International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 5, July - 2012

Optimization Technique Used for the Roller Conveyor System for Weight Reduction

S. M. Shinde [1], R.B. Patil [2]
PG student, Jawaharlal Nehru College of Engineering, Aurangabad, India. [1]
Associate Professor, Jawaharlal Nehru College of Engineering, Aurangabad, India. [2]

Abstract

The aim of this paper is to study existing conveyor system and optimize the critical parts like Roller, C-channels for chassis and support, to minimize the overall weight of assembly and material saving.

Paper also involves geometrical and finite element modeling of existing design and optimized design. Geometrical modeling was done using Catia V5R19 and finite modeling was done. Results of Linear static, Modal and Transient analysis of existing design and optimized design are compared to prove design is safe. Optimization gives optimum design for same loading condition with huge amount of weight reduction. Using this procedure and using practical available structure 30.931% weight reduction is achieved

Key Words: Optimized design, Weight reduction, material handling systems.

1.0 Introduction

1.1 Conveyors

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. [1] 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. [4]

- 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.

Fig. 1.1 Conveyor Systems

There are a variety of options available for running conveying systems, [3] including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs.

Conveyor systems are commonly used in many industries, including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors [2] are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transportation, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup points need to be. [6]

1.2 Types of Conveyor Systems

- Gravity Conveyor systems
- Powered Belt Conveyor systems
- Pneumatic conveyor systems
- Vibrating conveyor systems
- Flexible conveyor systems
- Vertical conveyor systems and spiral conveyors
- Live Roller Conveyor systems

2.0 Problem Definition

The aim of this project is to redesign existing gravity roller conveyor system by designing the critical parts (Roller, Shaft, Bearing & Frame), to minimize the overall weight of the assembly and to save considerable amount of material.

Gravity roller Conveyor has to convey 350 kg load, 30 inch above ground and inclined at 4 degree. Fig. 2.1 shows roller conveyor assembly.

Components of conveyor are as follows,

Sr. No.	Component	Material	Qty.
1	C-Channels for Chassis	ISMC 100	2
2	Rollers	Mild Steel	15
3	Bearing	Std.	30
4	C-Channels for Stand	ISMC 100	4
5	Shaft	Mild Steel	15

Design roller conveyor to reduce weight.

3.0 Objective of the Study

The following are the objectives of the study:

1. Study existing roller conveyor system and its design.
2. Geometric modeling [7] of existing roller conveyor.
3. To generate parametric model using ANSYS Parametric Design Language (APDL) program.
4. To carry out linear static, modal, transient and optimization analysis of existing roller conveyor.
5. Modification of critical conveyor parts for weight optimization.
6. To carry out Analysis of Modified design for same loading condition.
7. Recommendation of new solution for weight optimization.

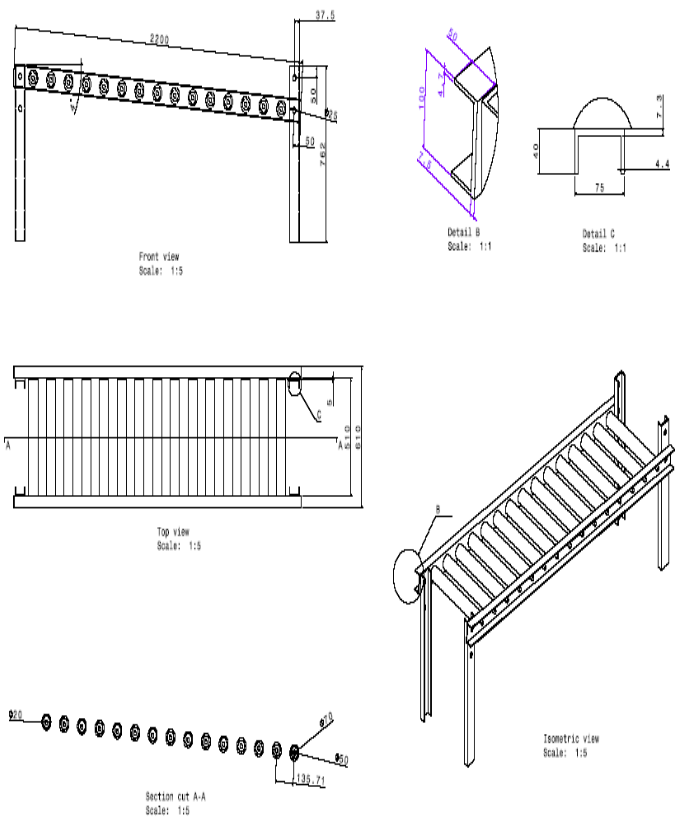

Fig. 2.1 Gravity Roller Conveyor Assembly

4.0 Scope of Present Study

1. Check design of existing conveyor system.
2. ANSYS APDL codes applied for linear static, modal, transient and optimization analysis.
3. 150 simulations for linear static Analysis.
4. 150 simulations for Modal Analysis.
5. Optimization of conveyor assembly for weight reduction.
6. Comparison between existing and optimized design.

