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Design and Analysis of Major Component of 120 Tones Capacity of EOT Crane

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***Abstract*— Material handling equipment are an eminent part of the human life. Modern technological era cannot be imagined without various materials handling equipment. Cranes are amongst one of the material handling equipment which finds wide applications in different fields of engineering. The present work is an effort to cover complete design and analysis of EOT crane 120 tones capacity. Manual design has been done in accordance to the various relevant IS codes. Since the procedural design involves exhaustive calculations. Modeling and analysis of components are done in CREO modeling software and ANSYS analysis software.**

I. INTRODUCTION

Material handling equipment is an eminent part of the human life. Modern technological era cannot be imagined without various materials handling equipment. Cranes are amongst one of the material handling equipment which finds wide applications in different fields of engineering. Overhead crane and gantry crane are particularly suited to lifting very heavy objects and huge gantry cranes have been used for shipbuilding where the crane straddles the ship allowing massive objects like ships' engines to be lifted and moved over the ship.

List of Components Used In EOT Crane

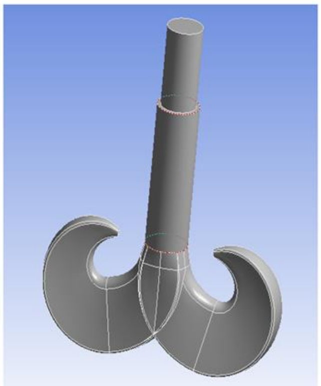
Design features vary widely according to their major operational specifications such as: type of motion of the crane structure, weight and type of the load, location of the crane, geometric features, operating regimes and environmental conditions.

1. Load handling attachment
2. Pulleys and drum
3. crane frames
4. Flexible hoisting appliances
5. Drives(motors)
6. Transmission components
7. Rail and traveling wheels
8. Control device

Design of Hook

1.1 Selection of Lifting Hooks

Single Point lifting hook is generally selected from IS 15560:1999 [1] Point hooks with shank up to 160 tones. Specification according to given crane capacity. Ramshorn hook is selected from IS 5749:1970 [2] as shown in figure 1.



