

Human-induced vibrations

Test Problem

Name:	Human-induced vibrations
Description:	The modeling and analysis of human-induced vibrations due to footfalls or another type of impact.
Program:	SAP2000
Version:	14.1.0
Model ID:	na

Modal [time-history](#) analysis is well-suited for the [modeling](#) and analysis of **human-induced vibrations** which result from such impacts as pedestrian footfalls. Guidelines are presented in this test problem. Please note that these parameters are not intended to be realistic. It is up to the engineer to determine load magnitude, stride length, load frequency, and other input values.

Human-induced vibrations may be modeled as follows:

1. Define a [load case](#) for each footfall location, and for convenience, name each according to the loading sequence, such as Step 1, Step 2, etc. For example, 100 footfall locations would require 100 load cases.
2. For each load case, apply a point load in the location of the corresponding footfall. It may be convenient to use a unit load, then adjust magnitude when setting the scale factor.
3. Define a single time-history function which will represent the footfall sequence. If a unit load is applied to each load case, set the magnitude in the function definition. Additional functions may be defined to consider multiple impulse-function shapes.
4. Define a time-history analysis case from the following options:
 - [Modal](#) time history based on [Eigen](#) modes, where a sufficient number of modes should be captured for the given structure.
 - Modal time history based on [Ritz](#) modes, which may be a better option as far as analysis goes, though Ritz formulation requires as many modes as there are footfall locations and load cases, since each position must be considered as a starting load vector. For example, 100 footfalls require 100 modes.
 - Direct-integration time history, which is not based on modes, but rather a step-by-step process. Direct integration typically demands more time, but if a large number of modes are necessary for modal analysis, direct integration may be more viable.
5. Add each footfall load case to the Loads Applied section (Figure 1), and specify the impulse function, scale factor, and arrival time. The timing of load sequence should be carefully considered and calculated, since arrival time and the application of impact is critical to dynamic response. Ensure that sufficient time steps are provided in the Time Step Data section to cover the duration of the time history.

Analysis Case Data - Linear Modal History

Analysis Case Name: Walking-ModalEigen Set Def Name Notes: Modify/Show...

Analysis Case Type: Time History

Initial Conditions:

☒ Zero Initial Conditions - Start from Unstressed State

☐ Continue from State at End of Modal History: []

Important Note: Loads from this previous case are included in the current case

Modal Analysis Case:

Use Modes from Case: Modal-Eigen

Analysis Type:

☒ Linear ☐ Nonlinear

Time History Type:

☒ Modal ☐ Direct Integration

Time History Motion Type:

☒ Transient ☐ Periodic

Loads Applied

Load Type	Load Name	Function	Scale Factor	Time Factor	Arrival Time	Coord Sys	Angle
Load	Step1	Stepping	1.	1.	0.	GLOBAL	0.
Load	Step1	Stepping	1.	1.	0.	GLOBAL	0.
Load	Step2	Stepping	1.	1.	4.	GLOBAL	0.
Load	Step3	Stepping	1.	1.	8.	GLOBAL	0.

☒ Show Advanced Load Parameters Add Modify Delete

Time Step Data:

Number of Output Time Steps: 120

Output Time Step Size: 0.1

Other Parameters:

Modal Damping: Constant at 0.05 Modify/Show...

OK Cancel

Figure 1 - Loads Applied

See Also

- [Power-spectral-density FAQ](#) article
- [Floor vibration due to human footfalls ETABS](#) article

Attachments

- [SAP2000 V11.0.8 model](#) (zipped .SDB file)