Experimental Transmissibility Investigation of Shock Absorber and Comparison with MATLAB results for Two Wheeler

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Abstract - *Shock absorber is very important term in automobile industries. They are used for the driving comfort and driving safety. This paper presents performance characteristics of the shock absorbers under real conditions. Dynamic behaviors of the absorber are studied by computer simulation and experimental testing and are validated with MATLAB results. The road disturbance is generated in the model by giving speed brakes fixed on drum which is rotated by using motor. In this paper study and analysis of single DOF spring-mass-damper system (Hero Splendor Rear Shock Absorber) and plotted its dynamic characteristics curve for different values of spring stiffness for different oils.*

Key Words: **Shock Absorber, design & calculations Transmissibility, MATLAB etc**.

1. INTRODUCTION

The Shock absorber is a Suspension system which designed mechanically to control shock impulse and dissipate kinetic energy. It reduces the amplitude of disturbances leading to increase in comfort and improved ride quality. Shock absorber minimizes the effect of traveling on a rough ground. Now-a-days Modern vehicles come along with strong shock absorbers to tolerate any type of bouncy conditions. If supposedly shock absorber is not used then to control excessive suspension movement, stiffer springs will be used. The suspension system of an automobile is one which separates the wheel assembly from the body.

The primary function of the suspension system is to isolate the vehicle structure from shocks and vibration due to irregularities of the road surface. The Suspension system is used to support weight, absorb and dampen road shock, and help maintain tire contact as well as proper wheel to chassis relationship. A vehicle in motion is more than wheels turning. As the wheel revolves, the suspension system turns in dynamic state of balance, continuously compensating and adjusting for changing driving conditions according to road profile. Suspension of vehicle need to analyze before the manufacturing. This is because to make sure components in shock absorber system remain in good conditions. The Shock absorber system need to analyze how shock to see how they are going to perform in worst case scenario. A safe vehicle must be able to stop and manoeuvre over a wide range of road conditions

Suspension is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels. Shock absorber with its whole assembly is an important part of automotive suspension system which has an effect on ride characteristics. Shock absorbers are also critical for tire to road contact which to reduce the tendency of a tire to lift off the road. This affects on braking, steering, cornering and overall stability of the vehicle. The removal of the shock absorber from suspension can cause the vehicle bounce up and down. It is possible for the vehicle to be driven, but if the suspension drops from the driving over a severe bump, the rear spring can fall out. Basically, the shock absorbers must be replaced after driving exceeds certain distance. But this actually not should have been followed if there are no defective.

2. PROBLEM SPECIFICATION

The aim of this paper is to study and analyze single degree of freedom spring-mass-damper system and plot its dynamic characteristics curve for different values of spring stiffness for various speed conditions using FFT Analyzer validation with Matlab Results.

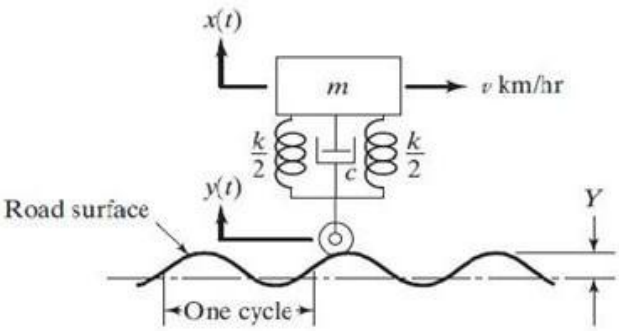

Figure 1. Problem Specification

3. OBJECTIVES

a) To test suspension on different types of oils and stiffness to find out optimum motion transmissibility using DOE
b) To determine dynamic characteristic of shock

absorber.

c) Suspension will be test for multiple stiffness by varying loads, speed and different oils.

