Design, Analysis and Optimisation of Belt Conveyor for Coal Application

Chudasama Pratik Naresh
Department of Mechanical Engineering
VCET, Vasai (W)

Darji Jaydeep Kanubhai
Department of Mechanical Engineering
VCET, Vasai (W)

Dalvi Yash Deepak*
Department of Mechanical Engineering
VCET, Vasai (W)

Borade Sandip Ramchandra
Department of Mechanical Engineering
VCET, Vasai (W)

***Abstract*--The aim of this paper is to study existing Belt conveyor system and optimize certain specifications like reducing the vibrations, increasing the fatigue cycles, minimizing the weight and reducing deflection of drive shaft. The paper also includes simulation and material selection of vital components like chassis, idler roller assembly, drive shaft used to achieve the desired objectives. Simulation was undertaken with the help of solid works 2017 and material selection for the above-mentioned parts was done in reference with standard Ashby charts. The simulation results were anticipated, thus satisfying the design constraints.**

Keywords – Conveyor, Idler Assembly, Simulation, Stress, Displacement

I. INTRODUCTION

Material handling is an important sector of an industry. Belt conveyors are being utilized as a vital part of material handling systems because of their high efficiency of transportation. A conveyor system is a common piece of mechanical handling equipment that advances materials from one location to another. Conveyors allow quick and efficient transportation for a wide variety of materials, reason why they are very popular in the material handling and packaging industries. Conveyors usually satisfy the demand for transportation of heavy or bulky materials. Conveyors can transport materials from one level to another without major difficulties, which when carried out by human labor would be toilsome and expensive. They can move loads of all shapes, sizes and weights. Also, many have advanced safety features which help prevent accidents. The options available for running conveying systems are available in variety, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs. Conveyor systems have their applications in abundance including the automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and packaging. There are many important parameters which play a vital role in meticulous selection of a conveyor system. It is important to know how the conveyor system will be used prior to the setup, hence some individual areas that are helpful to consider are the required conveyor operations such as, conveyor capacity, material to be conveyed, material characteristics, etc. and many more design parameters. These factors will serve the purpose of distinctly defining the facets upon which the work needs to be done.

II. OBJECTIVES

The current design of belt conveyor equipment is heavy weight and has high chassis vibration in running condition. The critical components such as shaft and idler roller also has high deflection. In order to optimize the conveyor equipment for efficient performance these parameters are reduced such as Reduction of motor frame vibrations to 11 - 16 Hz, reducing idler deflection to less than 5 mm, maximum shaft deflection to be achieved less than 1 mm, reduce the belt capacity to 31 TPH, reduce the overall conveyor weight to 0.9 TON. This objective is achieved in the following manner:

1. Checking the existing conveyor system.
2. Designing and calculation to obtain required specification.
3. Solid works simulation for static analysis, fatigue analysis and vibrational analysis.

III. PROCEDURE FOLLOWED TO ACHIEVE THE ABOVE OBJECTIVES

Design calculations are carried out to obtain the required belt capacity and the various conveyor components are selected accordingly. Solid works model of the selected specifications is created. Further, Various materials are applied to the conveyor components and analyzed in solid works simulation (static, fatigue and vibrational analysis). The results are then compared with the existing data and the necessary changes are made simultaneously in order the achieve the desired objectives.

4.IMPORTANT EQUATIONS

4.1 Belt Conveyor Belt Capacity, TPH

$$= \frac{\text{CFM x DEN } x\ 60}{2000}$$

$$= \frac{677 \times 80 \times 60}{2000}$$

$$= 31\ tons/hr$$

4.2 Total Belt Tension (Tt)

Total Belt Tension = Tt = $T4 + Ts$

Tt = 4190 lbs

4.3 Belt Tension Loading (Bt),

Belt Tension Loading = Bt = $\frac{Total\ belt\ tension}{Belt\ width}$

Bt = 209 lb/in Width

4.4Minimum conveyor motor power (P),

Power = P = $\frac{Force\ x\ Velocity}{3300}$

P = $\frac{Fc\ x\ Fs\ xTe\ x\ S}{(e\ X\ 33000)}$

P = 4 hp

V SIMULATION RESULTS

5.1 Idler roller assembly: - (AISI 1020)

Table 5.1 Simulation results for Idler Roller Assembly

Sr. no.	Parameter	Working limit	Safe limit
1	Stress	85.98 N/mm^2	350.57 N/mm^2
2	Displacement	0.175 mm	5.00 mm
3	Strain	0.00037	0

