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Energy Efficient Conveyor System for the Transport of Building Material from one Floor to the other

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Abstract: ***A material-handling system can be defined as movement, handling, storage and controlling of materials throughout the process. Flat conveyor belt is used to transport various things from one location to another location in horizontal as well as inclined directions. It is one of the type of material handling equipment. In developing countries manual material handling is done at a great extent at construction site for transporting different raw material such as cement, bricks, sand etc by local labours. Many times various accidents may occur due to improper handling of material leading to human injury or loss of quantity of material. Also the manpower required is large. So by using this flat belt conveyor, at a faster rate and with due to safety, we are trying to make such conveyor which can supply bricks from ground floor to first floor at construction site. Solar energy is rapidly advancing as an important means of renewable energy resources and also get available easily rather than other sources so that we also use solar panel as a energy source instead of electricity so that we can use this machine at areas where electricity is not available easily. If needed we can also use battery to store energy from solar panel so that on cloudy days also we are able to run the conveyor system. Our aim of the project is to reduce the effort required by worker at construction site, also to reduce the manpower needed for the same purpose and run this machine without electricity as an energy source so that we can also save it. We are also trying to make this project or machine in minimum cost so that small contractors can afford to purchase.***

Keywords: Conveyor Belt, Brick Transportation, Solar Energy

I. INTRODUCTION

Transportation of Bricks is a major problem for workers at construction site especially for women and weak labour. It would be very helpful for those people if anything beneficial can be done thereby reducing their work for loading and unloading of bricks, reducing accidental chances as well as increasing their efficiency. We can also reduce the manpower required for bricks supplying operation. Belt conveyor is the transportation of material from one location to another. Belt conveyor has high load carrying capacity, large length of conveying path, simple design, easy maintenance and high reliability of operation. By using inclined path we can supply the bricks from ground level to first floor with the help of belt conveyor. The important thing in this project is that we use solar panel as an energy source which is required to run the motor of conveyor. So by this we can use this machine in rural areas also where electricity is not available easily. We can run the total system on solar energy, available easily. By this project we are able to supply the bricks from ground level to first floor with much less effort. There are many machines or conveyors available in market to supply or transport various things in inclined direction but ease of dismantling, light weight, use of solar energy and safety is the important part of this project.

II. LITERATURE REVIEW

AbhilashaDongre, Professor N.Y. Mohite[1]: In this paper an attempt was made to review the considerations for material flow design problems (i.e. material handling equipment selection, flow path design, facility layout design, routing, etc.) for related product design in the Industry. It concludes that MH system plays a major role in productivity. Distribution, manufacturing, and warehousing and helps to give the best optimization to increase the productivity, reduced cost and idle time, proper utilization of labour, product quality and safety.

Ghazi Abu Taher, YousufHowlader, Md. Asheke Rabbi, Fahim Ahmed Touqir[2]: This paper is mainly based on the combination of Belt & Bucket Conveyers to perform complex task within a short time and successfully in a cost effective way. On account of this, a machine and its physical description are covered here with some basic calculation. The main purpose for building this machine was to automate the handling of bulk material and its packaging. They built a prototype for expressing their motive on this project. The total process is controlled by a control system automatically. They mainly focused on the packaging system. The control system helps to package the right amount of material in several packet. It stops the machine for a certain time between two packaging process. So once it is set, the requirement of skilled operator is also reduced as compared to a manual system.

Aniruddha V. Parlikar, Tanmay D. Kale[3]: This paper suggests the use of a material handling system to make a tedious task much easier. The task here is to load and unload different types of two wheelers (such as motorbikes and mopeds) in a multi-storeyed trailer used for their transportation. In India at least, this task is traditionally performed by the workers when a new set of vehicles is to be transported. A lot of effort is required by these workers to load the vehicle into the trailers. The system is inspired by escalators used to reduce human effort in climbing steps.

