

Design Consideration Of Adjustable Height And Radial Belt Conveyor System

R.K.Bhoyar¹, Dr. C.C.Handa²
P.G.Student¹, Head of Department²
Department of Mechanical Engineering
K.D.K College of Engineering, Nagpur (Maharashtra)

Abstract: In any industrial process, the product being manufactured passes through various phases and it needs to be transported from place to place. This could involve processes such as transporting of raw material to the machines and then shifting the machines from one station to another station and finally to the store or warehouse. This involves the use of material handling equipment. Simplest form of material handling is to take material from one place to another place manually or with the help of worker. In large production setups, where the production rates are high and the product to be handled is such that manual transportation is not possible, sophisticated material handling systems would be required. This paper attempts to discuss the generalized design consideration for adjustable height and radial belt conveyor.

Keywords: Adjustable height, belt conveyor, radial belt conveyor

I. INTRODUCTION

Depending on the density of raw material and the quantities to be handled, many different methods are employed for transporting sugar in bulk, including-

1. Screw conveyors;
2. Grasshoppers;
3. Belt conveyors;
4. Bucket: elevators.

Most of the above-mentioned types of conveyors may be seen in almost any factory, each method has its own particular problems which suit it to certain applications. Belt conveyors have their attraction for most applications because of the small number of wearing parts, which results in low maintenance costs; and the absence of relative movement between the raw material and conveyor components with which it is in contact, which results in minimum product degradation. However, they can be extremely difficult to install successfully. It may be stated that almost anyone could successfully design a belt conveyor to carry a given quantity of raw material, or any other commodity. The secret of the successful design of a conveying system lies in the design of the transfers to and from the conveyor, to ensure maximum loading of the belt with minimum spillage.

II. BASIC OBJECTIVES

These basic objectives that a material handling system should fulfill are:

1. Quick and precise pick-up of loads.
2. Quick and efficient transfer of load with planned time interval.
3. Transport of loads in planned quantity.
4. Safe transport without any damage.
5. Accuracy in delivering at the destination.
6. Automation with minimum human element.
7. Low initial and operational costs.
8. Simple and easy to maintain.

III. PROBLEM IDENTIFICATION

In many foods processing industry where spices are manufacture, the raw materials are feed manually in hooper; due to this following problems are identified-

- ❖ Required more labour
- ❖ Required more cost
- ❖ Less Efficiency
- ❖ Required more time in feeding
- ❖ Small working floor
- ❖ Human safety is less
- ❖ More Wastage

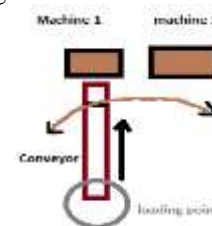


Fig.3.1. Proposed path of Belt conveyor system

IV. PROBLEM FORMULATION

After brief study on following aspect for food product industry manufacturing spices, it concludes that adjustable height and radial belt conveyor system is the best suitable for the industry.

- ❖ Design adjustable heighted belt conveyor to feeding
- ❖ Design belt conveyor to carry maximum load.
- ❖ Safety, load or impact factor to be use
- ❖ Preferred method of support and adjusted height of belt conveyor.
- ❖ Design the belt conveyor which works in straight as well as in inclined path and rotates in 360°.
- ❖ Path for belt conveyor to feeding raw material.
- ❖ After the formulation of problem, it is decide to design the belt conveyor roller system in following type:

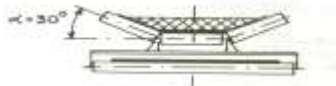


Fig.4.1. 30° Inclination of roller for Belt conveyor

V. BELT CONVEYOR SYSTEM

A belt conveyor consists of an endless belt of a resilient material connected between two pulleys and moved by rotating one of the pulleys through a drive unit gearbox, which is connected to an electric motor. Material is conveyed by placing it on the belt, through a feeder. As the belt rotates, the material is carried with it on the other end, where it is then dropped in the discharge chute. Height of conveyor belt is adjusted by Pneumatic cylinder. Roller wheel help to rotates conveyor system in all direction.

