Modelling and Analysis of a Conveyor

Abstract

Material handling in the manufacturing industry refers to the process of moving raw materials and other products from one location to another for use in the manufacturing process. It is a mechanical process that assists in the loading and unloading of goods within factories or warehouses. Additionally, material handling is also required for the storage, protection, and control of the material. The advancement of technologies and mechanisms has enabled the material to become more convenient and modern. With a conveyor belt in place, it is extremely easy to move materials, products, and components in an efficient, uncomplicated manner that saves money, energy and time. A conveyor belt on the other hand uses two motorized pulleys. Pulleys move in the same direction and speed to activate the conveyor belt. There are a lot of industrial uses for conveyor belts.

This study aims to study the design and analysis of a conveyor belt system used in the drying process of almonds. Several design parameters are taken into consideration for the conveyor's system. The design parameters evaluation is done by considering the required power and material load of the conveyor system. Material selection is carried out for the various components like the belt, pulley, stand, and drive unit. The material for the stand is made of mild steel, and the belt material is made of the material chosen from the design handbook. It is important to take into consideration the power transmission of the system. The modeling of each component is performed in SolidWorks and the analysis is performed in ANSYS for the more in-depth static analysis of the frame and the roller. The results of the deformation and stress are evaluated from the results of ANSYS under the roller and the frame is required to ensure the safety of the structure.

Chapter 1 Introduction

1.1 Overview

The conveyor belt is one of the most widely used materials handling equipment. It is crucial to perform the design calculation to evaluate all the parameters that are required for the performance of the conveyor system. As part of the design parameters, the belt speed, rotational speed belt length, and the power required for the system are needed to consider. Belt-drive geometry is another aspect that needs to be taken into consideration. Based on the given parameters, the allowable power or design parameter is calculated. As mentioned earlier, the stress, strain, and deformation values are based on the radial and axial forces as well as the centrifugal force that is acting on the belt. Bearings are selected for the conveyor so that they can handle both the radial loads and the axial loads that are applied to the system. To ensure the efficient performance of the conveyor, the design parameters must be properly considered.

1.2 History

It was found that the first conveyor was supposed to have been invented in 1795. It was either made of leather or a belt that traveled through the wood. Robbins invented the modern conveyor system in 1892. The first roller conveyor was invented in 1905 by Hymle Goddard, who patented it. Furthermore, Henry Ford developed an improved conveyor system in 1913 that would make it easier to manufacture cars. There was a change in the 1920s when the locomotives and rail lines were replaced by the conveyors, particularly in the mining and mineral industries. It was during the year of the Second World War when the use of synthetic materials was introduced in the Conveyor system. Since then, the conveyor system has been improved in terms of technology and mechanisms, and now it works more efficiently than it used to. Modern conveyor systems are fully automatic and are controlled and monitored by a computer system. About the drying conveyors, Berndorf manufactures a single belt conveyor that can be used for a variety of materials, such as food, chemicals, rubber, and many more. In addition to Ranar, a company also designed a small efficient conveyor which was for drying and curing the products.

1.3 Problem statement

Material handling equipment like conveyor systems has been around for a long time. As far as the drying of the food materials from the conveyor system, there have not been extensive studies conducted. Moreover, when it comes to the almond drying manufacturers, there are very few companies that publish information to the public. The conveyor system for drying has also been made smaller and is custom-made. These conveyor systems are only suitable for low production volumes. In addition, there will also need to be an analysis of the temperature required for the almonds to dry and the heat transfer rate in the system. Also, the materials needed for the efficient performance of the conveyor system are necessary to analyze.

1.4 Objectives

The purpose of the project is to model and simulate the conveyor mechanism for transporting the almonds.

The secondary objectives of this project are:

- To create a conveyor system that can transport small goods from one place to another in an efficient manner.
- To analyze conveyor belt design and obtain a structurally stable conveyor.
- To design the conveyor applicable for drying purposes.
- To make the conveyor system efficient and economic.

1.5 Scope

In addition, this project is applied not only to the almond manufacturing companies but also to the different types of food processing industries. The large-scale application of such types of conveyors can be done. The conveyor belt has a large application in such industries. The proper design is done to be done which could decrease the material and the service cost of the equipment. The efficient design of the system can be done and the service life of such types of conveyors can be improved by the analysis and improvement of the components of such conveyor system. For drying purposes, the heating equipment can be synchronized with the movement of the belt of the conveyor. This makes the drying process efficient. This process can be applied to the quick-service food industries which could increase the productivity of the services and reduces the manpower and cost.

1.6 Methodology

For the completion of this project, a brief study of different types of conveyor systems is done. The design and analysis of different types of conveyor systems are done. The materials for the project are sorted out and components are selected. The design calculation is done to calculate the performance of the system by considering the parameters like time for drying, sizing the power transmission, brake press, oven box bends, and many more. The modeling of the components of the conveyor is done in SolidWorks. The components like frame, chamber, blower, and belt conveyor are modeled by the use of SolidWorks. After the modeling of the components, it is necessary to perform the analysis of the model. ANSYS is used for the analysis and calculation of the values of stress, strain, and deformation and to evaluate the safeness of the model specific to the components like the roller and the frame.

Chapter 2 Literature review

For many years, a lot of tasks had been done to save the weight and the cost of the materials for the conveyor system. Nowadays, the weight per cost trend has been put forward to fulfill the requirement. The main purpose of this literature was to study the current in-use technology of conveyor systems and optimize the components of the system like the roller, shafts, and many more.
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.669.9121&rep=rep1&type=pdf

Transport of heavy material has been carried out for a long time by various methods including the use of belt conveyors to assist in moving bulky loads over long distances and multiple routes. With technology advancements in the field of design, analysis, and simulation of the conveyor systems have become better, the transportation of heavy materials has been made more efficient. Due to the non-traditional nature of the application, traditional components have been used in non-traditional applications that

have immediate drives and horizontal curves. The conveyor itself has been enlarged as well.
https://www.researchgate.net/profile/Mark_Alspaugh/publication/238729084_Latest_Developments_in_Belt_Conveyor_Technology/links/5ae0e2f1a6fdcc91399ec217/Latest-Developments-in-Belt-Conveyor-Technology.pdf
At present, conveyor systems are designed following the manufacturer's manual on standards such as ISO 5048 and DIN 22101. Based on static analysis, the design lacked any guidelines or rules for the belt's dynamic properties. As part of the new research, the analysis of the transverse and longitudinal vibrations of the conveyor system was more focused. Parameters including tension, idler spacing, and the trough configuration were considered for the transverse vibrations.
https://www.osti.gov/etdeweb/biblio/6785763

