

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****MODELING OF TRACTOR SEAT WITH REDUCED RISK OF WHOLE BODY
VIBRATION****Jiyaul Mustafa* , Dr. Mohd Farooq, Dr. Abid Ali Khan**^aDepartment of Mechanical Engineering, Faculty of Engineering & Technology, Jamia Millia Islamia,
New Delhi, 110025, India.^{b,c} Department of Mechanical Engineering, ZHCET, Aligarh Muslim University, Aligarh,
U.P.,202002,India.

ABSTRACT

Exposure to vibration is the cause of some occupational injuries and diseases. The objective of this study was determination of transmission of vibration which transmitted to tractor drivers from the seat operator system and breaking system. An investigation was conducted to determine the transmission of vibration from the seat operator system & breaking system to the neck, low back & feet under the different conditions i.e., farm field, tar-macadam road & bricks road. The vibration level was measured and analyzed and the frequency spectra for the chosen working conditions were obtained. The results indicate that the maximum transmissibility was observed in the first two frequency interval (in Hz) i.e. 1-5 and 6-10.

PRACTITIONER SUMMARY: The study of this paper is analysis of vibration in tractor driving that can causes deafness and disorders of the spinal column and stomach. The effect of implements on tractor ride is not well understood in India.

KEYWORDS: Frequency, Power spectrum density, Whole-body vibration, Vibration amplitude.

INTRODUCTION

India is the largest manufacturer of tractors in the world. It is the largest world market for tractors below 37 kW, due to the small size of land holdings. The current population of tractors in India is around 1.5 million and more than 0.15 million tractors are added to Indian agriculture every year [1]. They are being mainly used for primary and secondary tillage operations and as a means of transportation to haul goods, people and even animals. Vibration in tractor driving can cause deafness and disorders of the spinal column and stomach. The effect of implements on tractor ride is not well understood in India [2].

Most of the research on adverse health effects from whole-body vibration (WBV) deals with the musculoskeletal system, in particular, the lumbar spine. There is strong epidemiological evidence that occupational exposure to WBV is associated with an increased risk of low back pain (LBP), sciatic pain, and degenerative changes in the spinal system, including lumbar intervertebral disc disorders [3-4]. The mainly problems in human body, due to agriculture tractor vibrations are seating discomfort and muscle fatigue.

Seating discomfort led to various parameters such as the body pressure distributed under and supporting the buttocks, thighs and the back of an operator, control of posture in static or dynamic condition [5]. The biomechanical and engineering factors like ride vibration, pressure distribution at the seat operator interface and the body posture play an important role in a tractor seat-design.

A well designed seat should be able to accommodate all sizes and shapes of users and should provide adequate body support. When the body is not well supported, several muscle groups act together to restore stability, contributing to static loading resulting in discomfort [6]. A large number of studies have been conducted and suggested several criteria for evaluating discomfort and the suitability of a tractor seat in a given working condition. This information available in this regard and attempts to set the most appropriate procedure for assessment of seating discomfort during tractor driving [7]. Agricultural tractors are extensively used for on-road and off-road transportation and for different field operations. It is widely recognized that tractor operators are exposed to high levels of whole-body

vibration during farm operations [8]. In order to predict the ride vibration of an agricultural tractor, the vibrations transmitted to the driver's seat of an agricultural tractor, an analytical model has been constructed through the assembly of tire model & cab and seat suspension models [9].

METHODOLOGY

Materials

Mahindra Bhoomiputra 265 DI Model tractor was carried under working condition. It has a horse power of 30 H.P categories with bore and stroke of 88.9mm x 96 mm. It is couched with three cylinders whereas the cubic capacity of 1788 cc. The make and model of this variant is Mahindra MDI- 1785 and its total weight somewhere comes to around 1735 kg.

Approach

In this section it was tried to understand the transfer of vibration over whole body system in tractor seat operator system and breaking system.

Participants

In the present experiment, two healthy male participants were participated.

