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Design and Fabrication of Base Stand and Controlling the Speed of Belt Conveyor

Tajamul Pasha[1], Rakesh M[2], Suvarna Kartik Shashidar[3], Tanmay H Mudugal[4], Ujjwal Kumar[5], VishwanathPatil[6]

Department of Mechanical Engineering

The National Institute of Engineering, Mysuru-570008, Karnataka, India

Corresponding authors' email id: *tpniemech@gmail.com*

Abstract

Design and fabrication of base stand for a flat belt conveyor system and to control the speed of the system of the conveyor system which is done by integrating the conveyor system with Arduino and motor driver which is controlled by mobile app through Bluetooth module. Dynamic analysis of load acting on the base stand is done in order to make the whole system stable.

Keywords*: Conveyor belt, Arduino Board, Motor driver, Bluetooth Module*

OBJECTIVE

1) To design and fabricate base structure for flat belt conveyor

2) To control the speed of the belt conveyor using Arduino board

3) To recalculate the speed of conveyor with incorporation of wireless Bluetooth module

INTRODUCTION

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. They also have popular consumer applications, as they are often

found in supermarkets and airports, constituting the final leg of item/ bag delivery to customers. Many kinds of conveying systems are available and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

Conveyor systems are used widespread across a range of industries due to the numerous benefits they provide.

- Conveyors are able to safely transport materials from one level to another, which when done by human labor would be strenuous and expensive.

- They can be installed almost anywhere and are much safer than using a forklift or other machine to move materials.

- They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents.

- There are a variety of options available for running conveying systems, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs.

PROBLEM STATEMENT

Normally, belt conveyors are running with nominal speed, and the average utilization of belt is less than the design capacity. Rate of production is not the same all the time because it depends on several factors like labour capacity, average demand and buffer storage etc.

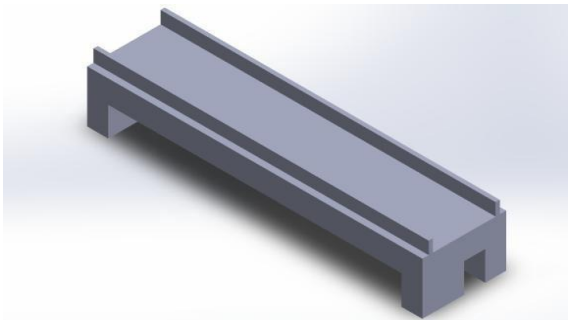
So, with variation of speed of a conveyor belt we can increase the utilization, production rate and reduce the idle time of system. So variation of speed is done with the use of Uno Arduino board and motor drives and by connecting a Bluetooth module the speed is controlled by mobile app.

METHODOLOGY

Concept Design

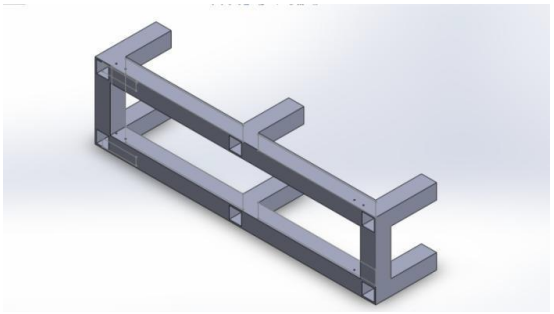
There are four designs selected by us by brainstorming. All the designs have different abilities to take load. To select the best design we have formulated the Pugh matrix.

DESIGN 1



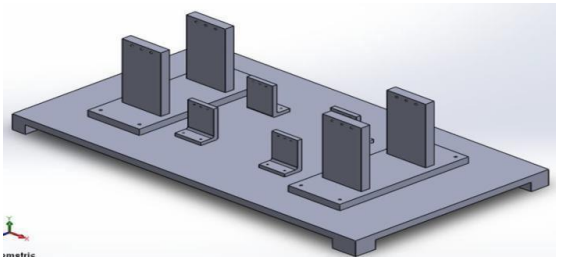
- It is a concept similar to rail system.
- The conveyor system will be mounted on the rail design type system.
- The axial forces will be there in the design.

