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Design and Analysis of CNC Lathe Bed Using FEM

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ABSTRACT

An engineer can be interested in a design that is not only functional but also the best design in some sense. The term "optimization" refers to the process of identifying the optimal design. In this research, dynamic loads and static structural are performed on the lathe floor under extreme load conditions. These analysis conclusion are used to decrease the mass of the lathe bed without reducing physical strength and capacitance by providing ribs and eliminating mass with less stress and deformation. In this research, the prototype model of the lathe bed and the enhanced outline has been completed by using SOLIDWORKS the analysis will be done using ANSYS and Design Optimization methods will be done by Ansys workbench 16.2. The results were presented through the help of charts to break down the influence of mass loss on the auxiliary uprightness of the machine bed before and after the mass loss, and results were reached about the improved plan.

Keywords: - Lathe bed, shape optimization, weight reduction, Ansys, Solid work
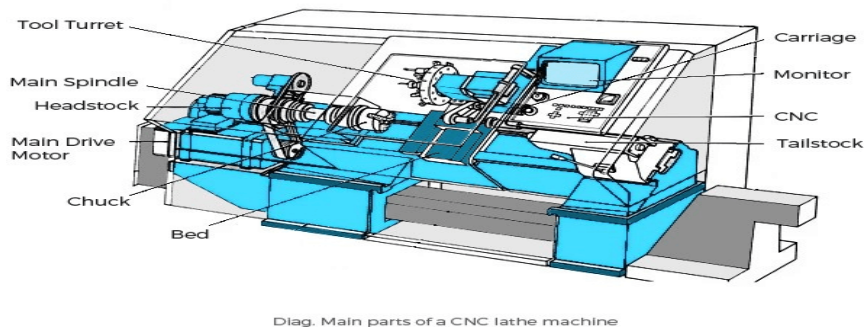
Fig No 1 CNC Lathe

INTRODUCTION

A lathe machine is general purpose tool. In which Unwanted material remove using lathe machine tool from a rotating object in the modes of chips by using a single point cutting tool. Tools can be introduced deep into the task and explored through it. It is one of the most multipurpose machine tools used in the world.

LITERATURE REVIEW

[1] Bhupesh Goyal et.al.:- In this article, MGX200 CNC lathe pad selected for the whole static and vibration investigation. The test effort finished to scale back the solidity of pad without spoil its easy inflexibility and therefore the exactness of the device through body process material. In this exertion, 3-d CAD version performed through the usage of Autodesk creator skilled 2018 computer code and analysis performed in ANSYS sixteen.2 Software. the results looked with the aid of qualities spoil down the influence of mass lower at the easy trustiness of the device pad whereas the burden lower then picks or so the improved structure.

[2] B.Maleswara Swami et.al.:- The 3D model for this study was created using CATIA software. The program HYPERMESH was used for the analysis. Here materials square measure used forged iron grade G15, forged iron grade G40 in addition forged iron grade G70. From the on top of material, grade G15 is chosen because the finest material for the reason that of its low stress and top most natural frequency.

[3] Hongwei Shan et.al.:- The dynamic and process design approach of ansys-based cnc lathe bed structure is the focus of this article. The design method of this document is straightforward and economical, dynamic style is applied to totally different structures.

[4] Kunal Gajjar et.al.:- The precision of a machine tool's operations is mostly influenced by its structure. The current work in this study focuses on reducing the weight of a CNC Lathe saddle. The usage of Intel Determinant of performance during the project optimization procedure aided in essential the material pattern for the CNC Lathe saddle's light weight and reinforced construction. When compared to the usual design approach, this method saves time.

[5] Hongping Yang et.al.:- The lathe quality has a direct influence on the machining accuracy. The static and dynamic structures of the CK61125 CNC lathe were initially modeled by finite element analysis. According to the info, the supreme pressure is 100.98MPa, the main strain stands 0.615m/mm, and

also the largest strain stands 0.1455mm. Second, exploitation finite component analysis, the strategy is explored, it's exposed that the first-order resonant rate of recurrence is 271.63 Hz, the second-order resonant rate of recurrence is 290.41 Hz, and also the resonant rate of recurrence is 290.41 Hz. isometric is 305.88 Hz. Using FEM, stress and strain parameters, and modal frequency, the stress, strain, deformation, and modal for the CK61125 CNC shaping machine bed elements are studied. It will give the machine tool with powerful theoretical parameters as well as modelling analytic approaches.

