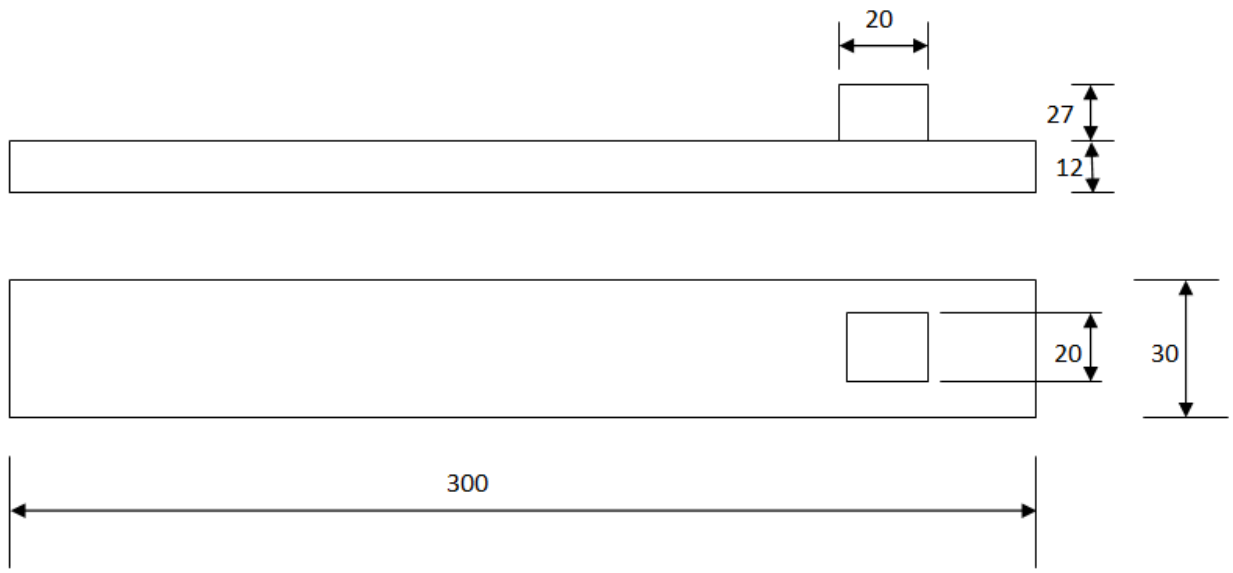
Analysis using Craig-Bampton reduced model

1. Free vibration analysis



PROCEDURE

1. **Create Keypoints**

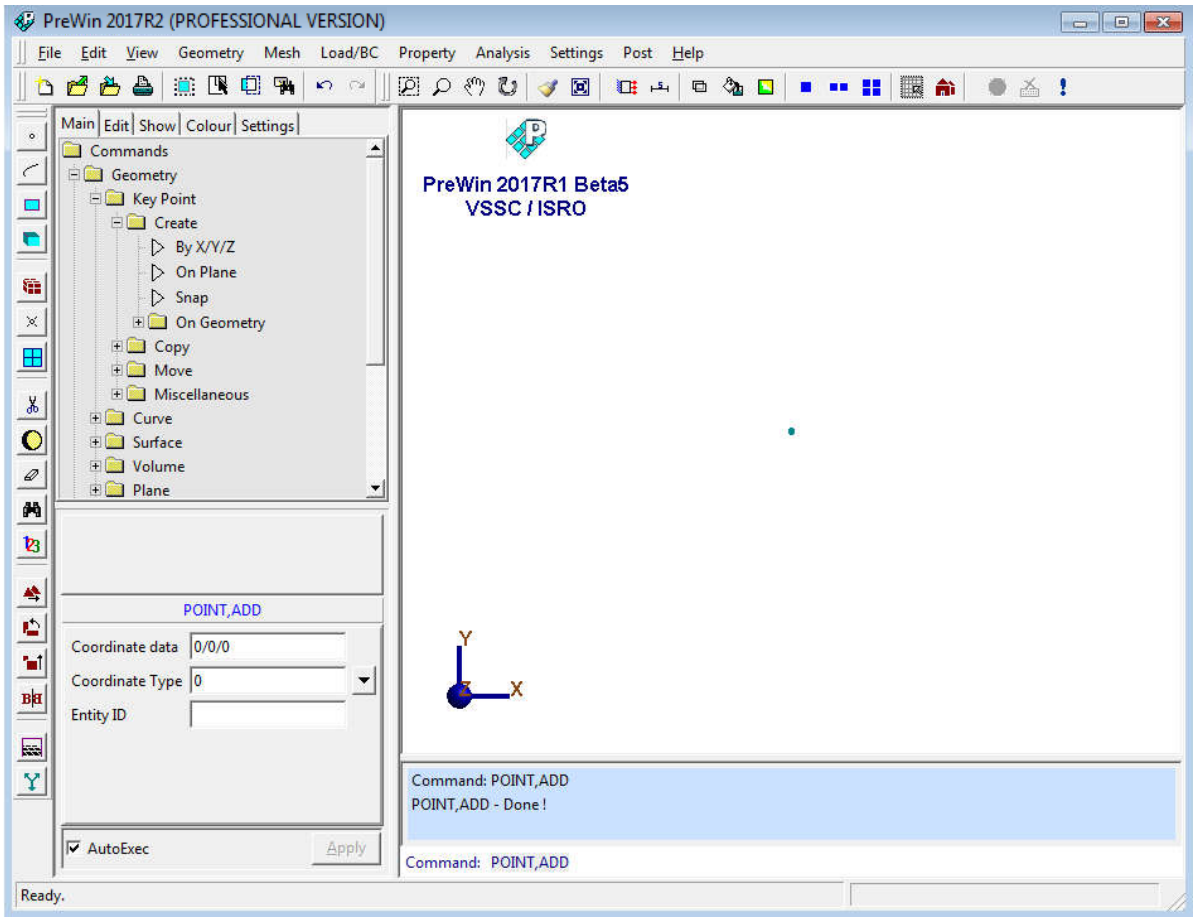
   Command : POINT,ADD

   Menu : Geometry → Keypoint → Create → By X/Y/Z

   Parameters :

Coordinate data	0/0/0
Coordinate type	0
Entity ID	

At the end of the operation your screen should look like this.



