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EXPERIMENTAL ANALYSIS OF DAMPING CAPACITY AND EFFECT OF THERMAL CHANGE ON SHOCK ABSORBER

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ABSTRACT:

The vehicle suspension system enables maximum contact between the road surface and the road surface. It also helps the vehicle demonstrate superior active safety that allows the vehicle to move comfortably. In this research, we aim to study the vibration characteristics of various road profiles by changing the damping oil on the shock absorber test platform. Impact simulation of MATLAB software controlling the state of brake fluid by the influence of the above parameters also affects the braking ability. The FFT analyzer is used to determine the vibration acceleration. From this study, the optimum damping coefficient for different roads reveals better driving and comfort.

KEYWORDS: Road profile, Passive suspension, MATLAB, FFT analyzer

1.INTRODUCTION:

The task of the vehicle's suspension is to maximize the friction between the tire and the road surface, improve the stability of the steering and ensure the comfort of passengers. If the road is completely flat and not irregular, the jetty is not needed. However, the road is not flat. Even on the newly paved highway, there are subtle flaws that can interact with the wheels of the car. This disadvantage is the addition of force to the wheels. Road cones move the wheels up and down perpendicular to the road surface. The magnitude of the force depends on whether the wheel hits a huge blow for a small spot.

The wheel receives acceleration in the vertical direction when it passes through the incomplete part. Without intermediate structures, the entire vertical energy of the wheel is transferred to a frame moving in the same direction. Under these conditions, the wheel can completely lose contact with the road. And under the pull of gravity, the wheel can be thrown back onto the road. You need a system that absorbs the vertically accelerated energy of the wheel, and you can ride the frame and body without worry, as long as the wheel follows the ridges of the road.

Road insulation is the ability of a vehicle to absorb or separate road shocks from the passenger compartment. By doing this, the car body can travel without moving while traveling on a non-uniform road. It absorbs energy from road bumps and spreads it without causing excessive vibration of the suspension vehicle. Suspension enables load holding. The suspension is also effective for bending. This is the ability of the vehicle to overcome the curved road. At the time of a good suspension turn, when lifting one side of the vehicle and lowering the other side, minimize the role of the car body which occurs when the centrifugal force is pushed out to the center of gravity of the car. When you fall down from the high side of the car to the low side, give the weight of the car.

There are several ways to check the state of the shock absorber. One of the tests is a method of the frequency response of durability use applied to suspension and tires. Because the machine is very expensive, this test is very complicated and expensive. Another way to test the shock absorber without removing the shock absorber from the car is to use a failure test. In the workshop, there is a mechanic to perform a fault test to repeatedly press each corner of the car to check the condition of the shock absorber. However, the results of this test are not very accurate to show the condition of the shock absorber. The purpose of this project is to determine the dynamic characteristics of automobile depreciation system. Vehicles traveling receive virtually constant vibration excitation. Therefore, a shock absorber (that is, vibration) is necessary for driving safety and driving comfort.

2. LITERATURE REVIEW:

Prof. Amol P. Kokare et all.[1] analyzed the display window, determining the speed of the transfer of motion, in order to achieve maximum ride comfort. The results of the analysis are based on the equation of absolute motion of one degree of freedom of the spring mass damping system under the condition of a forced attenuator in MATLAB, which is the tool used to achieve this goal. As MATLAB Simulink tests, the error is in the range of 0 to 15%. The suspension system is designed for unintentional ad-dumping and provides optimum performance if it is not overloaded.

S. Prabhakar, Dr. K. Arunachalam [2] modeled and analyzed the passive suspension system of various road profiles with various parameters of damping and stiffness. They simulated a passive suspension system for a model with a fourth car with variable damping and stiffness parameters. The latest automotive suspension systems use passive components that use only fixed speed springs and attenuation parameters.

Using variable damping and stiffness parameters, the suspension can provide optimum performance. Breach represents various simulated profiles of the main (unsprung (wheel) is in direct contact with it, which in turn can represent that simulated profile, which can cause unwanted vibration or shake, spring mass Body) It is sent to the system. It gives discomfort to passengers. Therefore, the idea of this research is to figure out a solution that can minimize this state of discomfort and improve grip. Comparison of passive suspension with traditional passive suspension system with variable damping and stiffness parameters is done using various types of road shape simulation. For ¼ Random Excitation Road Vehicle Model Results of the analysis of the suspension system, these values are very low. It shows that the deflection of the vehicle suspension has exceeded the maximum amplitude of 70% and 0.08 meters, the suspension can provide good comfort.

