Atir Software Development LTD

STRAP - Time history analysis

Step by step

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1. Abstract

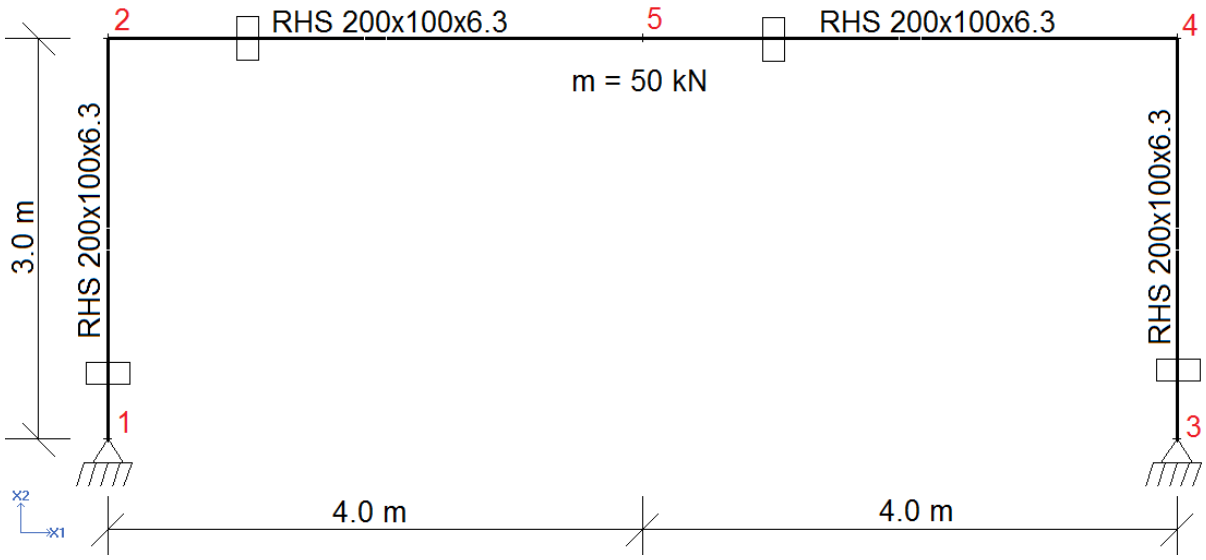
This module calculates the transient (history) response of a model subject to dynamic loads in which viscous damping is present. It enables the dynamic analysis of models subject to impact, impulse or cyclic loads or any other type of load that varies with time.

The stages in solving a **STRAP** model for this type of dynamic loading are:

- Geometry definition.
- Definition of masses.
- Calculation of natural frequency.
- Definition of the time-history function and associated loads.
- Display of results and transfer to **STRAP**

2. Geometry definition

Because the aim of this example is to describe the method to do Time-History Analysis, we will use a simple frame structure with a span of 8 meters and height of 3 meters. A ZIP file containing model files may be downloaded by clicking on this link: Model's geometry



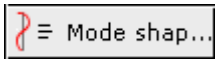
In the **STRAP** main menu:

- Click on Files and select Unzip a model; select the downloaded file.
- Click and highlight the model and click Copy.

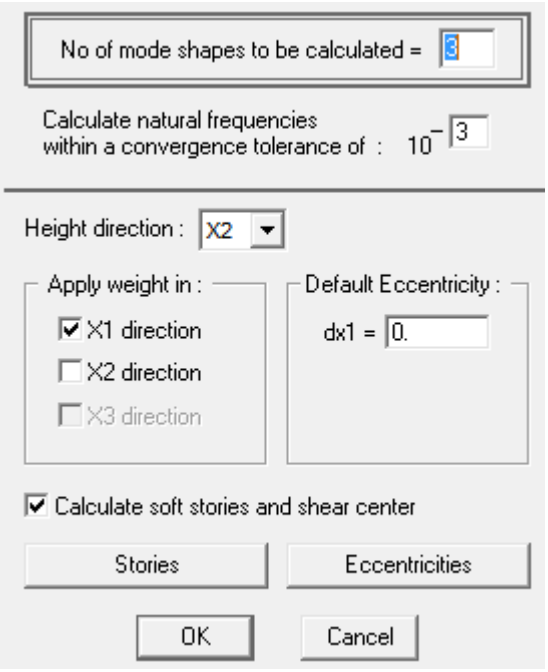
3. Modal analysis

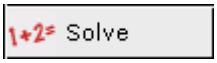
- Click the Weights tab
- Select the Add weights option in the side menu

- Define a weight = 50 kN on node 5:

- Select node 5.
- Select 

in the side menu and specify the following options:



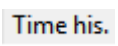
- Select 

in the side menu to calculate the mode shapes.

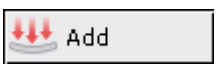
4. Time history analysis

4.1 Load suddenly released

Calculate the cycles of vibration if a horizontal load is applied to the top of the frame and then suddenly released. Assume 4% damping.

