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Study and Experimental Analysis for Vibration Reduction of Steering Wheel Assembly of Agricultural Tractor by Using Matlab Software

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Abstract: ***Steering wheel vibration is one of the principle explanation in picking out the operator comfort in agricultural tractor i.e. the operators hand subjected to the HAVS (Hand arm vibration syndrome) effect and nearly 10% of the operators are affected due to this affect and for increasing the operator comfort and reduce the adverse health effect of HAVS on human body. it is necessary to study the vibration in agricultural tractor by experimental ways and reduce by providing appropriate solution. The main objective of this work is to reduce the vibration produce in agricultural tractor and also find out the sources of vibration because of this vibration are created and also study of ambient excitation which are produce in agricultural tractor. The methodology used in this work is to measure the vibration level in the 40-50 KW agricultural tractor with and without providing isolation material i.e. By providing damper by experimental way in 2 degree of freedom (2DOF) system. Expression have been derived from vibration transmissibility from engine to steering wheel and coded in MATLAB.A simulation used to be carried out in RT –Pro program. The main benefits of this work are by using the isolation material dampers the amplitude of vibration may be reduce also Hand arm vibration syndrome effect also reduce and increase the operator comfort when the tractor operated in adverse environment so in this work it necessary to study the vibration in steering wheel assembly of agricultural tractor.***
Keywords: Steering wheel, Vibration, dampers, frequency, resonance, amplitude.

I. INTRODUCTION

Passenger comfort is a valuable criterion in the brand new vehicle design. Until up to date instances, tractors had been viewed as performance machines and the operator remedy was no longer given so much importance. Now the state of affairs hastransformed and tractor owners additionally need to have an equal stage of remedy, if no longer more than the passenger autos. Tractors as a rule operate in antagonistic environmental conditions and an ergonomically inferior tractor could make matters worse for the driving force. Operator relief in tractor manner many factors like area on hand for occupant, attain of controls, visibility, noise and vibration, temperature, and so on. Out of those vibration is one aspect which nownot best makes the operator uncomfortable, but in addition leads to failure of various parts of the tractor. Vibration can produce a wide variety of different effects to the operators. Machine operators are usually exposed to two types of vibration: whole-body vibration transmitted via the seat or via the floor and feet, and hand-arm-transmitted vibration. Both forms of vibration contribute to operator fatigue and can have a detrimental effect on job performance and health. To assess the effect of vibration, the vibration intensity and frequency must be taken into account together with exposure time. To quantify vibration exposure, measurements must be takenunder representative conditions. Guidelines for measuring and evaluating human exposure and details of different analysis methods are given in ISO 2631-1-1997 for the whole-body vibration and ISO 5349-1,-2001 for the hand-arm-transmitted vibration. Excessive exposure to hand-transmitted vibration can induce disturbances in finger blood flow, and in neurological and motor functions of the hand and arm. It has been estimated that 1.7–3.6% of the workers in the European countries and USA are exposed to potentially harmful hand-transmitted vibration. Vascular disorders and joint abnormalities caused by hand-transmitted vibration are compensated occupational diseases in 13% of total occupational diseases in Croatia (Kacian, 1997). These disorders are also included in an European list of recognized occupational diseases (ISO 5349-2001). The term ‘‘hand-armvibration syndrome’’ (HAVS) is commonly used to refer to the complex of peripheral vascular, neurological and musculoskeletal disorders associated with exposure to hand-transmitted vibration. Although it is a very serious problem in several countries, small attention is paid to it. Almost any operator of forestry and agricultural mechanization is exposed to whole-body vibration and/ or hand-arm-transmitted vibration. Even operators on jobs that seem easy, such as tractor driver, can be exposed to unexpected vibration. Specially unexpected are vibration transmitted from the steering wheel to the driver’s hands.

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II. LITERATURE SURVEY

Essential sources of steerage wheel vibration are engine imbalance, resonance of guidance system, lesser damping, road/discipline brought about vibration. Upon unique evaluation on that specified tractor, it was once found that the resonance of steerage approach with engine excitation is the root motive steerage wheel vibration is likely one of the principal reasons in determining the operator alleviation in for excessive vibration. Quite a lot of approaches to scale back vibration as a result of resonance had been viewed, equivalent to shifting the average frequency away from the 2ndorder engine frequency and increasing damping coefficient to shrink the vibration amplitude at resonance.

