Hoisting Mechanism for Loading and Unloading of Mechanical Components

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ABSTRACT

Modern technological period can't be imagined without various material handling equipment's. Hoists are amongst one of the material handling equipment which find wide applications Cranes are industrial machines that are mainly used for materials movements in construction sites, production halls, assembly lines, storage areas, power stations and similar places. Their design features vary widely according to their major operational specifications such as: type of motion of the crane structure, weight and type of the load, location of the crane, geometric features, operating regimes and environmental conditions. In the field of engineering. Due to incredible all around economic development, the operation rate of hoists has astonishingly increased year by year and many cranes are often used beyond their capacity in India. So analysis of main structure is very important and essential.

The purpose of our project is to design, analyse and optimize the structure of the hoist. In optimization part shape of the hook of the crane needs to be change as the present crane of the industry is not suitable for lifting the pack of helical gears. The gears are damaged during the lifting process. Hence shape of hook plays an essential role in safety of the mechanical components.

Keywords – *Hoist, shaft, ANSYS, bearing, hook, column.*

1. INTRODUCTION

Hoistare either attached to a building column or cantilever vertically from an independent floor mounted column. Shown in Figure 1 is a representation of a column mounted hoist. Essentially hoist is a beam with a moveable trolley hoist. The trolley hoist moves along the length of the boom and the boom swivels allowing the lifted load to be maneuverer about in a relatively small semi-circular area. The hoists and trolleys of hoists are usually slow moving and either manually or radio operated. The arc swing is usually manually accomplished but can be mechanized when required. There are two different types of column mounted jib beams normally encountered. The fundamental difference between the two is in the way in which the vertical column force is distributed. The suspended beam [7] as depicted in Figure 2a is analysed as if it delivers 100 percent of the vertical load to the column at the top hinge. The cantilevered beam [7] (Figure 2b) distributes the vertical load equallybetween the two hinges.

In this project we are designing, analysing and manufacturing the hoist mechanism. These are basically used for loading and unloading of mechanical components in the industries. The current hoist consists of shaft, I section, needle bearings, pressure rings and foundation. Shaft is used to transfer torque to theI section. The shaft is made up of Mild Steel. The I section is welded to the shaft. I section is 1.9m long and is made up of Cast Iron. The hook is attached on this I section. The movement of the hook is done with the help of Adjustable clutch mechanism. The VFD (Variable Frequency Drive) is used to vary the RPM of motor. Needle bearings are used on both sides of the shaft for the smooth rotation of the shaft. Pressure rings are used for counterbalancing the forces developed in I section.

1.1 Objectives

- Understanding the hoist construction.
- Identifying the critical locations in the construction.
- Suggest the modifications in the components without affecting functionality of the hoist.
- Calculations of the forces acting on various components of the hoist.
- Modification in the material selection of the shaft .
- Modification in the hook shape.
- Analysis of the hoist according to the modifications.
- Increase the load capacity of the hoist.

- Increase the rotation of the hoist.
- Manufacturing of the hoist.

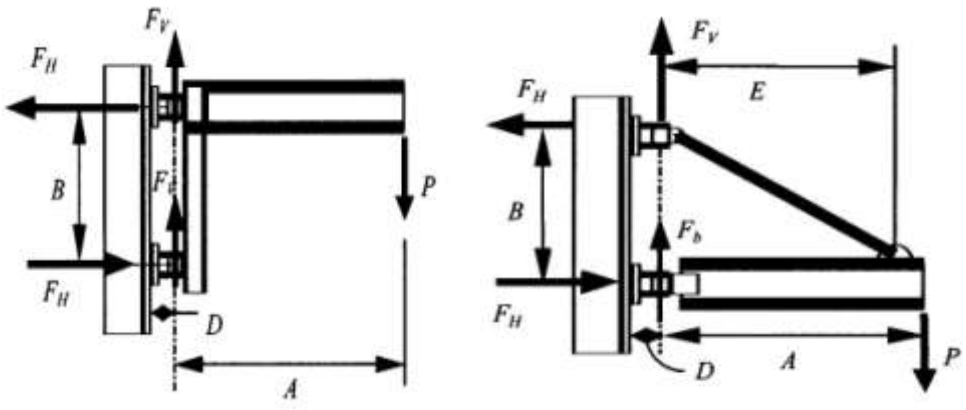

Fig 1. Forces acting on hoist

2. CALCULATIONS

1. Vertical column

Calculation of vertical column is based on the assumption that one side is fixed and the other is free. On the basis of load requirement mild steel is selected.