ISSN: 2278-0181
Vol. 1 Issue 5, July - 2012

5.0 Design and Study of the Existing Assembly of Conveyor System

5.1 DESIGN OF C-CHANNEL FOR CHASSIS:

5.1.1 Material- Rolled steel C-10,
$E= 2.10*10^5$ Mpa, $\rho= 7830$ Kg/m^3, $S_{yt} = 490$ Mpa

5.1.2 Maximum Stress Calculation for given condition
L= 2200 mm, W= (350/2) =175 kg on each channel,
Considering load act at a center & Factor of Safety =2
Allowable Stress (σ_{all}) = S_{yt} / F_s =490/2= 245 Mpa

Given C- Channel, ISMC 100
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 = 100 mm b = 50 mm t_f = 7.5 mm t_w = 4.7 mm
A = 10.65 cm^2 y = 50 mm I_{xx} = 220.05 cm^2
Considering simply supported beam with load act at centre**,**
Maximum bending moment (M_{max}) = WL/4
= 175*9.81*2.2/4
M_{max} = 944.2125 Nm
Maximum bending stress σ_b = M_{max}*y/ I
= 944.2125*(50*10^{-3}) / (220.05*10^{-4})
σ_b = 21.454 Mpa

5.1.3 Checking Factor of Safety for design-
$F_s = \sigma_{all} / \sigma_b$
= 245/ 21.454
F_s = 11.4198
As Calculated F_s is greater than assumed F_s, Selected Material can be considered as safe.

5.1.4 Maximum Deflection (y_{max})-
y_{max} = WL^3/48EI
= (175*9.81*2.2^3)/(48*2.10*10^{11}* 220.05*10^{-4})
y_{max} = 0.68*10^{-3} m
As compared to length 2200 mm deflection of 0.68 mm is very negligible. Hence selected channel can be considered as safe.

5.1.5 Weight of C-frame -
= cross-section area*length of frame* mass density
= (10.65*10^{-4} *2.2*7830)
= 18.3774 kg / per frame
= 2*18.3774 = 36.7548 kg

5.2 DESIGN OF ROLLER:

5.2.1 Material – MS
E = 2.10*10^5 Mpa, ρ= 7860 Kg/m^3, S_{yt} = 590 Mpa
Considering uniformly distributed load & FOS = 2
Allowable Stress (σ_{all}) = S_{yt} / F_s =590/2=295 Mpa

5.2.2 Maximum Stress Calculation for given condition
W= 350/4= 87.5kg (Load act on 4 rollers at a time)
D_1= Outer diameter of roller = 70 mm
D_2 = Inner diameter of roller = 50 mm
w = Width of roller = 500 mm
y = Distance from neutral axis = 0.07/2 = 0.035
Considering uniformly distributed load**,**
Maximum Moment (M_{max}) = W*L^2/8
= (87.5*9.81*.5^2)/8
M_{max} = 26.8242 Nm
Moment of Inertia (I) =Π (D_1^4 - D_2^4)/64
= Π (0.07^4 – 0.05^4)/64
I = 8.7179*10^{-7} m^4
Maximum bending stress σ_b = M_{max} * y/ I
= 26.8242 * 0.035/ 8.7179*10^{-7}
σ_b = 1.077 Mpa

5.2.3 Checking Factor of Safety for design-
$F_s = \sigma_{all} / \sigma_b$
= 295/1.077
F_s =273.9090
As Calculated F_s is greater than assumed F_s, Selected Material can be considered as safe.

5.2.4 Maximum Deflection (y_{max}) = 5*W*L^3/384EI
= (5*87.5*9.81*.5^3) / (384*2.10*10^{11}* 8.7179*10^{-7})
y_{max} = 7.631*10^{-3} mm
As compared to length 500 mm deflection of 7.631*10^{-3} mm is very negligible. Hence selected channel can be considered as safe.