DESIGN 2



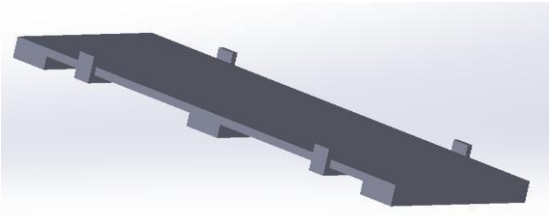
- This design is similar to a table.
- It has 6 legs to support the conveyor system.
- The load here is divided equally to 6 legs as compared to 4 legs from previous design.
- In this design the centre of mass has some support.

DESIGN 3



- This design consists of 4 columns and 4 L-clamps.
- The overall the load of the conveyor system is divided among 8 legs.
- If the column fails the 4 bars at the middle will support the conveyor system.
- Both the axial and radial loads are restricted here

DESIGN 4



- This is a simple design having clamps from bottom.
- The conveyor will be stable from sideways.
- The weight of the stand will be less in this design.

PUGH MATRIX

Serial No.	Criteria	DG-1	DG-2	DG-3	DG-4
1	Number of parts	6	4	6	9
2	Aesthetics	4	9	9	3
3	Weight	3	5	6	7
4	Cost	5	5	3	6
5	Availability Of Parts	6	8	6	8
6	Stability	6	5	9	3
7	Ease of Manufacturing	5	7	9	6
8	Ease of Assembly/Disassembly	8	7	5	6
9	Space Consumed	4	6	6	8
	Score	47	56	59	56

The Pugh matrix helps determine which items or potential solutions are more important or 'better' than others. It is a scoring matrix used for concept selection in which options are assigned scores relative to criteria. The selection is made based on the consolidated scores. So various factors mentioned above in the table are taken to consideration.Upon the evaluation done in the above table we can conclude that design 3 (DG-3) is the most appropriate one for making the stand of conveyor belt.

CONTROLLING OPERATION OF MOTOR

The fig below shows the actual circuit diagram that we have used for the project the Bluetooth module is connected to Arduino board and Arduino board in turn is connected to L298N motor driver, the motor driver is connected to the motor which is coupled to conveyer rollers. The power source should be a 12 volts DC battery which is connected to motor driver and Arduino board, the motor driver, Arduino board and Bluetooth module are connected by male to male pins connector.

