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VIBRATION ISOLATOR FOR THE OIL PALM MOTORISED CUTTER

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Abstract
*MPOB has introduced an oil palm motorised cutter called '**CANTAS**' that works effectively for palms with harvesting height of below 5-metres. CANTAS which is powered by a small petrol engine has been proven to double up harvesting output compared to manual harvesting. However, the existing CANTAS design generates vibration that may lead to Hand Arm Vibration Syndrome (HAVS) under prolonged exposure. It is necessary that the level of vibration to be managed and controlled. A vibration isolator has been designed and developed which functions to collect and isolate vibration of the motorized cutter. The isolator comprises of a pair of bearing and a spring which the spring functions to reduce the vibration while the bearings dispose the vibration from the motorized cutter. The study showed that the use of isolator reduced the magnitude of HAV at holding points (P1 and P2) by 54 and 45%, respectively. Minimum HAV was obtained when the vibration isolator was fixed at 70cm from the engine. The isolator was tested by a harvester in Banting Selangor who experienced that the isolator helped to reduce vibration effect thus giving him much more comfortable during handling the machine. This invention has further application that can also be extended to other vibration tools such as grass cutter machine, mist blower, pruning machine and so on.*

Keywords: *oil palm motorised cutter, CANTAS, vibration reduction, damper system, vibration isolator*

Introduction

The efficiency of harvesting of fresh fruit bunches (FFB) is important to ensure the FFBs are harvested follow the recommended of harvesting rounds of 10 to 12 days interval. The manual method of harvesting (using a sickle or chisel) can produce about an average of 1 t FFB man-1 day-1 (Azman *et al.,* 2015). Estates are now looking forward to efficient harvesting tools that could increase productivity and ultimately reduce the number of workers. The harvesting productivity needs to be increased to 4 t FFB man-1 day-1roughfly if the country wishes to reduce the labour requirement significantly (Abdul Razak *et al.,* 2013). One of the technologies that have been well accepted by the oil palm industry is the oil palm motorised cutter (called CANTAS) that was introduced in 2007 (Abdul Razak *et al*., 2013). CANTAS is powered by a small petrol engine and utilises either a specially designed C-sickle or chisel as the cutting knife. CANTAS has been categorised as a type of machine that generates vibration which could cause HAVS when overexposure of daily usage. Therefore, it is necessary that the risks from vibration generated by CANTAS should be managed and controlled. The objective of this paper is to design, develop and test the vibration isolator on the magnitude of vibration on CANTAS.

METHODOLOGY

Vibration isolator designs

Sources of vibration of the oil palm motorised cutter fundamentally come from both rotational and linear motions of the moving components such as engine, transmission shaft, shaft guiders and gear-box (*Figure 1*). Rotational motions basically come from the engine, transmission shaft and bearings, while linear motions come mainly from the gearbox, pole, and sickle. The vibration, therefore, is developed throughout the length of the machine during operation with the magnitude which may differ from point to point. Vibrations arise when a body oscillates due to external and internal forces. Vibration may be transmitted to the human body through the part in contact with the vibrating surface such as the handle and the pole of the machine.

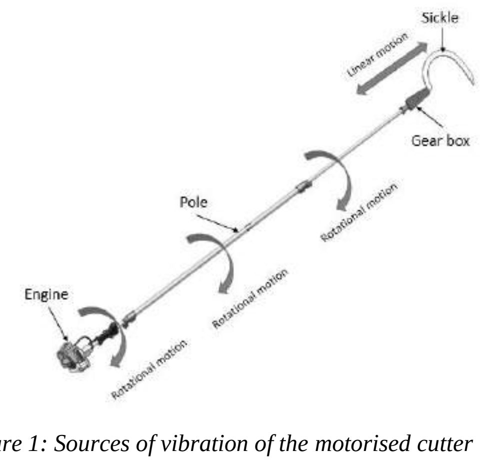


Figure 1: Sources of vibration of the motorised cutter

In this study, the vibration isolator was designed and developed. The vibration isolator is to be placed on the pole of the motorized cutter which its best position would be determined from this study. Theoretically, the vibration generated by the machine would be collected and stabilized by the vibration isolator (*Figure 2*).

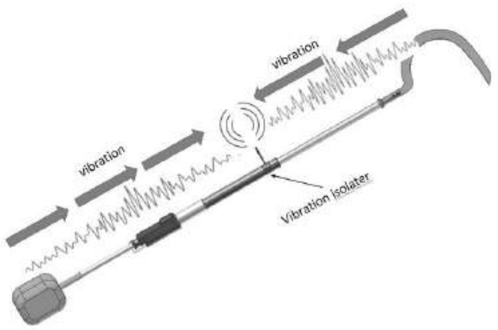


Figure 2: Vibration reduction of the motorized cutter by the vibration isolator system

The vibration isolator comprises of two basic components i.e. a compression spring and a pair of bearings. The spring with its nature of being elastic is functioning to isolate the vibration, while the bearings which are placed at both ends of the spring is functioning to stabilize the vibration collected by the spring.

The arrangements of bearings were fixed in line with the spring axis and the dimension of vibration isolator is shown in *Figure 3*.

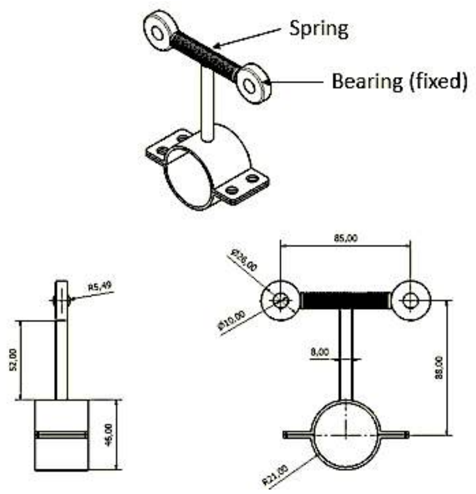


Figure 3: Schematic drawing of the Vibration isolator

The Experiment

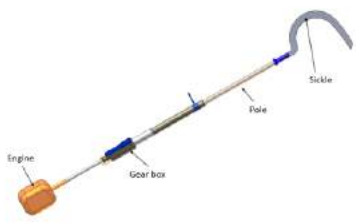
In the experiment, the vibration isolators will be fixed to CANTAS. The effect of vibration isolator designs and its position on the magnitude of hand-arm vibration (HAV) were studied using a 2x3 factorial experiment. Details of the vibration isolator experiment are as follows:

Subject: CANTAS

Vibration isolator position (L) - a distance of vibration isolator from the engine:

- For CANTAS: L1 (70) and L2 (120) cm from the engine

Table 1: Specification Of Motorised Cutter

Subject	CANTAS
Drawing	
Concept	The rotational motion generated by the engine is converted into linear motion by the gearbox which a pole is fixed to it. This allows the sickle which is fixed at the end of the pole to move linearly for cutting action. The gearbox is placed near the engine to reduce the point of the center of gravity as to ease the handling of the machine. The source of vibration comes from one rotational motion and two linear motion, i.e. • Rotational motion : engine • Linear motion :gear box and pole/sickle
Length (m)	2.90
Weight (kg)	7.40
Specific weight (kg/m)	2.55
Centre of gravity (cofg), m	1.07
Deflection at the point of cofg (cm)	3.00

Holding Points (P1 and P2)

Figure 4 shows the two holding points (denoted as P1 and P2) for CANTAS, the positions where the magnitude of HAV will be measured during the experiment. P1 is located at the engine's throttle, the point where the harvester controls the speed of cutting, while P2 is the point where the harvester holds the machine during the cutting operation. The distance of P1 and P2 were fixed at 30 cm and 80 cm from the engine.

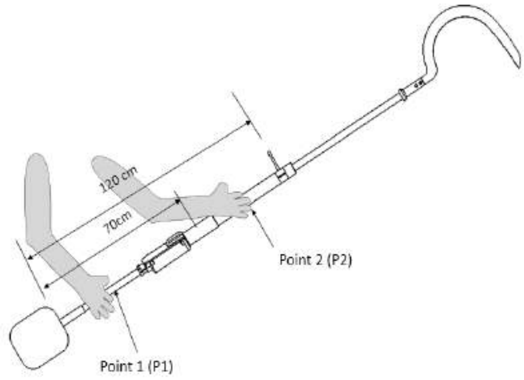


Figure 4: Vibration points (P1 and P2) and two distances of vibration isolator from the engine of CANTAS

Measurement of Vibration

The study was conducted at MPOB Keratong Research Station in Pahang. The palms where the experiment was conducted were about 10 years old with the height range from 2.5 m to 3.5 m. The field topography was flat.