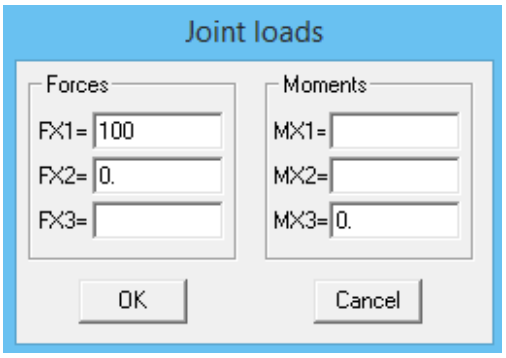
- Click on 

in the menu bar.
- Click on 

in the side menu.
- Type in the name of the load case, e.g. "Load suddenly removed".
- Click on 

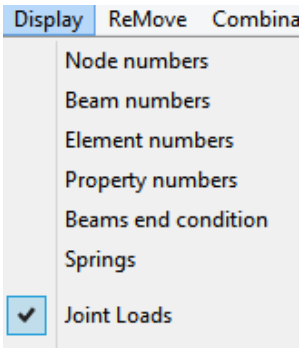
in the side menu.

- Define a horizontal load of 100 kN:



Note:

To display the load, set ☑ Joint loads" in the Display option:

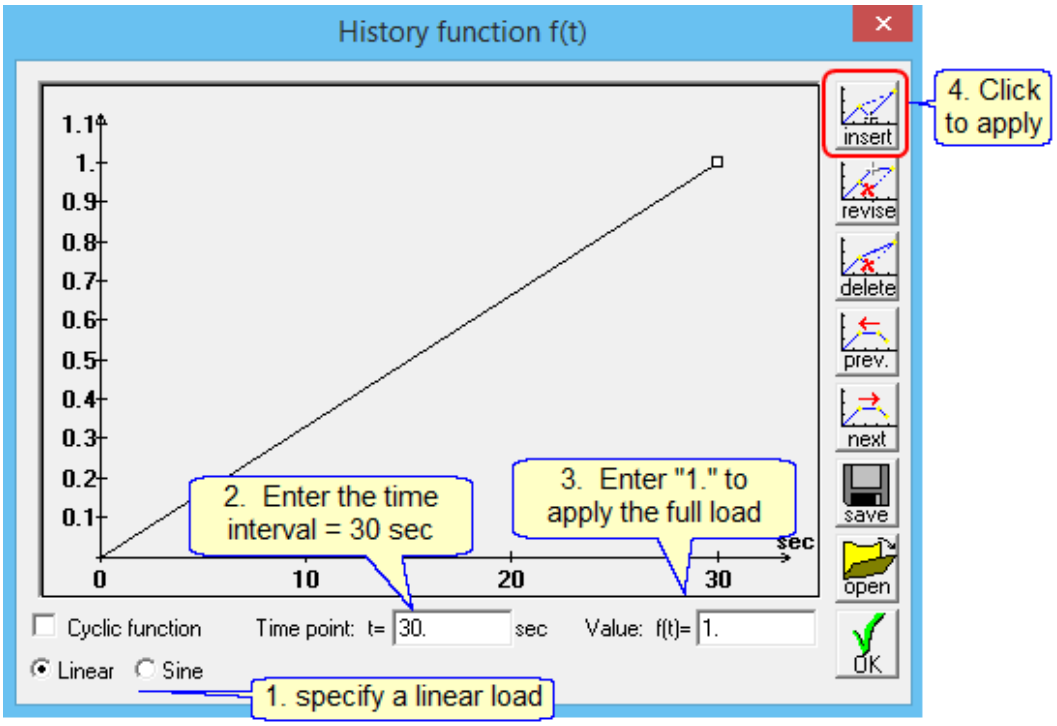


There are several ways to apply the load. We will apply it gradually and linearly so that the load is applied fully at t=30 sec, then reduce it to a zero load at t =30.01 sec.

