ENGINEERING STUDY ON THE EGYPTIAN RURAL CAR MANUFACTURED LOCALLY

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ABSTRACT

Studied Egyptian rural cars are the agricultural machines which fitted locally with small diesel engines (11 Hp) of irrigation pump and prevalent in the Egyptian countryside, especially delta province. Besides their on-farm application in Egypt, they are also engaged in transportation of agricultural products and human beings on rural roads, variety loads, different forward speeds and multiple models. In spite of their adverse effects due to by luck construction on operators and bystanders, limited information is available concerning the center gravity, rolling resistance and slippage investigation of these local modified machines. This study focused on three types of spreading model in the Egyptian countryside rural car, (pulling of trailer and irrigation crops [PI], Self-propelled trailer and irrigation crops [SI] and Transport and irrigation of crops [TI], three levels of rural car load (0, 550, and 850 kg) and four levels of rural car forward speed (8.5, 9.6, 10.8 and 11.5 km/h). So the objectives of this research were to study the center gravity trends, slippage as well as rolling resistance characteristics and tractive coefficient of Egyptian rural car on above studied different factors in transportation conditions. During measurement and recording the center gravity, slippage and rolling resistance of the rural car, the engine horse power, type of road and also tire sizes as well tires pressure air were fixed to cover the most normal range of the rural car operation in transportation conditions for the field land. The test sites were prepared according to standard measurement test procedures. The results show that the maximum of the traction efficiency 74 % was achieved at forward speed 8.5 km/h, self-trailer and irrigation crops (SI) and rural car load 850 kg. The overall slippage in this case is about 6.5 % lower than the two types of models. In the event that (Contiguity coefficient between the tire and the road, $\mu >$ coefficient of friction, $\tan \beta$, (h/b) mean that the likelihood of rollover is greater than sliding and vice versa.

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INTRODUCTION

Hosta (2004) showed that no other machine is more identified with the hazards of farming as the tractor. Nearly 50% of tractor fatalities come from tractor overturns. Tractors are used for many different tasks. Because the tractor is a versatile machine, operators sometimes stretch the use of the tractor beyond what the machine can safely do. Also, reported that *Center of gravity (CG) is the point where all parts of a physical object balance one another*. On a two-wheel drive tractor, CG is about 10 inches above and 12 inches in front of the rear axle gave the normal position of a tractor's CG. There are two very important points to remember about tractor CG and stability baselines: The tractor will not overturn if the CG stays inside the stability baseline. The CG moves around inside the baseline area as you operate the tractor. There are five main reasons why a tractor's CG moves outside the stability baseline. 1. The tractor is operated on a steep slope. 2. The tractor's CG is raised higher from its natural location 10 inches above the rear axle. 3. The tractor is going too fast for the sharpness of the turn. 4. Power is applied to the tractor's rear wheels too quickly. 5. The tractor is trying to pull a load that is not hitched to the drawbar. **Mansour and Al-Safty (2007)** demonstrated that regarding to the difficulties impeding the spread of rural car such as some damages resulting from the gear box, the gear lever, corona and other reasons that can be attributed to mis driving and use of out date spare parts as well as the lake of experience of many methods of manufactures. Also, they recommended that dealing with such problems and difficulties through providing of suitable raw materials at fair prices, spreading more professional efficient centers of manufacture, maintenance and training workers in this domain. At the same time they concluded that spreading more services for the producing processes and maintenance adherence to standardized particulars in designing to prevent accidents and risk that may occur due to running such car in villages. Also they mentioned that daily variable costs were totally about 44 L.E at a ratio of 96.5% of total cost whereas the net return per month mounted to 470.6 L.E. and the mentioned above were positive concerning the spread of the rural car in Egyptian villages. **Darryl (2008)** indicated that locating the center of gravity of a vehicle is important for anticipating the vehicle's behavior in different situations. The easiest way to find the lateral and longitudinal coordinates of the center of gravity is to place the vehicle on four individual level scales. First, the track and the wheelbase of the vehicle are recorded. Then the weight at each wheel is recorded. The weight from each wheel and geometry are used in moment calculations to find the center of gravity in the longitudinal and lateral equations. Also, he added that the most difficult center of gravity coordinate to attain in a vehicle is the height. There are multiple methods to attain this parameter, one of which is to lift the rear axle of the vehicle so the front to rear wheel centerline creates a certain angleβ, with the horizontal. **Sigrimis et al, (2010)** said that locating the Center of Gravity (CG) in three dimensions (length, width and height) is an important first step to analyzing many aspects of a vehicles performance, especially the handling characteristics. For instance, the length and height dimensions are important when analyzing anti-dive and anti-squat suspension geometry. The width and height dimensions can also tell us a lot about a vehicles roll-over properties. In order to calculate the length and width dimensions of the center of gravity the vehicle will need to be weighed on a level surface. Usually this entails measuring the weight under each wheel. To find the height dimension of the center of gravity, the vehicle will need to be raised (up to a maximum of 45 degrees from horizontal) at one end and the weight under each wheel measured while in the raised position. The present investigation was carried out for better understanding of the center gravity propagation trends as well as slippage and rolling resistance characteristics of rural car on different factors in transportation conditions. **Ingle (2011)** mentioned that the standards associated with agricultural and forestry tractors are more complicated than normally expected. Tractor standards handle mainly three issues:

safety, performance, and interoperability. Also, he added that, the car's ability to walk the straight path (do not turn) has a tendency both sides depends on beating workers. The first factor is the sliding car and the second factor is the car coup. The third factors contiguity coefficient between the tire and the road (μ). With the assumption that the contiguity coefficient μ high-value, the maximum mile either side of the car can walk it depends on the dimensions of the car: the distance between the track L Wheels and center of gravity h. Also, the maximum angle of inclination of the vehicle is $\theta = \tan^{-1}$ (height of center gravity (h) / distance between wheel and center gravity (b). he considered that did not take into account the previous equation looseness ground, the softer tires, suspension system, as well as the speed of the car while going into the turn (centrifugal force). He mentioned that a coup occurred at $\tan \beta > h/b$ and Sliding occurred at $\tan \beta > \mu$ and If $\mu < h/b$ sliding is larger than coup while if $\mu > h/b$ rollover is greater than sliding.

MATERIALS AND METHODS

Some of special workshops in Egyptian Delta governorates were achieved by luck manufacturing of rural car from ubiquitous irrigation pumps. The primeval manufacturing –method without Engineering and technical criteria caused slippage, rolling resistance and overturns this may be due to do not know the center gravity limitation. The main objective of this study is to evaluate the performance of three models from by luck manufacturing rural car that attached of locally irrigation pump for carrying the labors, Agricultural production materials and the yield of crops to choose the suitable options for Egyptian rural conditions. A field experiments were carried out at some workshops in Zifta city in Al-Garbia Governorate to optimum manufacturing of rural car in a small holding area (Egyptian village) and evaluate machine performance during the transporting operation for the first time in Egypt. The experiments were carried out at the tested forward speed (m/s), type of model and three level of load for rural car.

Machine used

Technical data of the studied rural cars

Items	pulling and irrigation [PI]
Length Width Height	2,680 mm 1,500 mm 1,800 mm
Weight	910 kg
Tires	13 x 6.5–6.0
Required power	Recommended: 7.6kW/11 HP
Items	**pulling and transfer [PT]**
Length Width Height	3,600 mm 1,500 mm 1,800 mm
Weight	750 kg
Tires	13 x 6.5–6.0
Required power	Recommended: 7.6kW/11 HP
Items	**pulling , transfer and irrigation [PTI]**
Length Width Height	3,600 mm 1,500 mm 1,800 mm
Weight	1,280 kg
Tires	13 x 6.5–6.0
Required power	Recommended: 7.6kW/11 HP

Measuring instruments:

1. Pallet balance: to measure the mass of rural car at different treatments an ordinary balance (accuracy of 1 kg).

2. Vernier caliper: to measure the dimension of shafts with accuracy 1/20 mm.

3. Stopwatch to record time consumed through a travel of 10 meters length for different units during different experiments. Range, min: 30, Sensitivity: 1

4. Steel tape: to measure length of tracks of plots.

Tested factors

The following parameters were studied to evaluate the performance of the rural car with three replicates for each parameter.

- Four forward speeds (Fs) (8.5, 9.6, 10.8 and 11.5 km/h):

Forward speed is calculated by measuring the necessary time to cover specified experiment and the travel distance

$$V = \frac{S}{T} x\ 3.6\ ....km / h$$

Where:

V = forward speed, km/h; S = travel distance, m and T = time of experiment, s.

- *Three types of rural car as follows:*
- *Pulling of trailer and irrigation crops [PI].*
- *Self-propelled trailer and irrigation crops [SI].*
- *Transport and irrigation of crops [TI].*
- *Three levels of rural car load* (Rl) as follows:

-0 kg, (without load) Rl_1.

- 550 kg, (medium load) Rl_2.

- 850 kg, (maximum load) Rl_3.

Fig.(1) Three studied local manufacture models

a. Pulling of trailer and irrigation crops [PI].

b. Self-propelled trailer and irrigation crops [SI].

c. Transport and irrigation of crops [TI].

