

## Hand-arm Vibration Analysis of Palm Oil Fruit Harvester Machine

MD Salleh, S.<sup>1,a</sup>, Erween Abd Rahim<sup>1,b</sup>, Imran Hj Ghazali<sup>1,c</sup>, Khairull Azmi<sup>1,d</sup>,  
Abdul Razak Jelani<sup>2,e</sup>, Mohd Fauzi Ismail<sup>2,f</sup>, Mohd Rizal Ahmad<sup>2,g</sup>

<sup>1</sup>Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia  
86400 Parit Raja, Batu Pahat, Johor, Malaysia

<sup>2</sup>Malaysian Palm Oil Board (MPOB), Bangi, Selangor Darul Ehsan, Malaysia

<sup>a</sup>saliha@uthm.edu.my, <sup>b</sup>erween@uthm.edu.my, <sup>c</sup>imran@uthm.edu.my, <sup>d</sup>khairullazmi@gmail.com,  
<sup>e</sup>razak@mpob.gov.my, <sup>f</sup>mfauzi@mpob.gov.my, <sup>g</sup>rizal.ahmad@mpob.gov.my

**Keywords:** Hand-arm vibration, CANTAS, cutting heads

**Abstract.** The objective of this study is to determine the vibration value of Palm Oil Harvester Machine or CANTAS motorized cutter profile. The CANTAS machines have been divided into twelve nodes and hand arm vibration measurements are taken for idle and full throttle operation. Three cutting heads provided by MPOB have been measured for comparison purposes. The hand-arm vibration values for Type A Cutting head achieves  $(3.89 \pm 1.10) \text{m/s}^2$  for idle condition and  $(10.71 \pm 2.88) \text{m/s}^2$  for full throttle condition. Meanwhile Type B Cutting Head achieves  $(3.63 \pm 0.87) \text{m/s}^2$  for idle condition and  $(11.22 \pm 1.74) \text{m/s}^2$  for full throttle condition. Type C of Cutting Head yields  $(3.51 \pm 0.82) \text{m/s}^2$  for idle condition and  $(15.54 \pm 3.81) \text{m/s}^2$  for full throttle condition along the structure. The results also shows which points depicted highest vibration level during idle (no operation, ideally from tree to tree) and full throttle (overuse operation). These values present the maximum and minimum vibration levels that will be received by the user in daily usage of the machine. design in reducing vibration to the hand-arm of the user.

### Introduction

Vibration from the hand-held power tools can be transmitted to the users' body. The vibration of the body occurred when the system involves the transfer of its potential energy to kinetic energy and kinetic energy to potential energy alternately. Vibration also can cause health effect to the users in regularly or frequently exposure. Commonly, the vibration affect to the hand-arm by transmitting the vibration from the work processes into users hands and arms. It can be caused by operating hand-held power tools such as chainsaw, jigsaw or any holding materials that being processed by the machines. This also includes the operation of harvesting oil palm fruits machine called CANTAS. CANTAS motorised cutter is new in the market but it has been well received by the industry. Powered by 2-strokes petrol engine, it is equipped with a telescopic pole and cutting head. Using the vibrating mechanism, the sickle at the cutting head was vibrating to perform cutting operation mechanically. The C-strike was designed to have enough force and sufficiently high resolutions also strong enough to overcome the toughness of oil palm fronds and bunches.

The performance of CANTAS had been evaluated at United Plantation, Jendera Estate, Hutang Melintang, Perak which covered 554 hectares, flat terrain, planted in 2001-2003. The case study was conducted from 1<sup>st</sup> July-30<sup>th</sup> September 2009 [1]. The results show that the usage of CANTAS can increased productivity, daily coverage and daily income more than 100% when compared with manual operation of a man per day.