Problem Statement And Specification

Problem Definition:-Mustang cnc involvement for higher gross mass of cnc lathe prototype MGX 200 this is made because of bulky bed weight. The company is desire to optimize CNC MGX 200 prototype base. Present mass of bed is 1135.6 KG. Situation is to decrease mass without changing vibrational stability and stiffness of present design.

METHODOLOGY

1) Solid model of Lathe bed with the use of Solidworks. [CAD software]
2) CAD model use into ANSYS software.
3) Conveying material properties.
4) Conveying boundary condition.
5) Applying force and support to the FEA model.
6) Simulating structure study for Outcome deformation and stress magnitude.
7) Simulating model study for outcome natural frequency limits.
8) Recognizing minimum stress and deformation region and by providing ribs reducing material through these region.
9) Later these deviations, again work on study on improved model.
10) Judgement of FEA results of initial and improved models.
11) Results are equated and proceed to conclusion.
12) Project preparation.

Technical Data of CNC Turning MGX200

SPECIFICATION	CAPACITY
Max. Turning Dia	200mm
Max. Turning length	170mm
Swing Over bed	380mm
STD. Turning Dia.	200mm
SPINDLE DRIVE	
Spindle Motor Power	7.5HP
Speed Range	3000
AXES SLIDES	
X Axis Strokes	350mm
Z Axis Strokes	200mm
Rapid Traverse: X Axis	24M/Min
Rapid Traverse: Y Axis	24M/Min
MAIN SPINDLE	
Spindle Nose	A2-6
Bore Through Spindle	55mm
Bar Capacity	42mm
Chuck size	200mm
ACCURACY	
Position Accuracy	0.015mm
Repeatability	±0.003mm

Autocad 2D Drawing of CNC MGX 200

SECTION A-A
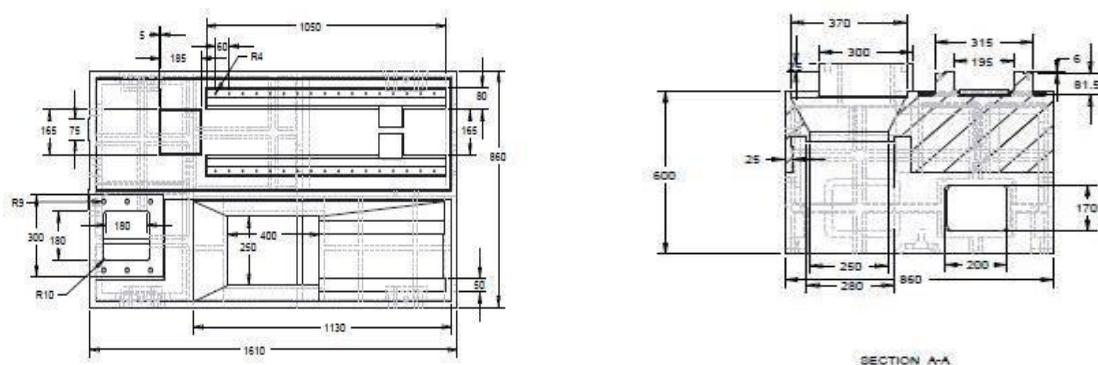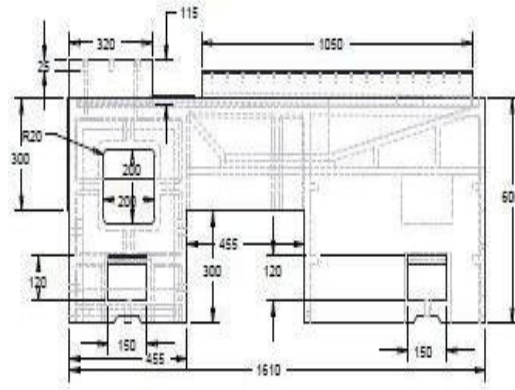
Material properties:-

Sr. No.	Model	Material	Yield (Mpa)	Allowable Stress With	Density (Kg/m³)
1	Lathe Bed	Gray Cast iron	172	~143	7200
2	Optimized Lathe Bed	Gray Cast iron GRADE 40	200	~167	7141.4

OBJECTIVES

In this project, the static structural and dynamic loading will be carried out on lathe bed at maximum load conditions. These simulation results will be used to reduce the weight of the lathe bed without deteriorating its structural strength and damping capacity by adding ribs and removing mass where less deformation and stresses are induced. In this work, the 3D CAD display of the standard and the advanced outline has been made by using SOLIDWORKS the investigations will be done utilizing ANSYS and Shape Optimization techniques will be done using ANSYS workbench 16.2.

