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The design and development of suspended handles for reducing hand-arm vibration in petrol driven grass trimmer

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ABSTRACT

The portable petrol driven grass trimmer is identified as a type of machine whose operator can be subjected to large magnitude of hand-arm vibration. These vibrations can cause complex vascular, neurological and musculoskeletal disorder, collectively named as hand-arm vibration syndrome. The vibration total level on the handle of grass trimmer of 11.30 m/s^2 was measured, and it has reached the exposure limit value of 5.0 m/s^2 for daily vibration exposure A(8). New suspended handles were designed to reduce the vibration level. Three different prototype handles with rubber mounts were designed. Handles were made of different materials, and the distance of rubber mounts were varied. From the study, it was observed that not all the handles with rubber mounts were effective in reducing hand-arm vibration. The reduction of vibration depended on the handle material and distance installed between rubber mount and vibration transmissibility of handle-isolation system. Subjective ratings of perception of vibration were measured, and the results indicated that operators were not fully aware of the level of vibration. A prototype handle that is made of heavier material results in the lowest hand-arm vibration of 2.69 m/s^2. The new handle has significantly reduced the vibration total value by 76% compare with the existing commercial handle.

Relevance to industry: Large numbers of workers are employed to perform grass trimming job in many developing countries. This paper presents the effect of handle types (commercial and prototype) on the commonly used grass trimmer.

1. Introduction

Hand-arm vibration (HAV) level is one of the safety aspects which must be controlled to prevent long term health problems such as secondary Raynaud's phenomena and carpal tunnel syndrome (Bovenzi, 1998; Fridén, 2001; Mansfield, 2005; Stoyneva et al., 2003). Both syndromes are referred to as hand-arm vibration syndrome (HAVs). European Union (2005) has defined the exposure action value of 2.5 m/s^2 and exposure limit value of 5.0 m/s^2 for daily vibration exposure A(8). The design of machines for low vibration is therefore of interest. Common sources of vibration for these machines are the interaction of the machine with the material being worked on, the forces generated by internal combustion engines and the rotating unbalanced mass.

Various techniques are available for controlling vibration at the handle. These include mounting a dynamic vibration absorber on the source of vibration; isolate the hand from the vibrating handle with the use of anti-vibration gloves (Brown, 1990; Muralidhar et al., 1999; Voss, 1996) and isolate the tool handle from the vibrating source by using isolators (Sam and Kathirvel, 2009; Tewari and Dewangan, 2009).

The use of anti-vibration gloves as a mean of attenuation has been studied by researchers (Chang et al., 1999; Dong et al., 2003). However, most of the commercially available anti-vibration gloves did not attenuate vibration below 100 Hz (Sampson and Van Niekerk, 2003) and only lessen high frequency vibration (Dong et al., 2009; Smutz et al., 2002). It is important to note that the effectiveness of anti-vibration gloves depends on the spectrum of the tool handle, vibration transmissibility of the glove and frequency weighting (Griffin, 1998). Different vibration levels produced by various hand tools will influence the isolation performance of anti-vibration gloves since they are tool or excitation spectrum specific (Rakheja et al., 2002). Dong et al. (2005a) found a strong linear correlation between effectiveness of anti-vibration gloves with biodynamic characteristic of human hand-arm system in the frequency range of 40–200 Hz and the anti-vibration gloves were less effective in the middle frequency range (50–100 Hz) for people with larger hand size. Furthermore, the effectiveness of anti-vibration gloves is location

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