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# Analysis of Passive & Active Fluid Damper of Wood Router

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**Abstract -** *Wood router machine is a high speed (hand held) wood working machine uses for removing material from the wood work-piece. Induced vibrations make it difficult to operate the machine for longer time and also tool consumption per unit cut has been found to be very high. While using the Router, we are facing the problem of Hand arm vibration (HAV). Hand-arm vibration is vibrations transmitted from a work process to workers' hands and arms. It caused due to operating handheld power tools, hand-guided equipment and by holding materials being processed by machines. Multiple studies have shown that frequent exposure to HAVs can lead to permanent adverse health effects, which are most likely to occur when contact with a vibrating tool or work process is a regular and significant part of a person's job. Analysis of the developer router will be with and without passive-active fluid damper at same cutting speed. The values of time based frequency will be determined using a Fast Fourier transform (FFT) analyzer on different component, the final conclusion will be drawn on the basis experimental results.*

***Key Words*:** Hand Arm Vibration (HAV), Fast Fourier transforms (FFT), Passive fluid damper, Active fluid Damper etc.

## 1. INTRODUCTION

Routing is applied to relatively soft and brittle materials, typically wood. As these materials are soft in small sections, router may run at extremely high speeds and so even a small router may cut rapidly. When milling metals, the material is relatively ductile, although remaining strong, even at a small scale. The cutters are thus runs more slowly, even when used in multi-horsepower milling machine.

There are two types of routers-plunge and fixed. When using a plunge base router, the sole of the base is placed on the face of the work with the cutting bit is raised above the work piece, then the motor is turned on and the cutter is moved downward into the work piece. For a fixed-base router, the cutting depth is set before the tool is turned on. The sole-plate is either rested flat on the workpiece overhanging the edge so that the router bit is not contacting the work (and then entering the work from the side, then the motor is turned on), or the sole-plate is placed at the required angle with the bit above the work and the bit is "rocked" into the work once the motor is turned on. In each case, the bit cuts its way in, but the plunge router does it in a more refined way, although the bit used must be shaped so that it bores into the wood when lowered.

The base plate (sole plate) is generally circular and may be used in conjunction with a fence attached to the base, which then ties the router against the edge of the work, or via a straightedge clamped across the work to obtain a straight cut. Other means of guiding the machine include the template guide bushing secured in the base around the router cutter, or router cutters with built in guide bearing. Router and cutter run against straight edges. Without this, the varying force reaction of the wood against the torque of the tool makes it impossible to guide with the precision normally required.

**Fig -1**: Wood router

A wood router is a tool used to rout out (hollow out) an area on the face of a relatively hard work piece typically of wood or plastic. The main applications of wood routers are woodworking, especially cabinetry. The hand tool form of router is the original form. Wood router is a specialized type of hand tool with a broad base and a narrow blade projecting well beyond its base plate power tool form of router, with a motor driven spindle, is the more common form, and the hand tool is now often called a router plane.

## 2. LITERATURE REVIEW

Debbie Sullivan [1], has provided guidelines for using handheld equipment. Work with hand-held power tools can be found in most industries all over the industries in the world. This type of work exposes the operators to various types of loads like gripping-forces, feed-forces, exposure to vibration and noise, holding hot or cold surfaces and the exposure to dust.

David J. Edwards et.al [2] stated that, Designing a power tool with good ergonomics is a matter of finding the best compromise. As a simple example, increasing the mass of the system is not acceptable because it will increase the forces required to handle the tool. At the same time the increased mass of the system will in most cases reduce the vibrations. Vibration disorders related to the use of handheld power tools have been known and reported since long. It is therefore necessary that low vibrating tools are developed and used. The new vibration regulations in Europe, based on the Physical Agents (Vibration) Directive, have put increased focus on the vibration control in industry.

Charlotte Astrom et.al [3] have compared the prevalence of symptoms of musculoskeletal symptoms and Hand Arm Vibration Syndrome (HAVS) in the neck and the upper limbs, between professional drivers of terrain vehicles and a referent group. Driving terrain vehicles are related to experiencing some symptoms related to HAVS, such as numbness, white fingers and sensation of cold suggesting that there is a possible association between exposure to HAV generated from steering devices in terrain vehicles and symptoms of HAVS. Driving terrain vehicles is also related to experiencing musculoskeletal symptoms in the neck, shoulders, and wrist. These indication seem to be related to the exposure time.

