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Optimization of the tractive performance of four-wheel-drive tractors - An experimental study

by

Zeljko Knezevic, B. Eng.

A thesis submitted to
The Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of
Master of Engineering

Department of Mechanical and Aerospace Engineering

Ottawa - Carleton Institute

for Mechanical and Aerospace Engineering

Carleton University

Ottawa, Ontario

December 10, 1997

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“OPTIMIZATION OF THE TRACTIVE PERFORMANCE OF
FOUR-WHEEL-DRIVE TRACTORS - AN EXPERIMENTAL STUDY”

submitted by Zeljko Knezevic, B.Eng.
in partial fulfilment of the requirements for
the degree of Master of Engineering

Thesis Supervisor

Chair, Department of Mechanical
and Aerospace Engineering

Carleton University

1997

Abstract

Previous analytical studies have shown that for a four-wheel-drive tractor to achieve the optimum tractive performance, the slip of the front tire must be equal to that of the rear tire. For a four-wheel-drive tractor with rigidly coupled front and rear drive axles, this requires that the theoretical speed (the product of angular speed and free rolling radius) of the front tire be equal to that of the rear tire, or the theoretical speed ratio be equal to 1.

To verify the above mentioned analytical findings, a series of field tests was carried out with an instrumented four-wheel-drive tractor. The torques and angular speeds at the front and rear tires and fuel consumption of the tractor were measured under various drawbar loads at various theoretical speed ratios which were obtained with different combinations of tire sizes and inflation pressures at the front and rear axles. Based on the experimental results, it is confirmed that at a given drawbar pull, a four-wheel-drive tractor achieves its optimum tractive efficiency and minimum specific fuel consumption, in terms of liters per hour per kW drawbar power, when the theoretical speed ratio is equal to 1.

The experimental confirmation of the analytical findings is of practical importance to designers and users of four-wheel-drive tractors, as it provides guiding principles for the optimization of the design and performance of this type of tractor, which has been gaining wide acceptance in agriculture, earthmoving, mining and logging industries.

Acknowledgments

The work described in this thesis was carried out under a Collaborative Research Agreement between Transport Technology Research Laboratory, Department of Mechanical and Aerospace Engineering, Carleton University and Eastern Cereal and Oilseed Research Center, Agriculture and Agri-Food Canada, project No. CRA 9601.WPD, dated May 22,1996. The work was supported in part by a research grant awarded to Professor J. Y. Wong by the Natural Sciences and Engineering Research Council of Canada, and in part by the Program for Energy Research and Development, Department of Natural Resources of Canada.

I wish to thank my supervisor, Professor J. Y. Wong for his guidance, patience and support throughout my thesis research. I appreciate his assistance and have gained valuable knowledge in the past two years. I would also like to thank Dr. Neil McLaughlin, Mr. Steve Burt and Dr. Clark Topp, Department of Agriculture and Agri-Food, Canada, for their guidance, cooperation and support in conducting field tests. Also, I appreciate very much the help received from my colleagues Mr. Yeun-Chung Wu, Mr. Chi-Feng Chiang and Dr. Jianqiao Li, of Transport Technology Research Laboratory.

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Notation

b, b_1, b_2	radius of a circular plate
c	soil cohesion
D, D_f, D_r	empirical coefficients of the thrust - slip relationship
F	total thrust ($F_f + F_r$)
F_d	drawbar pull
F_f	thrust developed by front tires (M_f / r_f)
F_r	thrust developed by rear tires (M_r / r_r)
g	gear ratio
i_f	slip of front tires
i_r	slip of rear tires
i_{eq}	equivalent slip of a four-wheel-drive tractor
K	horizontal shear deformation modulus
k_c	pressure-sinkage parameter of soil
k_ϕ	pressure-sinkage parameter of soil
k_{eq}	pressure-sinkage parameter of soil
M	torque at the driven tires
M_f	torque at the front tires
M_r	torque at the rear tires

n, n_{av}	pressure-sinkage parameter of soil (exponent of soil deformation)
N_E	engine power
N_d	drawbar power
N_w	power at the driven wheels
p, p_1, p_2	pressure
R	motion resistance
r	free rolling radius of the driven wheels, defined as the distance from the wheel axis to the line of action of the thrust
r_f	free rolling radius of front tires in the field
r_r	free rolling radius of rear tires in the field
V	actual forward speed of the tractor
V_{tf}	theoretical speed (product of angular speed and free rolling radius) of the front tire
V_{tr}	theoretical speed of the rear tire
W	total weight of the vehicle
w_r	weighting factor
z	sinkage
α	thrust distribution coefficient (F_f / F)
β	theoretical speed ratio ($r_f \omega_f / r_r \omega_r$)
η_d	tractive efficiency

η_r	efficiency of motion
η_s	efficiency of slip
η_{s2}	slip efficiency of a two-wheel-drive tractor
η_{s4}	slip efficiency of a four-wheel-drive tractor
σ	normal stress
τ	shear stress
ω	angular speed of the driven wheels
ω_f	angular speed of the front wheels
ω_r	angular speed of the rear wheels
Φ	angle of internal shearing resistance of soil

Chapter 1. Introduction

The use of four-wheel-drive vehicles in agriculture, earthmoving, cross-country transport and logging industry has grown rapidly in recent years. This is due to the increased demand for machines with higher power and higher production rate.

The comparison between the performance of two-wheel-drive and that of four-wheel-drive off-road vehicles has been made quite extensively [1,2]. However, investigation into the basic tractive characteristics and the optimization of major design factors of four-wheel-drive vehicles have not yet been given sufficient attention.

The results of previous theoretical analysis indicate that for a four-wheel-drive tractor to achieve the optimum tractive performance, the slips of the front and rear tires must be equal [3]. For four-wheel-drive tractors with rigidly coupled axles, this requires that the theoretical speed (the product of angular speed and free rolling radius) of the front tire is equal to that of the rear tire [3].

This thesis is mainly concerned with experimental verification of theoretical findings on the optimization of the tractive performance of four-wheel-drive tractors published previously [3].

To substantiate the findings of the previous analytical study, field measurements of the drawbar performance of an instrumented four-wheel-drive tractor (with front wheel assist) were carried out. Several front and rear tire combinations with different sizes were tested and the inflation pressures of the front and rear tires were systematically varied to create different combinations of theoretical speed ratios (i.e., different ratios of theoretical speed of the front tire to that of rear tire). Also, extensive measurements of soil properties were

made to define the conditions under which tests were performed and to provide soil data for the study of the relationship between tractor performance and soil characteristics in the future.

Chapter 2. Analysis of the Performance of Four-Wheel-Drive Tractors

2.1 Tractive efficiency of a four-wheel-drive vehicle

The tractive efficiency of a wheeled vehicle in straight-line motion, at a constant speed on a horizontal ground is usually determined by following equations [3]:

$$\eta_d = \frac{N_d}{N_w} = \frac{F_d \cdot V}{M\omega} \quad (1)$$

or

$$\eta_d = \eta_r \cdot \eta_s \quad (2)$$

η_r represents the efficiency of motion, which indicates the loss in transforming the torque available at the driven wheels to the pull at the drawbar. It is determined by the following equation:

$$\eta_r = \frac{F_d}{M / r} = \frac{F_d}{F} = \frac{F - R}{F} = 1 - \frac{R}{F} \quad (3)$$

The basic principles for determining η_r are the same with two-wheel-drive as with four-wheel-drive tractors.

η_s represents the efficiency of the slip, which characterizes the power loss and also the reduction in velocity of the vehicle due to slip of the driven wheels. This part of power dissipates through the sliding between the tire and soil surface, hysteresis of tire material and internal shearing of soil. The sliding between the tire and soil surface results in tire wear. The efficiency of slip, therefore, not only affects the drawbar power but also closely relates to tire wear. Usually, slip is the major source of power loss in the operation of off-road vehicles, it therefore needs to be analyzed in detail. In general, the efficiency of slip can be determined from the ratio of the power loss due to slip to the power available at the driven wheels. For a two-wheel-drive vehicle, the efficiency of slip, η_{s2} , is calculated by the following equation (assuming the performance of the two driven wheels are the same) [3]:

$$\eta_{s2} = 1 - \frac{i_r M_r \omega_r}{M_r \omega_r} = 1 - \frac{i_r V_{tr} F_r}{V_{tr} F_r} = 1 - i_r \quad (4)$$

For a four-wheel-drive tractor, the power loss due to the slip occurs at both the front and rear driven wheels. The efficiency, η_{s4} , should, therefore, be determined in the following way (assuming the performance of the two front wheels is identical and so is that of the rear wheels) [3]:

$$\eta_{s4} = 1 - \frac{i_f V_{tf} F_f + i_r V_{tr} F_r}{V_{tf} F_f + V_{tr} F_r} \quad (5)$$

where the front and rear slip are defined as $i_f = 1 - \frac{V}{V_{tf}}$ and $i_r = 1 - \frac{V}{V_{tr}}$.

There is a relationship between the velocity of the front wheels and that of the rear wheels of a four-wheel-drive vehicle in straight line motion. The relationship can be expressed by:

$$V_{tf}(1-i_f) = V_{tr}(1-i_r) = V \quad (6)$$

$$\text{or} \quad \beta = \frac{V_{tf}}{V_{tr}} = \frac{r_f \cdot \omega_f}{r_r \cdot \omega_r} = \frac{1-i_r}{1-i_f} \quad (6a)$$

where β is the ratio of the theoretical speed of the front wheel to that of the rear wheel, and is referred to as the theoretical speed ratio. This is due to the fact that the front and rear wheels are connected with the same tractor frame. Therefore,

$$\eta_{s4} = 1 - \frac{\left(\frac{1-i_r}{1-i_f} \right) \cdot i_f V_{tr} F_f + i_r V_{tr} F_r}{\left(\frac{1-i_r}{1-i_f} \right) \cdot V_{tr} F_f + V_{tr} F_r} = 1 - \frac{i_f(1-i_r) - (i_f - i_r) \cdot \alpha}{(1-i_r) - (i_f - i_r) \cdot \alpha} \quad (7)$$

where α is the thrust distribution coefficient and is defined as the ratio between the rear thrust and total thrust (sum of the front and rear thrust). This shows that in general the efficiency of slip of a four-wheel-drive vehicle depends not only on the slips of the front and rear wheels but also on the distribution of thrust between them.

It is also important to point out the similarity between Equations (4) and (7), which have the form of $\eta_s = 1 - x$

$$\eta_{s2} = 1 - i_r \quad \eta_{s4} = 1 - \frac{i_f(1-i_r) - (i_f - i_r) \cdot \alpha}{(1-i_r) - (i_f - i_r) \cdot \alpha}$$

In the case of two-wheel-drive vehicle x is the slip of wheels on the drive axle (usually rear axle), while for a four-wheel-drive vehicle x is represented by second term on the right-hand side of the Equation (7) that depends on the front wheel slip, rear wheel slip and coefficient of thrust distribution. This comparison leads to the conclusion that the expression for x in the case of η_{s4} can be considered as the equivalent slip i_{eq} , for four-

wheel-drive vehicles. This provides the basis for direct comparison of slip and slip efficiency between two-wheel-drive and four-wheel-drive vehicles.

$$i_{eq} = \frac{i_f(1-i_r) - (i_f - i_r) \cdot \alpha}{(1-i_r) - (i_f - i_r) \cdot \alpha} \quad \text{and} \quad \eta_{s4} = 1 - i_{eq} \quad (8)$$

From Equation (7) it is clear that under a particular condition there must be an optimum thrust distribution where the efficiency of slip of a four-wheel-drive vehicle reaches its peak. In order to find this optimum thrust distribution, the first partial derivative of η_{s4} with respect to α is taken and set equal to zero [3].

$$\frac{\partial \eta_{s4}}{\partial \alpha} = \frac{(1-i_f) \cdot (1-i_f) \cdot (i_f - i_r)}{[(1-i_r) - (i_f - i_r) \cdot \alpha]^2} = 0 \quad (9)$$

This can only be so if the slip of the front wheels or that of the rear wheels is one hundred percent, or the slip of the front wheels is equal to that of the rear wheels. When the slip of either the front or the rear wheels is one hundred percent, the tractive efficiency is equal to zero. Therefore, under normal operating conditions, only when the slip of the front wheels equals that of the rear wheels, can the first partial derivative be zero. This is necessary condition for achieving the maximum efficiency of slip for a four-wheel-drive vehicle.

The above analysis leads to a very interesting result. It shows that for the most efficient operation of a four-wheel-drive vehicle, the slip of the front wheels must be the same as that of the rear wheels. In other words, the optimum thrust distribution is that which can make the slips of the front and rear driven wheels equal. Only in this case can the efficiency of slip reach its peak. It is interesting to point out that when the slips of the front and rear wheels are equal ($i_f = i_r$), the efficiency of slip, η_{s4} , is simply equal to $1 - i_f$ (or

$1-i_r$), and the coefficient of thrust distribution no longer has an effect on determining the efficiency of slip (see Equation (7)).

The analytical results concerning the optimum efficiency of slip for a four-wheel-drive vehicle may be obtained in an alternative way. Substituting the theoretical speed ratio β for $(1-i_r)/(1-i_f)$ in Equation (7) gives [16]:

$$\eta_{s4} = 1 - \frac{i_f \beta - (\beta - 1) \cdot \alpha}{\beta - (\beta - 1) \cdot \alpha} \quad (10)$$

Taking the partial derivative of η_{s4} with respect to α and setting it to zero, one obtains

$$\frac{\partial \eta_{s4}}{\partial \alpha} = \frac{(\beta - 1) \cdot \beta \cdot (1 - i_f)}{[\beta - (\beta - 1) \cdot \alpha]^2} = 0 \quad (11)$$

Similar to Equation (9), to satisfy Equation (11) under normal operating conditions, the value of the theoretical speed ratio β must be equal to 1, or the theoretical speeds, and hence the slips, of the front and rear wheels must be equal. This is the same conclusion reached previously from Equation (9).

In order to calculate the slip efficiency by means of Equations (5) or (7) the relationship between slip and thrust should be determined. This depends on the vehicle parameters and terrain conditions, and is generally determined experimentally. However, as shown in Reference [3] it can be calculated by making use of a simple theory proposed by Bekker [4] and verified for tracks by Wills [5]. Reece [6] used the soil values $c=10342.5$ Pa (1.5 lb/in²) and $\Phi = 34^\circ$, which were found by Paine and Fountaine [7] to be the most common values for English farm soils, and the shear stress-displacement modulus $K=2.54$ cm (1 in). He showed that the computed results for a wide range of tires are very close to the test results obtained by the National Institute of Agricultural Engineering, England

(N.I.A.E.). This procedure has been followed in order to calculate the slip efficiency of a typical four-wheel-drive vehicle on farm soil. In making the computation, the following data are also used: the mass of the vehicle is 3175 kg (7000 lb); the static load of the front wheels is equal to that of the rear wheels; the length and the width of the contact patch of each tire are 38.1 cm (15 in) and 30.48 cm (12 in) respectively; drawbar height is small so that load transfer can be neglected. In the computation, it is also assumed that the front and rear wheels run on the same soil with identical properties [3].

Fig. 1
Variation of slip efficiency with the coefficient of thrust distribution of a four-wheel-drive vehicle at various thrust/weight ratios on a farm soil (from Reference [3])

Fig. 2
Variation of slip efficiency with the coefficient of thrust distribution of a four-wheel-drive vehicle at various thrust/weight ratios on tarmac (from Reference [3])

Figure (1) shows the relationship between the efficiency of slip, η_{s4} , and the coefficient of thrust distribution, α , at various values of total thrust to vehicle weight ratio, F/W , on farm soil, according to the computed results [3]. The efficiency of slip of the same vehicle operating on hard surface was also calculated, in order to evaluate the effect of terrain conditions. In this calculation, the relationship between thrust and slip is based on N.I.A.E. test report on similar tire with similar vertical load on tarmac [8]. The variation of slip efficiency with thrust distribution on tarmac is shown in Fig. (2) [3]. It should be noted that when $\alpha = 1$, the vehicle is rear-wheel-drive, whereas when $\alpha = 0$, it is front-wheel-drive. The negative sign of α indicates that the rear wheels develop negative thrust opposite to the direction of motion, and when $\alpha > 1$, it implies that the front wheels have negative thrust. The results of the computations show that the thrust distribution affects the efficiency of slip of a four-wheel-drive vehicle considerably. Even though the total thrust (or drawbar pull) is the same, a slight variation of thrust distribution causes considerable changes in slip efficiency, particularly when the value of thrust/weight ratio, F/W , is high and on soft ground. Figures (1) and (2) show that when the coefficient of thrust distribution equals 0.5, the maximum efficiency is reached. This is because in the computation the weight of the vehicle is assumed to be evenly distributed on all driven wheels and they have the same performance. It is therefore obvious that in order to make both front and rear wheels have the same amount of slip, the thrust must also be evenly distributed on all driven wheels. Variation of weight distribution and other conditions would change the optimum value of the coefficient of thrust distribution. The above theoretical analysis leads to the conclusion that in order to achieve the maximum

efficiency, the important matter in design and operation of a four-wheel-drive tractor is to match the thrust distribution with the weight distribution and terrain conditions, so that the slips of the front and rear wheels are equal under operating conditions. Since tire wear is closely related to the efficiency of slip as mentioned previously, inefficient distribution of thrust and slip also causes excessive tire wear [3].

2.2 Factors affecting the thrust distribution of a four-wheel-drive vehicle

Since the thrust distribution affects the tractive efficiency of a four-wheel-drive vehicle considerably, it is of importance to analyze the factors which in practice affect the thrust distribution. Generally speaking, there are two basic factors. First, the type of coupling between the front and rear driven axles, which may be rigid coupling, interaxle differential, over-running clutch, etc. Second, the difference in theoretical speed (wheel speed when no slip or skid occurs) between the front and rear wheels. A difference in theoretical speed often exists under operating conditions, and is usually caused by variation of radii of the front or rear wheels (tires), owing to unequal tire pressure, uneven wear of tires, or load transfer. When the size of the front wheels is smaller than that of rear ones, sometimes it is difficult to provide exactly the right gear ratio for them, and this also causes the difference in theoretical speed between them [3].

2.2.1 Thrust distribution when the front and rear axles are coupled rigidly

The kinematic characteristic of this type of simple and widely used vehicle is that the ratio of angular velocity of the front wheels to that of rear wheels is fixed. Therefore, from Equations (6) and (6a), the relationship between the slip of the front wheels and that of the rear wheels can be described as follows:

$$i_r = 1 - \frac{V_{tf}}{V_{tr}}(1 - i_f) = 1 - \beta \cdot (1 - i_f) \quad (12)$$

It shows that the relationship between the slip of the front wheels and that of the rear wheels depends on the difference in theoretical speed.

Fig. 3

Relationship between the slip of the front wheels and that of rear wheels of a four-wheel-drive vehicle with rigidly coupled driven axles (from Reference [3])

The variation of i_r with i_f and β is shown in Fig. (3). If $\beta = 0.85$ and $i_r < 15\%$, the front wheels skid and develop negative thrust opposite to the direction of motion. When $\beta = 1.15$ and $i_f < 13\%$, the rear wheels skid and also develop negative thrust. In both cases, torsional wind-up in the transmission inevitably occurs [3].

Fig. 4

Variation of the coefficient of thrust distribution α with β of a four-wheel-drive vehicle with rigidly coupled driven axles at various thrust/weight ratios on a farm soil (from Reference [3])

Fig. 5

Variation of the coefficient of thrust distribution α with β of a four-wheel-drive vehicle with rigidly coupled driven axles at various thrust/weight ratios on tarmac (from Reference [3])

Figures (4) and (5) show the relationship between α and β for different values of F/W on farm soil and tarmac respectively, computed for the same vehicle as that for Fig. (1) and (2) [3]. It is shown that if the value of thrust/weight ratio, F/W , is high (that is to say the vehicle is doing heavy work), the difference in theoretical speed ratio has less effect on thrust distribution. From Figs. (4) and (5), it is also interesting to note that for the same amount of difference in theoretical speed, the variation of thrust distribution on hard surface is much greater than that on soft soil. For example, when the value of F/W is 0.4 and $\beta = 1.2$, the coefficient of thrust distribution α is 0.28 on farm soil, whereas on tarmac α is -0.13, which indicates the rear wheels develop negative thrust. This implies that it is desirable to disengage one of the driven axles from the engine when this type of vehicle is traveling over hard surface with light drawbar load. The above analysis clearly shows that the thrust distribution of a vehicle of this type depends not only on the difference in theoretical speed, but also on the drawbar pull and terrain conditions. Figures (4) and (5) also show when $\beta = 1$, all curves passes through point $\alpha = 0.5$, which is the optimum value of the coefficient of thrust distribution as mentioned previously. This is because in the computation, the weight of the vehicle is assumed to be evenly distributed on all wheels, and the tires are of the same size and have the same performance. Variation of either the weight distribution between the front and rear wheels, or the size of the front and rear wheels would change the optimum value of the coefficient of thrust distribution. It is estimated that in practice, the difference in theoretical speed between the front and rear wheels may be quite considerable, if insufficient attention is given to the control of inflation pressure, the wear of tires, and also the effect of load transfer. It therefore follows that the thrust and slip distributions may depart noticeably from the optimum condition [3].

Fig. 6

Variation of slip efficiency with the ratio F/W of a four-wheel-drive vehicle at different values of β at various thrust/weight ratios on farm soil (from Reference [3])

Fig. 7

Variation of slip efficiency with the ratio F/W of a four-wheel-drive vehicle at different values of β at various thrust/weight ratios on tarmac (from Reference [3])

Figures (6) and (7) show the comparison between the efficiency of slip when $\beta = 1.2$ and that when the thrust (slip) distribution is an optimum ($\beta = 1$) on farm soil and tarmac respectively. These results are based on the computation using the same data as those for Figs. (1) and (2) [3]. It is interesting to note that the difference in efficiency of slip between these two conditions, $\beta = 1.2$ and $\beta = 1$, increases as the value of F/W decreases. On farm soil, it is about 3 % at $F/W=0.6$, but is as high as 26 % at $F/W=0.1$ (from Fig. (6)). On tarmac, it is about 9.5 % at $F/W=0.6$ and 42 % at $F/W=0.1$ (from Fig. (7)). As mentioned previously, this is because when the value of F/W is low, a slight difference in theoretical speed between the front and rear wheels causes the thrust

distribution to depart from the optimum condition considerably. This is particularly significant when the vehicle is traveling over hard surfaces. Under such conditions, either the front or the rear wheels will skid and will develop negative thrust. This inevitably increases the power loss and reduces the efficiency. It also results in the interesting situations where the overall slip loss can decrease as the thrust increases under certain conditions. The above theoretical analysis indicates that for a four-wheel-drive vehicle, with rigid coupling between driven axles, to achieve high efficiency of operation the theoretical speed of the front wheels and that of the rear wheels must be equal under operating conditions, so that the slip of the front wheels equals that of the rear wheels. Under this condition, the thrust distribution is automatically optimized and therefore the performance is not affected by the weight distribution. This leads to the important practical conclusion that the load transfer from the mounted implements and the like can be used to increase traction even if it results in very unequal weight distribution. However, this is so if, and only if, the dynamic radii of the tires are equal under working conditions, an important factor that the vehicle operator must control [3]. Under steering conditions, the kinematics of the vehicle requires that the front and rear wheels have different velocities depending on the turning radius and wheelbase (for a vehicle with front wheels Ackerman steering). This causes the ratio of the actual speed of the front wheels to that of the rear wheels to vary. For this type of vehicle, since the ratio of angular velocity of the front wheels to that of the rear wheels is fixed, the front and rear wheels will have different amount of slip (or skid). This causes adverse consequences described previously [3].

Chapter 3. Characterization of Terrain Behavior

To define the soil conditions under which tractive performance testing of a four-wheel-drive tractor (with front-wheel-assist) was conducted, the mechanical properties of the soil were measured. The soil data obtained would also provide basic information for correlating vehicle performance and soil conditions in future studies.

The bevameter technique developed by Bekker is one of the well-known techniques for identifying the mechanical properties of terrain in relation to vehicle mobility [9]. It was used to measure soil properties in the study. Two types of tests are usually performed using the bevameter: one is the pressure-sinkage test and the other is the shear test. In this research project a penetrometer was used to measure the pressure-sinkage relations and a Cohron sheargraph was used to determine the shear strength. These two instruments, developed by Agriculture and Agri-Food Canada, are schematically shown in Figs. (8) and (9), respectively. In the following, the basic methods for characterizing the pressure - sinkage relations and shearing behavior of terrains are briefly outlined.

Fig. 8
Penetrometer

Fig. 9
Cohron sheargraph
(from Reference No. [10])

3.1 Pressure-sinkage relationship

The pressure-sinkage relationship was measured using the penetrometer (Fig. (8)). It consists of an electric motor, data logger, load cell with capacity of 8.9 kN (2000 lb), frame, rod and circular plates. This instrument was handled by one operator standing on the frame base of the penetrometer. During the operation, the penetrometer probe (rod with a circular plate at the end) was vertically pushed into the soil with a constant speed. The load cell, mounted on the other side of the rod, measured the vertical force (soil resistance to the penetration), and the data were stored in the data logger. The penetrometer tests were conducted at six different locations across the field. At any one location, tests were repeated fifteen times using three circular plates with different radii (five tests for each plate). The penetrometer was driven by a electric motor, powered by the portable battery.

To characterize the pressure-sinkage relation of homogenous terrain, Bekker proposed the following equation

$$p = \left(\frac{k_c}{b} + k_\phi \right) \cdot z^n \quad (13)$$

where p is pressure [kPa], b is the radius of a circular plate [m], z is the sinkage [m] and n , k_c and k_ϕ are empirically determined terrain constants. In Equation (13), p and z are measured values. The three constants k_c , k_ϕ and n are to be derived from fitting the experimental data to the Bekker equation. To determine these three constants, a minimum of two tests with two circular plates having different radii, b_1 and b_2 are required [9]. These two tests produce two curves

$$p_1 = \left(\frac{k_c}{b_1} + k_\varphi \right) \cdot z^n \quad (14)$$

$$p_2 = \left(\frac{k_c}{b_2} + k_\varphi \right) \cdot z^n \quad (15)$$

Taking the logarithms of the above equations, one obtains

$$\ln p_1 = \ln \left(\frac{k_c}{b_1} + k_\varphi \right) + n \cdot \ln z \quad (16)$$

$$\ln p_2 = \ln \left(\frac{k_c}{b_2} + k_\varphi \right) + n \cdot \ln z \quad (17)$$

They represent two parallel straight lines when plotting the data on a logarithmic scale as shown in Fig. (10). It is evident that the exponent of the deformation n can be determined from the slope of the straight lines. To determine the values of k_c and k_φ , the values of the pressure for the two plates at sinkage $z = 1$ are used. From Equations (14) and (15), one obtains

$$(p_1)_{z=1} = \frac{k_c}{b_1} + k_\varphi = a_1 \quad (18)$$

$$(p_2)_{z=1} = \frac{k_c}{b_2} + k_\varphi = a_2 \quad (19)$$

Fig. 10
Idealized pressure-sinkage curves on a
log-log scale (from Reference [9])

Since $(p_1)_{z=1}$ and $(p_2)_{z=1}$ are measured values, the values of k_c and k_ϕ can be determined by

$$k_\phi = \frac{a_2 \cdot b_2 - a_1 \cdot b_1}{b_2 - b_1} \quad (20)$$

$$k_c = \frac{(a_1 - a_2) \cdot b_1 \cdot b_2}{b_2 - b_1} \quad (21)$$

There are certain practical problems in using the data reduction procedure described above. Experimental data from pressure-sinkage tests, particularly those obtained in the field, quite often do not exactly fit Equation (13). This means that subjective judgment has to be exercised in fitting a straight line to approximate the experimental data on a log-log scale. In addition, the two straight lines representing the experimental data obtained using two different plates may not be parallel. Thus adjustment of the slopes of the two lines has to be made to conform to Equation (13), which indicates that for a particular terrain there is a unique value of n . Furthermore, in the calculation of the values of k_c and k_ϕ , only two specific values of pressure (i.e. pressures for the two plates at $z = 1$) are used, and the pressure-sinkage characteristics over the full range are not properly taken into consideration.

To provide a more rational approach for deriving the values of the parameters characterizing the pressure-sinkage relation from experimental data, a weighted least squares method has been developed [9]. Consider the pressure-sinkage equation proposed by Bekker as an example. Taking the logarithms of both sides of Equation (13), one obtains

$$\ln p = \ln \left(\frac{k_c}{b} + k_\phi \right) + n \cdot \ln z \quad (22)$$

To obtain the best fitted line, based on Equation (22), the conventional least squares technique cannot be directly employed, as p and z are the measured quantities, not $\ln p$ and $\ln z$. Applying the conventional least squares principle to the logarithms of the deviations will give excessive weight to deviations at low pressures which are usually the least significant. However, one may approach the problem by introducing a weighting factor and by minimizing the value of

$$w_r \left[\ln p - \ln \left(\frac{k_c}{b} + k_\phi \right) - n \cdot \ln z \right]^2 \quad (23)$$

where w_r is an appropriate weighting factor [9]. If an equal liability is assumed for all observations, the weighting factor w_r may be taken as

$$w_r = p^2 \quad (24)$$

Thus to obtain the best value of k_c , k_ϕ and n for particular set of test data, the following function must be minimized

$$\begin{aligned} X &= \sum p^2 \left[\ln p - \ln \left(\frac{k_c}{b} + k_\phi \right) - n \cdot \ln z \right]^2 \\ \text{or} \quad X &= \sum p^2 \left[\ln p - \ln k_{eq} - n \cdot \ln z \right]^2 \end{aligned} \quad (25)$$

where $k_{eq} = k_c / b + k_\phi$ [9].

To minimize the value of the function X , the first partial derivatives of X with respect to n and k_{eq} are taken and set to zero. This leads to the following two equations :

$$\ln k_{eq} \cdot \sum p^2 \ln z + n \sum p^2 (\ln z)^2 = \sum p^2 \ln p \cdot \ln z \quad (26)$$

$$\ln k_{eq} \cdot \sum p^2 + n \sum p^2 \cdot \ln z = \sum p^2 \ln p \quad (27)$$

Solving these two equations simultaneously, one can obtain the best fitted values of n and k_{eq} for a particular data set

$$n = \frac{\sum p^2 \sum p^2 \ln p \cdot \ln z - \sum p^2 \ln p \sum p^2 \ln z}{\sum p^2 \sum p^2 (\ln z)^2 - (\sum p^2 \ln z)^2} \quad (28)$$

$$\ln k_{eq} = \frac{\sum p^2 \ln p - n \sum p^2 \ln z}{\sum p^2} \quad (29)$$

It should be mentioned that in practice the values of n calculated from the two sets of data obtained using two different sizes of plates are seldom identical, even under controlled laboratory conditions [9]. Since Bekker equations implies that for a particular type of terrain there is a unique value of n , an average value, n_{av} , is taken

$$n_{av} = \frac{(n)_{b=b_1} + (n)_{b=b_2}}{2} \quad (30)$$

where $(n)_{b=b_1}$ and $(n)_{b=b_2}$ represent the values of n obtained from the two sets of data using plates with radii b_1 and b_2 respectively. The value of n_{av} is then used to recalculate the value of k_{eq} for a particular set of data

$$\ln k_{eq} = \frac{\sum p^2 \ln p - n_{av} \sum p^2 \ln z}{\sum p^2} \quad (31)$$

From the two sets of test data, two values for k_{eq} , one from the data obtained using a plate with radius b_1 , $(k_{eq})_{b=b_1}$, and the other from the data obtained using a plate with radius b_2 , $(k_{eq})_{b=b_2}$, can be derived [9]. Thus the values of k_c and k_ϕ can be calculated by

$$k_c = \frac{(k_{eq})_{b=b_1} - (k_{eq})_{b=b_2}}{b_2 - b_1} b_1 \cdot b_2 \quad (32)$$

$$k_\phi = (k_{eq})_{b=b_1} - \left[\frac{(k_{eq})_{b=b_1} - (k_{eq})_{b=b_2}}{b_2 - b_1} \right] \cdot b_2 \quad (33)$$

3.2 Shear stress - normal pressure relationship

In using the Cohron sheargraph, the normal pressure is first increased to a predetermined value by applying a vertical force to the shearhead shown in Fig.(9) (Stage I in Fig. 11). The normal stress is then held constant while applying a torque to the handle and the shear stress is increased (Stage II in Fig. 11). Once the shear stress reaches a maximum (i.e. soil failure occurs), the shear and normal stresses are released together due to the energy accumulated in the spring of the sheargraph (Stage III in Fig. 11). The stress path is recorded on a chart. The exact shape of the stress path will depend on the properties of the soil, in particular whether it is normally or over-consolidated. As it can be seen from Fig. (11), stress path beyond the failure point in Stage III will be different for plastic and brittle soil. In the case of plastic soil, the shear stress decreases gradually with the decrease of normal pressure, while in the case of brittle soil the shear stress may drop significantly even the normal pressure is held steady.

Fig. 11

General form of the stress path using the Cohron sheargraph

Stage I, normal pressure increased

Stage II, shear stress increased

Stage III, shear stress and normal pressure decreased (from Reference [10])

In interpreting sheargraph results only the maximum shear stress and corresponding normal pressure are used for determining the cohesive and frictional properties of the soil. The friction angle is the slope of the straight line fitted to a number of points of maximum shear stress ($\tau_{\max}$) at several normal pressures. The cohesion is intercept of the straight line on the vertical axis of the $\tau_{\max} - \sigma$ graph. This is based on the Mohr-Coulomb failure criterion

$$\tau_{\max} = c + \sigma \cdot \tan \Phi \quad (34)$$

where $\tau_{\max}$ is the maximum shear stress at the failure point, σ is the normal pressure, and c and Φ are the cohesion and angle of internal shearing resistance of the terrain, respectively [10].

However, a much more precise approach may be followed. As can be seen from Fig. (12), the shear stress - displacement characteristics of terrain commonly encountered in off-road operations may be seen in two patterns. One displays a hump of maximum shear stress

$\tau_{\max}$ and a flattened portion of residual shear stress τ_r after yielding, as shown by curve 1 in Fig. (12). Undisturbed firm soils, such as compacted sand, silt, loam and frozen snow may exhibit these characteristics. It is seen that a certain shear deformation is developed before the maximum shear stress is reached. The relationship between shear stress τ and shear displacement j in this case may be expressed by an equation similar to that for defining an aperiodic damped vibration.

$$\tau = \frac{(c + \sigma \cdot \tan \Phi)}{y_{\max}} \left\{ \exp\left(-K_2 + \sqrt{K_2^2 - 1}\right) K_1 \cdot j - \exp\left(-K_2 - \sqrt{K_2^2 - 1}\right) K_1 \cdot j \right\} \quad (35)$$

where K_1 and K_2 are coefficients and $y_{\max}$ is the maximum value of the function enclosed between brackets $\{ \}$ [11].

Fig. 12

Two types of shear stress - shear displacement curve
(from Reference [11])

Another type of terrain exhibits a smooth shear stress - displacement characteristic, and the shear stress does not fall off after the maximum, as shown by curve 2 in Fig. (12). Loose soil, such as loose sand and saturated clay, dry snow and most of the disturbed soils are of this type. For this kind of terrain, the following shear stress-displacement relationship may be used :

$$\tau = (c + \sigma \cdot \tan \Phi) \cdot (1 - e^{-j/K}) = \tau_{\max} (1 - e^{-j/K}) \quad (36)$$

where K is the horizontal shear deformation modules. K may be considered as a measure of the magnitude of the deformation required to develop the maximum shear stress. The value of K is determined by the distance between the vertical axis and the point of intersection of the straight line tangent to the shear curve 2 at the origin and the extension of the horizontal portion of the curve as shown in Fig. (12) [11].

Bekker pointed out that the hump of the shear curve (curve 1 in Fig. (10)) has little practical meaning, as far as the prediction of vehicle thrust under normal operating conditions is concerned [11]. It is therefore suggested that the smoothing of the “humped” curve is desirable, whenever $\tau_{\max}$ is not too great in comparison with τ_r . After smoothing, the shear stress - displacement relationship can be expressed by Equation (36). The measurement and characterization of the mechanical properties of the soil described previously provide the basis for analyzing vehicle - terrain interaction. As will be shown later in the thesis, the thrust-slip relationship of a vehicle reflects the shearing behavior of the soil and can be described by an expression similar to Equation (36).

Chapter 4. Vehicle and Instrumentation used in the Experimental Study

To verify the analytical findings described in Chapter 2, a series of field tests was conducted in co-operation with Agriculture and Agri-Food Canada. The prime objective is to experimentally determine the variations of the efficiency of slip (or equivalent slip), tractive efficiency and fuel consumption per unit drawbar power with theoretical speed ratio β for various tire and inflation pressure combinations.

