e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

DESIGN, ANALYSIS AND OPTIMISATION OF BELT CONVEYOR SYSTEM FOR COAL APPLICATION

Yash Dhamane[*1], Vaibhav Garve [*2], Rushikesh Tajne[*3], Shubham Khandare[*4], Dhananjay Gawhale[*5], Vedneshwar Ghawat[*6], Prof. R.V. Rajkolhe[*7]

[*1,2,3,4,5,6]Student, Department of Mechanical Engineering, Shri Sant Gajanan Maharaj College Of Engineering, Shegaon, Maharashtra, India

[*7]Professor, Department of Mechanical Engineering, Shri Sant Gajanan Maharaj College Of Engineering, Shegaon, Maharashtra, India

ABSTRACT

Mechatol engineering solutions is an Engineering Design Solution and Consulting Company based in Pune, India. This report is an attempt to put in words the experience of our exposure to design and Analysis of Belt Conveyor System. The aim and objective of our project was to optimize our existing Belt Conveyor System. For this we used numerical and analytical method. The design involves Fatigue Cycle Analysis, Load/Weight Optimization, Static Analysis and Vibration Analysis. Procedure for selecting the optimum material played an important role in achieving the objectives. All the procedures and operations are done keeping in mind the dimensional restrictions for this project along with the economic views. We tried to give the direction for our project according to developing industrial sector in India and provide best alternatives. Finite Element Analysis also done for better understanding to optimize the load or weight. For modelling the whole system, we completed the internship for 30 days. Total objectives of the project is achieved by simulation software SOLIDWORKS 2018.

KEYWORDS: Static Analysis, Vibrations, Fatigue, Industry, Solid Works

I. INTRODUCTION

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. A conveyor system work by using two pulleys that continuously loop over the material that rotates over them the belt is then supported by a series of rollers along the path.

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. A conveyor system work by using two pulleys that continuously loop over the material that rotates over them. The belt is then supported by a series of rollers along the path.

Heavy industries like steel, fertilizer, chemical and cement etc. cannot function without the belt conveyors. In construction project the belt conveyors are used for handling. The material in asphalt plant, crushing and screening plants, aggregates mixing plants etc. In coal mining and other mining industries these arc used for handling coal or other raw material The belt conveyors arc capable of conveying large quantities of material continuously over considerably long distances at a fast speed. For transporting the material for short distances conveyors may be a portable or a fixed unit.

Fig. 1 Belt Conveyor

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

II. METHODOLOGY

The flow of our project design is by identifying the problem of the current design in order to make some improvement. The order in which the steps are taken for the completion of the project are as follows.

a) Understanding Customer Needs

As per the requirements, we need to reduce the fatigue cycle damage from 13% to 3% reduce the weight of the shaft assembly, reduce the vibrations in chassis and reduce its weight. To do this we first study the existing design and accordingly change the design of shaft and chassis by doing its calculation and change the material of shaft and chassis by doing analysis of the parts.

b) G A Layout

The general arrangement drawings present the overall design of the object. Depending on the complexity of the design it is likely to require a number of different projections such as planes, sections & elevations, and may be spread across drawing of different compositions. The G A layout is generally supplied by the client and design is made accordingly. It works as a basic blueprint of the project.

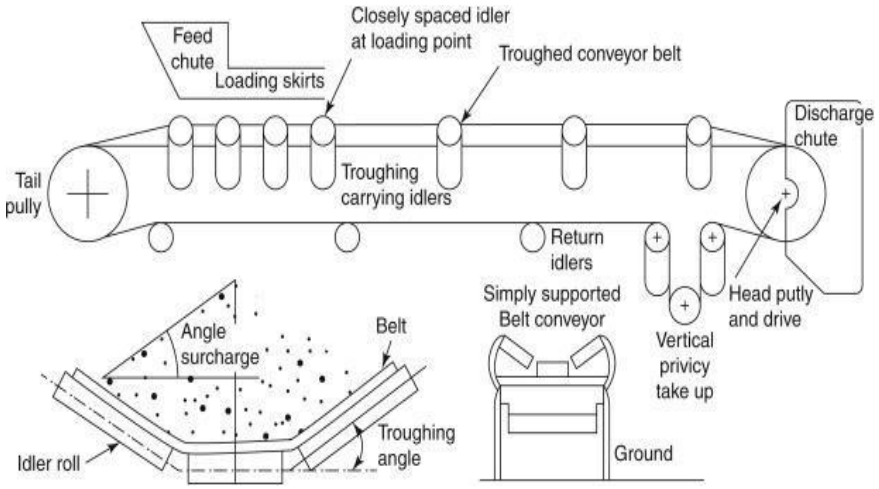

Fig.2: Sample Drawing

c) Material Selection

There are three methods for material selection

1) Cost per unit property method.
2) Weighted property method.
3) Digital logic method.

