DESIGN & ANALYSIS OF HEAVY-DUTY OVERHEAD CONVEYOR SYSTEM

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Abstract - *This document provides a detailed summary of the design & analysis of the Heavy-Duty Overhead Conveyor system. The task at hand is to Manufacture an overhead conveyor systems system that can carry a maximum payload of 100 kg which can be used instead of the current conveyor system having a payload of 50kg to make the system cost-effective as well as credible as per market requirements.*

***Key Words*: Conveyor, Overhead, Design, Analysis**

1. INTRODUCTION

A conveyor system is used in many industries as a standard piece of mechanical handling equipment to move goods, products, raw goods, and other materials from one location to another, usually in the same area or building a standard piece of mechanical handling equipment to move goods, products, raw goods, and other materials from one location to another, usually in the same area or building. They are extremely handy for businesses that deal with heavy goods, sharp items, raw materials, and mass-produced products.

Conveyor systems allow for quick and efficient transportation of business materials and products and can move heavy items such as cars down a production line used for unit material handling

2. LITERATURE SURVEY

Most of our information about this topic is from the book called 'Conveyors and Related Equipment' by 'A. Spivakovski' and 'V. Dyachkov's Automation of Conveyor system and Pouring system by Pritesh Thoriya, Manohar Kagthara, Amit Dudhatra. This book covers the vast domain of the conveyor system but for our project, we will focus only on the overhead conveyor systems system. From this book, we can get a comprehensive idea about overhead conveyor systems and their sub-systems, parts, designing, working, and also about its applications. The book focuses on all types of heavy-duty, high-capacity conveyors. Considering the scope of this project we had to translate the knowledge and information according to the problem statement.

3. METHODOLOGY

Initially, we will conduct research in-depth about the overhead conveyor systems used for heavy-duty weight through the internet.

Along with that, material research will be done by researching the material that matches all the required strength and heat conditions.

Calculations will be done to calculate the dimensions of the components.

Using software like Solidworks and Ansys, design and analysis of the components will be done to finalize the optimized design of chain drives, track, and conveyor chains.

Based on these designs, we will decide which manufacturing method will be used to manufacture the components, and finally, we will approach manufacturers to manufacture the desired prototype.

4. CALCULATIONS

4.1 Design of Loading pin

The loading pin is nothing but a beam of circular cross-section with a centre loading with simply supports at both ends.

So, for this, we can use analytical methods to do some preliminary hand calculations to design this beam. After this is done the beam will be analyzed using FEA methods. The software used for the is ANSYS. Following are the analytical steps for designing the beam.[3]

1) For the current design (50kg),

For the EN 8 material,

The yield strength, σy= 465 N/mm2

Elongation = 16 %

Tensile Strength = 550 N/mm2

Length of Shaft = 28 mm

Considering Factor of Safety = 12

Hence, Bending Moment at B = 250×14 mm

= 3500 N-mm

Permissible Shear Stress = $\frac{S_{yt}}{F(s)} = \frac{465}{10}$

Considering Shaft for pure bending moment

$$\frac{S_{yt}}{F(s)} = \frac{32M_b}{\pi d3}$$

$$d^3 = \frac{32 \times 3500 \times 7}{\pi \times 465}$$

d^3 = 535.38

d = 8.12 mm

2) For New Design (100kg),

For EN 8 Material,

σy = 465 N/mm2

σt = 550 N/mm2

Length of Shaft = 30 mm

Factor of Safety = 7

Hence, Bending Moment at B = 490 × 15

= 7350 N-mm

Permissible Shear Stress = $\frac{S_{yt}}{F(s)} = \frac{567.33}{7}$

Hence, For the diameter of the Shaft:

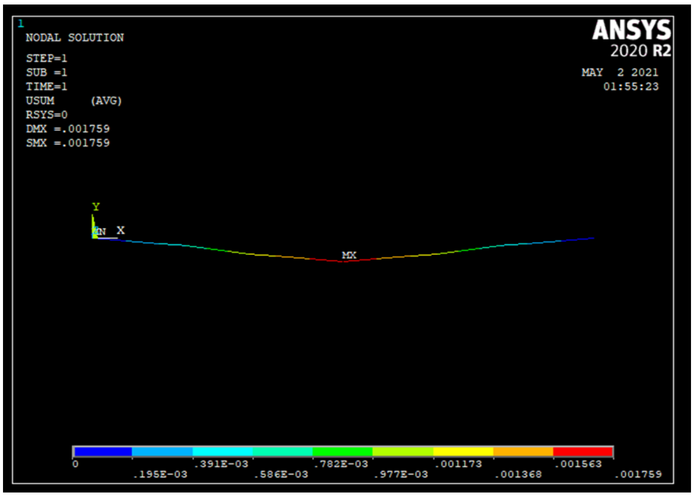
$$\frac{S_{yt}}{F(s)} = \frac{32M_b}{\pi d3}$$

d^3 = 1127.59

d = 10.4 mm

The derived diameter of the pin is 10.4 mm which has to be manufactured for a load of 980 N.