The outcomes were appearing with the assistance of charts, to breakdown the impact of weight diminishment on the auxiliary uprightness, of the machine bed prior and then afterward the weight lessening and conclusions were drawn, about the improved plan.

Finite Element Analysis

Meshing:- Meshing for the FEA is done with a 5mm element size and a 3mm edge size. This meshing type is commonly utilised in industries for producing accurate quadric meshing results. Edge sizing of 3mm is used in certain areas where load is higher and analysis is required to be very precise.
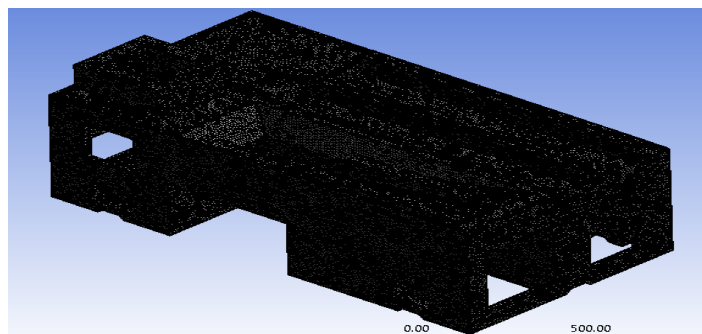

Fig no 2 Model Meshing

Boundary Condition:- After the discretization procedure is finished, you must establish the boundary and loading conditions for the analysis.
Standard Earth Gravity= 9806mm/s2
Fixed Support

Bed to Ground Support are consider as fixed point
- Force A is having 870kg (like spindle and chuck weight) of average weight. As we have considered (870*9.18=7986.05N) 8000N maximum load on tool.
- Force B is having 650kg (other fixture tools) of average weight. As we have considered (650*9.18=5967N) 6000N maximum load on tool.
- Force C is having 270kg (Tail stock and etc) of average weight. As we have considered (270*9.18=2478.6N) 2500N maximum load on tool.
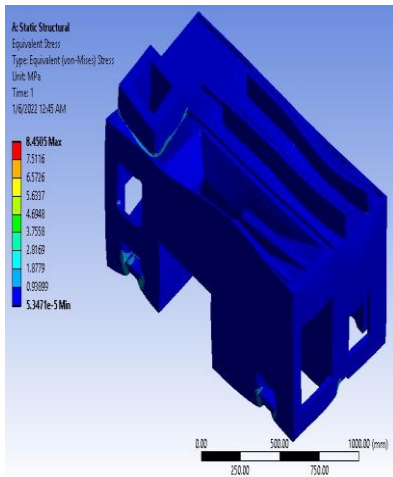
RESULTS

Fig No 3Maximum equivalent stress:-8.4505MPA
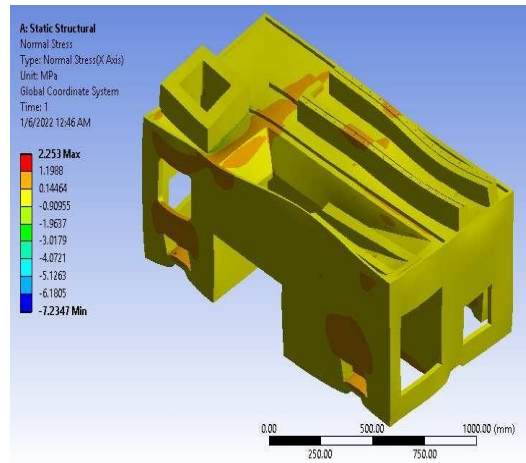

