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Experimental Investigation of Load Deflection Characteristics of Beam with Various End Conditions of Different Materials

Md. Liton Rabbani
Civil Engineering Department
Barishal Engineering College
Barishal, Bangladesh

Mohammad Saifullah
Civil Engineering Department
Barishal Engineering College
Barishal, Bangladesh

Mehedi Hasan
Civil Engineering Department
Barishal Engineering College
Barishal, Bangladesh

Ashikur Rahman
Civil Engineering Department
Barishal Engineering College
Barishal, Bangladesh

Abstract:- Deflection usually refers to the deformed shape and position of a member subjected to bending loads. More specifically, however, deflection is used in reference to the deformed shape and position of the longitudinal axis of a beam. In deformed condition, the neutral axis, which is, initially a straight longitudinal line assumes some particular shape, which is called deflection curve. A laboratory Investigation of the load deflection characteristic of selected materials (Steel, Aluminium and Brass) had been done. The Experimental programme involves the testing beam for deflection with structures test frame. Tests show that the recorded maximum deflection for Steel is 1.61 mm (downward), while for Aluminium and Brass beams deflection are 4.23 mm (downward) and 3.10 mm (downward) respectively. The load-deflection behaviors of the beams are essentially linear within the elastic range of loading. Based on the findings of this investigation, it was observed that the deflection behavior of different materials is similar; however, the Aluminium showed maximum deflection than the others beams.

Keywords:- *Load Deflection, Test Frame, Steel Beam, Aluminium Beam, Brass Beam.*

I. INTRODUCTION

The deflection of beams and cantilevers experiment gives visualization and proof of the basic concepts of beam deflection, end-fixing conditions and young's modulus [1].This provides a sound foundation for further work. Analysis of deflection in structural members is of great importance in structural design. Excessive deflection of structural member results in geometric distortion of the whole structure [2]. In designing metalworking equipment for precisions work, such as lathes, milling machines, the deformation must be kept below the permissible limit.[3] Deflection should therefore be designed not to exceed allowable range. Knowledge on theory of deflection in beams is used in analyzing for magnitudes of deflection resulting from a given loads Accurate calculation of service deflections can be done through integration of curvatures [4, 5] and making allowance for shear and bond deformations. However, such calculations are time consuming and not suitable for design. It is therefore important to develop simplified design methods to evaluate the deflection of construction elements with an acceptable accuracy. As a result, the deflection derived using only cracked moment of inertia is expected to provide an upper bound limit for short-term deflections. Shrinkage can also contribute to deformations [6, 7] due to the restrain provided by the flexural bars in the bottom of the beams and the consequent development of a shrinkage-induced curvature.

In deformed position, the axis of the beam, which was initially in a straight longitudinal line, assumes some particular shape, which is called deflection curve. The vertical distance between a point in neutral axis and corresponding a point in the deflection curve is called deflection at that point. In developing the theory determining deflection of a beam, it is assumed that shear strain do not significantly influence the deformation [8]. The deflection at any point along the beam span is function of bending moments and property of beam material and cross section. The deflection $y(x)$ equation is given in differential form as-

$$d^2y/dx^2 = M/EI$$

II. MATERIALS AND METHODS

To make the study clinically relevant, five type of support condition of beams with different materials *(Steel, Aluminum and Brass)* were tested by the deflection of Beams and Cantilever's experiment. The deflection of Beams and Cantilever's experiment fits into the structures test frame. The structures test frame is a sturdy aluminium frame that stands on a workbench. A digital dial test indicator measures deflections and can connect to a computer using an Automatic Data Acquisition Unit and software (STR2000) [1]. Figure-1 shows the deflection of Beams and Cantilever's experiment assembled in the Structures Test Frame.

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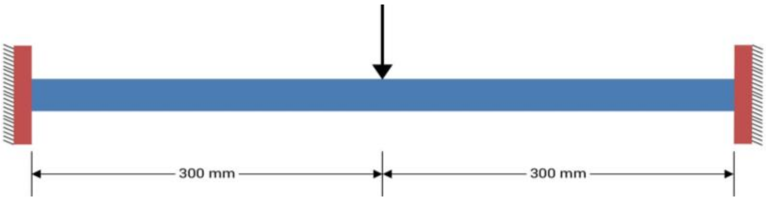
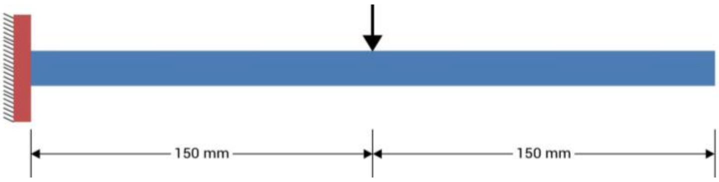
Fig.-01: Test Frame

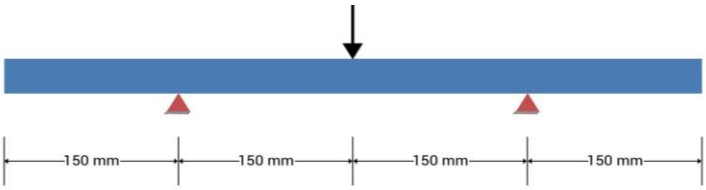
Beams are generally classified according to their geometry and manner in which they are supported. Geometrical classification includes such features as the shape of cross-section, whether the beam is straight or curved and whether the beam is tapered or has a constant cross section. On the manner in which they are supported, the beams may readily be classified as cantilevers, simply supported, overhanging, continuous and fix-ended beam. Beams can be further classified according to the type of load they are carrying, for example, a cantilever beam carrying a uniformly distributed load may be classified as a uniformly loaded cantilever beam. In experimental programme beam of point load with different magnitude and end condition were investigated. The different end condition of beams were tested are given in figure below;



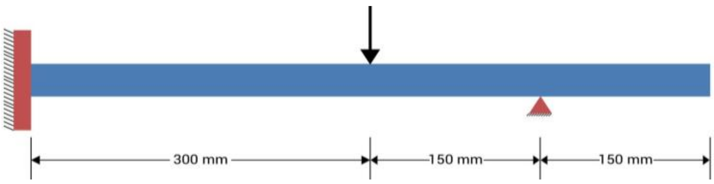
(a) Fixed Supports Beam



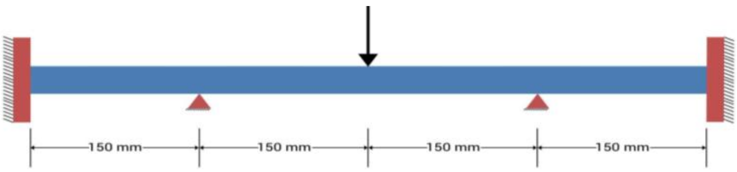
(b)Cantilever Beam



(c)Both Ends Overhanging Beam



(d) One End Overhanging Beam



(e) Both Ends Fixed with Two Internal Hinge Beam

Fig.-02: Different End Conditions of Beam.

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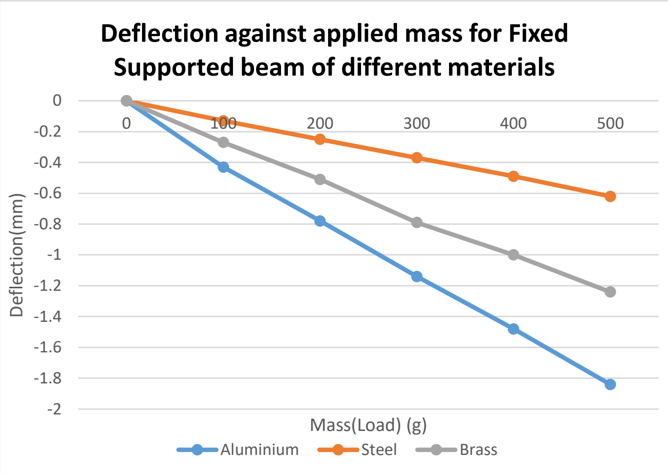
III. RESULTS AND DISCUSSION

The test carried out for different end condition (stated in Fig: 02). All the test beams have an I Value (moment of inertia) of 4.45 x 10^{-11} m^4 and length 600 mm except the cantilever condition. The length of cantilever beam is 300 mm. The test result is discuss below:

A. Fixed supported Beam:

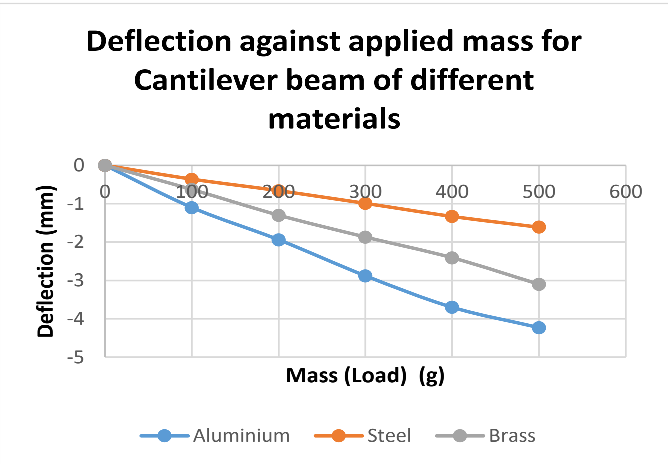
In this condition the deflection of fixed supported beam subjected to an increasing point load (0 to 500g) were measured. The deflection at mid span were measured. Thus, the load deflection relationship was established by plotting deflection vs load.



Graph-01: Deflection at Mid span of fixed supported beam

B. Cantilever condition:

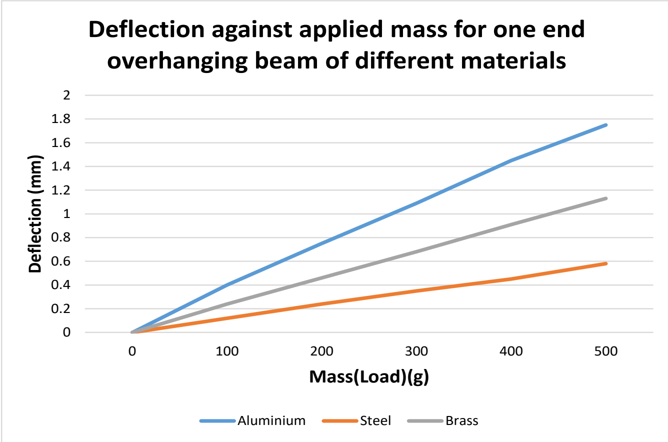
In this condition the deflection of free end subjected to an increasing point load (0 to 500g) at center point were measured. Thus, by plotting deflection, vs load and the load deflection relationship revealed.



Graph-02: Deflection at Free end of cantilever beam

C. One end overhanging beam:

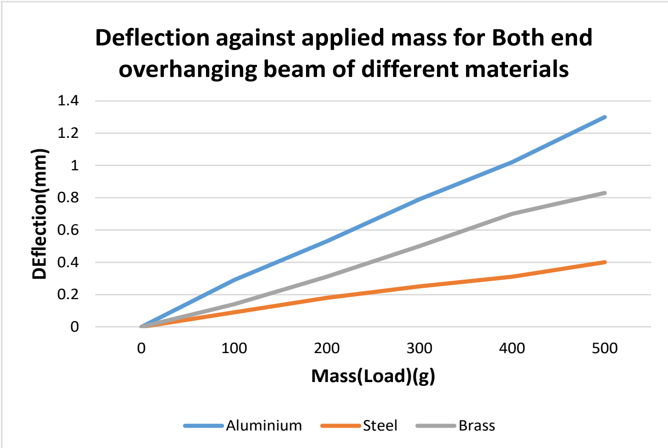
In this condition the deflection at free end of one end overhanging beam subjected to an increasing point load (0 to 500g) at center point were measured. Thus, the load deflection relationship was established.



Graph-03: Deflection at Free end of one end overhanging beam

D. Both end overhanging Beam:

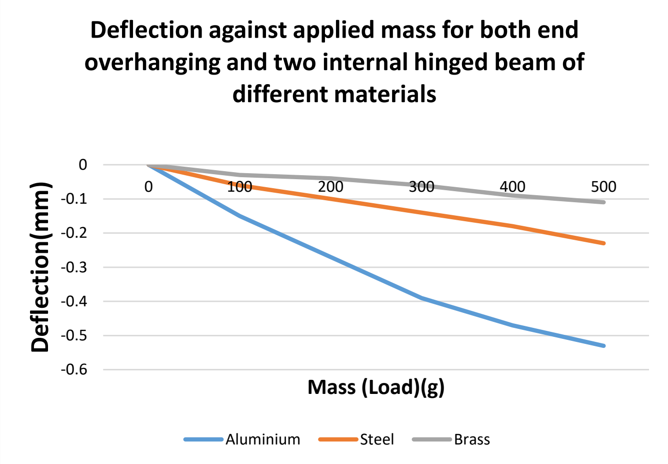
In this condition the deflection at free end of both ends overhanging beam subjected to an increasing point load (0 to 500g) at center point were measured. Thus, the load deflection relationship was established.



Graph-04: Deflection at Free end of both end-overhanging beam.

E. Both end fixed and two internal Hinged Beam:

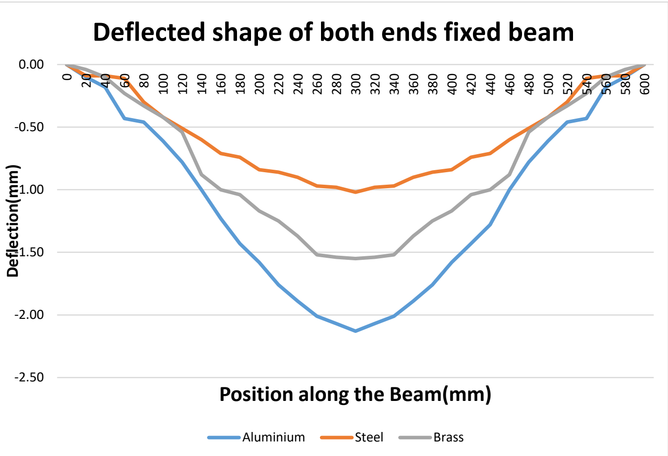
In the condition the deflection at mid span of both end fixed and two internal hinge beam subjected to an increasing point load (0 to 500g) at center point were measured. Thus, the load deflection relationship was established.



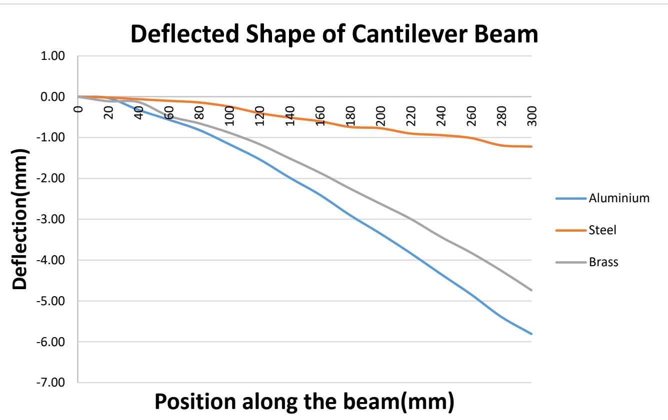
Graph-05: Deflection at mid span of fixed ends with two internal hinged beam.

F. The shape of the deflected beams

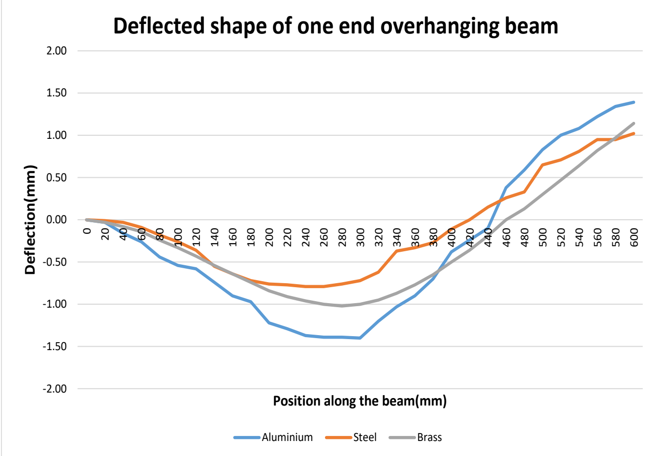
Another important finding of this test is the shape of the deflected beam. To show the shape of the deflected beams, the deflection of the beams at several positions (20mm interval) across its length with a central load of 500g were measured. Then deflection along the position of the beam revealed the shape of the deflected beam. For different supports condition the shape are different which is given below;



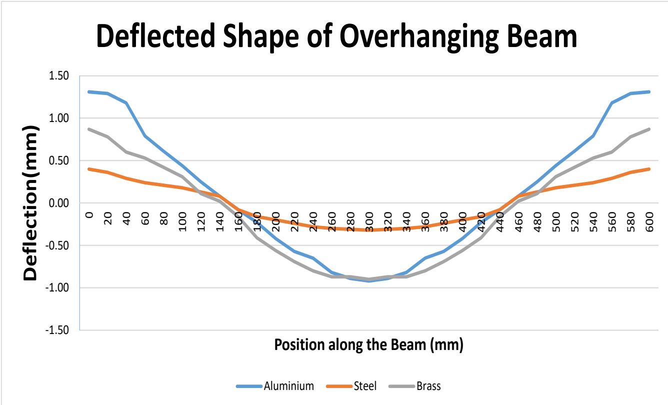
Graph-06: Deflected shape of fixed ends beam



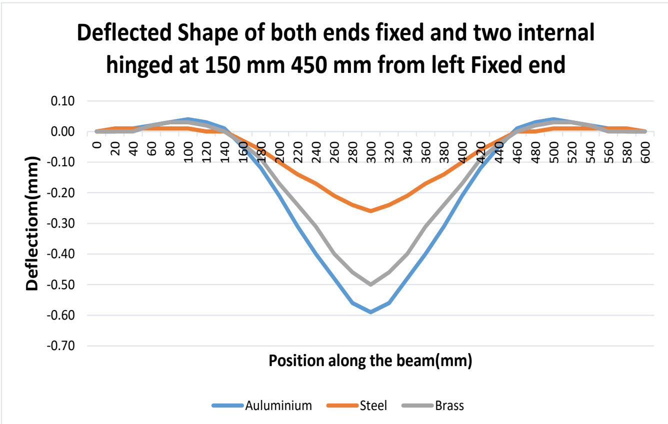
Graph-07: Deflected shape of cantilever beam



Graph-08: Deflected shape of one end overhanging beam



Graph-09: Deflected shape of both end overhanging beam



Graph-10: Deflected shape fixed supported beam with two internal hinge beam.

The graphs (1 to 5) are approximately linear and the load is proportional to deflection. It also show the ratio of relative deflection is the same as the ratio of Young's modulus for each beam. This graph also predicts the behavior equation of the beam. The entire graph give the result that deflection of beam increased exponentially with distance from support to position of loading. This graphs (1 t0 10) also show that the deflection of Aluminum materials is maximum among the three materials whereas the steel materials deflection is low.

IV. CONCLUSION

Deflection is very important for engineering works. This experimental investigation show that deflection of Aluminum is large than others materials (Steel & Brass). Deflected shape of beam gives the deflection along the beam.

V. RECOMMEDATION

In this experiment, only test beam of I equal to 4.45 x 10^{-11} m^4 is used and the length is small (600 mm).In future, room length beam with actual size can be tested. Loading variation can also be used instead of point load may be the uniform distributed and uniform varying load.

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REFERENCES

[1]. Lecturer's Guide " Deflection of Beams and Cantilevers" TecQuipment

[2]. Dinesh Agarwal. " Comparative Analysis of Deflection of Simply Supported Beam of Different Material Subjected to U.D.L using ANSYS" . *International Journal of Engineering Trends and Technology (IJETT) – Volume 59 Issue 2 – May 2018,163-165*

[3]. Ferdinand L.singer, Andrew Pytel "Strength of Materials".

[4]. Pilakoutas K, Neocleous K, Guadagnini M. "Design philosophy issues of fiber reinforced polymer reinforced concrete structures. Journal of Composites for Construction "2002; 6(3): 154-161.

[5]. CEB. CEB-FIP Model Code 1990. Comite Euro-International du Beton, Thomas Telford Ltd, 1993.

[6]. Al-Sunna R., Pilakoutas K, Waldron P, Al-Hadeed T. "Deflection of FRP reinforced concrete beams", In 4th Middle East Symp. on Structural Composites for Infrastructure Applications (MESC-4), Alexandria, Egypt, 2005.

[7]. Bischoff PH, Johnson RD. "Effect of shrinkage on short-term deflections of reinforced concrete beams and slabs" ACI Structural Journal 2008, 105 (4): 516 .

[8]. Frederick S. Merritt "Building Engineering and Systems Design"