This shows us that the diameter of 10 mm for the loading pin of the chain is suitable for the design. Thus, the diameter of 10 mm of the Loading pin was finalized and we moved to the FEA analysis of the same. The FEA analysis of the loading pin was conducted in the ANSYS Mechanical APDL software. The purpose was to verify the results obtained by the analytical method as well as to obtain the results about the total actual deformation in the design. The Mechanical APDL was used to minimize the processing time.



4.2 Design of Motor and Gearbox

One of the crucial aspects of selection of motor is chain pull calculation:

Weight of Chain Calculations:

Considering density of material for all parts = 0.00785 gm/mm3

Loading pin weight = 7.1gm × 1 = 7.1 gm

Load link weight = 52.55gm × 1 = 52.55 gm

Bush weight = 2.07gm × 1 = 2.07 gm

Spacer weight = 0.89 × 2 = 1.78 gm

Load wheel weight = 41 × 2 = 82 gm

Pin 12mm weight = 2.67 × 2 = 5.34 gm

Pin 15mm weight = 4 × 3 = 12 gm

Square block weight = 15.18gm × 2 = 30.36 gm

Guide link weight = 23.23 × 2 = 46.46 gm

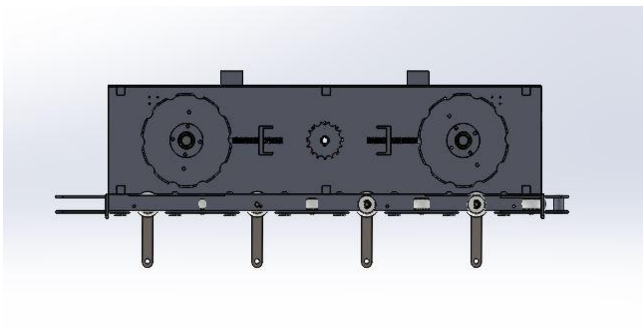
Guide wheel weight = 55.03gm × 1 = 56.03 gm

Therefore, total weight for 1 pitch of chain = 244.69 gm

Therefore, total weight for 50 m of chain = 244.69 × 333.33

= 81562.62 gm

= 81.5kg = 82 kg



Chain Pull –

Chain Pull = [total weight of chain + total weight of chain] × coefficient of friction of bearing

Considering the coefficient of friction for our application as μ = 0.03

1 m of chain contains 6.67 pitch

Chain pull = [Total weight on 1m chain + weight of 1m chain] × coefficient of friction of wheel (bearing)

= [(100 × 6.67) + (0.24469 × 6.67)] × 0.03

=20.05kg

Total chain pull = Chain pull for straight + Chain pull for 4 bends

= 20.05×48 + 9.75×4

= 100.14 kg

As there is no vertical so we will not consider chain pull for the vertical bend.

Now we will find torque required.

Torque = total chain pull × radius of sprocket

= 100.14 × 0.45

= 45 kg-m = 450 Nm

Selection of motor and gearbox :

Sprocket diameter = 0.264

Torque = 450 N

Consider maximum linear speed of chain = 4m/min

Sprocket perimeter = π × 0.264 = 0.82 min

Hence, for 1 RPM of sprocket = 0.82 m/min linear speed of chain.

For 4m/min speed of chain sprocket RPM will be

4 / 1.82 = 4.87 RPM

Now we will find the power required

Power = 2 × π × N × T / 60

Where, N – speed of sprocket

T – Torque

P = 2 × π × 4.87 × 450 / 60

P = 167.3 watts

1 watts = 0.00134 hp

Power = 229.5 × 0.00134

Power = 0.307 Hp

Selecting the motor of 0.5 Hp for our application with 1500 rpm speed.

5. RESULT

We have designed the heavy-duty conveyor system in a cost-effective way as per the given requirement and have proposed the same to Zenith Engineering to be executed in future manufacturing of conveyors.

We were effective in creating a design that significantly increased the load capacity of the previous conveyers. The design was validated with an analysis of all the different components.

6. CONCLUSION

In this project, we explored the various topics and systems of the overhead conveyor system. We have designed and analysed the main components of the overhead conveyor system. The design of the chain included various engineering problems that we had learned in our curriculum and were able to apply successfully in practice. We learned how a design process is influenced by various parameters and factors while working in the industry. We attained in-depth knowledge of how to tackle practical problems that occur during the design and development of this engineering system. During the design process, we understood and implemented the knowledge of various CAD/CAM and FEA software, which will make us industry ready ahead. While designing various components and subsystems, we considered various manufacturing processes and the material research for the same. The material research was a crucial step to start the design process. The various applications of the overhead conveyor system made our research a lot of materials that will hold structurally safe even in harsh environmental conditions. The main parameter for the entire design process was cost reduction. This made us work in unconventional methods to achieve a balance between quality and low investments. Different surface treatment methods were also understood by the team to design an industry approvable product. Thus, we completed the design of the chain, track and drive system.

6. REFERENCES

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