However, handling vibration tool can give risk for those who use regularly or frequently in their daily work routine [2-4]. Hand arm vibration syndrome (HAVS) is the disease that come from regularly or frequently exposure to the hand arm vibration. For some users, 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 the effect become permanently. The exposure of the vibration can cause early symptom to the users 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. For those that being continued exposed by vibration can give affects such as pain, distress and sleep disturbance. Hence, users are not able to do fine work, reduced ability to grip strength and affect the efficiency of the user's job.

Thus, it is important to give the information of vibration values received and awareness to the CANTAS user during operations and idle condition. The objective of this study is to measure the vibration values for each segment (node) that produced by CANTAS motorized cutter. As comparison, three types of cutting head were measured to determine the vibration value of idle and full throttle conditions. Vibration value on CANTAS Motorized Cutter also carried out with sickle and without sickle with three different cutting heads.

### Experimental Set Up

Vibration measurements at the handle grip of Cantas were carried out by mounting the triaxial acceler In order to determine the profile or vibration level at CANTAS structure, two conditions were considered. Firstly, the CANTAS was operated in idle condition. Secondly, CANTAS was operated in full throttle conditions. This condition is show the maximum speed and minimum speed that operated by the user either with or without operating condition. The stands were used for easily picked and placed back the CANTAS. Figure below show the methods during taking the reading of vibration value on CANTAS profile.

CANTAS was divided into twelve nodes from grip handle point to cutting head. Three different cutting heads were tested to evaluate the vibration level at different types of them. Table 1 shows the three types of cutting heads. The first type of CH1 was the first commercialised and released by MPOB. The CH2 is a current commercial type of cutting head. Meanwhile, the third of CH3 is currently under research and development. In order to measure the vibration on hand-arm, the accelerometer was placed on the handle of the CANTAS machine and also on the user's hand grip using the accelerometer. The limitation was considered on hand-arm vibration only without measuring the whole-body vibration. In this case CANTAS machine is assumed in a good condition and well maintenance. Environment condition factor was neglected during the measurement in Noise and Vibration Laboratory.