In this paper Ananth Sakthivel (2012), offers with the be taught of the special points of vibration produced inthe guidance vibration be taught was performed on quite a lot of tractor units (forty - 50 kW range) and one tractor was recognized for development upon special analysis on that particular tractor, it was observed that the resonance of steering process with engine excitation is the root motive for immoderate vibration. Quite a lot of approaches to scale down vibration because of resonance had been regarded, such as transferring the typical frequency far from the 2nd order engine frequency and growing damping coefficient to lower the vibration amplitude at resonance. Six specific standards have been generated and analyzed making use of the design comparison matrix. Two concepts have been chosen, particularly radial damper and axial damper ideas for extra processing. These concepts were proven and enormous reduction in vibration phases used to be carried out. Axial damper inspiration presents greater vibration reduction when compared to radial damper notion.

KandavelGowri Shankar (2009), in this paper, the writer demonstrates the systematic method in lowering the steering wheel vibration by way of Design for Six Sigma (DFSS). The obstacle was certain on excess vibration phases in the guidance wheel “principal Operator Interface” which used to be discovered unacceptable during the purchaser interaction and documented asVoice of client (VOC). The benchmarking evaluation was once achieved with selected tractor units qualitatively; to verify the difference in vibration level notion for patrons, for understanding the extent of the vibration quandary and developing a scale for setting up a goal for fulfillment. From the Qualitative evaluation knowledge, it was clear that the involved baseline “X” tractor had unacceptable vibration levels and the cause and outcomes for the trouble were anticipated to be the enhanced points of the tractor incomparison with the home “X (Power Steering).The paper Goglia, 2003, grants research outcome of the vibration transmitted from the guidance wheel of the small tractor with a 4-wheel power to the driver’s fingers. The vibration measurements had been applied on the tractor randomly chosen from the producer’s retailer-condo. Earlier than checking out the tractor used to be examined and adjusted following theproducer’s recommendations. The vibration stages have been measured at idling and at full load. The vibration stage on the guidance wheel used to be measured and analyzed and the frequency spectra for the chosen working conditions were bought. The frequency-weighted acceleration, given in m/s^2, was calculated. The vibration whole worth used to be outlined as the foundation-mean-square of the three aspect values. The acquired values are graphically represented based on ISO/DIS 5349-1979 and ISO5349-1- 2001. The vibration exposure for the anticipated 10% prevalence of vibration-brought on white finger in line with Annex C of the identical average used to be also confirmed. The physiological effects of the brand new seated role have been when put next with the results of the ordinary design where the operator have got to stroll at the back of the computing device. The study was once performed inthree operations, specifically, transportation on a tarmacadam road, rototilling and rota-puddling of the hand tractor beneath one-of-a-kind discipline stipulations. Parameters corresponding to vibration depth in root imply rectangular acceleration, coronary heart price, oxygen consumption expense and work-related body discomfort of operators have been evaluated to learn the fatigue on the operators, and the experiments have been statistically designed and replicated. The results indicate that vibration intensity in rms acceleration in all of the equipment settings and all of the conditions used to be minimum in the range of 1750–1850 min. The vibration depth in rms acceleration was once observed maximum as 45ms^2 without the seat whereas this worth used to be 20ms2 with the seating arrangement. The operators of the hand tractors are exposed to a high stage of vibration bobbing up from the dynamic interactions between the software and work piece. The vibration from the hand tractor is transmitted from the control to the arms, arms and shoulders

III. .METHOD

In the ISO 5349 recommendations, the most important quantity used to describe the magnitude of the vibration transmitted to the driver’s hands is root-mean square frequency-weighted acceleration expressed in m/s^2. In addition, it is strongly recommended that for additional purposes frequency spectra should be obtained. Acceleration values from one-third-octave band.Analysis can be used to obtain the frequency-weighted acceleration a_{hw}: It shall be obtained using:

$$a_{\mathrm{h,w}} = \left[\sum_{j=1}^{n} (W_j a_{wj})^2\right]^{1/2},$$

Where a_{wj} is the acceleration measured in the i^{th} one third-octave band in m/s^2, and Wj is the weighting factor for the i^{th} one-third-octave band as shown in Fig. 1

