DESIGN AND ANALYSIS OF SPINDLE

V.MALLIKARJUNA REDDY[1],K.RAJASEKHARA REDDY[2], V.PURUSHOTHAM[3]

[1]PG Student, Dept. of Mechanical, *Indira institute of technology and sciences, markapur, AP, India*.
[2]*Assistant professor,* Dept. of Mechanical *engineering,Indira institute of technology and sciences, markapur, AP, India*.
[3] *Assistant professor, Head of the* Dept,Mechanical *engineering,Indira institute of technology and sciences, markapur, AP, India*

ABSTRACT-
In modern machine tool applications the performance of a machine tool is judged by its strength. The machine tool spindle has a profound impact on the overall machine performance. The work presented here provides machine tool spindle designers to develop spindles that are sufficiently stiff to meet their need.

In this we are using the dynamic analysis and the static analysis is use to calculate the deflection of spindle-bearing system. This analysis is to find out the deflections, stress induced

And the frequencies of the mode shape for both steel material and 20MnCr5 material in machine tool spindle. This project is on the application of computer aided analysis using finite element method. The boundary conditions, loads, material properties are added according as per the design. The resultant of the deformation and stresses and the frequency of mode shapes obtained are reported and discussed.

I. INTRODUCTION

In machine tools, a spindle is a rotating axis of the machine, which often has a shaft at its heart. The shaft itself is called as a spindle, but also, in shop-floor practice, to refer to the entire rotary unit, including not only the shaft itself, but its bearings and anything attached to it (chuck, etc.).

A machine instrument may have a few shafts, principally the headstock and tailstock axles on a seat machine. The primary axle is typically the greatest one. References to "the shaft" without promote capability infer the primary axle. Some machine devices that represent considerable authority in high-volume large scale manufacturing have a gathering of 4, 6, or significantly more fundamental shafts. These are called multi axle machines. For instance, pack drills and numerous screw machines are multi shaft machines. A seat machine has more than one shaft (checking the tailstock), it isn't known as a multi axle machine; it has one fundamental axle. Examples of spindles include.

Spindle Style: Belt-Driven or Integral Motor-Spindle

The principal choice which must be made is if a belt-driven shaft or vital engine axle configuration will be required this must be dictated by assessing the necessities of the machine device, Which incorporate the greatest speed and power and solidness is required and taken a toll is an essential factor as a belt driven axle for the most part is a lower cost arrangement than a necessary engine axle.

Contact Angle

All precision bearings are manufactured to a tolerance standard. The most commonly used standard in the United States is the ABEC standard (America Bearing Engineers Committee) this standardization has been accepted by the American National Standards Institute (ANSI) conform essentially with the equivalent standards of the International Organization for Standardization (ISO). ABEC standards define tolerances for major bearing dimensions and characteristics. They are divided into mounting dimensions (bore, I.D. and width) and bearing geometry. Accuracy ratings range from a low of ABEC 1, for a general purpose bearing, to a high of ABEC 9, which describes a high precision bearing suitable for use in a high speed spindle. Typically, spindle bearings are manufactured with geometry accuracy of ABEC 9, to provide minimum run out rotational accuracy. Bore, O.D., and width are manufactured to ABEC 7, which allows for a more reasonable fitting and installation.

Spindle Motor Design

Basic engine axles must use an electrical engine as a component of the rotor shaft. In this way, the engine size and limit will depend firmly upon the accessible space. As we have examined before, bearing size is basic in a rapid axle plan, so the engine shaft will influence the bearing size that can be utilized. The bearing size likewise influences the stacking ability, solidness, and greatest speed, so the engine attributes must match the bearing capacity.

