COMPARISON OF JOLTING AND JARRING IN A NEWER AND OLDER DOZER AT A HIGHWAY CONSTRUCTION SITE

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This field study evaluated a newer and older dozer at a construction site. Both dozers performed similar activities in the same location within the construction site. Two operators participated in this study. One operator used the older equipment and the other operator used the newer equipment. Jolting and jarring measurements were taken at the seat/operator interface and at the floor of the cab. The result of this field study indicates that the newer dozer was better than the older dozer.

INTRODUCTION

Work related injuries and illnesses pose a continuing threat to the health and well-being of American workers. The construction industry has been historically recognized as having higher rates of fatality, injury, and illness than other industries (McVittie, 1995; BLS, 1996). In 1994, there were an estimated 218,800 lost workday injuries in the construction industry (BLS, 1996). Construction also had the second highest incidence rate for sprains and strains. Operating engineers (also known as hoisting and portable engineers) operate and maintain the heavy construction equipment, such as cranes, bulldozers, front-end loaders, rollers, backhoes, and graders. They may also work as surveyors or mechanics. The operators use these equipment to perform four main tasks (Stern and Haring-Sweeney, 1997): 1) the building of roads, bridges, tunnels, and dams; 2) the construction of buildings and power plants; 3) the removal of earth materials and grading earth surfaces and in the replacement of concrete, blacktop, and other paving materials; and 4) the constructing of drainage systems, pipelines, and other related tasks, such as blasting. It is estimated that there are 487,000 operating engineers (55% union and 45% non-union) in the United States and Canada. The majority of these workers are exposed to whole body vibration, albeit in concert with other occupational risk factors.

Past studies have shown that musculoskeletal disease affecting operators of construction equipment appears to be due to awkward postures (including static sitting), whole body vibration, work intensity, high resistance levers and repetitive motions (Kittusamy and Buchholz 2001; Kittusamy, 2002; Buchholz et al., 1997). It is believed that reducing ergonomic exposures, such as whole body vibration and postural stress, may be an important factor in improving the health, comfort and efficiency of these operators.

METHODOLOGY

This study evaluated workers employed in the highway construction industry in Iowa, USA. Two operators employed by a major construction contractor participated in the study. One operator used the older dozer, while the other operator used the newer dozer. Both dozers had good preventative maintenance records. Both dozers performed similar activities in the same location within the construction site. Although variations in field terrain conditions exist, it is believed there was minimal difference. Operators were briefed about the study and they signed an informed consent form.

Jolting and jarring were measured at the seat/operator interface using a tri-axial piezoelectric seat pad accelerometer (Bruel & Kjaer, Model # 4322). At the floor level three accelerometers internal to the SAVER unit (Lansmont Corporation) were used to measure the vibration. Calibration procedures and mounting of the test equipment were done according to the manufacturer's guidelines. The vibration data were sampled at a rate of 500 Hz.

RESULTS

A comparison of RMS for each event (663 out of 681 events) for X, Y, and Z axes of the seat for both dozers is presented in Table 1. This data showed that the older equipment's average RMS values were greater than that of the newer equipment. Also, the maximum RMS values were greater than the newer equipment. A power spectrum density of both dozers was examined (see Figures 1 and 2). The PSD shows that the older equipment was not attenuating jolts in the lower frequencies, especially below 10 Hz. While the newer equipment was more responsive to jolts in the lower frequencies.

In evaluating transmissibility of jolting and jarring, both equipment showed attenuation in the Z axis and ratios were below unity. However, both pieces of equipment showed an amplification in the X and Y axes. This amplification was markedly higher for the older dozer.

Table 1. Average and Maximum RMS values for shock events.

	Older Dozer			Newer Dozer		
	X Seat	Y Seat	Z Seat	X Seat	Y Seat	Z Seat
Avg G_{rms}	0.30	0.31	0.11	0.16	0.22	0.11
Max G_{rms}	0.89	0.90	0.31	0.46	0.73	0.21

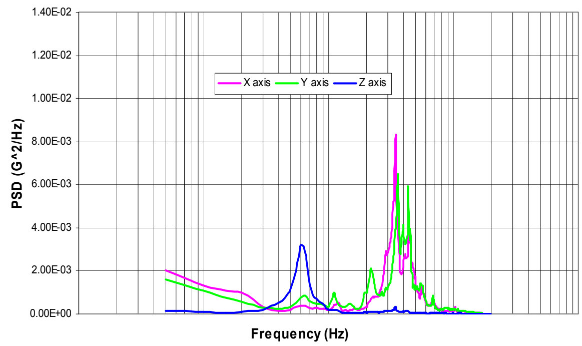

Figure 1. PSD of X, Y and Z axes at the seat for the Older Dozer

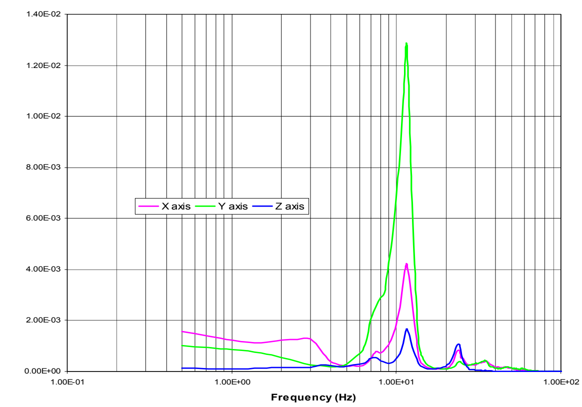

Figure 2. PSD of X, Y and Z axes at the seat for the Newer Dozer

SUMMARY

This study specifically evaluated the vibration levels of an old and new dozer at a construction site. The dozers were performing their regular activities at a highway construction site. The results of this study indicate that the newer dozer was noticeably better than the older dozer. The older dozer had higher amplitude of jolting and jarring than the newer dozer. The transmissibility data showed that the seat was amplifying vibration particularly in the lower frequencies for both older and newer dozer. Thus the seats in the equipment (particularly in the older dozer) may not be sufficient to protect the operator from long-term health effects of vibration exposure.

Engineering controls are the preferred method. This type of control focuses on design or redesign of the workstation or job to accommodate the operator. When engineering controls are not feasible or while implementation is occurring, administrative controls are frequently used to limit operator exposures. Some controls for whole-body vibration are as follows (Kittusamy, 2002):

1. Design and select seats based on the transmissibility characteristics and not just on the immediate comfort of the operator.
2. Design and select seats that will adequately damp vibration at all frequencies, but importantly in the lower frequencies (1 to 8 Hz).
3. Properly maintain the equipment to reduce wear and tear that could result in increased vibration.
4. Limit the speed of the equipment when driven, especially over bumpy or irregular surfaces.
5. Workers should avoid jumping off their equipment when exiting, since this introduces a shock to the body that has just been vibrated for several hours.

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