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VIBRATION CONTROL OF MACHINE TOOL BED BY COMPOSITE MATERIAL

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ABSTRACT:

The present study focuses on welding of P91 steel Nozzle with P91 steel pipe. The arc welding is the best choice for an existing joining of pipe with nozzle and it shows some causes at the joining of root. In the present developed method, Root joining is done separately by Tungsten inert gas welding method and then arc welding has to be followed to complete the entire section up to the end. For analyzing penetration quality, the Magnetic particle test and Ultrasonic test were conducted and it shows the acceptable level. Post heat treatment also done to release the stress. The mechanical properties like hardness & Tensile test are done.

1. INTRODUCTION:

1.1 MACHINE TOOL VIBRATIONS AND THEIR ADVERSE EFFECTS:

Machining and measuring operations are invariably accompanied by relative vibrations between work piece and tool. These vibrations are due to one or more of the following causes:

(1) in homogeneities in the work piece material;

(2) Variation of chip cross section;

(3) Disturbances in the work piece or tool drives;

(4) Dynamic loads generated by acceleration/deceleration of massive moving components;

(5) Vibration transmitted from the environment;

(6) Self-excited vibration generated by the cutting process or by friction (machine-tool chatter).

The adverse and undesirable effects of these vibrations include reduction in tool life, improper surface finish, unwanted noise and excessive load on the machine tool. A machine tool is expected to have high stiffness in order to avoid such effects. Hence the machines are to be made of robust structured materials through passive damping technology to suppress the chatter vibrations and thereby increasing the production rates.

1.2 MAIN OBJECTIVE OF THE RESEARCH WORK:

The main objective of the work is to study passive damping techniques in machine tool structures using composite materials and to reduce vibrations in the milling machine during cutting processes by using these materials as the base of the work piece which act like a bed absorbing vibration forces and record the vibration curves using digital storage phosphorous oscilloscope. Composites can be used in machine tool structures because of its inherent damping characteristics which reduces the undesirable effects of the vibrations. Passive damping technology has a wide variety of engineering applications, including bridges, engine mounts, and machine components such as rotating shafts, component vibration isolation, novel spring designs which incorporate damping without the use of traditional dashpots or shock absorbers, and structural supports

2. LITERATURE REVIEW:

2.1 INTRODUCTION TO MACHINE TOOLS:

The function of machine tool is to produce a workpiece of the required geometric form with an acceptable surface finish at high rate of production in the most economic way

[1]. In fact, general purpose machine tools, CNC lathes and machining centres are designed to cope with low cutting speeds with high cutting forces as well as high cutting speeds with low cutting forces. Machine Tool Structure must possess high damping, high static and dynamic stiffness. High cutting speeds and feeds are essential requirements of a machine tool structure to accomplish this basic function. Therefore, the material for the machine tool structure should have high static stiffness and damping in its property to improve both the static and dynamic performance..The static stiffness of a machine tool can be increased by using either higher modulus material or more material in the structure of a machine tool. However, it is difficult to increase the dynamic stiffness of a machine tool with these methods because the damping of the machine tool structure cannot be increased by increasing the static stiffness. Sometimes high specific stiffness is more important than stiffness to increase the natural frequency of the vibration of the machine tool structure in high speed machining

[2]. Often the most economical way of improving a machine tool with high resonance peaks is to increase the damping rather than the static stiffness even though it is not easy to increase the damping of the machine tool structure. The chatter is a nuisance to the metal cutting process and can occur on any chip producing tool. Chatter or Self-excited vibrations occurs when the width of cut or cutting speed exceeds the stability limit of the machine tool

[3, 4]. The effects of chatter are all adverse, affecting surface finish, dimensional accuracy, tool life and machine life

[5].When the machine tool is operated without any vibration or chatter, the damping of the machine tool plays no important role in machining. However, the machine tool structure has several resonant frequencies because of its continuous structural elements. If the damping is too small to dissipate the vibrational energy of the machine tool, the resonant vibration occurs when the frequency of the machining operation approaches one of the natural frequencies of the machine tool structure. Therefore the material for the machine tool structure should have high static stiffness and damping in its property to improve both the static and dynamic performance

3. PROBLEM IDENTIFICATION

3.1 COMPOSITE MATERIALS:

Composite materials, often shortened to composites, are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct at the macroscopic or microscopic scale within the finished structure. The constituents are combined in such a way that they keep their individual physical phases and are neither soluble in each other nor form a new chemical compound. One constituent is called reinforcing phase which is embedded in another phase called matrix. The most visible applications is pavement in roadways in the form of either steel and aggregate reinforced Portland cement or asphalt concrete.