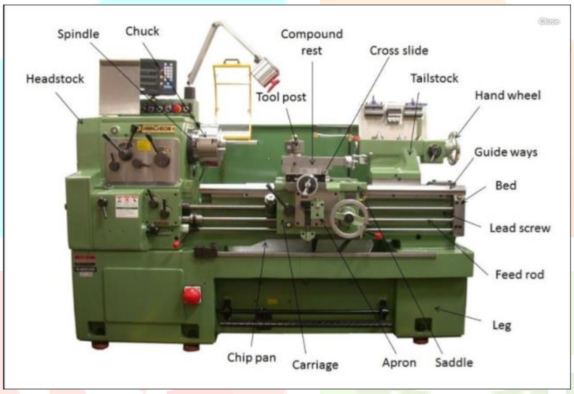
The most widely recognized sort of engine utilized as a part of fast engine shafts is an AC acceptance engine. In this outline, the rotor is connected to the axle shaft, either with a cement or warm clipping. The rotor and stator, the twisting in which the rotor spins, are for the most part given by an engine or drive provider. The rotor is appended to the pole amid get together. Following this, the direction is mounted to the front and back of the pole and the pole is then fitted into the shaft lodging.

The axle shaft is very vital, as it must exchange the power from the engine to the cutting instrument. The pole must find and bolster the heading, and contain the entire tooling framework also. One critical plan thought for the pole is bowing. Amid fast activity, the pole will display bowing attributes. The recurrence at which the pole will twist relies upon the breadth and length of the axle shaft.

SPINDLES USED FOR DIFFERENT MACHINERY

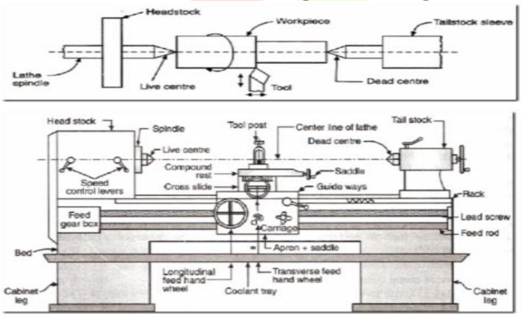
LATHE

A lathe machine is a machine tool which is used to remove metals from a work piece to give a desired shape and size. In other words it is a machine that is used to hold the work piece to perform various metal removing operations such as turning, grooving, chamfering, knurling, facing, forming etc with the help of tools. It is also called as mother of machine.



WORKING-PRINCIPLE

The lathe is a machine tool used principally for shaping pieces of metal (and sometimes wood or other materials) by causing the work piece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action.



II. LITERATURE REVIEW

1) Feng Cang-Xue (Jack) examined the effect of turning parameters on surface harshness.

He examined the effect of Feed, Speed and Depth of Cut, Nose range of hardware and work material at first glance unpleasantness of work material. He found that the encourage have most huge effect on the watched surface unpleasantness and furthermore watched that there were solid associations among various turning parameters.

2) JafarZare and Afsari Ahmad the execution qualities in turning tasks of Df2 (1.2510) steel bars utilizing TiN covered instruments. Three cutting parameters to be specific, cutting rate, nourish rate, and profundity of cut, will be upgraded with contemplations of surface harshness. The investigation demonstrates that the Taguchi technique is reasonable to understand the expressed inside least number of trials as contrasted and a full factorial outline. The principle goal of this examination was to show a deliberate technique of utilizing Taguchi plan strategy in process control of turning process and to discover a mix of swinging parameters to accomplish low material expulsion rate.

3) Prasad announced the advancement of an enhancement show for deciding the machining parameters for turning tasks as a piece of PC based generative CAPP framework. The work piece material considered in their examination incorporates steel, cast press, aluminum, copper and metal. Rapid steel and uncoated carbide embed device materials are considered in this examination. The minimization of generation time is taken as the reason for defining the goal work. The requirement considered in this examination incorporate power, surface complete, resistance, work piece unbending nature, scope of cutting rates, most extreme or least profundity of cut and aggregate profundity of cut. Enhanced numerical models are planned by altering the resilience and work piece inflexibility requirements for multipass turning tasks. The planned models are fathomed by the blend of geometric and straight programming procedures.

