Design and Analysis of EOT Crane Hook for Circular and Trapezoidal Sections

Chavan Bhushan R[1], Phadnis Swapnil S[2], Kulkarni P. D[3]
[1, 2, 3] Department of Mechanical Engineering
[1, 2, 3] Sinhgad Institute of Technology, Lonavala

Abstract- *In this project the design of EOT crane hook has been carried out. The dimensions of the hook have been determined for a load capacity between 12.5 tonnes. Various dimensions for cross sections of various shapes for crane hook have been found. After the system was designed, the stress and deflection are calculated at critical points using ANSYS and optimized. Which cross section would be better keeping some parameters constant for all the case. Various dimensions and load per wire for wire ropes has been found. Using various formulae found the dimensions for pulley, Rope-drum.*

Keywords- EOT, crane, ANSYS.

I. INTRODUCTION

ANSYS software (CAE tool) is a tool for structural analysis including linear, nonlinear and dynamic studies. The engineering simulation provides a complete set of element Behavior, material models and equation solvers for a wide range of mechanical design problems. In addition, ANSYS offers thermal analysis and coupled physics capabilities involving acoustic, piezoelectric, thermal structure and thermo-electric analysis Crane hooks are one of the important components which are used to transfer materials having heavy loads, mainly in industries. Crane hooks are liable components subjected to failure due to stress in accumulation of heavy loads. The design parameters for crane hook are area of cross section, material and radius of crane hook. Failure of a crane hook mainly depends on three major factors i.e. dimension, material, overload... The crane hook is modelled the stress analysis is done using ANSYS 14.5 workbench.

- To design an EOT hook in various cross section such as rectangle, trapezoidal, and circular.
- Find the stresses induced in all cross section at various loading conditions.

II. DESIGN AND CALCULATIONS

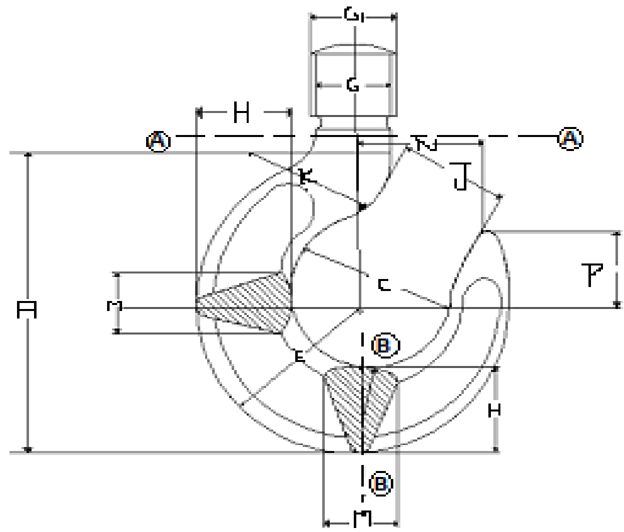


Figure 1 Hook

Part [A] Design of Rope

Design Load 12.5 Tonnes W= 12.5tonnes < 25 tones

Selecting Class II mechanism, Duty Factor is S.F= 1.2 … PSG 9.2 Design Load [W] = 125×1.2= 150 KN

- Selecting 6-fall system, no. of bends= 5, V.R=3. Rope to Sheave Dia $\frac{Dmin}{d} = 26.5$... PSG 9.1

Load acting per fall $F = \frac{[W]+w}{\eta f \times \eta trans}$., W= wt. of snatch box =4%of W= 1.5KN

Transmission efficiency 0.95, submitting all in equation, we get F=27KN. Breaking strength of rope

P= f × n, Where n= n`× duty factor, P=164 tones Selection of rope... PSG 9.4

Selecting rope diameter d= 18mm -- (6×37 group), Breaking strength 20 >19.2 tones ------- so OK

σ_u=1700N/mm^2, Wire Dia =$d_w = \frac{d}{1.5\sqrt{group\ of\ rope}}$, D_{min} = 0.805mm, Dia of sheave= 26.5×18= 500mm Checking for

Actual breaking strength…PSG 9.1 $[P] = \frac{F \times \sigma_u}{\frac{\sigma_u}{n} - \frac{d}{D} \times 3600}$ = 31.8 tonnes> 19 tonnes, so Safe.

Checking for life induced $N = \frac{0.4z}{a \times b \times z_2}$ ------- (a) …. PSG 9.7
a=3400, b=0.4, z_2=3 ---- PSG 9.8 table 2
$\frac{D}{d} = (m.\sigma.c_1.c + 8)$— (1), Where, c_1=1, c2=0.63, c=1.02 ………………………………… PSG9.8

Substituting in eq (1) m=1.0714, so from PSG9.8 by interpolation z=150000, sub in equation (a)
n= 14.7 months> 10 months, so Safe

Part [B], Design of Hook

Selecting std. hook based on static load, [W] = 150 KN= 15 tonnes, Selecting capacity with 16 tonnes >15 tones--- so OK. Material selected is high tensile steel… PSG 9.11, Diameter of inner curvature C=131mm

After Dimensions corresponding to Care, G=70mm, G_1=M68.

