Cross Sectional Analysis of EOT Crane Hook

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Abstract- *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.*

Keywords- Cross Sectional, Crane, Hooks, Ansys 14.5

I. INTRODUCTION

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 9 to 12.5 tones. 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.

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

II. DESIGN AND CALCULATIONS

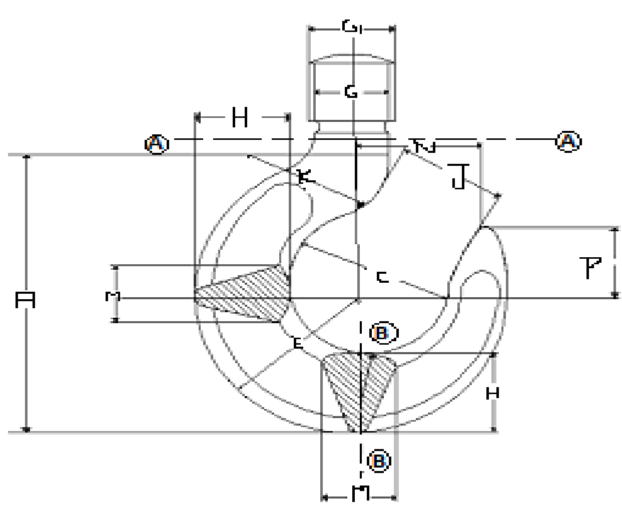


Figure 1 Hook

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

III. MESHED GEOMETRY

Trapezoidal

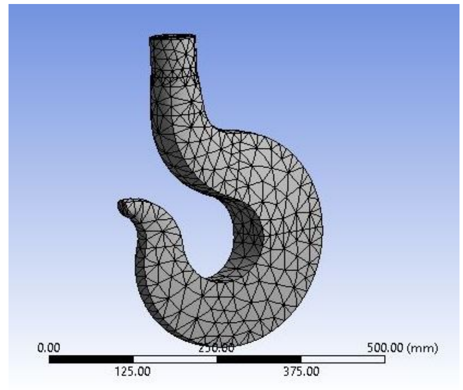


Figure 2

Rectangular

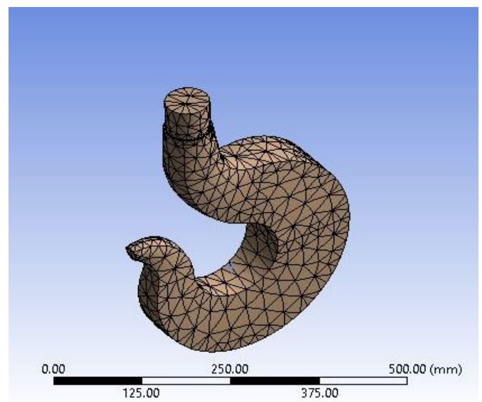


Figure 3

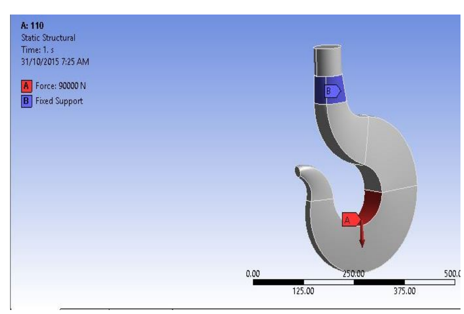
These models where analysed under various loading conditions using ANSYS 14.5 software

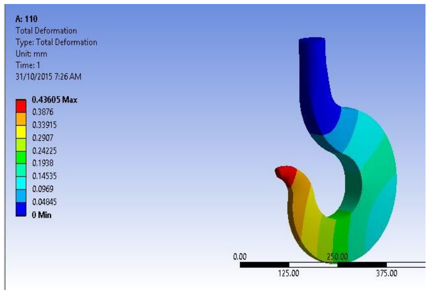
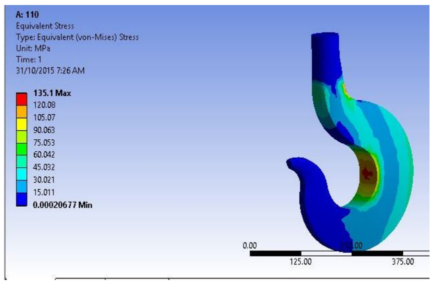
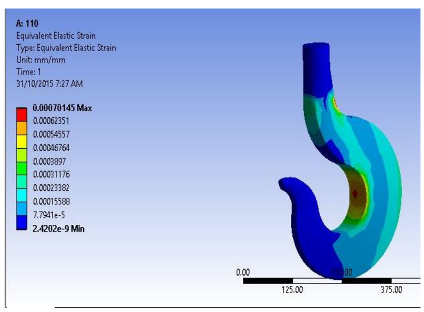
They were meshed with automatic meshing and standard program settings for each cross section these hooks were studied for deformation, equivalent stress and stress