4) Feng explored for the expectation of surface harshness in get done with turning task by building up an experimental model through considering working parameters, for example, workpiece hardness, nourish, cutting apparatus point edge, profundity of cut, axle speed and cutting time. Information mining methods, non-direct relapse examination with logarithmic information change were utilized for building up the experimental model to anticipate the surface harshness.

5) Kirby built up the forecast demonstrates for surface harshness in turning task. The relapse display was created by a solitary cutting parameter and vibrations along three tomahawks were decided for in-process surface unpleasantness expectation framework. By utilizing various relapse and investigation of fluctuation a solid straight relationship among the parameters sustain rate and vibration estimated in three tomahawks and the reaction surface harshness was found. The creators showed that axle speed and profundity of slice may not really must be settled for a compelling surface harshness expectation demonstrates.

6) Singh contemplated on enhancement of encourage constrain through setting of ideal benefit

of machining parameters in particular speed, bolster and profundity of cut in turning of EN24 steel with TiC covered tungsten uncoated carbide embeds. The creators utilized Taguchi's parameter configuration approach and reasoned that the impact of profundity of cut and nourish in variety of bolster compel were influenced more when contrasted with speed.

7) Ahmed built up the procedure required for acquiring ideal machining parameters for forecast of surface unpleasantness in Al turning. For improvement of experimental model nonlinear relapse investigation with logarithmic information change was connected. The created display indicated little blunders and palatable outcomes. The investigation presumed that low nourish rate regarded create decreased surface harshness and furthermore the rapid could deliver high surface quality inside the exploratory space.

8) Marinkovic Velibor examined the Taguchi technique for streamlining of surface harshness in dry single point turning of combination steel. They inferred that the surface unpleasantness is consistently enhanced with increment in cutting rate, yet in increment in nourish rate and profundity of cut causes critical crumbling of surface harshness. The outcomes got utilizing the Taguchi streamlining strategy uncovered that cutting rate ought to be kept at the largest amount, while both encourage rate and profundity of cut ought to be kept at the most minimal level.

9) Lin and chang examined the impact of outspread vibrations on surface complete, and found that the plentifulness and recurrence because of axle speed both effectsly affected the surface geology. Shaft vibrations because of harmed or uneven jaws, for instance, would along these lines have an impact of surface complete the process of relying upon the level of out-of-adjust condition and the speed of the axle.

10) Vernon and Ozel led thinks about utilizing the Taguchi Parameter Design strategy to optimize turning parameters. These examinations influenced utilization of different work to piece materials and controlled parameters to improve surface unpleasantness, dimensional exactness, or device wear. Each used diverse mixes and levels of cutting apparatus geometry, coolant, and other machining parameters. This would show that there are various diverse parameters that can be incorporated into this sort of study, and one of a kind blend of parameters can be custom fitted to suit a given circumstance.

III.FINITE ELEMENT METHOD

3.1 Introduction:

The basic idea in the Finite Element Method is to find the solution of complicated problem with relatively easy way. The Finite Element Method has been a powerful tool for the numerical solution of a wide range of engineering problems. Applications range from deformation and stress analysis of automotive, aircraft, building, defense, and missile and bridge structures to the field analysis of dynamics, stability, fracture mechanics, heat flux, fluid flow, magnetic flux, seepage and other flow problems. With the advances in computer technology and CAD systems, complex problems can be modeled with relative ease. Several alternate configurations can be tried out on a computer before the first prototype is built. The basics in engineering field are must to idealize the given structure for the required behavior. The proven knowledge in the computational aspects of the Finite Element Method is essential. In the Finite Element Method, the solution region is connected as built up of many small, interconnected sub regions called finite elements.

