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Vibration Analysis of Tractor Seat on Flat Field With Different Accesories for Comfort Ride of a Driver

Prof. Mikhil K. Bhavsar[1], Prof. Vilas M. Mhaske [2]

Assistant Professor, Mechanical Engineering Department, Late G.N. Sapkal COE, Nasik, Maharashtra, India[1]

Associate Professor, Mechanical Engineering Department, Amrutvahini COE, Sangamner, Maharashtra, India[2]

Abstract: Many farmers face the problem regarding low back pain. This is an important factor which affects the health of population. The Parliament of the European Community agreed that there should be some limiting exposure action values for health and safety requirements of exposure of workers for the risks from vibration. Many studies show that whole body vibration is responsible for low back pain and it can happen to any group of polpulation. Most of the tractor drivers complain about low back pain more than non-tractor drivers. In the present study, we collected data using FFT Analyzer. We attached the accelerometer below the driver seat of tractor by confirming to ISO standards. Then post analysis has been conducted in terms of rms accelerations & compared with ISO standards where it shows that measured values exceeded the health norms of ISO standards. The tractor seat is modified by passive type of suspension system for reducing vibration magnitude. Again tests were carried out on farm terrain for different accesories. The use of modified seat reduces the vibration amplitude within 'health guidance zone' specified by ISO 2631-1 in all farm terrains.

Keywords: LBP, ISO, FFT analyzer, rms accelerations, vibration amplitude.

I. INTRODUCTION

Whole-body vibration means when the whole body is exposed to vibration through any physical contact by the feet of employees who drive mobile machines, or other work vehicles, over rough and uneven surfaces as a main part of their job.

It is a generic term used where any vibration frequency is transferred to the human body.

Whole-body vibration is harmful to humans because it excites the natural frequency of the body. The dynamics of the human body has been researched to determine which frequencies are most harmful.

Gniady and Bauman from Aura Systems determined the natural frequencies of the human body in the sitting position. The human body usually has a natural frequency between 4 and 5 Hz.

Most of the vital organs of the body, such as the stomach, spine, and heart have a natural frequency around the 4 to 5 Hz range.

Knowledge of the most harmful frequency range of the sitting human body dictates the necessary frequency range of a vibration cancellation device.

Professional drivers are exposed to multiple factors which are considered as a risk for low back disorders, to deal with the complexity and diversity of these effects on the human body, it is customary to consider human vibration as either a whole-body vibration problem or a hand arm vibration problem.

Whole-body vibration refers to the vibration which occurs when the body is supported on a vibrating surface, constrained postures and repeated twisting or bending of the back and neck.

For example, agriculture tractor drivers adopt risky postures.

Whole-body vibration occurs in transport vehicle, heavy industrial vehicles, tractors, locomotives, buses and helicopters.

The operators of these vehicles are exposed to unsafe levels of WBV. Harmful effects of WBV are experienced when the exposure time is longer than the recommended standards set by ISO 2631.

Fig.1. Schematic of Agriculture Tractor Seat

1.1 Objective

The main aim of this work is to improve the design or made new design of suspension system for tractor seat for reducing the rms acceleration value near to the minimum health and safety requirement's ''exposure action values'' and ''exposure limit values'' in order to improve the ride comfort thereby increasing the potential of the operator to work longer.

II. EXPERIMENTAL SETUP

Vibration at the tractor floor is measured by using accelerometer attached to lower side of the tractor seat. Vibration amplitides are measured by FFT Analyzer. For the test we select Swaraj 735 FE tractor. Tests will be carried out on flat field with plough, cultivator and harrow connected to tractor. The speed of tractor is 05 Kmph and 08 Kmph.