4.1 Equipment and Instrumentation

An instrumented 97 kW Case-IH Magnum tractor (produced by Case Corporation, Hinsdale, IL, USA), owned by Agriculture and Agri-Food Canada in Ottawa, was chosen as the test vehicle [13]. The tractor was equipped with a power shift transmission with front wheel-assist (FWA). When the front drive axle was engaged, the front and rear drive axles were rigidly coupled with a gear ratio between the front and rear tires of 21.52 to 28.63. The static load on the front wheel axle with ballast was 43.26 kN and that on the rear axle was 64.16 kN. The instrumentation and data logging system mounted on the vehicle was designed and fabricated by Agriculture and Agri-Food Canada personnel. Factory installed transducers were employed where possible in the instrumentation system. Additional transducers were installed to measure front and rear axle torque, fuel consumption, drawbar pull and forces in the three point hitch, front and rear wheels rotations, and ground speed.

Strain-gauge type transducers were installed on the left and right hand side half shafts to measure the torques transmitted to two rear tires. Slip rings were used to transmit the signal to the on-board data acquisition system.

A Lebow model 1248-20k torque cell was installed to measure the torque on the front axle drive shaft. Front torque was determined by multiplying the drive shaft torque by the combined gear reduction ratio in the front axle differential and final drive.

Fuel consumption was measured by a specially designed system consisting of a charge pump, filter, heat exchanger, vapor eliminator and a four-piston positive displacement flow meter.

Drawbar link between the instrumented test vehicle and the load tractor was a steel beam. As an integral part of the link, a strain-gauge load cell was installed. The load cell had a capacity of 220 kN and was used to measure the drawbar pull.

Strain-gauge load cells installed on the links of the three-point hitch were used as additional means for measuring drawbar pull. By combining the forces measured by these load cells with geometry of the three-point hitch it was possible to calculate the drawbar pull. This conversion procedure was built into the data acquisition system.

Proximity sensors were employed to monitor the rotations of the front and rear tires.

Ground speed of the vehicle was measured by Doppler radar and a fifth wheel trailing behind the right hand side rear tire.

Signal conditioners and a computer based data logger were provided to amplify, filter and record transducer signals.

Power for the instrumentation system was supplied by a 110 V AC , 4.0 kVA Onan diesel generator mounted on the right side of the tractor. The generator provided power to the instrumentation system while in the field and was independent of the tractor electrical system or engine operation.

A cab extension was built on the left side of the existing tractor cab to accommodate the instrumentation and a data logger operator.

All transducers were calibrated and appropriate calibration constants were implemented into the data acquisition system.

A detailed description of the instrumented test vehicle is given in reference [13].

Fig. 13 Simplified block diagram of tractor instrumentation and data logging system (from Reference No. [13])

4.2 Calibrations

Prior to field tests, comprehensive calibrations of all main components of the data acquisition system were performed. Three strain-gauge load cells were calibrated using the MTS material strength testing machines; one for the drawbar link which measured the drawbar pull with a capacity of 220 kN, and the other two with a capacity of 89 kN. Another load cell with a capacity of 8.9 kN was calibrated using dead weights. During calibrations, these load cells were subject to loading-unloading cycles three times to ensure consistency and reliability. Three calibrated load cells (two with a capacity of 89 kN and one with a capacity of 8.9 kN) were later used for in-situ calibration of the front and rear axle torque cells mounted on the vehicle. They were subject to the loading - unloading cycles using specially designed calibration rigs. It is important to point out that all calibrations were performed and recorded using the data acquisition system mounted on the instrumented tractor. This means that load cell output in mV was multiplied by the calibration constants previously entered into the data logging software. Therefore, the load cell outputs (or torque cells output) on calibration charts are denoted in units of force (or torque). Actual load calculation was based on application of the known load. Laboratory calibrations using MTS machines were conducted in the Civil Engineering Laboratory at the Carleton University, while in-situ calibrations were conducted in facilities of Agriculture and Agri-food Canada. Specially designed rigs were developed by Agriculture and Agri-food Canada personnel. Representative calibration results are shown in the following figures.

Fig. 14 Drawbar Load Cell Calibration - Tension

Fig. 15 Drawbar Load Cell Calibration - Compression

Figures (14) and (15) show the results of the calibration for the drawbar load cell using the MTS machines under tension and compression.

Figure 16 Left Rear Torque Cell Calibration - Clock-wise Direction Torque applied on the left rear half-shaft (in-situ calibration)

Figure 17 Left Rear Torque Cell Calibration - Counterclock-wise Torque applied on the left rear half-shaft (in-situ calibration)

Figures (16) and (17) show the results of the calibrations for the left-rear torque cell obtained using a specially designed rig, in which external torque was applied through a load cell.

“Shunt calibration” is a method that checks the stability and consistency of the gain of the signal conditioner. This calibration is performed using “dummy load cell”, which consists of four permanent resistors connected in the Wheatstone bridge and sealed in plastics. Another permanent resistor was installed within the signal conditioner and was connected to one of the arms of the Wheatstone bridge. Details of this setup can be seen in Fig. (18).

Figure 18
“Shunt calibration” setup

“Dummy load cell” was connected to the particular signal conditioner instead of actual load cell (or torque cell). The output was recorded first without employing external resistor (in order to get the offset value). After that, the recording was repeated two more times with external resistor connected each time to different arm of the “dummy load cell”. These recordings simulated two loads, same in value but opposite in direction (compression and tension). Such a procedure was performed twice a day, at the beginning and at the end of the experiment.

Figure 19 Gain Calibration of the signal conditioner for the Drawbar Load Cell (Dummy load cell with resistors was used to conduct this check)

Figure 20 Gain Calibration of the signal conditioner for the Drawbar Load Cell (Dummy load cell with resistors was used to conduct this check)

Figures (19) and (20) show the results of “shunt calibrations” of the drawbar load cell in tension and compression. It is shown that the variations of the gain for the signal conditioner during the test period of six days was in the limited range of 0.33 to 0.71%, which was considered to be acceptable.

Figure 21
Fuel Rate Measuring System Calibration

Figure (21) shows the calibration results of the fuel consumption measuring device. The fuel rate was calibrated in liters per hour. This calibration was conducted using graduated cylinder, where fuel was collected during a given period of time. Such a procedure was repeated several times for different flow rates. The results were later compared with the fuel rate measured by the data acquisition system mounted on the test vehicle.

The results of calibrations of other load cells used in field tests are given in Appendix A.

4.3 Vehicle performance testing procedure

For performance testing of the instrumented tractor, drawbar load was applied by pulling a load tractor. By changing the gear in the transmission and by applying brakes to the load tractor, different drawbar loads were created. Tests were conducted at six levels of drawbar pull ranging from approximately 6.6 kN to 85 kN, and the engine speed was maintained at approximately 2000 rpm. The forward speed of the tractor was maintained at approximate 1 m/s. The test section was 30 m long, and during each run effort was made to maintain the drawbar pull as steady as possible. For each level of drawbar pull, three tests were performed on three different sections of the field, to ensure the reliability and repeatability of the test results. Figure (22) shows the field test arrangements and test sequence. It can be seen that the field was divided in three sections and a number of 30 meter distances that were precisely marked by stakes. These stakes were allocated across the field and the alignment of the stakes (observed by the computer operator in the test vehicle) was used to start and stop data logging. For one 30-meter run (distance between two stakes) the test started few meters before the first stake. Such a procedure allowed to bring the test vehicle up to the certain speed and to the required level of drawbar load. Also, for each complete set of six runs (at six levels of drawbar pull) one push-test (load tractor was pushing instrumented tractor while in neutral gear) was conducted in order to determine the free rolling radius of the tires. By measuring the revolutions of the front and rear wheels, along the 30-meter run, it was possible to calculate rolling radii of the front and rear wheels in the free rolling condition. To obtain various values of theoretical speed

ratio β , different combinations of tire size, as well as inflation pressure of the front and rear tires were used. Table 4.1 shows the tire size and pressure combinations used in vehicle performance testing, as well as coded names for different tire combinations. For example, file name t3p1 indicates data for tire combination No. 3, with inflation pressure combination No. 1.

Figures (23)-(24) show the free rolling radii measured in the field and on asphalt pavement and the static radii (i.e. vertical distance between tire center and pavement surface measured under static conditions) for the rear tire 20.8R38, and front tires of 16.9R26 (both Goodyear “Super Traction”, radial), respectively. Corresponding figures for other front tires, 16.9-26 (Goodyear “Dyna Torque 2”, bias), 13.6R28, 14.9R28 and 16.9R28 (Goodyear “Super Traction”, radial) are given in Appendix C. The measurements were taken when the tires were installed on the test tractor. The static load on the front axle was 43.26 kN and that on the rear axle was 64.16 kN. From these figures, it can be seen that the static radius of the tire is generally much lower than the free rolling radius measured in the field, while the free rolling radius measured on the asphalt pavement is slightly lower than that measured in the field. As noted previously, as a generally accepted practice, the free rolling radius measured in the field is used as a basis for determining tire slip under drawbar load. The values of the theoretical speed ratio β for a given set of tires under various inflation pressure combinations are, therefore, determined from the free rolling radii of the front and rear tires measured in the field.

Figure 22 Map of the test field and the test sequence

Tire Combination / Pressure Combination	Rear Tire / Rear Tire Pressure		Front Tire / Front Tire Pressure	
Tire Combination No. 1 (t1)	20.8R38		16.9-26 bias	
t1p1	193 kPa	28 psi	83 kPa	12 psi
t1p2	124 kPa	18 psi	124 kPa	18 psi
t1p3	193 kPa	28 psi	124 kPa	18 psi
t1p4	83 kPa	12 psi	193 kPa	28 psi
Tire Combination No. 2 (t2)	20.8R38		13.6R28	
t2p1	193 kPa	28 psi	124 kPa	18 psi
t2p2	83 kPa	12 psi	124 kPa	18 psi
t2p3	83 kPa	12 psi	207 kPa	30 psi
t2p4	193 kPa	28 psi	83 kPa	12 psi
Tire Combination No. 3 (t3)	20.8R38		16.9R28	
t3p1	193 kPa	28 psi	124 kPa	18 psi
t3p2	193 kPa	28 psi	83 kPa	12 psi
t3p3	83 kPa	12 psi	124 kPa	18 psi
t3p4	83 kPa	12 psi	193 kPa	28 psi
Tire Combination No. 4 (t4)	20.8R38		16.9R26	
t4p1	193 kPa	28 psi	124 kPa	18 psi
t4p2	193 kPa	28 psi	83 kPa	12 psi
t4p3	83 kPa	12 psi	124 kPa	18 psi
t4p4	83 kPa	12 psi	193 kPa	28 psi
Tire Combination No. 5 (t5)	20.8R38		14.9R28	
t5p1	83 kPa	12 psi	193 kPa	28 psi
t5p2	83 kPa	12 psi	124 kPa	18 psi
t5p3	193 kPa	28 psi	124 kPa	18 psi
t5p4	193 kPa	28 psi	83 kPa	12 psi

Table 4.1 Various tire size and inflation pressure combinations used in field tests

Figure 23

Radii under different conditions for rear tires 20.8R38 (used throughout the field testing for all tire combinations)

Figure 24

Radii under different conditions for front tires 16.9R26 (coupled with rear tires 20.8R38 designated as tire combination No. 4)

Chapter 5. Terrain Conditions on the Test Site

Field tests were conducted on an experimental farm of Agriculture and Agri-Food Canada in Ottawa in the summer of 1996. The field was prepared by moldboard plow in the fall of 1995 and then with one pass of a field cultivator to smooth the surface in the spring of 1996. The soil was classified as Dalhousie clay loam. The grain size distribution is for the terrain is shown in Fig. (25).

Figure 25

Grain size distribution of the soil particles

Grain size distribution analysis was conducted by combining two techniques: sample processing through a set of sieves (for large and medium size particles - sand, silt) and hydrometer analysis (for small size particles- clay). Figure (28) shows that the content of the soil sample taken from the test site can be described as 25% medium sand, 50% fine sand, 17% silt and 8% clay.

As mentioned previously in Chapter 3, the mechanical properties of the terrain on the test site were measured and characterized by the bevameter technique. The pressure - sinkage relations were measured by a penetrometer, previously shown in Fig. (8), with sinkage plates of diameters of 19.6, 28,3 and 40 mm. The relations were characterized by the Bekker equation (Equation (13)). The pressure - sinkage data obtained on Aug. 14, 1996 were shown in Figs. (26 A-C). The data obtained for other dates are given in Appendix B. The shear data were obtained using the Cohron Sheargraph, previously shown in Fig. (9). The shear strength of the terrain was characterized by the Mohr-Coulomb Equation (Equation (34)). The data obtained on Aug. 14, 1996 were shown in Fig. (27). Shear data of the terrain obtained for other dates are given in Appendix B.

Table 5.1 summarizes the pressure - sinkage parameters and shear strength parameters derived from data collected over the test period. It should be noted that some of the data were taken when terrain was in its virgin state while the other were taken in the rut formed by the tire (i.e. after the terrain was compacted by the tire). Results of the soil testing showed great variability. Even when the measurements were taken and repeated at approximately the same places (distances from point to point were within 1 meter) variations were still high. For that reason, all of the data taken on a particular day of the testing were combined and analyzed together.

Day	n [-]	K_c [kN/m ⁿ⁺¹]	K_ϕ [kN/m ⁿ⁺²]	c [kPa]	Φ [°]	Moisture [%]
Measurement taken in the virgin soil						
Aug. 14, 96	0.836	43.28	6251.27	21.58	19.29	24.15
Aug. 19, 96	0.793	33.52	4177.10	17.17	23.22	24.17
Measurements taken in the rut of the wheel						
Aug. 15, 96	0.998	130.73	14524.00	14.78	29.16	30.49
Aug. 16, 96	0.880	33.89	7486.80	21.02	28.68	28.99
Aug. 20, 96	1.049	99.31	10997.69	16.51	32.17	24.40

Table 5.1 Pressure - sinkage and shear strength parameters of
the test site during the test period

As can be seen from Table 5.1, soil parameters are much more stable in the case of the virgin soil. For measurements taken in the rut of the tire their variations are much higher. This is mainly due to the fact that the soil in the rut was remolded by the passage of the tire. This remolding effects varied greatly dependent upon the load and slip of the tire.

The pressure - sinkage and shear strength parameters shown are used to define the conditions of the test site and to provide the necessary information for correlating vehicle performance and terrain properties in future studies.

Aug. 14, 1996

All measurements were taken in virgin soil.

On this date tire combination No. 2 (front tires 13.6R28, rear tires 20.8R38) was tested.

Figure 26 A Penetrometer tests with the smallest plate (this figure shows test data as well as fitted curve according to Bekker's equation and the derived pressure - sinkage parameters)

Figure 26 B Penetrometer tests with the medium plate (this figure shows test data as well as fitted curve according to Bekker's equation and the derived pressure - sinkage parameters)

Figure 26 C Penetrometer tests with the largest plate (this figure shows test data as well as fitted curve according to Bekker's equation and the derived pressure - sinkage parameters)

Figure 27 Shear tests (this figure shows test data as well the fitted line according to the Mohr-Coulomb equation and derived shear strength parameters)

Chapter 6. Performance Test Results

As noted previously, the prime objective of the test program is to verify the theoretical findings that for a four-wheel-drive tractor with rigidly coupled drive axles to achieve optimum tractive performance, the theoretical speed ratio β must be equal to one. To obtain various values of β , different combinations of inflation pressures of the front and rear tires were used. In the following, the results of the tractive performance testing of the instrumented vehicle equipped with front tires of 16.9R26 and rear tires 20.8R38 (i.e. tire combination No. 4 shown in Table 4.1) will be presented and analyzed. Other tire combinations (Numbers 1,2,3 and 5 in Table 4.1) were also tested but their test results have not yet been fully analyzed. The results of the performance testing of the vehicle equipped with these tire combinations are given in Appendix C. The analysis of the performance data for these four tire combinations will be carried out when further experimental study of the effects of normal loads on the rolling radii of these tire combinations are completed in the second phase of the overall research program. It was found that normal load may have an effect on the rolling radius, and hence the theoretical speed ratio, for these tire combinations. For tire combination No. 4 with front tires of 16.9R26 and rear tires 20.8R38. based on the results shown in Figs. (23) and (24) and the gear ratio between the front and the rear axle (0.7517 to 1 or 21.52 to 28.63), the four different combinations of inflation pressure result in four values of theoretical speed ratio β , as shown in Table 6.1.

Tire/ Pressure Comb.	Rear Tire 20.8R38		Free Rolling Radius in the Field, [m]	Front Tire 16.9R26		Free Rolling Radius in the Field, [m]	Theoretical Speed Ratio β
	Inflation Pressure			Inflation Pressure			
	[kPa]	[psi]		[kPa]	[psi]		
t4p2	193	28	0.899	83	12	0.650	0.962
t4p1	193	28	0.898	124	18	0.659	0.976
t4p3	83	12	0.871	124	18	0.652	0.995
t4p4	83	12	0.873	193	28	0.667	1.017

Table 6.1 Combinations of front and rear tire inflation pressure and the resulting values of theoretical speed ratio β (from reference [16])

According to Equation (6a), for a given value of theoretical speed ratio β , there is a specific relation between the slip of the front tire i_f and that of the rear tire i_r . The relations between the slips of the front and rear tires at different values of theoretical speed ratio β (0.962, 0.976, 0.995 and 1.017 given in Table 6.1) are shown by solid lines in Fig. (28). The tractive performance of the vehicle equipped with front tires of 16.9R26 and rear tires 20.8R38 at the above-noted four values of the theoretical speed ratio were measured in the field. During tests, the torques on the two half-shafts of the rear axle and on the front axle drive shaft, angular speeds (or angular displacement) of the front and rear tires, ground speed (or distance traveled) of the tractor, drawbar pull, and fuel consumption were measured. Based on the measured data, the variations of the efficiency of the slip, tractive efficiency, and fuel consumption per unit drawbar power with theoretical speed ratio β were determined, from which the validity of the theoretical findings presented in Chapter 2 was evaluated.

Figure 28

Front tire slip versus rear tire slip for different beta values (i.e. for different pressure combinations) for tire combination No. 4 (rear tires 20.8R38, front tires 16.9R26)

6.1 Efficiency of Slip

Based on the measured free rolling radii and angular speeds (or displacements) of the front and rear tires, and ground speed (or distance traveled) of the tractor, the slips of the front and rear tires at various values of theoretical speed ratio β under different drawbar loads were derived. Figure (28) shows the measured relationships between the slips of the front and rear tires at different values of theoretical speed ratio β (corresponding to different combinations of inflation pressures of the front and rear tires). It can be seen that the measured data fit extremely well to the predicted relationship defined by Equation (12)

and shown in solid lines in Fig. (28). From the measured torques and the free rolling radii of the front and rear tires in the field, the thrusts developed by the front and rear axles, as well as the total thrust developed by the tractor, were derived for different values of theoretical speed ratio β under various drawbar loads. Figure (29) shows the relationship of the measured equivalent slip i_{eq} (based on Equation (8)), total thrust, and theoretical speed ratio β . The measured data points form a three-dimensional curved surface, as shown in Fig. (29). This surface was fitted to the measured data points using a quadratic polynomial function in the following form:

$$i_{eq} = a + b*\beta + c*F + d*\beta^2 + e*\beta*F + f*F^2$$

where i_{eq} is equivalent slip, β is theoretical speed ratio, F is total thrust [N], and a, b, c, d, e, f are coefficients of the equation. In fitting the data, the least squares method was used. By slicing the curved surface along a constant thrust plane, the relationship between the equivalent slip i_{eq} and theoretical speed ratio β at various values of total thrust can be obtained, as shown in Figs. (29 A-F). It can be seen from the figures that the measured equivalent slip i_{eq} is a minimum at theoretical speed ratio β equal or close to 1. This verifies the analytical prediction described in Chapter 2 that if the theoretical speed ratio $\beta=1$, or in other words when the slips of the front and the rear tires are equal, the equivalent slip i_{eq} will be a minimum and the slip efficiency of a four-wheel-drive tractor η_{s4} (Equations (5) and (7)) will reach a maximum. Table 6.2 shows a comparison of the equivalent slip at $\beta=0.95$, 1 and 1.03 at different levels of total thrust. It can be seen that the equivalent slip at $\beta=0.95$ is higher than at $\beta=1$ at the same total thrust. For instance,

with a total thrust of 37.03 kN (equivalent to a total thrust to vehicle weight ratio of 0.343), at $\beta=0.95$ the equivalent slip is 95% higher than at $\beta=1$ (Fig. (29B)), while with a total thrust of 85.10 kN (equivalent to a total thrust to vehicle weight ratio of 0.789), at $\beta=0.95$ the equivalent slip is only 15.8% higher than at $\beta=1$ (Fig. (29F)). It should be noted that the slip efficiency η_{s4} is equal to $1-i_{eq}$ (see Equation (8)). Consequently, the increase in equivalent slip indicates a proportional decrease in slip efficiency of the tractor. The variations of the efficiency of slip with theoretical speed ratio β and total thrust are also shown in Table 6.2. It can be seen from the table that with a given total thrust, the value of efficiency of slip at $\beta=0.95$ is lower than that at $\beta=1$. For instance, with a total thrust of 85.10 kN (equivalent to a total thrust to vehicle weight ratio of 0.789), at $\beta=0.95$ the efficiency of slip is 12.8% lower than that at $\beta=1$ [16].

Figure 29
Equivalent slip versus
total thrust and beta
for tire combination
No. 4 (rear tires
20.8R38, front tires
16.9R26)

A

B

C

Figure 29 A-C

Equivalent slip versus beta for tire combination
No. 4 at different values of total thrust

Figure 29 D-F Equivalent slip versus beta for tire combination
No. 4 at different values of total thrust

Total Thrust [kN]	Thrust to vehicle weight ratio [%]	$\beta = 1$			
		Equivalent slip [%]		Efficiency of slip [%]	
17.46	16.2	1.25		98.75	
37.03	34.3	5.00		95.00	
47.94	44.5	10.25		89.75	
65.55	60.8	23.40		76.60	
75.93	70.4	33.75		66.25	
85.10	78.9	44.75		55.25	
		$\beta = 0.95$			
Total Thrust [kN]	Thrust to vehicle weight ratio [%]	Eq. slip [%]	Increase in comparison with $\beta = 1$, [%]	Eff. of slip [%]	Decrease in comparison with $\beta = 1$, [%]
17.46	16.2	5.1	308	94.9	3.9
37.03	34.3	9.75	95	90.25	5.0
47.94	44.5	15.5	51.2	84.5	5.9
65.55	60.8	29.5	26.1	70.5	8.0
75.93	70.4	40.6	20	59.5	10.2
85.10	78.9	51.8	15.8	48.2	12.8
		$\beta = 1.03$			
Total Thrust [kN]	Thrust to vehicle weight ratio [%]	Eq. slip [%]	Increase in comparison with $\beta = 1$, [%]	Eff. of slip [%]	Decrease in comparison with $\beta = 1$, [%]
17.46	16.2	3.4	172	96.6	2.2
37.03	34.3	6.4	28	93.6	1.5
47.94	44.5	11.3	10.2	88.7	1.1
65.55	60.8	23.8	1.7	76.2	0.5
75.93	70.4	34.0	0.7	66.0	0.4
85.10	78.9	44.6	-0.3	55.4	-0.4

Table 6.2 Comparison of equivalent slip and slip efficiency at different values of theoretical speed ratio β (from reference [16])

6.2 Tractive Efficiency

Based on the measured torques and angular speeds of the tractor, the tractive efficiency, as defined by Equation (1), at various values of theoretical speed ratio β under different drawbar loads was derived. Figure (30) shows the relationships of the measured tractive efficiency, total thrust, and theoretical speed ratio β . The measured data points form a three-dimensional curved surface as shown in Fig. (30). This surface was fitted to the measured data points using a quadratic polynomial function in the following form:

$$\eta_d = a + b*\beta + c*F + d*\beta^2 + e*\beta*F + f*F^2$$

where η_d is tractive efficiency, β is theoretical speed ratio, F is total thrust [N], and a, b, c, d, e, f are coefficients of the equation. In fitting the data, the least squares method was used. By slicing the curved surface along a constant thrust plane, the relationships between the tractive efficiency and theoretical speed ratio β at various total thrust can be obtained, as shown in Figs. (30 A-F). It can be seen from the figures that the measured tractive efficiency is a maximum at a theoretical speed ratio β equal or close to 1.

Figure 30 Tractive efficiency versus total thrust and beta for tire combination No. 4 (rear tires 20.8R38, front tires 16.9R26)

A

Figure 30 A Tractive efficiency versus beta for tire combination No. 4 at a total thrust of 17.46 kN

B **C** **D**

Figure 30 B-D Tractive efficiency versus beta for tire combination No. 4 at different values of total thrust

E

F

Figure 30 E-F Tractive efficiency versus beta for tire combination No. 4 at a different values of total thrust

Table 6.3 shows a comparison of the tractive efficiency at $\beta = 0.95$, 1 and 1.03 at various levels of total thrust. It can be seen that the tractive efficiency at $\beta = 0.95$ or 1.03 is lower than that at $\beta = 1$. For instance, with a total thrust of 85.10 kN (equivalent to a total thrust to vehicle weight ratio of 0.789), at $\beta = 0.95$ the tractive efficiency is 15.2% lower than at $\beta = 1$. This indicates that the theoretical speed ratio β has a significant effect on the tractive efficiency of a four-wheel-drive tractor.

Total Thrust [kN]	Thrust to vehicle weight ratio, [%]	$\beta = 1$	$\beta = 0.95$		$\beta = 1.03$	
		Tractive Eff. [%]	Tractive Eff. [%]	Decrease in comparison with $\beta = 1$, [%]	Tractive Eff. [%]	Decrease in comparison with $\beta = 1$, [%]
17.46	16.2	64.2	57.2	10.9	61.2	4.7
37.03	34.3	79.6	72.3	9.2	77.0	3.3
47.94	44.5	81.7	74.2	9.2	79.2	3.1
65.55	60.8	74.8	67.1	10.3	72.5	3.1
75.93	70.4	65.0	57.1	12.2	62.8	3.4
85.10	78.9	52.8	44.8	15.2	50.6	4.2

Table 6.3 Comparison of tractive efficiency at different values of theoretical speed ratio β (from reference [16])

It should be noted that the tractive efficiency as defined by Equation (2) has two components, namely, the efficiency of slip and the efficiency of motion. Based on the measured drawbar pull and total thrust, derived from the measured torques at the front and rear drive axles and the free rolling radii of the front and rear tires in the field, the efficiency of motion can be determined. Table 6.4 shows the measured average values of the efficiency of motion at different values of total thrust and theoretical speed ratio. It can be seen that for a given total thrust, the efficiency of motion varies only slightly with the theoretical speed ratio β in most cases. Consequently, the variation of tractive efficiency

with theoretical speed ratio primarily depends on the changes in the efficiency of slip. As described in the previous section, the efficiency of slip reaches its peak at a theoretical speed ratio $\beta = 1$, therefore the tractive efficiency also reaches its maximum at $\beta = 1$.

Total Thrust [kN]	Thrust to vehicle weight ratio [%]	Efficiency of motion, [%]			
		$\beta = 0.962$	$\beta = 0.976$	$\beta = 0.995$	$\beta = 1.017$
17.46	16.2	60.6	63.6	64.0	67.9
37.03	34.3	83.5	83.4	84.5	83.9
47.94	44.5	86.8	87.5	86.9	84.8
65.55	60.8	88.9	88.6	87.2	88.1
75.93	70.4	89.3	89.0	90.0	89.0
85.10	78.9	89.7	87.8	89.3	88.9

Table 6.4 Measured efficiency of motion at different values of theoretical speed ratio β and total thrust (from reference [16])

6.3 Fuel Consumption per Unit Drawbar Power

Based on the measurements of fuel consumption, drawbar pull and ground speed of the tractor, the fuel consumption per unit drawbar power, referred to as specific fuel consumption in liters per hour per kW, was derived for different values of theoretical speed ratio under various total thrusts. Figure (31) shows the relationship of the specific fuel consumption, total thrust, and theoretical speed ratio β . The measured data points form a three-dimensional curved surface as shown in Fig. (31). This surface was fitted to measured data points using a quadratic polynomial function in the following form:

$$SFC = a + b*\beta + c*F + d*\beta^2 + e*\beta*F + f*F^2$$

where SFC is specific fuel consumption [l/hr/kW], β is theoretical speed ratio, F is total thrust [N], and a, b, c, d, e, f are coefficients of the equation. In fitting the data, the least squares method was used. By slicing the curved surface along a constant total thrust plane, the relationships between the specific fuel consumption and theoretical speed ratio β at various levels of total thrust can be obtained, as shown in Figs. (31 A-F). It can be seen from the figures that the measured specific fuel consumption is a minimum at a theoretical speed ratio β equal or close to 1. This indicates that the four-wheel-drive tractor achieves its optimum tractive performance when the theoretical speed ratio $\beta=1$, or in other words when the slips of the front and rear tires are equal. It can be seen from Figs. (31 A-F), when the theoretical speed ratio β is higher or lower than 1, the specific fuel consumption will increase.

Figure 31 Specific fuel consumption versus total thrust and beta for tire combination No. 4 (rear tires 20.8R38, front tires 16.9R26)

A

Figure 31 A Specific fuel consumption versus beta for tire combination No. 4 at a total thrust of 17.46 kN

B **C** **D****Figure 31 B-D**

Specific fuel consumption versus beta for tire combination
No. 4 at different values of total thrust

Figure 31 E-F Specific fuel consumption versus beta for tire combination No. 4 at different values of total thrust

Table 6.5 shows a comparison of the specific fuel consumption at $\beta = 0.95$, 1 and 1.03, at different levels of total thrust (or drawbar pull). It can be seen that with a total thrust of 65.55 kN (equivalent to a total thrust to vehicle weight ratio of 0.608), at $\beta = 0.95$ the specific fuel consumption is 16.38% higher than that at $\beta = 1$. (Fig. (31 D)). This represents a significant degradation in performance. At other levels of total thrust, similar increase in specific fuel consumption is observed when β is either greater or less than 1, although the magnitude is reduced in most cases [16].

Total Thrust [kN]	Thrust to vehicle weight ratio, [%]	Specific fuel consumption, [l/hr/kW]				
		$\beta = 1$	$\beta = 0.95$		$\beta = 1.03$	
		[l/hr/kW]	[l/hr/kW]	Increase in comparison with $\beta = 1$, [%]	[l/hr/kW]	Increase in comparison with $\beta = 1$, [%]
17.46	16.2	0.963	1.029	6.85	0.982	1.97
37.03	34.3	0.551	0.616	11.80	0.570	3.45
47.94	44.5	0.430	0.493	14.65	0.448	4.19
65.55	60.8	0.403	0.469	16.38	0.442	4.71
75.93	70.4	0.492	0.558	14.41	0.510	3.66
85.10	78.9	0.623	0.689	10.59	0.641	2.89

Table 6.5 Comparison of specific fuel consumption at different values of theoretical speed ratio β (from reference [16])

6.4 Torsional Wind-Up

As noted in Section 2.2, owing to the mismatch of tire size and/or inflation pressure of the front and rear tires, the theoretical speed ratio β may be less or greater than 1. When β is less than 1 (i.e., the theoretical speed of the front tire is less than that of the rear tire), the front tires may skid when the slip of the rear tire is less than a certain value. On the other hand, when β is greater than 1, the rear tires may skid when the slip of the front tires is less than a certain value. For instance, as shown in Fig. (3), if $\beta=0.85$, when the rear tire slip $i_r < 15\%$, the front tire will develop a braking force (negative thrust), opposing the forward motion of the vehicle. Under these circumstances, a phenomenon commonly known as torsional wind-up occurs. This would greatly increase the loading on the transmission and reduce the overall tractive efficiency of the vehicle. Figures (32 A-D) show that for tire combination No. 2 (with front tires of 13.6R28 and rear tires of 20.8R38), when the values of theoretical speed ratio β are equal to 0.908, 0.934, 0.951 and 0.964, the front tires develop braking force and torsional wind-up occurs, under no drawbar load conditions (i.e. when the test vehicle was self-propelled in the field). It should be noted that the magnitude of the braking force (negative thrust) becomes lower as the value of the theoretical speed ratio β approaches 1.

Figure 32 A

Illustration of the torsional wind-up phenomenon observed in the field under no drawbar load for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28) with $\beta = 0.908$

Figure 32 B

Illustration of the torsional wind-up phenomenon observed in the field under no drawbar load for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28) with $\beta = 0.934$

Figure 32 C

Illustration of the torsional wind-up phenomenon observed in the field under no drawbar load for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28) with $\beta = 0.953$

Figure 32 D

Illustration of the torsional wind-up phenomenon observed in the field under no drawbar load when tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28) with $\beta = 0.964$

6.5 Thrust - Slip Relationship

The measurement and characterization of the shearing characteristics of the soil described previously in Chapter 3 provide the basis for characterizing the thrust-slip relationship of an off-road vehicle. Of particular interest is Equation (36) describing the relation between shear stress and shear displacement. As the shear stress is related to vehicle thrust and shear displacement is related to slip, the relationship between vehicle thrust and slip should be similar to that between shear stress and shear displacement. If the shear stress - shear displacement relationship is described by an exponential function (Equation (36)), then vehicle thrust and slip should take the same form. This is verified by the measured thrust - slip relationship. As an example, Figs. (33 A-B) show the relationships between thrust and slip of the front and rear tires, respectively, for tire combination No. 4 (with front tires of 16.9R26 and rear tires 20.8R38). It can be seen that the relationships may well be described by an exponential equation similar to Equation (36). The thrust-slip relationships for other tire combinations are given in Appendix D.

Figure 33 A

Experimental data and fitted curve for front thrust - front slip relationship for tire combination No. 4 (rear tires 20.8R38, front tires 16.9R26)

Figure 33 B

Experimental data and fitted curve for rear thrust - rear slip relationship for tire combination No. 4 (rear tires 20.8R38, front tires 16.9R26)

Chapter 7 Concluding Remarks

7.1 Conclusions

- A. Results of theoretical analysis indicate that to achieve the optimum tractive performance of four-wheel-drive tractors, including those with front-wheel-assist, the thrust (or driving torque) distribution between the front and rear axles should be such that the slips of the front and rear tires are equal. For four-wheel-drive tractors with rigidly coupled front and rear drive axles, this can be achieved if the theoretical speed (the product of angular speed and free rolling radius of the tire) of the front and that of the rear wheel are equal or the theoretical speed ratio is equal to 1.

- B. Among the design and operating factors, inflation pressure has a noticeable effect on the free rolling radius of a tire in the field, hence its theoretical speed. To ensure that a four-wheel-drive tractor with rigidly coupled drive axles achieves its optimum performance, the sizes of the front and rear tires must be properly matched and tire inflation pressures must be kept in an appropriate range during operation.

- C. Results of the experiments for tire combination 4 confirm theoretical findings that when the theoretical speed ratio β is equal to 1, the slip efficiency of a four-wheel-drive tractor reaches its maximum. If the value of β is less or greater than 1, the slip efficiency will decrease. For instance, with a total thrust to vehicle weight ratio of 0.789, at $\beta = 0.95$ the efficiency of the slip is 12.8 % lower than at $\beta = 1$.

- D.** Experimental evidence indicates that under a given operating condition, the maximum tractive efficiency is reached when the theoretical speed ratio $\beta = 1$. Under any other conditions the tractive efficiency decreases. For example, for tire combination No. 4, with a total thrust to vehicle weight ratio of 0.789, at $\beta = 0.95$, the tractive efficiency is 15.2 % lower than that at $\beta = 1$.
- E.** Results of the field test also show that with a given total thrust, the specific fuel consumption in term of liters per hour per kW drawbar power is the lowest when the theoretical speed ratio $\beta = 1$. If the value of β is less or greater than 1, the specific fuel consumption will increase. For instance, for tire combination No. 4, with a total thrust to vehicle weight ratio of 0.608, at $\beta = 0.95$, the specific fuel consumption is 16.38 % higher than that at $\beta = 1$. This further confirms that a four-wheel-drive tractor achieves its optimum overall tractive performance when the theoretical speed ratio β is equal to 1. [16]

7.2 Recommendations

- A.** The results of this theoretical and experimental study indicate that to ensure the optimum performance of four-wheel-drive tractors, a case can be made for the development of an active device for distributing torques between the drive axles that can ensure the slips of the front and rear tires being equal under all operating conditions [16].
- B.** Preliminary analysis of the test data for tire combinations 1, 2, 3 and 5 indicates that the effect of load transfer due to the drawbar pull on the rolling radii of the front and rear tires should be investigated. The drawbar pull causes the redistribution of load between the front and rear axles. Consequently, it may change the rolling radii of the front and rear tires. It is suggested that additional testing be carried out to determine the effect of normal load on the rolling radii of the front and rear tires, and that this effect be taken into account in processing vehicle performance data, such as the relationship of equivalent slip, tractive efficiency, specific fuel consumption and theoretical speed ratio.

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Appendix A Results of Calibration of Load Cells

This appendix contains the results of calibration of the most important elements of the data acquisition system, in addition to these presented in Section 4.2.

