

Time-history analysis

Time-history analysis provides for linear or [nonlinear](#) evaluation of dynamic structural response under loading which may vary according to the specified [time function](#). Dynamic equilibrium equations, given by $K u(t) + C \frac{d}{dt} u(t) + M \frac{d^2}{dt^2} u(t) = r(t)$, are solved using either [modal](#) or [direct-integration](#) methods. Initial conditions may be set by continuing the structural state from the end of the previous analysis. Additional notes include:

- **Step Size** – Direct-integration methods are sensitive to time-step size, which should be decreased until results are not affected.
- **HHT Value** – A slightly negative [Hilber-Hughes-Taylor](#) alpha value is also advised to [damp](#) out higher frequency modes, and to encourage convergence of nonlinear direct-integration solutions.
- **Nonlinearity** – [Material](#) and [geometric](#) nonlinearity, including P-delta and large-displacement effects, may be simulated during nonlinear direct-integration time-history analysis.
- **Links** – [Link](#) objects capture nonlinear behavior during modal ([FNA](#)) applications.

Articles

Tutorials

Title	Description	Program
Time-history analysis first steps	Overview of the procedure for time-history analysis.	SAP2000
Vibrating-machinery steel skid on piles	This tutorial demonstrates the modeling of vibrating machinery and its connection to a steel-skid structural system.	SAP2000

Test Problems

Title	Description	Program
Human-induced vibrations	The modeling and analysis of human-induced vibrations due to footfalls or another type of impact.	SAP2000
Multi-pendulum model (Newton's cradle)	Model a pendulum system in SAP2000 using large-displacement time-history analysis.	SAP2000
Steady-state vs. time-history analysis	Test problems to demonstrate the differences and similarities between steady-state and time-history analyses.	SAP2000

See Also

- [Multi-support excitation](#) article