BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Journal of Mechanical Engineering Research

http://ojs.bilpublishing.com/index.php/jmer

ARTICLE

The Dynamic Simulation of Rotary Inertia on Light vehicle-Slope I

Run Xu* Boyong Hur

Gyeongsang National University, Metallurgical Engineering Department, Gyeongsang nam-do, Chinju, 52828, Korea

ARTICLE INFO

Article history
Received: 13 April 2020
Accepted: 22 April 2020
Published Online: 30 April 2020

Keywords:
Simulation
Dynamic
Light vehicle
Acceleration
Turn bending
Driven force
Torque
Rotation
Slope

ABSTRACT

According to formula we can simulate their driven force and acceleration on the slope. The mechanical formula is used to obtain force and theoretical dynamics in the slope. The driven force decreases when rotation increases. When power increases the acceleration increases. it reduces when its weight raises. It is found that the a will decrease as slope becomes high from 5 to 11° to 22°, which fit the formula too. Meantime as the radius is high from 0.3m to 0.4m to 0.47m a will be low. The needed force will increase as the slope decline becomes big at the same power.

1. Introduction

The power transmission of an light vehicle is driven by power on the gradient, which is generated by the engine. Therefore, the measurement of power is the evaluation of the light vehicle engine system on the gradient, has an important role [1,2,3]. This paper studies the overall performance of the light vehicle, including whether the gradient performance of the light vehicle achieves the best performance, through the power and revolution of the light vehicle engine. The kinematics of the light vehicle takes speed and acceleration as research parameters and acceleration as the main purpose of design. Therefore, the organic combination of power and movement is the real purpose of evaluating the light vehicle. Audi's 3.0t Engine has a maximum power of 333hp, while Mercedes-benz's A45 AMG has a 2.0t engine of 360hp. With the increase of horsepower, their dynamic analysis and kinematics become particularly important. Such as force, acceleration and rotation analysis.The horsepower of a truck is the most important factor. It is the main condition that designers should expect in advance that they can finish the task without failure.The light vehicle's load and acceleration etc. less trouble is the embodiment of its design level ability. The acceleration of the light vehicle is the main performance of the light vehicle, the force and acceleration is directly reflected in its engine function. A good engine function will be achieved in a relatively short

**Corresponding Author:*
Run Xu,
Gyeongsang National University, Metallurgical Engineering Department, Gyeongsang nam-do, Chinju, 52828, Korea;
Email: xurun1206@163.com

 DOI: https://doi.org/10.30564/jmer.v3i2.1800

time in a slope. Therefore, this paper explores whether the data of light vehicle design are feasible based on the high power and acceleration of the light vehicle on here, and discusses the status of high power and high acceleration to meet the needs of future light vehicle development on a slope.

2. Calculation Results

As shown in Figure 1 it is a vehicle driving forwards along the slope with θ. Here a is the tire acceleration, F is the force, and m is the mass. If *C* is the center of mass of the tire, R is the radius of the tire, and Mc is the torque of *C*. *O* is xy original point and *C* is x'y point.

If the vehicle runs at slope plane with θ, there is $md^2R/dt^2=\Sigma F$ and $J_c d^2\varphi/dt^2=\Sigma M_c$

$$F_s = m\sin\theta \tag{1}$$

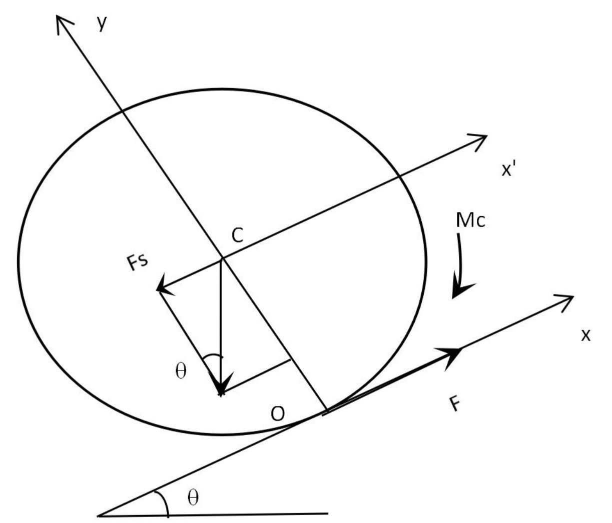


Figure 1. The relation of torque and Force on tire on the slope load in light vehicle, here q is slope angle

Referring to C $\frac{a}{R}\cdot\frac{mR^2}{2}+F\cdot R=M_c$ (2)

Referring to C $M_c = F_s R$ (3)

Substitute to below (4)

$$F-F_s=ma \tag{4}$$

Obtain

$$F=(M_c-\frac{mR^2}{2})/R=M_c/R-\frac{ma}{2} \tag{5}$$

Ie $M_C=\frac{mR^2}{2}+FR$ (6)

Due to $F_s<F$ (7)