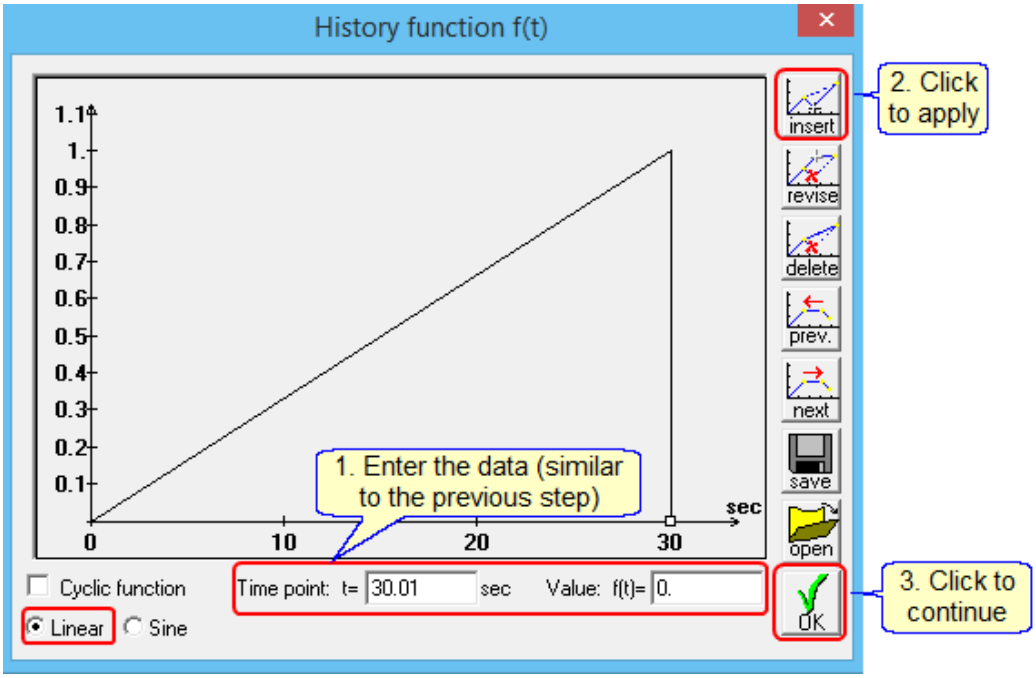
- Click on 

in the side menu

- Define the first segment of the load - 0 to 30 sec - as follows:

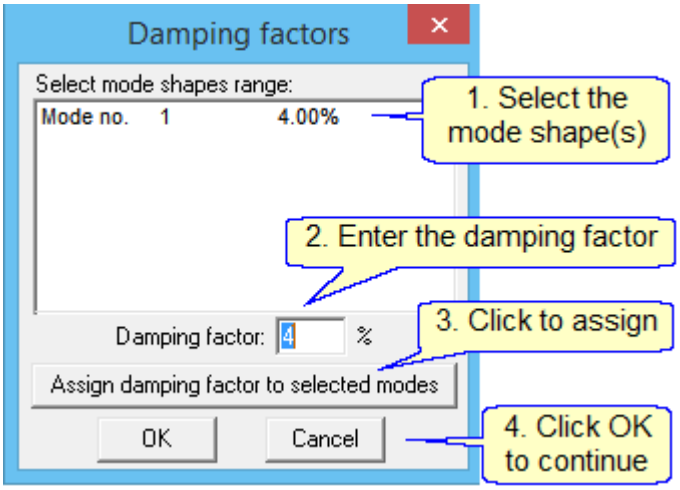


- Define the second segment of load - 30. to 30.01 sec - similar to above:



- Click Main menu to continue.

- Define the damping: click on Damping in the side menu



Display the results:

- Natural frequency and period:
  - Click on Display lo... in the side menu.
  - Select Modal Data table in the menu.

- The following table is displayed:

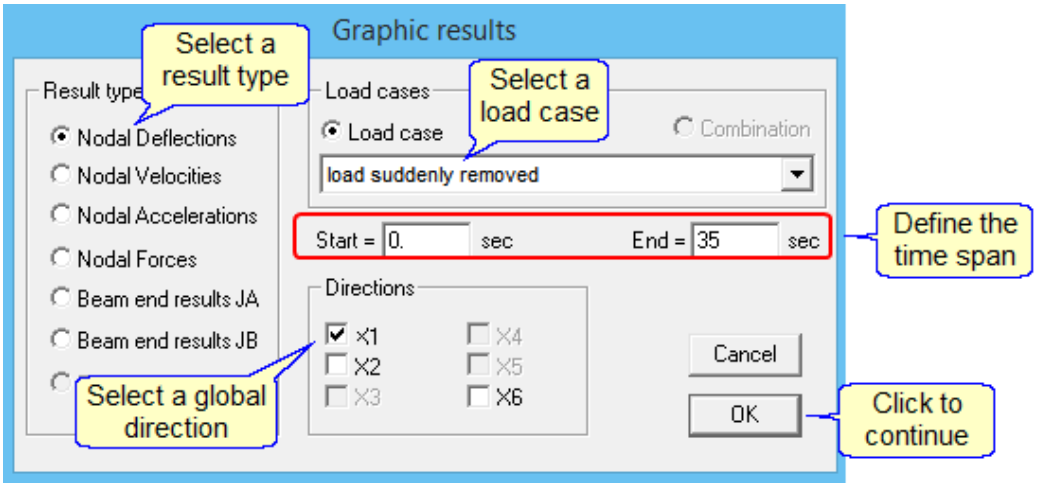
Mode No.	Eigenvalue (Omega**2)	Natural Frequency	Period	Damping Coeff.(%)	Max translation Node-DOF
1	344.672	2.9548	0.33844	4.00	5-1

- Displacements (graphic):

