Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Design and structural analysis of conventional lathe for retrofitting

Dhruv P. Chokshi[1*], Vijaykumar Chaudhary[2]

[1*]PG Student, Mechanical Engineering, C. S. Patel Institute of Technology, CHARUSAT, Anand, Gujarat, India, dchoksi9004@gmail.com
[2]Department of Mechanical Engineering, C. S. Patel Institute of Technology, CHARUSAT, Anand, Gujarat, India, vijaychaudhary.me@charusat.ac.in

ABSTRACT:

This paper mainly focuses on the design optimization of the lathe machine. Lathe machine is widely used to manufacture different parts in different types of the material. Static and dynamic analysis are performed on the main body parts of the machine like base square channel cage table, casting travel body, tool carriage. These analysis represent that, in both loading condition body can sustain maximum load with negligible deformation. To improve the design and optimize the design 3D cad model has been designed by using commercial 3D modelling software solid works. And the 3D finite element model has been generated in ansys and analysis also carried out using ansys.

KEY WORDS: Static analysis, Dynamic analysis, finite element analysis, ansys, design optimization

***Corresponding Author**

Dhruv P. Chokshi

Post Graduate Student,

C. S. Patel Institute of Technology, CHARUSAT,

Anand - 388120, Gujarat, India.

Email: dchoksi9004@gmail.com

Mob No. 8140617365

1. INTRODUCTION:

With the prospective of lathe machine, it is only one universal machine that can be used to develop required parts of another automated lathe. Conventional lathe machine rotate the work piece and tools are approaches the work piece to chips of the material. Lathes are ideal for the parts which have round shapes, which can fixed up in the chuck of the spindle of the lathe for operations on it.

Automated lathe have one advanced ability is to drive cutting tool with G- codes and can rotate it towards Z- axis and also can move the tool post in Y-direction, which is linear motion with respect to headstock. Automated lathe also have 4 tool carriage system so lathe have to programme for once for all operations to complete the product cycle.

Due to the automation, conventional lathe machine can quickly shift in to the automated lathe machine and automated lathe can replace the conventional lathe machine. Automated lathes have tremendous repeatability with high accuracy and precision up to macro level.

2. PROBLEM IDENTIFICATION:

During the operational time of the conventional lathe machine there are lots of things which worker have to handle like, Chuck movement, tool offset centres, jaw attachments, carriage alignment, tool travel speed, feed rate, drive motor speed, tool changing, linear motion of tool post in Y axis all this steps etc. to complete their work. Conventional lathe don’t have any feedback system so machine errors cannot be found easily.[1]

Major problem of conventional lathe machine are like

- Material is not cutting according to requirements.
- Lathe is not working properly
- Carriage isn’t moving
- Accidents
- Threads are not being cut properly

3. MODELLING AND FINITE ELEMENT ANALYSIS OF RETROFIT LATHE MACHINE:

Simplified CAD model retrofit lathe is created by using solid works and it is imported in ANSYS as a external geometry file. This model shown in below figure.

Major dimensions of the machine are as follow:

Length = 2050 mm

Width = 750mm

Height = 525 mm (table height)

Height = 1078 mm (total height)

Linear guide way motion area = 950mm

Tool carriage motion length = 350mm

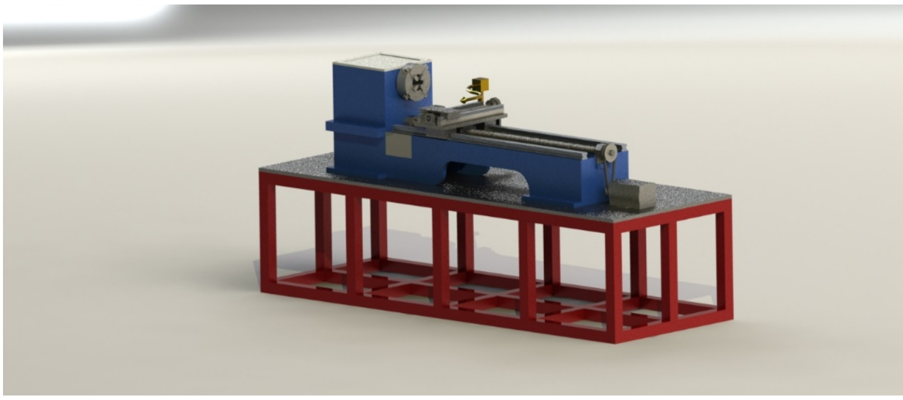

Figure 1 Cad model of retrofitted lathe machine

3.1.Loading and boundary condition:

