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Email : ijitce.editor@gmail.com or editor@ijitce.com

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DESIGN AND ANALYSIS OF CANTILEVER BEAM

P C Sekhar Reddy

ABSTRACT

This study investigates the deflection and stress distribution in a long, slender cantilever beam of uniform rectangular cross section made of linear elastic material properties that are homogeneous and isotropic. The deflection of a cantilever beam is essentially a three dimensional problem. An elastic stretching in one direction is accompanied by a compression in perpendicular directions.In this project, static and Modal analysis is a process to determine the stress, strain and deformation. vibration characteristics (natural frequencies andmode shapes) of a structure or a machine component while it is being designed. It has become a major alternative to provide a helpful contribution in understanding control of many vibration phenomena which encountered in practice.In this work we compared the stress and natural frequency for different material having same I, C and T cross- sectional beam. The cantilever beam is designed and analyzed in ANSYS. The cantilever beam which is fixed at one end is vibrated to obtain the natural frequency, mode shapes and deflection with different sections and materials.

Key words: Finite element analysis, cantilever beam,static and model analysis.

1. INTRODUCTION

1.1 BEAM CANTILEVER BEAM

A cantilever is a rigid structural element, such as a beam or a plate, anchored at only one end to a (usually vertical) support from which it is protruding.Cantilevers can also be constructed with trusses or slabs. When subjected to a structural load, the cantilever carries the load to the support where it is forced against by a moment and shear stress.

Cantilever construction allows for overhanging structures without external bracing, in contrast to constructions supported at both ends with loads applied between the supports, such as a simply supported beam found in a post and lintel system.

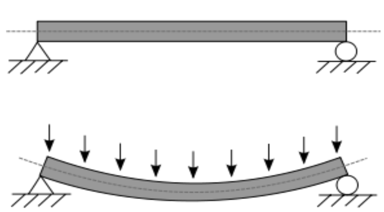
Associate Professor, Department Of Mechanical Engineering, Holy Mary Institute Of Technology And Science, Telangana

APPLICATIONS

In bridges, towers, and buildings

Cantilevers are widely found in construction, notably in cantilever bridges and balconies (see corbel). In cantilever bridges the cantilevers are usually built as pairs, with each cantilever used to support one end of a central section. The Forth Bridge in Scotland is an example of a cantilever truss bridge. A cantilever in atraditionally timber framed building is called a jettyr forebay. In the southern United States a historic barn type is the cantilever barn of log construction.

Temporary cantilevers are often used in construction. The partially constructed structure creates a cantilever, but the completed structure does not act asa cantilever. This is very helpful when temporarysupports, or falsework, cannot be used to support the structure while it is being built (e.g., over a busy roadway or river, or in a deep valley). So some truss arch bridges (see Navajo Bridge) are built from each side as cantilevers until the spans reach each other and are then jacked apart to stress them in compression before final joining. Nearly all cable- stayed bridges are built using cantilevers as this is one of their chief advantages. Many box girder bridges are built segmentally, or in short pieces. This type of construction lends itself well to balanced cantilever construction where the bridge is built in both directions from a single support.



A statically determinate beam, bending (sagging) under a uniformly distributed load

ADVANTAGES AND DISADVANTAGES

Advantages

Does not require a support on the opposite side (probably the main reason you would ever have a cantilever beam).
Creates a negative bending moment, which can help to counteract a positive bending moment created elsewhere. This is particular helpful in cantilevers with a backspan where a uniform load on the backspan creates positive bending, but a uniform loadon the cantilever creates negative bending.

Disadvantages

- Large deflections
- Generally results in larger moments
- You either need to have a fixed support, or have a backspan and check for uplift of the far support.

LITERATURE REVIEW

MODELLING, SIMULATION AND ANALYSIS OF CANTILEVER BEAM OF DIFFERENT MATERIAL BY FINITE ELEMENT METHOD, ANSYS

The dynamic analysis of a beam with multiple degree of freedom (MDOF) are studied in this paper. Due to the destructive effects of vibration inmachines and structures due to resonance. In multiple degree of freedom system, there are n natural frequencies and the concept of resonance iscomplicated by the effect of mode shapes. In the present work cantilever beam of different materials and dimensions is considered for the dynamic analysis of free vibration at no load condition as well as comparison between materials. The modelling, simulation and analysis of cantileverbeam is done by using ANSYS and theoreticallyby finite element method (FEM) for the evaluation of natural frequency and mode shape.

3. PROBLEM DESCRIPTION:

The objective of this project is to make a 3D model of the cantilever beam and study the static and model behavior of the cantilever beam by performing the

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finite element analysis. 3D modeling software (PRO-Engineer) was used for designing and analysis software (ANSYS) was used for static and modal analysis.

The methodology followed in the project is as follows:

- Create a 3D model of the cantilever beam assembly using parametric software pro-engineer.
- Convert the surface model into Para solid file and import the model into ANSYS to do analysis.
- Perform static analysis on the cantilever beam.
- Perform model analysis on the existing model of the cantilever beam.

4. INTRODUCTION TO CAD/CAE:

Computer-aided design (**CAD**), also known as **computer-aided design and drafting** (**CADD**), is the use of computer technology for the process of design and design-documentation.

4.1. INTRODUCTION TO CATIA

CATIA (an acronym of computer-aided three-dimensional interactive application) is a multi-platform software suite for computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE), PLM and 3D, developed by the French company Dassault Systems.

CATIA started as an in-house development in 1977 by French aircraft manufacturer AVIONS MARCEL DASSAULT, at that time customer of the CADAM software to develop Dassault's Mirage fighter jet. It was later adopted by the aerospace, automotive, shipbuilding, and other industries.