The simulation of the chained conveyor belt system in this paper was carried out. It was decided to employ the statistical analysis technique for the development of the overhead monorail conveyor system and multi-objective optimization of the manufacturing process. The simulation and the statistical analysis of this type of system were based on the methodology of the chain conveyor system that connects to the large space and makes the buffering to streamline the flow of material between the machines. It was discussed how to design an experimental conveyor system and how to optimize it. As well as the optimum speed of the belt, the total capacity of load carried in the system, and the step of carriers in the system have been analyzed. In addition, the delay phase in the conveyor system has also been detected.

https://www.actapress.com/Abstract.aspx?paperId=26772

In general, the large-scale conveyor is a piece of equipment that enables the transportation of bulk solids over a distance that is long. So, to make a prototype and to do research and development, analyze the virtual model, and evaluate its performance, a prototype and research and development are necessary. In comparison with the traditional conveyors, the development of a prototype for a lower cost and a better design was done. So, the development of a prototype for the development of the conveyor system will help in ensuring the safety and reliability of the system. It was also analyzed dynamically how the system will work. It was also attempted to determine how the conveyor system should be started. According to the simulation results, using the direct starting method resulted in high dynamic tension and a large deflection. When the Harrison method is introduced, the static tension is greatly reduced and the average dynamic tension makes the operating condition drop to a minimum and the system becomes stable.
https://www.scientific.net/AMM.148-149.879

As mentioned, the paper talks about ways and techniques to reduce the cost and time of designing, manufacturing, assembling, and finally disassembling a conveyor belt system

that is used in the food and beverage industry. According to the results obtained from the test, the overall material costs of the conveyor system have been reduced by 19% and all the assembly costs have been reduced to 20% compared to the traditional systems. The improved mechanical conveyor design has improved the efficiency of the conveyor system with the minimum use of the materials, components, and parts coupled with following the regulations of the manufacturing, design, and assembly of the components. From the test results obtained, the overall material cost has been reduced by 19% and all the assembly costs have been reduced to 20% compared to the traditional.
https://link.springer.com/article/10.1007/s00170-003-1843-3

This paper aims to study an existing conveyor system and optimize the components of parts of the conveyor system like rollers, and C-channels, and reduce the cost and weight of assembly by optimizing the parts. It also includes geometrical modeling of the parts and the use of finite element analysis. The linear static, modal, and transient analysis of the present design was completed, and the parts were optimized accordingly at the same loading condition of the conveyor system with a weight reduction. It was found that the process and the practical application of the current structure have a weight reduction of 30%.

https://www.ijert.org/optimization-technique-used-for-the-roller-conveyor-system-for-weight-reduction

A research program to develop a useful design tool to study conveyor belt dynamics began in 1950, but it wasn't until 1980 that the first tool was introduced. Initially, the focus was mainly on the start and the end of long overland, high load, and speed of conveyors. With the advancement of technological advancements, it has become possible to stop a conveyor belt in a smooth, quiet fashion. Based on this analysis, it was found that the starting and end of the belt do not take a lot of time. The focus of this paper is the work to be done for the dynamic analysis of the conveyor belt system. The paper also provides recommendations and provides ways to improve the performance of the conveyor system.

https://d1wqtxts1xzle7.cloudfront.net/32093061/1.two_decades_dynamics_of_belt_conveyor_systems-with-cover-page-v2.pdf?Expires=1655792949&Signature=Bhe5jA8JMww0u~dXL4qX2ZVIF0c5biVF6KDTrtkW6vN2kQpifSjzoeOiSfdUMr~1PbF8tCOe4ax5Z-IVrAMYobblEc9Pa1lEBDBnLb7u-XUJ2RGeQzUzN0tEr9t1SuvvFhoeH7wQFEFW2QaQyC3~tgjblbavPFiTqqeirqu4QOKdCy-qI5M8JqGoGmPXX~5l8qgKr~fB~b8f~fBm1oKho2NqNOUhaNV7qzurNjpYrEPB3uij1zeW1piKPBal0X9xBH3Zj4FTJtA1vYKDARb2PxoktapveWNJlP7aoeph3lzZDLORCWAG--hWl8C3tVT2lxa9clRj512fLILVBrTJ9w__&Key-Pair-Id=APKAJLOHF5GGSLRBV

Chapter 3 – Terms, Terminologies, and components

Mesh, ANSYS, SolidWorks, Sprocket, Mild steel, Gear reducer

- Mesh

In this particular case, it is the method of splitting geometry into multiple numbers of nodes and elements at the point where the optimal solution can be obtained. The network consists of both cells and points. The partial differential equations (PDEs) can have almost any shape in any size and can be solved with them in almost any situation. The mesh is composed of individual cells that, when combined, result in a total solution for the entire network.

- ANSYS

In the field of mechanical product design and civil structure design, ANSYS analysis software is widely used for developing and solving problems. ANSYS takes certain inputs and evaluates the behavior of the product by the physics that the product development engineers are using. It is a general use of software used to model the interactions between various surroundings, and physics, such as dynamics, statics, fluids, electromagnetics, thermals and also vibrations, and many more. It is typical for ANSYS to enable the user to create an environment that is virtual to simulate tests or working conditions of a product before the process of manufacturing. This would reduce the cost and time involved in producing prototypes.

- SolidWorks

Jon Hirschtick, an American programmer, developed this software in 1993. SolidWorks is a product of the Dassault Systems group of companies. With this software, CAD (Computer-Aided Design) is performed. As a result of this software, different types of files can be created, such as parts, assemblies, and drawings. Every time one of these files is modified, the rest also get modified. . This software can be used in the following ways: design, development, 3D file library, 2D drawing creation, etc.

- Sprocket

The sprocket, also known as a chain wheel, is a thin wheel with teeth on its surface. These are commonly used on bicycles to convert the movement of the rider's feet into wheel rotation. For flat wire belt sprockets, cast iron is the most used material, they are accurately cast from high-grade iron. As they line up with the links of the track, they pull the links with the conveyor.

- Mild steel

Mild steel is mostly used material for the design and manufacturing of the stand and other components of the conveyor system. It has high levels of strength and durability. The tensile strength is found to be 440 N/mm^2.

- Gear reducer

  A gear reducer, which is also known as the speed reducer, is an attachment of many gears. Here there is the involvement of the gears with less number of teeth and more number of teethes. This arrangement makes the speed of the output shaft lower, while the torque and speed values change.

Chapter 4 Material Selection, Calculation, Modelling and Analysis

4.1 Material Selection

The components of the conveyor, the material for the components and software for modelling and analysis are selected first. Along with this, several values are nominated and specified as required for the design of the components. A heating chamber, blower, belt drive and frame are chosen as the components of the conveyor. A belt drive is chosen for the movements and rollers and bearings are selected for the reduction of friction. Wheels and frame is selected for the movement of the system and for providing support to the system respectively. Further, mild steel is chosen as the material for components considering the fact that it has greater durability and strength. The breadth and velocity of the belt is nominated as 2 inches and 3 inches per minute respectively. A 0.5 HP motor running at 1800 RPM is selected. Sprockets with 10 and 20 teeth having 2.5 inches and 5inches diameter respectively are chosen. For the brake press 16GA sheet of thickness 0.0625 inches is taken. Bend angle and bend radius of oven box heads is nominated as 90 degrees and 0.125 inches respectively. Two powerful software are selected to model the conveyor and analyze it. For modelling of the conveyor, SolidWorks is chosen whereas for analysis ANSYS is chosen.