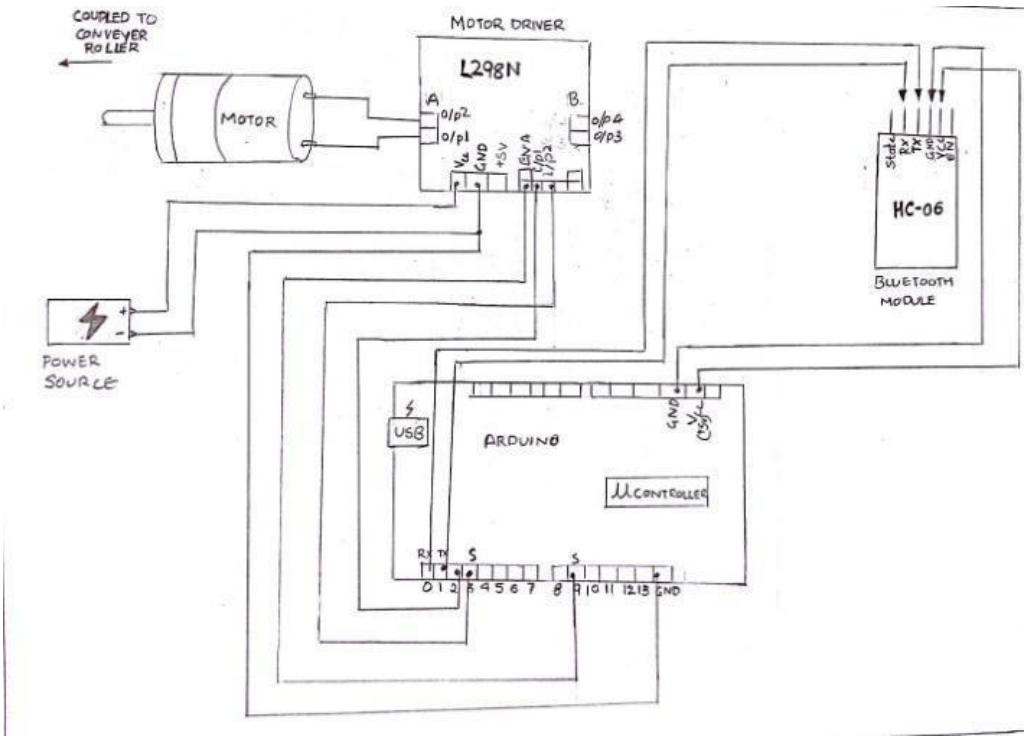


Figure: 1

The blue tooth module used is HC06 so no separate programming is required for this module, it has static port, receiver, transmitter, ground, enable and supply voltage port. The supply voltage is received from Arduino, the receiver part of blue tooth module is connected to transmitter part of Arduino similarly the receiver of Arduino is connected to transmitter part of Bluetooth module both of their ground is connected to each other. The Arduino board is connected to L298N motor driver it has two ports for controlling two motors but our project needs only one partof it, so all the connections from Arduino board are made to input of enable A port and not to B. The module has an onboard 5V regulator which is either enabled or disabled using a jumper. If the motor supply voltage is up to 12V we can enable the 5V regulator and the 5V pin can be used as output, for example for powering our Arduino board. But if the motor voltage is greater than 12V we must disconnect the jumper because those voltages will cause damage to the onboard 5V regulator. In this case the 5V pin will be used as input as we need connect it to a 5V power supply in order the IC to work properly. The analog input and output pins which are six in numbers and we are not using them; the 14

digital input and output pins are used to connect the motor driver out of which six are pulse width modulator which is used for controlling the speed. The pin 2 of Arduino board is connected to input 1 of motor driver and pin3(pulse width modulator) is connected to input 2, the enable A pin is connected to pin 9 of Arduino board.

The grounds of both Arduino and motor driver are connected and the ground for motor driver is also connected to the negative of the power source and its positive end is connected to supply of L298N motor driver. If the direction of motor is in reverse the connection from motor to motor driver can be reversed to get the correct effect.

RESULTS AND DISCUSSIONS

A. Analysis

The column stand is analyzed for stress, strain and maximum deflection to check for the stability of stand and to make sure that the baser stand wont fail.

The below figure shows the total deformation of the column of a conveyor base stand. As the figure shows the maximum deformation occurs on top side of the column and gradually decreases as we go towards bottom side of column.