III. FINITE ELEMENT METHOD

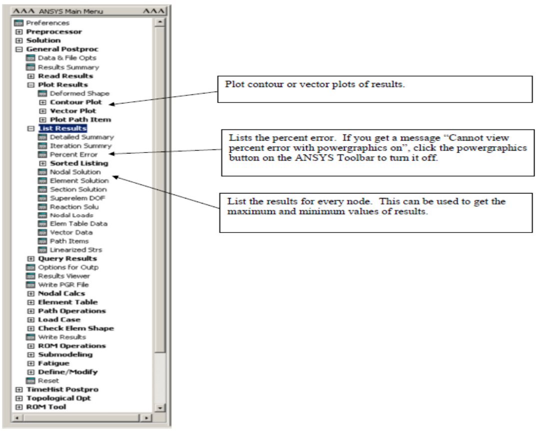
3.1 Introduction:

The basic idea in the Finite Element Method is to find the solution of complicated problem with relatively easy way. The Finite Element Method has been a powerful tool for the numerical solution of a wide range of engineering problems. Applications range from deformation and stress analysis of automotive, aircraft, building, defense, and missile and bridge structures to the field analysis of dynamics, stability, fracture mechanics, heat flux, fluid flow, magnetic flux, seepage and other flow problems. With the advances in computer technology and CAD systems, complex problems can be modeled with relative ease. Several alternate configurations can be tried out on a computer before the first prototype is built. The basics in engineering field are must to idealize the given structure for the required behavior. The proven knowledge in the computational aspects of the Finite Element Method is essential. In the Finite Element Method, the solution region is connected as built up of many small, interconnected sub regions called finite elements.

IV. INTRODUCTION ABOUT ANSYS

ANSYS is commercial finite-element analysis software with the capability to analyze a wide range of different problems. ANSYS runs under a variety of environments, including IRIX, Solaris, and Windows NT. Like any finite-element software, ANSYS solves governing differential equations by breaking the problem into small elements. The governing equations of elasticity, fluid flow, heat transfer, and electro-magnetism can all be solved by the Finite element method in ANSYS. ANSYS can solve transient problems as well as nonlinear problems. This document will focus on the basics of ANSYS using primarily structural examples.

ANSYS is available on all Menet Sun and SGI machines. It is available on the Linux machines by remote-login only. On the right side, rumor has it that ANSYS is looking into a Linux port. Currently, Menet uses the Research/Faculty version of ANSYS 12.1. The Research/Faculty license level permits larger, more complex models than does the current level running on the IT Labs machines. This document is meant to be a starting point. The material covered here is by no means comprehensive. In fact, we will only scratch the surface of ANSYS's capabilities. Given that, I will try to cover most of what I know about ANSYS and some tricks I have learned while using it. The document will begin with two simple examples, taking the user through all of the steps of creating a model, meshing, adding boundary conditions, solving, and, finally, looking at the results. The remainders of this document will over tips and tricks for each of the steps.



