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DEVELOPMENT OF VIBRATION ISOLATION DEVICE

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Abstract*—Professional workers in construction companies, manufacturing industries and workshops are continuously exposed to Hand arm vibrations (HAV) during their work schedule which is known to be harmful for their health causing Hand Arm Vibration Syndrome and various other musculoskeletal disorders. Various other occupational groups like local workers, mechanics, labour class or helpers at mechanical workshops are vulnerable to these problems due to the HAV originating from the motors of the hand grinding machine or the poor working skills. Hand tools users are considered to be more susceptible to these dangers according to the epidemiological studies due to long duration of exposure to these vibrations, prolonged usage of power hand-held tools while working hours. The purpose of this study is to check the HAV exposure to workers using grinding machine in local workshops and construction companies by using vibration sensing device for purpose of controlling HAV exposure. The accelerometers were used to measure vibrations transmitting from tool to hand arm system. Experimentation was done on selected workers while working on grinding machine so as to take proper readings of specified interval of time. Proper readings were taken using a device named Biometric DataLog device. Readings were taken for bare hands and two industrial gloves and silicone pad gloves for the hand grinder machine Results show that all materials i.e. two industrial gloves and silicone pad glove attenuated the vibrations according to their material properties. Bare hands transmitted higher amount of vibrations from grinder handle to hand arms system as compared to other three measures. Silicone pad glove attenuated significant amount of vibrations and also the highest amount of transmitted vibrations in comparison to other gloves used in testing process.

Keywords*—Hand Arm Vibration (HAV), Vibration White Finger(VWF), ISO (International Organization of standardization), Root Mean Squar(R.M.S), European Union(EU)

INTRODUCTION

Use of hand held percussion tools is common in manufacturing and construction organizations. Construction companies use these tools regularly. Un-organized sectors like cooler makers, iron grills makers use tools like drills, grinders, compactors and other tools which vibrate on higher frequencies. These vibrations are hand arm vibrations to which labourers and technicians are daily exposed. The sense of vibration has an adverse effect on an individual‘s health in the form of temporary or permanent physical damages. It is a term used to describe human exposure to the effects of mechanical forces such as shocks, jolts, lateral sway and vertical bouncing that are transmitted to the body.During the compression of the median nerve as it runs deep to the transverse carpal ligament (TCL) causes atrophy of the thenar eminence, weakness of the flexor pollicis brevis, opponenspollicis, abductor pollicis brevis, as well as sensory loss in the digits supplied by the median nerve. The structure of bones in carpal is shown in figure 1. The superficial sensory branch of the median nerve, which provides sensation to the base of the palm, branches proximal to the TCL and travels superficial to it.

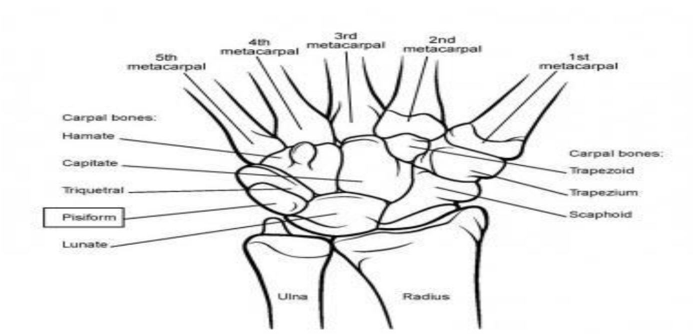

Figure 1 Structure of carpal bones

Gerhardsson and Balogh's (2005) compared the development of vibration white fingers (VWF) in workers in relation to different ways of exposure estimation, and their relationship to the standard ISO 5349, annex A. Nineteen vibration exposed (grinding machines) male workers completed a questionnaire followed by a structured interview including questions regarding their estimated hand-held vibration exposure. Neurophysiological tests such as fractionated nerve conduction velocity in hands and arms, vibrotactile perception thresholds and temperature thresholds were determined. The subjective estimation of the mean daily exposure-time to vibrating tools was 192 min (range 18–480 min) among the workers. The estimated mean exposure time calculated from the consumption of grinding wheels was 42 min (range 18–60 min), approximately a four-fold overestimation. Thus, objective measurements of the exposure time, related to the standard ISO 5349, which in this case were based on the consumption of grinding wheels, will in most cases give a better basis for adequate risk assessment than self-exposure assessment.

Hewitt et. al. (2016) studied the exposure to hand-transmitted vibration (HTV), personal protective equipment is sold in the form anti-vibration (AV) gloves, but it remains unclear how much these gloves actually reduce vibration exposure or prevent the development of hand-arm vibration syndrome in the workplace. This commentary describes some of the issues that surround the classification of AV gloves, the assessment of their effectiveness and their applicability in the workplace. The available information shows that AV gloves are unreliable as devices for controlling HTV exposures. Other means of vibration control, such as using alternative production techniques, low-vibration machinery, routine preventative maintenance regimes, and controlling exposure durations are far more likely to deliver effective vibration reductions and should be implemented. Furthermore, AV gloves may introduce some adverse effects such as increasing grip force and reducing manual dexterity. Therefore, one should balance the benefits of AV gloves and their potential adverse effects if their use is considered.

Rakhejaet. al. (2006) evaluated the methods for assessing the vibration isolation effectiveness through developing a mechanical- equivalent model of the glove-hand–arm system. The model (shown in figure 2) is developed based on the measured driving-point mechanical impedances distributed at the fingers and the palm of the hand with and without a glove. Six subjects participated in the experiments with two types of anti-vibration gloves (air-bladder glove and gel-filled glove) for measuring the required impedance data. The proposed model is applied to predict the effectiveness of the glove in terms of vibration transmitted to the fingers-glove and palm-glove interfaces, the finger bones, and the wrist. The results show that the gloves could provide some attenuation of the palm-transmitted vibration at frequencies above the fundamental resonant frequency of the gloved hand–arm system, but only little reduction in the finger vibration below the dominant finger resonant frequency.

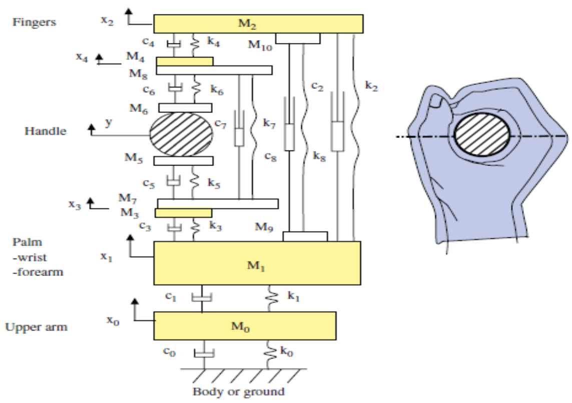

Figure 2 Mechanical- equivalent model of the glove-hand–arm system

The present standardized methodology based upon the transmissibility measurement at the palm alone would thus be inappropriate for characterizing the overall reduction of the vibration exposure by a glove. Moreover, the palm adapter could introduce some measurement errors because of its mass and misalignment effects and its interference with the glove- palm coupling relationship. Therefore, the standardized method may only be used for general screening tests. On the basis of the model results, several potential improvements in the current standardized methodologies for evaluations of gloves and glove material are proposed and discussed. The proposed model may also serve as a useful tool for further developments of anti-vibration gloves and other anti-vibration devices.

Objectives of proposed research work

1. To study the ill effect of hand arm vibration on the hand-held operators.
2. To develop anti vibration glove for vibration isolation device for power hand tools such as grinder, drilling and cutter.
3. To compare the measured vibration with bare hands, existing industrial gloves and proposed silicone pad gloves.

Methodology

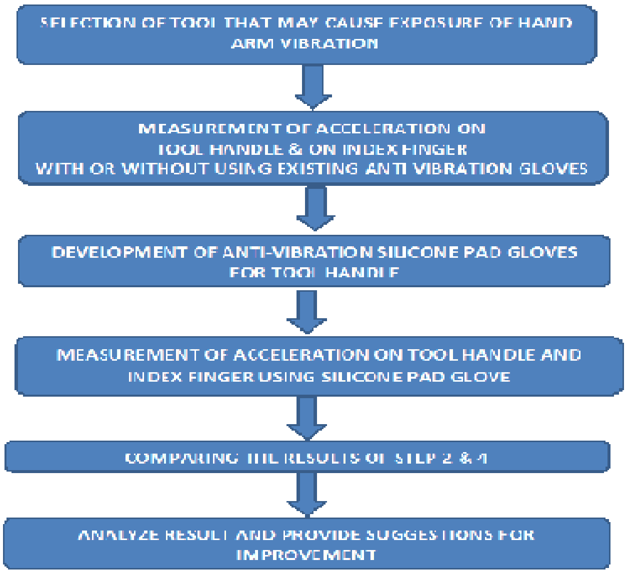

FIG 3: Methodology

Step 1 : Selection of tool that may cause exposure of hand arm vibration

The DeWALT DW824 5" small Angle Grinder, has a powerful 12 Amp motor for fast material removal and includes a high power to weight ratio efficiency and reduced fatigue. It was designed for concrete contractors, vehicle fabricators and other professionals who need a compact grinder. With a well-designed grip, lock-on slide switch, two-position side handle and 11,000 no-load rpm, this workhorse can get the job done.

Step 2 :Measurement of acceleration on tool handle & on index fingerwith or without using existing anti vibration gloves gloves

Two piezoelectric accelerometers of 16-G with nominal sensitivity 1.02 mV/ (m/s2) were used for measuring the acceleration data. One was attached to the handle and used as a reference accelerometer, whilst the other was mounted on an adapter strapped to the finger. The material sample was placed around the right-hand end of the handle, and the adapter was fitted onto the index finger of the left hand of the subject being tested. The subjects were asked to maintain a normal grip, and once they feel comfortable, the handle was excited using discrete sinusoidal vibration excitation signals that covered the range from 20 to 400 Hz. All experiments were carried out according to the above-listed methodology.

Grinder (DeWALT DW824-B1) was used for testing. First of all, readings of bare hands with respect to grinder were taken, shown in figure 4. One accelerometer was mounted on grinder handle and other was on index finger of left hand. A piece of metal was grind for time period of one minute. Readings were taken on Biometric DataLog device. After taking readings of bare hands, two industrial gloves were tested. One by one, readings on two gloves were taken. All the readings were taken for time period of one minute. Three readings on each step were taken so as to take root mean square value to compare with other values significantly.

Figure 4: Bare hands readings

Experiments were conducted using a grinder with bare hands, two industrial gloves and silicone pad gloves. All the ten subjects were asked to grind with a bare hand, using the two gloves (fig 5) and the silicone pad gloves (fig 7). Readings were taken and results of readings were compared at the end using Biometric DataLog software (NextGen).

Figure 5: Industrial Glove used for testing

Step 3: Development of anti-vibration silicone pad gloves for tool handle Show in figure 6.

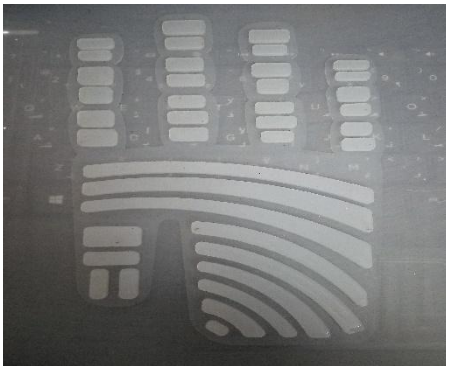

Figure 6: Silicone pad for gloves

Step 4: Measurement of acceleration on tool handle and index finger using silicone pad glove

Experiments was conducted using a grinder with silicone pad gloves. All the ten subjects were asked to grind with a bare hand, using the silicone pad gloves (fig 7). Readings were taken and results of readings were compared at the end using Biometric DataLog software (NextGen).

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Figure 7: Testing with Silicone pad gloves

Step 5: Comparing the results of step 2 & 4 Shown in fig 8 :

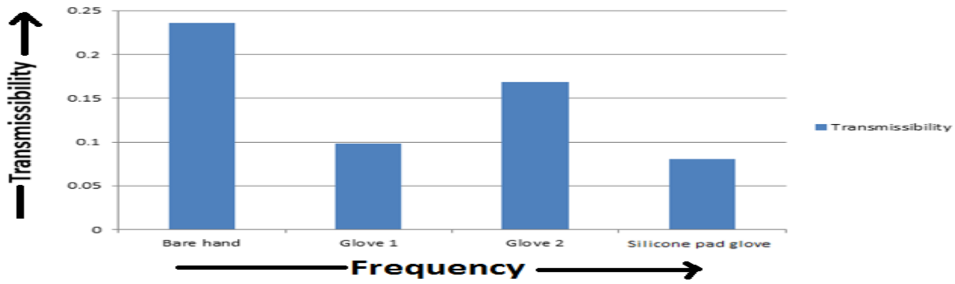

Figure 8: Transmissibility of all materials

Step 6:Analyze result and provide suggestions for improvement

RESULT

The demographics of the study population for HAV measurement is shown in table 1. From the table 1 it was shown that, there are moderate differences in the height and weight of the workers across the two conditions evaluated.

Table 1: HAV exposure evaluation [A(8)] values

Testing M/C	Type of Testing	R.M.S (m/s^2)			A(8)
		a_x	a_y	a_z	
Grinding M/C	Bare hand	0.19	0.18	0.19	0.41
	Leather Glove	0.16	0.09	0.05	0.26
	Fabric Glove	0.18	0.10	0.07	0.29
	Silicone pad glove	0.075	0.007	0.003	0.003

