

Comparison between FNA and direct-integration time-history analyses

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Overview

Nonlinear [modal](#) time-history analysis, also known as Fast Nonlinear Analysis (FNA), is generally more accurate and efficient than direct-integration [time-history](#) analysis. The accuracy of FNA depends upon the sufficiency of suitable mode shapes, similar to how direct integration requires small enough time steps to accurately characterize dynamic behavior.

[Damping](#) is handled differently between these two analysis methods. FNA limits proportional damping at the frequency extremes to 0.99995 that of critical, while direct integration uses [mass- and stiffness-proportional damping](#) in which damping at very low and very high frequencies may exceed critical.

We recommend using the default [Convergence tolerance](#) (1e-4) during FNA application, and for direct integration, a tolerance equal to or less than 1e-3.

Results may be sensitive to physical parameters, loading conditions, and the analytical technique applied, especially with irregular structures and advanced nonlinear systems. Since FNA is an accurate and efficient analysis method, it may be worthwhile to apply this technique to a series of models which simulate variable computational scenario. For example, [foundation springs](#) and substructure may be included, then omitted, to provide a comparison study.

Additional comparisons

- **Energy plots** are available only during modal time-history analysis, and not direct-integration time history.