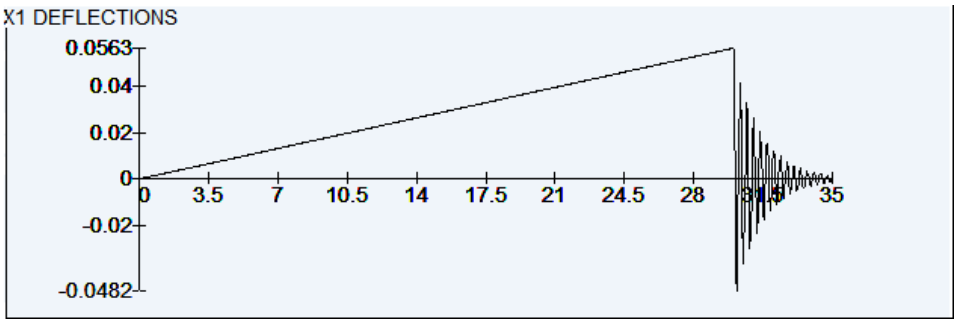
  A time span must be defined before displaying the displacements. For example, display the deflections from 0 to 35 sec:

  - Click on 

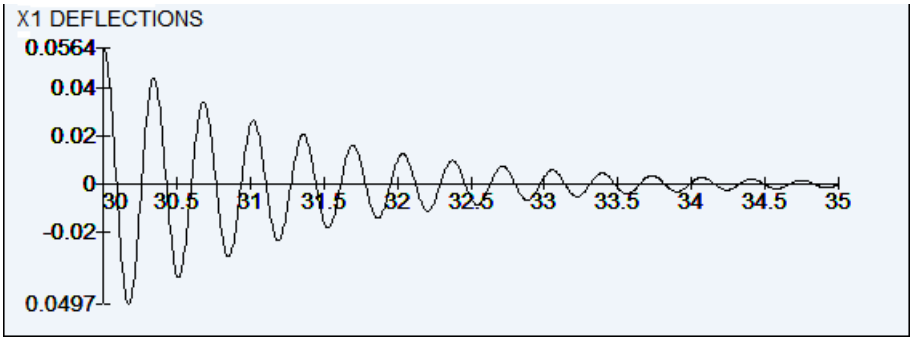
in the side menu.
  - Specify the result type, direction and time span:



  - Select node 2. The program displays the time-deflection diagram:



  - Zoom in on the 30 to 35 sec range:

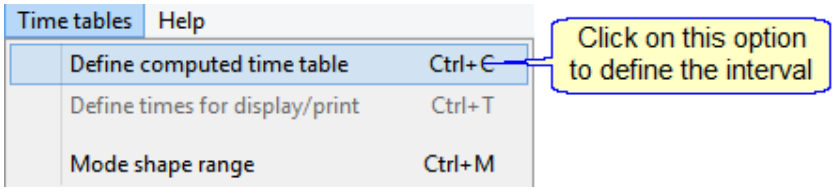


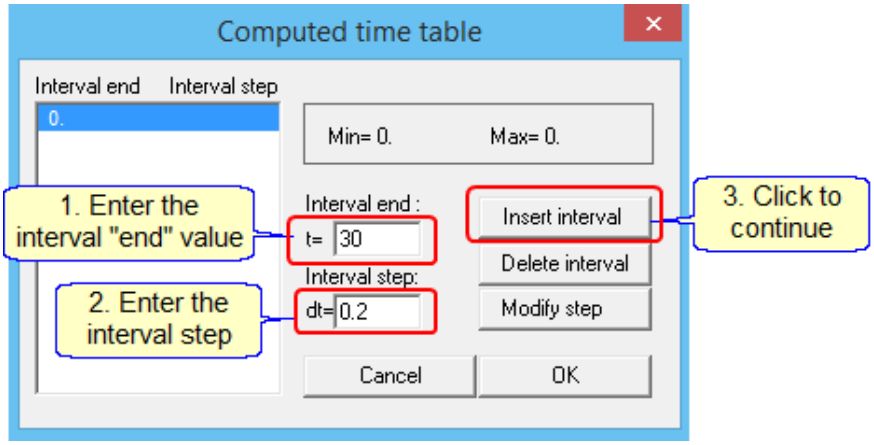
Note: The rate at which the displacements decrease is a function of the damping value.

- Displacements (tables):

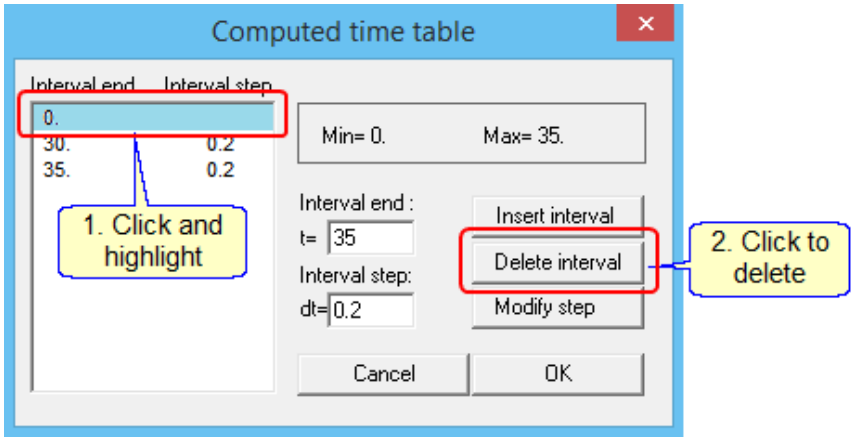
  A time span must be defined before displaying the displacements. For example, display the deflections from 0 to 35 sec at node 2:

  - Select "Time tables" in the menu bar:



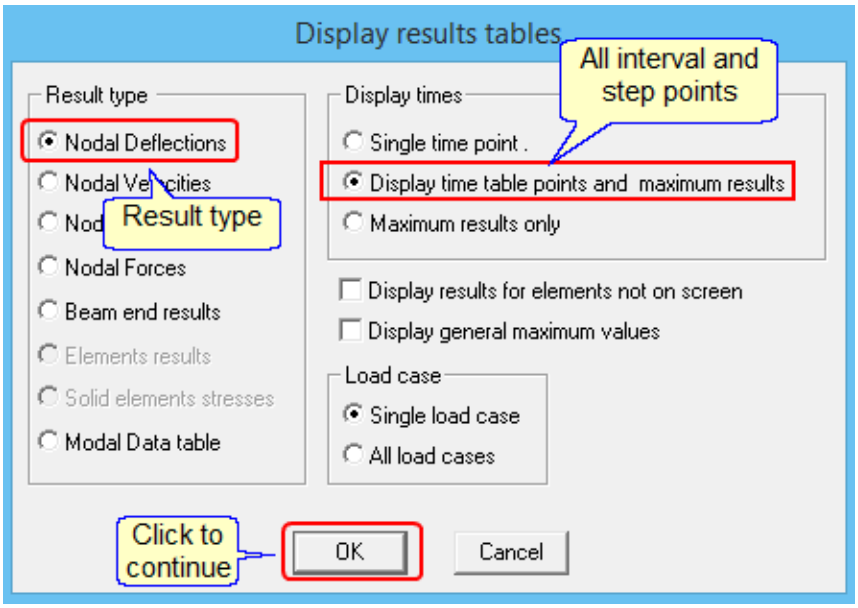


  - Repeat to add t = 35 sec, then delete t = 0 sec:



- Click  in the side menu.

- Select the result type, etc.:



- The program displays the table:

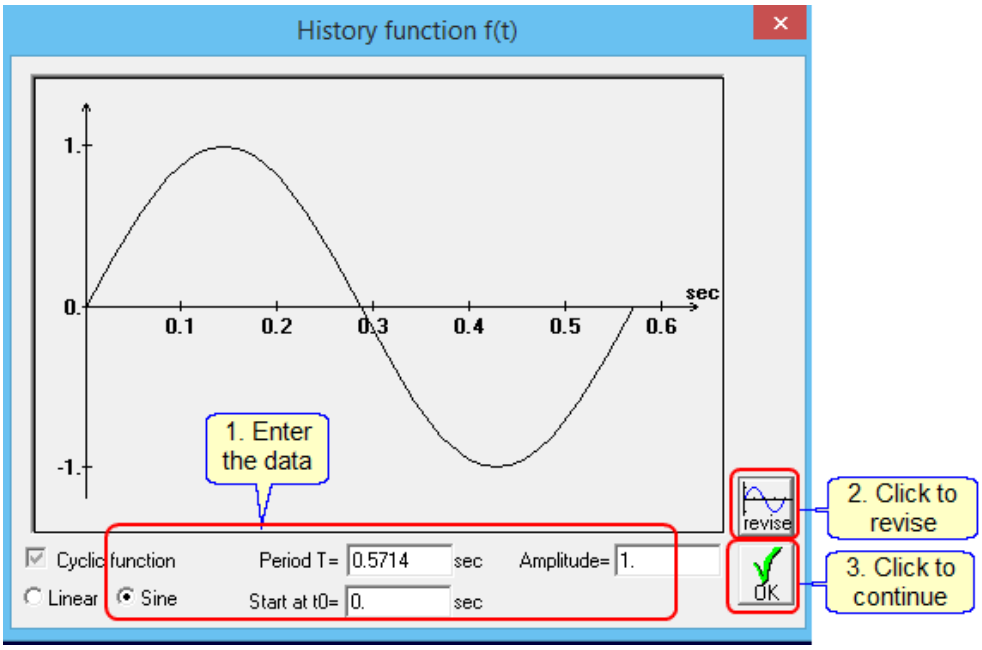
Node	Time	X1	X2	X6
2	30.00000	0.05639	0.00005	-0.0178
	30.20000	-0.04425	-0.00004	0.0140
	30.40000	0.02263	0.00002	-0.0071
	30.60000	0.00000	0.00000	0.0000
	30.80000	-0.01682	-0.00002	0.0053
		0.02443	0.00002	-0.0077
			-0.00002	0.0073
	33.60001			-0.0048
	33.80001	0.00109		
	34.00002	0.00069	0.00000	
	34.20002	-0.00181	0.00000	0.0006
	34.40002	0.00212	0.00000	-0.0007
	34.60002	-0.00173	0.00000	0.0005
	34.80002	0.00094	0.00000	-0.0003
	35.00000	-0.00008	0.00000	0.0000
Node max		0.05639	0.00005	-0.0178
2	Time	30.00000	30.00000	30.00000

