OpenSees Navigator

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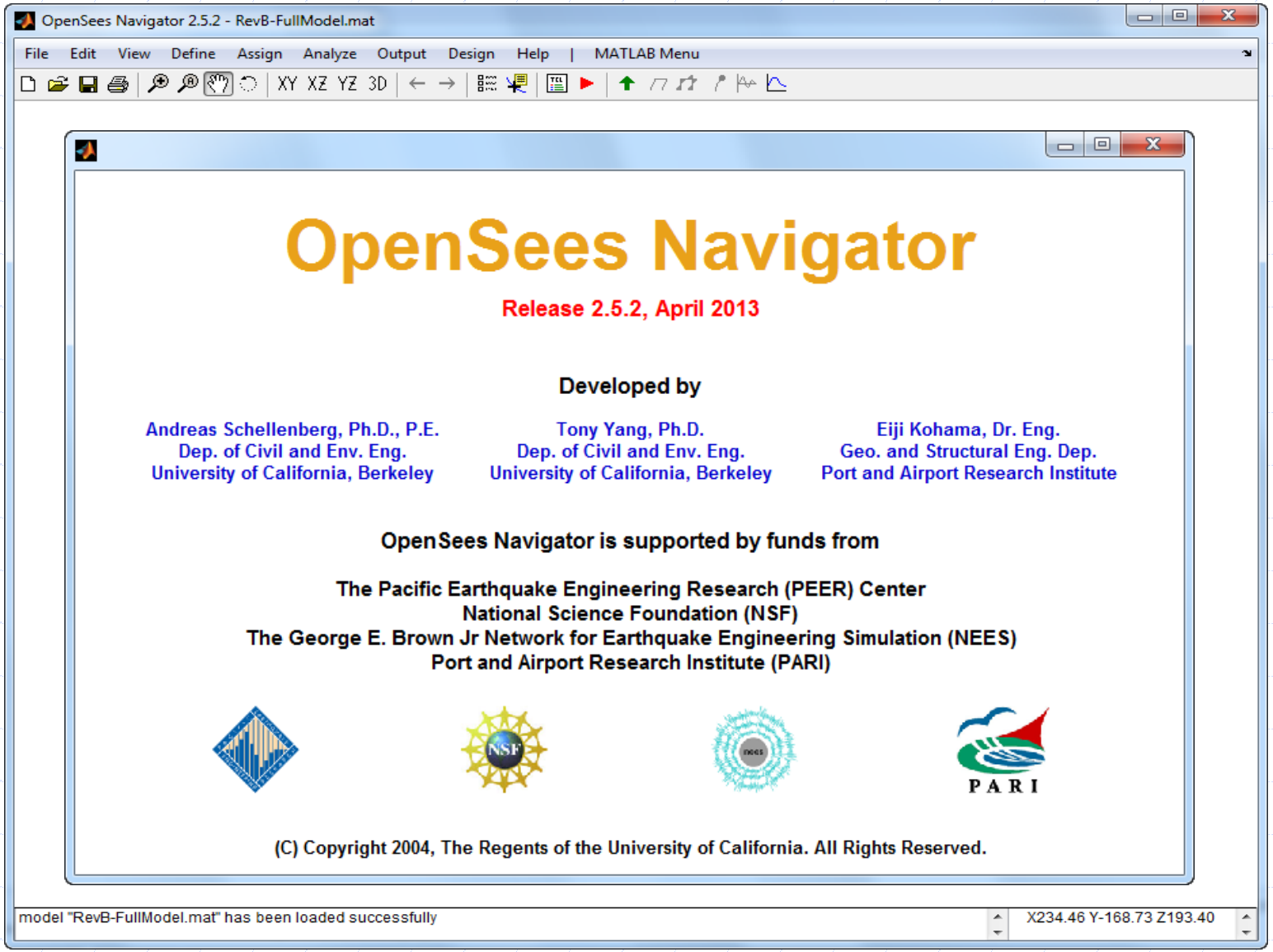
Introduction

- MATLAB based graphical user interface (GUI).
- Pre- and post-processing for OpenSees and OpenFresco.
- Design toolboxes: NSP, PBEE, AISC design checks, AISC database, response spectra for linear and bilinear systems and signal filtering.
- Both MATLAB Pcode and self-executable versions are available for Windows & Mac.
- Being used by researchers from Asia, US, Canada, South America and Europe.

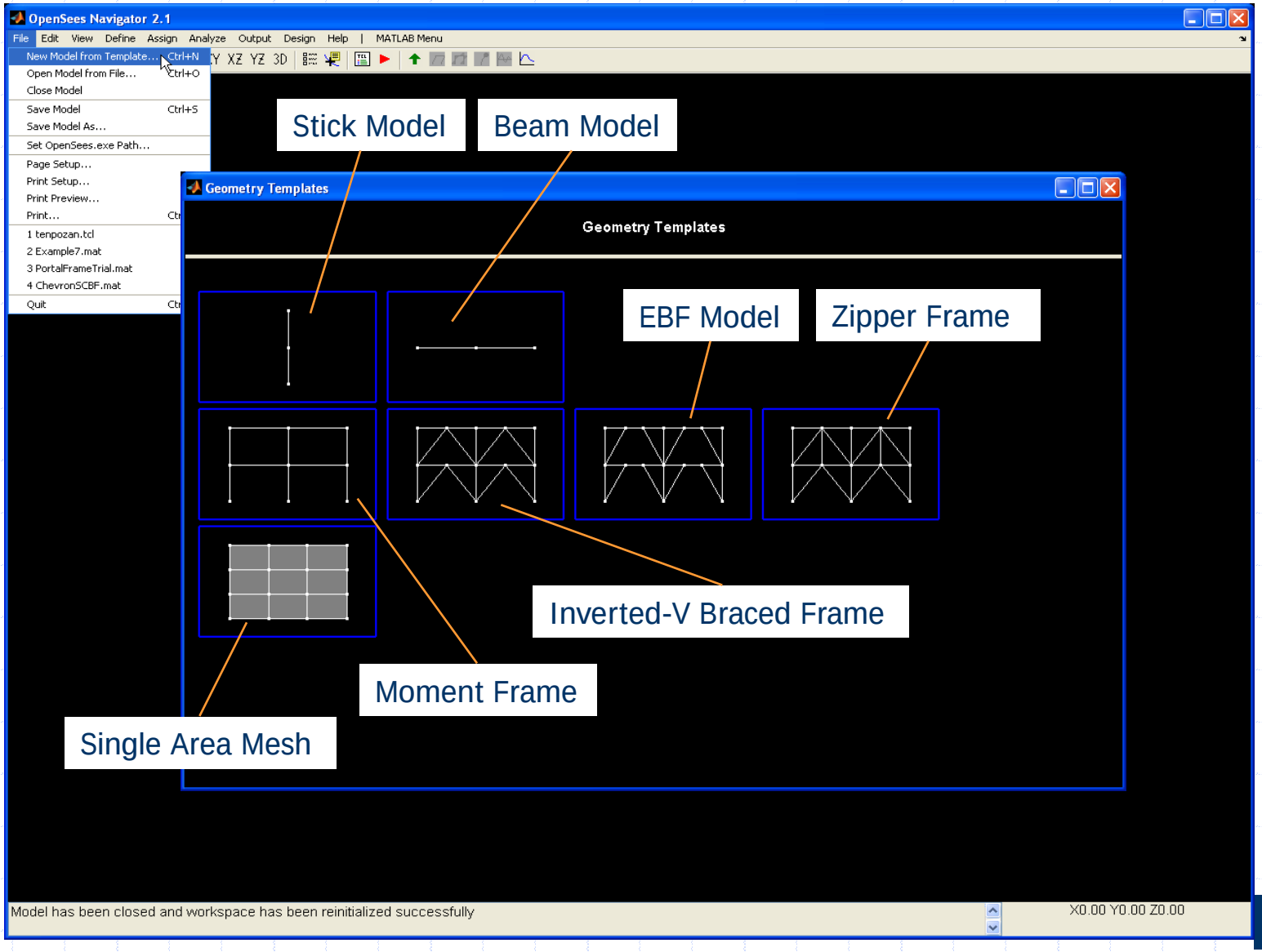
Motivations

- Replace the TCL text input with graphical input.
- Most researchers use MATLAB to do the post-processing, and MATLAB/Simulink is the typical framework for implementing hybrid simulation tests.
- OpenSees Navigator will create the OpenSees (analytical/hybrid) model and graphically display the results before, during or after a test.
- Provides many robust plotting algorithms and is very effective in generating the plots for engineering applications.
- Flexible to use and requires no programming skill.

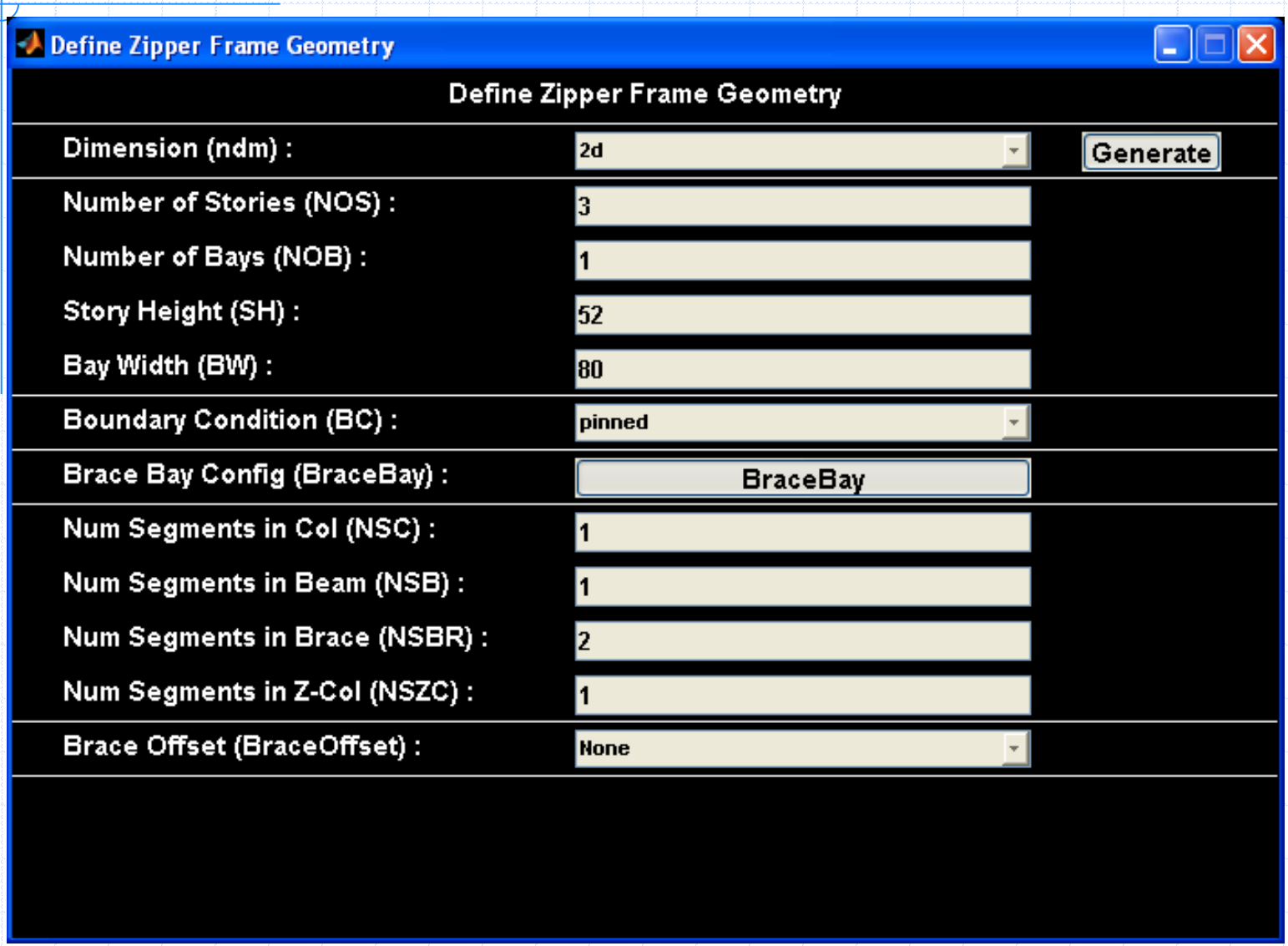
OpenSees Navigator



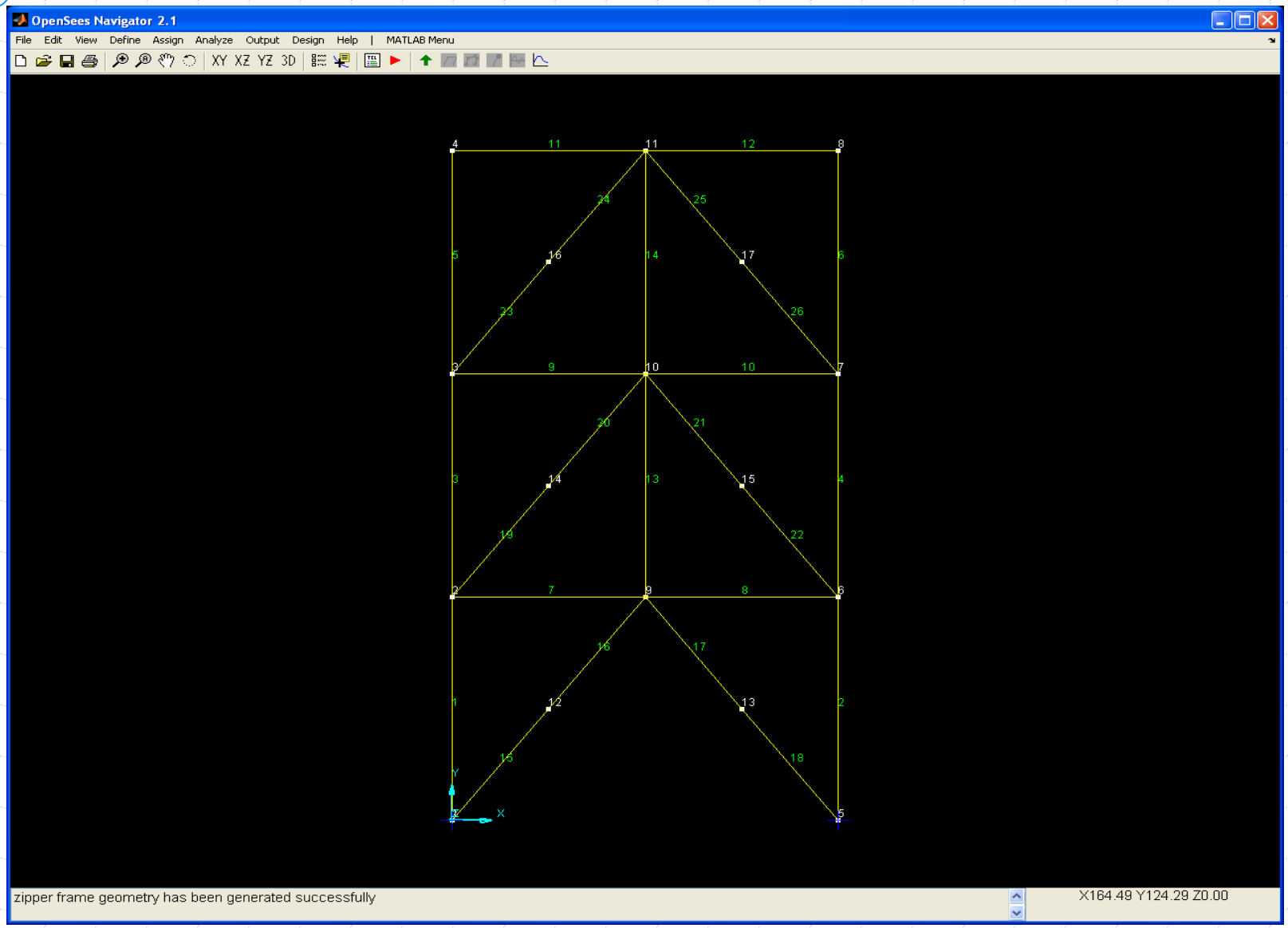
Define geometry: new model template



Define geometry: Zipper braced frame



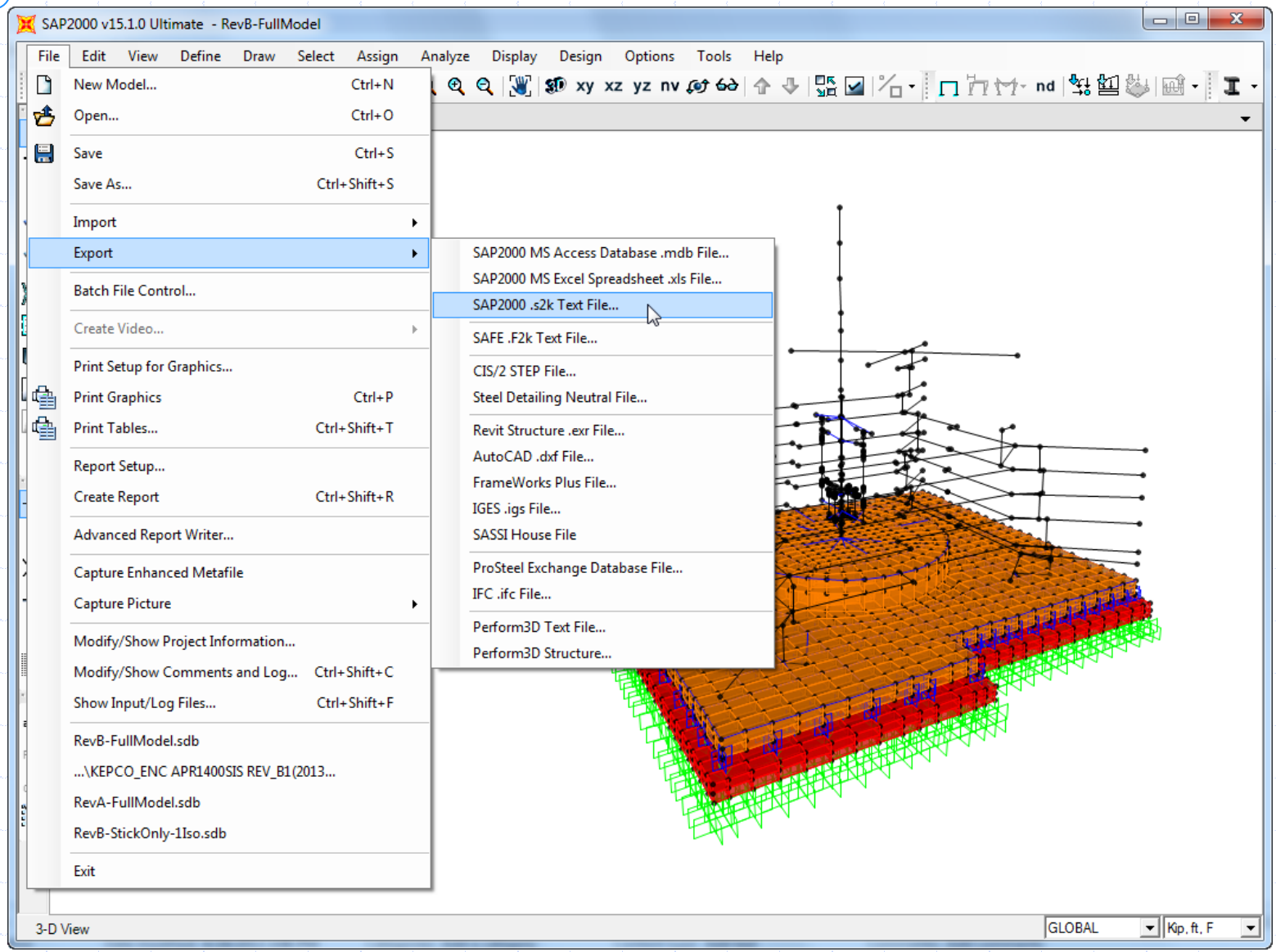
View geometry: display



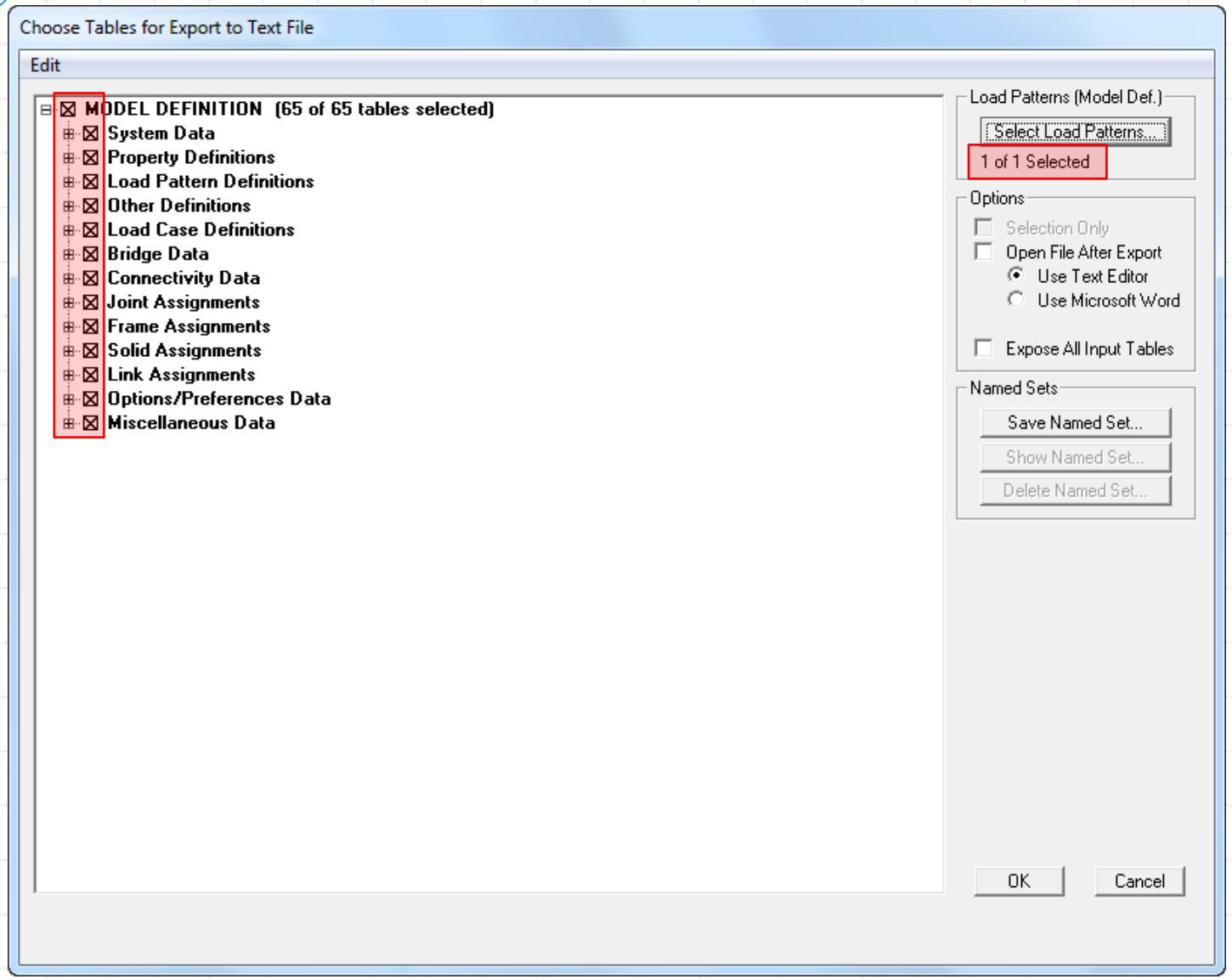
Conversion: SAP2000 to OpenSees

- Export SAP2000 model to .s2k file
- Start OpenSees Navigator program
- Select “Open Model from File…” and choose the earlier exported .s2k file
- There is no one-to-one relationship between SAP2000 and OpenSees objects, therefore
- Carefully check the converted model
- Element loads and nodal constraints are currently not converted yet

