad ...(iii)$$

This is based on the assumption that the base "b" of top triangular area is given by b = 0.8B, as considered in (i) earlier.

$$F = 0.16B^2 \tan(.35\varphi) + 0.12B^2 \tan\lambda = B^2[0.16 \tan(.35\varphi) + 0.12 \tan\lambda]$$

The conveying capacity "Q_{tr}" of the troughed conveyor is

$$3600FV\nu = B^2V\nu\,[576 \tan(.35\varphi) + 432 \tan\lambda], \text{ tons/hr} \qquad ...(iv)$$

(*iii*) In case of flat belt carrying unit (box shaped) load the belt width B is taken to be ≅ width of the load + 200 mm. The capacity of the conveyor in terms of number of unit loads conveyed per unit time depends on orientation of unit loads on belt and speed of belt. Orientation of load depends on strength of the belt to carry unit load as well as on stability of the load on conveyor. This can be explained by an example given below.

Example:

Boxes of size 220 mm × 180 mm × 100 mm have to be conveyed by a belt conveyor of sufficient belt strength, at the rate of 2000 boxes per hour. What will be the size and speed of the conveyor?

Solution:

For stability, the boxes should be conveyed with their 100mm side as height. For safe conveying of boxes without moving off the belt, the belt width should be suitable for conveying the boxes with 220 mm side as width on the belt. So belt width should be 220 + 2 × 100 = 420 mm or its nearest higher standard size.

With 420 mm belt width, even the maximum corner dimension of the box $\sqrt{220^2 + 180^2}$ = 284 mm will leave a side clearance of 1/2 (420 – 284) = 68 mm. As per IS 1891:1994 (part I), the next higher standard size of 500 mm wide belt is chosen.

If the boxes are placed with a gap of say 200 mm between two boxes, then the maximum speed of conveyor "V" $= \frac{2000 \times (180 + 200)}{60 \times 1000}$ =12.67 m/min, which is quite a low speed for a 500 mm belt conveyor, hence acceptable.

In this problem, it is to be noted that, delivery of 2000 boxes per hour means same number of boxes to be loaded also *i.e.*, at a rate of 3600/2000=1.8 seconds per box. This may not be possible by manual loading and some type of automatic loading device needs to be incorporated.

(b) Belt Tension

In belt conveyor, the motive force to draw the belt with load is transmitted to the belt by friction between the belt and the driving pulley rotated by an electric motor. From Euler's law of friction drive, considering no slip between the belt and pulley,

$$\frac{T_1}{T_2} = e^{\mu\alpha}, \qquad \ldots(v)$$

where, T_1 = Belt tension at tighter side
T_2 = Belt tension at slack side
α = Wrap angle in radian
μ = Coefficient of friction between pulley and belt

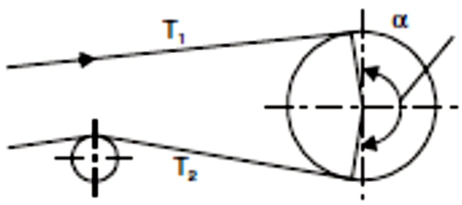


Fig. 6.1.13. Tensile forces on belt

T1 – T2 = ''Te'' is the effective pull in the belt which is pulling the loaded belt against all resistances against the belt movement.

From eqn.(*v*), $$T_e = T_1 - T_2 = T_2(e^{\mu\alpha} - 1) \qquad \ldots(vi)$$

(*d*) Motor Power

The power required at the driving pulley just for driving the belt is given by the formula:

$$P_d = \frac{T_e \times V}{1000} \text{ kW, where } T_e = \text{effective tension} = (T_1 - T_2) \text{ in Newton}$$

V = belt speed, m/sec
Pd = driving power, kW
However, the actual power requirements, considering the wrap resistance between belt and driving pulley, and driving pulley bearings resistance, the actual motor power, PA is given by

$$P_A = \frac{T_e V}{1000} + \frac{(R_{wd} + R_{bd})V}{1000} \text{ kW, where}$$

R_{wd} = wrap resistance between belt and driving pulley.
R_{bd} = driving pulley bearing resistance.

