

Design , Modeling and Analysis of conveyor system used for transportation of Cartons

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Abstract-In this paper I am suggesting a conveyor system for the company who are in a process of automization of a plant and they are in a need of a dedicated conveyor system for the contineous filling of liquid in the cartons having chamber of two types 1 X 16 (4 X 4) and 1 X 25 (5 X 5). With the proposed conveor system the labour cost will be reduced also the transportation and material handling cost will be reduced. With this conveyor system the 420 cartons can be filled with the help of programmable filling machine each chamber can be filled in 3 seconds.

Index Terms- Conveyor Selection, Design Calculations, Modeling Using CAD software, Analysis using ANSYS

1. INTRODUCTION

Conveyor is used in many industries to transport goods and materials between stages of a process. Using conveyor systems is a good way to reduce the risks of musculoskeletal injury in tasks or processes that involve manual handling, as they reduce the need for repetitive lifting and carrying. Conveyors are a powerful material handling tool. They offer the opportunity to boost productivity, reduce product handling and damage, and minimize labor required in a manufacturing or distribution facility.

All lifting and conveying machines can be divided by their operating principles into two large groups:

(i)Intermittent motion, (ii) Continuous motion

Intermittent motion includes all types of cranes, lifts; surface transport means (trucks, loaders, prime movers), aerial tramways and cable ways, scrappers and the like.

Continuous motion includes conveyors, pneumatic and hydraulic transport means etc. which may generally called continuous transport machines or conveying machines.

Continuous machines are characterized by non-stop motion of bulk or unit loads along a given path, without halts for loading and unloading. At the same time they can distribute loads among a number of destination points, deliver them to stores, and transfer products from one technological operation to another and ensure the desired pace of a production process.

Conveyors are classified into different categories those are as follows: (i) chute conveyor (ii) wheel conveyor (iii) roller conveyor (iv) chain conveyor (v) slat conveyor (vi) flat belt conveyor (vii) Magnetic belt conveyor (viii) troughed belt conveyor (ix) bucket conveyor (x) vibrating conveyor (xi) screw conveyor (xii) pneumatic conveyor (xiii) cart on track conveyor (xiv) tow conveyor (xv) trolley conveyor (xvi) power

and free conveyor (xvii) monorail (xviii) Sortation conveyor.

Conveyors are further classified as either Unit Load Conveyors that are designed to handle specific uniform units such as cartons or pallets, and Process Conveyors that are designed to handle loose product such as sand, gravel, coffee, cookies, etc. which are fed to machinery for further operations or mixing. It is quite common for manufacturing plants to combine both Process and Unit Load conveyors in its operations.

The aim of this paper is to develop a 3D model of a conveyor system and Analysis it. 3D model helps in exact visualization, an idea about what actually looking after implementing the system, also after complete assembly we can modify as per the need of a customer. This can be done by designing with the help of Pro/E software. A CAD system which can be used for the concept design and an appropriate CAD environment should be developed. And another purpose is to shorten the product development time.

The improved methodology for design and production of conveyor components is based on the minimization of materials, parts and costs, using the rules of design for manufacture and design for assembly. Results obtained on a test conveyor system verify the benefits of using the improved techniques. The overall material cost was reduced by 19% and the overall assembly cost was reduced by 20% compared to conventional methods.

The information like `weight` of the roller conveyor and `location of the Centre of Gravity` can be readily offered by the three dimensional CAD interface.

Although it is iterative process the physical design of each iteration for testing is not possible for conformance to the conditions specified (test conditions) could be done through the utilization of a suitable tool – Software for Analysis in the domain of Mechanism Design.

The following figure 1, shows the layout of area which we have to automate. In this automation we have to developed a conveyor system used for the transportation of cartons before and after the filling process and the precise Allocation (Threaded spindle with stepper motor) for the chamber system (1 x 16 chamber 1 x 25 chamber).

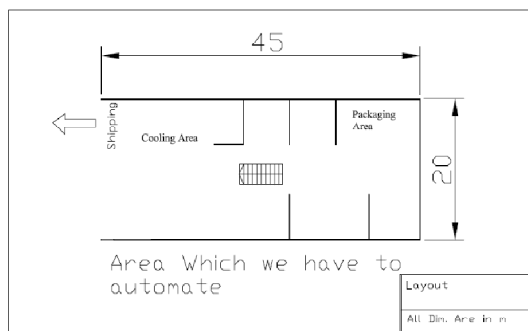


Fig1: Layout area

The parameters that can be considered for designing the conveyor system are

1. **Material to Transport:**
 - i. Carton with open lid
2. **Material to transport Dimensions:**
 - i. 240mm width
 - ii. 320mm length
 - iii. 210mm height
3. **Bag system in cartons:**
 - i. 16 bags (4 X 4)
 - ii. 25 bags (5 X 5)
4. **Material to Transport Weight:**
 - i. Min 1 Kg
 - ii. Max 25 Kg
5. **Production Per Day:**
 - i. 420 cartons/day
6. **Precise Allocation:**
 - i. Programmable