5.2.5 Weight of Rollers -
= cross-section area*width * mass density* number of rollers
= Π (0.07^2 - 0.05^2) *0.5*7860*15/4
=111.1181 Kg

5.3 DESIGN OF SHAFT:

5.3.1 Material – MS
E= 2.10*10^5 Mpa, ρ= 7860 Kg/m^3, S_{yt} = 560 Mpa
Considering uniformly distributed load & FOS =2
Allowable Stress (σ_{all}) = S_{yt} / F_s = 560/2=280 Mpa

5.3.2 Maximum Stress Calculation for given condition-
W= 350/4= 87.5kg (Load act on 4 rollers at a time)
D = Outer diameter of roller = 20 mm
w = Width of roller = 560 mm
y = Distance from neutral axis = 0.02/2 = 0.01
Considering beam with uniformly distributed load**,**
Maximum Moment (M_{max}) =W*L^2/8
= (87.5*9.81*.56^2)/8
M_{max} = 33.6483 Nm
Moment of Inertia I = Π (D^4)/64
= Π (0.02^4)/64
I = 7.8540*10^{-9} m^4

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

$= 33.6483 * 0.01 / 7.8540*10^{-9}$

$= 42.8422$ Mpa

5.3.3 Checking Factor of Safety for design-

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

$= 280/42.8422$

$F_s = 6.5356$

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

5.3.4 Maximum Deflection (y_{max}) = $5*W*L^3/384EI$

$= (5*87.5*9.81*.56^3) / (384*2.10*10^{11}* 7.8540*10^{-9})$

$y_{max} = 1.19$ mm

As compared to length 560 mm deflection of 1.19 mm is very negligible. Hence selected channel can be considered as safe

5.3.5 Weight of Shafts = cross-section area*width * mass density* number of shafts

$= \Pi (0.01^2) *0.56*7860*15$

$= 20.7421$ Kg

5.4 BEARING SELECTION:

5.4.1 Standard MRC Bearing,

MRC Bearing number CONV-4 SF, Weight =0.0998 Kg

d= Bore diameter = 20 mm

D=Outer diameter = 50 mm

B= width = 25.4 mm

Bearing is suitable for High radial loads, economical

5.4.2 Total weight of Bearing

= 30*0.0998 = 2.994 kg

5.5 DESIGN OF C- CHANNEL FOR SUPPORTS:

5.5.1 Material- Rolled steel C-10

$E= 2.10*10^5$ Mpa, $\rho= 7830$ Kg/m^3, $S_{yt} = 490$ Mpa

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

Allowable Stress (σ_{all}) = S_{yt} / F_s = 490/2 = 245 Mpa

5.5.2 Maximum Stress Calculation for given condition-

Load acting = (Load capacity +Weight of C- frame + Weight of Roller + Weight of Shaft + Weight of Bearing)/4

Load acting=(350+36.7548+111.1181+20.7421+2.994) /4 =130.4023 kg

L= 762 mm, W= 130.4023 kg on each channel,

Maximum bending moment (M_{max}) = WL/4

$= 130.4023 *9.81* .762/4$

$M_{max} = 243.696$ Nm

Given C- Channel, ISMC 75

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 mm b= 40 mm t_f = 7.3 mm t_w = 4.4 mm

A = 8.72 cm^2 y = 37.5 mm I_{xx} = 67.865 cm^2

Maximum bending stress,

$\sigma_b = M_{max} *y/I$

$= 243.696*(37.5*10^{-3})/ (67.865 *10^{-8})$

$\sigma_b = 13.4658$ MPa

5.5.3 Checking Factor of Safety for design

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

$= 245/ 13.4658$

$F_s = 18.1941$

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

5.5.4 Maximum Deflection (y_{max}) = $WL^3/48EI$

$=(130.4023 *9.81*0.762^3) / (48*2.10*10^{11}* 67.865 *10^{-8})$

$y_{max} = 8.274*10^{-5}$

$y_{max} = 0.08274$ mm

As compared to length 762 mm deflection of 0.08274 mm is very negligible. Hence selected channel can be considered as safe.

5.5.5 Weight of Channels-

= cross-section area*length * mass density* number of Channels

$= (8.72*10^{-4}*.762*7830*4)$

= 20.81 Kg

Table 5.1 Total Weight of Existing Conveyor Assembly

Sr. No.	Name of Component	Weight (Kg)
1	C- Channel for Chassis	36.7548
2	Rollers	111.1181
3	Shafts	20.7421
4	Bearing	2.994
5	C- Channel for Supports	20.81
	Total Weight of assembly	**192.419**

