Study and Analysis of Vibration Isolators on Vibration Reduction of a Power Tiller

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Abstract:
Indian farmers are using different type of agricultural implement for farming purpose. Power tiller is one of them which is uses for tillage operation. power tiller is a very useful agricultural machinery these are mini tractors. Power tiller is mostly used in small field. For long time working with power tiller creates lots of disorder, vascular diseases to operators. 13hp power tiller was used in this research in 3 level of speed 435rpm, 735rpm and 1235 rpm. According to ISO5349-2(2001) the working condition of power tiller operator fall into the highest risk of different type of diseases. Different type of passive vibration isolators had used for vibration reduction like rubber, cork and leather. Results revealed that rubber had reduced maximum vibration amplitude than other. Leather had reduced minimum vibration amplitude. Experiment was conducted on power tiller PT-6 at workshop and field of Norman E. Borlaug Crops Research Centre (CRC) pantnagar GBPUAT, Pantnagar, The experiment was conducted on crop research centre, GBPUAT pantnagar on both laboratory and field condition (tilled and untilled field).

I. INTRODUCTION
The unbalance forces are the main reason behind high range of vibration so, increasing value of unbalance forces shows value of vibration also. There are two method to reduce vibration, active isolation and passive isolation. actuators, control system and cancellation of dynamic forces is uses for active isolation but in passive method placement of rubber pad, cork sheet and mechanical spring is uses. The total vibration amplitude can be calculate by root mean square of both x and y direction component. The vibration reducing method which is using in this work is passive method. In this method we will use all passive things of vibration reduction, like rubber pad, cork sheet, leather sheet etc. The study of causes of vibration and the means to eliminate or reduce them has been the constant area of focus of engineers and scientists. Active and passive isolation methods are designed as per the requirements. Passive isolators are recommended where the cost is to be kept low and precision is not of paramount importance. This study is intended to analyze the performance of composite isolators to reduce the vibration of power tiller.

II. MATERIALS AND METHODS
The vibration amplitude at various positions at various speed levels with the vibration meter has been estimated. The vibration frequency have been estimated at two different state of power tiller ViZ, with laboratory condition and field condition. For laboratory condition the tiller was set on the level surface at workshop. For field condition the tiller was worked at field in CRC. after placing of setting of various sheet of materials in power tiller the vibration frequency at various position and at various level of speed and fuel consumption has been estimated. At that point the adjustment in vibration and fuel consumption because of decrease of vibration has been calculated. The test has been done taking a steady estimation of vibration decreasing limit of vibration reducing materials at load condition and no load condition at various engine speed. The vibration frequency was estimated by IS-8122-2000.

Figure 1. used power tiller and vibration meter
Vibration measurement

Vibration meter was used to measure the vibration under laboratory and actual field condition. It is a mechanical transducer for measurement of vibration amplitude in terms of displacement, velocity and acceleration. Vibration meter of model number Monitran VM 120 was used to measure the vibration. A magnetic connector was attached for measurement of vibration to get a fluctuation free reading. The measurement of vibration was measured in terms of velocity with unit mm/s. There are three different ranges for measurement in terms of velocity i.e 20mm/s, 200mm/s and 2000 mm/s. Vibration meter measure the r.m.s value of the vibration amplitude. The r.m.s value of the horizontal and vertical components of vibration amplitude was taken. The resultant vibration amplitude was calculated as r.m.s of the horizontal and vertical component. The resultant vibration amplitude is given by following equation:

\[ A_r = \sqrt{(A_x^2 + A_y^2)} \]  ..........(1)

Fuel Consumption

The fuel consumption was measured for different level of engine speed at field and laboratory condition, before an operation, the power tiller was positioned on a ground level. The fifteen liter capacity fuel tank was filled upto its brim. After completing each operation of a tillage implement, the tiller was repositioned at the marked place and fuel was refilled in auxiliary tank to its brim. The fuel required to refill the tank upto its brim was taken as fuel consumption for that tillage operation. This procedure was repeated for each treatment.

