Static Structural Analysis Of Crane Hook

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Abstract - 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. A hook is a tool consisting of a length of material that contains a portion that is curved or indented, so that this portion can be used to hold another object. In a number of uses, one end of the hook is pointed.

They are used to transfer the materials having heavy loads. Crane hooks are liable components subjected to failure due to stress in accumulation of heavy loads. Area of cross section, material and radius of crane hook are the design parameters for crane hook. Failure of a crane hook mainly depends on three major factors i.e. dimension, material, overload. The design of EOT crane hook has been carried out.

At present work To study the stress pattern of crane hook in its loaded condition, a solid model of crane hook is prepared with the help of ANSYS software. Real time pattern of stress concentration in 3D model of crane hook is obtained., the material of the crane is modified to increase its working life and reduce the failure rates. The chrome steel and Aluminum Alloy are used in this project for analyzing the hook. The complete study is an initiative to establish a FEA procedure, static linear analysis is carry out and dynamic analysis to find the modes and corresponding natural frequency and estimation of life cycle validating using Goodman diagram , for the measurement of stresses. For reducing the failures of hooks the estimation of stresses, their magnitudes and possible locations are very important. From the stress analysis.

***Key Words*: Crane hook, Static analysis, Winkler-Bach theory, ANSYS**

1.INTRODUCTION

A square besides handle might be a procedure regarding no fewer than two pulleys for a rope or acquaintanceship hung the middle of them, commonly used to lift alternately drive principal weights.

The pulleys compelling reason support assembled with packaging odds what's more a short timeframe later squares necessity help supported with those objective you stop putting forth on that one may be settled moreover you stop advertising on that particular case moves for the stack. Those rope is hung, alternately wind, through the pulleys ought further bolstering to furnish to mechanical immaculate position that enhances that to drive related for the rope.

Cranes are present day machines that are basically used for materials advancements being developed goals, era halls, mechanical generation frameworks, stockpiling regions, control stations and near spots. Their plan features change by and large according to their major operational judgments, for instance, sort of development of the crane structure, weight and kind of the store, territory of the crane, geometric features, working organizations and common conditions. A hook is an instrument involving a length of material that contains a bit that is twisted or indented, with the objective that this part can be used to hold another dissent. In different uses, one end of the hook is pointed, with the objective that this end can cut another material, which is then held by the twisted or indented segment. In the organizations crane hooks are one of the indispensable portions.

They are utilized to exchange the materials having substantial burdens. Crane hooks are at risk s

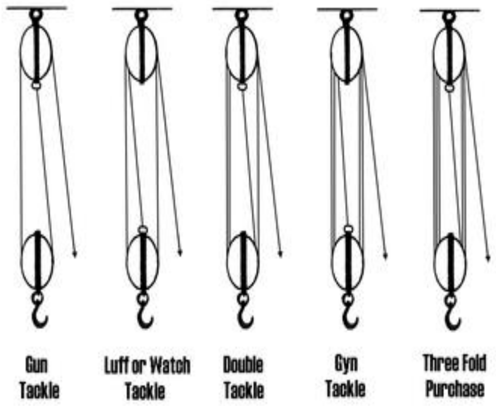


Figure 1: Various ways of rigging a tackle.

egments subjected to disappointment because of stress in amassing of substantial burdens. Zone of cross segment, material and range of crane hook are the plan parameters for crane hook.

A crane hook is expected to connect with chains and ropes joined to point loads like boxes, improvement bars, and mechanical assembly. The basic limit of it is to lift the load, to pass on it and to trade it beginning with one place then onto the following. Every so often a disaster may happen due to stress center think of it as so stress analysis is essential before make it significant. Nowadays, the blueprint and analysis both are done by software's with the help of

advanced planning. This article deals with the examination of crane hook involves distinctive cross fragments and furthermore the modification of standard hook in which the weight progression is done by changing cross section[1] and stress analysis is inspected in ANSYS.

Cranes are current machines that are essentially used for materials advancements being developed goals, creation passages, successive development frameworks, stockpiling zones, control stations and similar places. Their arrangement features vary comprehensively as shown by their major operational judgments, for instance, sort of development of the crane structure, weight and kind of the store, region of the crane, geometric features, working organizations and biological conditions.