III. PROPOSED WORK

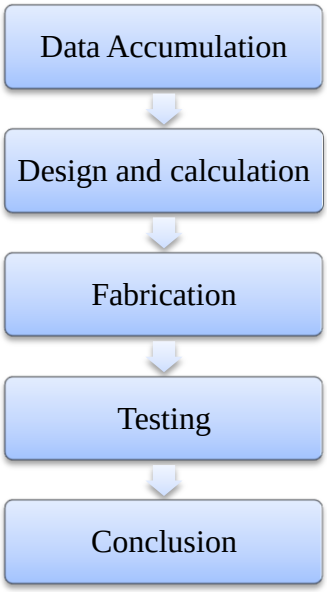

Fig 1. Flow chart of research methodology

Step-wise procedure

3.1 Data Accumulation: Study of material handling, various equipment's used in material handling, various types of conveyors, inclined flat belt conveyor and also various components to be used in project work and collected information from various sources. The various components which we have to be studied are motor, conveyor system, belt of conveyor, solar panel, battery, gearbox, bearings etc.

3.2 Design and calculation: To design and calculate parameters of various materials used in project.

3.3 Fabrication: Fabrication of actual inclined conveyor system which is our project for transporting bricks.

3.4 Testing: Testing various parameters like load carrying capacity, motor running etc of machine and calculation of working parameters.

3.5 Conclusion : By overall study of this project may conclude that we can able to achieve many advantages like we are able to reduce manpower, low cost, reduce electricity expenses, worker safety etc.

IV. WORKING PRINCIPLE

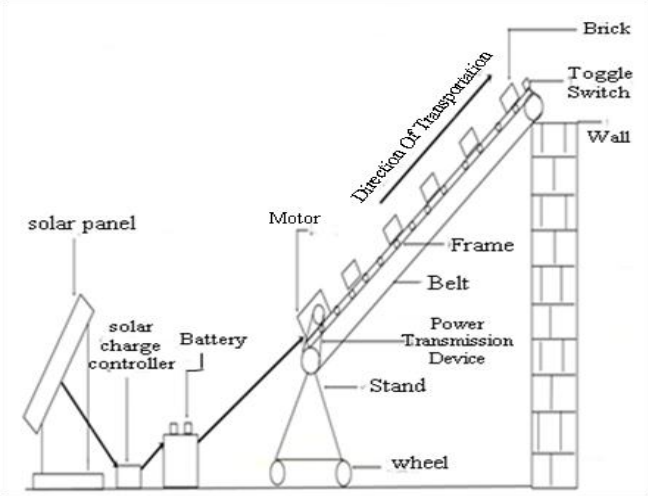

Fig. 2.Block Diagram of Inclined Belt Conveyor Attached With All Necessary Components

In this inclined flat belt conveyor system material is supposed to fed from one end to transport at required location but in straight inclined direction. Solar panel is connected to battery along with solar charge controller, which manages the power going into the battery bank from the solar array. Battery is connected to DC motor by which Solar energy is used as an power source to run the conveyor system instead of using electricity. To start and stop machine, toggle 3 pin switch is used on either side of the conveyor so that worker from both the end can start or stop the machine as per the need. As we start the conveyor, the belt is started moving with the help of pulley. One worker from the ground level continuously feeds bricks to transfer at required height and the worker on another side continuously picks bricks to put it to required location. In this way we can supply hundreds of bricks in an hour.

