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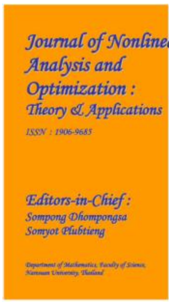

DESIGN AND STRENGTH IMPROVEMENT OF THE HOOK WITH LOADING CAPACITY OF 63000KG IN AN OPEN WINCH DRUM MODEL BY OPTIMIZING THE MATERIALS AND THE PROFILES

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ABSTRACT:
Material-handling equipment is equipment that relate to the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal. This equipment is the mechanical equipment involved in the complete system. Material handling equipment is generally separated into four main categories: storage and handling equipment, engineered systems, industrial trucks, and bulk material handling.

So here in this paper i designed a hook which is used at bulk material handling systems and can weight a maximum of 63000 kg in an open winch drum using CATIA software, and the optimization is done on the model to obtain the better improvement and performance even by changing the materials used for the hook. Here the analysis is conducted on the product by using static, vibrational and harmonic analysis to verify the strength of the product and sustainability of the materials used for the product using ANSYS software.

Keywords:
Material Handling, Winch Drum, Crane Hook.

I. INTRODUCTION

A Crane hooks are components which are always subjected to failure due to accumulation of large amount of stresses which can eventually lead to its failure. Crane hooks are generally used to lift the heavy load in industries and constructional sites. A crane is a machine, equipped with a hoist, wire ropes or chains and sheaves used to lift and move heavy material. Cranes are mostly employed in transport, construction and manufacturing industry. Overhead crane, mobile crane, tower crane, telescopic crane, gantry crane, deck crane, loader crane, jib crane, are some of the commonly used cranes.

A crane hook is a device used for lifting and grabbing up the loads by means of a crane. It is basically a hoisting fixture designed to engage a link of a lifting chain or the pin of a cable socket. Crane hooks with circular, trapezoidal, rectangular and triangular cross section are commonly used. So, crane hook must be designed and manufactured to deliver maximum performance without failure. The crane hooks are vital components and are most of the time subjected to failure due to accumulation of large amount of stresses, which are ultimately leading to failure. Fatigue of the crane hook is happening due to continuous loading and unloading of crane. If the crack is detected in the crane hook, it can cause fracture of the hook. Due to this there are chances of serious accident. Bending stress, tensile stress, weakening of the hook due to wear, plastic deformation due to overloading, excessive thermal stresses are some of the other reasons of failure.

II. LITEREATURE REVIEW

The section here shows the review of previous journals based on study and analysis of crane hook M.Amareswari Reddy *et.al* studied the load carrying capacity of crane hook by varying the cross sections. The selected sections were I-section and T-section. She kept area constant while changing the dimensions of two different sections. The crane hook is modelled using SOLIDWORKS software. She did stress analysis by using ANSYS 14.0 workbench. She found that T cross section yields minimum stresses at the given load of 6 tons for constant cross section area among two cross sections. For validation of stress distribution pattern for its correctness o he used Winkler-Bach theory for curved beams. The theoretical stresses calculated based on Winkler Batch theory and the corresponding crane hook model stresses determined by using ANSYS were tabulated and found that the deviations are at minimum of 5%. The FOS for crane hook in static analysis is to base on yield stress value. The theoretical stresses result and ANSYS results are compared and deviation is at minimum 5%. For 6 Ton loading the stresses induced in I-section and T section of Structural Steel, carbon steel, grey cast iron and Nickel Alloy (Wrought N06230) are below the allowable stresses. The stresses induced in the T section are little less than the other sections for same area of I-cross section and loading. It determines that T section of Nickel Alloy compromises good results for optimization of the crane hook design.

III. PROBLEM STATEMENT

As i verify the no of ports in India are a huge base for transportation of export. As in every port the material handling is very common thing which will be in use. As per the previous records, for the material handling unit there is a hook which lifts the materials and board to the required place in transportation. As here the size and weight of the shipment differs based on the shipment in the port. To bear the load capacity and to sustain the load capacity the crane hook is very important tool. When the hook in in continuously use in the port, the stress induced on the hook are very high and in the continuously load the deformation i.e. elasticity is being increased as increase in the load. So to improve the load capacity conditions here the profiles and materials are being optimized.

