Modeling And Analysis of CNC Lath Bed

[1] Amit Kumar, [2]Akshay Gajbhiye, [3]B Lohit Kumar,[4]Shailendra Patel

[1]Amit Kumar Department of mechanical engg. MATS University Raipur
[2]AkshayGajbhiyeDepartment of mechanical engg. MATS University Raipur
[3]B Lohit Kumar Department of mechanical engg. MATS University Raipur
[4]Shailendra PatelDepartment of mechanical engg. MATS University Raipur

ABSTRACT

The design of CNC machine tools focused on their functional aspects and was hard to acqu ire any resonance with customers. Nowadays, despite the needs of low price, capabilities withstand at higher cutting speeds and operate at high acceleration and deceleration with high quality machine, many customers request good -looking machine. The project mainly aims to focused on the efficiently and the emission Modeling and analysis of CNC lathe bed using composite material, so we want to basically critically examine the design of the CNC lathe bed. Principle parts were made in creo software and the analysis by using ANSYS for a material matrix which is way efficient and more economical. Numerical analysis was done and results were validated with experimental results. Results indicated that the cross and horizontal rib with hollow bed can increase the specific stiffness by 8% with 4% weight reduction and its dynamic performances is also better with increases in the first natural frequencies. The modified design is effective in improving the static and dynamic structural performances of high speed machine tools.

KEYWORDS:*Machine tool bed, Form designs, Stiffness*

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1. Introduction

Lathe is considered as one of the oldest machine tools and is widely used in industries.It is called as mother of machine tools. It is said that the first screw cutting lathe wasdeveloped by an Englishman named Henry Maudslay in the year 1797. Modern high speed,heavy duty lathes are developed based on this machine.

It is generally accepted that the precision of machine tools is determined by their static,dynamic and thermal characteristics. Especially, the dynamic characteristics play an important role inhigh speed, precision machine tool structures, because vibration during the machining process resultsin chatter marks on the machined surface and thus creates a noisy environment [1].High static stiffness against bending and torsion, good dynamic characteristics as reflected byhigh natural frequency and high damping ratio, ease in production, good long term dimensionalstability, reasonably low coefficient of expansion, low cost and low material requirements are thebasic properties of machine tool structures that engineers look for designing and fabricating. However,from user's point of view, machine tool vibration is an important factor because it adversely affectsthe quality of the machined surface. To improve both the static and dynamic performances, themachine tool structures should have high static stiffness and damping. Using either higher modulusmaterial or more material in the structure, the static stiffness of a machine tool may be increased.But, it is difficult to increases the dynamic stiffness of a machine tool with these methods and increasein the static stiffness cannot increase it damping property. Material distribution plays on the importantrole in the structural strength and using material in required place can increase static stiffness withless mass.

Higher cutting speeds can be facilitated only by structures which have high stiffness and gooddamping characteristics. The deformation of machine tool structures under cutting forces andstructural loads are

responsible for the poor quality of products and which in turn is also aggravatedby the noise and vibration produced. In many a situation, it is the level of deformation and vibrationthat determines the upper limit on the ability of the machine to produce components with highprecision. All these above said deleterious effects greatly necessitate constant innovations andcontinuous research to keep them under check. Increasing structural stiffness could help in avoidingsuch problems. To increase the static stiffness and damping, different form designs can be used.The high speed machining process requests completely new demands for the mechanism of suchprocessing equipment, as due to the process, path speeds exceeding 50m/min can be achieved. In thisfield, potential capacities of manufacturing processes require a dynamic behavior ten times higherthan the conventional machine tools and increased accuracy. This can be solved by the systematicevaluation of suitable machine kinematics, by the application of linear direct drives as well as by massreduction of the axis through light weight components of machine tool structure. The requirements ofhigh speed machining and ways to improve the performance of machine tool have been studied [2].Hollow boxes possess an efficient shape for engineering components due to their high inherentbending and torsional rigidities. For example, box-section steel girders are a familiar design of beamsin bridges and other civil engineering structures. Currently, industrial interest exists in the use of tubesfor the moving head of a milling machine. The milling machine heads have the topology of rectangulartubes with monolithic walls. The overall compliance of the milling head is partly due to macroscopicbending of the tube and partly due to the local compliance at the supports on the guide-rails.
The structural response was analyzed for beams of square sections with various internaltopologies: a solid section, a foam-filled tube with monolithic walls, a hollow tube with walls madefrom sandwich plates, and a hollow tube with walls reinforced by internal stiffeners. Finite elementanalysis was used to validate analytical models for the overall stiffness of the tubes in three-pointbending. Minimum mass designs were obtained as a function of the overall stiffness, and the relativemerits of the competing topologies were discussed [3].