Design of the Project

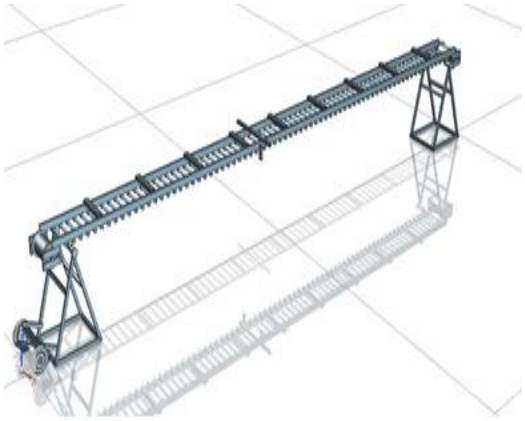

Fig.3. Final design of the inclined belt conveyor

Actual Images of Project

Image no 1. Frame Of Project

Image no 2. Project Assembly

Components used in project

i. Motor and gearbox – motor is used to run the conveyor belt and gearbox is used to control the speed of belt on which we will have supply bricks.
ii. Frame – As the height on which the material is to transport is long so the frame made for this conveyor made foldable.
iii. Conveyor belt – flat conveyor belt is used to supply bricks on it from ground level to first floor.
iv. Power Transmission device – chain drive is use as an power transmission device for this project.
v. Solar panel – we use solar panel as an energy source instead of electricity to run the conveyor system.
vi. Battery – if needed we can also use battery to store energy getting from solar panel
vii. Solar Charge Controller - A solar charge controller manages the power going into the battery bank from the solar array.
viii. Wheels–wheels are used for transportation of conveyor from one location to another.

V. CALCULATION

1) Belt Length

When the head and tail pulley are the same size:

L= (D + d) / 2 x 3.1416+2C

= (5 + 5) / 2 x 3.1416+ 2 x 235

= 12 m

2) Belt width

As the material of belt is PVC and it is artificially made by us so as per the brick specification we considered the width of belt is 0.3 meter.

3) Number of load carrying idler (Z_c)

The pitch if idler so choosing that it should be equal or less than the minimum dimension of bricks so at any instant bricks is supported by 2idler.

$T_c = L/(Z_c+ 1)$

T_c= pitch of idler

Z_c= number of load carrying idler

L = length of belt

$Z_c = 6096 – 1/77$

$Z_c = 78.16 \cong 79$

Hence we use total 79 idler in this conveyor system.

4) Conveyor Belt Speed

Measure the diameter of the rollers around which the conveyor belt is wrapped.

Diameter of roller = 5 inches = 0.127 m.

Multiply the diameter of the roller by pi, 3.14159.

5 × 3.14159 = 15.70795 inches = 0.398 m.

This calculation yields the circumference of the rollers. Every time the roller spins one revolution, the conveyor is moved a linear distance equivalent to the circumference of the roller. Pi is a dimensionless factor, meaning it does not matter whether inches, centimetres or any other units of measurement are used.

Measure the revolutions per minute of the rollers. Count how many full rotations are made by the roller in one minute.

The linear distance traversed by a point on the conveyor belt in one minute.

15.7079 × 20 = 314.158 inches/min.

= 7.98 m/min.

The total distance travelled per hour,

314.158 × 60 = 18849.48 inches per hour

18849.48 / 12 = 1570.79 feet per hour

3926.975 /3600 =0.132 m/s.

Speed of conveyor belt = 0.132 m/s.

5) Capacity of conveyor

If we consider that we have to supply 1200 bricks per hour so n = 1200 bricks/hr.

The mass of each brick is taken as avg of sample of 10 bricks is m = 2 kg

So the desired mass capacity of conveyor is,

$M = m \times n$

Where, m = mass of one brick and n = number of total bricks.

$M = 2 \times 1200 = 2400$ kg/hr

Now the volumetric capacity of conveyor,

$Q = M/\rho$

$= 2400 / 1046.38$

$= 2.29$ m

6) Power required transmitting the bricks

$P = \rho \times Q \times g \times h / 1000$ kW

$= M \times g \times h / 1000$ kW

$= 0.68 \times 9.81 \times 4 / 1000$

$= 0.027$ kW.

So actual power required for transport 1200 bricks is up to 0.027 kW, now the power required for overcoming friction must be considered.

7) Idler design

If we consider the worst condition when worker keeps twice the design capacity of weight that is 2 factor of safety. Then the weight on idler is 40 kg.