6.0 Geometric Modeling

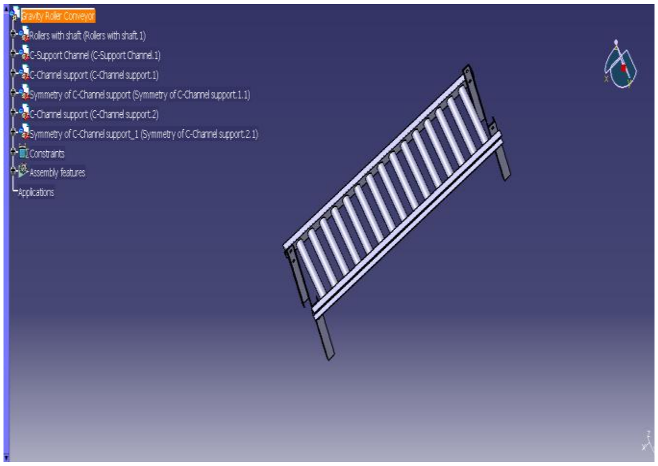

Fig. 6.1 Geometrical modeling using Catia

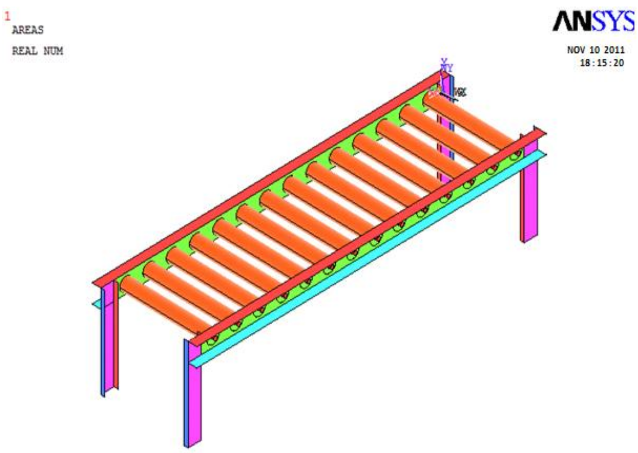

Fig. 6.2 Geometrical modeling using ANSYS APDL codes

6.3 Finite Element Modeling

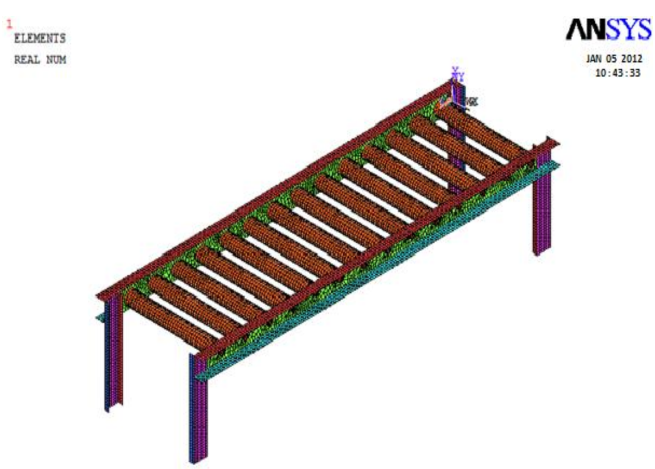

Fig. 6.3 Finite element mesh of the model

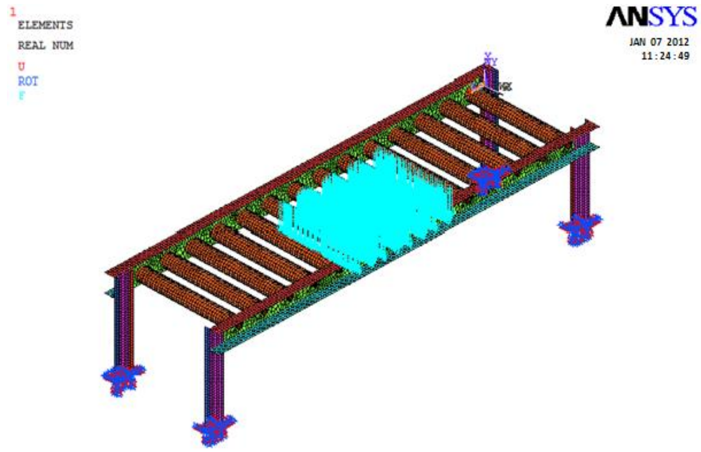

Fig. 6.4 A static load of 3500 N (approx 350 kg) is applied on the 4 rollers at the centre, as the deflection will be maximum, when the load is applied at the centre.

6.4 Static Structural Analysis

A static analysis calculates the effect of steady loading condition on a structure, while ignoring inertia and damping effects, such as those caused by time varying loads.

A static analysis can, however, include steady inertia load (such as gravity and rotational).

Design and analysis of roller conveyor for weight optimization & material saving (velocity) [2, 6, 8] and time varying load that can be approximated as static equivalent loads (such as static equivalent wind and seismic loads commonly defined in many building codes). Select element and apply material properties**.** Static analysis determines the displacements, stresses, strains, and forces in structures or components caused by lodes that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time.

Critical load condition-

Load act on any four rollers hence by considering 350 kg load act on four rollers maximum deflection, maximum stress values are checked for existing design.