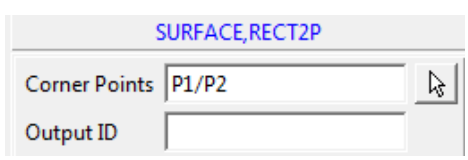
Similarly create a point at (300/30/0)

2. **Create Surface**

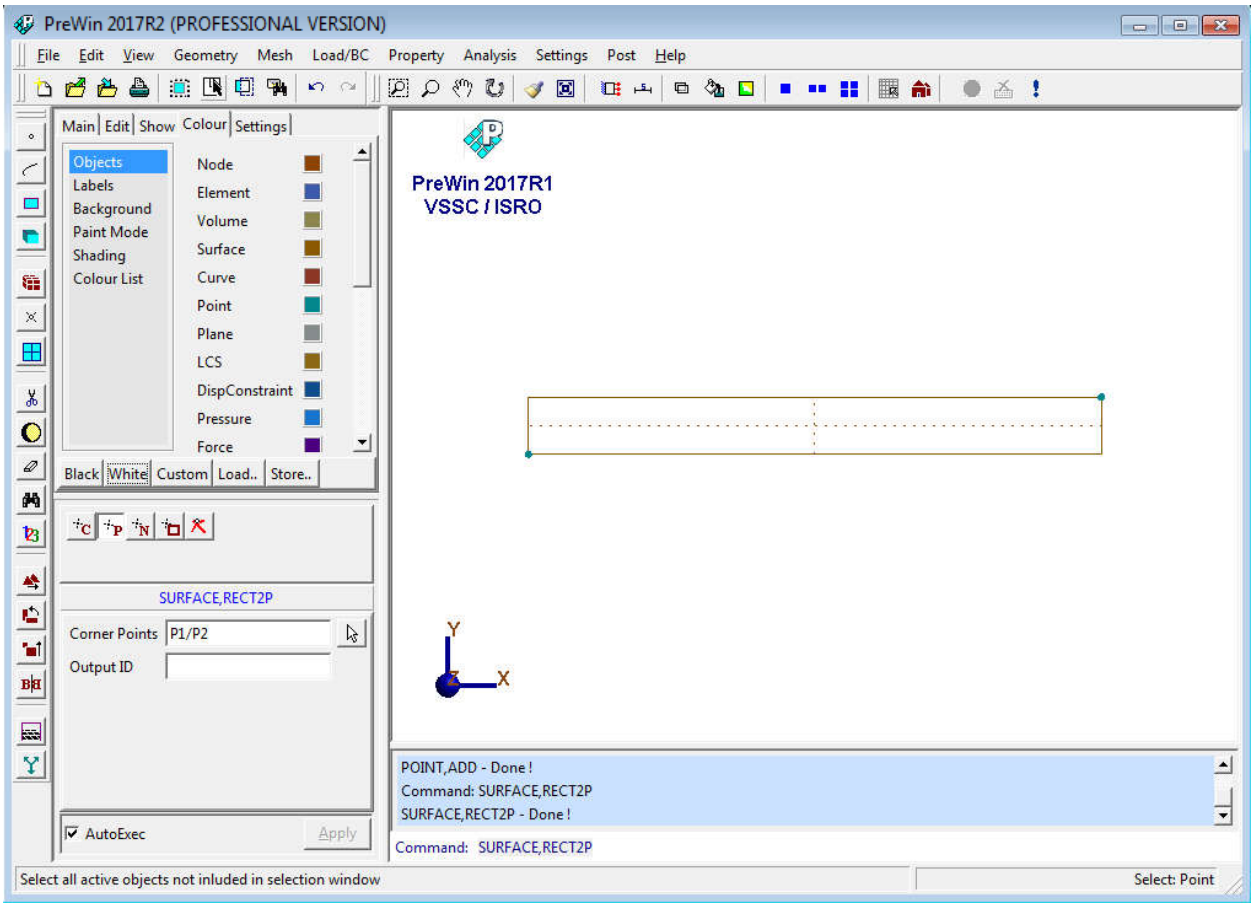
Command : SURFACE,RECT2

Menu : Geometry → Surface → Create → Rect2P

Parameters :



At the end of the operation your screen should look like this.

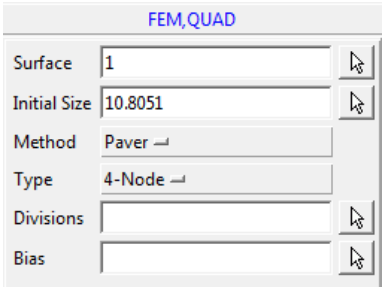


3. **Generate mesh**

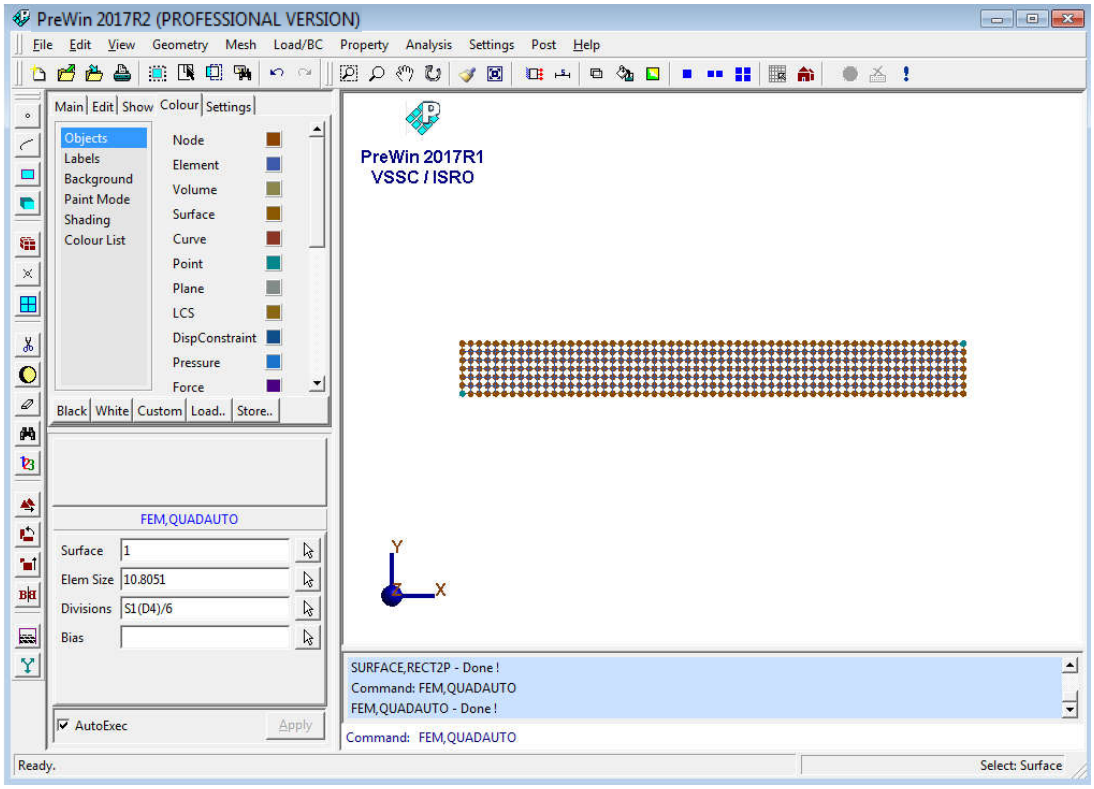
Command : FEM,QUAD

Menu : Mesh → FE Mesh → QUAD

Parameters :



