International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

MODELLING AND ANALYSIS OF CNC MILLING MACHINE BED WITH COMPOSITE MATERIALS

A.Ravi Teja[1], P.Puneeth[2], B.Sai Suresh[3], B.Bharath[4], U.Apparao[5], Ch Kiran Kumar [6]

[1,2,3,4,5] *B. Tech Final Year Students, Dept of Mechanical Engineering, Visakha Institute of Engineering and Technology.*

[6] *Asst.Professor, Dept of Mechanical Engineering, Visakha Institute of Engineering and Technology.*

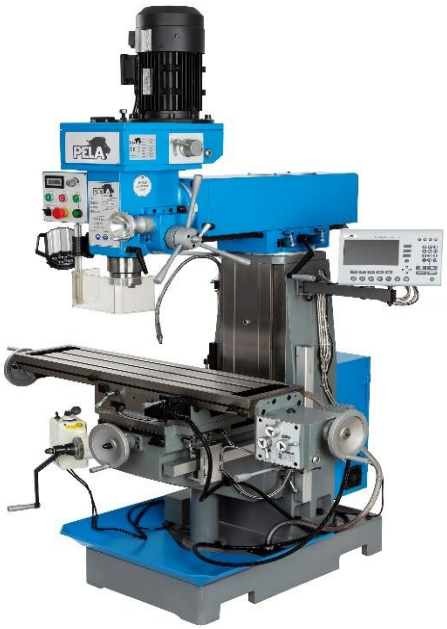
Abstract - The materials utilized as a part of a machine device have an unequivocal part in deciding the efficiency and exactness of the part made in it. The regular basic materials utilized as a part of exactness machine apparatuses, for example, cast iron and steel at high working velocities create positional mistakes because of the vibrations moved into the structure. Quicker cutting rates can be procured just by structure which has high firmness and great damping attributes. We know that by experiences life of a machine is inversely proportional to the levels of vibration that the machine is subjected. The further procedure is completed to experience the distortion, normal recurrence and removal utilizing Static examination, Modal investigation and Harmonic individually. Since the bed in machine apparatus assumes a basic part in guaranteeing the exactness and precision in segments. Is a standout amongst the most critical apparatus structures which have a tendency to retain the vibrations coming about because of the cutting operation. To break down the bed for conceivable material changes that could build solidness, diminish weight, improve damping characteristics. In this paper constant load is applied on a bed with and without Nanocoating on the material and with composite materials. Graphene is used for coating basing on strength and thermal properties. Modelling of the bed was carried out in SolidWorks and ANSYS is used for structural analysis. By comparing the stress distribution and deformation in the bed by changing its material with the previous. Finally this thesis summarizes the suitable materials can be used as machine bed material.

Key words: Machine Tool, Machine Bed, Stiffness, Damping, SOLID WORKS, Ansys

1.INTRODUCTION

In contemporary manufacturing, the careful selection of materials for machine tool components, such as milling machine beds, plays a pivotal role in achieving optimal performance and durability.This project focuses on assessing and comparing the suitability of two prevalent materials, namely gray cast iron and structural steel,for application in milling machine beds using advanced ANSYS simulation techniques. The primary motivation behind this study is to address the critical need for material optimization in machining operations.By thoroughly evaluating gray cast iron and structural steel under simulated machining conditions, we aim to make informed decisions regarding material selection for milling machine bed

2.0 MILLING MACHINE



2. ANSYS Workbench Overview

ANSYS Workbench:

ANSYS Workbench stands as a robust and integrated simulation platform designed to facilitate complex engineering analyses, including structural evaluations crucial for machine tool components like milling machine beds. It serves as a comprehensive environment where engineers and analysts can efficiently perform multiphysics simulations, leveraging its intuitive graphical interface and diverse set of tools.