Additional power requirements should be taken into considerations for each belt tripper, and belt cleaner used with the conveyor. The final motor power ''PM'' is calculated based on efficiency ''η'' of the transmission system used consisting of gear box, chain / belt drive, coupling etc. Thus,

$$P_M = \frac{P_A}{\eta}.$$

Actual motor is chosen with a power rating of 15% to 20% greater than the calculated power 'PM'.

B. CHAIN CONVEYORS

Definition / Description

The term chain conveyor means a group of different types of conveyors used in diverse applications, characterised by one or multiple strands of endless chains that travel entire conveyor path, driven by one or a set of sprockets at one end and supported by one or a set of sprockets on the other end. Materials to be conveyed are carried directly on the links of the chain or on specially designed elements attached to the chain.

General Characteristics

Different types of chain conveyors are used in wide varieties of applications. It is, therefore, not possible to have a set of common characteristics for all these chain conveyors. Special characteristics of individual type of chain conveyors have been described while discussing them.

Chain, compared to belts of a belt conveyor, have certain advantages as well as disadvantages. The major advantages are that the chain easily wraparound sprockets of small diameter and the drive is positive i.e. no slippage takes place between chain and sprocket. The chain stretch is also little. The disadvantages of chain are its high weight, high initial cost, higher maintenance cost and most importantly, limited running speed because of dynamic loading that come into play in chain-sprocket drive causing intensive wear at high speeds. Maximum length and maximum lift of chain conveyors are limited by the maximum allowable working tension of the chain used.

Courtesy : TRF Ltd., Kolkata

Fig. 6.2.1. Photographs of typical apron conveyor

Types of Chain Conveyors

(*a*) **Apron or Pan Conveyor.**

Applications: Generally apron and pan conveyors are used to perform severe duties of convey-ing large quantities of bulk load such as coal, ore, slag, rock, foundry sand etc. These are frequently used for feeding materials to large crushers, breakers, grinders and similar machines. Specially designed aprons are used for conveying unit loads, coils, hot forgings. Part of an apron conveyor may be run through a liquid or water bath for washing of the materials and then allow drainage of liquid from wet materials. Apron conveyors can have flexible layout to follow combined horizontal and inclined movement in the same vertical plane.

Apron/pan design: Depending on the nature of materials to be conveyed, different designs of apron and pan are used. Some of the common designs are:

(*i*) **Flat, spaced apron.**

(*ii*) **Corrugated apron.**

(*iii*) **Special types.**

(*b*) **Cross-Bar or Arm Conveyor.**

Applications: Crossbar conveyors are used for conveying and elevating or lowering unit loads like barrels, drums, rolls, bags, bales, boxes etc. The conveyors may be loaded/unloaded manually or at automatic loading / discharging stations. Cross-bar conveyors are also used in a wide range of process applications such as dipping, washing, spraying, drying and assembly etc.

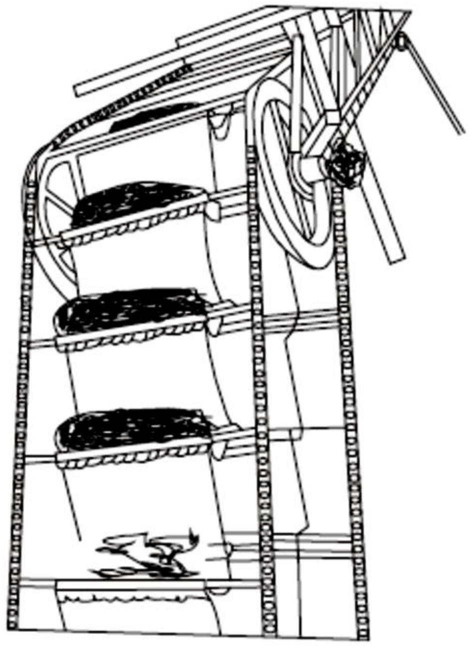


Fig. 6.2.4. Pocket type arm conveyor

(b) **Car-Type Conveyor**.

Applications: Car-type chain conveyors are particularly used for carrying heavy or irregular shaped large objects like moulds in foundries, coils for rolling plants etc.