Figure A 1
Load Cell S/N
1384 Calibration
- Tension (this
load cell was
used for rear
torque cell
calibration)

Figure A 2
Load Cell S/N
1384 Calibration
- Compression
(this load cell
was used for
rear torque cell
calibration)

Figure A 3 Load Cell S/N 1385 Calibration - Tension
(this load cell was used for rear torque cell calibration)

Figure A 4 Load Cell S/N 1385 Calibration - Compression
(this load cell was used for rear torque cell calibration)

Figure A 5 Right Rear Torque Cell Calibration - Clockwise Direction Torque applied on the right rear half-shaft (in-situ calibration)

Figure A 6 Right Rear Torque Cell Calibration - Counterclockwise Direction Torque applied on the right rear half-shaft (in-situ calibration)

Figure A 7
8.9 kN Load Cell
Calibration -
Tension
(this load cell was
used for calibration
of the front torque
cell)

Figure A 8
Front Torque Cell
Calibration - final
result (actual
torque was
obtained from 8.9
kN load cell output
upon correction for
calibration factor)

These calibrations showed certain problems. First, the 8.9 kN load cell was calibrated using previously inserted calibration constant that converts mV in Newtons. It is obvious that the constant should be corrected, in order to provide output that will be identical to the load applied. However, the linearity of that load cell is quite satisfactory. Upon correction for calibration factor, this load cell was used for in-situ calibration of the front torque cell. It was found that the torque cell output should be corrected.

Figure A 9 Gain Calibration of the signal conditioner for Rear Left Torque Cell
(Dummy load cell with resistors was used to conduct this check)

Figure A 10 Gain Calibration of the signal conditioner for Rear Left Torque Cell
(Dummy load cell with resistors was used to conduct this check)

Figure A 11 Gain Calibration of the signal conditioner for Rear Right Torque Cell
(Dummy load cell with resistors was used to conduct this check)

Figure A 12 Gain Calibration of the signal conditioner for Rear Right Torque Cell
(Dummy load cell with resistors was used to conduct this check)

Figure A 13 Gain Calibration of the signal conditioner for Front Torque Cell
(Dummy load cell with resistors was used to conduct this check)

Figure A 14 Gain Calibration of the signal conditioner for Front Torque Cell
(Dummy load cell with resistors was used to conduct this check)

Appendix B Terrain Conditions on the Test Site

This appendix contains terrain data. These graphs are grouped for the experiments conducted on a specific date. The first three figures represent the results of the pressure - sinkage tests, performed with different sizes of penetration plates. These figures give a comparison between the experimental data and fitted curve, according to Bekker's Equation (13). The fourth figure in the set represents the results of the shear tests and shows a comparison between the experimental results and the Mohr-Coulomb's equation (Equation (34)).

Aug. 15, 1996

All measurements were taken in the rut of the wheel

On this date tire combination No. 3 (front tires 16.9R28, rear tires 20.8R38) was tested

Figure B 1a Penetrometer tests with the smallest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 1b Penetrometer tests with the medium plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 1c Penetrometer tests with the largest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 2

Shear tests (this figure shows the test data as well as the fitted line according to Mohr-Coulomb's equation and the derived shear strength parameters)

Aug. 16, 1996

All measurements were taken in the rut of the wheel.

On that date tire combination No. 3 (front tires 16.9R28, rear tires 20.8R38) and tire combination No. 4 (front tires 16.9R26, rear tires 20.8R38) were tested.

Figure B 3a
 Penetrometer tests with the smallest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 3b
 Penetrometer tests with the medium plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 3c
 Penetrometer tests with the largest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 4

Shear tests (this figure shows the test data as well as the fitted line according to Mohr-Coulomb's equation and the derived shear strength parameters)

Aug. 19, 1996

All measurements were taken in the virgin soil.

On that date tire combination No. 4 (front tires 16.9R26, rear tires 20.8R38) and tire combination No. 5 (front tires 14.9R28, rear tires 20.8R38) were tested.

Figure B 5a
Penetrometer tests with the smallest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 5b
Penetrometer tests with the medium plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 5c
Penetrometer tests with the largest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 6

Shear tests (this figure shows the test data as well as the fitted line according to Mohr-Coulomb's equation and the derived shear strength parameters)

Aug. 20, 1996

All measurements were taken in the rut of the wheel.

On that date tire combination No. 5 (front tires 14.9R28, rear tires 20.8R38) and tire combination No. 1 (front tires 16.9-26 bias, rear tires 20.8R38) were tested.

Figure B 7a
 Penetrometer tests with the smallest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 7b
 Penetrometer tests with the medium plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 7c
Penetrometer tests with the largest plate (this figure shows test data as well as the fitted curve according to Bekker's equation and the derived pressure-sinkage parameters)

Figure B 8

Shear tests (this figure shows the test data as well as the fitted line according to Mohr-Coulomb's equation and the derived shear strength parameters)

Appendix C Test Results with Various Tire Combinations

This appendix contains test results for tire combinations 1, 2, 3 and 5. The first figure in the set, shows the relation between front tire slip and rear tire slip. The second figure shows the measured static rolling radius and free rolling radius on pavement and in the field for the front tire. In the next three figures equivalent slip, tractive efficiency and specific fuel consumption were plotted against theoretical speed ratio β and total thrust.

C1 Results for Tire Combination No. 1

Figure C 1

Front tire slip versus rear tire slip for different beta values
(i.e. for different pressure combinations) for tire combination No. 1

Figure C 2

Radii under different conditions for front tires 16.9-26

Figure C 3

Equivalent slip versus total thrust and beta for tire combination No. 1 (rear tires 20.8R38, front tires 16.9-26 bias)

Figure C 4

Tractive efficiency
versus total thrust
and beta for tire
combination

No. 1 (rear tires
20.8R38, front tires
16.9-26 bias)

Figure C 5

Specific fuel
consumption versus
total thrust and beta
for tire combination

No. 1 (rear tires
20.8R38, front tires
16.9-26 bias)

C2 Results for Tire Combination No. 2

Figure C 6

Front tire slip versus rear tire slip for different beta values (i.e. for different pressure combinations) for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28)

Figure C 7

Radii under different conditions for front tires 13.6R28

Figure C 8

Equivalent slip versus
total thrust and beta for
tire combination No. 2
(rear tires 20.8R38, front
tires 13.6R28)

Figure C 9

Tractive efficiency
versus total thrust and
beta for tire
combination No. 2 (rear
tires 20.8R38, front
tires 13.6R28)

Figure C 10

Specific fuel consumption versus total thrust and beta
for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28)

C3 Results for Tire Combination No. 3

Figure C 11

Front tire slip versus rear tire slip for different beta values (i.e. for different pressure combinations) for tire combination No. 3 (rear tires 20.8R38, front tires 16.9R28)

Figure C 12

Radii under different conditions for front tires 16.9R28

Figure C 13

Equivalent slip versus
total thrust and beta for
tire combination No. 3
(rear tires 20.8R38, front
tires 16.9R28)

Figure C 14

Tractive efficiency
versus total thrust and
beta for tire combination
No. 3 (rear tires
20.8R38, front tires
16.9R28)

Figure C 15

Specific fuel consumption versus total thrust and beta for tire combination No. 3 (rear tires 20.8R38, front tires 16.9R28)

C4 Results for Tire Combination No. 5

Figure C 16

Front tire slip versus rear tire slip for different beta values (i.e. for different pressure combinations) for tire combination No. 5 (rear tires 20.8R38, front tires 14.9R28)

Figure C 17

Radii under different conditions for front tires 14.9R28

Figure C 18

Equivalent slip versus
total thrust and beta for
tire combination No. 5
(rear tires 20.8R38,
front tires 14.9R28)

Figure C 19

Tractive efficiency
versus total thrust and
beta for tire
combination No. 5 (rear
tires 20.8R38, front
tires 14.9R28)

Figure C 20

Specific fuel consumption versus total thrust and beta for tire combination No. 5 (rear tires 20.8R38, front tires 14.9R28)

Appendix D Measured Thrust-Slip Relationships for Various Tire Combinations

D1 Results for Tire Combination No. 1

Figure D 1a Experimental data and fitted curve for front thrust - front slip relationship for tire combination No. 1 (rear tires 20.8R38, front tires 16.9-26 bias)

Figure D 1b Experimental data and fitted curve for rear thrust - rear slip relationship for tire combination No. 1 (rear tires 20.8R38, front tires 16.9-26 bias)

D2 Results for Tire Combination No. 2

Figure D 2a Experimental data and fitted curve for front thrust - front slip relationship for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28)

Figure D 2b Experimental data and fitted curve for rear thrust - rear slip relationship for tire combination No. 2 (rear tires 20.8R38, front tires 13.6R28)

D3 Results for Tire Combination No. 3

Figure D 3a Experimental data and fitted curve for front thrust - front slip relationship for tire combination No. 3 (rear tires 20.8R38, front tires 16.9R28)

Figure D 3b Experimental data and fitted curve for rear thrust - rear slip relationship for tire combination No. 3 (rear tires 20.8R38, front tires 16.9R28)

D4 Results for Tire Combination No. 5

Figure D 4a Experimental data and fitted curve for front thrust - front slip relationship for tire combination No. 5 (rear tires 20.8R38, front tires 14.9R28)

Figure D 4b Experimental data and fitted curve for rear thrust - rear slip relationship for tire combination No. 5 (rear tires 20.8R38, front tires 14.9R28)

Appendix E Field Test Data

This appendix contains measured field data, data processing procedure, as well as processed data. Each 30-meter test run in the field, as well as on the pavement, was recorded as a separate data file and given an appropriate file name. These names had the following form: t_p_r_l_. For example, file name t3p1r3l1 represents data for tire combination No. 3, with pressure combination No. 1, recorded in the field section No. 3 and with drawbar load No. 1 applied. There were seven such files (for six different drawbar loads and one without drawbar load) recorded in one section of the field. Files that start with "z" (zt3p1r3a, for example) were created while the test vehicle was disengaged from the load vehicle and was stationary. These files recorded "off-set" values of the sensing instruments. Files that represent "push" tests in the field ended with "p1" or "p2" (like t3p1r3p1), while files for "push" tests on the pavement ended with "palp" (like t3p1palp). With these identifications, one set of data consists of 14 separate files, recorded in similar sequence for each section of the field (loads were changed randomly). The following example represents one complete set of data:

zt3p4r1a	→	"off-set"
t3p4r1l1	}	different drawbar loads
t3p4r1l3		
t3p4r1l5		
t3p4r1l4		
t3p4r1l6		
t3p4r1l2		
t3p4r1l0		
zt3p4r1b	→	"off-set"
t3p4r1p1	}	"push" tests in the field
t3p4r1p2		
t3p4palp	}	"push" tests on pavement
t3p4palp		
t3p4palp		

For each 30-meter run the following parameters were measured:

- hitch center [N] (drawbar load measured by drawbar load cell)
- left rear torque [Nm]
- right rear torque [Nm]
- front torque [Nm]
- hitch draft [N] (drawbar load measured by three-point hitch)
- time [sec]
- rear axle rotation [pulses] (there was 2234 pulses per one revolution)
- front axle rotation [pulses] (there was $60 \times 21.52 = 1291.2$ pulses per one revolution)
- fuel rate [l/hr]
- 5th wheel rotation [pulses]

These represent the original measured data. Based on them, the values of a number of important parameters were calculated and used in vehicle performance analysis. The calculation procedure consists of the following:

$$\text{Drawbar Load} = \text{Hitch Center} - \text{Hitch Center Offset [N]}$$

$$\text{Net Left Rear Torque} = \text{Left Rear Torque} - \text{Left Rear Torque Offset [Nm]}$$

$$\text{Net Right Rear Torque} = \text{Right Rear Torque} - \text{Right Rear Torque Offset [Nm]}$$

$$\text{Net Front Torque} = \text{Front Torque} - \text{Front Torque Offset [Nm]}$$

$$\text{Net Hitch Draft} = \text{Hitch Draft} - \text{Hitch Draft Offset [N]}$$

For these calculations, the offset values were taken from recordings in the offset files. There were two of them for each set of data and an average value was used. This was necessary due to the analog character of the sensing instruments that measured loads and

torques. For data that were collected using digital technique (time clock, counters) no correction due to the offset readings was necessary.

$$\text{Average Time} = \text{Time} + 0.01, [\text{sec}] \text{ (correction due to the previous calibration)}$$

$$\text{Average Rear Wheel Rotation} = \text{Rear Wheel Rotation}, [\text{pulses}]$$

$$\text{Rear Wheel Speed} = \frac{\text{Rear Wheel Rotation} [\text{pulses}]}{2234 * \text{Average Time} [\text{sec}]}, [\text{RPS}]$$

$$\text{Average Front Axle Rotation} = \text{Front Wheel Rotation}, [\text{pulses}]$$

$$\text{Front Axle Speed} = \frac{\text{Front Wheel Rotation} [\text{pulses}]}{60 * 21.52 * \text{Average Time} [\text{sec}]}, [\text{RPS}]$$

$$\text{Rear Wheel Rolling Radius} = \frac{30 [\text{m}]}{2 * \pi * \frac{\text{Rear Wheel Rotation} [\text{pulses}]}{2234}}, [\text{m}]$$

$$\text{Front Wheel Rolling Radius} = \frac{30 [\text{m}]}{2 * \pi * \frac{\text{Front Wheel Rotation} [\text{pulses}]}{60 * 21.52}}, [\text{m}]$$

$$\text{Rear Wheel Slip} = \left(1 - \frac{\text{Rear Wheel Rolling Radius} [\text{m}]}{\text{Rear Wheel Free Rolling Radius} [\text{m}]} \right) * 100, [\%]$$

$$\text{Front Wheel Slip} = \left(1 - \frac{\text{Front Wheel Rolling Radius} [\text{m}]}{\text{Front Wheel Free Rolling Radius} [\text{m}]} \right) * 100, [\%]$$

It is important to distinguish two terms: rolling radius and free rolling radius. Rolling radius is calculated using data measured while the test vehicle was under different drawbar loads. Free rolling radius was calculated using the same equation, but calculated using data measured while the test vehicle was pushed by the load vehicle and the tire was under free rolling condition. Free rolling radii were determined in the field (for each section, as well as average value for the whole field) and on the asphalt pavement. However, in order to

maintain highest level of precision, free rolling radius calculated for each particular section of the field was used in computations.

$$\text{Front Axle Power} = \frac{\text{Net Front Torque [Nm]} * \text{Front Axle Speed [RPS]} * 2 * \pi}{1000}, [\text{kW}]$$

$$\text{Rear Axle Power} = \frac{\text{Net Total Rear Torque [Nm]} * \text{Rear Axle Speed [RPS]} * 2 * \pi}{1000},$$

where $\text{Net Total Rear Torque} = \text{Net Right Rear Torque} + \text{Net Left Rear Torque [Nm]}$

$$\text{Drawbar Power} = (\text{Drawbar Load [N]} * \text{Actual Vehicle Speed [m/s]}) / 1000, [\text{kW}]$$

$$\text{where Actual Vehicle Speed} = \frac{30 [\text{m}]}{\text{Average Time [sec]}}, [\text{m/s}]$$

$$\text{Tractive Efficiency} = \left(\frac{\text{Drawbar Power [kW]}}{\text{Front Axle Power [kW]} + \text{Rear Axle Power [kW]}} \right) * 100, [\%]$$

$$\text{Front Thrust} = \frac{\text{Net Front Torque [Nm]}}{\text{Front Wheel Free Rolling Radius [m]}}, [\text{N}]$$

$$\text{Rear Thrust} = \frac{\text{Net Left Rear Torque} + \text{Net Right Rear Torque [Nm]}}{\text{Rear Wheel Free Rolling Radius [m]}}, [\text{N}]$$

In the above equations, free rolling radii for the front and rear tires for a particular section of the field were used in the calculations.

$$\text{Alfa} = \left(\frac{\text{Rear Thrust [N]}}{\text{Front Thrust [N]} + \text{Rear Thrust [N]}} \right) * 100, [\%]$$

$$\text{Thrust over Weight} = \frac{\text{Front Thrust [N]} + \text{Rear Thrust [N]}}{\text{Vehicle Weight [N]}}$$

where Vehicle Weight was 116,606 [N]

$$\text{Equivalent Slip} = \frac{i_f (1 - i_r) - (i_f - i_r) \cdot \alpha}{(1 - i_r) - (i_f - i_r) \cdot \alpha}, [\%]$$

where i_f is front wheel slip and i_r is rear wheel slip.

$$\text{Vehicle Speed} = \frac{30 [m]}{\text{Average Time [sec]}}, [m/s]$$

Fuel Rate [l/hr] - measured value

$$\text{Specific Fuel Consumption. (F R / D P)} = \frac{\text{Fuel Rate [l / hr]}}{\text{Drawbar Power [kW]}}, [l/hr/kW]$$

$$\text{Beta in the Field} = \frac{\text{Front Wheel Free Rolling Radius in the Field Section} / 21,52}{\text{Rear Wheel Free Rolling Radius in the Field Section} / 28,63}$$

where 21,52 is the gear ratio in the front axle differential gear box and 28,63 is the gear ratio in the rear axle differential gear box.

$$\text{Beta on Pavement} = \frac{\text{Front Wheel Free Rolling Radius on Pavement} / 21,52}{\text{Rear Wheel Free Rolling Radius on Pavement} / 28,63}$$

$$\text{Beta in the Field (Average)} = \frac{\text{Front Wheel Free Rolling Radius across Field} / 21,52}{\text{Rear Wheel Free Rolling Radius across the Field} / 28,63}$$

$$\text{Total Thrust} = \text{Front Thrust} + \text{Rear Thrust}, [N]$$

$$\text{Total Power} = \text{Front Axle Power} + \text{Rear Axle Power}, [kW]$$

$$\text{Efficiency of Motion} = \left(\frac{\text{Drawbar Load [N]}}{\text{Total Thrust [N]}} \right) * 100, [\%]$$

Results are presented in sets. Each set contains original measured data and processed data for a particular tire and inflation pressure combination. They are organized in the following order:

Tire Combination No. 1, Pressure Combinations No. 1, 2, 3

Tire Combination No. 1, Pressure Combination No. 4

Tire Combination No. 2, Pressure Combination No. 1

Tire Combination No. 2, Pressure Combination No. 2

Tire Combination No. 2, Pressure Combination No. 3

Tire Combination No. 2, Pressure Combination No. 4

Tire Combination No. 3, Pressure Combination No. 1

Tire Combination No. 3, Pressure Combination No. 2

Tire Combination No. 3, Pressure Combination No. 3

Tire Combination No. 3, Pressure Combination No. 4

Tire Combination No. 4, Pressure Combination No. 1

Tire Combination No. 4, Pressure Combination No. 2

Tire Combination No. 4, Pressure Combination No. 3

Tire Combination No. 4, Pressure Combination No. 4

Tire Combination No. 5, Pressure Combination No. 1

Tire Combination No. 5, Pressure Combination No. 2

Tire Combination No. 5, Pressure Combination No. 3

Tire Combination No. 5, Pressure Combination No. 4

Tire Combination No. 1
Pressures 1, 2, 3
Experimental Data

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File	Hitch Centre	L_Axle Torque	R_Axle Torque	Cal. Front Torque	Fuel Rate	Hitch Draft	Time [sec]	Fifth Wheel [pulses]	Rear Wheel Rotation [pulses]	Fr_Shaft Rotation [pulses]
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]				
zt1p1r1a	614	64	88	614	2.21	873	3.06	0	0	5
t1p1r1i0	639	5453	5855	-2637	11.55	926	23.01	15486	12221	9400
t1p1r1i5	70140	25747	26444	11798	30.72	71126	32.63	15468	16235	12488
t1p1r1i6	76282	27982	28757	13188	30.25	77279	39.87	15390	18496	14230
t1p1r1i4	57448	21644	22575	10097	27.23	58517	29.02	15285	14576	11213
t1p1r1i1	15103	10022	9720	43	15.01	15994	24.39	15704	12807	9851
t1p1r1i3	40996	16282	16792	7121	22.13	41922	26.16	15202	13389	10300
t1p1r1i2	32081	14336	13317	4725	19.59	32920	25.18	15280	13021	10016
zt1p1r1b	615	271	221	560	2.19	899	2.94	1	0	0
t1p1r1p1	-6781	-101	-137	444	2.25	-6559	27.32	15436	11736	9698
t1p1r1p2	-6198	-93	-133	443	9.37	-6145	27.43	15440	11733	9674
t1p1r1p3	-5128	-89	-113	434	2.15	-4889	27.64	15495	11818	9787
t1p1palp	-2614	-84	-109	440	2.19	-2394	28.13	16015	12093	9842
t1p1palp	-2418	-85	-112	441	2.21	-2219	28.2	16057	12114	9855
t1p1palp	-2594	-87	-121	443	2.21	-2411	28.08	15970	12056	9809
zt1p2r1a	582	71	16	491	2.12	751	2.85	0	0	0
t1p2r1i3	40246	15041	15914	6586	21.80	40441	25.47	15281	13087	10068
t1p2r1i6	77198	28025	29037	13038	30.34	78293	38.26	15220	17688	13608
t1p2r1i1	4227	5099	4746	-587	11.99	4386	22.99	15411	12164	9357
t1p2r1i2	32926	13269	13612	5028	19.55	33272	25.12	15397	12952	9964
t1p2r1i4	61483	22909	23168	10104	27.82	61940	28.76	15209	14431	11101
t1p2r1i5	69592	25859	26152	11935	29.98	70419	32.78	15242	16279	12522
t1p2r1i0	586	3880	3710	-693	11.12	784	22.82	15376	12114	9319
zt1p2r1b	577	193	17	564	2.14	734	2.83	0	0	0
t1p2r1p1	-6629	-132	-242	360	2.29	-6928	27.6	15657	12046	9567
t1p2r1p2	-6733	-170	-290	350	2.17	-6787	28.24	15693	12068	9576
t1p2r1p2	-5406	-122	-251	347	2.17	-5421	28.24	15765	12152	9673
t1p2palp	-2771	-185	-339	366	2.15	-2933	28.14	16011	12220	9674
t1p2palp	-2573	-178	-338	367	2.16	-2742	28.01	15956	12166	9629
t1p2palp	-2727	-180	-336	371	2.17	-2944	28.22	16055	12246	9694
zt1p3r1a	301	167	-260	418	68.54	-29	3.06	0	0	0
t1p3r1i2	35057	14320	13115	5990	20.50	34991	25.02	15358	12933	9950
t1p3r1i3	45427	18227	16494	7854	23.31	45431	26.22	15327	13341	10262
t1p3r1i6	78108	30064	29336	12945	30.55	78167	41.84	15346	19120	14709
t1p3r1i1	21821	10689	9886	2606	16.42	21670	24.42	15558	12679	9756
t1p3r1i0	291	4632	4313	-1682	11.46	-46	23.02	15696	12266	9436
t1p3r1i5	70458	26912	27029	11892	31.01	70952	34.09	15463	16899	13010
t1p3r1i4	62637	23650	23025	10527	28.10	62107	29.26	15056	14636	11259
zt1p3r1b	294	81	-242	358	2.03	-52	3.18	0	0	0
t1p3r1p1	-7186	-229	-720	180	2.11	-7887	27.58	15763	11916	9536
t1p3r1p2	-5936	-195	-660	198	8.81	-6672	29.5	15707	11955	9604
t1p3r1p3	-6862	-160	-571	249	9.22	-7587	27.93	15806	11968	9580
t1p3palp	-3192	-193	-583	286	9.42	-3770	27.1	16050	12091	9633
t1p3palp	-3009	-194	-581	286	2.20	-3477	26.86	15902	11985	9543
t1p3palp	-3190	-196	-577	287	2.10	-3692	27.46	16247	12253	9758

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File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axle Speed
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[[RPS]	[pulses]	[RPS]
zt1p1r1a	614	64	88	614	873	3.07	0	0.000	5	0.001
t1p1r1l0	24	5286	5701	-3223	40	23.02	12221	0.238	9400	0.316
t1p1r1l5	69525	25580	26289	11212	70240	32.64	16235	0.223	12488	0.296
t1p1r1l6	75668	27814	28603	12601	76393	39.88	18496	0.208	14230	0.276
t1p1r1l4	56833	21477	22420	9510	57631	29.03	14576	0.225	11213	0.299
t1p1r1l1	14488	9854	9566	-544	15108	24.4	12807	0.235	9851	0.313
t1p1r1l3	40381	16115	16637	6534	41036	26.17	13389	0.229	10300	0.305
t1p1r1l2	31467	14169	13163	4138	32034	25.19	13021	0.231	10016	0.308
zt1p1r1b	615	271	221	560	899	2.95	0	0.000	0	0.000
t1p1r1p1										
t1p1r1p2		average	values	in the	field =	27.47333	11762.33	0.192	9719.667	0.274
t1p1r1p3										
t1p1palp										
t1p1palp		average	values	on the	pavement	28.14667	12087.67	0.192	9835.333	0.271
t1p1palp										
zt1p2r1a	582	71	16	491	751	2.86	0	0.000	0	0.000
t1p2r1l3	39667	14909	15897	6059	39699	25.48	13087	0.230	10068	0.306
t1p2r1l6	76619	27892	29020	12511	77551	38.27	17688	0.207	13608	0.275
t1p2r1l1	3647	4967	4730	-1114	3643	23	12164	0.237	9357	0.315
t1p2r1l2	32347	13137	13596	4500	32530	25.13	12952	0.231	9964	0.307
t1p2r1l4	60904	22776	23152	9576	61197	28.77	14431	0.225	11101	0.299
t1p2r1l5	69013	25727	26135	11408	69677	32.79	16279	0.222	12522	0.296
t1p2r1l0	6	3747	3694	-1220	42	22.83	12114	0.238	9319	0.316
zt1p2r1b	577	193	17	564	734	2.84	0	0.000	0	0.000
t1p2r1p1										
t1p2r1p2		average	values	in the	field =	28.03667	12088.67	0.193	9605.333	0.265
t1p2r1p2										
t1p2palp										
t1p2palp		average	values	on the	pavement	28.13333	12210.67	0.194	9665.667	0.266
t1p2palp										
zt1p3r1a	301	167	-260	418	-29	3.07	0	0.000	0	0.000
t1p3r1l2	34759	14196	13366	5602	35032	25.03	12933	0.231	9950	0.308
t1p3r1l3	45130	18103	16745	7466	45472	26.23	13341	0.228	10262	0.303
t1p3r1l6	77810	29940	29587	12557	78208	41.85	19120	0.205	14709	0.272
t1p3r1l1	21524	10566	10137	2218	21711	24.43	12679	0.232	9756	0.309
t1p3r1l0	-7	4509	4564	-2070	-5	23.03	12266	0.238	9436	0.317
t1p3r1l5	70161	26788	27280	11504	70992	34.1	16899	0.222	13010	0.295
t1p3r1l4	62340	23526	23276	10139	62148	29.27	14636	0.224	11259	0.298
zt1p3r1b	294	81	-242	358	-52	3.19	0	0.000	0	0.000
t1p3r1p1										
t1p3r1p2		average	values	in the	field =	28.34667	11946.33	0.189	9573.333	0.262
t1p3r1p3										
t1p3palp										
t1p3palp		average	values	on the	pavement	27.15	12109.67	0.200	9644.667	0.275
t1p3palp										

Tire Combination No. 1
Pressures 1, 2, 3

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R Wheel RRadius [m]	R Wheel Slip [%]	F Wheel RRadius [m]	F Wheel Slip [%]	F Axle Power [kW]	R Axle Power [kW]	Drawbar Power_A [kW]	Tractive Eff_A [%]	Front Thrust [N]	Rear Thrust [N]	Alfa (RTh/TTh) [%]
				0.005	0.000					
0.8728	3.75	0.6559	-3.40	-6.405	16.404	0.032	0.32	-5082	12115	172.26
0.6570	27.55	0.4937	22.17	20.873	72.561	63.902	68.39	17676	57197	76.39
0.5767	36.41	0.4332	31.70	21.879	73.592	56.922	59.62	19866	62213	75.80
0.7318	19.30	0.5498	13.32	17.874	61.990	58.732	73.54	14993	48407	76.35
0.8329	8.16	0.6258	1.33	-1.069	28.669	17.813	64.54	-858	21415	104.17
0.7967	12.15	0.5985	5.63	12.514	47.128	46.291	77.61	10301	36117	77.81
0.8192	9.67	0.6155	2.96	8.007	39.735	37.475	78.49	6524	30139	82.20
				0.000	0.000					
0.9068		0.6343								
0.8824		0.6268								
				0.000	0.000					
0.8151	7.63	0.6123	4.60	11.650	44.502	46.703	83.17	9440	34914	78.72
0.6030	31.66	0.4530	29.41	21.647	73.982	60.062	62.81	19492	64500	76.79
0.8769	0.62	0.6589	-2.65	-2.206	14.423	4.757	38.94	-1736	10989	118.77
0.8235	6.67	0.6187	3.60	8.683	38.751	38.616	81.41	7012	30297	81.21
0.7391	16.23	0.5554	13.47	17.981	64.793	63.508	76.72	14920	52051	77.72
0.6552	25.74	0.4923	23.29	21.199	72.416	63.141	67.45	17773	58777	76.78
0.8805	0.21	0.6616	-3.07	-2.424	11.105	0.008	0.09	-1901	8433	129.10
				0.000	0.000					
0.8824		0.6418								
0.8735		0.6378								
				0.000	0.000					
0.8248	7.63	0.6196	3.79	10.837	40.055	41.661	81.86	8699	30870	78.01
0.7995	10.45	0.6008	6.71	14.214	49.851	51.616	80.57	11594	39030	77.10
0.5579	37.52	0.4191	34.92	21.476	76.490	55.778	56.94	19499	66670	77.37
0.8413	5.78	0.6319	1.87	4.311	30.220	26.431	76.55	3445	23187	87.07
0.8696	2.61	0.6534	-1.46	-4.128	13.591	-0.009	-0.09	-3215	10162	146.28
0.6312	29.31	0.4739	26.42	21.357	75.361	61.725	63.82	17863	60556	77.22
0.7288	18.38	0.5476	14.97	18.978	65.822	63.894	75.35	15744	52418	76.90
				0.000	0.000					
0.8929		0.6440								
0.8808		0.6392								

Tire Combination No. 1
Pressures 1, 2, 3

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Thrust over Weight	Equivalent Slip [%]	Vehicle Speed [m/s]	Fuel Rate [l/h]	F_R/D_P case A [l/h/kw]	Beta (field)	Beta (pavement)	1-eq.slip	Total Power [kW]	Total Thrust [N]	Efficiency of Motion [%]
			2.21							
0.0603	2.27	1.303	11.55	364.8154	0.9305	0.9450	0.9773	9.999	7033	0.35
0.6421	26.05	0.919	30.72	0.4808	0.9305	0.9450	0.7395	93.435	74873	92.86
0.7039	35.14	0.752	30.25	0.5313	0.9305	0.9450	0.6486	95.471	82078	92.19
0.5437	17.42	1.033	27.23	0.4636	0.9305	0.9450	0.8258	79.864	63399	89.64
0.1763	50.36	1.230	15.01	0.8428	0.9305	0.9450	0.4964	27.599	20557	70.48
0.3981	9.50	1.146	22.13	0.4780	0.9305	0.9450	0.9050	59.642	46418	87.00
0.3144	6.38	1.191	19.59	0.5229	0.9305	0.9450	0.9362	47.743	36664	85.82
			2.19							
			2.25							
			9.37							
			2.15							
			2.19							
			2.21							
			2.21							
			2.12							
0.3804	6.62	1.177	21.80	0.4668	0.9677	0.9714	0.9338	56.152	44353	89.43
0.7203	31.10	0.784	30.34	0.5052	0.9677	0.9714	0.6890	95.629	83992	91.22
0.0793	0.67	1.304	11.99	2.5199	0.9677	0.9714	0.9933	12.217	9253	39.42
0.3200	5.64	1.194	19.55	0.5062	0.9677	0.9714	0.9436	47.434	37308	86.70
0.5743	15.52	1.043	27.82	0.4381	0.9677	0.9714	0.8448	82.774	66972	90.94
0.6565	25.13	0.915	29.98	0.4748	0.9677	0.9714	0.7487	93.615	76550	90.15
0.0560	0.36	1.314	11.12	1366.154	0.9677	0.9714	0.9964	8.681	6532	0.09
			2.14							
			2.29							
			2.17							
			2.17							
			2.15							
			2.16							
			2.17							
			68.54							
0.3393	6.09	1.199	20.50	0.4920	0.9595	0.9655	0.9391	50.892	39569	87.84
0.4341	9.22	1.144	23.31	0.4517	0.9595	0.9655	0.9078	64.065	50623	89.15
0.7390	36.90	0.717	30.55	0.5477	0.9595	0.9655	0.6310	97.966	86168	90.30
0.2284	4.03	1.228	16.42	0.6212	0.9595	0.9655	0.9597	34.530	26631	80.82
0.0596	1.91	1.303	11.46	-1283.5	0.9595	0.9655	0.9809	9.463	6947	-0.10
0.6725	28.59	0.880	31.01	0.5024	0.9595	0.9655	0.7141	96.719	78419	89.47
0.5845	17.45	1.025	28.10	0.4398	0.9595	0.9655	0.8255	84.799	68162	91.46
			2.03							
			2.11							
			8.81							
			9.22							
			9.42							
			2.20							
			2.10							

File	Hitch Centre	L_Axle Torque	R_Axle Torque	Cal. Front Torque	Fuel Rate	Hitch Draft	Time [sec]	Fifth Wheel [pulses]	Rear Wheel Rotation [pulses]	Fr_Shaft Rotation [pulses]
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]				
zt1p4r1a	511	116	-124	451	61.62	-39	3.41	0	0	0
t1p4r1l0	532	1890	1662	1615	11.36	-20	22.87	15431	12111	9316
t1p4r1l6	77598	29218	28269	12641	30.86	77753	36.2	15416	17103	13156
t1p4r1l5	70958	27185	26354	11623	30.66	71344	32.4	15282	16044	12342
t1p4r1l2	32084	12319	12371	5802	18.73	32115	24.38	15263	12592	9686
t1p4r1l1	10373	5037	4676	3014	13.07	10260	23.14	15328	12188	9377
t1p4r1l4	61502	23737	22384	10711	27.80	61787	29.24	15475	14643	11264
t1p4r1l3	40652	15929	14804	7525	21.60	40797	25.42	15451	13064	10050
zt1p4r1b	512	124	-84	506	2.21	-42	3.22	0	0	0
t1p4r1p1	-6445	-376	-634	475	9.44	-7027	27.16	15724	12194	9368
t1p4r1p1	-5524	-371	-630	497	2.26	-6214	26.95	15651	12133	9319
t1p4r1p3	-5714	-319	-574	476	2.15	-5959	28.13	15879	12273	9440
t1p4palp	-3328	-284	-526	460	2.06	-3408	26.96	15914	12197	9394
t1p4palp	-3126	-281	-521	455	2.20	-3130	27.26	16089	12338	9503
t1p4palp	-3344	-278	-524	460	2.15	-3353	27.07	15999	12258	9443

[illegible]

Thrust over Weight	Equivalent Slip [%]	Vehicle Speed [m/s]	Fuel Rate [l/h]	F_R/D_P case A [l/h/kw]	Beta (field)	Beta (pavement)	1-eq.slip	Total Power [kW]	Total Thrust [N]	Efficiency of Motion [%]
			61.62							
0.0495	-0.71	1.311	11.36	425.8454	1.0006	0.9983	1.0071	7.517	5773	0.35
0.7223	28.68	0.829	30.86	0.4832	1.0006	0.9983	0.7132	97.849	84229	91.52
0.6703	23.98	0.926	30.66	0.4702	1.0006	0.9983	0.7602	95.172	78167	90.12
0.3115	3.13	1.230	18.73	0.4823	1.0006	0.9983	0.9687	46.117	36318	86.93
0.1282	-0.07	1.296	13.07	1.0230	1.0006	0.9983	1.0007	19.356	14947	65.98
0.5857	16.70	1.026	27.80	0.4445	1.0006	0.9983	0.8330	84.091	68295	89.30
0.3932	6.64	1.180	21.60	0.4561	1.0006	0.9983	0.9336	57.932	45848	87.55
			2.21							
			9.44							
			2.26							
			2.15							
			2.06							
			2.20							
			2.15							

