POTENTIAL APPROACHES FOR REDUCING THE VIBRATION EXPOSURE OF WORKERS PERFORMING HANDHELD GRINDING OF GOLF CLUB HEADS

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Introduction

Prolonged, intensive exposure to hand-transmitted vibration may occur among some workers performing handheld grinding of golf club heads. As a result, vibration-induced white finger (VWF) has been found among some of these workers[1]. Some intervention is required to control this occupational disease. The objective of this study is to propose and discuss potential approaches for reducing the vibration exposure.

Figure 1 shows an example of the fine grinding of golf club heads at a workplace. Our experimental study found that the golf club head vibration during its grinding process resulted from the vibration transmitted from the machine and that generated in the grinding process itself[2]. Specifically, the majority of the large vibration peaks on the machines are in the critical middle frequency range (20 to 250 Hz). They are largely associated with the operation speed of the machine. This suggests that the machine vibration of major concern results primarily from mechanical sources such as unbalanced mass of the rotational parts, misalignments of shafts and bearings, tolerances in the bearings etc. The grinding vibration may result from the geometric irregularities of the grinding interface and the mechanical property irregularities of the grinding system. The dynamic responses of the club head and hand-arm system and the applied hand feed force may also influence the club head vibration. Based on these vibration sources, their characteristics, and the identified response mechanisms of the club heads, a set of potential approaches for controlling the vibration exposures to the grinding workers are proposed in this study.

Fig. 1: Fine grinding of golf club heads

Proposed Potential Approaches and Discussion

The vibration exposure of the grinding workers can be controlled by reducing the grinding machine vibration, changing the workpiece dynamic properties, and mitigating the vibration transmission in its pathway.

The proposed specific approaches are outlined as follows:

(1) Develop or select low-vibration machines, because the grinding vibration results partially from the machine vibration.
(2) Reduce machine vibrations by installing an anti-vibration device on an existing machine. For existing machines, some automatic balancing technologies can be used for retrofits.
(3) Regularly monitor and maintain grinding machines. An expert monitoring and diagnostic system can been developed based on the measurements of the equal-band vibration and noise spectra of a grinding machine in its free run test. A regular maintenance program should be established to assure the machines are operated in a good condition.
(4) Increase the effective mass and damping property of the club head using a workpiece support system and/or attaching some damping materials to the workpiece if feasible.
(5) Use an appropriate motor speed and control daily vibration exposure time.
(6) Substantially reduce the contact stiffness and damping at the workpiece-wheel interface. This can be achieved by grinding on the belt between the driving and passive wheels or selecting a grinding machine that is designed to perform the grinding at such a location.
(7) If a certain curvature and/or stiffness on the grinding interface is required, the grinding can be conducted at the passive wheel or an additional wheel that can be installed at the location between the driving and passive wheels. This can avoid the irregularities on the driving wheel. The grinding contact stiffness can also be controlled by designing a smooth layer of rubber or damping material on the tread of the passive or additional wheel. The contact wheel may be supported on the floor independently from the machine.
(8) Isolate the club head vibrations from effective transmission to the fingers or hands using vibration-reducing gloves.
(9) Isolate the vibration transmission by developing workpiece holders, which can increase the effective mass of the workpiece and the safety of the hands.
(10) Use appropriate grip and push forces in the grinding process. While increasing the feed force can increase the grinding efficiency, it can also increase the vibration of the workpiece and the vibration transmission from the workpiece to the hands.
(11) Mitigate the vibration transmissions among the machines installed on the same floor or building by installing the machine on a large concrete block and a vibration-reducing mat underneath the block.

It is emphasized that not every approach is applicable to each specific workplace or grinding task. It may also be difficult to use a single approach to control the vibration exposure to an acceptable level. A combination of suitable approaches may be the best strategy for the vibration control, which can be selected based on their feasibility for implementation, their cost-effectiveness, and their impacts on productivity and workplace safety. The specific methods and technologies for implementing these approaches require further developments and experiments.

References

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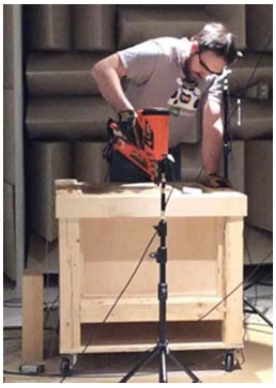

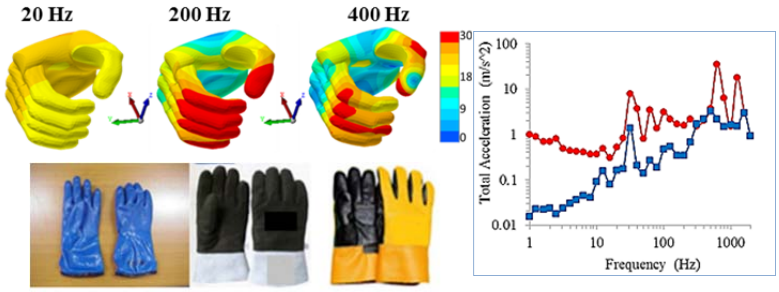

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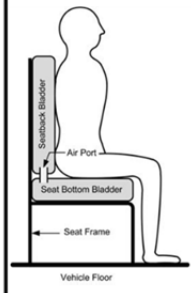

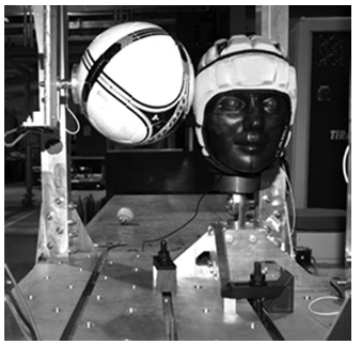

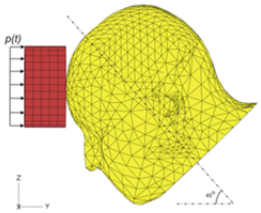

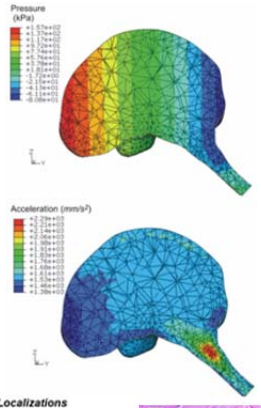

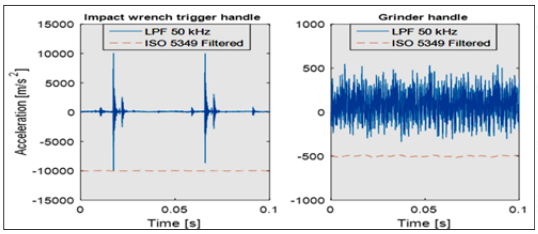

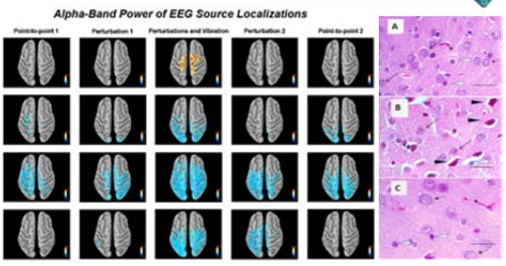

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