Max moment = $W/2 \times L/2$

$= 40 / 2 \times 4 / 2$

$= 24917.4$ N-mm

$= 2.54$ Kg-m

By maximum shear stress theory stress is given by

$\lambda = 16/\pi d^3 \times \sqrt{(Kb + M)^2 + (Kt + T)^2}$

Consider suddenly applied load with minor shock then,

$K_b = 2$ and $Kt = 1.5$

Since the idler do not transmit any torque only the bending moment is to be consider for shaft design

$\therefore T = 0$

$M = 0.68$ N.mm $= 0.000069$ Kg-m

We use M S material for idler, for MS material allowable shear is about 85 N/mm

$\therefore 85 = 16/\pi \times d^3 \times \sqrt{(2 + 24917)^2 + (1.5 + 0)^2}$

$\therefore d = 0.01439$ m

So we choose the next std size that is 0.019 m

$\therefore$ The diameter of idler is 0.019 m

8) Friction due to idler

It is given by $F_{cr} = F_c (m_m + m_i \times 2c/L) \times g \times L$

Where, F_c is friction factor for outdoor and extremely dusty conditions with presence of abrasive particle for straight idlers

$F_c = 0.040$

m_i = mass of idler

$= v_i \times \rho_{ms}$

$= \pi r^2 L \times \rho_{ms}$

$= 1.85 \times 10^5 \times 7.85 \times 10^{-6}$

$m_i = 1.5$ kg

$m_m = 20$ kg

$F_{cr} = 0.04 (20 + 1.5 \times 79 / 25.4) \times 9.81 \times 25.4$

$= 46.698$

Now, the torque required to overcome the friction is

$\tau = F_{cr} \times r$

$= 46.698 \times 0.019405 = 0.444$ N-m $= 0.0452$ Kg-m

Now, the conveyor velocity

Rpm of idler is 0.132 m/s

Power required for overcoming friction,

$P_f = 2 \times \pi \times N \times T / 60000$ kW

$= 2 \times \pi \times 130 \times 0.444 / 60000 = 0.0060$ kW

∴ Total power required is given by,

P = power required for lifting load through height

'h' × power required for overcoming frictional

resistance.

P = 0.26 + 0.006 kW

P = 0.266 kW

9) Solar panel

We have a battery of 35 AH with C 20 charge rate. Then we need a current of 35 amp / 20 charge rate = 1.75 Amps for charging.

Then we need 1.75 amp × 12 volt = 21 Watt solar panel, then in this case you may prefer a minimum of 37 W 12 volt solar panel.

10) Battery

For 60 watt DC 13.5 V motor, battery required is given as battery power = 12 × 4 = 48 watt so battery with 48 watt 12 V specification is needed for this system .

VI. RESULT

1) Time required to transport 1st set of 2 bricks from bottom to top of the conveyor is 20 / 0.436 = 45.87 sec.
Time to unload the 2nd set of bricks is 6 sec approximately.
∴ In 1 min we can unload 20 bricks similarly; in we can unload 1200 bricks per hour.

2) Minimum number of workers required for transporting bricks by manually = 4
Wages given to those 4 workers = 4 × 400
= 1600 rupees/day
Number of workers required for transporting bricks by conveyor = 2
Wages given to those 2 workers = 2 × 400
= 800 rupees / day
Hence we are able to reduce the **labour cost** required for transporting of bricks.

VII. CONCLUSION

By overall study of this project we can conclude that the proposed material handling system achieve many advantages as follows 1) solar energy is used as a power source for this project so otherwise the running expenses in electric bills is minimized. 2) This project is an example of a good material handling system that also ensures the safety of the worker at its highest level. 3) Only two workers are required for loading and unloading of bricks so the labour cost operating the system required to do this work is also minimized. 4) The overall cost of this conveyor is very much low as compared to other existing conveyor system hence we can make it affordable to any rural contractor. 5) Bricks handling is continuous, without any fatigue brake (unlike manual transport) so performs the task at a faster rate. 6) The conveyor system can be easily dismantled and also can be wheel mounted, this makes the system very portable. 7) Weight of the overall conveyor is comparatively low so that a single worker can also handle the system very well.

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