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STUDY, DESIGN, MODIFICATION AND ANALYSIS OF CHARGING BELT CONVEYOR SYSTEM TO SET OPTIMUM RESULTS

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ABSTRACT

The aim of the paper is knowledge of damage process which is required for the correct regulation of operation conditions for conveyor belt. The aim is to determine conditions caused this type of damage (height of impact and weight of material impact). The current trend is to provide weight/cost effective products which meet the stringent requirements. The aim of this paper is to study existing conveyor system and optimize the Belt speed,Width,Wrapping angle,troughing angle, Pulley diameter and addition of Snub pulley .

Keyword : Belt Conveyor, Idler, Pulley, Failure, Simulation Software(Solid Works),Ansys Software.

I. INTRODUCTION

This master of engineering project was carried out at a YASH ENTERPRISES, which produces all types soap manufacturing and packaging .Yash enterprises is located in Khamgaon Dist: Buldhana.

The purpose of this project was to provide a comprehensive knowledge of the basic production process theory of designing belt conveyor. The project focuses on choosing the right conveyor belt and suitable components to ensure manufacturing of high-quality belt conveyor. The existing problems of the idlers and belt conveyor are pointed out and proper solutions are given to make them a longer life. This project helps to improve the production by eliminating the various failures and other problem.

The final aim was to create a modified design to achieve large scale production, of idlers which enhances both the efficiency and productivity. In order to help the company to get larger sales market, a plan of designing a belt conveyor was carried out, but further research still is needed to make it come true.

II. PROBLEM DEFINITION

The aim of this project is to redesign existing charging belt conveyor system by designing the critical parts (Belt capacity,Belt tension,Belt power,Belt width, Shaft, pulley), to minimize the overall failureor problem of the conveyor system and to save considerable amount of material.

III. OBJECTIVE OF THE STUDY

The following are the objectives of the study :

1. Study existing charging belt conveyor system and its design.
2. Geometric modeling of existing roller conveyor.
3. To generate parametric model using ANSYS
4. To carry out linear static, modal, transient and optimization analysis of existing roller conveyor.
5. Modification of critical conveyor parameters for system optimization.
6. To carry out Analysis of Modified design for same loading condition.
7. Recommendation of new solution for system optimization.

IV. SCOPE OF PRESENT STUDY

1. Check design of existing conveyor system.
2. Simulation method applied to optimize parameters troughing angle, belt speed, addition of snub roller, belt width and shaft diameter.
3. ANSYS applied for linear static, modal, transient and optimization analysis.
4. Modal Analysis of belt conveyor system
5. Optimization of conveyor assembly for failure reduction.
6. Comparison between existing and optimized design.

V. STUDY OF THE EXISTING ASSEMBLY OFCONVEYOR SYSTEM

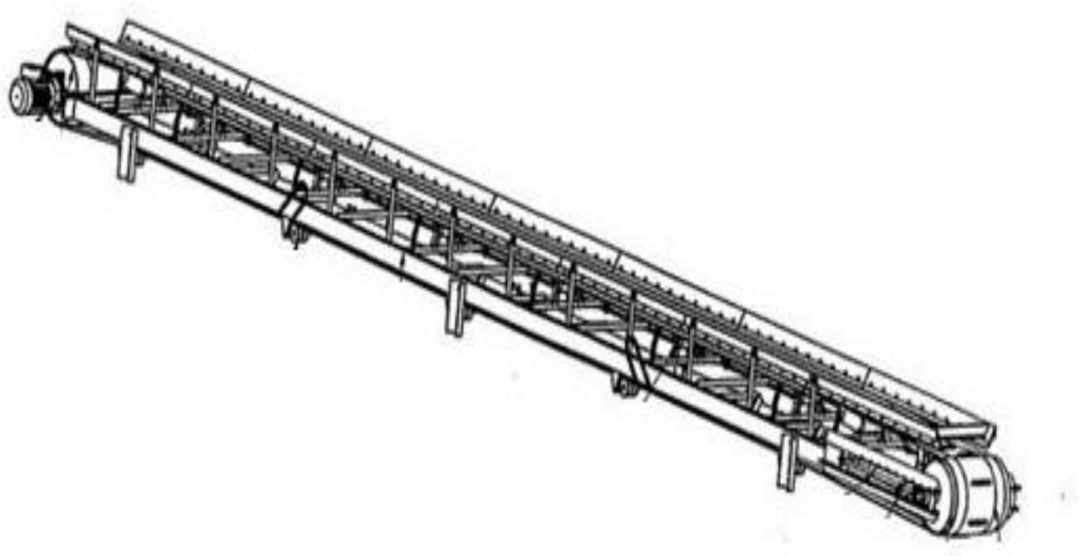

Fig1:-Existing Design of Charging Belt Conveyor System

5.1 Driving device

Driving device is the power transmitting mechanism of a belt conveyor. It is made up of an electromotor, coupling, reducer and driving pulley and so on. According to different using conditions and working requirements, the drive mode of a belt conveyor can be grouped to single-motor driving, multi-motor driving, single-pulley driving, and double-pulley driving and multi-pulley driving.

Single motor and single pulley driving is adopted by a belt conveyor. The driving device is installed at the discharge point which is located at the conveyor head. When the power is big, a single motor and double-pulley driving is used, precisely, one motor has two driving pulleys, and the two pulleys are connected by a pair of exposed gear which has the same number of teeth.

The pulleys can be classified into two types: driving pulleys and return pulleys. The belt is driven by friction which is produced by pulley's surface and belt's surface because of the function of driving pulley, and the movement direction of the belt is changed at the same time.

Driving pulley is the main component of transmitting power. In order to transmitting enough power, enough friction must be provided from the belt and pulley. According to the theory of friction transmission, the methods of increasing friction between the conveyor belt and the pulley and augmenting the wrap angle can be adopted to ensure enough driving power when a driving device needs to be chosen. Usually, when a single pulley is used, wrap angle can be 180^0-240^0; when double-pulley is used, the wrap angle can reach 360^0-480^0. Double-pulley's driving can enhance the conveyor's traction greatly, so it is often used especially when the transport distance is long.

Driving pulley's surface has glossy-faced and rubber-faced types. Rubber-faced pulley can be utilized to increase the friction coefficient between the driving pulley and the belt, as well as to reduce the wear of the pulley. When the pulley is small, the environment humidity is low, a glossy-faced pulley can be chosen. A rubber-faced pulley can be used when the environment humidity is high, power is big, and slip is easy.

Choosing a right pulley is important. When the belt of a fabric belt core is used, the pulley is chosen on the basis of the belt's thickness. The conveyor belt needs to move around the pulley repeatedly during the working process, and bending occurs. When the belt is bent, the external surface is stretched and while the internal surface is compressed, the stress and strain of each layer vary. The rubber layers have mechanical fatigue and are damaged due to the scaling when the repetitive bending reaches a certain level. The smaller diameter of pulley, the bigger the deflection of conveyor belt and the faster the scaling occurs.

5.2 Return Pulley

A return pulley has three categories: 180^0. The return pulley's diameter is related to driving pulley's diameter and the wrap angle that the belt has on the return pulley. Return pulley is a welded-steel plate construction with an antifriction bearing.

5.3 Troughing Plate

Troughing plate are used to support the belt during conveying the material into the feeder.Troughing platee having 550 mm distance from the sdjacent plate for the proper belt alignment.The plate having the trough angle is 45^0.

The belt conveyor is an endless belt moving over two end pulleys at fixed positions and used for transporting material horizontally or at an incline up or down. The main components of a belt conveyor are:

1. The ***belt*** that forms the moving and supporting surface on which the conveyed material rides. It is the tractive element. The belt should be selected considering the material to be transported.

2. The ***idlers***, which form the supports for the carrying and return stands of the belt.
3. The ***pulleys*** that support and move the belt and controls its tension.
4. The ***drive*** that imparts power to one or more pulleys to move the belt and its loads.
5. The ***structure*** that supports and maintains the alignments of the idlers and pulleys and support the driving machinery.
6. The trough plate that support the belt for carrying proper amount of material to the feeder.
7. Belt cleaner that keeps the belt free from materials sticking to the belt.
8. Surge hopper and feeder,which is essential for supplying material to the conveyor at uniform rate when the supply of material is intermittent.

5.4 From Actual Design of Charging Belt Conveyor System, The Following Problem or Failure Should be occur-

1) Belt slips when conveyor is started.
2) Belt slips while running.
3) The belt is stalling or jerking.
4) Excessive top cover wear over entire top surface or in load carrying area.
5) The covers are hardening and/or cracking.
6) Transverse breaks in belt at the edge.
7) Belt runs fine when it's empty but wont track right when it's loaded

VI. MODIFIED DESIGN OF THE CHARGING BELT CONVEYOR SYSTEM

6.1 By Adding Snub Roller and Idlers

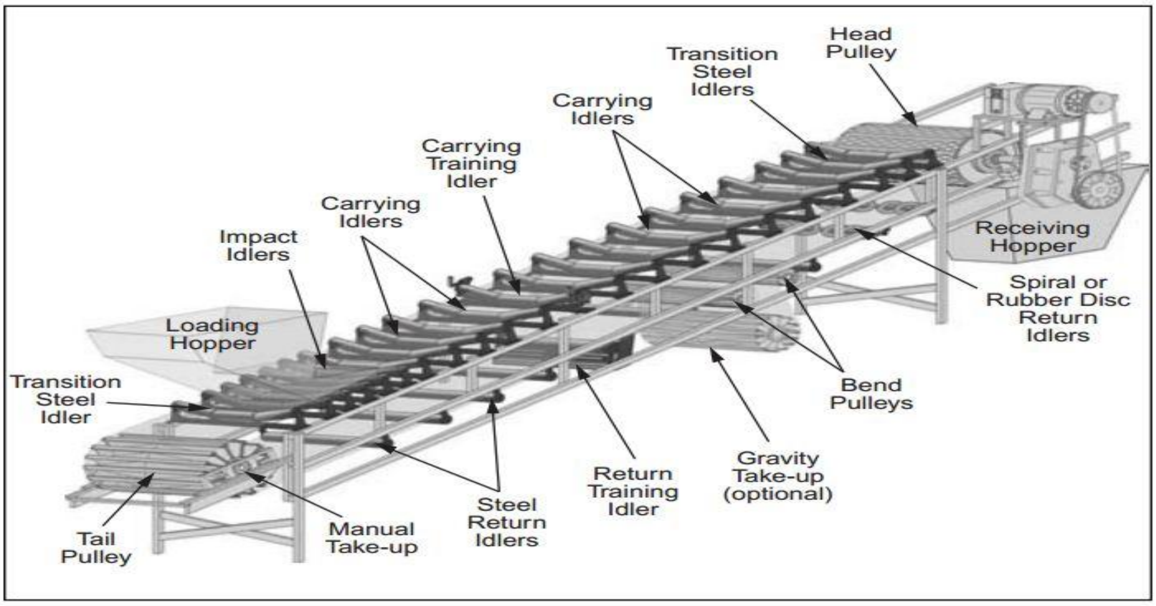

Fig2: Modified design of charging belt conveyor system

VII. IDLER FUNCTIONS

7.1 Idlers

Idler is the supporting device for belt. Idlers move as the belt moves so as to reduce the running resistance of the conveyor. Idlers' qualities depend on the usage of the belt conveyor, particularly the life span of the belt. However, the maintenance costs of idlers have become the major part of the conveyor's operating costs. Hence, idlers need to have reasonable structure, durability in use, small ratio of steering resistance, reliability, and dust or coal dust cannot get in bearing, due to which the conveyor has a small running resistance, saves energy and prolongs the service life.

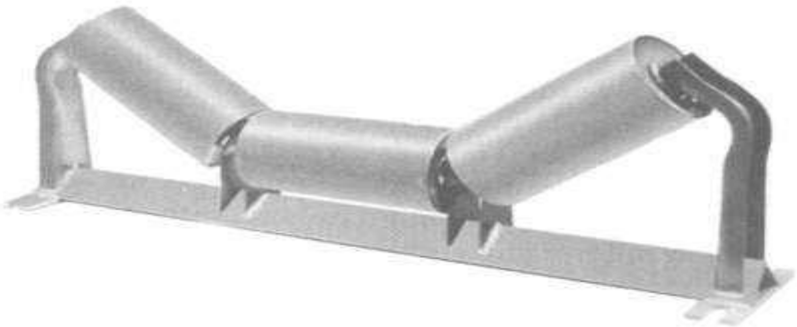

Fig. 3 Idlers Used on a Belt Conveyor to Support the Belt on the Carrying and Return Strands

VIII.THE FOLLOWING TYPE OF IDLERS ARE USED IN BELT CONVEYOR SYSTEM

8.1 Impact Idler

Rubber-cushioned impact idlers are one solution for absorbing impact in the belt's loading zone. The rubber covers absorb some of the energy to provide the benefit of shock absorption.

One disadvantage of using impact rollers in the load zone is that each idler supports the belt only at the top of the roller. No matter how closely spaced, the rounded shape of the roller and the ability of the rubber to deflect under the load will allow the conveyor belt to oscillate or sag away from the ideal flat profile. This sag allows and encourages the escape or entrapment of fugitive material. The space interval between impact rollers offers little protection from tramp materials dropping from above and penetrating the belt.

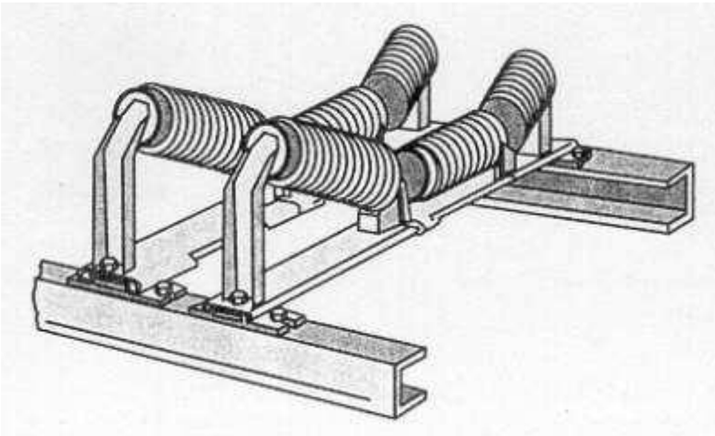

Fig. 4 Impact Idler

8.2 Carrying Idlers

Carrying idlers provide support for the belt while it carries the material. They are available in flat or troughed designs. The flat design usually consists of a single horizontal roll for use on flat belts, such as belt feeders.
The troughed idler usually consists of three rolls-one horizontal roll in the center with inclined rolls on either size. The angle of the inclined rollers from horizontal is called the trough angle. Typically, all three rolls are same length, although there are sets that incorporate a longer center roll and shorter inclined rollers called "picking idlers". This design supplies a larger flat area to carry material while allowing inspection.

8.3 Training Idler

There are a number of designs for training idlers that work to keep the belt running in the center of the conveyor structure. Typically, these idlers are self-aligning: they react to any mistracking of the belt to move into a position that will attempt to steer the belt back into the center. They are available for both carrying side and return side application.
Belt-training idlers should never be installed under the carrying side of the belt in the load zone, as they sit higher than the adjacent regular carrying idlers and raise the belt as they swivel.
TRANSITION: These idlers ease the belt from a troughed configuration to the flat pulley surface. Reducing stress in the outer belt edges.

8.4 Return Idler

Return idlers provide support for the belt on its way back to the loading zone after unloading cargo. These idlers normally consist of a single horizontal roll hung from the undesirable of the conveyor stringers-return idlers, incorporating two smaller rolls, are sometimes installed to improve belt tracking.

8.5 Idler Spacing

The spacing between the rolling components has a dramatic effect on the idler support and shaping missions. Idlers placed too far apart will not properly support the belt nor enable it to maintain the desired profile. Placing idlers too close together will improve belt support and profile, but will increase conveyor construction costs and may lead to an increase in the conveyor's power consumption.
The spacing of return idlers is determined by belt weight, because no other load is supported by these idlers and sag related spillage is not a problem on this side of the conveyor. Typical return idler spacing is3 meters.

IX. ANALYSIS OF CHARING BELT CONVEYOR STSTEM:

9.1 For Actual Design

1) LOAD ANALYSIS (STRESS ANALYSIS)

Stressϭ $=\frac{\text{Maximum tension in the belt }(T_{max})}{\text{Area of the belt}(m^2)}$ …………

Maximum tension in the belt, $T_{max}=T_1+T_c$

T_1=Tension in tight side taken from design section=328.95 KN

T_c=Centrifugal tension of the belt can be calculated as,=mv

m=Area×length×density =b×t×l×ρ =0.55×0.05×18.040×1220=605.242Kg=5937.42 N

$V=\frac{\pi dN}{60}=\frac{\pi\times0.05\times900}{60}$=2.09 m/sec

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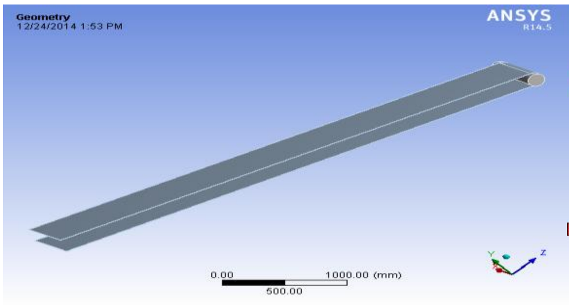
T_c=12.409KN

$T_{max}=T_1+T_c$=328.95+12.409=341.359 KN

Stress=$\frac{341.359\times10^2}{0.55\times0.05}$=12413054.55N/m^2 =12.41×10^6 N/m^2=12.41 Mpa



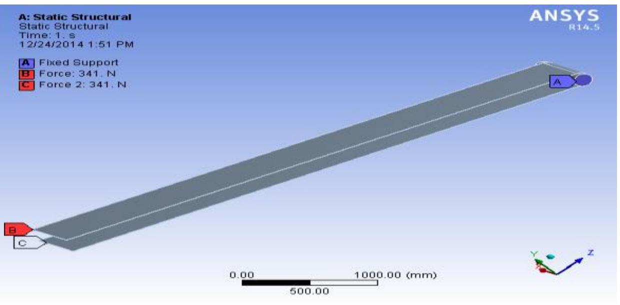


Fig5:Geometry of Actual Design **Fig6: Boundry Condion of Actual Design**

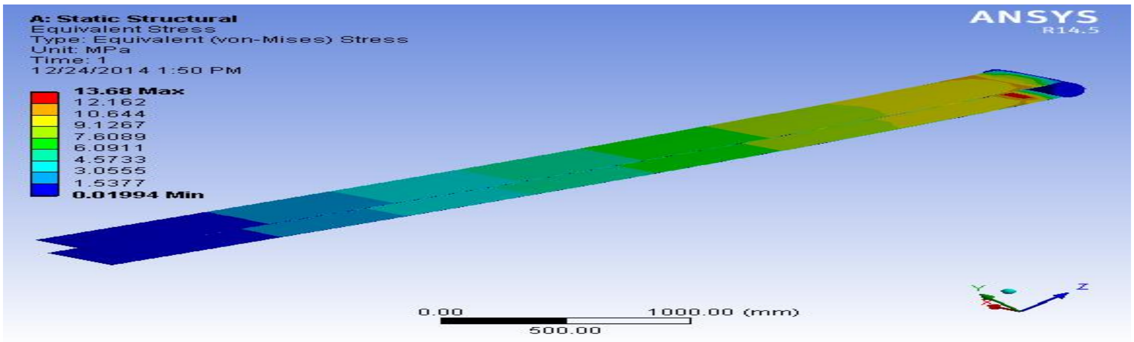


Fig7: Stress of Actual Design

X. MODIFIED DESIGN OF THE CHARGING BELT CONVEYOR SYSTEM

1)By adding snub roller and idlers for increasing the wrap angle between belt and pulley.

Calculate stress developed in the belt with modified design by adding snub roller ,

Stress6 =$\frac{Maximum\ tension\ in\ the\ belt\ (Tmax)}{Area\ of\ the\ belt\ (m^2)}$

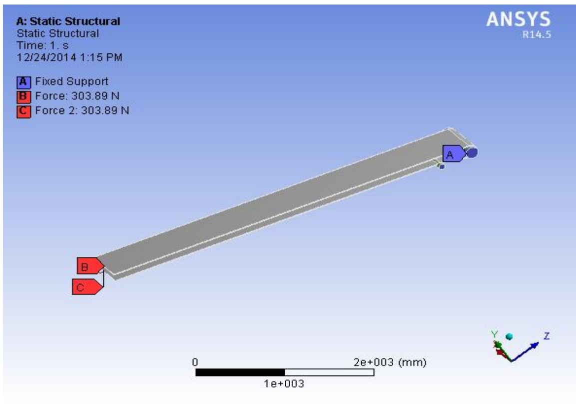
Maximum tension in the belt,

T_1=291.48 KN T_c=12.409KN

$T_{max}=T_1+T_c$=303.889 KN

Stress6=11.05×10^6 N/m^2

Stress6=11.05 Mpa



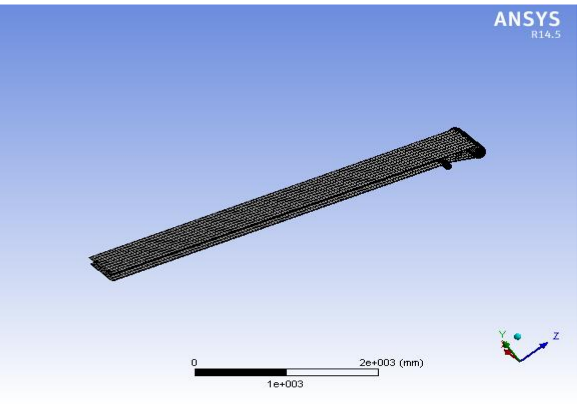
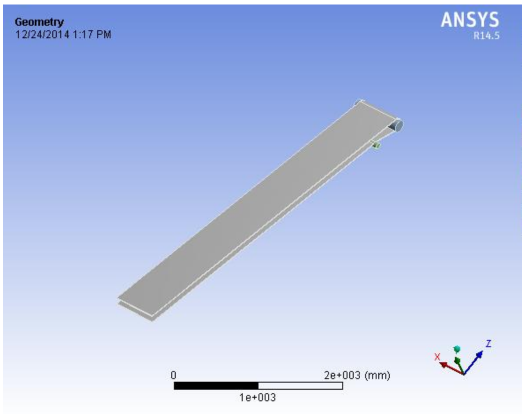


Fig8: Boundry Condition of Modified Design

Fig9: Meshing Model of Modified Design



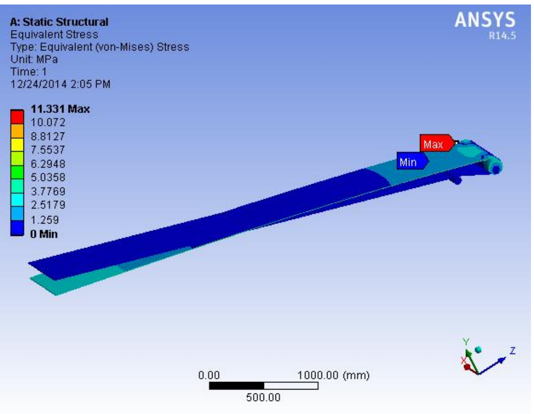


Fig10: Geometry of Modified Design

Fig11: Stress of Modified Design

XI. SOLUTIONS SUGGESTED

After completion of the project various suggestion were made to the company regarding the design and operation of the conveyor belt system

1. It was advised to use the impact, transition, trainingand carrier roller idlers in the conveyor system.
2. The transition distance of the belt was not adequate and it was increased .
3. The installation of snub roller for proper belt tensioning.
4. It was advised that the CCR operator should stop the Motorised Gate first and then turn the Belt off.This would ensure there is no pilling up of material at the feed point and the belt would be empty during the next start up.
5. The proper troughing angle should be provided.
6. Inorder to avoid dust emission it was advised to install bag filter for collecting dust from the Skirt Board area.

XII. CONCLUSION & FUTURE SCOPE

The material spillage from the conveyor belt is a significant problem not only from the point of view of environment and government regulations , but also because of number of labour hours lost in the cleaning, cost incurred due to frequent repairs or rollers and other conveyor parts etc.

Conveyor systems are present in alomost in every manufacturing unit be it a steel plant, mineral and ore processing facility, food and agro industry you name it.Thus knowing the basics of conveyor systems is essential for a mechanical engineer both for maintenance and design applications.

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