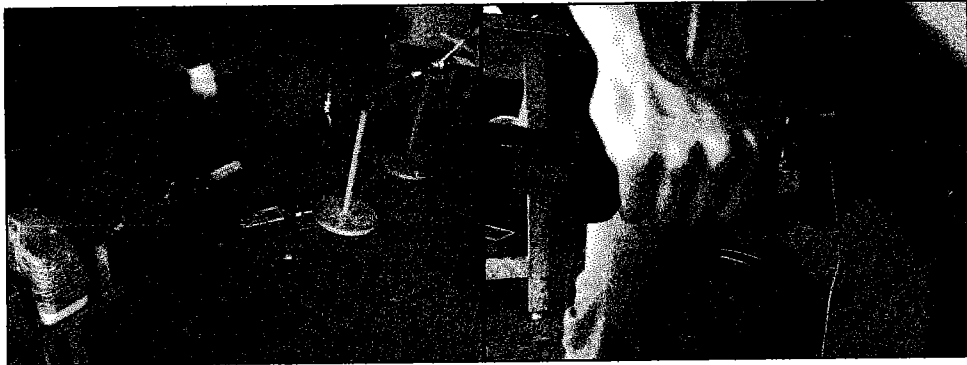


Figure 1: Vibration measurements when idle and full throttle

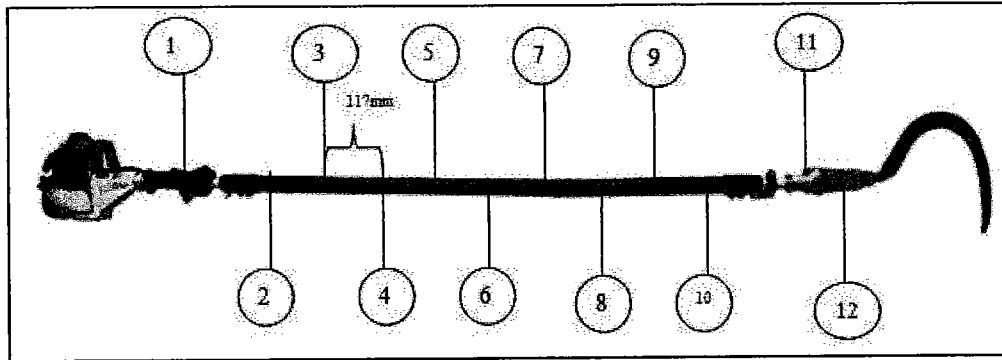


Figure 2: CANTAS with twelve measuring nodes

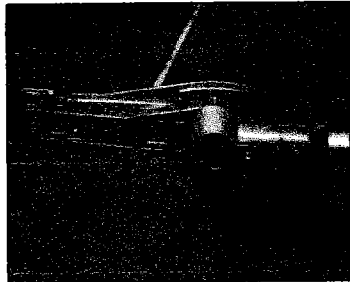


Cutting Head Type A	Cutting Head Type B	Cutting Head Type C
		
Type A - 1 <sup>st</sup> commercial released(1 <sup>st</sup> version)	Current commercial release	Under research and development (R&D)

Figure 3: Types of Cutting Head

**Results and Discussions**

All the tests data in laboratory were made to investigate the vibration values produced by the machine. It also will be used as a guideline to determine daily exposure to the user(s). The results obtained from the experiment as shown in Figure 4-6 for cutting head 1, cutting head 2 and cutting head 3, respectively. These results showed how the vibration value for the CANTAS machine achieved at idle and full throttle operation. Figure 4 shows the vibration value of twelve nodes when using Type A Cutting Head. Node 4 in idle recorded the highest vibration value which was 5.530 m/s<sup>2</sup>. In full throttle node 6 recorded the highest vibration value which was 13.960 m/s<sup>2</sup>. The hand-arm vibration values for Type A Cutting head achieves (3.89±1.10)m/s<sup>2</sup> for idle condition and (10.71±2.88)m/s<sup>2</sup> for full throttle condition.

Figure 5 and 6 shows the comparison of vibration value of each node when using different cutting head and without using cutting head-sickle in idle and full throttle conditions. For the CANTAS without cutting head-sickle, the vibration values are within the range of CANTAS with cutting head at most cases. Thus, the sickle do not affected the vibration values in both conditions of idle and full throttle without any operation cutting. In other words, no load to the sickle do not effect on the vibration values on the CANTAS motorized cutter.

