DESIGN AND CALCULATION OF MCPHERSON SUSPENSION SYSTEM AND MODIFIED SUSPENSION SYSTEM AND ITS COMPARISON

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ABSTRACT

Suspension system is the necessary part in the automobile vehicle. Suspension system provide comfort ride to the passengers. Suspension system absorbs the unnecessary vibration which applied on the upward from road irregularities. Here in this paper we will find deflection of existing car with the existing suspension system and going to modified suspension system and find deflection for modified design. Also, we are going to compare deflection for existing and modified design.

Keywords—Mcpherson suspension system, Deflection, Damping Ratio

I. INTRODUCTION

Suspension system is the essential part of the automobile vehicle. Springs and dampers can make a huge difference in the handling of car. A car's suspensions job is to maximize the friction between the tyres/tires and the surface of road. This provides steering stability with good handling and to ensure the comfort of the passengers. While the purpose of a car manufacturer will be a comfy ride for passengers, this will not take the ultimate reward for the driver's car requiring agile handling.

If a road surface were perfectly flat and had no irregularities in it, then suspensions should not be required. But roads are far from flat, freshly paved motorways/highways also having subtle imperfections that can interact with the wheels. It's these imperfections that apply forces to the wheels and suspension components and causes handling imbalances in compromised set ups.

II. PARTS OF MCPHERSON SUSPENSION SYSTEM

In McPherson Suspension System apart from the linkages, the basic components of any suspension are springs, dampers and stabilizer also called anti-roll bars. For unsprung masses such as knuckles and control arms, light weight presents additional advantages. Thus a reduction of the weight of the unsprung masses will also remain a most important phenomenon for future developments in suspension system.

As the car maneuvers over terrain, such as bumps, the front suspension [1] allows the wheel and tire to move up and down with respect to the frame of the truck. The specific direction of this movement is controlled through the geometry and mounting points of the upper control arm, lower control arm, and tie rod.

III. DESIGN PROCEDURE OF SUSPENSION SPRING

For calculation of deflection and force of spring, we need to measure the data from existing McPherson suspension system. We have done measurements of free length, mean diameter of coil, deflection of spring, pitch, number of coils with calibrated instrument on existing car. Table 1 shows the data of the existing car. kerb weight of the existing car is 825kg. Calculation for deflection of the spring with existing car kerb weight and also with addition of people's weight is done.

Parts	Measured Data
Number of coil	8 turns
Active turns	6 turns
Mean diameter of coil	95mm
Deflection of Spring	70mm
Pitch	39mm
Free length of spring	244mm
Solid length of spring	80mm
Kerb weight	825 kg

We have data for calculation for existing design of suspension system. Data for calculating existing suspension system are as follows

$$L_f = p.n + 2d$$

From using above equation we found out the free length of spring that is 244 which is equals to our measured free length of the spring.

$$d = \sqrt{\frac{8WCK}{\pi L}}$$

From the Eq. above we find wire diameter of coil spring wire diameter. Diameter of coil spring is 10.45 mm but as per design standards it is 10 mm.

$$\delta = \frac{8WD^3n}{Gd^4}$$

$$\frac{w}{\delta} = K = \frac{Gd^4}{8D^3n}$$

From the above first equation we can find stiffness of the spring. After finding stiffness using a deflection equation we can find deflation of spring for the given load. Total deflection is 114.43 mm in full load condition and Max. Allowable deflection of the spring in the base car is 144mm only. So in Full load condition car is having only 29.57 mm deflection available to deal with bump and digs of the road, this is so less for the comfortable ride. From equation we can find out that initial deflection of the spring is 89.41mm with kerb weight.

IV. DAMPING RATIO

We can consider a Suspension system as a Forced damped system, where force is exerting from the road surface and M is the body weight. K is stiffness of spring and where C is damping coefficient. So system equation written as