The Proposed layout of conveyor system is shown in the figure:2 as follows

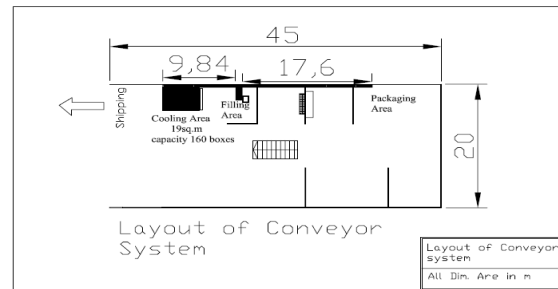


Fig2: Proposed Layout

2. OBJECTIVE OF PROJECT

- ❖ Automization of plant by developing conveyor system
- ❖ Study Various types of conveyor
- ❖ Put CAD technology to work and insure the design intent is realistic in operation
- ❖ Shorten the product development time and improve the product quality
- ❖ the minimization of materials, parts and costs, using the rules of design for manufacture and design for assembly
- ❖ Safety transport material from one level to another which done by human labour would be strenuous and expensive
- ❖ Study and analysis of various conveyor systems.
- ❖ Avoid losses during transportation and improper handling

3. LITERATURE REVIEW

We could not find much of the literature directly related to Design, Modeling and Analysis of Conveyor System to Transport of cartons before and after the filling process and the precise Allocation. Few of the literatures are cited below.

3.1 An investigation into design and manufacturing of mechanical Conveyors Systems for food processing.

S.H. Masood, B. Abbas, E. Shayan, A. Kara (2005), in this paper author has presents a application of **concept of concurrent engineering** and the principles of design for manufacturing and design for assembly concept, several critical conveyor parts were investigated for their functionality, material suitability, strength criterion, cost and ease of assembly in the overall conveyor system. The critical parts were modified and redesigned with new shape and geometry, and some with new materials. The improved design methods and the functionality of new conveyor parts were verified and tested on a new test conveyor system designed, manufactured and assembled using the new improved parts. The improved methodology for design and production of conveyor components is based on the minimization of

materials, parts and costs, using the rules of design for manufacture and design for assembly. Results obtained on a test conveyor system verify the benefits of using the improved techniques. The overall material cost was reduced by 19% and the overall assembly cost was reduced by 20% compared to conventional methods.

3.2 Latest Developments in Belt Conveyor Technology

M. A. Alspaugh, Overland Conveyor Co., Inc (2004)

This paper presents latest development in belt conveyor technology & the application of traditional components in non-traditional applications requiring horizontal curves and intermediate drives have changed and expanded belt conveyor possibilities. Examples of complex conveying applications along with the numerical tools required to insure reliability and availability will be reviewed. This paper referenced Henderson PC2 which is one of the longest single flight conventional conveyors in the world at 16.26 km. But a 19.1 km conveyor is under construction in the USA now, and a 23.5 km flight is being designed in Australia. Other conveyors 30-40 km long are being discussed in other parts of the world.

3.3 Availability modelling of powered roller conveyers

John R. English, University of Arkansas, John Usher, University of Louisville (2006). This paper provides an analysis of the reliability and availability of two common designs of the line-shaft roller conveyor. The first is a standard design in which each roller is belted directly to a spinning line shaft under the conveyor. The second is a new design in which only one top roller is belted to the line shaft, and all other rollers are belted to the one powered roller in a series arrangement. The main reason for this design is that the upper belts are faster to replace than belts connected to the line shaft, thus increasing system availability. However, the latter design is less reliable in that the failure of a single belt may lead to multiple roller failures.

3.4 Design and its Verification of Belt Conveyor System used for Cooling of Mould using Belt Comp Software (2011) (2012)

S. S. Vanamane¹, P.A.Mane², K. H. Inamdar³ P. G. Student¹, Assistant Professor², Assistant. Professor³ Department of Mechanical Engineering Walchand College of Engineering, Sangli (Maharashtra)

In this paper the study is carried out on DISA pattern moulding machine to meet the requirement of higher weight castings. From the DISA specification the belt conveyor system is designed by using different standards like CEMA (Conveyor Equipment

Manufacture's Association) standards, some handbooks of belt conveyor system etc. then this parameter are verified by using Belt Comp software. The result got from the Belt Comp software is in close agreement of theoretical results. After the design the manufacturing is done and the installation is done on the manufacturer's site. The trials are carried out on the belt conveyor system successfully and the problems occurs during the trials are overcome in the analysis by taking proper steps.

3.5 DYNAMIC ANALYSIS & WEIGHT OPTIMIZATION OF ROLLER CONVEYOR (2014) (2013)

1Satish Vithoba Gaikwad, 2N.S. Kulkarni, 3Swapnil S. Kulkarni 1ME-Mech Design – pursuing, 2Asst. Prof. VIT, Pune. 3Director-Able Technologies India Pvt. Ltd., Pune India

In this paper the study is carried out on existing conveyor system. In this, the mechanical elements of the Roller Conveyed system designed individually and tested in the assembly environment. The structure should be tested for external forces acting on the entire assembly. For design and assembly purpose they use CATIA V5 R18 and for dynamic analysis uses MSC/PATRAN and MSC/NASTRAN.