By Euler's theory crippling load(P)[1] is given by

$P=\pi^2EI/4L^2$

E= 210 Gpa

$I= \pi d^4/64$

P= 345.69 KN

2. Bearing

Needle roller bearing consists of roller elements in the form of thin cylindrical rollers all around the circumference of bearing. These bearings are used where radial space is limited. They have highest radial load capacity for given size of bearing.

From manufacture's catalogue,

- Co=basic static capacity of bearing = 20700*4.45 = 92115N
- Dynamic load capacity=12000 lbs.=12000*4.45=53400 N
- Maximum speed (in RPM)=1900 rpm
- Bore diameter=2 inch=2*25.4=50.8 mm
- Outer diameter=2.5625*25.4=65.0875 mm
- Width=1.25*25.4=31.75 mm
- Mass = 240 Kg*9.81=2.3544 N
- Operating Temperature = 20 F to 250 F
- $P_e=[XVF_r+YF_a]=4856$ N
- $L_{10}=(\frac{C_o}{P_e})^q = 18204.22779$ mhr
- $L_{h10} = 16000$ hrs.

3. Pressure Rings

Pressure rings are used to absorb the stresses developed due to vibrations.The vibrations are developed due to rotation of the shaft and during lifting of load. Pressure ring reduces the vibrations and provide smooth movement of the shaft.

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409 – 414

4. Variable frequency drive

A **variable-frequency drive** (**VFD**) (also termed adjustable-frequency drive, variable speed drive, AC drive, micro drive or inverter drive) is a type of adjustable-speed drive used in electro mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage. The AC electric motor used in a VFD system is usually three phase induction motor.

5. Shaft

Calculations of shaft is carried on the basis of maximum shear stress theory[2].

Modified Goodman diagram is also used.

Given data,

S_{ut}= 820 N/mm^2,S_{yt} = 248 N/mm^2, Ns = 3, T_{max} = 6867*10^3 N/mm

T_{min} = - 6867*10^3 N/mm, Ka=0.7, Kb=0.75, Kc=1, Kd=1

Endurance limit

Se= Ka*Kb*Kc*Kd*Se'

= 215.25 N/mm^2

From modified Goodman diagram [2]

$\theta_L = 39.91^0$

As $\theta_{L>}\ \theta$ so

$S_{a/}\ S_{e = 1}$

d = 96.3mm

6. I Section Beam

- Flange thickness:- 5 mm
- Web thickness:- 5 mm
- Flange depth:- 90 mm
- Flange width:- 50 mm
- Centroid:-

X=25 mm

Y=50 mm

- Moment of inertia about neutral axis:-

$$I = \frac{100^3 * 50}{12} - \frac{90^3 * 45}{12}$$

= 1432916.667mm^4

- Force =250*9.81N

= 2452.5 N

- Maximum shear stress

T_{max}=

= 5.797 N/mm^2

- **Shear stress distribution**

At upper edge is zero

At the lower edge

T =0.40649 N/mm^2, when y=d/2=45 mm

Shear stress at junction of web and flange

T =4.064 N/mm^2

Total shear force carried by one flange

= 51.69 N

Total shear force carried by web-

=2452.5 – (2*51.69) =2349.12 N

$$\frac{M}{I} = \frac{\sigma}{Y}$$

Y= 50mm, E=210 Mpa

σ =188 Mpa

3. RESULT

3.1 Analysis of I section Beam-As per the calculations the analysis[3] of I-section beam is carried out in ANSYS 14.0.the result obtained is within permissible limits and is shown below, Fig 1 shows maximum deflection of i-section beam**.**