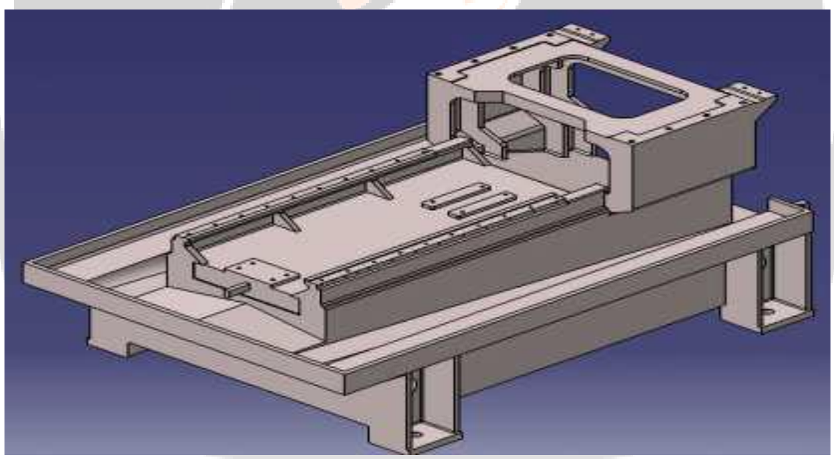
Fig.1: 3D CAD model of machine bed

Modern precision manufacturing demands extreme dimensional accuracy and surface finish. Such performance is very difficult to achieve manually, if not impossible, even with expert operators. In cases where it is possible, it takes much higher time due to the need for frequent dimensional measurement to prevent overcutting. It is thus obvious that automated motion control would replace manual “hand wheel” control in modern manufacturing. Development of computer numerically controlled (CNC) machines hasalso made possible the automation of the machining processes with flexibility to handle production of small to medium batch of parts. In the 1940s when the U.S. Air Force perceived the need to manufacture complex parts for high speed aircraft. This led to the development of computer-based automatic machine tool controls also known as the Numerical Control (NC) systems. Commercial production of NC machine tools started around the fifties and sixties around the world. Note that at this time the microprocessor has not yet been invented. Initially, the CNC technology was applied on lathes, milling machines, etc. which could perform a single type of metal cutting operation. Later, attempt was made to handle a variety of work pieces that may require several different types machining operations and to finish them in a single set-up. Thus CNC machining Centers capable of performing multiple operations were developed. To start with, CNC machining centers were developed for machining prismatic components combining operations like milling, drilling, boring and tapping. Gradually machines for manufacturing cylindrical components, called turning centers were developed. The transfer of high speed as well as the high cutting speed of machine tools is important .It ensures not only faster cutting rates but also lesser cutting force. Faster cutting speeds can be acquired only by structure which has high stiffness and good damping characteristics. The deformation of machine tool structure under cutting forces and loads which leads to the poor quality of products with less accuracy, both dimensional as well as geometrical of the product. So, the level of deformation and vibration that determines the components with high precision. Clearly the life of a machine is inversely proportional to the levels of vibration that the machine is subjected. The further process is carried out to under goes the deformation, natural frequency and displacement using Static analysis, Modalanalysis and Harmonic analysis respectively. To analyse the bed for possible material changes that could increase stiffness, reduce weight, improve damping characteristics and isolate natural frequency from the operating range. At present the Machine Beds are made of grey Cast Iron material, which cause a number of problems in Machine tools. Cast Iron cannot with stand the sudden loads during operation whenever the load reaches Ultimate loads it Simply fails without any prior indication. Casting is only the Manufacturing process used to produce the beds. This Process leads to various Casting Defects in the component. In order to have high strength and high stiffness the weight of the machine bed should be high.

