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Research Article

Experimental Analysis on Surface Finish by controlling the vibrations using Composite Materials on Radial Drilling Machine

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Abstract

The present paper is an experimental study aiming to analyze and improve the surface finish during drilling operation by controlling the unwanted vibrations in machine tool structures using composite materials. In general unwanted vibrations results in degraded quality on machined parts, shorter tool life and unpleasant noise which must be arrested in order to ensure higher accuracy along with productivity. Aim of study is to control parameters like unwanted vibrations using different thickness of composite plates, which affects on response like amplitude of vibration and surface roughness of machined part. In present work machine tool vibration on slotted table Radial drilling machine have been reduced using composites. In this work glass fiber epoxy plates and glass fiber polyester plates are used as composites. Initially holes are drilled on each composite plate. Mild steel plate is placed on the composite plates and setup is fixed to the table of radial drilling machine using nuts and bolts. A drilling operation is carried out using glass fiber epoxy and glass fiber polyester as a substitute for the base of work piece. Amplitude of vibrations is recorded on the screen of digital phosphor storage oscilloscope of Tektronix 1000 series through a magnetic base vibration pickup and Surface roughness of machined mild steel plate is measured by surface roughness tester machine (Sv-400). The experimental results reveal that the use of composite layers have significantly improved the surface quality and reduced the roughness value by 40%.

Keywords: *Radial drilling machine, vibrations, surface roughness, composite layers, glass fiber epoxy, glass fiber polyester*

1. Introduction

[1]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 and surface finish during drilling operation. Bert and Nashif et al. had done survey on the damping capacity of fiber reinforced composites and found out that composite materials generally exhibit higher damping than structural metallic materials. Chandra et al. has done research on damping in fiber-reinforced composite materials. Gibson, et.al, worked on complex moduli of aligned discontinuous fiber discontinuous reinforced polymer composites, Nisarg M. Trivedi and J.R Mevada et.al have worked on improvement of surface finish by vibration control using composite materials in milling machine. Mohamed Elajrami et al, have worked to analyze the effects of drilling parameters on hole quality in aluminum alloy 2024-T3. Krishna mohana rao.G and Vijay Mohan.s et.al worked on Analysis of Passive Damping Technique on Conventional Radial Drilling Machine Tool Bed using Composite Materials.

2. Experimental Details

As shown in figure 1, the specimens of 210 x 210 x 6 size are prepared for Glass Fiber Epoxy and Glass Fiber Polyester. Size of the mild steel plate is taken as 210 x 210 x 10mm, figure 2 shows the digital storage oscilloscope with is used to record the signal amplitude of vibrations; figure 3 shows Magnetic base vibration pickup and figure

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4 shows surface roughness apparatus used for measuring surface roughness.

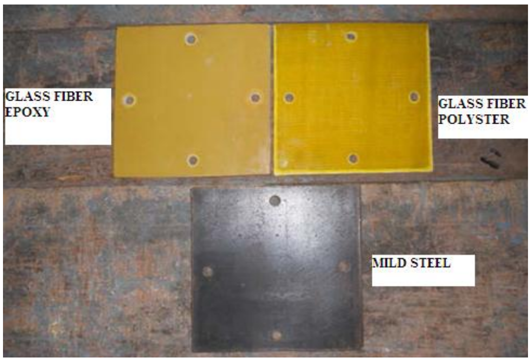


Fig. 1 Composite Layers

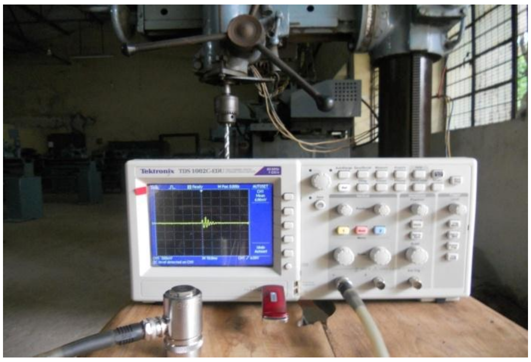


Fig. 2 Digital Storage Oscilloscope.

Fig. 3 Magnetic Base vibration pickup

Fig. 4 Surface roughness apparatus (surftest Sv-400)

3. Experimental set up

The Drilling operation is carried out using a 12mm drill bit to a depth of 3mm with while increasing the number of composite plates from one to five.