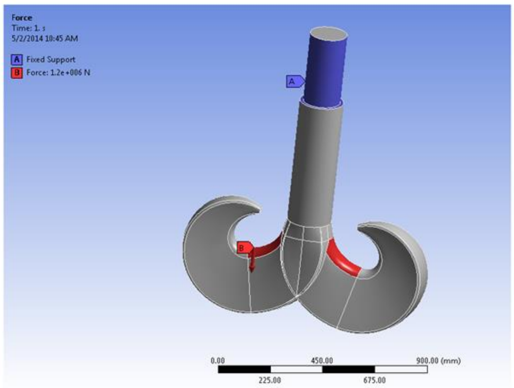


Figure 1 3-D model of Ramshorn Hook   Figure 2 Fixed support and load

1.2 FEA of hook

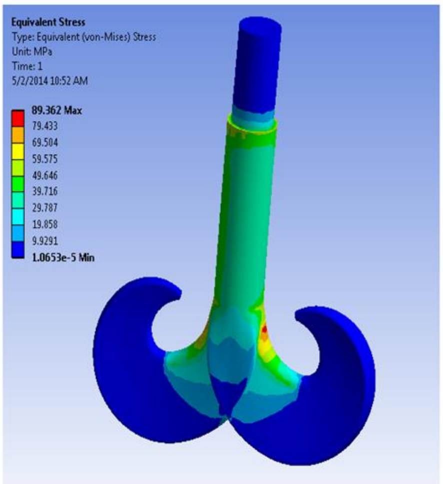


Figure 3 Von-mises stress of hook

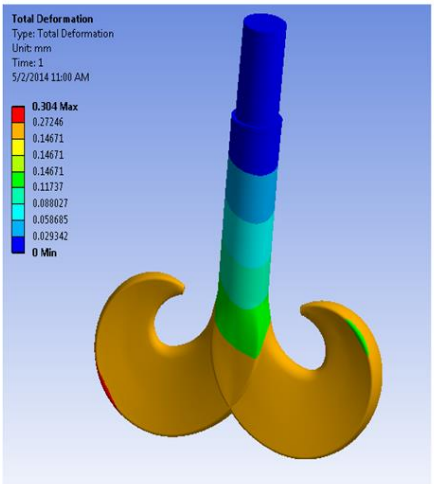


Figure 5Total deflection of hook

II. DESIGN OF WIRE ROPES

Wire rope, unless otherwise specified or agreed by the purchaser, shall conform to "IS 2266:2002 .Steel wire rope for general engineering purpose Specification" [3]. Steel core ropes with tensile designation of wires as `1960' shall be used for the application under water or in the corrosive atmosphere or while handling the hot metal. For 120 tones Capacity, M5 class of mechanism and12 rope parts minimum breaking load calculated from standard formula is 540 KN. We can select a wire rope of 32 mm diameter of 6X19 M construction, 1770 CWR tensile designation.

III. SHEAVE DESIGN

Selection of Lifting Hooks

Diameter of sheave measured at the bottom of the groove shall not be less than the value calculated by using following formula:

$$Ds = 12 \times d \times C_{df} \times C_{rc} \times Crr \ \ [3]$$

Diameter of the sheave measured at the bottom of the groove shall be 720 mm. as shown in figure 6.

Radius of groove shall be 17.6 in mm

Depth of groove shall not be less than 48 mm.

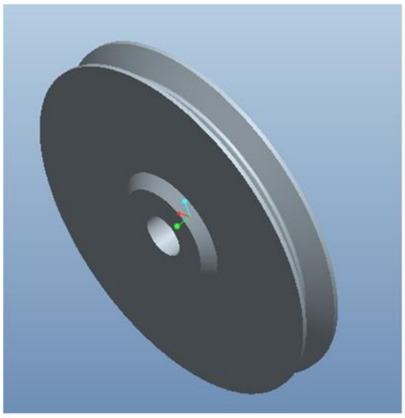


Figure 6 3-D model of pulley

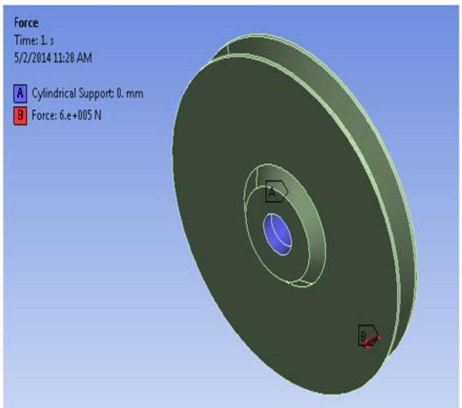


Figure 7 Fixed support and load application

FEA of sheave

Apply cylindrical support at center surface of sheave where shaft is fixed. Here two sheave is is used so half load of 600000 is applied on the groove applied as shown in figure 7. As shown in figure 8 the equivalent stress is approximate 14 Mpa which is within the limit and shown in figure 9 the total deflection is about 0.01 mm.

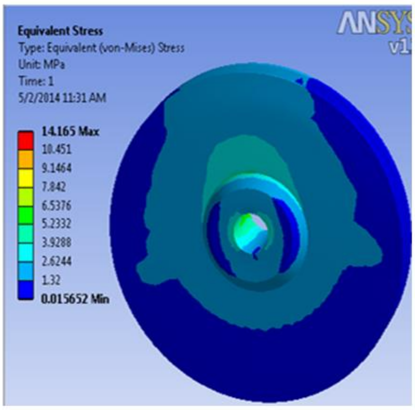


Figure 8 Von-mises stress of sheave

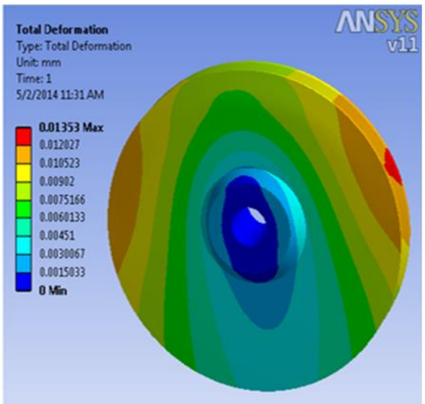


Figure 9 Total deflection of sheave

IV. DRUM DESIGN

Dimension of drum and pulley are depending on the wire rope diameter. Diameter of drum measured at the bottom of the groove shall not be less than the value calculated by using following formula:

$$Dd = 12 \times d \times C_{df} \times C_{rc} \quad [3]$$

$$D = 32 \text{ mm} \qquad C_{df} = 1.5 \qquad C_{rc} = 1.25$$

Standard Diameter of drum at the bottom the groove from IS 3177:1999 [3] is 800 mm.
Radius of Groove shall be 17.60 in mm as shown in figure 10.