Table 2.1

Notation on PSG 9.11	Dimension in(mm)	Notation on PSG 6.3
H=0.6C	121.83	h
M=0.6C	78.6	b_i
2z=2(0.12C)	31.44	b_r
C/2	65.5	r_i
H=C/2	187.33	r_o

Using same procedure we have designed the EOT hook for different cross sections such as rectangular and circular

For rectangular section the parameters are as follows

Table 2.2

Notation on PSG 9.11	Dimension in(mm)	Notation on PSG 6.3
H=0.6C	121.83	h
M=0.6C	78.6	b_i

The rectangular cross section will be seen as follows

Also the circular section is designed as follows

Table 2.3

Notation on PSG 9.11	Dimension in(mm)	Notation on PSG 6.3
H=0.6C	121.83	h

The neck Dia at section 1-1 is same as of trapezoidal i.e. G= 70mm

The stress calculations as done is similar as above for the load of 125kN and the values for this are as follows

Table 2.4

Parameter/loads	Circular	Trapezoidal
Section A-A at curvature		
Bending stress $[\sigma_b]$	168.391	175.57
Direct stress $[\sigma_d]$	12.86	22.37
Total stress $[\sigma]$	181.258	197.94
Total tensile stress $[\sigma]$	38.98	38.98
Section B-B		
Shear stress $[\tau]$	22.37	22.37
Total tensile stress $[\sigma]$	128.16	139.97
Principle tensile stress σ_p	128.81	141.72
Principle shear stress τ_{max}	64.72	71.74

III. GEOMETRY

Trapezoidal

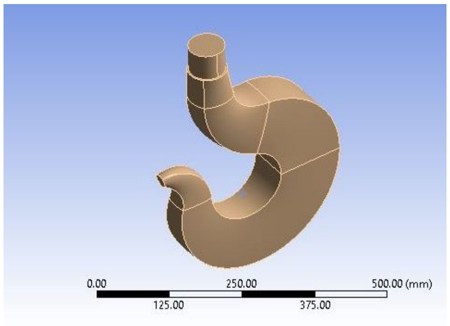


Figure 2

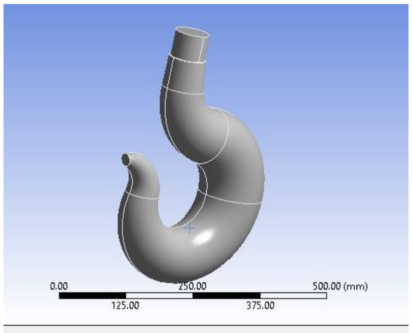


Figure 3

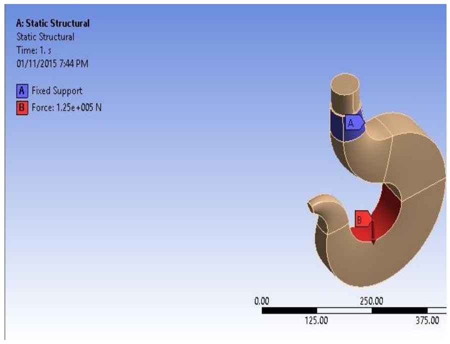
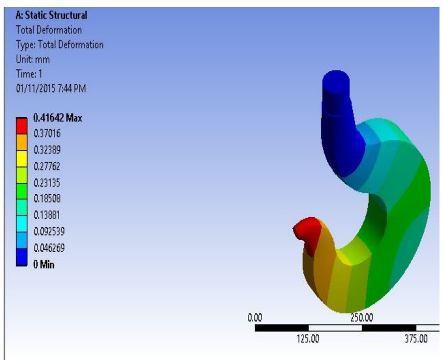
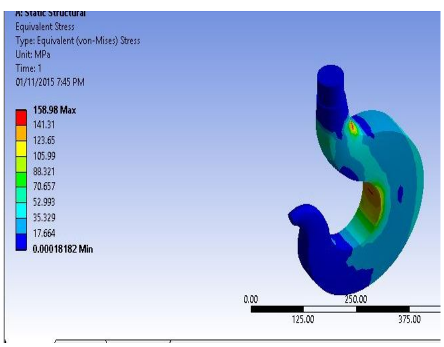
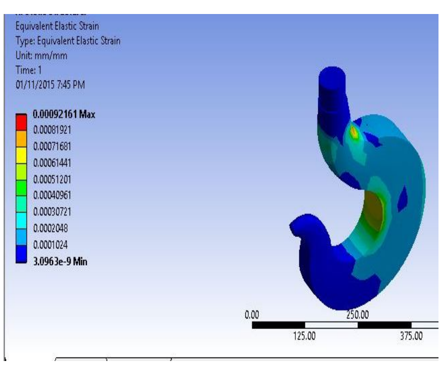
These models where analysed under various loading conditions using ANSYS 14.5 software

