DESIGN AND ANALYSIS OF NOISE, VIBRATION AND HARSHNESS CONTROL FOR AUTOMOTIVE STRUCTURES USING FINITE ELEMENT ANALYSIS

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ABSTRACT: Many machines and machine mechanisms run under dynamic working conditions. The vibrations produced under dynamic conditions affect many important designs Parameters such as strength, production costs, productivity. Computer aided engineering (CAE) procedures are used to analyses the dynamic Response of the vibration controls. The finite element methods used in the analysis are Applied by a computer aided design and analysis software ANSYS. The aim of this paper is to study existing design automotive structures can operate safely environment to reduced vibration resonances. An ANSYS APDL code is developed to obtain the time- histories to frequency range of model and transient analysis APDL stands for ANSYS Parametric Design Language.

Keyword: Modal Transient Analysis, APDL Programming, Noise and Harshness, Natural Frequency.

1. Introduction

The automotive industry is currently spending millions of dollars on NVH work to develop new materials and damping techniques. The new design methods are starting to consider NVH issues throughout the whole design process. This involves integrating extensive modeling, simulation, evaluation, and optimization techniques into the design process to insure both noise and vibration comfort. New materials and techniques are also being developed so that the damping treatments are lighter, cheaper, and more effective. The structures their vibration characteristics which are natural frequencies and mode shapes should be well identified [1]. A modal formulation method is also introduced in this study to calculate the tuned angular speed of a rotating beam at which resonance occurs. The solution of the governing equation reveals the super harmonics of the fundamental frequency due to the nonlinear effects in the dynamic response of the cracked beam [2]. The Free vibration of the beam is measured from the position of the steady state axial deformation. Natural frequencies of nonlinear coupled planar vibration are investigated for axially moving beams in the supercritical transport speed ranges [3]. This paper is aimed at determining how material dependent damping can be specified conveniently in ANSYS in a mode superposition transient dynamic analysis. A simple cantilever beam is analyzed using various damping options in ANSYS [7]. The mode superposition method is often used for dynamic analysis of complex structures, such as the seismic Category. I structures in nuclear power plants, in place of the less efficient full method, which uses the full system matrices for calculation of the transient responses.

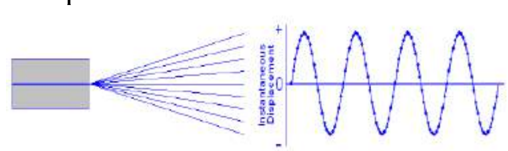


Fig 1.1 sound.

2. Problem Definition:

This paper is aimed at determining how acoustic calculation can be specified conveniently in ANSYS in a mode superposition transient dynamic analysis. A simple cantilever beam is analyzed using various damping options in ANSYS [12]. A recent review of the ANSYS manual for several releases found that the use of time-dependent damping is not clearly explained for performing a mode superposition transient dynamic analysis. This paper includes several mode superposition transient dynamic analyses using different ways to specify acoustic calculation in ANSYS. Modal analysis in ANSYS program is linear analysis. The mode extraction method includes Block Lanczos (default), sub space, Power Dynamics, reduced, unsymmetrical, and damped and QR damped. The damped and QR damped methods allow to include damping in the structure.

2.1 Applications of cantilever beams:

Another important class of problems involves cantilever beams. A system is said to be a cantilever beam system if one end of the system is rigidly fixed to a support and the other end is free to move. Cantilevers are widely found in construction, in cantilever bridges and balconies. In cantilever bridges the cantilevers are usually built as pairs, with each cantilever used to support one end of a central section. Another use of the cantilever is in fixed-wing aircraft design; Cantilevered beams are the most ubiquitous structures in the field of micro electro mechanical systems (MEMS). A cantilever rack is a type of warehouse storage system.