Tire Combination No. 2
Pressure 1
Experimental Data

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File	Hitch	L_Axle	R_Axle	Cal. Front	Fuel_Rate	Hitch	Time	Fifth	Rear Wheel	Fr. Shaft
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zat2p1r1	343	-8	-35	513	63.68	652	3.29	0	0	0
t2p1r1i2	26831	13004	12744	3134	18.85	27557	25.26	15459	13177	10138
t2p1r1i4	57269	22328	22769	9903	28.01	58185	30.56	15268	15570	11977
t2p1r1i1	12891	9619	9579	-425	15.22	13493	24.11	15556	12725	9789
t2p1r1i5	64845	24162	25184	11271	30.09	65682	32.9	15358	16730	12869
t2p1r1i3	39184	16246	16478	6266	21.90	40158	26.62	15409	13661	10509
t2p1r1i6	72480	27585	28234	12377	31.13	73116	43.67	15245	21199	16307
t2p1r1i0	314	5723	5843	-3127	11.55	678	23.31	15762	12400	9538
zat2p1r1	343	-8	-35	513	63.68	652	3.29	0	0	0
t2p1r1p1	-7943	-421	-453	335	8.67	-7922	28.77	15934	11991	9952
t2p1r1p2	-7896	-406	-430	341	8.51	-7820	28.06	15879	11927	9917
t2p1r1p3	-8198	-414	-384	344	8.49	-8125	28.15	15950	11986	10000
t2p1palp	-2989	-168	-451	263	2.16	-3333	27.35	16027	12052	10026
t2p1palp	-2784	-157	-457	264	2.21	-3140	27.35	16025	12055	10030
t2p1palp	-3014	-170	-459	265	2.24	-3370	27.65	16202	12180	10133
zbt2p1r2	356	-15	-47	517	2.28	644	4.09	0	0	0
t2p1r2i3	43409	18908	17341	7041	23.55	43854	27.16	15256	13801	10616
t2p1r2i2	29177	15162	13332	2730	19.52	29316	25.63	15460	13262	10202
t2p1r2i0	62	7059	5560	-3561	11.91	-291	23.28	15726	12330	9485
t2p1r2i6	74959	29143	27139	12222	31.68	75082	38.25	15255	18732	14409
t2p1r2i5	69838	27844	25792	11722	31.29	70463	35.4	15301	17709	13623
t2p1r2i4	57293	22952	21279	9317	26.93	57812	29.38	15333	14784	11372
t2p1r2i1	12180	10285	9789	-1372	14.70	12307	24.19	15740	12739	9799
zbt2p1r2	356	-15	-47	517	2.28	644	4.09	0	0	0
t2p1r2p1	-7672	-336	-789	179	8.40	-8154	27.61	15734	11836	9905
t2p1r2p2	-8229	-398	-869	146	8.70	-9142	27.69	15855	11876	9921
t2p1palp	-2989	-168	-451	263	2.16	-3333	27.35	16027	12052	10026
t2p1palp	-2784	-157	-457	264	2.21	-3140	27.35	16025	12055	10030
t2p1palp	-3014	-170	-459	265	2.24	-3370	27.65	16202	12180	10133
zat2p1r3	258	136	-134	392	8.06	193	3.38	0	0	0
t2p1r3i3	43110	18232	17708	6041	22.75	43652	26.89	15543	13715	10550
t2p1r3i1	12840	10293	9693	-1817	14.30	13000	24.12	15633	12688	9760
t2p1r3i5	69625	27287	25087	11194	30.17	70209	33.92	15370	16868	12978
t2p1r3i2	28509	14155	14165	2279	18.45	28780	25.34	15530	13117	10090
t2p1r3i6	74080	29320	26992	12622	30.87	74103	44.11	14949	21212	16317
t2p1r3i4	58008	23046	22288	10218	27.03	58402	30.38	15078	15211	11702
t2p1r3i0	260	6644	6274	-2834	11.68	221	23.43	15706	12407	9544
zat2p1r3	258	136	-134	392	8.06	193	3.38	0	0	0
t2p1r3p1	-6351	-283	-683	196	8.43	-6806	28.02	15335	11889	9956
t2p1r3p2	-8346	3553	3163	-4814	8.81	-8893	28.28	15953	12328	9485
t2p1palp	-2989	-168	-451	263	2.16	-3333	27.35	16027	12052	10026
t2p1palp	-2784	-157	-457	264	2.21	-3140	27.35	16025	12055	10030
t2p1palp	-3014	-170	-459	265	2.24	-3370	27.65	16202	12180	10133

File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axle Speed	R Wheel Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zat2p1r1	343	-8	-35	513	652	3.3	0	0.000	0	0.000	
t2p1r1i2	26488	13012	12779	2621	26905	25.27	13177	0.233	10138	0.311	0.8095
t2p1r1i4	56926	22336	22803	9390	57533	30.57	15570	0.228	11977	0.303	0.6851
t2p1r1i1	12548	9626	9614	-937	12841	24.12	12725	0.236	9789	0.314	0.8382
t2p1r1i5	64502	24170	25219	10758	65030	32.91	16730	0.228	12869	0.303	0.6376
t2p1r1i3	38840	16254	16513	5753	39506	26.63	13661	0.230	10509	0.306	0.7808
t2p1r1i6	72136	27592	28268	11864	72464	43.68	21199	0.217	16307	0.289	0.5032
t2p1r1i0	-29	5731	5878	-3639	26	23.32	12400	0.238	9538	0.317	0.8602
zat2p1r1	343	-8	-35	513	652	3.3	0	0.000	0	0.000	
t2p1r1p1	average	values	across	the field =			11976.14		9876.571		0.8907
t2p1r1p2	average	values	within the	section =	28.33667		11968	0.189	9956.333	0.272	0.8913
t2p1r1p3											
t2p1palp											
t2p1palp	average	values	on the	pavement	27.46	12095.67	0.197	10063	0.284	0.8819	
t2p1palp											
zbt2p1r2	356	-15	-47	517	644	4.1	0	0.000	0	0.000	
t2p1r2i3	43053	18924	17388	6524	43210	27.17	13801	0.227	10616	0.303	0.7729
t2p1r2i2	28821	15177	13379	2213	28672	25.64	13262	0.232	10202	0.308	0.8043
t2p1r2i0	-294	7074	5607	-4078	-935	23.29	12330	0.237	9485	0.315	0.8651
t2p1r2i6	74603	29158	27186	11705	74438	38.26	18732	0.219	14409	0.292	0.5694
t2p1r2i5	69482	27860	25840	11205	69819	35.41	17709	0.224	13623	0.298	0.6023
t2p1r2i4	56937	22967	21326	8800	57168	29.39	14784	0.225	11372	0.300	0.7215
t2p1r2i1	11824	10300	9836	-1889	11664	24.2	12739	0.236	9799	0.314	0.8373
zbt2p1r2	356	-15	-47	517	644	4.1	0	0.000	0	0.000	
t2p1r2p1	average	values	across	the field =			11976.14		9876.571		0.8907
t2p1r2p2	average	values	within the	section =	27.66		11856	0.192	9913	0.278	0.8997
t2p1palp											
t2p1palp	average	values	on the	pavement	27.46	12095.67	0.197	10063	0.284	0.8819	
t2p1palp											
zat2p1r3	258	136	-134	392	193	3.39	0	0.000	0	0.000	
t2p1r3i3	42851	18096	17842	5649	43459	26.9	13715	0.228	10550	0.304	0.7777
t2p1r3i1	12582	10157	9827	-2209	12807	24.13	12688	0.235	9760	0.313	0.8407
t2p1r3i5	69367	27151	25220	10802	70016	33.93	16868	0.223	12978	0.296	0.6324
t2p1r3i2	28251	14019	14299	1887	28587	25.35	13117	0.232	10090	0.308	0.8132
t2p1r3i6	73821	29184	27125	12230	73911	44.12	21212	0.215	16317	0.286	0.5029
t2p1r3i4	57750	22909	22422	9826	58209	30.39	15211	0.224	11702	0.298	0.7012
t2p1r3i0	2	6508	6408	-3226	28	23.44	12407	0.237	9544	0.315	0.8597
zat2p1r3	258	136	-134	392	193	3.39	0	0.000	0	0.000	
t2p1r3p1	average	values	across	the field =			11976.14		9876.571		0.8907
t2p1r3p2	average	values	within the	section =	28.16		12108.5	0.192	9720.5	0.267	0.8809
t2p1palp											
t2p1palp	average	values	on the	pavement	27.46	12095.67	0.197	10063	0.284	0.8819	
t2p1palp											

[illegible]

Tire Combination No. 2
Pressure 1

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]				av RRradius	[N]	[kW]	[%]
	63.68								
1.187	18.85	0.600	0.9243	0.9243	0.9324	0.9527	33170	42.941	79.85
0.981	28.01	0.501	0.9243	0.9243	0.9324	0.7871	65811	82.563	86.50
1.244	15.22	0.975	0.9243	0.9243	0.9324	0.9492	20074	26.698	62.51
0.912	30.09	0.512	0.9243	0.9243	0.9324	0.7320	72790	91.087	88.61
1.127	21.90	0.500	0.9243	0.9243	0.9324	0.9048	46057	58.325	84.33
0.687	31.13	0.628	0.9243	0.9243	0.9324	0.5763	81836	97.802	88.15
1.286	11.55	-308.467	0.9243	0.9243	0.9324	0.9787	7147	10.117	-0.41
	63.68								
	8.67								
	8.51								
	8.49								
	2.16								
	2.21								
	2.24								
	2.28								
1.104	23.55	0.495	0.9196	0.9243	0.9324	0.8872	50853	64.282	84.66
1.170	19.52	0.579	0.9196	0.9243	0.9324	0.9227	35299	45.828	81.65
1.288	11.91	-31.472	0.9196	0.9243	0.9324	0.9777	7538	10.801	-3.90
0.784	31.68	0.542	0.9196	0.9243	0.9324	0.6474	81449	99.038	91.59
0.847	31.29	0.531	0.9196	0.9243	0.9324	0.6852	77704	96.510	89.42
1.021	26.93	0.463	0.9196	0.9243	0.9324	0.8238	63383	79.235	89.83
1.240	14.70	1.003	0.9196	0.9243	0.9324	0.9526	19344	26.090	61.12
	2.28								
	8.40								
	8.70								
	2.16								
	2.21								
	2.24								
	8.06								
1.115	22.75	0.476	0.9578	0.9243	0.9324	0.8927	49703	62.314	86.22
1.243	14.30	0.914	0.9578	0.9243	0.9324	0.9743	19202	25.205	65.52
0.884	30.17	0.492	0.9578	0.9243	0.9324	0.7255	76483	93.332	90.70
1.183	18.45	0.552	0.9578	0.9243	0.9324	0.9307	35121	44.865	80.44
0.680	30.87	0.615	0.9578	0.9243	0.9324	0.5769	83204	98.151	88.72
0.987	27.03	0.474	0.9578	0.9243	0.9324	0.8053	66952	82.226	86.26
1.280	11.68	4641.800	0.9578	0.9243	0.9324	0.9822	9575	12.835	0.02
	8.06								
	8.43								
	8.81								
	2.16								
	2.21								
	2.24								

Tire Combination No. 2
Pressure 2
Experimental Data

125

File	Hitch Centre	L_Axle Torque	R_Axle Torque	Cal. Front Torque	Fuel_Rate	Hitch Draft	Time	Fifth Wheel	Rear Wheel Rotation	Fr_Shaft Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt2p2r1b	833	64	282	613	8.64	1855	4.07	0	0	0
t2p2r1l2	28380	14101	13125	2846	19.29	30144	25.11	15470	13070	10055
t2p2r1l6	75797	28389	27719	12598	30.63	77444	40.21	15279	19096	14691
t2p2r1l5	69732	25414	26350	11297	30.14	71336	32.17	15246	16030	12331
t2p2r1l4	56622	21363	21284	8995	25.52	58039	29.42	15428	14599	11231
t2p2r1l3	41440	16846	17841	5073	21.87	43186	25.89	15261	13277	10214
t2p2r1l0	837	4842	5227	-2572	10.76	1891	23.28	15636	12398	9537
t2p2r1l4	56622	21363	21284	8995	25.52	58039	29.42	15428	14599	11231
zt2p2r1	839	79	301	606	8.05	1852	2.64	0	0	0
t2p2r1p1	-7406	2516	2611	-3222	2.30	-6585	29.04	16055	12464	9588
t2p2r1p2	-6446	-316	-44	546	2.24	-5563	28.44	15943	12352	10069
t2p2palp	-2874	-260	-250	359	9.54	-3094	27.42	16031	12255	10018
t2p2palp	-2753	-253	-256	357	2.26	-2912	27.51	16085	12303	10056
t2p2palp	-2972	-262	-258	355	9.26	-3174	27.83	16281	12434	10166
zt2p2r2a	570	-219	77	616	7.83	975	3.4	0	0	0
t2p2r2l1l6	77631	29634	28348	12867	29.47	79564	43.05	15155	19499	14999
t2p2r2l1l2	29706	14426	14738	2327	18.90	30750	25.16	15414	12985	9989
t2p2r2l1l5	68913	25755	24967	10836	29.39	70037	31.85	15262	15846	12190
t2p2r2l3	42159	18032	17130	5788	22.28	43489	26.66	15451	13588	10454
t2p2r2l1	11089	8921	8623	-977	13.86	11755	23.79	15599	12597	9690
t2p2r2l4	58661	22933	21998	9073	26.90	59680	28.98	15438	14633	11257
t2p2r2l0	585	5408	5532	-2555	11.11	1237	23.59	15545	12361	9508
zt2p2r2b	568	-224	66	612	8.35	1092	4.1	0	0	0
t2p2r2p1	-7717	-237	-138	436	9.23	-7429	28.18	15770	12153	9864
t2p2r2p2	-7314	-436	-167	422	2.08	-7132	28.21	15922	12235	9956
t2p2palp	-2874	-260	-250	359	9.54	-3094	27.42	16031	12255	10018
t2p2palp	-2753	-253	-256	357	2.26	-2912	27.51	16085	12303	10056
t2p2palp	-2972	-262	-258	355	9.26	-3174	27.83	16281	12434	10166
zt2p2r3a	493	-135	-41	522	8.01	1121	3.34	0	0	1
t2p2r3l3	41259	16781	16327	5486	21.33	42324	26.65	15581	13698	10536
t2p2r3l5	68861	24145	27737	11093	29.97	69963	33.02	15216	16419	12631
t2p2r3l6	73845	26336	27495	11837	30.20	75214	35.96	15348	17506	13468
t2p2r3l1	10761	8630	8842	-1824	13.51	11794	23.82	15486	12563	9664
t2p2r3l2	30017	14459	14757	2553	19.08	31375	25.05	15339	12988	9991
t2p2r3l0	501	5401	5374	-2488	11.35	1141	23.49	15815	12495	9614
t2p2r3l4	56957	22350	21162	8969	26.31	57586	28.46	15055	14409	11083
zt2p2r3b	488	-114	-26	514	8.46	1108	3.2	0	0	0
t2p2r3p1	-5419	-350	-211	379	9.23	-4892	27.97	15719	12151	9928
t2p2r3p2	-5352	-275	-225	376	2.25	-5240	27.97	15851	12239	9988
t2p2palp	-2874	-260	-250	359	9.54	-3094	27.42	16031	12255	10018
t2p2palp	-2753	-253	-256	357	2.26	-2912	27.51	16085	12303	10056
t2p2palp	-2972	-262	-258	355	9.26	-3174	27.83	16281	12434	10166

File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axle Speed	R Wheel R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt2p2r1b	833	64	282	613	1855	4.08	0	0.000	0	0.000	
t2p2r1i2	27544	14029	12833	2237	28291	25.12	13070	0.233	10055	0.310	0.8161
t2p2r1i6	74961	28317	27428	11989	75591	40.22	19096	0.213	14691	0.283	0.5586
t2p2r1i5	68897	25342	26058	10687	69483	32.18	16030	0.223	12331	0.297	0.6654
t2p2r1i4	55786	21292	20992	8385	56186	29.43	14599	0.222	11231	0.296	0.7306
t2p2r1i3	40604	16774	17550	4463	41333	25.9	13277	0.229	10214	0.305	0.8034
t2p2r1i0	1	4771	4936	-3182	37	23.29	12398	0.238	9537	0.317	0.8603
t2p2r1i4	55786	21292	20992	8385	56186	29.43	14599	0.222	11231	0.296	0.7306
zt2p2r1	839	79	301	606	1852	2.65	0	0.000	0	0.000	
t2p2r1p1	average	values	across	the field =			12265.67		9898.833		0.8696
t2p2r1p2	average	values	within the	section =	28.75	12408		0.193	9828.5	0.265	0.8597
t2p2palp	average	values	on the	pavement	27.59667	12330.67		0.200	10080	0.283	0.8650
t2p2palp											
zt2p2r2a	570	-219	77	616	975	3.41	0	0.000	0	0.000	
t2p2r2i16	77062	29856	28277	12253	78530	43.06	19499	0.203	14999	0.270	0.5470
t2p2r2i12	29137	14648	14666	1713	29716	25.17	12985	0.231	9989	0.307	0.8215
t2p2r2i15	68344	25976	24895	10222	69003	31.86	15846	0.223	12190	0.296	0.6731
t2p2r2i3	41591	18253	17058	5174	42455	26.67	13588	0.228	10454	0.304	0.7850
t2p2r2i1	10521	9143	8552	-1591	10721	23.8	12597	0.237	9690	0.315	0.8468
t2p2r2i4	58092	23155	21926	8459	58646	28.99	14633	0.226	11257	0.301	0.7289
t2p2r2i0	17	5629	5460	-3169	203	23.6	12361	0.234	9508	0.312	0.8629
zt2p2r2b	568	-224	66	612	1092	4.11	0	0.000	0	0.000	
t2p2r2p1	average	values	across	the field =			12265.67		9898.833		0.8696
t2p2r2p2	average	values	within the	section =	28.205	12194		0.194	9910	0.272	0.8747
t2p2palp	average	values	on the	pavement	27.59667	12330.67		0.200	10080	0.283	0.8650
t2p2palp											
zt2p2r3a	493	-135	-41	522	1121	3.35	0	0.000	1	0.000	
t2p2r3i3	40768	16906	16360	4968	41209	26.66	13698	0.230	10536	0.306	0.7787
t2p2r3i5	68370	24270	27771	10575	68849	33.03	16419	0.223	12631	0.296	0.6496
t2p2r3i6	73354	26461	27529	11319	74099	35.97	17506	0.218	13468	0.290	0.6093
t2p2r3i1	10270	8755	8876	-2343	10680	23.83	12563	0.236	9664	0.314	0.8490
t2p2r3i2	29527	14583	14791	2035	30261	25.06	12988	0.232	9991	0.309	0.8213
t2p2r3i0	11	5526	5408	-3006	27	23.5	12495	0.238	9614	0.317	0.85

[illegible]

Tire Combination No. 2
Pressure 2

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Tractive	Vehicle	Fuel	F. R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Eff. A	Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[%]	[m/s]	[l/h]	[l/h/kw]			av RRadius		[N]	[kW]	[%]
		8.64								
84.11	1.194	19.29	0.586	0.9707	0.9406	0.9528	0.9570	34814	43.667	79.12
75.55	0.746	30.63	0.548	0.9707	0.9406	0.9528	0.6544	83959	95.748	89.28
89.72	0.932	30.14	0.469	0.9707	0.9406	0.9528	0.7796	76830	91.941	89.67
96.95	1.019	25.52	0.449	0.9707	0.9406	0.9528	0.8562	62555	74.565	89.18
95.57	1.158	21.87	0.465	0.9707	0.9406	0.9528	0.9418	47043	58.052	86.31
0.01	1.288	10.76	8302.335	0.9707	0.9406	0.9528	0.9968	6219	8.193	0.02
96.95	1.019	25.52	0.449	0.9707	0.9406	0.9528	0.8562	62555	74.565	89.18
		8.05								
		2.30								
		2.24								
		9.54								
		2.26								
		9.26								
		0.00								
		7.83								
73.44	0.697	29.47	0.549	0.9462	0.9406	0.9528	0.6341	86154	94.808	89.45
90.62	1.192	18.90	0.544	0.9462	0.9406	0.9528	1.0451	36265	45.841	80.34
91.64	0.942	29.39	0.457	0.9462	0.9406	0.9528	0.7808	74588	90.194	91.63
93.89	1.125	22.28	0.476	0.9462	0.9406	0.9528	0.9132	48685	60.469	85.43
50.28	1.261	13.86	1.045	0.9462	0.9406	0.9528	0.9723	17671	23.189	59.54
95.24	1.035	26.90	0.448	0.9462	0.9406	0.9528	0.8462	65135	79.984	89.19
0.13	1.271	11.11	521.904	0.9462	0.9406	0.9528	0.9880	7584	10.124	0.22
		8.35								
		9.23								
		2.08								
		9.54								
		2.26								
		9.26								
		8.01								
97.10	1.125	21.33	0.465	0.9417	0.9406	0.9528	0.9078	46057	57.626	88.52
86.60	0.908	29.97	0.483	0.9417	0.9406	0.9528	0.7546	76578	92.435	89.28
83.99	0.834	30.20	0.494	0.9417	0.9406	0.9528	0.7076	80009	94.525	91.68
49.41	1.259	13.51	1.045	0.9417	0.9406	0.9528	0.9756	16373	21.519	62.72
67.43	1.197	19.08	0.540	0.9417	0.9406	0.9528	0.7690	36871	46.766	80.08
0.08	1.277	11.35	837.375	0.9417	0.9406	0.9528	0.9823	7646	10.367	0.14
97.34	1.054	26.31	0.442	0.9417	0.9406	0.9528	0.8620	63578	78.172	88.81
		8.46								
		9.23								
		2.25								
		9.54								
		2.26								
		9.26								

Pressure 3
Experimental Data

File	Hitch	L_Axle	R_Axle	Cal. Front	Fuel_Rate	Hitch	Time	Fifth	Rear Wheel	Fr_Shift
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt2p3r1a	400	26	-63	468	7.97	523	3.53	0	0	0
t2p3r1i2	29320	12414	14445	3192	18.43	29924	25.17	15521	13051	10041
t2p3r1i3	42433	16670	18083	6203	22.14	43581	26.57	15430	13591	10454
t2p3r1i5	68358	25203	26476	11050	29.56	68711	33.57	15422	16704	12851
t2p3r1i4	56477	21665	22067	9357	26.07	57176	29.89	15186	15006	11544
t2p3r1i1	11855	7769	8145	417	14.09	12443	23.85	15637	12599	9691
t2p3r1i0	399	3737	3481	-791	10.60	540	23.35	15270	12391	9534
t2p3r1i6	71463	26852	27086	12018	30.98	71530	39.94	15269	19748	15193
zt2p3r1b	403	27	-58	474	2.15	510	3.62	0	0	0
t2p3r1p1	-8126	-216	-374	373	2.05	-8199	28.63	16005	12269	9739
t2p3r1p2	-8422	-241	-404	367	1.99	-8590	28.55	15967	12198	9711
t2p3palp	-2930	-237	-420	290	2.26	-3229	26.99	15999	12219	9889
t2p3palp	-2734	-242	-425	288	2.33	-3032	27.15	16098	12296	9946
t2p3palp	-3013	-231	-423	285	9.34	-3276	27.5	16301	12448	10069
zt2p3r2a	315	55	-82	531	8.00	253	2.84	0	0	0
t2p3r2i0	315	4799	4542	-1533	11.23	240	23.3	15706	12378	9522
t2p3r2i6	75193	29268	27662	12263	30.69	75072	39.61	15154	18919	14555
t2p3r2i5	66317	25996	24806	10503	26.48	66461	36.58	15350	16127	12409
t2p3r2i1	11907	8313	8772	363	14.03	12494	23.93	15649	12624	9711
t2p3r2i3	41458	17344	17308	5773	22.09	42255	26.35	15465	13525	10405
t2p3r2i2	29645	14164	13914	3525	18.90	30208	25.24	15554	13098	10076
t2p3r2i4	57163	22241	22068	8789	26.40	57778	28.75	15411	14525	11173
zt2p3r2b	308	55	-80	523	8.58	256	3.19	0	0	0
t2p3r2p1	-7987	-211	-378	328	2.01	-8348	27.82	15659	12079	9645
t2p3r2p2	-6374	-177	-336	325	2.20	-6587	27.99	15704	12181	9749
t2p3palp	-2930	-237	-420	290	2.26	-3229	26.99	15999	12219	9889
t2p3palp	-2734	-242	-425	288	2.33	-3032	27.15	16098	12296	9946
t2p3palp	-3013	-231	-423	285	9.34	-3276	27.5	16301	12448	10069
zt2p3r3a	370	112	-81	535	2.06	537	2.45	0	0	0
t2p3r3i2	31086	14477	12825	3231	18.65	31763	25.22	15375	13097	10075
t2p3r3i4	58893	22176	23356	9151	26.88	59316	29.57	15513	14891	11455
t2p3r3i6	74844	28176	27214	11920	30.53	75077	37.67	15351	18248	14038
t2p3r3i3	40198	16930	15928	5384	21.31	40764	26.43	15510	13625	10482
t2p3r3i5	68916	27728	25068	11569	30.49	69129	34.09	15069	17003	13079
t2p3r3i0	351	4637	4636	-1171	10.97	525	23.38	15813	12473	9595
t2p3r3i1	12057	8893	8082	-16	14.18	12517	23.97	15760	12640	9727
zt2p3r3b	373	112	-76	529	2.09	536	3.3	0	0	0
t2p3r3p1	-5717	-176	-361	318	2.19	-5980	27.97	15877	12143	9781
t2p3r3p2	-8278	-215	-408	307	2.13	-8473	28.02	15821	12215	9725
t2p3palp	-2930	-237	-420	290	2.26	-3229	26.99	15999	12219	9889
t2p3palp	-2734	-242	-425	288	2.33	-3032	27.15	16098	12296	9946
t2p3palp	-3013	-231	-423	285	9.34	-3276	27.5	16301	12448	10069

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt2p3r1a	400	26	-63	468	523	3.54	0	0.000	0	0.000	
t2p3r1i2	28918	12387	14505	2721	29408	25.18	13051	0.232	10041	0.309	0.8173
t2p3r1i3	42031	16644	18143	5732	43064	26.58	13591	0.229	10454	0.305	0.7848
t2p3r1i5	67956	25176	26536	10579	68194	33.58	16704	0.223	12851	0.296	0.6386
t2p3r1i4	56075	21639	22127	8887	56659	29.9	15006	0.225	11544	0.299	0.7108
t2p3r1i1	11453	7742	8205	-53	11927	23.86	12599	0.236	9691	0.315	0.8466
t2p3r1i0	-2	3711	3541	-1262	23	23.36	12391	0.237	9534	0.316	0.8608
t2p3r1i6	71062	26825	27147	11548	71013	39.95	19748	0.221	15193	0.295	0.5401
zt2p3r1b	403	27	-58	474	510	3.63	0	0.000	0	0.000	
t2p3r1p1	average	values	across	the field =			12180.83		9725		0.8757
t2p3r1p2	average	values	within the	section =		28.6	12233.5	0.191	9725	0.263	0.8719
t2p3palp											
t2p3palp	average	values	on the	pavement	27.22333		12321	0.203	9968	0.284	0.8657
t2p3palp											
zt2p3r2a	315	55	-82	531	253	2.85	0	0.000	0	0.000	
t2p3r2i0	4	4744	4623	-2060	-15	23.31	12378	0.238	9522	0.316	0.8617
t2p3r2i6	74882	29213	27744	11736	74818	39.62	18919	0.214	14555	0.285	0.5638
t2p3r2i5	66005	25941	24887	9976	66207	36.59	16127	0.197	12409	0.263	0.6614
t2p3r2i1	11595	8258	8853	-163	12240	23.94	12624	0.236	9711	0.314	0.8449
t2p3r2i3	41147	17289	17390	5247	42000	26.36	13525	0.230	10405	0.306	0.7887
t2p3r2i2	29334	14109	13995	2998	29953	25.25	13098	0.232	10076	0.309	0.8144
t2p3r2i4	56852	22186	22150	8262	57523	28.76	14525	0.226	11173	0.301	0.7344
zt2p3r2b	308	55	-80	523	256	3.2	0	0.000	0	0.000	
t2p3r2p1	average	values	across	the field =			12180.83		9725		0.8757
t2p3r2p2	average	values	within the	section =		27.915	12130	0.195	9697	0.269	0.8794
t2p3palp											
t2p3palp	average	values	on the	pavement	27.22333		12321	0.203	9968	0.284	0.8657
t2p3palp											
zt2p3r3a	370	112	-81	535	537	2.46	0	0.000	0	0.000	
t2p3r3i2	30715	14365	12903	2700	31227	25.23	13097	0.232	10075	0.309	0.8144
t2p3r3i4	58522	22064	23434	8620	58780	29.58	14891	0.225	11455	0.300	0.7163
t2p3r3i6	74473	28064	27292	11388	74540	37.68	18248	0.217	14038	0.289	0.5845
t2p3r3i3	39827	16818	16006	4852	40227	26.44	13625	0.231	10482	0.307	0.7829
t2p3r3i5	68545	27616	25146	11037	68592	34.1	17003	0.223	13079	0.297	0.6273
t2p3r3i0	-21	4525	4715	-1703	-11	23.39	12473	0.239	9595	0.318	0.8552
t2p3r3i1	11686	8781	8161	-547	11980	23.98	12640	0.236	9727	0.314	0.8439
zt2p3r3b	373	112	-76	529	536	3.31	0	0.000	0	0.000	
t2p3r3p1	average	values	across	the field =			12180.83		9725		0.8757
t2p3r3p2	average	values	within the	section =		28.005	12179	0.195	9753	0.270	0.8758
t2p3palp											
t2p3palp	average	values	on the	pavement	27.22333		12321	0.203	9968	0.284	0.8657
t2p3palp											

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[illegible]

Tire Combination No. 2
Pressure 3

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Vehicle	Fuel	F R/D_P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRradius		[N]	[kW]	[%]
	7.97								
1.191	18.43	0.535	0.9673	0.9504	0.9631	0.9453	35135	44.483	82.31
1.129	22.14	0.467	0.9673	0.9504	0.9631	0.9078	48940	60.999	85.88
0.893	29.56	0.487	0.9673	0.9504	0.9631	0.7382	75997	92.050	89.42
1.003	26.07	0.463	0.9673	0.9504	0.9631	0.8220	64213	78.472	87.33
1.257	14.09	0.978	0.9673	0.9504	0.9631	0.9712	18205	23.578	62.91
1.284	10.60	-4070.061	0.9673	0.9504	0.9631	0.9880	6327	8.313	-0.03
0.751	30.98	0.580	0.9673	0.9504	0.9631	0.6244	80116	96.407	88.70
	2.15								
	2.05								
	1.99								
	2.26								
	2.33								
	9.34								
	8.00								
1.287	11.23	2167.746	0.9619	0.9504	0.9631	0.9837	7412	9.895	0.05
0.757	30.69	0.541	0.9619	0.9504	0.9631	0.6470	83231	97.474	89.97
0.820	26.48	0.489	0.9619	0.9504	0.9631	0.7591	73493	79.470	89.81
1.253	14.03	0.966	0.9619	0.9504	0.9631	0.9625	19202	25.055	60.39
1.138	22.09	0.472	0.9619	0.9504	0.9631	0.9057	47688	60.121	86.28
1.188	18.90	0.542	0.9619	0.9504	0.9631	0.9353	36675	46.824	79.98
1.043	26.40	0.445	0.9619	0.9504	0.9631	0.8432	63413	78.595	89.65
	8.58								
	2.01								
	2.20								
	2.26								
	2.33								
	9.34								
	2.06								
1.189	18.65	0.511	0.9602	0.9504	0.9631	0.9403	35405	45.057	86.75
1.014	26.88	0.453	0.9602	0.9504	0.9631	0.8261	65586	80.663	89.23
0.796	30.53	0.515	0.9602	0.9504	0.9631	0.6739	81221	96.045	91.69
1.135	21.31	0.471	0.9602	0.9504	0.9631	0.9030	45155	56.934	88.20
0.880	30.49	0.506	0.9602	0.9504	0.9631	0.7235	77703	94.592	88.21
1.283	10.97	-416.924	0.9602	0.9504	0.9631	0.9811	7856	10.459	-0.26
1.251	14.18	0.970	0.9602	0.9504	0.9631	0.9669	18478	24.036	63.24
	2.09								
	2.19								
	2.13								
	2.26								
	2.33								
	9.34								

Tire Combination No. 2
Pressure 4
Experimental Data

File	Hitch	L Axle	R Axle	Cal. Front	Fuel_Rate	Hitch	Time	Fifth	Rear Wheel	Fr_Shift
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt2p4r1a	250	66	-147	406	7.97	-104	3.41	0	0	0
t2p4r1l5	66771	26270	23604	11419	29.92	66986	33.81	15271	17052	13119
t2p4r1l4	57864	23751	20088	10192	27.26	58158	29.97	15159	15196	11688
t2p4r1l6	73835	30074	26215	12572	30.86	74422	42.45	15165	20438	15723
t2p4r1l1	11741	11040	9158	-1583	14.37	11914	24.25	15670	12851	9885
t2p4r1l2	29544	16018	13342	2844	19.38	29829	25.61	15426	13335	10258
t2p4r1l0	256	6866	7033	-4091	11.54	-109	23.26	14905	12437	9567
t2p4r1l3	40775	18454	15875	5814	22.09	41378	26.45	15214	13634	10489
zt2p4r1b	261	63	-152	396	7.97	-98	3.67	0	0	0
t2p4r1p1	-8700	-176	-487	226	8.32	-9274	27.75	15865	11847	10037
t2p4r1p2	-7888	-140	-460	227	8.20	-8549	28.34	16059	11917	10089
t2p4palp	-3228	-121	-446	223	3.24	-3931	28.07	16190	12168	10191
t2p4palp	-3035	-133	-451	221	3.10	-3744	27.97	16127	12127	10159
t2p4palp	-3239	-129	-453	221	3.25	-3928	28	16153	12130	10158
zt2p4r2a	253	172	-183	401	8.50	166	2.41	0	0	0
t2p4r2l1	11828	10543	10348	-1648	14.50	11996	24.21	15579	12828	9868
t2p4r2l0	251	7142	7180	-3723	11.97	180	23.35	15540	12477	9598
t2p4r2l3	41523	17643	17317	6092	22.25	41882	26.72	15456	13756	10581
t2p4r2l5	67805	25765	25765	11844	30.32	68351	34.32	15239	17201	13233
t2p4r2l2	29136	14642	14255	3066	19.00	29358	25.67	15512	13367	10281
t2p4r2l6	74008	28217	28515	13211	30.83	73845	46.3	15301	21998	16922
t2p4r2l4	56947	22187	21407	10076	26.73	57351	29.63	15342	15008	11545
zt2p4r2b	251	174	-186	382	8.01	167	2.86	0	0	0
t2p4r2p1	-6703	-155	-462	236	8.21	-7355	28.19	15736	11873	10062
t2p4r2lp	-7507	-141	-461	237	8.04	-8222	27.96	15914	11929	10112
t2p4palp	-3228	-121	-446	223	3.24	-3931	28.07	16190	12168	10191
t2p4palp	-3035	-133	-451	221	3.10	-3744	27.97	16127	12127	10159
t2p4palp	-3239	-129	-453	221	3.25	-3928	28	16153	12130	10158
zt2p4r3a	271	56	-310	436	2.14	70	4.07	0	0	1
t2p4r3l2	29769	14733	14495	2770	18.77	30184	26.16	15540	13423	10327
t2p4r3l6	75030	29026	27240	12621	30.55	75401	41.55	15316	19803	15233
t2p4r3l4	57505	22122	21132	9240	25.97	57795	29.24	15420	14597	11229
t2p4r3l1	58925	22223	21975	9794	26.28	59567	29.8	15484	14866	11435
t2p4r3l5	67286	25564	24440	11198	29.30	68020	32.73	15226	16384	12605
t2p4r3l3	41922	17942	17880	5994	22.33	42315	26.64	15383	13667	10514
t2p4r3l0	272	7856	6997	-4056	11.71	73	23.86	15978	12713	9779
zt2p4r3b	270	90	-283	441	2.02	97	3.73	0	0	0
t2p4r3p1	-5817	-84	-390	236	2.00	-6642	27.94	15782	11937	10111
t2p4r3p2	-7021	-93	-410	227	9.21	-7746	27.94	15968	12043	10206
t2p4palp	-3228	-121	-446	223	3.24	-3931	28.07	16190	12168	10191
t2p4palp	-3035	-133	-451	221	3.10	-3744	27.97	16127	12127	10159
t2p4palp	-3239	-129	-453	221	3.25	-3928	28	16153	12130	10158