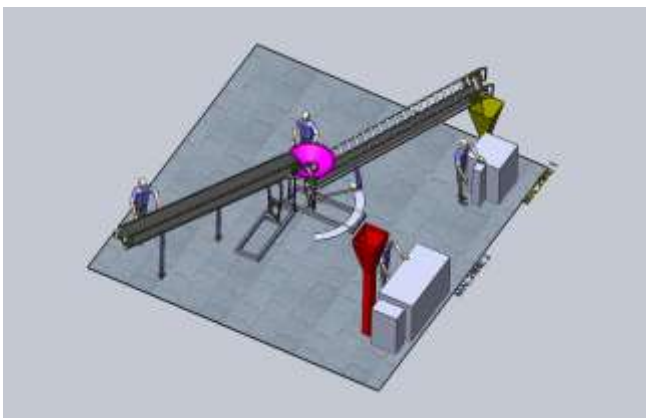


Fig.5.1. Proposed Diagram of belt conveyor system.

VI. MAJOR EQUIPMENTS OF BELT CONVEYOR SYSTEM

- A. Conveyor Belt
- B. Pulleys and Idlers
- C. Coupling
- D. Bearing
- E. Motor
- F. Pneumatic Cylinder
- G. Structural Frame
- H. Hopper

A. Conveyor belt:

Conveyor belt is made up of compounds comprised of natural rubbers, Styrene-butadiene rubber blends of natural

of raw material in hooper of grinder.

and other synthetics, nitrites, butyl, ethylene propylene-based polymer, polychloroprene, polybutadiene, polyvinyl chloride, urethanes and silicones, etc., Each of those elastomers has specific usefulness for various ranges of properties and operating conditions from which manufacturers and end-users can choose.



Fig.6.1. Section view of belt

B. Pulleys and Idlers

The most commonly used conveyor pulley is the standard steel pulley. They are manufactured in a wide range of sizes and consist of a continuous rim and two end discs fitted with compression type hubs. In most wide faced conveyors pulleys, intermediated stiffening discs are welded inside the rim. Outer pulleys available are self cleaning wing types, which are used at the tail, take up or snub locations where materials tends to built up on the pulley face, and magnetic types which are used to remove tramp iron from the material being conveyed. The needs for Idlers are to give proper support to conveyor and also to the Material to conveyor. An endless conveyor belt in a conveyor structure is dragged from the tail pulley where material is loaded onto the conveyor, to the head pulley or drive pulley where the material is discharged. Between a conveyors' tail and head pulleys, whether the distance is a number of kilometers or merely a few meters, the carrying and return strand belting is supported on idler sets. The rolls are fitted with antifriction bearings with seals and with adequate lubrication packed into it. The friction between the roller surface and the belt makes the rollers to rotate and thus material is transferred from one point to another through belt conveyor.



Fig.6.2. The arrangement of Idlers in a Belt Conveyor

C. Coupling

Couplings are the device used to couple or connect two shafts; this is one of the most important components of any drive system. Since it is impossible to maintain co linearity between two shafts couplings are designed to provide better flexibility to allow initial or running shaft misalignment. Following are the type of flexible couplings.

- Fluid Coupling
- Chain Coupling
- Geared Coupling
- Grid coupling

- Universal coupling

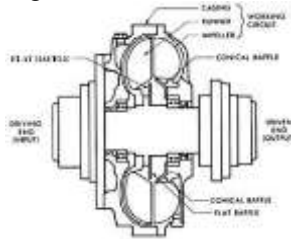


Fig.6.3. Diagram of Coupling

D. Bearing

Bearings are used to give support the shaft of the roller or idle pulley at both ends. They give also rotational motion of shaft by giving it support with very less friction. Though some friction is taken place due to the metal to metal contact inside the bearing between metal balls and metal casings, it is very negligible as compare with the direct contact of rotating shaft and main frame of the conveyor.

TYPES OF BEARINGS:

There are many types of bearings, each used for different purposes. These include-

1. Ball bearings
2. Roller bearings
3. Ball thrust bearings
4. Roller thrust bearings
5. Tapered roller thrust bearings.

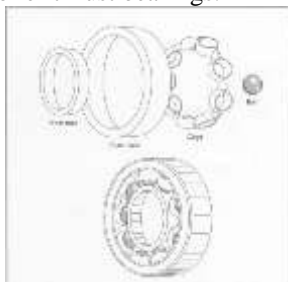


Fig.6.4. Diagram of Bearing

E. Motor

Motor is a prime source of the energy to run the whole belt conveyor system. By taking current, it produces the mechanical work and this mechanical work is given to head pulley or tail pulley of the conveyor by means of gear box drive as discussed above. We can also use an induction motor with variable speed drive by changing its frequency.