$m\ddot{x}+c\dot{x}+kx = F\sin\omega t$

On solving this equation we find solution X is in the form of

$$x = X_0 e^{\left[-\frac{c}{2m}\pm\sqrt{(c/2m)^2-k/m}\right].t}$$

For weak damping,

$$\left(\frac{C}{2m}\right)^2 \ll \frac{k}{m}$$

and for hard damping

$$\left(\frac{C}{2m}\right)^2 > \frac{k}{m}$$

A compromise between these extremes is “critical damping”, for that value of the damping coefficient is chosen so that

$$\left(\frac{C}{2m}\right)^2 = \frac{k}{m}$$

Below figure indicates that neither higher value nor lower value of ζ gives comfortable ride to the vehicle

$$\zeta = \frac{C}{2\sqrt{km}}$$

From the above equation of the forced mass damped system Transmissibility of the suspension system is given by

$$T_s = \sqrt{\frac{(1+4\zeta^2r^2)}{(1-r^2)^2+4\zeta^2r^2}}$$

Where, $r = \frac{\omega_B}{\omega_N} =$

From The equation of Transmissibility and substituting a different value of ζ and keeping r = 1 (constant) we find can find relation between Ts and ζ and that is as under.

Damping Ratio(ζ)	Peak Transmissibility (T_{max})
0.10	5.123
0.20	2.733
0.30	1.995
0.40	1.655
0.50	1.468
0.60	1.353
0.70	1.276
0.80	1.223
0.90	1.184
1.00	1.155
1.20	1.114
1.50	1.078
2.00	1.047

From the graph we can see that for a damping ratio of 0.3 we are having a transmissibility of 1.995 and for a critical value of ζ =1 we are having a transmissibility of 1.155. Transmissibility is changed only in a few amounts but the damping ratio increasing in a large amount and as we know that damping ratio increases ride for passenger becomes harsh. That's why in a passenger vehicle damping ratio is ranged from 0.2 to 0.4. For passenger car optimal damping ratio chosen is 0.32.

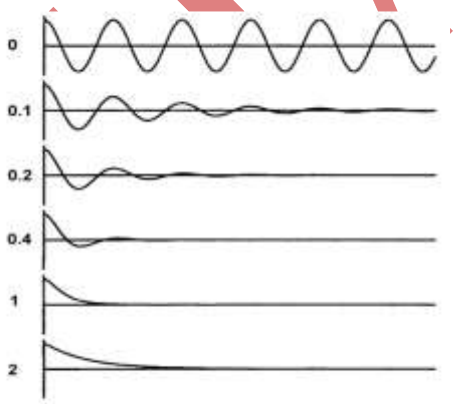

Fig 1 Damping

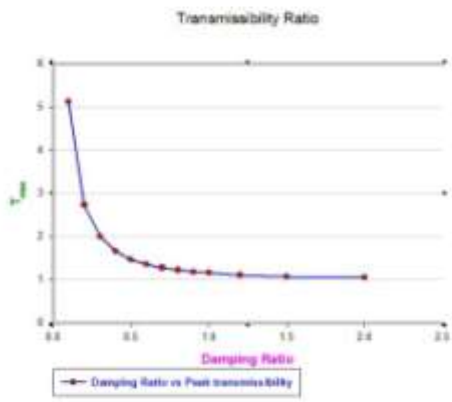

Fig 2 Damping Ratio Vs Peak Transmissibility

V. MODIFIED DESIGN OF SUSPENSION

In existing design available actual length in five person car is 20.56 mm, which is very low to absorb shock and forces which is acting upwards. So, we will modify our existing system for reducing shocks when road irregularities are more. We will try to make design which will absorb more forces to reduce the shock which acts upward directly on passenger car which gives uneasy ride.

In parallel suspension system is one of the modified suspension system, where we put 2 springs in the parallel with same stiffness. Where, we assume stiffness for spring 1 as 12 and stiffness of spring 2 as 12. Resulting stiffness is 24, which is more than the existing stiffness of the spring., where behavior of the parallel springs is different than existing spring.

For parallel spring we assume that K_1 = 12N/mm and K_2 = 12N/mm

Where, $K = K_1 + K_2$

Where combined stiffness of the springs are

K = 24 N/mm

Table 2 Shows That We Modified Data In Existing Suspension And Made One Parallel Suspension System

	For spring 1	For spring 2
W	808.5N	808.5N
K	12 N/mm	12
D	85mm	85mm
d	10mm	10mm
n'	12	12
p	20mm	20mm
L_f	244mm	244mm
L_s	120mm	120mm

After applying the above changes deflection of suspension system will be find. Which is equals to 60mm, where deflection of parallel suspension system is less than the existing suspension system.

VI. CONCLUSION

From comparison of above designing and deflection results from equations used for spring, we can say that deflection for modified design is less. This will give better suspension system. In future modified design can be done on software and also dynamic analysis can be done.

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