NORA
Symposium 2003

Session: 5 Paper Number: 70

Evaluation of Jolting and Jarring and Its Effects among Operators of Mobile Equipment

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The goal of the research program is to reduce back injuries resulting from jolting and jarring while operating mobile equipment used in the construction and agricultural industries. This work supports two of the NORA priority areas: Low Back Disorders and Traumatic Injuries. Three divisions are collaborating in this project: Spokane Research Laboratory (SRL), Pittsburgh Research Laboratory (PRL), and Division of Applied Research and Technology (DART). Reducing back injuries would be a significant benefit, not only to construction and agriculture, but to the transportation industry as well. Back injuries are the most common nonfatal injuries in many industries including construction and agriculture. The U.S. Bureau of Labor Statistics (BLS) incident rates (1996-2000) of nonfatal construction injuries with days away from work averaged 3.3 (per 100 full-time workers). This compares with averages for farming of 2.9, mining of 2.3, and private industry of 1.9. Also, during the same reporting period, the BLS average number of nonfatal farm injuries involving days away from work because of back injury was 12,181. The project objectives include: 1) characterize the magnitude of jolting and jarring on construction and agriculture equipment in a field setting, 2) conduct laboratory studies to understand the response of low-back muscles to sudden and unexpected side-impacts, 3) evaluate health and work history among operators of heavy construction and farm equipment, and 4) estimate the loading on the spine due to jarring and jolting using a specialized multi-body biomechanical model of the musculoskeletal system. This paper highlights the major aspects of the project including: field measurements to assess levels of jolting and jarring on construction and agriculture equipment; human subject testing using unanticipated low-level bilateral and vertical impacts while subjects sit on a rigid seat fixed to a suspended platform; questionnaire data to assess demographics, work information, job history, and musculoskeletal symptoms in operators of heavy construction equipment; and focus group discussions to obtain health and work history information from operators of farm equipment. Moreover, this paper discusses the estimation of the loading on the spine due to jolting and jarring derived from a general multi-body dynamics computer simulator. Some results show noticeably high levels of jolting and jarring for specific tasks performed by operators of construction and agriculture equipment. Highly demanding tasks showed higher frequency of these jolts and jars. Transmissibility data shows that the seat was amplifying vibration particularly in the lower frequencies for these equipment. The questionnaire data shows: 1) that workers might be at risk of developing musculoskeletal disorders; 2) the need to perform larger studies to substantiate the outcome; and 3) the need to quantify risk factors. Furthermore, the biomechanical model is discussed in terms of its capability to: 1) estimate potential tissue damage from predicted spinal forces and spinal tissue tolerance limits and 2) calculate ISO exposure limit values. This project will better enable us to characterize exposures in a field setting and motivate us to explore possible engineering and administrative controls to effectively reduce or eliminate the risk factors experienced by the operating engineers.

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