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	RRadius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt2p4r1a	250	66	-147	406	-104	3.42	0	0.000	0	0.000	
t2p4r1i5	66515	26205	23753	11017	67087	33.82	17052	0.226	13119	0.300	0.6255
t2p4r1i4	57609	23686	20237	9791	58259	29.98	15196	0.227	11688	0.302	0.7019
t2p4r1i6	73579	30009	26364	12171	74523	42.46	20438	0.215	15723	0.287	0.5219
t2p4r1i1	11485	10976	9308	-1985	12015	24.26	12851	0.237	9885	0.316	0.8300
t2p4r1i2	29288	15953	13491	2443	29930	25.62	13335	0.233	10258	0.310	0.7999
t2p4r1i0	1	6801	7182	-4493	-8	23.27	12437	0.239	9567	0.318	0.8576
t2p4r1i3	40519	18389	16025	5413	41479	26.46	13634	0.231	10489	0.307	0.7824
zt2p4r1b	261	63	-152	396	-98	3.68	0	0.000	0	0.000	
t2p4r1p1		average	values	across	the field =		11924.33		10102.83		0.8945
t2p4r1p2		average	values	within the	section =	28.055	11882	0.190	10063	0.278	0.8977
t2p4palp											
t2p4palp		average	values	on the	pavement	28.02333	12141.67	0.194	10169.33	0.281	0.8785
t2p4palp											
zt2p4r2a	253	172	-183	401	166	2.42	0	0.000	0	0.000	
t2p4r2i1	11576	10369	10533	-2039	11829	24.22	12828	0.237	9868	0.316	0.8315
t2p4r2i0	-1	6969	7364	-4114	13	23.36	12477	0.239	9598	0.318	0.8549
t2p4r2i3	41271	17470	17501	5701	41716	26.73	13756	0.230	10581	0.307	0.7754
t2p4r2i5	67553	25592	25949	11452	68184	34.33	17201	0.224	13233	0.299	0.6201
t2p4r2i2	28884	14469	14440	2675	29191	25.68	13367	0.233	10281	0.310	0.7980
t2p4r2i6	73756	28044	28699	12819	73679	46.31	21998	0.213	16922	0.283	0.4849
t2p4r2i4	56695	22014	21591	9684	57185	29.64	15008	0.227	11545	0.302	0.7107
zt2p4r2b	251	174	-186	382	167	2.87	0	0.000	0	0.000	
t2p4r2p1		average	values	across	the field =		11924.33		10102.83		0.8945
t2p4r2ip		average	values	within the	section =	28.085	11901	0.190	10087	0.278	0.8963
t2p4palp											
t2p4palp		average	values	on the	pavement	28.02333	12141.67	0.194	10169.33	0.281	0.8785
t2p4palp											
zt2p4r3a	271	56	-310	436	70	4.08	0	0.000	1	0.000	
t2p4r3i2	29499	14660	14792	2332	30101	26.17	13423	0.230	10327	0.306	0.7946
t2p4r3i6	74760	28952	27537	12183	75318	41.56	19803	0.213	15233	0.284	0.5386
t2p4r3i4	57235	22049	21429	8802	57712	29.25	14597	0.223	11229	0.297	0.7307
t2p4r3i1	58655	22149	22271	9355	59484	29.81	14866	0.223	11435	0.297	0.7175
t2p4r3i5	67015	25491	24737	10760	67937	32.74	16384	0.224	12605	0.298	0.6510
t2p4r3i3	41651	17869	18177	5556	42232	26.65	13667	0.230	10514	0.306	0.7805
t2p4r3i0	1	7782	7294	-4494	-10	23.87	12713	0.238	9779	0.317	0.8390
zt2p4r3b	270	90	-283	441	97	3.74	0	0.000	0	0.000	
t2p4r3p1		average	values	across	the field =		11924.33		10102.83		0.8945
t2p4r3p2		average	values	within the	section =	27.95	11990	0.192	10158.5	0.281	0.8896
t2p4palp											
t2p4palp		average	values	on the	pavement	28.02333	12141.67	0.194	10169.33	0.281	0.8785
t2p4palp											

[illegible]

Tire Combination No. 2
Pressure 4

Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]				av RRradius	[N]	[kW]	[%]
	7.97								
0.887	29.92	0.507	0.9079	0.9181	0.9076	0.7178	73635	91.641	90.33
1.001	27.26	0.473	0.9079	0.9181	0.9076	0.8092	64910	81.191	88.75
0.707	30.86	0.594	0.9079	0.9181	0.9076	0.5972	82663	98.250	89.01
1.237	14.37	1.012	0.9079	0.9181	0.9076	0.9480	19355	26.284	59.34
1.171	19.38	0.565	0.9079	0.9181	0.9076	0.9425	36787	47.864	79.62
1.289	11.54	9575.500	0.9079	0.9181	0.9076	0.9755	8243	12.031	0.01
1.134	22.09	0.481	0.9079	0.9181	0.9076	0.9129	47170	60.314	85.90
	7.97								
	8.32								
	8.20								
	3.24								
	3.10								
	3.25								
	8.50								
1.239	14.50	1.011	0.9072	0.9181	0.9076	0.9482	19985	27.094	57.93
1.284	11.97	-11487.1	0.9072	0.9181	0.9076	0.9732	9261	13.306	-0.01
1.122	22.25	0.480	0.9072	0.9181	0.9076	0.9047	48347	61.600	85.36
0.874	30.32	0.514	0.9072	0.9181	0.9076	0.7129	76244	94.114	88.60
1.168	19.00	0.563	0.9072	0.9181	0.9076	0.9452	36631	47.533	78.85
0.648	30.83	0.645	0.9072	0.9181	0.9076	0.5561	84284	98.603	87.51
1.012	26.73	0.466	0.9072	0.9181	0.9076	0.8217	64497	80.454	87.90
	8.01								
	8.21								
	8.04								
	3.24								
	3.10								
	3.25								
	2.14								
1.146	18.77	0.555	0.9076	0.9181	0.9076	0.9511	36949	46.965	79.84
0.722	30.55	0.566	0.9076	0.9181	0.9076	0.6223	83572	97.433	89.46
1.026	25.97	0.442	0.9076	0.9181	0.9076	0.8522	63375	77.466	90.31
1.006	26.28	0.445	0.9076	0.9181	0.9076	0.8358	65347	79.767	89.76
0.916	29.30	0.477	0.9076	0.9181	0.9076	0.7545	74190	90.853	90.33
1.126	22.33	0.476	0.9076	0.9181	0.9076	0.9232	49673	62.657	83.85
1.257	11.71	6268.996	0.9076	0.9181	0.9076	0.9714	9542	13.625	0.02
	2.02								
	2.00								
	9.21								
	3.24								
	3.10								
	3.25								

Tire Combination No. 3
Pressure 1
Experimental Data

137

File	Hitch	L_Axle	R_Axle	Cal. Front	Fuel Rate	Hitch	Time	Fifth	Rear Wheel	Fr. Shaft
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt3p1r1a	282	85	-263	411	8.19	478	3.51	0	0	0
t3p1r1d	58559	21239	20848	12712	25.13	58720	32.44	15495	14306	11005
t3p1r1e	30573	11642	10919	8829	20.12	30880	24.42	15412	12573	9671
t3p1r1f	76672	28865	28326	14843	30.05	76589	45.82	15349	20609	15853
t3p1r1g	11712	4855	4234	5853	14.45	12015	23.17	15571	12185	9374
t3p1r1h	42862	15787	15229	10783	23.13	43472	26.11	15500	13252	10195
t3p1r1i	295	1584	1145	3786	11.45	478	22.85	15848	12089	9298
t3p1r1j	69953	26368	25644	14176	31.44	69741	34.82	15334	17170	13210
zt3p1r1b	286	81	-270	409	8.67	482	3.05	0	0	0
t3p1r1p	-8020	-440	-860	486	2.76	-8499	27.79	15751	11876	9046
t3p1r1q	-9429	-433	-874	522	2.23	-10018	28.54	16033	12013	9136
t3p1palp	-2627	-329	-625	515	2.57	-2998	27.36	15852	11964	9167
t3p1palp	-2507	-342	-607	513	9.94	-2795	27.78	16090	12153	9310
t3p1palp	-2696	-328	-626	514	2.66	-2986	27.66	16017	12091	9261
zt3p1r2a	344	52	-267	440	8.14	210	2.13	0	0	0
t3p1r2b	71285	26996	26135	14211	31.09	71161	35.2	15515	17244	13266
t3p1r2c	43527	15793	15776	10622	23.50	43714	25.52	15324	13078	10060
t3p1r2d	322	1395	1149	3313	11.61	237	22.12	15424	11807	9082
t3p1r2e	28195	9764	9632	8240	18.62	28659	23.9	15381	12474	9596
t3p1r2f	76936	28849	28067	15369	29.27	76342	44.44	15312	19541	15032
t3p1r2g	12532	4993	4721	5922	14.37	12791	22.98	15443	12160	9354
t3p1r2h	56740	21036	20402	12349	27.26	56881	27.91	15474	14089	10840
zt3p1r2b	343	38	-283	402	8.68	207	2.69	0	0	0
t3p1r2p	-8943	-460	-865	520	8.25	-9282	27.9	15927	11946	9347
t3p1r2q	-8426	-454	-795	511	8.25	-9123	27.96	15753	11882	9039
t3p1palp	-2627	-329	-625	515	2.57	-2998	27.36	15852	11964	9167
t3p1palp	-2507	-342	-607	513	9.94	-2795	27.78	16090	12153	9310
t3p1palp	-2696	-328	-626	514	2.66	-2986	27.66	16017	12091	9261
zt3p1r3a	342	100	-282	407	4.56	298	3.05	0	0	1
t3p1r3b	321	1403	1022	3701	11.50	245	22.3	15663	11913	9164
t3p1r3c	43113	15834	15298	10355	22.62	43641	25.81	15447	13091	10070
t3p1r3d	71264	26748	25544	13966	30.88	71489	33.33	15375	16332	12564
t3p1r3e	56311	20999	19414	11915	26.22	56847	27.58	15353	13799	10615
t3p1r3f	75233	30462	27284	14964	29.32	75424	50.1	14820	22038	16952
t3p1r3g	30747	11449	10934	8697	19.36	31241	24.36	15284	12492	9611
t3p1r3h	11870	4846	4971	5722	13.91	12260	23.41	15534	12238	9413
zt3p1r3b	315	105	-277	406	4.31	268	2.96	0	0	0
t3p1r3p	-7867	-409	-752	490	8.51	-8315	27.72	15806	11861	9041
t3p1r3q	-7033	-410	-750	518	8.17	-7268	27.97	15930	12007	9135
t3p1palp	-2627	-329	-625	515	2.57	-2998	27.36	15852	11964	9167
t3p1palp	-2507	-342	-607	513	9.94	-2795	27.78	16090	12153	9310
t3p1palp	-2696	-328	-626	514	2.66	-2986	27.66	16017	12091	9261

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	RRadius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
z3p1r1a	282	85	-263	411	478	3.52	0	0.000	0	0.000	
t3p1r1i4	58275	21156	21115	12302	58240	32.45	14306	0.197	11005	0.263	0.7456
t3p1r1i2	30289	11559	11186	8419	30400	24.43	12573	0.230	9671	0.307	0.8484
t3p1r1i6	76388	28782	28593	14433	76109	45.83	20609	0.201	15853	0.268	0.5176
t3p1r1i1	11428	4772	4500	5443	11535	23.18	12185	0.235	9374	0.313	0.8754
t3p1r1i3	42578	15704	15496	10373	42992	26.12	13252	0.227	10195	0.302	0.8049
t3p1r1i0	11	1501	1412	3376	-2	22.86	12089	0.237	9298	0.315	0.8823
t3p1r1i5	69669	26285	25910	13766	69261	34.83	17170	0.221	13210	0.294	0.6212
z3p1r1b	286	81	-270	409	482	3.06	0	0.000	0	0.000	
t3p1r1p1	average	values	across	the field =			11930.83		9124		0.8940
t3p1r1p2	average	values	within the	section =		28.18	11944.5	0.190	9091	0.250	0.8930
t3p1palp											
t3p1palp	average	values	on the	pavement		27.61	12069.33	0.196	9246	0.259	0.8838
t3p1palp											
z3p1r2a	344	52	-267	440	210	2.14	0	0.000	0	0.000	
t3p1r2i5	70941	26951	26410	13790	70952	35.21	17244	0.219	13266	0.292	0.6186
t3p1r2i3	43184	15748	16051	10200	43506	25.53	13078	0.229	10060	0.305	0.8156
t3p1r2i0	-21	1350	1424	2892	29	22.13	11807	0.239	9082	0.318	0.9034
t3p1r2i2	27852	9719	9906	7819	28450	23.91	12474	0.234	9596	0.311	0.8551
t3p1r2i6	76592	28804	28342	14948	76133	44.45	19541	0.197	15032	0.262	0.5459
t3p1r2i1	12189	4948	4996	5501	12583	22.99	12160	0.237	9354	0.315	0.8772
t3p1r2i4	56397	20991	20677	11928	56673	27.92	14089	0.226	10840	0.301	0.7571
z3p1r2b	343	38	-283	402	207	2.70	0	0.000	0	0.000	
t3p1r2p1	average	values	across	the field =			11930.83		9124		0.8940
t3p1r2p2	average	values	within the	section =		27.94	11914	0.191	9193	0.255	0.8953
t3p1palp											
t3p1palp	average	values	on the	pavement		27.61	12069.33	0.196	9246	0.259	0.8838
t3p1palp											
z3p1r3a	342	100	-282	407	298	3.06	0	0.000	1	0.000	
t3p1r3i0	-8	1300	1301	3294	-38	22.31	11913	0.239	9164	0.318	0.8954
t3p1r3i3	42784	15731	15578	9948	43358	25.82	13091	0.227	10070	0.302	0.8148
t3p1r3i5	70935	26645	25823	13560	71206	33.34	16332	0.219	12564	0.292	0.6531
t3p1r3i4	55982	20896	19694	11509	56564	27.59	13799	0.224	10615	0.298	0.7730
t3p1r3i6	74904	30359	27564	14557	75141	50.11	22038	0.197	16952	0.262	0.4840
t3p1r3i2	30418	11346	11213	8291	30958	24.37	12492	0.229	9611	0.305	0.8539
t3p1r3i1	11541	4743	5251	5316	11977	23.42	12238	0.234	9413	0.311	0.8716
z3p1r3b	315	105	-277	406	268	2.97	0	0.000	0	0.000	
t3p1r3p1	average	values	across	the field =			11930.83		9124		0.8940
t3p1r3p2	average	values	within the	section =		27.86	11934	0.192	9088	0.253	0.8938
t3p1palp											
t3p1palp	average	values	on the	pavement		27.61	12069.33	0.196	9246	0.259	0.8838
t3p1palp											

[illegible]

Tire Combination No. 3
Pressure 1

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRradius		[N]	[kW]	[%]
	8.19								
0.924	25.13	0.4664	1.0103	1.0037	1.0055	0.8326	65476	72.715	89.00
1.228	20.12	0.5409	1.0103	1.0037	1.0055	0.9472	37885	49.141	79.95
0.655	30.05	0.6009	1.0103	1.0037	1.0055	0.5781	85531	96.858	89.31
1.294	14.45	0.9769	1.0103	1.0037	1.0055	0.9774	18409	24.419	62.08
1.149	23.13	0.4730	1.0103	1.0037	1.0055	0.8986	50234	64.222	84.76
1.312	11.45	782.8641	1.0103	1.0037	1.0055	0.9860	8239	11.013	0.14
0.861	31.44	0.5240	1.0103	1.0037	1.0055	0.6938	78748	97.774	88.47
	8.67								
	2.76								
	2.23								
	2.57								
	9.94								
	2.66								
	8.14								
0.852	31.09	0.5144	0.9965	1.0037	1.0055	0.6914	80165	98.784	88.49
1.175	23.50	0.4631	0.9965	1.0037	1.0055	0.9119	50729	65.374	85.13
1.356	11.61	-411.2519	0.9965	1.0037	1.0055	1.0108	7410	9.937	-0.28
1.255	18.62	0.5329	0.9965	1.0037	1.0055	0.9562	33580	44.067	82.94
0.675	29.27	0.5663	0.9965	1.0037	1.0055	0.6102	86118	95.256	88.94
1.305	14.37	0.9037	0.9965	1.0037	1.0055	0.9813	19310	25.684	63.12
1.074	27.26	0.4499	0.9965	1.0037	1.0055	0.8463	64328	81.674	87.67
	8.68								
	8.25								
	8.25								
	2.57								
	9.94								
	2.66								
	4.56								
1.345	11.50	-1111.98	1.0097	1.0037	1.0055	0.9925	7767	10.492	-0.10
1.162	22.62	0.4549	1.0097	1.0037	1.0055	0.9091	49694	63.526	86.09
0.900	30.88	0.4838	1.0097	1.0037	1.0055	0.7289	78692	97.154	90.14
1.087	26.22	0.4308	1.0097	1.0037	1.0055	0.8626	62378	78.644	89.75
0.599	29.32	0.6539	1.0097	1.0037	1.0055	0.5402	86265	95.611	86.83
1.231	19.36	0.5171	1.0097	1.0037	1.0055	0.9527	37462	48.435	81.20
1.281	13.91	0.9411	1.0097	1.0037	1.0055	0.9723	19017	25.084	60.69
	4.31								
	8.51								
	8.17								
	2.57								
	9.94								
	2.66								

Tire Combination No. 3
Pressure 2
Experimental Data

141

File	Hitch Centre	L. Axle Torque	R. Axle Torque	Cal. Front Torque	Fuel Rate	Hitch Draft	Time	Fifth Wheel	Rear Wheel Rotation	Fr. Shaft Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt3p2r1a	439	154	-154	406	8.16	592	3.13	0	0	0
t3p2r1i5	71770	27130	25488	14328	31.10	72600	36.79	15387	17932	13796
t3p2r1i4	58570	22715	20209	12531	27.69	58816	28.58	15230	14368	11053
t3p2r1i0	437	2464	2154	1289	11.08	598	22.44	15513	11955	9198
t3p2r1i1	14009	9766	8524	524	14.69	14286	24.33	15523	12607	9213
t3p2r1i3	43543	16844	14298	10415	22.56	44212	26.18	15425	13183	10142
t3p2r1i6	77927	30377	26963	15241	29.99	77850	48.44	15225	21749	16730
t3p2r1i2	29354	10638	10440	8247	18.62	29545	24.97	15524	12767	9822
zt3p2r1b	450	150	-161	392	8.68	602	4.27	0	0	0
t3p2r1p1	-7359	-214	-550	278	2.12	-7882	27.62	15815	11943	9274
t3p2r1p2	-7182	-169	-537	259	2.21	-7841	27.82	15769	11896	9238
t3p2palp	-3123	-152	-584	257	2.09	-3861	27.08	15891	11995	9311
t3p2palp	-2964	-151	-575	255	2.09	-3661	27.37	16079	12131	9417
t3p2palp	-3146	-154	-583	256	2.10	-3865	27.29	16011	12086	9382
zt3p2r2a	269	51	-185	411	7.93	332	4.91	0	0	0
t3p2r2i3	41224	14945	14381	10263	22.08	41713	25.66	15376	12998	9998
t3p2r2i0	289	2698	2137	1635	11.09	347	22.93	15719	12081	9295
t3p2r2i4	11164	5463	5247	4299	13.91	11431	23.39	15579	12295	9459
t3p2r2i1	56428	20953	19687	12293	26.73	56756	27.79	15320	13963	10743
t3p2r2i5	69331	24991	25507	14148	30.76	69707	33.1	15364	16390	12607
t3p2r2i6	72041	27210	25792	14316	30.75	72773	35.34	15579	17150	13194
t3p2r2i2	29429	10974	10806	8487	19.82	29501	24.53	15351	12594	9689
zt3p2r2b	277	49	-185	411	2.10	320	3.4	0	0	0
t3p2r2p2	-8347	-237	-616	325	8.60	-8963	28.33	15880	11964	9280
t3p2r2p2	-8347	-237	-616	325	8.60	-8963	28.33	15880	11964	9280
t3p2palp	-3123	-152	-584	257	2.09	-3861	27.08	15891	11995	9311
t3p2palp	-2964	-151	-575	255	2.09	-3661	27.37	16079	12131	9417
t3p2palp	-3146	-154	-583	256	2.10	-3865	27.29	16011	12086	9382
zt3p2r3a	320	107	-296	492	8.41	-34	2.73	0	0	0
t3p2r3i5	70720	26778	24839	14302	31.23	71468	34.06	15278	16808	12931
t3p2r3i0	338	2622	2242	1511	11.47	-4	22.29	15613	12012	9240
t3p2r3i4	63097	23099	21835	13545	29.29	63304	29.03	15406	14774	11367
t3p2r3i3	42285	15428	14050	10550	22.82	43056	25.1	15466	13040	10031
t3p2r3i6	74530	28503	27732	15273	30.77	75094	44.57	14998	20870	16053
t3p2r3i2	32029	11788	11285	8760	19.93	32339	24.38	15586	12777	9830
t3p2r3i1	12033	6024	5398	4294	14.07	12184	23.3	15543	12284	9449
zt3p2r3b	328	117	-283	455	8.87	-27	2.52	0	0	0
t3p2r3p1	-8013	-230	-624	314	8.52	-8561	28.28	15831	11876	9219
t3p2r3p2	-8550	-258	-650	310	8.47	-9311	28.36	15883	11842	9178
t3p2palp	-3123	-152	-584	257	2.09	-3861	27.08	15891	11995	9311
t3p2palp	-2964	-151	-575	255	2.09	-3661	27.37	16079	12131	9417
t3p2palp	-3146	-154	-583	256	2.10	-3865	27.29	16011	12086	9382

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File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axle Speed	R Wheel RRadius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt3p2r1a	439	154	-154	406	592	3.14	0	0.000	0	0.000	
t3p2r1i5	71325	26978	25645	13929	72003	36.80	17932	0.218	13796	0.290	0.5948
t3p2r1i4	58125	22563	20367	12132	58219	28.59	14368	0.225	11053	0.299	0.7424
t3p2r1i0	-8	2312	2311	890	1	22.45	11955	0.238	9198	0.317	0.8922
t3p2r1i1	13565	9614	8682	125	13689	24.34	12607	0.232	9213	0.293	0.846
t3p2r1i3	43098	16692	14455	10016	43615	26.19	13183	0.225	10142	0.300	0.8091
t3p2r1i6	77482	30225	27120	14842	77253	48.45	21749	0.201	16730	0.267	0.4904
t3p2r1i2	28910	10486	10598	7848	28948	24.98	12767	0.229	9822	0.305	0.8355
zt3p2r1b	450	150	-161	392	602	4.28	0	0.000	0	0.000	
t3p2r1p1	average	values	across	the field =		11914.17			9244.833		0.8953
t3p2r1p2	average	values	within the	section =	27.73	11919.5	0.192	9256	0.259	0.8949	
t3p2palp											
t3p2palp	average	values	on the	pavement	27.26	12070.67	0.198	9370	0.266	0.8837	
t3p2palp											
zt3p2r2a	269	51	-185	411	332	4.92	0	0.000	0	0.000	
t3p2r2i3	40950	14895	14566	9852	41387	25.67	12998	0.227	9998	0.302	0.8206
t3p2r2i0	16	2648	2322	1224	21	22.94	12081	0.236	9295	0.314	0.8829
t3p2r2i1	10891	5413	5432	3888	11105	23.40	12295	0.235	9459	0.313	0.8676
t3p2r2i4	56155	20903	19872	11882	56430	27.80	13963	0.225	10743	0.299	0.7639
t3p2r2i5	69057	24941	25692	13737	69380	33.11	16390	0.222	12607	0.295	0.6508
t3p2r2i6	71768	27160	25977	13905	72447	35.35	17150	0.217	13194	0.289	0.6220
t3p2r2i2	29156	10924	10991	8076	29175	24.54	12594	0.230	9689	0.306	0.8470
zt3p2r2b	277	49	-185	411	320	3.41	0	0.000	0	0.000	
t3p2r2p2	average	values	across	the field =		11914.17			9244.833		0.8953
t3p2r2p2	average	values	within the	section =	28.34	11964	0.189	9280	0.254	0.8916	
t3p2palp											
t3p2palp	average	values	on the	pavement	27.26	12070.67	0.198	9370	0.266	0.8837	
t3p2palp											
zt3p2r3a	320	107	-296	492	-34	2.74	0	0.000	0	0.000	
t3p2r3i5	70396	26666	25128	13829	71499	34.07	16808	0.221	12931	0.294	0.6346
t3p2r3i0	14	2510	2531	1038	27	22.30	12012	0.241	9240	0.321	0.8880
t3p2r3i4	62772	22987	22124	13072	63334	29.04	14774	0.228	11367	0.303	0.7220
t3p2r3i3	41961	15316	14339	10077	43087	25.11	13040	0.232	10031	0.309	0.8180
t3p2r3i6	74206	28391	28021	14800	75124	44.58	20870	0.210	16053	0.279	0.5111
t3p2r3i2	31705	11676	11574	8287	32370	24.39	12777	0.234	9830	0.312	0.8348
t3p2r3i1	11709	5912	5687	3820	12214	23.31	12284	0.236	9449	0.314	0.8683
zt3p2r3b	328	117	-283	455	-27	2.53	0	0.000	0	0.000	
t3p2r3p1	average	values	across	the field =		11914.17			9244.833		0.8953
t3p2r3p2	average	values	within the	section =	28.33	11859	0.187	9198.5	0.251	0.8994	
t3p2palp											
t3p2palp	average	values	on the	pavement	27.26	12070.67	0.198	9370	0.266	0.8837	
t3p2palp											

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R Wheel	F Wheel	F Wheel	F Axle	R Axle	Drawbar	Tractive	Front	Rear	Alfa	Thrust	Equivalent
Slip	Radius	Slip	Power	Power	Power_A	Eff_A	Thrust	Thrust	(RTh/TTTh)	over	Slip
[%]	[m]	[%]	[kW]	[kW]	[kW]	[%]	[N]	[N]	[%]	Weight	[%]
			0.000	0.000							
33.53	0.4469	32.91	25.411	72.120	58.146	59.62	20913	58805	73.77	0.6836	33.36
17.04	0.5578	16.26	22.823	60.679	60.992	73.04	18214	47972	72.48	0.5676	16.82
0.30	0.6703	-0.63	1.774	6.924	-0.011	-0.12	1336	5166	79.46	0.0558	0.20
5.45	0.6692	-0.47	0.231	26.653	16.719	62.19	188	20445	99.09	0.1769	5.62
9.58	0.6079	8.74	18.875	44.096	49.368	78.40	15038	34807	69.83	0.4275	9.31
45.20	0.3685	44.67	24.939	72.400	47.977	49.29	22283	64081	74.20	0.7407	45.06
6.64	0.6277	5.76	15.017	30.306	34.719	76.60	11783	23560	66.66	0.3031	6.31
			0.000	0.000							
	0.6669										
	0.6661										
	0.6580										
			0.000	0.000							
7.96	0.6166	7.18	18.672	41.956	47.858	78.94	14829	33045	69.02	0.4106	7.70
0.97	0.6633	0.16	2.413	7.361	0.021	0.22	1842	5575	75.17	0.0636	0.96
2.69	0.6518	1.89	7.647	16.027	13.963	58.98	5852	12165	67.52	0.1545	2.31
14.32	0.5739	13.62	22.344	57.600	60.599	75.80	17886	45734	71.89	0.5456	14.11
27.00	0.4890	26.39	25.453	70.493	62.571	65.21	20678	56791	73.31	0.6644	26.84
30.24	0.4673	29.66	25.255	72.505	60.906	62.30	20931	59601	74.01	0.6906	30.09
5.00	0.6363	4.22	15.517	31.632	35.643	75.60	12157	24581	66.91	0.3151	4.71
			0.000	0.000							
	0.6669										
	0.6643										
	0.6580										
			0.000	0.000							
29.44	0.4768	28.86	25.541	71.865	61.986	63.64	20634	57584	73.62	0.6708	29.29
1.27	0.6672	0.45	2.093	7.637	0.018	0.19	1549	5605	78.35	0.0613	1.40
19.73	0.5424	19.08	24.899	64.548	64.848	72.50	19504	50155	72.00	0.5974	19.54
9.06	0.6146	8.30	19.589	43.313	50.133	79.70	15035	32970	68.68	0.4117	8.80
43.18	0.3840	42.70	25.934	74.276	49.936	49.83	22083	62718	73.96	0.7272	43.05
7.18	0.6272	6.42	16.253	34.255	38.997	77.21	12365	25849	67.64	0.3277	6.92
3.46	0.6525	2.65	7.536	17.191	15.069	60.94	5700	12896	69.35	0.1595	3.14
			0.000	0.000							
	0.6669										
	0.6702										
	0.6580										

Tire Combination No. 3
Pressure 2

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RR Radius		[N]	[kW]	[%]
	8.16								
0.815	31.10	0.535	0.9902	0.9906	0.9910	0.6664	79718	97.531	89.47
1.049	27.69	0.454	0.9902	0.9906	0.9910	0.8318	66186	83.501	87.82
1.336	11.08	-1032.826	0.9902	0.9906	0.9910	0.9980	6502	8.698	-0.12
1.233	14.69	0.879	0.9902	0.9906	0.9910	0.9438	20633	26.884	65.74
1.145	22.56	0.457	0.9902	0.9906	0.9910	0.9069	49845	62.971	86.46
0.619	29.99	0.625	0.9902	0.9906	0.9910	0.5494	86365	97.339	89.72
1.201	18.62	0.536	0.9902	0.9906	0.9910	0.9369	35343	45.323	81.80
	8.68								
	2.12								
	2.21								
	2.09								
	2.09								
	2.10								
	7.93								
1.169	22.08	0.461	0.9913	0.9906	0.9910	0.9230	47874	60.628	85.54
1.308	11.09	522.077	0.9913	0.9906	0.9910	0.9904	7416	9.774	0.22
1.282	13.91	0.996	0.9913	0.9906	0.9910	0.9769	18017	23.675	60.45
1.079	26.73	0.441	0.9913	0.9906	0.9910	0.8589	63620	79.944	88.27
0.906	30.76	0.492	0.9913	0.9906	0.9910	0.7316	77469	95.946	89.14
0.849	30.75	0.505	0.9913	0.9906	0.9910	0.6991	80532	97.761	89.12
1.222	19.82	0.556	0.9913	0.9906	0.9910	0.9529	36738	47.149	79.36
	2.10								
	8.60								
	8.60								
	2.09								
	2.09								
	2.10								
	8.41								
0.881	31.23	0.504	0.9913	0.9906	0.9910	0.7071	78217	97.406	90.00
1.345	11.47	630.596	0.9913	0.9906	0.9910	0.9860	7153	9.730	0.19
1.033	29.29	0.452	0.9913	0.9906	0.9910	0.8046	69659	89.447	90.11
1.195	22.82	0.455	0.9913	0.9906	0.9910	0.9120	48005	62.902	87.41
0.673	30.77	0.616	0.9913	0.9906	0.9910	0.5695	84801	100.210	87.51
1.230	19.93	0.511	0.9913	0.9906	0.9910	0.9308	38213	50.508	82.97
1.287	14.07	0.934	0.9913	0.9906	0.9910	0.9686	18596	24.727	62.96
	8.87								
	8.52								
	8.47								
	2.09								
	2.09								
	2.10								

Tire Combination No. 3
Pressure 3
Experimental Data

File	Hitch	L_Axle	R_Axle	Cal. Front	Fuel_Rate	Hitch	Time	Fifth	Rear Wheel	Fr. Shaft
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt3p3r1a	241	274	-111	273	2.14	-303	3.08	0	0	0
t3p3r1i0	244	1	-434	5179	12.10	-221	22.69	15504	12077	9291
t3p3r1i5	70702	26397	25035	13666	31.17	70615	33.2	15040	16467	12666
t3p3r1i2	32223	11957	11418	8766	20.38	32151	24.6	15168	12617	9707
t3p3r1i6	78506	30729	27507	15161	28.74	78754	50.98	15061	21487	16531
t3p3r1i4	63576	23594	22292	12585	29.06	63159	28.87	15046	14477	11137
t3p3r1i3	43329	16003	14953	9931	23.18	43577	25.47	15304	13021	10016
t3p3r1i1	10061	2713	2379	6233	13.38	9863	23.43	15637	12405	9543
zt3p3r1b	236	267	-116	281	2.32	-281	2.71	0	0	0
t3p3r1p1	-8466	-566	-930	521	2.21	-9057	28.9	15606	12132	8982
t3p3r1p2	-8549	-532	-890	536	2.03	-9682	27.27	15689	12127	9005
t3p3palp	-3428	-499	-714	595	2.12	-3528	27.26	15863	12165	9180
t3p3palp	-3196	-476	-725	595	9.37	-3272	27.78	16192	12406	9364
t3p3palp	-3411	-487	-719	595	2.16	-3511	27.62	16073	12329	9307
zt3p3r2a	391	40	-250	512	56.68	391	3.71	0	0	39849
t3p3r2i2	32397	11954	11347	8557	19.86	32456	24.5	15193	12663	9741
t3p3r2i6	74884	27852	27190	13943	30.97	75070	36.34	15109	17327	13328
t3p3r2i1	10902	3651	3353	6360	14.15	11010	23.3	15501	12303	9466
t3p3r2i5	70889	25317	25353	13321	31.06	70838	31.48	15222	15762	12126
t3p3r2i3	43861	16191	15585	9921	23.18	44273	25.65	15439	13095	10074
t3p3r2i0	392	-151	-467	4765	11.22	409	22.69	15424	12064	9280
t3p3r2i4	60944	22490	21989	12272	28.35	61740	28.1	15199	14174	10903
zt3p3r2b	411	71	-225	504	2.10	393	4.01	0	0	0
t3p3r2p1	-7681	-523	-851	558	9.20	-8153	28.04	15526	12097	9040
t3p3r2p2	-8052	-510	-820	567	2.26	-8473	27.64	15742	12248	9149
t3p3palp	-3428	-499	-714	595	2.12	-3528	27.26	15863	12165	9180
t3p3palp	-3196	-476	-725	595	9.37	-3272	27.78	16192	12406	9364
t3p3palp	-3411	-487	-719	595	2.16	-3511	27.62	16073	12329	9307
zt3p3r3a	352	123	-178	440	2.23	362	3.51	0	0	0
t3p3r3i2	30376	10573	10429	8275	18.79	30718	24.28	15228	12548	9653
t3p3r3i0	355	-159	-467	4613	11.47	402	23.03	15665	12269	9438
t3p3r3i6	78799	29112	29231	14860	29.03	78972	48.26	15080	20731	15951
t3p3r3i1	28595	10063	9390	8203	18.74	28779	24.4	15552	12705	9773
t3p3r3i4	62004	22676	22615	12071	28.47	61530	28.16	15078	14143	10879
t3p3r3i3	42528	15443	15440	9439	22.50	43114	25.2	15269	12858	9891
t3p3r3i5	71264	26374	26272	13301	31.16	71287	32.28	14939	15977	12290
zt3p3r3b	364	116	-180	409	2.02	367	3.8	0	0	0
t3p3r3p1	-7531	-475	-768	570	2.33	-8074	28.39	15556	12047	8961
t3p3r3p2	-6989	-486	-770	580	2.17	-7579	29.16	15898	12337	9199
t3p3palp	-3428	-499	-714	595	2.12	-3528	27.26	15863	12165	9180
t3p3palp	-3196	-476	-725	595	9.37	-3272	27.78	16192	12406	9364
t3p3palp	-3411	-487	-719	595	2.16	-3511	27.62	16073	12329	9307

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	RRadius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt3p3r1a	241	274	-111	273	-303	3.09	0	0.000	0	0.000	
t3p3r1i0	5	-269	-320	4902	70	22.70	12077	0.238	9291	0.317	0.8832
t3p3r1i5	70464	26126	25148	13389	70906	33.21	16467	0.222	12666	0.295	0.6478
t3p3r1i2	31985	11686	11531	8489	32443	24.61	12617	0.229	9707	0.305	0.8454
t3p3r1i6	78267	30459	27620	14883	79046	50.99	21487	0.189	16531	0.251	0.4964
t3p3r1i4	63337	23323	22406	12308	63451	28.88	14477	0.224	11137	0.299	0.7368
t3p3r1i3	43090	15732	15066	9654	43868	25.48	13021	0.229	10016	0.304	0.8192
t3p3r1i1	9822	2443	2492	5956	10155	23.44	12405	0.237	9543	0.315	0.8599
zt3p3r1b	236	267	-116	281	-281	2.72	0	0.000	0	0.000	
t3p3r1p1	average	values	across	the field =			12164.67		9056		0.8768
t3p3r1p2	average	values	within the	section =		28.10	12129.5	0.193	8993.5	0.248	0.8794
t3p3palp											
t3p3palp	average	values	on the	pavement		27.56	12300	0.200	9283.667	0.261	0.8672
t3p3palp											
zt3p3r2a	391	40	-250	512	391	3.72	0	0.000	39849	8.296	
t3p3r2i2	31996	11898	11585	8049	32064	24.51	12663	0.231	9741	0.308	0.8423
t3p3r2i6	74483	27797	27427	13435	74678	36.35	17327	0.213	13328	0.284	0.6156
t3p3r2i1	10501	3596	3590	5851	10618	23.31	12303	0.236	9466	0.315	0.8670
t3p3r2i5	70488	25262	25590	12813	70446	31.49	15762	0.224	12126	0.298	0.6767
t3p3r2i3	43460	16136	15823	9413	43881	25.66	13095	0.228	10074	0.304	0.8146
t3p3r2i0	-9	-206	-229	4256	17	22.70	12064	0.238	9280	0.317	0.8842
t3p3r2i4	60543	22434	22226	11764	61348	28.11	14174	0.226	10903	0.300	0.7525
zt3p3r2b	411	71	-225	504	393	4.02	0	0.000	0	0.000	
t3p3r2p1	average	values	across	the field =			12164.67		9056		0.8768
t3p3r2p2	average	values	within the	section =		27.85	12172.5	0.196	9094.5	0.253	0.8763
t3p3palp											
t3p3palp	average	values	on the	pavement		27.56	12300	0.200	9283.667	0.261	0.8672
t3p3palp											
zt3p3r3a	352	123	-178	440	362	3.52	0	0.000	0	0.000	
t3p3r3i2	30018	10453	10607	7851	30353	24.29	12548	0.231	9653	0.308	0.8501
t3p3r3i0	-3	-279	-288	4189	37	23.04	12269	0.238	9438	0.317	0.8694
t3p3r3i6	78441	28992	29410	14435	78608	48.27	20731	0.192	15951	0.256	0.5145
t3p3r3i1	28237	9943	9569	7778	28414	24.41	12705	0.233	9773	0.310	0.8396
t3p3r3i4	61646	22557	22794	11647	61165	28.17	14143	0.225	10879	0.299	0.7542
t3p3r3i3	42170	15323	15618	9015	42749	25.21	12858	0.228	9891	0.304	0.8296
t3p3r3i5	70906	26254	26450	12877	70922	32.29	15977	0.221	12290	0.295	0.6676
zt3p3r3b	364	116	-180	409	367	3.81	0	0.000	0	0.000	
t3p3r3p1	average	values	across	the field =			12164.67		9056		0.8768
t3p3r3p2	average	values	within the	section =		28.79	12192	0.190	9080	0.244	0.8749
t3p3palp											
t3p3palp	average	values	on the	pavement		27.56	12300	0.200	9283.667	0.261	0.8672
t3p3palp											