Key Features of ANSYS Workbench for Structural Analysis:

Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Model (A4)

TABLE 2
Model (A4) > Geometry Imports

Object Name	*Geometry Imports*
State	Solved

TABLE 3
Model (A4) > Geometry Imports > Geometry Import (A3)

Object Name	*Geometry Import (A3)*
State	Solved
Definition	
Source	C:\Users\HP\Desktop\Projects\design and analysis of mcng bed\ci and ss machning bed_files\dp0\SYS\DM\SYS.agdb
Type	DesignModeler
Basic Geometry Options	
Parameters	Independent
Parameter Key	
Advanced Geometry Options	
Compare Parts On Update	No
Analysis Type	3-D

. Iterative Analysis (Optional)

In addition to the static structural analysis outlined previously, ANSYS Workbench offers advanced capabilities for conducting iterative analysis, including parametric studies and sensitivity analyses. These iterative techniques enable engineers to explore design variations, optimize performance metrics, and identify critical factors influencing the milling machine bed's behavior.

Parametric Studies:

Material Properties Variation:

- Conduct parametric studies by varying material properties such as Young's modulus, Poisson's ratio, density, or thermal conductivity of the milling machine bed materials (gray cast iron and structural steel).
- Evaluate the impact of material variations on stress distribution, deformation, and safety factors to identify optimal material selections for enhanced performance.

Loading Conditions Variation:

- Explore parametric variations in loading conditions by adjusting applied loads (magnitude and distribution) on the milling machine bed model.
- Assess how changes in machining forces affect structural responses such as stress levels, displacements, and deformation patterns.

Geometry Parameters Variation:

- Investigate the influence of geometric parameters (e.g., thickness, ribbing design) on the milling machine bed's structural behavior through parametric studies.
- Optimize geometric configurations to enhance stiffness, reduce weight, or improve vibration damping characteristics.

Sensitivity Analysis:

Key Design Parameters Evaluation:

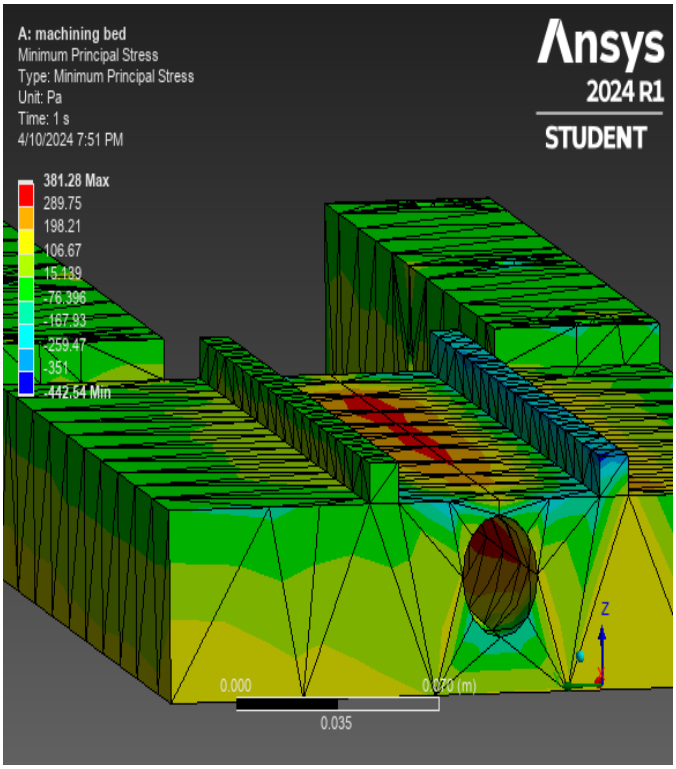
- Perform sensitivity analysis to evaluate the sensitivity of key design parameters (e.g., material properties, boundary conditions) on the milling machine bed's structural response.
- Identify critical factors that significantly impact stress distribution, deformation behavior, and overall performance under varying operating conditions.

Factorial Design Approach:

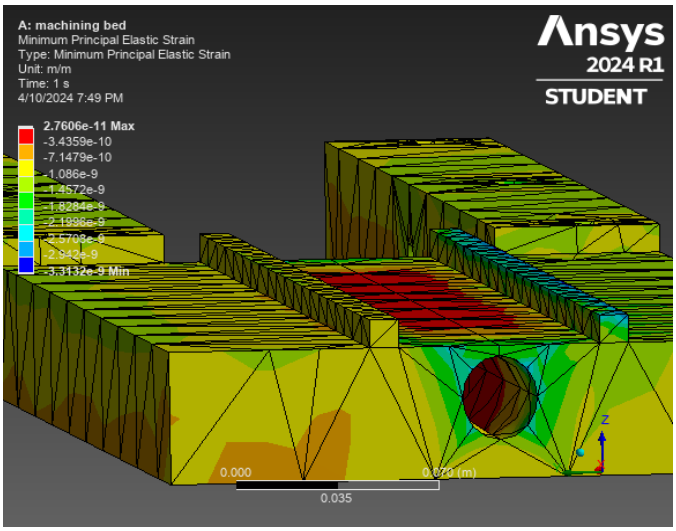
- Utilize factorial design techniques to systematically vary multiple parameters simultaneously and assess their combined effects on the milling machine bed's behavior.
- Analyze interaction effects between design factors to understand complex relationships and optimize design configurations.

Benefits of Iterative Analysis:

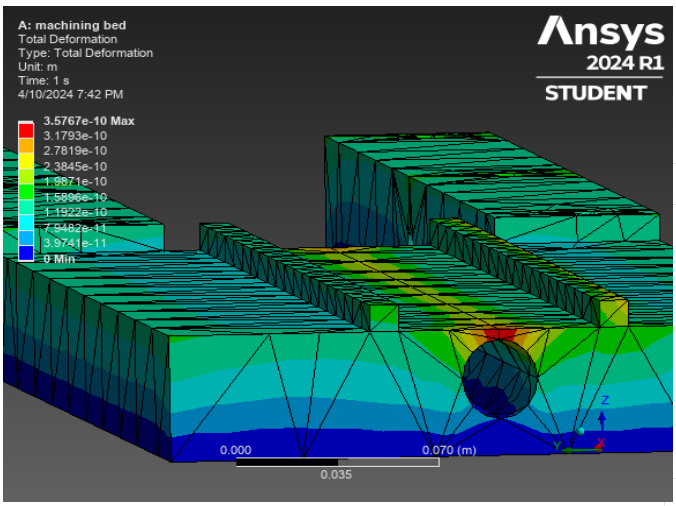
- **Optimization:** Iterative analysis allows for the optimization of milling machine bed design by exploring a range of design alternatives and identifying optimal solutions.
- **Performance Enhancement:** By conducting parametric studies and sensitivity analyses, engineers can enhance the milling machine bed's performance characteristics, such as stiffness, durability, and vibration damping.
- **Decision Support:** Iterative analysis provides valuable insights into the factors influencing structural behavior, enabling informed decision-making during the design and manufacturing process.



