EVALUATION OF SCRAPER OPERATOR EXPOSURE TO WHOLE-BODY VIBRATION IN THE CONSTRUCTION INDUSTRY: A TASK ANALYSIS

E.K. Gillin[1], A.Cann1, P. Vi[2], T. Eger[4], M. Hunt[1], A. Salmoni[3]
[1]Doctoral Program in Rehabilitation Sciences, University of Western Ontario, Canada
[2]Construction Safety Association of Ontario, Canada
[3]School of Kinesiology, University of Western Ontario, Canada
[4]School of Human Kinetics, Laurentian University, Ontario, Canada

Introduction

Kittusamy (Kittusamy & Buchholz, 2004) state that there have been few studies conducted to assess exposure to whole-body vibration (WBV) in the construction industry. They suggest that there is very little reliable data from the construction industry that characterizes exposure levels to various hazards including WBV or the health outcomes from such exposure and that there is a need for more exposure data. In a recent exploratory study of heavy construction equipment Cann (Cann, Salmoni, Vi, & Eger, 2003) looked at vibration levels for 14 different types of construction equipment. Eight of the 14 pieces of equipment tested exposed operators to levels of WBV that exceeded the recommended limits for an 8-hour period when comparing the measured VDV to the ISO 2631-1 standards. The purpose of the present research was not only to test a larger number of scrapers but also to investigate scraper operator exposure to whole body vibration (WBV) separately for each task.

Methods

33 scrapers were evaluated for WBV in a variety of residential and road construction projects. Testing equipment consisted of triaxial accelerometers that allowed vibration data collection in all three orthogonal axes, with the x-axis positioned to measure vibration in the anterior-posterior direction, the y-axis in the medial-lateral direction, and the z-axis in the vertical direction. Root mean square accelerations (aRMS), vibration dose value (VDV), crest factor, and maximum transient vibration values (MTVV) were derived from this software and exported to an Excel™ spreadsheet for later data analysis.
Test sessions for each piece of equipment lasted for approximately 20 minutes until at least three work cycles had been completed. Tasks included: idling while waiting for a bulldozer to push the scraper through the scraping phase, scraping, traveling loaded with dirt, dumping and traveling empty.

Results

Task breakdown by time reveals 25% of the work cycle was spent traveling fully loaded with dirt, 19% dumping, 21% traveling unloaded, 17% idling and 18% scraping. Calculation of aRMS vector sums gave values of 2.55 m/s^2 during loaded transport, 2.46 m/s^2 during dumping, 2.31 m/s^2 during unloaded travel, 0.55 m/s^2 during idling and 1.46 m/s^2 during scraping (see Table 1). The highest acceleration values recorded were found in the z-axis during fully loaded transport reaching an average aRMS over three work cycles of 2.55 m/s^2.

Table 1: Summary of WBV aRMS from the x,y,z axes *n=33*

aRMS (m/s²)	*Loaded*	*Dump*	*Unloaded*	*Idle*	*Scrape*	*Overall*
X (m/s^2)	0.97	0.94	0.88	0.23	0.60	0.81
Y (m/s^2)	1.04	0.99	0.95	0.21	0.59	0.86
Z (m/s^2)	1.55	1.49	1.39	0.32	0.83	1.28
Vector Sum (m/s^2)	2.55	2.46	2.31	0.55	1.46	2.12

Discussion

The overall vector sum aRMS values exhibit accelerations well beyond the Commission of European Communities (CEC) recommended 8 hour levels. In a review of European Union whole body vibration exposure standards Griffin confirms the 8 hour action limit to be 0.5 m/s^2 and the 8 hour exposure limit of 1.15 m/s^2 (Griffin, 2004). Results are consistent with whole body vibration measurements from previous work. Accelerations are repeatedly in excess of maximal exposure limits recommended by ISO. This leads one to conclude that all scrapers will expose the operator to excessive levels of whole body vibration that may lead to injury or illness. There are researched methods that a scraper operator can do to decrease this risk. First, they can decrease speed while traveling loaded, dumping and unloaded. Second, they can ensure that tire pressure is at optimal levels. Third, they can maintain a healthy posture while driving.
However, the effect of such risk reducing factors is minimal. The solution to harmful vibration does not lie in wasting more money testing construction equipment to determine that it is exposing the user to potentially higher than recommended levels of vibration. The solution lies in the engineer's hands. Attacking this problem through better seat design is thought to enable a decrease of over 50% (Griffin, 1990). In addition, improving vehicle suspension, cab vibration absorption and engine mounts keeps solutions at the source of the problem versus at the operator.

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