

Stress Analysis in Pulley of Stacker-Reclaimer by Using Fem Vs Analytical

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ABSTRACT: The main aim of this project is to reduce the stress act on the shaft. This project leads to the stress optimization of the shaft. By producing a middle disc we reduced the stress developed on the shaft. So, that there is increase in shaft life. By applying various thickness of the middle disc we increase the life of the shaft. There is a chance for reducing the weight of the component by using light weight material. The load distribution on the shaft is even with the supporting discs. So, that we reduce the total load act on the particular contact on shaft. The main components are shaft, disc, cylinder, and hub. Designing units of this kind requires precise calculations of all loads in static conditions. In this paper the component cross section was analyzed. The stress analysis using ansys is performed on the cross section of assembly of the reclaimer pulley considered as a reference for the existing design and even for the altered design which is the main task of this project. The cross section of the model was analyzed with the simple loading conditions. With that the cylinder deflection is minimized in the cross section analysis.

Key words: reclaimer pulley, design, calculating diameter, altering the design, analysis.

I. INTRODUCTION

Pulley: Conveyor Pulley is used to transmit the motion power to belt and also Pulleys are necessary to change the direction of belt in any direction, and to form endless loop for continuous operation, and it is also used for the material handling system in various industries to transfer raw material from one place to another.

II. COMPONENTS OF PULLEY:

- 2.1. Drum or shell
- 2.2. Diaphragm plates
- 2.3. Shaft
- 2.4. Locking elements
- 2.5. Hub
- 2.6. Lagging
- 2.7. Bearing assemblies

2.1. Drum or Shell: The drum is the portion of the pulley in direct contact with the belt. The shell is fabricated from either a rolled sheet of steel or from hollow steel tubing Diaphragm.

2.2. Plates: The diaphragm or end disc of a pulley is circular discs which are fabricated from thick steel plate and which are welded into the shell at each end, to strengthen the drum.

2.3. Shaft: The shaft is designed to accommodate all the applied forces from the belt and / or the drive unit, with minimum deflection. The shaft is located and locked to the hubs of the end discs by means of locking elements.

2.4. Locking Elements: These are high-precision manufactured items which are fitted over the shaft and into the pulley hubs. The locking Elements attach the pulley firmly to the shaft via the end plates.

2.5. Hubs: The hubs are fabricated and machined housings which are welded into the end plates.

2.6. Lagging: It is sometimes necessary or desirable to improve the friction between the conveyor belt and the pulley in order to improve the torque that can be transmitted through a drive pulley.

2.7. Bearing assemblies: Bearings support the rotating shaft and hence the pulley. Which enable the mass of the pulley assembly plus the belt tension forces to be transmitted for the supporting pulley structure.

3. Pulley design: Design Considerations for Pulleys: The procedure for selecting pulleys for a conveyor for any given application involves the evaluation of a number of factors pertinent to the installation Consideration should be given to the following:-

- a) Application/Environment ,
- b) Conveyor design
 1. Angle of Wrap.
 2. Belt selection.
 3. Conveyor duty.
 4. Belt Tension.
 5. Belt width.
- c) Standardization ,
- d) Specifications ,
- e) Layout , and f) Pulley design .

For the pulley design the main design of the pulley structure is dependent on the shaft design. Hence the shaft design is the initial consideration of the pulley design.

III. SHAFT DESIGN:

In designing shafts on the basis of strength, the following cases may be considered:

1. Shafts subjected to twisting moment or torque only.
2. Shafts subjected to Bending moment only.
3. Shafts subjected to Combined twisting and bending moments, and
4. Shafts subjected to axial loads in addition to combined torsion and bending loads.

IV. MATERIAL USED IN THIS MODEL:

Shaft	-SAE-1045
Discs	-ASTM A-36
Cylinder	-ASTM A-36
Hub	-ASTM A-36

V. DESCRIPTION OF AN ANALYTICAL MODEL

6.1. Description of an analytical method :Most of the formulas of strength of materials express the relations among the form and dimensions of a member, the loads applied thereto, and the resulting stress or deformation. The pulley is basically composed by; expansion ring (when applicable), hub, shaft, disc and cylinder, as seen in the Figure no1 below.