These conveyors are conveniently used to combine different processing operations during transportation of the loads. Rolled coils may be cooled, molten metals may be solidified in moulds, assembly of components may be achieved, testing inspection may be performed etc.

The conveyors with horizontal runarounds can be arranged to move in any straight or irregular shaped path in the same horizontal plane, hence called contour type, which makes them very suitable for use in different process plant for picking up and delivery of materials from and to desired locations of the plant. On horizontal runarounds, a load not removed will continue to move with the conveyor. This gives an obvious advantage of using a short conveyor for accomplishing long duration processes (drying, cooling etc.) and irregular processes (foundry, testing etc). Horizontal carousel conveyor usually occupies larger floor space.

(*d*) **Carrier chain & Flat-top chain conveyor.**

(*e*) **Trolley Conveyor:** These conveyors consist of a series of trolleys supported from an overhead endless track and propelled by an endless chain or cable, with the loads usually suspended from the trolleys. This is one of the most versatile type of chain conveyors which can work in horizontal and inclined paths, vertical curves and horizontal turns to follow complicated routes.

(*f*) **Power and Free Conveyor:** These conveyors are basically a special design of the **Load-propelling or pusher trolley conveyors**. In a normal pusher trolley conveyor the non-powered trolleys, supported from a monorail, carry the load and are pushed by dogs/pushers attached to the chain trolleys mounted on a separate track. A power and free conveyor is one in which the power trolleys run directly above the free trolleys, which run in double channel track, and arrangements are made such that at desired points the non-powered load carrying trolleys may be engaged to or disengaged from the power trolleys.

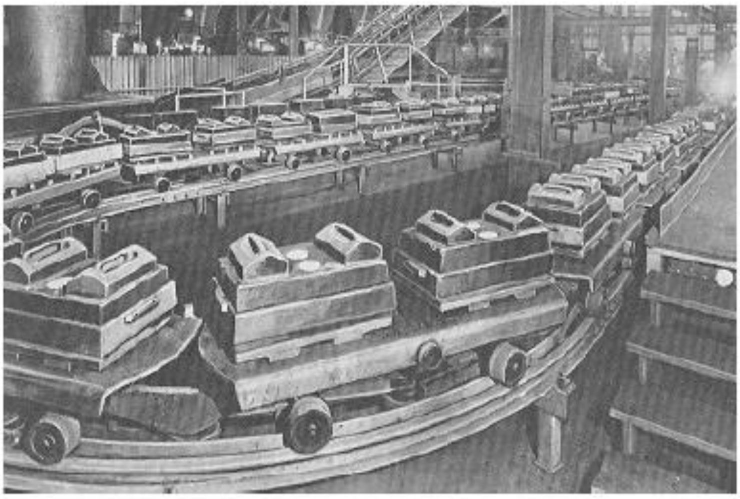


Fig. 6.2.5. Photographic view of car conveyor

(*g*) **Suspended Tray Conveyor**

conveyor. The bulk material is fed into the buckets on the lower horizontal section and carried through various sections without transfers, and hence is not crushed en-route. The pivoted buckets are discharged at the upper horizontal section automatically by tippers or dischargers. The buckets are fitted with projecting curved cams or guide rollers, which on coming in contact with the arms of tippers, tip the buckets. Pivoted bucket conveyors are used in power plants in carrying coal and ashes, in cement mills, ceramic industry, stone crushing plants etc.

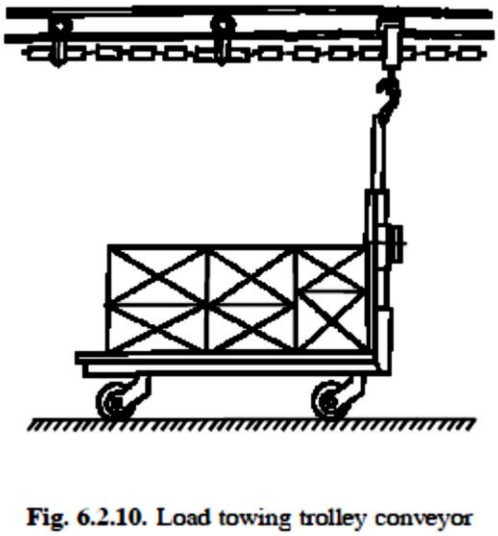


Fig. 6.2.10. Load towing trolley conveyor

Components of Chain Conveyor

The major components of a chain conveyor are: (*i*) Pulling chain, (*ii*) Sprocket to drive and support the chain, (*iii*) Take-up arrangement, (*iv*) Drive arrangement and (*v*) Various other components specific to various type of chain conveyors.

