VIBRATION TRANSMISSIBILITY FROM SEAT TO HUMAN OPERATOR HEAD DURING TRACTOR DRIVING IN VERTICAL DIRECTION

D.K.Verma[1*], Dr. A.A.Khan[2]

[1]M.Tech, Department of Mechanical Engineering, Aligarh Muslim University,*
[2] Lecturer, Department of Mechanical Engineering, Aligarh Muslim University, INDIA

ABSTRACT

India is one of the largest manufacturer of tractors in the world. They are used for primary and secondary village operations and as a mean of transportation. Vibration in tractor driving can cause serious injury to the head of the driver during ride operation. The present study was undertaken to detect the most harmful frequency zone of ride vibration of low horse power tractor system. Tractor rider vibration levels have been measured at the person seat interface along vertical axis and as well on head by using adjustable helmet strap mounted accelerometer on the driver in same direction, under harrowing operation condition. The frequency range of 1-24 Hz has been observed to be the most harmful for the human operator because resonance occurs within this frequency range. Considerable effort has been made to establish the optimum design parameters for tractor seats and suspensionsystem.

Keywords: *vibration, tractor, spectral density, human head.*

INTRODUCTION

All of the machineries with moving parts, in addition of being noise sources, are considered as vibration sources, too. Among these, motor vehicles used in particular agricultural and road building machineries are some of important vibration sources, that many workers are exposed to the hazard of vibration produced by these machineries. Different studies were administered to tractor drivers, to measure vibration and investigate vibration effects on the health of the drivers [1]. Tractors do not have suspension systems and the vibration levels (particularly for those without suspended cabins) are high compared to other road vehicles [2]. With the high degree of mechanization of farms along with increasing size and complexity of farm machinery, the occupational hazards of tractor driving include deafness and disorders of the spinal column and stomach, caused by vibration are also increased. This effect reflects in lower work output and quality. Vibration results from the interaction of the vehicle with the rough terrain or tar road and from the vehicle's power source.

In India tractor are being mainly used for primary and secondary village operations and as a means of transportation to haul goods and animals. According to the regional and geographical situation, tractor is one of the important conveyances in Indian village and city, it is a great part

of transportation, including the transportation of drinking water, and displacement of soil. Thus, many occupiers are exposed to the vibration caused by tractor, that most of them are unaware of its harmful effects. Besides this, people do not pay attention to the repairing and maintenance of tractors, because of their low income and bad economical situation, which causes increase of vibration in tractors. In addition, tractors drivers are mainly people with low education and do not pay attention to their health, which it causes the increase of the effect of vibration onthem.

Unlike passenger vehicles, the suspension systems of many off-road vehicles, such as tractors, consist only of the tyre and the seat, as there is no good suspension system connecting the vehicle wheel to the chassis. Now days in India, suspended seats fitted to most tractors reduce the vertical component of vibration, but the levels are still undesirably high and there is little potential for further improvement using this technique. A further reduction in the vibration level may be obtained by introducing wheel suspension, but it makes the system complicated and costly. Cab suspension is another method of reducing ride vibration which is almost as expensive as wheel suspension, although useful. Vehicle purchases are driven by consumer requirements such as functionality, safety, luxury, comfort, cost and performance.

The issue of the vibration transmitted through the seat of agricultural tractors to the driver body has been widely discussed. There are many factors which affects the readings of vibrations directly. The reliability of the prediction of the vibration level and amount of vibration received during driving is often poor because the driver adjusts speed of tractor, course and his posture to improve the work quality and capacity, and own comfort [3].

Passenger seat comfort depends on both static and dynamic comfort. Static comfort refers to the comfort of the vehicle occupants when the vehicle is stationary. A statically comfortable seat requires the minimum muscular effort from the occupant to maintain the seated position. This implies that muscular fatigue is minimized because the body is sufficiently supported by its contact with the seat, seatback and floor [4]. Dynamic comfort is mostly characterized by the noise, vibration and harshness (NVH) attributes when the vehicle is driven. The interior sound of the passenger's compartment has become increasingly important as automotive manufacturers strive to improve brand identity, customer loyalty, and perceived quality of their products [5]. The purpose of the study to find out the frequency range, which is harmful to human operator during harrowing operation.

