PRACTICE 5 Exercise 1

COMPUTATIONAL STRUCTURAL MECHANICS AND DYNAMICS

Marcos Boniquet Aparicio

RamSeries Professional is used for this exercise.

Analysis type: **Dynamic Analysis**

Material and constraints are settled.

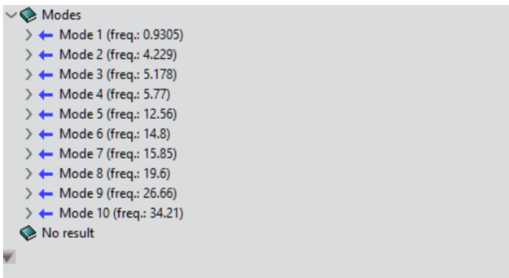
$E=3*10^{10}$ Pa
ν=0,2
γ=25KN/m^3

0,01 size elements mesh is created:

Num. of Linear elements=3.000
Num. of nodes=2.999

At Dynamic Analysis Data is chosen ***Modal Analysis*** and Only calculate ***Natural frequencies.*** These are the *Eigenvalues* of the governing equation $[\mathbf{K}\text{-}w^2\mathbf{M}]\mathbf{D}^{\mathbf{bar}}=0$. A vibration mode will be obtained when elastic force are balanced by inertia forces.

Natural frequencies are calculated:



Modes

Only shape of mode is meaningful, not its magnitude. Damping is not considered within this simulation. The modes are calculated without any forces applied, and are invariants to the structure, so they do not depend in forces applied, but in the constraints, the material, and the shape of the elements.

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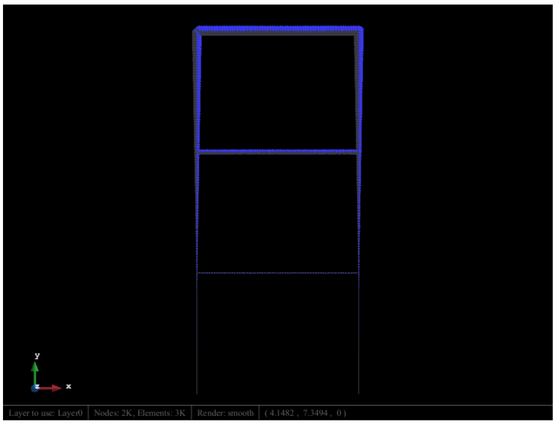
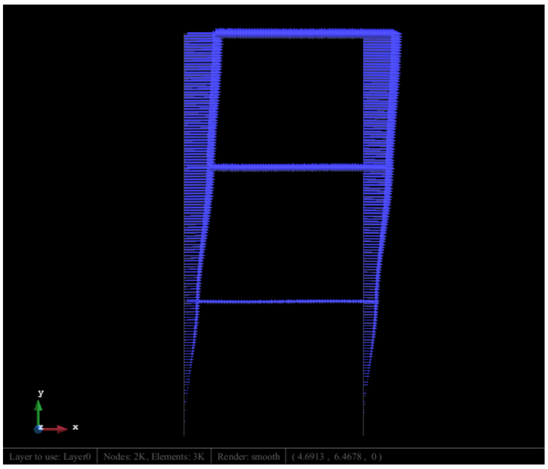
Mode 1 at f_1=0,9305 Hz:



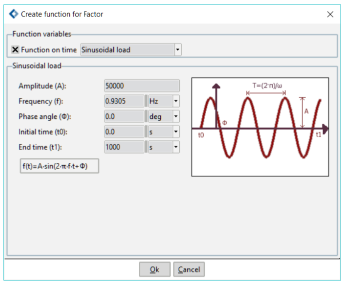
Mode 2 at f_2=4,229Hz:



Mode 3 at f_3=5,178Hz:

If **Direct Integration** is carried out:
For this particular case, a sinusoidal force is applied at the top-left corner of structure, with Amplitude=50000N

Thus this force will be: ***P_0=50.000*sin(w_p*t)*** *, where w_p=0,75w_1;1w_1;1,25w_1* and w_1=2*π*f_1, so it's testes at **w_p= 3/2*π*f_1; 2*π*f_1 ; 5/2*π*f_1,**



A force of 1N is settled on x-axis to fix direction and sense of vector force. Notice that option on setting Sinusoidal force Amplitude at 1N an 50000 at x-axis leds to same result.

It must be ensured that NOT only natural freq. are calculated.

Of course interval time and number steps is key, not only for computation time, but for having reliable results. Given that sinusoidal force last 1000 seconds and f_1=1Hz aproximately, values of Δt lower -or same magnitude order- than the natural frequency would not ensure that it's evaluated near the maximums. It could be near minimums for all steps as an example.