Mathematical procedure for selection of different vibration isolators

Vibration isolators of a system means to reduce the vibration of the system by using suitable means of isolators between the system to be isolated and the source of vibration. The isolation was measured in terms of transmissibility, and stiffness. Stiffness was calculated as-

\[ T = \frac{W}{D} \]  ..............(4)

Where, \( W \) = Weight of each vibration isolators used, grms
\( D \) = Deformation in each vibration isolators after use , mm

Transmissibility of the material may be calculated by

\[ T_r = \frac{1}{r^2 - 1} \]  ..........(5)

Where, \( r = \frac{\omega}{\omega_n} \), \( \omega = 2 \times 3.14 \times N \div 60 \), \( \omega_n = \sqrt{\frac{k}{m}} \)

Where, \( N \) = Engine speed , rpm
\( k \) = stiffness of each vibration isolators
\( m \) = Mass of each vibration isolate

Selection of location in power tiller

The location selected for measurement of vibration amplitude in the power tiller are given below:
1. Handle chassis of the power tiller (Ax1)
2. both left and right handle of power tiller (Ax2 and Ax3)

Placing Area of Vibration Isolators: vibration isolators was placed at the right and left handle chassis and both right and left handle supporting rod angle, the exact placing area of vibration isolators is given below:

Procedure for measurement of vibration amplitude

The vibration amplitude was measured with vibration meter at the different locations on the power tiller mentioned above. The magnitude of vibration was measured in both horizontal and vertical directions at all the selected locations. The resultant vibration was calculated as the root mean square of the horizontal and vertical component of the vibration. The vibration amplitude was measured at two different condition ViZ. laboratory condition and field conditions. For power tiller the different engine speed at which vibration was measured were 430 rpm (m/s), 740 rpm (m/s) , 1265 rpm (m/s). The vibration amplitude was measured before and after placing of rubber sheet, cork sheet, leather sheet at the seleted locations and at different conditions for the different levels of engine speed.
IV. RESULT AND DISCUSSION:

The average vibration amplitude was reduced by 18.7 m/sec² when single layer of rubber, cork and leather sheet were placed at both right and left handle chassis at 430 rpm. At 735 rpm the average vibration amplitude was reduced by 21.11 m/sec² at 1235 rpm the average vibration amplitude was reduced by 24.9 m/sec². The average value of vibration reduction when double layer of rubber, cork and leather sheet were placed at both right and left handle chassis at 430 rpm was 12.7 m/sec², at 735 rpm the average vibration amplitude was reduced by 20.1 m/sec² at 1235 rpm the average vibration amplitude was reduced by 24.3 m/sec². The average vibration amplitude was reduced by 11.5 m/sec² when triple layer of rubber, cork and leather sheet were placed at both right and left handle chassis at 430 rpm, at 735 rpm the average vibration amplitude was reduced by 17.1 m/sec² at 1235 rpm the average vibration amplitude was reduced by 24.9 m/sec², laboratory condition. At field condition (tilled and untilled field) for, tilled field condition at 430 rpm average vibration reduction when single, double and triple layer of vibration isolators were placed at both right and left handle chassis was 19.6 m/sec², at 735 rpm average vibration reduction at both right and left handle chassis was 25.5 m/sec², at 1235 rpm average vibration reduction at both right and left handle chassis was 30.0 m/sec². In untilled field condition at 430 rpm average vibration reduction when single layer of vibration isolators were placed at both right and left handle chassis was 25.6 m/sec², at 735 rpm average vibration reduction at both right and left handle chassis was 27.7 m/sec², at 1235 rpm average vibration reduction at both right and left handle chassis was 37.0 m/sec².

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Ethical approval: This article does not contain any studies with human animal performed by any of the author.- by Pooja Arya

Conflict of interest: none declared

V. REFERENCES

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