Javad Marzbanrad*, Masoud Mohammadi and SaeedMostaani[4] Raju was investigated to determine the flight and damper parameters in order to guarantee the optimal driving of the car at different speeds using the design of experimental method (DOE). We examined the extent to which the ride comfort of the optimum suspension setup was different with respect to road level and achievable ride of varying roughness and different speeds. For optimization, the optimal speed method from 60 to 90 km / h for the DOE method with 7 degrees of freedom, modeled with MATLAB software, is most effective at 60 km / h vertical acceleration, Speed increase from 60 to 110 km / h improves the characteristics of the peach angle from 5% to 25%, but improves the speed of the vehicle.

Tamboli, J.A. and Joshi[07] turned out that the actual drive PSD roads are accompanied by a nearly exponential curve reduction. Also, changing the speed of the vehicle has a serious effect on the value of Root Mean Square Acceleration Response "RMSAR". Therefore we did effective random road excitation obtained by considering the effect of frequent change of the actual driving PSD road and the vehicle speed of this work RMSAR vehicle dynamic system. The optimization method is proposed to minimize the RMSAR vehicle suspension system by taking the desired boundary value RMSAR defined on the wheel base with the influence of the vehicle speed RMSAR, and RMSAR is proportional to the vehicle speed Then it is inversely proportional to its wheelbase.

JigneshRana, SwastikGajjar ,Ankit Patel[3] conducted an experimental analysis of the damping fluid in the shock absorber and heat transfer studies. The purpose of this experiment is to test and modify the absorber with various working fluids. When the absorption device is running, the absorber is heated. Heat heats the damping fluid inside the absorber to change the properties of the damping fluid and degrade the absorber's performance if heat is not well tolerated in the environment. To solve this problem, it is necessary to add a substance having a high thermal conductivity to the inside of the absorbing material. Many existing absorbers have voids between the inner cylinder and the outer shell of the absorber. Air has a low thermal conductivity and is a bad substance for transferring the amount of heat. Using propylene glycol, it is possible to improve heat transfer inside the absorber by 39%. The use of ethylene glycol gives better results than propylene glycol and increases the heat transfer coefficient to 52%. Glycerin gives better results than both glycols, giving up to 64% heat transfer.

3. PROBLEM STATEMENT AND OBJECTIVE:

From the review of the literature, it can be seen that investigation of vibration characteristics of shock absorbers under different road surface profiles and use of different damping oils were not performed. The rear wheel shock absorber of Honda Activa has been tested for vibration characteristics of two different road profiles and two types of damping oil. Monitor the condition of brake fluid due to temperature change. The main purpose of this research is the experiment, modeling, modeling of the suspension of a motorcycle. Measure the viscosity of the oil in the specified state of the shock absorber.

4. MATHEMATICAL MODELING:

The main function is to create four influential parameters for the two main responses is Road Comfort and Road Holding with The main function is to create four influential parameters for the main responses is sprung mass (m in Kg), spring stiffness (k in N/m), damping coefficient (c in N-s/m), Viscosity (μ in poise). The damping coefficient is different from the damping oil. We used 20w 30 and 20 w 40 oils.

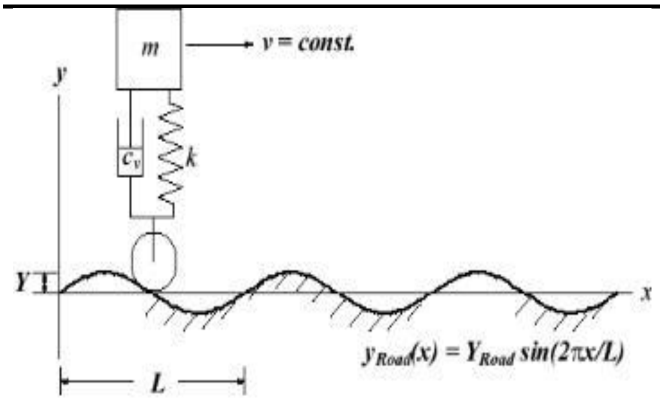


Fig.1.Free body diagram of suspension model with sinusoidal road profile

Mathematical equations formulated for the above system.

