THEORETICAL AND ANALYTICAL ANALYSIS OF OVER HANGING DIVING BOARD

Mr. K. VIJAY KUMAR[1], Mr. V.GURUSHANKER[2], Mr. P.VINOD[3], Mr. A.VENKATRAM REDDY[4]

[1,2,3,4]*Assistant Professor in Mechanical Department, Vignan Institute of Technology & Science, Deshmukhi,Telangana,India.*

Abstract - *The paper is theoretical and analytical analysis of overhanging diving board, in the present study an analysis tool finite element analysis (FEA) will be used. The work presented in this paper is aimed at the study of effect of vibration characteristics of aluminum, brass and copper material. The modeling and analysis will be carried out using ANSYS software. A modal analysis will be carried out to understand the vibration behavior i.e., natural frequency and mode shapes, of the material considered. The mode shapes and natural frequency play an important role in the design of dynamic machines. The modal analysis will be done to determine mode shape and results selection of suitable material was diving pool is used for people can dive in water. When people stand on diving board the huge amount weight act at end of diving board, there is chance to form huge damping frequency response? This causes to break the diving board. Avoiding frequency response is treatment for breakages. So suitable material used in diving board is solution for avoiding frequency response.*

The damping capacity is very important to some materials, especially the structural materials. It is well known that mechanical vibration causes much damage in aerospace industry, automotive industry and architectural industry. So, it is urgent to seek for high damping capacity materials to eliminate the damage.

1.INTRODUCTION

Diving board consists of two ends. One of end is rigidly fixed and another end was weigh by people who can dive into water. The middle portion of board should hinge supported for lifting purpose.

Vibration is the motion of the particle or a body or a system of connected bodies displaced from a position of equilibrium. Most vibrations are undesirable in machines and structures because they produce increased stresses. Energy losses, cause added wear, increase bearing loads, induce fatigue, create passenger discomfort in vehicles, and absorb energy from the system. Rotating machine parts need careful balancing in order to prevent damage from vibrations.

The analytical description of the dynamics of the discrete case is a set of ordinary differential equations. While for the continuous case it is a set of partial differential equations. The analytical formulation of a dynamic system depends upon the kinematic or geometric constraints and the physical laws governing the behaviour of the system. In this chapter, the basic concepts and different types of vibrations are discussed.

Fig.1. Diving Board

2. DESIGN OF OVER HANGING DIVING BOARD

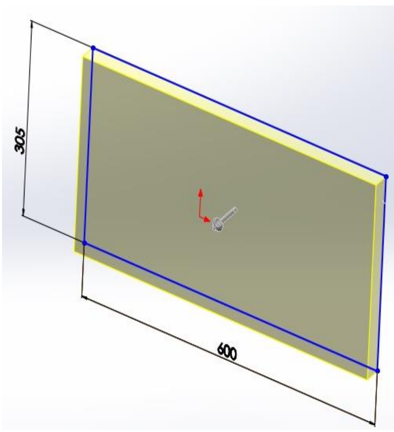

Fig.2.Isometric View

2.1. Diving Board Parameters

- Total length of diving board (L1) = 1000 m
- Span Length (distance between support to free end) (L) = 600 m
- Width of diving board (b) = 305 m
- thickness of diving board (t) = 32 m

2.2. Moment of Inertia (I)

I = Moment of Inertia $(bd^3)/12$
Where
Width of diving board (b) = 305 m
Height of diving board (d) = t = 32 m
$I = (305\times 32^3)/12 = 832853.33$ m4
Cantilever beam deflection formula, $\delta = (Wb^2 L)/3EI$
W = Applied load at free end of diving board = mg [mass(m) =100 kg, gravity (g) = 9.8 m/s2
= 100× 9.8= 980N

3. MATERIAL PROPERTIES

Table.1. material properties

S.No	Name of The Material	Young's Modules (G.Pa)	Possion's Ratio	Density (Kg/M³)
1	Aluminum	70	0.3	2710
2	Brass	96 - 110	0.34	8587
3	Copper	110 - 120	0.36	8944

4.DEFLECTION THEORETICAL CALCULATION (δ)

4.1. ALUMINUM

W= 980 N b= 32 m L= 600

$E = 70 \times 10^6$ I= 832853.33

$$\text{Maximum Deflection } (\delta) = \frac{980\times 32^2\times 600}{3\times(70\times 10^6)\times 832853.33}$$