The calculation of individual components is still not an issue nowadays and classical formulas may be applied without main difficulties. But when there is an increase of components quantity and the interaction among them takes place, the analytical method cannot predict the real and accurate interaction, energy shared by each component in the assemble, due the imposed deformations. In other words, the proportion of deformation of each individual into the ensemble is a very complex to determine accurately and manually.

It is quite easy to identify the contribution of each element by simple comparison between the pulleys components in the formula above and in the Figure. The load is transmitted by the pulley cylinder toward the discs, which suffer the high deformation due to its low inertia, then to the shaft which is bent due to the reactions at the bearing blocks.

This is a normal condition found in driven pulleys, the drive pulleys contain an additional load, torque, transmitted from the shaft to the discs and lately to the cylinder. The drive pulley won't be covered at this chapter.

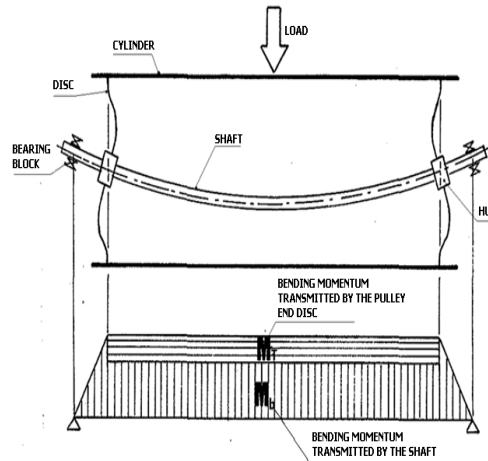


Fig.No:1 Load transmitted on the pulley

The load is transmitted by the pulley cylinder toward the discs, which suffer the high deformation due to its low inertia, then to the shaft which is bent due to the reactions at the bearing blocks. This is a normal condition found in driven pulleys, the drive pulleys contain an additional load, torque, transmitted from the shaft to the discs and lately to the cylinder.

VI. METHODOLOGY

7.1. The design proposal of the project : There are various design proposals with respect to varying the thickness parameter and varying the distance parameter. These are the two parameters that are to be varied in this project. There is a result of analysis with the simple loading conditions. There are eight types of design proposals are made. But in this paper only the cross section of the model is taken for analysis. In the actual loading condition the load applied on the half of the surface (180°) of the cylinder.

There is a chance to reduce the weight using light weight material. The shaft directly transmits the load on the shaft. There is a chance to different varying loads like pressure load, shock load are to be applied. So main reduce the deformation occur on the shaft. If the shaft to be deformed then the total bucket wheel assembly does not rotate. So we reduce the deformation of the shaft.