III. MODELLING AND DATA ACQUISITION

3.1 Measurement of Acceleration on Conventional Tractor Seat with Plough

Frequency Hz	Ploughing flat Fieldrms m/s^2	
	05 Km/hr	08 Km/hr
0.5	0.3187	0.2679
1.0	0.5562	1.0668
1.5	0.9655	1.1369
2.0	1.0296	2.6989
2.5	1.8287	2.4687
3.0	0.9192	2.9616
3.5	1.4732	2.4772
4.0	1.7441	2.4940
4.5	4.2158	3.4917
5.0	3.0009	3.1641
5.5	6.0348	4.3510
6.0	5.2484	4.4738
6.5	6.1093	3.5139
7.0	5.9488	4.0850
7.5	4.1657	3.0969
8.0	4.5491	1.8308
8.5	3.5845	2.4503
9.0	2.6993	1.9165
9.5	3.8590	1.7581
10.0	3.3996	1.5594

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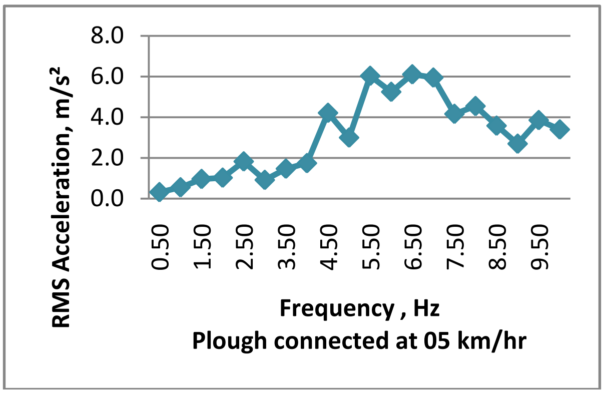
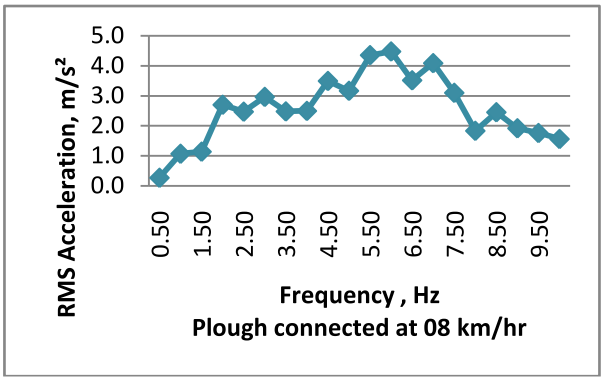
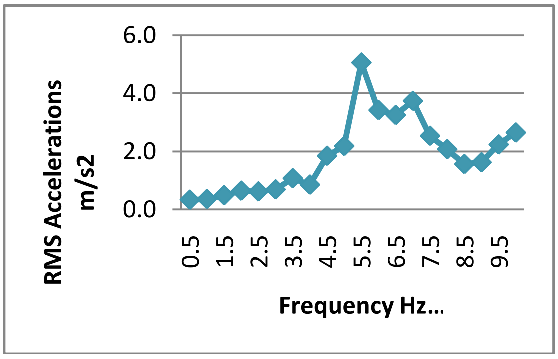
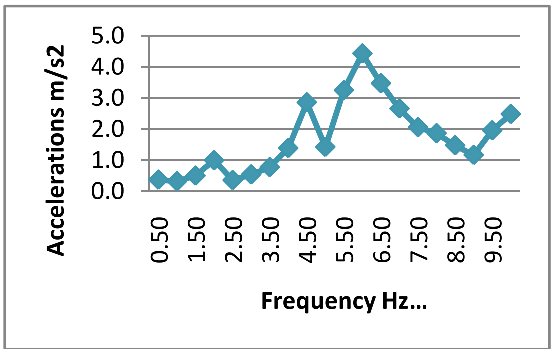