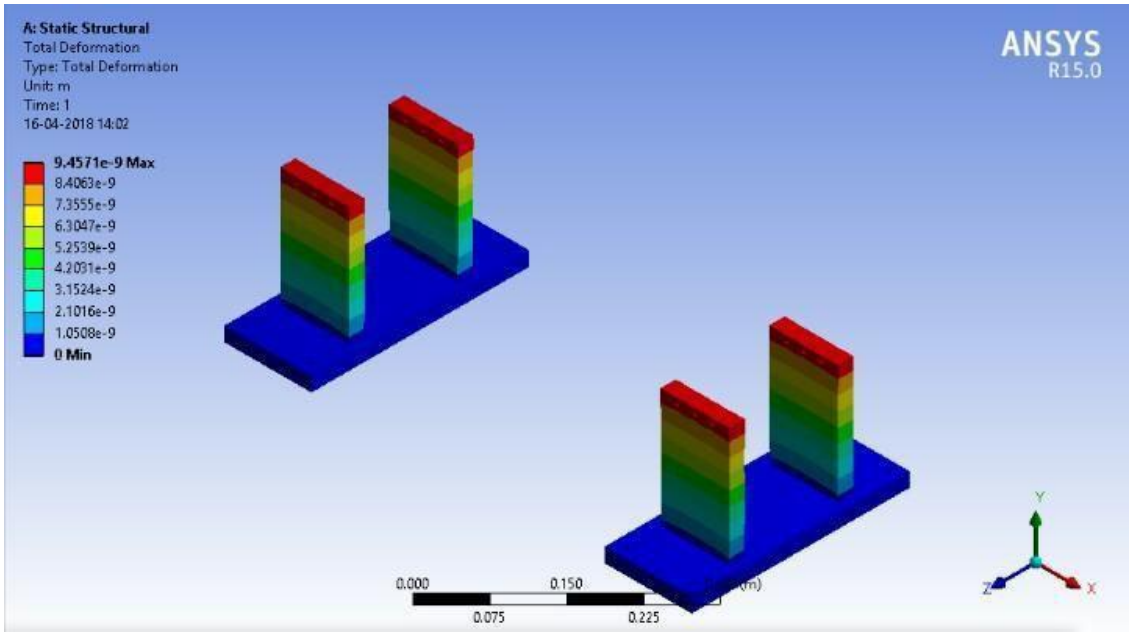


Figure: 2

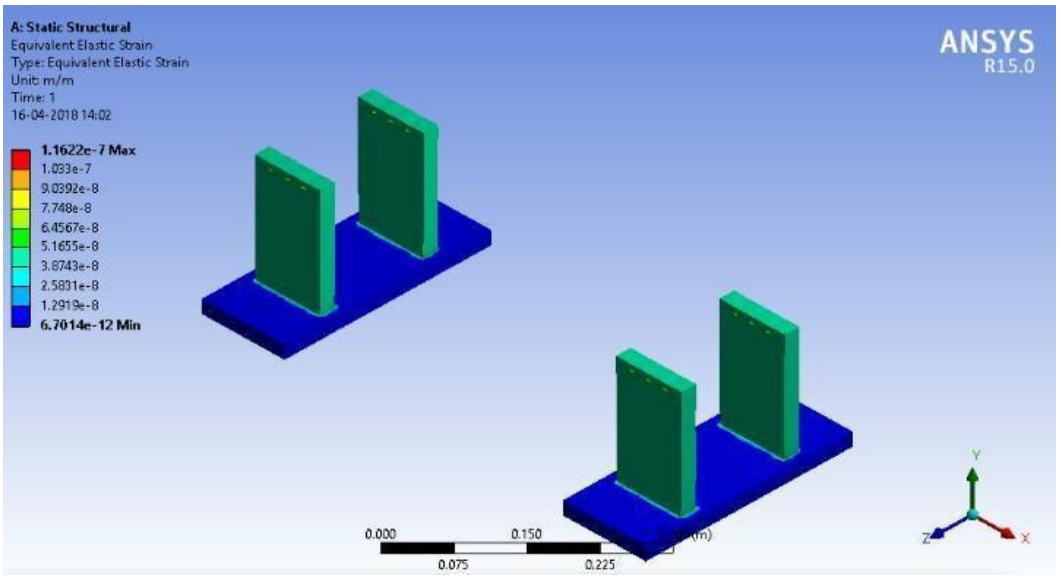


Figure: 3

The above figure shows the elastic stain acting on the column of a conveyor base stand. As the figure shows the elastic strain is constant throughout region of the column.

The below figure shows the stress analysis using von mises criteria of the column of conveyor base stand. As we can see the stress acting on column is distributed uniformly along the column.