At the end of the above operation your screen should like this

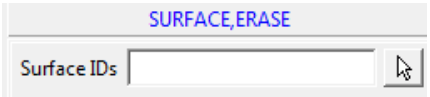


4. Erase Surface

Command : SURFACE,ERASE

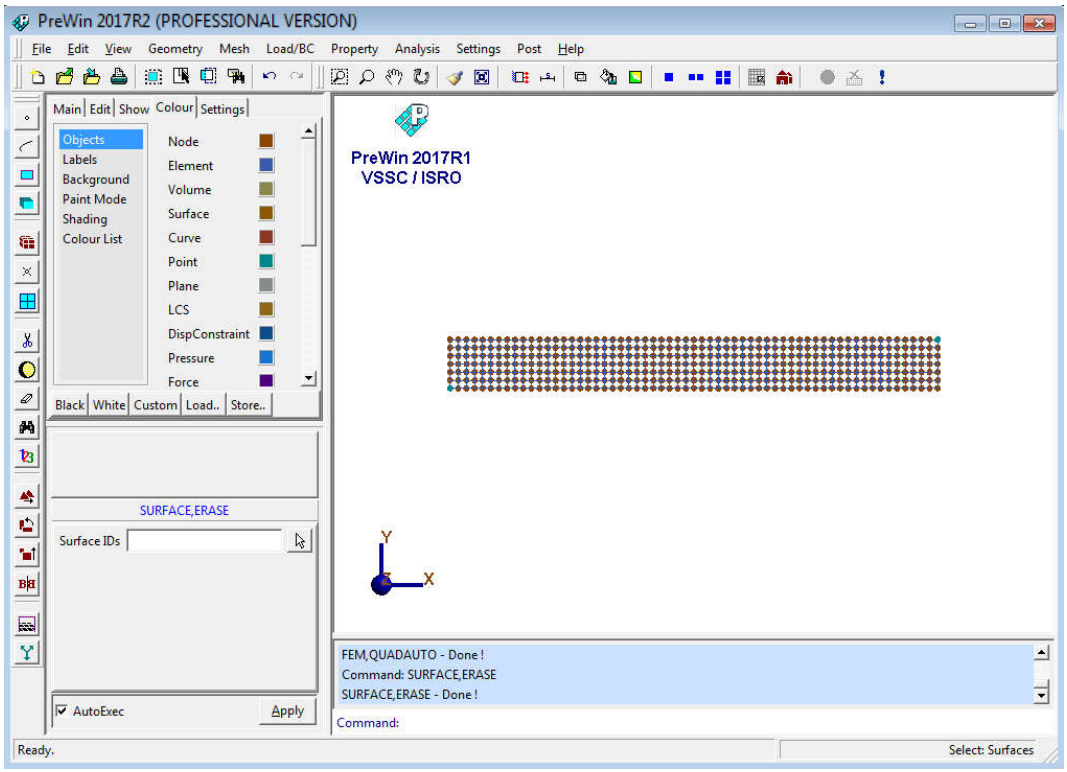
Menu : Geometry → Surface → Miscellaneous → Erase

Parameters :



Enter the surfase ID in the box or pick the curve using mouse pointer.

At the end of the above operation your screen should like this

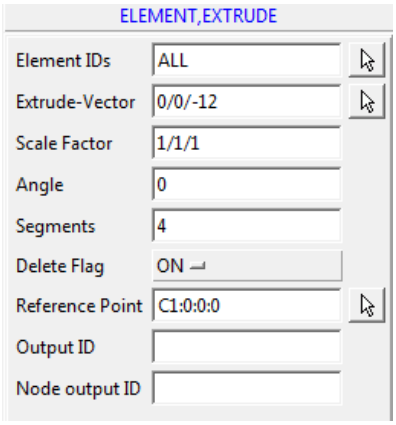


5. Create Brick Element

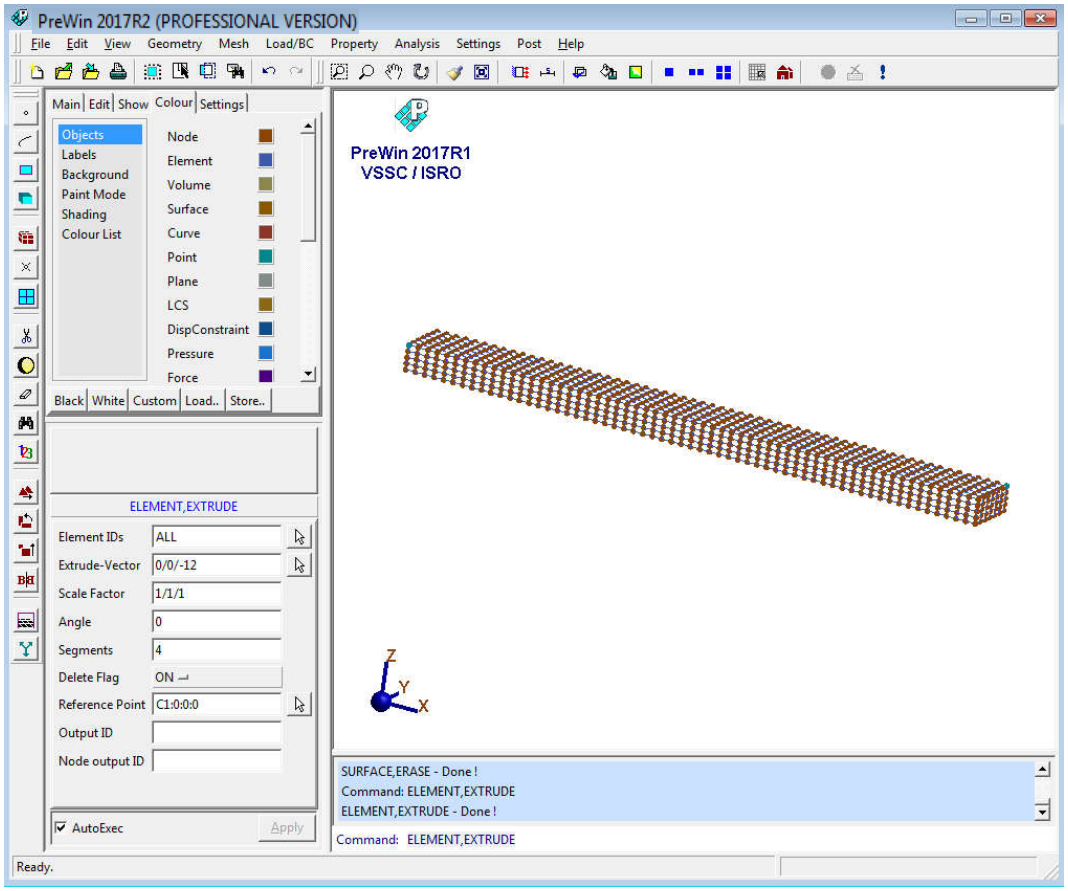
Command : ELEMENT,EXTRUDE

Menu : Mesh → Element → Create → Extrude

Parameters :