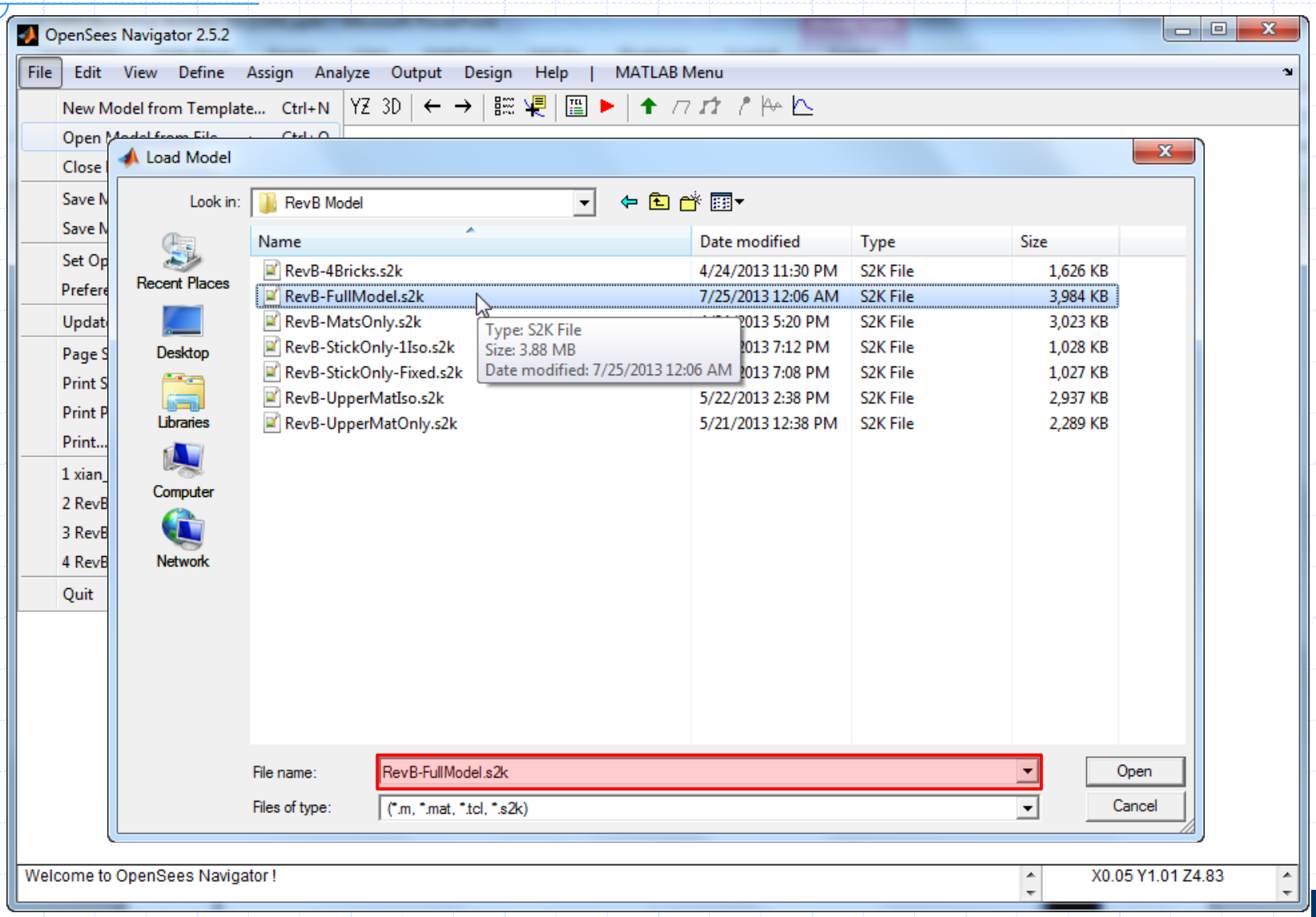
Export to s2k file



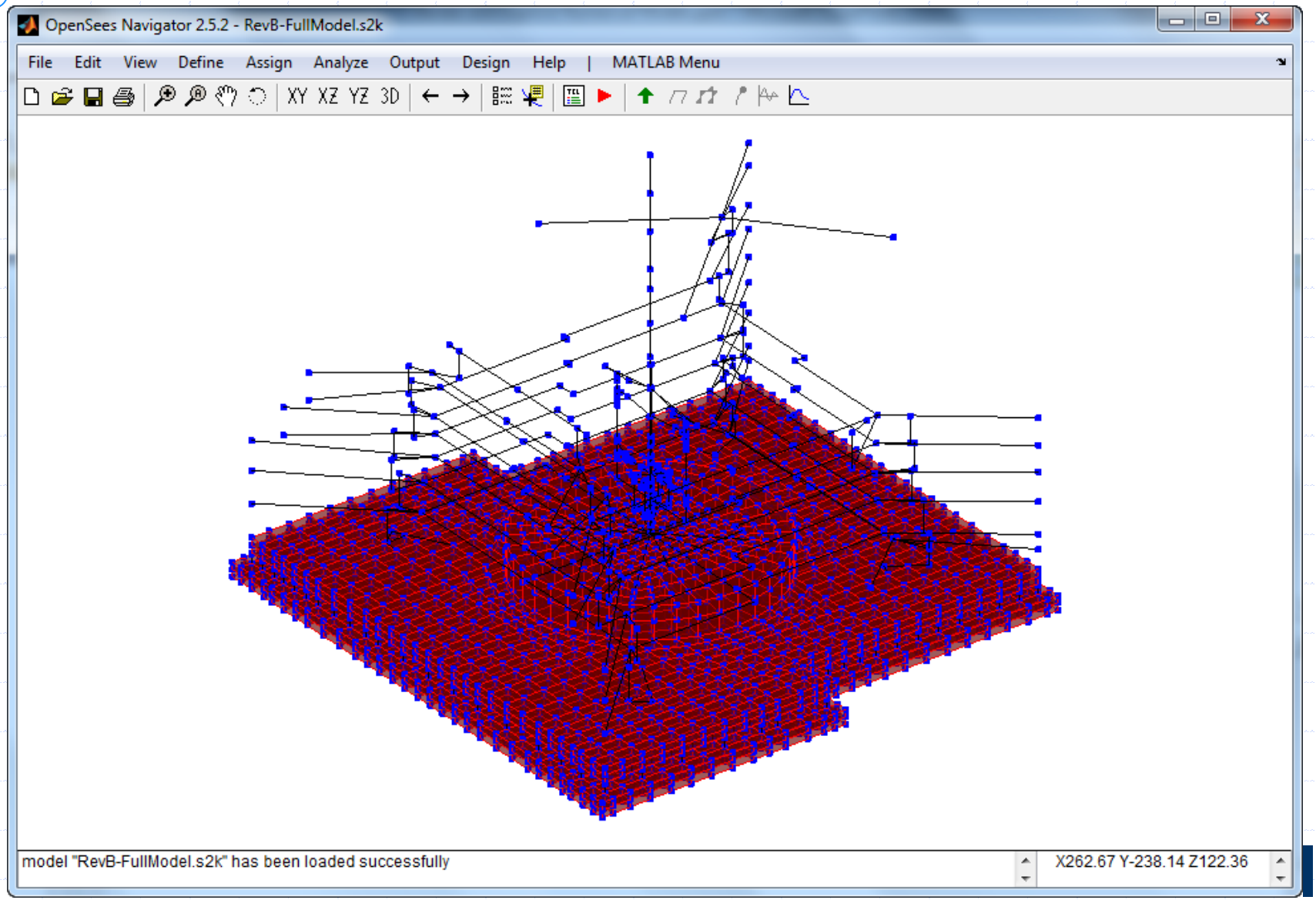
Export to s2k file



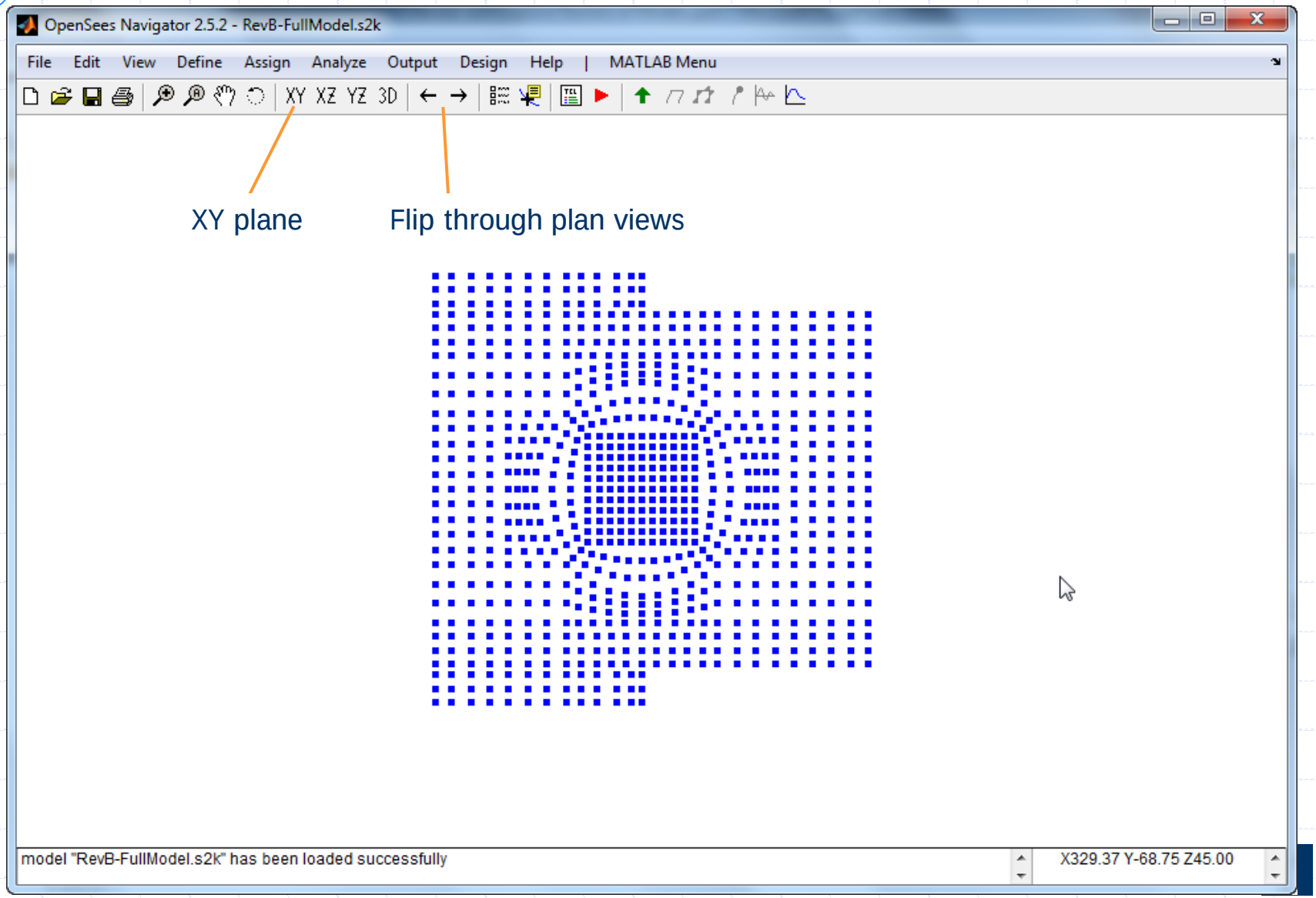
Define geometry: import from SAP2000



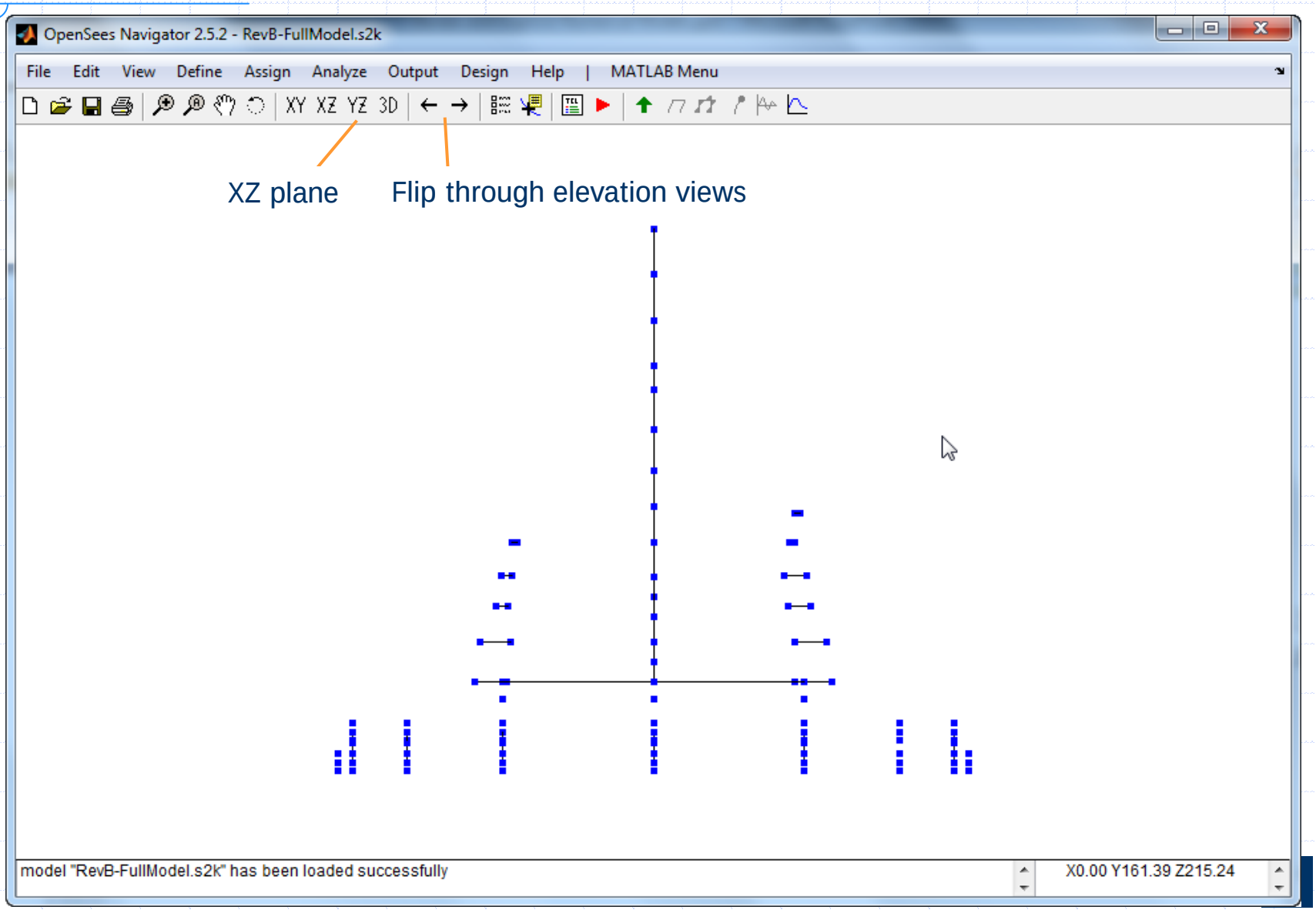
Define geometry: import from SAP2000



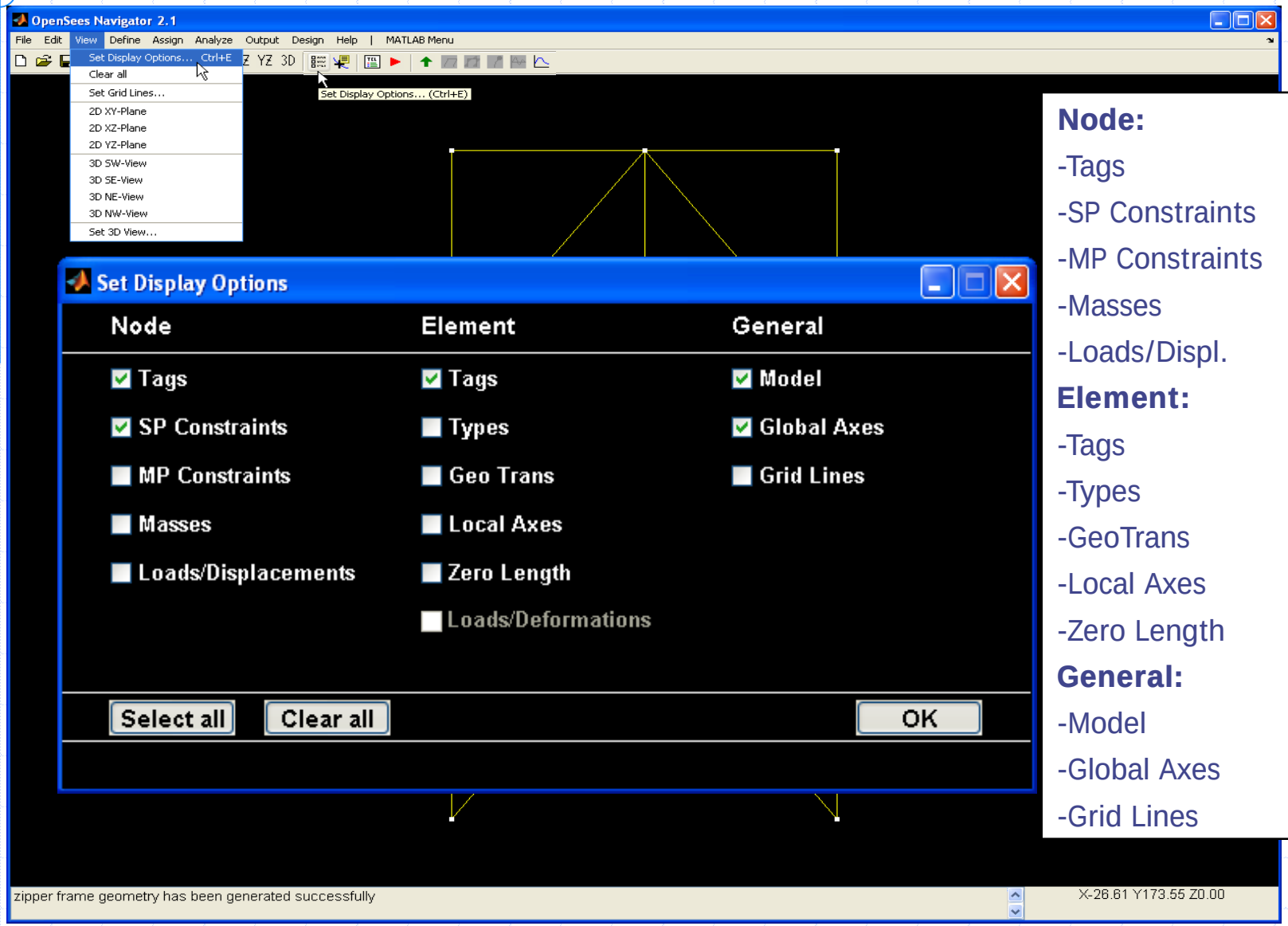
Define geometry: import from SAP2000



Define geometry: import from SAP2000



View geometry: set display options



Node:

-Tags

-SP Constraints

-MP Constraints

-Masses

-Loads/Displ.

