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Review of Design of Shock Absorber Spring.

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***Abstract*-This paper aims at to design and analyze the performance of Shock absorber by varying the wire diameter of spring. The Shock absorber is designed to handle shock waves and dissipation of kinetic energy. It reduces the amplitude of vibration. It increases in comfort and improve riding quality. The spring is compressed quickly when the wheel strikes on the bump of road. That compressed spring comes to its normal length which lifts the body. The spring goes down below its normal height when the weight of the vehicle pushes the spring down. This causes the spring to comes to its original length. The spring bouncing occurs again and again each and every time, until the up and down movement finally stops. The vehicle handling becomes very imperfect and leads to uncontrol ride when bouncing is allowed for long and long time. Hence, the designing of spring in a suspension system is very challenging thing. The analysis is done by considering bike mass, loads, and no of persons seated on bike.**

***Keywords* - Coil spring, Modified design, Shock Absorber, Stress analysis.**

I. INTRODUCTION

Working of shock absorbers Spring:

Shock absorbers work in two cycles the compression cycle and the expansion cycle. The compression cycle occurs as the piston moves downward and compressing the hydraulic fluid in the chamber below the piston. The expansion cycle occurs as the piston moves toward the top of the pressure tube and compressing the fluid in the chamber above the piston.[4]

Applications Of Shock Absorber

Shock absorbers are an important part of automobile suspensions, aircraft landing gear.Large shock absorbers have also been used in structural engineering structures to earthquake A transverse mounted shock absorber helps keep railcars from swaying excessively from side to side[6]

II. VEHICLE SUSPENSION

Shock absorber reduces the effect of traveling over rough ground and leading to improvement in ride quality.Also it increases in comfort due to substantially reduced amplitude of vibration. Without shock absorbers, the vehicle would have a bouncing ride.Control of excessive suspension movement without shock absorption requires stiffer springs and in turn it gives a harsh ride. Shock absorbers allow the use of soft springs simultaneously controlling the rate of suspension movement in response to bumps.

The following terms used in connection with compression springs[5]

1. Solid length (Ls)- It is the product of total number of coils and the diameter of the wire.
2. Free length (Lo):It is the overall length of a compression spring or an extension spring measured when no load is applied.

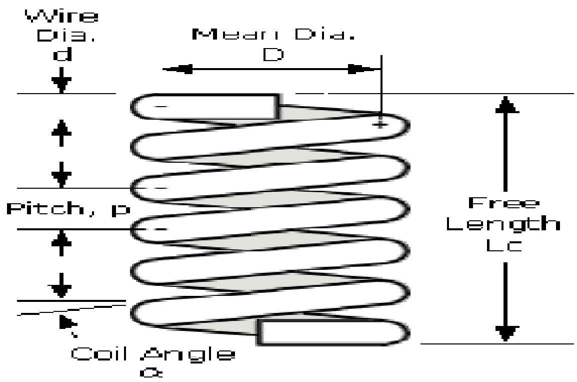

Fig.1 Terminology of Spring[5]

3. Load (P):The force applied to a spring to cause a deflection.
4. Deflection-Motion of spring ends under the application or removal of an external load.
5. Wire Diameter (d) - The diameter of the wire that is in form of a helix.
6. Spring index- It is ratio of Mean diameter to wire diameter. **C=D/d**
7. Coil Diameter (D) – It is the mean diameter of the helix, **D= (D outer+ Dinner)/2.**
8. Pitch (p) – It is the centre to centre distance of the wire in adjacent active coils.
9. Active Coils (N_a) - The number of coils which actually deform when the spring is loaded.
10. Total Coils (N_t)- The number of coils in the spring.
11. Pitch Angle (a) - The angle between the coils and the base of the spring.

$$\alpha = \tan^{-1}\left(\frac{p}{\pi D}\right)$$ [5]

General spring design recommendations[1]

1. Try to keep the ends of the spring within such standard forms as closed loops, full loops to centre, closed.
2. Pitch-Keep the coil pitch constant until we have a criteria for a spring as variable pitch.

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3. Keep the spring between 6.5 and 10. Stress problems occur when the index is too low
4. Do not electroplate the spring until spring is required by the design application. The spring will be subject to hydrogen embrittlement until it is processed correctly after electroplating.

The main objectives of spring are as follows[2]

1. *To apply force:* To provide the operating force in brakes and clutches, to provide a clamping force, to keep rotational mechanisms in contact make counterbalance loading, etc.
2. *To control motion:* wind-up springs for motor, constant torque applications, torsion control, etc.
3. *To control vibration:* flexible couplings, isolation mounts, spring and dampers, etc.
4. *To reduce impact:* Used to reduce the magnitude of the transmitted force due to impact in buffers, end stops, bump stops etc.