MATERIAL AND METHODS

Apparatus

A LABVIEW code was written to design the instrument for the recording of vibration levels. The data acquisition was made possible using tri axial transducer (which was attached to operator seat having -model no. SEN041F) and 353B18 SN 140184 vibration sensor attached to operator helmet and both were connected to NI card (Model No. NI 9234 made by National instruments) using lead and the card was interfaced with a Acer laptop(specifications P6000

processor ,3 GB RAM)(Fig 1).This setup was supportive to the sampling rate of 26,400 per second .However the mean values were only recorded .The recorded data was auto stored in text/excel files in the laptop. The power spectral density calculated using Mat lab. Procedure to measure the vibration on tractor seat was very much standardized; vibration was measured along z-vertical axis only i.e. vertical direction.

Procedure

Prior to the first, subject of the test was given written information about the experiment, which included the purpose of the study. A Swaraj 855 FE tractor (3-cylinder, 3308 cc, water-cooled diesel engine produces 55 HP (SAE) at 2000 RPM) available at hathras district was selected for the study. The tractor was in working condition, tyres of the tractor were of standard size. Subject was considered to be healthy with no signs of musculo-skeletal system disorders, having normal physique and mass (59kg). The test was conducted on agricultural field with load i.e. harrowing equipment. For measuring vibration, the tractors were moving in an agricultural field with a speed of 10-15 kmph. The whole test was carried out on Indian tractor without any trailer attached with it but it have a load i.e. harrowing equipment (Fig2).

Fig 1: close up view of setup of sensor and transducer at specified location

Fig 2: The measurement of vibration of Swaraj tractor 855 FE while harrowingoperation.

RESULT AND DISCUSSION

As we observe the reading, the low frequency zone is very harmful to tractor driver head during operation in comparison to high frequency zone. Frequency reading for Swaraj 855 FE model is high in the range of 1-24 Hz and having band power value of .0619 for subject seat and .0512 for subject head. Maximum peak of power spectral density for z-base and z-target lies in the first interval of frequency zone (Fig 3) (Fig4). Fig 5 and Fig 6 shows the band power value in 25 frequency zone over a interval of 0 to 600 Hz.