Element:

-Tags

-Types

-GeoTrans

-Local Axes

-Zero Length

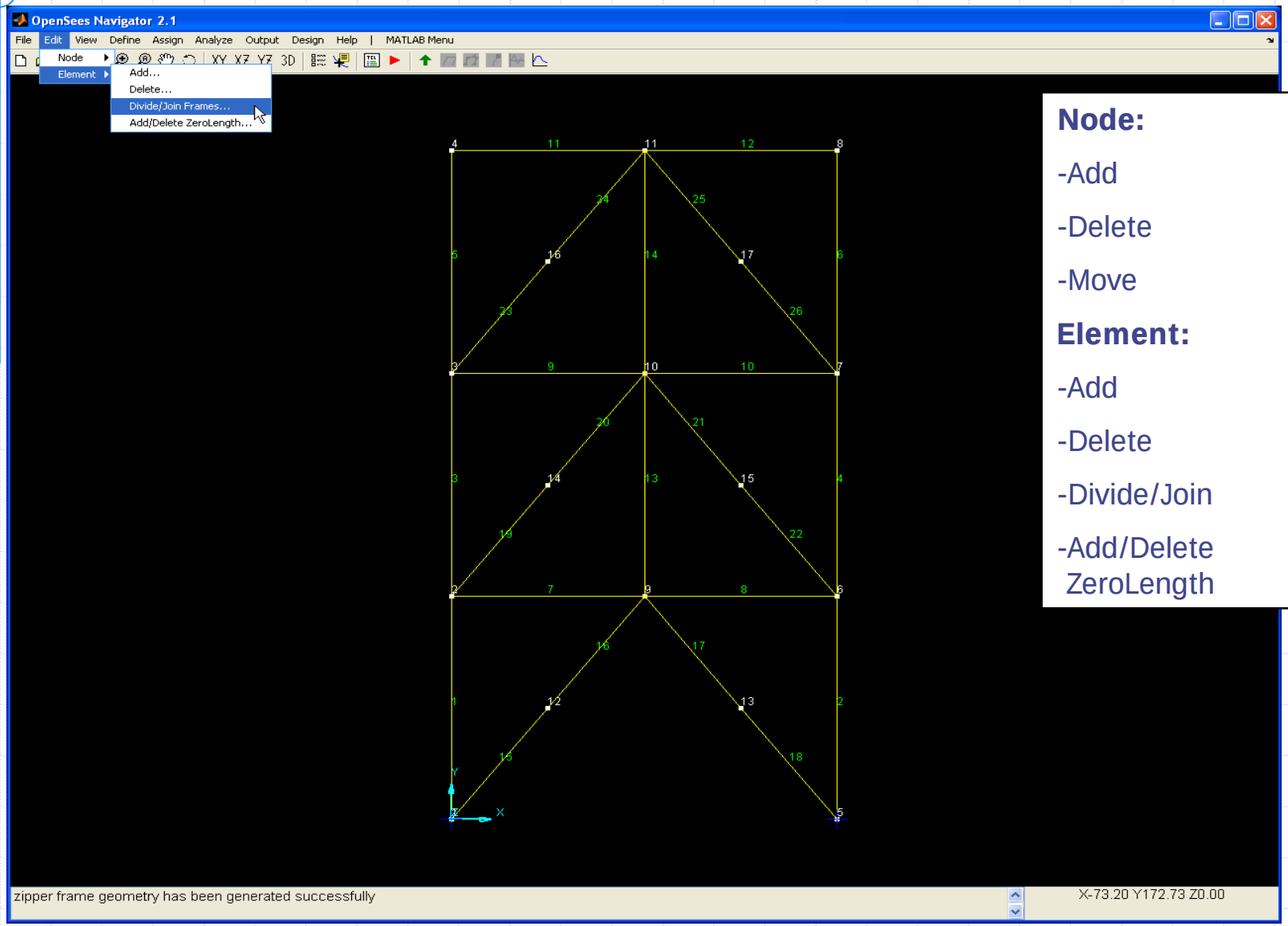
General:

-Model

-Global Axes

-Grid Lines

Edit geometry



Node:

-Add

-Delete

-Move

Element:

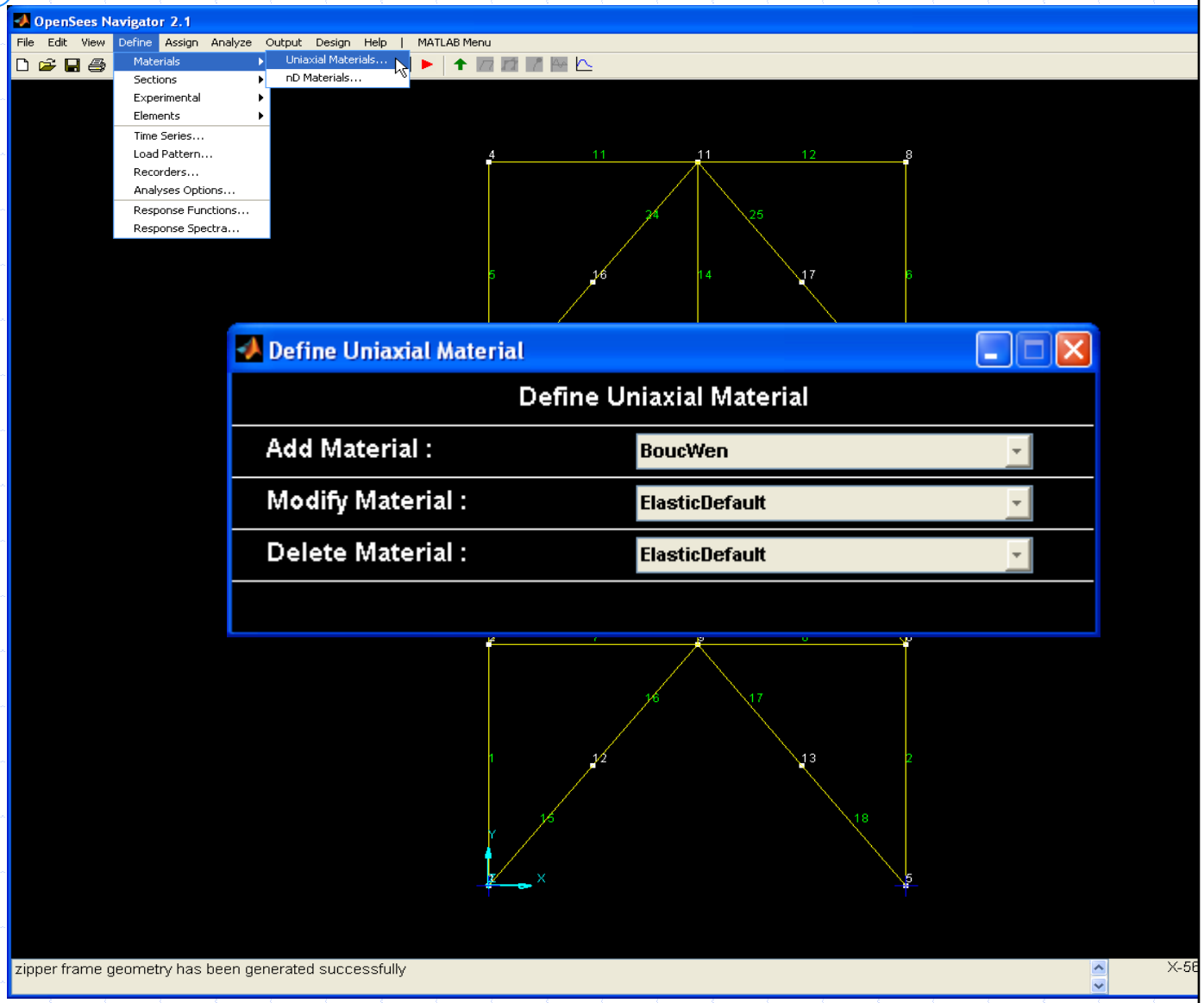
-Add

-Delete

-Divide/Join

-Add/Delete ZeroLength

Define material: uniaxial materials



Templates:

-BoucWen

-Concrete01

-Concrete02

-Concrete04

-Elastic

-ElasticNoTension

-ElasticPP

-ElasticPPGap

-Fatigue

-Hardening

-Hysteretic

-MinMax

-Parallel

-ReinforcingSteel

-Series

-Steel01

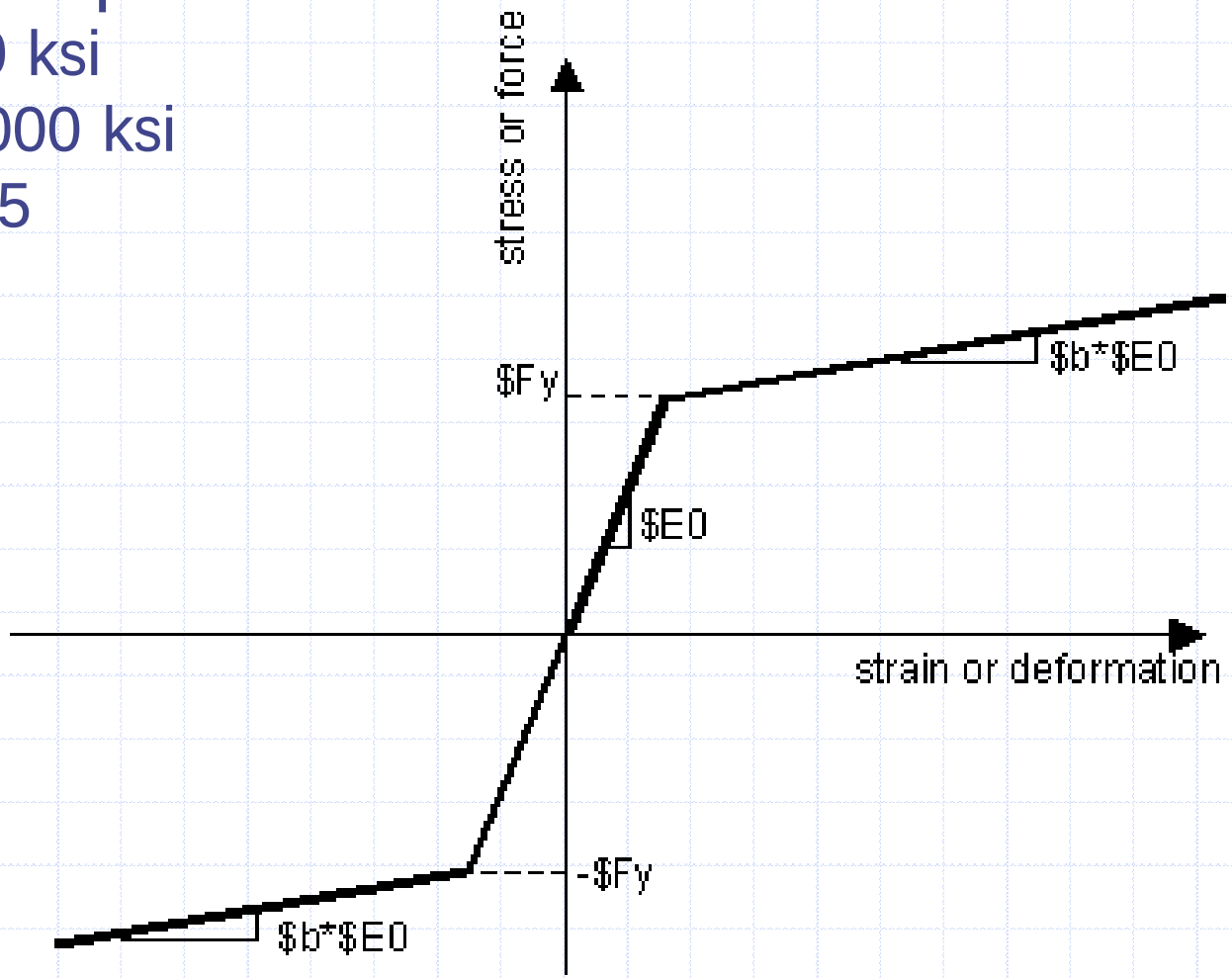
-Steel02

-Viscous

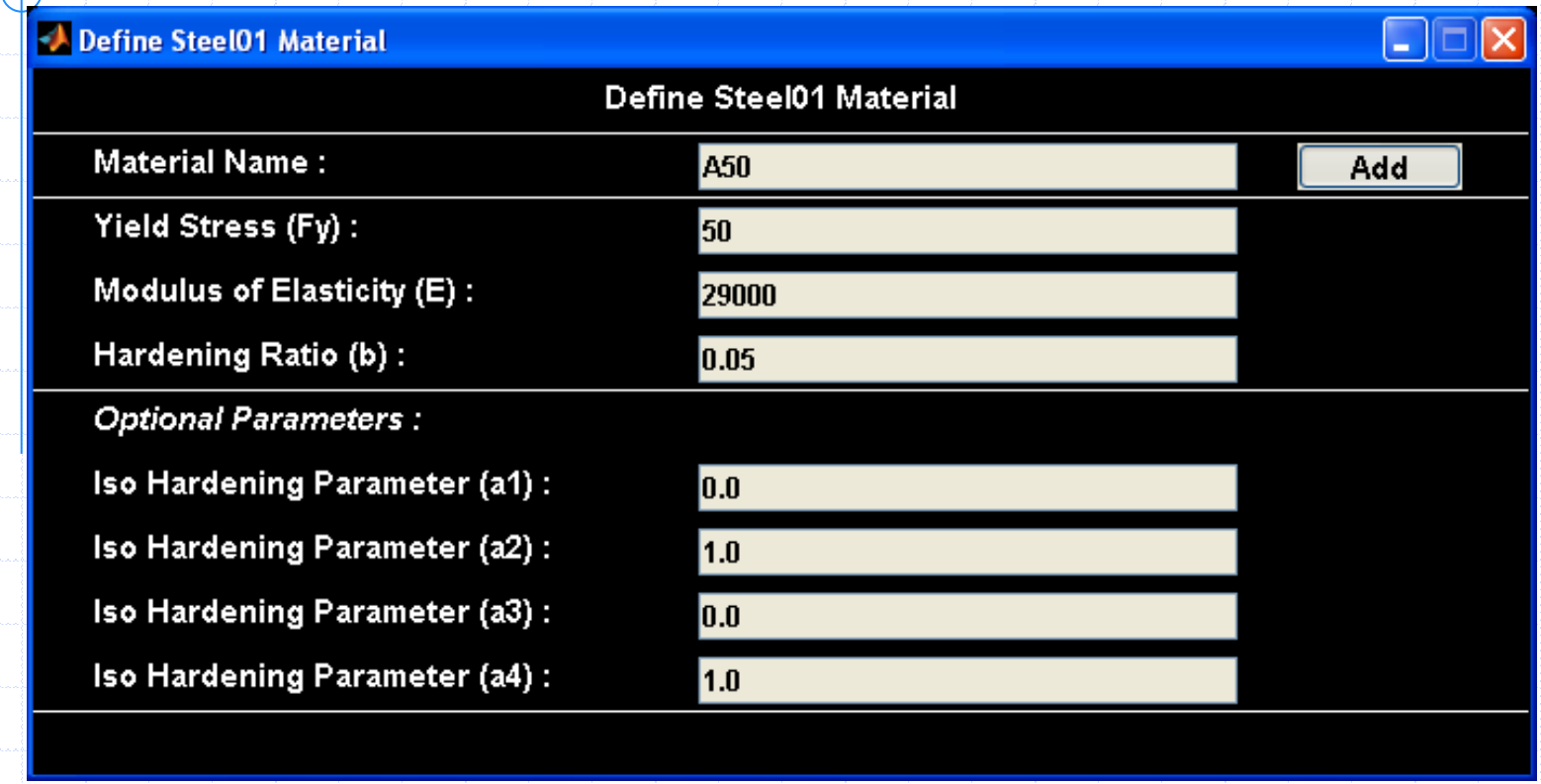
-...

Define uniaxial material: Steel01

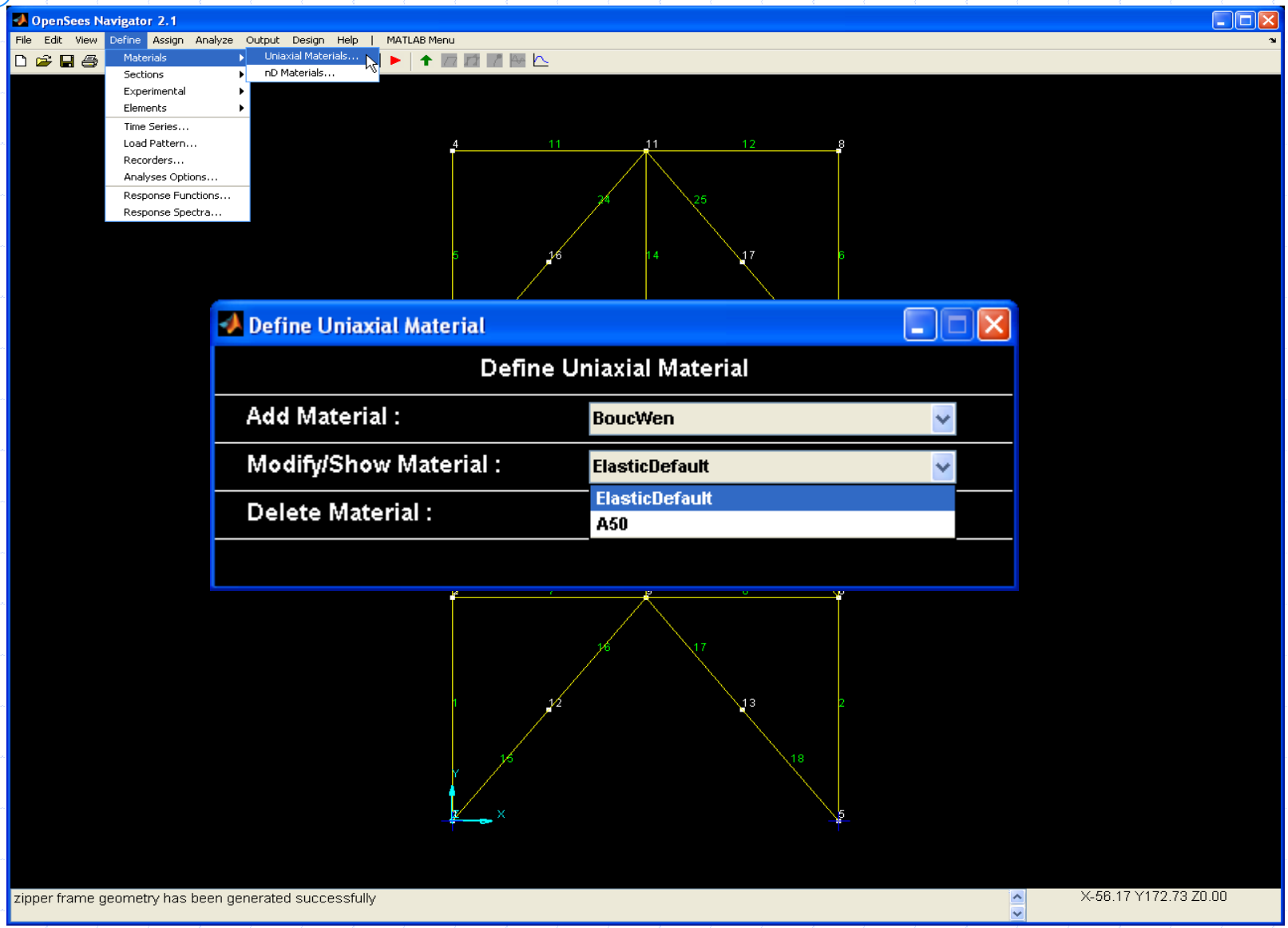
- Material properties
  - Fy = 50 ksi
  - E = 29000 ksi
  - b = 0.05



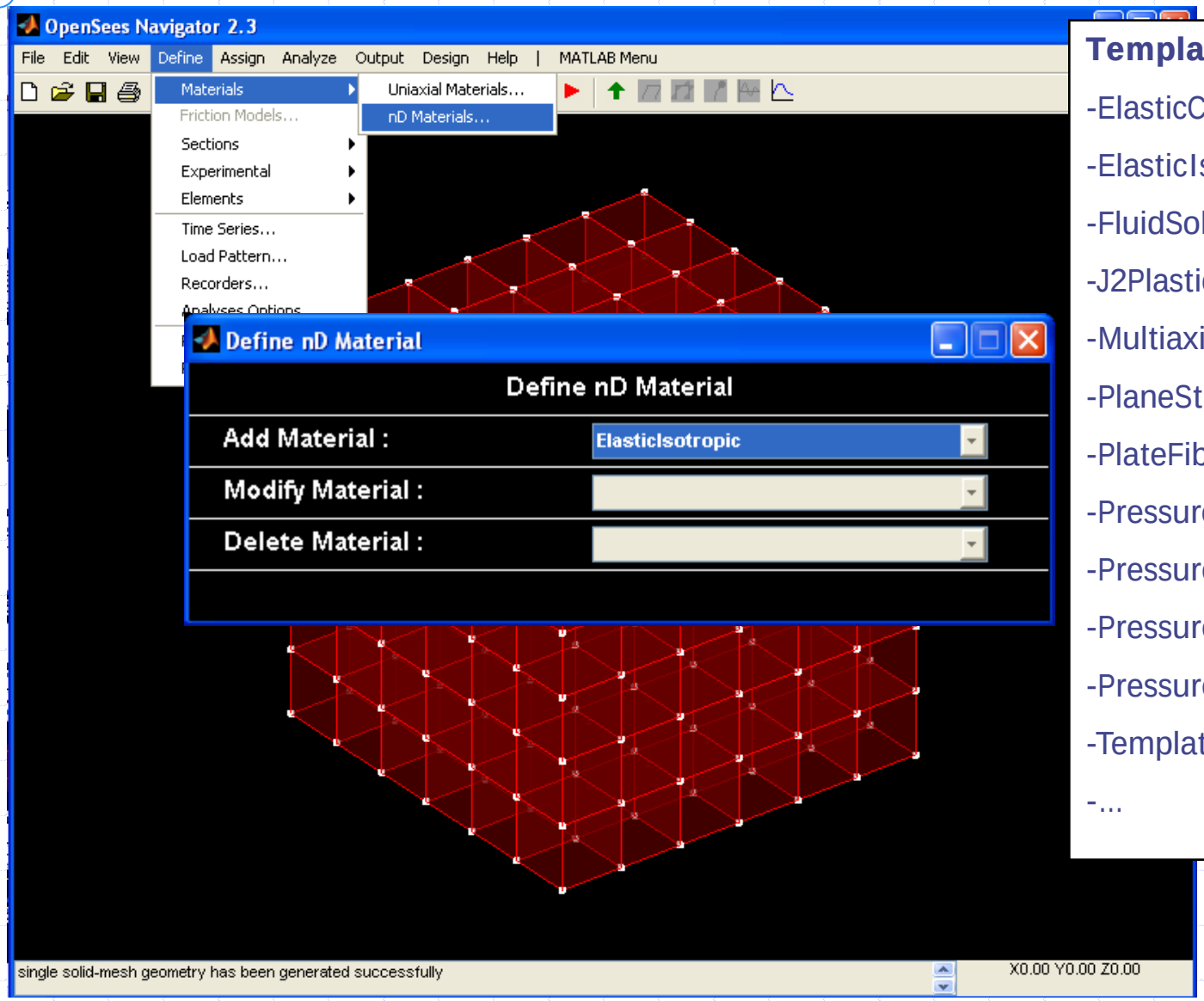
Define uniaxial material: Steel01



Define material: uniaxial materials



Define material: nD materials



Templates:

-ElasticCrossAnisotropic3D

-ElasticIsotropic

-FluidSolidPorous

-J2Plasticity

-MultiaxialCyclicPlasticity

-PlaneStress

-PlateFiber

-PressureDependMultiYield

-PressureDependMultiYield02

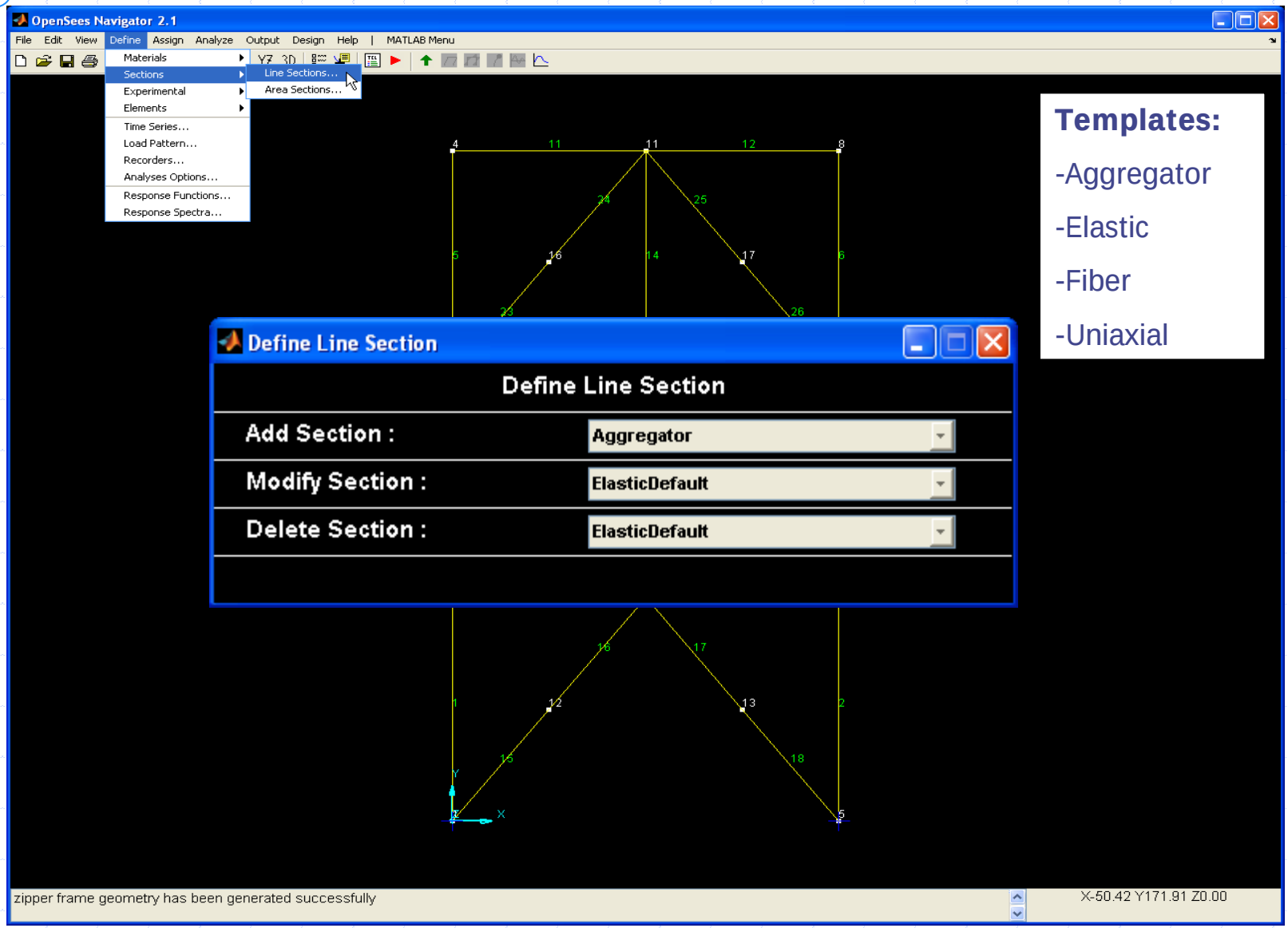
-PressureDependentElastic3D

-PressureIndependMultiYield

-Template3DElastoPlastic

-...

Define section: line sections



Templates:

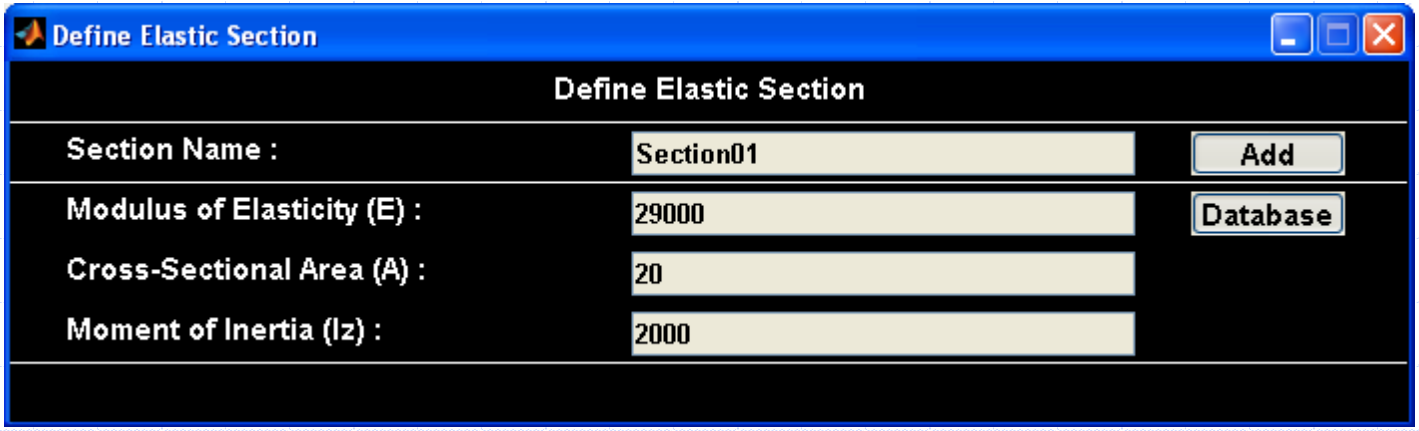
-Aggregator

-Elastic

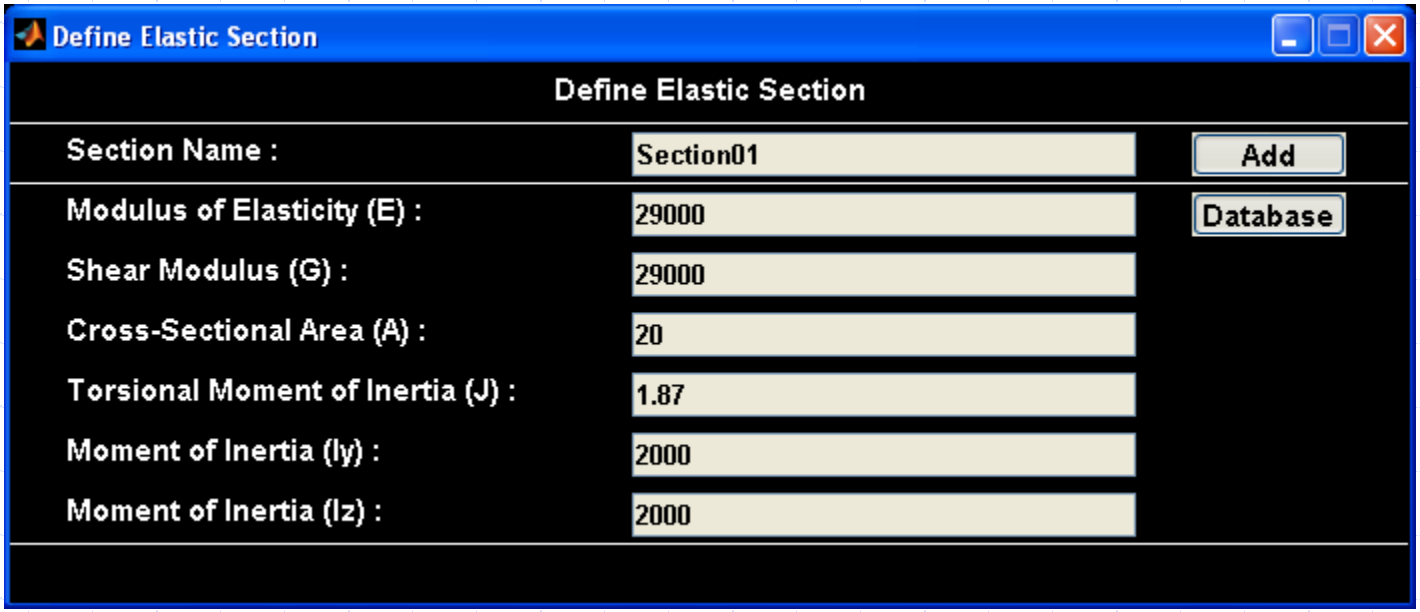
-Fiber

-Uniaxial

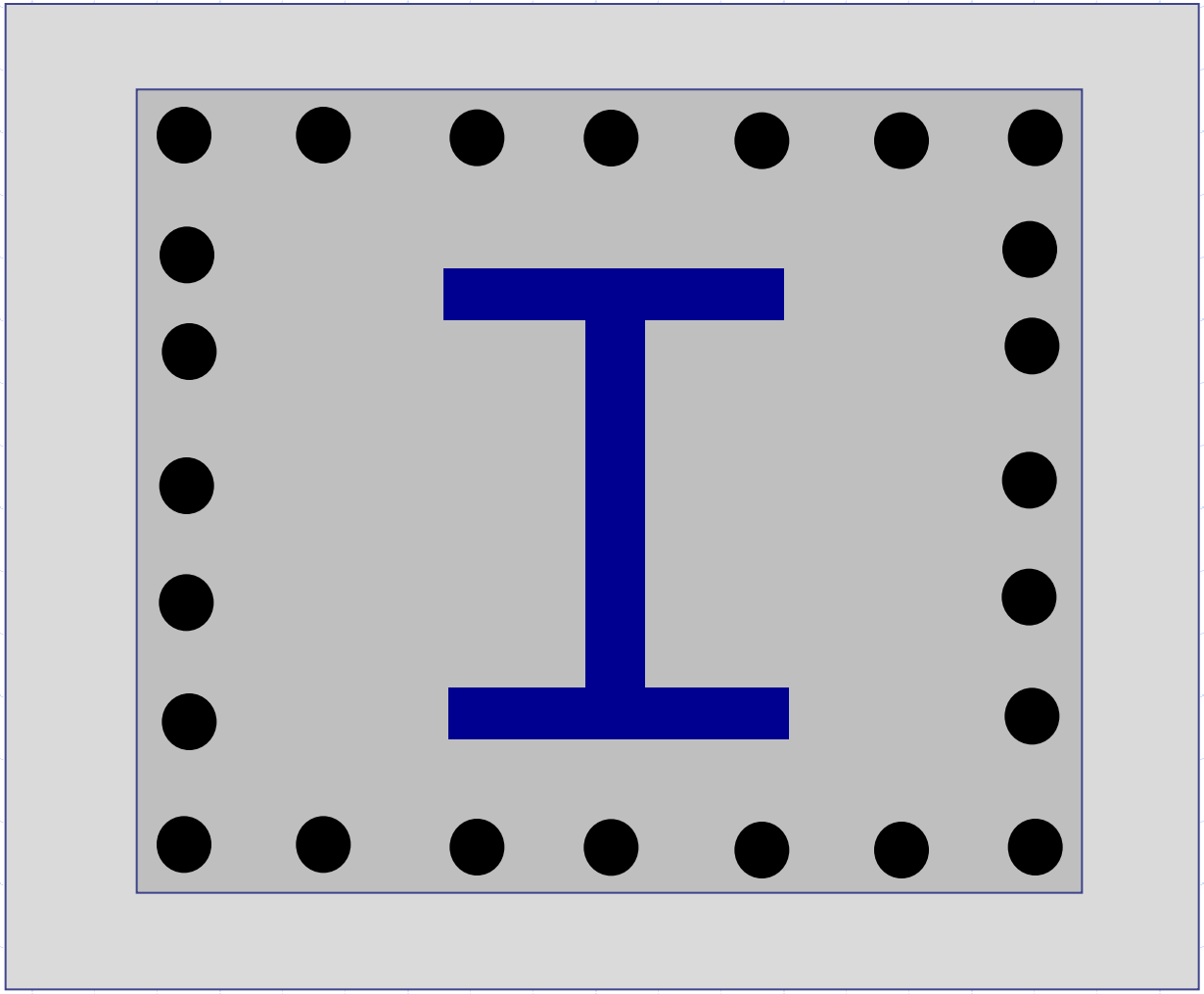
Define line section: elastic section



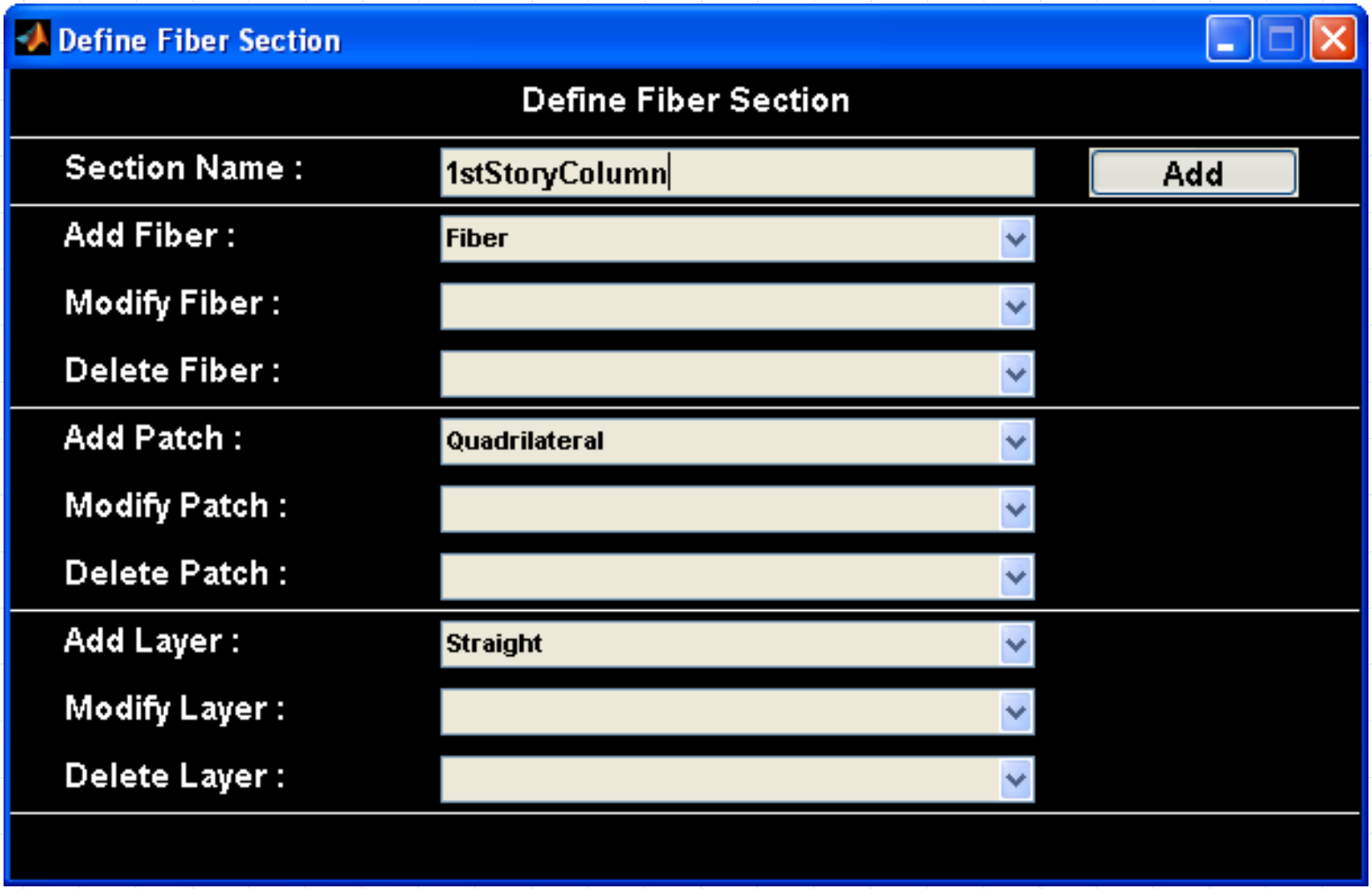
If the model is 3D



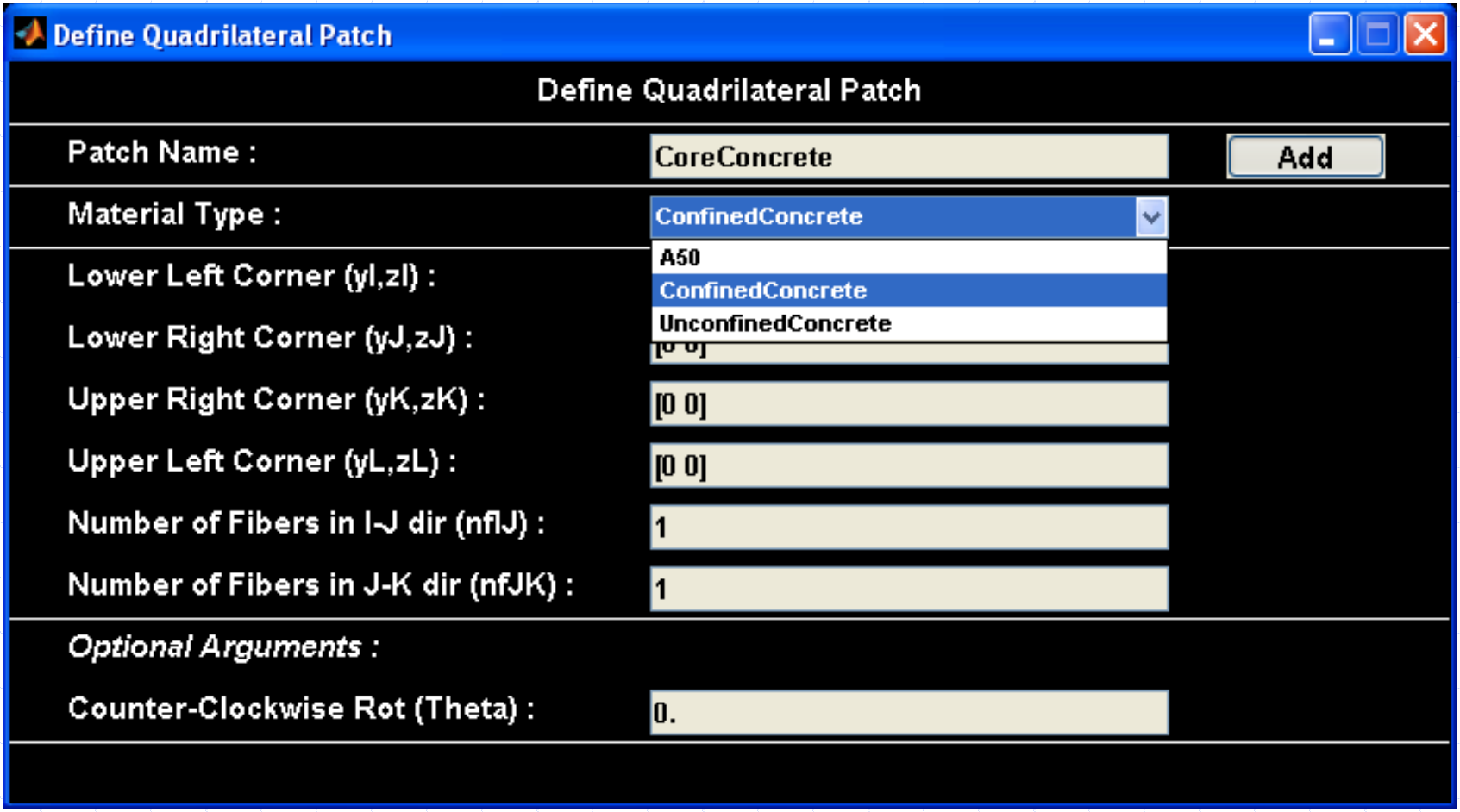
Define fiber section: Composite patch



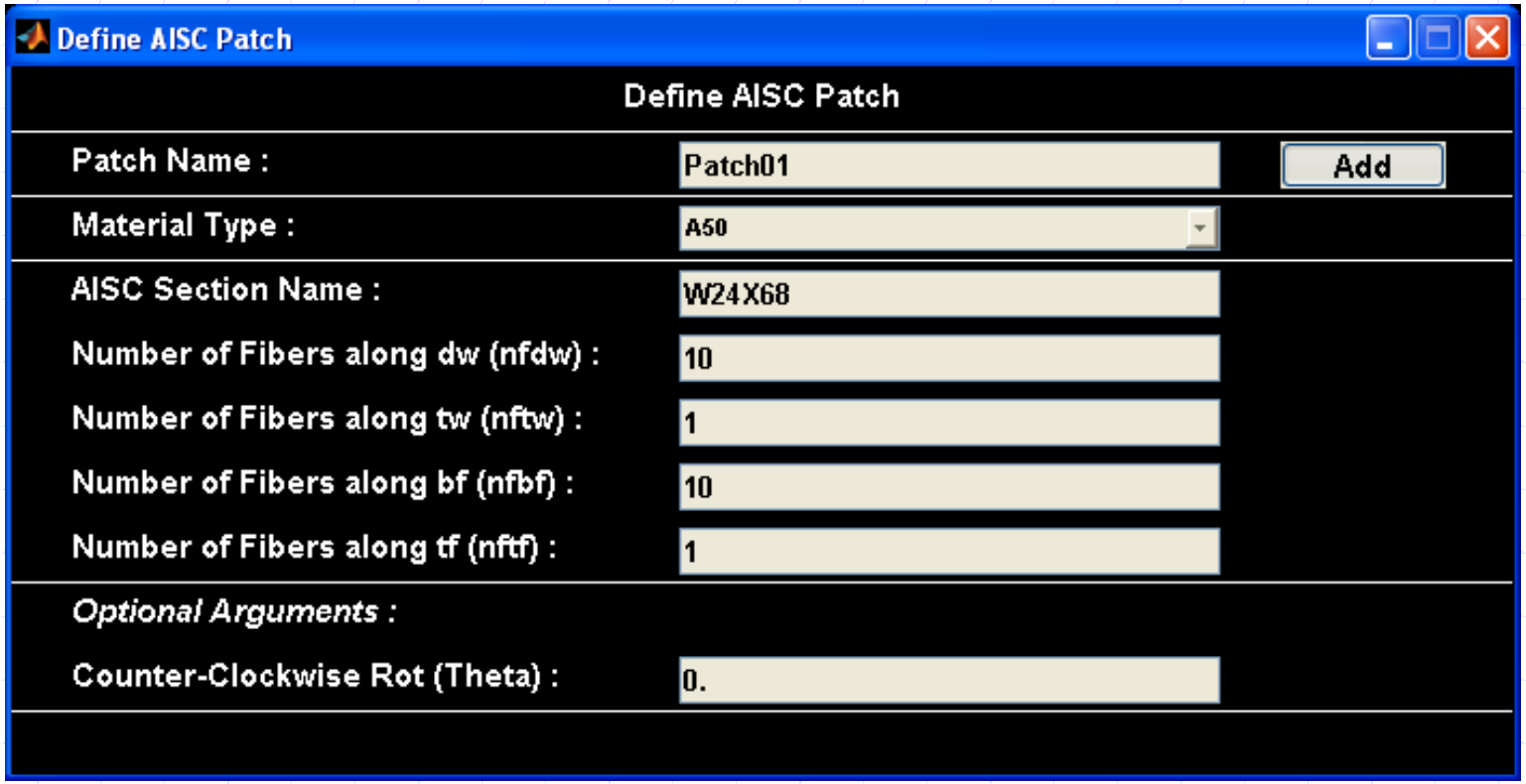
Define line section: fiber section



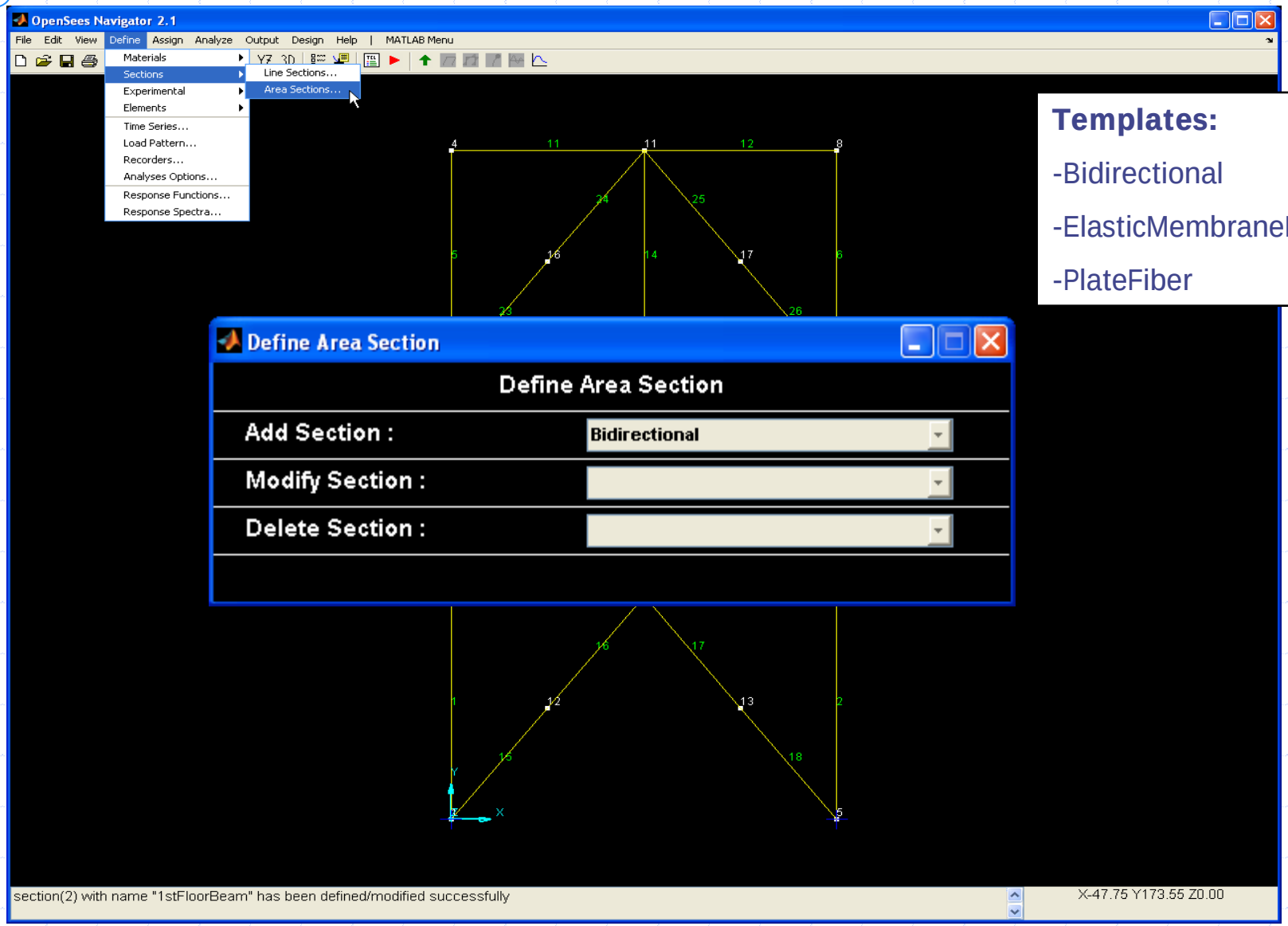
Define line section: quadrilateral patch



Define fiber section: AISC patch



Define section: area section



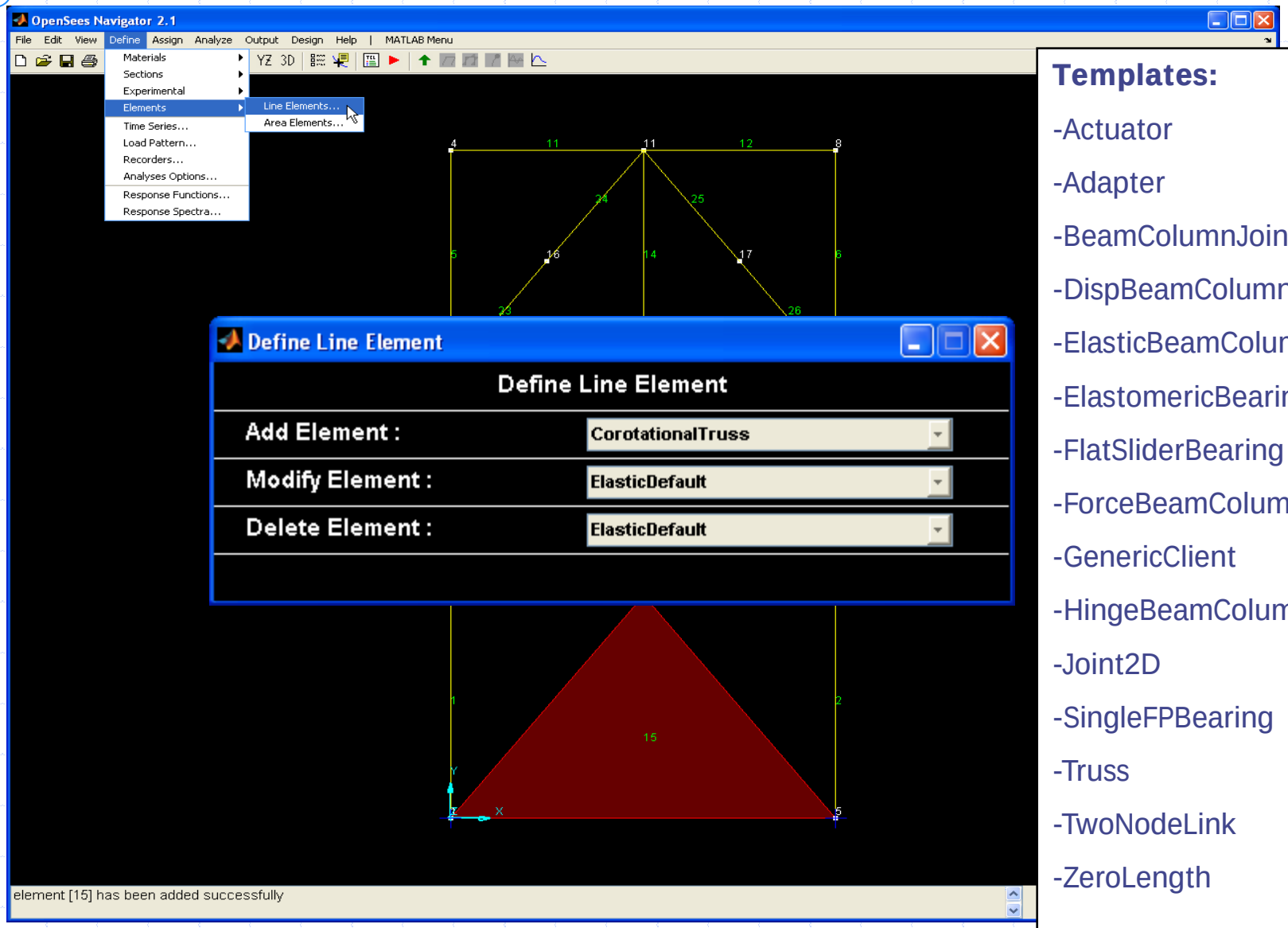
Templates:

-Bidirectional

-ElasticMembranePlate

-PlateFiber

Define element: line element



Templates:

-Actuator

-Adapter

-BeamColumnJoint

-DispBeamColumn

-ElasticBeamColumn

-ElastomericBearing

-FlatSliderBearing

-ForceBeamColumn

-GenericClient

-HingeBeamColumn

-Joint2D

-SingleFPBearing

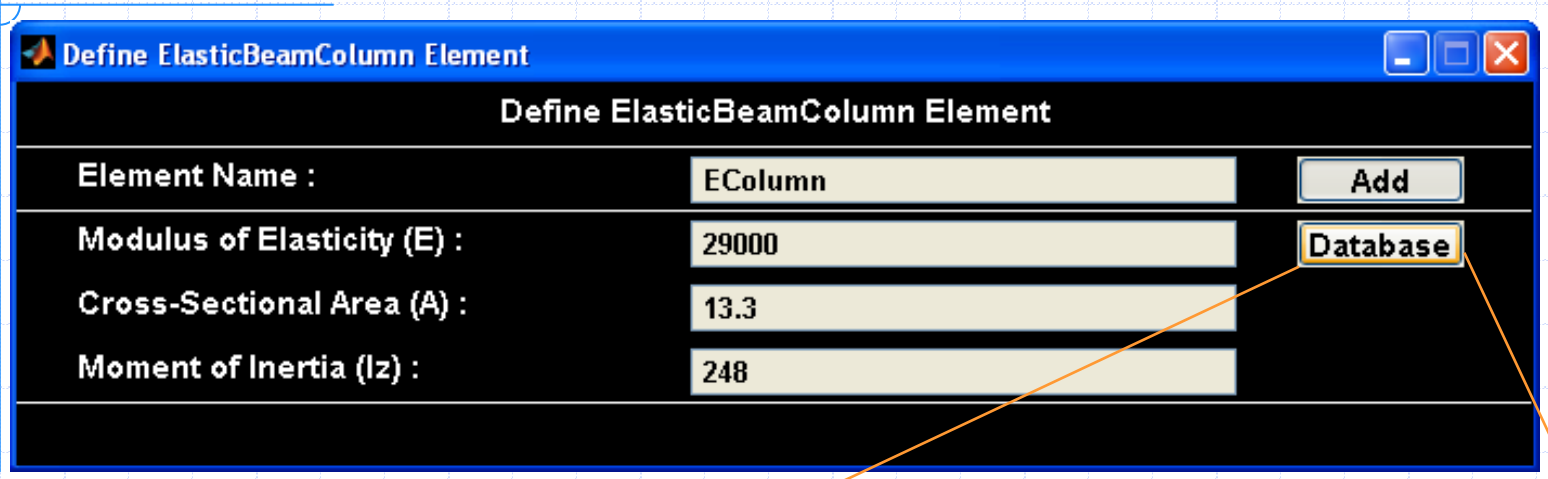
-Truss

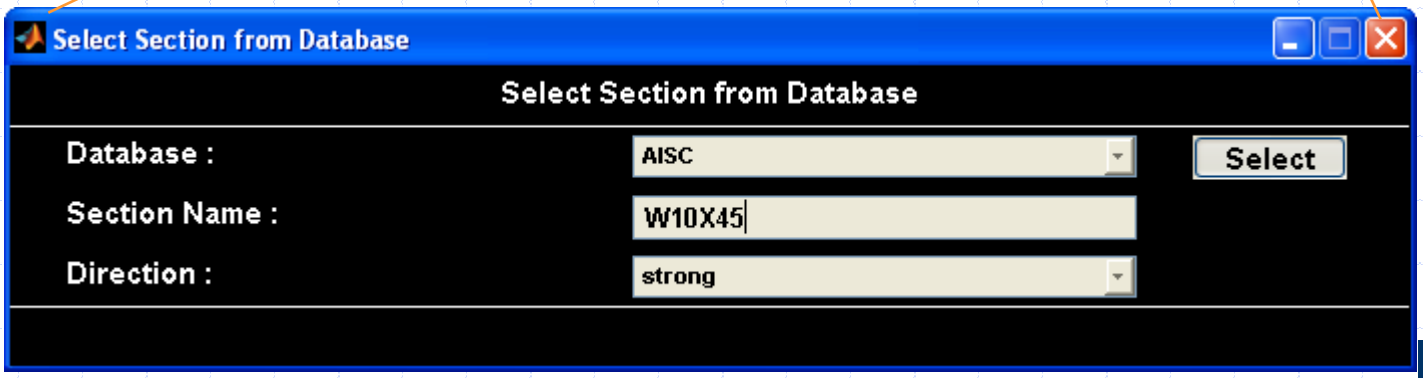
-TwoNodeLink

-ZeroLength

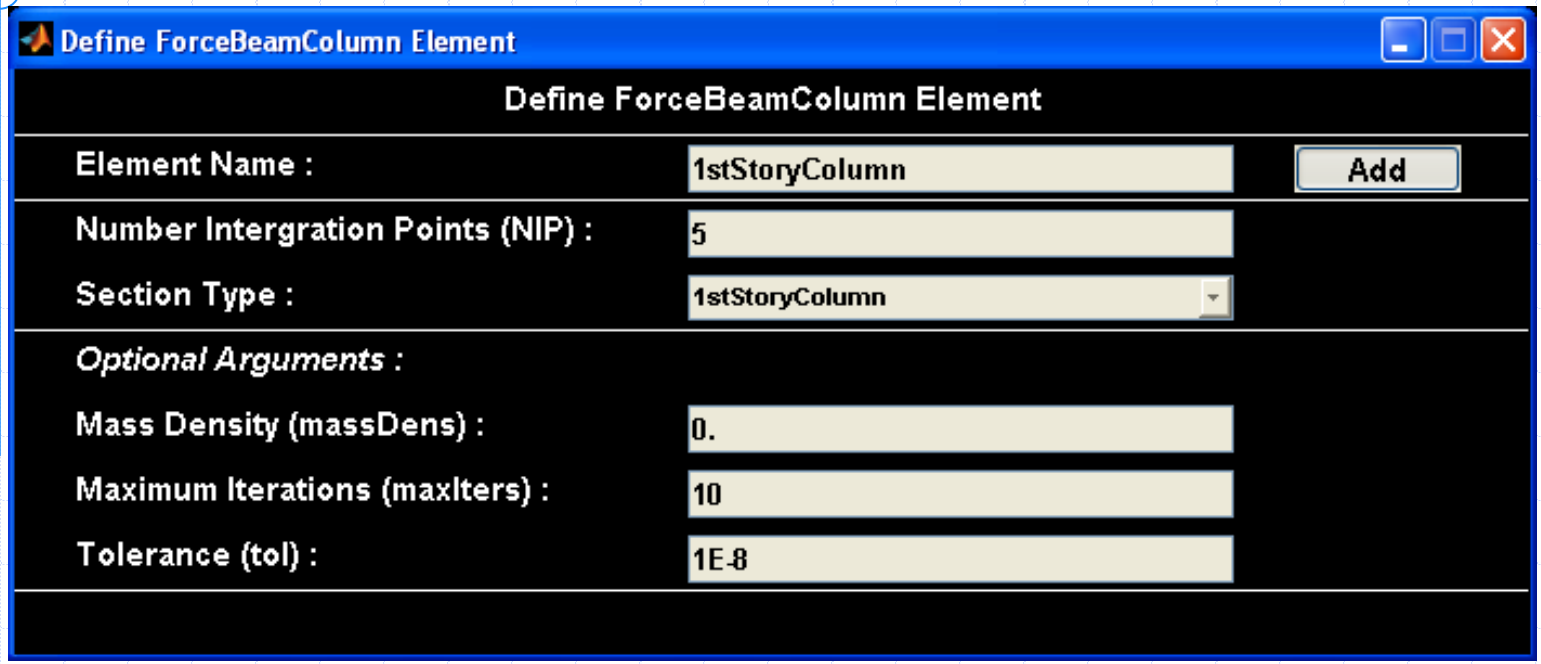
-...

Define line element: ElasticBeamColumn

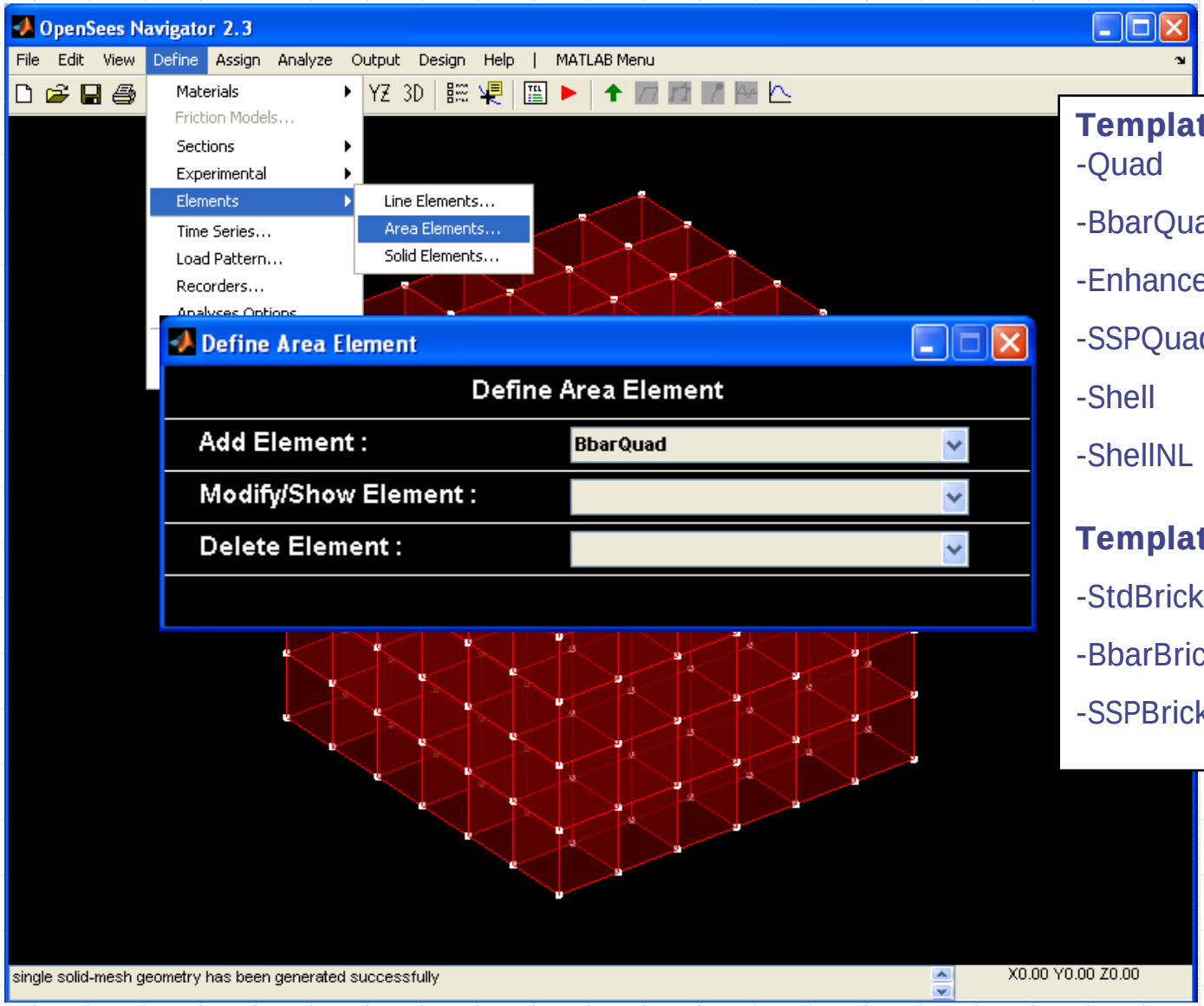




Define line element: ForceBeamColumn



Define element: area and solid elements



Templates (area):