= 0.034

4.2.BRASS

$$\text{Maximum Deflection } \boldsymbol{\delta} = \frac{\boldsymbol{Wb^2L}}{\boldsymbol{3EI}}$$

W= 980 N b= 32 m L= 600

$E = 110 \times 10^6$ I= 832853.33

$$\text{Maximum Deflection } (\delta) = \frac{980\times 32^2\times 600}{3\times(110\times 10^6)\times 832853.33}$$

= 0.021

4.3.COPPER

W= 980 N b= 32 m L= 600

$E = 120 \times 10^6$ I= 832853.33

$$\text{Maximum Deflection } (\delta) = \frac{980\times 32^2\times 600}{3\times(120\times 10^6)\times 832853.33}$$

=0.020

5. DEFLECTION IN STATIC ANALYSIS BY USING ANSYS SOFTWARE

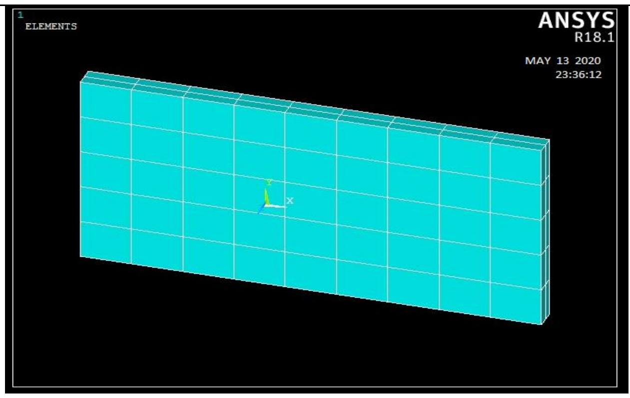

Fig.3. Meshing Model

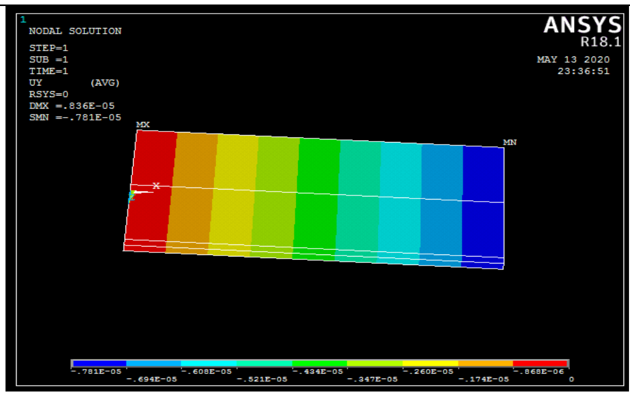

Fig.4.Deflection of Aluminium

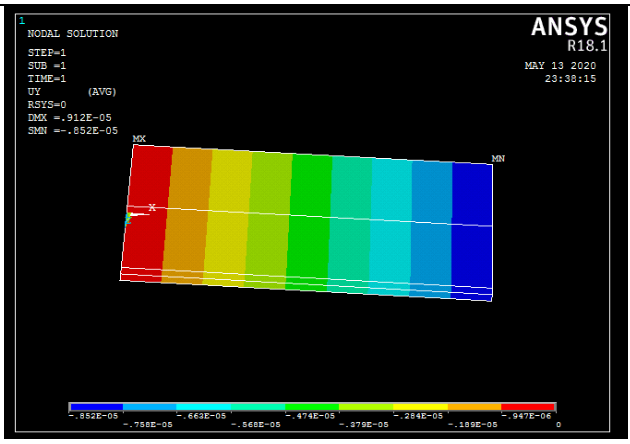

Fig.5. Deflection of Brass

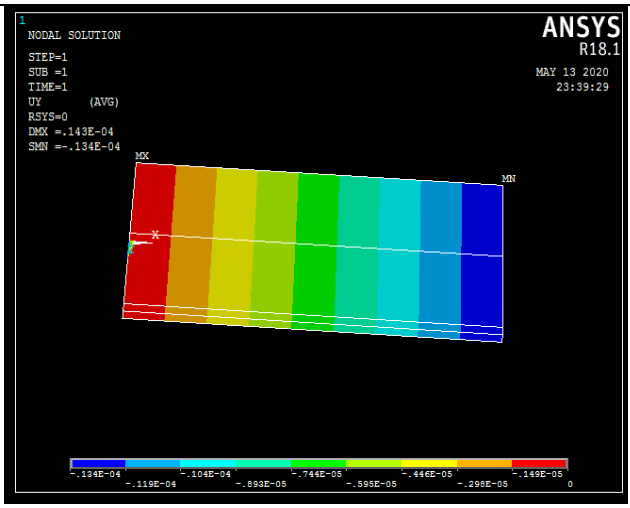

Fig.6. Deflection of Copper