3.6 Survey of research in modeling conveyor-based automated material handling systems in wafer fabs

Dima Nazzal, Ahmed El-Nashar Department of Industrial Engineering and management Systems, University of Central Florida.(2007)

This paper discusses literature related to models of conveyor systems in semiconductor fabs. A comprehensive overview of simulation-based models is provided. We also identify and discuss specific research problems and needs in the design and control of closed-loop conveyors. It is concluded that new analytical and simulation models of conveyor systems need to be developed to understand the behaviour of such systems and bridge the gap between theoretical research and industry problems.

After doing a brief literature review it has been observed that following parameter has to be considered while designing of conveyor system:

1. Principles of design for manufacturing and design for assembly concept, several critical conveyor parts were investigated for their functionality, material suitability, strength criterion, cost and ease of assembly in the overall conveyor system.
2. The critical parts were modified and redesigned with new shape and geometry, and some with new materials.

3. The overall material cost and the overall assembly cost reduced as compared to conventional methods.
4. Software's like ANSYS used for dynamic analysis and weight optimization of conveyor which is helpful in designing of conveyor.

4 RESEARCH METHODOLOGY:

- ❖ Design Entire System Using conveyor parameters the parameters for design of conveyor:
 - Speed
 - Width
 - Absorbed power
 - Gear box selection
 - Drive shaft
- ❖ For designing a conveyor belt, some basic information e.g. the material to be conveyed, its lump size, tonnage per hour, distance over which it is to be carried, incline if any, temperature and other environmental conditions is needed.
- ❖ Modelling Conveyor using (PRO-E Software)
- ❖ ANSYS-structural analysis , stress
- ❖ To generate a model suitable for static analysis.
- ❖ To generate a finite element model of the same.
- ❖ To carry out all the necessary checks on the model.
- ❖ To carry out the analysis to study the behaviour.

5 DESIGN OF ROLLER CONVEYOR

INPUT DATA

- Material to Transport: Carton with open lid
- Material to transport Dimensions: 240mm width x 320mm length x 210mm height
- Bag system in cartons: 16 bags (4 X 4) , 25 bags (5 X 5)
- Material to Transport Weight: Min 1 Kg- Max 25 Kg
- Conveyor Speed : 0.2 m/s

Important Components of Single Strand Chain Driven Live Roller Conveyor

- 1) C-Channel for Chassis
- 2) Rollers
- 3) Shaft
- 4) Sprocket
- 5) Bearing
- 6) Chain
- 7) C-Channels for Support
- 8) DC Motor

5.1 C-Channel for chassis:

There are various C-channel catalogues available on internet such as continental steel private Ltd, MNC Steel India Pvt Ltd, Cluster Steel Pvt Ltd, Etc. As the weight convey by the conveyor is very less thus we

are going for a c-channel of minimum thickness having less weight.

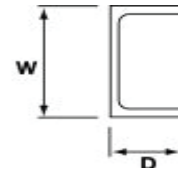


Fig 3: C-channel

Thus selected C-Channel of size is w=75, D= 40 having thickness of 2.3 mm and weight 3.25 Kg/m

5.2 Roller:

Rollers can be manufactured manually in workshop or directly available in the market. The selected roller of O/D 32mm and I/D 29mm.

Thus the weight of roller is given by

$$\begin{aligned} \text{Roller wt.} &= \pi (D^2 - d^2) \times l \times 7.850 / 10^6 \times 4 \\ &= \pi (32^2 - 29^2) \times 400 \times 7.850 / 10^8 \times 4 \\ &= 0.45 \text{ Kg} \end{aligned}$$

For the same shaft of dia. 12mm x 410 mm can be selected whose wt. is given by 0.12 Kg. Total weight of roller is 0.60 + 0.12 == 0.36 Kg.

5.3 Standard MRC Bearing,

SKF Bearing number CONV-4 SF, Weight =0.0344 Kg
 d= Bore diameter = 12 mm
 D=Outer diameter = 30 mm
 B= width = 15 mm
 Bearing is suitable for High radial loads, economical.

5.4 Common data for all 5 positions of conveyor system

Conveyor Width :

The effective conveyor width should be approximately 70 mm wider than the widest product to be conveyed. If your application consists only of straight conveyor sections, the recommended conveyor width is:

$$\text{Conveyor Width} = \text{Package Width} + 3 \text{ inches (70 mm)}$$

Product size: 240mm width x 320mm length x 210mm height

$$\text{Conveyor Width} = 320 \text{ mm} + 70 \text{ mm}$$

$$\text{Conveyor Width} = 390\text{mm (Roller Usable Width)}$$

Roller Centre Spacing (PITCH):

For chain driven live roller conveyors to have a minimum of three rollers must support the smallest unit load.

$$\text{Maximum Roller spacing} = \frac{\text{Package Length}}{3}$$

$$\text{Maximum roller spacing} = 210/3 = 70 \text{ mm}$$

Roller Capacity

$$\text{Minimum capacity required per roller} = \frac{\text{Max Package weight}}{\text{No of rollers under load}}$$

$$\text{Minimum capacity required per roller} = 8.33 \text{ kg}$$

Sprocket selection:

At present, all the motors are of 1440 rpm. We have V=0.2 m/s

RPM of rollers is;

$$V = \pi D N/60$$

$$0.2 = \pi \times 50 \times N / 60$$

$$N = 76.40$$

Therefore the gear box required

$$= \text{Input rpm} / \text{required rpm}$$

$$= 1440 / 76.40$$

$$= 18 \text{ (required ratio)}$$

From the catalogue of Premium Transmission gearbox which is directly available.