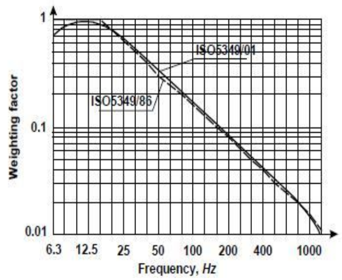

Fig.1: Frequency weighting curve for hand transmitted vibration

It is known that the vibration entering the hand contains contributions from all three measurement directions. Therefore, the measurement should preferably be made for all three directions simultaneously. In accordance with ISO 8727 the three directions of an orthogonal coordinate system in which the vibration accelerations should be measured is shown in Fig. 2. For practical measurements, the orientation of the coordinate system may be defined with reference to an appropriate bicentric coordinate system originating in vibrating handle (steering wheel) gripped by the hand. The evaluation of vibration exposure in accordancewith ISO 5349-2001 is based on a quantity that combines all three axes. This is the vibrationtotal value a_{hv} and it is defined as the root-mean-square of the three component values:

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2},$$

where a_{hwx}, a_{hwy}, a_{hwz} are frequency-weighted acceleration values for the singleaxes.

As it was mentioned before, the vibration exposure depends on the magnitude of the vibration total value and on the duration of the exposure. Daily exposure duration is the total time for which the hand(s) is(are) exposed to vibration during the working day. It is very important to base estimates of total daily exposure duration on appropriate representative samples for the various operating conditions. The daily vibration exposure shall be expressed in terms of the 8-h energy equivalent frequency-weighted vibration total value as

$$A(8) = a_{hv}\sqrt{\frac{T}{T_0}},$$

Where T is the total daily duration of the exposure expressed in s to the vibration a_{hv} and T_0 is the reference duration of 8 h (28 800 s).

If the work is such that the total daily vibration exposure consists of several operations with different vibration magnitudes, than the daily vibration exposure,A (8), shall be obtained using:

$$A(8) = \sqrt{\frac{1}{T_0} \cdot \sum_{i=1}^{n} a_{hvi}^2 \cdot T_i},$$

Where a_{hvi} is the vibration total value for the i^{th} operation, n is the number of individual vibration

Exposures and Ti is the duration of the i^{th} operation. The intention of the research was to define the vibration exposure level of the hand-arm-transmitted vibration from the tractor steering wheel to the driver's hands. The research was carried out on the small tractor with a 4-wheel drive. The measurements were carried out on the standard tractor randomly chosen. Before testing the tractor was examined and adjusted following the producer's recommendations.The vibration levels transmitted to the driver's hands were measured under two operating conditions:

1) *At idling,*
2) *At full load.*

The measurement procedure was in accordance with ISO 5349-2001. The vibration levels were measured in all three axes simultaneously. For all three axes in both operating conditions the frequency spectra were obtained.The vibration measurements and analyses were carried out using the measuring chain shown in Fig. 3.All components of the measuring chain are Bruel&Kjaer products and they all meetthe requirements stated in the recommendations of the IEC publications No. 651, 225, 184 and 222. For each operating condition three independent measurement values were taken. Based on the five measurement values, the arithmetic mean value of the acceleration values from one-third-octave band analysiswere calculated. The frequency-weighted acceleration were calculatedfrom the arithmetic mean value of the acceleration values from one-third-octave band analysis. During measurement the accelerometers were located as it is recommended in ISO 5349-2-2001 (see Fig. 3).

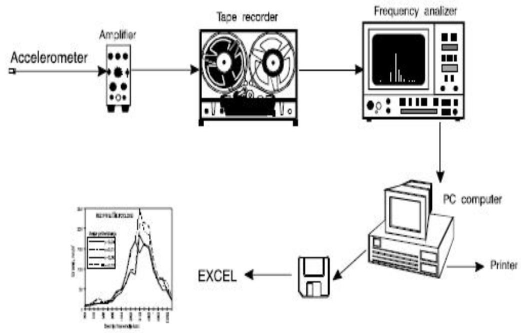

Fig.2 :Schematic representation of the equipment used for vibrationreduction andmeasurement

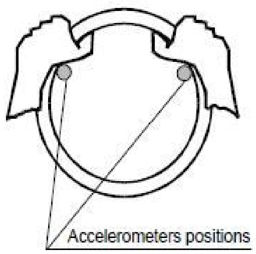

Fig.3:Accelerometerlocationsonsteering wheel during measurement

IV. CONCLUSION

Based on the measurement results it is quite certain that the vibration acceleration level transmitted from the steering wheel to the driver's hands will produce finger blanching in 10% of exposed persons after less than 2 years. Therefore, it is necessary that persons who are responsible for occupational health and safety take preventive measures. It is presumed thatvibration hazards are reduced whencontinuous vibration exposures over longperiod are avoided.Therefore,workschedules should be arranged to includevibration-free periods.