5. ERROR IN BETWEEN THE THEORETICAL AND ANALYTICAL ANALYSIS

Table.2. error in between the theoretical and analytical analysis

S.NO	METAL	DISPLACEMENT		
		Theoretical	Analytica	Error
1	Aluminum	0.034	0.023	0.011
2	Brass	0.021	0.011	0.010
3	Copper	0.020	0.015	0.005

Maximum deflection of material is aluminum (0.034), minimum deflection of material is copper (0.020)

7. MODEL ANALYSIS

7.1 ALUMINUM

Table 3. Node set and frequency of aluminum

Available Data Sets:

Set	Frequency	Load Step	Substep	Cumulative
1	2.19998E-03	1	1	1
2	9.40493E-03	1	2	2
3	1.83416E-02	1	3	3
4	7.38404E-02	1	4	4
5	0.15181	1	5	5
6	0.29428	1	6	6

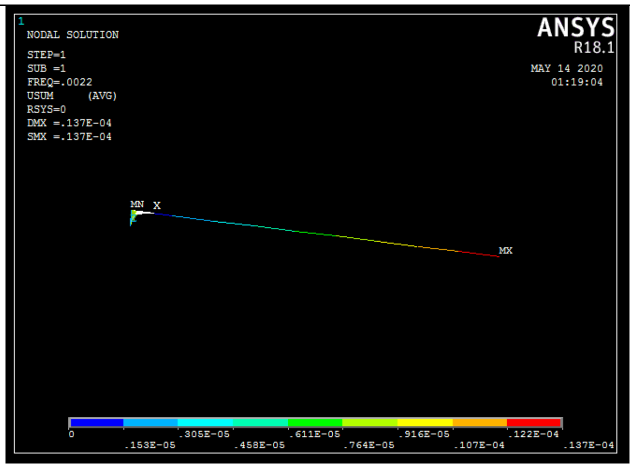

Fig.7. Mode shape1

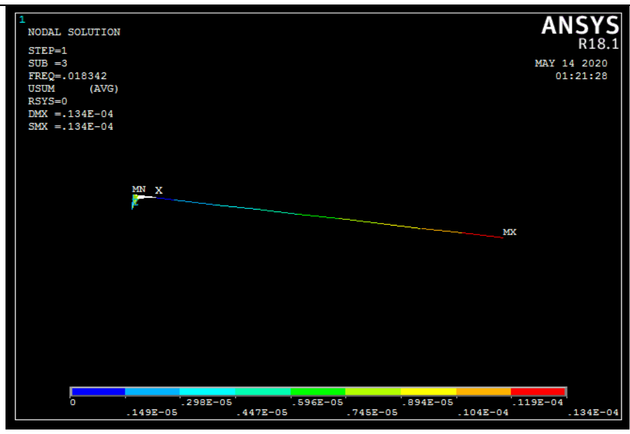

Fig.8. Mode shape 2

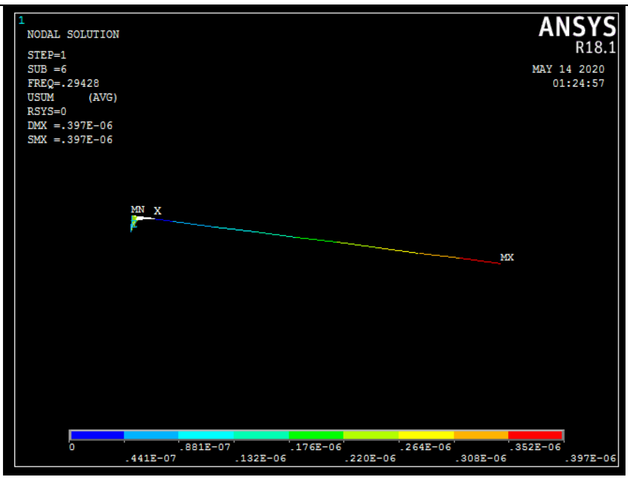

Fig.9. Mode shape 3

7.2. BRASS

Table .4. Node set and frequency of brass

Available Data Sets:

Set	Frequency	Load Step	Substep	Cumulative
1	1.54778E-03	1	1	1
2	6.52358E-03	1	2	2
3	1.28720E-02	1	3	3
4	5.20002E-02	1	4	4
5	0.10567	1	5	5
6	0.20432	1	6	6

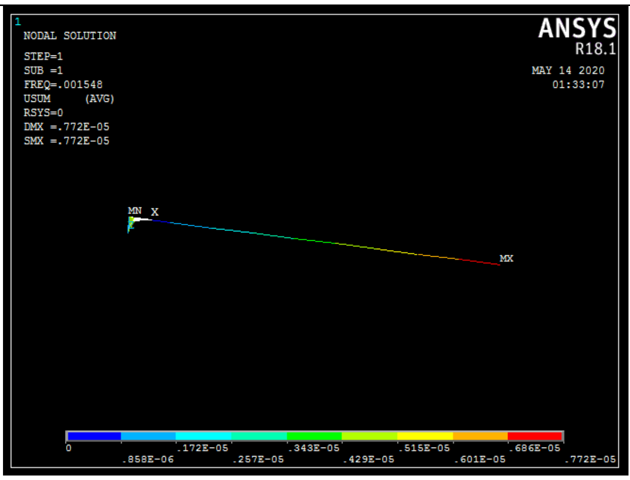

Fig.10. Mode shape 1

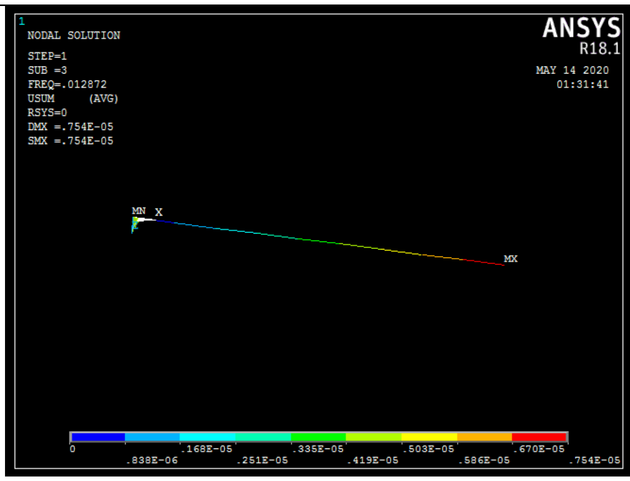

Fig.11. Mode shape 2

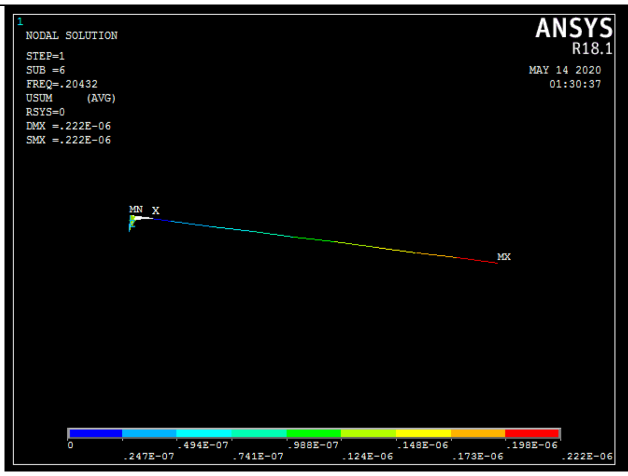

Fig.12. Mode shape 3

7.3.Copper

Table .5. Node set and frequency

Available Data Sets:

Set	Frequency	Load Step	Substep	Cumulative
1	1.58325E-03	1	1	1
2	6.62702E-03	1	2	2
3	1.31507E-02	1	3	3
4	5.32175E-02	1	4	4
5	0.10753	1	5	5
6	0.20766	1	6	6