A tri-axial accelerometer was used to measure the magnitude of vibration generated by the machine. The measurement complied with the standard ISO5349, the same standard used by other reports (Salihatun *et al*., 2013 and 2014; Amitkumar *et al*., 2015). In the experiment, the vibration sensor was placed at the holding points (P1 and P2) with the machine's pole angle was set at 60^o as shown in *Figure 5*. The data was recorded when the worker started cutting the frond until the finish.

Figure 5: Vibration measurement during cutting of frond

The HAV of the motorised cutter fixed with the vibration isolators were compared against the HAV of the motorized cutter without vibration isolator.

Results and discussion

Effect of Vibration Isolator on HAV of CANTAS

Table 3 and *Figure 6* show the average data of HAV generated by CANTAS from the experiment conducted. The highest HAV was obtained at P2L1 (1.8 m/s^2) and the lowest HAV was obtained at P1L1 (1 m/s^2). As for comparison, the HAV of CANTAS without vibration isolator was 2.7 m/s^2 and 3.2 m/s^2 for P1 and P2, respectively.

Table 3: Hav Of Cantas (With And Without Vibration Isolator)

Holding point	Control **(without vibration isolator)**	With vibration isolator	
		D	
		70	**120**
P1 (m/s^2)	2.7 n=6 σ = 1.29	1 n=6 σ = 0.50	1.5 n=6 σ = 0.68
P2 (m/s^2)	3.2 n=6 σ = 0.61	1.8 n=6 σ = 0.92	1.7 n=6 σ = 0.69

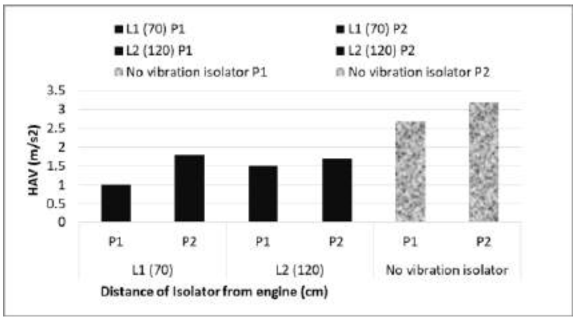


Figure 6: Results of hand-arm vibration (HAV) of CANTAS

Referring to *Table 4*, generally fixing a vibration isolator on CANTAS have given significant effects on the reduction of HAV. The isolators were found to reduce HAV significantly. The isolator had given a better effect where the HAV were reduced by 54% and 45%, respectively at P1 and P2, compared to HAV without vibration isolator. The experiment disclosed that the isolator is with overall HAV reduction of 49.5%.

Table 4: Average Of Hav Of Cantas With Vibration Isolators Vs Without Vibration Isolator

Holding Point	Without vibration isolator (m/s^2)	With vibration isolator (m/s^2)
P1	2.7	1.25 (-54%)
P2	3.2	1.75 (-45%)
	Overall	-49.5%

Comparison of minimum and maximum HAV of CANTAS

Table 5 shows the summary of the results of the minimum and maximum HAV of the motorised cutter fixed with vibration isolators. The minimum HAV at P1 and P2 occurred at the combination of L1P1 (1.0 m/s^2) when using an isolator.

Table 5: Result Summary - Minimum And Maximum Of Hav For The Motorised Cutter

	CANTAS		
	No vibration isolator	**Isolator**	
	Mag*	**Mag***	**Com****
Minimum HAV	1.2	1.0	L1P1
Maximum HAV	4.7	1.8	L1P2

Remark:
*Mag – magnitude
**Com – combination

Table 6: Result Summary – The Effect Of Vibration Isolator On Cantas At Holding Points (P1 And P2)

	CANTAS	
	No vibration isolator	**Isolator**
P1	2.7	1.25 (-54%)
P2	3.2	1.75 (-45%)

Conclusion:

The introduction of this technology is expected to give experience to the users' for comfortable handling. Initial tests as shown here indicated that the vibration level had been reduced when vibration isolator was installed to the CANTAS. Feedback from harvester using the vibration isolator that it reduces vibration of CANTAS which make the handling of CANTAS is more comfortable. The use of vibration isolator will give more comfortable handling for harvesting that ultimately will increase productivity and reduces HAVS issues. The invention is not only for CANTAS but can also be used in other vibrating tools such as grasscutter machine, mist blower, pruning machine and so on.

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