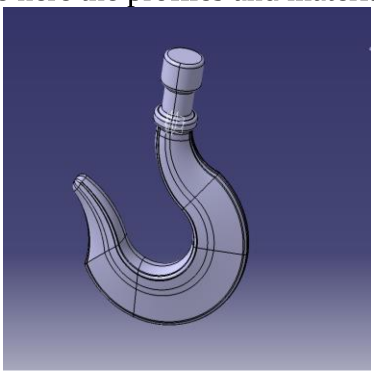

Fig 3.1 Original Model

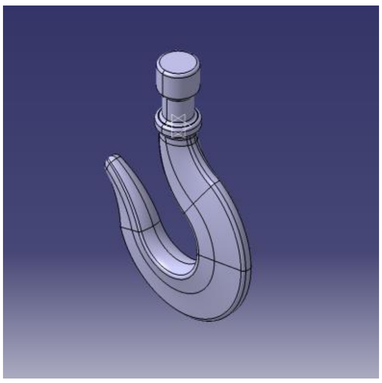

Fig 3.2 Modified 1 –Model

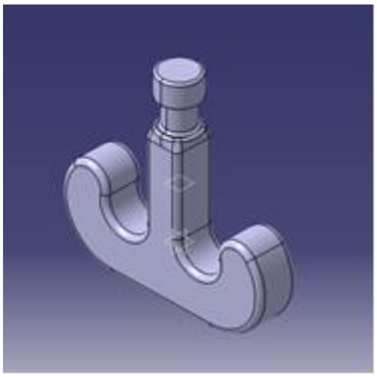

Fig 3.3 Modified Model of "W" Type Crane Hook

IV. ANALYSIS OF ORIGINAL MODEL USING AISI G60 MATERIAL

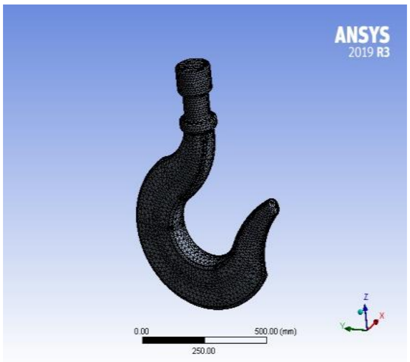

Fig 4.1 Original Model Analysis

The above figure represents the meshed file, as this is the next step to the geometry file. Here mesh is created as to create nodes and elements. As to find out the best output approximately this is required to do as possible as to smaller nodes. As in meshing a set of nodes are called as element. Here in meshing there are different types of meshing ways, such as tetra mesh, quadrilateral mesh, prism mesh, triangular mesh and hexa mesh. Here in this project i have used triangular mesh with fine mesh model.