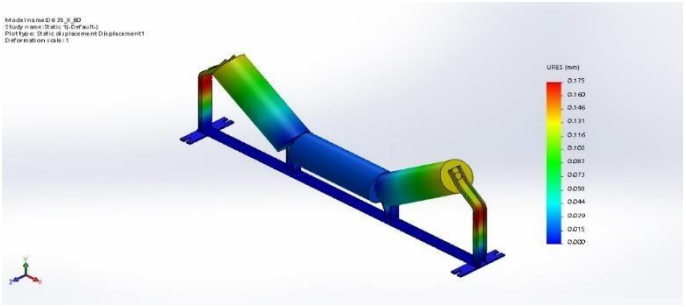

Fig: 5.1 (a) Static Displacement Analysis

Fig: 5.1 (b) Fatigue Analysis

5.2 Shaft: - 1100-O Rod (SS)

Table 5.2 Simulation results for Shaft

Sr. no.	Parameter	Working limit	Safe limit
1	Stress	56.03 N/mm^2	34.5 N/mm^2
2	Displacement	0.082 mm	5.00 mm
3	Strain	0.000721	0

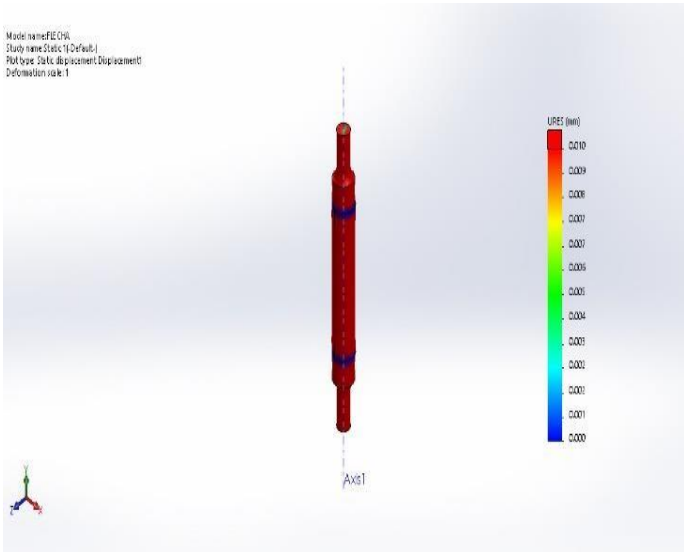

Fig: 5.2 (a) Static Displacement Analysis

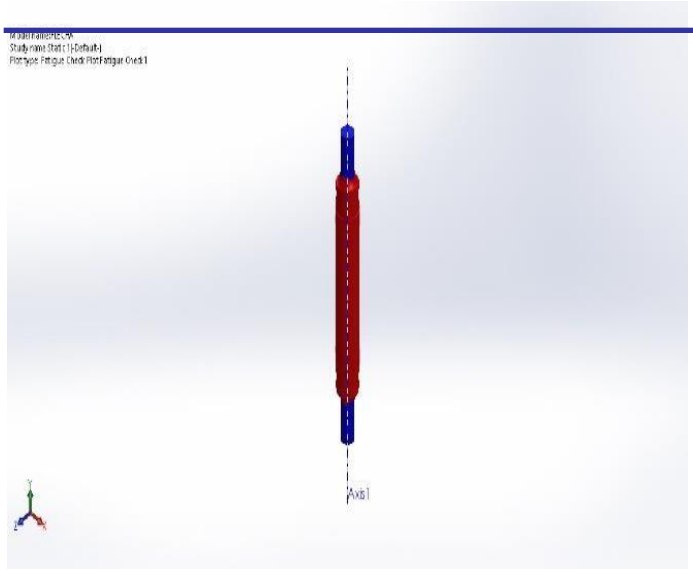

Fig: 5.2 (b) Fatigue Analysis

VI. RESULT

The above simulations were performed by using different materials for the idler roller assembly and the shaft. Hence multiple simulations led to failure at first but with the help of proper screening, appropriate material was selected and it us yielded satisfactory results for both the components. Upon looking at the results achieved, which are mentioned in the above tables (table 5.1 and table 5.2), we can say that all the parameters are under the enumerated limits.

CONCLUSION:

This project focuses on the design and optimization of the belt conveyor. Theoretical evaluation of the belt conveyor was performed and the capacity of the of the belt conveyor, total belt tension, minimum motor conveyor power and maximum torsion shear stress was obtained as 31 TPH, 4190 lbs., 4 Hp and 400 lbf/in^2 respectively.

Static and fatigue analysis was performed over components like Idler roller assembly, Shaft and Chassis followed by vibration analysis on the motor frame which gained satisfactory results thus meeting the required specifications.

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