Measurements:

1- Drawbar pull (kN)

The spring dynamometer was fixed between rubber wheel tractor and the agricultural rural car during transporting to record the pull required for moving the rural car.

During the above operation obtained the following measurements:

A = Rolling resistance for the working rural car

B = recoding pull by using trailer

Net drawbar pull, kN = B - A

2- Wheel slippage (%)

The slippage was measured by the following formula:

$$S = \frac{FS1 - FS2}{FS1} x\ 100$$

Where:

S = Wheel slip, %

FS1 = traveling speed without load, km/h.

FS2 = traveling speed with load, km/h.

3. Rural car power balance:

3.1. Drawbar pull power (Dp)

Drawbar pull power (kW) = Draft force (kN) x forward speed (km/h)/3.6

3.2. power consumed by rolling resistance(DR).

The rolling resistance can be expressed as:

Fr = c W

Where :

Fr = rolling resistance (N).

C = rolling resistance coefficient (dimensionless). For car tire on solid roads from 0.04 to 0.08 **(The engineering toolbox on line)**

W = mg = normal force =weight of the body (N).

m = mass of body (kg).

g = acceleration of gravity (9.81 m/s^2)

Rolling resistance (kW) = rolling resistance (kN) x forward speed (km/h)/3.6

3.3. Power consumed by slip (DS).

DS =(DP+DR)x (S÷ 100-S)

Where:

DS = Power consumed by slip

DP = Drawbar pull power (kW)

DR = Rolling resistance power (kW)

DS = Slippage (%)

4. Traction efficiency (TE ratio):

Traction efficiency is defined according to **(Sharma and Mukesh 2010)** as follows:

$$TE\ (\%) = \frac{output\ power}{input\ power} = \frac{Dp\ \ power}{axel\ power}$$

5. Center gravity (C.G):

To limit center gravity actually uses pallet balance to weight the rural car in different positions for the model to limit X, Y, and Z direction to give the point of the intersection curves that considering the center gravity of rural car. This achieved at recorded the total weight of the rural car, then placed on her longitudinal side and move it slightly up to take the half of weight and drawing the line, placed also on her laterally side and move it slightly up to take the half of weight and drawing the line and place on her vertical side and move it slightly up to take the half of weight and drawing the line and take the point of the intersection curves that considering the center gravity of rural car (CG). **(Hosta 2004).**

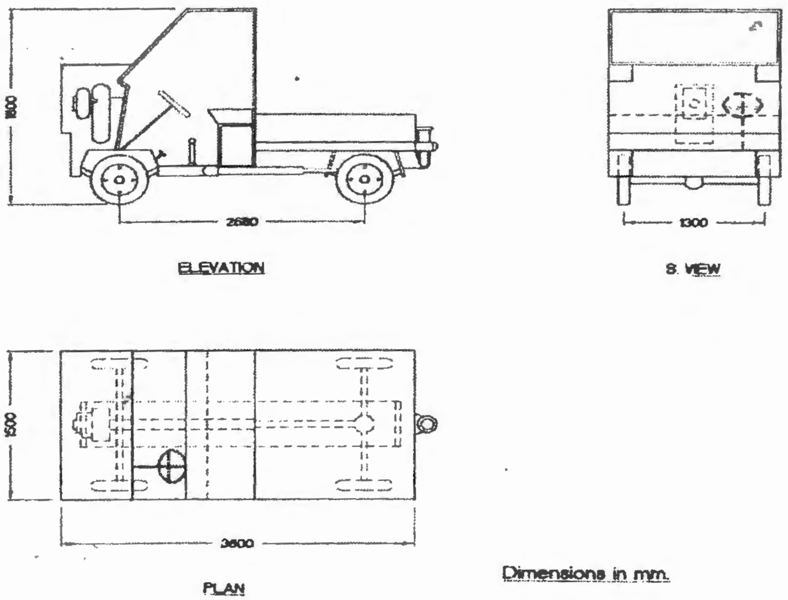

Fig. (2) Three views pulling and irrigation model. (P_1)

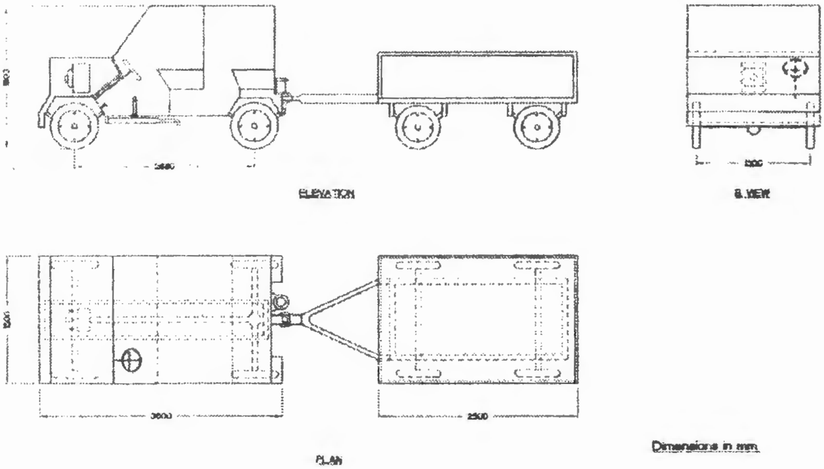

Fig. (3) Three views for self-propelled trailer and irrigation model. (S_T)