Fig.6.5. Electric motor

TYPES OF DRIVE UNIT

- A) Direct gear motor drive.
- B) Drive through parallel shaft gear box.

- C) Drive through primary reduction by v belt and secondary by gear box.
- D) Drive through spiral bevel or worm gear box.

F. Pneumatic Cylinder

A pneumatic cylinder is a device with two chambers separated by a bore. Each chamber has 1 valve and each valve has two ports (orifices): One port (The supply port) connects the chamber to a compressor and the other port (The exhaust port) connects the chamber to atmospheric pressure. A small cylinder typically has a bore diameter of 5/16 and a stroke of 2 inches. Larger, yet typical cylinders have bore diameters of 3 inches stroke lengths of about 6 inches.

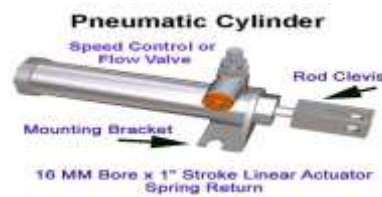


Fig.6.6. Pneumatic Cylinder

G. Structural frame

Lower frame and the upper frame of the belt conveyor are fabricated from steel sheets and formed in the shape of C channel. Four legs are fabricated from steel angles. Two wheels are fixed to the front side lower frame to facilitate its movement in the field and also used lead screw or piston cylinder (pneumatic or hydraulic) arrangement for movement in up and down direction for adjusting height. The upper frame consists of the belt frame, drums, transmission system, belt, and linen cover.

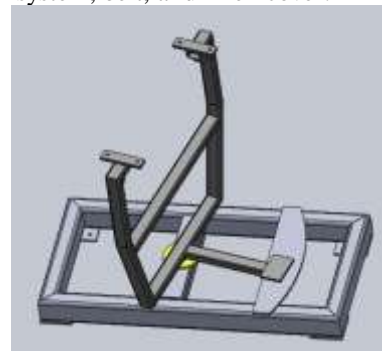


Fig.6.7. Proposed diagram of Structural Frame

H. Hopper

Circular type of hopper is used for transferring the raw material from one conveyor belt to other. Circular hopper help to avoid the spillage of material. It is made up of mild steel. Frame portion of circular hopper is attached with horizontal conveyor belt structure. Both conveyor belt move in any direction, but the material is fall in the centre of second belt conveyor.

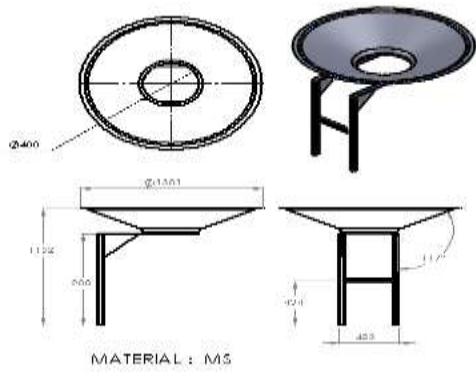


Fig.6.8. Proposed diagram of Hopper

VII. WORKING PROCESS OF BELT CONVEYOR SYSTEM

Figure shows the complete assembly of belt conveyor system. It consists of two belt conveyor, Y-Bracket, Pneumatic cylinder, bottom stand and circular hopper. Raw material which is stocked in all the floor area are feed on the first horizontal belt conveyor from which material is transfer to another belt through the circular hooper. Second belt transfer raw material in inclined direction to the hopper of grinding machine. All hoppers are

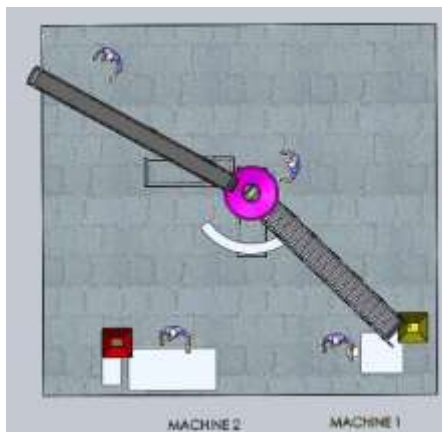


Fig.7.1. Top View of Proposed conveyor system

of different height, belt conveyor achieved this height by using pneumatic cylinder. It also rotates radically with the help of bearing support at the base. It is easily move in any direction. It run by drive unit, the speed of belt conveyor can be controlled by using control system as per the need of feeding. Vertical column of first conveyor belt is help to move conveyer belt in any direction for conveying of raw material. The lock system is provided to the wheel for locking the wheel at the time of running of belt conveyer system.