4.2 Calculation of design parameters

After the necessary selection is made, calculations are performed to determine the design parameters of the conveyor system. The calculations are done by estimating the weight of the almonds as 175 pounds. Taking a time of 25 minutes for 150 lb almonds and 45 baking sheets of size 16inch x 10 inches, load of almonds on each sheet is calculated as 4.45lb/sheet with the volume of almonds per sheet being 0.0926 ft^3. Then, the calculation is done for the time required for drying 150 lb almonds. The time for drying 150 lb almonds is calculated as 140 minutes considering the dimension of the box, the velocity of the belt and its breadth as nominated during the selection of components and materials. Then, calculations are done for the sizing of the power transmission unit. Taking the ratio of 1^{st} gear reducer as 40:1 and 2^{nd} reducer gear as 20:1, the rpm after gear reduction and sprocket reduction is calculated as 2.25 rpm and 1.125 rpm respectively. The belt speed is reckoned to be 17.67 in/min. Further, calculations are performed for brake press and oven box bends. The total length without bend is calculated as 65.13 inches with a setback on the outer side as 0.0078 inches and an allowance of 0. 237583 for the bend. Hence, 64.56 is determined as the actual length of the brake press. Lastly, the design of the frame is carried out. The frame is designed for a point load. A 3-inch channel having a load of 200 lbs supported at three different points is taken and calculations are done for each point taking the sectional modulus of the channel as 1.1 $inch^3$ and allowable stress as 22 Kpsi. The next step in the project after the calculation of design parameters involves modelling the conveyor system.

CALCULATION

Estimated time for 175 lb. almonds

We have,

1 lb. almonds ≅ 3 cups

120 cups = 1 ft^3

150 lb. almonds = 450 cups = 3.75 ft^3

Time for 150 lb. almonds = 25 minutes

Baking sheets = 45 sheets of 16-inch x 10 inch

Similarly, each sheet can have 1-inch-high almonds batch.

Load of almonds per sheet = 200 lb. / 45 = 4.45 lb/sheet

Volume of almonds per sheet = L×B×H = 16 × 10 × 1 = 192 $inch^3$ = 0.0926 ft^3

Time for drying 150 lb. almonds

Dimension of the box

= L×B×H

= 5' × 2.18' × 1.5'

Breadth of belt = 2 inch

Velocity of the belt = 3 inch per min

Overall needed belt for 150 lb. almond

V_b = 5 ft^3 = 8640 in^3

Also,

V_b = length of belt × 1 inch × 24 inch

= 8640

Length of belt = 360 inches

Belt travel = 360 + 60 = 420 inches

Time = 420 / 3 inch per min = 140 minutes

Power transmission sizing

We considered

Sprockets with 10 teeth and 2.5-inch dia. and 20 teeth and 5-inch dia.

1st gear reducer = 40:1

2nd gear reducer = 20:1

0.5 HP motor @ 1800 RPM

$$RPM\ after\ gear\ reduction\ = \frac{1800}{40 \times 20}\ =\ 2.25\ RPM$$

$$RPM\ after\ sprocket\ reduction\ = \frac{2.25}{\frac{20}{10}}\ =\ 1.125\ RPM$$

$Belt\ speed$

$=\ 1.125 \times (5\ inch \times\ \pi)$

$$=\ 17.67\ in/min$$

Brake Press and Oven Box Bends

We have,

16 GA sheet having a thickness of 0.0625 inches = t

Bend angle = 90 degree

Bend radius = r = 0.125 inch

For K factor

$Start\ with\ Radius\ <\ (2\ \times\ thickness)$

$=\ 0.125\ inch\ <\ (2\ \times\ 0.0625)$

$=\ 0.125\ inch\ =\ (0.125)$

$Start\ with\ Radius\ >\ (2\ \times\ thickness)$

$=\ 0.125\ inch\ >\ (2\ \times\ 0.0625)$

$=\ 0.125\ inch\ =\ (0.125)$

Hence K factor is needed between the 2 factors.

K factor = (0.33 + 0.5 / 2) = 0.42

$Total\ length\ without\ bend\ =\ All\ sides\ length\ without\ bend$

$=\ 1.5''\ +\ 17.94''\ +\ 26.25''\ +\ 17.94''\ +\ 1.5''\ =\ 65.13\ inches$

$$Set\ back\ in\ outer\ side\ =\ Tan\left(\frac{Angle}{2}\right) \cdot (Radius \times Thickness)$$

$$=\ Tan\left(\frac{90}{2}\right) \cdot (0.125 \times 0.0625) = 0.0078\ inch$$

Allowance for the bend

$$= \ Angle \times \frac{\pi}{180} \times (Radius + K\ Factor \times thickness)$$

$$= \ 90 \times \frac{\pi}{180} \times (0.125 + 0.42 \times 0.0625) \ = \ 0.237583\ inches$$

Compensation for the bend

= Allowance for the bend - (2 × set back) = 0.237583 - 2×0.19 = -0.1424 inch

Actual length = Total length without bend + Compensation for the bend × number of bends

= 65.13 inches - 0.1424 × 4 = 64.56 inches

Frame's Design for Point Load

A 3-inch channel had load of 200 lbs. at three distinct points and it was supported at A, B and C points.

Sectional Modulus of the channel = S = 1.1 inch^3

Allowable stress = 22 Kpsi

For Point A

$$R \ = \ V \ = \ P/2 \ = \ 200/2 \ = \ 100\ lbs$$

$$Mmax \ = \ P \times \frac{L}{4} \ = \ 200 \times \frac{36}{4} \ = \ 1800\ in.lbs.$$

$$S \ = \frac{Mmax}{allowable} stress \ = \frac{1800}{22000} \ = \ 0.0818\ in^3$$