V. PROCEDURE FOR ANALYSIS OF SPINDLE

5.1 PROCEDURE FOR STATIC ANALYSIS OF SPINDLE USING STEEL MATERIAL.

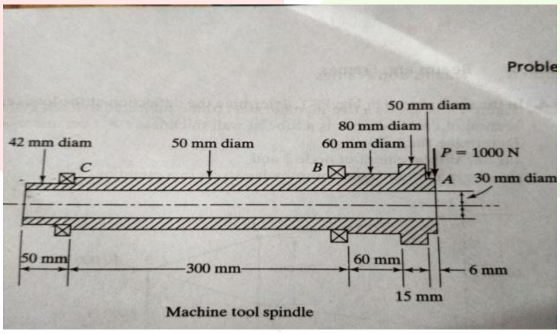


Fig shows 2d dimensions of spindle

CREATE – AREAS- ARBITRARY - BY LINES- SELECT ALL LINES

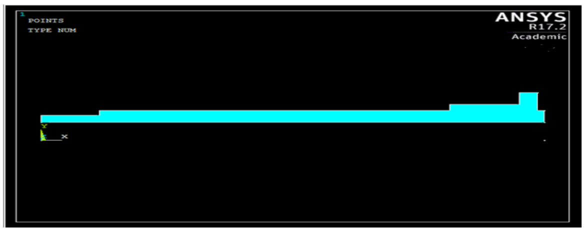


Fig Created area

MESHING – VOLUMES- FREE- SELECT VOLUME- OK

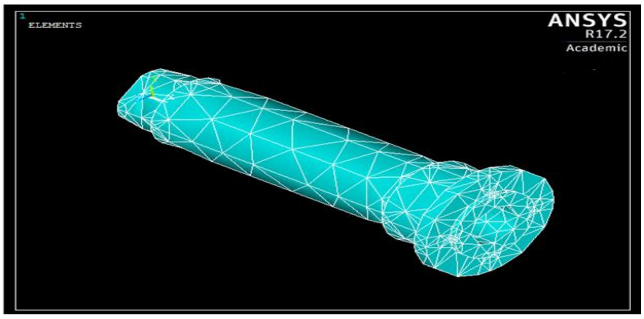


Fig Mesh model

PLOT RESULTS - CONTOURED PLOT- VONMISES STRESS- AT Z COMPONENT

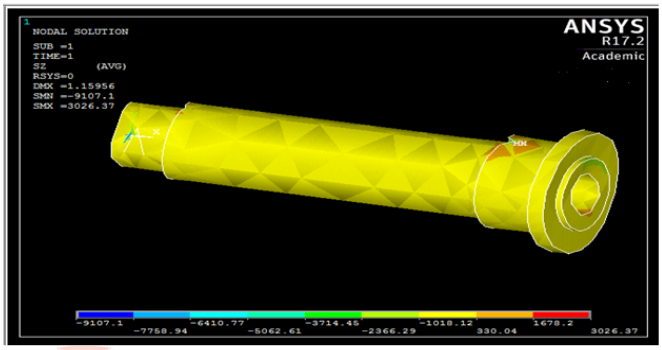


Fig Stress values along Z-axis

PLOT RESULTS - CONTOURED PLOT- VONMISES STRESS

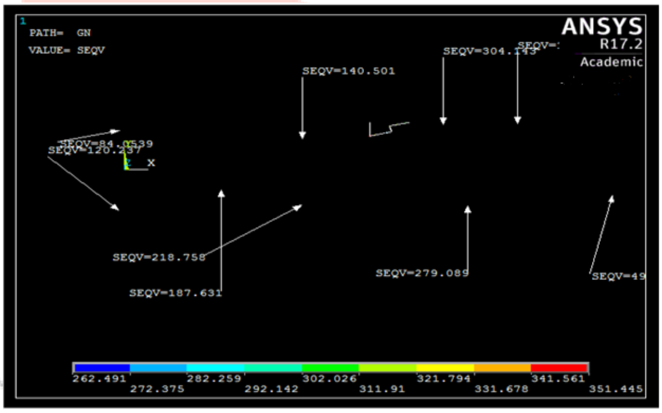


Fig Von mises Stress values along geometry

MODAL ANALYSIS RESULTS OF STEEL MATERIAL

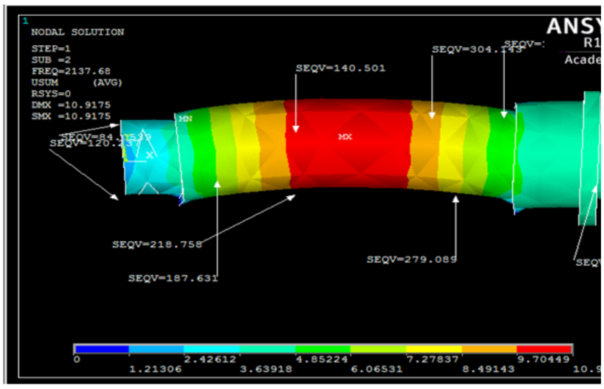


Fig .5.19 Displacement vector sum of 2nd frequency

STATIC ANALYSIS OF SPINDLE USING 20MnCr5 MATERIAL.