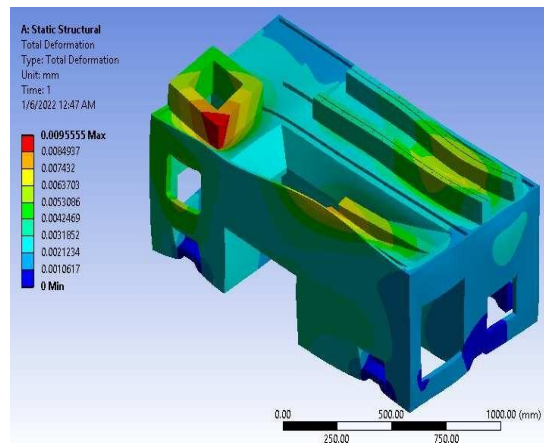**Fig No 4 Normal Stress in X direction:-2.253MPA**

Fig No 5Total deformation:- 00095 MPA

Modified Design And Analysis Of CNC Lathe Bed:-

Existing mode has been modified in present work and same has been analyzed using different optimization tools available in FEM base software Ansys without affecting its performance

Shape optimization 1:-The goal of the optimization technique is to lower production costs by reducing the mass of the lathe bed. The optimization focused on the non-crucial regions that had to be cut.

Shape optimization Analysis Result

Initial Mass	1088 kilogram
Marginal Mass	10.853 kilogram
Improved Mass	855.53 kilogram
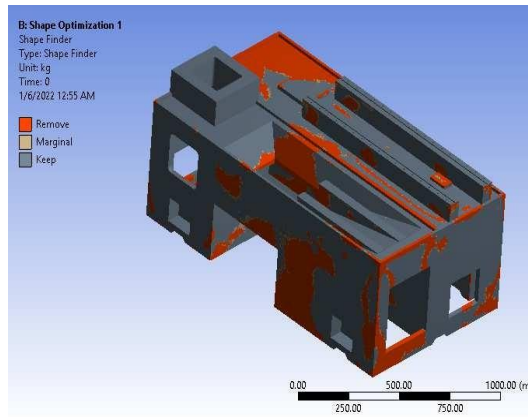
Fig no 6 shape optimization of base model

After applying shape optimization to initial model which shows unwanted material this material further remove from model in solidwork.

- Weight of optimized model 1 is 1047.7 Kg

Analyse result of optimize Body 1:- Now in this Analysis we consider all Analysis process same as we used in previous analysis like material, meshing & load conditions.

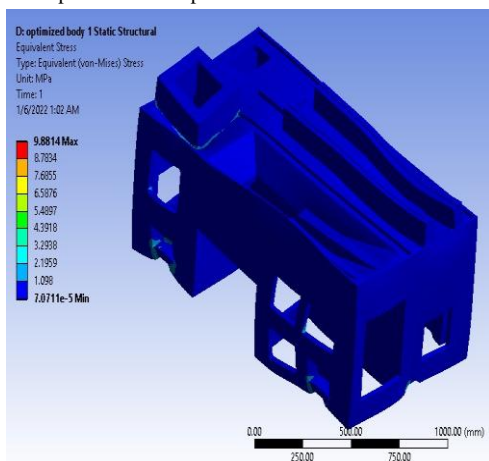Here just I import modified optimize model rather than initial model and found the solution for comparison

Fig No7 Maximum Equivalent stress of optimized body
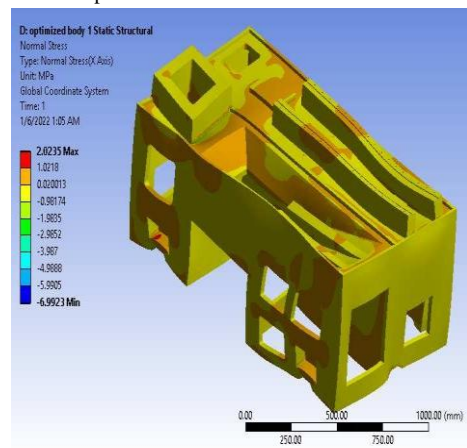
Fig No 8 Maximum Normal stress in x direction
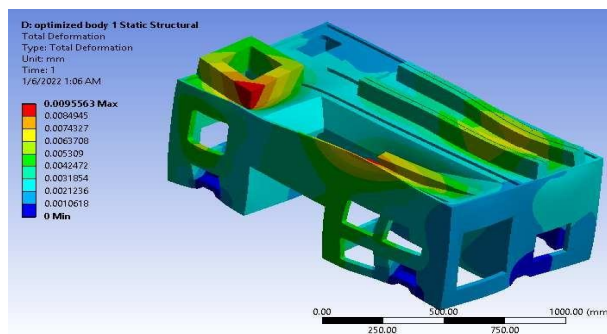
Fig No 9 Total deformation of optimize body

Shape optimization 2:-Further I apply shape optimization on optimized body 1 which gives result in which red portion shows removable material and gray potion show material which require to keep.

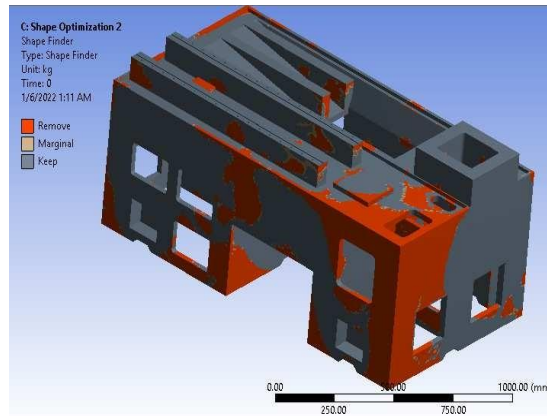- Weight of optimized model 2 is 968.82 Kg after removing unwanted material.

Fig No 10 Shape optimization of optimize body1
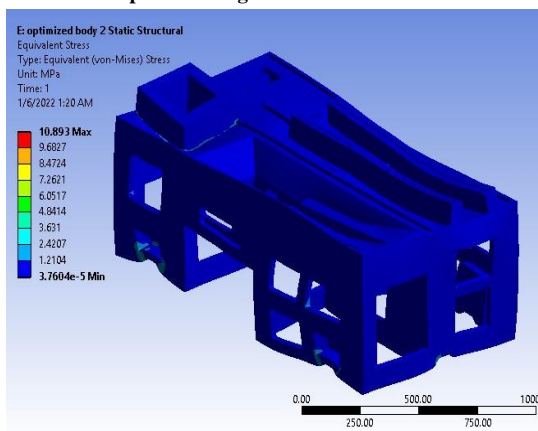
Analysis Results of optimize design 2:-

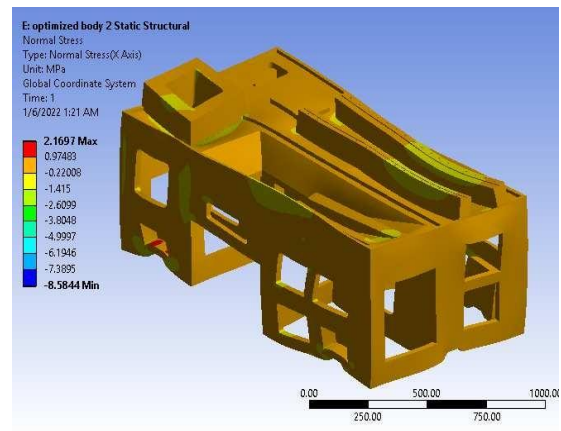**Fig11 Maximum Equivalent Stress of Optimize body2**

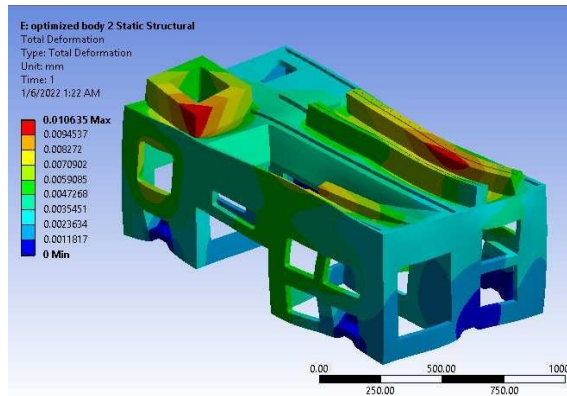**Fig12 Maximum Normal Stress in optimize body 2**

Fig 13 Total Deformation Of Optimize body2

Analysis of Optimized design 2 For Material change-ASTM 40 Gray cast iron:-

Now in this Analysis we consider all Analysis process same as we used in previous Analysis of Optimize design 2 like optimized Geometry, meshing, load conditions & Fixed support. Only we have to change material.

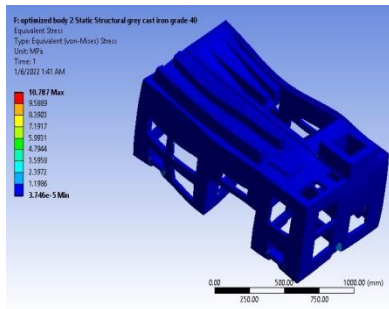Weight of optimized model 2 is **960.93 Kg** for ASTM 40 Gray cast iron material.

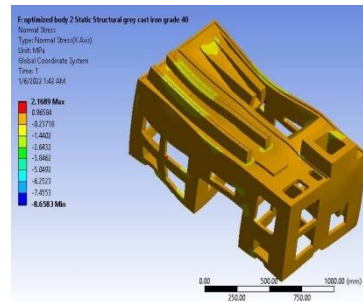**Fig14 Maximum Equivalent stress of optimized body2(ASTM40)**

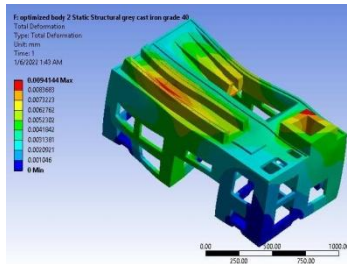**Fig15 Normal stress of optimized body 2(ASTM40)**

**Fig 16Total Deformation of optimized Body2(ASTM 40)**

Modal Analysis Of Optimized Body 2:-

The use of modal analysis is required to understand the vibration properties of mechanical constructions. It converts excitation and response vibration signals from a difficult-to-perceive complex structure into a collection of modal parameters that can be simply applied to forces.