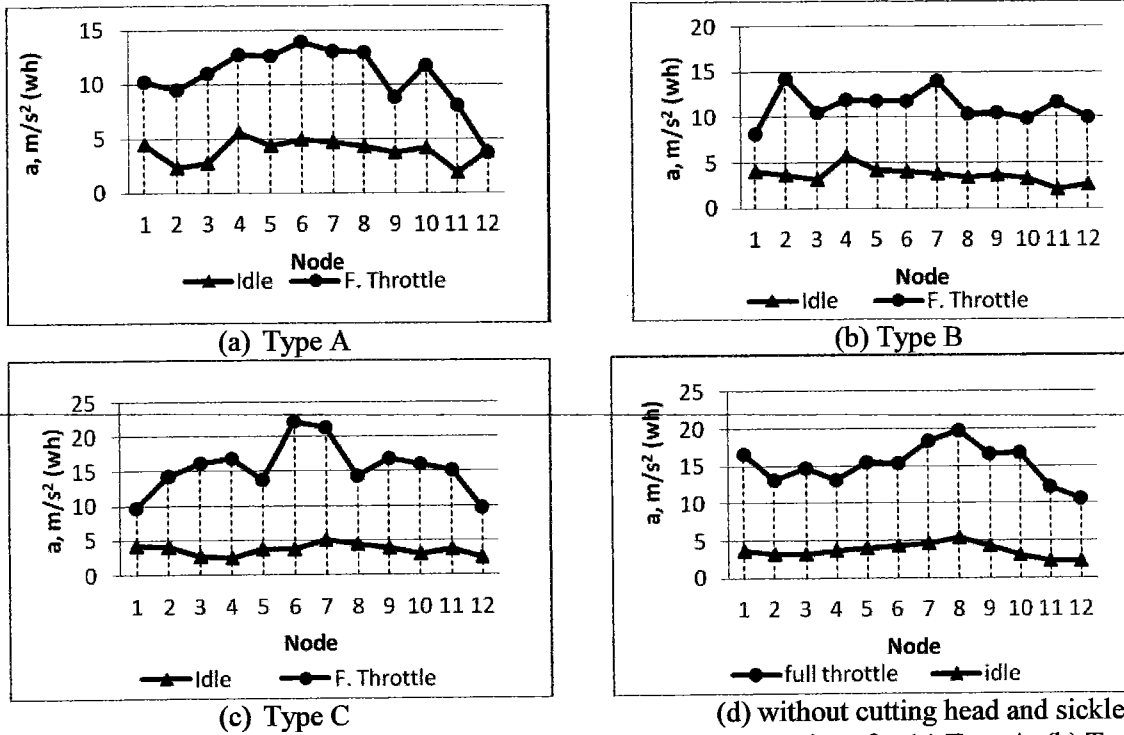


Figure 4 : Graph of acceleration against idle and full throttle operations for (a) Type A, (b) Type B, (c) Type C (d) with no cutting head and sickle

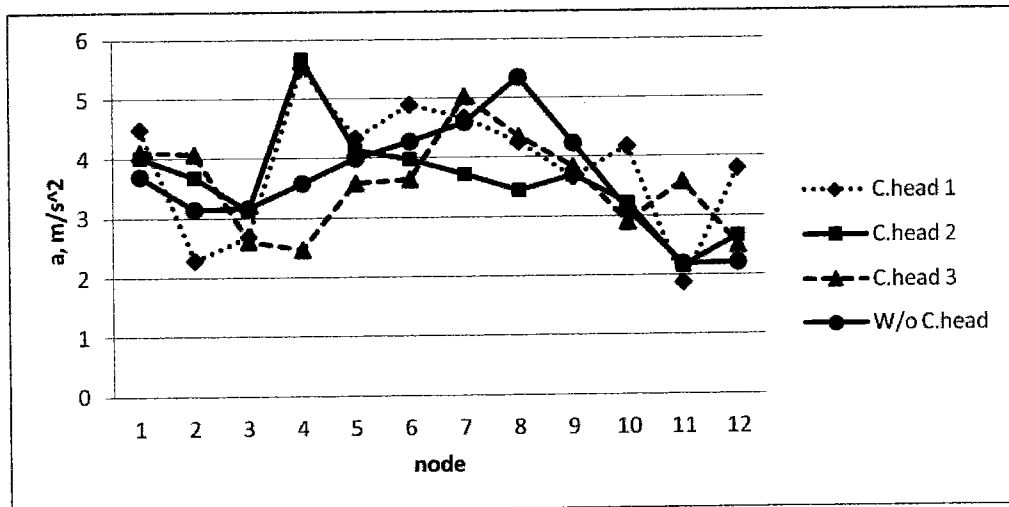


Figure 5: Vibration values for twelve nodes of Cutting Head 1, 2, 3 and without cutting head-sickle in idle

