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EVALUATION OF THE DYNAMIC SUSPENSION FOR FORD PUMA

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Abstract: The modification of a suspension is a critical step to achieve a better performance, with even the possibility of obtaining high performances from a medium class passenger car, like an automobile with high equipment. This can be achieved by balancing the suspension leading to a maximization of the level of adhesion for the axles and non-motors. This paper aims to identify the physical parameters (drivers) that influence the dynamic behaviour of a MacPherson suspension, these parameters are required in the design phase, grant for operation, repair or tuning. The main function of the suspension is to keep the wheels in constant contact with the road surface and to optimize the tire footprint. CarSim is a software package that allows the study of performance for motor vehicles (steering, throttle, brakes, and clutch shift) in a given environment (road geometry, coefficients of friction, wind).
Keywords: MacPherson suspension, physical parameters (drivers), CarSim software package, performance

1. INTRODUCTION

The main function of the suspension is to keep the wheels in constant contact with the road surface and to optimize the tire footprint. It can improve acceleration, braking and steering behaviour modifying the suspension.

The modification of a suspension is a critical step to achieve a better performance, with even the possibility of obtaining high performances from a medium class passenger car, like an automobile with high equipment. This can be achieved by balancing the suspension leading to a maximization of the level of adhesion for the axles and non-motors.

In this paper we will focus on three very important parameters: camber coefficient of compression springs and ground clearance using specialized CarSim software [1], [2].

— Angle of fall

Changing the angle of fall can be accomplished in three configurations: positive angle of fall, neutral angle of fall, negative angle of fall, measured in degrees from the normal to the road surface. The angle of fall has an influence on the contact patch of the tire to the road, the dynamic operation of the suspension [3].

— The influence of the centre of gravity change

It is necessary to understand that the acceleration, braking, and side forces are influenced by the center of gravity, and the whole suspension is designed according to this point. In fact we have little chance of making changes to the existing point on a car [3].

— The ground clearance

Except for the use on bumpy road of off-road vehicles, for roads and sports competitions is desirable ground clearance minimized while still maintaining a mechanical safety. A low ground clearance helps fuel economy even as it prevents air currents to circulate in the body and thus helps the relatively high speed stability of the vehicle [3].

To identify the importance of granting a suspension to road conditions we used a CarSim 2016 software (Figure 1) in which we set out in detail the operating parameters of a Ford Puma car (Figure 2). They studied two situations where I tried to consider changing the state of wear of the suspension.

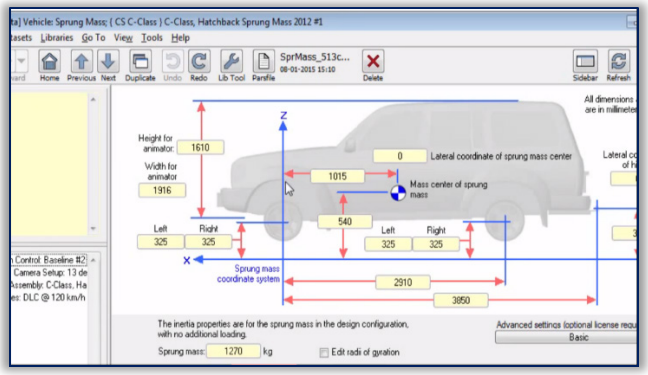

Figure 1. Modifying the CarSim physical parameters

Figure 2. Ford Puma

2. THE STUDY OF MODIFICATION OF MECHANICAL PARAMETERS USING CarSim SOFTWARE

The test route the software is an uneven road whose frequency is regular so that the shock felt by the mechanism of suspension of the car to have a sinusoidal distribution [4], [5]. In the two tests was considered suspension as follows [6]:

- Test 1: Used suspension;
- Test 2: Suspension with replaced elastic elements

Table 1. Modified parameters during the tests

	Free running ray [mm]	Effective running ray [mm]	Coefficient of the spring compression [N/mm^2]	Report of compression spring / damping race
Test 1	310	305	225	0.750
Test 2	310	305	240	0.985

3. RESULT INTERPRETATION

The results of the simulation are shown in graphical form in Figures 3-10.

- Vertical oscillation forces (Figures 3 and 4)