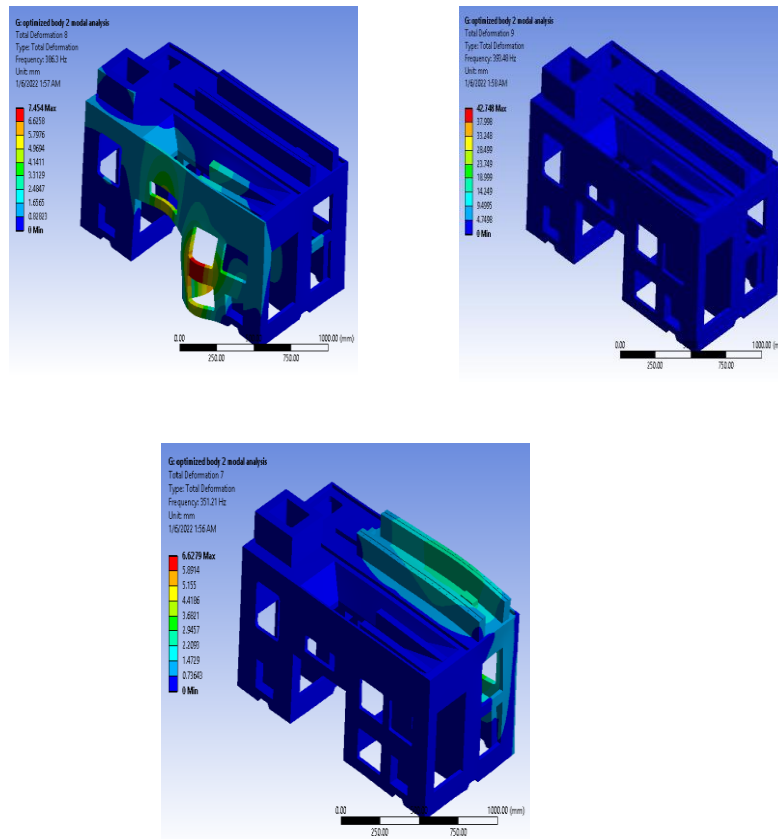**Analysis setting Maximum Numbers of mode = 9**
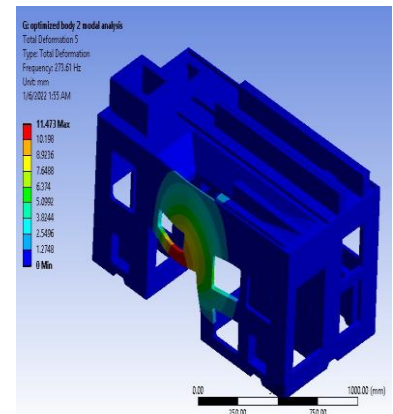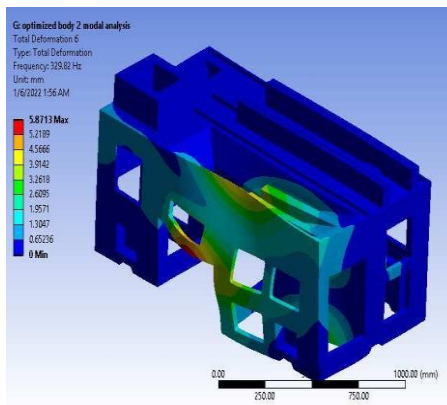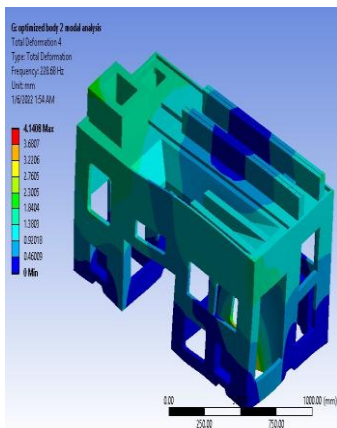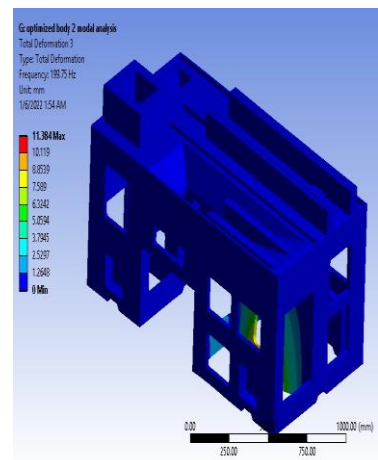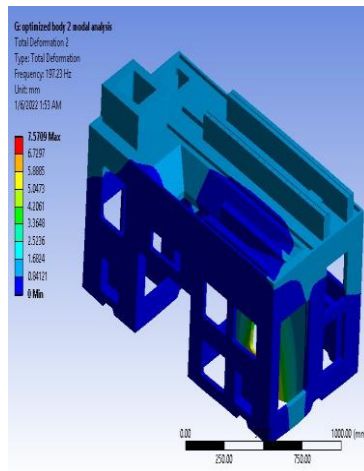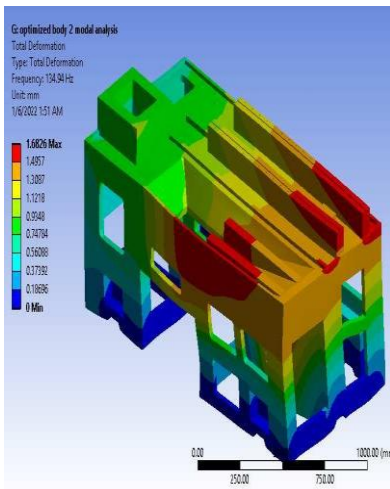
Fig 17 (9) Mode shapes at different frequency

Conclusion and Future Scope:-

Results	EXISTING	OPTIMIZE BODY 1	OPTIMIZE BODY 2	ASMT 40
EQUIVALENT (VON-MISES) STRESS (MPa)	8.4505	9.8814	10.893	10.787
NORMAL STRESS (MPa)	2.253	2.0235	2.1697	2.1689
TOTAL DEFORMATION (mm)	0.0095	0.0095	0.010635	0.00941
WEIGHT(Kg)	1087.8	1047.7	968.82	960.93

As per results table weight goes on decreases as we modified the design and at last material without affecting strength and damping ability of machine base. Weight reduce by 126.87 kg at end of optimization process.