Aspects of Chain Conveyor Design

(a) **Dynamic Phenomena in Chain Conveyors:** In a chain-sprocket drive, engagement of sprocket to chain being discontinuous in nature, the linear velocity of the chain between two successive engagements with sprocket teeth becomes non-uniform. The reason for this is that the chain does not wrap around the driving sprocket on the pitch circle, but traces a pitch polygon, a phenomenon known as *chordal action*. The period of irregularity is equal to the time taken by the sprocket between two successive engagements (*i.e.* time taken by the sprocket to rotate by one pitch),

(*b*) **Chain Pull and Conveyor Horsepower:** The entire weight of materials and the moving parts of a chain conveyor is pulled by the chain or chains employed. It is, therefore, important to calculate the tension of each chain and select the chain with adequate strength to work safely under the working pull, the chain will be subjected to.

C. HAULAGE CONVEYORS

Definition/Characteristics

Haulage conveyor is a special group of chain conveyors. As the name implies, the material is dragged, pushed or towed by means of a chain or chains, making use of flights or surfaces which are parts of the chain themselves. The weight of the material is generally carried by stationary troughs, surfaces, or wheeled trucks/dollies on rails/floor. In certain designs, the chain may be replaced by cables. These conveyors are run at slow speed (15 to 60 mpm) and being built for heavy duty need little maintenance. However, the chains undergo wear under heavy tension and work in one direction only.

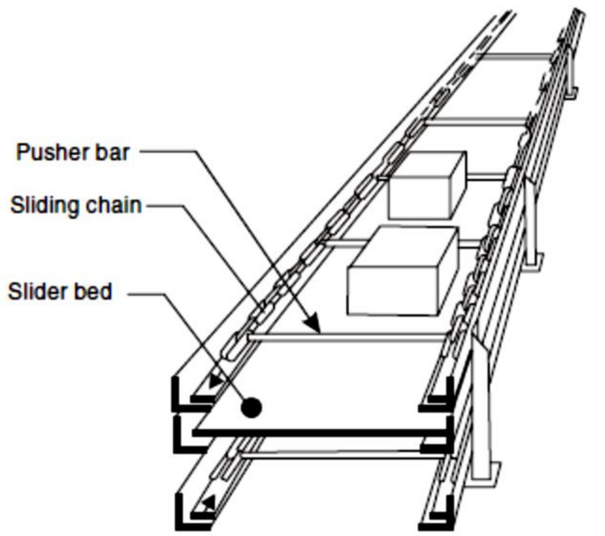


Fig. 6.3.1. Schematic view of a pusher-bar drag conveyor

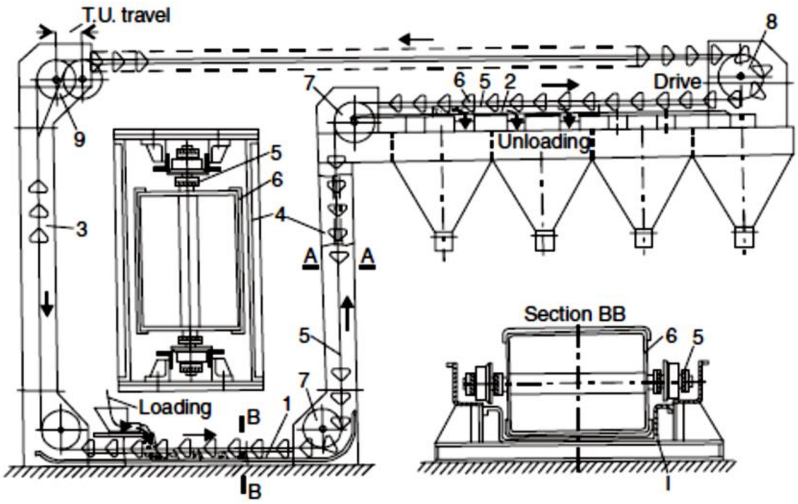
Types of Haulage Conveyors

Haulage conveyors are generally classified into drag conveyor, flight conveyor and tow conveyor.