So interval time is taken at least one order magnitude smaller than f_1. Also a certain amount of time is needed in order to ensure a permanent regime has been achieved. This is Δt *steps and it's been considered of 10s . Tests for higher total time do not vary the result, so there's confidence on being it enough. For less time it's the result differ too much.

total_time (s)	**10**
steps	**100**
Δt (s)	**0,1**
max x_{displ} w_p=w_1	0,026623
max x_{displ} w_p=0,75w_1	0,024828
max x_{displ} wp=1,25w_1	0,021989

It's clear that at mode 1 amplitude becomes **maximum**, and around this frequency it only can decrease the displacement.

This does not imply that at higher modes the max. displacement must be higher, or lower, it will depend on structure and will increase or decrease without a clear pattern in such values of frequency.

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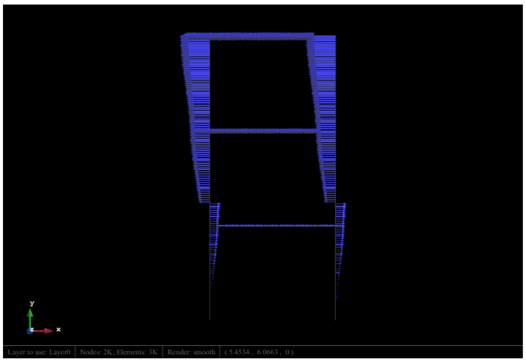
RESULTS ON MAX. DISPLACEMENTS:

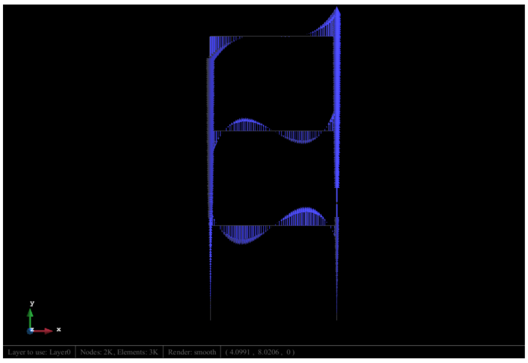
Following are shown the maximum displacements (in all steps) for each point at a given frequency. So these charts don't show the modes, but the maximum displacements overall.

$w_p=w_1$

X-AXIS

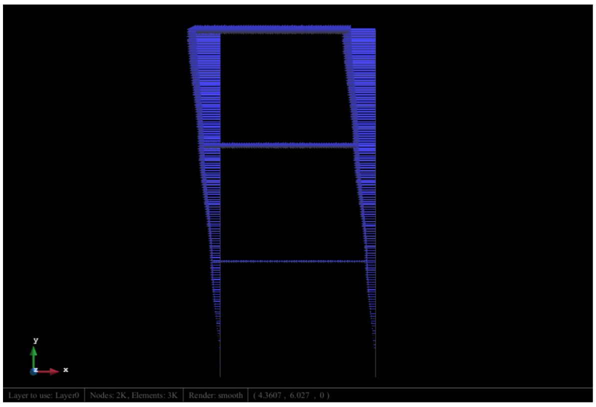


Y AXIS

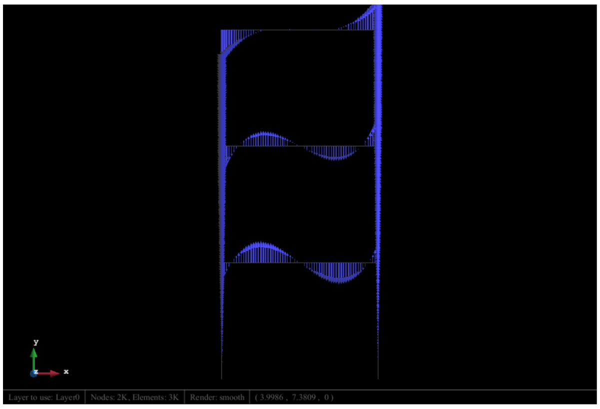


$w_p=0{,}75*w_1$

X-AXIS

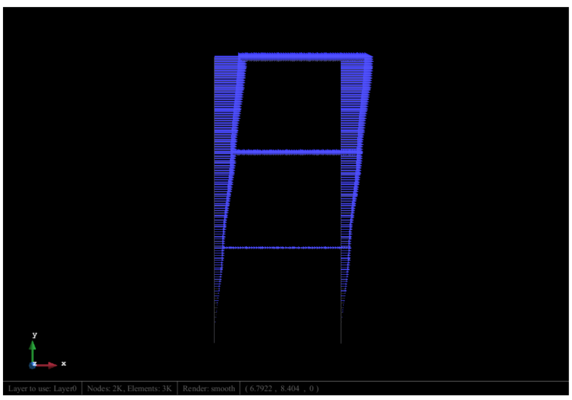


y-AXIS



$w_p=1{,}25*w_1$

X-AXIS



Y-AXIS