*International Journal of Automotive Technology*, Vol. 21, No. 1, pp. 115–121 (2020)
DOI 10.1007/s12239–020–0012–0


pISSN 1229–9138/ eISSN 1976–3832

# NECK/SHOULDER MUSCLE FATIGUE OF MILITARY VEHICLE DRIVERS EXPOSED TO WHOLE-BODY VIBRATION ON FIELD TERRAIN ROAD

Dong Jun Park[1)], Jun Woo Lee[1)], Jin Han Park[2)], Jong Tak Song[3)], Se Jin Ahn[4)*] and Weui Bong Jeong[1)]

[1)]School of Mechanical Engineering, Pusan National University, Busan 46241, Korea
[2)]Ref. Research/Engineering Division, LG Electronics, 170 Seongsanpaechong-ro, Seongsan-gu, Changwon-si, Gyeongnam 51533, Korea
[3)]The 5th R&D Institute, Agency for Defence Development, 135 Jayeo-ro, Dong-eup, Uichang-gu, Changwon-si, Gyeongnam 51504, Korea
[4)]Division of Energy & Electric Engineering, Uiduk University, Gyongbuk 38004, Korea

*(Received 11 February 2019; Revised 11 April 2019; Accepted 12 May 2019)*

**ABSTRACT**–A driver of a military vehicle is exposed to whole-body vibration when driving in field terrain conditions, and the driver's muscles become tired. Muscle fatigue occurs most strongly near both shoulders, which must be used to steer the vehicle in the target direction. The degree of a muscle fatigue is predicted to correlate with the exposure amount of the human body to vibration. In this study, the vibration driving a military vehicle on a field terrain test road was simulated using a 6-degree-of-freedom (DOF) exciter, and the muscle fatigue was analyzed by measuring electromyography (EMG) signals from subjects before and after the vibration exposure. Surface EMG (sEMG) measurements were taken at the deltoid and trapezius muscles of subjects for the muscle fatigue analysis. Before and after the vibration exposure, the Maximal Voluntary Contraction (MVC) state was determined. The change of the median frequency of the sEMG signal was measured in this state and analyzed. The output values of the sEMG signal at MVC decreased after the vibration exposure, suggesting reduced muscle activation. The change of the median frequency value after the vibration exposure was sharply reduced, which means that the muscles are fatigued more rapidly with the same load.

**KEY WORDS** : Military vehicle drivers, sEMG (Surface electromyography), Field terrain driving vibration, Muscle fatigue, MVC (Maximal voluntary contraction), Median frequency

## NOMENCLATURE

a : acceleration, m/s$^2$
$\omega$ : angular velocity, rad/s
$\alpha$ : angular acceration, rad/s$^2$
R : displacement, m
T : transfer matrix
$\ddot{\mathbf{X}}$ : acceleration matrix

## SUBSCRIPTS

A : driver's seat on a real miliraty vehicle
B, p : exciter point for input signal
c : seat cushion position on a exciter

## 1. INTRODUCTION

The driver of a military vehicle is exposed to whole-body vibration in field terrain road conditions. A driver's muscles become fatigued when exposed to whole-body vibrations for a long time, and the driver may not perform tasks normally as a result (Mansfield, 2004; Griffin, 2012). Therefore, it is necessary to predict the efficiency of mission performance by analyzing the correlation between vibration exposure and muscle fatigue in field terrain conditions.

Park *et al*. (2018) measured the amount of vibration that occurs when a military vehicle is operated at three speeds on a 3-km field terrain test road. The amount of vibration measured at each speed was transformed into the human body vibration exposure amount that the driver perceives according to the procedure of ISO 2631-1 international standard, and the health effects were evaluated. The amount of vibration exposure was calculated for driving one lap, and the allowable daily driving time for the health risk level was obtained.

Park *et al*. (2017a) studied the degradation of driver attention in a military vehicle when exposed to vibration from field terrain driving. The study analyzed the phenomenon in which a subject's attentiveness decreases

**Corresponding author*. e-mail: sjahn@uu.ac.kr