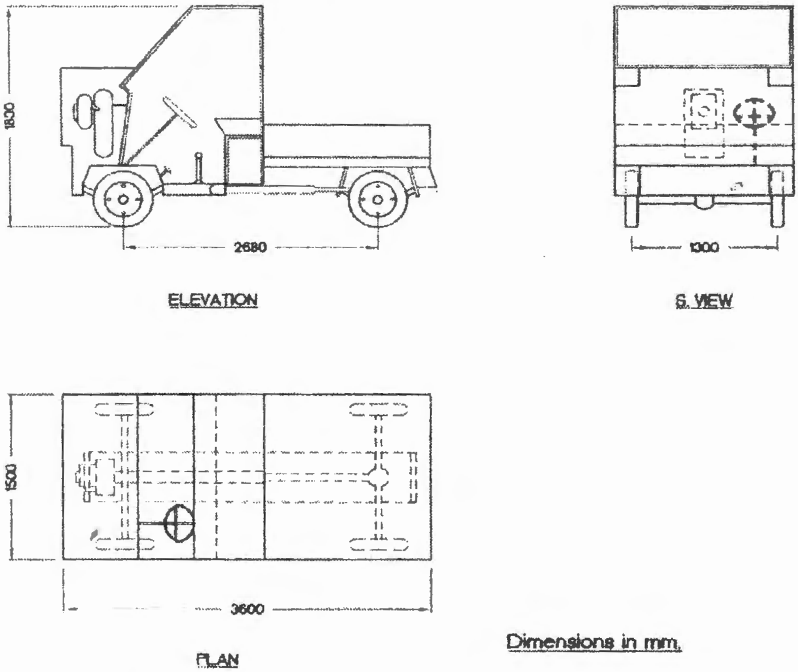

Fig. (4) Three views for transport and irrigation model. (T_I)

Theoretical considerations:

Calculation of center gravity on latitudinal axle for tested rural car.

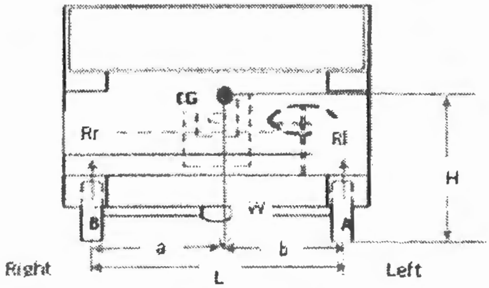

Fig.(5) The normal method for locating rural car CG height

From above mentioned Fig. (5) one can noticed that, total moments around any point equal zero then one can calculating the following:

$$\sum M_b = 0$$

Then total moments around point A = 0 then $R_rL - Wb = 0$ and $R_rL = Wb$

Then $b = \frac{Rr.L}{W} = \frac{Rr}{W} x\, L$

Where:

Rr = reaction force of ground on right wheel = weight on right side

W = the weight of rural car

L = the distance between lift and right center of wheel

a= longitudinal horizontal distance co-ordinate of the Centre of Gravity from center of right wheel.

b= longitudinal horizontal distance co-ordinate of the Centre of Gravity from center of left wheel.

One can noticed that distance of center gravity about right side equal a part from distance between two centers (ratio between the weight on right side to weight of rural car times the distance between two centers), this distance increasing at increment of weight on right side.

From the same mentioned fig. (5).

L = a + b

$a = L- b = L - R_rL/W = L\ (1- Rr/w) = L\ ([w-Rr]/w) = (Rr/w)\ .L$

a= (Rr/w) .L ....(1)

b = L-a = L- R_l/w.L = L (1- Rl/w) = L ([w-Rl]/w) = (Rl/w) .L

b = (Rl/w) .L.....................(2)

Height Dimension

From fig (6) it one is a little more complicated, but the way it is calculated and essentially requires that we assume the rural car is a solid object and that the CG doesn't move, within that object, regardless of the orientation that the object is held at. Since we can't measure the height of the CG with just a tape measure, we rather cleverly measure instead the effect of a known change in the orientation of the whole object. To achieve the most accurate results the suspension should be immobilized as much as possible because either compression or extension of the springs may affect the CG location. The rural car's ability to walk the straight path (do not turn) has a tendency both sides depends on the sliding car and the car coup, the contiguity coefficient between the tire and the road (μ). The maximum mile either side of the car can walk it depends on the dimensions of the car: the distance between the track L Wheels and center of gravity h. Also, the maximum angle of inclination of the vehicle is $\beta = \tan^{-1}$ (h / b). Must be did not take into account the previous equation looseness ground, the softer tires, suspension system, also, the speed of car while going into the turn (centrifugal force).