Apparatus

A Lab VIEW code was written to design the instrument for the recording of vibration level. The data acquisition was made possible using tri axial transducer (model no. SEN041F was made by PCB piezoelectronics, NEW YORK, USA; having 10.23 mV/g, 10.66mV/g and 10.41Mv/g sensitive in x, y, z direction respectively, the certificate is enclosed as appendix A) that was connected to NI card (Model No. NI9234 made by National instruments) using lead and the card was interfaced with a Wipro laptop (specifications P6000 PROCESSOR, 3 GB RAM). The setup was supportive to the sampling rate of 26,400 per second.

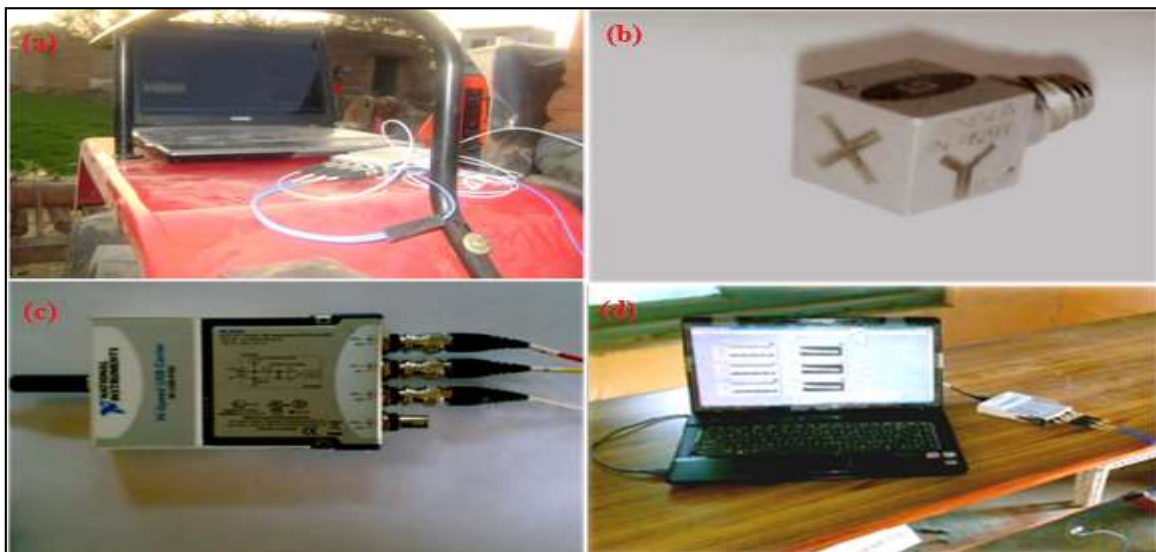


Figure 1: Experimental set-up ((a) whole set-up with tractor, (b) tri-axial transducer, (c) data acquisition card and (d) interfacing with Laptop)

However, the mean values were only recorded. The recorded data was auto stored in text/excel files in the laptop. The procedure to measure the vibration on tractor steering is very much standardized. Vibration measurement on tractor seat pad & breaking system have been performed, vibration are measured along z- axis vertical axis. We were used NI USB-9233 data acquisition device. The USB-9233 consists of two components: an NI 9233 module and aUSB-9162 USB carrier, for vibration measurement, NI USB-9233 connected with personal computer through lead.

Procedure

For vibration measurement from the seat operator system & breaking system to the neck, low back & feet of driver, the tractor was carried out under the different conditions i.e., farm field, tar-macadam road & bricks road. Subjects were considered to be healthy with no signs of muscular-skeletal system disorders. It was used two integrated electronic piezoelectric (IEPE) sensor connected to BNC connector. For the measurement of vibration in z direction, first sensor is SEN041F tri-axial accelerometer, this recognized as a z-base sensor, it is attached to tractor seat pad & breaking system. The first set of experiment was carried out by one of the sensor are attached to seat pad (z-base) and second one sensor are attached to driver neck and low back (z-target) & second set of experiment was carried out by attached the one sensor to breaking system (z-base) & second one sensor were attached to driver feet (z-target) as shown in figure 1, so we get The collected data was processed and analyzed with Lab View TM and by using MATLAB programme for each test.