4.2 Periodic forcing function

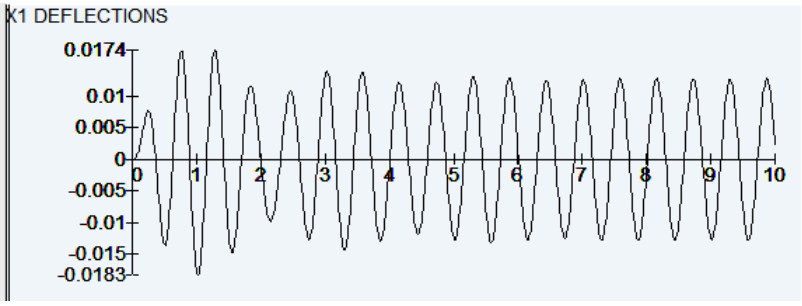
The following motor is located at node 5:

- Weight = 40 kN.
- Horizontal period force = 8.5 kN at a frequency = 1.75 Hz.
- Damping ratio = 4%.

- Select the Add weights option in the side menu and define an additional weight = 40 kN on node 5.
- Select Solve in the side menu to calculate the mode shapes.
- Click on Time his. in the menu bar.
- Click on New load in the side menu
- Type in the name of the load case, e.g. "Periodic force"
- Define a horizontal load of 8.5 kN at node 2.
- Click on History in the side menu
- Enter the following history function (1.75 Hz = 0.5714 sec)



- Click Main menu and display the results as described in the previous example.
  - X1 deflections (graphic):

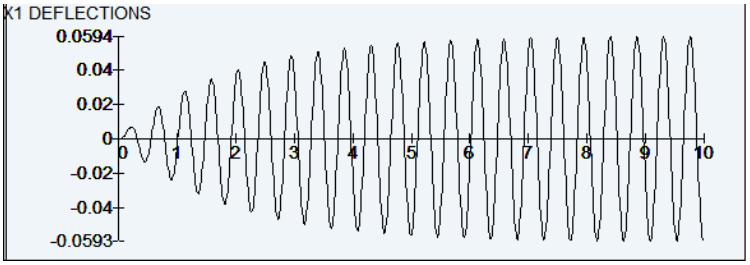


The deflections become stable after 7 sec.

- the natural frequency:

Mode No.	Eigenvalue (Omega**2)	Natural Frequency	Period	Damping Coeff.(%)	Max translation Node-DOF
1	191.485	2.2024	0.45406	4.00	5-1

- Click on Revise load in the side menu
- Click on History in the side menu and revise the "Period T" to 0.454 sec (the natural frequency).
  - The X1 deflections are:

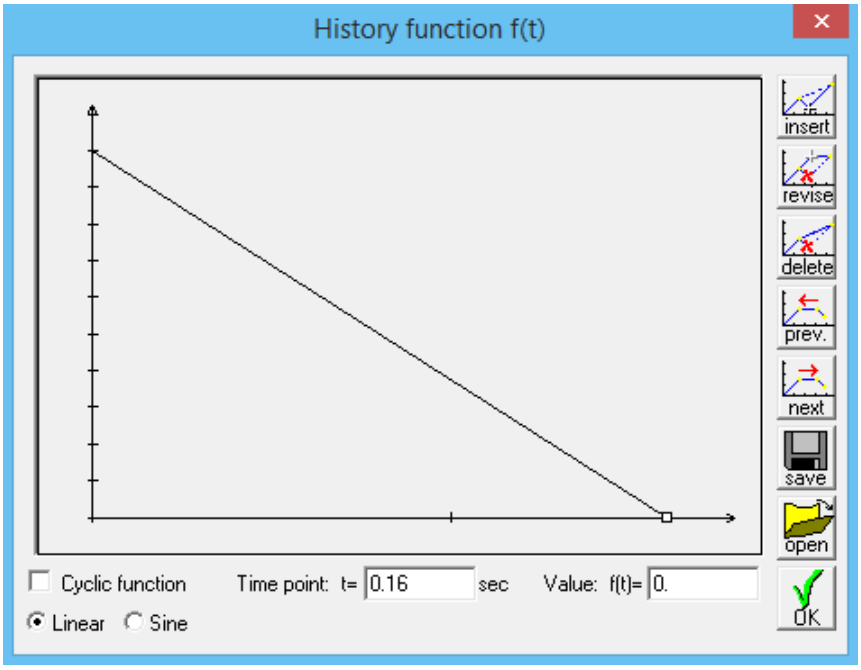


    - The steady-state deflection is 59.4 mm.
    - The horizontal deflection for a model with a horizontal static load = 8.5 kn is 4.83 mm.
    - The Dynamic Load Factor (DLF) = 59.4/4.83 = 12.3.