Using Digital Logic Method,

i For Strength, Toughness etc

Scaled Property = (Numerical Value of property x 100)/Max.Value in the list

ii For Cost, density corrosion etc

Scaled Property = (Min. Value in the list x 100)/Numerical Value of property

iii Material Performance Index is given as

$$\text{Material performance index, } \gamma = \sum_{i=1}^{n} B_i \alpha_i$$

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

iv Figure of merit (FOM) for the material can then be defined as

C is the total cost of the material per unit weight (stock, processing, finishing, etc.) it is based from type of loading
ρ is the density of the material

$$M = \frac{\gamma}{C\rho}$$

v Refined FOM

C′ is relative cost of material and is defined as the ratio of the price per unit mass of the material and low carbon steel

$$M = \frac{\gamma}{C'}$$

As taking above terminologies in consideration let us understand how we implemented this process for our design.

Methodology

Step 1- Screening : It include function, objective, variable, constraints

Function	To Support in Combined Loading
Objective	To increase the strength
Variable	Density , Cross Sectional Area
Constraint	Length, Force

Step 2 - Property Selection (Appropriate property should be taken under consideration according to screening)

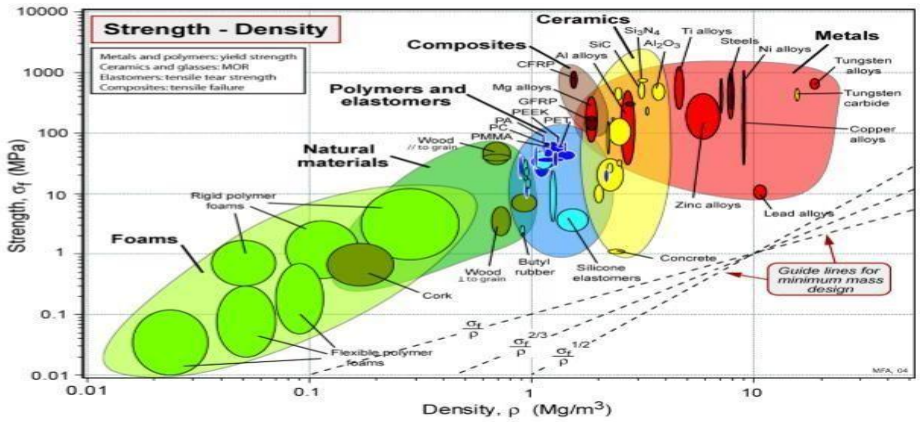

Fig.3: Strength Density curve

Step 3 - Candidate Material Selected

1) 4340 Steel
2) Aluminium Alloy (2024-T6)
3) Titanium Alloy (Ti-6Al-4V)

Result: The one with highest material evaluation factor is considered as final material for the product. In our case of Belt Conveyor its **4340 Steel.**

d) Design Calculations

First, we find out required Belt conveyor dimensions to fulfil customer's needs. Then we find total forces acting on different components of drag chain conveyor and tensions acting on tight & slack sides belt conveyor. After that we

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

find out motor power required for driving our mechanism and according to that we finally find out desired diameter of shaft.

- **Conveyor Motor Power**

The conveyor motor power must overcome the difference between the tight side and slack side tensions.This is effective belt tension (Te)

Input data:

Conveyor drive efficiency, e = 80%, e =80%

Loading chute factor, Fc = 1.1, Fc = 1.1

Start acceleration factor, Fs =1.15, fs = 1.15

Calculations

Minimum conveyor motor power, P = Force * Velocity / 3300

P =Fc * Fs * Te * S / (e x 33000)