Mass versus cost analysis:- Main aim of this work to reduce the mass of the lathe bed which leads direct reduce in cost of lathe bed. Here I consider the cost per kg of gray cast iron is 50Rupees.The initial weight of lathe bed is 1087kg and corresponding cost is 54350.After applying shape optimization and reducing weight one by one upto 1047kg I plot a first graph base on this which shows the linear relation between mass versus cost. After the weight is reduce upto 1047 than I apply shape optimization another time and mass is reduce upto 968kg without demeriting its basic property and calculate cost for corresponding mass which shows this results by doing this cost is reduce upto 5950 Rupees and for mass production it is very big amount.
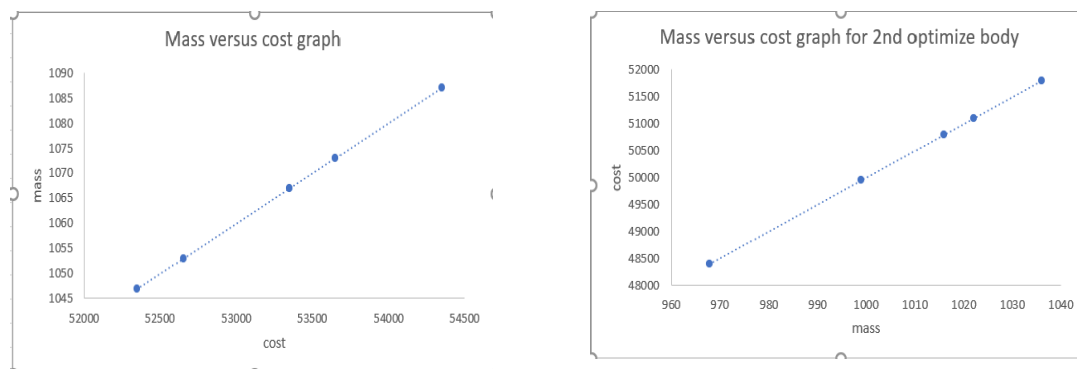

Fig 18 Mass versus cost graph (mass in kg & cost in rupees)

Future Scope:-

- Fatigue Analysis for Life calculation can be explored.
- Drafting for CNC lathe machine Bed.
- Another boundary condition also be add like tool post.
- Experimental results for Lathe Bed can be obtained.

References

1. Hongwei Shan (2015), et al. "Optimization of CNC lathe-bed structure based on ansys", *Applied Mechanics and Materials Trans Tech Publications, Switzerland* Vols 713-715 (2015) pp 43-46 ©

2. B. Malleswara Swami1 (DEC. 2012), et.al "Design and Structural Analysis of CNC Vertical Milling Machine Bed" *IJAET*, ISSUE NO.-0976-3945.

3. JuturiSaidaiah (July 2017), et al. "Weight Optimization of Lathe Bed by Design Modification and Epoxy Granite", *SSRG-IJME*, ISSN NO. 2348-83607.

4. Hongping Yang, (year 2016), et al. "Static and dynamic characteristics modeling for CK61125 CNC lathe bed basing on FEM" *GCMM*, ISSN NO. 489- 496.

5. Mr. B. Sakthi (YEAR 2011), et al. "Structural Redesigning of A CNC Lathe Bed to Improve Its Stiffness and Damping Characteristics" *AFEH-IJE*, ISSN – 1584-2673.

6. Gururaj Deshpande, (YEAR 2016), et al. "Structural Analysis for Weight Optimization of Machine Tool Bed" *IJIERT*, ISSN NO. 2394-3696.

7. S. SyathAbuthakeer (Year 2011), et al. "Structural Redesigning of a CNC Lathe Bed to Improve Its Static and Dynamic Characteristics" *NSPGS*, ISSN-1584-2673.

8. TAPAN A PANDYA, M. Tech, et al. (May 2016) "Evaluation of alternative material for lathe bed"

9. D. Li, Y. Guan, G. Xu and W. Mao,(2009) "Optimization design of lather-beds based on Fea",International Conference on Information and Automation, pp. 865-869

10. Suresha. D. B, Devendra Reddy. M & Murali. C T(oct 2017) "Structural Optimization Of Lathe Machine Bed", International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) ISSN (P): 2249-6890; ISSN (E): 2249-8001 Vol. 7, Issue 5.

11. Ripalkumar C. Patel (APRIL 2015), et al. "Finite Element Analysis and Optimization of Conventional Lathe Bed Using CAE Tool" ISBN-978-81-929339-1-7.