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Development and Optimization of a Tractor-Mounted Boring Mechanism for Efficient Fertilizer Application in Rubber Plantations

Mongkol KATHAPANT[a], Yongyuth SENGDANG[b], Khongdet PHASINAM[c,*] and Payungsak JUNYUSEN[a]

[a]Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima, Thailand

[b]Faculty of Engineering and Technology, Rajamangala University of Technology Isan, Nakhon Ratchasima, Thailand

[c]Faculty of Food and Agricultural Technology, Pibulsongkram Rajabhat University, Phitsanulok, Thailand

*Corresponding author's email: phasinam@psru.ac.th

Introduction

The rubber tree (*Hevea brasiliensis* Müll. Arg.) is a key tropical economic crop, primarily grown in ASEAN countries, which accounted for 77.78% of global rubber plantations in 2017. Thailand, Indonesia, and Vietnam led global natural rubber production in 2020, contributing 65.79% of the total output. Fertilization in rubber plantations is typically manual, requiring significant labor and precision to avoid root damage and nutrient loss. Despite existing mechanized solutions, such as tractor-mounted spreaders, challenges remain, including inefficiencies in depth control and equipment wear. This study aims to address these issues by designing and testing a drilling mechanism for more efficient fertilizer application in rubber plantations.

Research objectives

The goal of this research is to develop, fabricate, and test a boring mechanism for a tractor that will be used to fertilize rubber plants.

Materials and Methods

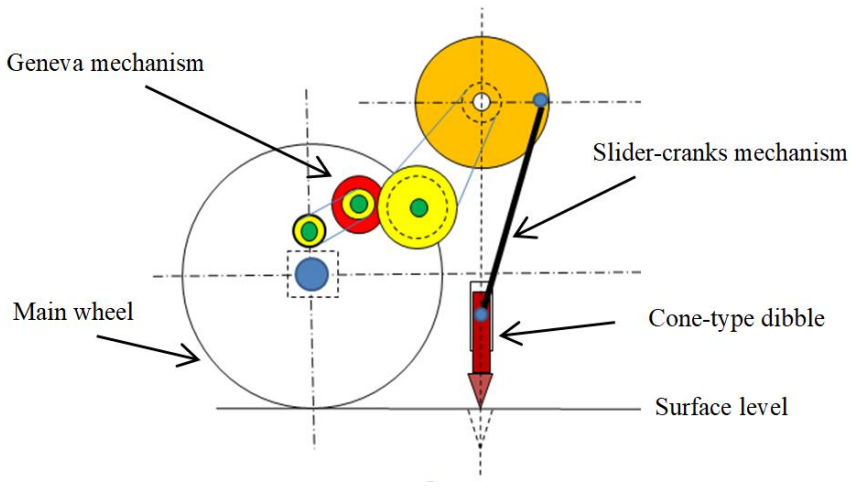


Fig. 1: The boring mechanism for fertilizing the rubber plants.

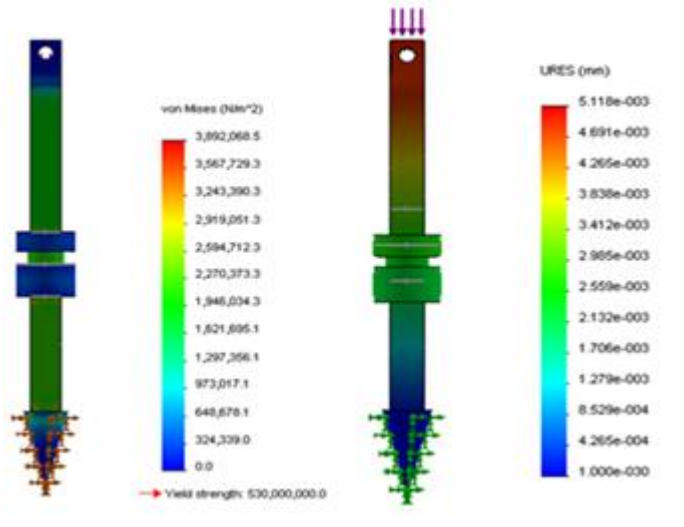
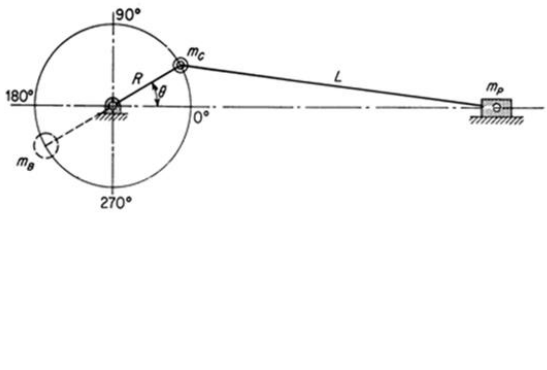