For Point B

$$R \ = \ V \ = \frac{P}{2} \ = \ 200/2 \ = \ 100\ lbs$$

$$Mmax \ = \ P \times \frac{L}{4} = \ 200 \frac{48}{4} \ = \ 2400\ in.lbs.$$

$$S = \frac{Mmax}{allowable} stress = \frac{2400}{22000} = 0.109\ in^3$$

For Point C

$$R = V = \frac{P}{2} = \frac{200}{2} = 100\ lbs$$

$$Mmax = P \times \frac{L}{4} = 200 \times \frac{36}{4} = 1800\ in. lbs.$$

$$S = \frac{Mmax}{allowable} stress = \frac{1800}{22000} = 0.0818\ in^3$$

4.3 Modelling

Modelling of the conveyor is done in SolidWorks based on the nominated sizes and design calculations done above. Initially, 2D models are prepared for the components which are later converted to the 3D models. Different commands, features and tools of the software are used properly to obtain the required model. The unit of measurement is selected as inches and sizes are provided to the pieces on the sketch panel. Then, the front plane is selected for sketching and on the front plane, the model of the belt drive is prepared using tools such as circle, arc and extrude cut. Then, a 2D model of the roller is made using arc and circle tools. The excess part is removed using the trim command. Using the extrude boss option, the 2D model is converted to the 3D model by providing the required thickness. Further, the model of the frame is prepared using tools such as rectangle and square. For the frame, the weldment feature is also utilized. The belt drive is added by using the inbuilt option belt feature in SolidWorks. It is selected from the SolidWorks library and dragged to the system. After obtaining the models of each component, these individual components are assembled together in a single conveyor system using the mate command of the software. In this way, a 3D model of the conveyor is obtained. Dimensions are provided to the models using the dimension command. The assembly drawing is saved. The different views of the assembled model of the conveyor are drafted which makes it easy to visualize the conveyor. After the completion of all the steps, the file is saved in standard .IGES format which can be easily read by the analysis software.

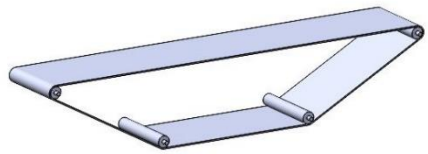

Figure 1: Belt conveyor

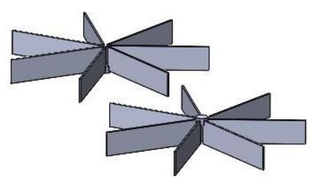

Figure 2: Blower

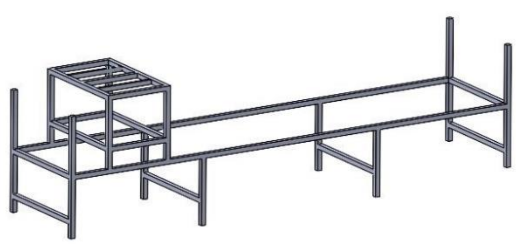

Figure 3: Frame design

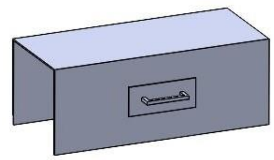

Figure 4: Heating chamber

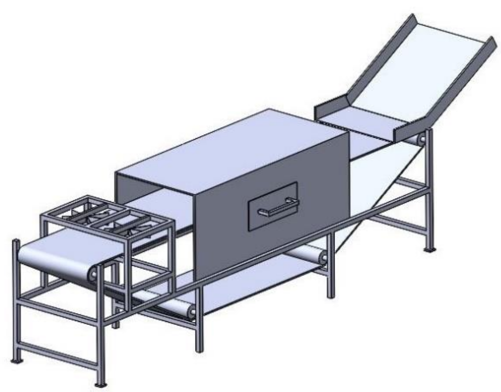

Figure 5: Assembled model

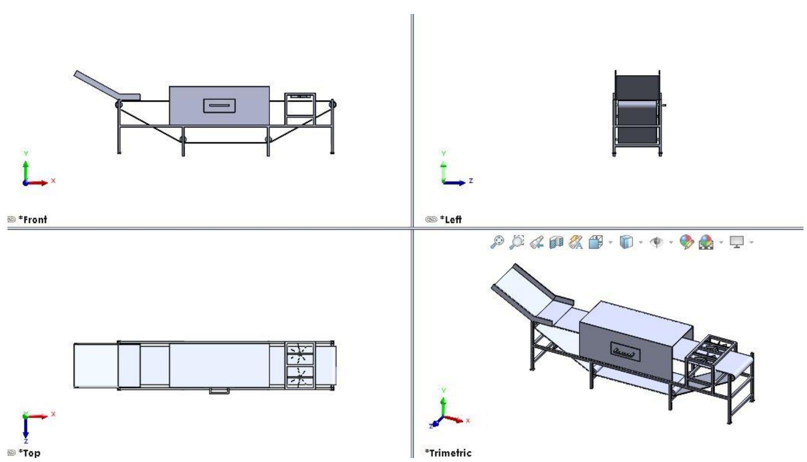

Figure 6: Different Views of Assembled Model

4.4 Analysis

The file containing the 3D model of the conveyor prepared in SolidWorks is imported to ANSYS Workbench for the static structural analysis. The software is based on computational techniques and the problems are solved using the finite element analysis. The analysis is carried out for frame and roller. The type of analysis is selected as static structural analysis. In the ANSYS Workbench, the material of the component is defined as mild steel and respective material properties are defined from the ANSYS library by selecting the engineering data option. After defining the material properties, the model is discretized into finer elements. For meshing, the method option is clicked in ANSYS and then the required geometry to mesh is selected. Further, tetrahedron mesh creation algorithm is chosen and the update option is clicked. Fine meshing option is done while performing the meshing as it gives more accurate results. Then, the meshed model is generated to see if there are any errors while meshing. Once an error-free meshed model is obtained, further, boundary conditions that simulate the real-life situation are assigned to the model. To all the supports, fixed supports are provided. Along with this, the external loads that the system may experience during its lifetime are also assigned. Finally, the simulation is run and the results are obtained for maximum strain, maximum stress and maximum deformation in the roller and frame. The values are compared with the standard values of material and a conclusion is drawn to ascertain whether the designed conveyor is structurally safe or not.

