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Ride Comfort Test and Evaluation Analysis of the Typical Off-Road Vehicle

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ABSTRACT

Article

The assessment of ride comfort consists of the domains like seat vibration, steering wheel vibration, interior noise, general handling and motion of the vehicle. Measuring and quantifying ride comfort will help in meeting the necessary standards and regulations and will gives the required insight to troubleshoot, understand and improve off road ride comfort of the vehicle.

This paper focuses on the factors which affect on the quality of the ride comfort. Also this chapter covers the elements of suspension system of vehicle and basic classification of suspension system. The vibration characteristics of off-road vehicle also mentioned here. The outline of the work carried out is presented at the end.

I. INTRODUCTION

In recent years, the ride comfort is the main performance parameter in the vehicle design. Ride Comfort is the general sensation of noise, vibration and motion inside a driving vehicle, experienced by both the driver as well as the passengers. Comfort is the first impression during a test drive and is an important criterion when buying a new vehicle, and therefore it represents the first appreciation of the brand while safety is essential parameter. The ride characteristics affect not only the work performance and physical health of the driver, but also affect the vehicle's power, economy and handling performance. Ride comfort optimization goes beyond the pure ISO 2631 whole body vibration certification testing as it affects the comfort, safety and health of the

II. Literature Review:

In this paper, the literature review of the research publications relevant to subject area of dissertation work. This includes the types of off-road vehicle suspension systems, theoretical, experimental and

passengers subjected to it.

Ride comfort is one of the most critical factors to estimate the automobile performance and has been an interesting topic for researchers for many years. The ride characteristics affect not only the comfort of the crew, work performance and physical health, but also directly or indirectly affect the vehicle's power, economy and handling performance. A greater need to improve comfort characteristics during vehicle design process has recently forced the manufacturers to develop simulation- based approaches instead of costly prototyping manufacturing. Therefore, in recent years, the number of studies on developing the techniques to optimize the vehicle ride comfort characteristics is gradually increasing to meet the customer requirements.

simulation analysis related for providing off- road vehicle like tractor ride comfort. Overall papers from international, national journals, conferences and periodicals are referred and following is the brief review of the literature review.

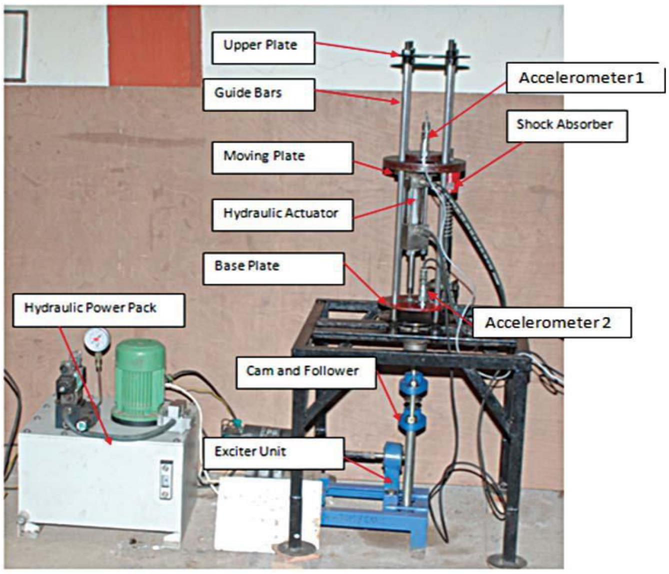
III. Problem Statement:

To analyze and to assess the ride comfort characteristic and vertical bounce characteristics in particular of various farm tractors. This has been carried out by providing and generating a dynamic tractor as input and analyze the vertical vibrations transmitted to the driver using ride comfort testing with the help of FFT analyzer and data acquisition system.