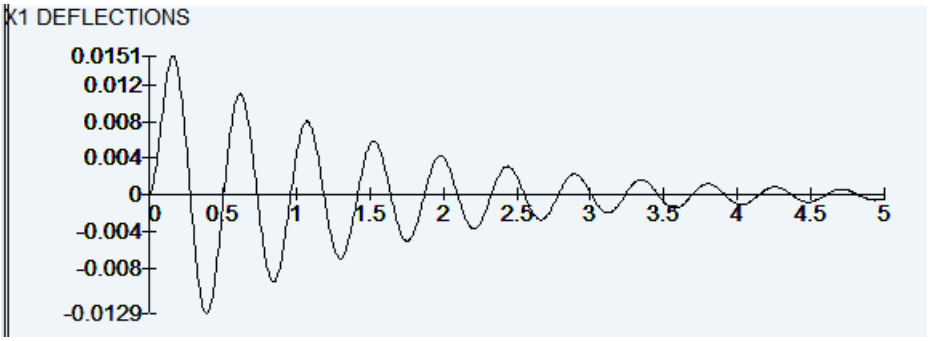
4.3 Blast load

Calculate the deflections for a blast load of 30 kN that is applied at t =0 and decreases linearly to 0 kN ant t = 0.16 sec.

- Click on New load in the side menu
- Type in the name of the load case, e.g. "Blast load"
- Define a horizontal load of 30 kN at node 2.
- Click on History in the side menu
- Enter the following history function (as described in the first example) by defining two points: t=0, f(t) =1.0 and t=0.16, f(t)=0.



- Click Main menu
- Click on Damping in the side menu and define 5% damping.
- Display the results as described in the previous examples.
  - X1 deflections (graphic):



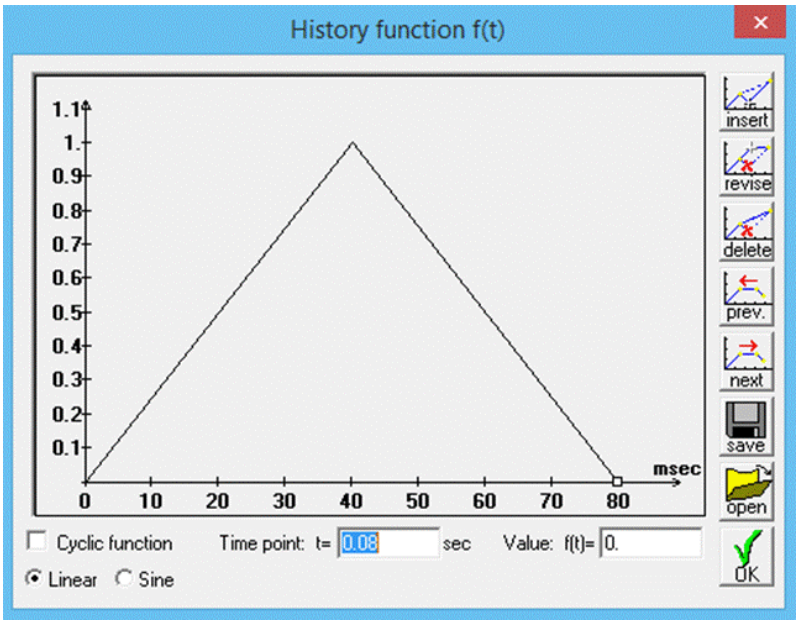
4.4 Ground motion

Calculate the deflections for a horizontal ground acceleration that increases linearly from 0 to 1.962 m/sec2 at 0.04 sec, then subsides linearly to 0 m/sec2 at 0.08 sec.

- Click on New load in the side menu
- Type in the name of the load case, e.g. "Ground motion"
- Click on Base accel. in the side menu and define a magnitude = 0.2g (= 0.2x9.981 = 1.962 m/sec2).

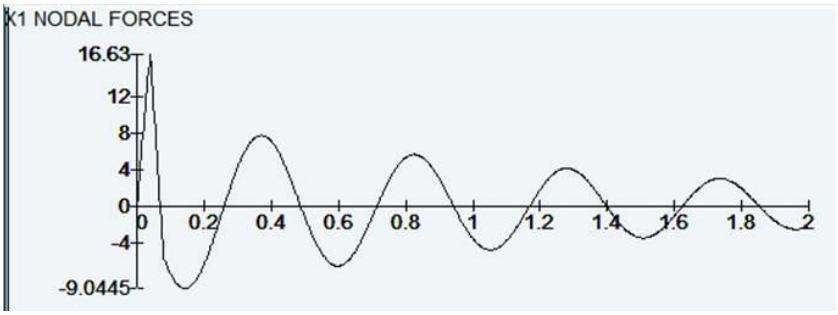
- Click on 

in the side menu
- Enter the following history function (as described in the first example):