P =17 hp

- **Capacity**

Input Data

Bulk Material Density, DEN =80 lb/ft^3

Bulk Material Repose Angle, X =15 deg

Belt Width, W = 20 in

Belt Speed, S =115 ft/min

Idler Angle, Y = 45 deg

Edge of Pile to Edge of Belt, G =1.0 in Edge of Idler to Edge of Belt, H =0.6 in

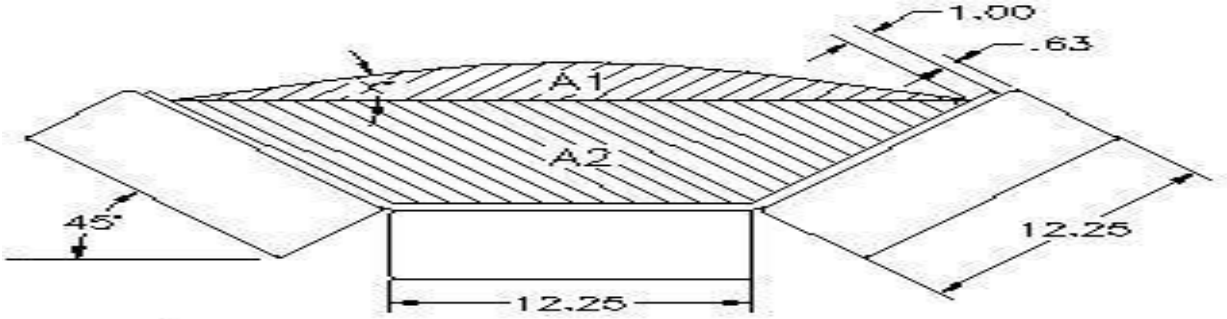

Fig. 4: 20" Belt X 45˚ equal length idlers

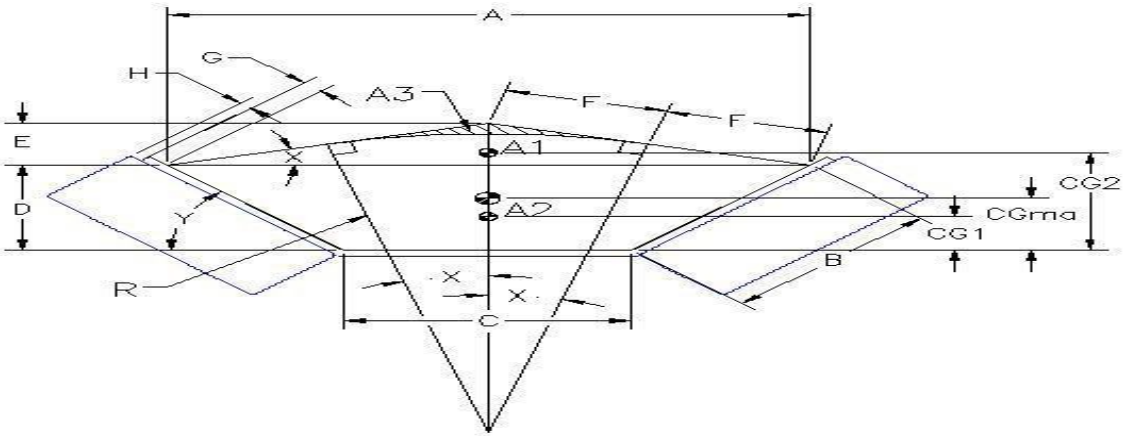

Fig.5: Various Parameters of Idlers

Geometry below is for any belt size:

- **Calculations**

C =0.09+ W / 2

C =10.09

B =C - (G + H) + 0.19

B =8.65 in

A =C + 2*B*COS(Y / 57.2956)

A =22.32 in

F =A / (4*COS(X / 57.2956)) F =5.78 in

R =F / TAN(X / 57.2956)

R =21.56 in

Sector area, SA =2*Pi*X*R^2 / 360

SA =121.72 in^2

Area of Two Triangles, TT =R^2*TAN(X / 57.2956)

TT =124.58 in^2

A3 =TT - SA

A3 =2.86 in^2

D =B*SIN(Y / 57.2956)

D = 6.12 in

A2 =D*(A + C) / 2

A2 =99.13 in^2

CG2 =D*(2*A + C) / (3*(A + C))

CG2 =3.44 in

E =A*TAN(X / 57.2956) / 2

E =2.99 in

A1 = (A*E / 2) - A3

A1 =30.52 in^2

Approximate CG dimension , CG1 = D + E / 3

CG1 =7.11 in

Bulk Material Section Area, MA =1.033*(A1 + A2 -A3)

MA =130.97 in^2

MA =0.91 ft^2

Geometry below is for any belt size: Continued

Bulk Material Section Centroid, CGma = (A1*CG1 + A2*CG2) / (A1 + A2)

CGma =4.31 in

Belt Conveyor Volume Capacity, CFM = MA*S

CFM =105 cu ft/min

Belt Conveyor Weight Capacity, TPH = CFM*DEN*60 / 2000

TPH = 251 tons/hr

e) Modeling Parts and Assembling

We create the 3D models of the parts in the SOLIDWORKS software , the 3D modelgive an correct view of the part. It is much easier to change the parameters of the project while it is in design phase as it helps to save the losses which can be caused after the final construction. As per the requirements and by doing the calculations we model the parts like base frame, shaft, drive mechanism, belt and roller. And finally after the completion of the parts we did the assembly of the belt conveyor.

f) Performing Analysis

After the completion of the parts we did the analysis on them to analyze the stress distribution, deformation and various parameter so as to test if the parts fulfill the customer requirements. Static and Dynamic analysis on shaft are done as it is an important component in transmitting the power and torque. Analysis on base frame, drive shaft and idler roller are also done. Drive shafts are subject to torsion and stresses, that's why they need to be strong enough to bear the stress while avoiding additional weight as this increases the material consumed increasing the cost and also increase the inertia consuming more power.