PLOT RESULTS - CONTOURED PLOT-VONMISES STRESS

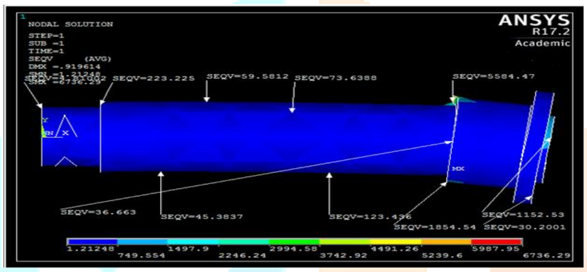


Fig .5.28 Von mises Stress values along geometry.

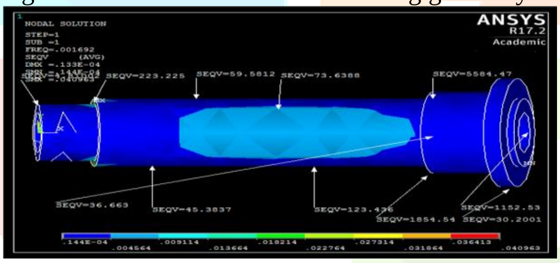


Fig .5.35 Von mises stress values

VI. CONCLUSION

The aim of this project is to model and to analysis on the Machine tool Spindle. Static analysis and Dynamic analysis is to calculate the deflection of spindle-bearing system. And it is performed by applying the loads and boundary conditions on the component using ANSYS by finite element method. The work presented here provides machine tool spindle designer to develop spindles that are sufficiently stiff to meet their need.

Total deformation and Von-Mises stresses and Displacement vector frequency are obtained by performing the analysis.
The three materials have been taken and both the static and dynamic analysis has been performed. And the results obtained by the materials has been noted and discussed.

FUTURE SCOPE

High speeds can be accomplished through the use of magnetic or fluid bearings. These non-contact bearing systems will exhibit no mechanical wear, so their life will be very long. Diagnostic information can be relayed to the CNC for action. Superconducting materials and new motor technologies will provide compact, high power motor system's that produce little heat. Thermal affects on the spindle shaft can be compensated for electronically.

REFERENCES

[1]Thitima Jintanawan, "Effects of distributed bearing forces and bearing locations on rocking vibration of FDB (Fluid dynamic bearings) spindle systems", ASME Information Storage and Processing Systems Conference, 2005

[2]. Al-Shareef.K.J.H, Brandon. J.A, "Effects of variations in the design parameters on the dynamic performance of machine tool spindle-bearing systems", International Journal of Machine Tools and Manufacture, Vol 30, Pages 431–445, 1990.

[3]. Rathour. A. N, Darji P. H, "Design, development and analysis of high speed spindle: a review" Department of Mechanical Engineering, C. U. Shah College of Engineering and Technology, Surendranagar, Gujarat.

[4]. Machine tool design hand book by central machine tool institute, Bangalore.

[5]. Ball and roller bearing engineering by palmgren.A, Third edition 1959, burkank and co, Philadelphia

[6]. Luk, Y.W. and Mitchell, L.D, "System modeling and modification via modal IJSER analysis", Proceedings of the first Int

[7].Tirupathi R.Chandrupatla and Ashok D.Belegundu "Finite Elements in Engineering" Third Edition

[8] PRASAD RAO, T.H.V. Computer Aided Static and Dynamic Analysis of Machine Tool Spindle System. Proc. 8th AIMTDR Conf. (INDIA) pp 189–193.

[9] SKF (1962) "Engineering Data" and (1969) "Bearings in Machine Tools" Catalogue

[10] JANA, S (1974) Some aspects of Machine Tool Spindle Design, Machine Building Industry Vol.13.