Figure 2. Mahindra Bhoomiputra 265 DI Model tractor on farm field conditions (a) Breaking system arrangement, (b) Seat pad arrangement.

The first set of experiment was carried out by one of the sensor are attached to seat pad (z-base) and second one sensor are attached to driver neck and low back (z-target) & second set of experiment was carried out by attached the one sensor to breaking system (z-base) & second one sensor were attached to driver feet (z-target) as shown in figure 2, So we get the collected data was processed and analyzed with Lab View TM and by using MATLAB programme for each test.

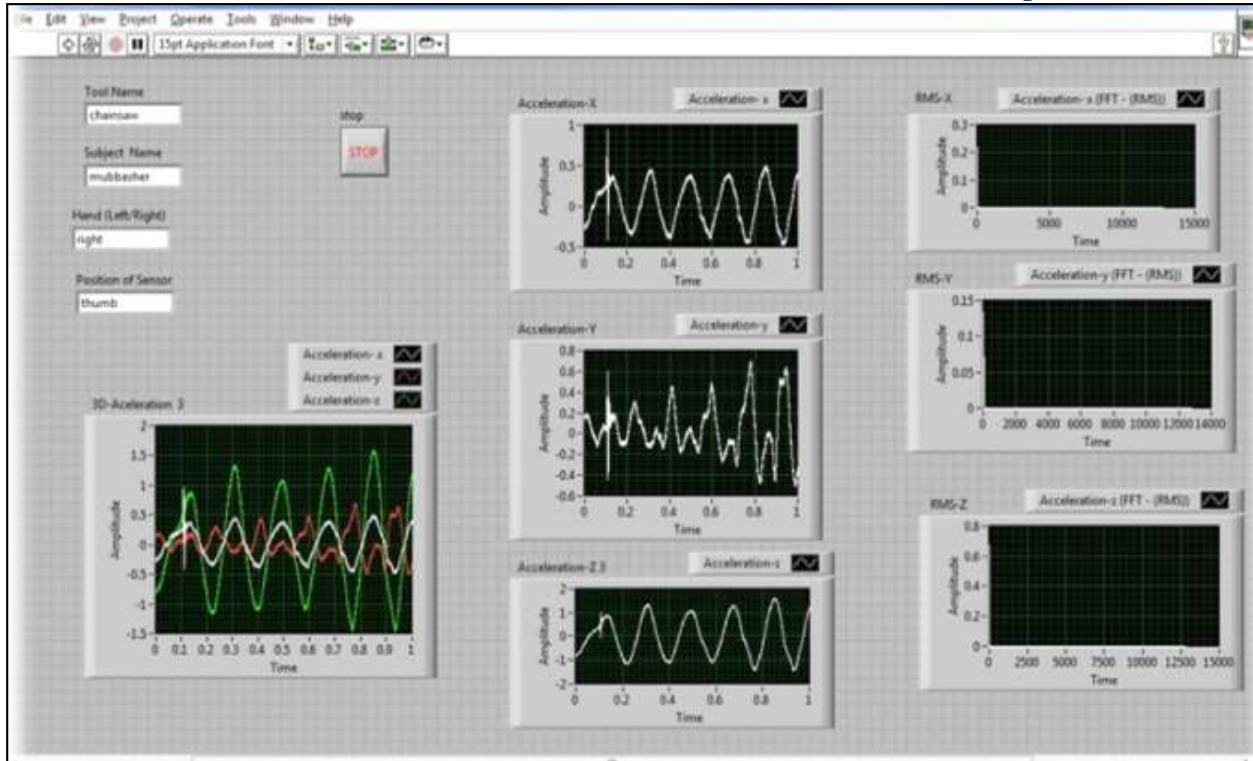


Figure 3. Screen Shot of the LABVIEW Code for recording Vibration levels in X, Y and Z directions