Initially named CATI (conception assistée tridimensionnelle interactive – French for interactive aided three-dimensional design), it was renamed CATIA in 1981 when Dassault created a subsidiary to develop and sell the software and signed a non-exclusive distribution agreement with IBM.

4.2. INTRODUCTION TO FINITE ELEMENT METHOD:

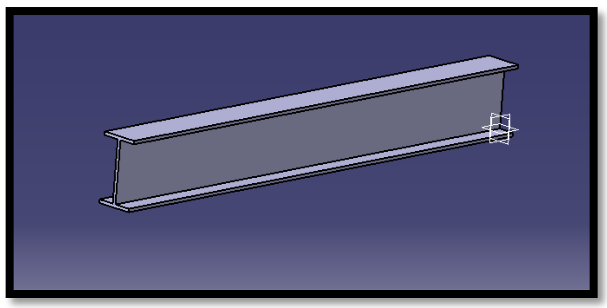
Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is abasic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results.

5. RESULTS AND DISCUSSIONS:

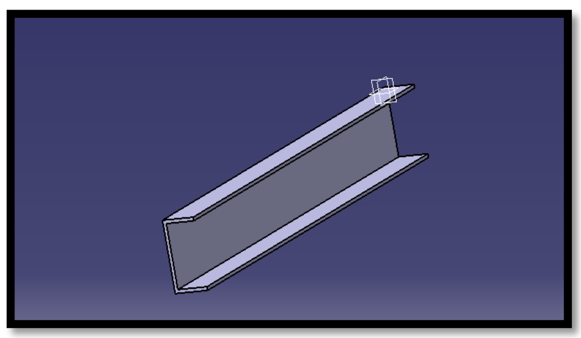
5.1. Models of cantilever beam using pro-e wildfire 5.0: The cantilever beam is modeled using the given specifications and design formula from databook. The cantilever beam outer casing body profileis sketched in sketcher and then it is extruded using extrude option.

Cantilever beam 3D

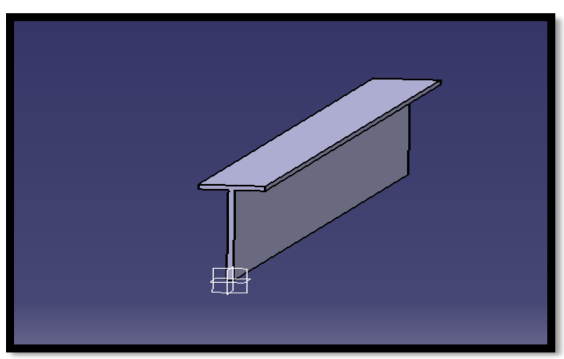
modelI-Section



C-Section



T-Section



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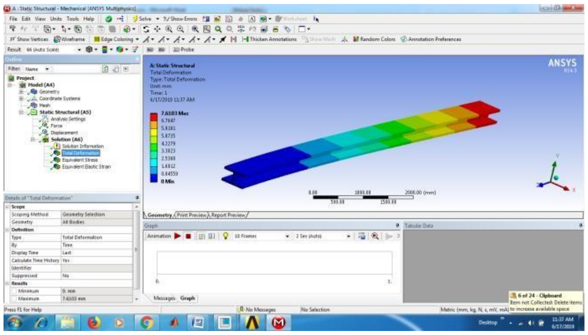
5.2. STRUCTURAL ANALYSIS OFCANTILEVER BEAM

MATERIAL-Steel

Deformation



According to the above contour plot, the deformation is maximum at the free end of the beam and the deformation is minimum at the fixed end. At this condition the maximum deformation of the beam is

STRESS

According to the above contour plot, the maximumstrain occurs at the fixed end of the beam i

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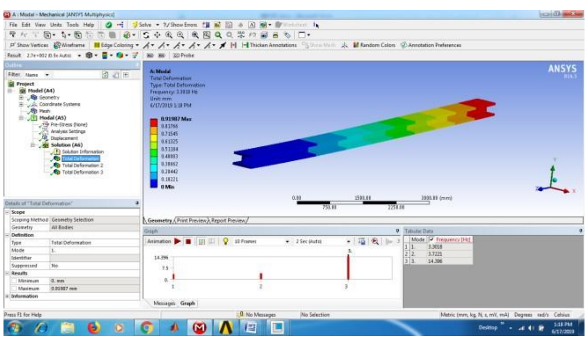
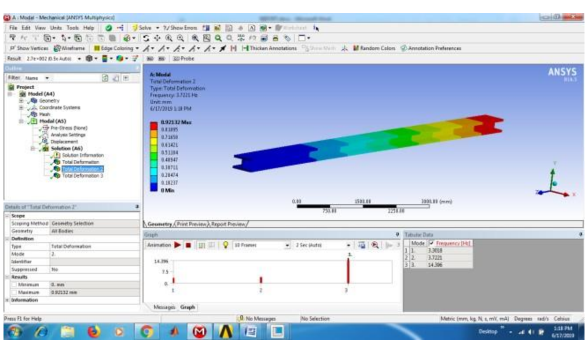
5.3 MODAL ANALYSIS OFCANTILEVERBEAM

Material-Steel

Total Deformation-1



Total deformation-2



7. CONCLUSION

The stress and natural frequency were studied for several materials with the same I, C, and T cross-sectional beam in this study. The cantilever beam is created and evaluated using the ANSYS software. The natural frequency, mode forms, and deflection with various sections and materials are obtained by vibrating the cantilever beam, which is fixed at one end.Static study shows that when using cast iron as the material for the I-section cantilever beam, deformation and stress values are lower than when using steel or stainless steel. Deformation and frequency values are lower for the I-section cantilever beam and higher for the T-section, according to the modal analysis findings.Therefore, it is clear that cast iron is the superior material for the cantilever beam in this type I substructure.

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