At the end of the above operation your screen should like this

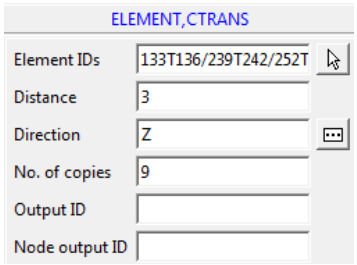


Create the projected mass portion by following method

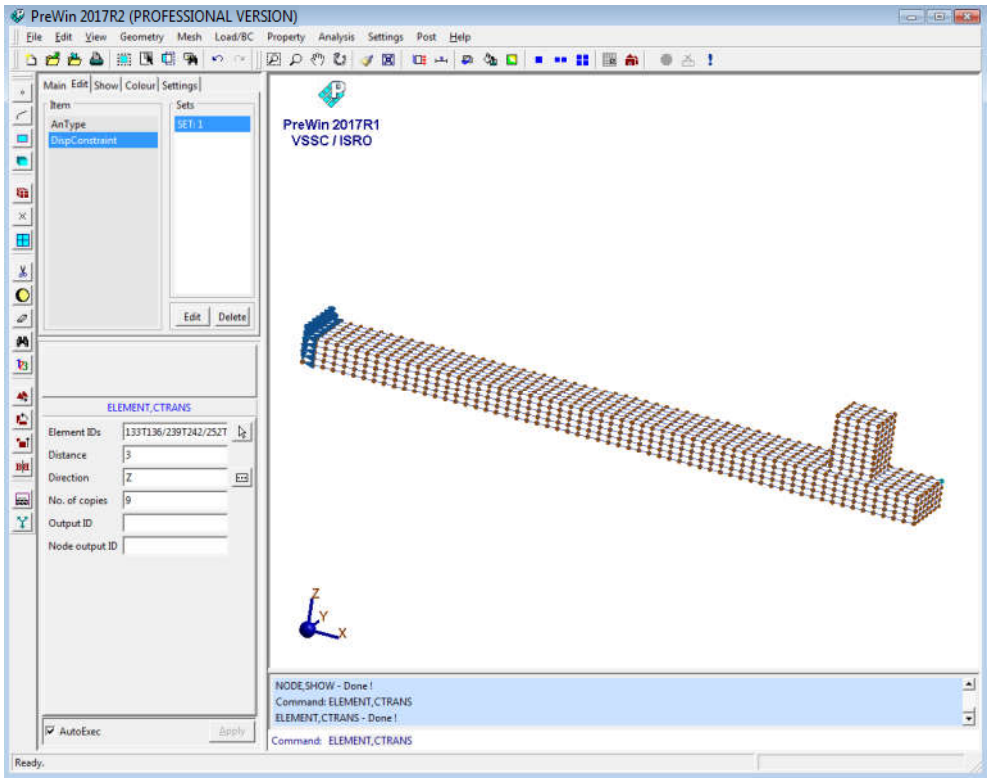
Command : ELEMENT,CTRAN

Menu : Mesh→ Element→ Copy→ Translate

Parameters :



At the end of the above operation your screen will look like this.

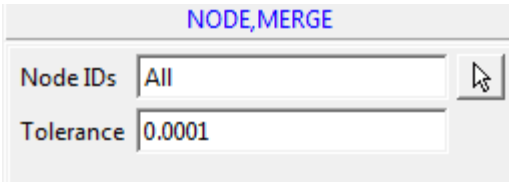


6. **Merge Nodes**

   Command : NODE,MERGE

   Menu : Mesh→ Node→ Modify→ Merge

   Parameters :

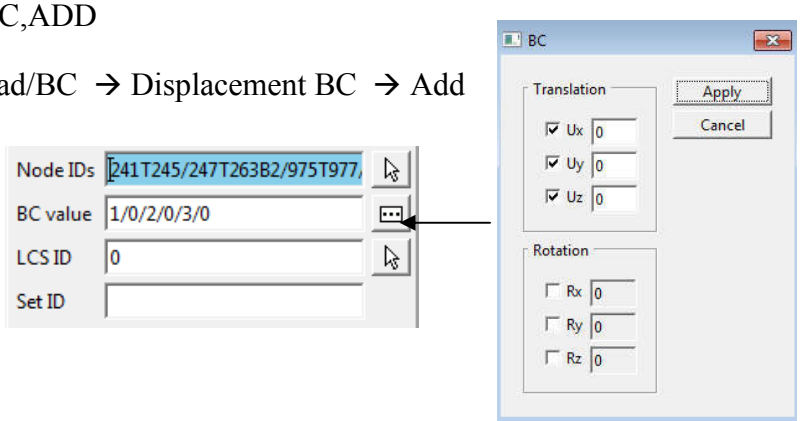


7. Apply Boundary Condition

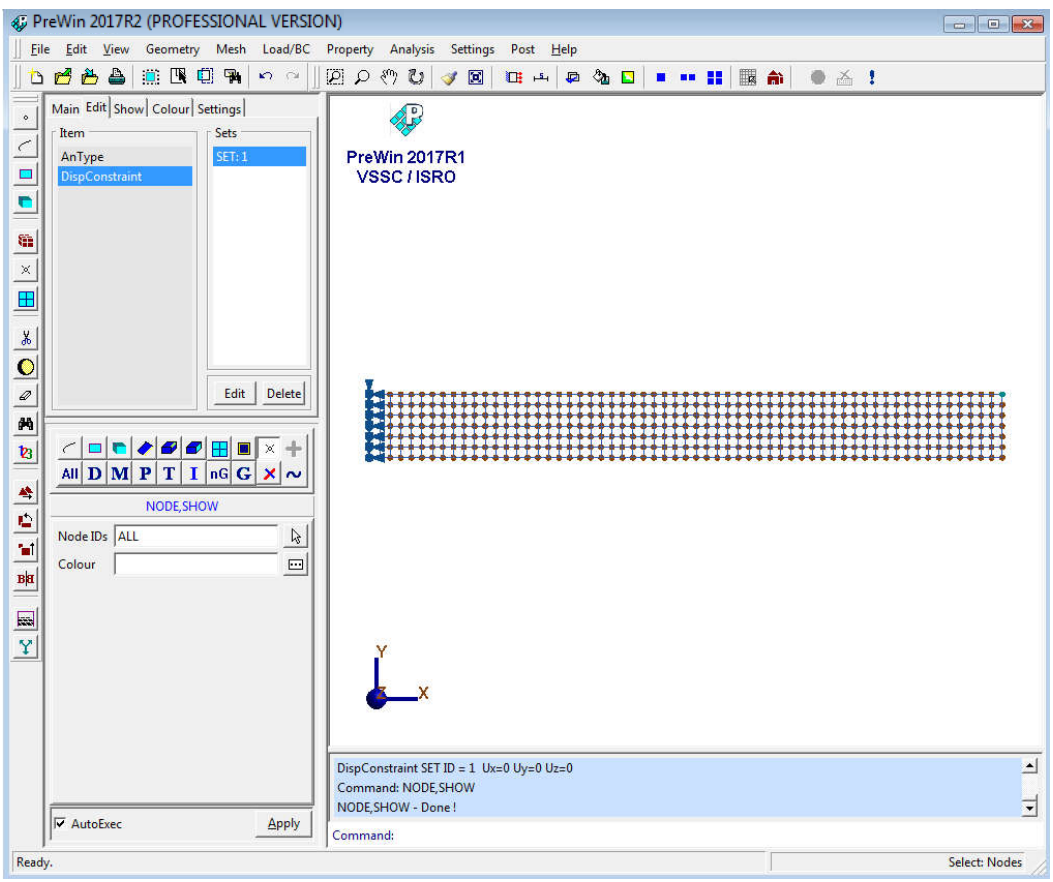
Command : BC,ADD

Menu : Load/BC → Displacement BC → Add

Parameters :



At the end of the above operation your screen will look like this.