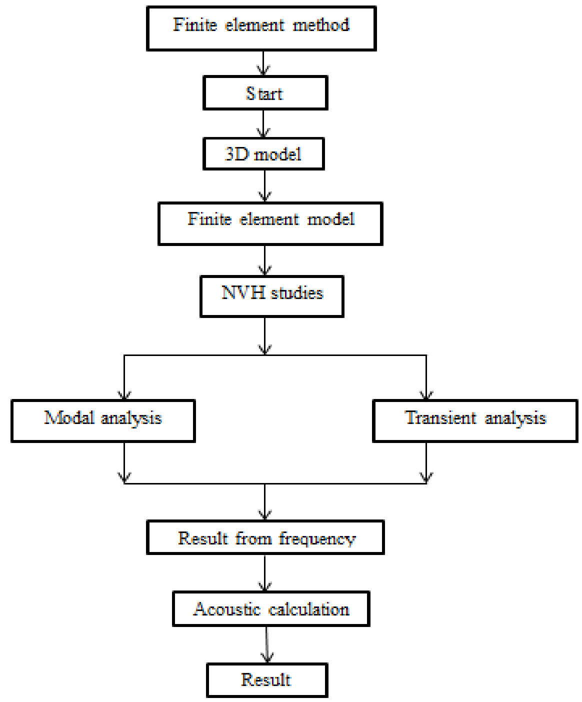
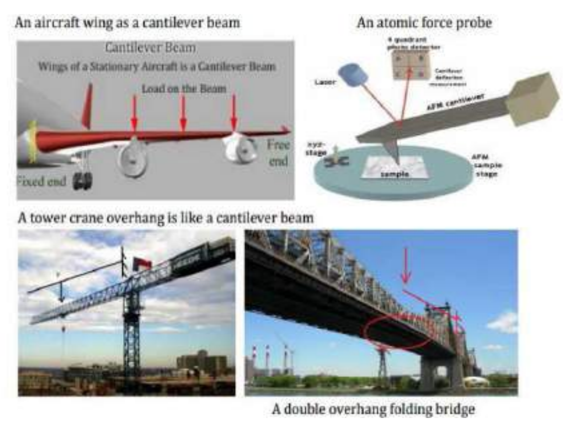


Fig 2.1 Flow chart



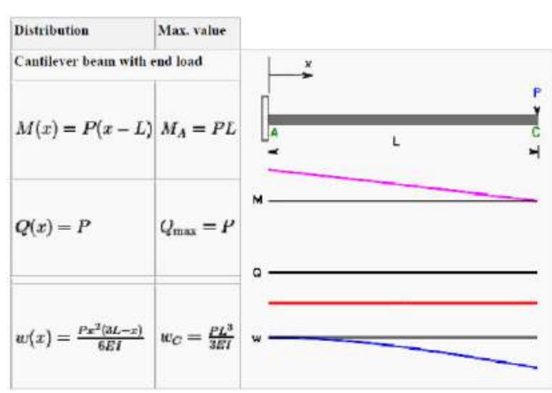
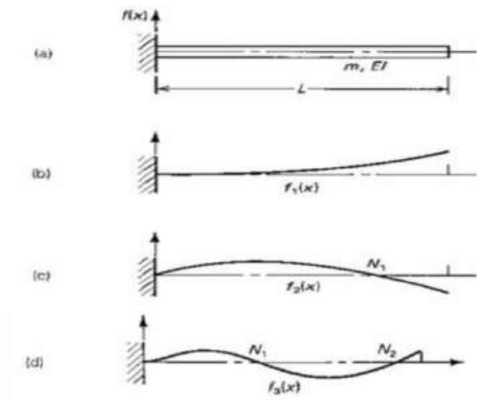