Fig. 3: The distribution of the von Mises stress and the displacements of the cone-type dibble.



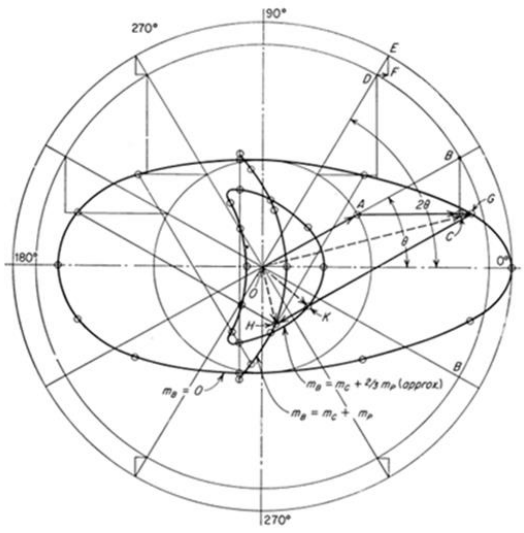


Fig. 2: The forces at the cone type dibble at the positions of the slider-crank angles.

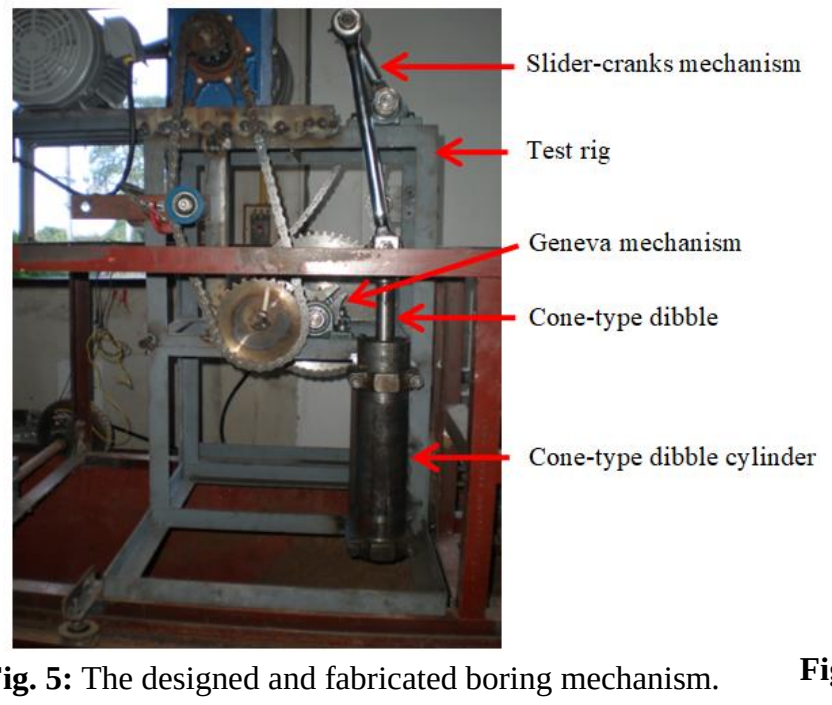


Fig. 5: The designed and fabricated boring mechanism.

