Design and Analysis of EOT Crane Hook

[1] Mhashilkar Deepali P., [2] Phadnis Swapnil S
[1] Student, B.E. Mechanical, Department of Mechanical Engg, SSJCE, Dombivli, India
[2] Asst. Professor, Department of Mechanical Engg, SSJCE, Dombivli, India

---

***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

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 modeled the stress analysis is done using ANSYS 14.5 workbench.

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

- 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

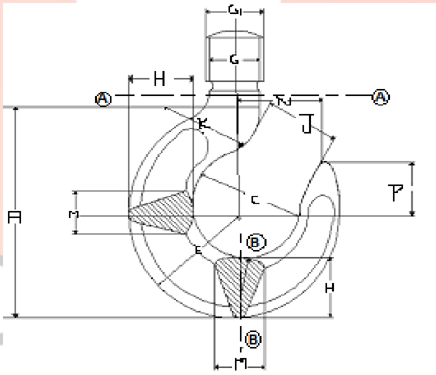


Figure 1 Hook

Part [A] Design of Rope
Design Load 12.5 Tones 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 $F = \frac{[W]+w}{{}^{n}f \times {}^{n}trans}$., 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.

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

Table 2.1

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

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

Table 2.2

The rectangular cross section will be seen as follows
Also the circular section is designed as follows

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

Table 2.3

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

Parameter/loads	Rectangular	Circular	Trapezoidal
Section A-A at curvature			
Bending stress $[\sigma_b]$	145.35	168.391	175.57
Direct stress $[\sigma_d]$	15.66	12.86	22.37
Total stress $[\sigma]$	161.01	181.258	197.94
Total tensile stress $[\sigma]$	38.98	38.98	38.98
Section B-B			
Shear stress $[\tau]$	15.66	22.37	22.37
Total tensile stress $[\sigma]$	113.85	128.16	139.97
Principle tensile stress σ_p	114.94	128.81	141.72
Principle shear stress τ_{max}	57.99	64.72	71.74