VIII. ANALYTICAL CALCULATION OF BELT CONVEYOR SYSTEM

Step 1: Belt selection

Step 2: Pulley and drive design

Step 3: Frame design

Step 4: Supports design

Step 1: Belt selection

Operation forces and torque:

Pulley speed, $\omega = 12 \text{ s} / (30 \text{ dp})$

Pulley weight, $W_p = (0.283 \text{ lbs/in}^3) \pi \text{ dp}^2 \text{ wp} / 4$

Pulleys mass inertia, $J_p = 2 (W_p \text{ dp}^2 / 8)$

Belt weight, $W_b = m \text{ wb}(24 \text{ Lb} + \pi \text{ dp}) / 144$

Belt mass inertia, $J_b = W_b \text{ dp}^2 / 4$

Load mass inertia, $J = W \text{ dp}^2 / 4$

Total mass inertia, $J_t = J_p + J_b + J$

Acceleration torque, $T_a = J_t a / 386$

Friction force between belt and slider bed,

$$F_f = (W + 12 m \text{ Lb} \text{ wb} / 144) f_b \cos(\alpha)$$

Friction torque, $T_f = F_f \text{ dp} / 2$

Lifting force, $F_l = W \sin(\alpha)$

Lifting torque, $T_l = F_l \text{ dp} / 2$

Total torque, $T_t = T_a + T_f + T_l$

Power, $P = T_t \omega / 6600$

Belt tension and stress

Tension (carrier side)

$$F_1 = \{T_t / (\text{dp} / 2)\} / \{1 - 1 / (2.718 (f_p \theta))\}$$

Tension (return side) $F_2 = F_1 / (2.718 (f_p \theta))$

Step 2: Pulley and drive design

Pulley deflection under maximum load Section inertia,

$$I_p = \pi (\text{dp}^4 - \text{di}^4) / 64$$

Deflection,

$$y = \{5 (F_1 + F_2) \text{ wp}^3\} / \{384 \times 29000000$$

$I_p\}$

Drive shaft loads

Force from gear motor torque, $F_m = 2 T_t / D_s$

Distributed belt force,

$$Q = (F_1 + F_2) / C$$

Left bearing reaction,

$$R_1 = (Q C (C/2 + D) + F (A + B + C + D)) / (B + C + D)$$

Right bearing reaction,

$$R2 = Fx + Q C - R1$$

IX. ANALYSIS OF BELT CONVEYER SYSTEM

In the initial year, the conveyer belt design techniques were built on top of commercial CAD system and expert system tools. These approaches were mainly concerned with design configuration and there were little analysis on the components of the belt conveyer system.

A. Meshing of vertical column

Before analysis of vertical column of conveyer belt system, it is need to mesh of all the portion of vertical column.

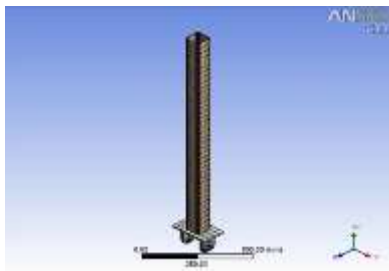


Fig.9.1. Meshing of vertical column

After meshing the analysis is proceed on vertical column in solid works software system and the result is obtained on directional deformation, total deformation and equivalent stresses. The analysis of the designed vertical column element has been done using analysis software “Ansys-V11”.

Directional Deformation

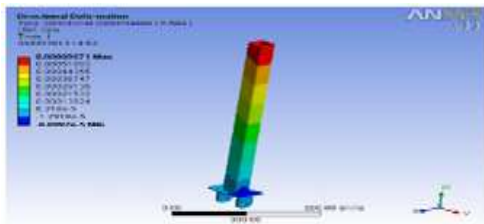


Fig.9.1.1. Directional Deformation of vertical column

Fig shows the directional deformation developed in the vertical column. It is seen that the maximum deformation value is 0.06 mm. The value of directional deformation developed ranges from -8.8997e-5 mm to 0.06 mm.