6.5 Procedure of Static analysis consists of these tasks

1. Build the Model
2. Set Solution Controls
3. Set Additional Solutions Options

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 5, July - 2012

4. Apply the loads
5. Solve the Analysis
6. Review the Results

Results for static analysis,

-Weight = the weight of the model is 193 kg

- Maximum deflection plot shown in fig. 6.5
- Maximum stress plot shown in fig. 6.6

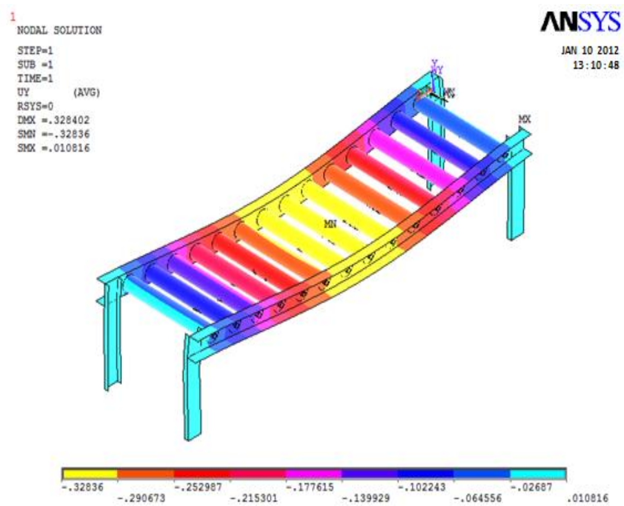

Fig. 6.5 Deflection plot

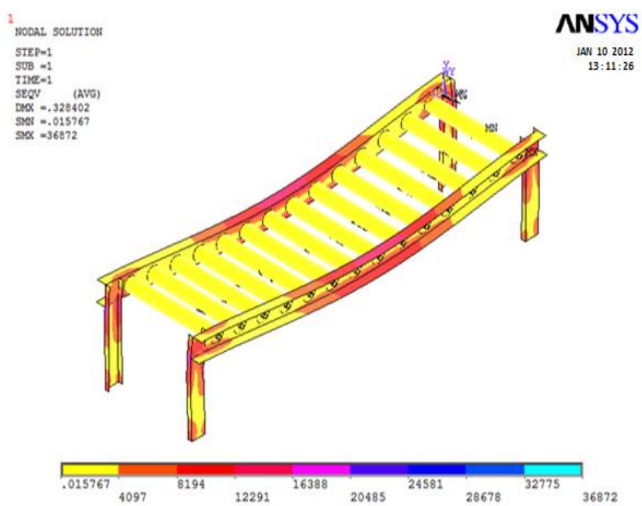

Fig. 6.6 Stress Plot

6.6 Modal analysis

- Modal analysis is carried out to find natural frequency and mode shapes.
- As the loading will be in vertical direction (gravity) the mode shape which will show movement in vertical direction is important.

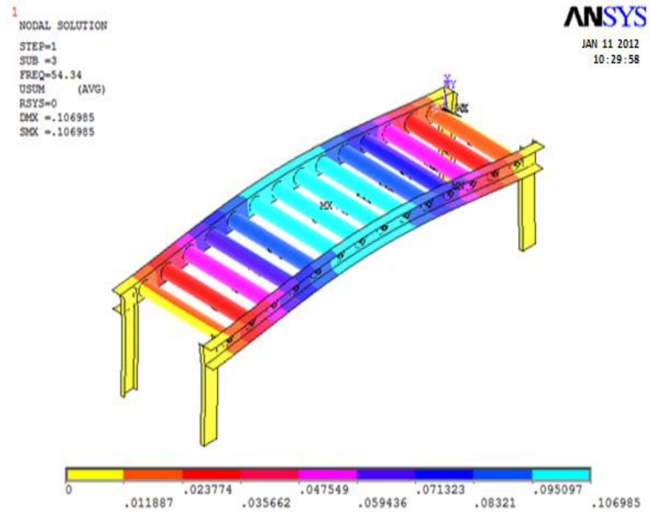

Fig. 6.7 Critical Mode Shape

Result from Modal analysis-

- From the results it is clear that the third mode shape will have maximum motion in vertical direction. So third natural frequency should be greater than the excitation frequency.
- Third natural frequency is 54.34 Hz.

7.0 Need of Optimization

As factor of safety of C-Channels and Rollers is very high there is scope of weight reduction in this component.

7.1 Selection of Critical Parameter

- Flange Width
- Flange thickness
- Web height
- Web thickness
- Roller Outer diameter
- Roller thickness

7.2 APDL Codes for Simulation

- “Do loop” is formed for to calculate effect of critical parameter on various factors like maximum deflection, stress, weight, first, second and third natural frequency. [7]
- For each parameter 25 simulations are carried out.
- Total 150 Simulations carried out.