A coup (Wcos β) bWsin β h >Tanβ > b/h

A coup occurred at Tan β>b/h

End sliding sin β >μcosβ and Sliding occurred at Tan β >μ

If μ <b/h sliding is larger than coup while if μ >b/h rollover is greater than sliding.

Where:

μ= coefficient of contiguity between the frame and the road

β = inclination angle of the side of the road = Tan^{-1} (h/b) = $Sin^{-1}(h_l/L)$.

h = Height of the rural car center

L = a+b = Distance between the wheels (impact), W =Weight of the rural car

a= (Rr/w) .L ....(1)

b = L-a = L- R_l/w.L = L (1- Rl/w) = L ([w-Rl]/w) = (Rl/w) .L

b = (Rl/w) .L.....................(2)

Height Dimension

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L = a+b = Distance between the wheels (impact),   W =Weight of the rural car

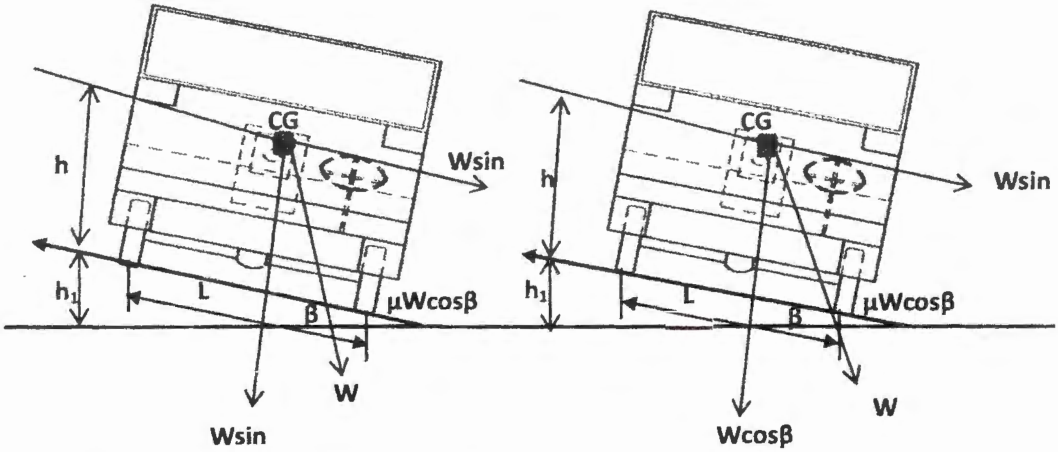

Fig.(6) Modified Reaction Method for Locating Rural Car CG Height

RESULTS AND DISCUSSION

1. Rolling risestance:

Data was graphically in fig. (7) showed that the rolling resistance for the rural car at the tested forward speed (km/h), levels of weight and type of studied rural car. The results revealed that both levels of weight and type of studied rural car affected deeply the rolling resistance at different forward speed. increasing forward speed result increasing rolling resistance. The overall data mentioned that, at the level of weight 1280 kg without loading and type of studied rural car PI under forward speed of 8.5, 9.6, 10.8 and 11.5 km/h, average of rolling resistance was 1123.52, 1348.23, 1593.36 and 1736.36 while at the same mentioned factors with loading 850 kg were 1243, 1456, 1704 and 1854 respectively. From the figures, it was clear that the rolling resistance was higher at SI than PI and TI attached loading. The highest value of rolling resistance 1854 W at SI was obtained under forward speed of 11.5 km/h while the lowest value of the rolling resistance under PI was 1123 W under forward speed of ٨.5 km/h. Data analyzed showed that there was a significant effect for using PI and with loading 850 kg ($p < 0.01$) under the same forward speed. Also, there are a direct proportional between the rolling resistance and forward speed and optimum results achieved at PI, this may be due to at the highest forward speed (11.5km/h) increasing the rolling resistance more than the others forward speed and PI model with heavy load 850 kg caused the same effect that need more power to avoid rolling resistance led to 1850 W.