4. DESIGN AND ANALYTICAL CALCULATIONS

4.1 Spring Stiffness Calculation

As initially we don't have spring stiffness value for two suspensions those are used for experimentation .For this one small experiment is done to calculate the stiffness. Initial length of the spring is measured with scale. Then 60 Kg load is applied on spring of one of the shock absorber. Thus spring gets compressed and now again spring length is measured. Now by using the formula for calculating spring stiffness,

K= (F/X) ×9.81 N/mm

Where,

K-Spring stiffness inN/mm F-Load applied in Kg

X-Displacement due to loading=

(Free length -Compressed length) in mm. Sample Calculation

For Splendor,

K= (60 ×9.81)/ (230-205)

K= 23.54 N/mm

Table -1: SPRING STIFFNESS OF SPLENDOR AND HONDA SHINE SHOCK ABSORBER

Sr. No	Shock Absorber	Load on Spring Kg	Length mm		Spring Stiffness (K) N/mm
			Free Length	Comp. Length	
1	Splendor	60	230	205	23.540
2	Honda Shine	60	240	206	17.310

4.2. Calculation

Perimeter of Drum

P=2πr

P=2π×0.305 P=1.91637m

volume of drum

V=2πr^2 h V=2×3.14×0.305×0.305×0.005 V=0.00292246 m3

Mass of Drum M=V×ρ M=0.00292246×7860 M=22.98 kg

WEIGHT OF DRUM

W=m×g W=22.98×9.81 W=225.48 N

By maximum shear stress theory

Support reaction (RA, RB)

∑MA=0

[(-RB×0.6096) + (740×0.305×0.15252)]=0 RB=112.74N

RA= -RB+ (740×0.305) RA=112.74 N

Bending Moment (M) M=RA ×w × (0.15252)/2

M=112.74×0.305-740×(0.15252)/2 M=25.78 N-m

Torque T=F×r

T= (149×9.81) ×0.405

T= 592 N-m

Equivalent Torque Te = √ (M2+T2)

Te = √ (25.782 + 5922)

Te = 593 N-m

Diameter of Shaft

d= ∛ (16×Te/ π τ)

d = ∛ [(16×593×1000)/ (π×45)]

d=40.69 mm~50 mm

By maximum principal stress theory

Equivalent Moment Me= [M +√ (M2+T2)] /2

Me= [25.78+√ (25.782+5922)] /2

Me=309.17 N-m

Diameter of Shaft d= ∛ (32×Me/πσ)

d=∛((32×309.17)/(π×75))

d=41 mm

Selecting maximum diameter & after select the roller bearing Find Te < T

T= (60×1000×P/2πN)

T= (60×1000×2.238/2 π×240) T=89.047 N-m

Velocity

V= πDN/60 V=π×0.05×240/60 V= 628.31 m/s

V=2.2611 Kmph

Key

TMax=1.25×593

TMax=741.25 N-m 741.25×103=(π/16) ×d3×45

d=50mm w=h=50/4≈13mm, l=75mm

Shear Stress

TMax= w×l× (d/2) × (τ per) Key

741.25×103= 13×l× (50/2) ×45

l= 50.68 mm

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Crushing Stress

TMax= (h/2) ×l× (d/2) × (σ per) Key

741.25×103= (13/2) ×l× (50/2) ×80, l=57mm

1.4EXPERIMENTAL SETUP

Figure 2&3. Actual Experimental Setup and Experimental Setup (CAD Model)

WORKING:

- Shaft is mounted in bearing on which drum is mounted Speed breaker profiles are welded on drum.
- On drum wheel assembly is mounted.
- Shaft is coupled to motor. Motor shaft rotates the Drum shaft which simultaneously rotates the wheel which in on drum.
- Motor speed is controlled by using Dimmerstat.
- As wheel and drum rotates wheel reaches to speed beaker profile it create bump on shock absorber.
- Shock absorber will get compress.
- FFT analyzers sensors will attached to Upper and lower point of shock absorbers and readings displayed on computers screen

5. RESULTS AND DISCUSSION

5.1 RESULTS

Table 2. SPLENDOR SUSPENSION (OIL 1)

S.N	Spring Stiffness (K)	Load (Kg)	Peak(RMS) m/s2		Transmissibility TR=(A/B)
			Top (A)	Bottom (B)	
1	23540	27	17.085	23.347	0.7317
2	23540	32	14.420	24.23	0.6073
3	23540	37	11.71	22.955	0.4932
4	23540	42	10.59	23.544	0.4147

Table 3. HONDA SHINE SUSPENSION (OIL 1)

S. N	Spring Stiffness (K)	Load (Kg)	Peak(RMS) m/s2		Transmissibility TR=(A/B)
			Top (A)	Bottom (B)	
1	17310	27	13.34	24.32	0.5485
2	17310	32	11.54	25.66	0.45
3	17310	37	10.73	26.19	0.41
4	17310	42	10.30	28.61	0.36

Table 4. SPLENDOR SUSPENSION (OIL 2)