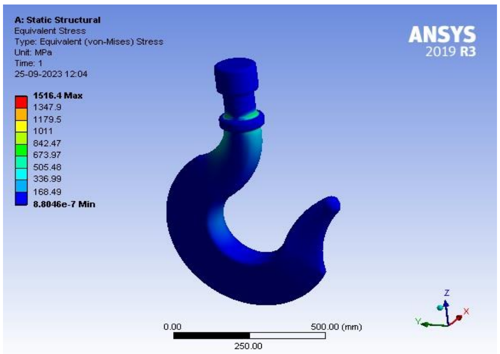

Fig4.2 Stress

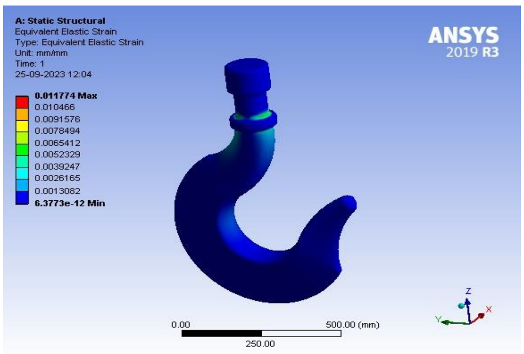

Fig4.3 Strain

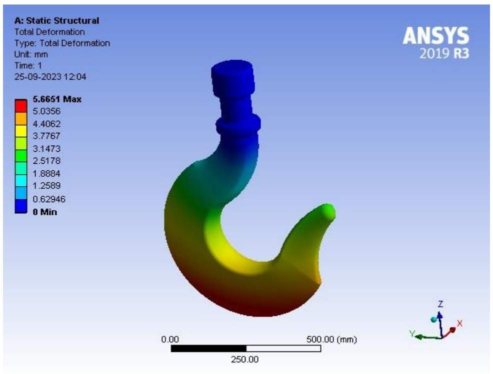

Fig 4.4 Total Deformation

V. VIBRATIONAL RESULTS

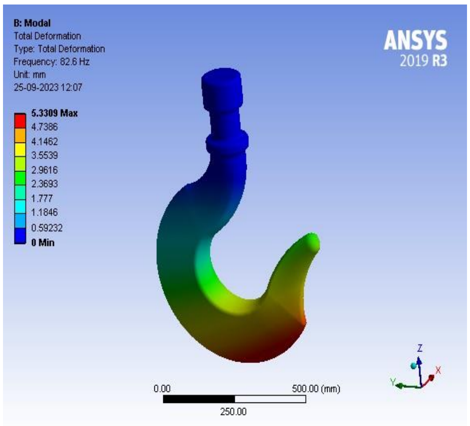

Fig 5.1 Deformation 1

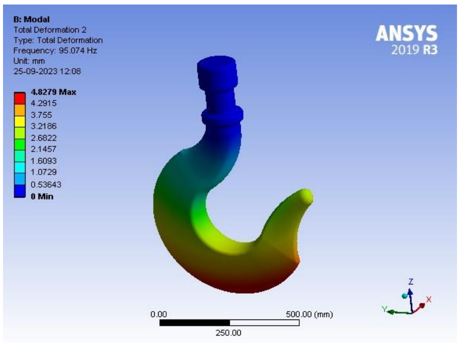

Fig 5.2 Deformation 2

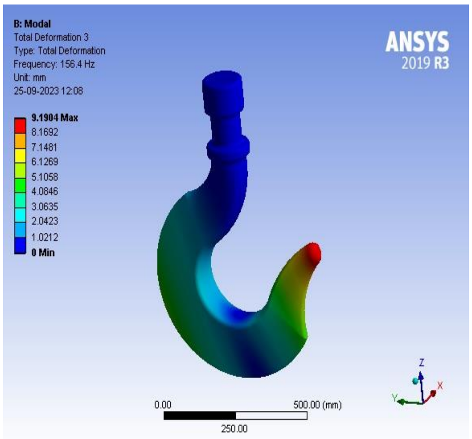

Fig 5.3 Deformation 3

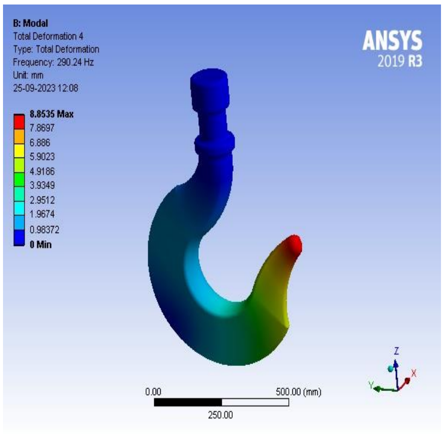

Fig 5.4 Deformation 4

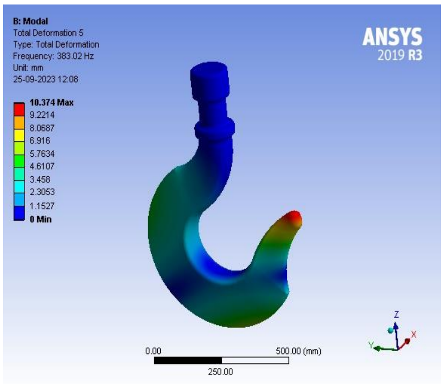

Fig 5.5 Deformation 5

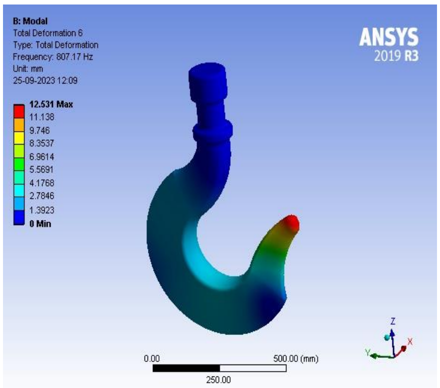

Fig 5.6 Deformation 6

VI. HARMONIC RESULTS

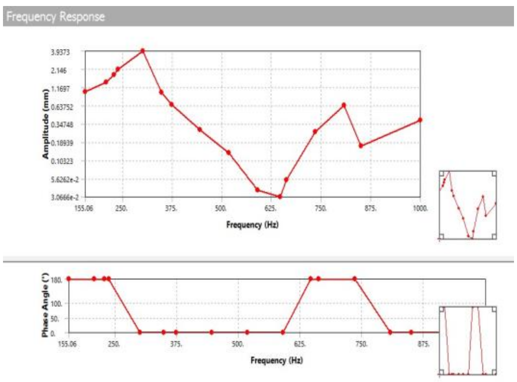

Fig 6.1 Frequency Response

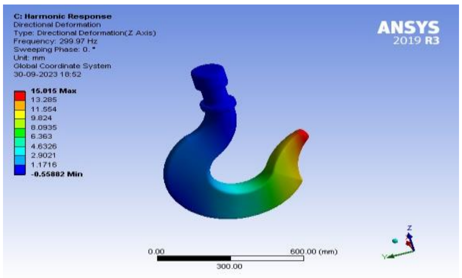

Fig 6.2 Harmonic Deformation

STRUCTURAL ANALYSIS OF A CRANE HOOK BY USING INCONEL 718 MATERIAL

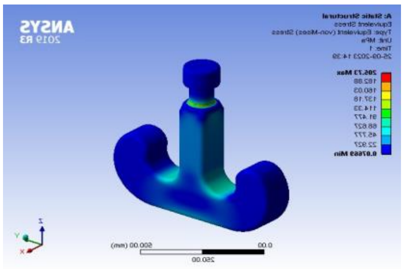

Fig 6.3 Stress

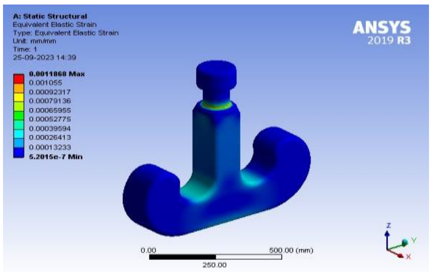

Fig 6.4 Strain

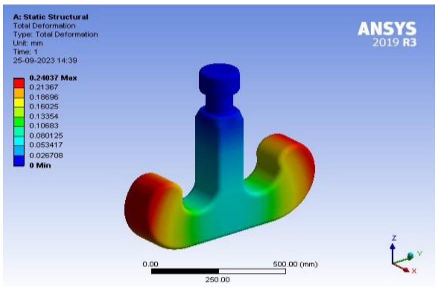

Fig 6.5 Deformation

HARMONIC RESULTS

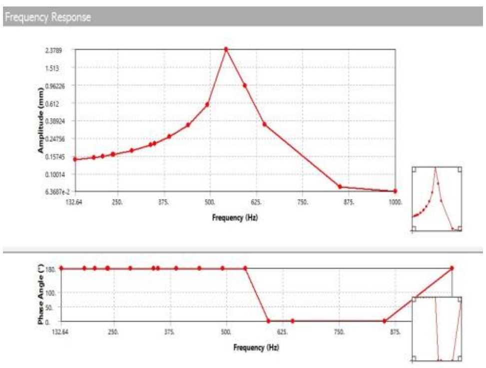

