ESTIMATION OF NATURAL FREQUENCY OF MOTORCYCLE HANDLEBAR

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Abstract - *This paper gives the natural frequency motorcycle handlebar (HERO SPLENDOR PLUS). The motorcycle handlebar is modeled by using CATIA and analyzed by using ANSYS a conventional FEM package. Here we are going to compare the natural frequency by FEM package with the practically by using FFT analyzer, so as to compare working frequency with natural frequency for validation purpose.*

Key Words: Natural frequency HERO SPLENDOR PLUS, handlebar, ANSYS, FFT analyser

1.INTRODUCTION

Motorcycle handlebar is rider's fist touch point to the motorcycle. It is complex in structure and has important role as functionality and safety point of view. Handlebar assembly consists of mirrors, brake levers, clutch, head lamp and plastic coverings. The failure comes in the handlebar because of engine vibrations, uneven road surface, bumps, rider force, braking etc.

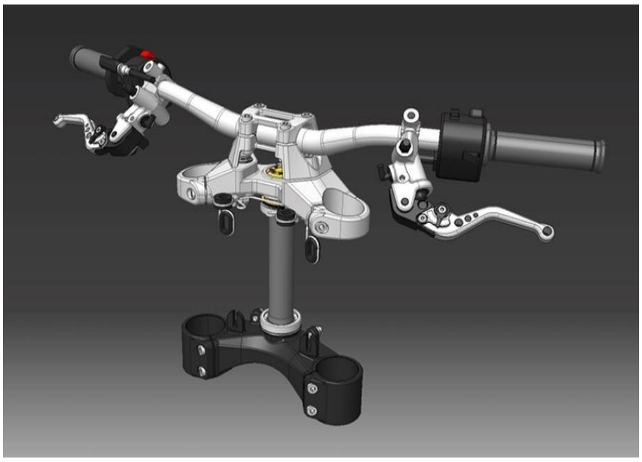

Fig-1: Handlebar assembly

Fig- 2: Motorcycle handlebar (HERO SPLENDOR PLUS)

2. ESTIMATION OF NATURAL FREQUENCY

The natural frequency of a system is the frequency at which it will vibrate freely (i.e in the absence of damping) in simple harmonic motion, when set in motion. Free vibrations of any elastic body are called natural vibrations and occur at a frequency called the natural frequency. The natural frequency of a structure depends on its physical characteristics like for example - its mass and stiffness. A system with n degrees-of-freedom, will have n modes of vibration - each of which has its own natural frequency.

2.1 Mathematical Modeling

Mathematically Natural Frequency of the handlebar is calculated as below

$$\omega_n = \sqrt{\frac{k}{m}} \quad \text{.........} \quad (1)$$

where k is stiffness of handlebar

$$k = \frac{A.E}{L}$$

$$A = \frac{\pi}{4}(d^2_o - d^2_i)$$

where d_o=outer diameter of handlebar

=22.3mm

d_i=inner diameter of handlebar

=18.4

L=length of spring

L =1000 mm

E =Young's modulus

E =200 GPa

and m is mass of spring,

m= ρAL

where ρ is density of the handlebar material

ρ=7860 ×10^-9 kg/mm^3

$$\omega_n = \sqrt{\frac{AE}{L\rho AL}}$$

$$\omega_n = \sqrt{\frac{E}{\rho L^2}}$$

$$\omega_n = \sqrt{\frac{210 \times 10^3}{7860 \times 10^{-9} \times 1000^2}}$$

$$\omega_n = 163.46\ Hz$$

Hence natural frequency of the handlebar found out by mathematical calculation is $\omega_n = 163.46\ Hz$.

2.2 Finite Element Analysis of HERO SPLENDOR PLUS Handlebar

The finite element analysis of HERO SPLENDOR PLUS handlebar is done by Ansys. Boundary conditions are applied as shown in fig 3.

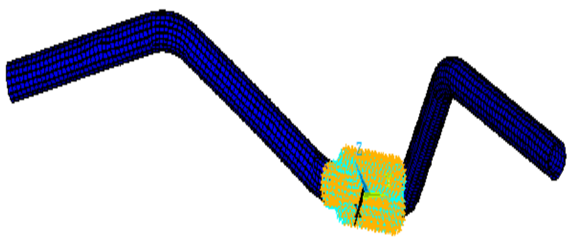

Fig-3: Boundary condition

The fig. 4 shows the natural frequency (ω_n=137.343 Hz). It is the first mode of natural frequency.

