PRACTICE 5 Exercise 2

**COMPUTATIONAL STRUCTURAL MECHANICS AND DYNAMICS**

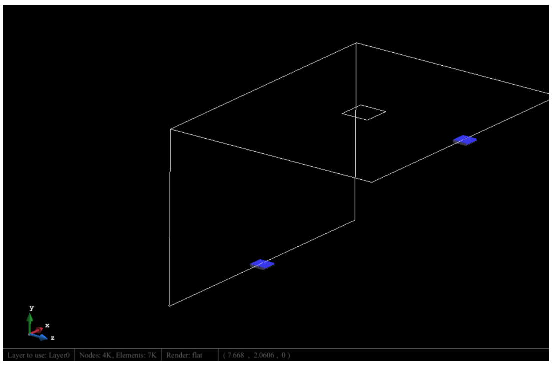
Marcos Boniquet Aparicio

It's chosen a problem type: 3D SHELL dynamic analisis RamSeries.

Material  and constraints are settled.

*$E=3*10^{10}$ Pa*
*$\nu=0,3$*
*$\gamma=25KN/m^3$*
*$q=1*10^4$ $N/m^2$*

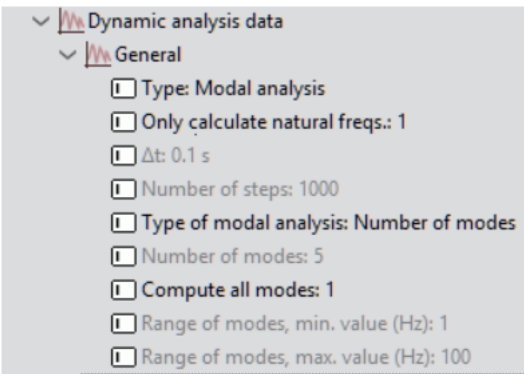
*Following lines are constrained with zero displacement and zero spin.*

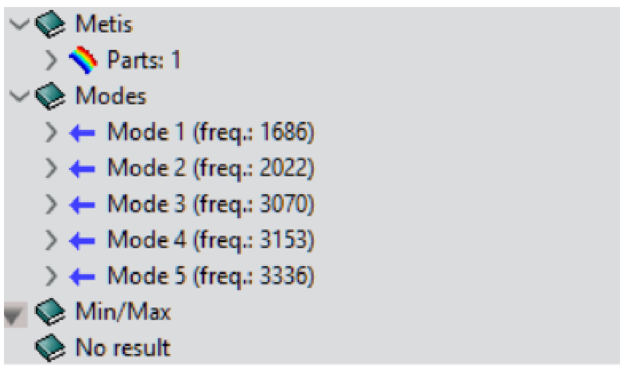


Triangular DKT mesh

*Num. of Triangle elements=7.870*
*Num. of nodes=4.056*

A modal Analysis is carried out:



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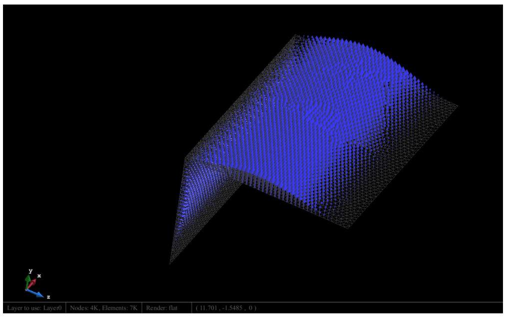
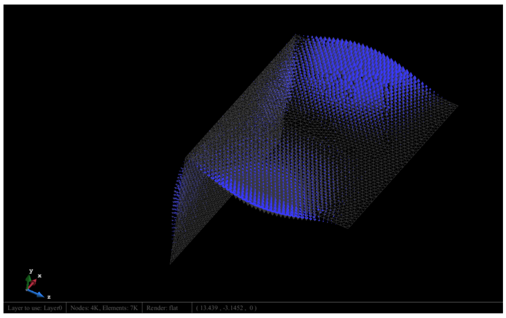
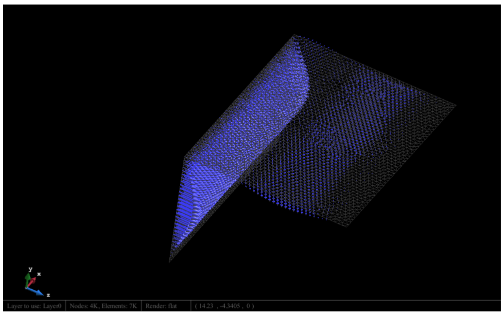
*Mode1*