Square tube cage table is loaded by static force from the lathe body and work piece load. For the modal, the maximum loaded weight of the structure is 649 kg. The load is assumed as a uniformed distributed obtained from the maximum loaded weight divided by the total length of the cage square Chanel cage.Details of allloading condition of modal is listed down below in table.

There are 4 boundary condition of the model; the first is applied at bottom of the square tube chanel cage, second boundary condition is applied on the side edges of the square tube chanel cage, third boundary condition is applied on the top of the square chanel table, like this other bodies have boundary condition.

3.2.Applying load:

Load on bottom support table	=3500 N (static loading condition)
Load on bottom support table	=1500 N (Dynamic loading condition)
Load on bottom cast body	=900 N (Static loading condition)
Load on bottom cast body	=900 N (Dynamic loading condition)
Load on carriage	=750N (Static loading condition)
Load on bottom cast body	=750N (Dynamic loading condition)
Load on top cast body	=200 N.mm moment

3.3.ELEMENTS AND NODES:

The meshed assembly model has 52376 nodes and 26873 elements. The element is tetrahedral. In order to get a better results, locally finer meshing applied in the region which have high loading effect.[1]

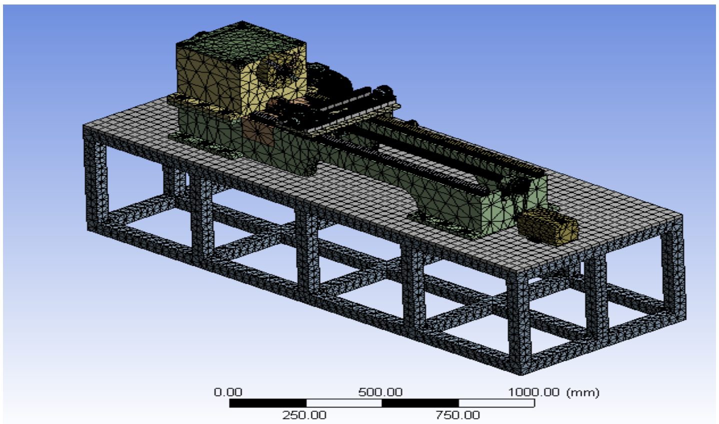

Figure 2 Various loads applied on milling machine bed

Table 3: MATERIAL PROPERTIES:

Sr. NO	Material properties	Youngs modulus	Poission ratio	Density
1	Cast iron	1.1×10^5MPa	0.28 MPa	7.25×10^{-6} kg mm^{-3}
2	Aluminium alloy	71000 MPa	0.33 MPa	2.77×10^{-6} kg mm^{-3}
3	Structural steel	2×10^5MPa	0.3 MPa	7.85×10^{-6} kg mm^{-3}