As the reduction gear box available the number of teeth on sprocket will be same.

Therefore, No. of teeth on drive sprocket == No. of teeth on driven sprocket.

Thus from standard sprocket catalogue of Martin we have selected sprocket of size 08B16 having pitch 12.70 mm and weight 0.46 kg. Also sprocket should of same pitch of 12.70mm. Thus the specifications of chain can be tabulated

Design for chain pull

From packaging area to filling area of length 17.60 m

- Traveling side of carton is 320 mm
Thus total number of cartons over 17.6 m length of conveyor
= 17600/320
= 55 cartons
- Live load :(A)
A == total cartons x wt. of carton
A == 55 x 25
A == 1375 Kg
(Note: Here we are calculating for maximum load condition)
- Chain Pull Calculations :

Chain pull is the force required to start and maintained the movement of all rollers and live load is obtained by multiplying the total live load plus dead load by the coefficient of friction which varies with the type of conveyor.

Type of Conveyor	Coefficient of friction(μ)
Single strand CDLR conveyor	0.06
Double strand CDLR conveyor	0.05

Tab1: Coefficient of Friction

We have A = 1375 kg

Now we have to calculate Dead Load (B) which is given by

B = (Roller wt. + sprocket wt + wt. of chain)

Total No. of rollers in 17.60 m = 251

$$\text{Roller Weight} = 251 \times 0.81$$

$$= 203.31 \text{ Kg}$$

- Sprocket Weight:
In single strand CDLR conveyor system
No. Of rollers = No. of sprockets
Total No of Sprockets = 251
Total Wt. = 251 x 0.46 = 115.45 Kg.
- Chain Weight:
From chain catalogue chain no. 40 whose pitch is 12.70 mm and wt. is 0.70 Kg/m
For the same total chain required is

$$L = 2C + \frac{(N+n)}{2} + \left(\frac{N-n}{2}\right) 2 \frac{P}{C}$$

$$L = 2 \times 17.60 + \frac{16+16}{2}$$

$$L = 51.2 \text{ m}$$

$$\text{Total Wt. of chain} = 51.2 \times 0.70$$

$$= 35.80 \text{ Kg}$$

$$B == (203.31 \text{ Kg} + 115.45 \text{ Kg.} + 35.80 \text{ Kg})$$

$$== 354.56 \text{ Kg}$$

Also, the second part is the weight of all drive sprockets and end rollers

Let it will be minimum of 50 Kg.

$$\text{Total dead load} = 354.56 + 50 = 404.56 \text{ Kg}$$

$$\text{Chain pull} == (A + B) \times \mu$$

$$== (1375 + 404.56) \times 0.06$$

$$== 106.77 \text{ Kg}$$

Effective Chain pull

For effective chain pull add 25% to the total chain pull for chain flexing and bearing friction losses.

$$\text{Effective chain pull} == \text{total chain pull} \times 1.25$$

$$== 106.77 \times 1.25$$

$$== 133.50 \text{ Kg}$$

After determining the effective chain pull, we have to check that figure against the chart below which shows allowable chain pull, to make sure we are not exceeding the capacity of the chain.

If we exceed the capacity we need to shorten the conveyor length or decrease the live load.

Maximum allowable chain pull (Kg)		
Chain No.	Conveyor speed in m/s	
	0-0.3 m/s	0.4 m/s and above
40	250	230
50	400	360
60	550	480
80	950	880
100	1600	1470

Tab3.4: Allowable chain pull

From the above table the selected chain No is 40 is ok. As effective chain pull is less than the given load i.e $133 < 250$

Thus chain section is OK.

- Power Calculation:

Horsepower == effective chain pull x conveyor speed
 == 1330 N x 0.2 m/s
 == 266 watts
 == 0.266 KW
 == 0.356 Hp (1Hp= 745.70 W)

Similarly calculate power required for each position of conveyor.

Required Horsepower for each conveyor system can be tabulated as follows

Part No	Kilowatt	Horsepower
1	0.266 KW	0.35 Hp
2 & 3	0.052 KW	0.070 Hp
4	0.142 KW	0.190 Hp
5	0.075 KW	0.100 Hp

Tab1: Required Horsepower

From the above table we observed that each conveyor required different power thus it may create confusion in making record. To avoid such confusion we suggest use only single motor of common power to all. The minimum output KW power motor available is 0.35Hp hence selected.

Checking for Factor of Safety and Deflection

Now We have to check that the selected material is safe or not.

For the same here we consider for Pos 2 of length 2500mm.