Fig 6.6 Frequency Response

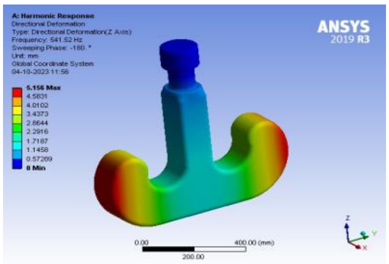

Fig 6.7 Harmonic Deformation

GRAPHS

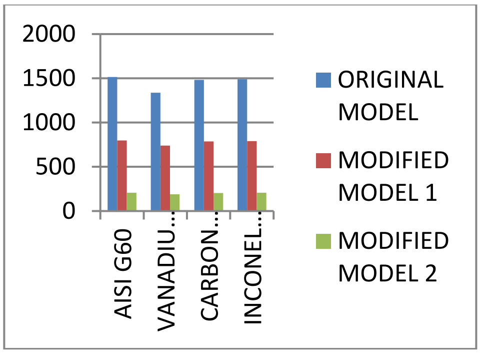

Fig 7.1 Stress Graph

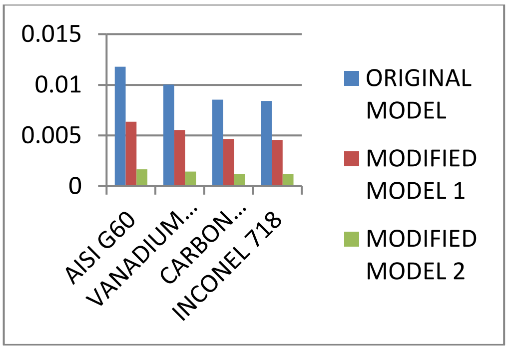

Fig 7.2 Strain Graph

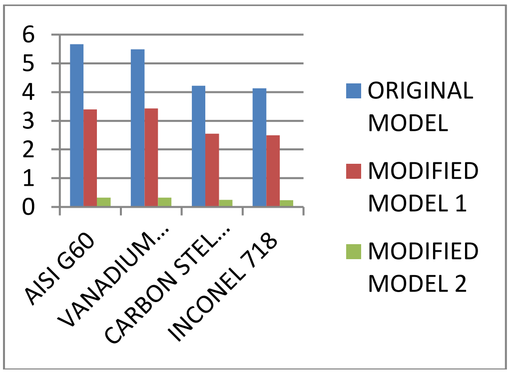

Fig 7.3 Total Deformation Graph

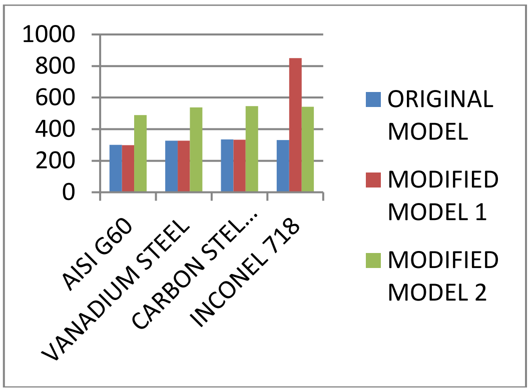

Fig 7.4 Harmonic Analysis Frequency Graph

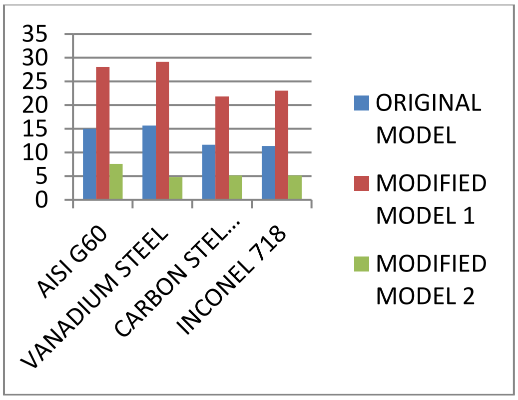

Fig 7.5 Harmonic Analysis Deformation Graph

VII. RESULTS AND DISCUSSIONS

TABLE

MODEL	MATERIAL	STRESS (MPa)	STRAIN	TOTAL DEFORMATION (mm)	DIRECTIONAL DEFORMATION (mm)
Original Model	AISI G 60	1516.4	0.011774	5.6651	0.027476
	Vanadium steel alloy	1338	0.010011	5.487	0.036214
	Carbon steels 1018	1480.5	0.0085519	4.222	0.022034
	Inconel alloy 718	1489.4	0.0084101	4.1255	0.021163
Modified Model 1	AISI G 60	798.74	0.006368	3.3969	0.025269
	Vanadium steel alloy	739.34	0.005556	3.4288	0.035312
	Carbon steels 1018	787.67	0.0046459	2.5532	0.020756
	Inconel alloy 718	790.46	0.0045637	2.4897	0.019827