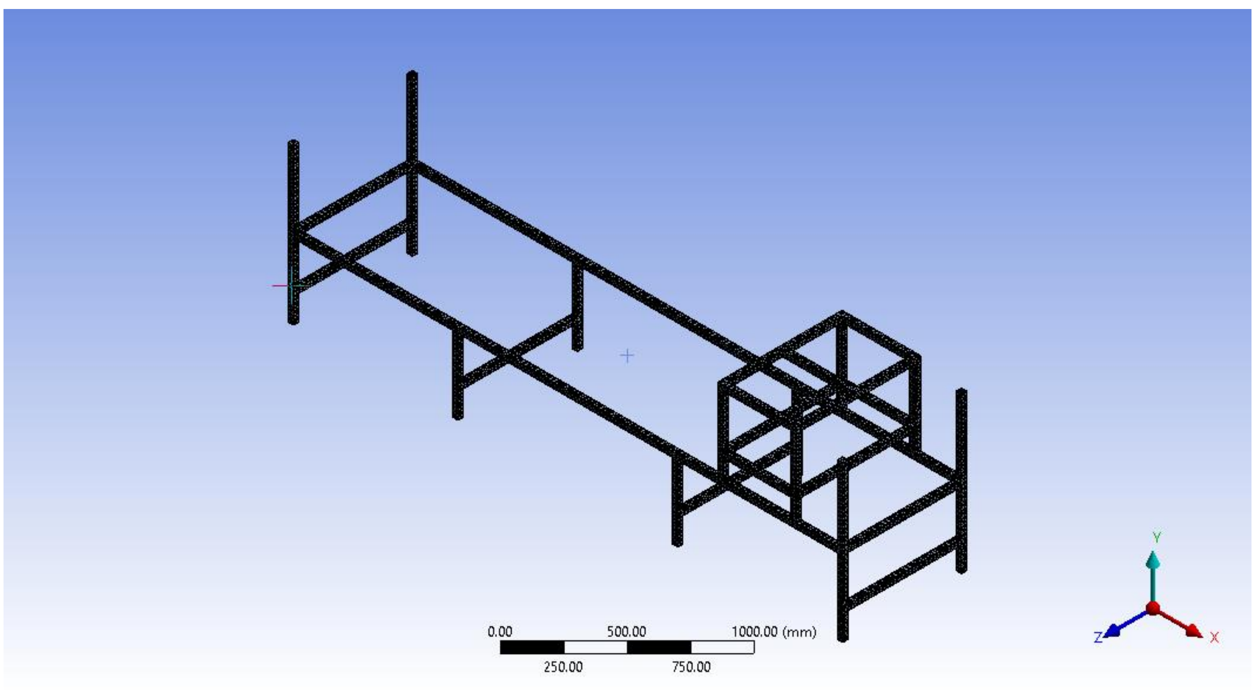

Figure 7: Meshed model of frame

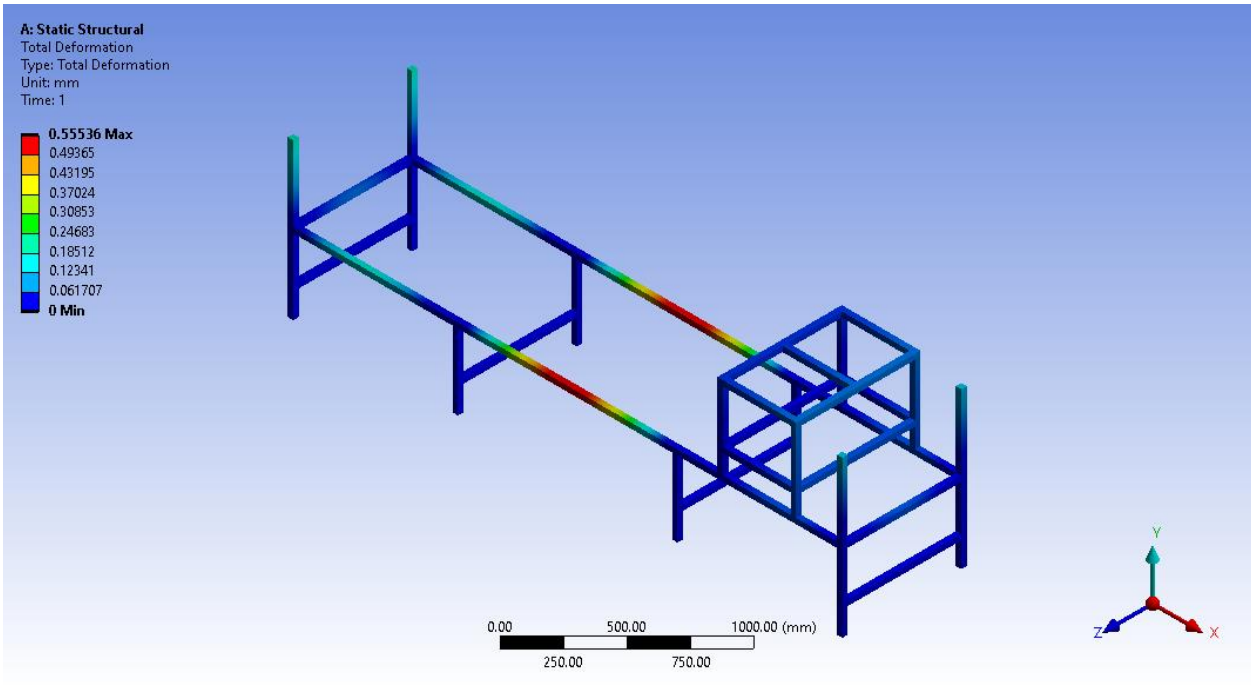

Figure 8: Deformation

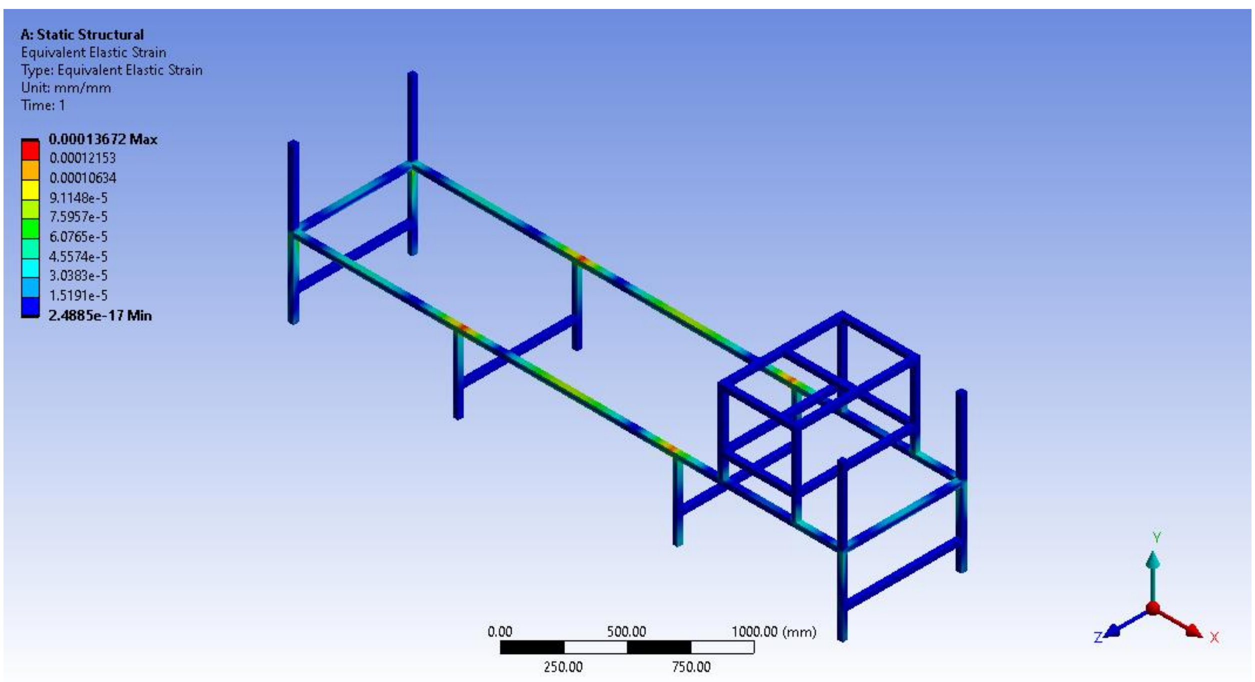

Figure 9: Strain

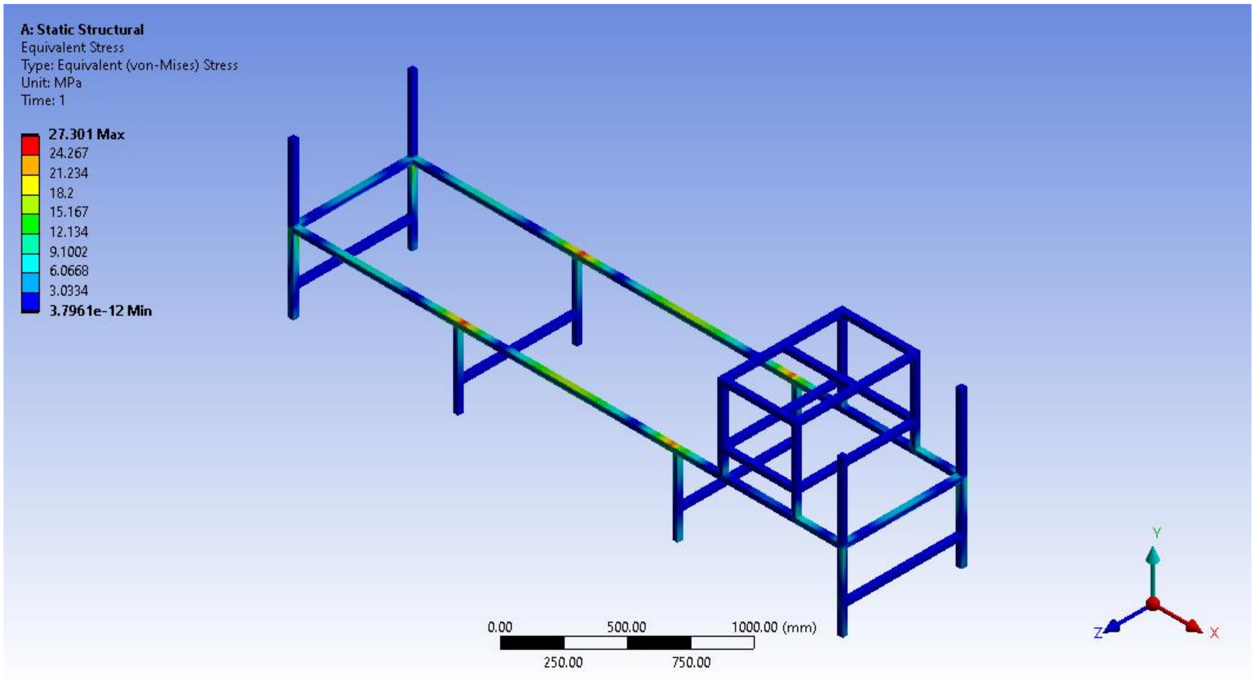

Figure 10: Stress

Roller

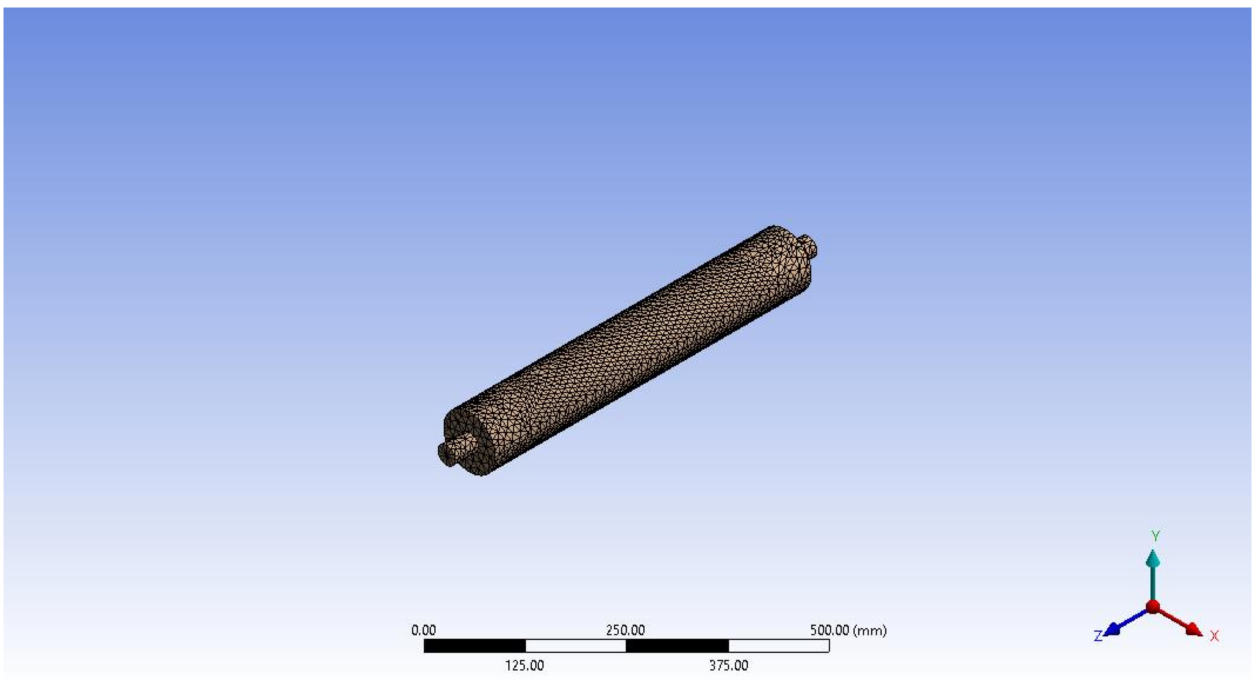

Figure 11: Meshed model of roller

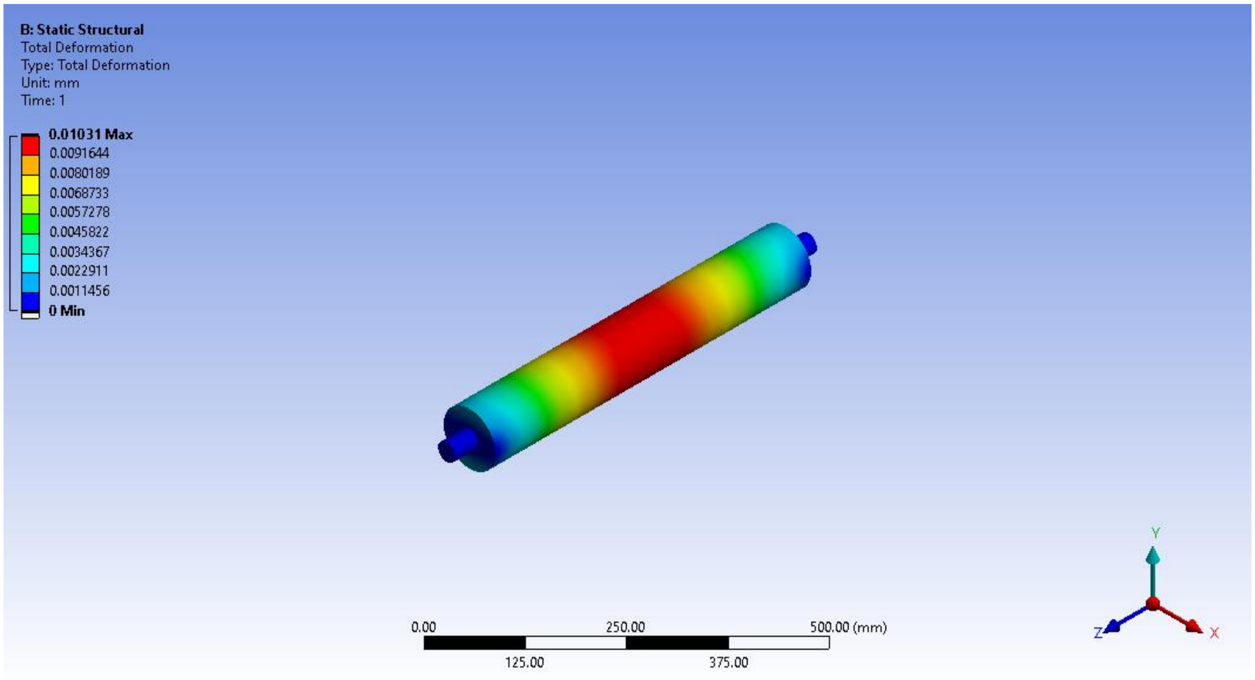

Figure 12: Deformation

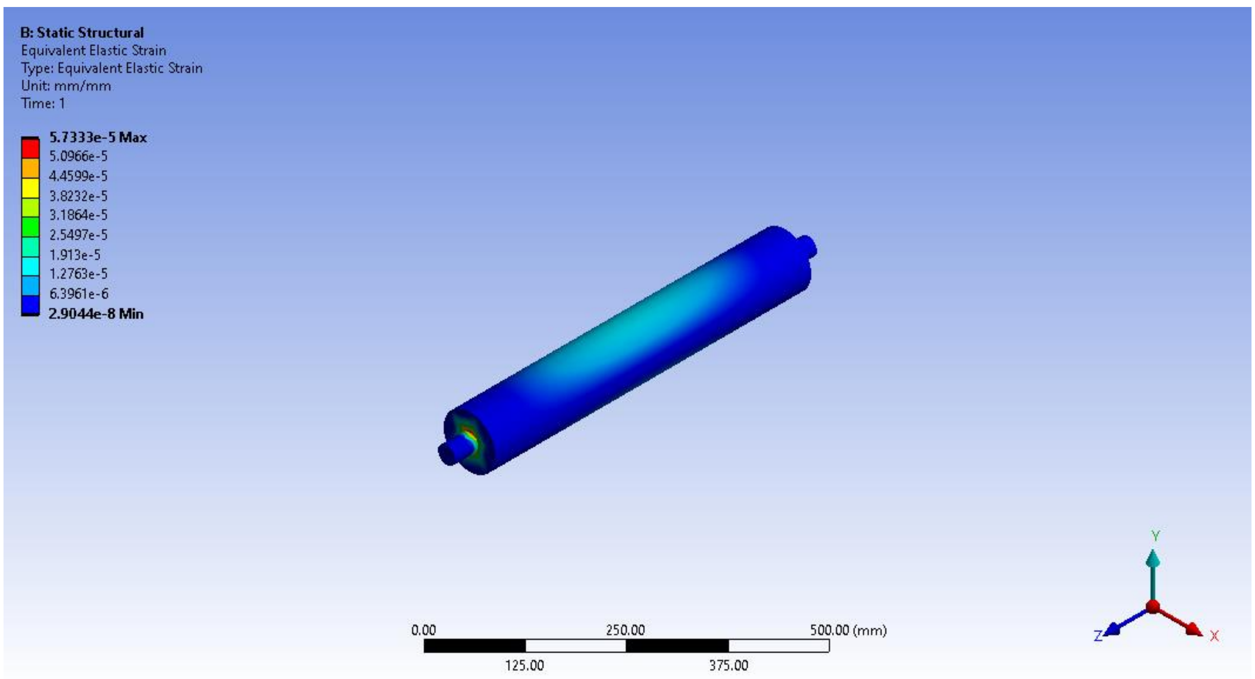

Figure 13: Strain

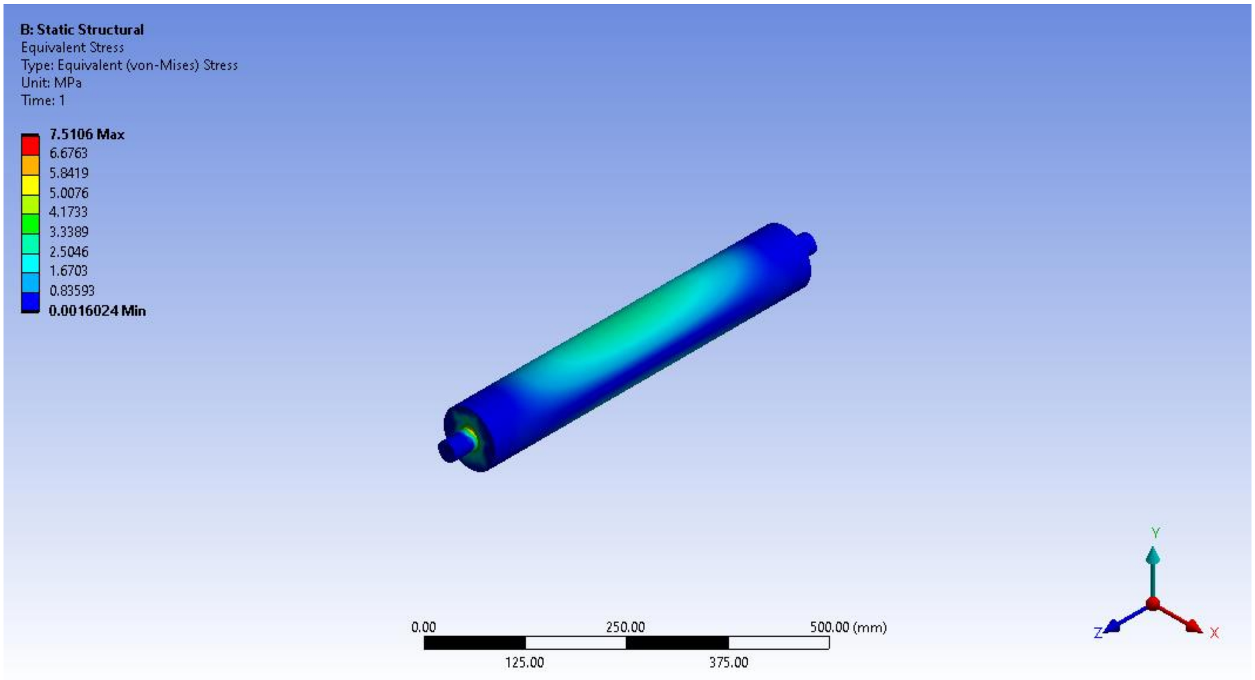

Figure 14: Stress

Chapter 5 Results and Discussion

5.1 Results

The results from the analysis are obtained in the form of graphs and they are presented in the form of tables for easy comparison. The outcomes of the analysis show that the maximum total deformation in the frame is 0.55536mm. The maximum elastic strain and the minimum elastic strain are 0.00013672 mm/mm and $2.4885e^{-17}$ mm/mm respectively. Maximum deformation and strain are observed in the upper part of the frame. Similarly, the maximum Von-Mises stress in the frame is found to be 27.301 MPa whereas it's minimum value is $3.7961e^{-12}$ MPa. At places of maximum stress, maximum deformation is seen to have occurred. For the roller, maximum deformation is observed as 0.01031 mm around the central portion of the roller. Similarly, the maximum and minimum elastic strain in the roller is found to be $5.7333e^{-5}$ and $2.9044e^{-8}$ respectively. Likewise, the maximum Von-Mises stress in the roller is observed as 7.5106 MPa and 0.0016024 is obtained as the minimum Von-Mises stress. The maximum values of strain, deformation and stress for roller and frame are checked against the standard values of the material used in them. It is found that these values are under the allowable limits which ensures that the model of the conveyor system designed in the project is structurally safe and stable.

Table 1: Outcomes of analysis

