Hand-arm Vibration of Unskilled Oil Palm Motorised Cutter Operator

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Abstract. The portable petrol driven oil palm motorised cutter or CANTAS has been identified as a type of machine that generates hand-arm vibration. These vibrations can cause complex vascular, neurological and musculoskeletal disorder known as hand-arm vibration syndrome (HAVS) when over exposure of daily usage. The objective of this study is to investigate the vibration level at different angles during the operational of the CANTAS including idle and full throttle conditions. The CANTAS vibration experiments were carried out at a farm in Parit Raja, Batu Pahat, Johor. A student participated as the unskilled worker and was assisted by two technical staffs to conduct the vibration measurements. The measurement was taken during the operations of cutting first fronds, second fronds and a fruit bunch during idle and full throttle conditions and by varying the inclination angle. The inclinations of cutting angle were varied from 45°, 60° and 75°. The hand-arm vibration value, ah, achieved 10.93 ±1.2 m/s² and 7.94 ± 1.0 m/s² for unskilled user during operation of two bunches and one pruning frond for all angles at point 1 and point 2 handle respectively. Mean vibration values at both point of handles resulted in vibration values of 10.12 ±3.8 m/s² at 45°, 9.15 ±3.0 m/s² at 60° and 9.03 ±1.8 m/s² at 75°. Increasing the angle overall results in decreasing the level of vibration at both handle points.

Introduction

Hand arm vibration affects very common types of occupations manual workers both skilled and unskilled workers. Among manual workers, the prevalent includes occupations in agricultural, forestry, construction and many others field. Vibration affect to the hand-arm by transmitting the vibration from the work processes into workers hands and arms. For examples by operating hand-held power tools such as chainsaw, jig-saw or any holding materials that being processed by the machines. Hand arm vibration syndrome (HAVS) is the disease that resulted from regularly or frequently exposure to the hand arm vibration. For some workers, the symptoms may appear after a few months of exposure or others may take a few years. The continued exposure to vibration may likely to get worse and become permanent.

The exposure of the vibration can cause early symptom to the workers for instances tingling and numbness in the fingers, not able to feel things properly, loss strength in hands and fingers going to blanching and becoming red and painful to the workers. For those that being continuously exposed by vibration affects such as pain, distress and sleep disturbance can occur. In addition, workers are not able to do fine work, reduced ability to grip strength and affect the job efficiency.

Handling vibration tool can give risk for those who use regularly or frequently in their daily work routine. ISO 5349-1 was used as a reference for measuring and reporting hand-transmitted vibration in many cases of study. A study by Bheem and Jeffery in 1999 [1] showed the effects of rivet guns on hand-arm vibration. They conducted the test to investigate the effect of four types of rivet guns on hand-arm vibration. The study found that the large size of type 4 rivet gun was the worst among all the rivet guns and need to be considered to reduce the vibration level. In order to
control the vibration transmitted on the hand power tools, a mechanism to reduced the vibration level need to be used. A study was conducted by Ko et al. in 2011 to design and develop a suspended handles for reducing hand-arm vibration in petrol driven grass trimmer [2]. The study among three prototype handles with rubber mounts design to suppress the hand-arm vibration. The handles were made with different materials and the rubber mounts were varied according to the distances. A study on the hand-arm effects to user had been studied by Antonio et al. in 2007 [3]. The study showed the vibration tool or machine handling can influence the user’s illness by absorption of energy by hand-arm system. The result showed that hand–arm power dissipation was influenced by the direction of the vibrations. In the tests, the application of a pushing force, or the use of a strong grip force, produced greater mechanical impedance in the hand–arm system. In Malaysia, Su et al. [4] studied on the extent of hand transmitted vibration exposure problems, particularly hand-arm vibration syndrome (HAVS), among construction workers in Malaysia. They found the clinical symptoms and signs suggesting that HAVS occur among construction workers exposed to hand transmitted vibration in a warm environment.

In recent application, the oil palm motorised cutter has been used widely in Malaysia which was firstly introduced in 2007 [5]. Thus, it is vital to identify if unskilled workers will receive high hand-arm vibration level during operating the CANTAS machine. In this study, the vibration measurements were conducted to unskilled worker at palm oil farm. The objectives of the study are to investigate the vibration level transmitted to the hands using CANTAS at different angle of operations including idle and full throttle conditions. Measurements have been conducted on unskilled user in harvesting one fruit bunch and two fronds at different angles of 45°, 60° and 75°.

CANTAS and Operational Measurement

The human vibration meter used to measure the level of vibration produced by CANTAS machine, complies with the specifications of the standards ISO 8041 and ISO 5349. The measurement was recorded when the worker started cutting from the first palm fronds (f1), second palm fronds (f2) and finish at fruit bunch (f) on one palm tree. The cutting angle was varied from 45°, 60° and 75° as shown in Fig. 1. The vibration values along the perpendicular axes of the accelerometer \(a_{hux}, a_{huy}, a_{huz}\) were recorded for each measurement and these data were then used to obtain the total acceleration value, \(a_{hv}\) as written in Eq. 1,

\[
a_{hv} = \sqrt{a_{hux}^2 + a_{huy}^2 + a_{huz}^2} \quad (Eq. 1)
\]

Fig. 2 shows the general working procedure for the operator to conduct the test. Hand arm vibration need to be measured at the points that vibration was transmitted from the CANTAS machine to the worker hand. Thus the accelerometer is placed at near grip position during the operation of the machine. The equipment used to conduct this study comprises the CANTAS machine of Type 3 Cutting Head, a vibration analyser or human vibration meter and Hand-Arm Triaxial Accelerometer with holder. A student was participated as the unskilled worker and assisted by two technical staffs to conduct the vibration measurements.
Results and Discussions

All the tests data in palm oil farm were carried out to investigate the vibration values by unskilled user using CANTAS CH Type 3. The details of the results are summarised in Table 1. The summary results consist of vibration level during idle, full throttle, palm fronds (f1, f2) and fruit bunch (b) at two handle position points at 45, 60 and 75 degrees.

