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## Free Vibrational Analysis of Cracked and Un-cracked Cantilever Beam

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**Abstract.** Early detection of damage is of special concern for engineering structures. A comparatively recent development for the diagnosis of structural crack location and size by using the finite element method and fuzzy logic techniques has improved. The traditional methods of damage detection include visual inspection or instrumental evaluation. A method based on measurement of natural frequencies is presented for detection of the location and size of a crack in a cantilever beam. Numerical and programming in MATLAB is used for solving the Euler equation for an crack beam to obtain first three natural frequencies of different modes of vibration considering boundary conditions for the beam.

Here in this, ANSYS software package is used for finite element analysis of both crack and un-crack cantilever beam taking input file as a GAO design developed in CATIA. Experiments are done for total 10 models of crack beam having different cross section, crack location and crack depth and it generates natural frequency for 3 modes of vibration. A part of Matlab introduced is curve fitting toolboxes and Fuzzy logic controller. The curve fitting toolboxes introduced for crack identification by using simple curve. The Fuzzy controller here used comprises of three input variables (TNS, SNF and TNS) and two output variables (RCD and RCL) are generated with Triangular MF. Fuzzy analysis is done based on some set of fuzzy rules obtained from the information supplemented by Finite Element Analysis and Numerical Analysis. The proposed approach has been verified by comparing results obtained from fuzzy logic technique and finite element analysis.

**Key Words:** Cantilever beam, Free vibration, frequency, Crack, ANSYS

### 1. INTRODUCTION

#### 1.1 CONCEPT OF VIBRATION

With the discovery of musical instruments, people started taking interest in vibration. Since then, people have applied investigation and theories to study the vibration phenomenon. Sir Galileo is considered to be the founder of vibration phenomenon. He has performed his experiments on free vibrations of simple pendulum. After Sir Galileo, a lot

of research is made by Merenne (Vibrating string), Newton (Laws of motion), Taylor (Taylor series for vibration analysis), Alenbert (Principles of equilibrium), Euler (Euler's beam theory), Fourier (sine wave analysis), Rayleigh (frequency measurement) and Lagrange's method of vibration analysis. Since then the vibration has covered a brief history from Sir Galileo's work to modern vibration researches.

Any motion which repeats itself after a certain interval of time is called vibration. The swing of pendulum is a typical example of vibration. The theory of vibration deals with study of oscillatory motions of bodies and the forces associated with them. A vibration can be caused due to external unbalanced force also. A vibratory system, in general, includes elastic member for storing potential energy, a mass or inertia member for storing kinetic energy and damper by which gradual loss of energy takes place. A simple pendulum as shown in fig. 1.1 is an example of vibration system. Pendulum has a string for elastic nature, mass of bob acts as a means for kinetic energy. Like pendulum, spring-mass system, vehicle suspension system, simply supported and cantilever beam, lateral vibrating string, vibration due to unbalance, reciprocating or rotating force, etc. are the examples of vibrating system.

Vibrations with certain amplitude and frequency may be reliable but excessive vibrations causes

- Resonance and excessive noise.
- Structural failure of the machine components.
- Power transmission loss in case of gears.
- Increases bearing clearances.
- Reduces the working life of components.
- Effect on financial growth.



Fig. 1.1 Free Vibrations of Simple Pendulum



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