Comparative Analysis of Deflection of Simply Supported Beam of Different Material Subjected to U.D.L using ANSYS

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ABSTRACT

The word deflection generally 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. Work is designed to understand the deflection behavior of various engineering material. Analysis is made four different engineering material by using static structural model of ANSYS. The simply supported beam with uniformly distributed load on whole span is taken for exercise.

INTRODUCTION

Analysis of deflection in structural and machine members is of great importance in machine and structural design. Excessive deflection of structural member results in geometric distortion of the whole structure whereas in a machine excessive deflection may result in interference between moving parts increasing the rate of wear or total failure due to broken or jammed parts. Deflection should therefore be designed not to exceed allowable space between the moving parts and the stationary ones for example casing or between the moving parts themselves. Under these conditions the part may be subjected to load whose magnitude is much less to cause failure by yielding however the geometric distortion and jamming of structural and machine parts respectively renders the structure or machine not to perform its desired function and may therefore be considered to half failed. Knowledge on theory of deflection in beams is used in analyzing for magnitudes of deflection resulting from a given loads.

In selecting material for application in as a machine part or as structural members many factors have to be considered in order to choose a material that meets the demand requirements at minimal cost. materials which machine or structural parts are made of are:

(a) Structural steel
(b) Stainless Steel
(c) Copper and its alloys
(d) Gray cast iron

The above material are very frequently used in mechanical machine parts . In this paper author trying to explain comparative deflection behavior of simply supported beam subjected to uniformly distributed load.

GENERAL CONCEPT ABOUT BEAMS

Beam may be defined as member whose length is large in comparison with its thickness and is loaded with transverse loads or couples that produce significant bending effects.

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.

Loads

Any force that is transmitted to a body from another body by means of direct contact over an area on the surface of the first body is a load due to body contact. Loads may be classified as follows:

(i) Concentrated load (point load):- This is a load whose area of contact is relatively small compared to the total area over the entire length of the beam.

(ii) Distributed load:- This is a load whose area of contact is large relative to the length of the beam. Distributed loads may further be classified as linearly varying or uniformly distributed loads depending on the manner in which the load vary along the length of the beam.
(iii) Couples: Couple is a turning moment applied at a particular point along the beam span. This turning moment can be achieved by using mechanism for application of parallel forces whose directions of action are opposite but are separated by a distance called moment arm.

DEFLECTION

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. The deflection at any point along the beam span is function of bending moments and property of beam material and cross section. In the theory section of this report; deflection *y(x)* equation is developed and is given in differential form as:-

$$\frac{d^2y}{dx^2} = \frac{M}{EI}$$

Methods of Analyzing for deflection

There are various methods of determining beam deflections common amongst these are:
(i)Deflection by (Double) direct integration
(ii)Deflection by moment-area method
(iii)Strain- Energy or Catigliano's method
(iv)Method of superposition
(v)ANSYS (software approach)

Deflection by direct integration

$$\frac{d^2y}{dx^2} = \frac{M}{EI}$$

The above equations integrations with the appropriate constants of integration will give the slope θ and deflection y as function of x. The step by step procedure is as follows:

1. Set up a reference coordinate system consistent with differential deflection equation.
   The origin of right- hand system at the left hand end of the beam is one such coordinate system.
2. Define the equilibrium requirement expression for moment as a function of x. In cases where there are discontinuations in the loading several expressions may be necessary.
3. Determine bending modulus or flexural rigidity EI. If the cross- section varies with length the moment of inertia **I** must be expressed as function of x. If there are abrupt discontinuities in cross section or in the beam material then several expressions may be necessary.
4. Integrate the equation once for the slope and twice for the deflection y being careful to include the constants of integration. These constants are then evaluated from the
   conditions imposed on the deflection curve by the supports. A free- hand sketch of the deflection is often helpful in recognizing the conditions of restraint.

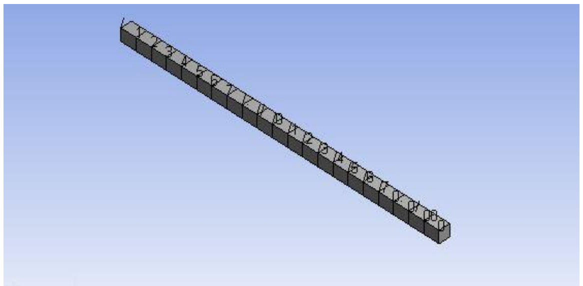
Dimension & Physical Properties Of Beam

Length = 3000mm
Cross section = 10000mm^2
Moment of inertia ($I_{XX)=}$ 8.33E+006mm^4
Moment of inertia ($I_{yy)=}$- 4.36E-010 mm^4
Moment of inertia ($I_{zz)=}$ 8.33E+006mm^4
Polar of inertia (J)=1.4058e+007