Spring Materials are as follows[2]

1. *Oil-tempered wire:* It is a cold drawn, quenched, tempered. It is not suitable for fatigue or sudden loads.
2. *Chrome Vanadium:* This alloy spring steel is used for high stress conditions.It is good for fatigue resistance
3. *Chrome Silicon:* This material can be used for highly stressed springs. It offers excellent service for long life.
4. *Music wire:* - This spring material is most widely used for small springs. It is the toughest and has highest tensile strength
5. *Stainless steel:* Widely used alloy spring materials.
6. *Phosphor Bronze / Spring Brass:* It has good corrosion resistance and electrical conductivity. It is commonly used for contacts in electrical switches.

Calculations for Design 1(wire diameter 8mm)

1.**Shear Modulus**= 77000 MPa

2.**Mean diameter of coil (D)**=50mm

3.**Diameter of wire (d)**=**8mm**

4.**Total no of coils (n1)**=15

5.**Height(h)=**200mm

6.**Pitch of coil ($P=L_f$-2d/n)**=216-16/15=**12.3mm**

7.**Outer diameter of spring coil(D0)**=D+d=50+8=**58mm**

8.**No. of active turns (n)**=15

9.**Weight of bike**=125Kg

Table 1.
Different loading conditions for design 1 and design2[3]

Sr. No.	Parameter	Unit	Design1	Design 2
1	Weight of bike	Kg	125	125
2	Let weight of 1 person	Kg	75	75
3	Weight of 2 persons	Kg	150	150
4	Weight of bike+persons	Kg	275	275
5	Rear suspension will carry 60% of total weight	Kg	165	165
6	Considering dynamic loads it will be double (w)	Kg	330	330
7	w	N	3237	3237
8	**For single shock absorber weight ,W=w/2**	**N**	**1619**	**1619**

10.Let weight of 1 person=75Kg

11.Weight of 2 persons=150Kg

12.Weight of bike + persons=275Kg

13.Rear suspension will carry 60% of total weight=165Kg

14.Considering dynamic loads it will be double,w=330Kg

w=330 * 9.81=**3237N**

15.For single shock absorber weight (W)=w/2=**1619N**

16.Compression of spring (δ)=WD^3n/Gd^4=$1619*50^3*15/77000*8^4$

=**77mm**

17.Spring index (C)=D/d=**6**

18.Solid length (L_s)=n1*d = 15*8 =**120mm**

19.Clearance=19mm

20.Free length of spring(L_f)=solid length+maximum compression+ clearance

=120+77+19=**216mm**

21.Spring rate(K)=W/δ= 1619/77 =**21 N/mm**

Stresses in helical spring: maximum shear stress induced in the wire

22.$\tau = K_s*8WD/\pi d^3$

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$=1.24*8*1619*50/\pi 8^3$

= 500 MPa

23.Ks=4C-1/4C-4 + 0.615/C = 4*6-1/4*6 + 0.615*6

=1.2

Table 2
Analytical calaculations for Design 1 & Design 2[2]

Sr. No.	Parameter	Unit	Design 1	Design 2
1	Shear Modulus	MPa	77000	77000
2	Mean diameter of coil (D)	mm	50	50
3	Wire diameter (d)	mm	8	10
4	Total no. of coils (n1)	--	15	15
5	Height (h)	mm	200	200
6	Pitch of coil (p)	mm	12.3	12
7	Outer diameter of coil (D0)	mm	58	60
8	No.of active turns (n)	--	15	15
9	Weight of bike	Kg	125	125
10	Let weight of 1 person	Kg	75	75
11	Weight of 2 persons	Kg	150	150
12	Weight of bike+persons	Kg	275	275
13	Rear suspension will carry 60%total weight	Kg	165	165
14	Considering dynamic load(w)	Kg	330	330
15	w	N	3237	3237
16	For single shock absorber weight(W)=w/2	N	1619	1619
17	Compression of spring (δ)	mm	77	32
18	Spring Index (C)	--	6	5
19	Solid length (L_s)	mm	120	150
20	Free length(L_f)	mm	216	189
21	Spring rate(K)	N/mm	21	51
22	Shear stress in coil(τ)	N/mm^2	500	270
23	K_s	--	1.24	1.31

III. CONCLUSION

1. We have design the spring by considering bike mass, load on bike and no of persons seated on bike analytically.
2. We have find out shear stress in coil of spring analytically.
3. As stress, deflection is inversely proportional to wire diameter of coil spring. Then we have to use coil spring of more diameter so as to reduce stress, deflection.
4. So 10 mm wire diameter is best suitable for current two wheeler bike so as to improve ride quality and suspension.
5. System is verified by varying wire diameter of coil spring to verify the best dimension for spring in shock absorber

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