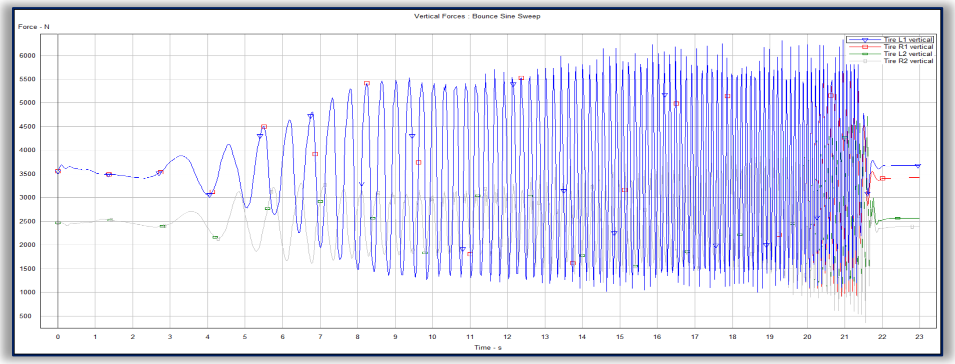

Figure 3. Vertical oscillation forces – Test 1

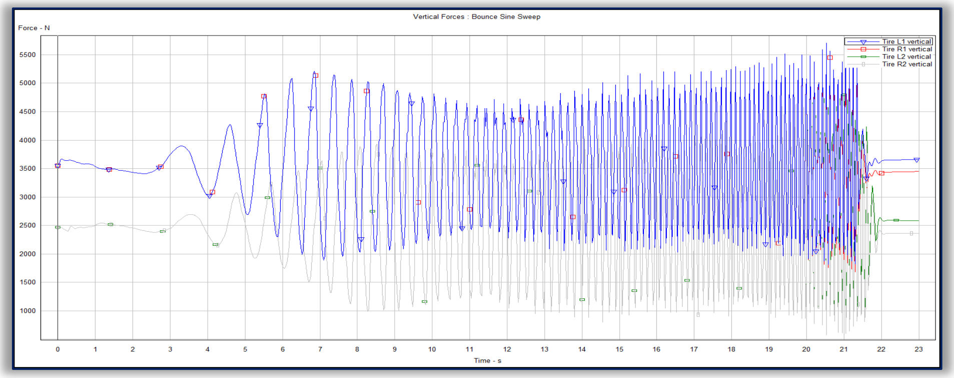

Figure 4. Vertical oscillation forces – Test 2

After the tests it is observed that the vertical forces are developed in the lower case we have a higher compression ratio (Figure. 4) and they increase with the wear of the shock absorber and the spring element (Figure 3) .

- Angle of fall depending on the rate of damping (Figures 5 and 6)

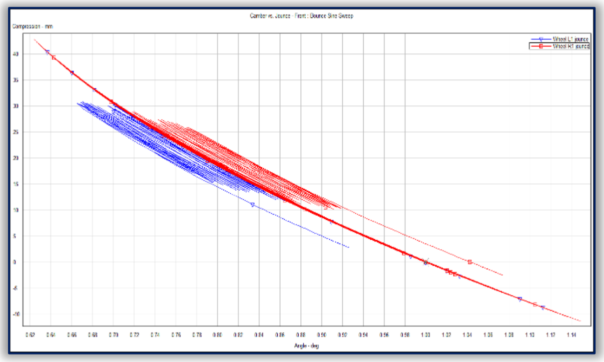

Figure 5. Angle of fall depending on the rate of damping – Test 1

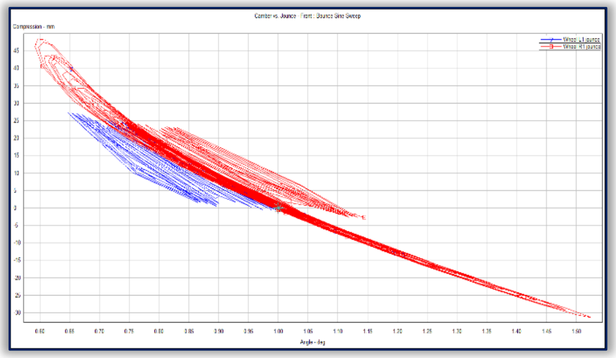

Figure 6. Angle of fall depending on the rate of damping – Test 2

It is noted that the change in the angle of fall of the wheels is influenced by the length of damping stroke. So in test 2 (Figure 6) angle of fall remains in narrower limits during operation, even if the end points have a greater value than the situation described in Example 1 (Figure 5).

— Damping force (Figures 7 and 8)