A hook is a contraption including a length of material that contains a section that is twisted or indented, with the objective that this bit can be used to hold another question. In different uses, one end of the hook is pointed, with the objective that this end can infiltrate another material, which is then held by the twisted or indented segment. In the endeavors crane hooks are one of the fundamental parts. They are used to trade the materials having overpowering weights. Crane hooks are at hazard parts subjected to dissatisfaction due to stress in gathering of generous weights. Scope of cross territory, material and breadth of crane hook are the arrangement parameters for crane hook. Dissatisfaction of a crane hook basically depends on upon three essential issue i.e. estimation, material, over-weightunit tesla).

2.LITERATURE REVIEW

TENSION EXAMINATION REGARDING CRANE CATCH USING FEA. B Nagaraju 1, m RajaRoy1 , p Venkatesh Reddy1 think as of crane make may be amazingly fundamental package used to lifting the individuals load with the individuals support from claiming chain alternately wire ropes. Crane catches have support especially at peril territories In addition might continually subjected will bowing concentrates for which prompts those slip something like crane get. Will cutoff the individuals frustration starting with asserting crane catch, the uneasiness provoked previously, it must make pondered.

STRUCTURAL ANALYSIS OF CRANE HOOK Joseph Leo .A.1, ArutPranesh .K.2, Balasubramani .V.3 consider Crane catches are exceptionally committed parts that are conventionally used for mechanical purposes. Thusly such parts in an industry must be delivered and made in a way to deal with pass on most noteworthy execution without frustration. Disillusionment of a crane catch basically depends on upon three essential issue i.e. estimation , material, overload .The wander is stressed towards extending the ensured load by changing the cross sectional estimations of the three particular ranges. The picked fragments are rectangular,triangular, and trapezoidal.

DETERMINATION OF STRESS DISTRIBUTION IN CRANE HOOK BY CAUSTIC M. Shaban1, m. I. Mohamed2, An. E. Abuelezz3, t. Khalifa study's crane snares are greatly In peril portions what's more are continually subjected to dissatisfaction because of the measure of anxieties focus which might through the whole deal actuate its disappointment. Will imagine the strain body of evidence of crane snare previously, its stacked condition, a robust model of crane snare is set up with the help from claiming ABAQUS modifying. Relentless the event from claiming stress fixation previously, 3d model of crane snare may be acquired. The apprehension dispersal delineation may be checked to its rightness for an acrylic model for crane snare utilizing shadow optical methodology (Caustic method) set up.

DESIGN AND STRESS ANALYSIS OF VARIOUS CROSS SECTION OF HOOK G.E.V.Ratnakumar considers Crane catch is a reshaped shaft. Gets are used as a piece of overpowering relationship to pass on tones of loads safely. These gets have a fundamental part to play the degree that the security of crane stacked is concerned. With more industrialization the rate at which these gets are formed are building up .This wander is finished to think the tension variation in crane hooksfor assorted cross territories, for instance, round and square and for different radii of shape as well, probably and speculatively. Probably, the loads are gotten for different crane catches for 5mm extending on UTM (Universal Testing Machine).

STRESS ANALYSIS OF CRANE HOOK AND VALIDATION BY PHOTO ELASTICITY Rashmi Uddanwadiker recognizes crane snares are profoundly committed segments furthermore would continually subjected will disappointment due to gathering about broad measure about anxieties which might inescapably prompt its disappointment. Will focus the tension illustration for crane catch done its stacked condition, a strong model of crane catch may be set up with the aid about CMM and lowlife modifying. Continuous instance for stress center for 3d model from claiming crane catch will be obtained. That uneasiness allotment sample will be affirmed to its exactness looking into an acrylic model about crane catch using diffused light Polariscope set up. Toward foreseeing the tension obsession region, those state of the crane is transformed with manufacture it's attempting life and diminish the disappointment rates.

STRUCTURAL ANALYSIS OF CRANE HOOK Joseph Leo .A.1, examines Crane hooks are exceptionally liable segments that are normally utilized for modern purposes. In this way such parts in an industry must be produced and outlined in an approach to convey most extreme execution without disappointment. Failure of crane hook mainly depends on three major factors i.e. dimension , material , overload .The project is concerned towards increasing the safe load by varying the cross sectional dimensions of the three different sections .The selected sections are rectangular ,triangular, and trapezoidal

DESIGN AND ANALYSIS OF EOT CRANE HOOK FOR VARIOUS CROSS SECTION Sarvesh A. Mehendale1, Prof. Santosh. R. Wankhade2Crane hooks are one of the critical segments which are utilized to exchange materials having substantial loads, for the most part in ventures. Crane hooks are obligated parts subjected to disappointment because of worry in accumulation of overwhelming loads. Failure of a crane hook mainly depends on three major factors i.e. dimension, material, overload. The plan parameters for crane snare are range of cross area, material and radius of crane snare. In this venture the outline of EOT crane snare has been completed. The measurements of the snare have been resolved for a heap limit between 9 to 12.5 Tones for Trapezoidal, Rectangular and Circular cross-segments.

3.OBJECTIVES

- Estimation of linear stress, strain and deformation of a Crane hooks by linear static structural analysis.
- Estimation of bi-linear stress, strain, and deformation of Crane hooks by linear static structural analysis.
- Determination of average linear and bilinear stress of Crane hooks at different sections in order to evaluate whether the design is safe or not.

- Dynamic analysis to find the different modes and natural frequency Crane hooks.
- Evaluation of fatigue life of Crane hooks.
- Optimization of Crane hooks to increase the life and efficiency.

4.METHODOLOGY

A. DESIGN OF HOOK

The hook is to be designed having load carrying capacity of 125kN. Hook is made up of high tensile steel. Three different cross sections i.e. trapezoidal, rectangular and circular are considered. By keeping area same for all cross sections as a design criteria, direct stress, bending stress, shear stress are found.

B. CALCULATION FOR TRAPEZOIDAL CROSS SECTION

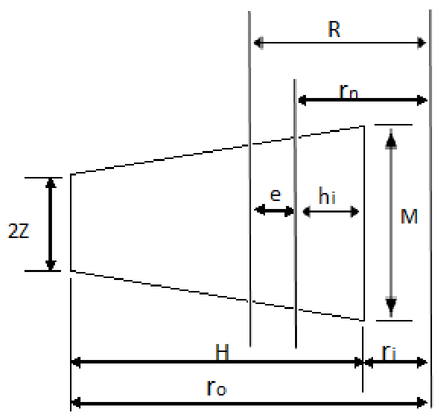


Figure 2: Standard Trapezoidal Hook

Eye diameter of hook, C=131mm and Dimensions corresponding to C are G=70mm, G1=M68.

Distance of neutral axis from axis of curvature(PSG 6.3)(I)= 107.98 mm

A. Distance of CG from axis of curvature.(PSG6.3)

R = , R = 117.71mm (II)

Cross section area,

, a = 6703.08 mm2 (III)

Total stress induced at A-A

For innermost layer: - Total stress, +

Where,

Direct stress = 18.648N/mm

Bending stress = 146.312 N/mm

Hence = 164.96 N/mm2,

taking FOS=3.= 494.88 N/mm

Selecting material 40cr1 (PSG 1.13)

Yield stress = 600 N/mm (PSG 1.13)

Hence,

design stress = FOS = 200

N/mm2 (VI)[ ] = / 2.

FOS = 100 N/mm2

C. CALCULATION FOR RECTANGULARC/S

For same cross section by keeping area is same and assuming h/b = 1.5

Cross section area, a = 6703.08 = b * h = b * (1.5b) = 1.5 b2

Hence,

b = 67mm and h = 101mm (VIII)

ro = ri + h = C/2 + h = 65.5+ 101= 166.5mm

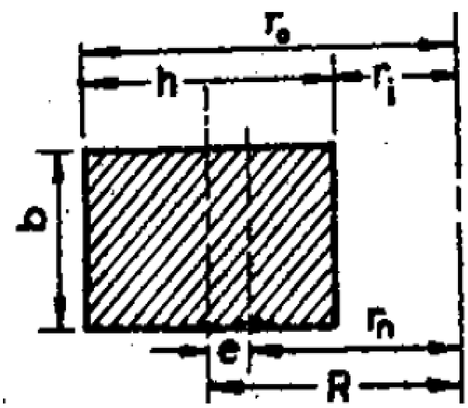


Figure 3: Standard Rectangular Hook

A) Distance of neutral axis from axis of curvature (PSG 6.3)

r= h / ln (ro / ri) = 108.25mm

B) Distance of CG from axis of curvature

R = ri + h/2 = 116mm

D. CALCULATION OF CIRCULAR C/S

Cross section area, a = 6703.08 = π/4 * d2hence, d = 93mm

ro = ri + d = 65.5 + 93 = 158.5mm

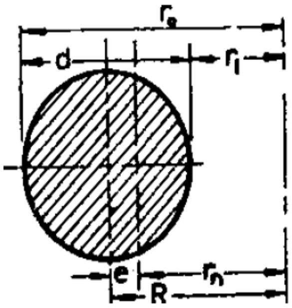


Figure 4: Standard Circular Hook

A) Distance of neutral axis from axis ofcurvature

R = [√ ro + √ ri] 2 / 4 = 106.95mm

B) Distance of CG from axis of curvature

R = ri + d/2 = 112mm (XIV)

Material	Chrome steel(X28CrMoNiV49)
Density at room temperature, ρ	7.7×10^{-9} kg/mm^3
Modulus of elasticity, E	2.1×10^5 Mpa
Yield Strength, σ_y	585 Mpa
Tangent Modulus, E_T	5500 Mpa
Operating Speed	6920 rpm = 724.75 rad/sec
Poisson's Ratio, µ	0.3
Factor of Safety, FOS	1.68

Table 1: Material Properties

5.RESULT & DISCUSSION

5.1 GENERAL MODEL

Figure 5: front model view of crane hook

Meshing of Model

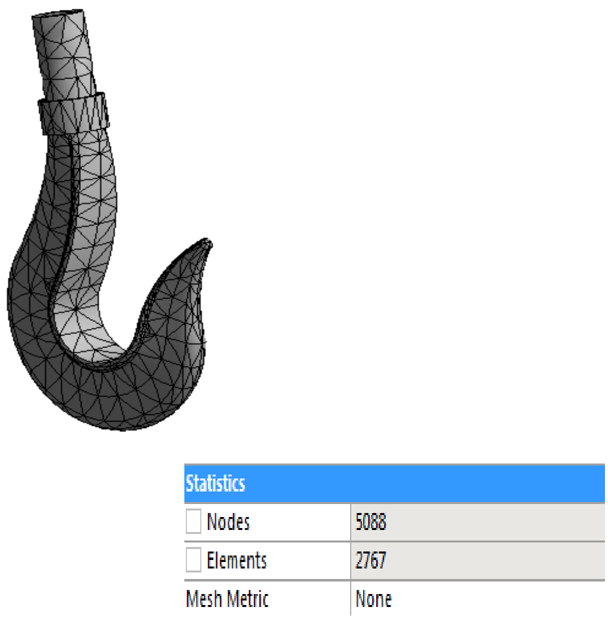


Figure 6: Isometric Meshed model of crane hook

Boundary conditions

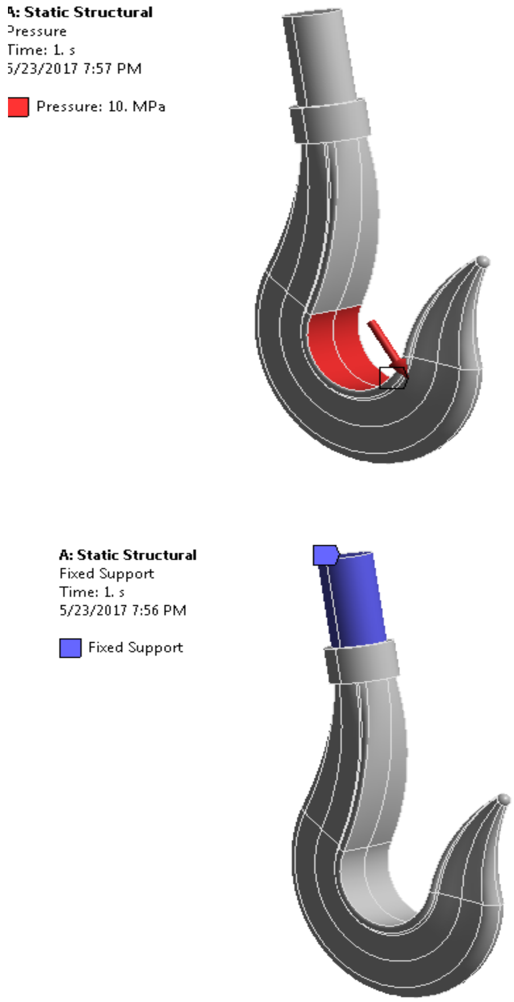
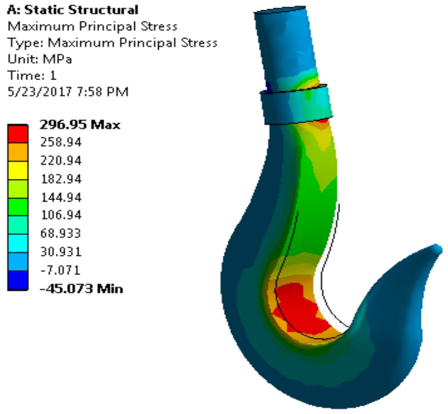
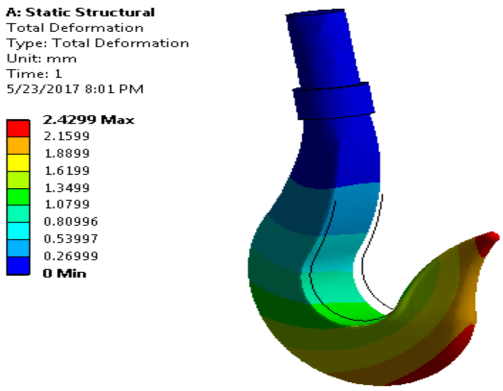