(a) **Drag chain conveyor.**
(b) **Flight Conveyor.**

(*c*) **Tow Conveyor:** This consists of a single strand endless chain which tows floor/ track mounted trucks, dollies or cars on which the materials are placed. Tow conveyors are generally used for handling of unit loads like boxes, barrels, crates, cartons, in the warehouse, in assembly lines and for intra-plant movement. Though the tow conveyors follow a fixed path, the carts can be detached easily from the conveyor and moved to other points.

(c) (i) over-head
(d) (ii) flush-floor
(e) (iii) under-floor



1,2- horizontal trough; 3,4-casing of vertical sections; 5-chain; 6-buckets; 7-turning sprockets; 8-driving sprocket; 9-take-up sprocket.

Fig. 6.3.2. V-bucket flight conveyor

Applications (It's handling the following items)

- Bulk materials,
- Hot materials, (transferring hot steel sections)
- Abrasive materials,
- Logs/timber,
- Packages,
- Moving car assembly,
- Handling refuse materials like clinkers,
- Handling coal, ashes, sand, ore, wood chips,
- Handling of unit loads like boxes, barrels, crates, cartons,
- Moving automobiles, wash racks

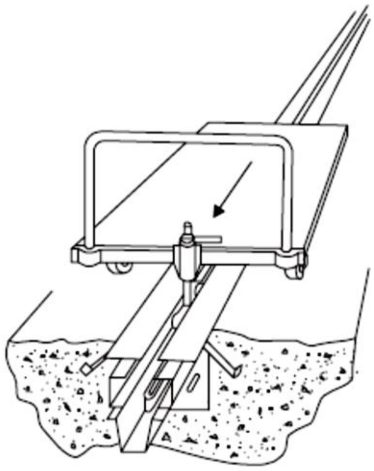


Fig. 6.3.3. Underfloor tow conveyor

D. CABLE CONVEYORS

Definition, Description and General Characteristics

These conveyors form a distinct group of materials handling equipment to transport people and bulk materials in load carrying buckets, using overhead moving cables and/or wire ropes and are composed of one or more spans from the loading point to the discharge point/points covering long distances upto several kilometers. These conveyors are also known as **ropeways** or **aerial tramways**.

Classification

From design point of view there are primarily two distinct systems of aerial tramways/ropeways, the **bicable** and the **monocable** system.

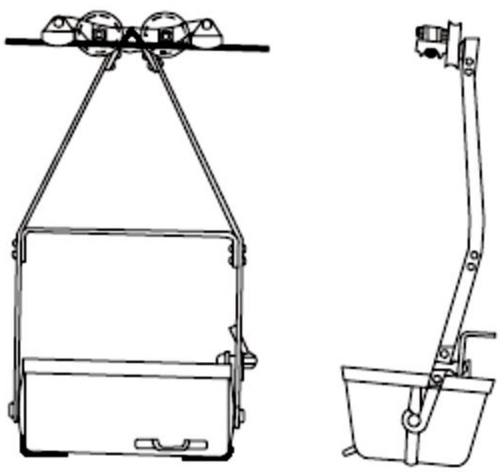


Fig. 6.4.1. Monocable carrier with rope grip, of the rotary dump bucket type

In the bicable system one or more (commonly two) stationary high-tensioned track cables are used over which carriers are placed from which hang the load carrying buckets. For a continuous bicable system, two stationary cables are needed. The carriers are pulled by one endless traction or pulling rope moving continuously in one direction. The loaded carriers move from the loading terminal to the discharge terminal, while the empty ones move in the opposite direction. For reversible bicable system one track cable is sufficient.

In the monocable tramways system, one endless moving wirerope is used for supporting as well as moving the carriers.

Monorail Tramways is another type of cable conveyor in which the load carriers run on suspended rails, and moved by a moving wire rope. This is essentially a trolley chain conveyor where the traction chain is replaced by a wire rope. These are used for towing load between much shorter distances.