[illegible]

Tire Combination No. 3
Pressure 3

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRradius		[N]	[kW]	[%]
	2.14								
1.322	12.10	1815.375	1.0371	1.0188	1.0329	0.9726	6480	8.881	0.08
0.903	31.17	0.490	1.0371	1.0188	1.0329	0.7304	77838	96.354	90.53
1.219	20.38	0.523	1.0371	1.0188	1.0329	0.9553	38785	49.770	82.47
0.588	28.74	0.624	1.0371	1.0188	1.0329	0.5596	87756	92.315	89.19
1.039	29.06	0.442	1.0371	1.0188	1.0329	0.8311	69955	87.567	90.54
1.177	23.18	0.457	1.0371	1.0188	1.0329	0.9247	49106	62.732	87.75
1.280	13.38	1.064	1.0371	1.0188	1.0329	0.9677	14300	19.144	68.69
	2.32								
	2.21								
	2.03								
	2.12								
	9.37								
	2.16								
	56.68								
1.224	19.86	0.507	1.0292	1.0188	1.0329	0.9562	38673	49.690	82.74
0.825	30.97	0.504	1.0292	1.0188	1.0329	0.6979	82839	98.007	89.91
1.287	14.15	1.047	1.0292	1.0188	1.0329	0.9888	16832	22.230	62.39
0.953	31.06	0.463	1.0292	1.0188	1.0329	0.7672	76933	95.598	91.62
1.169	23.18	0.456	1.0292	1.0188	1.0329	0.9240	50357	63.854	86.30
1.322	11.22	-928.886	1.0292	1.0188	1.0329	0.9812	5782	7.817	-0.16
1.067	28.35	0.439	1.0292	1.0188	1.0329	0.8533	68320	85.540	88.62
	2.10								
	9.20								
	2.26								
	2.12								
	9.37								
	2.16								
	2.23								
1.235	18.79	0.507	1.0325	1.0188	1.0329	0.9669	35635	45.781	84.24
1.302	11.47	-2628.558	1.0325	1.0188	1.0329	0.9760	5521	7.501	-0.06
0.622	29.03	0.596	1.0325	1.0188	1.0329	0.5837	88015	93.758	89.12
1.229	18.74	0.540	1.0325	1.0188	1.0329	0.9534	33759	43.718	83.64
1.065	28.47	0.434	1.0325	1.0188	1.0329	0.8562	68989	85.924	89.36
1.190	22.50	0.448	1.0325	1.0188	1.0329	0.9428	48644	61.597	86.69
0.929	31.16	0.473	1.0325	1.0188	1.0329	0.7577	79206	97.194	89.52
	2.02								
	2.33								
	2.17								
	2.12								
	9.37								
	2.16								

Tire Combination No. 3
Pressure 4
Experimental Data

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File	Hitch	L. Axle	R. Axle	Cal. Front	Fuel Rate	Hitch	Time	Fifth	Rear Wheel	Fr. Shaft
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt3p4r1a	646	211	17	688	1.99	994	4.37	0	0	0
t3p4r1l1	16115	5346	4780	7783	16.06	17031	23.59	15304	12370	9517
t3p4r1l3	43714	15672	15555	10312	23.32	44896	25.41	15199	12985	9989
t3p4r1l5	69669	25442	26023	13403	30.76	69953	32.8	15181	16200	12462
t3p4r1l4	61633	22087	23162	12618	28.07	61646	29.54	15335	14720	11324
t3p4r1l6	78111	29157	28869	14953	29.19	78374	47.55	15234	20881	16064
t3p4r1l2	29529	10338	9882	8730	18.95	30099	24.16	15195	12510	9624
t3p4r1l0	642	-751	-928	6130	11.14	987	22.85	15638	12086	9298
zt3p4r1b	655	196	74	674	50.23	965	4.31	0	0	0
t3p4r1p1	-7747	-373	-546	779	2.21	-7787	28.22	15826	12210	8909
t3p4r1p2	-7275	-354	-527	760	2.28	-7214	27.27	15594	12158	8880
t3p4palp	-2983	-355	-578	655	2.14	-3016	27.05	16006	12286	9149
t3p4palp	-2666	-357	-592	654	2.12	-2789	26.86	15919	12215	9097
t3p4palp	-2898	-373	-571	654	2.26	-3033	27.25	16107	12375	9219
zt3p4r2a	630	286	101	649	2.04	959	4.52	0	0	0
t3p4r2l6	76314	26944	30459	15606	29.14	77214	51.72	15140	22536	17335
t3p4r2l1	12508	3910	3833	7723	14.44	13158	23.73	15543	12496	9613
t3p4r2l2	29205	9814	9892	8963	18.73	29689	24.05	15156	12479	9600
t3p4r2l4	57276	20403	21362	12120	27.04	57918	27.96	15353	14094	10841
t3p4r2l3	41520	14432	15364	9965	22.49	42259	25.38	15308	12990	9997
t3p4r2l0	608	-272	-469	6507	11.68	953	22.65	15331	12011	9239
t3p4r2l5	69792	25035	26100	13671	30.98	70443	32.53	15213	16173	12441
zt3p4r2b	643	163	-1	648	2.22	905	4.13	0	0	0
t3p4r2p1	-8356	-348	-521	738	9.00	-8550	28.91	15779	12252	8945
t3p4r2p1	-8139	-332	-531	736	2.25	-8335	28.99	15779	12260	8966
t3p4palp	-2983	-355	-578	655	2.14	-3016	27.05	16006	12286	9149
t3p4palp	-2666	-357	-592	654	2.12	-2789	26.86	15919	12215	9097
t3p4palp	-2898	-373	-571	654	2.26	-3033	27.25	16107	12375	9219
zt3p4r3a	548	239	-24	587	2.08	728	4.09	0	0	0
t3p4r3l5	69123	26326	24170	13441	30.38	69090	32.73	15242	16276	12520
t3p4r3l2	32399	11758	11195	9090	19.41	32976	24.63	15307	12703	9773
t3p4r3l3	42475	15670	15284	10049	22.64	43296	25.01	15081	12784	9834
t3p4r3l6	77901	29954	27667	15040	29.30	78231	47.38	15093	20939	16107
t3p4r3l0	538	-372	-570	6067	11.32	718	22.86	15539	12159	9353
t3p4r3l4	57825	22359	20701	11238	27.00	57830	28.26	15491	14258	10968
t3p4r3l1	12055	3668	3364	6947	13.81	12605	23.51	15507	12346	9497
zt3p4r3b	562	261	-12	527	2.24	715	4.18	0	0	0
t3p4r3p1	-6615	-313	-548	669	2.19	-6934	28.48	15698	12200	8930
t3p4r3p1	-6994	-328	-539	670	2.20	-7256	28.5	15665	12184	8895
t3p4palp	-2983	-355	-578	655	2.14	-3016	27.05	16006	12286	9149
t3p4palp	-2666	-357	-592	654	2.12	-2789	26.86	15919	12215	9097
t3p4palp	-2898	-373	-571	654	2.26	-3033	27.25	16107	12375	9219

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	RRadius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt3p4r1a	646	211	17	688	994	4.38	0	0.000	0	0.000	
t3p4r1i1	15464	5143	4735	7101	16052	23.60	12370	0.235	9517	0.312	0.8623
t3p4r1i3	43064	15469	15510	9631	43917	25.42	12985	0.229	9989	0.304	0.8215
t3p4r1i5	69018	25238	25977	12722	68974	32.81	16200	0.221	12462	0.294	0.6584
t3p4r1i4	60982	21883	23117	11937	60667	29.55	14720	0.223	11324	0.297	0.7244
t3p4r1i6	77460	28954	28823	14272	77394	47.56	20881	0.197	16064	0.262	0.5108
t3p4r1i2	28878	10134	9837	8049	29120	24.17	12510	0.232	9624	0.308	0.8526
t3p4r1i0	-9	-954	-974	5449	8	22.86	12086	0.237	9298	0.315	0.8826
zt3p4r1b	655	196	74	674	965	4.32	0	0.000	0	0.000	
t3p4r1p1	average	values	across	the field =		12210.67			8920.833		0.8735
t3p4r1p2	average	values	within the	section =		27.76	12184	0.197	8894.5	0.248	0.8755
t3p4palp											
t3p4palp	average	values	on the	pavement		27.06	12292	0.203	9155	0.262	0.8678
t3p4palp											
zt3p4r2a	630	286	101	649	959	4.53	0	0.000	0	0.000	
t3p4r2i6	75677	26720	30409	14958	76282	51.73	22536	0.195	17335	0.260	0.4733
t3p4r2i1	11872	3686	3783	7074	12226	23.74	12496	0.236	9613	0.314	0.8536
t3p4r2i2	28568	9590	9841	8314	28757	24.06	12479	0.232	9600	0.309	0.8548
t3p4r2i4	56640	20179	21312	11471	56986	27.97	14094	0.226	10841	0.300	0.7568
t3p4r2i3	40883	14208	15313	9316	41328	25.39	12990	0.229	9997	0.305	0.8211
t3p4r2i0	-28	-496	-520	5858	21	22.66	12011	0.237	9239	0.316	0.8881
t3p4r2i5	69156	24811	26050	13023	69512	32.54	16173	0.222	12441	0.296	0.6595
zt3p4r2b	643	163	-1	648	905	4.14	0	0.000	0	0.000	
t3p4r2p1	average	values	across	the field =		12210.67			8920.833		0.8735
t3p4r2p1	average	values	within the	section =		28.96	12256	0.189	8955.5	0.239	0.8703
t3p4palp											
t3p4palp	average	values	on the	pavement		27.06	12292	0.203	9155	0.262	0.8678
t3p4palp											
zt3p4r3a	548	239	-24	587	728	4.10	0	0.000	0	0.000	
t3p4r3i5	68568	26076	24188	12885	68369	32.74	16276	0.223	12520	0.296	0.6554
t3p4r3i2	31844	11508	11213	8533	32255	24.64	12703	0.231	9773	0.307	0.8397
t3p4r3i3	41919	15420	15302	9492	42575	25.02	12784	0.229	9834	0.304	0.8344
t3p4r3i6	77346	29704	27685	14483	77510	47.39	20939	0.198	16107	0.263	0.5094

[illegible]

Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRadius		[N]	[kW]	[%]
	1.986								
1.271	16.056	0.817	1.0533	1.0324	1.0525	0.9811	21528	28.496	71.83
1.180	23.321	0.459	1.0533	1.0324	1.0525	0.9302	49280	62.922	87.39
0.914	30.762	0.487	1.0533	1.0324	1.0525	0.7439	76856	94.636	89.80
1.015	28.070	0.453	1.0533	1.0324	1.0525	0.8188	68624	85.306	88.86
0.631	29.186	0.597	1.0533	1.0324	1.0525	0.5768	86587	94.802	89.46
1.241	18.952	0.529	1.0533	1.0324	1.0525	0.9684	34425	44.668	83.89
1.312	11.137	-994.109	1.0533	1.0324	1.0525	0.9741	5659	7.917	-0.15
	50.226								
	2.211								
	2.281								
	2.144								
	2.119								
	2.259								
	2.043								
0.580	29.138	0.664	1.0523	1.0324	1.0525	0.5374	87370	94.390	86.62
1.264	14.441	0.963	1.0523	1.0324	1.0525	0.9730	18858	24.997	62.95
1.247	18.732	0.526	1.0523	1.0324	1.0525	0.9787	34404	44.489	83.04
1.073	27.040	0.445	1.0523	1.0324	1.0525	0.8607	64337	80.438	88.04
1.182	22.490	0.466	1.0523	1.0324	1.0525	0.9356	47453	60.329	86.15
1.324	11.683	-312.371	1.0523	1.0324	1.0525	0.9737	7342	10.108	-0.38
0.922	30.980	0.486	1.0523	1.0324	1.0525	0.7495	77357	95.326	89.40
	2.218								
	8.999								
	2.248								
	2.144								
	2.119								
	2.259								
	2.079								
0.916	30.381	0.484	1.0519	1.0324	1.0525	0.7409	76080	94.256	90.13
1.218	19.411	0.501	1.0519	1.0324	1.0525	0.9523	38306	49.414	83.13
1.199	22.639	0.450	1.0519	1.0324	1.0525	0.9468	48838	62.305	85.83
0.633	29.298	0.598	1.0519	1.0324	1.0525	0.5756	86534	95.271	89.38
1.312	11.325	-512.609	1.0519	1.0324	1.0525	0.9693	6624	9.211	-0.25
1.061	26.998	0.444	1.0519	1.0324	1.0525	0.8469	64395	80.918	88.93
1.276	13.806	0.941	1.0519	1.0324	1.0525	0.9849	17011	22.595	67.60
	2.243								
	2.194								
	2.204								
	2.144								
	2.119								
	2.259								

Tire Combination No. 4
Pressure 1
Experimental Data

File	Hitch	L. Axle	R. Axle	Cal. Front	Fuel_Rate	Hitch	Time	Fifth	Rear Wheel	Fr. Shaft
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt4p1r1a	575	189	84	559	2.204157	317	3.19	0	0	0
t4p1r1k4	56075	21854	20680	11423	27.5173	56984	29.55	15098	14939	11491
t4p1r1i0	573	3380	3196	939	11.71858	331	22.63	15421	12053	9273
t4p1r1i5	68492	26905	25819	12738	30.92522	69080	36.29	15309	18032	13871
t4p1r1i3	42706	16350	16108	9084	22.97838	43043	26.44	15162	13498	10384
t4p1r1i2	32818	12420	13042	7339	20.11762	32801	25.23	15130	12995	9997
t4p1r1i6	74240	30472	28262	13632	28.76364	74917	55.82	15196	24159	18585
t4p1r1i1	9051	5753	5571	2001	13.05062	9440	23.18	15452	12236	9413
zt4p1r1b	587	153	-19	557	2.171132	303	3.42	0	0	1
t4p1r1p1	-7137	-129	-254	337	9.253423	-7674	27.91	15721	11916	9359
t4p1r1p2	-7318	-108	-244	327	9.242441	-7666	28	15611	11781	9235
t4p1palp	-2394	-114	-303	269	2.222022	-2763	27.07	15796	11959	9490
t4p1palp	-2143	-107	-308	269	2.2266	-2547	27.44	16019	12124	9618
t4p1palp	-2389	-111	-307	269	9.406873	-2740	27.57	16088	12178	9665
zt4p1r2a	515	144	-45	529	2.164111	623	3	0	0	0
t4p1r2i1	10635	6529	6271	2147	13.83859	10828	23.32	15344	12299	9462
t4p1r2i5	67780	26623	25593	12002	30.44361	68261	34.01	15054	16910	13009
t4p1r2i2	26862	10536	10631	5576	17.78685	27161	24.41	15302	12679	9753
t4p1r2i0	524	3539	3294	-55	11.19112	640	22.83	15576	12144	9340
t4p1r2i3	41583	15797	15549	8455	22.19107	42319	26.01	15269	13325	10252
t4p1r2i6	76545	31171	28095	13917	28.81452	76441	51.89	15153	22409	17238
t4p1r2i4	56577	21975	21339	10637	27.14591	57137	28.94	15286	14620	11247
zt4p1r2b	527	147	-44	530	74.0981	590	2.83	0	0	0
t4p1r2p1	-7164	-151	-267	311	2.208908	-7609	27.35	15579	11874	9368
t4p1r2p1	-7635	-121	-242	313	2.219215	-8030	27.84	15815	12026	9466
t4p1palp	-2394	-114	-303	269	2.222022	-2763	27.07	15796	11959	9490
t4p1palp	-2143	-107	-308	269	2.2266	-2547	27.44	16019	12124	9618
t4p1palp	-2389	-111	-307	269	9.406873	-2740	27.57	16088	12178	9665
zt4p1r3a	436	171	-9	506	70.61828	521	2.97	0	0	0
t4p1r3i6	73570	28118	27817	13828	30.30222	73599	49.05	15219	22874	17598
t4p1r3i2	29337	11683	12159	6390	18.9148	29544	24.79	15240	12817	9859
t4p1r3i3	41203	15150	15642	8237	21.64602	41571	25.78	15156	13155	10120
t4p1r3i1	12544	6803	6636	1786	13.84739	12929	23.79	15583	12489	9608
t4p1r3i4	57980	21690	21621	10784	26.97832	58784	29.12	14963	14615	11244
t4p1r3i5	68044	27103	25118	11939	30.25654	68719	34.85	15205	17334	13335
t4p1r3i0	446	3649	3399	-497	10.90941	533	22.54	15346	12005	9234
zt4p1r3b	437	15	-137	499	2.182284	523	2.47	0	0	0
t4p1r3p1	-6566	-105	-280	291	2.143279	-6924	27.34	15534	11837	9363
t4p1r3p2	-6029	-89	-268	285	9.405183	-6347	27.33	15473	11828	9361
t4p1palp	-2394	-114	-303	269	2.222022	-2763	27.07	15796	11959	9490
t4p1palp	-2143	-107	-308	269	2.2266	-2547	27.44	16019	12124	9618
t4p1palp	-2389	-111	-307	269	9.406873	-2740	27.57	16088	12178	9665

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File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt4p1r1a	575	189	84	559	317	3.2	0	0.000	0	0.000	
t4p1r1l4	55494	21683	20648	10865	56674	29.56	14939	0.226	11491	0.301	0.7140
t4p1r1l0	-8	3209	3163	381	21	22.64	12053	0.238	9273	0.317	0.8850
t4p1r1l5	67911	26734	25786	12180	68770	36.3	18032	0.222	13871	0.296	0.5915
t4p1r1l3	42125	16179	16075	8526	42733	26.45	13498	0.228	10384	0.304	0.7902
t4p1r1l2	32238	12249	13009	6781	32491	25.24	12995	0.230	9997	0.307	0.8208
t4p1r1l6	73660	30301	28229	13075	74607	55.83	24159	0.194	18585	0.258	0.4415
t4p1r1l1	8470	5582	5538	1443	9130	23.19	12236	0.236	9413	0.314	0.8717
zt4p1r1b	587	153	-19	557	303	3.43	0	0.000	1	0.000	
t4p1r1p1	average	values	across	the field =			11877		9358.667		0.8981
t4p1r1p2	average	values	within the	section =	27.965	11848.5	0.190		9297	0.257	0.9002
t4p1palp											
t4p1palp	average	values	on the	pavement	27.37	12087	0.198		9591	0.271	0.8825
t4p1palp											
zt4p1r2a	515	144	-45	529	623	3.01	0	0.000	0	0.000	
t4p1r2l1	10114	6383	6315	1618	10221	23.33	12299	0.236	9462	0.314	0.8673
t4p1r2l5	67258	26477	25637	11473	67654	34.02	16910	0.222	13009	0.296	0.6308
t4p1r2l2	26341	10391	10676	5046	26554	24.42	12679	0.232	9753	0.309	0.8413
t4p1r2l0	3	3394	3339	-584	33	22.84	12144	0.238	9340	0.317	0.8783
t4p1r2l3	41062	15651	15594	7926	41712	26.02	13325	0.229	10252	0.305	0.8005
t4p1r2l6	76024	31025	28139	13388	75834	51.9	22409	0.193	17238	0.257	0.4760
t4p1r2l4	56056	21829	21383	10107	56530	28.95	14620	0.226	11247	0.301	0.7296
zt4p1r2b	527	147	-44	530	590	2.84	0	0.000	0	0.000	
t4p1r2p1	average	values	across	the field =			11877		9358.667		0.8981
t4p1r2p1	average	values	within the	section =	27.605	11950	0.194		9417	0.264	0.8926
t4p1palp											
t4p1palp	average	values	on the	pavement	27.37	12087	0.198		9591	0.271	0.8825
t4p1palp											
zt4p1r3a	436	171	-9	506	521	2.98	0	0.000	0	0.000	
t4p1r3l6	73133	28025	27891	13326	73077	49.06	22874	0.209	17598	0.278	0.4663
t4p1r3l2	28901	11590	12232	5888	29023	24.8	12817	0.231	9859	0.308	0.8322
t4p1r3l3	40766	15057	15716	7734	41050	25.79	13155	0.228	10120	0.304	0.8108
t4p1r3l1	12107	6710	6710	1283	12408	23.8	12489	0.235	9608	0.313	0.8541
t4p1r3l4	57543	21597	21694	10281	58262	29.13	14615	0.225	11244	0.299	0.7298
t4p1r3l5	67608	27010	25191	11437	68197	34.86	17334	0.223	13335	0.296	0.6154
t4p1r3l0	9	3556	3472	-1000	11	22.55	12005	0.238	9234	0.317	0.8885
zt4p1r3b	437	15	-137	499	523	2.48	0	0.000	0	0.000	
t4p1r3p1	average	values	across	the field =			11877		9358.667		0.8981
t4p1r3p2	average	values	within the	section =	27.345	11832.5	0.194		9362	0.265	0.9015
t4p1palp											
t4p1palp	average	values	on the	pavement	27.37	12087	0.198		9591	0.271	0.8825
t4p1palp											

[illegible]

Tire Combination No. 4
Pressure 1

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]				av RRadius	[N]	[kW]	[%]
	2.20								
1.015	27.52	0.489	0.9800	0.9690	0.9758	0.7975	63407	80.722	87.52
1.325	11.72	-1092.517	0.9800	0.9690	0.9758	0.9821	7652	10.300	-0.11
0.826	30.93	0.551	0.9800	0.9690	0.9758	0.6603	76708	96.026	88.53
1.134	22.98	0.481	0.9800	0.9690	0.9758	0.8830	48686	62.582	86.52
1.189	20.12	0.525	0.9800	0.9690	0.9758	0.9176	38283	49.644	84.21
0.537	28.76	0.727	0.9800	0.9690	0.9758	0.4928	84733	92.414	86.93
1.294	13.05	1.191	0.9800	0.9690	0.9758	0.9804	14529	19.353	58.30
	2.17								
	9.25								
	9.24								
	2.22								
	2.23								
	9.41								
	2.16								
1.286	13.84	1.064	0.9758	0.9690	0.9758	0.9349	16697	22.020	60.57
0.882	30.44	0.513	0.9758	0.9690	0.9758	0.7108	75909	94.204	88.60
1.229	17.77	0.549	0.9758	0.9690	0.9758	0.9514	31309	40.570	84.13
1.313	11.19	3016.496	0.9758	0.9690	0.9758	0.9849	6650	8.905	0.04
1.153	22.19	0.469	0.9758	0.9690	0.9758	0.9036	47111	60.199	87.16
0.578	28.81	0.656	0.9758	0.9690	0.9758	0.5364	86733	93.486	87.65
1.036	27.15	0.467	0.9758	0.9690	0.9758	0.8227	63850	80.484	87.79
	74.10								
	2.21								
	2.22								
	2.22								
	2.23								
	9.41								
	70.62								
0.611	30.30	0.678	0.9718	0.9690	0.9758	0.5210	82264	96.584	88.90
1.210	18.91	0.541	0.9718	0.9690	0.9758	0.9327	35368	46.018	81.71
1.163	21.65	0.456	0.9718	0.9690	0.9758	0.9078	45881	58.915	88.85
1.261	13.85	0.907	0.9718	0.9690	0.9758	0.9545	16835	22.326	71.92
1.030	26.98	0.455	0.9718	0.9690	0.9758	0.8159	63636	80.399	90.43
0.861	30.26	0.520	0.9718	0.9690	0.9758	0.6873	75274	94.293	89.81
1.330	10.91	895.725	0.9718	0.9690	0.9758	0.9866	6278	8.531	0.15
	2.18								
	2.14								
	9.41								
	2.22								
	2.23								
	9.41								

Tire Combination No. 4
Pressure 2
Experimental Data

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File	Hitch Centre	L. Axle Torque	R. Axle Torque	Cal. Front Torque	Fuel_Rate	Hitch Draft	Time	Fifth Wheel	Rear Wheel Rotation	Fr. Shaft Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt4p2r1a	458	111	-32	477	2.156212	351	2.92	0	0	0
t4p2r1l5	66974	25397	25384	12471	30.98133	67417	35.35	15215	17653	13580
t4p2r1l2	29987	11773	12288	6310	19.53118	30380	25.02	15301	13010	10008
t4p2r1l0	463	4136	4060	-713	11.17519	359	22.73	15425	12098	9307
t4p2r1l6	75434	28960	29049	13430	29.2626	76102	49.27	15105	21805	16774
t4p2r1l1	12367	7643	7350	1857	14.40188	12534	23.85	15647	12588	9684
t4p2r1l4	59068	21868	22488	11479	28.11779	59812	30.86	15262	15509	11931
t4p2r1l3	40865	15860	15062	8602	22.14379	41137	25.78	15088	13188	10145
zt4p2r1b	455	46	-75	467	78.88485	328	2.66	0	0	0
t4p2r1p1	-6704	-103	-291	266	9.317722	-7203	27.79	15712	11853	9468
t4p2r1p1	-7017	-113	-292	265	9.249952	-7499	28.07	15764	11945	9540
t4p2palp	-2542	-65	-307	279	2.209969	-2985	27.16	15960	12041	9635
t4p2palp	-2326	-70	-307	280	2.14505	-2800	27.11	15923	12022	9621
t4p2palp	-2524	-70	-306	281	2.142508	-2997	27.5	16142	12191	9757
zt4p2r2a	423	180	-55	479	2.146519	384	3.22	0	0	0
t4p2r2l1	10102	7247	6906	1516	14.09541	10569	23.68	15467	12439	9569
t4p2r2l5	67819	25318	26018	12315	30.35245	67516	34.52	15288	17140	13185
t4p2r2l6	76392	28628	28789	13654	30.08614	77380	44.4	15256	20371	15669
t4p2r2l4	56213	22032	20545	10893	26.57912	56774	29.05	15131	14635	11257
t4p2r2l0	427	4719	4326	-1303	11.20226	395	22.78	15368	12092	9301
t4p2r2l2	34614	14538	12977	7364	20.49135	35035	25.44	15254	13088	10067
t4p2r2l3	41453	15761	15753	8632	22.16438	41738	26.24	15214	13429	10330
zt4p2r2b	436	100	-74	481	2.123999	382	2.81	1	0	0
t4p2r2p1	-7638	-115	-285	260	9.303129	-8020	27.88	15493	11835	9460
t4p2r2p2	-7221	-84	-277	255	9.240063	-7703	28.07	15659	11896	9517
t4p2palp	-2542	-65	-307	279	2.209969	-2985	27.16	15960	12041	9635
t4p2palp	-2326	-70	-307	280	2.14505	-2800	27.11	15923	12022	9621
t4p2palp	-2524	-70	-306	281	2.142508	-2997	27.5	16142	12191	9757
zt4p2r3a	359	183	-64	487	2.108394	247	3.86	0	0	0
t4p2r3l6	75314	28456	27938	13891	30.51062	75824	46.15	15310	21649	16653
t4p2r3l2	33351	13126	13084	6930	19.89271	33498	24.96	15136	12866	9897
t4p2r3l0	352	4509	4204	-1325	11.03864	259	22.8	15473	12131	9336
t4p2r3l5	67712	24689	26445	12450	30.36101	68301	33.89	15240	16837	12953
t4p2r3l3	41257	14839	16119	8353	21.90507	41855	25.28	15030	12972	9978
t4p2r3l4	57835	20564	22334	10998	26.76584	58554	28.92	15294	14544	11192
t4p2r3l1	11684	8071	7389	1144	14.08668	11929	23.4	15251	12276	9448
zt4p2r3b	356	65	-129	492	2.196142	242	4.29	0	0	0
t4p2r3p1	-5995	-57	-301	264	2.049321	-6454	27.16	15521	11752	9420
t4p2r3p2	-6877	-58	-305	272	2.153473	-7412	27.94	15691	11885	9526
t4p2palp	-2542	-65	-307	279	2.209969	-2985	27.16	15960	12041	9635
t4p2palp	-2326	-70	-307	280	2.14505	-2800	27.11	15923	12022	9621
t4p2palp	-2524	-70	-306	281	2.142508	-2997	27.5	16142	12191	9757

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File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[[RPS]	[pulses]	[RPS]	[m]
t4p2r1a	458	111	-32	477	351	2.93	0	0.000	0	0.000	
t4p2r1i5	66517	25319	25438	11998	67078	35.36	17653	0.223	13580	0.297	0.6042
t4p2r1i2	29530	11695	12342	5838	30040	25.03	13010	0.233	10008	0.310	0.8199
t4p2r1i0	6	4058	4114	-1186	20	22.74	12098	0.238	9307	0.317	0.8817
t4p2r1i6	74977	28882	29102	12958	75762	49.28	21805	0.198	16774	0.264	0.4892
t4p2r1i1	11910	7564	7403	1385	12194	23.86	12588	0.236	9684	0.314	0.8474
t4p2r1i4	58611	21790	22542	11006	59473	30.87	15509	0.225	11931	0.299	0.6878
t4p2r1i3	40408	15782	15115	8130	40797	25.79	13188	0.229	10145	0.305	0.8088
t4p2r1b	455	46	-75	467	328	2.67	0	0.000	0	0.000	
t4p2r1p1	average	values	across	the field =			11861		9488.5		0.8993
t4p2r1p1	average	values	within the	section =		27.94	11899	0.191	9504	0.263	0.8964
t4p2palp											
t4p2palp	average	values	on the	pavement		27.26667	12084.67	0.198	9671	0.275	0.8827
t4p2palp											
zt4p2r2a	423	180	-55	479	384	3.23	0	0.000	0	0.000	
t4p2r2i1	9672	7107	6970	1035	10186	23.69	12439	0.235	9569	0.313	0.8575
t4p2r2i5	67390	25178	26083	11835	67133	34.53	17140	0.222	13185	0.296	0.6223
t4p2r2i6	75963	28488	28853	13174	76997	44.41	20371	0.205	15669	0.273	0.5236
t4p2r2i4	55784	21892	20609	10413	56391	29.06	14635	0.225	11257	0.300	0.7288
t4p2r2i0	-3	4579	4390	-1783	12	22.79	12092	0.238	9301	0.316	0.8821
t4p2r2i2	34185	14398	13042	6884	34652	25.45	13088	0.230	10067	0.306	0.8150
t4p2r2i3	41023	15621	15817	8152	41355	26.25	13429	0.229	10330	0.305	0.7943
zt4p2r2b	436	100	-74	481	382	2.82	0	0.000	0	0.000	
t4p2r2p1	average	values	across	the field =			11861		9488.5		0.8993
t4p2r2p2	average	values	within the	section =		27.985	11865.5	0.190	9488.5	0.263	0.8990
t4p2palp											
t4p2palp	average	values	on the	pavement		27.26667	12084.67	0.198	9671	0.275	0.8827
t4p2palp											
zt4p2r3a	359	183	-64	487	247	3.87	0	0.000	0	0.000	
t4p2r3i6	74957	28332	28034	13402	75580	46.16	21649	0.210	16653	0.279	0.4927
t4p2r3i2	32993	13002	13180	6441	33254	24.97	12866	0.231	9897	0.307	0.8291
t4p2r3i0	-5	4385	4300	-1815	15	22.81	12131	0.238	9336	0.317	0.8793
t4p2r3i5	67354	24566	26541	11960	68056	33.9	16837	0.222	12953	0.296	0.6335

[illegible]

Tire Combination No. 4
Pressure 2

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Tractive Eff A	Vehicle Speed	Fuel Rate	F R/D P case A	Beta (field)	Beta (pavement)	Beta (field)	1-eq.slip	Total Thrust	Total Power	Efficiency of Motion
[%]	[m/s]	[l/h]	[l/h/kw]					[N]	[kW]	[%]
		2.16								
60.29	0.848	30.98	0.549	0.9627	0.9608	0.9612	0.6808	75118	93.691	88.55
76.53	1.199	19.53	0.552	0.9627	0.9608	0.9612	0.9281	35814	46.498	82.45
0.08	1.319	11.18	1432.707	0.9627	0.9608	0.9612	0.9850	7288	9.866	0.08
48.78	0.609	29.26	0.641	0.9627	0.9608	0.9612	0.5508	84660	93.622	88.56
60.70	1.257	14.40	0.962	0.9627	0.9608	0.9612	0.9597	18832	24.944	63.24
68.44	0.972	28.12	0.494	0.9627	0.9608	0.9612	0.7755	66421	83.340	88.24
78.68	1.163	22.14	0.471	0.9627	0.9608	0.9612	0.9152	47001	60.000	85.97
		78.88								
		9.32								
		9.25								
		2.21								
		2.15								
		2.14								
		2.15								
57.20	1.266	14.10	1.151	0.9616	0.9608	0.9612	1.0203	17253	22.824	56.06
62.64	0.869	30.35	0.518	0.9616	0.9608	0.9612	0.6994	75237	93.554	89.57
53.16	0.676	30.09	0.586	0.9616	0.9608	0.9612	0.5883	84061	96.594	90.37
72.27	1.032	26.58	0.462	0.9616	0.9608	0.9612	0.8202	63305	79.829	88.12
-0.04	1.316	11.20	-3052.092	0.9616	0.9608	0.9612	0.9841	7233	9.844	-0.04
76.50	1.179	20.49	0.509	0.9616	0.9608	0.9612	0.9202	41119	52.939	83.14
77.33	1.143	22.16	0.473	0.9616	0.9608	0.9612	0.8957	47518	60.845	86.33
		2.12								
		9.30								
		9.24								
		2.21								
		2.15								
		2.14								
		2.11								
49.81	0.650	30.51	0.626	0.9593	0.9608	0.9612	0.5518	83046	97.878	90.26
79.29	1.201	19.89	0.502	0.9593	0.9608	0.9612	0.9350	38907	50.365	84.80
-0.07	1.315	11.04	-1627.662	0.9593	0.9608	0.9612	0.9806	6835	9.377	-0.08
63.74	0.885	30.36	0.509	0.9593	0.9608	0.9612	0.7097	75004	93.629	89.80
81.76	1.186	21.91	0.451	0.9593	0.9608	0.9612	0.9267	46354	59.719	88.23
74.29	1.037	26.77	0.449	0.9593	0.9608	0.9612	0.8226	63647	80.399	90.31
59.87	1.282	14.09	0.970	0.9593	0.9608	0.9612	0.9569	18106	24.047	62.56
		2.20								
		2.05								
		2.15								
		2.21								
		2.15								
		2.14								

