Assumptions
in
Modal Analysis Simulations

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Introduction

- The modal analysis simulations done in the industry are subject to many assumptions. The analysis is valid only if all the assumptions hold true.
- If one or more assumptions are invalidated by the actual situation, the integrity of the modal evaluation gets compromised.

The CAD model represents the actual geometry

- It is assumed that the CAD model represents the actual geometry exactly which is an approximation of reality because there is no such thing as perfect manufacturing. Every thing can be manufactured only correct to some tolerance values.
- Mostly this assumption holds true for modal analyses to a high degree of accuracy but not always.

The boundary conditions assigned are exact

- The boundary conditions are assumed to be exactly representative of the real world conditions.
- This assumption is usually not satisfied exactly and can only be approximated to a certain degree of accuracy. This problem is the biggest challenge of the CAE analyst. People generally feel happy if the error in simulation is restricted to 15% or less than the experimentally measured values.

There is no damping

- The modal analysis simulations assume no damping.
- This assumption is fine as long as the actual damping ratio is small.
- In case the damping ratio is large, the modal analysis done on the basis of zero damping will give faulty results which can cause incorrect evaluations of stresses and displacements in the ensuing mode-superposition analyses (frequency response, transient dynamic, random vibration or response spectrum).

The temperature does not changes during the course of deformation

- The elastic modulus and Poisson's ratio are temperature dependent for engineering materials. The temperature and hence the material properties are assumed to remain constant during the deformation.
- This is not satisfied exactly as the deformation itself causes localised heating and cooling in the body. But such effects are not significant in most industrial applications.

There is no change in contact status

- It is assumed in the modal analysis that the surfaces (and their parts) of the objects initially in contact remain in contact always and surfaces (and their parts) initially not in contact never come into contact ie. there is no change in contact status.
- This is a vexing problem as this assumption often does not hold true in practice. This is usually remedied by not modelling the contacts that change status making the model conservative.

The stress-strain curve is a straight line

- This assumption is valid for most materials like steel, aluminium, etc as long as stress does not cross the yield point stress.

The strain-displacement plot is a straight line

- This assumption is valid as long as the displacements are small relative to the dimensions of the structure.

The material is homogeneous

- The continuum hypothesis is used. Although not strictly true, this holds to a high degree of accuracy for modal analysis.

The material is elastic

- The material should not have any plastic or permanent deformation.

The material is rate-independent

- The elastic modulus and the Poisson’s ratio of the material of the body should not be dependent on the rate of strain.

The material does not rupture anywhere

- It is also assumed that the material does not rupture anywhere in the structure.

The material properties assigned are perfect

- There will be a scatter in material properties from the tested specimen to different parts of the structure but this is ignored and the material is assumed to have the same properties as the test specimen of the material.