6 DESIGN OF C- CHANNELS FOR CHASSIS

Material- Rolled steel C-10,

$$E = 2.10 \times 10^5 \text{ Mpa,}$$

$$\rho = 7830 \text{ Kg/m}^3,$$

$$\text{Yield stress} = 490 \text{ Mpa}$$

Calculation for given dimension

$$L = 2500 \text{ mm,}$$

$$W = (354/2) = 177 \text{ kg on each channel,}$$

Considering load act at a centre & Factor of Safety =2

$$\text{Allowable Stress } (\sigma_{all}) = S_{yt} / F_s = 490/2 = 245 \text{ Mpa}$$

$$\text{Maximum bending moment (Mmax)} = WL/4$$

$$= 177 \times 9.81 \times 2.5/4$$

$$M_{max} = 1085 \text{ Nm}$$

Considering available C-Channel – of size 75 x 40 x 2.3 from tab3.1

h= Depth of section,

t_f = thickness of flange,

t_w = thickness of web, A= Sectional area

I_{xx} = Moment of Inertia along x-axis

$$h = 75 \text{ mm } b = 40 \text{ mm } t_f = 2.3 \text{ mm}$$

$$t_w = 2.3 \text{ mm } A = 4.137 \text{ cm}^2 \quad y = 37.5 \text{ mm}$$

$$I_{xx} = 37.1 \text{ cm}^4$$

$$\text{Maximum bending stress } \sigma_b = M_{max} \cdot y / I$$

$$= 1085 \cdot (37.5 \cdot 10^{-3}) / (37.1 \cdot 10^{-8})$$

$$\sigma_b = 109.66 \text{ Mpa}$$

Checking Factor of Safety for design-

$$F_s = \sigma_{all} / \sigma_b$$

$$= 245 / 109.66$$

$$F_s = 2.30$$

As Calculated F_s is greater than assumed F_s, Selected Material can be considered as safe.

Maximum Deflection (y_{max})-

$$y_{max} = WL^3/48EI$$

$$= (177 \cdot 9.81 \cdot 2.5^3) / (48 \cdot 2.10 \cdot 10^{11} \cdot 37.1 \cdot 10^{-8})$$

$$y_{max} = 7.25 \cdot 10^{-3} \text{ m}$$

As compared to length 2200 mm deflection of 7.25 mm is very negligible. Hence selected channel can be considered as safe.

7 DESIGN OF ROLLER:

Material – MS

$$E = 2.10 \cdot 10^5 \text{ Mpa, } \rho = 7860 \text{ Kg/m}^3, S_{yt} = 250 \text{ Mpa}$$

Considering uniformly distributed load & FOS = 2

$$\text{Allowable Stress } (\sigma_{all}) = S_{yt} / F_s = 250/2 = 125 \text{ Mpa}$$

Maximum Stress Calculation for given condition

$$W = 25/3 = 8.33 \text{ kg (Load act on 3 rollers at a time)}$$

$$D_1 = \text{Outer diameter of roller} = 32 \text{ mm}$$

$$D_2 = \text{Inner diameter of roller} = 29 \text{ mm}$$

$$w = \text{Width of roller} = 400 \text{ mm}$$

$$y = \text{Distance from neutral axis} = 0.032/2 = 0.016$$

Considering uniformly distributed load,

$$\text{Maximum Moment (Mmax)} = W \cdot L/8$$

$$= (8.33 \cdot 9.81 \cdot 0.4)/8$$

$$M_{max} = 4 \text{ Nm}$$

$$\text{Moment of Inertia (I)} = \Pi (D_1^4 - D_2^4)/64$$

$$= \Pi (0.032 - 0.029)/64$$

$$I = 1.675 \cdot 10^{-8} \text{ m}^4$$

$$\text{Maximum bending stress } \sigma_b = M_{max} \cdot y / I$$

$$= 4.0 \cdot 0.016 / 1.675 \cdot 10^{-8}$$

$$\sigma_b = 3.82 \text{ Mpa}$$

Checking Factor of Safety for design-

$$F_s = \sigma_{all} / \sigma_b$$

$$= 125/3.82$$

$$F_s = 32.72$$

As Calculated F_s is greater than assumed F_s, Selected Material can be considered as safe.

$$\text{Maximum Deflection (y}_{max}) = 5 \cdot W \cdot L^3/384EI$$

$$= (5 * 8.33 * 9.81 * 0.4^3) / (384 * 2.10 * 10^{11} * 1.675 * 10^{-8})$$

$$y_{max} = 1.935 * 10^{-3} \text{ mm}$$

As compared to length 400 mm deflection of $1.935 * 10^{-3}$ mm is very negligible. Hence selected roller can be considered as safe.

8 DESIGN OF SHAFT:

Material – MS

$E = 2.10 * 10^5$ Mpa, $\rho = 7860$ Kg/m³, $S_{yt} = 560$ Mpa

Considering uniformly distributed load & FOS = 2

Allowable Stress (σ_{all}) = $S_{yt} / F_s = 250/2 = 280$ Mpa

Maximum Stress Calculation for given condition-

$W = 25/3 = 8.33$ kg (Load act on 3 rollers at a time)

$D =$ Outer diameter of roller = 12 mm

$w =$ Width of roller = 420 mm

$y =$ Distance from neutral axis = $0.012/2 = 0.006$

Considering beam with uniformly distributed load,

Maximum Moment (M_{max}) = $W * L / 8$

$$= (8.33 * 9.81 * 0.42) / 8$$

$$M_{max} = 4.29 \text{ Nm}$$

$$\text{Moment of Inertia } I = \frac{\pi (D^4)}{64}$$

$$= \frac{\pi (0.012^4)}{64}$$

$$I = 1.01 * 10^{-9} \text{ m}^4$$

$$\text{Maximum bending stress } \sigma_b = \frac{M_{max} * y}{I}$$

$$= \frac{4.29 * 0.006}{1.01 * 10^{-9}}$$

$$= 25.48 \text{ Mpa}$$

Checking Factor of Safety for design-

$$F_s = \frac{\sigma_{all}}{\sigma_b}$$

$$= \frac{125}{25.48}$$

$$F_s = 4.90$$

As Calculated F_s is greater than assumed F_s , Selected Material can be considered as safe.

$$\text{Maximum Deflection } (y_{max}) = \frac{5 * W * L^3}{384EI}$$

$$= \frac{(5 * 8.33 * 9.81 * 0.42^3)}{(384 * 2.10 * 10^{11} * 1.01 * 10^{-9})}$$

$$y_{max} = 3.716 * 10^{-4} \text{ m}$$

As compared to length 420 mm deflection of 0.3716 mm is very negligible. Hence selected channel can be considered as safe.

9 PROCESS :

1.From packaging area to filling- In packaging area one person can put cartons on the conveyor of pos 1. In filling area there is a filling tank situated which can fill cartons of given sizes with the help of nozzels loaded on conveyor.

2.From filling area to cooling area- After filling it get transfer to the cooling area which is shown in above figure.

3.shipping to store: Collected filled carton can be transferred to store by one person

Thus complete system required only 2 persons and one maintenance person.

10 MODELLING:

Design methodology to develop the CAD model of Single Strand Chain Driven Live Roller conveyor

LIST OF THE COMPONENTS

There are different components of conveyor are as follows

Sr.No	Component	Material	Qty	Dimensions
1	C-channel	C-10	2	75 x 40 x 2.3 x 2480
2	Rollers	MS	35	$D_1=32, D_2=29, L=390$
3	Shaft	MS	35	Dia.12mm
4	Sprocket	MS	35	16 teeth
5	Bearing		70	30 x 12 x 15
6	chain	MS	21 m	No.40(P=12.7 mm)

Tab1. List of Components

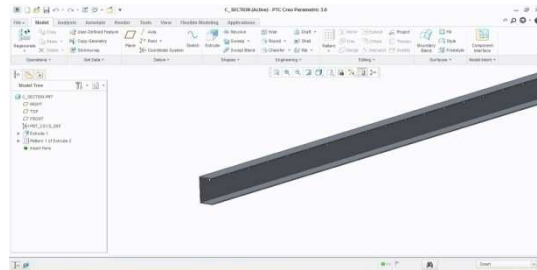


Fig4.C-Channel

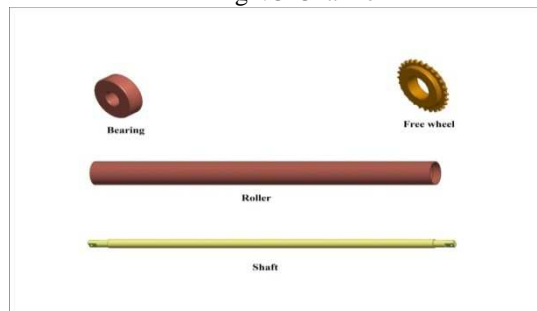


Fig5:Parts Of Roller Assembly

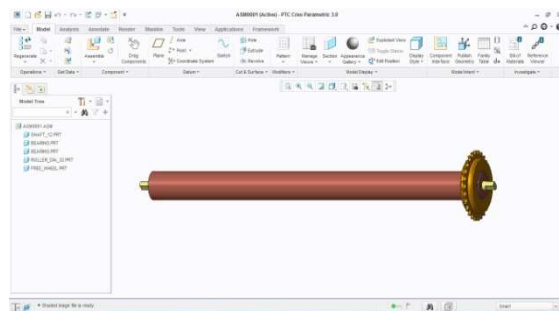


Fig6: Roller Assembly

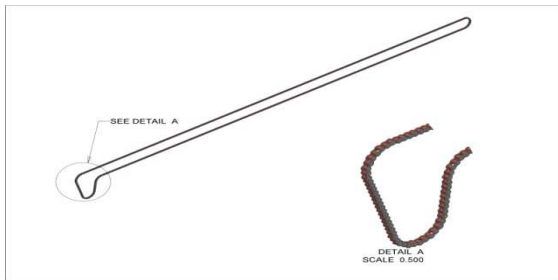


Fig7: Chain Modeling

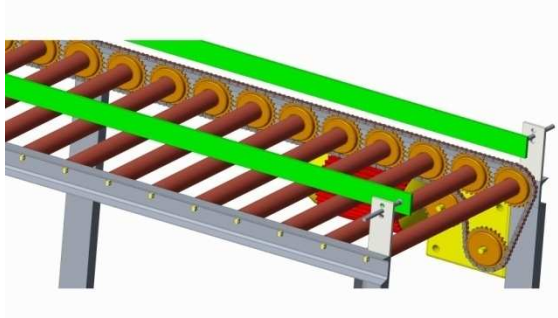


Fig8: Chain sprocket Arrangement

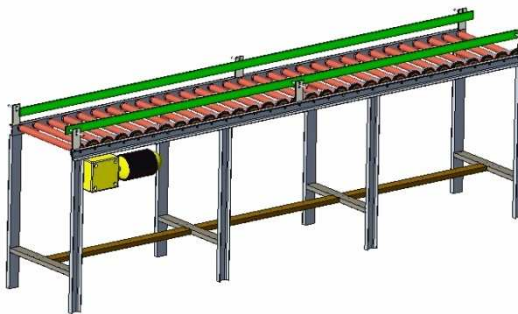


Fig9: Complete Assembly

Similarly we model Pos1 of 17.6 m, Pos 4 of 9.50m and Pos 5 of 3.8m Thus the complete assembly of Proposed layout can be modeled which can be shown in following figure.