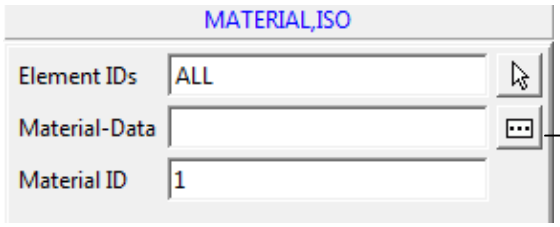


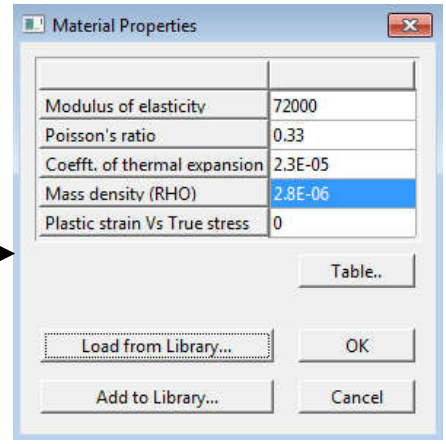
8. Apply Material Property

Command : MATERIAL,ISO

Menu : Property → Material → Isotropic → Add

Parameters :





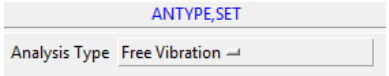
You can enter the material data from 'Load from Library' option or you can manually type in the required data.

9. Set Analysis Type

Command : ANTYPE,SET

Menu : Analysis → Analysis Type

Parameters :



10. Set analysis Option

Command : ANOPTION,SET

Menu : Analysis → Analysis Option

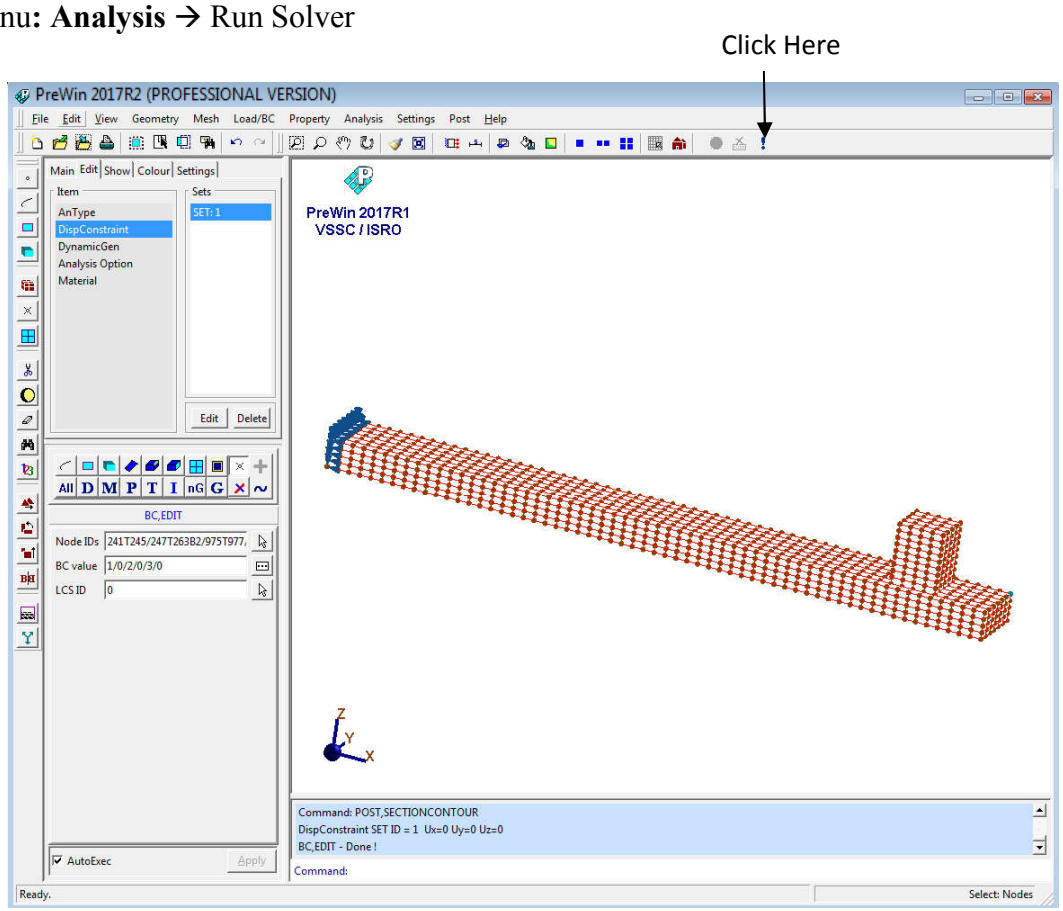
Parameters :

11. Save the project model

Menu : File → Save
Save the file to desired directory

12. Submit the job in to FEAST

Menu**: Analysis** → Run Solver



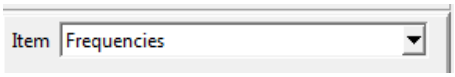
13. Post Processing

i. View Results

Command : POST,VIEWRESULTS

Menu : Post → View Results

Parameters :



The following table will be displayed

Frequencies

Mode	Frequency(Hz)
1	3.06229
2	7.58525
3	20.5739
4	38.0013
5	51.1168
6	57.1893
7	106.962
8	126.317
9	134.689
10	138.301
11	179.802
12	242.9
13	255.347
14	266.287
15	364.495

Copy Close

Creating Craig –Bampton for the above model

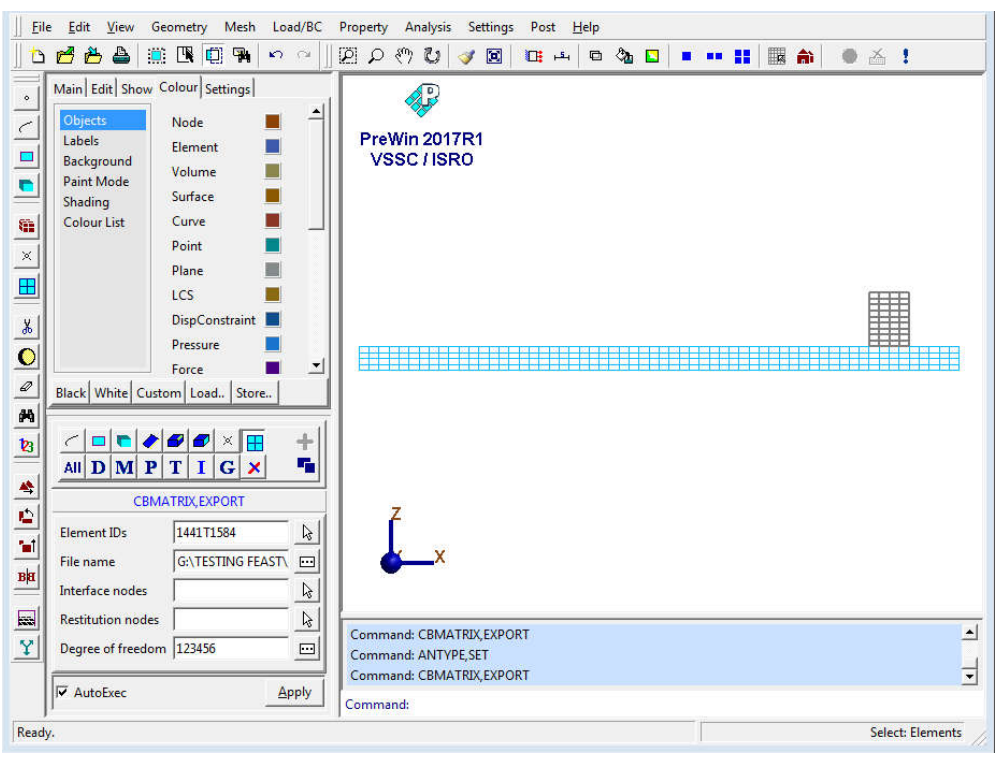
First create a copy of the above geometry by saving it with another name.Then export the Craig-Bampton elements such that the impacts of those elements are taken into consideration while analysis but the Craig-Bampton elements are not displayed.