Tire Combination No. 4
Pressure 3
Experimental Data

File	Hitch Centre	L Axle Torque	R Axle Torque	Cal. Front Torque	Fuel Rate	Hitch Draft	Time	Fifth Wheel	Rear Wheel Rotation	Fr. Shaft Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt4p3r1a	342	30	-152	505	2.086231	-11	4.37	0	0	0
t4p3r1i0	348	2061	1772	2000	11.21333	-9	22.97	15572	12196	9382
t4p3r1i3	42854	16765	15820	8387	22.50134	43124	26.07	15259	13366	10284
t4p3r1i5	69241	26336	24522	12322	30.17609	69185	33.16	15063	16523	12709
t4p3r1i6	75998	29568	27203	13568	30.59991	76011	44.07	14966	20655	15888
t4p3r1i1	10827	5698	5243	2822	13.43405	11123	23.72	15595	12465	9589
t4p3r1i2	31837	13019	11882	6443	19.0438	32204	24.9	15188	12829	9868
t4p3r1i4	57257	21881	21165	10684	26.54603	57067	28.74	15244	14415	11090
zt4p3r1b	338	226	-155	491	50.03241	-32	4.2	0	0	0
t4p3r1p1	-6630	-266	-558	398	2.194756	-7337	29.71	15790	12183	9378
t4p3r1p2	-5727	-213	-519	339	9.259917	-6204	27.58	15850	12206	9442
t4p3palp	-3642	-215	-650	270	2.217127	-4355	28.68	15976	12262	9573
t4p3palp	-3440	-195	-643	270	2.215821	-4128	28.8	16040	12323	9620
t4p3palp	-3671	-196	-641	270	9.121598	-4341	28.65	15959	12255	9568
zt4p3r2a	309	147	-230	434	2.071935	192	4.61	0	0	0
t4p3r2i1	11096	5966	5845	2855	13.37735	11330	23.98	15659	12608	9698
t4p3r2i4	61024	22164	23492	10871	27.41713	61642	28.53	14854	14312	11010
t4p3r2i2	32917	12724	13079	6244	19.22482	33144	24.68	15319	12754	9813
t4p3r2i3	42143	15867	16549	7708	22.00981	42558	25.32	15086	12956	9968
t4p3r2i5	69793	25154	25685	12095	29.46784	69960	31.98	15161	15860	12203
t4p3r2i6	77975	29201	29500	13442	30.58058	78101	42.09	15233	19561	15047
t4p3r2i0	301	2301	1933	835	10.76493	247	22.71	15405	12097	9306
zt4p3r2a	309	147	-230	434	2.071935	192	4.61	0	0	0
t4p3r2p1	-6400	-216	-531	355	2.017679	-7070	28.06	15608	12177	9406
t4p3r2p2	-7181	-293	-652	312	2.174948	-7920	27.73	15658	12196	9420
t4p3palp	-3642	-215	-650	270	2.217127	-4355	28.68	15976	12262	9573
t4p3palp	-3440	-195	-643	270	2.215821	-4128	28.8	16040	12323	9620
t4p3palp	-3671	-196	-641	270	9.121598	-4341	28.65	15959	12255	9568
zt4p3r3a	171	24	-320	473	2.178481	-338	2.06	0	0	0
t4p3r3i0	167	2288	1642	773	11.09412	-349	23.06	15687	12266	9438
t4p3r3i2	32318	13407	11778	5910	19.43495	32132	24.55	15191	12696	9768
t4p3r3i3	40717	15689	14225	7713	21.53327	40939	25.55	15258	13109	10085
t4p3r3i5	42753	16068	17036	7928	22.48746	42641	26.03	15461	13287	10221
t4p3r3i4	60191	21666	23026	10779	27.67714	60222	28.94	15412	14590	11224
t4p3r3i6	76354	28346	28095	13099	31.71152	76467	37.02	14910	18136	13951
t4p3r3i1	10611	5995	5375	2208	13.41753	10596	23.7	15560	12456	9582
zt4p3r3b	172	57	-315	390	2.179767	-363	2.51	0	0	0
t4p3r3p1	-5981	-246	-710	296	2.283881	-6560	27.98	15709	12250	9480
t4p3r3p2	-6422	-263	-705	297	8.950742	-7136	29.09	15962	12428	9633
t4p3palp	-3642	-215	-650	270	2.217127	-4355	28.68	15976	12262	9573
t4p3palp	-3440	-195	-643	270	2.215821	-4128	28.8	16040	12323	9620
t4p3palp	-3671	-196	-641	270	9.121598	-4341	28.65	15959	12255	9568

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File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	RRadius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt4p3r1a	342	30	-152	505	-11	4.38	0	0.000	0	0.000	
t4p3r1i0	8	1933	1925	1503	13	22.98	12196	0.238	9382	0.316	0.8746
t4p3r1i3	42514	16637	15974	7889	43145	26.08	13366	0.229	10284	0.305	0.7980
t4p3r1i5	68901	26208	24675	11824	69206	33.17	16523	0.223	12709	0.297	0.6456
t4p3r1i6	75658	29440	27357	13070	76033	44.08	20655	0.210	15888	0.279	0.5164
t4p3r1i1	10487	5570	5396	2325	11144	23.73	12465	0.235	9589	0.313	0.8557
t4p3r1i2	31497	12891	12036	5945	32225	24.91	12829	0.231	9868	0.307	0.8314
t4p3r1i4	56917	21753	21319	10187	57089	28.75	14415	0.224	11090	0.299	0.7400
zt4p3r1b	338	226	-155	491	-32	4.21	0	0.000	0	0.000	
t4p3r1p1	average	values	across	the field =		12240			9459.833		0.8715
t4p3r1p2	average	values	within the	section =	28.655	12194.5	0.190		9410	0.254	0.8747
t4p3palp											
t4p3palp	average	values	on the	pavement	28.72	12280	0.191		9587	0.259	0.8686
t4p3palp											
zt4p3r2a	309	147	-230	434	192	4.62	0	0.000	0	0.000	
t4p3r2i1	10787	5819	6074	2421	11138	23.99	12608	0.235	9698	0.313	0.8460
t4p3r2i4	60715	22017	23722	10437	61450	28.54	14312	0.224	11010	0.299	0.7453
t4p3r2i2	32607	12577	13309	5809	32952	24.69	12754	0.231	9813	0.308	0.8363
t4p3r2i3	41834	15719	16779	7274	42366	25.33	12956	0.229	9968	0.305	0.8233
t4p3r2i5	69483	25007	25915	11660	69768	31.99	15860	0.222	12203	0.295	0.6725
t4p3r2i6	77666	29054	29730	13007	77909	42.1	19561	0.208	15047	0.277	0.5453
t4p3r2i0	-8	2154	2163	400	55	22.72	12097	0.238	9306	0.317	0.8818
zt4p3r2a	309	147	-230	434	192	4.62	0	0.000	0	0.000	
t4p3r2p1	average	values	across	the field =		12240			9459.833		0.8715
t4p3r2p2	average	values	within the	section =	27.905	12186.5	0.195		9413	0.261	0.8753
t4p3palp											
t4p3palp	average	values	on the	pavement	28.72	12280	0.191		9587	0.259	0.8686
t4p3palp											
zt4p3r3a	171	24	-320	473	-338	2.07	0	0.000	0	0.000	
t4p3r3i0	-5	2248	1960	341	2	23.07	12266	0.238	9438	0.317	0.8696
t4p3r3i2	32146	13367	12095	5479	32483	24.56	12696	0.231	9768	0.308	0.8402
t4p3r3i3	40545	15649	14543	7281	41290	25.56	13109	0.230	10085	0.306	0.8137
t4p3r3i5	42582	16028	17353	7496	42992	26.04	13287	0.228	10221	0.304	0.8028
t4p3r3i4	60019	21626	23344	10347	60573	28.95	14590	0.226	11224	0.300	0.7311
t4p3r3i6	76183	28306	28413	12667	76818	37.03	18136	0.219	13951	0.292	0.5881
t4p3r3i1	10440	5954	5692	1777	10947	23.71	12456	0.235	9582	0.313	0.8563
zt4p3r3b	172	57	-315	390	-363	2.52	0	0.000	0	0.000	
t4p3r3p1	average	values	across	the field =		12240			9459.833		0.8715
t4p3r3p2	average	values	within the	section =	28.545	12339	0.193		9556.5	0.259	0.8645
t4p3palp											
t4p3palp	average	values	on the	pavement	28.72	12280	0.191		9587	0.259	0.8686
t4p3palp											

[illegible]

Tire Combination No. 4
Pressure 3

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]				av RRadius	[N]	[kW]	[%]
	2.09								
1.305	11.21	1085.356	0.9965	0.9849	0.9949	1.0008	6704	8.744	0.12
1.150	22.50	0.460	0.9965	0.9849	0.9949	0.9130	49324	62.145	86.19
0.904	30.18	0.484	0.9965	0.9849	0.9949	0.7386	76220	93.334	90.40
0.681	30.60	0.594	0.9965	0.9849	0.9949	0.5908	84882	97.776	89.13
1.264	13.43	1.013	0.9965	0.9849	0.9949	0.9791	16085	20.773	65.20
1.204	19.04	0.502	0.9965	0.9849	0.9949	0.9513	37572	47.566	83.83
1.043	26.55	0.447	0.9965	0.9849	0.9949	0.8466	64790	79.860	87.85
	50.03								
	2.19								
	9.26								
	2.22								
	2.22								
	9.12								
	2.07								
1.251	13.38	0.992	0.9955	0.9849	0.9949	0.9676	17284	22.342	62.41
1.051	27.42	0.430	0.9955	0.9849	0.9949	0.8523	68192	84.103	89.03
1.215	19.22	0.485	0.9955	0.9849	0.9949	0.9564	38445	48.845	84.82
1.184	22.01	0.444	0.9955	0.9849	0.9949	0.9415	48235	60.680	86.73
0.938	29.47	0.452	0.9955	0.9849	0.9949	0.7691	75981	92.649	91.45
0.713	30.58	0.553	0.9955	0.9849	0.9949	0.6236	87020	99.440	89.25
1.320	10.76	-1031.116	0.9955	0.9849	0.9949	1.0078	5544	7.263	-0.14
	2.07								
	2.02								
	2.17								
	2.22								
	2.22								
	9.12								
	2.18								
1.300	11.09	-1841.554	0.9928	0.9849	0.9949	1.0064	5396	6.971	-0.09
1.221	19.43	0.495	0.9928	0.9849	0.9949	0.9739	37947	47.623	84.71
1.174	21.53	0.452	0.9928	0.9849	0.9949	0.9430	46213	57.531	87.74
1.152	22.49	0.458	0.9928	0.9849	0.9949	0.9302	50235	62.224	84.76
1.036	27.68	0.445	0.9928	0.9849	0.9949	0.8471	68060	83.263	88.19
0.810	31.71	0.514	0.9928	0.9849	0.9949	0.6814	85247	101.352	89.37
1.265	13.42	1.016	0.9928	0.9849	0.9949	0.9907	16227	20.703	64.33
	2.18								
	2.28								
	8.95								
	2.22								
	2.22								
	9.12								

Tire Combination No. 4
Pressure 4
Experimental Data

File	Hitch	L. Axle	R. Axle	Cal. Front	Fuel Rate	Hitch	Time	Fifth	Rear Wheel	Fr. Shaft
	Centre	Torque	Torque	Torque		Draft		Wheel	Rotation	Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt4p4r1a	228	183	-246	440	2.3213	203	3.11	0	0	1
t4p4r1l6	77530	28869	29425	14216	29.65635	77539	54.81	15088	24078	18526
t4p4r1l1	10009	4491	4095	4350	13.94665	9905	23.57	15594	12424	9560
t4p4r1l0	238	1105	721	3430	11.83481	207	23.11	15671	12267	9437
t4p4r1l2	31447	12020	12354	6755	19.84209	31581	25.14	15289	12961	9970
t4p4r1l3	42556	16634	16195	8680	23.10197	43295	26.21	15297	13324	10252
t4p4r1l4	59303	22565	21747	10809	27.44204	59815	28.99	15044	14519	11169
t4p4r1l5	68723	27210	24303	12066	30.51383	68814	33.25	15121	16546	12729
zt4p4r1b	245	47	-199	471	2.165626	200	2.28	0	0	0
t4p4r1p1	-8064	-549	-939	544	2.22949	-8541	29.49	15713	12203	9196
t4p4r1p2	-7616	-516	-862	557	9.173951	-7782	28.27	15735	12127	9153
t4p4r1p3	-7793	-509	-792	576	2.064862	-8374	28.27	15688	12173	9162
t4p4palp	-3184	-293	-490	441	9.091952	-3086	28.63	15999	12291	9464
t4p4palp	-2953	-287	-485	431	2.126842	-2870	28.72	16063	12334	9499
t4p4palp	-3169	-281	-493	434	2.096972	-3131	28.59	15964	12262	9444
zt4p4r2a	260	5	-212	546	2.131404	307	2.73	0	0	0
t4p4r2l4	57398	22820	21465	10717	27.26695	58452	29.72	15171	14948	11500
t4p4r2l1	15936	7225	6593	4539	15.22813	16386	23.65	15487	12430	9562
t4p4r2l2	28521	11851	10923	6595	18.92814	29058	24.55	15280	12722	9787
t4p4r2l0	270	1273	989	3632	11.43714	325	23.07	15644	12234	9411
t4p4r2l6	75812	29063	28940	13683	30.17329	76767	49.38	15021	22543	17343
t4p4r2l5	67971	26395	24788	12354	30.64327	68624	33.45	15041	16740	12878
t4p4r2l3	42527	16840	16722	8748	22.74789	42984	26.37	15138	13408	10313
zt4p4r2b	279	88	-199	467	2.153118	302	3.04	1	0	0
t4p4r2p1	-7510	-446	-685	581	9.119808	-7677	28.28	16096	12364	9360
t4p4r2p1	-7885	-448	-694	588	2.143106	-8127	27.94	15861	12223	9225
t4p4r2p1	-7539	-435	-691	582	9.150897	-7707	28.06	15985	12244	9236
t4p4palp	-3184	-293	-490	441	9.091952	-3086	28.63	15999	12291	9464
t4p4palp	-2953	-287	-485	431	2.126842	-2870	28.72	16063	12334	9499
t4p4palp	-3169	-281	-493	434	2.096972	-3131	28.59	15964	12262	9444
zt4p4r3a	349	212	-93	569	2.175331	100	2.32	0	0	0
t4p4r3l2	32869	12083	12419	6382	19.06384	33043	24.79	15449	12793	9841
t4p4r3l6	77316	28752	28233	13545	29.99696	76780	42.89	15121	19662	15128
t4p4r3l4	61453	24218	22224	10944	28.26292	61175	29.09	15101	14621	11247
t4p4r3l0	351	1349	1099	2864	11.10296	127	23.25	15704	12314	9474
t4p4r3l4	61453	24218	22224	10944	28.26292	61175	29.09	15101	14621	11247
t4p4r3l3	42026	16081	16183	7966	22.3269	42473	25.69	15334	13256	10197
t4p4r3l1	14300	6138	6230	4337	14.49477	14999	23.45	15330	12345	9497
zt4p4r3b	348	141	-126	557	77.29906	138	2.71	0	0	0
t4p4r3p1	-6596	-443	-690	560	2.154135	-6675	19.02	15776	12218	9292
t4p4r3p2	-6248	-430	-653	574	2.121577	-6603	27.64	15581	12146	9240
t4p4r3p3	-6982	-445	-660	598	9.299222	-7107	27.74	15710	12253	9277
t4p4palp	-3184	-293	-490	441	9.091952	-3086	28.63	15999	12291	9464
t4p4palp	-2953	-287	-485	431	2.126842	-2870	28.72	16063	12334	9499
t4p4palp	-3169	-281	-493	434	2.096972	-3131	28.59	15964	12262	9444

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch centre	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
z14p4r1a	228	183	-246	440	203	3.12	0	0.000	1	0.000	
t4p4r1i6	77294	28754	29648	13760	77337	54.82	24078	0.197	18526	0.262	0.4430
t4p4r1i1	9773	4375	4318	3894	9703	23.58	12424	0.236	9560	0.314	0.8585
t4p4r1i0	2	990	944	2974	5	23.12	12267	0.238	9437	0.316	0.8695
t4p4r1i2	31211	11905	12577	6300	31379	25.15	12961	0.231	9970	0.307	0.8230
t4p4r1i3	42320	16519	16418	8225	43094	26.22	13324	0.227	10252	0.303	0.8006
t4p4r1i4	59067	22450	21970	10353	59613	29	14519	0.224	11169	0.298	0.7347
t4p4r1i5	68487	27095	24526	11610	68613	33.26	16546	0.223	12729	0.296	0.6447
z14p4r1b	245	47	-199	471	200	2.29	0	0.000	0	0.000	
t4p4r1p1	average	values	across	the field =			12216.78		9237.889		0.8731
t4p4r1p2	average	values	within the	section =	28.68667	12167.67	0.190	9170.333	0.248	0.8766	
t4p4r1p3											
t4p4palp											
t4p4palp	average	values	on the	pavement	28.65667	12295.67	0.192	9469	0.256	0.8675	
t4p4palp											
z14p4r2a	260	5	-212	546	307	2.74	0	0.000	0	0.000	
t4p4r2i4	57129	22773	21670	10210	58147	29.73	14948	0.225	11500	0.300	0.7136
t4p4r2i1	15667	7178	6798	4033	16081	23.66	12430	0.235	9562	0.313	0.8581
t4p4r2i2	28252	11804	11128	6088	28754	24.56	12722	0.232	9787	0.309	0.8384
t4p4r2i0	0	1226	1194	3125	20	23.08	12234	0.237	9411	0.316	0.8719
t4p4r2i6	75543	29016	29145	13177	76462	49.39	22543	0.204	17343	0.272	0.4732
t4p4r2i5	67701	26349	24993	11847	68319	33.46	16740	0.224	12878	0.298	0.6372
t4p4r2i3	42258	16793	16927	8242	42679	26.38	13408	0.228	10313	0.303	0.7955
z14p4r2b	279	88	-199	467	302	3.05	0	0.000	0	0.000	
t4p4r2p1	average	values	across	the field =			12216.78		9237.889		0.8731
t4p4r2p1	average	values	within the	section =	28.10333	12277	0.196	9273.667	0.256	0.8688	
t4p4r2p1											
t4p4palp											
t4p4palp	average	values	on the	pavement	28.65667	12295.67	0.192	9469	0.256	0.8675	
t4p4palp											
z14p4r3a	349	212	-93	569	100	2.33	0	0.000	0	0.000	
t4p4r3i2	32520	11907	12528	5819	32925	24.8	12793	0.231	9841	0.307	0.8338
t4p4r3i6	76968	28575	28343	12982	76661	42.9	19662	0.205	15128	0.273	0.5425
t4p4r3i4	51104	24042	22334	10382	61056	29.1	14621	0.225	11247	0.299	0.7295
t4p4r3i0	2	1172	1209	2301	8	23.26	12314	0.237	9474	0.315	0.8662
t4p4r3i4	61104	24042	22334	10382	61056	29.1	14621	0.225	11247	0.299	0.7295
t4p4r3i3	41677	15904	16293	7403	42354	25.7	13256	0.231	10197	0.307	0.8047
t4p4r3i1	13951	5961	6339	3774	14881	23.46	12345	0.236	9497	0.314	0.8640
z14p4r3b	348	141	-126	557	138	2.72	0	0.000	0	0.000	
t4p4r3p1	average	values	across	the field =			12216.78		9237.889		0.8731
t4p4r3p2	average	values	within the	section =	24.81	12205.67	0.220	9269.667	0.289	0.8739	
t4p4r3p3											
t4p4palp											
t4p4palp	average	values	on the	pavement	28.65667	12295.67	0.192	9469	0.256	0.8675	
t4p4palp											

[illegible]

Tire Combination No. 4
Pressure 4

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRadius		[N]	[kW]	[%]
	2.32								
0.547	29.66	0.701	1.0203	0.9985	1.0169	0.5030	87088	94.773	88.75
1.272	13.95	1.122	1.0203	0.9985	1.0169	0.9760	15709	20.566	62.21
1.298	11.83	4467.162	1.0203	0.9985	1.0169	0.9972	6631	8.794	0.03
1.193	19.84	0.533	1.0203	0.9985	1.0169	0.9351	37298	47.637	83.68
1.144	23.10	0.477	1.0203	0.9985	1.0169	0.9093	49806	62.723	84.97
1.034	27.44	0.449	1.0203	0.9985	1.0169	0.8344	66071	81.951	89.40
0.902	30.51	0.494	1.0203	0.9985	1.0169	0.7321	76155	93.848	89.93
	2.17								
	2.23								
	9.17								
	2.06								
	9.09								
	2.13								
	2.10								
	2.13								
1.009	27.27	0.473	1.0180	0.9985	1.0169	0.8181	66512	82.066	85.89
1.268	15.23	0.767	1.0180	0.9985	1.0169	0.9870	22152	28.582	70.72
1.221	18.93	0.548	1.0180	0.9985	1.0169	0.9621	35553	45.216	79.46
1.300	11.44	21679.297	1.0180	0.9985	1.0169	0.9808	7487	9.809	0.01
0.607	30.17	0.658	1.0180	0.9985	1.0169	0.5424	86764	97.179	87.07
0.897	30.64	0.505	1.0180	0.9985	1.0169	0.7304	76915	94.432	88.02
1.137	22.75	0.473	1.0180	0.9985	1.0169	0.9122	51209	63.883	82.52
	2.15								
	9.12								
	2.14								
	9.15								
	9.09								
	2.13								
	2.10								
	2.18								
1.210	19.06	0.485	1.0125	0.9985	1.0169	0.9518	36710	46.688	88.59
0.699	30.00	0.557	1.0125	0.9985	1.0169	0.6190	84649	95.645	90.93
1.031	28.26	0.449	1.0125	0.9985	1.0169	0.8325	68677	85.059	88.97
1.290	11.10	3638.548	1.0125	0.9985	1.0169	0.9931	6185	8.107	0.04
1.031	28.26	0.449	1.0125	0.9985	1.0169	0.8325	68677	85.059	88.97
1.167	22.33	0.459	1.0125	0.9985	1.0169	0.9184	47974	61.001	86.88
1.279	14.49	0.812	1.0125	0.9985	1.0169	0.9883	19750	25.639	70.64
	77.30								
	2.15								
	2.12								
	9.30								
	9.09								
	2.13								
	2.10								

Tire Combination No. 5
Pressure 1
Experimental Data

File	Hitch Centre	L Axle Torque	R Axle Torque	Cal. Front Torque	Fuel Rate [l/h]	Hitch Draft	Time [sec]	Fifth Wheel [pulses]	Rear Wheel Rotation [pulses]	Fr. Shaft Rotation [pulses]
	[N]	[Nm]	[Nm]	[Nm]		[N]				
zt5p1r1a	378	-26	-225	453	78.84	-145	2.66	1	0	0
t5p1r1i2	31397	12705	12700	5361	19.43	31915	24.94	15340	12871	9902
t5p1r1i4	56991	21621	21267	9657	26.74	56983	28.9	15505	14530	11178
t5p1r1i5	70048	26705	25427	11512	30.56	70128	33.09	15337	16422	12632
t5p1r1i1	14597	7340	6816	2886	14.90	14806	23.86	15550	12521	9631
t5p1r1i0	387	2271	2048	932	11.19	-113	23.06	15572	12280	9447
t5p1r1i6	76277	28444	27984	12818	29.95	76240	40.15	15237	18383	14142
t5p1r1i3	41490	15725	16883	7263	22.38	41879	26.44	15413	13462	10355
zt5p1r1b	379	40	-164	429	2.20	-143	2.38	0	0	0
t5p1r1p1	-6859	-333	-572	317	2.16	-7433	27.24	15409	12076	9328
t5p1r1p2	-6377	-291	-585	276	2.24	-7340	27.91	15688	12238	9463
t5p1r1p3	-6247	-299	-609	282	9.08	-6808	27.99	15635	12204	9441
t5p1palp	-3286	-244	-544	244	2.18	-3424	27.33	15963	12260	9571
t5p1palp	-3100	-250	-540	244	2.02	-3196	27.36	16000	12279	9586
t5p1palp	-3296	-244	-551	244	2.13	-3411	27.54	16085	12357	9652
zt5p1r2a	219	-30	-336	375	52.58	4	4	0	0	1
t5p1r2i2	30955	12676	13144	5652	19.54	31163	25.02	15335	12852	9888
t5p1r2i4	57762	21645	22647	10243	26.93	58472	29.17	15142	14610	11239
t5p1r2i0	208	2286	1882	1660	11.06	20	23.46	15840	12433	9563
t5p1r2i5	66486	24383	25828	11614	30.12	66890	34.19	15010	17138	13183
t5p1r2i1	8936	5477	5022	3007	13.49	8892	23.6	15678	12454	9581
t5p1r2i6	73933	28414	28782	13444	30.24	73703	48.68	15019	22537	17337
t5p1r2i3	41328	15922	16739	7647	22.26	41446	26.32	15204	13462	10356
zt5p1r2b	222	95	-189	367	2.03	23	4.4	0	0	0
t5p1r2p1	-8773	-380	-685	353	2.25	-9303	28.36	15969	12331	9483
t5p1r2p2	-7722	-357	-664	399	2.16	-7918	28.48	15707	12134	9308
t5p1r2p3	-8196	-377	-665	415	2.09	-8577	28.24	15818	12189	9360
t5p1palp	-3286	-244	-544	244	2.18	-3424	27.33	15963	12260	9571
t5p1palp	-3100	-250	-540	244	2.02	-3196	27.36	16000	12279	9586
t5p1palp	-3296	-244	-551	244	2.13	-3411	27.54	16085	12357	9652
zt5p1r3a	290	32	-220	410	1.98	137	3.91	0	0	0
t5p1r3i6	75476	28430	27879	13556	30.79	75330	43.46	14946	20482	15763
t5p1r3i1	17452	8513	7805	3796	15.58	17884	23.95	15447	12525	9635
t5p1r3i2	31222	12795	12729	5697	19.03	31365	25.23	15425	13002	10001
t5p1r3i0	284	2335	2096	1564	10.88	155	22.66	15310	12019	9245
t5p1r3i3	40577	16376	15498	7013	21.94	41300	26.02	15365	13289	10223
t5p1r3i5	69175	26474	25876	11767	30.49	68834	33.16	14951	16506	12697
t5p1r3i4	57692	22983	21222	9860	27.06	57797	29.45	15132	14833	11410
zt5p1r3b	305	83	-201	387	2.21	135	3.51	0	0	0
t5p1r3p1	-7861	-353	-650	411	9.14	-8255	28.45	15533	12072	9278
t5p1r3p2	-7752	-363	-645	400	2.23	-8511	27.54	15614	12076	9275
t5p1r3p3	-7668	-281	-573	319	2.01	-7906	28.42	15676	12161	9394
t5p1palp	-3286	-244	-544	244	2.18	-3424	27.33	15963	12260	9571
t5p1palp	-3100	-250	-540	244	2.02	-3196	27.36	16000	12279	9586
t5p1palp	-3296	-244	-551	244	2.13	-3411	27.54	16085	12357	9652

File	Net Load	Net Left	Net Right	Net Front	Net Load	Average	Av R Wheel	R Wheel	Av F Shaft	F Axle	R Wheel
	Hitch cent	R Torque	R Torque	Torque	Hitch Draft	Time	Rotation	Speed	Rotation	Speed	R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
z5p1r1a	378	-26	-225	453	-145	2.67	0	0.000	0	0.000	
t5p1r1i2	31019	12698	12895	4920	32059	24.95	12871	0.231	9902	0.307	0.8287
t5p1r1i4	56612	21614	21462	9216	57126	28.91	14530	0.225	11178	0.299	0.7341
t5p1r1i5	69670	26698	25621	11071	70272	33.1	16422	0.222	12632	0.296	0.6495
t5p1r1i1	14219	7333	7010	2444	14950	23.87	12521	0.235	9631	0.312	0.8519
t5p1r1i0	9	2264	2242	491	30	23.07	12280	0.238	9447	0.317	0.8686
t5p1r1i6	75899	28437	28179	12377	76383	40.16	18383	0.205	14142	0.273	0.5802
t5p1r1i3	41112	15718	17077	6821	42022	26.45	13462	0.228	10355	0.303	0.7923
z5p1r1b	379	40	-164	429	-143	2.39	0	0.000	0	0.000	
t5p1r1p1	average	values	across	the field =			12164.56		9370		0.8769
t5p1r1p2	average	values	within the	section =	27.72333		12172.67	0.197	9410.667	0.263	0.8763
t5p1r1p3											
t5p1palp											
t5p1palp	average	values	on the	pavement	27.42		12298.67	0.201	9603	0.271	0.8673
t5p1palp											
z5p1r2a	219	-30	-336	375	4	4.01	0	0.000	1	0.000	
t5p1r2i2	30734	12644	13406	5281	31149	25.03	12852	0.230	9888	0.306	0.8300
t5p1r2i4	57542	21612	22909	9872	58458	29.18	14610	0.224	11239	0.298	0.7301
t5p1r2i0	-13	2253	2144	1289	7	23.47	12433	0.237	9563	0.316	0.8579
t5p1r2i5	66266	24350	26090	11243	66876	34.2	17138	0.224	13183	0.299	0.6224
t5p1r2i1	8716	5445	5284	2636	8879	23.61	12454	0.236	9581	0.314	0.8565
t5p1r2i6	73712	28382	29044	13073	73689	48.69	22537	0.207	17337	0.276	0.4733
t5p1r2i3	41108	15890	17002	7277	41432	26.33	13462	0.229	10356	0.305	0.7923
z5p1r2b	222	95	-189	367	23	4.41	0	0.000	0	0.000	
t5p1r2p1	average	values	across	the field =			12164.56		9370		0.8769
t5p1r2p2	average	values	within the	section =	28.37		12218	0.193	9383.667	0.256	0.8730
t5p1r2p3											
t5p1palp											
t5p1palp	average	values	on the	pavement	27.42		12298.67	0.201	9603	0.271	0.8673
t5p1palp											
z5p1r3a	290	32	-220	410	137	3.92	0	0.000	0	0.000	
t5p1r3i6	75178	28372	28089	13158	75194	43.47	20482	0.211	15763	0.281	0.5208
t5p1r3i1	17155	8456	8016	3398	17748	23.96	12525	0.234	9635	0.311	0.8516
t5p1r3i2	30924	12738	12939	5299	31229	25.24	13002	0.231	10001	0.307	0.8204
t5p1r3i0	-13	2278	2306	1166	19	22.67	12019	0.237	9245	0.316	0.8875
t5p1r3i3	40279	16319	15708	6615	41164	26.03	13289	0.229	10223	0.304	0.8027
t5p1r3i5	68878	26416	26086	11369	68698	33.17	16506	0.223	12697	0.296	0.6462
t5p1r3i4	57394	22926	21432	9462	57661	29.46	14833	0.225	11410	0.300	0.7191
z5p1r3b	305	83	-201	387	135	3.52	0	0.000	0	0.000	
t5p1r3p1	average	values	across	the field =			12164.56		9370		0.8769
t5p1r3p2	average	values	within the	section =	28.14667		12103	0.192	9315.667	0.256	0.8813
t5p1r3p3											
t5p1palp											
t5p1palp	average	values	on the	pavement	27.42		12298.67	0.201	9603	0.271	0.8673
t5p1palp											

[illegible]

Tire Combination No. 5
Pressure 1

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRRadius		[N]	[kW]	[%]
	78.84								
1.202	19.43	0.521	0.9946	0.9848	0.9983	0.9468	36716	46.634	84.48
1.038	26.74	0.455	0.9946	0.9848	0.9983	0.8387	63226	78.230	89.54
0.906	30.56	0.484	0.9946	0.9848	0.9983	0.7421	76606	93.565	90.95
1.257	14.90	0.834	0.9946	0.9848	0.9983	0.9734	20099	25.959	70.74
1.300	11.19	961.228	0.9946	0.9848	0.9983	0.9914	5892	7.724	0.15
0.747	29.95	0.528	0.9946	0.9848	0.9983	0.6629	83503	94.097	90.89
1.134	22.38	0.480	0.9946	0.9848	0.9983	0.9053	47838	59.939	85.94
	2.20								
	2.16								
	2.24								
	9.08								
	2.18								
	2.02								
	2.13								
	52.58								
1.199	19.54	0.531	1.0012	0.9848	0.9983	0.9503	37877	47.771	81.14
1.028	26.93	0.455	1.0012	0.9848	0.9983	0.8360	66024	81.198	87.15
1.278	11.06	-685.374	1.0012	0.9848	0.9983	0.9823	6999	9.108	-0.18
0.877	30.12	0.518	1.0012	0.9848	0.9983	0.7127	74889	92.178	88.49
1.271	13.49	1.218	1.0012	0.9848	0.9983	0.9807	16302	21.124	53.46
0.616	30.24	0.666	1.0012	0.9848	0.9983	0.5419	85676	97.409	86.04
1.139	22.26	0.475	1.0012	0.9848	0.9983	0.9073	48751	61.225	84.32
	2.03								
	2.25								
	2.16								
	2.09								
	2.18								
	2.02								
	2.13								
	1.98								
0.690	30.79	0.593	0.9990	0.9848	0.9983	0.5909	83947	98.040	89.55
1.252	15.58	0.725	0.9990	0.9848	0.9983	0.9664	23824	30.866	72.01
1.189	19.03	0.518	0.9990	0.9848	0.9983	0.9310	37141	47.417	83.26
1.323	10.88	-624.305	0.9990	0.9848	0.9983	1.0071	6962	9.148	-0.19
1.153	21.94	0.473	0.9990	0.9848	0.9983	0.9109	46335	58.628	86.93
0.904	30.49	0.489	0.9990	0.9848	0.9983	0.7333	76751	94.656	89.74
1.018	27.06	0.463	0.9990	0.9848	0.9983	0.8161	64629	80.648	88.81
	2.21								
	9.14								
	2.23								
	2.01								
	2.18								
	2.02								
	2.13								

Tire Combination No. 5
Pressure 2
Experimental Data

173

File	Hitch Centre	L. Axle Torque	R. Axle Torque	Cal. Front Torque	Fuel Rate [l/h]	Hitch Draft	Time [sec]	Fifth Wheel [pulses]	Rear Wheel Rotation [pulses]	Fr. Shaft Rotation [pulses]
	[N]	[Nm]	[Nm]	[Nm]		[N]				
zt5p2r1a	360	111	-145	479	2.07	240	3.25	0	0	0
t5p2r1l5	69466	26006	25618	11565	30.76	69352	31.94	15186	16102	12386
t5p2r1l2	33199	13379	13818	5117	19.60	33655	24.65	15277	12836	9873
t5p2r1l6	77551	28738	28015	13268	30.36	77969	39.13	15095	18273	14057
t5p2r1l1	12399	7701	7066	811	13.73	12796	23.74	15366	12449	9577
t5p2r1l4	59440	21993	22614	10018	26.63	59894	29.19	15487	14597	11230
t5p2r1l3	40951	16700	15655	6639	21.45	41328	25.7	15279	13106	10082
t5p2r1l0	358	3243	3080	-382	10.76	259	23.28	15618	12398	9538
zt5p2r1b	361	86	-197	416	3.14	216	3	0	0	0
t5p2r1p1	-6415	-227	-497	280	2.17	-6554	28.29	15599	12167	9558
t5p2r1p2	-6725	-220	-505	262	9.12	-7367	28.79	15741	12227	9577
t5p2r1p2	-6160	-208	-491	263	2.11	-6830	29.09	15962	12405	9716
t5p2palp	-3413	-199	-495	229	2.22	-3769	28.07	15981	12277	9695
t5p2palp	-3214	-186	-486	229	2.16	-3517	28.27	16098	12369	9769
t5p2palp	-3399	-183	-468	230	2.08	-3687	28.19	16041	12318	9726
zt5p2r2a	267	60	-185	471	2.00	447	3.08	0	0	0
t5p2r2l2	29406	15793	15808	554	19.13	29686	25.06	15183	13036	9406
t5p2r2l0	277	3489	3119	-308	10.92	462	23.14	15627	12369	9513
t5p2r2l5	68956	26136	25344	12022	30.74	69574	33.02	15187	16654	12813
t5p2r2l6	75528	28150	27163	13240	30.68	75521	39.17	15084	18778	14448
t5p2r2l1	12017	6988	7055	1468	13.82	12293	23.62	15283	12391	9532
t5p2r2l4	58046	21950	21754	9923	26.39	57752	28.78	15032	14416	11090
t5p2r2l3	40768	15914	16444	6648	21.43	41001	26.09	15247	13320	10247
zt5p2r2b	273	59	-195	464	2.23	425	3.11	0	0	0
t5p2r2p1	-7502	-238	-517	259	2.21	-7732	28.93	15666	12252	9617
t5p2r2p2	-6932	-207	-498	249	8.99	-6967	28.52	15607	12173	9556
t5p2r2p2	-7236	-206	-495	251	2.03	-7326	28.85	15712	12287	9612
t5p2palp	-3413	-199	-495	229	2.22	-3769	28.07	15981	12277	9695
t5p2palp	-3214	-186	-486	229	2.16	-3517	28.27	16098	12369	9769
t5p2palp	-3399	-183	-468	230	2.08	-3687	28.19	16041	12318	9726
zt5p2r3a	337	20	-190	414	2.06	49	2.82	0	0	0
t5p2r3l3	41388	16679	16199	7234	21.83	41599	25.94	15152	13245	10187
t5p2r3l4	59475	22408	21393	10427	26.85	60087	28.71	15040	14382	11063
t5p2r3l5	66771	25071	24399	11931	29.57	67122	32.82	14968	16312	12550
t5p2r3l6	74899	28190	27177	13273	30.47	74790	40.95	15027	19484	14987
t5p2r3l0	332	3288	2953	-236	10.70	60	22.92	15363	12137	9338
t5p2r3l1	8880	6327	5674	763	13.05	9042	23.8	15715	12560	9661
t5p2r3l2	32292	14465	13000	4789	19.33	32608	24.99	15241	12869	9902
zt5p2r3b	329	19	-194	460	1.93	57	2.97	0	0	0
t5p2r3p1	-6656	-192	-485	248	9.03	-6898	28.64	15577	12173	9531
t5p2r3p2	-7433	-204	-490	245	2.09	-7931	28.79	15620	12169	9545
t5p2r3p2	-7869	-208	-505	249	8.92	-8249	29.1	15701	12258	9594
t5p2palp	-3413	-199	-495	229	2.22	-3769	28.07	15981	12277	9695
t5p2palp	-3214	-186	-486	229	2.16	-3517	28.27	16098	12369	9769
t5p2palp	-3399	-183	-468	230	2.08	-3687	28.19	16041	12318	9726