Components of a Cable Conveyor

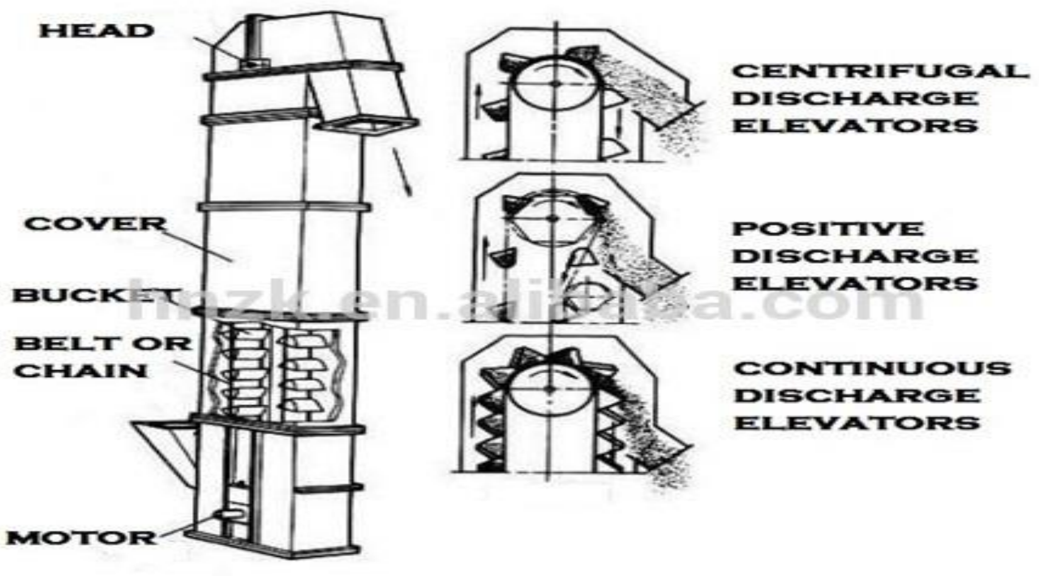
A cable conveyor basically consists of (*i*) one or more cables/wireropes, one of which is driven which pulls the load; (*ii*) a number of load carrying buckets or carriers which are hung through hangers from wheeled (2-wheel or 4-wheel type) carriages; (*iii*) loading and discharge terminals; (*iv*) intermediate towers for supporting the cable/rope and (*v*) drive arrangement.

Applications

- Handling of Coal
- Used in Cranes
- Transporting People (Carrying Bucket)
- Bulk Material

E. BUCKET CONVEYORS

These conveyors convey bulk loads in bucket shaped vessels which are attached to a system of moving chains or belt. These are generally classified as (*a*) Gravity discharge bucket conveyor, (*b*) pivoted bucket conveyor and (*c*) bucket elevator.



TYPES OF BUCKET ELEVATORS

F. ROLLER CONVEYORS

Definition and Characteristics

A roller conveyor supports unit type of load on a series of rollers, mounted on bearings, resting at fixed spacing on two side frames which are fixed to stands or trestles placed on floor at certain intervals. A roller conveyor essentially coveys unit loads with at least one rigid, near flat surface to touch and maintain stable equilibrium on the rollers, like ingots, plates, rolled stock, pipes, logs, boxes, crates, moulding boxes etc. The spacing of rollers depend on the size of the unit loads to be carried, such that the load is carried at least by two rollers at any point of time.

Roller conveyors are classified into two groups according to the principle of conveying action. These are:

1. Unpowered or Idle Roller Conveyor.
2. Powered or Live Roller Conveyor.

In an unpowered roller conveyor, the rollers are not driven or powered from an external source. The loads roll over the series of rollers either by manual push or push from an endless moving chain or rope fitted with pusher dogs, rods or clamps. Generally these conveyors operate at horizontal plane, but at times a gentle slope is given to these conveyors to aid motion of the loads. An inclination of 1.5% to 3% ensures that the load will roll by gravity. Such conveyors are termed **"gravity roller conveyor''**.