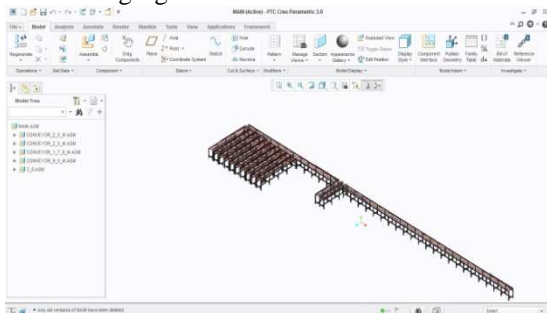


Fig10: Final Assembly

11 ANSYS MODULES:

ANSYS package includes the following modules.

Structural Analysis:

Structural analysis is probably the most common application of the finite element method as it implies bridges and buildings, naval, aeronautical and mechanical structures such as ship hulls, aircraft

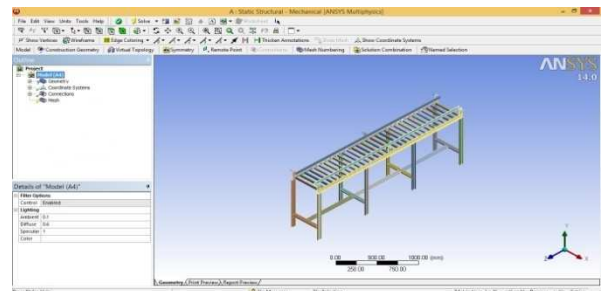
bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools.

Static Analysis
Used to determine displacements, stresses, etc. under static loading conditions.

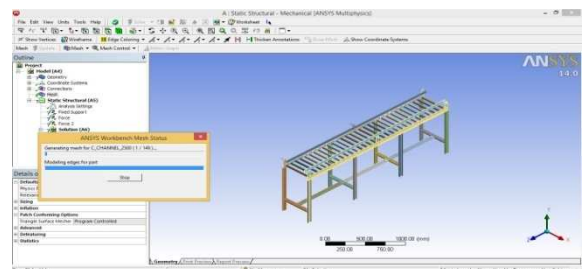
ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.

➤ Steps in ANSYS :

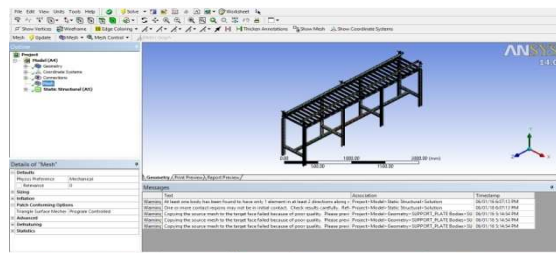
11.1 File > import external Geometry > Generate



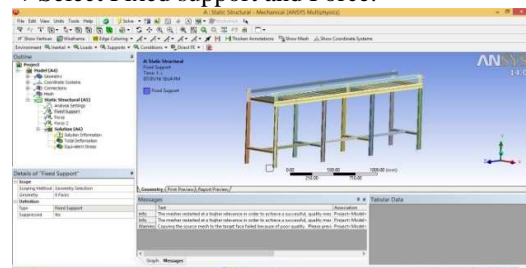
11.2 Right click on mesh --- select generate mesh.



11.3 Mesh > Right click > Generate Mesh

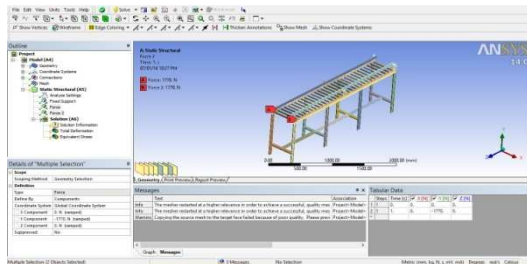


11.4 Right click on Static Structural > Select Insert -> Select Fixed support and Force.

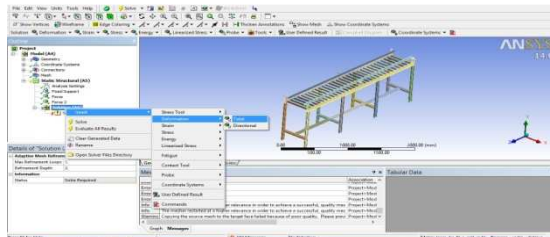


11.5 Right click on Steady State Thermal > Select Insert > Force

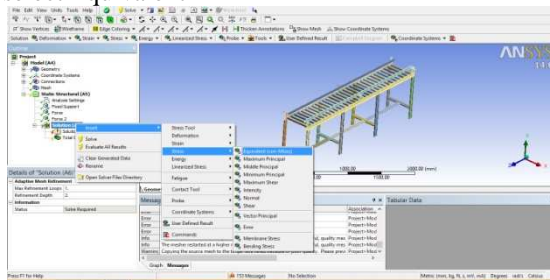
Select Surface where you want to apply forces--- then put the force of -1770 N values



