DESIGNING A TRACKED PRIME MOVER FOR IN-FIELD COLLECTION AND TRANSPORTATION OF OIL PALM FRESH FRUIT BUNCHES ON LOW BEARING CAPACITY PEAT TERRAIN

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AND TRANSPORTATION OF OIL PALM FFB ON LOW BEARING 
CAPACITY PEAT TERRAIN

By

MOHAMMAD HADI GHASSEMI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in 
Partial Fulfilment of the Requirement for the Degree of Master of Science

March 2011
Dedicated to

My father Saeed
My mother Parvaneh
My elder brother Eaman
My sister Raya
Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DESIGNING A TRACKED PRIME MOVER FOR IN-FIELD COLLECTION AND TRANSPORTATION OF OIL PALM FFB ON LOW BEARING CAPACITY PEAT TERRAIN

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Chairman: Associate Professor Azmi Yahya, PhD, PEng
Faculty: Engineering

A rubber tracked prime mover having 550 kg maximum payload has been successfully designed, developed, and evaluated to solve the vehicle floatation problems of in-field collection and transportation of the oil palm fresh fruit bunches (FFB) over low bearing capacity peat terrain in Malaysia.

This tracked prime mover runs on a 37.7 kW (50.6 hp) @ 3600 rpm 4TNE84 Yanmar diesel engine driving in-tandem two units 50 cm³/rev @ 350 bar SAMHYDRAULIK variable displacement HCV 50 Series axial piston main pumps. Each of the pumps then runs a 565 cm³/rev @ 250 bar SAi GM2 600 series high torque hydraulic motor to provide the rear sprocket torque for the 1800 mm × 350 mm metal reinforced rubber tracks.
Vehicle engine power of 35.8 kW running at travel speed of 11 km/hr and sinkage limitation of 120 mm on low bearing capacity peat terrain of 19.50 kN/m² was selected based from the Uniform Ground Pressure Distribution (UGPD) and Non Uniform Ground Pressure Distribution (UGPD) straight motion mathematical models and turning motion model. Under a total vehicle of mass of 2500 kg, a total minimum driving torque of 2079 N.m was required at the rear track sprockets to overcome the tracks total motion resistance of 1.63 kN and develop the tracks tractive effort of 10.55 kN. Finally, computations were made to estimate the required hydrostatic pressure and flow for the driving motors of the rear sprockets to develop the expected tractive effort and the hydraulic cylinders on the dumping assembly on developed the expected tipping force. The field performance evaluation of the tracked prime mover regarding vehicle sinkage and speed was carried out on three type of terrain.

Field evaluation of developed vehicle on asphalt under the engine speed from 1500 to 2500 rpm and total vehicle mass from 1950 to 2650 kg results with the travelling speed of 8.28 to 11.85 km/hr. Similarly under both engine speed and total vehicle mass variations, the vehicle travelling speed is 6.43 to 10.42 km/hr on tilled terrain. The vehicle average sinkage on low bearing capacity peat terrain at vehicle total mass of 2500 kg was found to be 104.2 mm which is 13.04% lower than the critical sinkage of 120 mm for the low bearing capacity peat terrain. The average sinkage range of the vehicle under total mass from 1950 to 2650 kg within 71.73 mm to 108.11 mm on tilled terrain and within 81.13 mm to 130.08 mm on the low bearing capacity peat terrain. The average sinkage of the right track is greater than that of left track by
20.52 % during left turning while the average sinkage of the left track is greater than that of right track by 15.93 % during right turning because of off set lateral location of center of gravity.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat ijazah Master Sains

MERENGA BENTUK DAN MEMBINA SEBUAH PENGGERAK UTAMA TREK UNTUK PENGUMPULAN DAN PENGANGKUTAN BUAH SEGAR KELAPA SAWIT DI LADANG YANG BERKEADAAN TANAH GAMBUT BERKEUPAYAAN RENDAH

Oleh
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Sebuah penggerak utama trek bergetah dengan beban maksima 550 kg telah berjaya direka bentuk, dibangunkan dan diuji untuk menyelesaikan masalah pengumpulan dan pengangkutan tandan buah segar kelapa sawit di atas tanah gambut berkeupayaan rendah di Malaysia. Ianya merupakan sebuah mesin yang beroperasi dengan dua orang operator dimana seorang bertindak sebagai pemandu kenderaan dan seorang lagi memuat buah segar kelapa sawit yang sudah dipotong ke dalam bekas buah kenderaan.