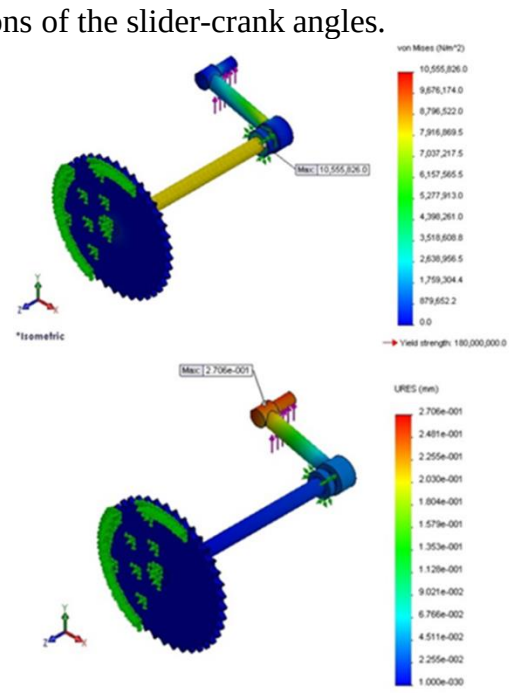


Fig. 4: The distribution of the von Mises stress and the displacements of the slider-crank.

Results

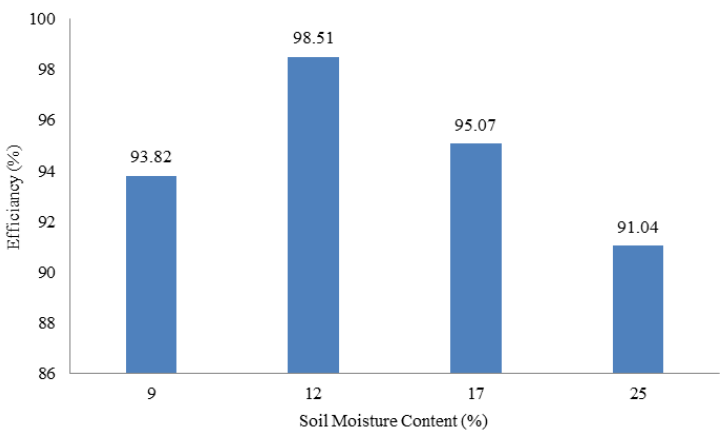


Fig. 6: Bar chart showing the relationship between total efficiency and soil moisture content.

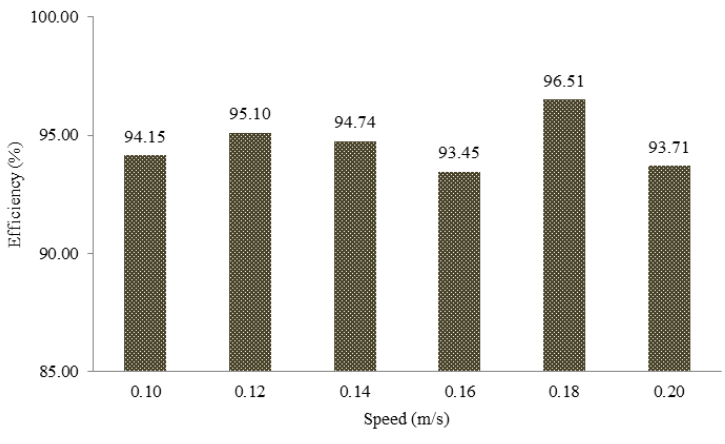


Fig. 7: Bar chart showing the relationship between total efficiency and speed.

Conclusion

This study aids in understanding and designing fertilizer drilling machines for fertilization in rubber gardens. The mechanism with slider-crank, Geneva mechanism, Cone type dibble. As per results, it has been found that the optimum speed has 0.18 m/s (80 rpm) given an efficiency of 96.51% with an appropriate soil moisture content of 12%. Holes were having a depth of about 7–10 cm with the spacing distance between the holes being 60 cm.

Acknowledgement

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