IV. Experimental Analysis:

Kumar et al. [9] introduced that occupational health problems of agricultural workers have not received significant attention in low-income countries (LICs). This is particularly true for tractor drivers who operate the tractor in extreme temperatures, high level of suspended particles and without vibration attenuating designs of tractors and tractor seats. Tractors in high-income countries (HICs) have become very complicated and almost all have enclosed environment controlled suspended cabins and well-designed instrumentation and controls. These designs are not likely to become common in countries such as India in the near future because of economic reasons. Measurements of vibrations were conducted on tractors of different sizes under varying terrain conditions. Analysis has been done in terms of root mean square (rms) accelerations in one-third-octave band and International Standard Organisation (ISO) weighted overall rms. The values were compared with ISO 2631-1, 1985 and 1997 standards. In the overall ISO-weighted rms acceleration procedure of ISO 2631-1 (1997) in all farm and non-farm terrains working time of 3 h exceeded the upper limit of health guidance caution zone. A tractor-operator model was adapted for prediction of the rms accelerations on the ISO 5008 track.

Patil and Joshi [10] described an experimental analysis of 2 degree-of-freedom (DOF) quarter-car passive suspension system and hydraulic active suspension system (QC- H-ASS) for ride comfort as shown in fig. 2.3. A hydraulic actuator has been considered as one of the most feasible choices for an active suspension system due to its high power-to-weight ratio and low price. The results showed considerable improvement in ride comfort over the passive system. The details of the quarter-car model improvement with the test set-ups for the passive and hydraulic active suspension systems, suspension elements employed, experimental analysis and results are presented. The focus of the work was on the development of an active suspension system for such vehicles to provide better ride comfort to the occupants of the vehicle and ensure reliable operation by incorporating design features for better road holding, stability and maneuverability.



V. Strategy of Off-Road Ride Comfort Testing:

After selection of different categories of tractors, test track has been selected. The FFT analyzer with appropriate instrumentation is used for the ride comfort analysis. The metal plate is placed and fixed on the driver seat upon which an accelerometer is mounted. After all this arrangement, the tractor travels at an average speed of 3-6 km/hr for plowing, 6-8 km/hr for rotor and 7-9 km/hr for stunted operation and fo village road 8-11 km/hr. The off-road ride comfort analysis tests were carried out by considering the vertical bounce characteristics i.e. rms displacement, rms velocity and rms acceleration as the performance parameters. The same strategy is applied for remaining tractors and tests are carried out accordingly. The rms displacement, rms velocity and rms acceleration response curves are obtained on FFT analyzer. The results from FFT analyzer are then exported to the DDS 2011 software. The results obtained from off-road ride comfort testing are then plotted with respect to frequency. According to the results, the comparison is made between all the selected tractors for different instruments. The tractor operation and its recommended speed are given in table 3.5.

Table 3.5: Tractor operation and its recommended speed

Sr.No.	Operation	Speed km/hr
1	Plowing	3-6
2	Rotoring	6-8
3	Stunted operation	7-9

VI. Health Guidance Caution Zone Limit

The overall root mean square acceleration values and comparison with ISO 2631-1 health guidance caution zone limit (ISO 1997) are given in table 5.10 [9]. For the plowing operation upper health limit 0.88, 0.99 and 1.01 for case I, case II and case

III. For rotoring operation upper health limit 1.08, 1.18 and 1.31 for case I, case II and case III. And stunted operation gives upper health limit 1.62, 3.22 and 3.44 for case I, case II and case III. The result shows that maximum upper limit of the health caution zone for plowing operation case III tractor is 1.08 h, for rotoring operation case III tractor is 1.31 h, for stunted operation case III tractor is 3.44 h. For the village road case II tractor upper health limit is 3.82 h.

Table 5.10: Health guidance caution zone limit [9]

Tractor Power (HP)	Velocity km/hr	R.M.S. Acceleration m/s^2	Health limit, h	
			Upper	Lower
45	3-6	2.33	0.88	0.11
55	3-6	2.25	0.94	0.11
60	3-6	2.18	1.01	0.12
45	6-8	2.10	1.08	0.13
55	6-8	2.01	1.18	0.14
60	6-8	1.91	1.31	0.16

VII. Conclusion:

It is seen that for various farming operations as shown in table 5.10 the health exposure zone is found to be at minimum zone is found to be at minimum duration for the operation of plowing with 45 HP farm tractor with upper health limit of 0.88 hours where in the maximum health exposure zone is derived for the operation of stunted with 60 HP farmtractor with upper limit of 3.44 hours.

VIII. Future Scope:

With the health limit data derived with real time experimentation for various farming operations with different engine capacities. The data can be further utilized for modifications in the farm tractor and farm equipment design to enhance the respective health limits.

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