2. Traction Efficiency:

From data graphically in figure (8) one can noticed that total tractive efficiency decrement linearly with increasing tractor forward speed, but they increment linearly with PI and TI models more than the third model SI. Also, increasing tractor forward speed from 8.5 to 11.5 km/h at model (PI) and load (850 kg) increased the tractive efficiency from 57.39 to 64.76 % respectively. This may be due to increasing forward speed with PI model led to decreasing tractive efficiency that resulting increment of forward speed and decrement of load, that causing gives the smallest of benefit. Also, the higher tractive efficiency achieved with the lowest forward speed, PI model and lowest of tractive efficiency at the highest forward speed (11.5 km/h), connected of SI model that achieved the minimum tractive efficiency this may be due to increment of load which led to increment of tractive efficiency. Also, drawn data caused flow curves (descending) with tractive efficiency; this meant that there was an indirect relationship between tractive efficiency and forward speed and an indirect proportional between tractive efficiency and load. This indicates that optimum type of model was the (SI) and load (850 kg). These optimum factors may be attributed to the excessive manufacturing of the rural car led to increasing of benefit and avoiding accidents. So the forward speed 8.5 km/h, SI model and 850 kg load are recommended for increasing the total benefit and good spreading.

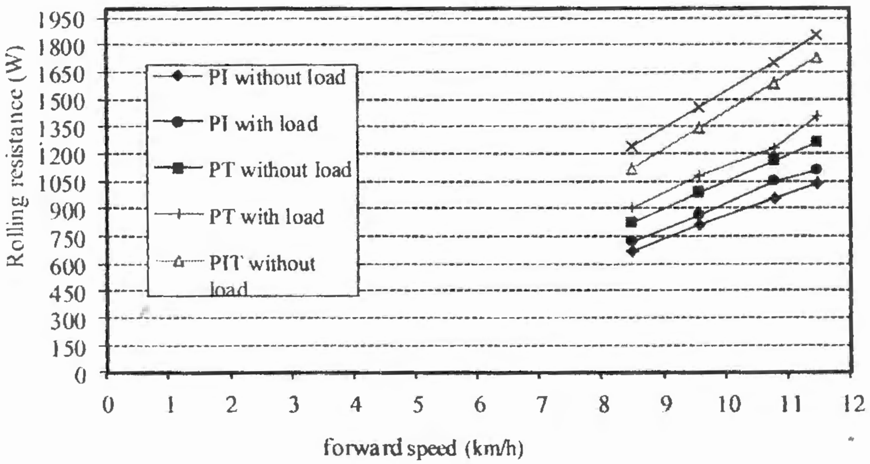

Fig.(7) The rolling resistance (W) at the tested forward speed (km/h) and type of loading for three types of studied rural cars (PI, SI and TI).

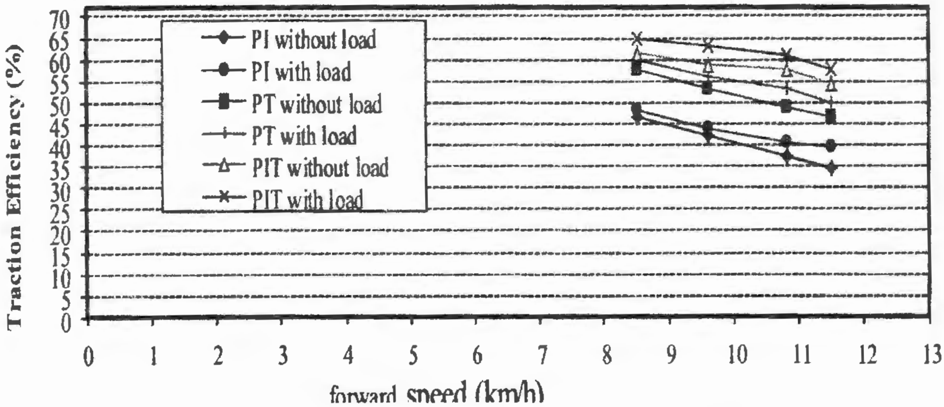

Fig. 8: The traction efficiency (%) for the rural car at the tested forward speed (km/h) and type of loading for three types of studied rural cars (PI, SI and TI).

3. Center gravity:

From the mentioned result of C.G show that the position of C.G according to **Hosta 2004** and calculated the following data in the table.