In a powered roller conveyor, all or a selected number of rollers are driven by one or a number of motors depending on the selected drive arrangement. The driven rollers transmit motion to the loads by friction. The powered roller conveyors may be installed at a slightly inclined position, up to 10° up or up to 17° down. The load can be moved in either directions by changing the direction of rotation of the rollers, where these are called reversing conveyors.

Roller conveyors are used for conveying almost any unit load with rigid riding surface that can move on two or more rollers. These are particularly used between machines, buildings, in warehousing as storage racks, docks, foundries, rolling mill plants, manufacturing, assembly and packaging industry. They are also used for storage between work stations and as segment of composite handling system.

However, the limitations of rollers conveyors are that they can be best used for objects with rigid flat surfaces, and for movement to relatively short distances. Needs side guards to retain the loads from falling off. Gravity roller conveyors have the risk of accelerating loads.

Types of Roller Conveyor

(*a*) **Unpowered Roller Conveyor**

Special designs/features

A number of features can be incorporated in an unpowered conveyor to satisfy different functional requirements. Some of these are described below.

(*i*) Double-row roller conveyor.

(*ii*) Curved sections.

(*iii*) Switches.

(*iv*) Stops

(*b*) **Powered Roller Conveyor.**

(*i*) Rollers.

(*ii*) Frames.

(*iii*) Drive arrangement.

(*c*) **Portable Roller Conveyor**

Aspects of Roller Conveyor Design

(*a*) **Unpowered Roller Conveyors**

The major design calculations involved are to determine the force required to overcome the resistance to motion of the loads and the angle of inclination required for a gravity conveyor.

(*b*) **Powered Roller Conveyors**

Transport conveyor

The rollers of a group driven transport conveyor are rotated continuously in one direction irrespective of loads being on the conveyor or not.

The maximum torque of a reversing conveyor drive motor is so chosen that the motor does not stall even if the load does not move, i.e. the rollers can skid under the static load.

Applications

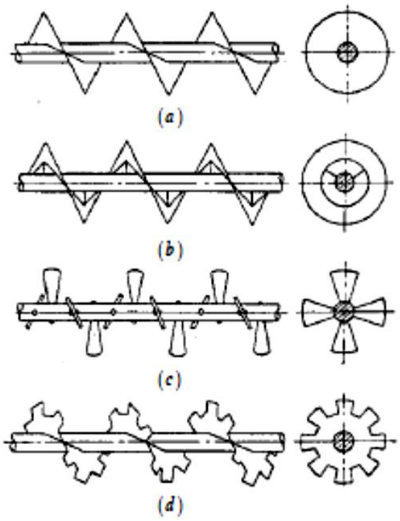
- Used for conveying almost any unit load with rigid riding surface
- Used between machines, buildings, in warehousing as storage racks, docks, foundries, rolling mill plants, manufacturing, assembly and packaging industry.
- Used for storage between work stations and as segment of composite handling system.

G. SCREW CONVEYORS

Definition, Characteristics and Use

A screw conveyor consists of a continuous or interrupted helical screw fastened to a shaft which is rotated in a U-shaped trough to push fine grained bulk material through the trough. The bulk material slides along the trough by the same principle a nut prevented from rotating would move in a rotating screw. The load is prevented from rotating with screw by the weight of the material and by the friction of the material against the wall of the trough.

A screw conveyor is suitable for any pulverized or granular non viscous material, and even at high temperature. The conveyor is particularly suitable for mixing or blending more than one material during transportation, and also for controlling feed rate of materials in a processing plant. Abrasion and consequently certain amount of degradation of the material is unavoidable, hence it is not suitable for brittle and high abrasive materials. It is also not suitable for large-lumped, packing or sticking materials.



(a) solid, continuous; (b) ribbon; (c) paddle-flight; (d) cut-flight

Photographs of different types of screw

Fig. 6.7.2. Types of screw used in screw conveyor

Descriptive Specifications

The screw shaft, if short (up to 5 meters), is supported at two ends. But for longer shafts (upto 40 to 50 m), they are supported by bearing hangers, at intermediate points. The shaft may be solid or hollow. Hollow shafts are lighter and can be easily joined to make a long shaft. The screw shaft is driven at one end, and the design may permit discharge of material from the bottom or one end. Opposite handed screw at two sides will cause the center dis-charge. The U-shaped fabricated trough is generally covered at the top to avoid particulate pollution. The bottom portion of the trough is of circular cross section matching the diameter of the screw. Generally a radial gap of 10 mm to 20 mm is kept between the screw and the trough, depending on size of the screw.