10. CBMATRIX EXPORT

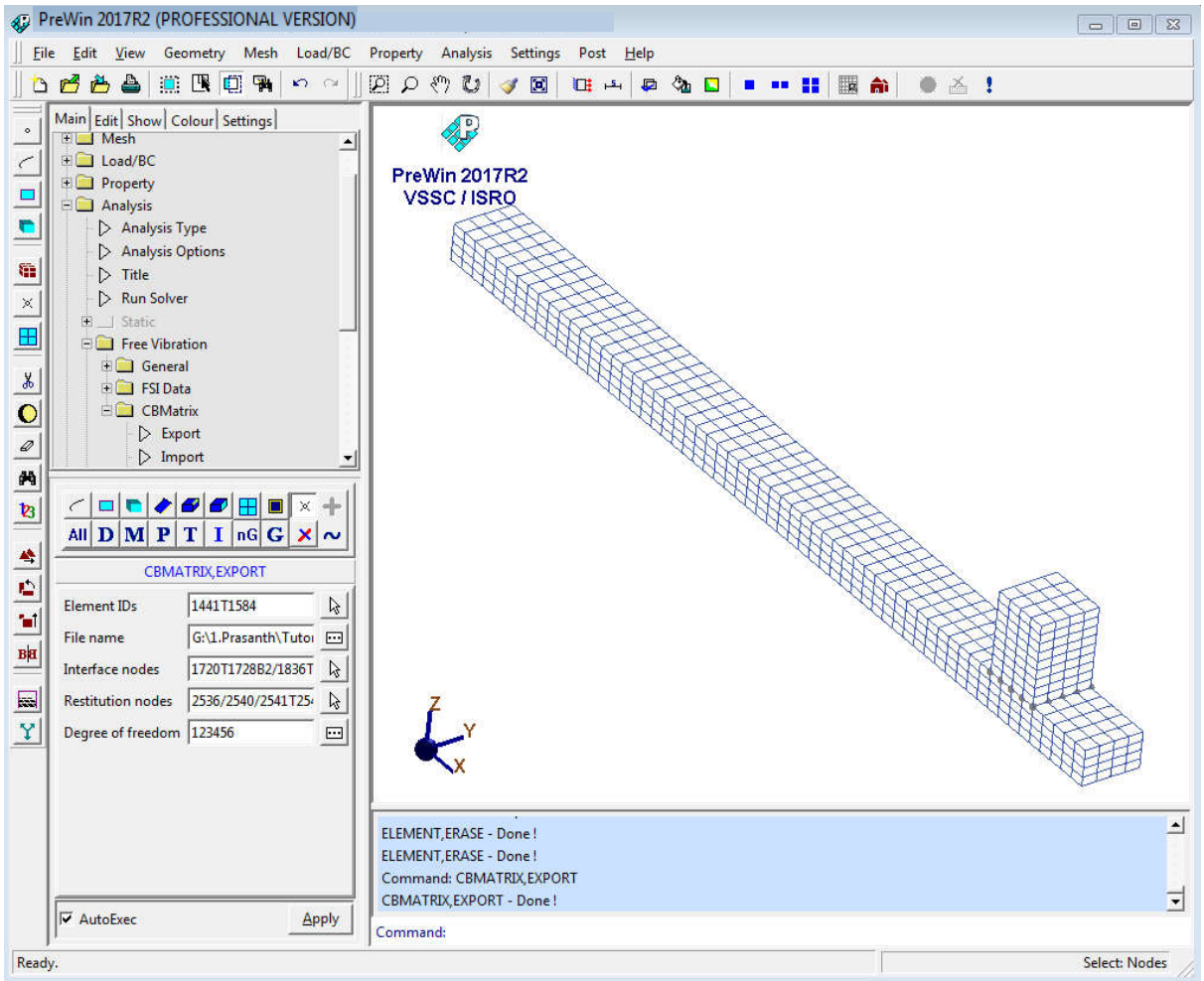
Command : CBMATRIX EXPORT

Menu : Analysis → Free Vibration→CB Matrix →Export

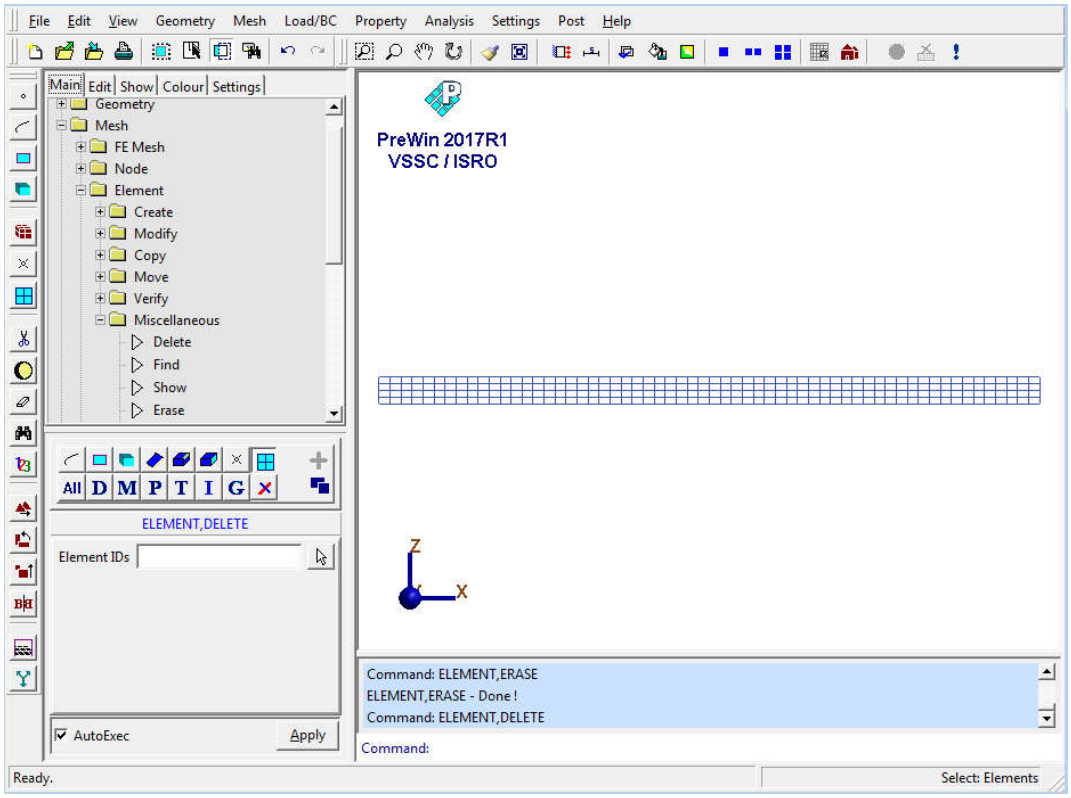
Element IDs	Specify the elements to be created as CB
File Name	Specify the location to save the CB .pch file
Interface Nodes	Select the nodes that interface both the surface
Restitution Nodes	Optional
Degree of Freedom	123456