S. N	Spring Stiffness (K) (N/m)	Load (Kg)	Peak(RMS) m/s2		Transmissibility TR=(A/B)
			Top (A)	Bottom (B)	
1	23540	27	18.774	25.407	0.7371
2	23540	32	14.469	24.525	0.6045
3	23540	37	11.375	21.876	0.52
4	23540	42	9.809	21.876	0.4484

Table 5. HONDA SHINE SUSPENSION (OIL 2)

S. N	Spring Stiffness (K) (N/m)	Load (Kg)	Peak(RMS) m/s2		Transmissibility TR=(A/B)
			Top (A)	Bottom (B)	
1	17310	27	13.791	25.898	0.5325
2	17310	32	12.24	27.664	0.4427
3	17310	37	9.4176	24.721	0.3809
4	17310	42	7.651	23.093	0.33134

5.2 Transmissibility comparison

Now we can compare the transmissibility calculated from experimental readings and MATLAB solution. The percentage error in transmissibility is shown in following table

5.2.1 Splendor Suspension (K=23540N/m and Oil 1)

Table 6. Transmissibility comparison of Splendor suspension with Oil 1

Load (Kg)	ω/ ωn	Transmissibility		% Error
		Experimental	MATLAB	
27	1.524	0.7317	0.7859	6.896
32	1.659	0.5951	0.6073	2.009
37	1.784	0.51	0.4932	3.406
42	1.901	0.45	0.4147	8.512

5.2.2 Honda Shine Suspension (K=17310N/m and Oil 1)

Table 7. Transmissibility comparison of Honda Shine suspension with Oil 1

Load (Kg)	ω/ ωn	Transmissibility		% Error
		Experimental	MATLAB	
27	1.777	0.5485	0.5203	5.419
32	1.9348	0.45	0.4149	8.459
37	2.08	0.41	0.3445	19.013
42	2.21	0.36	0.2943	22.324

5.2.3 Splendor Suspension (K=23540N/m and Oil 2)

Table 8. Transmissibility comparison of Splendor suspension with Oil 2

Load (Kg)	ω/ ωn	Transmissibility		% Error
		Experimental	MATLAB	
27	1.524	0.7371	0.7837	5.946
32	1.659	0.59	0.6045	2.398
37	1.784	0.52	0.4906	5.993
42	1.901	0.4484	0.4123	8.756

5.2.3 Honda Shine Suspension (K=17310N/m and Oil 2)

Table 8. Transmissibility comparison of Honda Shine suspension with Oil 2

Load (Kg)	ω/ ωn	Transmissibility		% Error
		Experimental	MATLAB	
27	1.777	0.5325	0.5159	3.218
32	1.9348	0.4427	0.411	7.713
37	2.08	0.3809	0.3411	11.67
42	2.21	0.33134	0.2913	13.745

6. Result of MATLAB

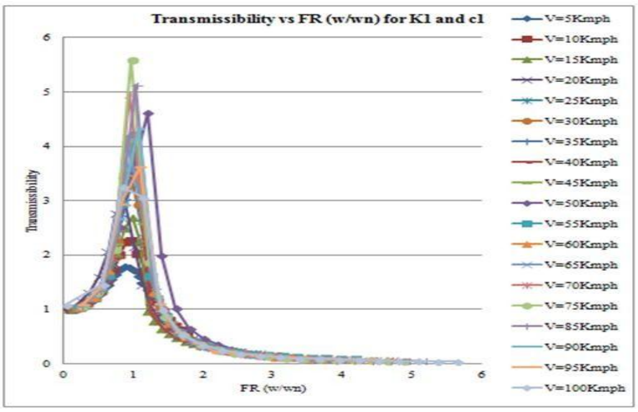

Figure 4. Transmissibility Vs FR (ω/ ωn) for K1 and c1

CONCLUSIONS

From this Suspension testing setup we can test multiple numbers of suspensions at different loads and different speeds. Also we can use suspensions of different height.

By changing different suspensions and oils we can find out optimum motion transmissibility. With ultimate objective of studying and plotting dynamic characteristics for Hero Splendor suspension and Honda Shine suspension using single wheel model of suspension analysis to produced large number of results. However it concludes the project work with following points:

1. The suspension system gives best performance when designed to be slightly under-damped.
2. From experimental results and graphs we can conclude that for good ride, transmissibility should be as low as possible and this can be attained by using low damping constant and high spring stiffness and Honda Shine suspension gives the better results as compared to Splendor suspension

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