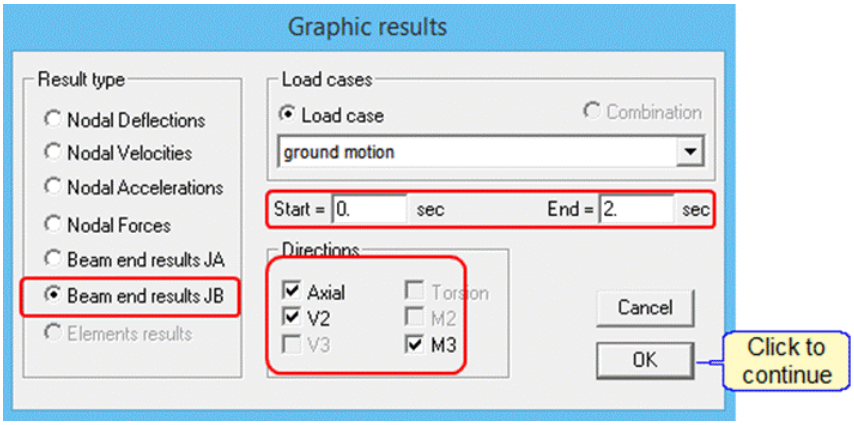
- Click 

and display the results as described in the previous examples.
  - X1 deflections (graphic):

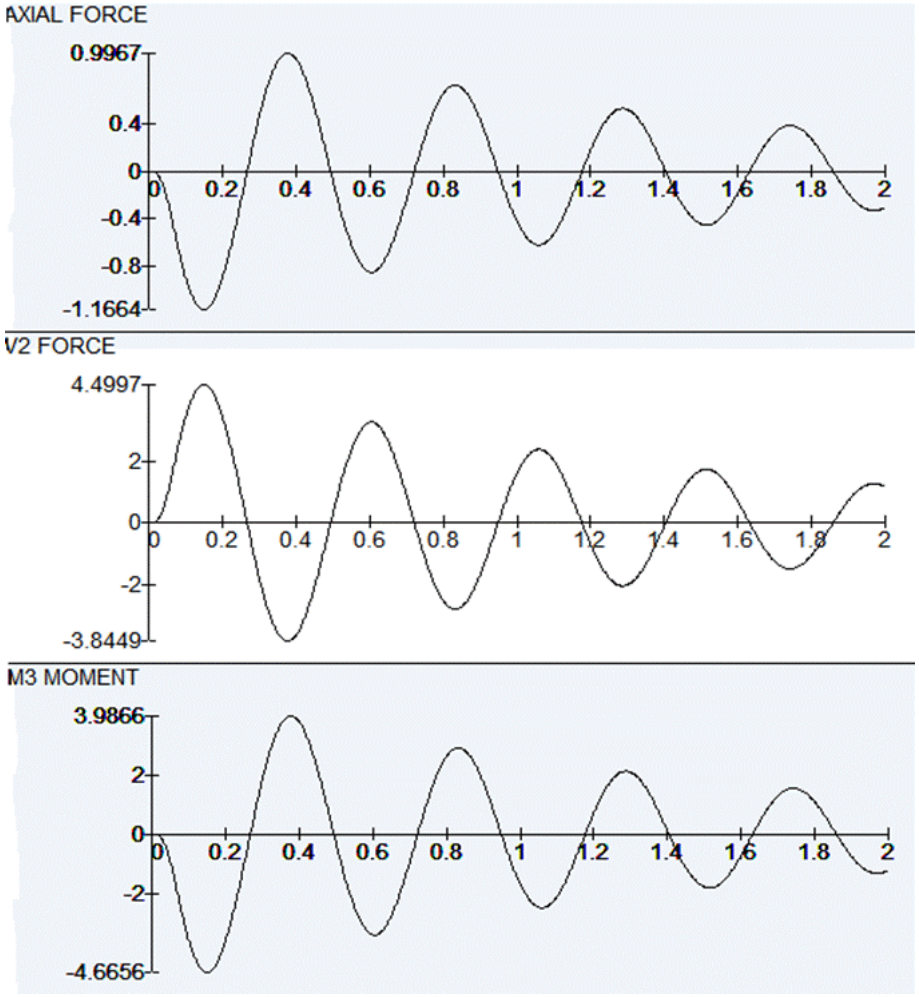


  - Display the forces and the moments at the top end of the left column as they vary in time:
    - Click on 

in the side menu and select the following options:



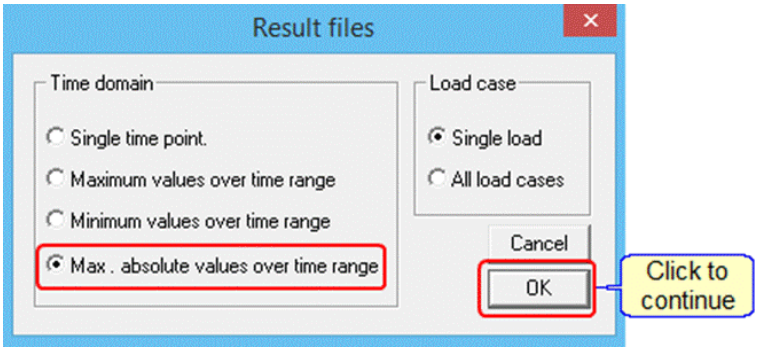
- The program displays the results:



These results can be transferred to **STRAP** and added as load case results:

- Click on 

in the main side menu
- Select the following options:



- Select the "Ground motion" load case.

Return to the **STRAP** results module and display the graphic results for this load case. For example, moments: