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Anti-leaking Automotive Shock Absorber

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ABSTRACT
Shock absorber unit is a major part in automotive, it shows response of driver or rider comfortably, the shock absorber units consists of spring (coil type in general) and damping element (cylindrical shape in general), the spring stiffness depends on its geometry and material, and the damping coefficient of the damping element depends of the piston design, in this study the impact force on the damper is found for different humps style, the main reason of leaking in the dampers is the impact force, a new damper unit designed as anti-leaking shock absorber.
Keywords – Suspension, Shock absorber, Impact, Leaking, Damper.

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I. INTRODUCTION

In automotive (car or truck) near wheels, there is spring and damper unit, this unit is called the shock absorber unit, the damper element located inside the spring if it's located near the front wheel but the damper is free from the spring if it is located near the rear wheel. The shock absorber or the damper consists of a number of pistons (values), these values are oil operated, based on conservation of energy, in shock absorber converts the mechanical energy to heat. The main problems in shock absorber units can be summarized in the following points:

1. Leaking from seals, seals are located between piston and cylinder in the absorber, due to environmental conditions seal elasticity decreased and it became brittle, this cause leaking and the absorber ability to absorb energy is reduced as shown in figure (1).
2. There is an entire piston in some shock absorber types, the piston moves inside the cylinder and it can be bent from impact.
3. Wear is one of the important defects in the shock absorbers, wear due to friction between the moving parts inside the absorber.
4. the driving strategy can be considered is one of the shock absorbers defects, driving strategy mean sudden braking, impact from road humps.

There are some signs in the car driving to show shock absorbers faults, these faults may be intersected with or problems in a car like a misalignment of balancing, there is main faults appear in the car when shock absorbers are not in good conditions:

1. Bouncy, this appears in moderate speeds and high speeds.
2. Vibration in the steering wheel when front shock absorbers are in bad conditions.
3. Car may be the nose dive or diving when braking.
4. Wear in tires increased.
5. Oil around the absorbers, it needs a visual inspection.

Figure-1: Rear shock leaking (wwundrasolutions.com).

Figure -2: (a) Normal absorbers, (b) Abnormal absorbers. (www.kyb.com).

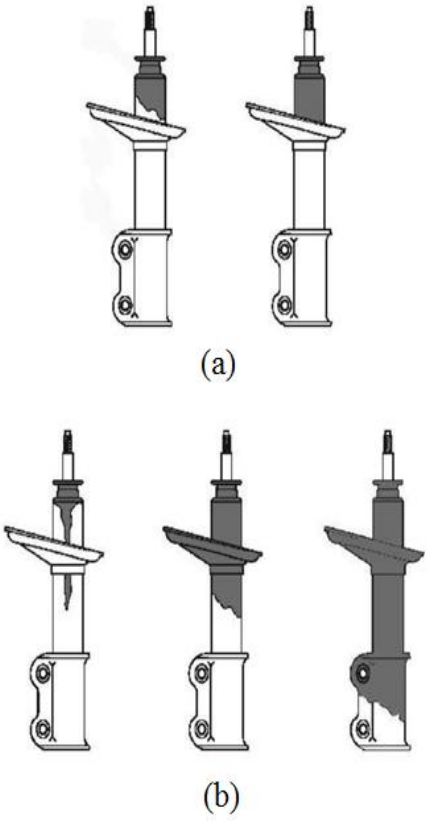


Figure-3: Rear Shock absorber in Volvo (https://volvoforums.com).

II. LITERATURE REVIEW

[1]Varies types of suspension systems described and discussed in this paper, passive, semi-active, and active systems, a comparison between the types of the suspension systems is done, the results are focused on the selection of the best system based on the car vibration or responsible behavior. [2] In shock absorber unit (spring and damper) there are different types of springs can use such as helical, leaf, and coil springs. A study of a certain automotive for different suspension systems is created based on vibration analysis (comfort criteria).

[3] Design software Pro/Engineering is used to design the shock absorber coil spring based on stress analysis, the design criteria of the coil spring is the spring diameter, the diameter controls the spring weights also the design focused on the mechanical stress values. [4] The FEA used to design the shock absorber spring according to the deflection and the shear stress, the software shows the best design, different springs are tested based on material and dimensions. [5] A traditional and modified dampers compared based on displacement, damping coefficient, and rebound damping coefficient, the study showed that the modified (variable damper) has more displacement, less compression damping co-efficient& less rebound damping coefficient. The modification in the absorber is the number of the holes so the damping coefficient is changed. [6] A set of changes on shock absorber presented in this study, Proportional solenoid type, Magnetic fluid type, and Stepping motor type. A modified shock absorber with an external solenoid valve is studied.