8.0 Optimized design & Design Calculation

- Selecting available components which are similar to optimized design.
- Select ISJC 100 and ISJC 75 C-channels for chassis and supports respectively
- Roller Outer diameter is 60 mm and roller thickness 5 mm

8.1 DESIGN OF C- CHANNELS FOR CHASSIS

8.1.1 Material- Rolled steel C-10,
E= $2.10*10^5$ Mpa, ρ= 7830 Kg/m^3, S_{yt} = 490 Mpa

8.1.2 Calculation for given dimension
L= 2200 mm, W= (350/2) =175 kg on each channel,
Considering load act at a center & Factor of Safety =2
Allowable Stress (σ_{all}) = S_{yt} / F_s =490/2= 245 Mpa
Maximum bending moment (M_{max}) = WL/4
= 175*9.81*2.2/4
M_{max} = 944.2125 Nm

Considering available C-Channel - ISJC 100
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= 100 mm b = 45 mm t_f = 5 mm
t_w = 3 mm A = 7.41cm^2 y = 50 mm
I_{xx} = 138.10 cm^2
Maximum bending stress σ_b = M_{max}*y/ I
= 944.2125 *($50*10^{-3}$)/ ($138.1*10^{-8}$)
σ_b = 34.666 Mpa

8.1.3 Checking Factor of Safety for design
$F_s = \sigma_{all} / \sigma_b$
= 245/ 34.666
F_s = 7.068
As Calculated F_s is greater than assumed F_s, Selected Material can be considered as safe.

8.1.4 Maximum Deflection (y_{max}) = $WL^3/48EI$
= ($175*9.81*2.2^3$) / ($48*2.10*10^{11}$* $123.8*10^{-8}$)
y_{max} = 1.108*10
y_{max} = 1.108 mm
As compared to length 2200 mm deflection of 1.108 mm is very negligible. Hence selected channel can be considered as safe.

8.1.5 Weight of C-frame
= cross-section area*length of frame* mass density
= $7.41*10^{-4}$ *2.2*7830
= 12.5101 kg/ per frame
= 2*12.5101
= 25.020 kg

8.2 DESIGN OF ROLLER

8.2.1 Material – MS
E = $2.10*10^5$ Mpa, ρ= 7860 Kg/m^3, S_{yt} = 590 Mpa
Considering uniformly distributed load & FOS =2
Allowable Stress (σ_{all}) = S_{yt} / F_s = 590/2 = 295 Mpa

8.2.2 Calculation by considering given roller dimension
W= 350/4= 87.5kg (Load act on 4 rollers at a time)
D_1 = Outer diameter of roller = 60 mm
D_2 = Inner diameter of roller = 50 mm
w = Width of roller = 500 mm
y = Distance from neutral axis = 0.06/2 = 0.03

8.2.3 Maximum Moment (M_{max}) = $W*L^2/8$
= ($87.5*9.81*.5^2$)/8
M_{max} = 26.8242 Nm

8.2.4 Moment of Inertia (I) =Π (D_1^4 - D_2^4)/64
= Π ($0.06^4 – 0.05^4$)/64
I = $4.9029*10^{-7}$ m^4

8.2.5 Maximum bending stress,
σ_b = M_{max} * y/ I
= 26.8242 * 0.035/ $4.9029*10^{-7}$
σ_b = 9.95 Mpa

8.2.6 Checking Factor of Safety for design
$F_s = \sigma_{all} / \sigma_b$
= 295/9.95
F_s = 29.64
As Calculated F_s is greater than assumed F_s, Selected Material can be considered as safe.

8.2.7 Maximum Deflection (y_{max}) = $5*W*L^3/384EI$
= ($5*87.5*9.81*.5^3$) / ($384*2.10*10^{11}$* $4.9029*10^{-7}$)
y_{max} = 1.605 mm
As compared to length 500 mm deflection of 1.605 mm is very negligible. Hence selected channel can be considered as safe.

8.2.8 Weight of Rollers = cross-section area*width * mass density* number of rollers
= Π (0.06^2 - 0.05^2) *0.5*7860*15/4
= 71.96 Kg

8.3 DESIGN OF C-CHANNELS FOR SUPPORTS

8.3.1 Material- Rolled steel C-10
E= $2.10*10^5$ Mpa, ρ= 7830 Kg/m^3, S_{yt} = 490 Mpa

8.3.2 Calculation of given dimension
Considering load act at a center & Factor of Safety =2
Allowable Stress (σ_{all}) = S_{yt} / F_s =490/2 = 245 Mpa

Load acting = (Load capacity +Weight of C- frame + Weight of Roller + Weight of Shaft + Weight of Bearing)/4