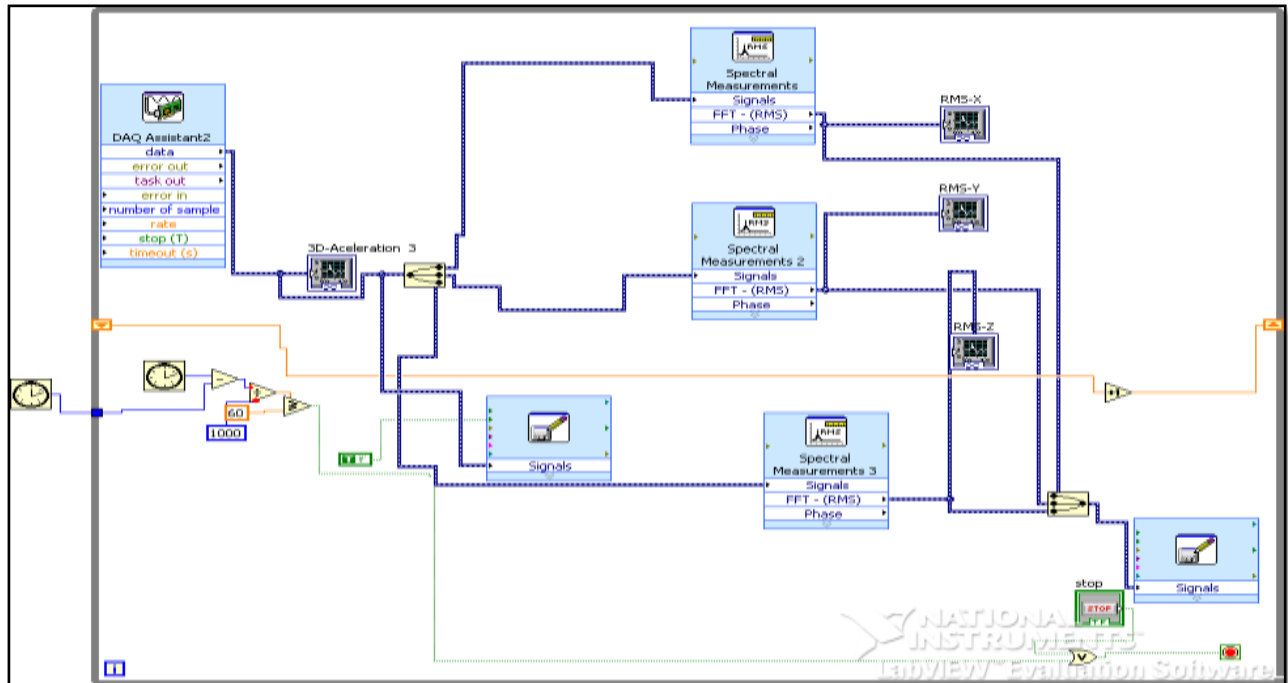


Figure 4. Block diagram of LABVIEW code used for the recording of Vibration levels.

RESULTS & DISCUSSION

The analysis for vibration was done through the MATLAB. A program was written in MATLAB for that purpose. In the analysis, some graphs were obtained between the different variables for different condition of the sensor and for each participant.

In the analysis, graphs were obtained between the One-sided Power Spectrum Density (PSD) (dB/rad/sample) and the Frequency (Hz). A sample graph for the PSD was shown in the Figure 5. The graphs were also obtained between the Frequency of Occurrence and the Vibration Amplitude, between the RMS value and the Number of Frames and for the Amplitude of Vibration and the Time (in seconds).