Modified Model 2	AISI G 60	208.42	0.001653	0.32913	0.0070389
	Vanadium steel alloy	189	0.0014458	0.32527	0.010182
	Carbon steels 1018	204.82	0.0012088	0.24623	0.0058225
	Inconel alloy 718	205.73	0.0011868	0.24037	0.0055524

VIBRATIONAL RESULTS

MODEL	MATERIAL	TD 1	TD 2	TD 3	TD 4	TD 5	TD 6
Original Model	AISI G 60	5.3309	4.8279	9.1904	8.8535	10.374	12.531
	Vanadium steel alloy	5.8686	5.287	9.9397	9.6844	11.351	13.68
	Carbon steels 1018	5.1584	4.6674	8.8677	8.5564	10.025	12.106
	Inconel alloy 718	5.0548	4.575	8.6986	8.387	9.826	11.868
Modified Model 1	AISI G 60	5.4219	4.9047	9.5039	9.2955	10.521	11.674
	Vanadium steel alloy	5.9727	5.3717	10.264	10.167	11.505	12.744
	Carbon steels 1018	5.2498	4.7418	9.1615	8.983	10.171	11.278
	Inconel alloy 718	5.1444	4.6478	8.9872	8.8054	9.9707	11.057
Modified Model 2	AISI G 60	2.8146	2.8842	3.7044	3.6994	5.3505	3.8145
	Vanadium steel alloy	3.0819	3.1552	4.0478	4.0427	5.583	4.1852
	Carbon steels 1018	2.7207	2.7875	3.5795	3.5747	5.1716	3.6888
	Inconel alloy 718	2.6668	2.7324	3.509	3.5043	5.0694	3.6154

HARMONIC RESULTS