Literature Review

Kim et al designedcomposite-foam-resin concrete sandwich structures for the design of machine tool [4]. **Chang and Leeet al** have fabricated a hybrid column by adhesively bonding glass fabric epoxy compositesimproved [5,6]. Although the stiffness of machine tool structures can be increased either byemploying higher stiffness materials or by increasing the sectional modulus of structures [7]. Inmachine tool, bed forms the vital part of the machine tool on which table and other relevant parts ofthe machine tool move. Many researches were carried out to enhance the performance of the machinetool bed by improving material property and optimizing structural attributes. It is therefore evidentthat the bed should be sufficiently strong and rigid. Further it should be easier to remove the chipsproduced during machining operation [8].

PROBLEM IDENTIFICATION

We are critically examine the from the previous research papers of the cnc lathe bed the following defects are found :

i. Increased weight
ii. Vibration during process
iii. Damping efficiency is high
iv. Cannot bear sudden loads
v. Casting defects of bed

METHADOLOGY

The composite material to be used is formulated for individual analysis,Which is followed by mixture analysis. There is also a structural modification Which is of hollow passage in the bed To reduce weight which can sustained by providing ribs made up of carbon polymer to support the bed during high efficiency modelling on CNC machine.

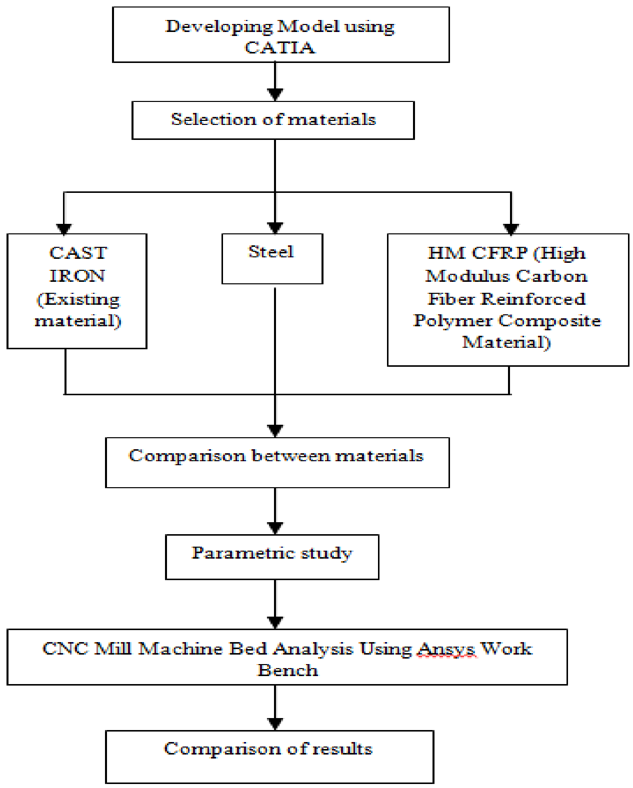

Fig.2 The flow chart representing the analysis procedure

Result and discussions

The modal experiments wererepeated five times on each bed model. The mode shapes were obtained.
In table 6, the first four natural frequencies are listed. The first natural frequencies of verticalribs with hollow bed one were increased by about 31.23 %. But the remaining frequencies were lowerthan those of original type. However, the lowest modal shapes are usually most important forstructural vibration. In addition, the first order mode shapes were the bending of bed along the Ydirection, which would be critical for machining precision. So it could be concluded that the verticalribs with hollow bed type reached better dynamic performance. There are several limitationsassociated with the scaled-model tests due to the different material and technological level. However,the focus is more on the relative effectiveness between original and vertical ribs with hollow bedmodels. So with the results comparison, the vertical ribs with hollow bed design have improved thestatic and dynamic performance of the bed, which is encouraging for further study. Casting can beused for manufacture.

CONCLUSIONS

(1) Based on the configuration principles, the existing bed was redesigned to improve the static and dynamic performances. Simulation results show that the static and dynamic performances of vertical ribs with hollow bed have been improved.
(2) Scale-down models were used to verify the improvements of vertical ribs with hollow bed design. Static and dynamic experiments show that the mass and deflection are reduced by 3.66% and 8.08%% respectively and the lower order natural frequencies are increased. Experimental results agreequalitatively with the FEM simulation.
(3) Structural vertical ribs with hollow offers a method to improve the conventional design of machine

structure. Based on structural modifications, ribs parameters and distributions can be furtheroptimized.

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