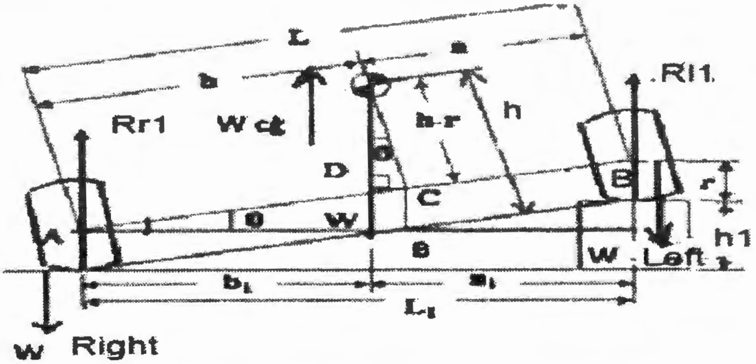

Fig.(9) lifting the rural car to calculate the height of center gravity theoretically.

At lifting the rural car 35 cm from the right side (h_1) and measuring the weight on the right axle (Rr) and calculated the weight on the left axel Rl with subtracting the weight on the right axle from the weight of rural car as follows:

$W = R_{l\,l} + R_{rl}$ and $Rr_l = W - Rl_l$

Taking the torque around point A

$R_{l\,l}(b_l+a_l) = W\, b_l$From the figure6

$\cos\theta = L_l / L = b_l+a_l /L$ and $b_l+a_l = L \cos\theta$

$b_l = AB - CD = b \cos\theta - (h-r) \sin\theta$

$R_{rl}\,(L \cos\theta) = W\, b_l = W\,(b \cos\theta - (h-r) \sin\theta) = W\, b \cos\theta - W\,(h-r) \sin\theta$

$(h-r) = (W.b \cos\theta - R_{rl} \,.\, L \cos\theta) / W \sin\theta$

$h = [(W.\, b \cos\theta - Rr_l \,.\, L \cos\theta) / W \sin\theta] + r)$

where:

h = Height of CG, r = Tire radius, $\theta = \sin^{-1}(h_l/L)$, h_l =height of front axle above horizontal, $R_{l\,l}$ = vertical reaction of left weight, R_{rl} = vertical reaction of right weight and W = weight of rural car

Table (1) showed the dimensions of the three model (PI, SI and TI)

Item	PI			SI			TI		
h_l	0.25	0.3	0.35	0.25	0.3	0.35	0.25	0.3	0.35
L	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
H	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
M	750	750	750	910	910	910	1280	1280	1280
a	0.615	0.63	0.645	0.63	0.645	0.66	0.645	0.66	0.66
b	0.885	0.87	0.855	0.87	0.855	0.84	0.855	0.84	0.84
Rr_l	367.5	360	352.5	436.8	427.7	418.6	601.6	588.8	576
Rl_l	382.5	390	397.5	473.2	482.3	491.4	678.4	691.2	704
h_l/l	0.17	0.20	0.23	0.17	0.20	0.23	0.17	0.20	0.23
β	9.55	11.46	13.37	9.55	11.46	13.37	9.55	11.46	13.37
h-r	0.71	0.44	0.25	0.53	0.30	0.13	0.36	0.15	0.06
(h-r)+r	0.92	0.65	0.46	0.74	0.50	0.33	0.56	0.35	0.27
μ	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
h/b	1.04	0.75	0.54	0.85	0.59	0.39	0.66	0.42	0.32
case	Sliding	Sliding	Sliding	Sliding	Sliding	Rollover	Sliding	Rollover	Rollover

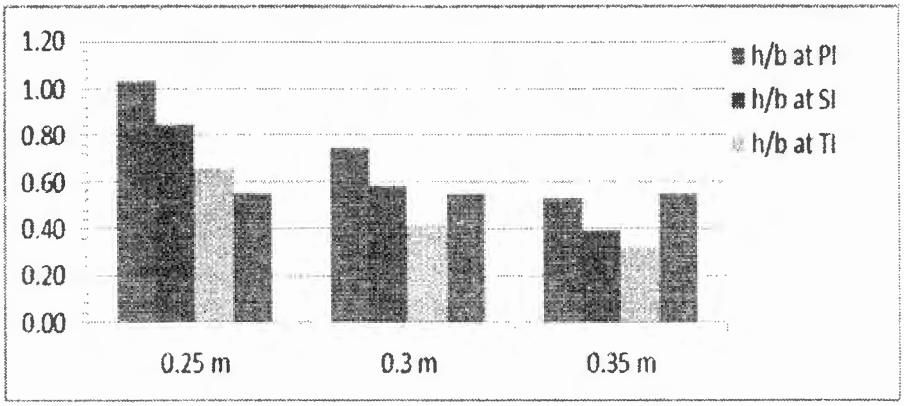

Fig (10) showed when sliding and rollover occurred, If μ <b/h sliding is larger than coup while if μ >b/h rollover is greater than sliding.