They were meshed with automatic meshing and standard program settings for each cross section these hooks were studied for deformation, equivalent stress and stress

ANSYS simulations

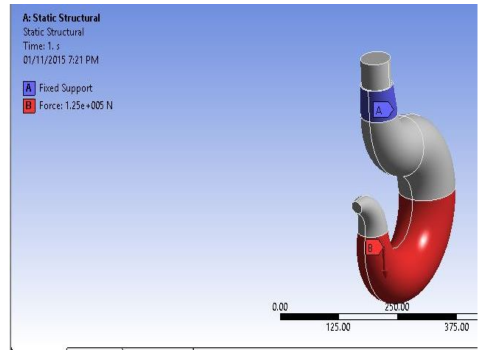
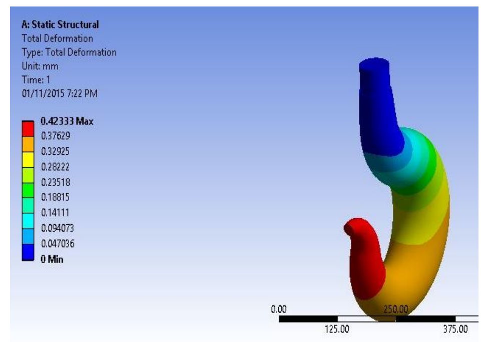
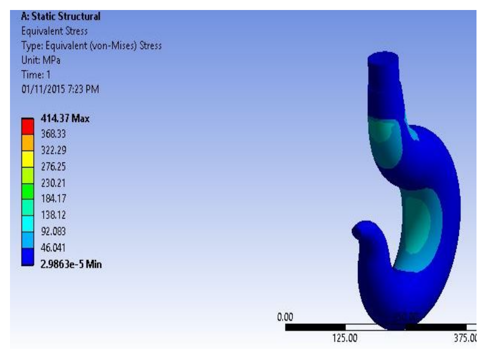
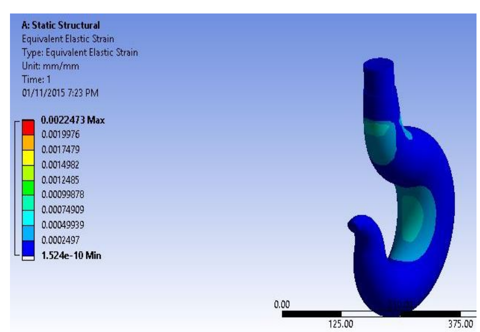
For 125 KN loading Trapezoidal

Table 2.6

Loading conditions	
Total deformation	
Equivalent stress	
Equivalent strain	

For 125 KN loading Circular

Table 2.7

Loading conditions	
Total deformation	
Equivalent stress	
Equivalent strain	

IV. RESULTS AND DISCUSSIONS

Table 3.1

Loads		Total deformation	Stress	strain
Trapezoidal	Min	0. mm	1.8182e-004 MPa	3.0963e-009 mm/mm
	Max	0.41642 mm	158.98 MPa	9.2161e-004 mm/mm
circular	Min	0. mm	2.9863e-005 MPa	1.524e-010 mm/mm
	Max	0.42333 mm	414.37 MPa	2.2473e-003 mm/mm

V. CONCLUSIONS

- The trapezoidal sections are preferred over Circular section to avoid the stress concentration on edges.
- The circular section has more stress induced than other two cross section
- The trapezoidal cross section gives better results in comparison with Circular section as because Total deformation is less in trapezoidal cross section.
- Theoretical and analytical methods Prove that use of trapezoidal sections is better

REFERENCES

[1] Jayesh chopda, S.H. Mankar, May 2015,” Design analysis and optimiszation of electric overhead travelling crane hook”, IJMTER, ISSN 2349-9745

[2] A Gopichand , R.S. Lakshmi,Dec 2013,”Optimization of design parameters for crane hook using taguchi method” IJIRSET, issn 2319-8753

[3] Design data book of engineers, January 2010”PSG college of technology”, Coimbatore

[4] Patel Ravin, Patel Bhakti, 2015, “Design and analysis of crane hook with different materials, IJACT, ISSN 2319-7900.

[5] Tushar Hire, V.N bartaria, 4/2014,” Optimum analysis of crane hook with help of finite element: IJEET.

[6] Rashmi U.,” 3/2011”Stress Analysis of crane hook and validation by photo elasticity” SciRP.org