B. Meshing of Y-bracket

Before analysis of Y-Bracket of conveyer belt system, it is need to mesh of all the portion of Y-bracket.

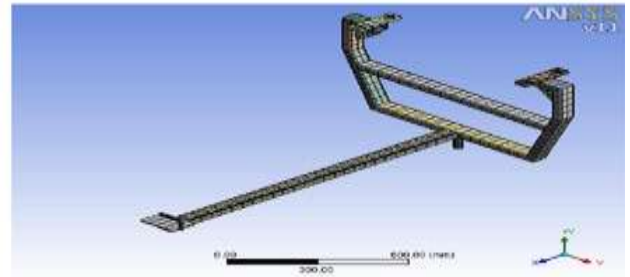


Fig.9.2. Meshing of Y-bracket

After meshing the analysis is proceed on Y-bracket in solid works software system and the result is obtained on equivalent elastic strain, total deformation, directional deformation and equivalent stresses. The analysis of the designed Y-bracket element has been done using analysis software “Ansys-V11”.

Directional Deformation

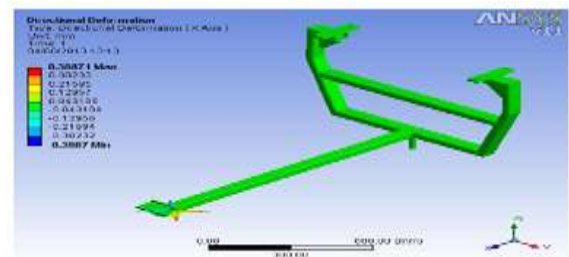


Fig.9.2.1. Directional deformation of Y-bracket

Fig shows the directional deformation developed in Y-bracket. It is seen that the maximum deformation value is 0.388mm. The value of directional deformation developed ranges from -0.388 mm to 0.388 mm.

X .CONCLUSION

After calculating all the values by analytically method and analyzing the main components of belt conveyer system. It is conclude that the belt conveyer system work safely.

The system suggested is easy to install. The system is having greater reliability and protection. The system does not require any complicated components

REFERENCES

- [1] A.m. guthrie and J. r. pilcher (April 1968) “The Design of belt conveyor for bulk sugar handling “
- [2] El-Gindy, A. M. , Baiomy, M. A., Abdelhamed, M. M.And Mosa, Sahar, A (April 2009) “Design and

fabrication of a simplified mechanical handling system of rice straw baling operation to reduce environment pollution”

- [3] S. S. Vanamane, P.A. Mane, K. H. Inamdar (2011) “Design and its Verification of Belt Conveyor System used for Cooling of Mould using Belt Comp Software”
- [4] radosław zimroz, robert król (2009) “Failure analysis of belt conveyor systems for condition monitoring purposes”
- [5] A.W. Roberts (1981) “Economic analysis in the optimization of belt conveyor systems”
- [6] Raghendra Singh gurjar, Arvind yadav, Pratesh jayaswal (May 2012) “Failure analysis of belt conveyor system in a thermal power plant”
- [7] Larry Goldbeck (9th International Conference-2007) “Improving Belt Conveyor Safety With Better Procedures and Training”
- [8] H. Lauhoff, Germany (2005) “Speed Control on Belt Conveyors -Does it really Save Energy?”
- [9] David Beavers, David Morrison & David Rea (2005) “Non-Linear Model for Dynamic Analysis of Conveyors”
- [10] Franz Kessler (2006) “Recent developments in the field of bulk conveying.
- [11] Bulk material handling by conveyor belt v-Aallen reicks, Michael t. Myers, Society for Mining Metallurgy & Exploration (February 2004)
- [12] Conveyors: application, selection, and integration- Patrick m McGuire, CRC Press; 1 edition (August 5, 2009)
- [13] Food plant engineering systems- Theunis Robbert, CRC Press, (February 20, 2013)
- [14] Handbook of conveying and handling of particulate solids-Avi levy, Haim kalman, Volume 10 of Handbook of powder technology, ISSN 0167-3785 (2001)
- [15] Manufacturing processes and systems -Phillip f. Ostwald, Jairo Munoz, Wiley; 9 edition (January 24, 1997)