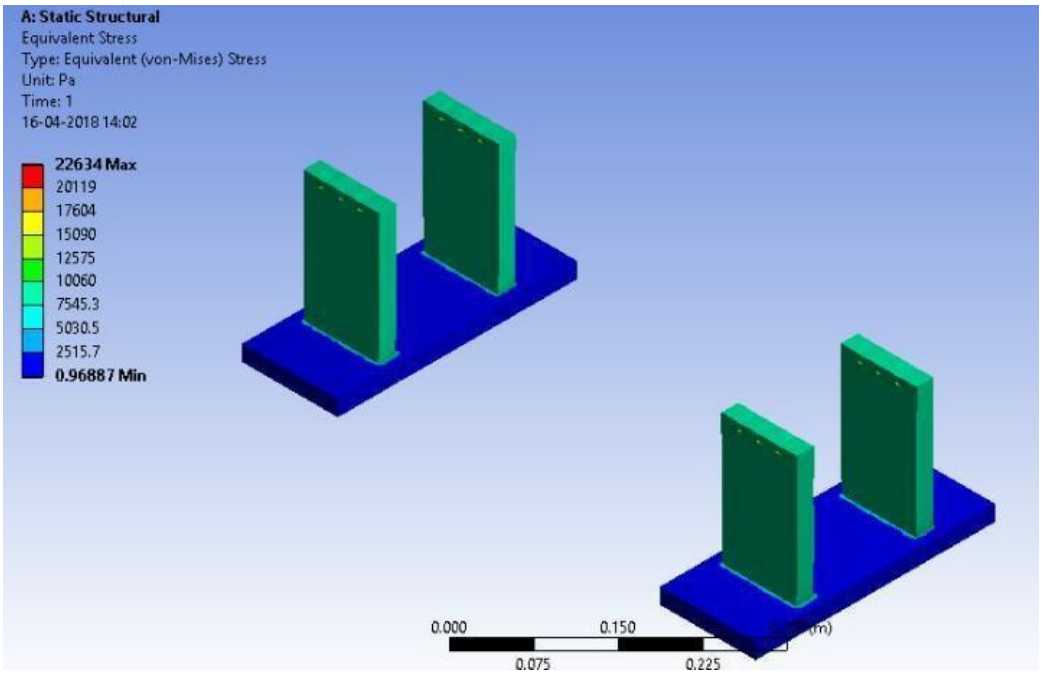


Figure: 4

CALCULATIONS:

Let t be thickness of the column

E- Young's modulus of mild steel,

I - moment of inertia of column.

L- Effective length of column.

b- width of the column.

Pcr- load at which buckling starts.

Then

The moment of inertia is given by

$I=(b*t3)/12$

Substituting the known parameters,

$I= (85*t3)/12$

The support system is made from mild steel and the material selection process is explained in chapter 7.

E= 210 Gpa - (from design data hand book)

Le=600mm - (assumed for calculation purpose)

Substituting the values for buckling load we get,

$P= (\pi 2*210*103*85*t3)\ (12*6002)$

$= 40.7*t3$ - (1)

We know that critical stress (f) is given by

Critical stress,$fc=P/A$ –(2) A- Cross section area of column.

$A=85*t.$

The von Misses yield criterion for pure shear stress, expressed in principal stresses, is

$(f1-f2)2+ (f2-f3)2+ (f3-f1)2=\sigma y2$

f1, f2, f3 are principal stress,

In our case f2=f3=0 and

fs is the shear stress along x-y direction,

fx andfy is normal stress along x and y direction.

Therefore f1= fmax=fx since fy and fs is zero

Using von misses theory,

$\sigma y2=fx2$

Yield stress for mild steel= 324 Mpa- (DDHB)

$fc = \sigma y = 324Mpa.$

Factor of safety=4 – (for static loading DDHB)

Equating the equations (1 an 2) we get,

t= 13.00063 mm.

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CONCLUSIONS

- The conveyer support system can take up all the load of conveyor belt, motor, power source and other electrical components and is proved to be safe from design, and analysis point of view.

- The assumptions made such as loading is done as static loading even though a bit of it is dynamic loading which acts when components are passed over the conveyor belt causes the actual value of dimensions has to be adjusted to the required design criterion to make it look aesthetically good.

- The speed of the motor which is directly coupled to the conveyor roller which runs the conveyor belt has been successfully controlled by the Arduino board and motor driver.

- A wireless Bluetooth connection has been enabled through which the conveyor belt speed can be adjusted without even coming in contact with the conveyor system through a mobile application software.

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