Components	Max. deformation, mm	Max. Stress, MPa	Max. Strain
Frame	0.55536	27.301	0.00013672
Roller	0.01031	7.5106	5.7333 e^{-5}

5.2 Discussion

Several factors are taken into account during the project such that a structurally safe and efficient design of the conveyor is obtained and all the phases of the project are properly supervised. The conveyor system is designed in such a way that manual labour is not required for handling and transferring almonds. Along with this, the space for drying is also eliminated. The steps and procedures that are followed during the project comply with the standard codes. ICS 53.040.10 is referred to get an idea of the conveyors. Mild steel is chosen as the material for the components considering the fact that it has high durability, strength and good welding ability. Calculations are done carefully to determine the design parameters. The speed of the belt, the volume of almond and the time for drying the almond were taken into special consideration while performing the calculations for the design of the conveyor. The power of the electric motor is chosen in such a way that it can drive the conveyor system easily. The design of the model is such that the driver and driven sprocket are easily accessible which makes it easy for changing the sprockets to the desired gear ratio. References are taken from ICS 35.240.10 to prepare the CAD model of the various components of the conveyor. The model is such that if the machine is fabricated then, the assembling and dissembling of the components is easy. Several errors are encountered while preparing the models and performing the analysis. These are mitigated using creative techniques. During the analysis, the number of nodes is increased for a fine meshing option as the model gets discretized to many fine elements which make the results from the analysis more accurate. The high deformation obtained in the frame is reduced as a high deformation reduces the durability of the frame. The thickness of the frame is increased to an appropriate level such that the frame can withstand higher stresses and consequently, the maximum deformation is reduced.