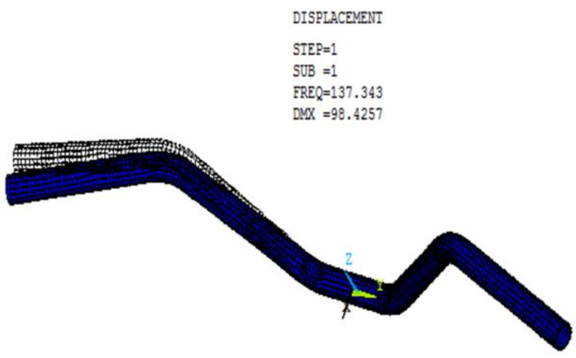

Fig- 4: Natural frequency (1st Mode)

The fig. 5 shows the natural frequency (ωn=137.347 Hz). It is the second mode of natural frequency.

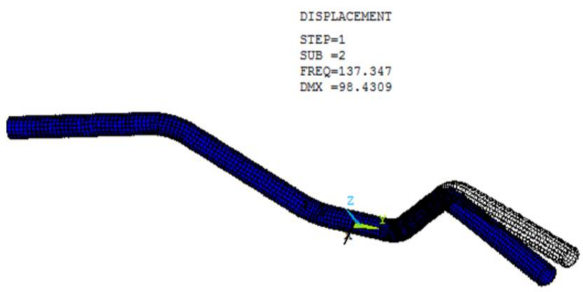

Fig- 5: Natural frequency (2nd Mode)

The fig. 6 shows the natural frequency (ω_n=140.444 Hz). It is the third mode of natural frequency.

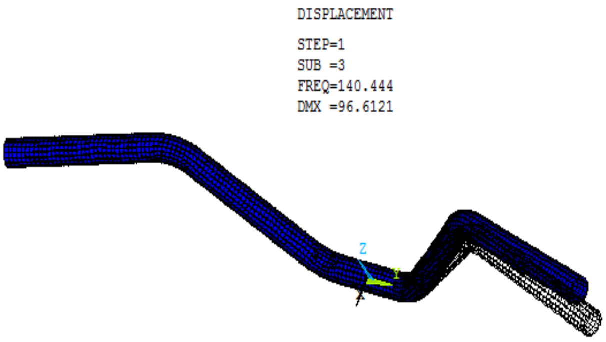

Fig- 6: Natural frequency (3rd Mode)

The fig. 7 shows the natural frequency (ω_n=140.459 Hz). It is the fourth mode of natural frequency.

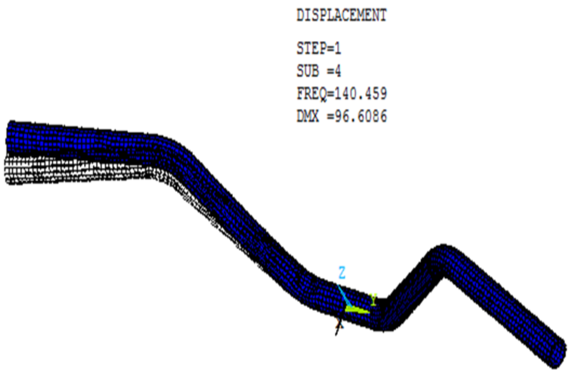

Fig-7: Natural frequency (4th Mode)

The fig. 8 shows the natural frequency (ω_n=566.756 Hz). It is the fifth mode of natural frequency.

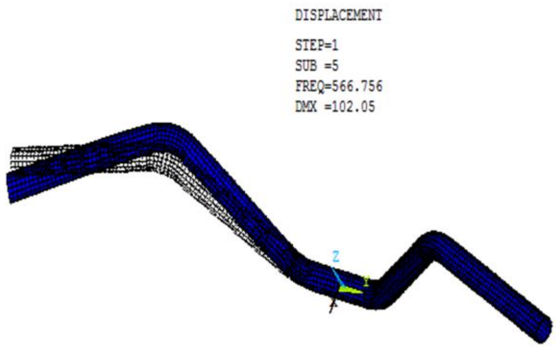

Fig-8: Natural frequency (5th Mode)

First five natural frequencies of handlebar are given in tabular form as below

Table 1. First Five Natural Frequencies of Handlebar

Sr. No.	Mode Number	Natural Frequency (Hz)
1	1	137.343
2	2	137.347
3	3	140.444
4	4	140.459
5	5	566.756

2.3 Experimental Validation

There are two requirements for the use of computational tools for simulations: verification and validation. It doesn't matter how high the computational power of your system is or what computational method you are using, the result obtained is still an approximation. And there are certain cases where these approximations fail. (e.g. when stress distribution has a concave shape and high magnitude). For any proposed problem the desired result is always real world implementation, therefore experimental validation though expensive, is essential. In this experimentation handlebar is in the hanging position which is hanged by using two strings at two free ends i.e. the handlebar is in free free condition. The acclerometer is mounted at middle of the handlebar. Four channel FFT analyser is attached to it. Handlebar is striked by feedback hammer.

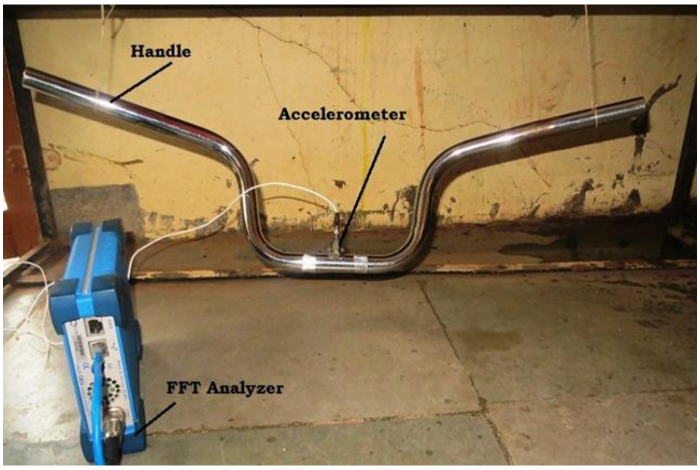

Fig- 9: Experimental validation of natural frequency

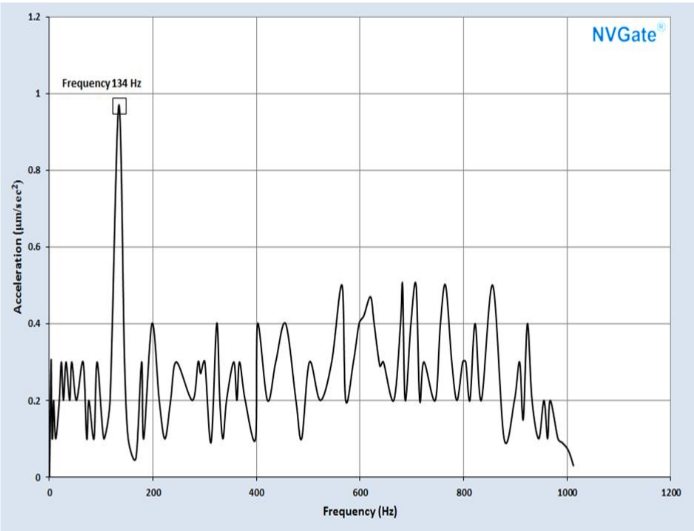

Fig-10:Natural frequency (Experimental)

The resulting natural frequencies are acquired by using NV Gate software as shown in figure 10 which shows that he natural frequency is 134 Hz.

3. CONCLUSION

The natural frequency is calculated by using three different methods such as mathematical calculation, finite element analysis and experimental methods.

- Natural frequency of the handlebar found out by mathematical calculation is $\omega_n = 163.46\ Hz$.
- Natural frequency found out by FEA for the 1st mode is $\omega_n = 137.343\ Hz$.
- Natural frequency found out by experimental test is $\omega_n = 134\ H$.

The results are compared and found to be approximately same.

ACKNOWLEDGMENT

Working with highly devoted teacher's community at the Department of Mechanical Engineering, DYPIET, Ambi, Pune will probably remain the most eventful and memorable experience of my life.

I take this opportunity with great pleasure to express my gratitude towards my guide Prof. M. G. Qaimi, He took keen interest in checking the details of project report and guided me with amicable assistance and inspiration in all phases of my project work. I am thankful to our ME Coordinator Prof. P. R. Sonawane for guiding me throughout for project work. It is my pleasure to acknowledge sense of gratitude to Prof. S. K. Bhor, HOD and Dr. D. M. Mate, Dean Academics for their guidance at each stage of this work. Also I am thankful to our esteemed Principal Dr. R. J. Patil for providing amenities for carrying out the project work.

Mere thanks in few words would be highly insufficient for the valuable guidance and positive criticism provided by the faculty of Mechanical Engineering Department.

Further, I am also thankful to my family and friends for their kind support and cooperation. The helping hand extended by them is worth mentioning.

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BIOGRAPHIES

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