4. RESULTS:

4.1. *Static structure analysis results of the assembly parts:*

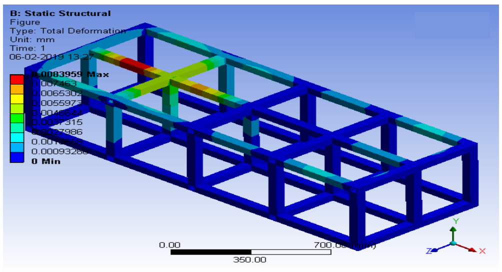

Figure 3 Total deformation, bottom support frame

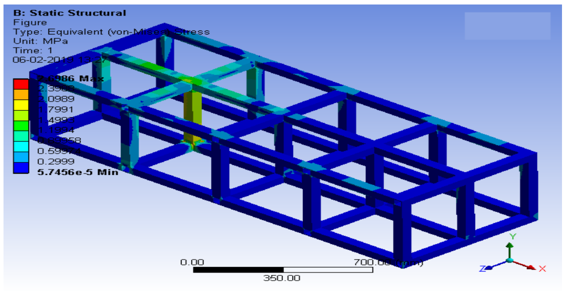

Figure 4 Equivalent (von-Mises stress), bottom support frame

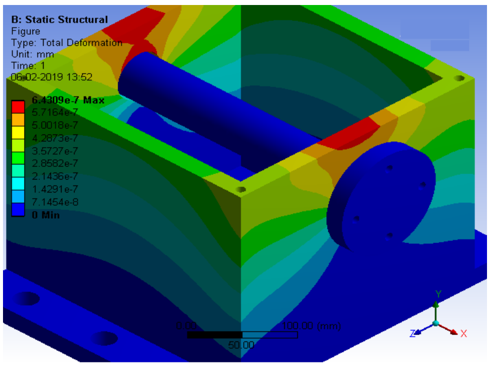

Figure 5 Total deformation, top cast body

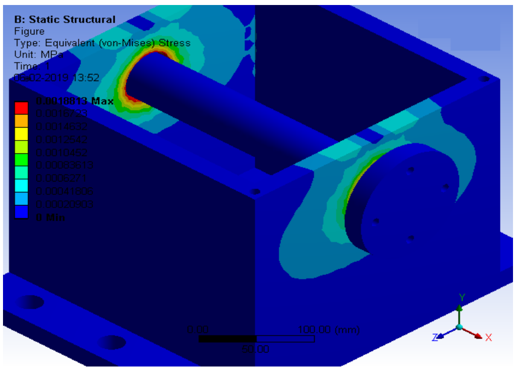

Figure 6Equivalent (von-mises stress), top cast body

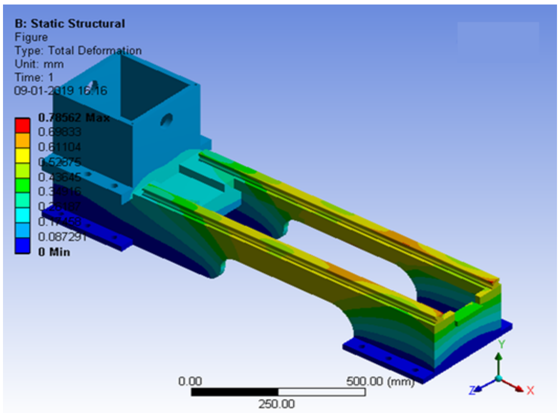

Figure 7 Total deformation in static load condition, casting body assembly

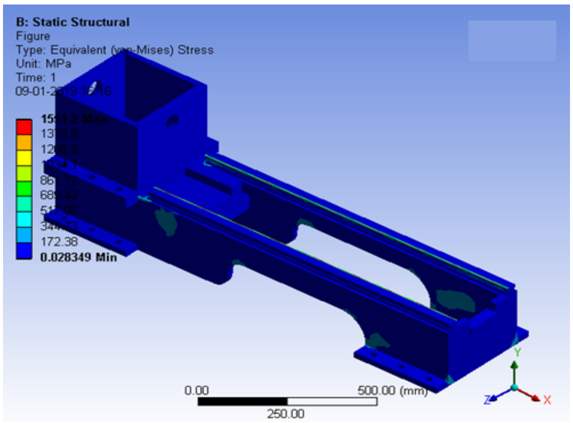

Figure 8 Equivalent (von-Mises) stress, casting body assembly

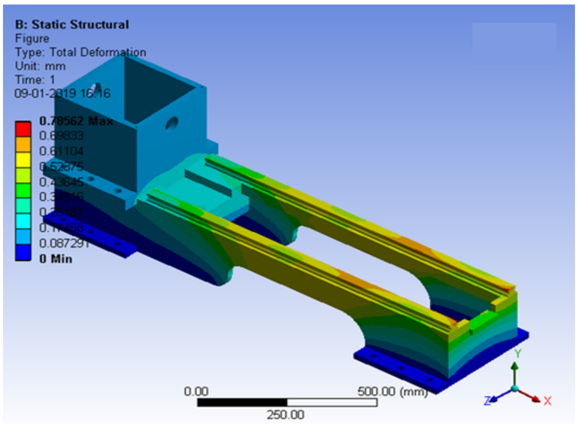

Figure 9 Total deformation in static load condition, casting body assembly

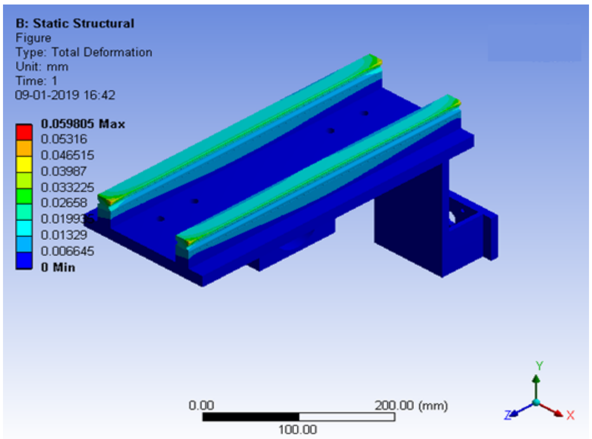

Figure 10 Total deformation of tool post

4.2. Transient structure analysis of the assembly parts:

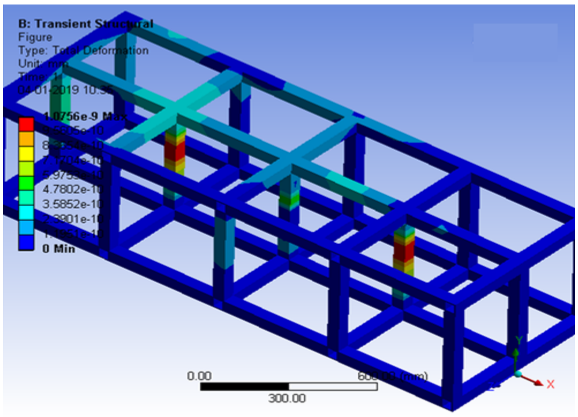

Figure 11 Dynamic total deformation, bottom support frame

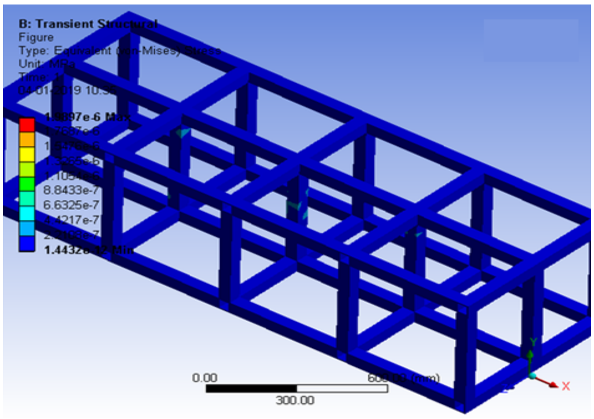

Figure 12 Equivalent(von-mises stress), bottom support frame

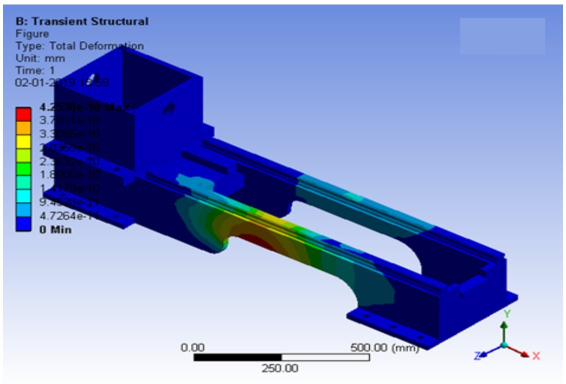

Figure 13 Total deformation, casting body assembly

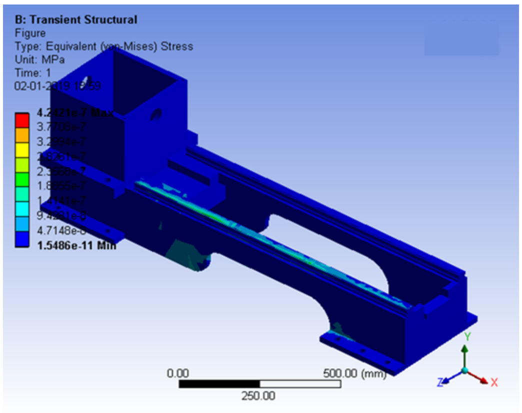

Figure 14 Equivalent (von-Mises) stress, Casting body assembly

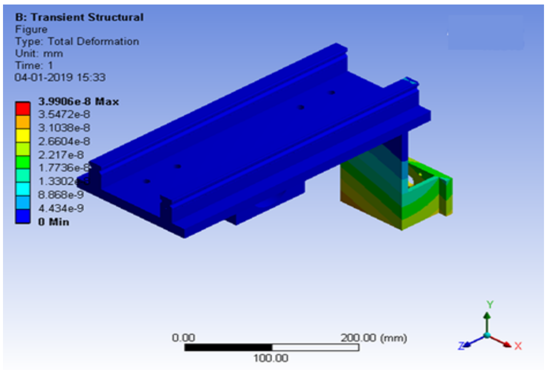

Figure 15 Total deformation, carriage

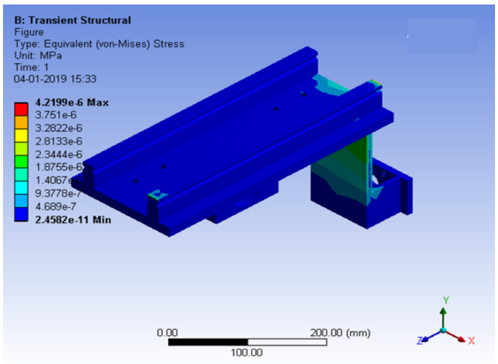

Figure 16 Equivalent (von-Mises) stress

4.3. Results & discussion:

The results of static structural analysis and transient structure analysis are done with ANSYS and here weight reduction of the machine is possible. The effect of mass reduction on the static and dynamic analysis of tool carriage, bottom support frame and bottom cast body discussed in detail.

Table 2: Results of static structure analysis

Sr. NO	Part name	Total displacement		Equivalent (von-mises) stress	