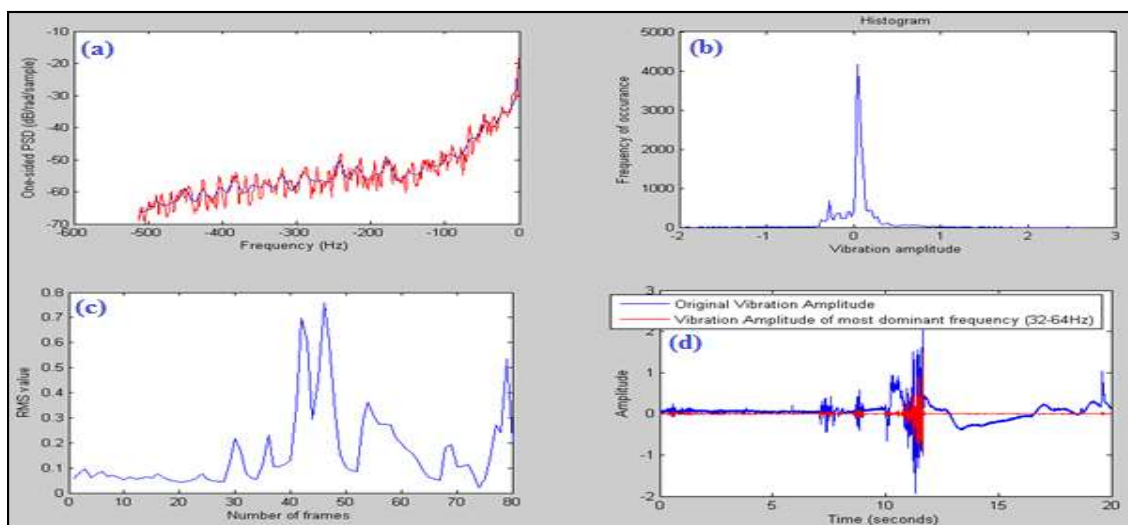


Figure 5. (a) Graph between the one-sided power spectrum density (PSD) (dB/rad/sample) and the frequency (Hz), (b) The histogram between the frequency of occurrence and the vibration amplitude, (c) The graph between the RMS value and the number of frames and (d) The graph between amplitude of vibration and time (in seconds).

On the basis of the analysis through MATLAB, summary tables were made for different participants. The summary table was showing the Surface conditions, Position of the sensor, Maximum Power Density and the Frequency zone.

Table 1. Power spectral density with frequency zone for different surface condition and participants.

Surface Conditions	Position of Sensor	Frequency Zone (Hz)	Power spectral density
Farm Field	Neck	1-5	0.0840
	Low Back	1-5	0.1044
	feet	6-10	0.4967
Tar-Macadam Road	Neck	1-5	0.1519
	Low Back	1-5	0.1899
	Feet	6-10	0.2496
Bricks Road	Neck	1-5	0.0733
	Low Back	1-5	0.0792
	Feet	6-10	0.6472

The vibrations transmitted to whole body through seat pad system & breaking system of tractor have been analyzed with Lab View TM and by using MATLAB programme for each test and the results we get in the form of table 1. Table 1 is showing the vibration level on neck, low back & feet under different surface condition far different

participants. The results indicate that the maximum transmissibility was observed in the first two frequency interval (in Hz) i.e. 1-5 and 6-10. The frequency interval under different surface conditions was 1-5 (neck), 1-5 (low back), and 6-10 (feet).

CONCLUSION & FUTURE STUDY

The results show that the vibration level of tractor driver from the seat operator system & breaking system under the different surface conditions (i.e., farm field, tar-macadam road & bricks road) have given the frequency zone 1-5 Hz and 6-10 Hz was the maximum power spectral density. The frequency zone (1-5 Hz & 6-10 Hz) is the most harmful for the tractor driver. Prasad et al. [10] have suggested that the frequency zone 2-6 Hz has been the most harmful for the tractor driver because resonance occurs within this frequency.

Authors have found most harmful range of frequency zone for tractor driver and the next challenge will be evaluate the analytical model for tractor seat operator system and also, will be find spring constant & damping co-efficient of suspension system for the tractor.

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