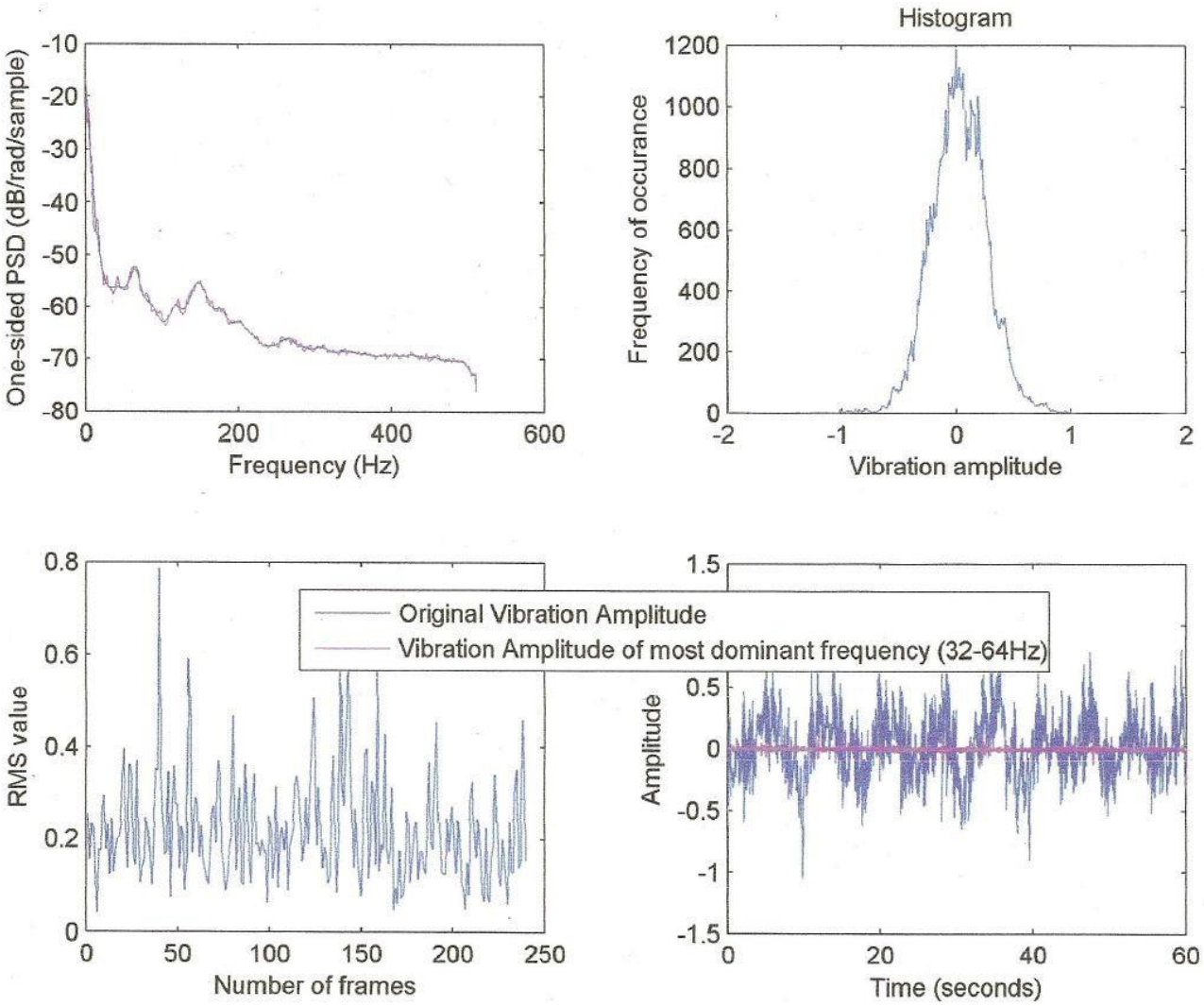

Fig 3: Power Spectral Density for Swaraj 855 FE z-base (seat)

