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DESIGN OF GRAVITY BASEDMATERIAL CONVEYOR EQUIPMENT

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ABSTRACT:

Industrial automation in recent decade has demonstrated to be the effective way of development of performance in industrial system. The results of the research carried out for optimization of the industrial processes in last decade leads to the implementation of automation in large industries. The small industries are still waiting for the low price systems for process enhancement. The small industries have the opportunities to partially replace the present system with automated system, by considering the cost limitations. Handling the material is one of the main features of the production industries and it holds 25% shares of the production cost of any product. The conveyor with the adjustable length feature and high mass handling capacity becomes the basic need for development of the automation system during the production for managing the material. Authors have developed and presented the conveyor for material flow on the basis of gravity.

KEYWORDS: Industrial automation, material flow and handling, gravity conveyor

INTRODUCTION:

Handling of the raw material during the production of any product is relatively very important process. The material passing through special stages of the fabrication process. A particular material is utilized in the particular stage of the production. It is always important to store, transport, and make available the material for achieving the targets of the production. Any production line requires completing the given task in given stipulated time. The process will be very effective if the material reaches to the particular place of its utilization during shortest possible time. The minimization of the time required for this process gives better effective performance in terms of improved per unit production during the stipulated time. This leads to better production and profit to the organization.

Moving the material with the controlled movement is achieved best by the conveyor system.This movement of the material is from one department to other or between the two separated processing units of the production line. The effective handling process of the material reduces the cost of production there by reducing the handling cost of the material. Saving the cost due to effective handling gives better per unit cost saving. The reduced efforts by implementation of this system improve the efficiency of the system. Automation is always preferred as it avoids the human errors and works very effectively. Generally the automation is useful to reduce the human efforts in the repetitive tasks of the industrial processes. Authors have cognizantto present the gravity based arrangement for the conveyors. The intended system has confirmed its usefulness in the movement of the matter for better handling. The weight when placed in particular place results in the movement as shown in figures below.

Fig. 1.1: Position 1

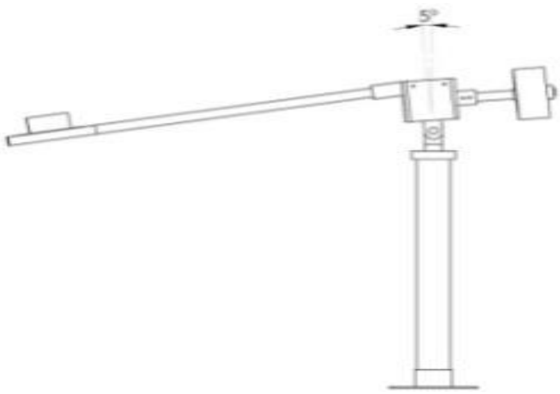

Fig. 1.2: Position 2

The material is moved in the required direction on the same concept presented in the figures below. The principle of the counterweight helps for creation of the movement of the object. Balancing the weight and the counter is very important for success of this system.

MATHEMATICAL ANALYSIS:

Here, forces acting on the weight and counterweight are vertical, tangential and horizontal. But the force responsible for the motion is tangential in direction.

From the diagram we can see,
m_1= mass of tray
m_2= mass of counterweight Fig. 1.1
m= mass of object to be transferred
x= length of tray pipe
y= length of counterweight pipe
θ= angle of inclination of bearing block
Taking α = angular acceleration about the axis X – X

POSITION 1(FIG. 1.1):

At initial position without any mass added on the tray,
Moment about O,
Tray side →
mass = m_1

Tangential acceleration in horizontal plane = xα

Tangential force = $m_1 x\alpha$

Moment about X - X = $m_1 x\alpha(x \cos\theta) = m_1 x^2\alpha \cos\theta$
Counterweight side → mass = m_2

Tangential acceleration in horizontal plane = yα

Tangential force = $m_2 y\alpha$

Moment about X − X = $m_2 y\alpha(y) = m_2 y^2\alpha$
For the motion to take place moment at tray should be less than moment at counterweight side.

$$m_1 x^2\alpha \cos\theta < m_2 y^2\alpha$$

$$\therefore m_1 x^2 \cos\theta < m_2 y^2 \qquad \text{.................. (1)}$$

POSITION 2(FIG. 1.2):

After loading mass m on the tray,
Moment about O,
Tray side →
mass = $m_1 + m$

Tangential acceleration in horizontal plane = xα

Tangential force = $(m_1 + m)x\alpha$

Moment about X − X = $m_1 x\alpha(x \cos\theta)$ = $(m_1 + m)x^2\alpha \cos\theta$
Counterweight side → mass = m_2

Tangential acceleration in horizontal plane = yα

Tangential force = $m_2 y\alpha$

Moment about X − X = $m_2 y\alpha(y) = m_2 y^2\alpha$
Now, for the motion to take place moment at tray should be more than moment at counterweight side.

$$(m_1 + m)x^2\alpha \cos\theta > m_2 y^2\alpha$$

$$\therefore (m_1 + m)x^2 \cos\theta > m_2 y^2 \qquad \text{.................. (2)}$$

