Theoretical and Software Based Comparison of Cantilever Beam: MODAL ANALYSIS

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ABSTRACT-- Modal analysis is a process of describing a structure in terms of its natural characteristics which are the natural frequency and mode shape it's a dynamic property [1]. The change of modal characteristic directly provides force excitation of structure condition based on change in frequency and mode shape of vibration. This paper presents results of a theoretical modal analysis of beam made with different materials such as aluminium and mild steel. The beams were excited assign impact hammer excitation frequency response functions (FRFS) were obtained using lab view.(Signal Express). The FRFS were processed using signal express to identify the natural frequency and mode safe of aluminium and mild steel beam.

INTRODUCTION

A model testing has become to identifying the understanding and simulating dynamic behaviour and response of structure. Experimental model analysis (EMA) or model testing is a non-destructive testing based on vibration response of the structures [2]. One of the techniques widely used in modal analysis is based on impact hammer excitation. By using signal analysis, the vibration response of the structure to the impact excitation is measured and transformed into frequency response function using FFT technique, the measurement of the frequency response function is the heart f medal analysis. FRFs are used t extract such modal parameters as natural frequency and mode shape. In wide range of practical applications the modal parameters are required to avoid resonance in structures affected by external periodic dynamic loads. Practical applications of modal analysis over various fields of science engineering and technology. In particular, numerous investigations related to aeronautical engineering, automobile engineering, and mechanical engineering. The experimental modal analysis hens received wide acceptance in structural engineering application, particularly for identification of modal properties of bridges, damage detection of structures using modal data, structural health monitoring. Dynamic FEM updating of structures etc. The present investigation reports the dynamic characteristics of common structural materials.

Experimental Investigation

For carrying out the experimental modal analysis the test specimens made of different material aluminium and mild steel. The dimensions of the tested beams are shown in table 1 . All the test specimens were tested under free condition. A completely free dynamic test setup is only aimed to eliminate the support to the dynamic characteristics. The excitations were on the top surface of the beam along the length. The number of specimen of different length and different thickness are used for the testing of vibration mode. In this case, an accelerometer had a fixed position at mid point, an impact hammer was roved along the excitation on the beam. The measurement set up for the present experiential work shown n fig. (1). The force applied to the structure by an impact hammer the corresponding response of the accelerometer attached to the specimen is measured by lab view.

Material	Length	Thickness
Aluminium	95 cm	3 mm, 6 mm, 10 mm
	85 cm	3 mm, 6 mm, 10 mm
	75 cm	3 mm, 6 mm, 10 mm
Mild Steel	95 cm	3 mm, 6 mm, 10 mm
	85 cm	3 mm, 6 mm, 10 mm
	75 cm	3 mm, 6 mm, 10 mm

Table-1 dimensions of test specimens

The instrument used in this study ware the PCB impact hammer (MODEL 08CO3) having sensitivity 2.25mV/N an accelerometer (Model 780989-01) having sensitivity 100mV/g and 4-chenel, ±5V, 24 bit, software-selectable IEPE and AC/DC analog input module. (NI 9234) dynamic analyzer.

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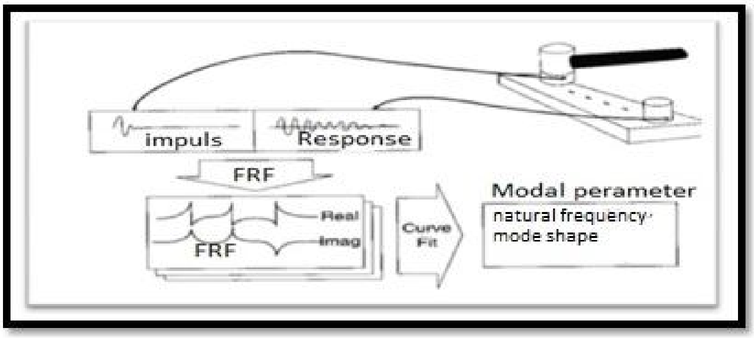
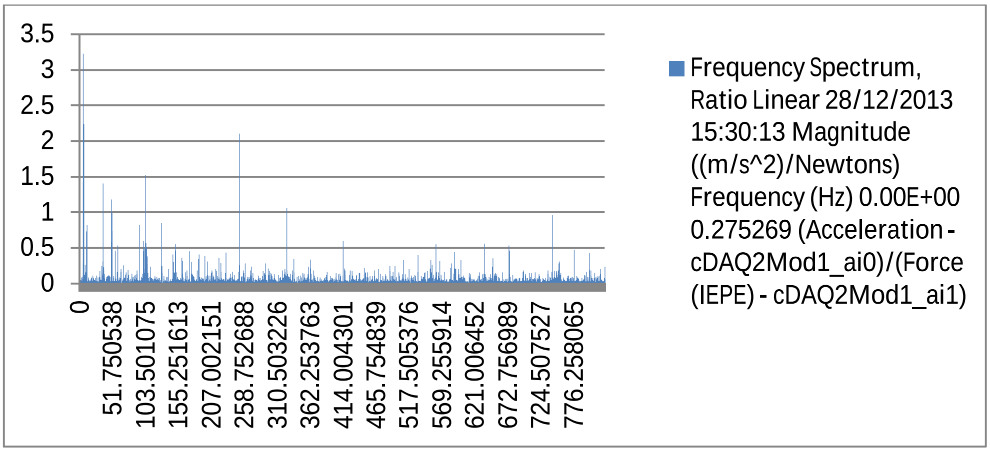


Figure 1 Schematic diagram of test setup

Input setting and analyzer setting made in DAQmx acquire in signal express. Vibration analyzer to obtain magnitude v/s frequency graph. The obtain frequency response were processed to get the modal parameter. (Frequency and mode shape) using signal express



Graph 1 Frequency response function

Theoretical Natural Frequencies

Experimental obtained natural frequency and theoretical natural frequency of the specimen which was tested under free vibration condition also calculated based on the free vibration analysis of continues system. As the initial modes is signification in the vibration analysis, the calculated theoretical natural frequency of first three modes Shown in the table.