III. MODELING AND ANALYSIS

Modelling is defined as the complete representation of an object or a system with the graphical and non-graphical information. It is also known as geometric modelling. It generates the mathematical description of the geometry and nongeometry of an object or a system in the computer database and the image of an object or system on the graphic screen. With the use of modelling the designer constructs the graphical image of an object on the computer screen

- **Modelling**

The important parts of Belt Conveyor

1. **Base Frame-**Supports the assembly

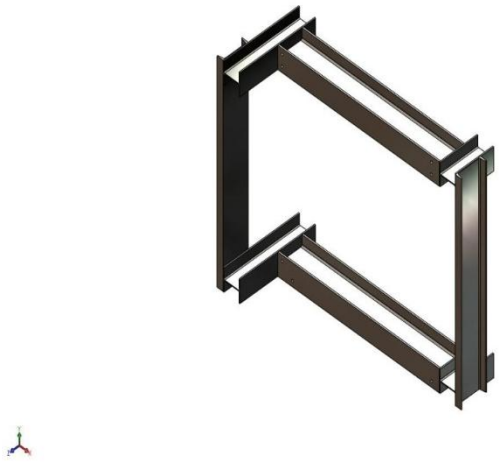

Fig.6: Base Frame

2. **Shaft**-Transmits power, motion and torque.

Fig.7: Shaft

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

3. **Idler Roller**-Idler rollers, or sometimes simply known as conveyor rollers, are cylindrical-shaped bars that run along and underneath a conveyor belt.They also assist in the smooth, continuous movement of the material along the belt. Idler roller canbe self aligning.

Fig.8: Idler Roller

- **Analysis**
  - Stress Analysis of Idler Roller : Resultant Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	4.15602	17995.6	-5.83607	17995.6

Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	0	0	0	0

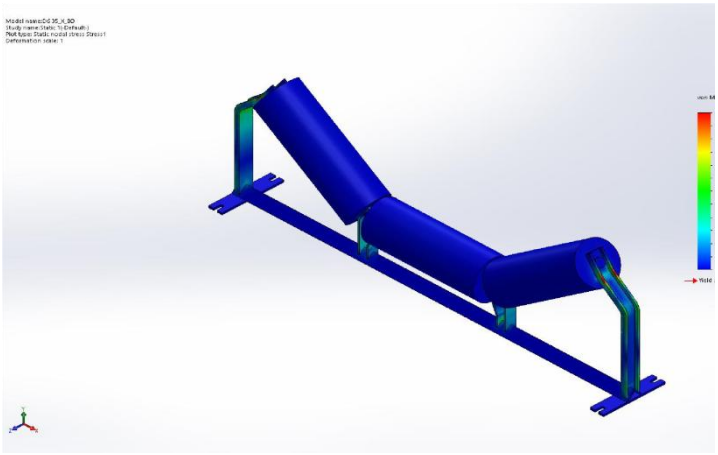

Fig.9: Study Analysis

- **Displacement Analysis:** From displacement analysis we can study deformation of component due to force acting on it.

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000 mm Node: 348	0.170 mm Node: 8419

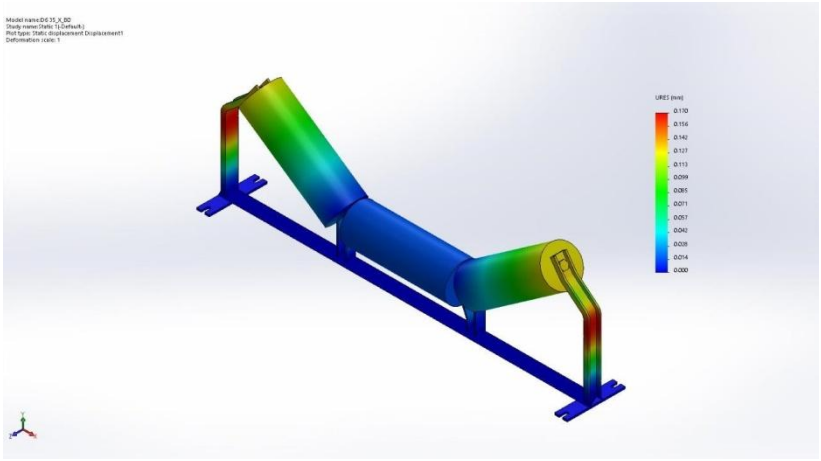

Fig.10: Displacement Analysis

- **Factor of safety-** Factor of safety may be expressed as ratio that compares absolute stain to actual applied load. The factor of safety depends on the material and use of and item different industries have varying ideas on what FoS should be required.