3.2 Measurement of Acceleration on Conventional Tractor Seat with Cultivator

Frequency	Cultivating flat Field	
	05 Km/hr	08 Km/hr
0.5	0.3299	0.3618
1.0	0.3558	0.3107
1.5	0.4862	0.4936
2.0	0.6409	0.9864
2.5	0.6155	0.3501
3.0	0.6857	0.5316
3.5	1.0725	0.7673
4.0	0.8510	1.3811
4.5	1.8440	2.8510
5.0	2.1813	1.4173
5.5	5.0549	3.2421
6.0	3.4176	4.4235
6.5	3.2488	3.4622
7.0	3.7357	2.6514
7.5	2.5325	2.0500
8.0	2.0716	1.8583
8.5	1.5595	1.4693
9.0	1.6216	1.1601
9.5	2.2337	1.9495
10.0	2.6450	2.4748





3.3 Measurement of Acceleration on Conventional Tractor Seat with Harrow

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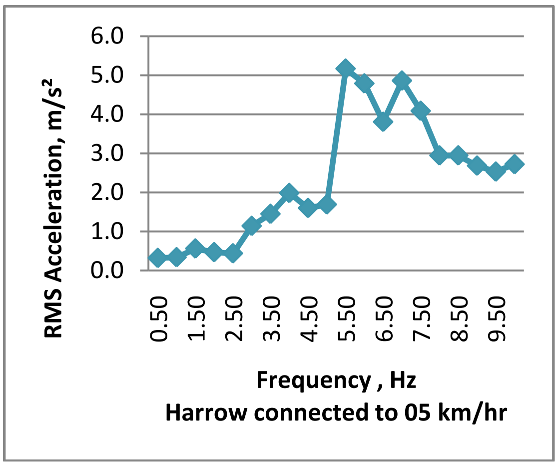
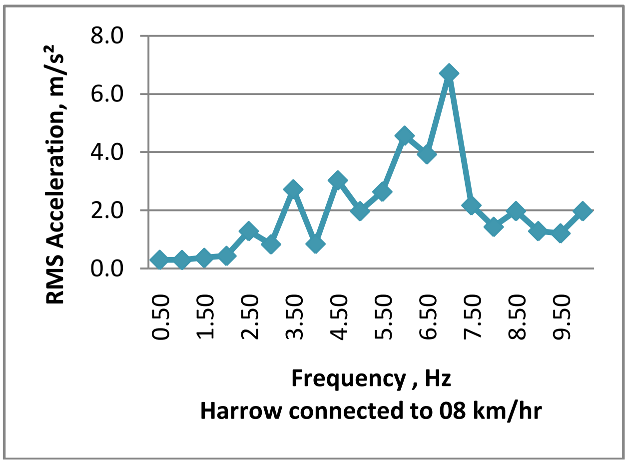
Frequency Hz	Harrowing flat Field rms m/s^2	
	05 Km/hr	08 Km/hr
0.5	0.3183	0.3019
1.0	0.3375	0.2965
1.5	0.5598	0.3693
2.0	0.4669	0.4371
2.5	0.4368	1.2897
3.0	1.1388	0.8360
3.5	1.4464	2.7239
4.0	1.9809	0.8513
4.5	1.5970	3.0340
5.0	1.6884	1.9748
5.5	5.1635	2.6414
6.0	4.7850	4.5666
6.5	3.8019	3.9261
7.0	4.8572	6.7085
7.5	4.0829	2.1755
8.0	2.9423	1.4356
8.5	2.9434	1.9780
9.0	2.6802	1.2888
9.5	2.5279	1.2121
10.0	2.7173	1.9749





From the above table & graph, the values of rms accelerations with plough for conventional tractor seat is in between 2.5 - 6 m/s^2, with cultivator for conventional tractor seat is in between 1 - 5 m/s^2, with plough for conventional tractor seat is in between 1.5 – 6.5 m/s2 on Flat Field, it shows that the measured values of conventional tractor seat's root mean square (rms) accelerations with two different speed i.e. 05 km/hr & 08 km/hr on flat field with multiple accesories has exceeded the upper limit of 'health guiding caution zone' specified by ISO 2631-1. So there should be modifications needed in the existing seat suspension system of conventional tractor for meeting the specifications of ISO standards.