Mostly fibers are used as the reinforcing phase and are much stronger than the matrix and the matrix is used to hold the fibers intact. Examples of such composites are an aluminums matrix embedded with boron fibers and an epoxy matrix embedded with glass or carbon fibers. The fibers may be long or short, directionally aligned or randomly orientated, or 'some sort of mixture, depending on the intended use of the material. Commonly used materials for the matrix are polymers, metals, ceramics, carbon and fibers are carbon (graphite) fibers, aramid fibers and boron fibers.

Fiber-reinforced composite materials are further classified into the following
: a) continuous fiber-reinforced

b) discontinuous aligned fiber-reinforced

c) discontinuous random-oriented fiber-reinforced.

4. METHODOLOGY

4.1 MILLING MACHINE:

A milling machine is a machine tool used to machine various materials. Milling machines are often classed in two basic forms, horizontal and vertical, which refers to the orientation of the main spindle. Both types range in size from small, benchmounted devices to room-sized machines. Unlike a drill press, which holds the workpiece stationary as the drill moves axially

to penetrate the material, milling machines also move the workpiece radially against the rotating milling cutter, which cuts on its sides as well as its tip. Workpiece and cutter movement are precisely controlled to less than
0.001 in (0.025 mm), usually by means of precision ground slides and lead screws or analogous technology. Milling machines may be manually operated, mechanically automated, or digitally automated via computer numerical control (CNC). They can perform a vast number of operations, from simple to complex (slot and keyway cutting, planing, drilling to contouring, diesinking). Cutting fluid is often pumped to the cutting site to cool and lubricate the cut and to wash away the resulting swarf. The different types of milling machines are

1) Bed mill
2) Box mill
3) Gantry mill
4) Horizontal boring mill
5) Turrent mill
6) Knee and Column mill

Horizontal knee-and-column mill:

The most distinguishing characteristic type of milling machine is the knee and column configuration. This type of milling machine is unique in that the table can be moved in all three directions. The table can be moved longitudinally in the X-axis as well as in and out on the Y-axis. Since the table rides on top of the knee, the table can be moved up and down on the Z-axis. There are several different types of knee and column type milling machines, but they all have the same characteristic. The knee slides up and down on the column face.

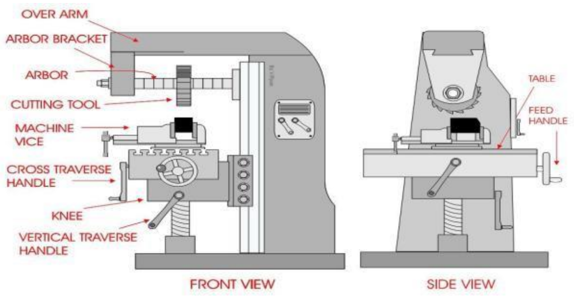

Fig 4.1 Horizontal Knee and Column Milling Machine

5. DESIGN AND CALCULATION

5.1 DEFINITION OF DAMPING:

In physics, damping is any effect that tends to reduce the amplitude of oscillations in an oscillatory system, particularly the harmonic oscillator. In mechanics, friction is one such damping effect. In engineering terms, damping may be mathematically modeled as a force synchronous with the velocity of the object but opposite in direction to it. If such force is also proportional to the velocity, as for a simple mechanical viscous damper (dashpot), the force F may be related to the velocity v by $F= cv$, where c is the viscous damping coefficient, given in units of newton-seconds per meter.