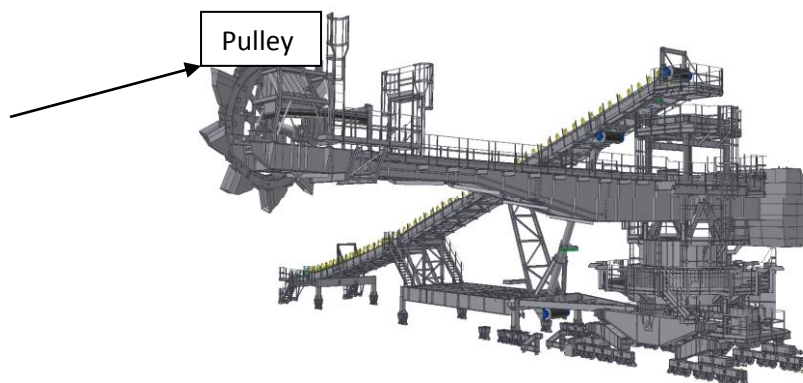


Fig.No:2 Stacker- reclaimer machine overview

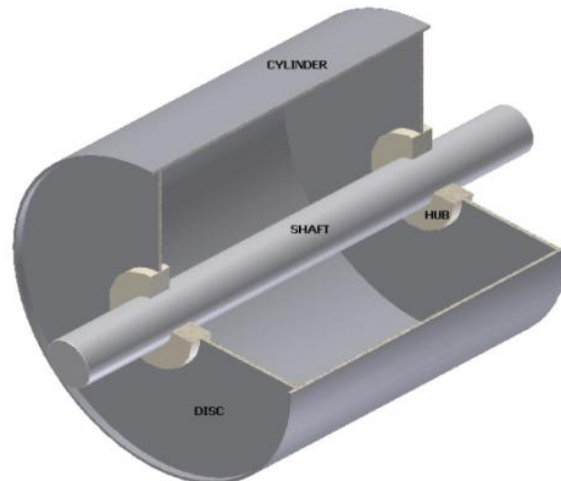


Fig.No:3 Present existing model

7.2. Varying parameters for design:

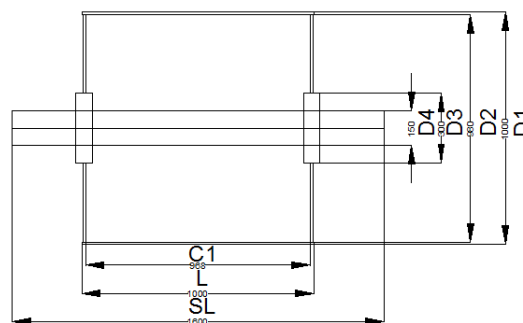
1. Thickness of the disc.
2. Distance between the discs
3. Total number of discs

7.3. Varying thickness of the discs:

1. 12mm thickness discs
2. 10 mm thickness discs
3. 6 mm thickness discs

In this cross section models there are two parameters 12 mm and 6 mm only used.

8. 2D DRAWING OF EXISTING MODEL OF STACKER RECLAIMER PULLEY:



VII. DIMENSIONS OF MODELS:

- Standard length of the shaft (SL)- 1600mm.
- Length of the cylinder (L)-1000mm.
- D1, D2, D3, D4-outer diameters of shaft, hub, discs, cylinder.
- C1, C2, C3 -distance between the discs.
- T1- No. of 12 mm thickness discs.
- T2- No. of 6 mm thickness discs.

VIII. THE TWO MAIN REASONS FOR STRESS REDUCTION ON THE STACKER RECLAIMER SHAFT:

1. The shaft is deformed due to the load the proper rotation of the bucket wheel cannot be obtained.
2. There is a chance for speed reduction in bucket wheel. The bucket wheel rotates less than the optimal speed.

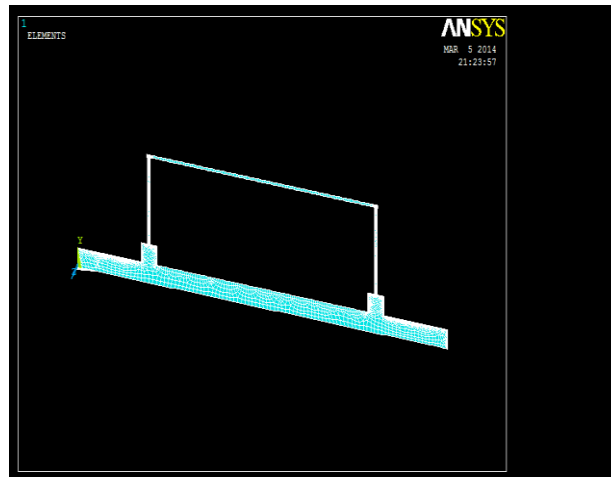
3. There is a chance for reduction of shaft life due to shock load.

IX. LOADING CONDITION OF THE CROSS SECTION MODEL:

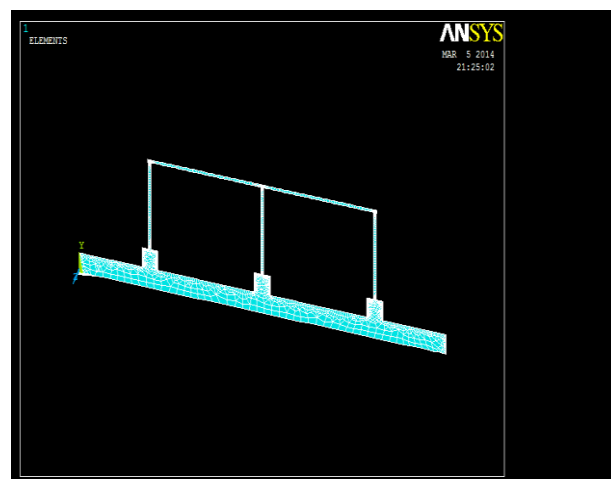
1. The two ends of the cross section model were fixed position so that the displacement is zero.
2. The pressure of 316kN was given on the line of the cylinder. The supporting discs and hub and the shaft are considered as a single area.
3. Then the cylinder area is attached to the other area. Then the load is given to the model. As a result the y direction displacement is analyzed.