IV. AFTER MODIFICATIONS MADE IN CONVENTIONAL TRACTOR SEAT

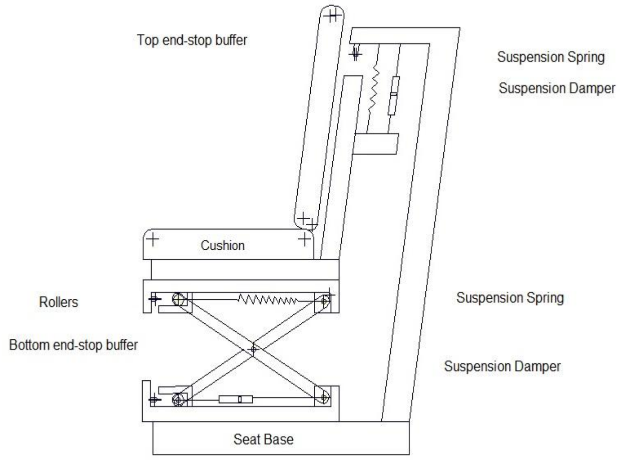


Fig. 2 Schematic diagram of modified Tractor seat

4.1 Measurement of Acceleration on Modified Tractor Seat with Plough

Frequency Hz	Ploughing flat Field rms m/s^2	
	05 Km/hr	08 Km/hr
0.5	2.2920	2.5830
1.0	1.9310	2.1160
1.5	1.6520	1.8500
2.0	1.8200	1.9460
2.5	1.8940	1.9100
3.0	1.6020	1.5720
3.5	1.3210	1.2840
4.0	1.4570	1.3760
4.5	1.5890	1.4940
5.0	1.3840	1.3420
5.5	1.0700	1.0600
6.0	1.1310	1.0550
6.5	1.3450	1.2660
7.0	1.2900	1.2970
7.5	1.0240	1.0980
8.0	0.9750	0.9990
8.5	1.1890	1.1800
9.0	1.2410	1.2950
9.5	1.0550	1.1600
10.0	0.9660	1.0030

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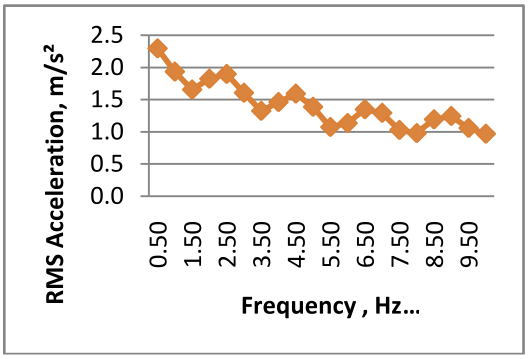
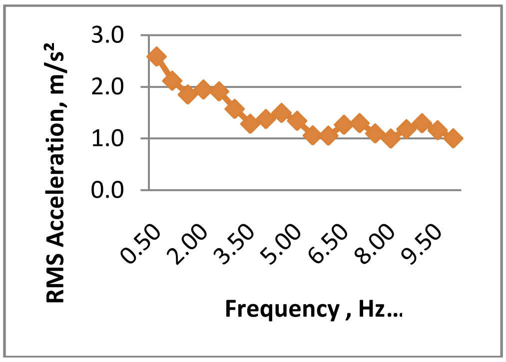
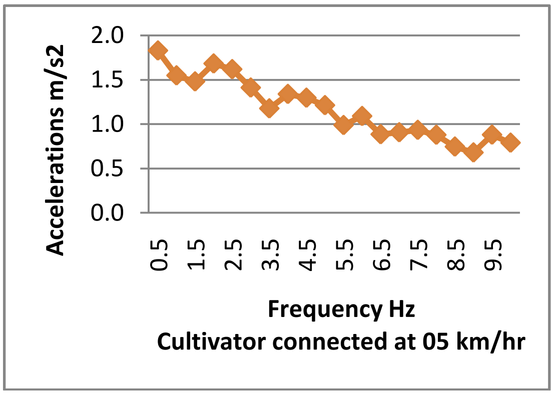
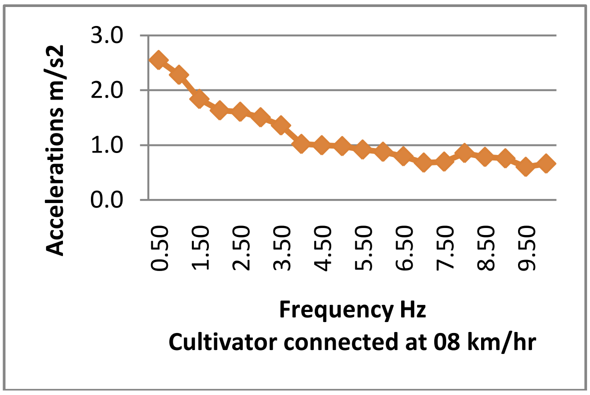




