Modal analysis FAQ
This page is devoted to frequently asked questions (FAQ) related to modal analysis.

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Modal analysis

For a structure with cables, how should modal analysis proceed?

Extended Question: I would like to perform a modal analysis of a structure with cables. Because cables are tension-only, the model is nonlinear, though modal analysis is theoretically elastic. Are there any guidelines for this situation?

Answer: To obtain meaningful results when performing modal analysis of a structure with cables, load cases in which dead and other loads are applied should use the option for Stiffness at the end of nonlinear load case. Modes will then be based on the stiffness of the cables under applied loading. To capture complete nonlinear dynamic behavior, nonlinear direct-integration time-history analysis is most effective.

Analysis output

Why is my simply supported beam not returning a fundamental period?

Answer: To compute the modes of vibration, un-check the option to Lump Mass at Story Levels, available through Define > Mass Source.

Error and warning messages

What is the meaning of the warning message: Eigenvalue was found out of sequence?

Answer: This warning message indicates that numerical problems occurred during analysis due to the structure being unstable when solving for eigenvalues.

What is the meaning of the warning message: Excessively large effective-damping ratios have been set to 0.999950?

Extended Question: When I run a time-history analysis using modes from the Ritz-vector modal load case, I receive a warning message which states: Excessively large effective-damping ratios have been set to 0.999950. This message does not occur when using Eigenvectors. Is there an explanation?

Answer: This warning message may occur when using proportional damping for which damping increases with large frequency. Ritz vectors would subsequently generate high-frequency modes with large damping. This round-off to 0.999950 is necessary for numerical formulation.

What is the meaning of the warning message: Loads are applied to massless degrees of freedom?

Extended Question: During Ritz-vector modal analysis, I received a warning message which states: Loads are applied to one or more massless degrees of freedom, corresponding Ritz modes may be unavailable or inaccurate for dynamics. What does this mean, can it be ignored, and if not, how should I revise the model?

Answer: This message indicates that load is applied to a joint which either has no mass or is restrained. Gravity load from structural self-weight creates a set of fixed-end forces which includes shear and moment. These forces will also impose load on massless degrees-of-freedom (DOF). In a structure with frame or shell objects, each joint has up to six DOF, including translations (UX, UY, UZ) and rotations (RX, RY, RZ). Mass from the material density of structural objects is assigned to translational DOF. Additional mass may be assigned to any DOF, including rotational DOF such that rotational inertia is captured.

Ritz-vector application during dynamic loading is most effective when all applied loads act on DOF with mass. While earthquake loads automatically act on DOF with mass, mass should be assigned to DOF subjected to other types of load, and to nonlinear NLink elements, which are treated as external force generators.

It is not necessary for loaded DOF to have mass when Ritz vectors are generated for gravity and other static loading conditions applied during time-history analysis because load is applied so slowly that dynamic behavior is not important. In this case, either the warning may be ignored, or a small mass may be assigned to DOF in question.

Additional information is available in the CSI Analysis Reference Manual (Modal Analysis > Starting Load Vectors, page 331).
After assigning shell joint offsets during Ritz-vector modal analysis, what is the meaning of the warning message: Loads are applied to massless degrees of freedom?

**Answer:** When joint offsets are applied to shell objects, translational forces may cause moments at joint locations. Because mass is lumped at translational DOF (UX, UY, and UZ), the rotational DOF (RX, RY, RZ) which correlate with applied moments are massless, causing the warning message to generate. Unless the offsets are very large, the warning message is not significant, and may be ignored.

To edit the model such that the warning message does not occur, mass may be assigned to the rotational DOF of loaded joints to provide for rotational inertia. A reasonable mass value would be between $\frac{1}{10} \text{md}^2$ and $\frac{1}{100} \text{md}^2$, where $m$ is the translational mass located at the joint, and $d$ is the offset distance. A smaller value on the order of $\frac{1}{1000} \text{md}^2$ may be used to simply avoid the massless condition.