		Minimum	Maximum	Minimum	Maximum
1	Bottom support frame	0. mm	8.3959×10^{-3} mm	5.7456×10^{-5} MPa	2.6986 MPa
2	Top cast body	0. mm	6.4309×10^{-7} mm	0. MPa	1.8813×10^{-3} MPa
3	Bottom cast body	0. mm	0.078562 mm	2.8349×10^{-2} MPa	2.8349×10^{-2} MPa
4	Tool carriage	0. mm	5.9805×10^{-2} mm	1.6842×10^{-5} MPa	1162.4 MPa

Here in static and dynamic analysis observed that deformation of the bodies are negligible due to CI cast iron and due to fillet radius at the all corners deformation of the bodies edges also not more than 0.001 mm.

Table 3: Results of transient structure analysis

Sr. NO	Part name	Total displacement		Equivalent (von-Mises) stress	
		Minimum	Maximum	Minimum	Maximum
1	Bottom support frame	0. Mm	1.0756×10^{-9} mm	1.4432×10^{-12} mpa	1.9897×10^{-6} mpa
2	Bottom cast body	0. Mm	4.2538×10^{-10} mm	1.5486×10^{-11} mpa	4.2421×10^{-7} mpa
3	Tool carriage	0. Mm	3.9906×10^{-8} mm	2.4582×10^{-11} mpa	4.2199×10^{-6} mpa