Figure 7: Applying Boundary Conditions

Principle Stress





igure 9: Maximum principal stress in crane hook is 296.95 mpa & Minimum principal stress in crane hook is 45.073 mpa

Maximum Equivalent Stress

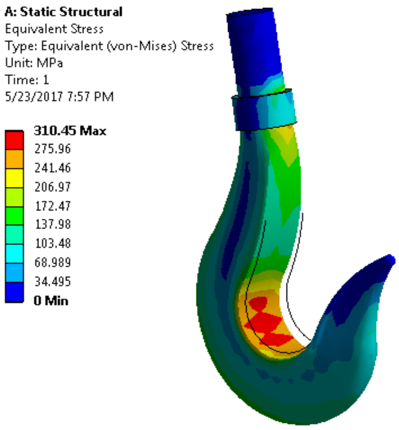


Figure 8: max equivalent stress in crane hook is 310.45 mpa

Total Deformation

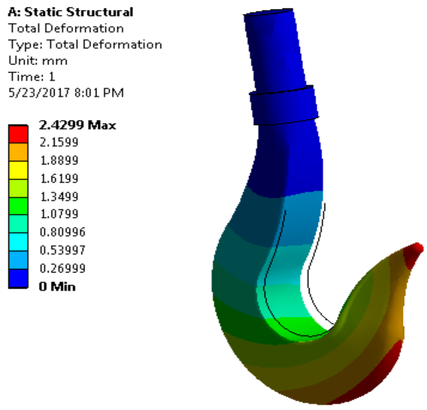


Figure 10: total deformation in crane hook is 2.4 mm

5.2 ALUMINUM ALLOY

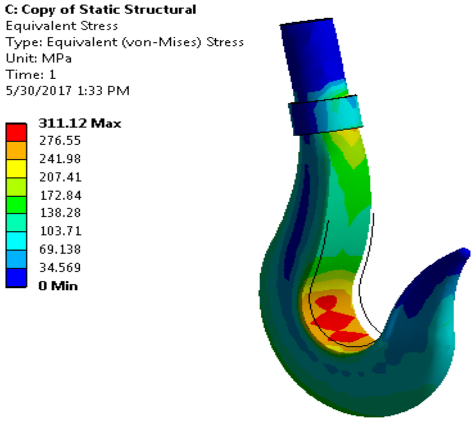


Figure 11: max equivalent stress in crane hook is 311.12 mpa

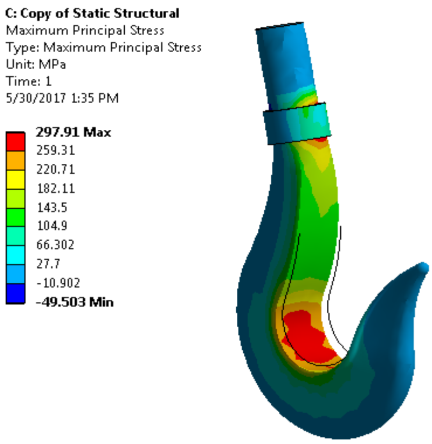
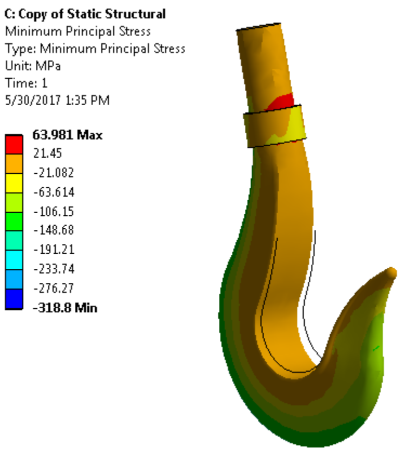