The drive unit comprises of an electrical motor, gear box and couplings.

Material is fed through the feed hopper fixed on the trough cover. A number of discharge sprouts with rack gears for closing and opening as required, are provided.

Screw conveyors are generally operated horizontally or at a small inclination (10° to 20°). However, there are special designs where the load is moved vertically up or at a small angle to vertical. These are called vertical screw conveyors.

Advantages

- Shorter distance,
- Totally enclosed from atmosphere,
- Cheap Initial Cost,
- Simple and Compact,

Disadvantages

- High Power Consumption
- Length is limited up to 30m
- High Maintenance

Aspects of Screw Conveyor Design

(*a*) **Recommended Dimension of a Screw Conveyor:** The dimensions of principal components of a screw conveyor are nominal diameter of the helical screw, pitch of the screw, diameter of screw shaft, width of trough determining the gap between trough and screw, trough height from center of screw shaft, thickness of trough material and nominal thickness of screw flights.

(*b*) **Effect of Lump Size**: The selection of size of a screw conveyor basically depends on two factors. (*i*) the conveying capacity required and (*ii*) the lump size of the materials to be conveyed. The lump size of materials determines the minimum size of the screw diameter 'D' to be chosen. D is recommended to be at least 12 times the lump size of a sized material or at least 4 times the largest lumps of an unsized material.

(*c*) **Capacity of Screw Conveyor:** The volumetric capacity 'V' in M3/Hr depends on screw diameter 'D' in meters, screw pitch 'S' in meters, its rotational speed 'n' rpm and the loading efficiency of the vertical cross sectional area 'φ'. The tonnage capacity 'Q' in tons/hr is given by:

$$Q = V\gamma = \frac{\pi D^2}{4} S\ 60 n \phi \gamma C \text{ tons/Hr.}$$

Where, γ = bulk density of material in tons per m3
C = factor depending on inclination of conveyor.
In a typical design , S = D to 0.8 D.
φ varies with flow ability of the material as under:

Material Characteristics	Value of φ
1. Slow flowing, abrasive (clinker, ash)	0.125
2. Slow flowing, mild abrasive	0.25
3. Free flowing, mild abrasive (sand)	0.32
4. Free flowing, non-abrasive (grain)	0.4

Value of 'C' varying with inclination angle β is related as shown in following chart.

β	0°	5°	10°	15°	20°
C	1.0	0.9	0.8	0.7	0.65

The screw diameter and speeds vary widely depending on the designed capacity of the conveyor and the nature of the material handled. However, the speed is generally reduced as the diameter goes up, as shown in following table:

Screw dia, mm	160	200	250	300	400	500	630
Maximum rpm	150	150	120	120	95	90	75
Minimum, rpm	25	25	20	20	20	15	10

(*d*) **Power Requirements of Screw Conveyor:** IS:12960:1990 "Determination of Power Requirement of Screw Feeder—General Requirements", has recommended the method for calculation of power requirement of a screw conveyor. The driving power of a loaded screw conveyor may be estimated by the formula:

$$P = PH + PN + Pst$$

where,

PH = power necessary for conveying the material.

PN = driving power of the conveyor at no load.

Pst = power requirement for inclination of the conveyor.

$$P_H = \frac{QL'}{3600} \lambda g, \text{kW} = \frac{QL'\lambda}{367}, \text{kW}$$

where,

Q = mass flow rate in t/hour.

L = length of material movement in conveyor in m.

λ = progress resistance coefficient.

$$P_N = \frac{DL}{20}, \text{kw}$$

Where,

D = Nominal screw diameter, m

L = Length of screw, m

$$P_{st} = \frac{QHg}{3600} = \frac{QH}{367}, \text{kW}$$

Where,

Q = mass flow rate in t/hr.

H = height in m.