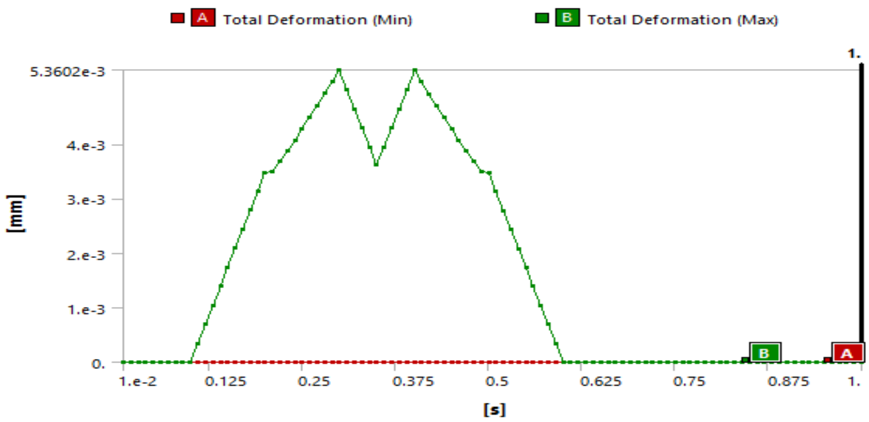

Figure 17 Deformation-Time diagram

1. CONCLUSION:

- The importance of the lathe and milling machine aren't undetermined if they are conventional. They are very important in manufacturing world and laid the foundations. But the modification and new technology must require to improve manufacturing in today's era. Here with all analysis and calculation retrofitting can be a good option for advance manufacturing process.
- Reduce machine space area.
- Improve the machining process with automated tool post up to macro finishing level.
- Reduce the human error with feedback (closed loop) system to improve machine efficiency and working time.
- In terms of manufacturing cost, it may cost around budgetdue to its condition, by means of that only casting body can be used for retrofitting and these may reduce the cost of the manufacturing and other all parts must be use new.

2. FUTURE SCOPE:

- Retrofit lathe could be replace the conventional lathe machine due to its advantages.[2, 3]

REFERENCES:

1. Patel, Vijaykumar V., and R. I. Patel. "Structural analysis of a ladder chassis frame." World Journal of science and Technology 2012; 2(4): 05-08.
2. Tseng, P-C., and J-L. Ho. "A study of high-precision CNC lathe thermal errors and compensation." The international journal of advanced manufacturing technology 2002; 19(11): 850-858.
3. Wang, Yiqiang, et al. "Field failure database of CNC lathes." International Journal of Quality & Reliability Management 1999; 16(4): 330-343.
4. Wang, Yiqiang, et al. "A comprehensive reliability allocation method for design of CNC lathes." Reliability engineering & system safety 2001; 72(3): 247-252.
5. Wang, Chen Sheng, Tjamme Wiegers, and Joris SM Vergeest. "An implementation of intelligent CNC machine tools." Applied Mechanics and Materials. Trans Tech Publications, 2011; 44
6. Xu, Xun William, and Stephen T. Newman. "Making CNC machine tools more open, interoperable and intelligent—a review of the technologies." Computers in Industry 2006; 57(2): 141-152.
7. Yeo, S. H. "A multipass optimization strategy for CNC lathe operations." International journal of production economics 1995; 40(2-3): 209-218.
8. Yun, Won Soo, Soo Kwang Kim, and Dong Woo Cho. "Thermal error analysis for a CNC lathe feed drive system." International Journal of Machine tools and manufacture 1999; 39(7): 1087-1101.
9. Zhang, Gen Bao, Lian Zhang, and Yan Ran. "Reliability and failure analysis of CNC machine based on element action." Applied Mechanics and Materials.Trans Tech Publications, 2014; 494
10. Zhang, Jun, et al. "Research on the dynamics of ball screw feed system with high acceleration." International Journal of Machine Tools and Manufacture 2016; 111: 9-16.
11. Zhu, Wen-Hong, Martin B. Jun, and Yusuf Altintas. "A fast tool servo design for precision turning of shafts on conventional CNC lathes." International Journal of Machine Tools and Manufacture 2001; 41(7): 953-965.'