Interface nodes are selected as shown in figure below



Restitution nodes are those nodes on the Craig-Bampton reduced portion at which responses are required to be calculated while solving response analysis problems. In case of free vibration analysis restitution nodes need not be specified. But here we are doing response analysis also. Hence, specify the nodes at which responses are to be extracted. In this case select some nodes from top of the Craig-Bampton reduced portion. Now save the same file as different name. Then delete the element that has been converted to CB Matrix in this file. At the end of this operation your screen should look like this.



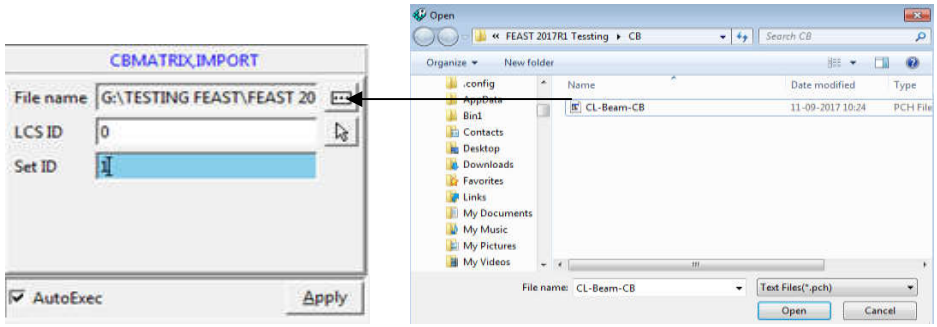
Now to verify the Craig-Bampton properties import the CB Matrix written as .pch file follow the procedure below.

1. CB IMPORT

Command : CBMATRIX IMPORT

Menu : Analysis → Free Vibration→CB Matrix →Import

File Name	Select the .pch file created as CB
LCS Id	0
SET Id	1



2. Save the Project File

Menu : File → Save

3. Submit the file to FEAST

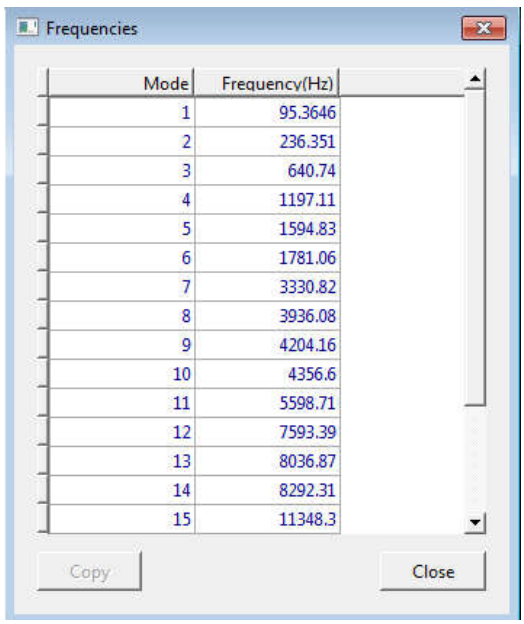
Menu : Analysis → Run Solver

4. Perform post processing

a) Mode Shape

Command : POST, VIEWRESULTS

Menu : Post → View results→Frequencies



Mode	Frequency(Hz)
1	95.3646
2	236.351
3	640.74
4	1197.11
5	1594.83
6	1781.06
7	3330.82
8	3936.08
9	4204.16
10	4356.6
11	5598.71
12	7593.39
13	8036.87
14	8292.31
15	11348.3

The above figure shows the frequencies of the model with CB. So from both the analysis i,e from free vibration of the complete model and free vibration of the model with CB the frequencies are matching.

2. Frequency response analysis

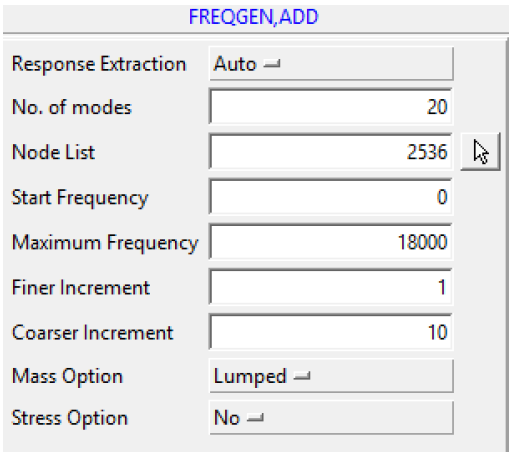
After doing free vibration analysis save a copy of the file for frequency response analysis. In the new file change analysis type to Frequency Response.

1. Specify frequency response general properties.

Commands : FREQGEN,ADD

Menu : Analysis → Frequency Response → General → Add

Parameter :

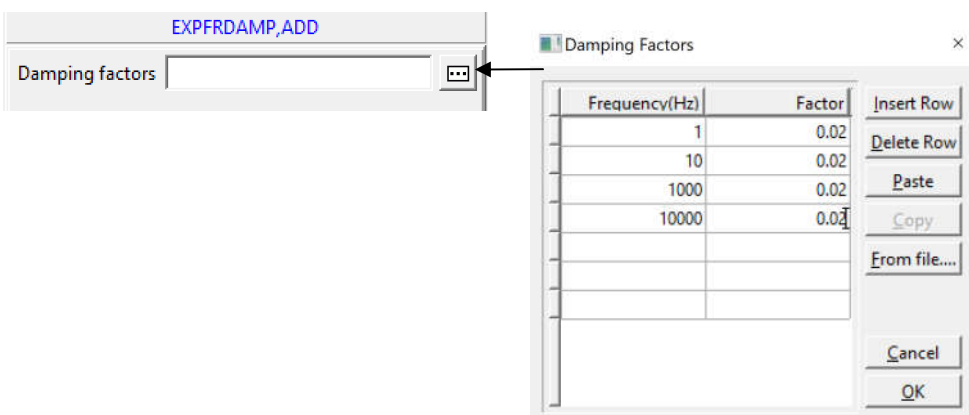


2. Specify damping factor

Commands : EXPFRDAMP,ADD

Menu : Analysis → Frequency Response → Damping → Add

Parameter :