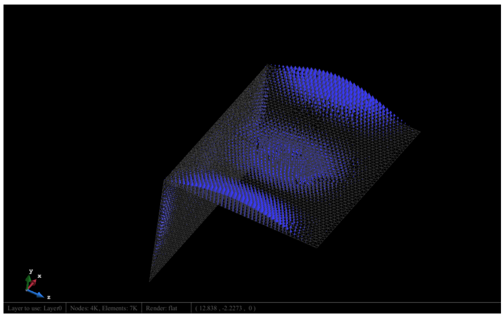
*Mode 2*



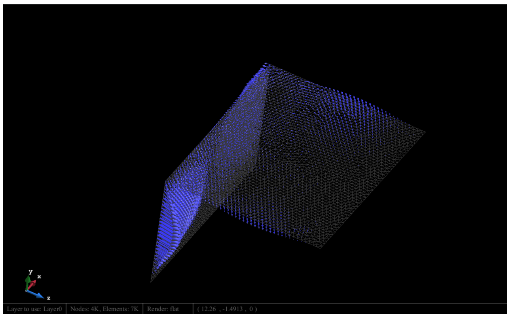
*Mode 3*



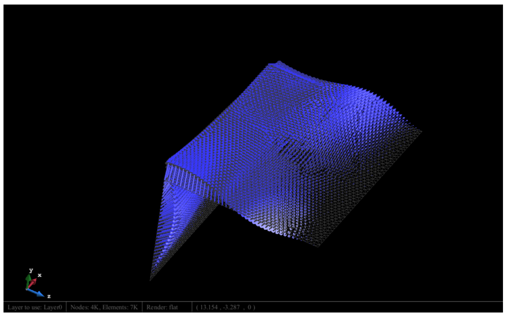
*Mode 4*



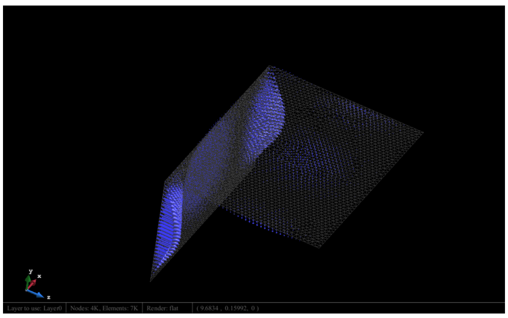
*Mode 5*



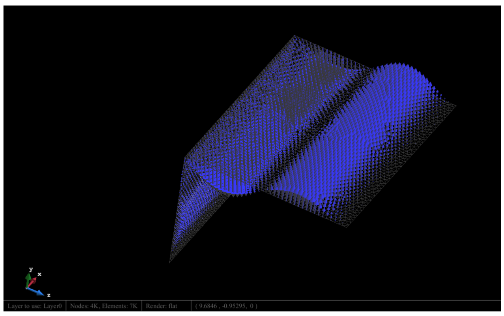
*Mode 6*



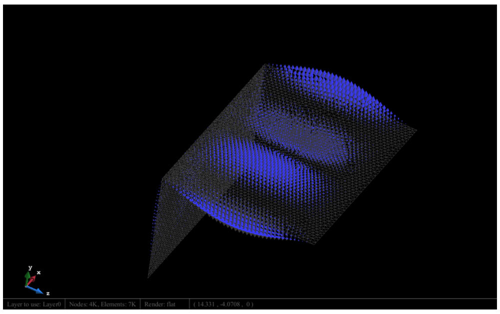
*Mode 7*



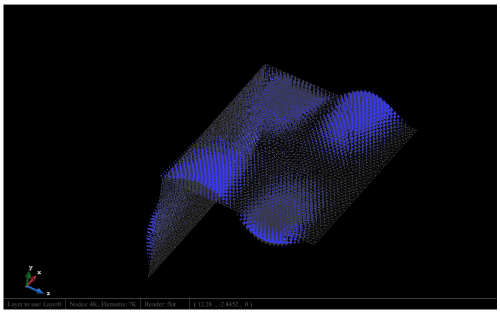
*Mode 8*



*Mode 9*



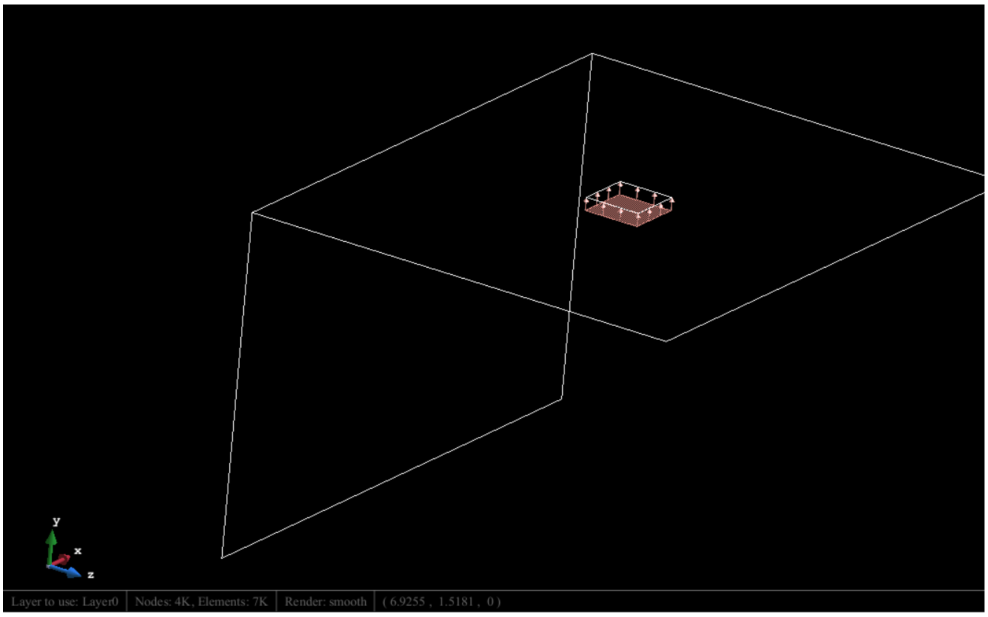
*Mode 10*



**Direct integration with sinusoidal force applied**

The $\Delta$t chosen is 0,0001 (f1 is over 1000 HZ). The steps are 100, in order to ensure a permanent regime and evaluate maximum displacement with a certain confidence.
Wen steps are doubled, max y displacements are almost exactly the same, whereas for x and z axis may vary roughly 10%.

The Sinusoidal load is settled.



**COMPUTATIONAL STRUCTURAL MECHANICS AND DYNAMICS**

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**MAXIMUM Displacements $\Delta$t=0,0001, 100 steps:**

For mode 1,**$w_p$=$w_1$** being **$f_{1=}$1686Hz**
max. x-displacement =2,7919*$10^{-7}$
max. y-displacement =1,2598*$10^{-6}$
max. z-displacement =5,2349*$10^{-7}$

In order to evaluate if steps are enough it's repeated process with an order of magnitude more steps:

**MAXIMUM Displacements $\Delta$t=0,0001, 1000 steps:**

For mode 1,**$w_p$=$w_1$** being **$f_{1=}$1686Hz**
max. x-displacement =3,39*$10^{-7}$ (+21% respect to $\Delta$t=0,0001 ,100 steps)
max. y-displacement =1,48*$10^{-6}$(+18% respect to $\Delta$t=0,0001, 100 steps)
max. z-displacement =7,28*$10^{-7}$ (+39% respect to $\Delta$t=0,0001, 100 steps)

So 100 steps weren't sufficient. Next step is to repeat process with **lower $\Delta$t:**