Load acting = (350+25.020+71.96+20.7421+2.994)/4 =117.274 kg

L= 762 mm, Consider W= 120 kg on each channel,

Maximum bending moment (M_{max})

$$M_{max} = WL/4$$
$$= 120 *9.81* .762/4$$
$$M_{max} = 224.256 \text{ Nm}$$

Considering the available C- Channel, ISJC 75

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 mm b= 22 mm t_f = 2.2 mm

t_w = 1.8 mm A = 5.106 cm^2 y = 37.5 mm

I_{xx} = 103.1 cm^2

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

$$= 224.256*(37.5*10^{-3})/ (103.1 *10^{-8})$$
$$\sigma_b = 8.1567 \text{ MPa}$$

8.3.3 Checking Factor of Safety for design

$$F_s = \sigma_{all} / \sigma_b$$
$$= 245/ 8.1567$$
$$F_s = 30.036$$

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

8.3.4 Maximum Deflection (y_{max}) = $WL^3/48EI$

$$= (120 *9.81*0.762^3) / (48*2.10*10^{11}* 103.1 *10^{-8})$$
$$y_{max} = 5.018*10^{-5} \text{ m}$$
$$y_{max} = 0.05018 \text{ mm}$$

As compared to length 762 mm deflection of 0.05018 mm is very negligible. Hence selected channel can be considered as safe.

8.3.5 Weight of Channels = cross-section area*length * mass density* number of Channels

$$= (5.106*10^{-4}*.762*7830*4)$$
$$= 12.187 \text{ Kg}$$

8.4 Total Weight of Conveyor Assembly (Optimized Design)-

Sr. No.	Name of Component	Weight (Kg)
1	C- Channel for Chassis	25.020
2	Rollers	71.96
3	Shafts	20.7421
4	Bearing	2.994
5	C- Channel for Supports	12.187
	Total Weight	**132.9031**

8.5 Analysis of Optimized Design:

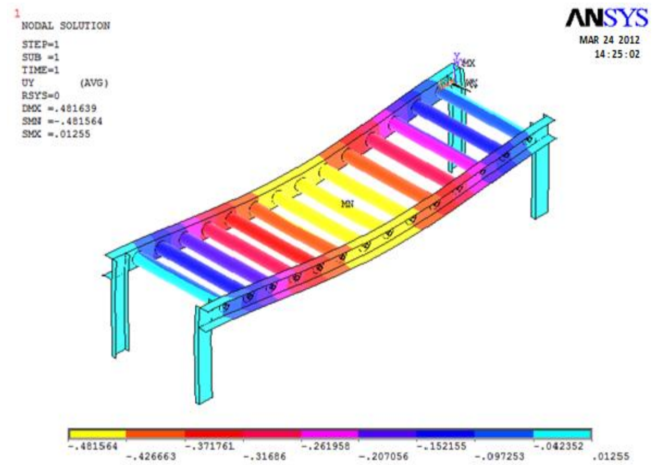

Fig 8.1 Linear Static Analysis of Optimized design: Deflection plot

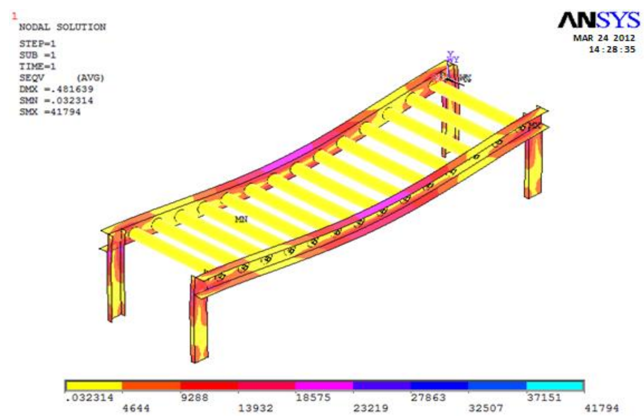

Fig 8.2 Stress Plot – Optimized design

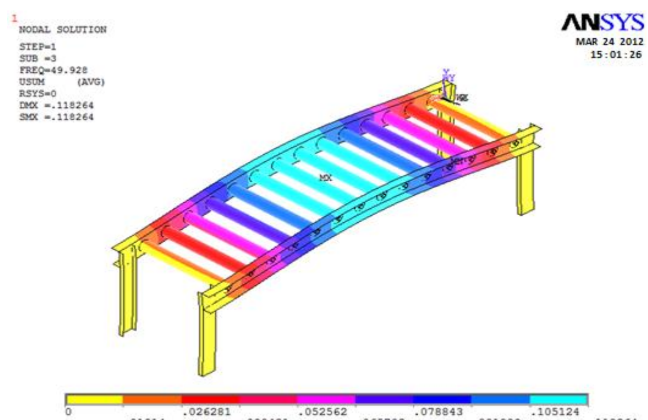

Fig. 8.3 Critical Mode Shape of Optimized design

9.0 Results- Effect of Optimized Design Compared with existing design:

Sr. No	Name of Component	Weight (Kg) Optimized Design	Weight (Kg) Existing Design
1	C-Channels for Chassis	25.020	36.7548
2	Rollers	71.96	111.1181
3	Shafts	20.7421	20.7421
4	Bearings	2.994	2.994
5	C-channels for Supports	12.187	20.81
	Total Weight of Conveyor	**132.9031**	**192.419**