Substitute (5) into (2)

$$a\frac{mR}{2}+(M_c/R-\frac{ma}{2})=M_c \tag{8}$$

Ie

$$a=\frac{2M_c(1-1/R)}{m(R-1)} \tag{9}$$

Or due to

$$F-F_s=ma \tag{10}$$

Is $a=(F-F_s)/m=\frac{M}{Rm}-\frac{a}{2}-\sin\theta$ (11)

Ie

$$a=\frac{2}{3}(\frac{M}{Rm}-\sin\theta) \tag{12}$$

and

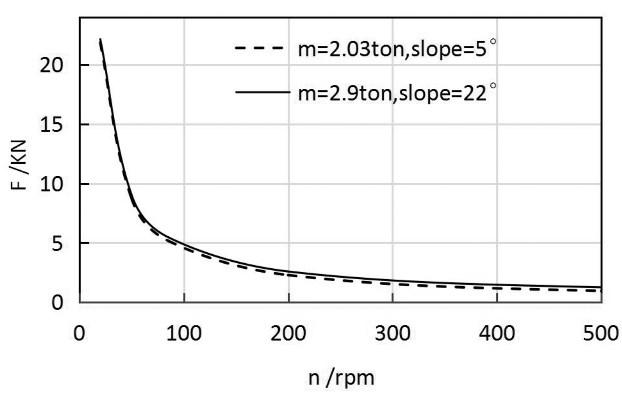
$$F=M/R-\frac{ma}{2} \tag{13}$$

Prove too above equation.

Substitute (12) into above is

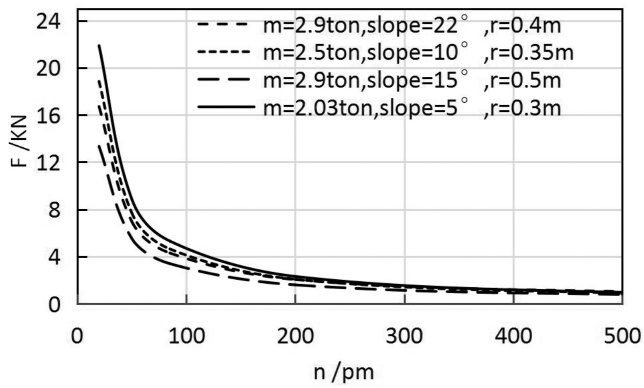
$$F=\frac{2M}{3R}+\frac{m}{3}\sin\theta \tag{14}$$

3. Discussion



(a) r=0.5m

DOI: https://doi.org/10.30564/jmer.v3i2.1800



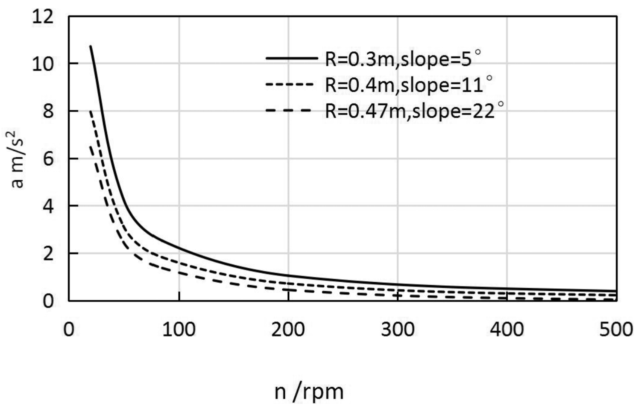
(b)

Figure 2. The relation force and rotation in light vehicle at the 85.2KW

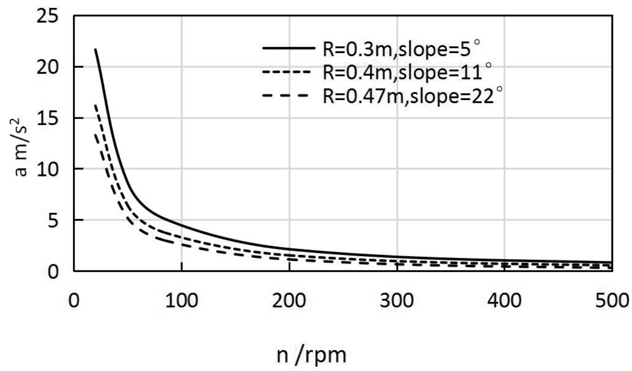
Figure 2(a) shows the curves of light vehicle force and rotation when tire tire radius R is 0.5 meters. At this time, the engine power is set at 85.3KW. As the tire slope decreases into 5° the torque decreases some. meantime the force decreases with rotation ie. rotation increases the force decreases too. It fits to formula well. When the rotation is 100r/m, the force reaches 5KN steeply. Then the force changes to decrease sluggishly. At 400r/m it reaches 2r/m. As the tire radius r decreases into 0.3m the force will be higher than that into 0.4m. It fits to the formula well too. At rotation being 300r/m it will be constant at radius 0.3m & 0.4m. It is due to big θ resulting big force in terms of formula (14). Table 1 is the parameters in this study. There are mass、tire radius & powers respectively. When the slope is above 20° the high force is needed. It needs small radius、high power & heavy weight for the moment of inertia optimum design. Otherwise the cease fire will happen due to weak power.

As shown in Figure 3(a,b,c), when horsepower is 115~575 & tire mass is 2030~2890Kg, they are the curves between acceleration and rotation of the light vehicle. As horsepower increases the mass of the light vehicle increases the acceleration increases, they are inverse proportional. It is due to the big horsepower firstly then the mass little. Therefore, when designing a light vehicle, it is necessary to choose big power one and the light weight as possible, so as to increase the acceleration a very short time and save cost.

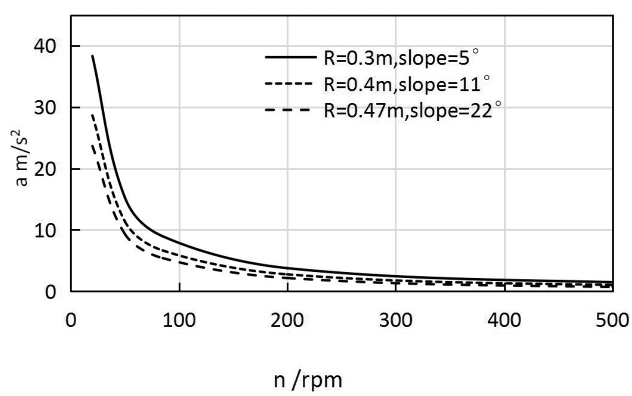
It is found that the a will decrease as slope becomes high from 5 to 11° to 22°, which fit the formula too. Meantime as the radius is high from 0.3m to 0.4m to 0.47m a will be low. So it is chosen that the small slope and use small tire radius is to promote acceleration in motion.



(a) 115 horses; 2.03tons



(b) 283 horses; 2.5tons

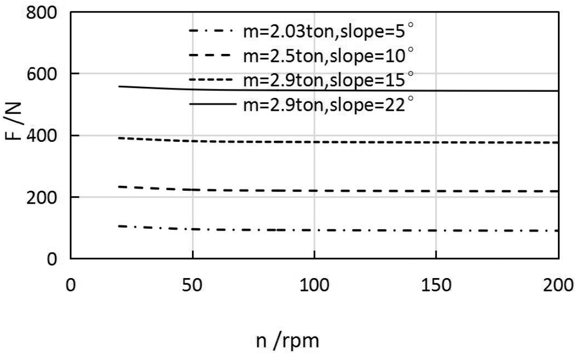


(c) 574 horses; 2.89tons

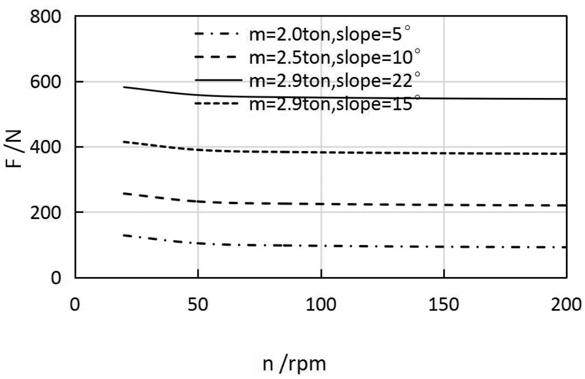
Figure 3. The relation of acceleration and torque in light vehicle if R=0.3, 0.4,0.47mm

Table 1. The mechanical parameters in light vehicle

Item / No.	light vehicle mass /Kg	Tire radius /m	Engine power / KW
1	2030	0.30	85.3
2	2300	0.35	208
3	2900	0.47	423



(a) 85.3KW



(b) 208KW

Figure 4. The relation of force and rotary in light vehicle at the 85.2KW and 208KW

The force will decrease a little when power is 208KW to compare with 85.3KW from Figure 4 (a,b). It expresses that the a little more force is produced in high power as the value is near neglectful. In addition the little decrease happens too below 50r/m due to relatively high velocity. Meantime the force will maintain a about constant after this point with a sluggish decline. This is since the low torque caused by high rotary and slope angle increases which results in some drag down. These two factors interact together to offset force. This is a main reason to be found sluggish force decrease here in this paper. The needed force will increase as the slope decline becomes big at the same power.

4. Conclusions

(1) According to formula we can simulate their driven force and acceleration on the slope. The mechanical formula is used to obtain force and theoretical dynamics in the slope. The driven force decreases when rotation increases. When power increases the acceleration increases. it reduces when its weight raises.

(2) It is found that the a will decrease as slope becomes high from 5 to 11° to 22°, which fit the formula too. Meantime as the radius is high from 0.3m to 0.4m to 0.47m a will be low. The needed force will increase as the slope decline becomes big at the same power.

References

[1] Lianggui Pu, Guoding Chen, Liyan Wu. Mechanical Design[M]. Advanced Education Publisher, 2015, 24: 30.

[2] Shijie Fang, Yaoguang Qi. Mechanical Optimization Design[M]. Machinery Industry Publisher, 2003: 11.

[3] W S Peng, Z M Li, H l Huang. Mechanical Design[M]. Advanced Education Publisher, 2008: 195-196.

DOI: https://doi.org/10.30564/jmer.v3i2.1800