CHECKING WITH THE PRACTICAL CONDITIONS:

Taking $m_1 = 1$kg
$x = 860$mm
$y = 240$mm
$\theta = 5°$
We get $m_2 > 12.8$kg
For the system to stay in Position 1 without any load on tray side the counterweight should be at least be 12.8kg.Now when a mass m is placed on the tray, the system tends to rotate to Position 2. For this to happen it must satisfy equation (2).Assuming the mass m to be 0.1kg, 0.2kg, 0.5kg and 1kg and checking equation (2),
For m = 0.1kg,
L. H. S. = 0.81 Nm
R. H. S. = 0.74Nm
L. H. S. > R. H. S.
Hence the system will rotate.
Later results are tabulated as follows,

Table 1: Result Table

Mass m	$\mathbf{(m_1 + m)x^2\cos\theta}$	$\mathbf{m_2 y^2}$
0.2kg	0.88Nm	0.74Nm
0.5kg	1.105Nm	0.74Nm
1kg	1.47Nm	0.74Nm

From above table for every value ofm, it is seen that L. H. S. > R. H. S.
Minimum value of m for system to work as desired,
From equations (1) and (2),

$$(m_1 + m)x^2 \cos\theta > m_2 y^2 > m_1 x^2 \cos\theta$$

$$\therefore (m_1 + m)x^2 \cos\theta > m_1 x^2 \cos\theta$$

$$\therefore m > 0$$

It can be seen that for required system to work any mass greater than0kg. But in practical use, considering friction a mass of 0.5kg can be assumed to be the lower limit.

SYSTEM COMPONENTS:

The developed system has utilized the following components for completion of the required task of movement of the matter for better handling of the material.

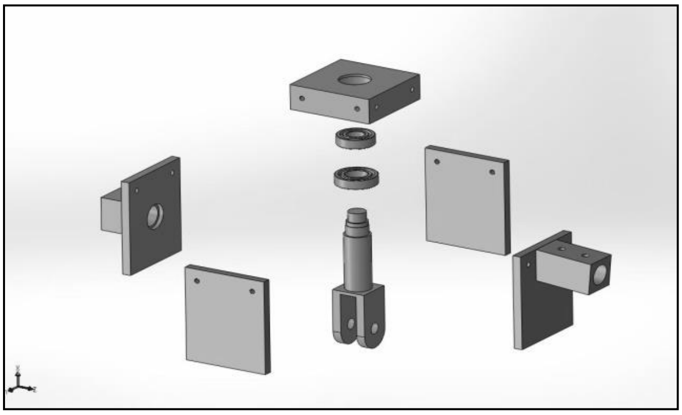

Fig. 2: Various components of the system

Table 2: System Components Details

Sr. No.	Particulars	Details
1	Bearing Housing	100×100×32mm (Plain Carbon Steel)
2	Casing Plates	120×100×10mm
3	Main Shaft	Inclined at an angle
4	Hinge Nut and Bolt	Diameter 16 mm
5	Bearings	Ball bearings
6	Damper Bracket and spring	Vibration absorption
7	Base and Base Plate	Transmission of vibration
8	Tray and Counterweight	Square shape, pipe welded

CAD DESIGN AND DRAFTING:

The system is developed by using the 3D design software solid-works. The fast and accurate design of the system in the software is needed for physical implementation of the system. Multiple softwares can be used for better and faster implementation of the system.

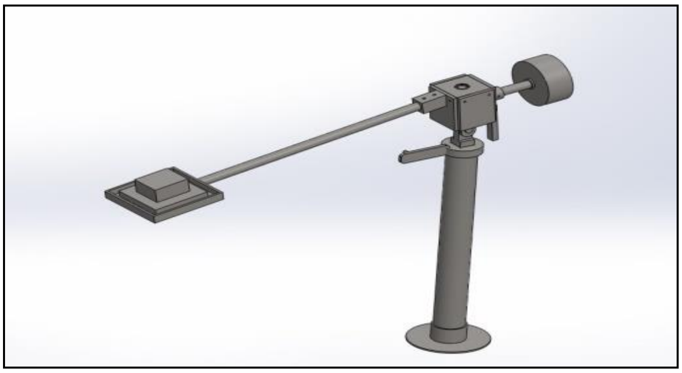

Fig. 3: System to be implemented in CAD

CONCLUSION

The design of the system for conveyor with the consideration of the parameters to improve the performance of the system is the key objective of presenting this paper. Authors have carried out the analysis of the said system and results are presented in this paper. Authors are working further for better implementation of the automation in small industries at lowest investment. The partial automated processes are useful for small industries as the cost for implementation is significantly less and saving is effective in terms of the cost.

After the fabrication and implementation of the effective material handling system, one could easily demonstrate the improved material handling. "Revolving Material Transfer Systems" shows how some simple and innovative ideas can be used to develop cheap and non-power consuming material transfer systems that can significantly relieve the operator fatigue make the material transfer safer along with the increased productivity.

The project was just an effort to demonstrate the need and means of improving the material transfer systems and highlight the future scope of effective material transfer.

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