Fig. 4 Experimental Setup

A contact type magnetic base vibration pickup connected to a digital phosphor storage oscilloscope of Tektronix 1000 series is used to pick up amplitude. Finally Mild steel plate alone is machined with no layer under it. Figure 4 shows the experimental setup.

3.4 Experimental Procedure

- Initially four holes of 12mm diameter are drilled on the specimen’s at the respective positions and the holes are needed to be coaxial when the plates are placed upon one another for fixing during operation.
- The glass fiber epoxy and polyester composite plates are thoroughly cleaned.
- In order to clear off the irregularities the plates are fixed to a bench vice and the edges are filed to the exact dimensions for the operations.
- After that Five **Glass fiber polyester** sheets each of 6mm thickness are placed on the slotted table and the work piece (i.e., **Mild Steel**) is then mounted on it and tightly bolted to slotted table of the Drilling machine using bolts and nuts.
- A contact type magnetic base vibration pickup connected to a digital phosphor storage oscilloscope of Tektronix 1000 series is placed on the mild steel.
- A drilling operation with required depth of cut of 3 mm is performed during all the experiments.
- During the drilling operation the response signals with respect to amplitude are recorded and stored on the screen of the storage oscilloscope into a portable device.
- Then the numbers of layers are reduced to four layers and the observations are recorded.
- In this way, the experiments are repeated by decreasing the number of layers of various composites.
- The experiments are conducted for 5, 4,3,2,1 number of layers respectively.
- The whole process is again repeated using **Glass fiber epoxy** plates and also with the Sandwich plates (**both fiber epoxy and polyester**) combination of 10, 8,6,4,2 layers respectively.
- Finally Mild steel plate alone is machined with no layer under it and the readings are noted and compared.
- After performing the Drilling operations now set up the surface roughness tester in position and take the reading of each hole on mild steel plate placed above the glass fiber epoxy and polyester and sandwich type composite material respectively.
- And the amplitude and surface roughness readings are noted and tabulated.

5. Result and discussions

Table 1 gives the experimental values for glass fiber Epoxy plates. It is observed that when the number of layers are increased, the signal amplitude has decreased this shows presence of composite layers increased thecounter vibration characteristics of the system. It is also observed that when number of layers are increased from 3 to 5 the amplitude of vibrations are increased abruptly, it represents after a certain limit it would have a negative effect with much of the progress and the surface roughness value has decreased in increasing the number of layers i.e., as the thickness of the composite layers increased there is an abrupt change in surface roughness this indicates that the surface quality of the drilled hole has increased with increase in thickness of composite layers.

Table 1 Experimental signal amplitude and surface Roughness data recorded for Glass fiber epoxy plates

Sl. No	Depth of cut (mm)	No.of layers	Signal amplitude (mv)	Surface roughness (ra)
1	3	1	32.5	1.86
2	3	2	28.8	1.34
3	3	3	51.1	2.53
4	3	4	56.2	2.72
5	3	5	63.2	2.89

Table 2 Experimental signal amplitude and surface Roughness data recorded for Glass fiber Polyester plates

Sl. No	Depth of cut (mm)	No.of layers	Signal amplitude (mv)	Surface roughness (ra)
1	3	1	51.2	2.59
2	3	2	32.4	1.91
3	3	3	22.2	1.32
4	3	4	44.4	2.43
5	3	5	48.9	2.54

Table 2 gives the experimental values for glass fiber Polyester plates. It is observed that when the number of layers are increased, the signal amplitude has decreased this shows presence of composite layers increased the counter vibration characteristics of the system. It is also observed that when number of layers are increased from 4 to 5 the amplitude of vibrations are increased abruptly, it represents after a certain limit it would have a negative effect with much of the progress and the surface roughness value has decreased in increasing the number of layers i.e., as the thickness of the composite layers increased there is an abrupt change in surface roughness indicates the surface quality of the drilled hole has increased with increase in thickness of composite layers.