CANTILEVER BEAM

For mild steel

LENGTH: 95 cm			
Mode(n)	**Natural Frequency (f) in Hz**		
Thickness	**03 mm**	**06mm**	**10mm**
1	2.114805	9.038261	10.84592
2	16.99378	56.6459	67.97514
3	47.58788	158.6261	190.3515

Table 2 different material parameter for 95 cm length of beam

LENGTH: 85 cm			
Mode(n)	**Natural Frequency (f) in Hz**		
Thickness	**03 mm**	**06mm**	**10mm**
1	3.387005	11.2 9001	13.54802
2	21.22753	70.75838	84.91012
3	59.44368	198.1454	237.7747

Table 3 different material parameter for 85 cm length of beam

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LENGTH: 75 cm			
Mode(n)	**Natural Frequency (f) in Hz**		
Thickness	**03 mm**	**06mm**	**10mm**
1	4.35042	14.50139	17.40168
2	27.26558	90.88521	190.0623
3	76.3521	254.5068	305.4084

Table 4 different material parameter for 75 cm length of beam

For Aluminium

LENGTH: 95 cm			
Mode(n)	**Frequency (f) in Hz**		
Thickness	**03 mm**	**06mm**	**10mm**
1	2.735228	9.117418	10.94091
2	17.14262	57.14201	68.57046
3	48.00465	160.0154	192.0186

Table 5 different material parameter for 95 cm length of beam

LENGTH: 85 cm			
Mode(n)	**Natural Frequency (f) in Hz**		
Thickness	**03 mm**	**06mm**	**10mm**
1	3.416668	11.38885	13.66667
2	21.41344	71.37808	85.65376
3	59.96428	199.8808	239.8571

Table 6 different material parameter for 85 cm length of beam

LENGTH: 75 cm			
Mode(n)	**Natural Frequency (f) in Hz**		
Thickness	**03 mm**	**06mm**	**10mm**
1	4.388521	14.62839	17.55408s
2	27.50437	91.68117	110.0175
3	77.02079	256.7358	308.0832

Table 7 different material parameter for 75 cm length of beam

Result & Discussion

- **Modal Parameter:**
  The experimental modal results (Modal frequency and mode shapes) are discussed in the following section.
- **Natural Frequency:**
  Modal analysis gives the value of natural frequency. These natural frequencies were calculated by beam theory. The experiential and theoretical natural frequencies of mild steel and aluminium beam for the three modes are given below table.

Mode shape

The mode shapes obtain using ANSYS 14 solution modal analysis software is presented in following table.

RESULT OBTAIN IN ANSYS FOR CANTILEVER

950 mm length and 03 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	2.9002	2.898
2nd mode	18.175	18.161
3rd mode	50.886	50.846

Table 8 compressions between different materials

950 mm length and 06 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	5.8003	5.7958
2nd mode	36.343	36.315
3rd mode	101.73	101.65

Table 9 compressions between different materials

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950 mm length and 10 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	9.6604	9.6518
2nd mode	60.507	60.453
3rd mode	169.27	169.11

Table 10 compressions between different materials

850 mm length and 03 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	3.6233	3.6206
2nd mode	20.706	22.689
3rd mode	63.571	63.524

Table 11 compressions between different materials

850 mm length and 06 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	7.2464	7.241
2nd mode	45.402	45.368
3rd mode	127.08	126.98

Table 12 compressions between different materials

850 mm length and 10 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	12.068	12.057
2nd mode	75.575	75.508
3rd mode	211.37	211.18

Table 13 compressions between different materials

750 mm length and 03 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	4.6548	4.6515
2nd mode	29.169	29.149
3rd mode	81.665	81.608

Table 14 compressions between different materials

750 mm length and 06 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	9.3093	9.3027
2nd mode	58.323	58.282
3rd mode	163.23	163.11

Table 15 compressions between different materials

750 mm length and 10 mm thickness

	Natural frequency in Hz	
Mode	**Aluminium**	**Mild steel**
1st mode	15.502	15.488
2nd mode	97.6	96.975
3rd mode	271.38	271.13

Table 16 compressions between different materials

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CONCLUSION

The dynamic parameter such as natural frequency and mode shape are very important component of structure.
Modal testing is a Non-destructive testing based on vibration response of the structural beam. In this paper, the application of experimental modal testing to various beams based on the rowing hammer, the beam observe excitation, the natural frequency and mode shape are the example of these. The modal testing has effective and non-destructive test method for estimating of characteristic of beam. The natural frequency of both the beam is increase with increase in the modulus of elasticity and by decreasing the density of the material. It is observed that natural frequency is higher for aluminium than mild steel material beam of same geometry.

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