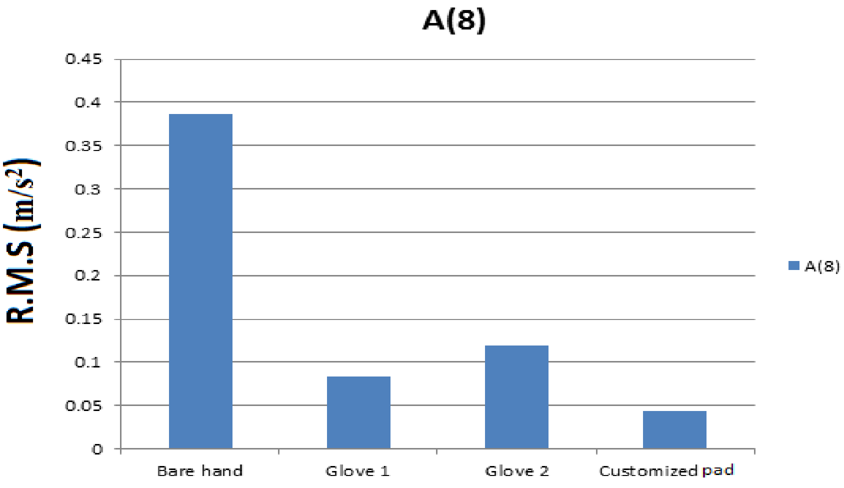

Figure 9:A(8) according to type of test

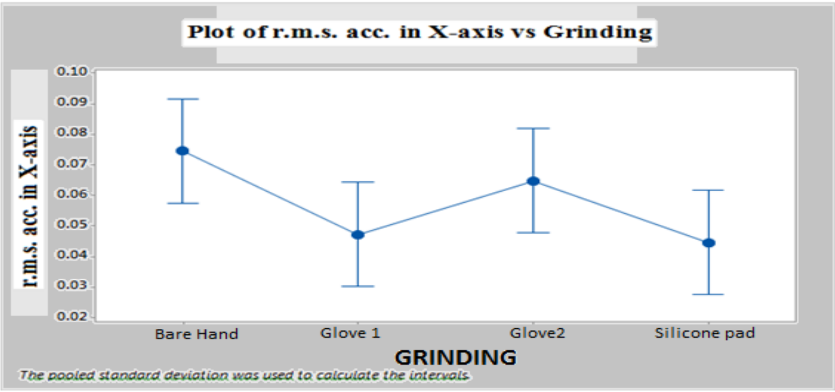

Figure 10: R.M.S Accelerations acting on X-axis while Grinding

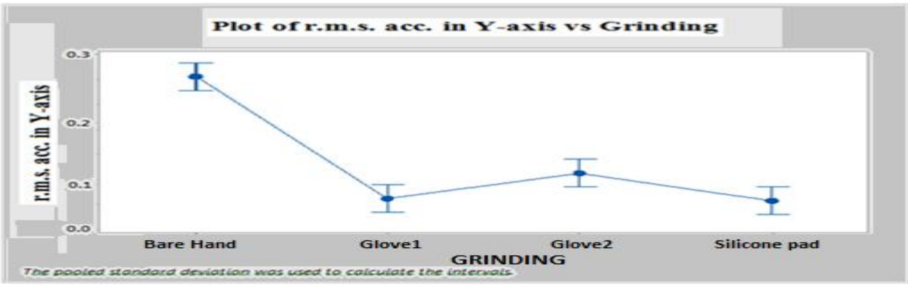

Figure 11: R.M.S Accelerations acting on Y-axis while Grinding

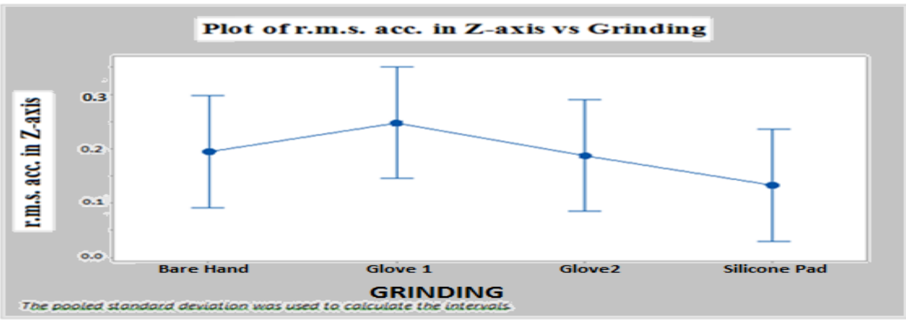

Figure 12: R.M.S Accelerations acting on Z-axis while Grinding

CONCLUSIONS

Following conclusions are drawn from the study:

1. Anti-vibration isolation pad glove was successfully developed and found to be work effectively to attenuate vibration power hand held tools.
2. Comparison was done between existing gloves, bare hands and the silicone pad gloves for hand tools and it was found that vibrations transmitted through bare hands were 0.23609, through leather glove were 0.09856, fabric gloves were 0.16799 and through the silicone pad gloves were 0.080818.
3. Transmissibility of Silicone pad was lower than other two existing gloves such as leather and fabric glove.

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