9.1 Observation from Results- Effect of Optimized Design Compared with existing design-

1) From above chart we can find the great change in weight of optimized design and existing design. (59.5159 Kg. weight reduction)

2) Here we can observe changes in 3 main components, i.e. C-channels for Chassis, C- Channels for Supports and Rollers due to optimization.

Design	Max. Def (mm)	Natural Freq. (Hz)	Max. Stress (N/mm^2)
Existing	0.3284	54.34	36.872
Optimized	0.4816	49.928	41.794

9.1 Weight reduction due to Optimization

Design	Weight (Kg)	% Material required compared To Existing design	% Material save compared To Existing design
Existing	192.419	100	--
Optimized	132.9031	69.069	30.931

10.0 Validation

Actual physical model is done for validation using optimized design parameters and it is found that the design is working safely.
As the parts in which changes are made in existing design are standard so made easily available in market and are assembled for testing on which 350 kg load is applied and safety is checked.
The weight of the physical model is slightly more than the optimized model values, shown in below table.

Sr. No	Name of Component	Weight (Kg) Optimized Design	Weight (Kg) Actual Physical Model
1	C-Channels for Chassis	25.020	25.30
2	Rollers	71.96	72.20
3	Shafts	20.7421	20.75
4	Bearings	2.994	3.050
5	C-channels for Supports	12.187	12.50
	Total Weight of Conveyor	**132.9031**	**133.80**

11.0 Conclusions

- Existing design calculation shows the factor of safety is very greater than requirement and there is a scope for weight reduction.
- Critical parameter which reduces the weight are C-channels, roller outer diameter and roller thickness.
- Though value of deflection, stress is more in case of Optimized design, but it is allowable.
- 30.931 % of weight reduction is achieved due to Optimized design.
- 59.5159 Kg. weight reduction achieved by optimized design than existing design.
- Actual physical model is done for validation using optimized design parameters and it is found that the design is working safely

12.0 Future Scope

1) Fatigue analysis for life calculation.
   Fatigue analysis can be done by obtaining the SN curve. ANSYS predicts the number of cycles of different regions.
2) Buckling analysis.
   Buckling analysis of support channels can be done to find maximum load.
3) Non-linear analysis.
   Material non-linearity can be considered to find more accurate results.
4) Selection of appropriate material.
   By selecting inferior quality of material further weight reduction of conveyor is possible.
5) Thermal Analysis can be consider for further study.
6) NVH (Noise vibration and Harshness) Analysis can be possible for better and safer results.

References

[1]. M. A. Alspaugh, "Latest Developments in Belt Conveyor Technology" MINExpo 2004, Las Vegas, NV, USA. September 27, 2004
[2]. S.H. Masood · B. Abbas · E. Shayan · A. Kara "An investigation into design and manufacturing of mechanical conveyors Systems for food processing", Springer-Verlag London Limited 2004
[3]. Dima Nazzal , Ahmed El-Nashar "Survey Of Research In Modeling Conveyor-Based Automated Material Handling Systems In wafer fabs" Proceedings of the 2007 Winter Simulation Conference.
[4]. Chun-Hsiung Lan, "The design of a multi-conveyor system for profit maximization" International Journal Adv Manuf Technol (2003) 22: 510–521.
[5]. John Usher, John R , G. Don Taylor "Availability modeling of powered roller conveyors".
[6]. Espelage W, Wanke E."Movement minimization for unit distances in conveyor flow shop processing",
[7]. C.Sekimoto "Development of Concept Design CAD System", Energy and Mechanical Research Laboratories, Research and Development Center, Toshiba Corporation.
[8]. Ying WANG, Chen ZHOU "A Model and an analytical method for conveyor system in distribution centers", J Syst Sci Syst Eng (Dec 2010) 19(4): 408-429.
[9]. R. Long, T. Rom, W. H¨ansel, T.W. H¨ansch, J. Reichel "Long distance magnetic conveyor for precise positioning of ultra cold atoms" Eur. Phys. J. D 35, 125–133 (2005).