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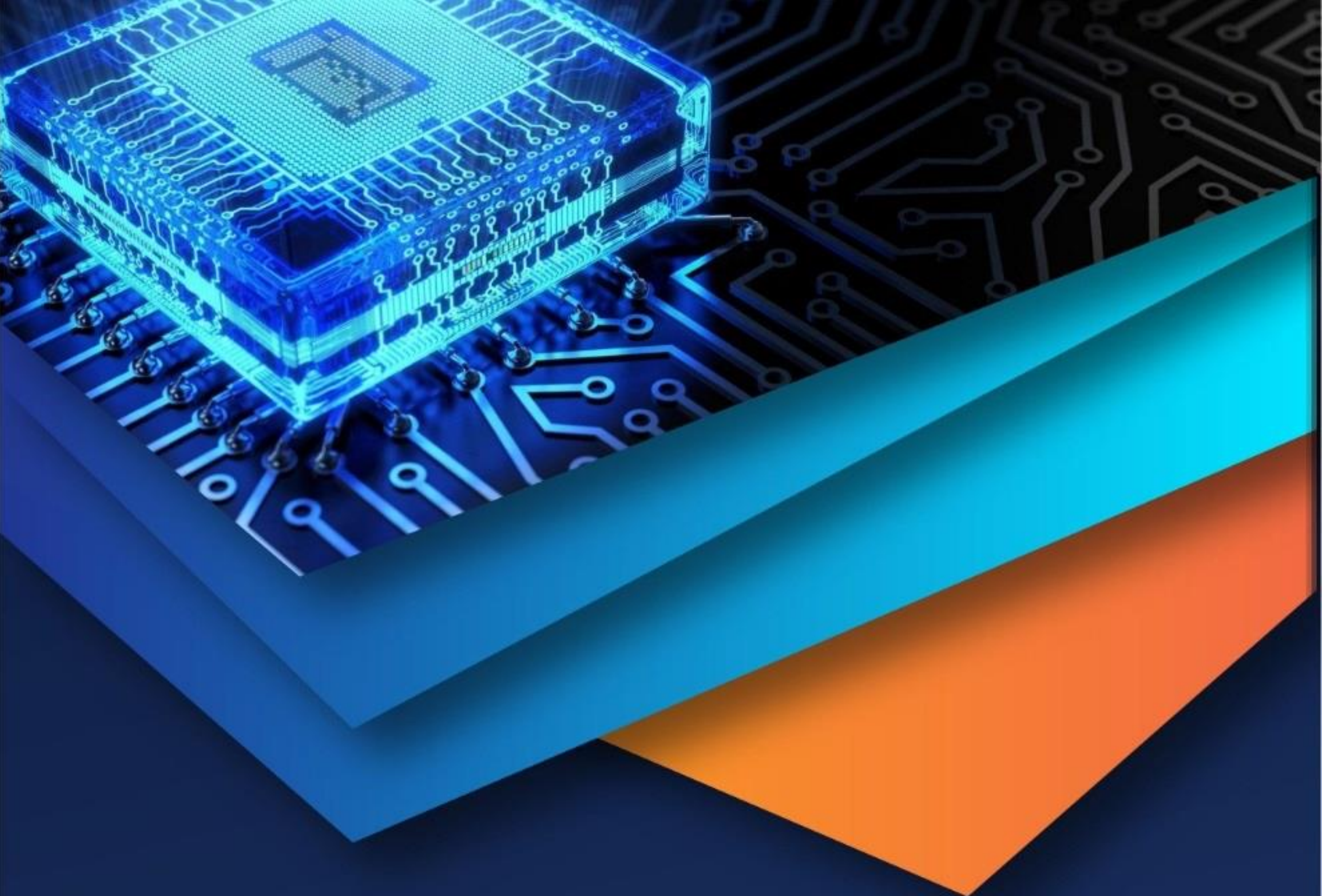

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