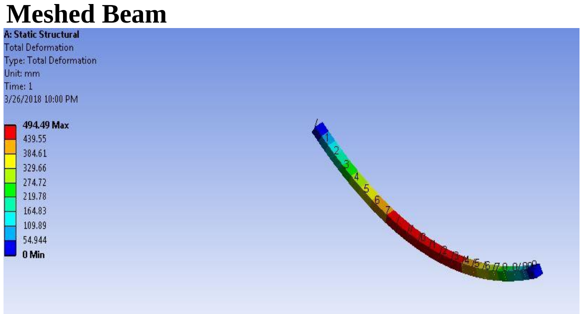
Mechanical properties of material

Name of property	Unit	Structural steel	Stainless steel	Gray cast iron	Copper alloy
Density	**Kg/m^3**	**7850**	**7750**	**7250**	**8300**
Young modulus	**Pascal (N/m2)**	**2E+11**	**1.93E+11**	**1.1E+11**	**1.1E+11**
Bulk modulus	**Pascal (N/m$^{2)}$**	**1.66E+11**	**1.69E+11**	**8.33E+10**	**1.145E+11**
Share modulus	**Pascal (N/m$^{2)}$**	**7.69+E10**	**7.366+E10**	**4.296E+10**	**4.10E+10**
Tensile yield strength	**Pascal (N/m$^{2)}$**	**2.5E+08**	**2.07E+08**	**0**	**2.8E+08**
Compressive yield strength	**Pascal (N/m$^{2)}$**	**2.5E+08**	**2.07E+08**	**0**	**2.8E+08**
Tensile ultimate strength	**Pascal (N/m$^{2)}$**	**4.6E+08**	**5.86E+08**	**2.4E+08**	**4.3E+08**
Compressive ultimate strength	**Pascal (N/m$^{2)}$**	**0**	**0**	**8.2E+08**	**0**
Poission ratio	**-**	**0.3**	**0.31**	**0.28**	**0.34**

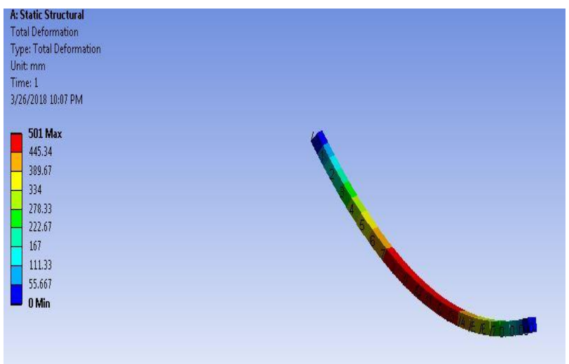
DEFLECTION ANALYSIS WITH ANSYS



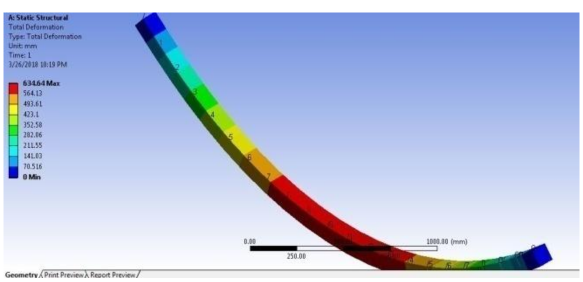
Meshed Beam



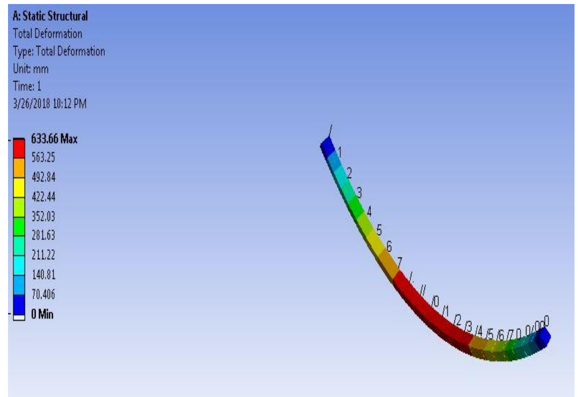
Structural steel



Stainless steel



Copper Alloy



Gray cast iron

Conclusion

By observation of analysis, able to conclude as follows:

1) Deflection in static structural material & stainless steel almost have same values with given loading condition .
2) Deflection in copper alloy & gray cast iron also have almost sjmilar values .
3) Deflection of copper alloy & gray cast iron have great difference over structural steel & static structural material.

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