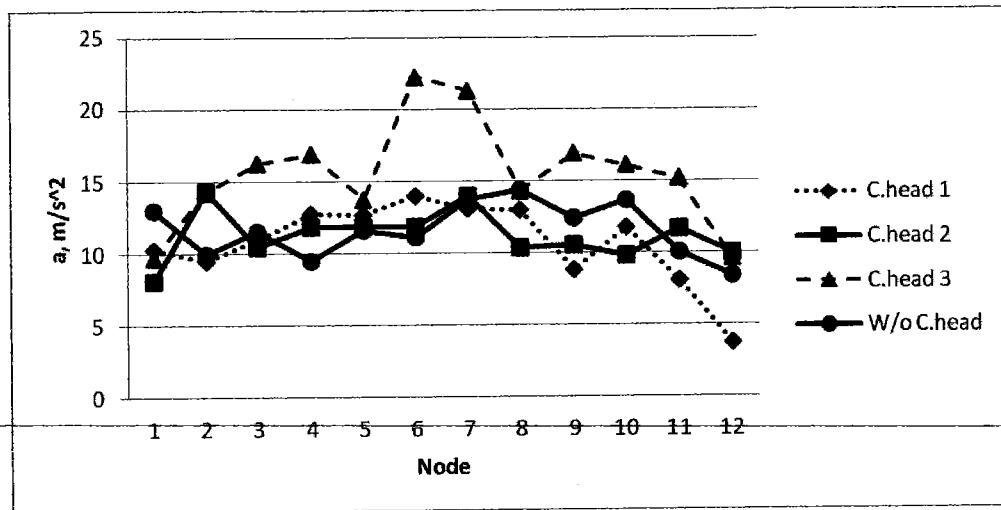


Figure 6: Vibration values for twelve nodes of Cutting Head 1, 2, 3 and without cutting head-sickle in full throttle

### Summary

The results for CANTAS profiles show the higher vibration for CH1, CH2 and CH3 are mostly at CANTAS pole. The range of vibration values is  $5.0 \text{ m/s}^2$  to  $5.7 \text{ m/s}^2$  for idle and  $13.9 \text{ m/s}^2$  until  $23.0 \text{ m/s}^2$  for full throttle operation. It is that recorded the highest value at node 4 and 7 for idle and node 6 and 7 for full throttle operation where the CANTAS pole is between nodes 2 until 10. The hand-arm vibration values for Type A Cutting head achieves  $(3.89 \pm 1.10) \text{ m/s}^2$  for idle condition and  $(10.71 \pm 2.88) \text{ m/s}^2$  for full throttle condition. Meanwhile Type B Cutting Head achieves  $(3.63 \pm 0.87) \text{ m/s}^2$  for idle condition and  $(11.22 \pm 1.74) \text{ m/s}^2$  for full throttle condition. Type C of Cutting Head yields  $(3.51 \pm 0.82) \text{ m/s}^2$  for idle condition and  $(15.54 \pm 3.81) \text{ m/s}^2$  for full throttle condition along the structure. This data will support in future study of daily vibration exposure permitted for the user.

### Acknowledgment

The authors would like to thank the MPOB with the Cantas equipment provided throughout the work of study.

### References

- [1] Razak A. J (2010). CANTAS mark-iii mudah tuai hasil. Retrieved on March 7, 2010 on [www.bharian.com.my](http://www.bharian.com.my)
- [2] Bheem P. K, Jeffrey E. F (1998). The effects of rivet guns on hand-arm vibration. Wichita State University, USA
- [3] Su T. A, Victor C.W.H, Retneswari M, Awang B (2010). Arm Vibration Syndrome Among A Group of Construction Workers In Malaysia. Occupational and Environment Med in Malaysia 68, pp 58-63.
- [4] European Union (EU) guideline 2002/44/EC. Exposure Action Value (EAV) and Exposure Limit Value (ELV) on [www.hse.gov.uk](http://www.hse.gov.uk)
- [5] The Performance Management & Delivery Unit (PEMANDU). (2010). Chapter 9: Deepening Malaysia's Palm Oil Advantage. In T. P. (PEMANDU), Economic Transformation Programme, A Roadmap For Malaysia (pp. 281-314).

**Mechanical & Manufacturing Engineering**

10.4028/www.scientific.net/AMM.315

**Hand-Arm Vibration Analysis of Palm Oil Fruit Harvester Machine**

10.4028/www.scientific.net/AMM.315.621

---