فصلنامه قطعه سازان صنعت

جلد ۱، شماره ۱، (پیاپی: ۱)، بهار ۱۳۹۹

از صفحه ٦ لغایت ۸

Calculation of the loads exerted on the front and rear axles of Peugeot ۴۰۵

Seyed MohammadReza Hosseini Aliabad[۱*], MohammadMoein Rashidpour[۲], Mohsen Alizadeh[۴]

۱- Department of mechanical engineering, mazandaran
۲- Department of Automotive engineering, anzali
۳- Department of Automotive engineering, anzali

ABSTRACT

Even flat, smooth roads cause vibrations that are transferred to the car body and, ultimately, the passengers. These transferred vibrations are required to be minimized by the suspension system of the car. The present study aimed to calculate the loads exerted on the front and rear axles of a Peugeot ٤٠٥. The results showed that the front and rear axles experience a load of ٥,٧ kN in the first scenario, ٥,١٠ and ٦,٢٩ kN in the second scenario, and ٤,٨٦ and ٦,٤٤ in the third scenario, respectively.

Keywords: Suspension system, force, axle, Peugeot ٤٠٥

١. INTRODUCTION

When in contact with the road roughness, the car wheels experience vertical, longitudinal, and lateral forces. Direct transmission of these loads without any suspension systems causes wear and tear in the car body as well as the discomfort of the passengers. Hence, a suspension system is required to dampen these forces (Sharif et al. ٢٠١٩). The suspension system connects the wheels to the body, reducing the degree of freedom (DoF) from ٦ to ٣ in the steering wheels, and to ٢ in the non-steering wheels. This system is responsible for three important, fundamental tasks, namely stability, handling, and riding. Therefore, it can be stated that the suspension system in cars plays a major role in the comfort of the passengers and, additionally, directly affects the stability of the car as one of the effective factors in controlling and steering the car (Amrollahi Biouki and Mahmoudi Kaleybar, ٢٠١٠) (Niajalili et al. ٢٠٢٠).

٢. Calculation of the loads exerted on the front and rear axles

In this section, the loads exerted on the front and rear axles are calculated by plotting the free diagram of the car forces, as shown in Fig ١, and using the Newton's second law.

فصلنامه قطعه سازان صنعت

جلد ۱، شماره ۱، (پیاپی: ۱)، بهار ۱۳۹۹

از صفحه ٦ لغایت ۸

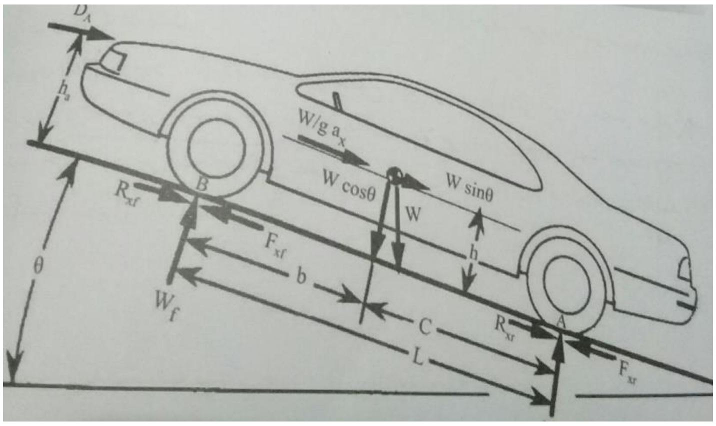

Figure۱. The free diagram of the car forces

Table ۱ shows the specifications for Peugeot ۴۰۵ as the studied car model.

Table۱. The specifications Peugeot ۴۰۵

W = ۱۱/۴ KN
C = ۱/۳ m
b = ۱/۳ m
L = ۲/۶ m
h = ۰/۷ m
a_x = ۲ m/s^{۲}
g = ۹/۸
Θ = ۰/۰۶

The loads exerted on the front and rear axles of the car are calculated for the following scenarios.
First scenario: The car is stationary on a road with no slope. In this case:

If Θ = ۰ ➔ sin Θ = ۰ , cos Θ = ۱

If V = ۰ ➔ D_A = ۰

The loads exerted on the front and rear axles of the car are then calculated.

$$W_{fs} = W \cdot \frac{C}{L} \Rightarrow ۱۱/٤ \times \frac{۱/۳}{۲/٦} \Rightarrow W_{fs} = ٥/۷ \text{ KN}$$

$$W_{rs} = W \cdot \frac{b}{L} \Rightarrow ۱۱/٤ \times \frac{۱/۳}{۲/٦} \Rightarrow W_{rs} = ٥/۷ \text{ KN}$$