File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axis Speed	R Wheel R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt5p2r1a	360	111	-145	479	240	3.26	0	0.000	0	0.000	
t5p2r1i5	69105	25907	25789	11118	69125	31.95	16102	0.226	12386	0.300	0.6624
t5p2r1i2	32839	13280	13989	4669	33427	24.66	12836	0.233	9873	0.310	0.8310
t5p2r1i6	77190	28639	28186	12821	77741	39.14	18273	0.209	14057	0.278	0.5837
t5p2r1i1	12038	7602	7237	363	12569	23.75	12449	0.235	9577	0.312	0.8568
t5p2r1i4	59079	21894	22785	9571	59667	29.2	14597	0.224	11230	0.298	0.7307
t5p2r1i3	40590	16601	15826	6192	41100	25.71	13106	0.228	10082	0.304	0.8139
t5p2r1i0	-3	3144	3251	-830	32	23.29	12398	0.238	9538	0.317	0.8603
zt5p2r1b	361	86	-197	416	216	3.01	0	0.000	0	0.000	
t5p2r1p1		average	values	across	the field =		12234.56		9589.556		0.8718
t5p2r1p2		average	values	within the	section =	28.73333	12266.33	0.191	9617	0.259	0.8696
t5p2r1p2											
t5p2palp											
t5p2palp		average	values	on the	pavement	28.18667	12321.33	0.196	9730	0.267	0.8657
t5p2palp											
zt5p2r2a	267	60	-185	471	447	3.09	0	0.000	0	0.000	
t5p2r2i2	29136	15734	15998	87	29250	25.07	13036	0.233	9406	0.291	0.8182
t5p2r2i0	6	3430	3309	-775	26	23.15	12369	0.239	9513	0.318	0.8624
t5p2r2i5	68686	26076	25534	11554	69138	33.03	16654	0.226	12813	0.300	0.6405
t5p2r2i6	75258	28091	27353	12772	75085	39.18	18778	0.215	14448	0.286	0.5680
t5p2r2i1	11747	6929	7245	1001	11857	23.63	12391	0.235	9532	0.312	0.8608
t5p2r2i4	57776	21890	21944	9455	57316	28.79	14416	0.224	11090	0.298	0.7399
t5p2r2i3	40498	15855	16634	6180	40565	26.1	13320	0.228	10247	0.304	0.8008
zt5p2r2b	273	59	-195	464	425	3.12	0	0.000	0	0.000	
t5p2r2p1		average	values	across	the field =		12234.56		9589.556		0.8718
t5p2r2p2		average	values	within the	section =	28.77667	12237.33	0.190	9595	0.258	0.8716
t5p2r2p2											
t5p2palp											
t5p2palp		average	values	on the	pavement	28.18667	12321.33	0.196	9730	0.267	0.8657
t5p2palp											
zt5p2r3a	337	20	-190	414	49	2.83	0	0.000	0	0.000	
t5p2r3i3	41056	16660	16391	6797	41546	25.95	13245	0.228	10187	0.304	0.8053
t5p2r3i4	59142	22389	21585	9990	60034	28.72	14382	0.224	11063	0.298	0.7417
t5p2r3i5	66438	25051	24590	11494	67069	32.83	16312	0.222	12550	0.296	0.6539
t5p2r3i6	74566	28170	27369	12835	74737	40.96	19484	0.213	14987	0.283	0.5475
t5p2r3i0	-1	3269	3145	-673	7	22.93	12137	0.237	9338	0.315	0.8788
t5p2r3i1	8547	6307	5866	326	8989	23.81	12560	0.236	9661	0.314	0.8492
t5p2r3i2	31959	14445	13192	4352	32555	25	12869	0.230	9902	0.307	0.8289
zt5p2r3b	329	19	-194	460	57	2.98	0	0.000	0	0.000	
t5p2r3p1		average	values	across	the field =		12234.56		9589.556		0.8718
t5p2r3p2		average	values	within the	section =	28.85333	12200	0.189	9556.667	0.257	0.8743
t5p2r3p2											
t5p2palp											
t5p2palp		average	values	on the	pavement	28.18667	12321.33	0.196	9730	0.267	0.8657
t5p2palp											

R Wheel Slip [%]	F Wheel RRadius [m]	F Wheel Slip [%]	F Axle Power [kW]	R Axle Power [kW]	Drawbar Power_A [kW]	Tractive Eff_A [%]	Front Thrust [N]	Rear Thrust [N]	Alfa (RTh/TTh) [%]	Thrust over Weight	Equivalent Slip [%]
			0.000	0.000							
23.82	0.4977	22.36	20.973	73.276	64.887	68.85	17343	59449	77.42	0.6586	23.47
4.44	0.6244	2.59	9.097	39.921	39.950	81.50	7284	31358	81.15	0.3314	3.82
32.87	0.4386	31.59	22.406	74.615	59.165	60.98	19999	65348	76.57	0.7319	32.56
1.47	0.6437	-0.42	0.713	21.875	15.206	67.32	566	17064	96.79	0.1512	1.49
15.97	0.5490	14.36	17.911	62.817	60.698	75.19	14930	51380	77.49	0.5687	15.57
6.41	0.6115	4.61	11.815	46.491	47.363	81.23	9659	37290	79.43	0.4026	5.91
1.06	0.6464	-0.83	-1.654	9.575	-0.003	-0.04	-1294	7355	121.36	0.0520	1.05
			0.000	0.000							
	0.6429										
	0.6411										
	0.6336										
			0.000	0.000							
6.13	0.6554	-2.01	0.158	46.408	34.865	74.87	135	36405	99.63	0.3134	6.18
1.06	0.6481	-0.86	-1.550	10.127	0.008	0.10	-1207	7731	118.49	0.0560	1.05
26.52	0.4812	25.12	21.811	73.189	62.385	65.67	17983	59211	76.70	0.6620	26.18
34.83	0.4267	33.59	22.919	74.737	57.625	59.01	19878	63608	76.19	0.7160	34.53
1.24	0.6468	-0.66	1.964	20.904	14.914	65.22	1557	16261	91.26	0.1528	1.27
15.11	0.5559	13.48	17.723	61.732	60.204	75.77	14716	50289	77.36	0.5575	14.71
8.13	0.6016	6.36	11.807	46.634	46.549	79.65	9619	37274	79.49	0.4021	7.68
			0.000	0.000							
	0.6429										
	0.6425										
	0.6336										
			0.000	0.000							
7.89	0.6052	6.19	12.983	47.444	47.463	78.55	10536	37801	78.20	0.4145	7.43
15.17	0.5573	13.62	18.726	61.934	61.778	76.59	15486	50296	76.46	0.5641	14.77
25.21	0.4912	23.85	21.382	69.371	60.711	66.90	17918	56778	76.11	0.6397	24.87
37.38	0.4114	36.23	22.853	74.305	54.614	56.21	19897	63524	76.15	0.7154	37.10
-0.52	0.6602	-2.34	-1.333	9.548	-0.001	-0.02	-1043	7336	116.58	0.0540	-0.39
2.87	0.6381	1.08	0.644	18.061	10.769	57.57	506	13924	96.50	0.1237	2.05
5.20	0.6226	3.49	8.387	40.013	38.351	79.24	6746	31611	82.41	0.3289	4.75
			0.000	0.000							
	0.6429										
	0.6451										
	0.6336										

Tire Combination No. 5
Pressure 2

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RR Radius		[N]	[kW]	[%]
	2.07								
0.939	30.76	0.474	0.9808	0.9737	0.9810	0.7653	76792	94.249	89.99
1.217	19.60	0.491	0.9808	0.9737	0.9810	0.9618	38643	49.018	84.98
0.766	30.36	0.513	0.9808	0.9737	0.9810	0.6744	85347	97.021	90.44
1.263	13.73	0.903	0.9808	0.9737	0.9810	0.9851	17630	22.588	68.28
1.027	26.63	0.439	0.9808	0.9737	0.9810	0.8443	66309	80.729	89.10
1.167	21.45	0.453	0.9808	0.9737	0.9810	0.9409	46949	58.307	86.46
1.288	10.76	-3286.956	0.9808	0.9737	0.9810	0.9895	6060	7.922	-0.04
	3.14								
	2.17								
	9.12								
	2.11								
	2.22								
	2.16								
	2.08								
	2.00								
1.197	19.13	0.549	0.9807	0.9737	0.9810	0.9382	36540	46.566	79.74
1.296	10.92	1309.362	0.9807	0.9737	0.9810	0.9895	6525	8.576	0.10
0.908	30.74	0.493	0.9807	0.9737	0.9810	0.7382	77193	95.000	88.98
0.766	30.68	0.532	0.9807	0.9737	0.9810	0.6547	83486	97.655	90.14
1.270	13.82	0.926	0.9807	0.9737	0.9810	0.9873	17818	22.868	65.93
1.042	26.39	0.438	0.9807	0.9737	0.9810	0.8529	65005	79.455	88.88
1.149	21.43	0.460	0.9807	0.9737	0.9810	0.9232	46892	58.441	86.36
	2.23								
	2.21								
	8.99								
	2.03								
	2.22								
	2.16								
	2.08								
	2.06								
1.156	21.83	0.460	0.9816	0.9737	0.9810	0.9257	48337	60.428	84.94
1.045	26.85	0.435	0.9816	0.9737	0.9810	0.8523	65782	80.660	89.91
0.914	29.57	0.487	0.9816	0.9737	0.9810	0.7513	74596	90.753	89.06
0.732	30.47	0.558	0.9816	0.9737	0.9810	0.6290	83421	97.158	89.39
1.308	10.70	-8310.915	0.9816	0.9737	0.9810	1.0039	6292	8.214	-0.02
1.260	13.05	1.212	0.9816	0.9737	0.9810	0.9795	14429	18.705	59.24
1.200	19.33	0.504	0.9816	0.9737	0.9810	0.9525	38357	48.401	83.32
	1.93								
	9.03								
	2.09								
	8.92								
	2.22								
	2.16								
	2.08								

Tire Combination No. 5
Pressure 3
Experimental Data

File	Hitch Centre	L_Axle Torque	R_Axle Torque	Cal. Front Torque	Fuel_Rate [l/h]	Hitch Draft	Time [sec]	Fifth Wheel [pulses]	Rear Wheel Rotation [pulses]	Fr_Shaft Rotation [pulses]
	[N]	[Nm]	[Nm]	[Nm]		[N]				
zt5p3r1a	277	154	-192	442	1.93	5	3.44	0	0	0
t5p3r1i5	69194	26610	25301	11520	30.73	69146	32.47	15080	16263	12511
t5p3r1i2	30617	13001	12900	4839	18.75	30869	25.05	15259	12898	9922
t5p3r1i1	10134	7267	7339	155	13.48	10041	23.61	15383	12391	9540
t5p3r1i6	76444	28311	28645	13246	30.96	76897	39.67	15370	18781	14447
t5p3r1i3	40800	16385	15905	7104	21.56	40986	25.9	15256	13234	10181
t5p3r1i4	60226	23172	22412	10549	27.45	60262	30.11	15187	15050	11578
t5p3r1i0	280	4237	4054	-1706	10.65	53	22.99	15468	12189	9377
zt5p3r1b	281	129	-215	451	2.18	9	3.21	0	0	0
t5p3r1p1	-5823	-169	-447	264	2.27	-6371	28.21	15640	11900	9579
t5p3r1p1	-5859	-181	-450	261	9.06	-6408	28.55	15788	12071	9711
t5p3r1p3	-6590	-161	-451	243	2.18	-7188	27.22	15771	11922	9596
t5p3palp	-2851	-136	-532	170	9.06	-3505	27.88	16007	12091	9720
t5p3palp	-2656	-142	-528	170	2.07	-3328	28.23	16208	12247	9845
t5p3palp	-2885	-135	-533	169	2.14	-3504	27.81	15965	12067	9699
zt5p3r2a	203	137	-256	392	2.06	-53	3.13	0	0	0
t5p3r2i5	68757	25860	26197	12195	30.63	68844	34.24	15109	17104	13158
t5p3r2i2	33270	14365	13673	5596	20.03	33455	25.3	15393	13108	10085
t5p3r2i1	10218	7206	7245	26	13.47	10325	23.54	15443	12444	9572
t5p3r2i4	58649	22749	22286	10049	27.09	58829	28.71	15029	14461	11124
t5p3r2i3	40707	16781	16048	7373	22.09	40961	26.25	15207	13375	10291
t5p3r2i6	75608	30000	27588	13388	30.75	75736	44.36	14926	20853	16074
t5p3r2i0	193	4411	4329	-1632	10.96	-43	22.45	15242	11977	9213
zt5p3r2b	215	140	-223	415	2.17	-36	2.96	0	0	0
t5p3r2p1	-7987	-147	-467	215	2.17	-8528	29.02	15988	12156	9761
t5p3r2p2	-6727	-158	-482	205	9.47	-7513	26.59	15309	11726	9444
t5p3r2p3	-6600	-137	-478	197	2.09	-7204	27.9	15800	12025	9680
t5p3palp	-2851	-136	-532	170	9.06	-3505	27.88	16007	12091	9720
t5p3palp	-2656	-142	-528	170	2.07	-3328	28.23	16208	12247	9845
t5p3palp	-2885	-135	-533	169	2.14	-3504	27.81	15965	12067	9699
zt5p3r3a	254	207	-177	271	2.04	-226	3.13	0	0	1
t5p3r3i0	245	4821	4101	-1299	11.12	-195	23	15629	12208	9390
t5p3r3i6	76140	29067	28508	13478	30.83	76040	44.37	15273	20809	16008
t5p3r3i4	59700	22444	22204	11068	27.75	59781	29.29	15161	14756	11352
t5p3r3i3	40337	15864	16536	7348	21.99	40597	25.68	14896	13085	10065
t5p3r3i2	32719	13750	13727	5523	19.66	32737	25.38	15351	13044	10068
t5p3r3i1	14479	9402	9277	2423	15.61	14651	23.95	15247	12493	9610
t5p3r3i5	65725	25747	25250	12590	30.38	66004	37.45	15123	18686	14375
zt5p3r3b	256	142	-177	398	2.17	-259	3.03	0	0	0
t5p3r3p1	-6280	-134	-498	179	9.38	-6809	27.49	15569	11885	9558
t5p3r3p2	-7087	-136	-502	176	9.11	-7650	27.83	15665	11922	9583
t5p3r3p3	-7911	-140	-517	174	9.09	-8449	28.33	15739	11942	9595
t5p3palp	-2851	-136	-532	170	9.06	-3505	27.88	16007	12091	9720
t5p3palp	-2656	-142	-528	170	2.07	-3328	28.23	16208	12247	9845
t5p3palp	-2885	-135	-533	169	2.14	-3504	27.81	15965	12067	9699

File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axle Speed	R Wheel R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt5p3r1a	277	154	-192	442	5	3.45	0	0.000	0	0.000	
t5p3r1i5	68915	26469	25505	11074	69139	32.48	16263	0.224	12511	0.298	0.6559
t5p3r1i2	30338	12859	13104	4393	30862	25.06	12898	0.230	9922	0.307	0.8270
t5p3r1i1	9855	7125	7543	-291	10033	23.62	12391	0.235	9540	0.313	0.8608
t5p3r1i6	76165	28169	28849	12799	76889	39.68	18781	0.212	14447	0.282	0.5679
t5p3r1i3	40521	16244	16109	6658	40979	25.91	13234	0.229	10181	0.304	0.8060
t5p3r1i4	59947	23030	22615	10103	60254	30.12	15050	0.224	11578	0.298	0.7087
t5p3r1i0	1	4096	4258	-2152	45	23	12189	0.237	9377	0.316	0.8751
zt5p3r1b	281	129	-215	451	9	3.22	0	0.000	0	0.000	
t5p3r1p1	average	values	across	the field =			11949.89		9611.889		0.8926
t5p3r1p1	average	values	within the	section =	28.00333		11964.33	0.191	9628.667	0.266	0.8915
t5p3r1p3											
t5p3palp											
t5p3palp	average	values	on the	pavement	27.98333		12135	0.194	9754.667	0.270	0.8790
t5p3palp											
zt5p3r2a	203	137	-256	392	-53	3.14	0	0.000	0	0.000	
t5p3r2i5	68548	25722	26437	11792	68889	34.25	17104	0.224	13158	0.298	0.6236
t5p3r2i2	33061	14226	13913	5192	33499	25.31	13108	0.232	10085	0.309	0.8137
t5p3r2i1	10009	7067	7484	-377	10369	23.55	12444	0.237	9572	0.315	0.8572
t5p3r2i4	58440	22611	22526	9645	58874	28.72	14461	0.225	11124	0.300	0.7376
t5p3r2i3	40498	16643	16288	6969	41005	26.26	13375	0.228	10291	0.304	0.7975
t5p3r2i6	75399	29862	27828	12984	75780	44.37	20853	0.210	16074	0.281	0.5115
t5p3r2i0	-16	4272	4568	-2036	2	22.46	11977	0.239	9213	0.318	0.8906
zt5p3r2b	215	140	-223	415	-36	2.97	0	0.000	0	0.000	
t5p3r2p1	average	values	across	the field =			11949.89		9611.889		0.8926
t5p3r2p2	average	values	within the	section =	27.84667		11969	0.192	9628.333	0.268	0.8912
t5p3r2p3											
t5p3palp											
t5p3palp	average	values	on the	pavement	27.98333		12135	0.194	9754.667	0.270	0.8790
t5p3palp											
zt5p3r3a	254	207	-177	271	-226	3.14	0	0.000	1	0.000	
t5p3r3i0	-10	4647	4278	-1633	48	23.01	12208	0.237	9390	0.316	0.8737
t5p3r3i6	75885	28892	28685	13143	76282	44.38	20809	0.210	16008	0.279	0.5126
t5p3r3i4	59445	22270	22382	10733	60024	29.3	14756	0.225	11352	0.300	0.7229
t5p3r3i3	40082	15690	16714	7014	40840	25.69	13085	0.228	10065	0.303	0.8152
t5p3r3i2	32464	13575	13904	5188	32980	25.39	13044	0.230	10068	0.307	0.8177
t5p3r3i1	14224	9227	9454	2088	14894	23.96	12493	0.233	9610	0.311	0.8538
t5p3r3i5	65470	25572	25427	12256	66247	37.46	18686	0.223	14375	0.297	0.5708
zt5p3r3b	256	142	-177	398	-259	3.04	0	0.000	0	0.000	
t5p3r3p1	average	values	across	the field =			11949.89		9611.889		0.8926
t5p3r3p2	average	values	within the	section =	27.89333		11916.33	0.191	9578.667	0.266	0.8951
t5p3r3p3											
t5p3palp											
t5p3palp	average	values	on the	pavement	27.98333		12135	0.194	9754.667	0.270	0.8790
t5p3palp											

R Wheel Slip	F Wheel Radius	F Wheel Slip	F Axle Power	R Axle Power	Drawbar Power A	Tractive Eff A	Front Thrust	Rear Thrust	Alfa (RTh/TTh)	Thrust over Weight	Equivalent Slip
[%]	[m]	[%]	[kW]	[kW]	[kW]	[%]	[N]	[N]	[%]		[%]
			0.000	0.000							
26.43	0.4928	23.04	20.757	73.192	63.653	67.75	17295	58297	77.12	0.6483	25.57
7.24	0.6213	2.96	8.464	37.583	36.318	78.87	6861	29122	80.93	0.3086	5.40
3.44	0.6462	-0.93	-0.573	21.642	12.517	59.41	-455	16452	102.84	0.1372	3.30
36.30	0.4267	33.35	22.677	75.902	57.585	58.42	19990	63955	76.19	0.7199	35.55
9.59	0.6055	5.43	12.730	46.476	46.918	79.24	10398	36289	77.73	0.4004	8.10
20.50	0.5325	16.84	18.899	64.147	59.708	71.90	15780	51199	76.44	0.5744	19.49
1.84	0.6575	-2.68	-4.270	12.450	0.001	0.01	-3361	9369	155.95	0.0515	1.50
			0.000	0.000							
	0.6414										
	0.6403										
	0.6320										
			0.000	0.000							
30.02	0.4685	26.83	22.044	73.259	60.042	63.00	18416	58528	76.07	0.6599	29.19
8.69	0.6113	4.53	10.067	40.988	39.187	76.76	8109	31575	79.57	0.3403	7.20
3.82	0.6441	-0.59	-0.746	21.626	12.750	61.06	-589	16328	103.74	0.1350	3.55
17.23	0.5542	13.45	18.179	63.921	61.045	74.36	15063	50648	77.08	0.5635	16.17
10.51	0.5991	6.44	13.290	47.174	46.266	76.52	10884	36952	77.25	0.4102	9.13
42.60	0.3835	40.10	22.889	76.256	50.980	51.42	20278	64734	76.15	0.7290	41.98
0.07	0.6692	-4.51	-4.064	13.259	-0.022	-0.24	-3180	9920	147.18	0.0578	0.33
			0.000	0.000							
	0.6414										
	0.6403										
	0.6320										
			0.000	0.000							
2.39	0.6566	-2.01	-3.244	13.318	-0.012	-0.12	-2538	9971	134.15	0.0637	1.93
42.73	0.3851	40.16	23.069	75.929	51.297	51.82	20421	64323	75.90	0.7268	42.08
19.24	0.5431	15.62	20.235	63.246	60.865	72.91	16676	49883	74.95	0.5708	18.18
8.93	0.6125	4.83	13.371	46.419	46.807	78.28	10897	36200	76.86	0.4039	7.36
8.65	0.6123	4.86	10.011	39.705	38.358	77.15	8061	30699	79.20	0.3324	7.35
4.62	0.6415	0.33	4.075	27.396	17.810	56.59	3244	20870	86.55	0.2068	26.16
36.23	0.4289	33.37	22.885	71.550	52.432	55.52	19042	56975	74.95	0.6519	35.46
			0.000	0.000							
	0.6414										
	0.6436										
	0.6320										

Tire Combination No. 5
Pressure 3

Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RR Radius		[N]	[kW]	[%]
	1.93								
0.924	30.73	0.483	0.9555	0.9566	0.9560	0.7443	75592	93.949	91.17
1.197	18.75	0.516	0.9555	0.9566	0.9560	0.9460	35983	46.047	84.31
1.270	13.48	1.077	0.9555	0.9566	0.9560	0.9670	15997	21.069	61.60
0.756	30.96	0.538	0.9555	0.9566	0.9560	0.6445	83945	98.578	90.73
1.158	21.56	0.459	0.9555	0.9566	0.9560	0.9190	46687	59.207	86.79
0.996	27.45	0.460	0.9555	0.9566	0.9560	0.8051	66978	83.045	89.50
1.304	10.65	12463.8	0.9555	0.9566	0.9560	0.9850	6008	8.181	0.01
	2.18								
	2.27								
	9.06								
	2.18								
	9.06								
	2.07								
	2.14								
	2.06								
0.876	30.63	0.510	0.9559	0.9566	0.9560	0.7081	76944	95.303	89.09
1.185	20.03	0.511	0.9559	0.9566	0.9560	0.9280	39684	51.055	83.31
1.274	13.47	1.057	0.9559	0.9566	0.9560	0.9645	15739	20.880	63.59
1.045	27.09	0.444	0.9559	0.9566	0.9560	0.8383	65711	82.099	88.94
1.142	22.09	0.477	0.9559	0.9566	0.9560	0.9087	47836	60.464	84.66
0.676	30.75	0.603	0.9559	0.9566	0.9560	0.5802	85012	99.145	88.69
1.336	10.96	-504.987	0.9559	0.9566	0.9560	0.9967	6740	9.195	-0.24
	2.17								
	2.17								
	9.47								
	2.09								
	9.06								
	2.07								
	2.14								
	2.04								
1.304	11.12	-891.138	0.9566	0.9566	0.9560	0.9807	7433	10.074	-0.13
0.676	30.83	0.601	0.9566	0.9566	0.9560	0.5792	84744	98.999	89.55
1.024	27.75	0.456	0.9566	0.9566	0.9560	0.8182	66559	83.481	89.31
1.168	21.99	0.470	0.9566	0.9566	0.9560	0.9264	47097	59.790	85.11
1.182	19.66	0.512	0.9566	0.9566	0.9560	0.9265	38759	49.716	83.76
1.252	15.61	0.876	0.9566	0.9566	0.9560	0.7384	24114	31.471	58.99
0.801	30.38	0.579	0.9566	0.9566	0.9560	0.6454	76017	94.436	86.13
	2.17								
	9.38								
	9.11								
	9.09								
	9.06								
	2.07								
	2.14								

Tire Combination No. 5
Pressure 4
Experimental Data

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File	Hitch Centre	L. Axle Torque	R. Axle Torque	Cal. Front Torque	Fuel Rate	Hitch Draft	Time	Fifth Wheel	Rear Wheel Rotation	Fr. Shaft Rotation
	[N]	[Nm]	[Nm]	[Nm]	[l/h]	[N]	[sec]	[pulses]	[pulses]	[pulses]
zt5p4r1a	142	131	-269	461	2.24	-148	2.86	0	0	0
t5p4r1i0	152	5547	5209	-2924	12.12	-153	22.85	15403	12208	9392
t5p4r1i2	31677	13463	13665	4450	19.82	31906	25.02	15271	12880	9907
t5p4r1i4	61740	23305	22734	10615	28.18	62512	29.52	15374	14792	11378
t5p4r1i1	14114	9218	9048	-150	14.77	14485	23.85	15364	12519	9630
t5p4r1i6	77513	28094	29566	13383	30.81	78223	39.99	15387	18635	14335
t5p4r1i5	70511	25321	26989	12273	30.74	71487	33.17	15589	16437	12644
t5p4r1i3	40409	16127	15737	6565	22.01	41088	25.73	15267	13170	10133
zt5p4r1b	172	145	-242	430	65.88	-148	3.31	1	0	0
t5p4r1p1	-6808	-258	-625	239	2.40	-7175	28.13	15695	12001	9799
t5p4r1p2	-6958	-224	-560	250	2.20	-7457	28.34	15639	11867	9692
t5p4r1p3	-6680	-200	-512	255	2.22	-6849	28.41	15432	11768	9613
t5p4palp	-2772	-137	-358	275	2.15	-2951	27.37	15933	12055	9774
t5p4palp	-2545	-146	-363	274	9.35	-2788	27.31	15899	12028	9753
t5p4palp	-2744	-141	-362	273	2.00	-3000	27.73	16143	12208	9899
zt5p4r2a	285	105	-109	426	2.01	110	3.11	0	0	1
t5p4r2i6	77512	30171	28350	13374	29.82	78231	45.25	15559	20410	15701
t5p4r2i1	14477	9434	9435	-316	14.90	14740	23.95	15475	12583	9681
t5p4r2i3	41430	16820	16226	6951	22.07	41975	25.65	15162	13147	10114
t5p4r2i5	69872	25809	25819	12017	30.60	70754	32.36	15471	16106	12390
t5p4r2i0	283	5612	5400	-2619	11.19	137	23.4	15607	12392	9533
t5p4r2i2	31159	13790	13424	4393	19.40	31268	24.85	15165	12824	9865
t5p4r2i4	61872	23264	22954	10947	28.33	62515	29.55	15402	14786	11374
zt5p4r2b	285	53	-206	479	2.18	137	3.29	0	0	0
t5p4r2p1	-6716	-175	-475	260	9.38	-6966	27.29	15438	11772	9608
t5p4r2p2	-6046	-172	-425	260	2.16	-6522	27.4	15650	11952	9742
t5p4r2p3	-7031	-166	-419	254	2.14	-7477	27.71	15699	11920	9722
t5p4palp	-2772	-137	-358	275	2.15	-2951	27.37	15933	12055	9774
t5p4palp	-2545	-146	-363	274	9.35	-2788	27.31	15899	12028	9753
t5p4palp	-2744	-141	-362	273	2.00	-3000	27.73	16143	12208	9899
zt5p4r3a	325	17	-144	426	2.25	134	2.94	0	0	0
t5p4r3i5	68737	25866	24544	12637	30.50	69207	33.16	15266	16494	12687
t5p4r3i3	40254	15759	15595	6963	21.58	40804	25.74	15277	13211	10162
t5p4r3i0	293	5655	5231	-2687	11.58	116	23.09	15485	12231	9409
t5p4r3i1	10787	8836	8899	551	14.74	11012	23.77	15291	12490	9608
t5p4r3i2	32356	14451	14009	5598	19.93	32549	25.55	15357	13157	10122
t5p4r3i6	69204	28234	25348	13014	30.78	69866	41.38	15106	20152	15504
t5p4r3i4	59219	22823	21683	10997	27.63	59747	29.49	15329	14791	11379
zt5p4r3b	296	46	-130	500	2.07	119	3.54	0	0	0
t5p4r3p1	-7292	-155	-417	260	9.05	-7570	28.96	15736	11902	9705
t5p4r3p2	-6844	-152	-401	257	2.11	-7165	27.73	15706	11930	9735
t5p4r3p2	-7690	-150	-399	256	2.12	-7975	27.73	15669	11871	9680
t5p4palp	-2772	-137	-358	275	2.15	-2951	27.37	15933	12055	9774
t5p4palp	-2545	-146	-363	274	9.35	-2788	27.31	15899	12028	9753
t5p4palp	-2744	-141	-362	273	2.00	-3000	27.73	16143	12208	9899

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File	Net Load Hitch centre	Net Left R Torque	Net Right R Torque	Net Front Torque	Net Load Hitch Draft	Average Time	Av R Wheel Rotation	R Wheel Speed	Av F Shaft Rotation	F Axle Speed	R Wheel R Radius
	[N]	[Nm]	[Nm]	[Nm]	[N]	[sec]	[pulses]	[RPS]	[pulses]	[RPS]	[m]
zt5p4r1a	142	131	-269	461	-148	2.87	0	0.000	0	0.000	
t5p4r1i0	-5	5409	5465	-3369	-5	22.86	12208	0.239	9392	0.318	0.8737
t5p4r1i2	31520	13325	13921	4005	32054	25.03	12880	0.230	9907	0.307	0.8281
t5p4r1i4	61583	23168	22990	10170	62660	29.53	14792	0.224	11378	0.298	0.7211
t5p4r1i1	13957	9080	9303	-595	14633	23.86	12519	0.235	9630	0.313	0.8520
t5p4r1i6	77356	27956	29822	12938	78371	40	18635	0.209	14335	0.278	0.5724
t5p4r1i5	70353	25183	27245	11827	71635	33.18	16437	0.222	12644	0.295	0.6489
t5p4r1i3	40252	15990	15993	6120	41236	25.74	13170	0.229	10133	0.305	0.8099
zt5p4r1b	172	145	-242	430	-148	3.32	0	0.000	0	0.000	
t5p4r1p1	average	values	across	the field =			11887		9699.556		0.8973
t5p4r1p2	average	values	within the	section =	28.30333	11878.67	0.188	9701.333	0.265	0.8980	
t5p4r1p3											
t5p4palp											
t5p4palp	average	values	on the	pavement	27.48	12097	0.197	9808.667	0.276	0.8818	
t5p4palp											
zt5p4r2a	285	105	-109	426	110	3.12	0	0.000	1	0.000	
t5p4r2i6	77227	30092	28508	12922	78107	45.26	20410	0.202	15701	0.269	0.5226
t5p4r2i1	14192	9355	9593	-768	14617	23.96	12583	0.235	9681	0.313	0.8477
t5p4r2i3	41144	16741	16383	6498	41852	25.66	13147	0.229	10114	0.305	0.8113
t5p4r2i5	69586	25730	25976	11565	70630	32.37	16106	0.223	12390	0.296	0.6623
t5p4r2i0	-3	5533	5557	-3071	13	23.41	12392	0.237	9533	0.315	0.8608
t5p4r2i2	30874	13711	13581	3941	31144	24.86	12824	0.231	9865	0.307	0.8318
t5p4r2i4	61587	23185	23112	10495	62391	29.56	14786	0.224	11374	0.298	0.7214
zt5p4r2b	285	53	-206	479	137	3.3	0	0.000	0	0.000	
t5p4r2p1	average	values	across	the field =			11887		9699.556		0.8973
t5p4r2p2	average	values	within the	section =	27.47667	11881.33	0.194	9690.667	0.273	0.8978	
t5p4r2p3											
t5p4palp											
t5p4palp	average	values	on the	pavement	27.48	12097	0.197	9808.667	0.276	0.8818	
t5p4palp											
zt5p4r3a	325	17	-144	426	134	2.95	0	0.000	0	0.000	
t5p4r3i5	68427	25834	24681	12175	69080	33.17	16494	0.223	12687	0.296	0.6467
t5p4r3i3	39943	15727	15732	6501	40677	25.75	13211	0.230	10162	0.306	0.8074
t5p4r3i0	-18	5623	5368	-3150	-10	23.1	12231	0.237	9409	0.315	0.8721
t5p4r3i1	10477	8804	9035	88	10885	23.78	12490	0.235	9608	0.313	0.8540
t5p4r3i2	32045	14419	14146	5136	32422	25.56	13157	0.230	10122	0.307	0.8107
t5p4r3i6	68894	28203	25485	12552	69740	41.39	20152	0.218	15504	0.290	0.5293
t5p4r3i4	58909	22792	21820	10534	59621	29.5	14791	0.224	11379	0.299	0.7212
zt5p4r3b	296	46	-130	500	119	3.55	0	0.000	0	0.000	
t5p4r3p1	average	values	across	the field =			11887		9699.556		0.8973
t5p4r3p2	average	values	within the	section =	28.15	11901	0.189	9706.667	0.267	0.8963	
t5p4r3p2											
t5p4palp											
t5p4palp	average	values	on the	pavement	27.48	12097	0.197	9808.667	0.276	0.8818	
t5p4palp											

Tire Combination No. 5
Pressure 4

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Vehicle	Fuel	F R/D P	Beta	Beta	Beta	1-eq.slip	Total	Total	Efficiency
Speed	Rate	case A	(field)	(pavement)	(field)		Thrust	Power	of Motion
[m/s]	[l/h]	[l/h/kw]			av RRRadius		[N]	[kW]	[%]
	2.24								
1.312	12.12	-1828.895	0.9415	0.9483	0.9423	0.9819	6808	9.597	-0.07
1.199	19.82	0.525	0.9415	0.9483	0.9423	0.9545	36644	47.145	86.02
1.016	28.18	0.450	0.9415	0.9483	0.9423	0.8178	67406	84.097	91.36
1.257	14.77	0.842	0.9415	0.9483	0.9423	0.9546	19535	25.959	71.45
0.750	30.81	0.531	0.9415	0.9483	0.9423	0.6478	84703	98.268	91.33
0.904	30.74	0.483	0.9415	0.9483	0.9423	0.7350	76996	94.979	91.37
1.166	22.01	0.469	0.9415	0.9483	0.9423	0.9254	45246	57.747	88.96
	65.88								
	2.40								
	2.20								
	2.22								
	2.15								
	9.35								
	2.00								
	2.01								
0.663	29.82	0.583	0.9428	0.9483	0.9423	0.5910	85585	96.136	90.23
1.252	14.90	0.839	0.9428	0.9483	0.9423	0.9552	19898	26.476	71.32
1.169	22.07	0.459	0.9428	0.9483	0.9423	0.9270	47111	60.196	87.33
0.927	30.60	0.474	0.9428	0.9483	0.9423	0.7500	75774	93.899	91.83
1.282	11.19	-3445.921	0.9428	0.9483	0.9423	0.9770	7526	10.426	-0.03
1.207	19.40	0.521	0.9428	0.9483	0.9423	0.9615	36595	47.207	84.37
1.015	28.33	0.453	0.9428	0.9483	0.9423	0.8182	68066	84.782	90.48
	2.18								
	9.38								
	2.16								
	2.14								
	2.15								
	9.35								
	2.00								
	2.25								
0.904	30.50	0.493	0.9428	0.9483	0.9423	0.7341	75530	93.308	90.60
1.165	21.58	0.464	0.9428	0.9483	0.9423	0.9241	45335	57.878	88.11
1.299	11.58	-507.071	0.9428	0.9483	0.9423	0.9813	7304	10.125	-0.24
1.262	14.74	1.115	0.9428	0.9483	0.9423	0.9521	20043	26.527	52.27
1.174	19.93	0.530	0.9428	0.9483	0.9423	0.9269	39957	51.252	80.20
0.725	30.78	0.616	0.9428	0.9483	0.9423	0.6000	79663	96.397	86.48
1.017	27.63	0.461	0.9428	0.9483	0.9423	0.8197	66360	82.683	88.77
	2.07								
	9.05								
	2.11								
	2.12								
	2.15								
	9.35								
	2.00								

IMAGE EVALUATION TEST TARGET (QA-3)

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989

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