X. MESHING VIEW FOR CORRESPONDING DISC MODELS:

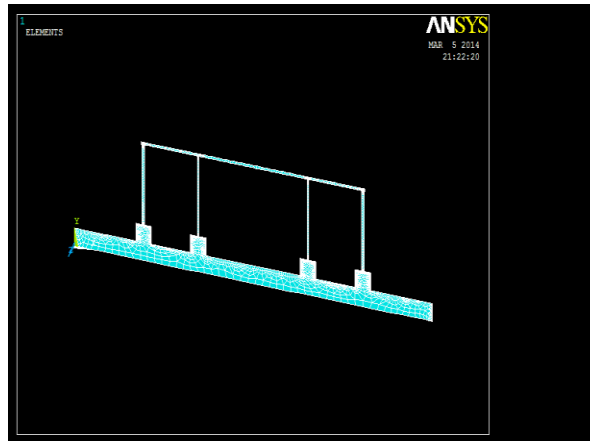
DESIGN: 1



DESIGN: 2

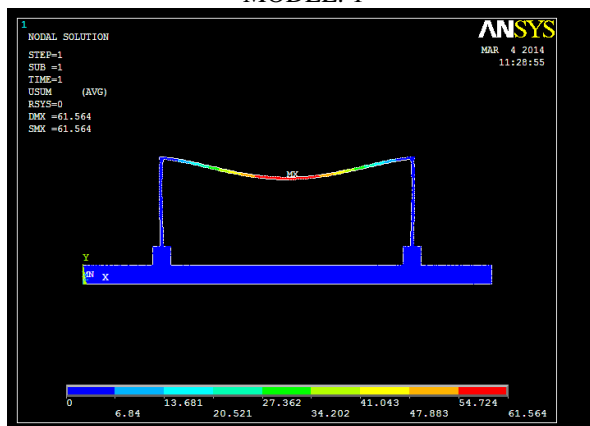


DESIGN: 3



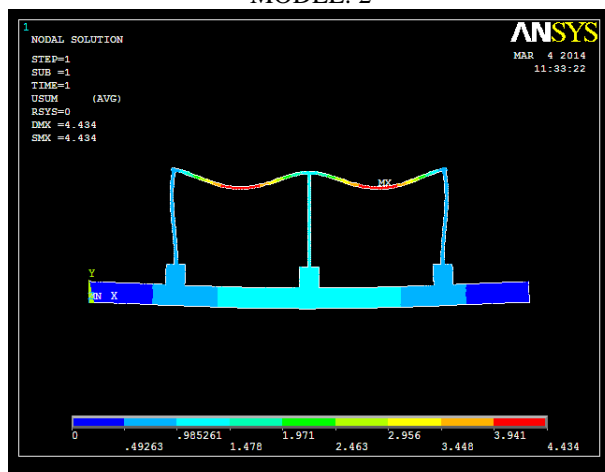
XI. RESULTS:

MODEL: 1



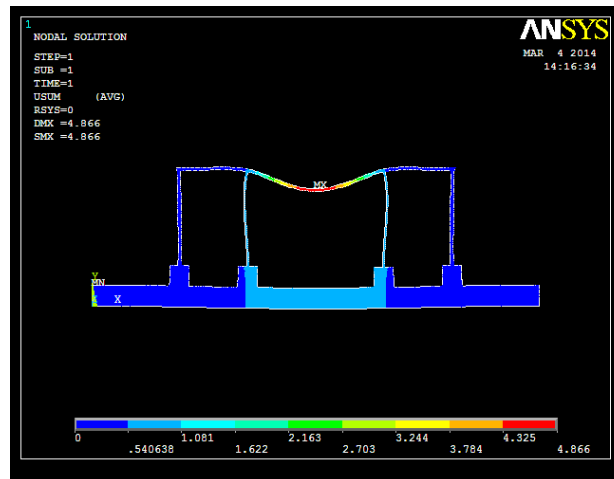
In this first result the maximum deflection in y direction is 61.564 mm. With this loading condition the variable pressure load on the cylinder is applied.

MODEL: 2



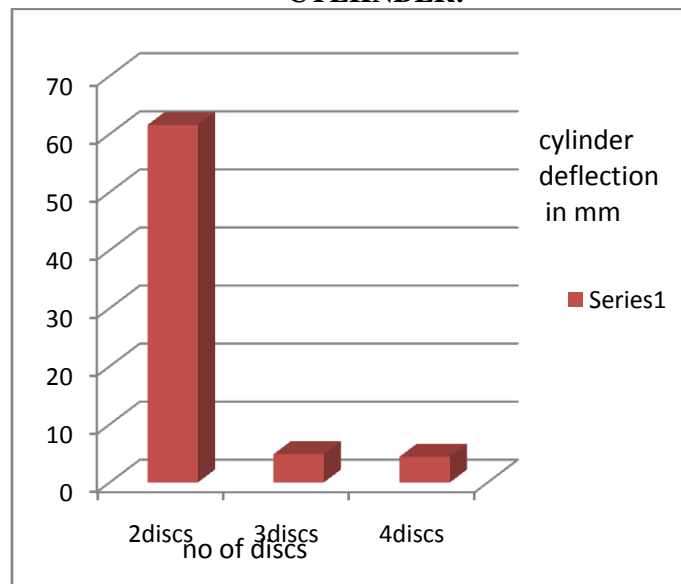
In this second result the supporting disc in the middle of the cross section minimize the deflection in the y direction. The middle disc is transmitting the load directly to the shaft. The deflection of the cylinder minimized with the supporting disc is 4.434 mm.

MODEL: 3

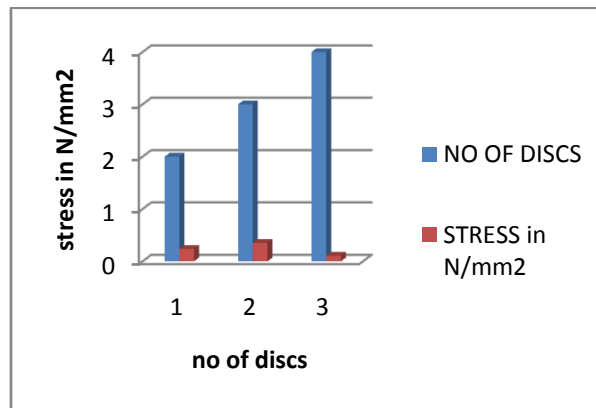


In this third result the supporting results with the two supporting discs between the end discs the deflection is minimized so the maximum deflection value is 4.866 mm.

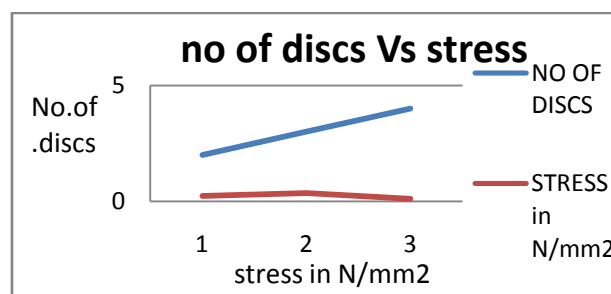
XII. THE GRAPH BETWEEN THE NO OF DISCS AND THE DEFLECTION OF CYLINDER:



XIII. THE GRAPH BETWEEN THE NO OF DISCS AND STRESS IN N/mm²



XIV. THE LINE GRAPH BETWEEN THE NO OF DISCS AND STRESS IN N/mm2



XV. CONCLUSIONS:

According to the Indian Standards the materials chosen for design of conveyor pulley followed by the total assembly of the conveyor pulley cross section design with and without supporting discs is analysed with the displacements in y direction. Hence, The deflection is minimized with the supporting discs.

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