MODEL	MATERIAL	MAX AMPLITUDE (mm)	FREQUENCY (Hz)	DIRECTIONAL DEFORMATION (mm)
Original Model	AISI G 60	3.9373	299.97	15.015
	Vanadium steel alloy	4.1081	326.95	15.671
	Carbon steels 1018	3.0527	334	11.632
	Inconel alloy 718	2.9754	331.51	11.337
Modified Model 1	AISI G 60	5.2118	299.46	28.021
	Vanadium steel alloy	5.3963	326.4	29.097
	Carbon steels 1018	4.0568	333.34	21.804
	Inconel alloy 718	6.8219	850.31	23.053
Modified Model 2	AISI G 60	3.5009	488.52	7.563
	Vanadium steel alloy	2.1604	537.22	4.7892
	Carbon steels 1018	2.3784	545.8	5.1608
	Inconel alloy 718	2.3789	541.52	5.156

VIII. CONCLUSION

Here in this project i have designed 3 different model of cranes. So here i have considered 4 different materials such as AISI G 60, vanadium steel, carbon steels 1018 and Inconel 718. All the obtained results are tabulated in the tabular and the graphical format for the better comparison. As if i verify the obtained results here the model 2 using vanadium steel and Inconel 718 materials has obtained the better outputs in terms of stress and deformations.