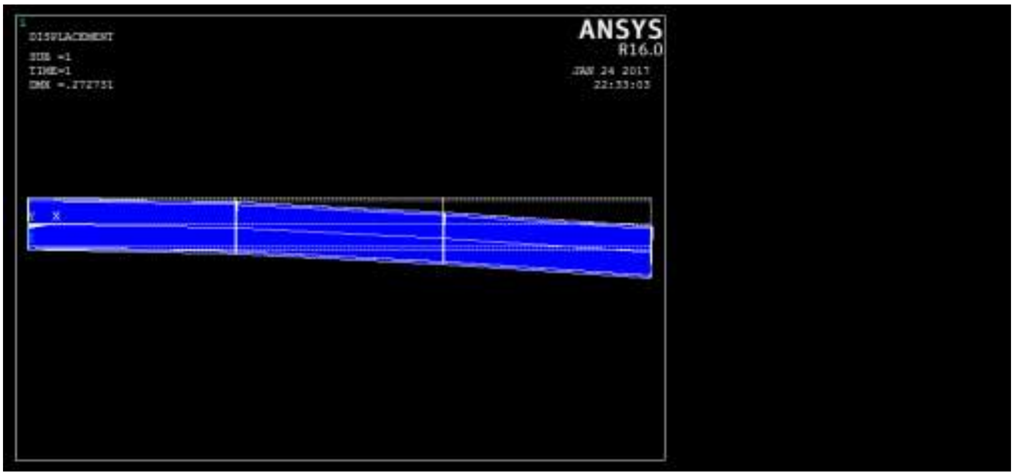

Fig. 1 Analysisof I section Beam

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409 – 414

Fig 2 shows the stress distribution in the I section when load is applied. The stress distribution is within permissible limits and is shown below-

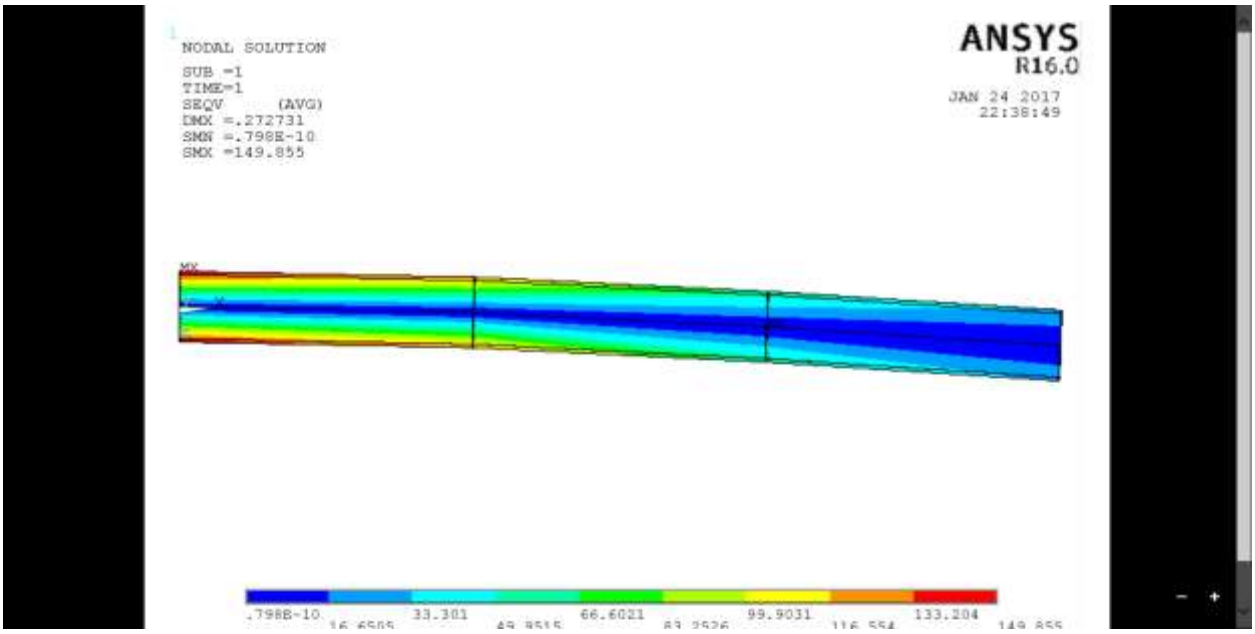

Fig.2 Stress distribution in the I section Beam

3.2 Buckling of Column

The analysis of the column is performed according to the Euler'sformula [1] for buckling of column. The result obtained is within the permissible limits and sustain the maximum load. The result of the analysis is shown below.