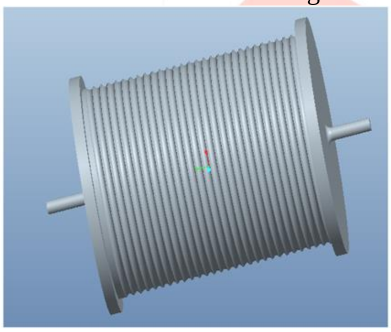


Figure 10 3-D model of drum

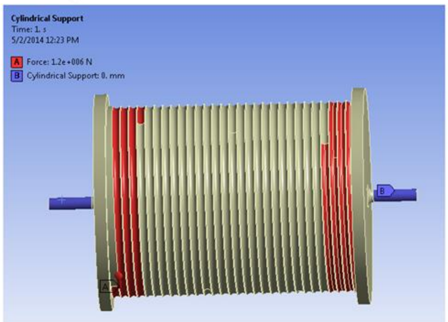


Figure 5.11 Fixed support and load application

FEA of drum

Apply cylindrical support at both surface of bar. Here two rope is used to carry the load so 1200000 is applied on the groove as shown in figure 5.11 As shown in figure 5.12 the equivalent stress is approximate 77 Mpa which is within the limit and shown in figure 5.13 the total deflection is about 0.06 mm.

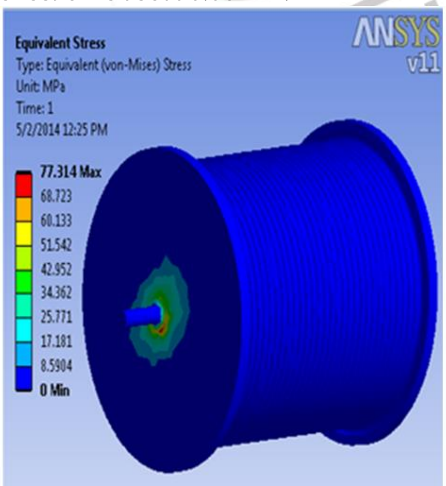


Figure 5.12 Von-mises stress of drum

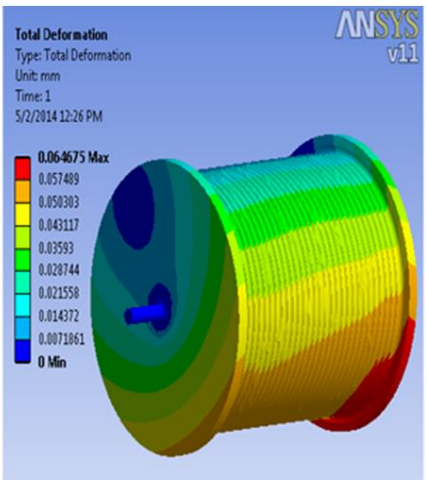


Figure 5.13 Total deflection of drum

V. DESIGN OF STRUCTURE OF EOT CRANE

Crane Girder Design [4]

Find cross section of gantry girder

$$Z = \frac{M}{\sigma} = \frac{1806\times10^6}{0.66\times250} = 11\times10^6 \text{ mm}^3$$

The section modulus increased by 25 percent to actual for bending
$Z_{req} = 1.25 \times 11 \times 10^6\ mm^3 \qquad = 13.75 \times 10^6\ mm^3$
Here select box section for girder [5] as shown in figure 14.

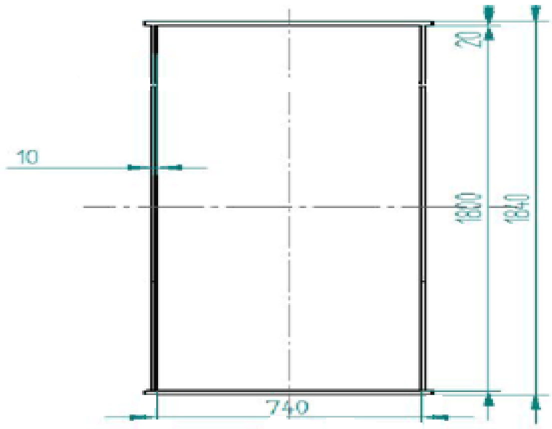


Figure 14 Figure of box section of gentry girder

Modulus of this section is $Z = \frac{b \times h^3 - b1 \times h1^3}{6 \times h} = 38 \times 10^6\ mm^3$
Here 3 times lager modulus is selected so it is safer than the limit.