**MAXIMUM Displacements $\Delta$t=0,00005, 1000 steps:**

For mode 1,**$w_p$=$w_1$** being **$f_{1=}$1686Hz**
max. x-displacement =7,75*$10^{-7}$(+128% respect to $\Delta$t=0,0001 ,1000 steps)
max. y-displacement =2.64*$10^{-6}$(+78% respect to $\Delta$t=0,0001 ,1000 steps)
max. z-displacement =8.6*$10^{-7}$(+18% respect to $\Delta$t=0,0001 ,1000 steps)

So we try for shorter periods of time:

**MAXIMUM Displacements $\Delta$t=0,00001, 1000 steps:**

For mode 1,**$w_p$=$w_1$** being **$f_{1=}$1686Hz**
max. x-displacement =5,48*$10^{-7}$(-25% respect to $\Delta$t=0,00005 ,1000 steps)
max. y-displacement =2,10*$10^{-6}$(-20% respect to $\Delta$t=0,00005 ,1000 steps)
max. z-displacement =7,75*$10^{-7}$(-7% respect to $\Delta$t=0,00005 ,1000 steps)

We will accept this as a reliable Dynamic Analisis Data, and compare to the cases beneath and over this natural frequency for mode1, with the objective of comparing the maximum displacements for each of them:
**$w_p$=0,75*$w_1$**:
max. x-displacement =6,30*$10^{-7}$ (+15% respect to **$w_1$**)
max. y-displacement =2.62*$10^{-6}$ (+24% respect to **$w_1$**)
max. z-displacement =9,2*$10^{-7}$ (+18,7% respect to **$w_1$**)
**$w_p$=1,25*$w_1$**:
max. x-displacement =2,97*$10^{-7}$ (-45% respect to **$w_1$**)
max. y-displacement =1,67*$10^{-6}$(-20% respect to **$w_1$**)
max. z-displacement =5,53*$10^{-7}$(-28% respect to **$w_1$**)

Although max. displacement is detected at $0{,}75w_1$, at 1,25 times $w_1$ it is registered a lower displacement for any axis.

Furthermore, if frequencies are diminished for this exercise, we obtain higher displacements in all axis. So there is not such a clear amplitude-frequency relation, just a shape of the displacement field, which matches a characteristic pattern for each of the modes.