Considering Y: Amplitude of road profile

$$m\ddot{x} + c(\dot{x} - \dot{y}) + k(x - y) = 0$$

Where y : Road excitation

$$y = Y \sin wt$$

$$m\ddot{x} + c\dot{x} + kx = ky + c\dot{y}$$

$$\ddot{x} = \frac{Yk}{m}\sin wt + \frac{cw}{m}\cos wt - \frac{c}{m}\dot{x} - \frac{k}{m}x$$

Solution of this differential equation is done in the MATLAB Simulink 2013

Amplitude: Y =10mm

Stiffness of spring: k = 12732 N/m

Total mass on shock absorber: m =37 kg

Damping coefficient: C1 =245.3 Ns/m (20w30)

C2=373.16 Ns/m (20w40)

The damping coefficient is determined by logarithmic decrement.

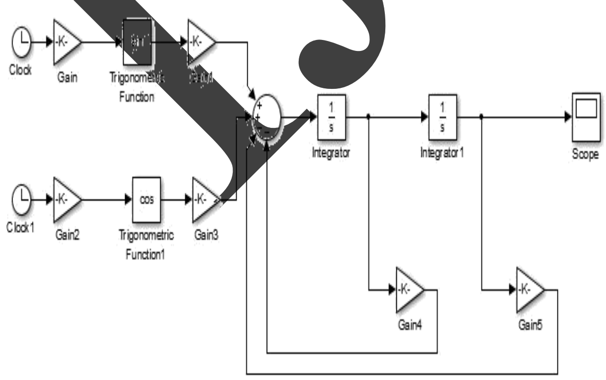


Fig.2. Block diagram of shock absorber with road excitation using MATLAB

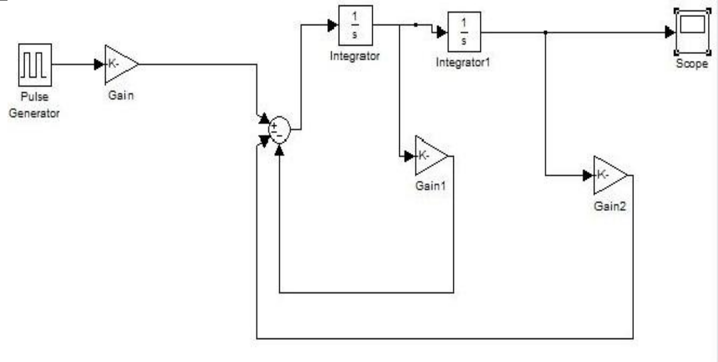


Fig.3. Block diagram of shock absorber with Stepped road excitation using MATLAB

5. RESULT OF SIMULATION:

1) When damping fluid is considered 20w30

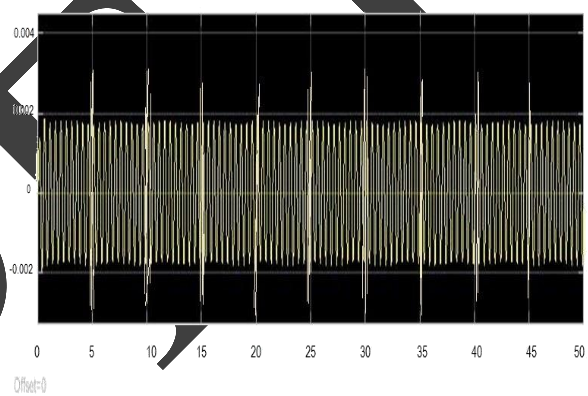


Fig.4.Amplitude v/s time plot of MATLAB

It is observed that the maximum amplitude of vibration is up to 2.8mm

2)When Damping fluid is considered 20w40

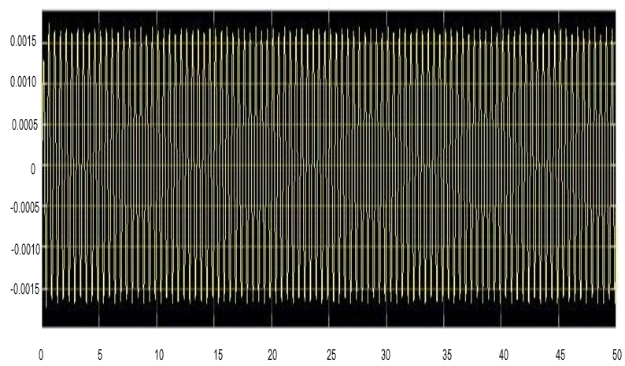


Fig.5.Amplitude v/s time plot of MATLAB

It is observed that maximum amplitude of vibration is up to 1.8mm

3) When damping fluid considered 20w30 for stepped road profile

Stepped road profile considered of 10mm step. Pulse generator is used for modelling of system in MATLAB.

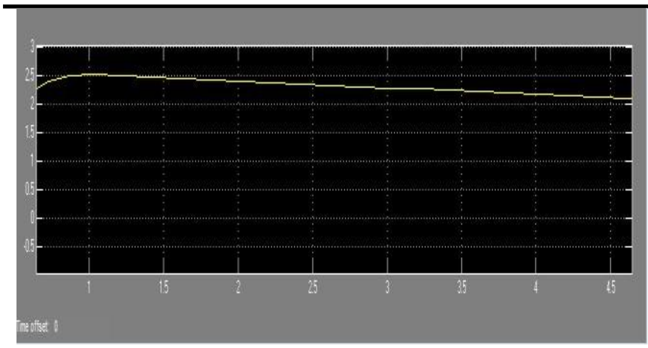


Fig.6. Amplitude v/s time plot of MATLAB for 20w30 for stepped road

It is observed that maximum amplitude of vibration up to 2.5mm

4) When damping fluid considered 20w40 for stepped road profile

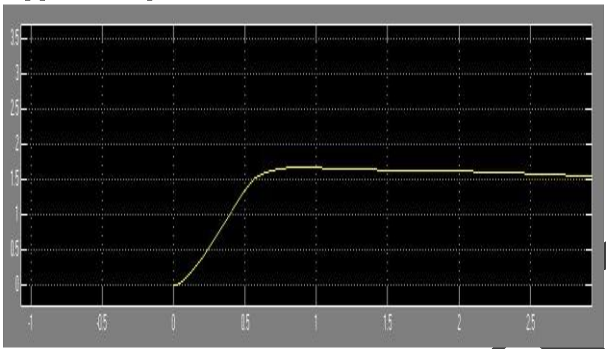


Fig.7. Amplitude v/s time plot of MATLAB for 20w40 for stepped road

It is observed that maximum amplitude of vibration up to 1.6 mm

6. EXPERIMENTATION:

Shock absorber mount, Equipment with cam profile, attached to the shaft of the gearbox. This reducer is connected to the 1 Hp motor. The speed of the motor is regulated by a variable-frequency drive. One is sinusoidal, and the other is a step. We processed two different cams. One of them was a circle having an eccentricity of 10 mm, and the other a form of a ladder with a pitch of 10 mm. The vibration characteristics are collected using an FFT analyzer. The FFT analyzer type SRF 60 SKF is used for the measurement. The FFT probe is stored in the collected load and acceleration vibration.

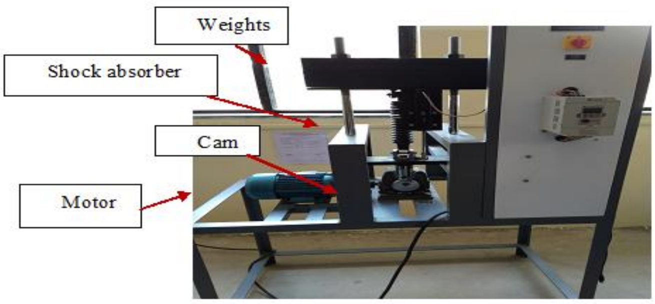
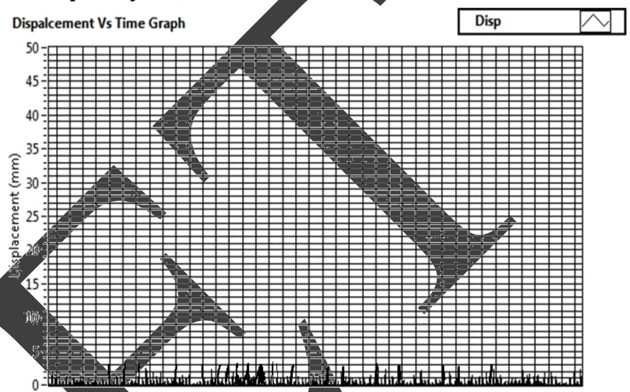