Table 3 Experimental signal amplitude and surface Roughness data recorded for Sandwich plates

Sl. No	Depth of cut (mm)	No.of layers	Signal amplitude (mv)	Surface roughness (ra)
1	3	2	57.1	2.79
2	3	4	56.6	2.64
3	3	6	30.6	1.71
4	3	8	48.2	2.49
5	3	10	51.1	2.61

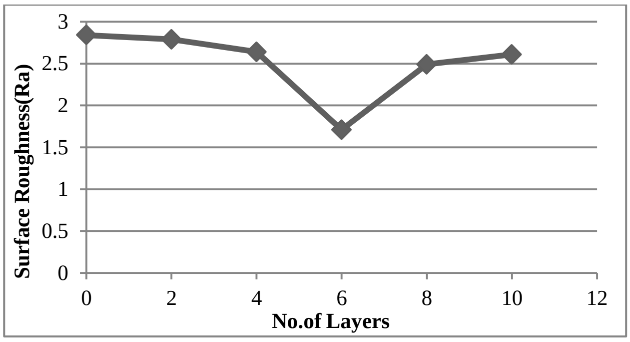
Table 3 gives the experimental values for sandwich plates. It is observed that when the number of layers are increased, the signal amplitude has decreased this shows presence of composite layers increased the counter vibration characteristics of the system. It is also observed that when number of layers are increased from 8 to 10 the amplitude of vibrations are increased abruptly, it represents after a certain limit it would have a negative effect with much of the progress and the surface roughness value has decreased in increasing the number of layers i.e., as the thickness of the composite layers increased there is an abrupt change in surface roughness indicates the surface quality of the drilled hole has increased with increase in thickness of composite layers.

Table 4 Experimental signal amplitude and surface Surface Roughness data recorded for Mild steel plate

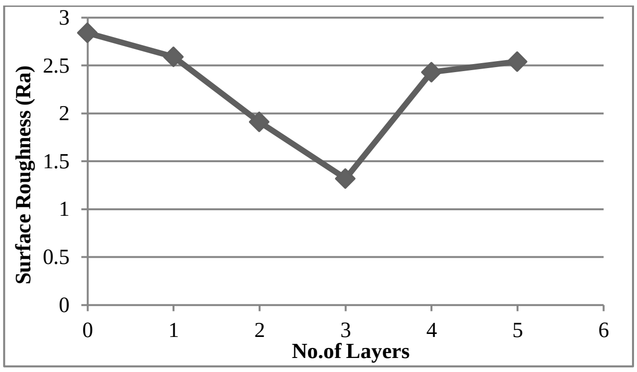
Sl.no	Depth of cut (mm)	No.of layers	Signal amplitude (mv)	Surface roughness (ra)
1	3	1	58.6	2.84

6. Discussions

1. The Graph shown below depicts that variation of surface roughness with respect to No. of Layers with sandwich plates (i.e., both glass fiber Epoxy and glass fiber Polyester) as a machine tool bed during drilling operation.



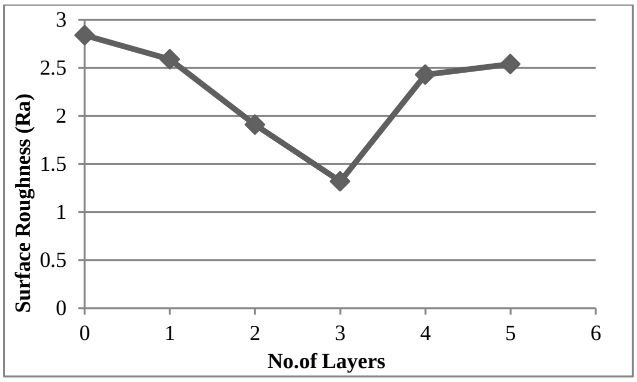
Plot between No. of Layers Vs Surface Roughness for sandwich plates.



Plot between No. of Layers Vs Surface Roughness for Glass fiber Epoxy Plates

2. The Graph shown below depicts that variation of surface roughness with respect to No. of Layers of Glass fiber Epoxy as a machine tool bed during drilling operation.

3. The Graph shown below depicts that variation of surface roughness with respect to No. of Layers of Glass fiber Polyester as a machine tool bed during drilling operation.



Plot between No. of Layers Vs Surface Roughness for polyester plates.

Conclusions

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) It is observed from the graphs that increase in no. of layers had increased the ability to absorb the vibrations within the composite layers resulting in decrease in surface roughness.
3) The results obtained are compared with respect to each other. Out of the two materials, signal amplitudes and surface roughness values 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 and to increase the surface quality of machined parts.
4) More over the surface roughness values reveal that the use of composite layers have significantly improved the surface quality and reduced the roughness value by 40%.
5) Improvement of surface quality of drilling operation can be improved by using composite materials as a substitute for machine tool bed compared with conventional bed material.

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