Figure 12: Maximum principal stress in crane hook is 297.95 mpa



Fig, 13: Minimum principal stress in crane hook is 63.95 mpa

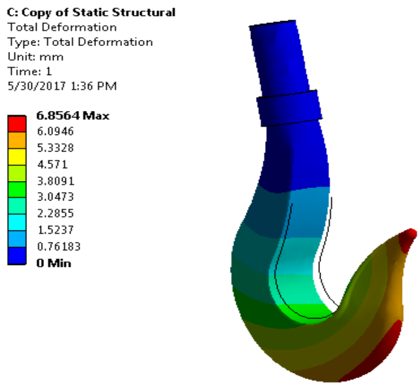


Figure 14: Total Deformation

Sl.no	Equivalent stress	Maximum principal stress	Minimum principal stress	Weight
Chrome steel	310 mpa	296 mpa	62 mpa	18.614 kg
Aluminum	311mpa	297mpa	63 mpa	6.5682 kg

Table 2: Material Comparison

YNAMIC ANALYSIS

Tabular Data

	Mode	Frequency [Hz]
1	1.	0.
2	2.	0.
3	3.	3.4608e-004
4	4.	5.3933e-004
5	5.	5.7826e-004
6	6.	8.2783e-004
7	7.	849.48
8	8.	906.15
9	9.	1249.3
10	10.	1643.9