Table 2.4

Geometry

Trapezoidal

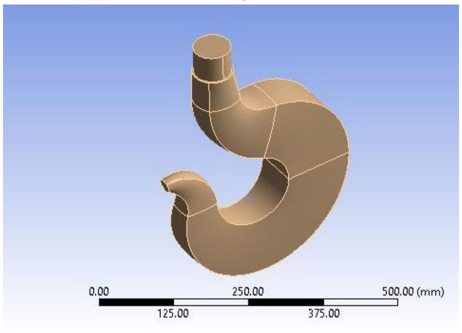


Figure 2

Rectangular

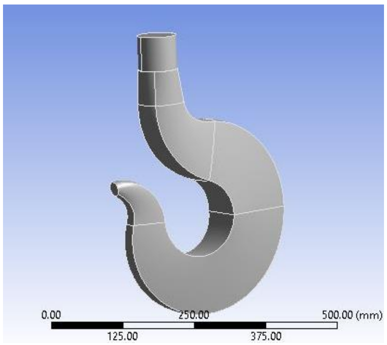


Figure 3

Circular

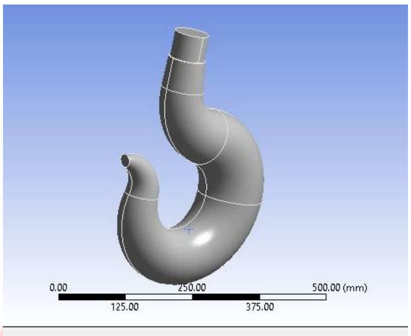
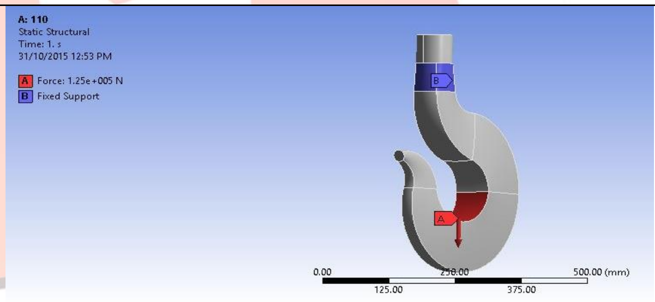
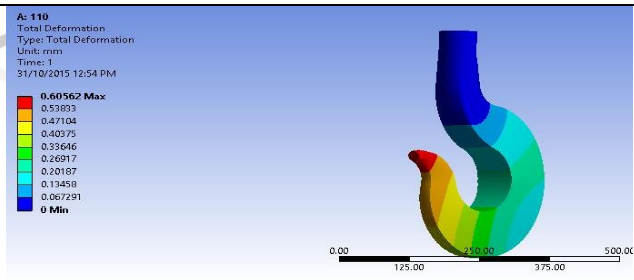
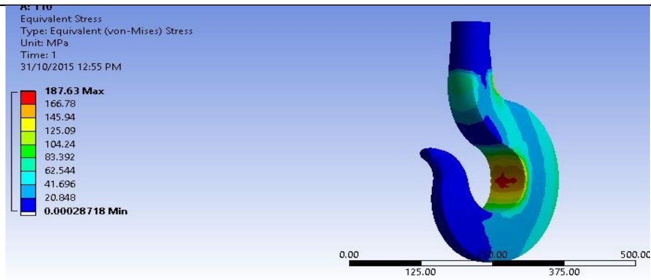


Figure 4

These models where analyzed 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 125KN loading rectangular

Loading conditions	
Total deformation	
Equivalent stress	

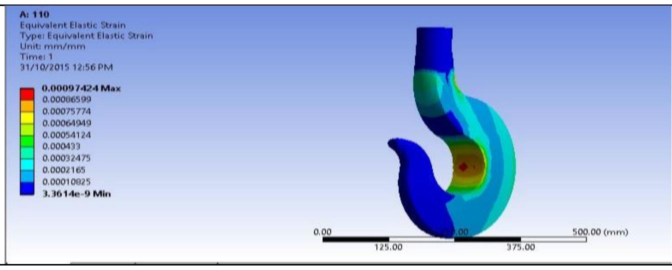
Equivalent strain	

Table 2.5

For 125 KN loading Trapezoidal

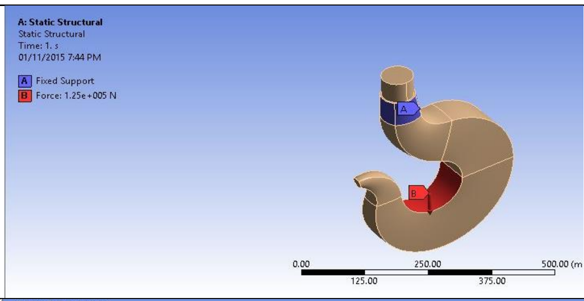
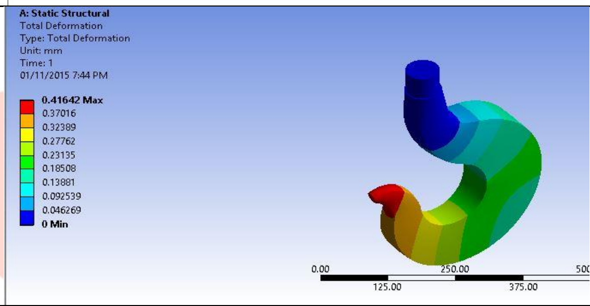
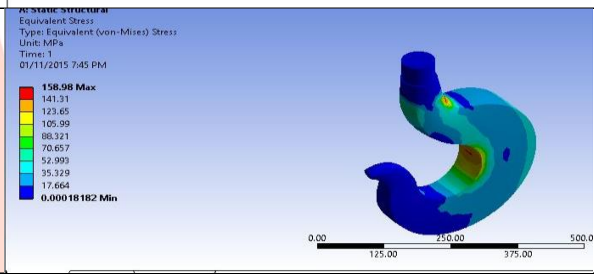
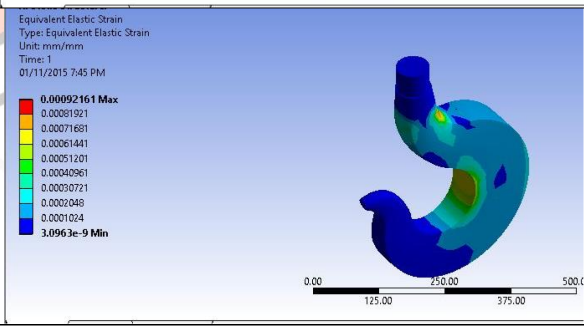
Loading conditions	
Total deformation	
Equivalent stress	
Equivalent strain	