4.2 Measurement of Acceleration on Modified Tractor Seat with Cultivator

Frequency Hz	Cultivating flat Field rms m/s^2	
	05 Km/hr	08 Km/hr
0.5	1.8270	2.5480
1.0	1.5470	2.2790
1.5	1.4790	1.8380
2.0	1.6810	1.6300
2.5	1.6170	1.6040
3.0	1.4100	1.5030
3.5	1.1760	1.3560
4.0	1.3380	1.0170
4.5	1.2960	0.9930
5.0	1.2120	0.9770
5.5	0.9880	0.9140
6.0	1.0900	0.8740
6.5	0.8850	0.7920
7.0	0.9070	0.6760
7.5	0.9340	0.6940
8.0	0.8790	0.8520
8.5	0.7460	0.7800
9.0	0.6800	0.7540
9.5	0.8800	0.5990
10.0	0.7900	0.6590





4.3 Measurement of Acceleration on Modified Tractor Seat with Harrow

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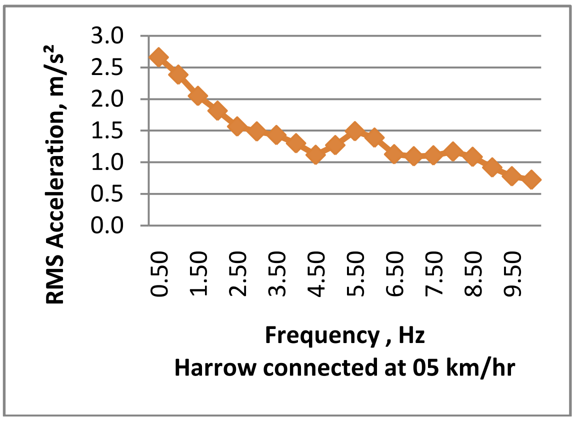
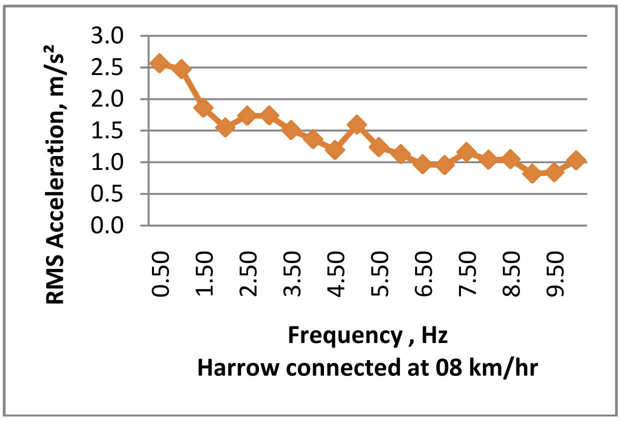
Frequency Hz	Harrowing flat Field rms m/s^2	
	05 Km/hr	08 Km/hr
0.5	1.3590	2.5600
1.0	1.6360	2.4680
1.5	1.4880	1.8590
2.0	0.9880	1.5460
2.5	0.8740	1.7330
3.0	1.4000	1.7370
3.5	1.3310	1.5060
4.0	0.6860	1.3640
4.5	1.2110	1.1910
5.0	0.9730	1.5920
5.5	0.9290	1.2380
6.0	2.3840	1.1260
6.5	2.0480	0.9660
7.0	1.8130	0.9530
7.5	0.6510	1.1580
8.0	0.7400	1.0380
8.5	0.7180	1.0460
9.0	0.7620	0.8180
9.5	0.4634	0.8400
10.0	0.7870	1.0280





From the above table & graph, the values of rms accelerations with plough for modified tractor seat is in between 1.5 - 1 m/s^2, with cultivator for modified tractor seat is in between 1.5 - 1 m/s^2, with plough for modified tractor seat is in between 1.75 – 1 m/s^2 on Flat Field. The graphs of conventional and modified tractor seat represents that in all terrain conditions RMS acceleration of conventional seat is much higher than required value of RMS acceleration, while the acceleration has been controlled in Modified tractor seat as per ISO 2631-1.

V. CONCLUSION

The anti-vibration system reduces the RMS acceleration thereby increasing the potential of the operator to work longer. Such type of passive suspension system reduces the vibration and improves considerable ride comfort for different roads, applications & speeds which improves the ride comfort of the tractor driver.

FUTURE SCOPE

The research completed here provides a foundation for continued research and development of a tractor seat. The design and building of the passive type of suspension system opens the door to many research possibilities. Some possible additions to the model are presented below,

- The experiments can be conducted by changing different spring for different loads.
- Developing a software model for simulation which directly gives the value for spring stiffness for different applications as well as different operating conditions (i.e. Flat Field, Sugarcane Field, Road etc.).
- Inclusion of knob at seat base for changing stiffness of spring for different operator having different weights.

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REFERENCES

[1]. T. Gunston, “The development of a suspension seat dynamic model”, Human Response to Vibration Conference, Institute of Sound and Vibration Research, Southampton, UK, 1998
[2]. Laxmaiah Manchikanti, MD “Epidemiology of Low Back Pain” Pain Physician, Volume 3, Number 2, pp 167-192 (2000)
[3]. M J Griffin “Minimum health and safety requirements for workers exposed to hand-transmitted vibration and whole-body vibration in the European Union; are view” –Occup. Environ Med 2004; 61:387–397. doi: 10.1136/oem.2002.006304
[4]. Ch. Sreedhar , Dr. K. C. B. Raju , Dr. K. Narayana Rao “Development and Optimization of Vibration Protection Seats (Tempered Springs) for Agricultural Tractor” Proceedings of the World Congress on Engineering 2008 Vol II WCE 2008, July 2 - 4, 2008, London, U.K.
[5]. S. Segla, N. Trisovic “Modelling and Optimization of Passive Seat Suspension” American Journal of Mechanical Engineering, 2013, Vol. 1, No. 7, 407-411
[6]. Adarsh Kumar, Puneet Mahajan, Dinesh Mohan, Mathew Varghese “Tractor Vibration Severity and Driver Health: a Study from Rural India” J. agric. Engng Res. doi:10.1006/jaer.2001.0755
[7]. Niranjan Prasad, V. K. Tewari And Rajvir Yadav “Tractor Ride Vibration - A Review” Journal of Terrarnechanics, Elsevier Science Ltd, Vol. 32. No. 4, pp. 205-219. 1995

BIOGRAPHIES

Prof. Mikhil Kailas Bhavsar, has completed ME in Design Engineering & currently working as an Assistant Professor in Late G. N. Sapkal COE, Anjaneri, Nasik, Maharashtra, India.

Prof. Vilas M Mhaske, Has completed ME in Design Engineering & currently working as an Associate Professor in Amrutvahini COE Sangamner, Dist: - Ahmednagar, Maharashtra, India.