Table 15: Dynamic Analysis

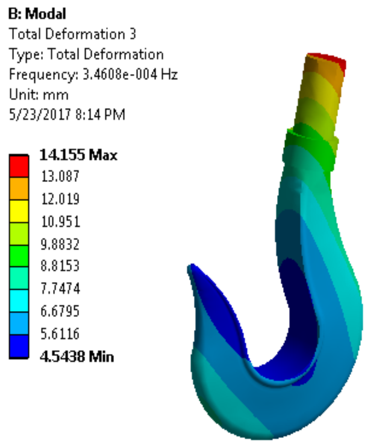


Figure 16: 3rd mode in hook corresponding frequency is 3.46Hz

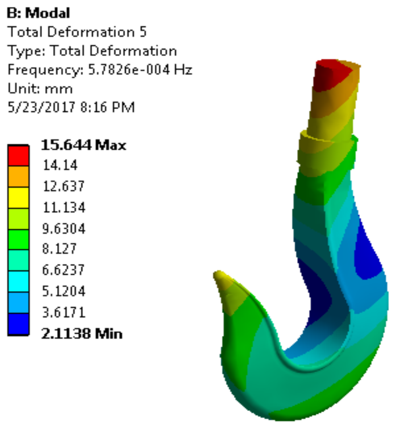


Figure 17: 5th mode in hook corresponding frequency is 5.78Hz

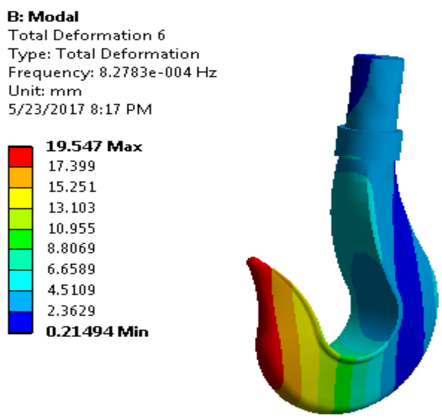


Figure 18: 6th mode in hook corresponding frequency is 8.278Hz

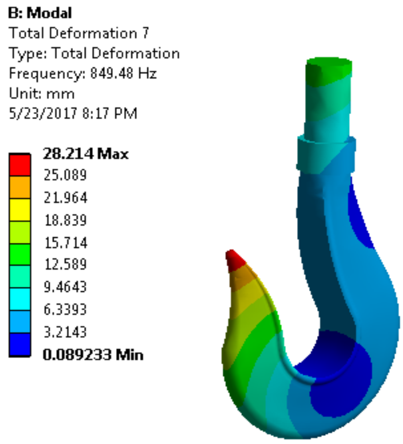


Figure 19: 7th mode in hook corresponding frequency is 849.48Hz

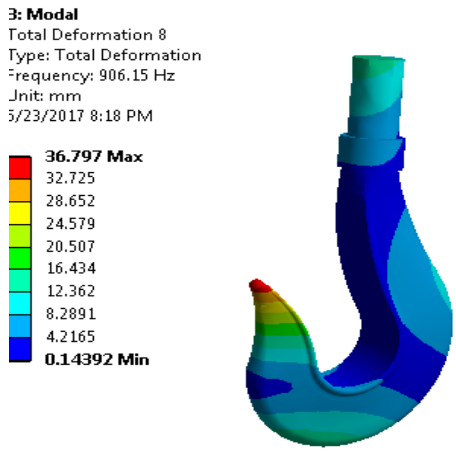


Figure 20: 8th mode in hook corresponding frequency is 906.15H

5.3 FATIGUE LIFE OF CRANE HOOKS

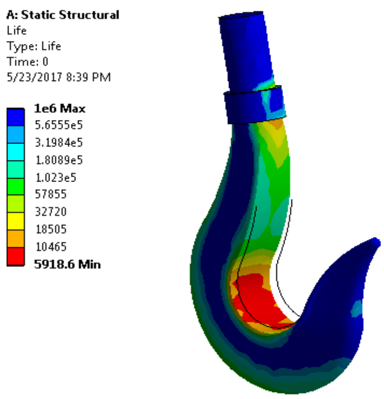


Figure 21: Estimated Life cycle of crane hook is 1000000 cycle

GOODMAN DIAGRAM

Mean Stress can be calculated from,

= 330.5mpa

Where

σ_{von} = Equivalent von-Misses Stress

=140.965 mpa

Where

σ_1= Maximum Principal Stress

σ_2= Minimum Principal Stress

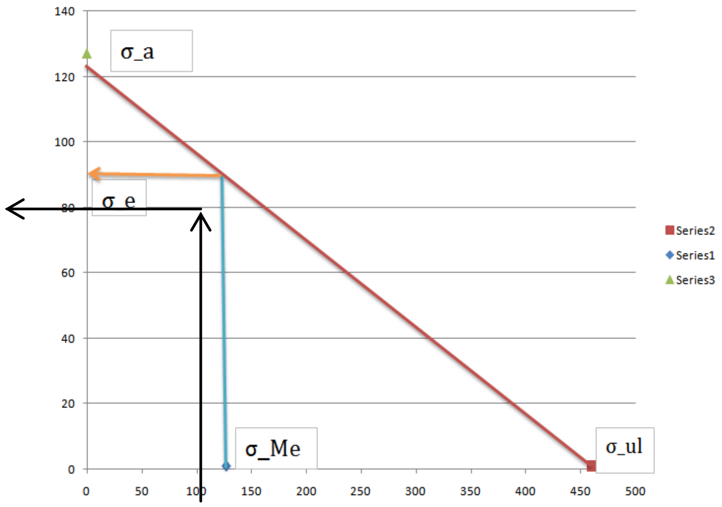


Figure 22: Goodman Diagram

Number of cycles:

$$N_f = \left\{ \frac{[\sigma_{ult} - \sigma_{ult}(\frac{1}{fos} - \frac{\sigma_a}{\sigma_e})]}{\sigma_a} \right\}^{\frac{1}{0.08}}$$

Where,

N_f =Fatigue life

σ_{ult}=Ultimate stress

fos=Factor of Safety

σ_e=Endurance limit

b = Fatigue strength exponent

σ_a=Alternating stress

$$N_f = \left\{ \frac{580 - 580(\frac{1}{1.4} - \frac{122}{79})]}{122} \right\}^{\frac{1}{0.08}}$$

$N_f = 1.01 \times 10^6$

Life Estimation using FEM Approah is 1000000cycles which is Validated through analytical method (goodman diagram) which is 1000000.

6.CONCLUSION

1. Linear static structural analysis has been carried out to estimate the maximum stress, strain and deformation at blade, disc and fillet regions. It is found that peak stress of 310.45 Mpa, total deformation of 2.423 mm is obtained along the hook.
2. find the initial modes and corresponding natural frequency of Crane hooks.
3. Fatigue analysis of crane hook was carried out for 1000000 cycles of startup and shutdown, the fatigue life results obtained is more than 100000 cycles, hence the design is safe.
4. Weight of 12.1 kg is reduce in crane hook which is Optimization of Crane hooks to increase the life and efficiency.

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