Chapter 6

6.1 Conclusion

Modelling and analysis of the conveyor system is successfully accomplished. Mild steel is used as a material for the components. Different components of the conveyor system such as the heating chamber, frame, blower, belt etc are modelled in SolidWorks and then assembled into a single model whose static structural analysis is done in ANSYS. The Roller and frame of the conveyor are simulated. The results of the analysis are obtained in the form of Von Mises stress, total deformation and elastic strain. The maximum stress in roller and frame is obtained as 7.5106 MPa and 27.301 MPa respectively. Likewise, deformation for roller and frame is observed as 0.01031mm and 0.55536mm respectively and maximum elastic strain is 5.7333 e^{-5} and 0.00013672 respectively. Higher stress is observed in the frame while the roller has significantly lesser deformation. Due to the higher stress in the frame, a higher deformation is observed in the frame. However, the structural analysis of the system shows that the stress is within the acceptable limit for the mild steel which ensures the deformation is under the allowable range and hence, the designed conveyor is safe and stable. Also, the conveyor system holds the capability of conveying goods efficiently. Since the designed conveyor system has the ability to convey goods and is found to be structurally safe through analysis, the secondary objective of the project to develop a structurally strong conveyor that transports the goods from one location to the other efficiently is fulfilled.

6.2 Advantages

The advantages of the project can be explained in the following points:

- Mild steel is used in the components of the conveyor which possesses higher durability and strength properties.