Fig 2.2 Point load at the free end and a uniformly distribute



3. ANSYS MODELING

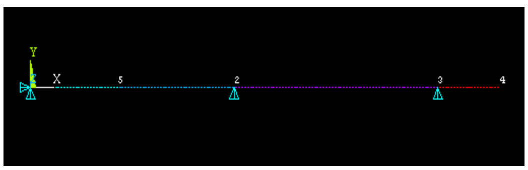


Figure: - 3.1. Model of the continuous beam

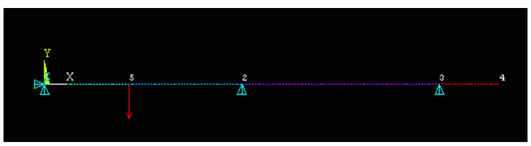
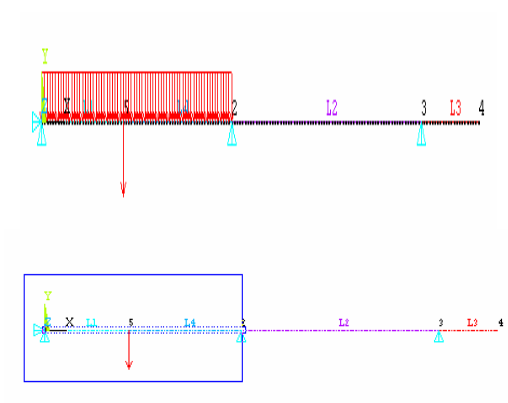
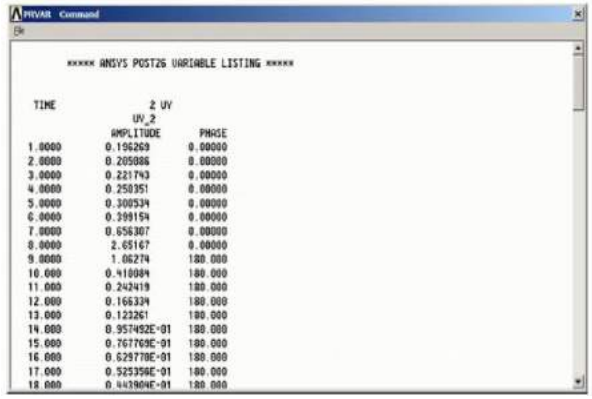


Figure: - 3.2 Apply boundary condition to the beam





PRVAR Command

***** ANSYS POST26 VARIABLE LISTING *****

TIME	2 UY UV_2 AMPLITUDE	PHASE
1.0000	0.196269	0.00000
2.0000	0.205086	0.00000
3.0000	0.221743	0.00000
4.0000	0.250351	0.00000
5.0000	0.300534	0.00000
6.0000	0.399154	0.00000
7.0000	0.656307	0.00000
8.0000	2.65167	0.00000
9.0000	1.06274	180.000
10.000	0.410084	180.000
11.000	0.242419	180.000
12.000	0.166334	180.000
13.000	0.123261	180.000
14.000	0.957492E-01	180.000
15.000	0.767769E-01	180.000
16.000	0.629770E-01	180.000
17.000	0.525356E-01	180.000
18.000	0.443904E-01	180.000