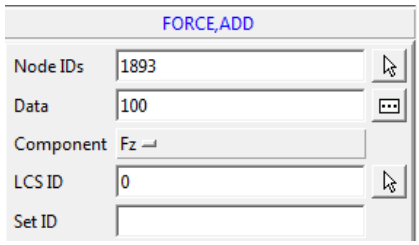


3. Specify the load

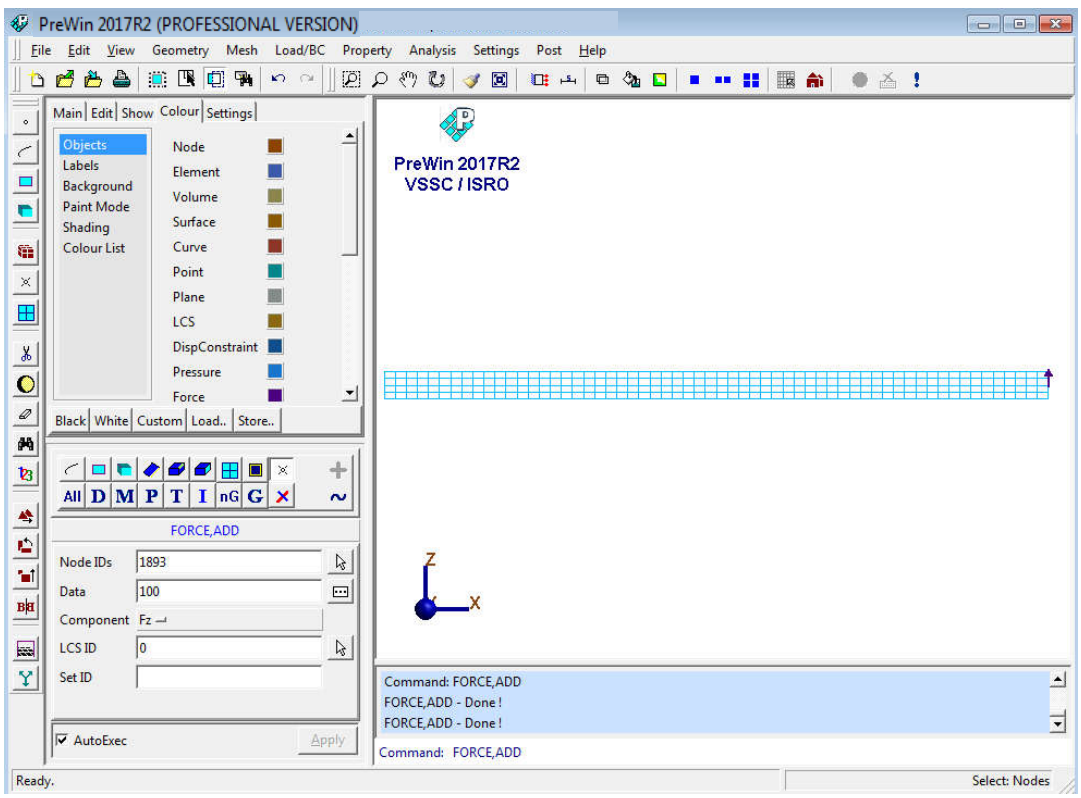
Commands : FORCE,ADD

Menu : Load/BC → Point Load → Add

Parameter :



At the end of above operation your screen should look like this.



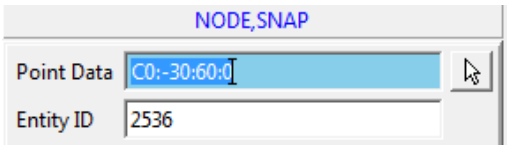
4. Creating dummy nodes

Nodes having same ID as that of restitution nodes should also be present in the Craig-Bampton reduced model in order to extract responses. But its co-ordinates need not be the same as that of the actual nodes. Hence create nodes with same ID as that of the restitution nodes in the reduced model.

Commands : NODE,SNAP

Menu : Mesh → Node → Create → Snap

Parameter :



Create as many IDs as you included in restitution nodes.

5. Save the project model

Menu : File → Save

Save the file to desired directory

6. Run solver

Menu : Analysis → Run Solver

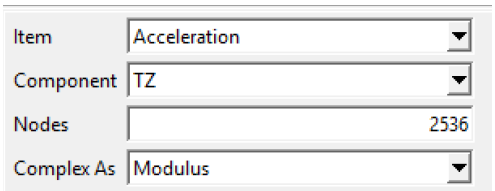
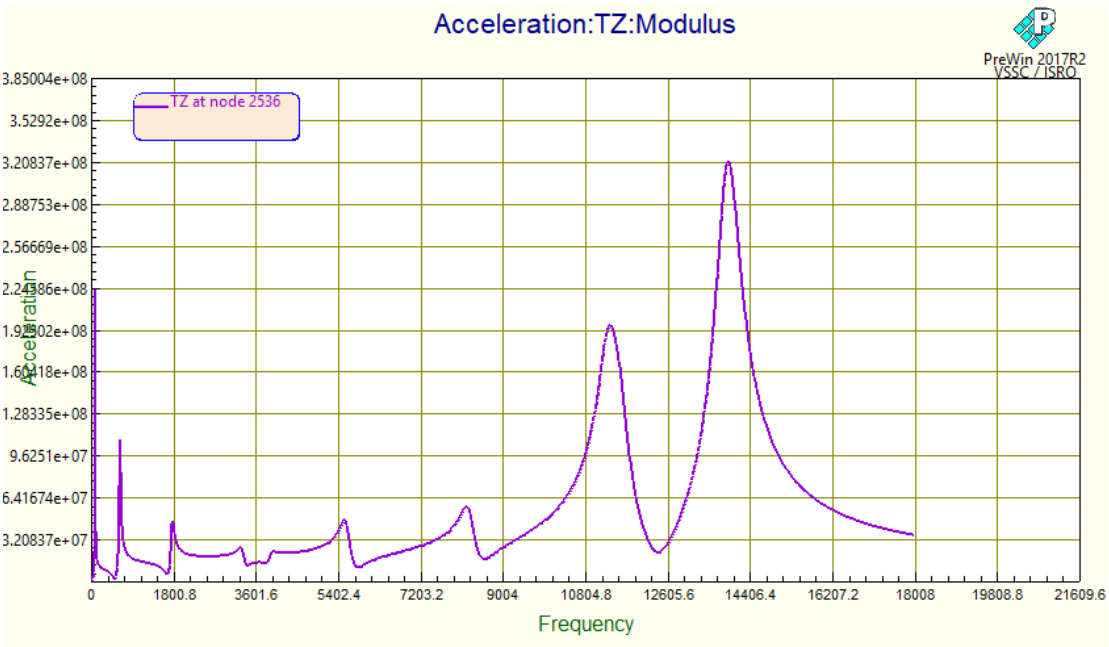
7. Perform post processing

a. History plot

Commands : POST,HISTORYPLOT

Menu : Post → History plot

Parameter :



At the end of above operation you will get the response plot as shown in figure below.