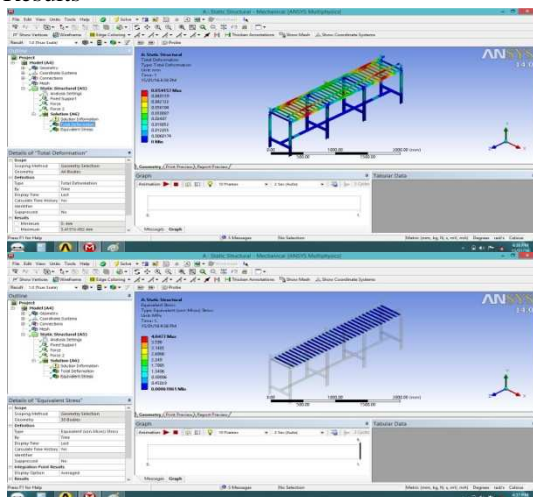
11.6(Solution Right click on Solution->Insert->click on deformation->select total



11.7Right click on Solution->Insert->click on stress->select Equivalent



11.8ANSYS Workbench Solution Status Solve All the Results



12 RESULT:

Viewing the results:

The result generated by the software can be tabulated as follows

Model (A4) > Static Structural (A5) > Solution (A6) > Results		
Object Name	Total Deformation	Equivalent Stress
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	30 Bodies
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier	Suppressed	
Results		
Minimum	0. mm	6.1961e-004 MPa
Maximum	5.4167e-002 mm	4.0477 MPa
Minimum Occurs On	SUPPORT_CHANNEL	ROLLER_DIA_32
Maximum Occurs On	SIDE_SUPPORT_PLATE	ROLLER_DIA_32
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option	Averaged	

Tab5.4: Result

From above table we observe that there is maximum stress occurred is 4.047 Mpa and the total deformation is 5.41×10^{-2} mm as compared to the length of conveyor 2500mm which is negligible. It is also observed that maximum load occurred at support Channel and maximum stress on roller from the result table.

13 CONCLUSION :

In this project, a conveyor system for the company who are in a process of automization of a plant and they are in a need of a dedicated conveyor system for the continuous filling of liquid in the cartons having chamber of two types 1 X 16 (4 X 4) and 1 X 25 (5 X 5) has been designed and developed.

The major components and its parameters in the conveyor system are finalised. The designed parameters are calculated by using standard practice. The width of SSCDLR conveyor is 410 mm in which 350mm is useful conveying. The Roller and shaft diameters are $D_1=32$ mm, $D_2=29$ mm and 12mm also having a length of 400 and 420 mm respectively. The spacing between the rollers is 70mm. The reduction gearbox is required of ratio 18:1 to match the required speed of conveyor which is also helpful in proper selection of sprockets and chain.

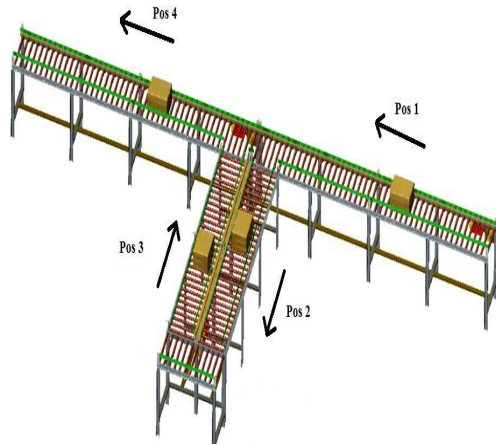
The Components get modelled by using Creo Software and final assembly of conveyor system is completed.

The Assembly is tested for maximum loading condition. The result shows that the assembly is stable as there is very less deformation generated which is 0.0541 mm and also stress developed are very negligible that is up to 4.047 Mpa. Thus we conclude that our material selected for conveyor structure with proper dimensions is safe

Also the simulation of the process with the help of new developed conveyor system has been carried out and it has been observed that the conveyor system is working satisfactorily as the requirement of the company.

With the proposed conveyor system the labour cost will reduce also the transportation and material

handling cost will be reduced. In this system maximum 3 persons are required, one for loading, one for unloading or shipping to store and one for maintenance of conveyor system which is achievable. Also total power required for the conveyor system is 0.78 Hp thus one motor of 1.0 Hp should be used with the different transmission system.



14 FUTURE SCOPE

- In this project due to the shortage of fund only CAD model and Simulation has been carried out.
- The design of conveyor system can be tested by fabricating it in a real life situation.
- Dynamic Analysis can be possible to perform
- Selection of appropriate material. By selecting inferior quality of material further weight reduction of conveyor is possible.
- One common motor of 1.0 Hp should be used with different transmission system.
- NVH (Noise vibration and Harshness) Analysis can be possible for better and safer results.

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(A.1)