Fig.8.Test Rig of Shock absorber

Shock absorber is fitted in the given fixer on Test rig.

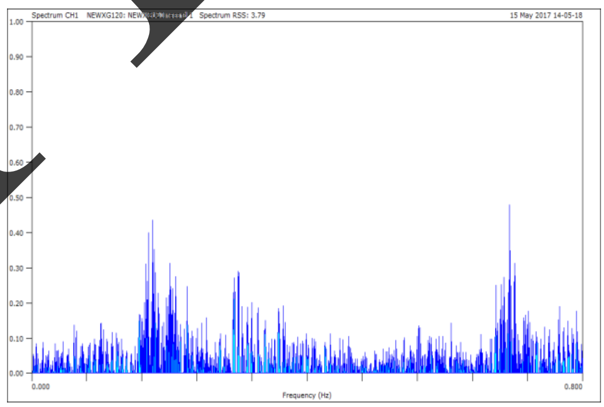
A) SINUSOIDAL ROAD PROFILE:

Below the shock absorber is a sinusoidal outline of the road. The load is 37 kg. When variable frequency is used, the rotation speed of the cam can be adjusted up to 120 rpm. Offset against time The site was filmed in software. The FFT analyzer is used to measure the actual vertical acceleration. The FFT analyzer probe is stored above the load. The graph was created from FFT Acceleration versus Frequency Analyzer. When using damping fluid, 20 w 30 - Amplitude vs time, Acceleration vs frequency.

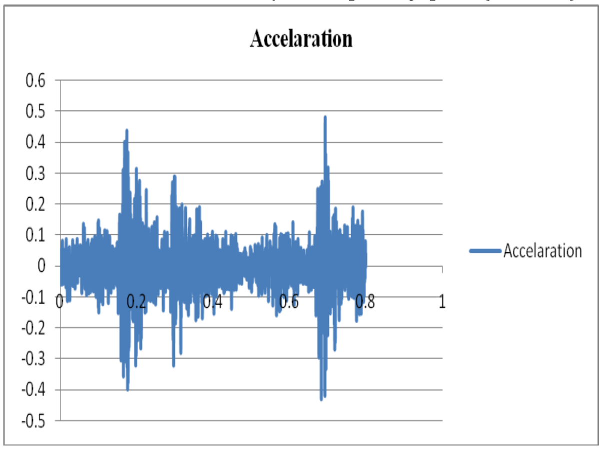


Plot.1 Displacement v/s time plot (20w30)

Above plot shows that maximum peak amplitude is 3.1mm.



Plot.2 Acceleration v/s Frequency plot (20w30)

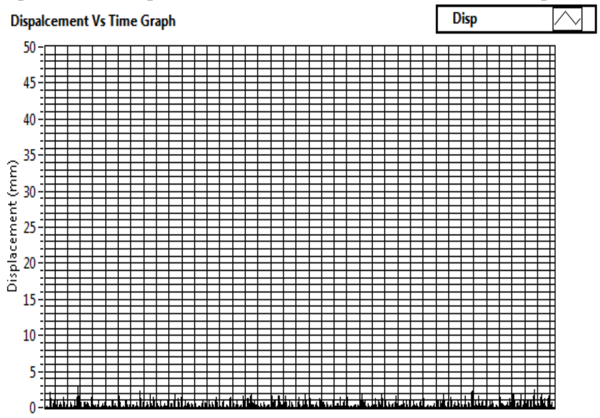


Plot.3 plot of acceleration using FFT when damping fluid used 20w30

Above plot is of vertical vibration Acceleration with respective frequency when damping oil used is

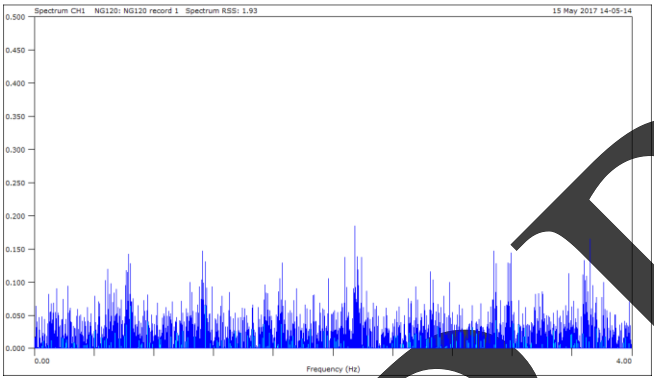
20w30.Maximum acceleration come across is about 0.45 mm/s2 and 0.48 mm/s2.

When Damping fluid used was 20w40 following are the plots of Amplitude vs time,Accelaration vs frequency.

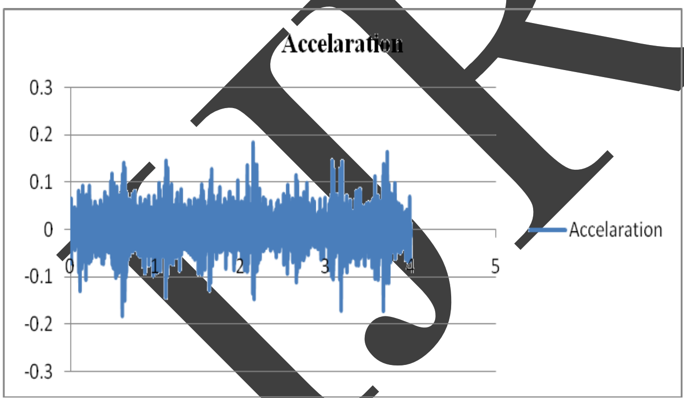


Plot 4. Displacement v/s time plot (20w40)

Above plot shows that maximum peak amplitude is 2mm .



Plot.5 Acceleration v/s Frequency plot (20w40)

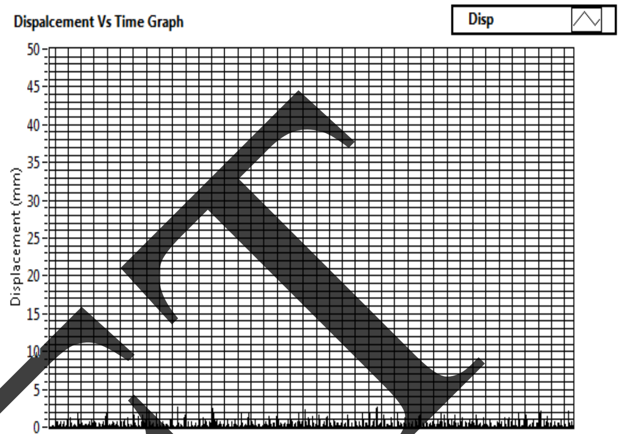


Plot6.plot of acceleration using FFT when damping fluid used 20w40

Above plot is of acceleration when damping oil used is 20w40.Maximum acceleration come across reading 0.18 mm/s2.

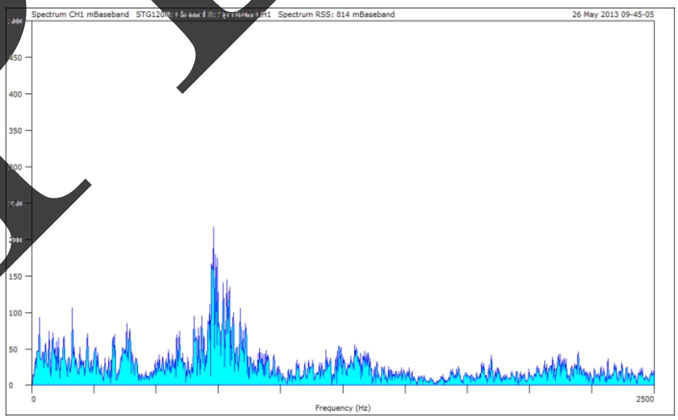
B) STEPPED ROAD PROFILE:

The surface of the stepped road is attached under the shock absorber. The load is 37 kg. Using the frequency with the frequency drive, the cam can be adjusted to 120 rpm. The bias and time graphs were taken in the software. The FFT analyzer is used to measure the actual vertical acceleration. The FFT analyzer probe is stored above the load. The graph was obtained from the acceleration and frequency of the FFT analyzer. If the damping liquid used is 20 w 30, there is a plot of the amplitude versus time and acceleration as compared to the frequency.

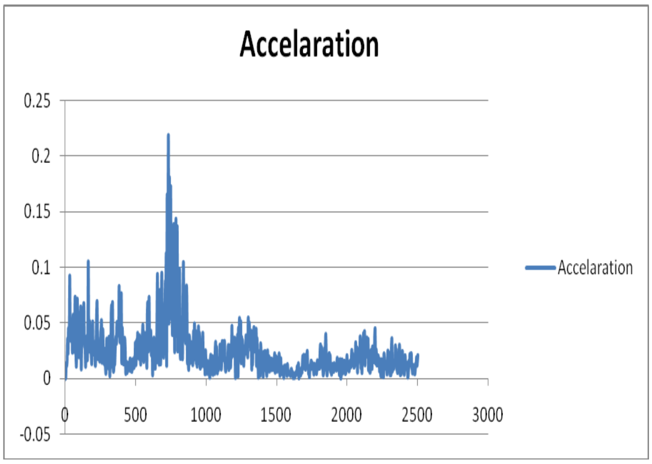


Plot 7. Displacement v/s time plot (20w30) stepped road profile

Above plot shows that maximum peak amplitude is 2.2 mm .



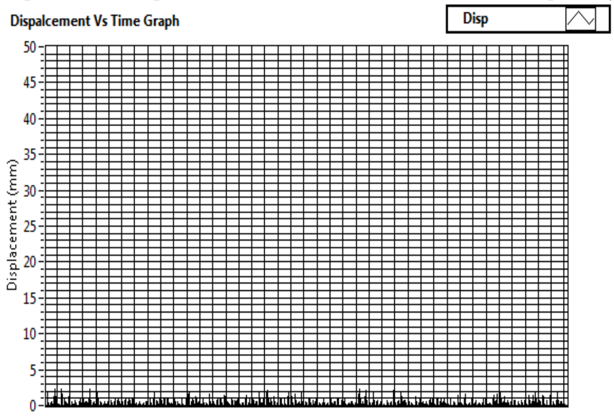
Plot 8. Frequency v/s Frequency plot (20w30) stepped road profile



Plot 9. Plot of acceleration using FFT when damping fluid used 20w30 in stepped profile.

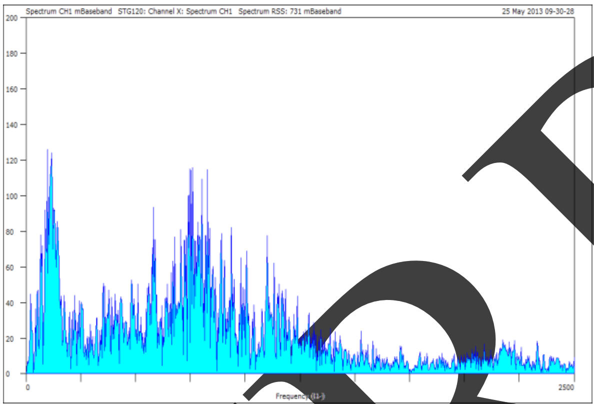
Above plot is of acceleration when damping oil is 20w30 and stepped road profile. Maximum acceleration is 0.22mm/s2.

When Damping fluid used was 20w40 following are the plots of Amplitude vs time,Accelaration vs frequency.

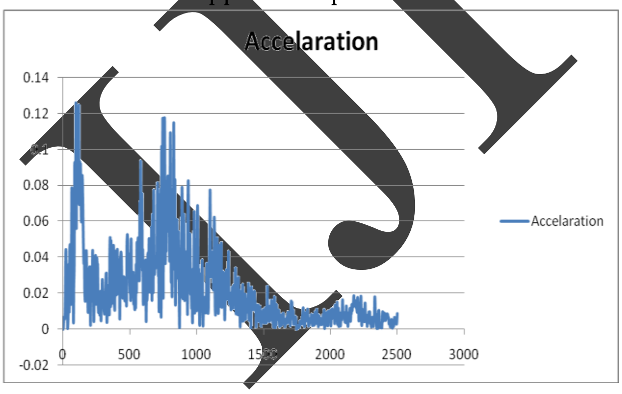


Plot 10. Displacement v/s time plot (20w40) stepped road profile

Above plot shows that maximum peak amplitude is 1.8 mm .



Plot 11. Acceleration v/s Frequency plot (20w40) stepped road profile



Plot12.Plot of acceleration using FFT when damping fluid used 20w40 in stepped profile.

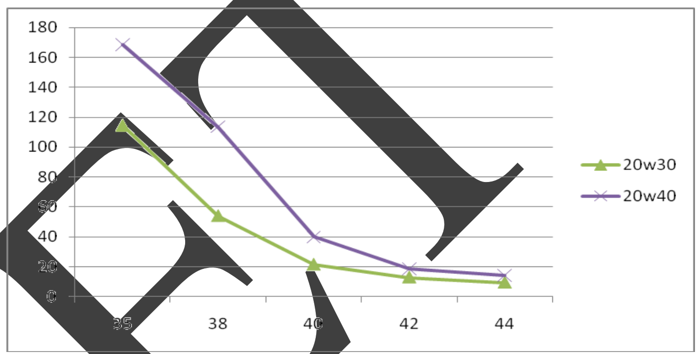
Above plot are of Vibration accelerations when oil used 20w40 .Reading shows that maximum acceleration is 0.14mm/s2.

C) CONDITION MONITORING OF DAMPING FLUID:

Due to continue running it is observed that viscosity of oil change as there is change in temperature. Measurement of viscosity is did with the help of Redwood viscometer of Type-1.

Table1.Viscosity of oil at different temperature

Viscosity at Temperature / Oil	35^0	38^0	40^0	42^0	44^0
20W30	114.71 cSt	54.05 cSt	21.51 cSt	12.94 cSt	9.40 cSt
20W40	168.35 cSt	113.48 cSt	39.86 cSt	18.74 cSt	14.23 cSt



Plot13. Oil Viscosity Vs Temperature plot

7. RESULT AND DISCUSSION:

Shock absorber modeled for different road profiles of MATLAB Simulink using various damping oils. The simulation result shows that the vibration amplitude of 20 w 30 is higher than 20 w 40 oil under the same condition. Compared to the case where 20 w 30 is 0.48 mm / s 2, it has been experimentally established that the maximum RMS acceleration 20 w 40 is 0.18 mm / s 2, and the profile of the stepped road which has decreased by the same size step as the eccentricity Of the PCP acceleration sine wave cam. As the temperature rises, when moving continuously along these road shapes, the viscosity of the damping oil decreases.

Table 2.RMS acceleration for road profile

Road Profile	RMS Acceleration mm/s2	
	20w30	20w40
Sinusoidal	0.48	0.18
Stepped	0.22	0.14

Table 3.Vibration Amplitude for Different road profile in MATLAB and in FFT

Road Profile	Amplitude in mm			
	20w30		20w40	
	MAT LAB Result	Actual Result	MAT LAB Result	Actual Result
Sinusoidal	2.8	3.1	1.8	2
Stepped	2.5	2.2	1.6	1.8

CONCLUSION:

From the above experiments, it can be concluded that the shock absorber transmits a high vibration to the passenger of the sinusoidal road in comparison with the profile of the road on the stairs. When the attenuation changes from 20 w 30 to 20 w 40, the vibration value is suppressed up to 3 times. As the temperature of the damping fluid changes, the viscosity of the oil changes. It decreases as the temperature rises.

In the future range, we can determine and formulate the effect of increasing the temperature of the damping fluid.

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