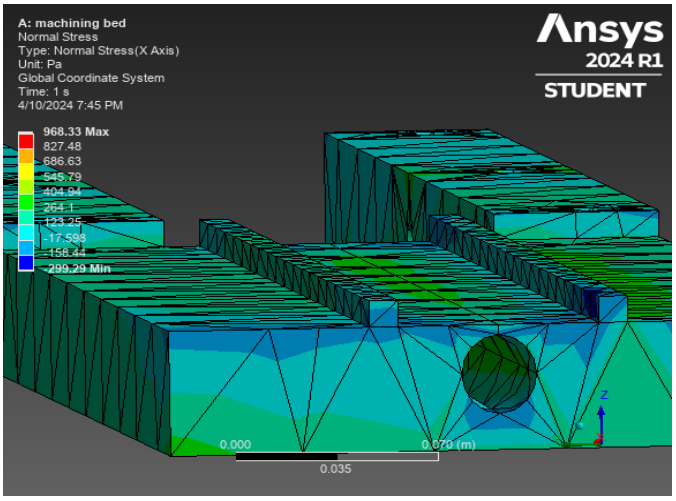
Manimum principal stress



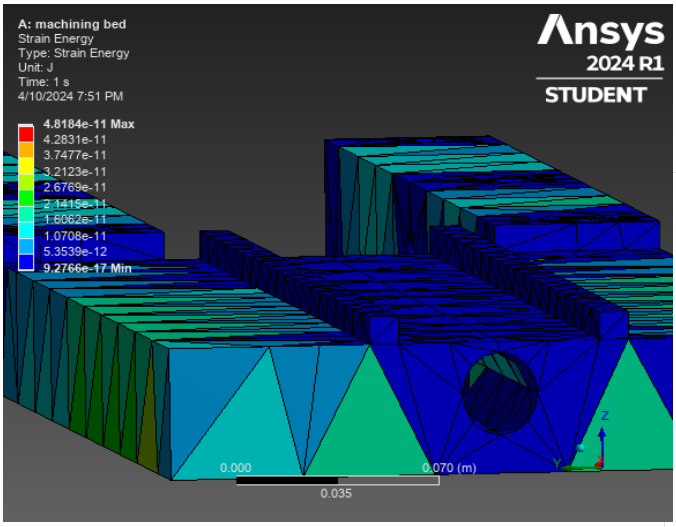
Minimum principal elastic strain



Total deformation



Normal stress (x axis)



Strain energy

Objectives

The objectives of this study are twofold:

1. **Assess Mechanical Properties and Performance:**
   - Conduct a comprehensive analysis of the mechanical properties of gray cast iron and structural steel, focusing on stiffness, strength, and vibration damping characteristics.
   - Evaluate the behavior of both materials under simulated machining loads to understand their performance in real-world applications.
2. **Recommend Material Selection:**
   - Perform a static structural analysis using ANSYS to simulate stress distribution and deformation patterns within a milling machine bed model.
   - Based on the analysis results, make informed recommendations on the most suitable material for the milling machine bed to enhance operational efficiency and longevity.

. ANSYS Workbench Overview

Introduction to ANSYS Workbench:

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Key Features of ANSYS Workbench for Structural Analysis:

1.
2.
3. **Integrated Environment:**
4. **Preprocessing Tools:**
5. **Solver Capabilities:**
6. **Postprocessing and Visualization:**
7. **Parametric Analysis and Optimization:**
8. **Simulation Process Automation:**

- **Efficiency**
- **Accuracy**.
- **Versatility**

CONCULSION

Solidworks software was used to model and design the milling machine bed for various composite materials such as grey cast iron, and structural steel, and ANSYS was used to perform static structural analysis. The following conclusions can be drawn from the above result

Based on configuration principles, the Existing bed material was replaced by composite materials like Gray cast iron, Structural steel improved in the static characteristics. Generally composite materials also offer high specific strength and high specific modulus with less weight in machine tool industries .

Composite materials also offers high accuracy and precession of the component manufactured in such machine tools made of composite materiaL

REFERENCES

1. Kang SK, Ehmann KF, Lin C (1996) A CAD approach to helical groove machining, part 1: mathematical model and model solution. Int J Mach Tools Manuf 36:141–153
2. Chen CK, Lin RY (2001) A study of manufacturing models for ball-end type rotating cutters with constant pitch helical grooves. Int J Adv Manuf Technol 18:567–578
3. Wu CT, Chen CK (2001) Study on rotating cutters with different definitions of helical angle. Int J Adv Manuf Technol 17:627–638
4. Chen WF, Lai HY, Chen CK (2001) A precision tool model for concave cone end milling cutters. Int J Adv Manuf Technol 18:567–578
5. Kang D, Armarego EJA (2003) Computer aided geometric analysis of the fluting operation for twist drill design and production, part I: Forward analysis and generated flute profile. Mach Sci Technol 7(2):221–248
6. Zhang W, Wang X, He F, Xiong D (2006) A practical method of modelling and simulation for drill fluting. Int J Mach Tools Manuf 46:667–672
7. Hsieh JF (2006) Mathematical model and sensitivity analysis for helical groove machining. Int J Mach Tools Manuf 46:1087–1096
8. Lu Y, Takeuchi Y, Takahashi I, Anzai M (2005) An integrated system development for ball end mill design, creation, and evaluation. Int J Adv Manuf Technol 25:628–646
9. Xu ZG, Zhao B (2006) A research on the design and management of the carbide end mill. Proceedings of the SICE-ICASE International Joint Conference, IEEE
10. Ko S. L. (1994) Geometric analysis of helical flute grinding and application to end mills. Trans. NAMRI/SME, XXII
11. Kim YH, Ko SL (2002) Development of a design and manufacturing technology for the end mill in machining-hardened steel. J Mater Process Technol 130–131:653–661