III. IMPACT ON SHOCK ABSORBER

The impact force on the shock absorber unit presented, the idea is to show the impact force on the shock absorber unit based on the hump design and configuration, figure (4) shows the dynamic model of the automotive quarter.

Single degree of freedom model used to simulate the car quarter, the model consists of car quarter mass (m), shock absorber stiffness (K), and the damping element in the shock absorber unit (C). table (1) below shows the numerical values of the dynamic model parameters.

Table -1: The dynamic model physical parameters.

Quarter car mass [m]	500 kg
Coil spring Stiffness [K]	30,000 N/m
Damper coefficient [C]	1,500 N.s/m

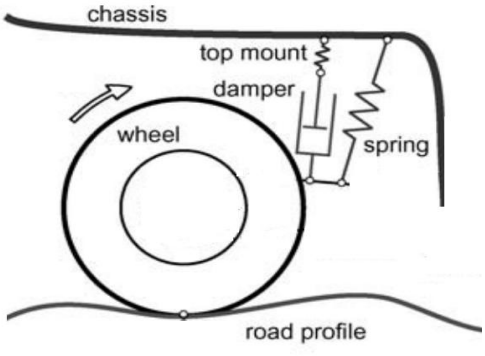
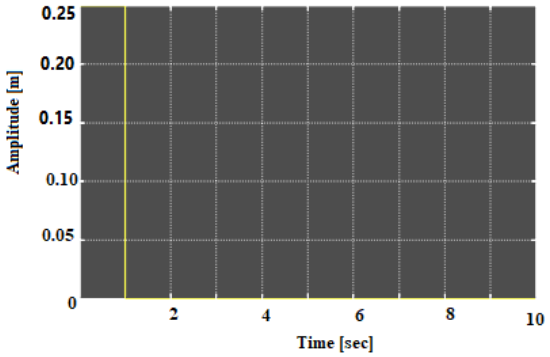
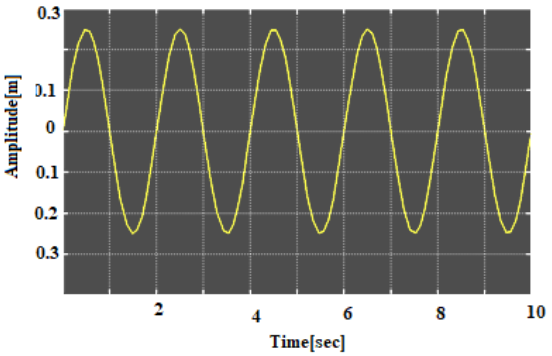


Figure-4: Dynamic model of the car quarter.

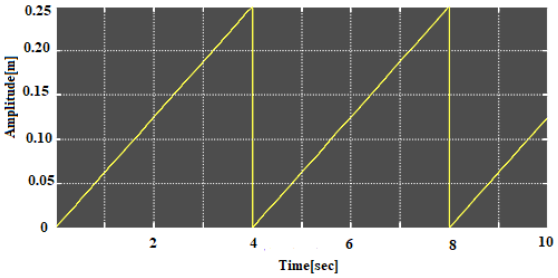
The Simulink software used to show the impact force on the quarter car shock absorber unit for different humps configurations. The hump height is 0.25m. Figure (5) shows the test humps, (a) impulse hump, (b), sinusoidal hump, and (c) ramp hump. The simulation results shows the external impact force on the damping element in the front car shock absorber unit, figure (6) shows the impact force on the damping element based on impulse hump, figure (7) shows the impact force on the damping element based on sinusoidal hump, and figure (8) shows the impact force on the damping element based on ramp hump.



(a) The Impulse hump.



(b) The Sinusoidal hump.



(c) The Ramp hump.

Figure-5: The test humps, (a) impulse hump, (b), sinusoidal hump, and (c) ramp hump.

The peak impact force on the damping element about 2.15kN for impulse ramp, and 1.5kN for the other test humps. The high impact force leads to major damage and leaking in the absorber.

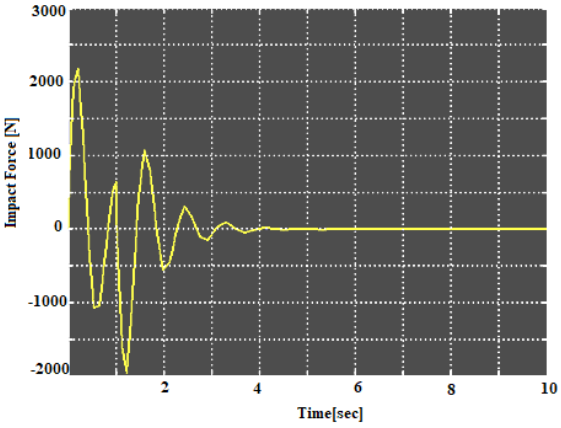


Figure-6: Impact force on the damper element due to an impulse hump.