IV. ANSYS SIMULATIONS

Trapezoidal cross section
For 90 KN loading

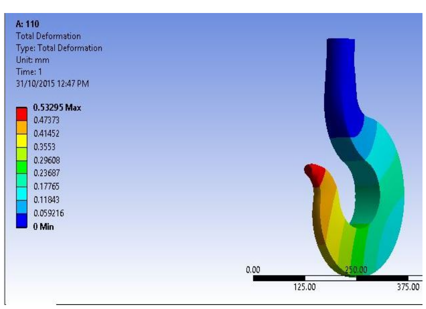
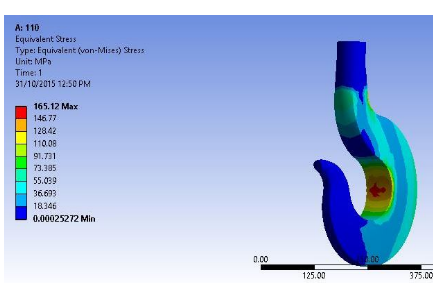
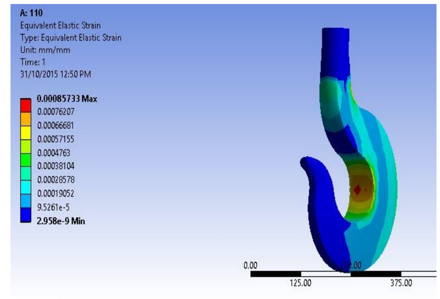
Table 4.1

Loading conditions	

Total deformation	
Equi stress	
Equi strain	

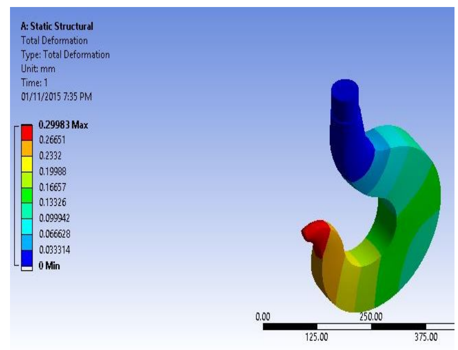
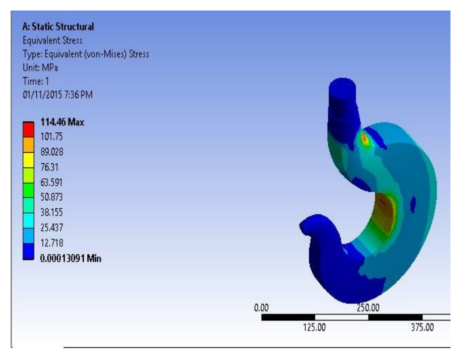
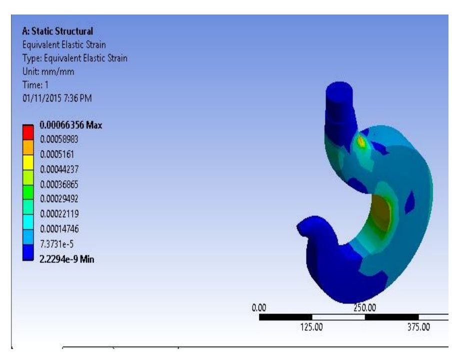
For 110 KN loading

Table 4.2

Total deformation	
Equivalent stress	
Equivalent strain	

Rectangular cross section
For 90 KN loading

Table 4.3

Total deformation	
Equivalent stress	
Equivalent strain	

For 110KN loading

Table 4.4

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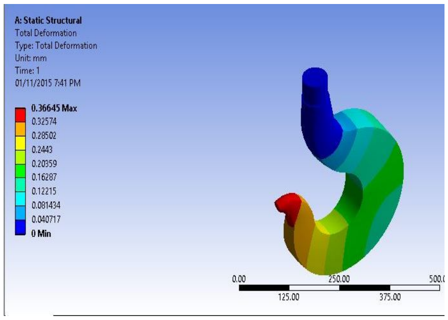
<tr><td>Total deformation</td><td>
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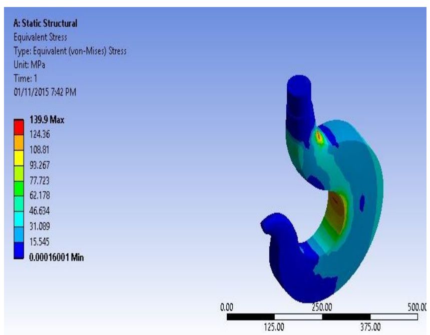
<tr><td>Equivalent stress</td><td>
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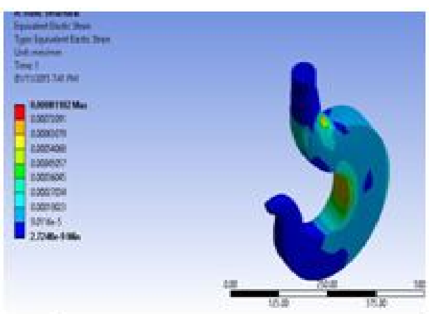
<tr><td>Equivalent strain</td><td></td></tr>
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V. RESULTS AND DISCUSSIONS

The ANSYS results are as follows
Trapezoidal section

Loads		Total deformation	Stress	strain
90 KN	Min	0. mm	2.0677e-004 MPa	2.4202e-009 mm/mm
	Max	0.43605 mm	135.1 MPa	7.0145e-004 mm/mm
110 KN	Min	0. mm	2.5272e-004 MPa	2.958e-009 mm/mm
	Max	0.53295 mm	165.12 MPa	8.5733e-004 mm/mm

Table 5.1

Rectangular section

Loads		Total deformation	Stress	strain
90 KN	Min	0. mm	1.3091e-004 MPa	2.2294e-009 mm/mm
	Max	0.29983 mm	114.46 MPa	6.6356e-004 mm/mm
110 KN	Min	0. mm	1.6001e-004 MPa	1.6001e-004 MPa
	Max	0.36645 mm	139.9 MPa	8.1102e-004 mm/mm

Table 5.2

VI. CONCLUSIONS

- The Rectangular section has more stress induced than other Trapezoidal section
- The trapezoidal sections are preferred over rectangular section to avoid the stress concentration on edges.
- 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.

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