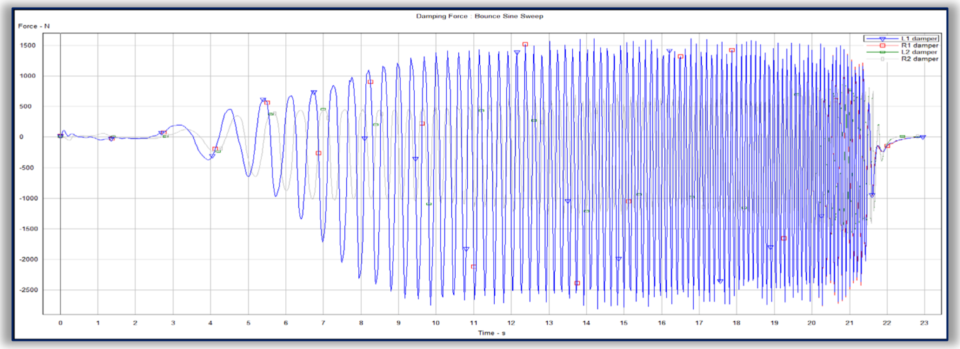

Figure 7. Damping force – Test 1

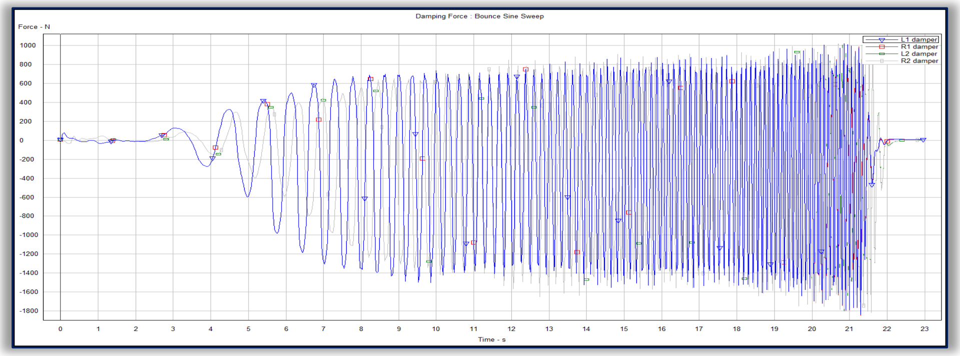

Figure 8 Damping force – Test 2

During test 1, the average damping force is within the range (1500 - 2500) N (positive values representing the compression stroke and negative values representing strength return stroke or expansion) (Figure 7);

In the second test (Figure 8), the suspension is equipped with a spring having a relatively high compression ratio, it is observed that the maximum values of the damping force falls in (1000 - 1800) N.

— Spring compression (Figure 9 and 10)

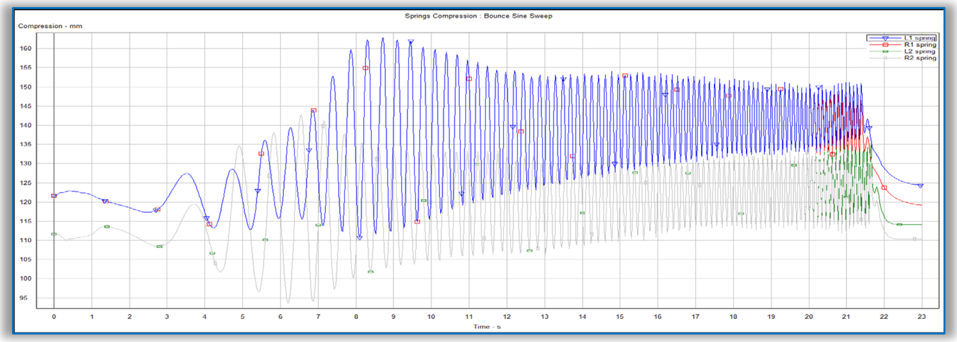

Figure 9. Spring compression – Test 1

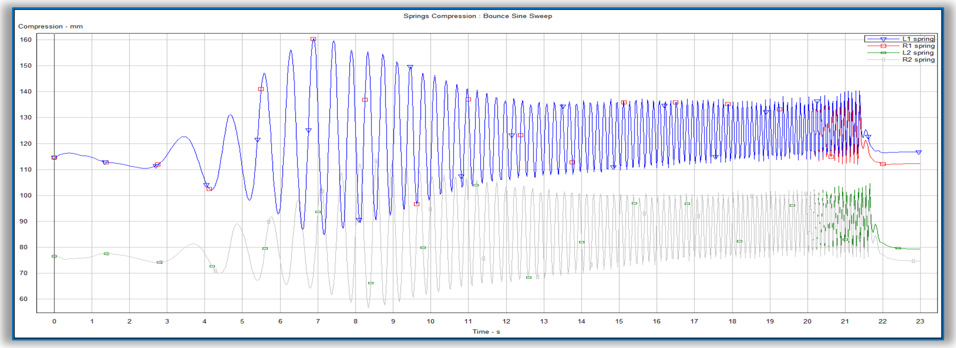

Figure 10. Spring compression – Test 2

In Test 1 the graph indicates that the spring allows the compression stroke relatively high compared to test 2 due to low stiffness after wear.

4. CONCLUSIONS

These simulations indicate that an over wear of damping elements leads to an uneven tire wear and the possibility of loss of traction in bumpy corners. Also, if the damping is too long at a low obstacles resulting excessive body balance, the balance is not beneficial or passenger comfort but no acceleration, braking or the maneuvering of vehicles.

By mounting machine springs, we observed that the spring has a shorter race compression in the route where irregularities are more frequent, but at the start of the route where irregularities are rare stroke compression is comparable with the bows of the first test, which means that the properties and arc geometry allows it to provide comfort at low speed and high speed stability.

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