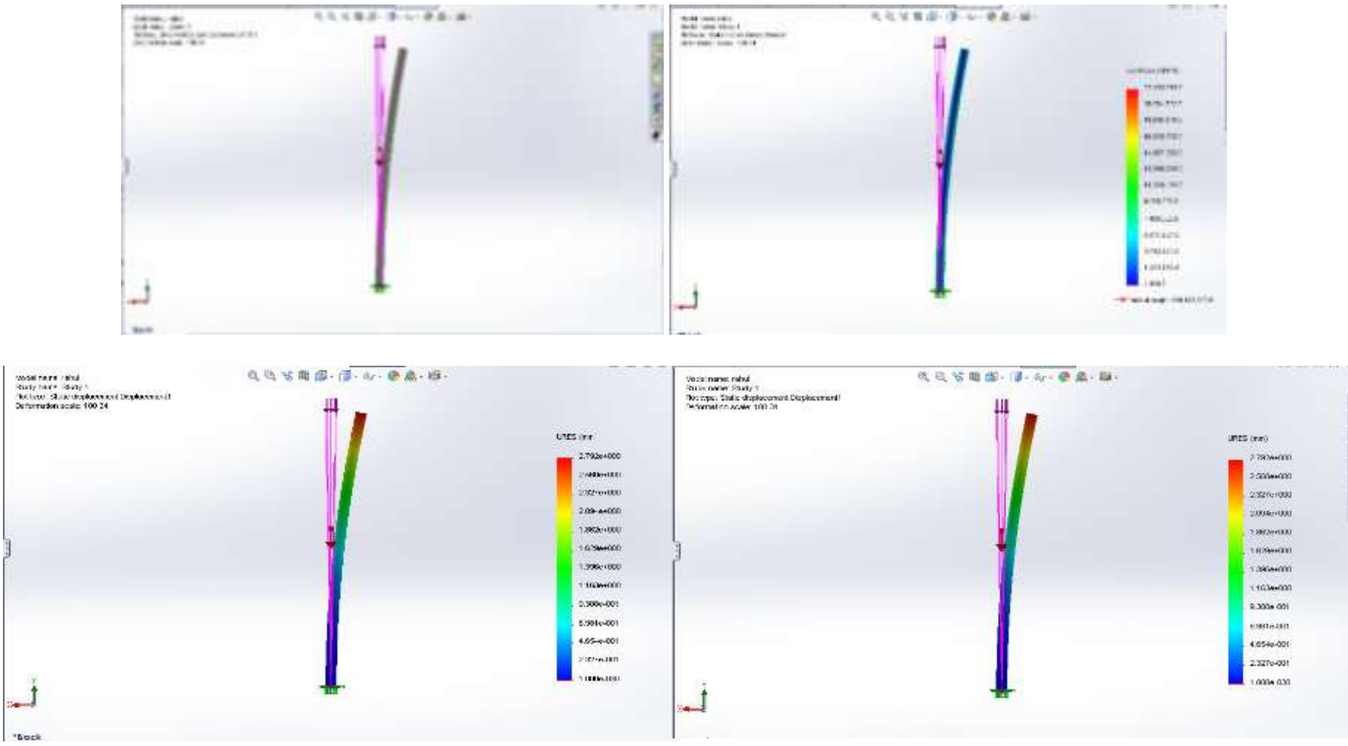

Fig 3. Buckling of Column

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409 – 414

3.3 Optimization of Hook

The original hook which the industry was using was causing damage to the manufactured gear. The hook was damaging the splines while loading and unloading of the gears. So design of the hook was optimized accordingly

Fig 4. Optimization of Hook

The modified hook design is easy for handling as worker doesn't need to fix different gears every time. The modified hook contracts as the chain starts lifting the work piece. The modified hook is shown as below.

Fig 5Modified Design model of hook

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