Name	**Type**	**Min**	**Max**
Factor of Safety1	Automatic	8.32 Node: 12333	4.2e+13 Node: 10978

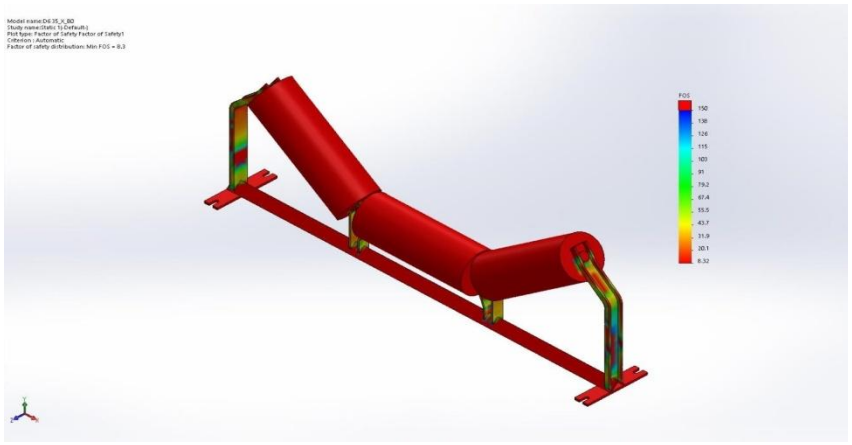

Fig.11: Factor of safety

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:02/Issue:05/May-2020 www.irjmets.com

- **Fatigue Check**

Name	Type
Fatigue Check1	Fatigue Check Plot

Fig.12: Fatigue Check

IV. RESULTS AND DISCUSSION

The required modifications achieved in this project are,

a. The fatigue cycle damage is reduced from 13% to 3 % followed by fatigue analysis.
b. As drive shaft assembly was overweight initially we successfully reduced the weight by FRP material and optimized weight is achieved.
c. Fulfilling problem statement, Increases the capacity of coal at outlet.
d. Vibration in bottom chassis of the belt conveyor is reduced upto 45 Hertz followed by vibration analysis
e. As chassis was overweight initially we reduced it upto 600 kg by weight optimization thus,we successfully achieved the objectives of our project.

V. CONCLUSION

From the above Project Report Confer, we conclude that,
Belt Conveyor is capable for complete elimination of Drawback raised in previous model. The study is completely done regarding this project on various sources of literature. The many methodologies are studied and this information has helped to complete the project successfully. The design calculations for machine regarding parameters like fatigue cycle, load, vibrations were done keeping in mind the dimensional restrictions of this project, along with the economic views. The values are well within the limits and the design is safe and accurate. The components were chosen with cost as parameter to optimize the development of the system. The material inspection and sorting conveyor which is capable of inspecting components without human intervention is modelled successfully.

By producing such system, the scope is in the field of manufacturing, identification of suitable solution, evaluation processes, design of proposal, to build the prototype.

The project is successfully completed and tested. All the specified requirements were fulfilled upon completing the project.

VI. REFERENCES

[1] Design of Belt Conveyor System International Journal of Science, Engineering and Technology Research (IJSETR) Volume 7, Issue 7, ISSN: 2278 -7798.
[2] Shinde,Suhas M., and B. Patil. " Design and Analysis of A Belt Conveyor System for Wight Optimization and Material Saving" International General Of Emerging(2018)
[3] R. S. Khurmi S. Chand Textbook Of "Machine Design"

[4] Recent Research Development in Belt Conveyor Technology, A.W. Roberts and A. Harison, University of New Castle, Australia
[5] Study and Performance of Belt Conveyor System For Different Parameters, IJIRST, Vol 2, Issued Nov 2017
[6] Typical failure analysis and processing of belt conveyor, Lihua Zhao, First International Symposium on Mine Safety science and Engineering, Northeast Dianli University, China.
[7] Design and Analysis of Belt Conveyor System of Sugar Industry for Weight Reduction. Mr. Memane Vijay S. , Prof. N.N. Biradar, Imperial College Of Engineering and Research, Pune, India.