FEA of main girder

Apply cylindrical support at both side of girder. And applied load of each wheel of 980000 N on girder as shown in figure 5.15

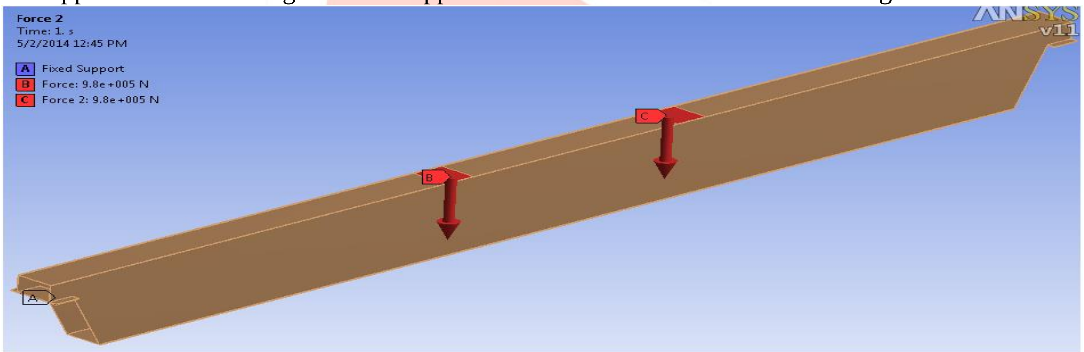


Figure 5.15 Fixed support and load application of main girder

As shown in figure 5.16 the equivalent stress is approximate 94 Mpa which is within the limit and shown in figure 5.17 the total deflection is about 7 mm.

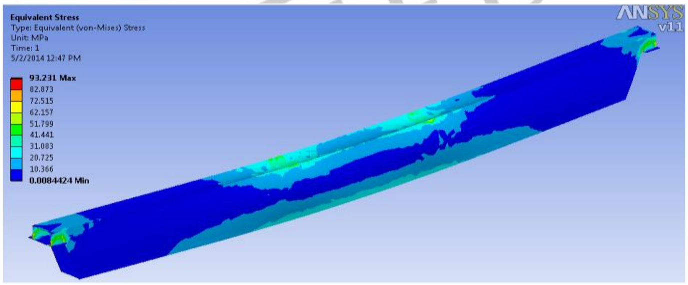


Figure 5.16 Von-mises stress of main girder

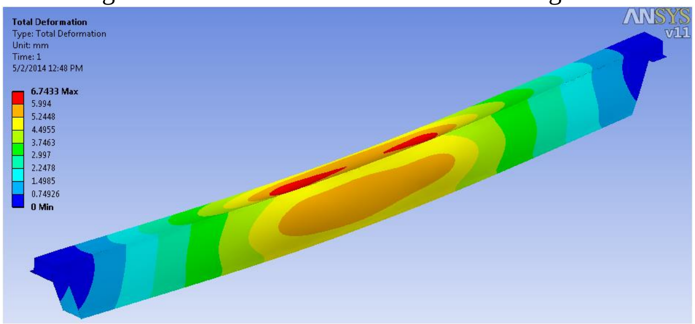


Figure 5.17 Total deflection of main girder

VI. CONCLUSION

Manual design of EOT cranes has been done using IS codes, on the basis of which 3-DModeling and Analysis of the major components has been carried out using Creo software as modeling software and ANSYS as analysis software. All results are within the limit.

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[2] IS 5749:1970 Specification for Forged ram shorn hooks, 1997

[3] IS 3177 Code of practice for electric overhead travelling cranes and gantry cranes other than steel work cranes, 1999

[4] Rudenko N, Material Handling Equipment, Mir Publisher, Moscow, 1981

[5] IS 800-2007 general construction in steel –code for practice.