5.2.1 Material (Internal) damping:

Internal damping of materials originates from the energy dissipation associated with microstructure defects, such as grain boundaries and impurities; thermoelastic effects caused by local temperature gradients resulting from non uniform stresses, as in vibrating beams; eddy current effects in ferromagnetic materials; dislocation motion in metals; and chain motion in polymers. Several models have been employed to represent energy dissipation caused by internal damping. This variety of models is primarily a result of the vast range of engineering materials; no single model can satisfactorily represent the internal damping characteristics of all materials.

5.2.2 Structural damping:

Rubbing friction or contact among different elements in a mechanical system causes structural damping. Since the dissipation of energy depends on the particular characteristics of the mechanical system, it is very difficult to define a model that represents perfectly structural damping. The Coulomb-friction model is as a rule used to describe energy dissipation caused by rubbing friction. Regarding structural damping (caused by contact or impacts at joins), energy dissipation is determined by means of the coefficient of restitution of the two components that are in contact

5.2.3 Fluid damping:

When a material is immersed in a fluid and there is relative motion between the fluid and the material, as a result the latter is subjected to a drag force. This force causes an energy dissipation that is known as fluid damping.

The damping phenomenon can be applied to the machine tool systems in two ways :

1. Passive damping
2. Active damping

Passive damping refers to energy dissipation within the structure by add on damping devices such as isolator, by structural joints and supports, or by structural member's internal damping. Active damping refers to energy dissipation from the system by external means, such as controlled actuator.

6 RESULT AND DISCUSSION

6.1 EXPERIMENTAL SET-UP:

Table 6.1 Specimen Details:

Material No	Name of the Material	Cross section (mm)
1	Glass Fiber Polyester	70x25x6
2	Glass Fiber Epoxy	70x25x6
3	Natural Fiber Epoxy	70x25x6

Digital Storage Oscilloscope Tektronix 4000 series:

- Display: - 8x10 cm. rectangular mono-accelerator c.r.o. at 2KV e.h.t. Trace rotation by front panel present.

- Vertical Deflection: - Four identical input channels ch1, ch2, ch3, ch4.
- Band-width:- (-3 db) d.c. to 20 MHz (2 Hz to 20 MHz on a.c.)
- Sensitivity: - 2 mV/cm to 10 V/cm in 1- 2-5 sequence. Accuracy: - ± 3 %
- Variable Sensitivity:- > 2.5% 1 range allows continuous adjustment of sensitivity from 2-1(mV/cm).
- Input impedance: - 1M/28 PF appx.
- Input coupling: - D.C. and A.C. Input protection: - 400 V d.c.
- Display modes: - Single trace ch1 or ch2 or ch3 or ch4.
- Dual trace chopped or alternate modes automatically selected by the T.B. switch.

7. CONCLUSION:

7.1 FUTURE SCOPE:

1) Use of composite materials reduces the vibrations of the system as desired which is justified from the experimental observations. With increase in number of layers of composites at an optimum level the vibrations are decreased considerably.
2) Effective damping can be obtained only by proper fixation of the composites to the bed and the work piece. With improper nut and bolt joint there is a danger of additional slip vibrations between the plates. Hence a proper and intact joint is preferably necessary. On the contrary the optimum number of plates is decided and a single plate of optimum thickness is used as the bed material.
3) Extensive experiments with different layer combinations along with sandwich plates are carried out to determine vibration response of work specimen with specified machining parameter, i. e., depth of cut and feed rate. The experiments are duly carried out at small feed, low depth of cut and low cutter speed to primarily investigate the scope of damping phenomenon in composite materials.
4) Abrupt increase in vibration amplitude has also been observed with increase in number of layers of composites above an optimum limit interposed between the table and work piece
5) The results obtained are compared with respect to each other. Out of the two materials, signal amplitudes obtained are less for Glass fiber epoxy material. Therefore, it can be concluded that Glass fiber epoxy material can be used for machine tool structures to reduce the undesirable effects of vibrations.
6) The density of the matrix phase plays an important role in damping the vibrations. With same fiber phase, lower the matrix phase density more is the damping ability. Though both the thermosets polyester and epoxy have same material properties like Young’s modulus, Rigidity modulus and Poisson’s ratio, epoxy has more damping ability than polyester because of its low density.

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