Penggerak utama trek dijalankan dengan sebuah enjin diesel Yanmar 4TNE84 berkuasa 37.7 kW (50.6 hp) dengan kadar kelajuan 3600 psm yang beroperasi untuk menggerakkan dua unit pam utama jenis pengepam aksial omboh dengan pengalihan berubah-ubah berjenama SAMHYDRAULIK HCV 50 Series yang mempunyai kuasa...
pengalihan 50 sm
3/pusingan pada tekanan 350 bar. Kedua-dua pam kemudian menggerakkan sebuah motor hidraulik situ berjenama SAi GM2 600 yang mempunyai tork tinggi dengan keupayaan pengalihan 565sm
3/pusingan pada tekanan 250 bar untuk membekalkan tork yang diperlukan oleh sprocket tork belakang untuk trek bergetah dengan ukuran 1800 mm x 350 mm.

Kenderaan berkuasa enjin 35.8 kW bergerak pada kelajuan 11 km/jam dengan kemendapan 120 mm di atas tanah gambut berkeupayaan rendah 19.50 kN/m
2 dipilih berdasarkan pengiraan di bawah tiga keadaan yang berbeza iatu gerakan UGPD, gerakan NUGPD dan model gerakan berbelok. Dibawah berat total kenderaan 2500 kg, total tork panduan 2079 N diperlukan pada sprocket trek belakang untuk mengatasi tahan gerakan 1.63 kN dan membangunkan daya tekanan trek 10.55kN. Pengiraan ini adalah untuk menganggarkan tekanan dan aliran hidostatik untuk membangunkan daya jolokan bagi motor penggerak sprocket belakang untuk membangunkan daya tekanan yang diharapkan dan kuasa untuk silinder hidraulik bagi menggerakkan susunan penumpah buah.

Hasil dari uji kaji kenderaan di aspal dibawah kelajuan enjin 1500 psm dan 2500 psm dengan berat total kenderaan 1950 to 2650 kg menunjukkan kelajuan 8.25 km/jam hingga 11.85 km/jam. Dengan ujian yang sama pada keadaan tanah yang sudah dibajak, kelajuan kenderaan ialah 6.43 hingga 10.42 km/jam. Purata kemendapan penggerak utama trek dengan beban 2500 kg ketika sedang bergerak di atas tanah gambut berkeupayaan rendah ialah 104.2 mm, dimana 13.04% lebih rendah dibandingkan
dengan kemendapan kritikal tanah gambut sedalam 120 mm. Purata kemendapan penggerak utama trek dengan beban 1950 hingga 2650 kg ketika sedang berjalan di atas tanah yang telah dibajak ialah 71.73 mm hingga 108.11 mm. Purata kemendapan trek sebelah kanan ialah 15.93% lebih besar jika dibandingkan dengan kemendapan trek sebelah kiri ketika kenderaan ini sedang membelok ke kiri, manakala purata kemendapan trek sebelah kiri ialah 20.52% lebih besar jika dibandingkan dengan kemendapan trek sebelah kanan ketika kenderaan ini membelok ke kanan.
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I certify that a Thesis Examination Committee has met on 28-03-2011 to conduct the final examination of Mohammad Hadi Ghassemi on his thesis entitled “Designing a Tracked Prime Mover for In-Field Collection and Transportation of Oil Palm FFB on Low Bearing Capacity Peat Terrain” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

MOHAMMAD HADI GHASSEMI

Date: 28 March 2011
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