Table 2.6

For 125 KN loading Circular

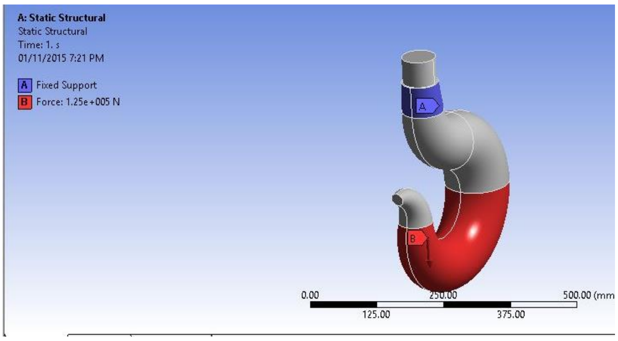
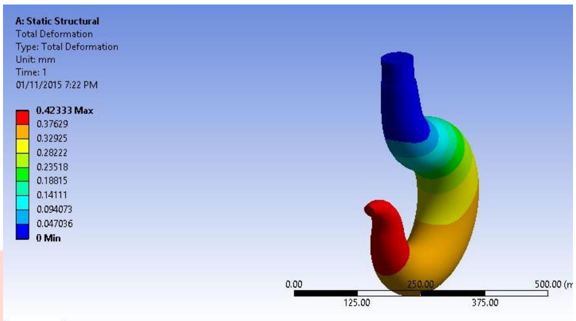
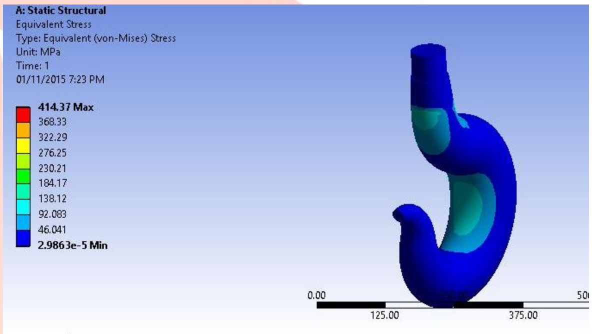
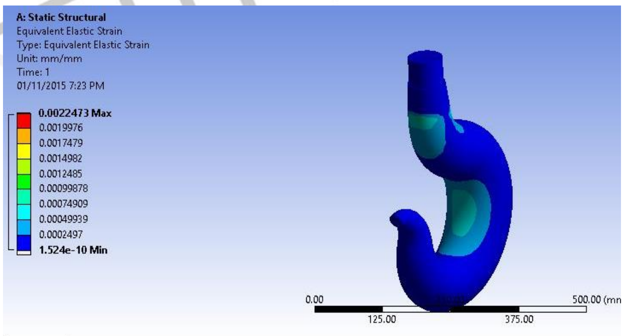
<table>
<tr><td>Loading conditions</td><td>
</td></tr>
<tr><td>Total deformation</td><td>
</td></tr>
<tr><td>Equivalent stress</td><td>
</td></tr>
<tr><td>Equivalent strain</td><td>
</td></tr>
</table>

Table 2.7

III. RESULTS AND DISCUSSIONS

Loads		Total deformation	Stress	strain
Rectangular	Min	0. mm	2.8718e-004 MPa	3.3614e-009 mm/mm
	Max	0.60562 mm	187.63 MPa	9.7424e-004 mm/mm

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

Table 3.1

IV. CONCLUSIONS

- The circular section has more stress induced than other two cross section
- The trapezoidal sections are preferred over rectangular section to avoid the stress concentration on edges.
- The trapezoidal cross section gives better results in comparison with other three cross sections as because stresses induced are less in trapezoidal cross section.
- The stresses obtained in theoretical and analytical methods are in good agreement. The model prepared is used for further studied with different loads and also for different materials.

REFRENCES

[1] Design data book of engineers, January 2010"PSG college of technology", Coimbatore,

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

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

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

[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