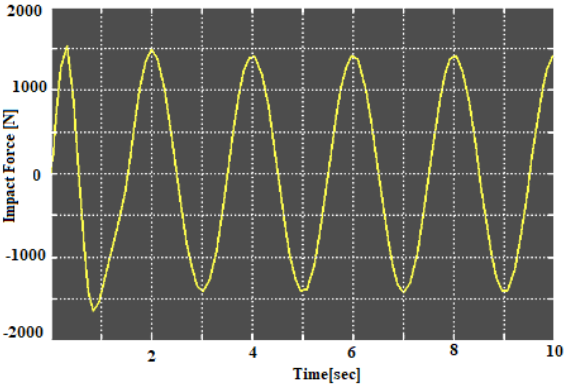


Figure-7: Impact force on the damper element due to a sinusoidal hump.

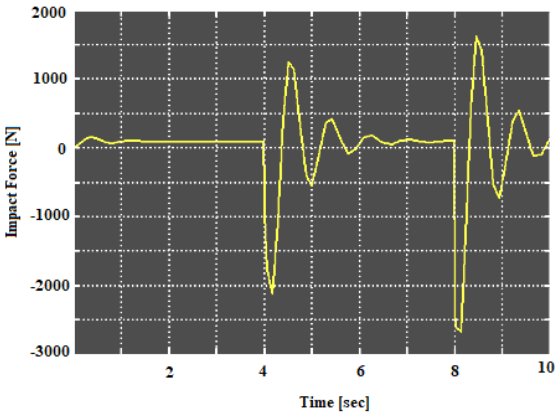


Figure-8: Impact force on the damper element due to a ramp hump.

IV. THE MODIFIED DAMPING ELEMENT

The simulation shows that the impact force is the major parameter in damper leaking problem, the impact force is about 2.0kN for a medium car with 0.25m height hump, this impact force depends on the dead weight of the automotive and the hump configuration.

The modified damper (shock absorber) consists of two refile valves, these valves are operated according to set pressure, the set pressure depends on the car operating conditions, car mass, and road conditions. Figure (9) shows a 3D model of the modified unit, figure (10) shows a cross-section in the modified unit.

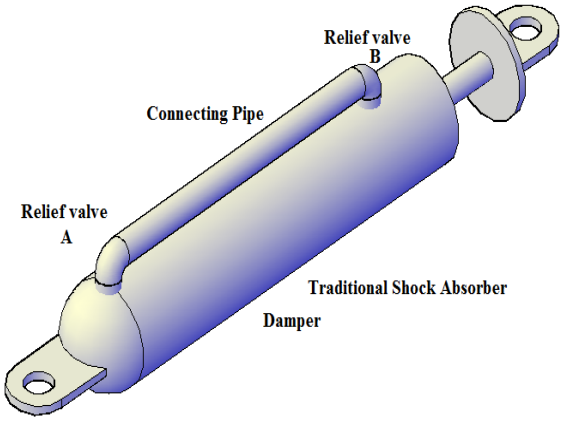


Figure-9: The modified damping unit 3D model.

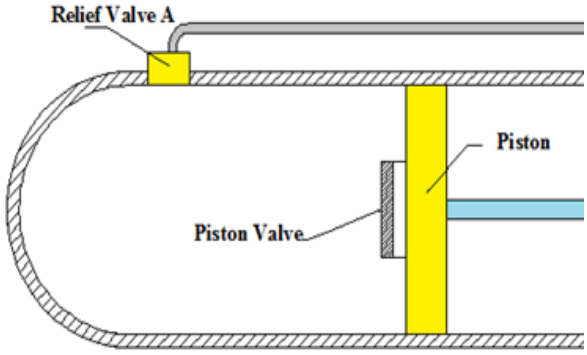


Figure-10: A cross section in the modified damping unit.

V. CONCLUSION

New modifications are presented in this study, the modifications on the damper unit is produced to avoid the leaking problems, the major reason of leaking in dampers (shock absorbers) is the impact force, two relief valves are attached to the damping unit to reduce the high impact internal pressure and to avoid and leaking or damage in the shock absorber element.

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