As if i verify the vibrational results, here i have considered 6 modes of deformations and here the modified model using Inconel and carbon steels 1018 has obtained the lesser deformation values when compared with other materials and models. So finally as if i verify the harmonic analysis results here the Inconel 718 and vanadium steel has obtained the better results when compared with the other materials.

So while observing all the results here the Inconel 718 material using modified model 2 has obtained the better outputs when compared with the other materials and models.

REFERENCES

1. M.Amareswari Reddy1, M.N.V Krishnaveni2, B.Nagaraju3, M RajaRoy4 “Static Analysis of Crane Hook with I- Section and T- Section using Ansys”, IJETT – 2015
2. Ms. Mamta .R. Zade “Finite Element Analysis and Fatigue Analysis of Crane Hook with Different Materials”, IRJET 2017
3. I Vivek Mahadev Thakur, II Vaibhav Pawar, III Dr. M.D. Nadar, III Sanjay Ghorpade, IIISahil Patil, Study and Analysis of Crane Hook in Loading Area IJARET 2016
4. RashmiUddianwadikar, "Stress Analysis of Crane Hook and Validation by Photo Elasticity", Scientific Research, 2011
5. Takuma Nishimura, Takao Muromaki, Kazuyuki Hanahara "Damage factor Estimation of Crane Hook (A database approach with Image, Knowledge and simulation. " Research publishing services" .2010
6. Govind Naryan Sahu, Narendra Yadav "Design and stress analysis of various cross section of hook" International Journal of modern engineering research.2013
7. Bhupender Singh, Bhaskar Nagar, B.S. Kadam and Anuj kumar, "Modelling and Finite Element Analysis of Crane Boom", International Journal of Advanced Engineering Research and Studies.2011
8. Ram Krishna Rathore, AmitSarda, RiturajChandrakar "An Approach to optimize ANN Meta model with Multi Objective Genetic Algorithm for multi-disciplinary shape optimization". International Journal of Soft Computing and Engineering (IJSCE) 2012
9. Y. Torres, J.M. Gallardo, J. Dominguez, F.J. Jimenez E, "Brittle fracture of a crane hook”, J-GATE Engineering journals, 2008
10. Apichit Manee-ngam*, Penyarat Saisirirat, Patpimol Suwankan “Hook Design Loading by The Optimization Method With Weighted Factors Rating Method ”International Conference on Alternative Energy in Developing Countries and Emerging Economies ELSEVIER 2017
11. Patel Ravin B, Patel Bhakti K., Patel Priyesh M, Patel Dixit H, Patel hirak s. Design And Analysis Of Crane Hook With Different Material IJACT
12. Mahesh Solanki1 Antriksh Bhatt2 Anilkumar Rathour3 Design, Analysis and Weight Optimization of Crane Hook: A Review IJSRD 2014
13. Chetan N. benkar, Dr. N. A. Wankhade (2014):- Finite element stress analysis of crane hook with different cross- section.
14. M. Shaban, M. I. Mohamed, A. E. Abuelezz, T Khalifa (2013):- Determination of stress distribution in crane hook by caustic.
15. Govind narayansahu, narendra yadav (2013) design and stress analysis of various cross section of hook.
16. Ajeetbergaley, Anshumanpurohit (2013):- Structural analysis of crane hook using finite element method.
17. E. Narayndas, N. Puodziuniene (2012) circumferential stress concentration factor t the symmetric shallow notches of lifting hook of trapezoidal cross section.
18. Rashmi uddanwadiker (2011):- Stress analysis of crane hook and validation by photo elasticity. Takuma nishimura, Taka muromaki, Kazu-yuki Hanahara, Yukio Tada, Shigeyuki Ku-roda and tadahisafukui (2010):-Damage factor estimation of crane hook.