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Design of Permanent Magnet Suspension Systems for 2 Wheelers-TVS Star Bike

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ABSTRACT : **The suspension of a motorcycle contributes to vehicle's handing and braking in such a way that it isolates the passengers from bumps, vibrations in order to provide comfort.Suspensions are categorized as Front Fork and Rear Cushion Suspensions. We however are particularly interested in the most common form of front suspension for a modern motorcycle i.e. a telescopic fork suspension.Shock absorbers consist of a spring which determines posture and cushioning buffer action a damper which reduces vibration.Our purpose is to obtain natural frequency of vibration of the damper system.The experimental setup of FFT analyzer is connected to suspension system and modes of vibration are extracted from the unit. The traditional choice in motorcycle front suspension systems is the telescopic fork. Although after many decades of development the performance of such systems is often already adequate, the design inherit disadvantages are still present. With the help of experimental analysis in real-time condition the time domain and frequency domain values are obtained. This paper reviews the topic in a way of aiming to develop a methodology for a quick andeffective diagnostic procedure that could be carried out in any repair facility**

Keywords –Damping, FFT Analyzer,Mode Shapes, Natural Modes of Frequencies, Suspension System.

INTRODUCTION:

This paper addresses the issue of vibration analysis of suspension system with use of experimental setup.The frequencies at which vibration naturally occurs, and the modal shapes which the vibrating system assumes are properties of the system, and can be determined analytically using Modal Analysis. Our involvement here is in obtaining values of mode shapes from experimental setup of FFT analyzer. The Fast Fourier Transform (FFT) and the power spectrum are powerful tools for analyzing and measuring signalsfrom plug-in data acquisition (DAQ) devices. For example, we can effectively acquire time-domain signals, measure the frequency content, and convert the results to real-world units and displays as shown on traditional benchtop spectrum and network analyzers. The basic functions for FFT-based signal analysis are the FFT, the Power Spectrum but additional measurement functions such as frequency response,impulse response, coherence, amplitude spectrum, and phase spectrum. It involves the marking of certain positions on the suspension bar, keeping required points fixed and attaching the accelerometer sensors to other positions, collectively taking the readings to obtain mode shape frequencies

I. INTRODUCTION TO THE PROBLEM

Shock absorbers are an important part of automobile and motorcycle suspensions, aircraft landing gear, and the supports for many industrial machines. The shock absorbers' duty is to absorb or dissipate energy. One design consideration, when designing or choosing a shock absorber, is where that energy will go. The suspension used here is of motorcycle TVS-Star. Five points were marked over the length of suspension bar, and the sensors were fixes to one of the points in order to fix its single degree of freedom. Impact Hammer was used in order to excite the particles of the bar, and readings are obtained in Data Acquisition System.

Positioning of Sensors and Excitation by Hammer:-

The whole length of the Telescopic Suspension was mainly divided into 5 parts depending upon the convenience of sensor positioning. The surface of the suspension is cleaned so as to remove all oil traces and remove all the dust from it, So as to position the sensor properly and acquire the proper grip on it. The Sensors are positioned alternatively at position 1, 3, 5 and simultaneously the excitation was done using impact hammer at all positions except at that where the sensor is mounted. Corresponding readings are taken from the Data Acquisition System and NaturalFrequency and mode shapes are plotted and calculated from the plots obtained.

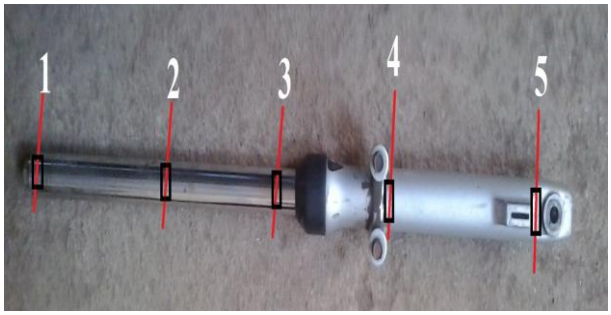


Fig. (I)

Impact Hammer:

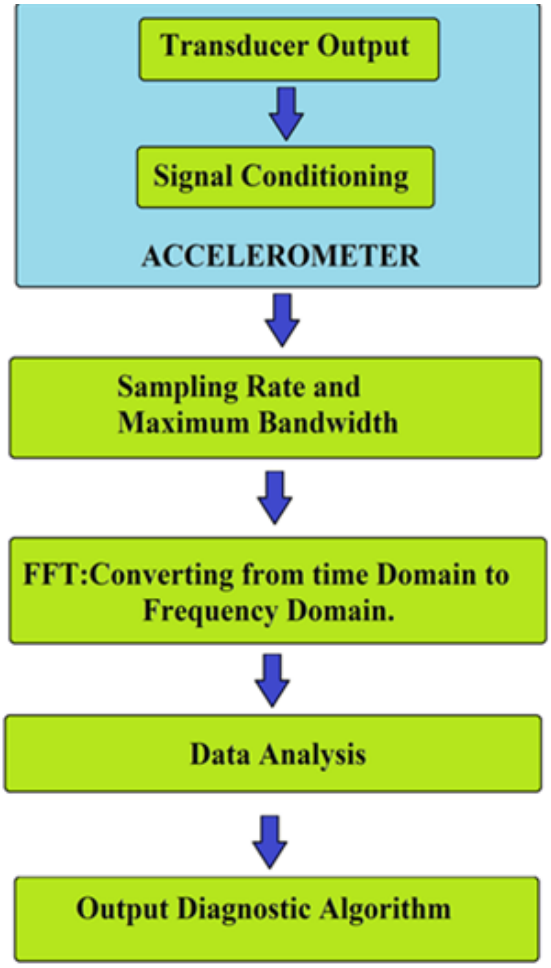
- **DYTRAN Impact Hammer- 1pc**

Impact hammer is basically used for transient excitation. The Impact Hammer test has very distinct advantage. The input spectrum from the impact is flat out to the roll-off the frequency with no holes in the spectrum. It is very convenient technique and is used for lightly damped linear test structures and very high quality Frequency Response Function (FRF).

Accelerometer Sensors:

- **Accelerometer Sensors**- 2pc

The accelerometer generates an output signal that is proportional to the acceleration of the vibrating mechanism. The accelerometers are light in weight, compact and capable of measuring vibrations at specified points. The output produced from the accelerometer depends upon the sensitivity moreover it does not need any structural loading. However accelerometer mounting, interconnection cables are the critical factors to look for while analysis. Accelerometer Sensors are used to obtain frequency values and pass it to the Data Acquisition System for analysis, Accelerometer sensors are connected at points where the vibrations are to be sensed, which are caused due the help of excitation made by Impact Hammer.



Block Diagram of Vibration Sensing

II. INDENTATIONS AND EQUATIONS

The two working conditions are as:-

- Free-Free Condition
- Fixed Condition

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.

III. FIGURES AND TABLES:

Free –Free Condition:

The Free-Free condition is required in Modal analysis, however the condition is difficult to achieve. So the Suspension system is generally conditioned using Soft Spring of negligible mass and good stiffness value. The free-free condition once achieved produces displacement when any external force acts on it.The excitation was done as stated earlier and the data was collected for further analysis.

The Free-Free Condition is as shown:-

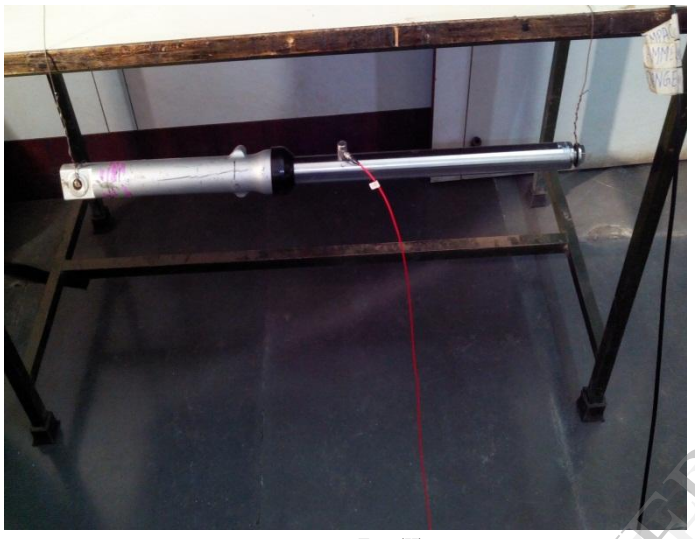


Fig. (II)

Fig. (III)

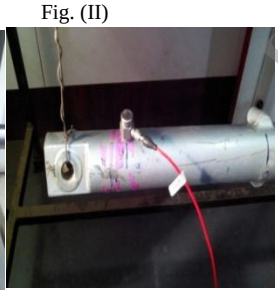


Fig. (IV)

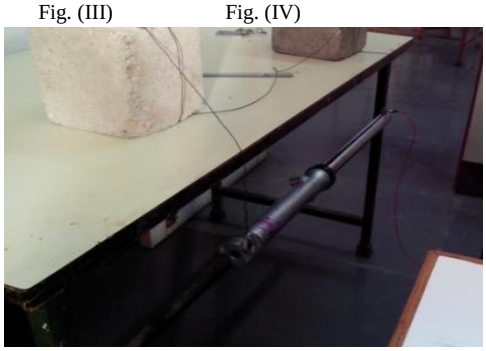


Fig. (V)

The graphs of the Free-Free Conditions obtainedFrom FFT Analyzer are:-

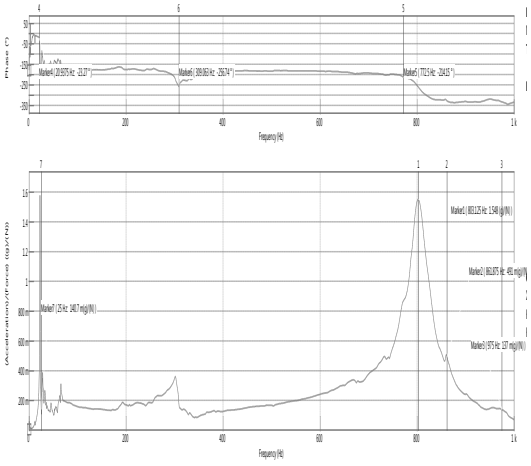


Fig. 1.2(a)

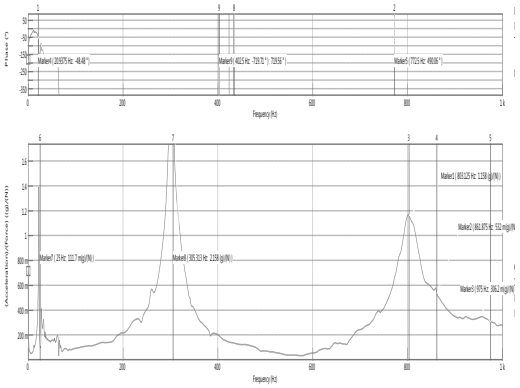


Fig 1.3(b)

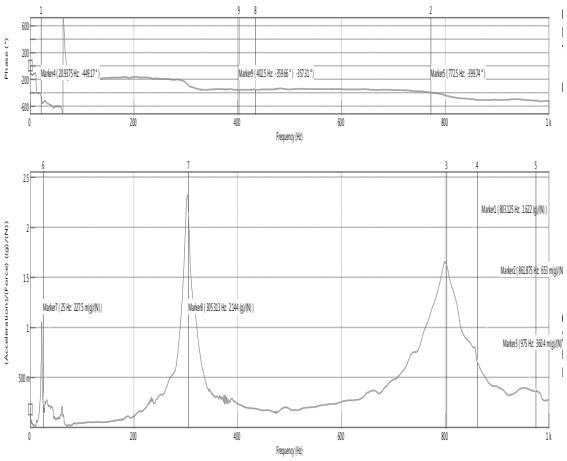


Fig 1.4(c)

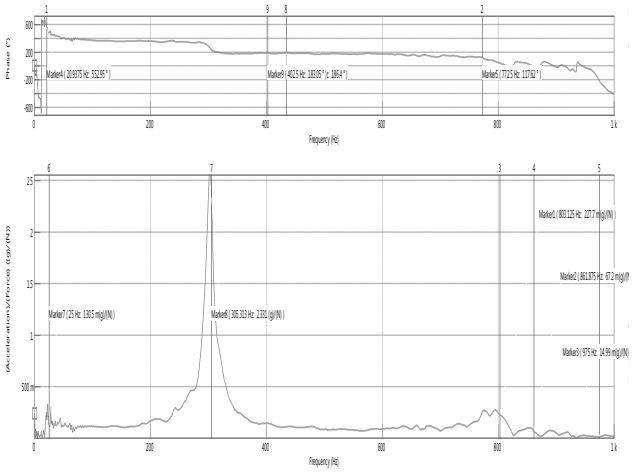


Fig 1.5(d)

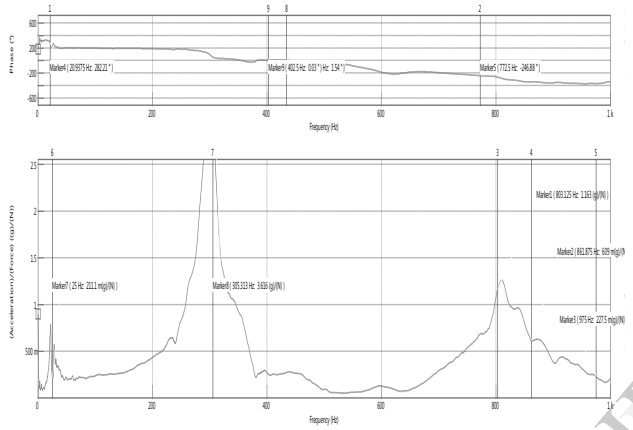


Fig 3.1(e)

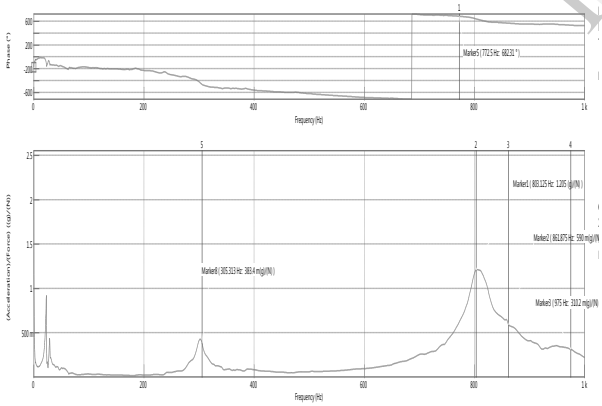


Fig 3.2(f)

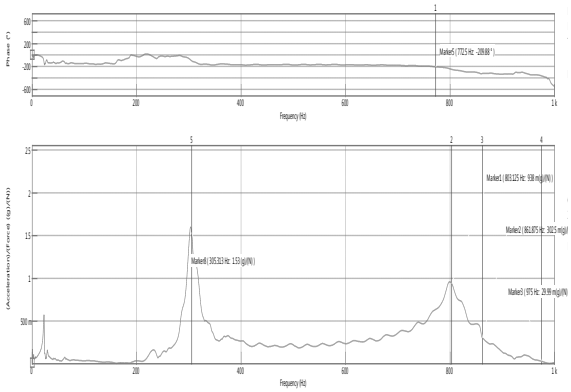


Fig. 3.4(g)

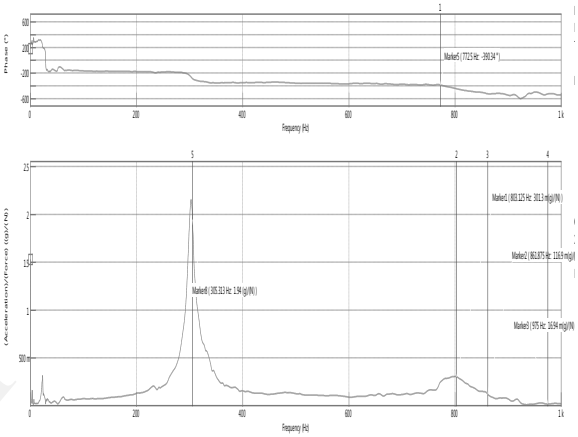


Fig 3.5(g)

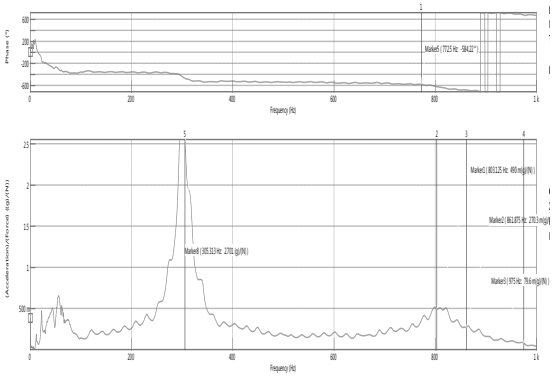


Fig. 5.1 (h)

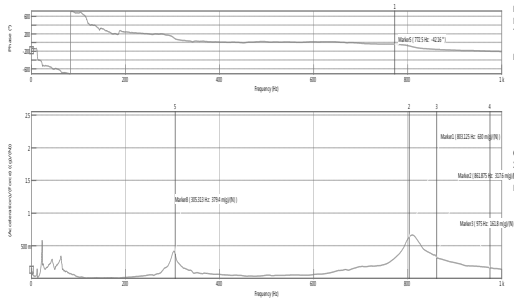


Fig 5.2(i)

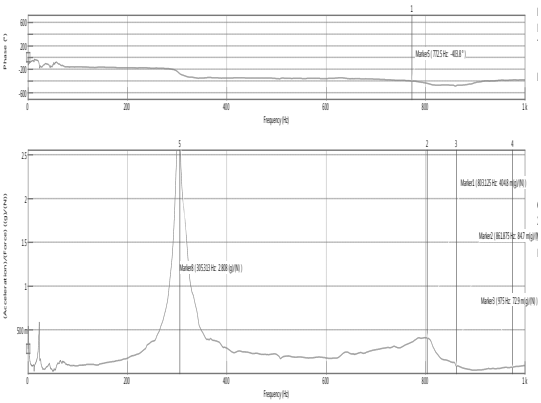


Fig. 5.3 (j)

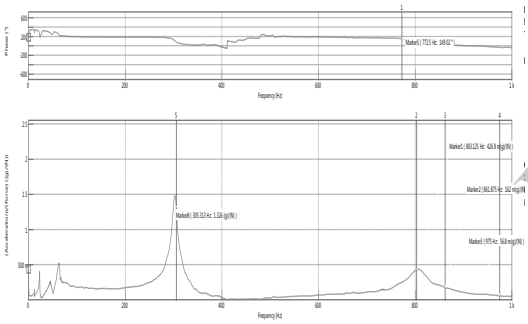


Fig 5.4 (k)

Fixed Condition:-

In fixed condition the Telescopic Suspension was placed in the Jaws of chuck and it was placed vertically.
The excitation was done as stated earlier and the data was collected for further analysis. The setup made for the Fixed Condition is as follows:-

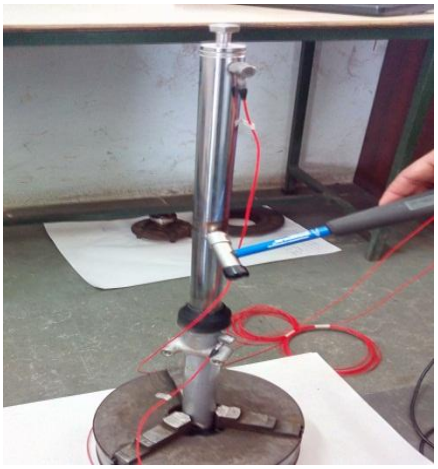


Fig. (VI)

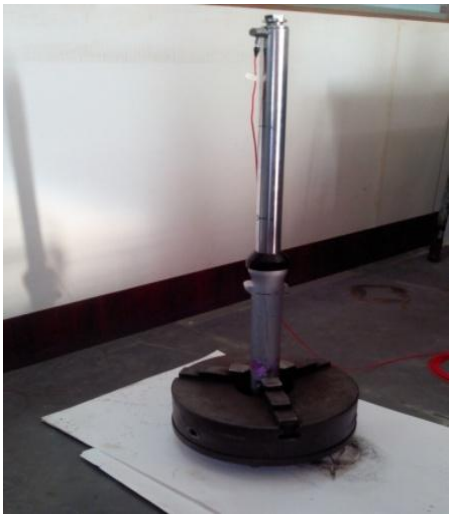


Fig. (VII)

Fig.(VIII)

Fig. (IX)

The graphs of the Fixed Conditions Obtained from FFT Analyzer are:-

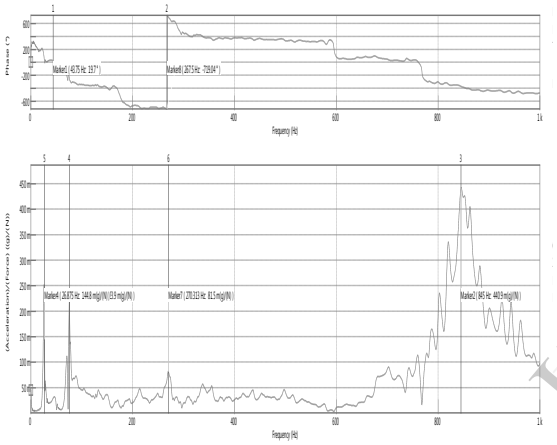


Fig. 1.2 (l)

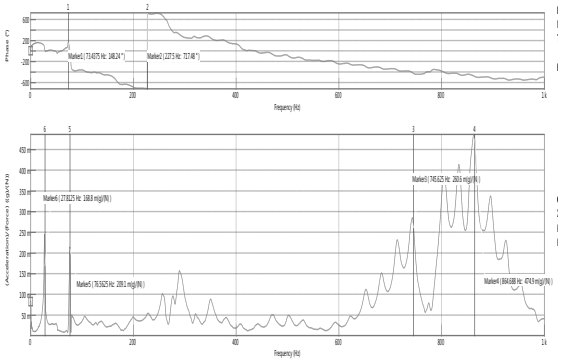


Fig:1.3 (m)

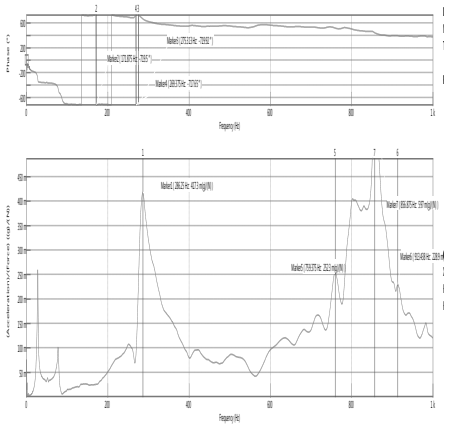


Fig. 1.4 (n)

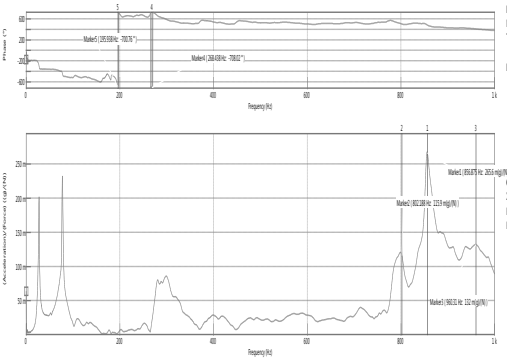


Fig 1.5 (o)

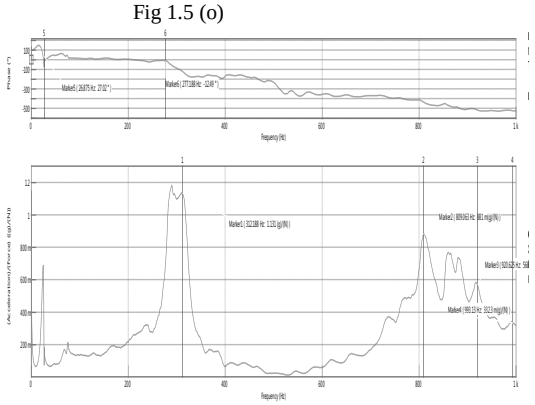


Fig. 3.1 (p)

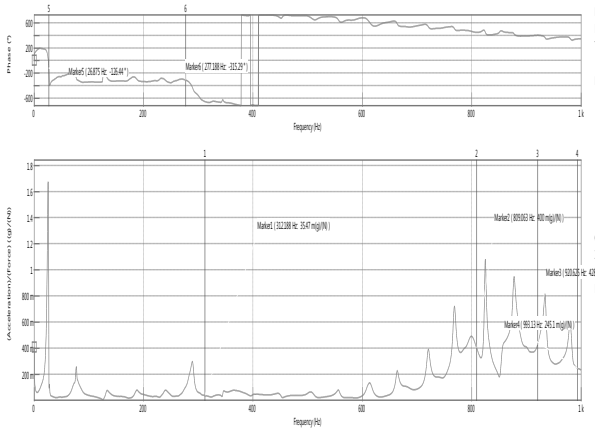


Fig 3.2 (q)

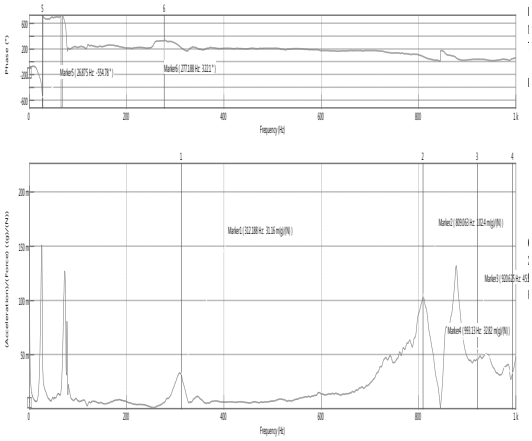


Fig 5.1 (t)

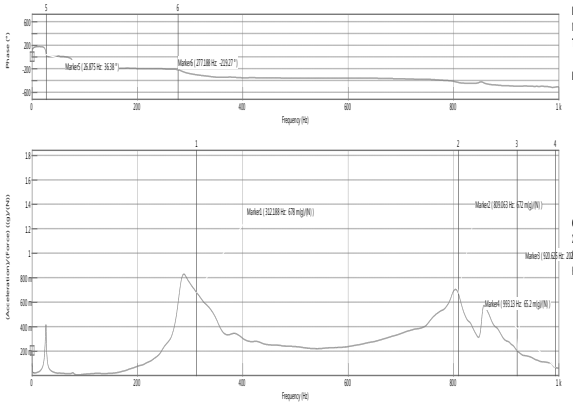


Fig. 3.4 (r)

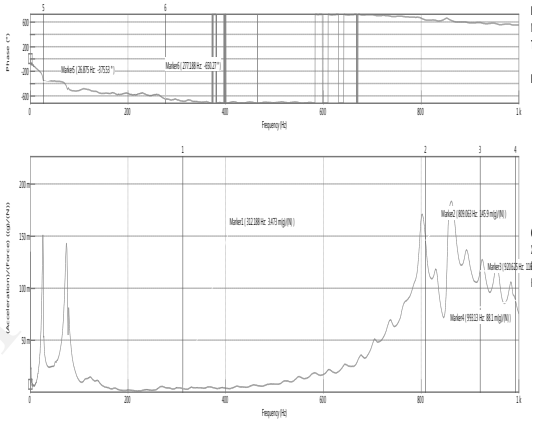


Fig 5.2 (u)

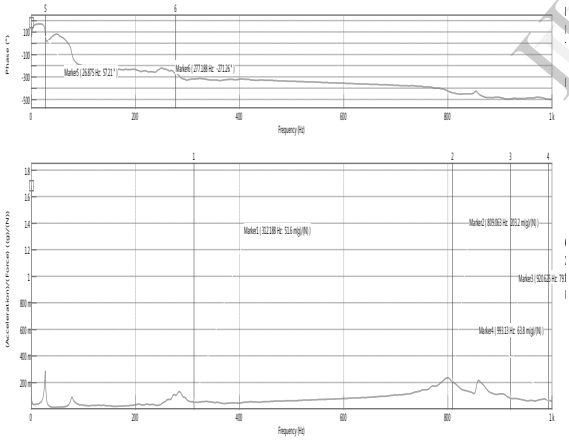


Fig 3.5 (s)

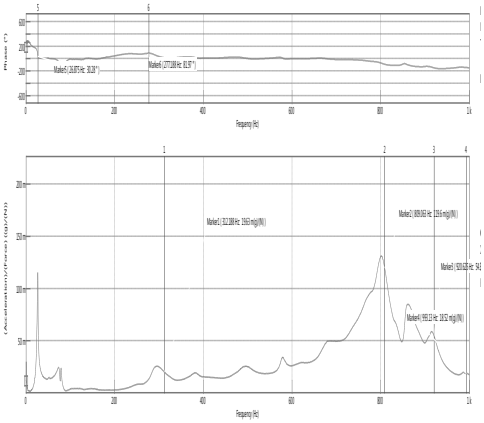


Fig. 5.3 (v)

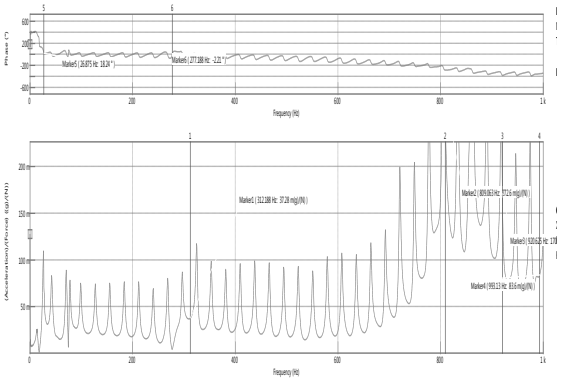
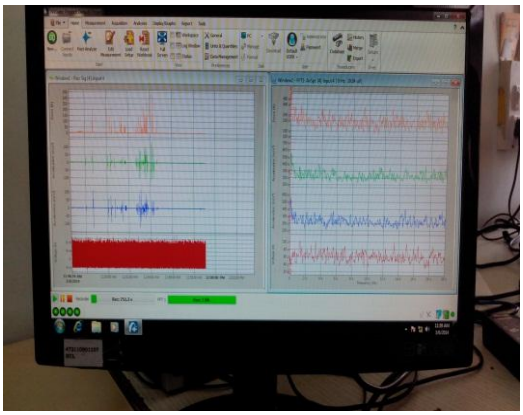


Fig 5.4 (w)



Real-time analysis output

IV. TABLES &RESULTS

Sr. No.	Natural Frequency (Hz)
1.	269.5
2.	312.188
3.	759.625
4.	846.688
5.	960.31
6.	933.13
7.	1025.32
8.	1205.42
9.	1365.42
10.	1493.62
11.	1678.2
12.	1998.72
13.	2105.12
14.	2321.21
15.	2457.32
16.	3215.32

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CONCLUSION:

Sr. No.	Condition	Measured Length
1	Suspension Length when its fixed on bike	34.2 cm
2	Reading taken when bike is loaded	31.6 cm
3	Free length of suspension after removing it from bike	35.2 cm

Table of Displacement data:-

	Loading Load (Y)	Deform	Deform	Avg	(X)	Disp
1	2.25	35.45	35.45	35.45	33.65	1.55
2	12.25	34.75	34.45	34.6	32.8	2.4
3	20	32.1	32.3	32.2	30.4	4.8
4	30	30	30	30	28.2	7
5	40	28.9	28.9	28.9	27.6	8.1
6	50	27.7	27.5	37.6	25.8	9.4
7	60	26.6	26.6	26.6	24.8	10.4
8	70	26	26	26	24.2	11
9	80	26	26	26	24.2	11