Mirta Widia et.al [4] have conducted an experiment on effect of handheld vibrating equipment on the human body. The aim of the study is to identify the effect of hand held vibrating tools on muscle activity and grip strength. The study was conducted on seven subjects (three male and four female). The experiments were performed with two kinds of exposure time, 5 and 15 minutes. Subjects were required to drill wood material using electric drill. Electromyography (EMG) and Vernier Labpro with 3 axis accelerometer used in the experiment.

The results shows that mean vibration level for electric drill machine is 10.53 $m/s^2$ for 15 minutes and 10.39 $m/s^2$ for 5 minutes duration. The most exaggerated muscle by vibration factor was found to be the extensor Carpi radial muscle. Extensor Carpi radials are one of the muscles in the forearm. Muscle activity and grip strength increasing as the vibration level increasing.

Lars Skogsberg [5] stated that Forces acting on the tool to cause vibration. Tools for industrial use must be of very robust design to withstand the very hard use they are exposed to. Industrial tools are therefore in general designed with the main parts made of metal. From a vibration point of view, this means that most tools can be regarded as rigid bodies, especially because the dominating frequency normally is equal to the rotational frequency of the tool spindle or the blow frequency for a percussive tool. These frequencies are, with few exceptions below 200 Hz. Handles however, cannot always be regarded as rigidly connected to the tool. There are some examples of weak suspensions designed to decrease vibration transmitted to the hands of the operator. There are also examples of designs where the handles just happened to be non-rigidly connected and in some cases even in resonance within the frequency region of interest. Oscillating forces act on the tool and the result is vibration.

## 3. EXPERIMENTAL PROCEDURE

In this methodology the 8 Port DEWE 43A channel is used. The trial is taking for five different components as shown ex. Devgad, Jackfruit, Mango, Neem, Sal, etc. The accelerometer AC-A03471 is selected for measurement of acceleration. The Accelerometer is connected to channel for port 1 by using A/D converter MSI-BR-ACC.

**Fig -2**: Model Without damper

The setup for vibration measurement is shown in fig.-2, which includes Router machine model which is placed on the ground, an accelerometer is placed to handle in vertical direction to measure longitudinal vibrations. The accelerometer is connected to channel by a flexible cable. Another USB cable is used to attach Channel to PC. A power cable is attached to supply power input to the channel. DELL Inspiron 1420 is used for testing.

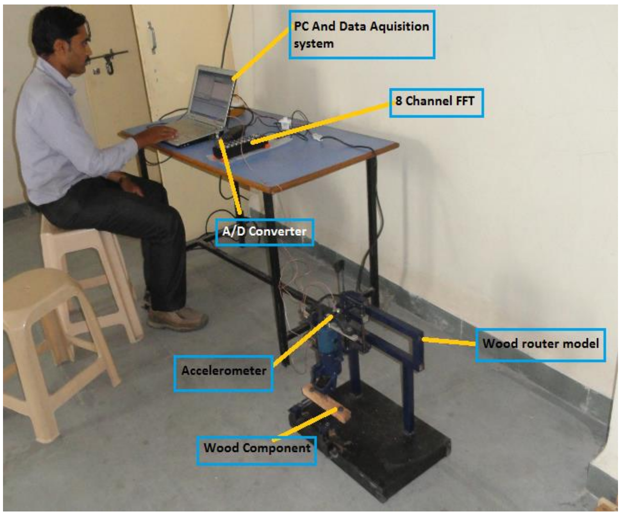


**Fig -3**: Machine testing setup

Initially the trail is conducted for without damper condition. The handle is most sensitive part of the machine because the handle is connected to the motor casing. The induced vibrations are directly transferred to handle. The test setup of model for without damper is shown in fig.3. The input parameter for testing FFT is only sensible & that value would evaluate during calibration. For this setup the sensitivity value is given 9.749mV/g.

To control the rotation of the model a regulator is attached at power supply to the motor. Regulator controls the current such that we can maintain the required speed for trial. The regulator is connected in between motor & power supply.

## 4. RESULT AND DISCUSSION

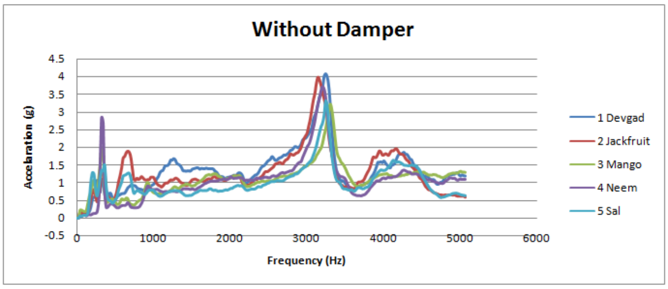


**Fig -4**: FFT Result for without Damper

The graph is drawn acceleration v/s Frequency which is shown in fig.4 The maximum acceleration produced at around 3200Hz. The values for acceleration at respective Frequency shown in Table No.1

**Table -1:** Acceleration for without Damper

| Sr. No. | Components | Acceleration [g] |
|---|---|---|
| 1 | Devgad | 4.125 |
| 2 | Jackfruit | 3.971 |
| 3 | Mango | 3.218 |
| 4 | Neem | 3.721 |
| 5 | Sal | 3.316 |

From Table No.1 it is clear that acceleration produced without damper is in the ranges 3.2g to 4.2g (i.e 31m/s$^2$ to 41m/s$^2$) for different components. Initially We have taken devgad component for testing, for Devgad induced acceleration value is 4.125g. A second trial is conducted on Jackfruit which has given acceleration 3.971g. Third trial is taken in Mango wood, induced acceleration is 3.218g, Then we have tested Neem component, the value of acceleration is 3.721g & finally we have tested sal component which has given acceleration equal to 3.316g. So, the induced acceleration values are very high. We need to reduce the induced acceleration values.

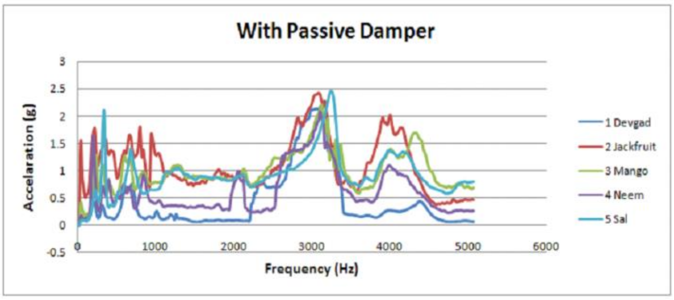


**Fig -5:** FFT Result for with Passive Damper

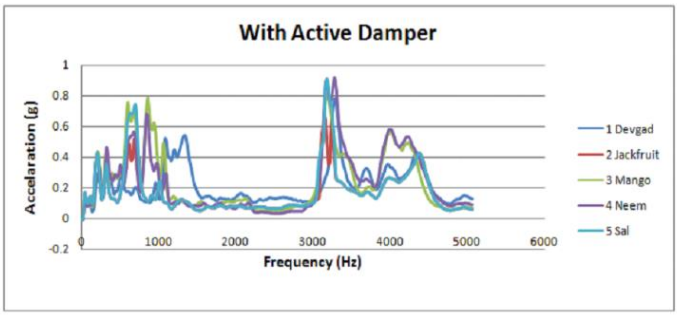


**Fig -6:** FFT Result for with Active Damper

**Table -2:** Acceleration values Comparison

| Sr. No. | Components | Acceleration [g] | | |
|---|---|---|---|---|
| | | Without Damper | With Passive Damper | With Active Damper |
| 1 | Devgad | 4.125 | 2.456 | 0.834 |
| 2 | Jackfruit | 3.971 | 2.26 | 0.658 |
| 3 | Mango | 3.218 | 2.207 | 0.808 |
| 4 | Neem | 3.721 | 2.095 | 0.906 |
| 5 | Sal | 3.316 | 2.45 | 0.911 |

In above Table Comparison of Acceleration of different material is explained. From the table it is observed that vibration induce from wood router which is more in without Damper Condition. Vibration reduced in passive damper Condition by an amount approximately 2g. In case of Active Damper it is reduced up to 3g.

## 5. CONCLUSION

Initially, we have conducted trials without damper. The handle is directly connected to motor bracket. The accelerometer is mounted on the handle in vertical position to measure vibration in longitudinal direction. We have tested five components in which the devgad and sal wood have comparatively high density. In testing it is seen that without damper acceleration magnitude for different components in the range of 3.2 - 4.2g & it is very high.

In passive damping case we have maintained piston orifice diameter constant i.e. 2.5mm. Due to its adverse effect the acceleration value come in the range of 2g-2.2g. So the vibration reduced up to 50%. In case of Active Damper the orifice diameter is further reduced. Its effect was the acceleration come in the range 0.6g to 1g. So the Acceleration value reduced by 70-80%.

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