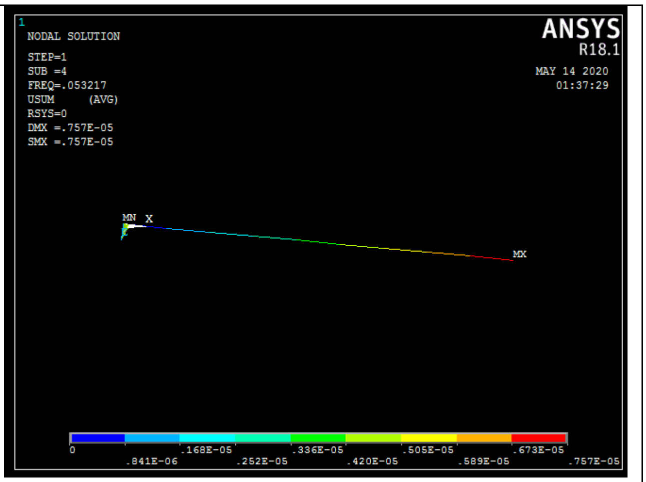

Fig.13. Mode shape 2

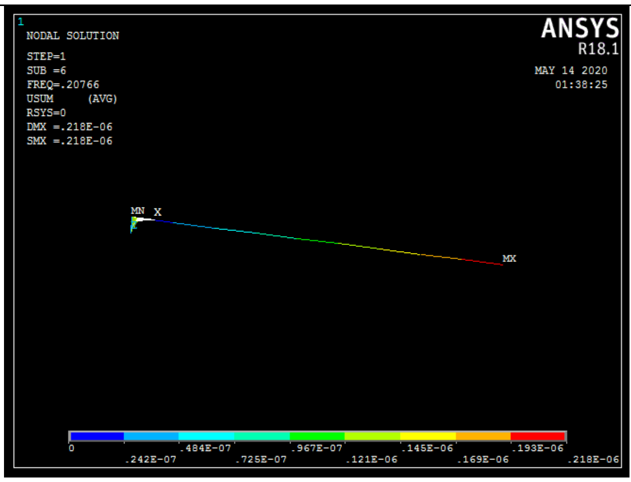

Fig.14. Mode shape 3

Table.6. Three materials frequency

S.No	Metal	Frequency		
		Mode 1	Mode 2	Mode 3
1	Aluminum	0.137× 10-4	0.772× 10-5	0.757× 10-5
2	Brass	0.134× 10-4	0.754× 10-5	0.758× 10-5
3	Copper	0.397× 10-6	0.222× 10-6	0.218× 10-6

8. RESULTS AND CONCLUSION

The frequencies recorded during analysis are listed below in the table it clearly shows that aluminum recorded less frequency than copper, because copper is much stiffer then reaming materials

But if the frequencies match with the natural frequencies the structure then the structure will fail so we should provide damping, and also the frequencies increase with increase in mode so we should reduce the modes by providing rigid supports and dampers.

Diving board material selection as per Strength is copper is better, as per elastic is aluminum is better.

REFERENCES

[1] A B Blair Jr and R L Stallings Jr. (1989), “Cavity Door Ejects on Aerodynamic Loads of Stores Separating from Cavities”, Journal of Aircraft, Vol. 26, No. 7, pp. 615-620.

[2] A J Keane (1994), “The Options Design Exploration System User Guide and Reference Manual”.

[3] Berens R J and Weigle C G M (1996), “Cost Analysis of Ceiling Tile Replacement for Noise Abatement”, Journal of Perinatology, Vol. 16, No. 3, pp. 199-201.

[4] D E Goldberg (1989), “Genetic Algorithm in Search Optimization and Machine Learning”, Addison-Wesley, Cambridge, MA.

[5] F J Wilcox Jr. (1990), “Experimental Measurements of Internal Store Separation Characteristics at Supersonic Speeds”, NASA Technical Report.

[6] K Shankar, A J Keane (1995), “Energy Flow Predictions in a Structure of Rigidly Joined Beams Using Receptance Theory”, Journal of Sound and Vibration, Vol. 185, pp. 867-890.

[7] Michael J Garee, Raymond R Hill and Brent Russell (2014), “Fragment Capture Simulation for Missile Blast Test Optimization”.

[8] N E Leonard and E Fiorelli (2001), “Virtual Leaders, Artificial Potentials and Coordinated Control of Groups”, In Proc. 40th IEEE Conf. Decision and Control.