Fig 3.3 Amplitude vs. Frequencies

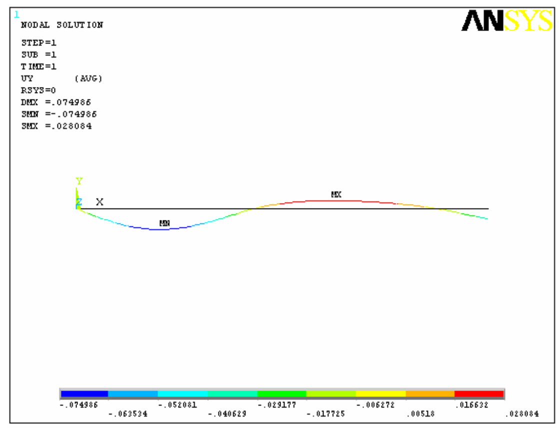


Fig: 3.4 Mode shape

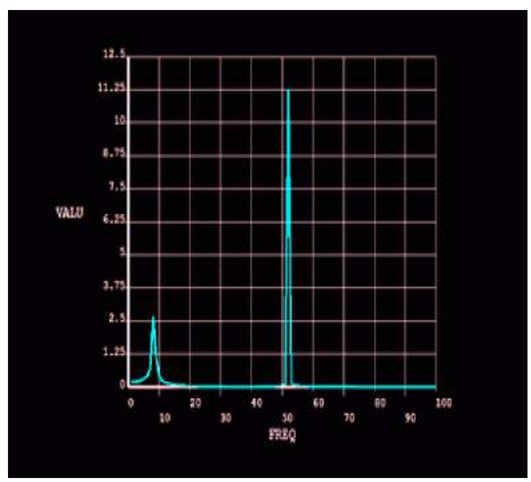


Fig 3.5 Modal & Harmonic Analysis

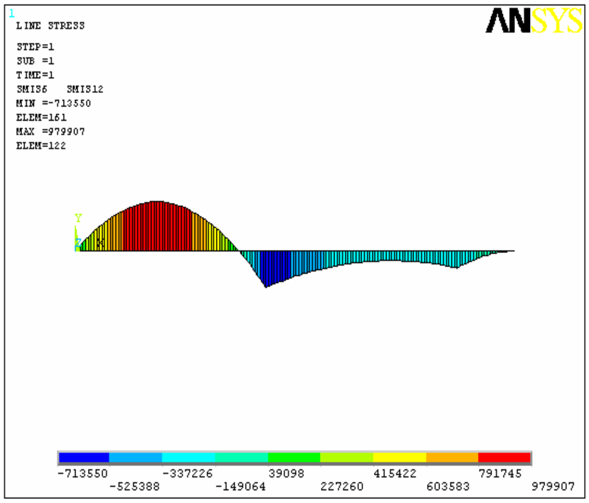


Fig 3.6 Stress varying models

4. ACOUSTIC CALCULATION

4.1 Sound Pressure Level:

The human ear can hear a broad range of sound pressures. Because of this, the sound pressure level (L_p) is measured in decibels (dB) on a logarithmic scale that compresses the values into a manageable range.

In contrast, direct pressure is measured in Pascal's (Pa). L_p is calculated as 10 times the logarithm of the square of the ratio of the instantaneous pressure fluctuations (above and below atmospheric pressure) to the reference pressure:

$L_p = 10 \times \log10 \, (P/Pref)^{2}$

Where P is the instantaneous sound pressure, in units Pa, and Pref is the reference pressure level,

Defined as the quietest noise a healthy young person can hear (20 µPa).

Sound pressure of 2 Pa The sound pressure level is calculated:

Lpreal = 20 log10 (2/0.00002) = 20

log10 (100,000) = 20 × 5.0 = 100 DB

4.2 Sound Power Level:

Sound power level (L_w) is similar in concept to the wattage of a light bulb. In fact, L_w is measured in watts (W). Unlike L_p, L_w does not depend on the distance from the noise source. The sound power level is calculated using the following equation:

$L_w = 10 \times \log10 \, (W/Wref)$

Where W is the acoustic power in watts and W_{ref} is the reference acoustic power, 10-12.

Sound power of 0.00001 W

Lpimag = 10 × log10(0.00001/10-12) = 70 dB

5. CONCLUSION:

In this project, Finite element analysis of a cantilever beam free end was used to demonstrate and investigate aspects of vibration theory. The solutions existing design calculation shows the decibel range safety is very less than requirement and there is a scope for weight increment. Results obtained using ANSYS method. Lastly when transient analysis is performed, it also favors the result obtained using different approaches and confirms that resonance occurs at fundamental natural frequency. Future work will be mostly focused on the improvement of the mechanical modeling of the structure and the force definition together with the impedance characterization of the sound absorbing materials and reduced vibrations.

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