- The power of the electric motor can drive the conveyor easily.
- The design of the conveyor is such that the assembly and disassembly of the components is easy which makes the maintenance of the machine easier.
- The stress and deformation in the frame and roller are within the acceptable limits which ensures the structural safety of the conveyor.
- The designed conveyor system eliminates the conventional labor-intensive conveyor mechanism.

6.3 Limitations

The limitations of the project are enlisted below:

- The structural suitability of the conveyor system cannot only be assessed through stress and deformation obtained in the components.
- Since, the model is not fabricated, the real-life efficiency of conveying goods is not known.
- The cost analysis is not done and the cost required for developing the machine is not known. Hence, not much idea is gained if the machine is affordable or not.

6.4 Future Works

A lot of work can be done in the future regarding the project to bring about improvisation in the conveyor system. Only the design of the conveyor is shown in the report. In the future, the model designed in the project can be fabricated and tested to know the real-life capability of the system to convey goods and its efficiency. Material other than steel can be used for the components and the structural performance of the machine can be investigated. Further, the dimensions of the components can be varied and the design of the conveyor can be optimized for better efficiency. The power of the motor can be altered and the gear ratio can be changed. With respective changes, a better design of the conveyor system can be selected. The scope of the project can be expanded to other types of analyses such as modal analysis, thermal stress analysis etc. Further, the project report can be used by students to take references and guidelines for the design of the components of the mechanical conveyor.