Second scenario: The stationary car on a road with no slope and starts to move. In this scenario, given the low velocity, the aerodynamic forces can be neglected, in which case the loads exerted on the front and rear axles are calculated as follows:

$$W_f = W \left(\frac{C}{L} - \frac{ax}{g} \cdot \frac{h}{L}\right) = W_{fs} - W \cdot \frac{ax}{g} \cdot \frac{h}{L} \Rightarrow ۵/۷ - ۱۱/۴ \times \frac{۲}{۹/۸} \times \frac{۰/۷}{۲/۶} \Rightarrow W_f = ۵/۱۰ \text{ KN}$$

$$W_r = W \left(\frac{b}{L} + \frac{ax}{g} \cdot \frac{h}{L}\right) = W_{rs} + W \cdot \frac{ax}{g} \cdot \frac{h}{L} \Rightarrow ۵/۷ + ۱۱/۴ \times \frac{۲}{۹/۸} \times \frac{۰/۷}{۲/۶} \Rightarrow W_r = ۶/۲۹ \text{ KN}$$

Therefore, a load proportional to the force caused by acceleration is lifted from the front axle and transferred to the rear axle.

Third scenario: The car starts to move on a sloped surface. In this case, given that the sub-arterial and arterial roads are generally constructed with a slope of ۱۰٪ to ۱۲٪, the cos of the angle can be approximated as ۱, and its sin equal to the angle. Hence, the loads exerted on the front and rear axles on a sloped road are calculated as follows:

$$W_f = \frac{W\,(C\cos\theta - h \times \frac{ax}{g} - h\sin\theta)}{L} \Rightarrow W_f = \frac{۱۱.۴ \times (۱.۳\cos ۳.۴۳ - ۰.۷ \times \frac{۲}{۹.۸} - ۰.۷\sin ۳.۴۳)}{۲.۶} \Rightarrow W_f = ۴/۸۶ \text{ KN}$$

فصلنامه قطعه سازان صنعت

جلد ۱، شماره ۱، (پیاپی: ۱)، بهار ۱۳۹۹

از صفحه ٦ لغایت ۸

$$W_r = \frac{W\,(b\cos\theta + h\times\frac{ax}{g} + h\sin\theta)}{L} \Rightarrow W_r = \frac{\text{۱۱.۴}\times(\text{۱.۳}\cos\text{۳.۴۳} + \text{۰.۷}\times\frac{\text{۲}}{\text{۹.۸}} + \text{۰.۷}\sin\text{۳.۴۳})}{\text{۲.۶}} \Rightarrow W_r = \text{۶/۴۴ KN}$$

Note**:** A slope (Ө) of ۰,۰۶ is equal to ۳/۴۳ °: Arc tan (۰,۰۶) = ۳,۴۳

Therefore, a positive slope causes part of the load to be transferred from the front axle to the rear axle.

۳. Nomenclature

W: vehicle weight
c: center of gravity of the car with respect to the rear wheel
b: center of gravity of the car with respect to the front wheel
L: distance between the front and rear wheels
H: height
a_x: acceleration
g: gravitational acceleration
Ө: slope
w_f: load exerted on the front axle
w_r: load exerted on the rear axle

٤. Conclusion

This study aimed to calculate the loads exerted on the front and rear axles of a Peugeot ٤٠٥ by plotting the free diagram of the car and using Newton's second law. Car specifications are given in Table ١. Based on the results, the front and rear axles experience a loads of ٥,٧ kN in the first scenario, ٥,١٠ and ٦,٢٩ kN in the second scenario, and ٤,٨٦ and ٦,٤٤ in the third scenario subject to a slope, respectively.

REFERENCES

[١] Sharif, Mehrdad; Sarkari Zavareh, Mohammad; Eskandari, Aliakbar; Arefian, Mohammad. "Repairing Suspension and Breaking Systems of a Car"; Iran Schools Books Printing and Distribution Company, Third Edition; ٢٠١٩.

[٢] Amrollahi Biouki, Hamid; Mahmoudi Kaleybar, Mehdi. "Chassis and Body Technology"; Saad Publications, First Edition, ٢٠١٠.

[٣] Niajalili, Mehdi; Hosseini Aliabad, S. Mohammadreza; KouchakiNejad, Ali; Mousavi Mirkalaei, S. Mohammadreza. "Investigation and Analysis of Front Axle of Peugeot ٤٠٥ under the Impacts of Road Roughness"; Scientific-specialized Publication of Novel Researches in Engineering Sciences, Fourth Year, No. ٢٧, Winter of ٢٠٢٠.