From mentioned data, the rural car's ability to walk the straight path (do not turn) has a tendency both sides depends on the sliding car and the car coup. The contiguity coefficient between the tire and the road (μ) was 0.52, the distance between tracks L (1.5 m) and center of gravity (h.). Also, the maximum angle of inclination of the vehicle is $\theta = \tan^{-1}(h / b)$ at lifting the rural car 0.2, 0.25 and 0.3 m noticed that a coup (Wcos β) b/Wsin β h >Tanβ>b/h, a coup occurred at Tan β>h/b, End sliding sin β >μcosβ and Sliding occurred at Tan β >μ, If μ <h/b sliding is larger than coup while if μ > h/b rollover is greater than sliding.

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الملخص العربى

دراسات هندسية على السيارة الريفية المصرية المصنعه محليا

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تعانى القرى المصرية من نقص فى وسائل المواصلات وضيق الطرق المؤدية للمزارع او الحقول وكذلك عدم توافر الطرق الممهدة للتحرك والإنتقال داخل القرى المصرية. ومن ثم كان ذلك مدعاة لظهور السيارة الريفية التى تحقق عدة أغراض منها نقل الأفراد ومستلزمات الإنتاج والمحاصيل الزراعية المنتجة من حقولهم. ومن هنا كان لزاما من التعرض لمثل هذه السيارة الريفية التى فرضت وجودها بمنطقة الدلتا وخاصة من وجهة النظر الهندسية حيث تم تصنيعها بصورة عشوائية من مجرد فنيين وحرفيين دون دراسة هندسية. مما يعرض النماذج الحالية لكثرة الحوادث والأعطال المتعددة. تتناول هذه الدراسة ثلاثة نماذج منتشرة من السيارة الريفية وتركزت عوامل الدراسة على :

دراسة هندسية نظرية على تحديد مركز الثقل لهذه النماذج على وضعها الحالى. مما يمهد للتوصية بإعادة توزيع الأثقال المختلفة لإعطاء مركز ثقل نموذجى مما يجعلها امنه فى التحرك على الطرق المختلفة لا تنزلق او تنقلب. لذا كان الهدف من هذا البحث:

١. تحديد العوامل الهندسية المثلى لتصنيع السيارة الريفية.

٢. دراسة تأثير العوامل الهندسية المختلفة على كفاءة تشغيل الالة.

٣. تقديم التوصيات بالعوامل التشغيلية المثلى للشركات والورش المصنعه لها.

١و٢ باحث اول – معهد بحوث الهندسة الزراعية

أجريت التجارب فى زفتى – محافظة الغربية على النماذج المصنعه من السيارة الريفية.وكانت أهم العوامل الهندسية التى درست: السرعة التقدمية لآلة الزراعة (٨,٥ – ٩,٦– ١٠,٨ – ١١,٥ كم/س) , مستويات التحميل (٠ كجم – ٥٥٠ كجم– ٨٥٠ كجم). النموذج التصنيعى الموجود (جر و رى – مقطورة ذاتية ورى – نقل و رى). وتم تثبيت عوامل أخرى مثل القدرة الحصانية (١١ حصان) و نوع الطريق (طريق زراعى) . كما تم قياس كل من كفاءة الشد ونسبة الإنزلاق و مركز الثقل.

النتائج والتوصيات التطبيقية:

بناء على الدراسات العملية والحسابات النظرية... لوحظ ان النماذج التى درست جميعها معرضة للإنزلاق عندما يكون معامل الإلتصاق بين الإطارات والأرض اصغر من ضعف إرتفاع مركز الثقل مقسوما على المسافة بين عجلة الأرض المستقرة ومركز ثقل السيارة الريفية ($\mu<h/b$) كما وجد ان السيارة الريفية معرضة للإنقلاب على الطرق المائلة عندما تكون معامل الإلتصاق بين الإطارات والأرض اكبر من إرتفاع مركز الثقل مقسوما على المسافة بين عجلة الأرض المستقرة ومركز ثقل السيارة الريفية ($\mu>h/b$) وبناء عليه إرتأت الدراسة ان توصى بعمل بعض التعديلات مثل تخفيض إرتفاع الموتور فى حدود معينة بحيث يكون مركز الثقل فى الحدود الموصى بها...ويكون على إرتفاع امثل بدلا من التذبذب الحادث فى ظروف التصنيع العشوائى الحالية...حتى نتفادى إنقلاب السيارة الريفية على الطرق الزراعية أو إنزلاقها على الطرق المائلة.... كما توجه الدراسة بإستخدام سرعة التقدم ٨,٥ كم/س والنموذج الأمثل هو SI كما يوصى البحث بأن لايزيد الوزن عن٠,٨٥٠ ميجا جرام وكذلك الخامات المستخدمة تحتاج لدراسة هندسية مستفيضة فى أبحاث قادمة.