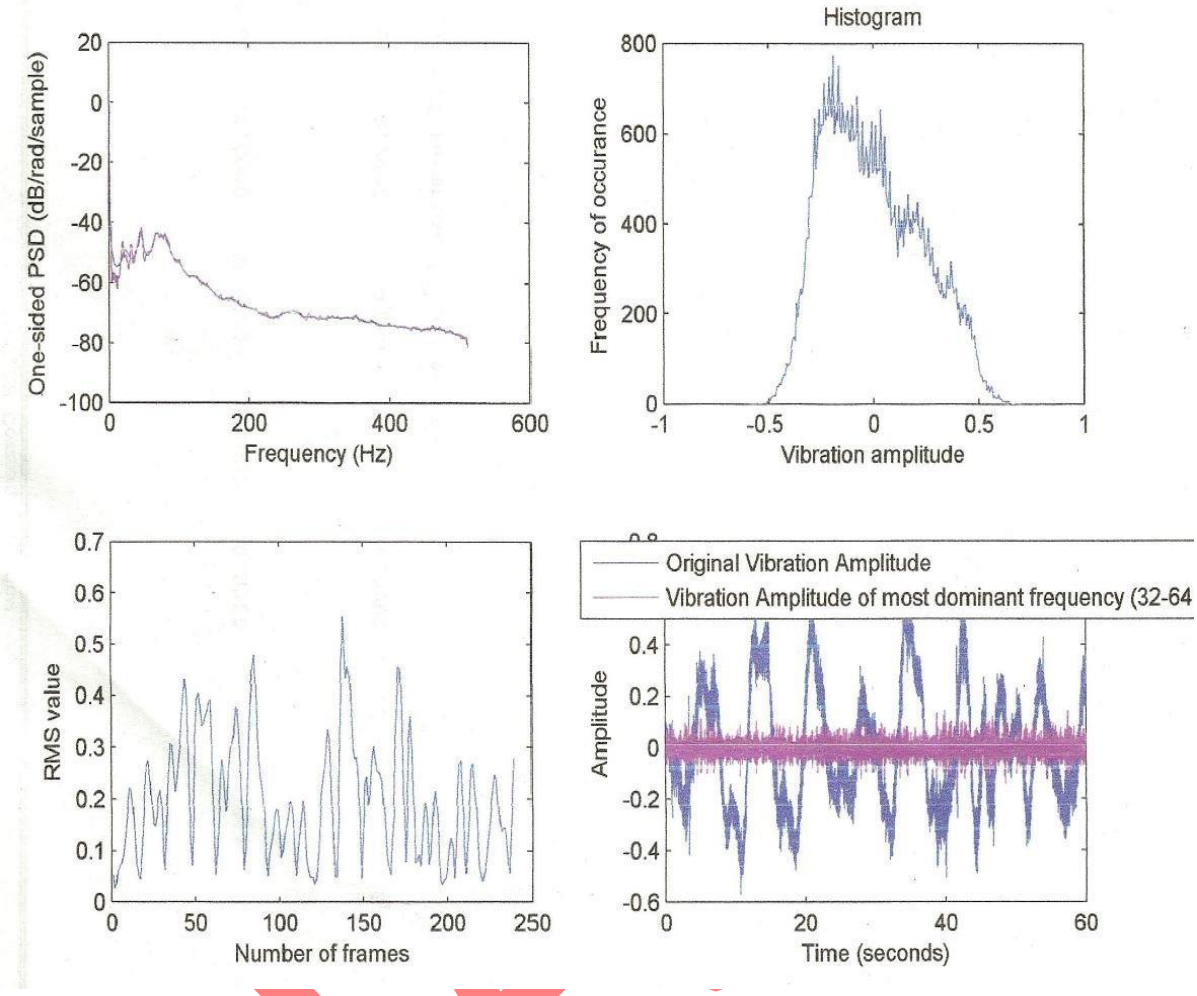

Fig 4: Power Spectral Density for Swaraj 855 FE z-target (head)

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>> band_power

band_power =

  Columns 1 through 15

    0.0619    0.0001    0.0001    0.0001    0.0000    0.0000    0.0000    0.0001
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

  Columns 16 through 25

    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000

>>
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Fig 5: Frequency zone of Swaraj tractor for z-base

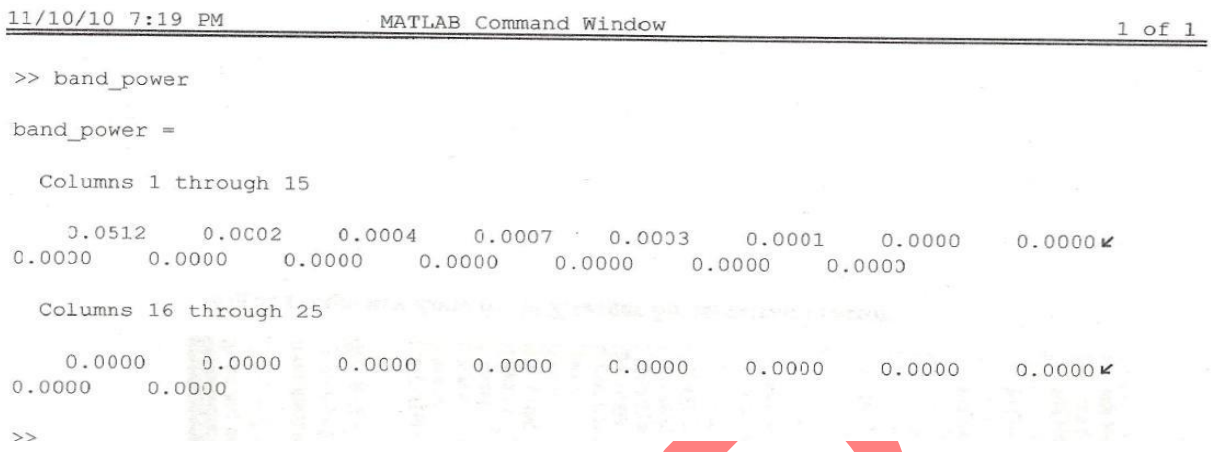

Fig 6: Frequency zone of Swaraj tractor for z-target

CONCLUSION

Ultimately, it is clear that the issue is very complex. The axis, frequency, amplitude, duration, and surrounding tissue health can all influence the head response to vibration. Vibration causes health problem and makes under utilization of human power. The frequency range of 1-20 Hz is the most harmful for the human operator. Therefore, the vibration level at the operator's seat needs to be attenuated within acceptable limits in this frequency range. Both epidemiological and ergonomically studies are recommended to determine dose–response relationships in agricultural productionactivities.

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