The results as shown in Fig. 3 presented vibration value of CANTAS machine operated at two handle points, Point 1 and Point 2 for different angle operations of 45, 60 and 75 degrees. In all cases show point 1 handle yields higher vibration level if compared to point 2 handle. The unskilled user gripped and received higher vibration at Point 1 as the point is near to the engine which is known as main source of vibration. However mishandling the CANTAS machine for unskilled user make cutting operation of fronds is inconsistent. The results also show CANTAS machine produced higher vibration at first frond if compared with the second frond.

Fig. 4 and Fig. 5 illustrated the value of vibration during idle, full throttle, palm fronds (f1, f2) and fruit bunch (b) operations at different degrees. Considering all cutting angles, the hand-arm vibration value, $a_{h,a}$ at point 1 and point 2 handles achieved $10.93 \pm 1.2 \text{ m/s}^2$ and $7.94 \pm 1.0 \text{ m/s}^2$ respectively, regardless of the vibration value when idling and full throttling handle vibration value. The cutting operationals of CANTAS are within full throttle and idle conditions. At full throttle, hand arm vibration value represents overuse of the machine. In other words, CANTAS did not reach this vibration level to be operated at normal operation. The measurement should be retested if the user mishandled the CANTAS at the early time of usage. In this case, the user does not have enough skill to handle the machine. Mean vibration values result are $10.12 \pm 3.8 \text{ m/s}^2$ at $45^0$, $9.15 \pm 3.0 \text{ m/s}^2$ at $60^0$ and $9.03 \pm 1.8 \text{ m/s}^2$ at $75^0$ for both point of handles. The mean values consider are the average vibration values of f1,f2 and b at each cutting degrees.
Table 1: Hand arm vibration at two points of cutting angle 45, 60 and 75 degrees

<table>
<thead>
<tr>
<th>Operation</th>
<th>$a_{hv}$ (Point1)</th>
<th>$a_{hv}$ (Point2)</th>
<th>Operation</th>
<th>$a_{hv}$ (Point1)</th>
<th>$a_{hv}$ (Point2)</th>
<th>Operation</th>
<th>$a_{hv}$ (Point1)</th>
<th>$a_{hv}$ (Point2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td>2.81</td>
<td>1.77</td>
<td>Idle</td>
<td>2.09</td>
<td>1.50</td>
<td>Idle</td>
<td>1.83</td>
<td>1.60</td>
</tr>
<tr>
<td>Full Throttle</td>
<td>20.85</td>
<td>12.01</td>
<td>Full Throttle</td>
<td>18.79</td>
<td>11.52</td>
<td>Full Throttle</td>
<td>15.36</td>
<td>11.78</td>
</tr>
<tr>
<td>45 (f1)</td>
<td>17.73</td>
<td>8.13</td>
<td>60 (f1)</td>
<td>14.08</td>
<td>10.70</td>
<td>75 (f1)</td>
<td>11.50</td>
<td>9.54</td>
</tr>
<tr>
<td>45 (f2)</td>
<td>9.09</td>
<td>8.08</td>
<td>60 (f2)</td>
<td>7.46</td>
<td>7.23</td>
<td>75 (f2)</td>
<td>8.37</td>
<td>7.23</td>
</tr>
<tr>
<td>45 (b)</td>
<td>10.01</td>
<td>7.69</td>
<td>60 (b)</td>
<td>9.59</td>
<td>5.84</td>
<td>75 (b)</td>
<td>10.50</td>
<td>7.04</td>
</tr>
</tbody>
</table>

(a) Cutting Operation at 45 degrees  
(b) Cutting Operation at 60 degrees  
(c) Cutting Operation at 75 degrees

Fig. 3: Vibration level of CANTAS operations of palm fronds (f1, f2) and fruit bunch (b) at 45, 60 and 75 degrees

Fig. 4: Vibration level of CANTAS operations: palm fronds (f1, f2), fruit bunch (b), idle and full throttle at Point 1 handle
Conclusion

The hand arm vibration for unskilled user showed different values at the inclination of cutting angle was varied from 45°, 60° and 75°. CANTAS produced 10.93 ±1.2 m/s² and 7.94 ± 1.0 m/s² for unskilled user during operation of two bunches and one pruning frond for all angles at point 1 and point 2 handles at all angles of cutting. Mean vibration values at both points of handle resulted in vibration values of 10.12±3.8m/s² at 45°, 9.15±3.0m/s² at 60° and 9.03±1.8m/s² at 75° regardless of the idle and full throttle conditions. At higher inclination of angle operations, unskilled user experienced low vibration influenced on hand-arm. This data were required to estimate the daily vibration exposure permitted for unskilled user in future study.

Acknowledgement

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References