-Quad

-BbarQuad

-EnhancedQuad

-SSPQuad

-Shell

-ShellNL

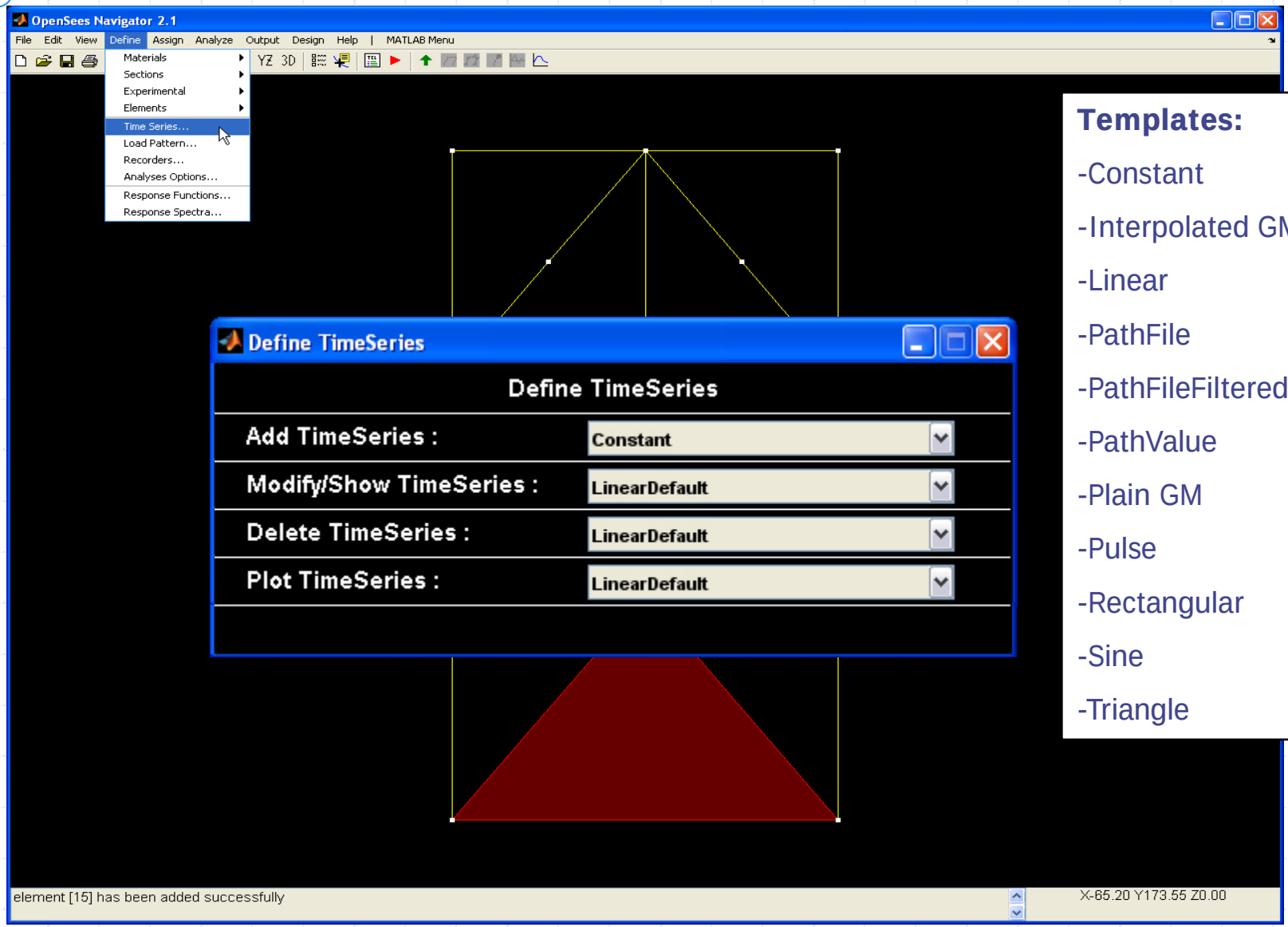
Templates (solid):

-StdBrick

-BbarBrick

-SSPBrick

Define TimeSeries:



Templates:

-Constant

-Interpolated GM

-Linear

-PathFile

-PathFileFiltered

-PathValue

-Plain GM

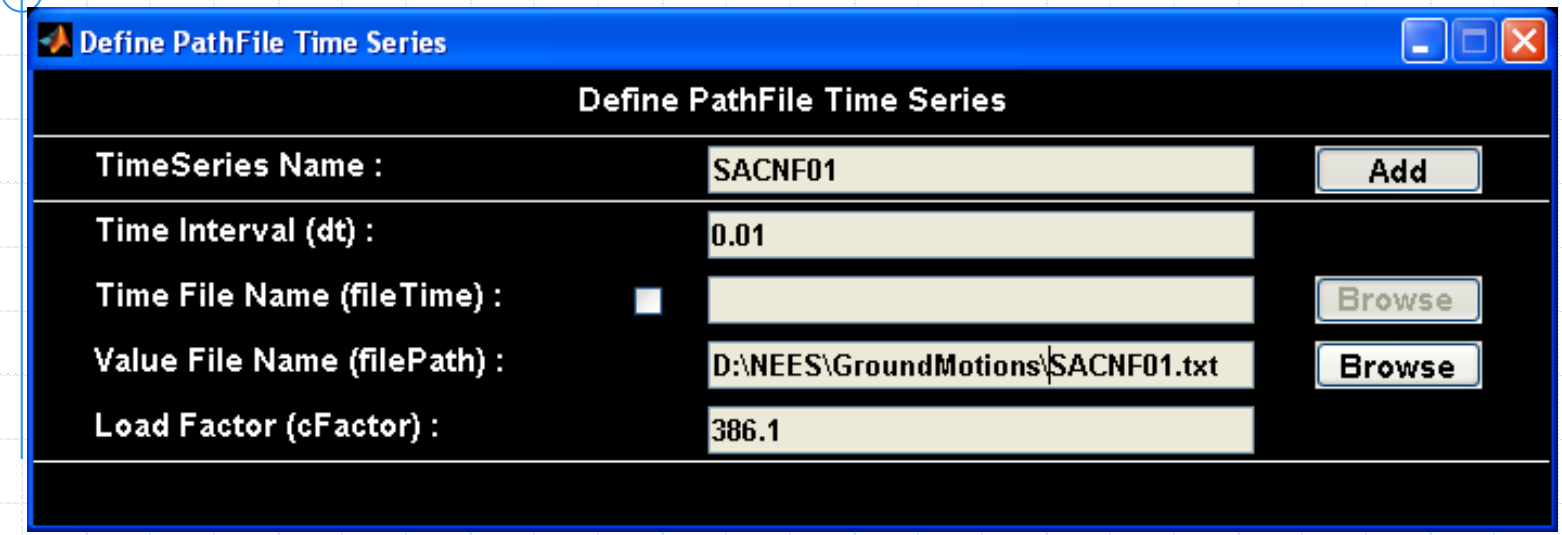
-Pulse

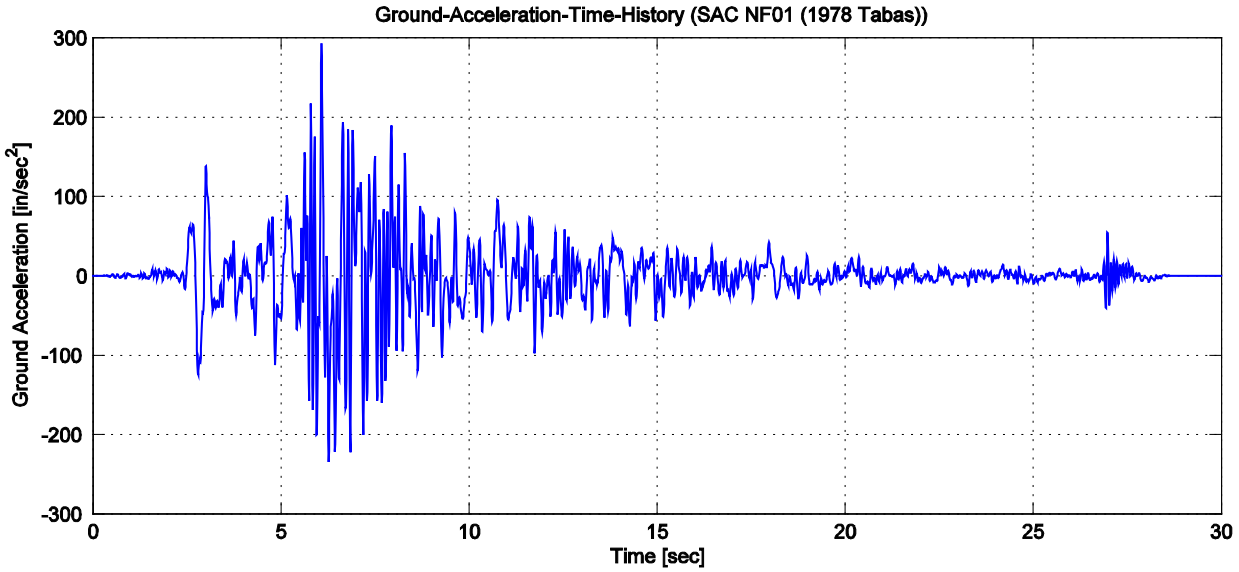
-Rectangular

-Sine

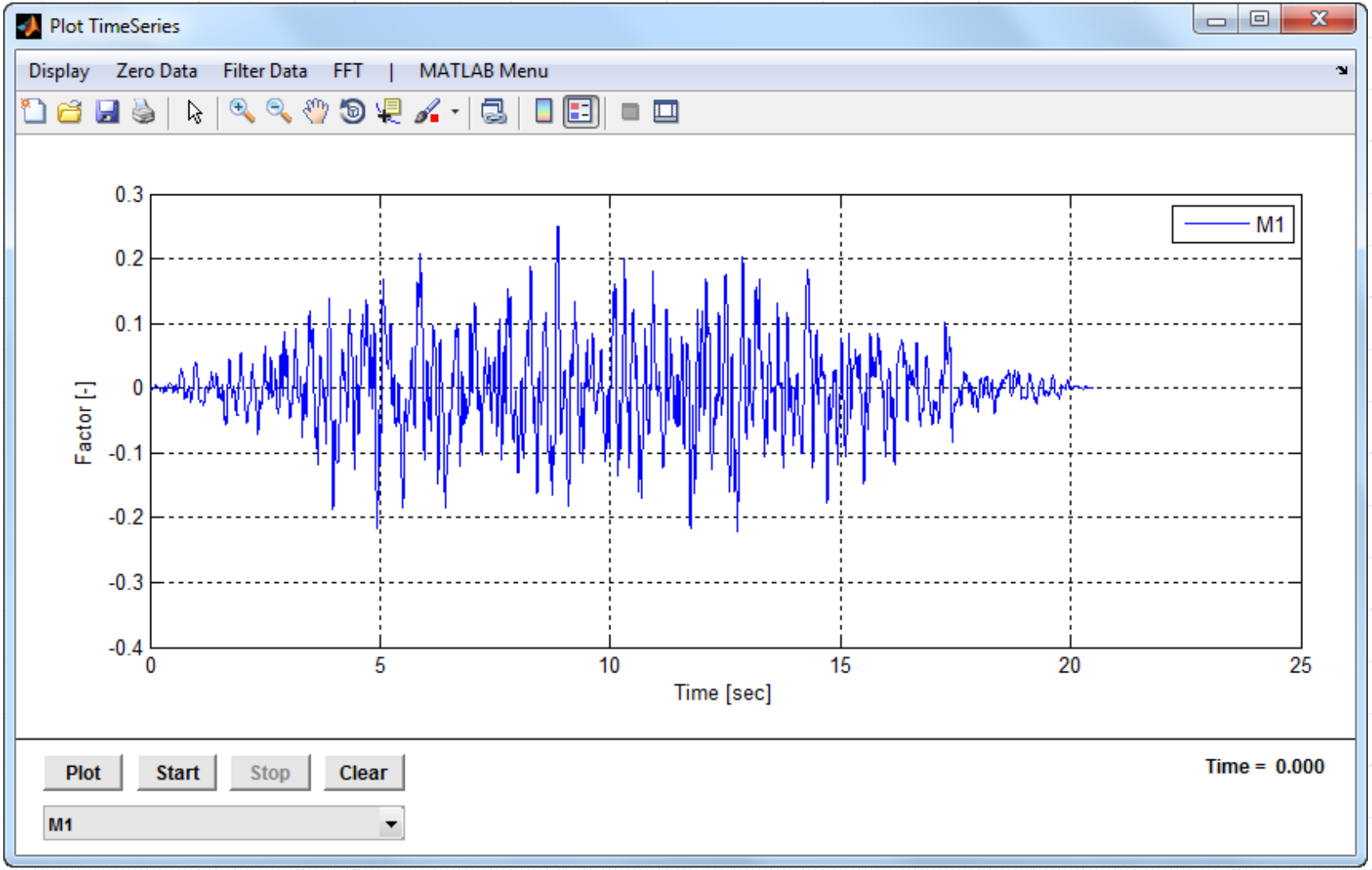
-Triangle

Define TimeSeries: PathFile

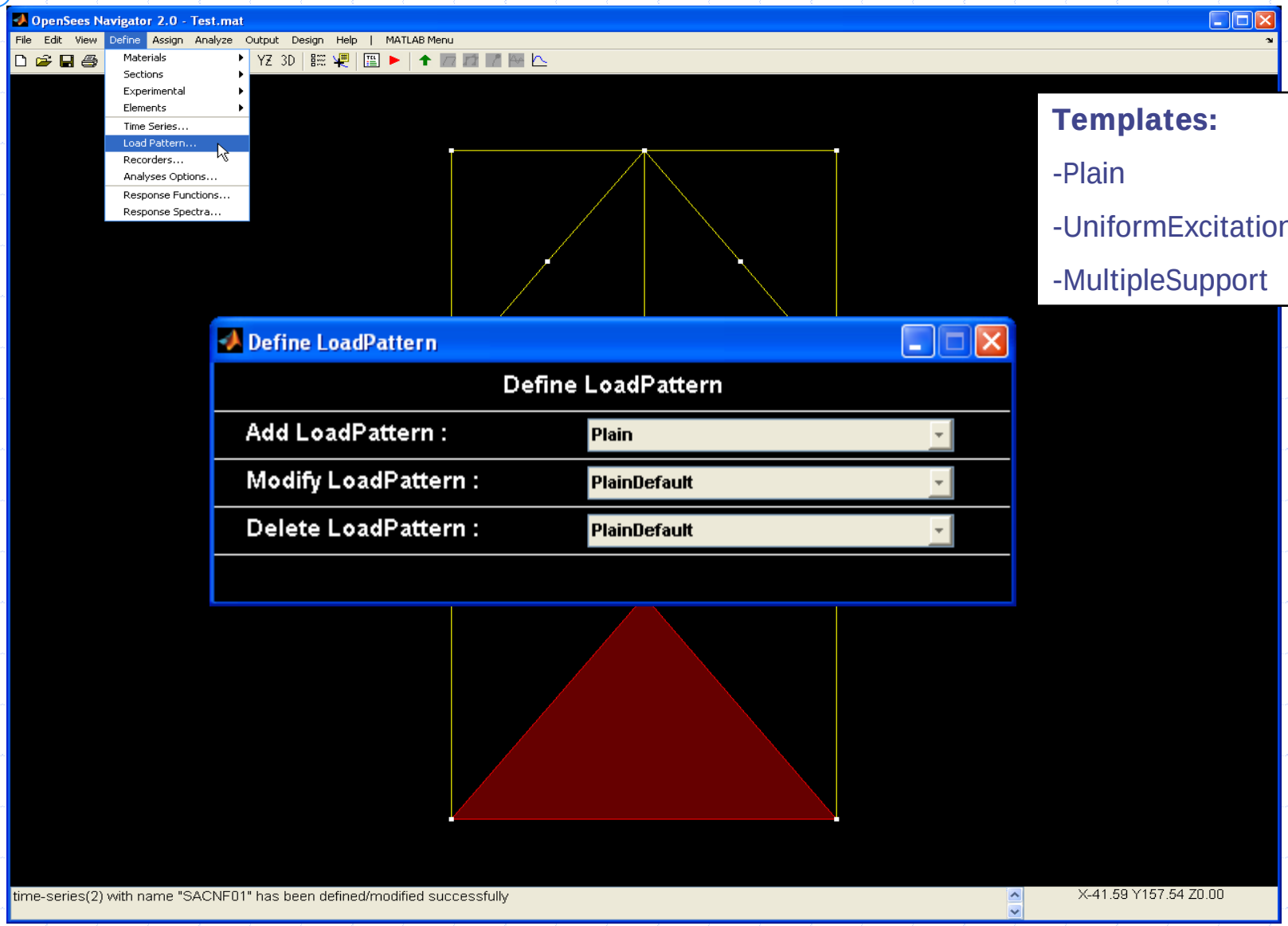




Plot TimeSeries



Define LoadPattern:



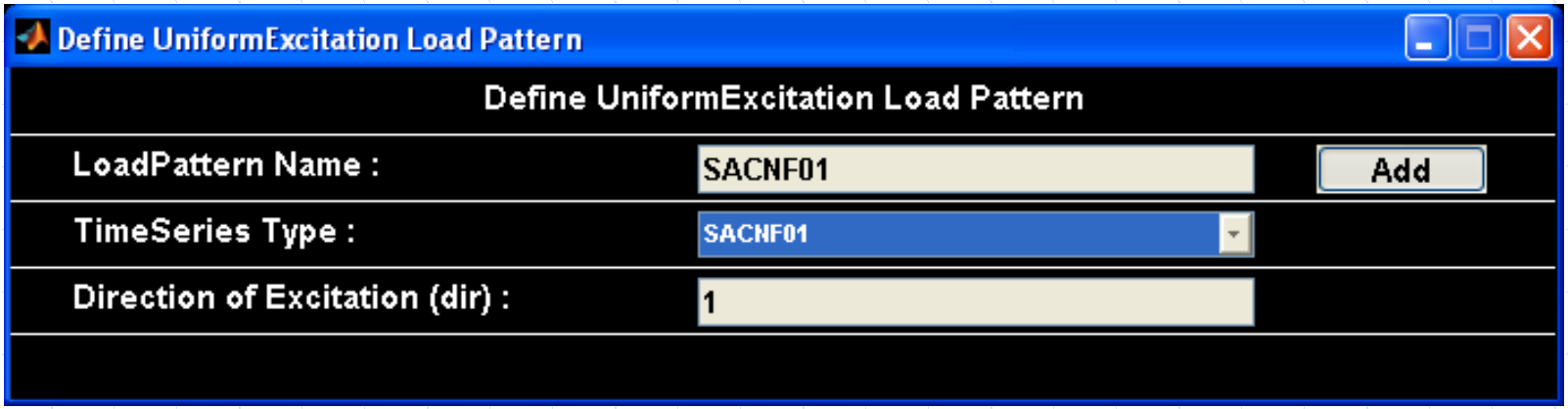
Templates:

-Plain

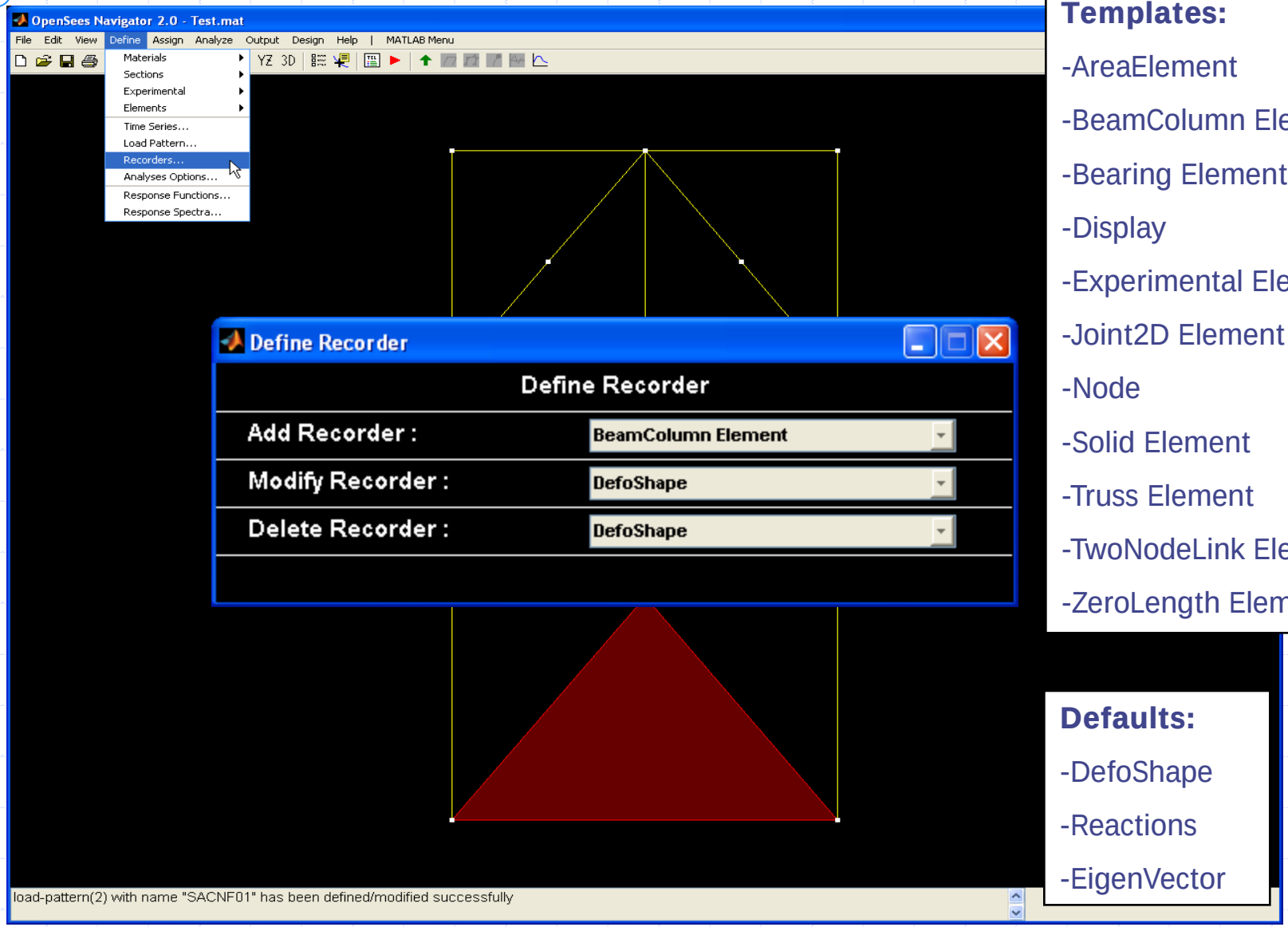
-UniformExcitation

-MultipleSupport

Define LoadPattern: UniformExcitation



Define recorder



Templates:

-AreaElement

-BeamColumn Element

-Bearing Element

-Display

-Experimental Element

-Joint2D Element

-Node

-Solid Element

-Truss Element

-TwoNodeLink Element

-ZeroLength Element

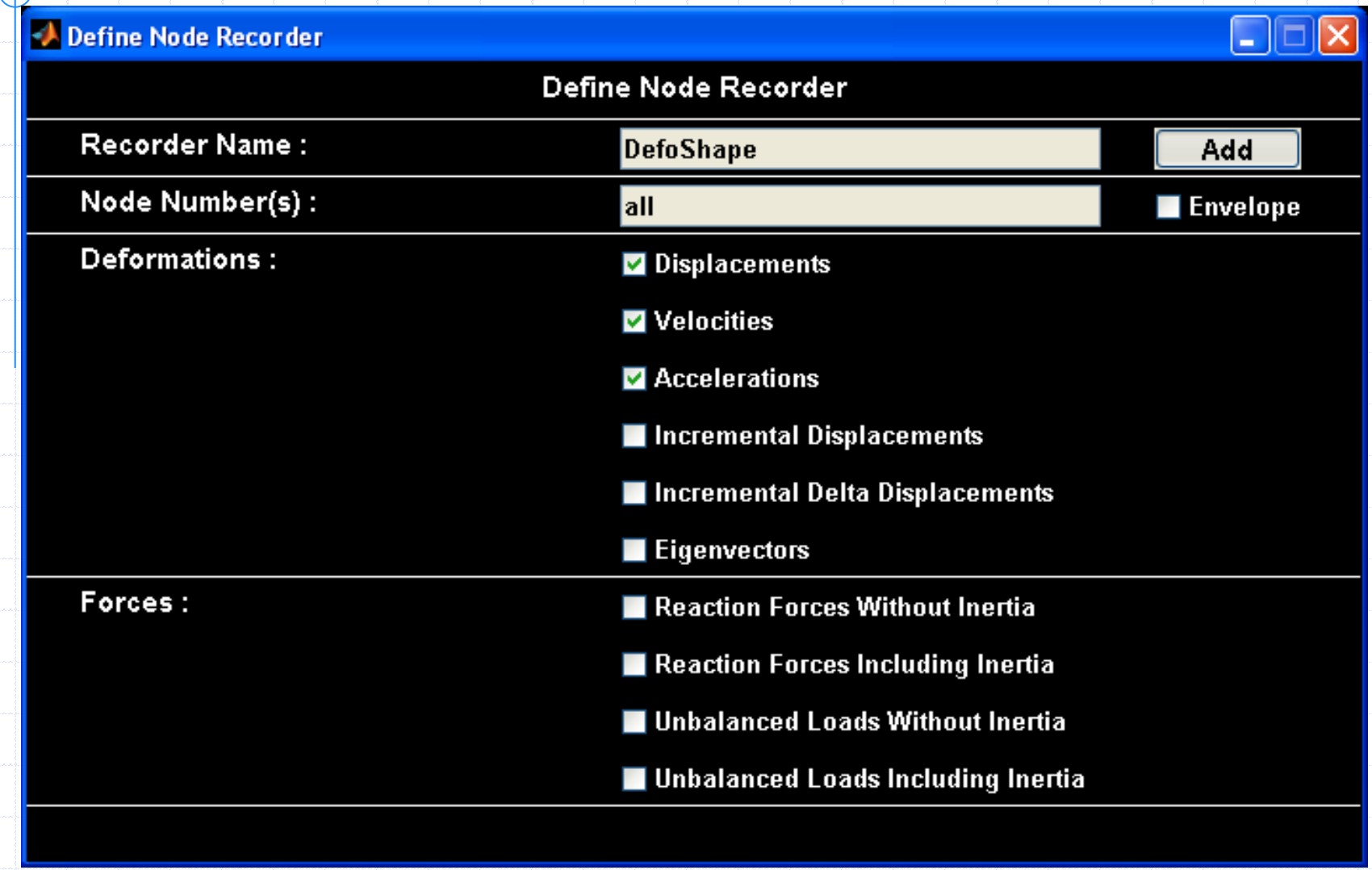
Defaults:

-DefoShape

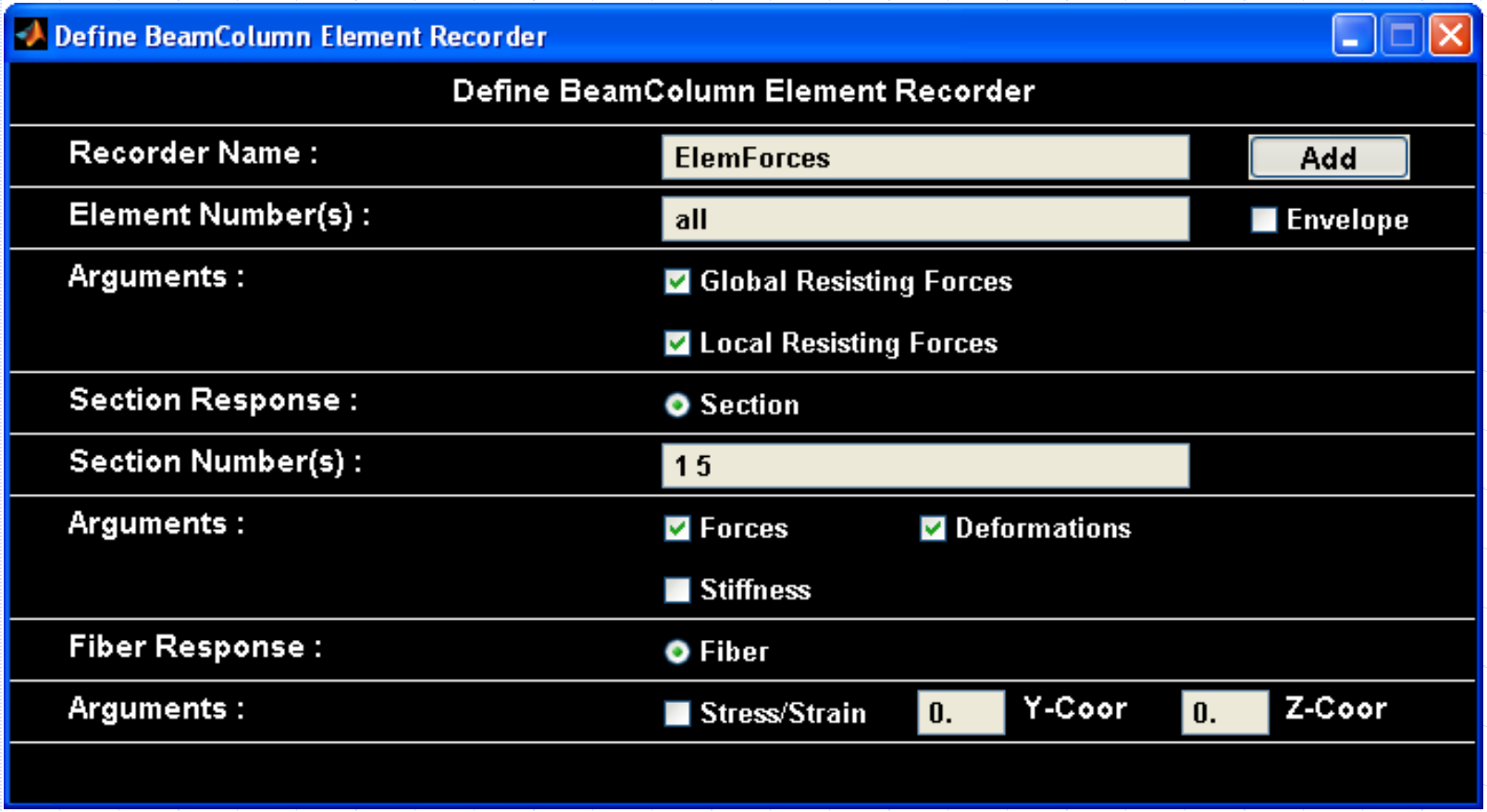
-Reactions

-EigenVector

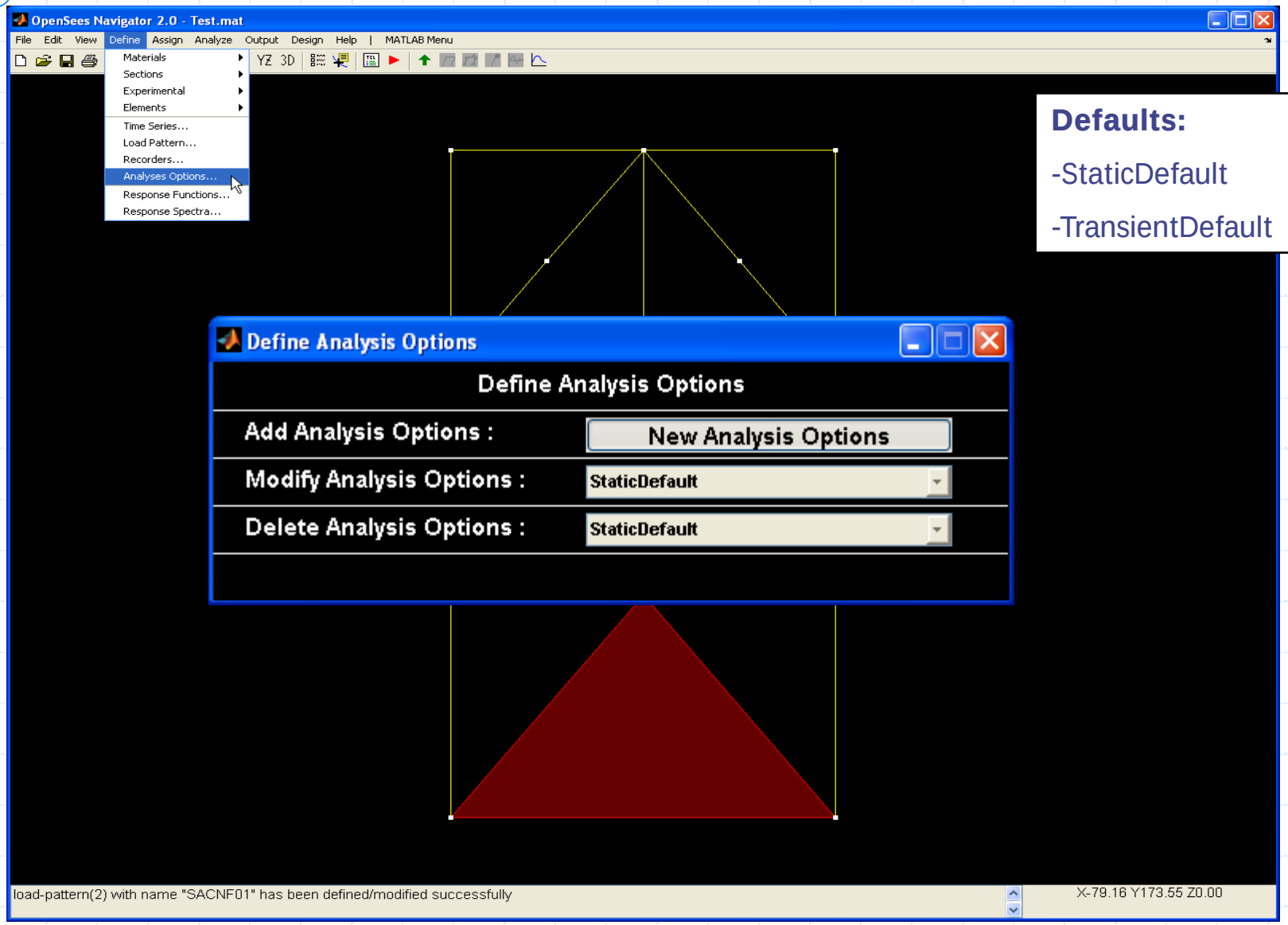
Define recorder: node recorder



Define recorder: BeamColumn recorder



Define analysis options

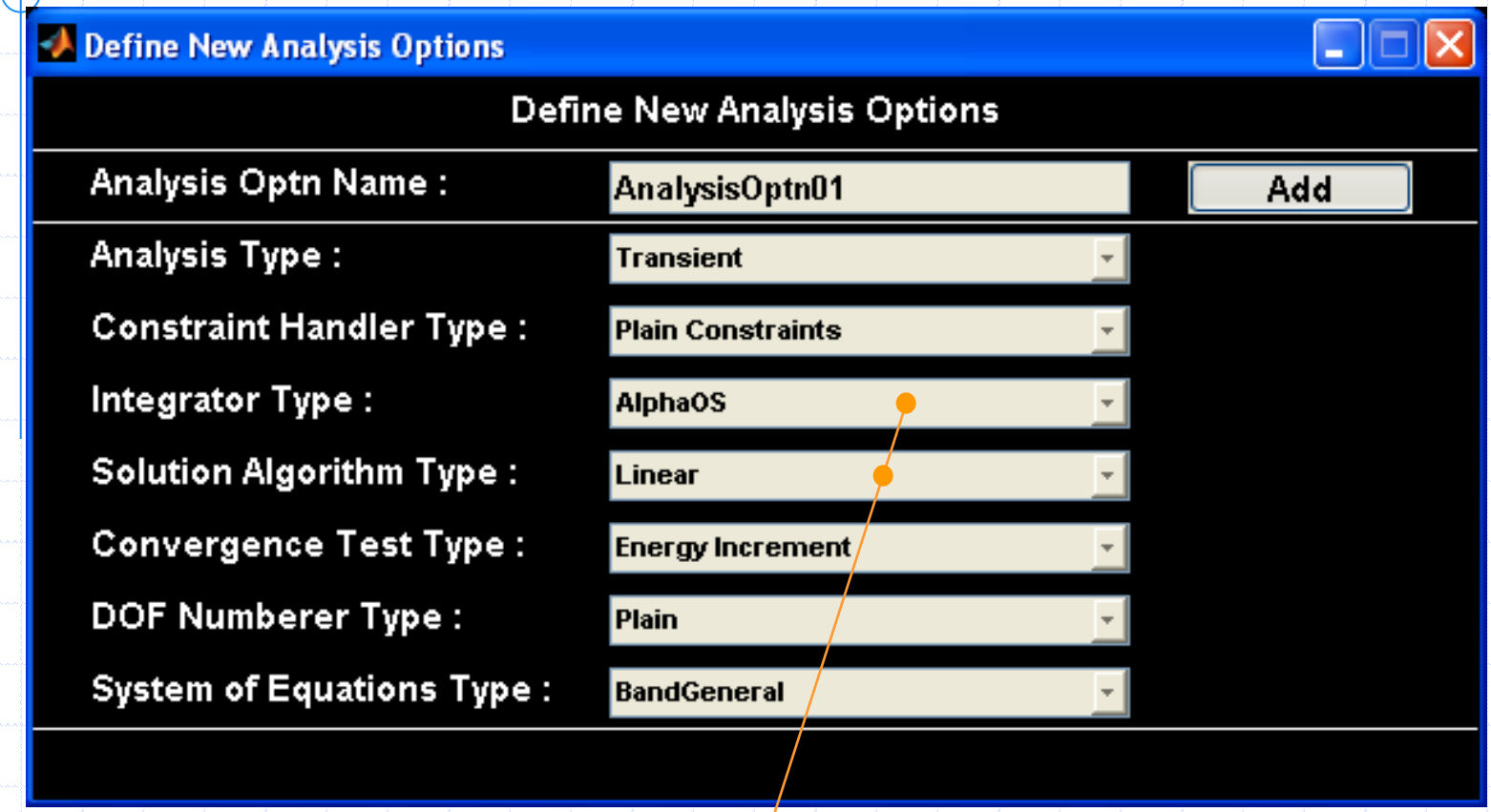


Defaults:

-StaticDefault

-TransientDefault

Define analysis options: new analysis



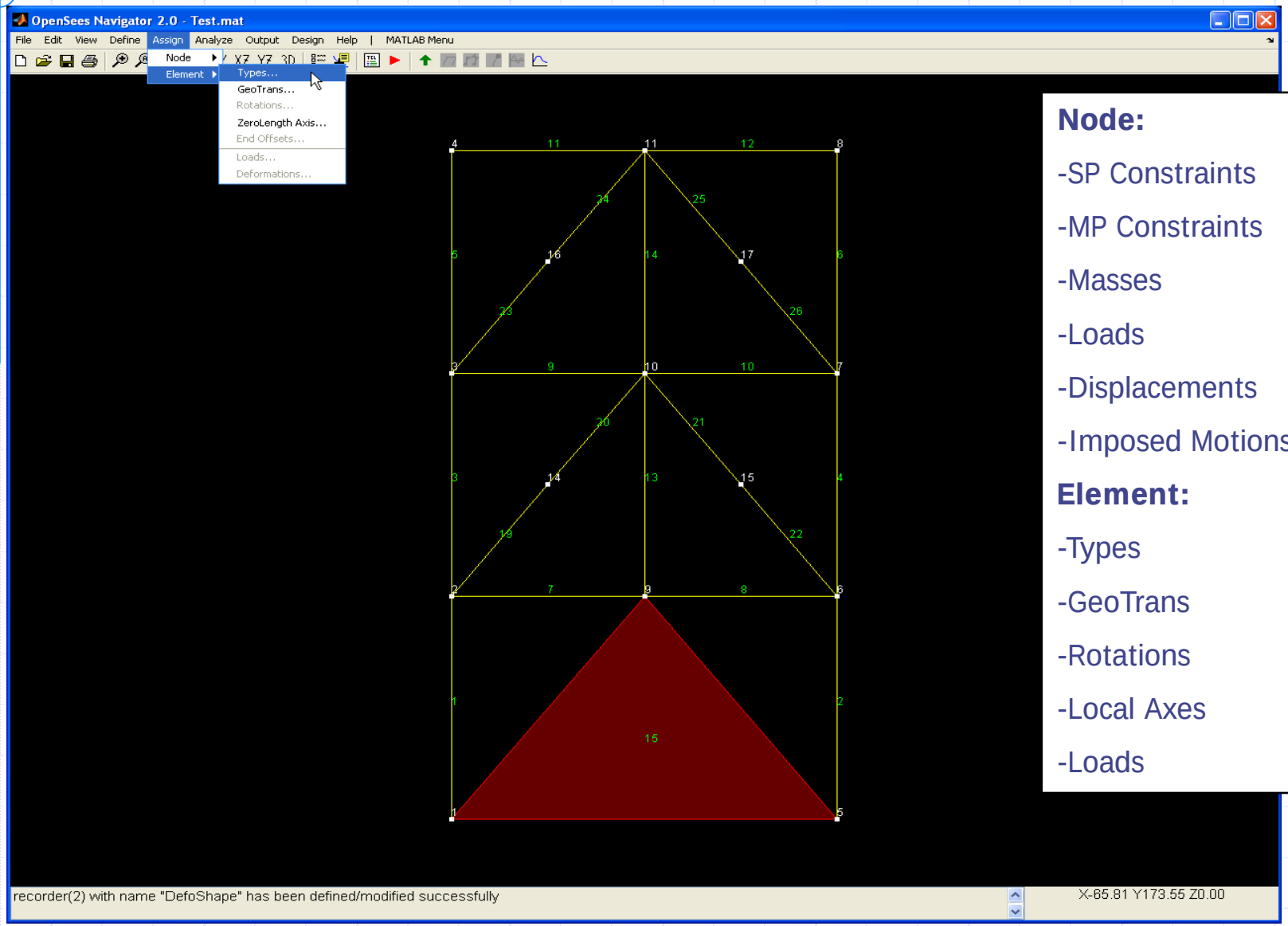
Integrator Type:

For example use AlphaOS Method for Hybrid Simulation

Solution Algorithm:

The AlphaOS Method requires a Linear solution algorithm

Assign menu



Node:

-SP Constraints

-MP Constraints

-Masses

-Loads

-Displacements

-Imposed Motions

Element:

-Types

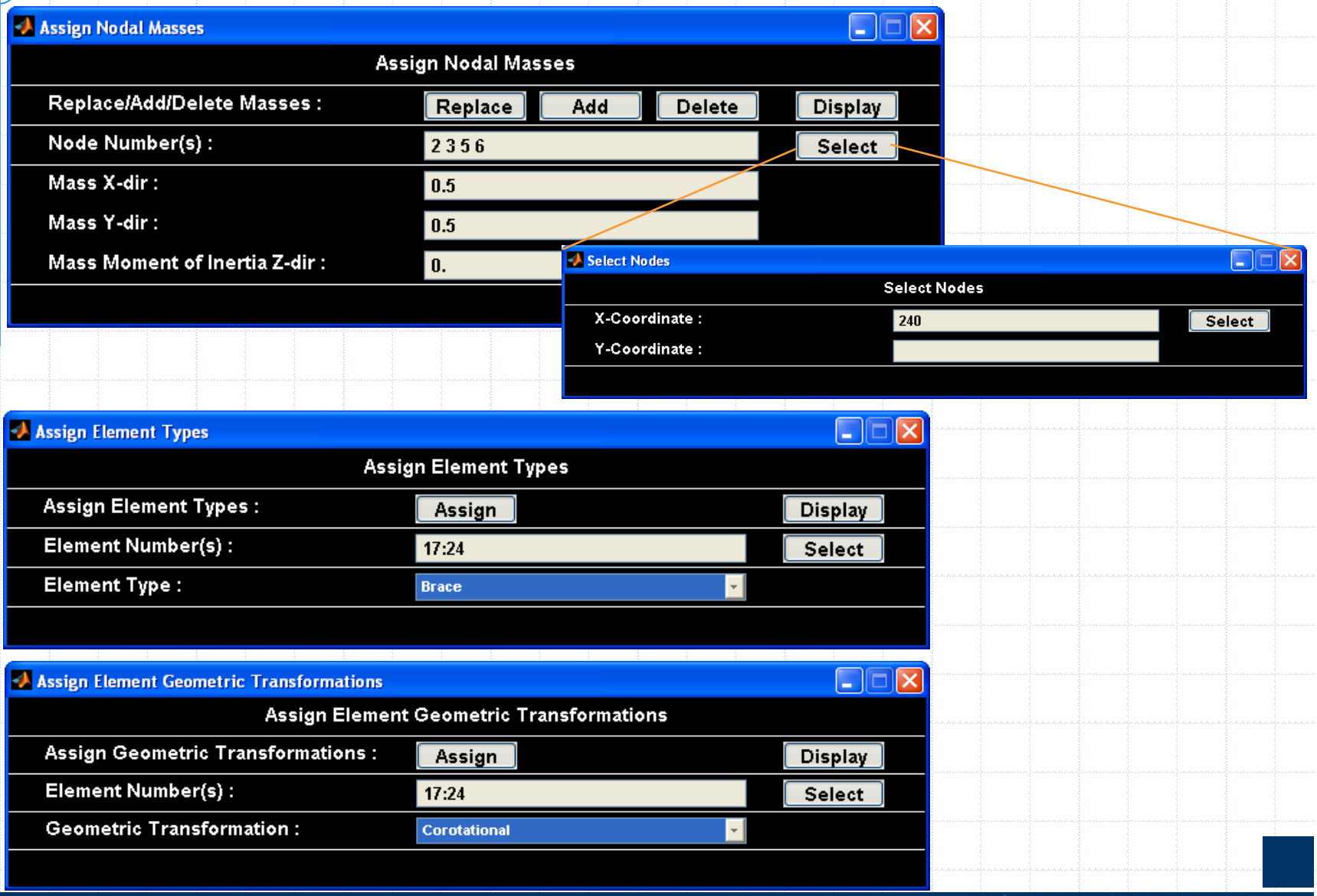
-GeoTrans

-Rotations

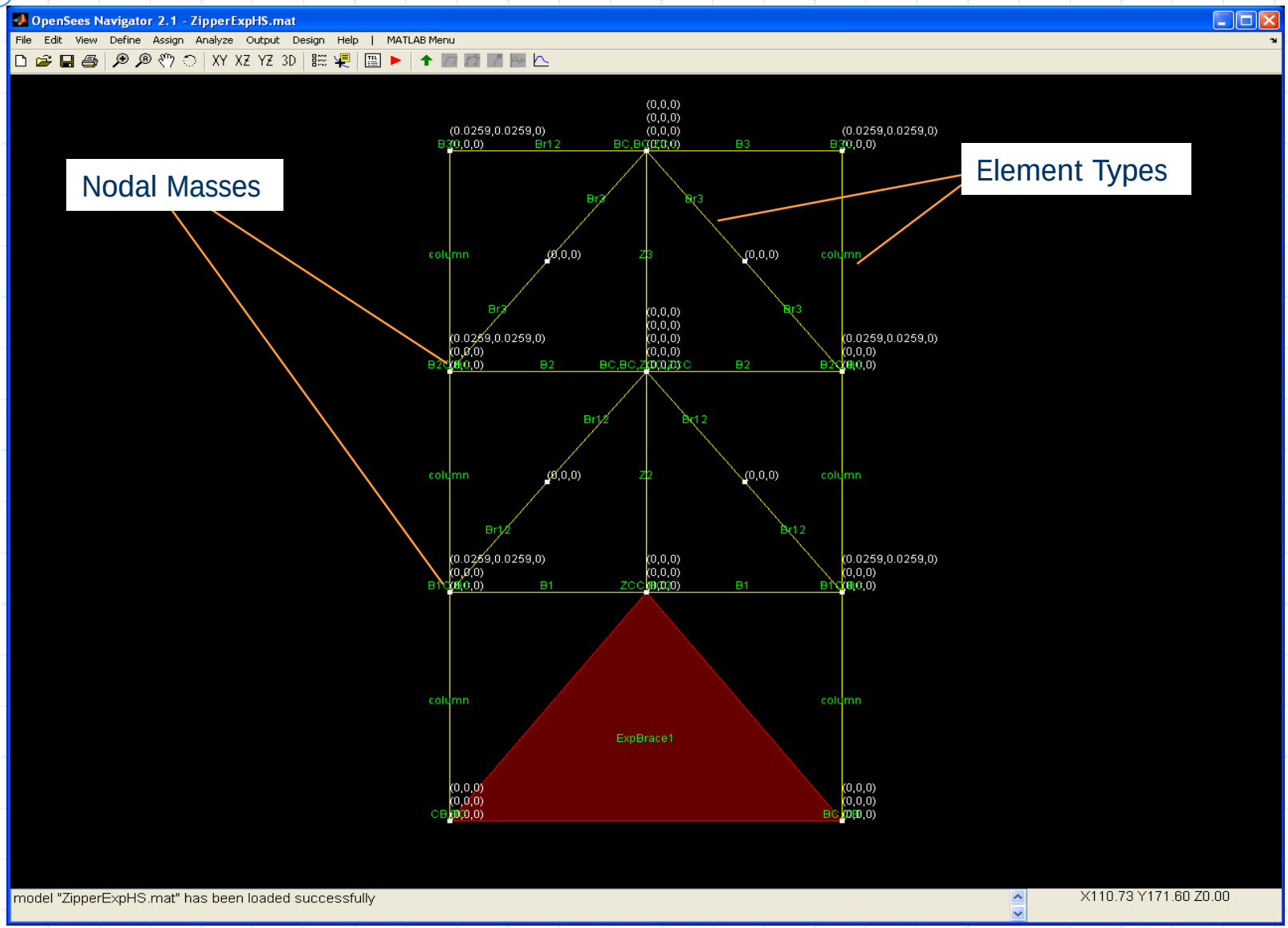
-Local Axes

-Loads

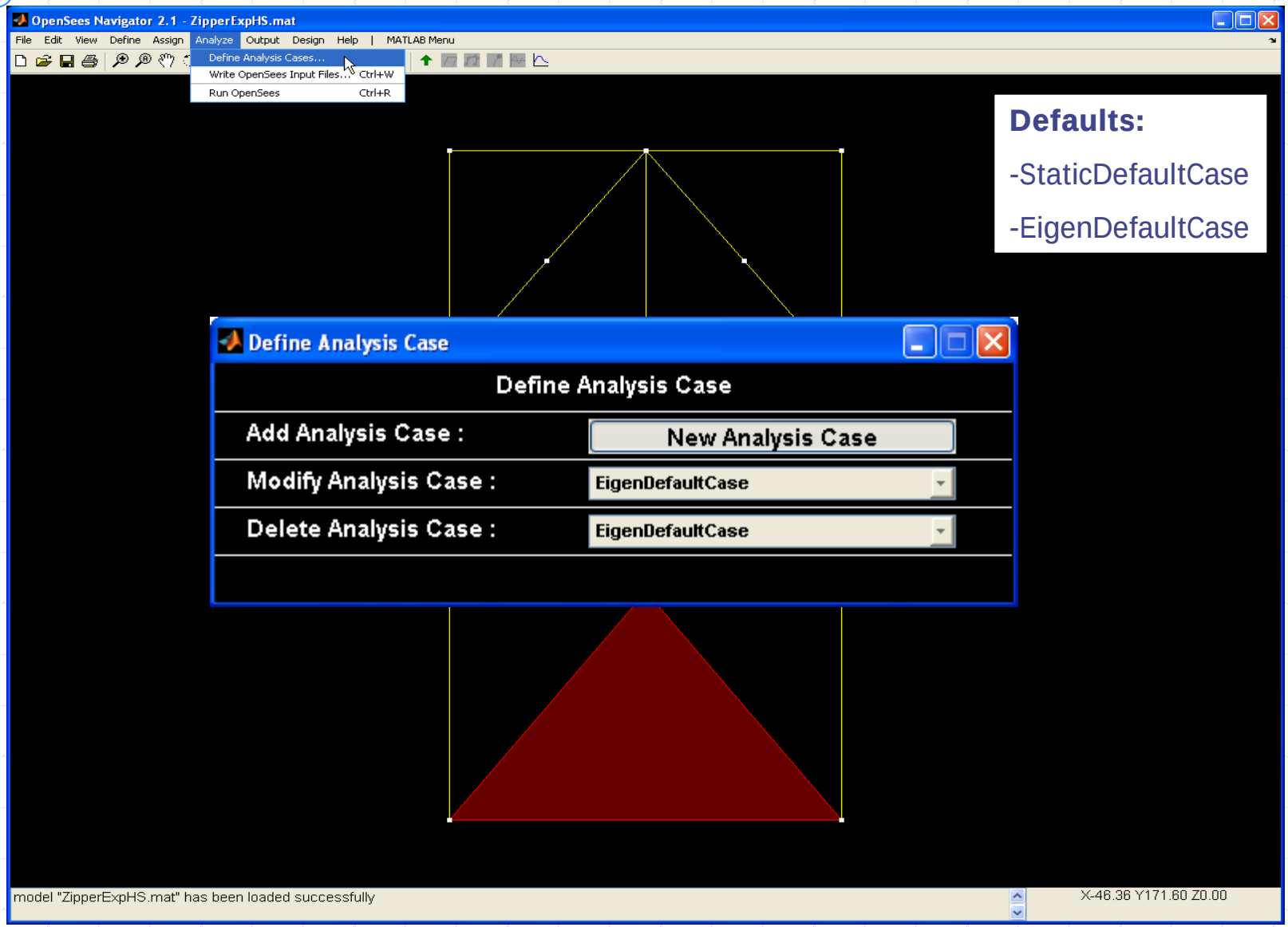
Assign menu


Assign Nodal Masses
Assign Nodal Masses
Replace/Add/Delete Masses :
Replace
Add
Delete
Display
Node Number(s) :
2 3 5 6
Select
Mass X-dir :
0.5
Mass Y-dir :
0.5
Mass Moment of Inertia Z-dir :
0.
Select Nodes
Select Nodes
X-Coordinate :
240
Select
Y-Coordinate :
Assign Element Types
Assign Element Types
Assign Element Types :
Assign
Display
Element Number(s) :
17:24
Select
Element Type :
Brace
Assign Element Geometric Transformations
Assign Element Geometric Transformations
Assign Geometric Transformations :
Assign
Display
Element Number(s) :
17:24
Select
Geometric Transformation :
Corotational

Display assigned properties



Define analysis case

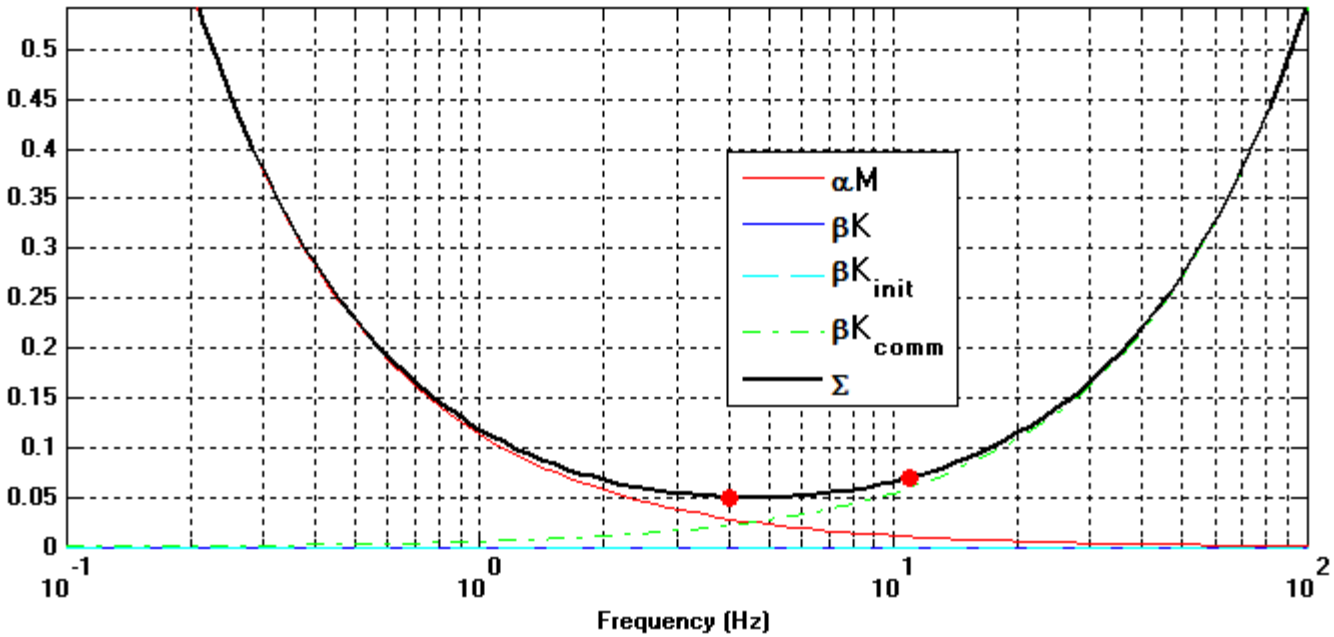


De

Define New Damping Parameters

Define New Damping Parameters

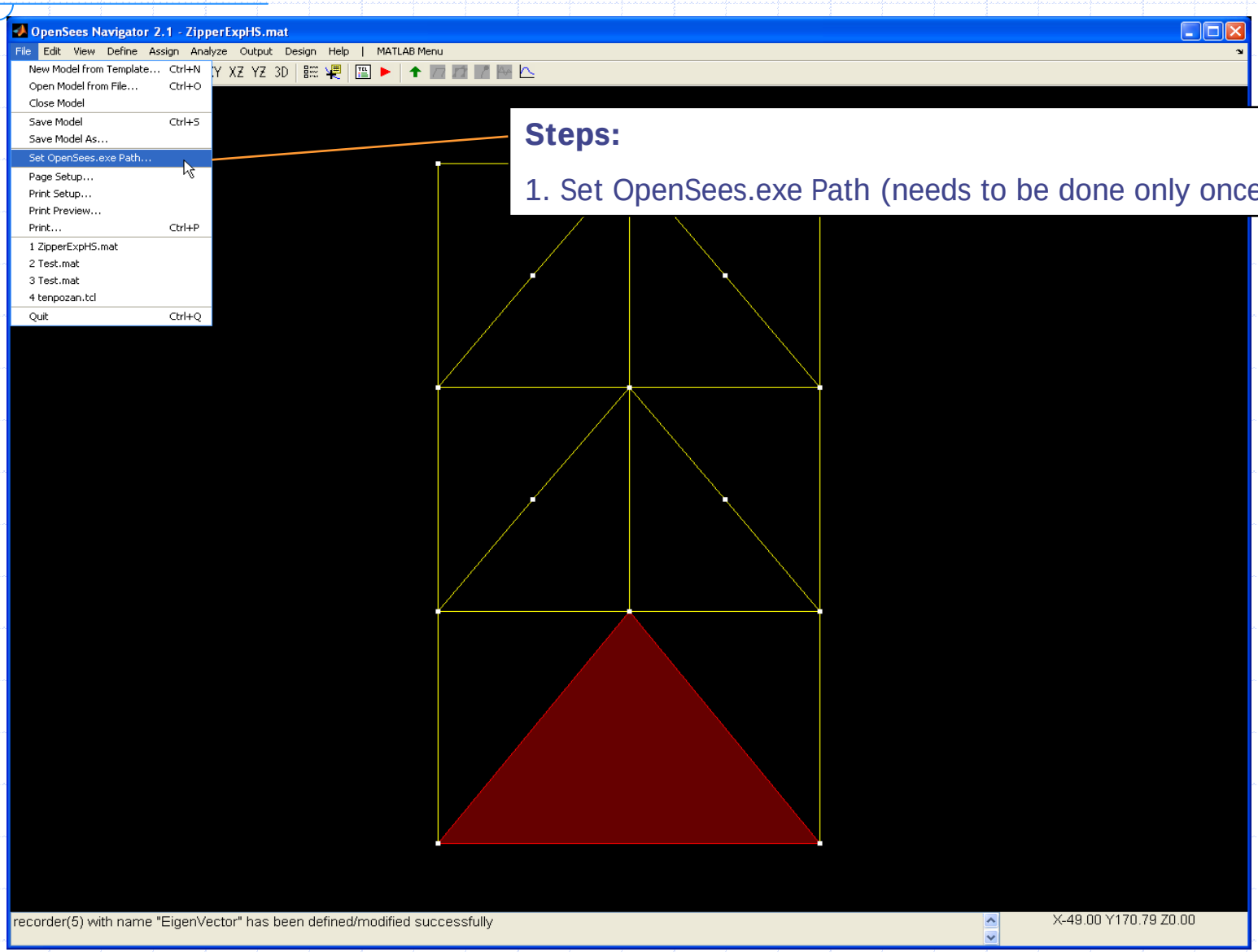
Damping Parameter Set Name :	DampingParam01	Add
Region Defined by :	Nodes	
Node or Element Number(s) :	all	
Mass Prop. Damping (alphaM) :	1.4218	Calculate
Kcurr Prop. Damping (betaK) :	0.	
Kinit Prop. Damping (betaKinit) :	0.	
Kcom Prop. Damping (betaKcom) :	0.001728	



User Defined Analysis Script

```
# set the test parameters
set testType NormDispIncr
set testTol 1.0e-8;
set testIter 25;
test  $testType $testTol $testIter

# set the algorithm parameters
set algoType KrylovNewton
algorithm  $algoType

set ok 0;
set tFinal [expr $numSteps * $dt]
set tCurrent [getTime]

while {$ok == 0 && $tCurrent < $tFinal} {
   if {fmod($tCurrent,1) < 1.0E-16} {
          puts "$i $tCurrent"
       }
       set ok [analyze 1 $dt]

   if {$ok != 0} {
      puts " "
      puts [format "KrylovNewton failed (time = %1.3e), try Newton" $tCurrent]
            algorithm Newton
      test $testType $testTol $testIter 0
      set ok [analyze 1 $dt]
      algorithm $algoType
   }

   if {$ok != 0} {
      puts " "
            puts [format "Newton failed (time = %1.3e), try Newton  w/ iniCurrent" $tCurrent]
            algorithm Newton -initialCurrent
      test $testType $testTol $testIter 0
      set ok [analyze 1 $dt]
      algorithm $algoType
   }

     if {$ok != 0} {
      puts " "
            puts [format "Newton  w/ iniCurrent failed (time = %1.3e), try Newton  w/ ini" $tCurrent]
            algorithm Newton -initial
      test $testType $testTol [expr 500 * $testIter] 0
      set ok [analyze 1 $dt]
      algorithm $algoType
      test $testType $testTol $testIter 0
```

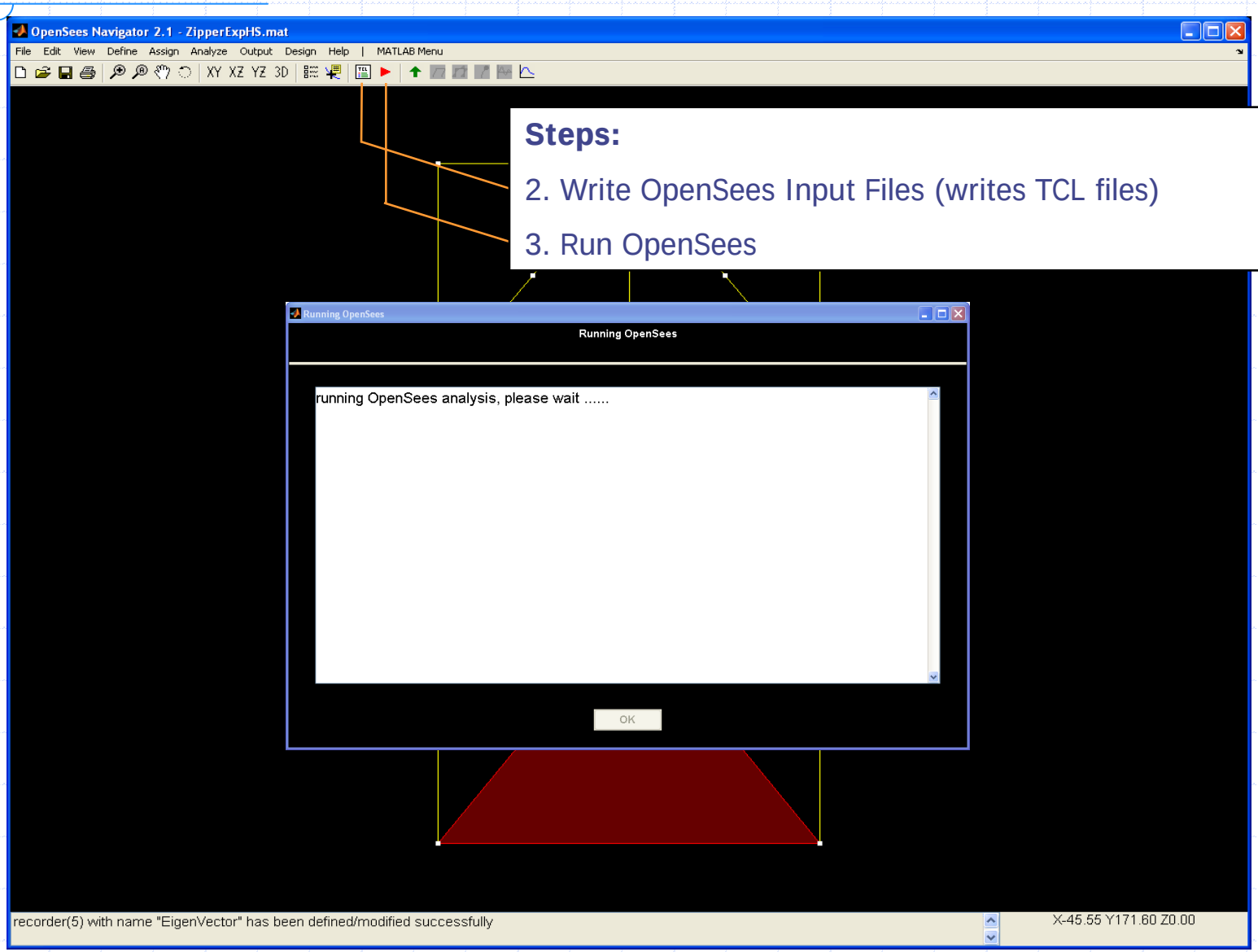
Run OpenSees: set OpenSees.exe path



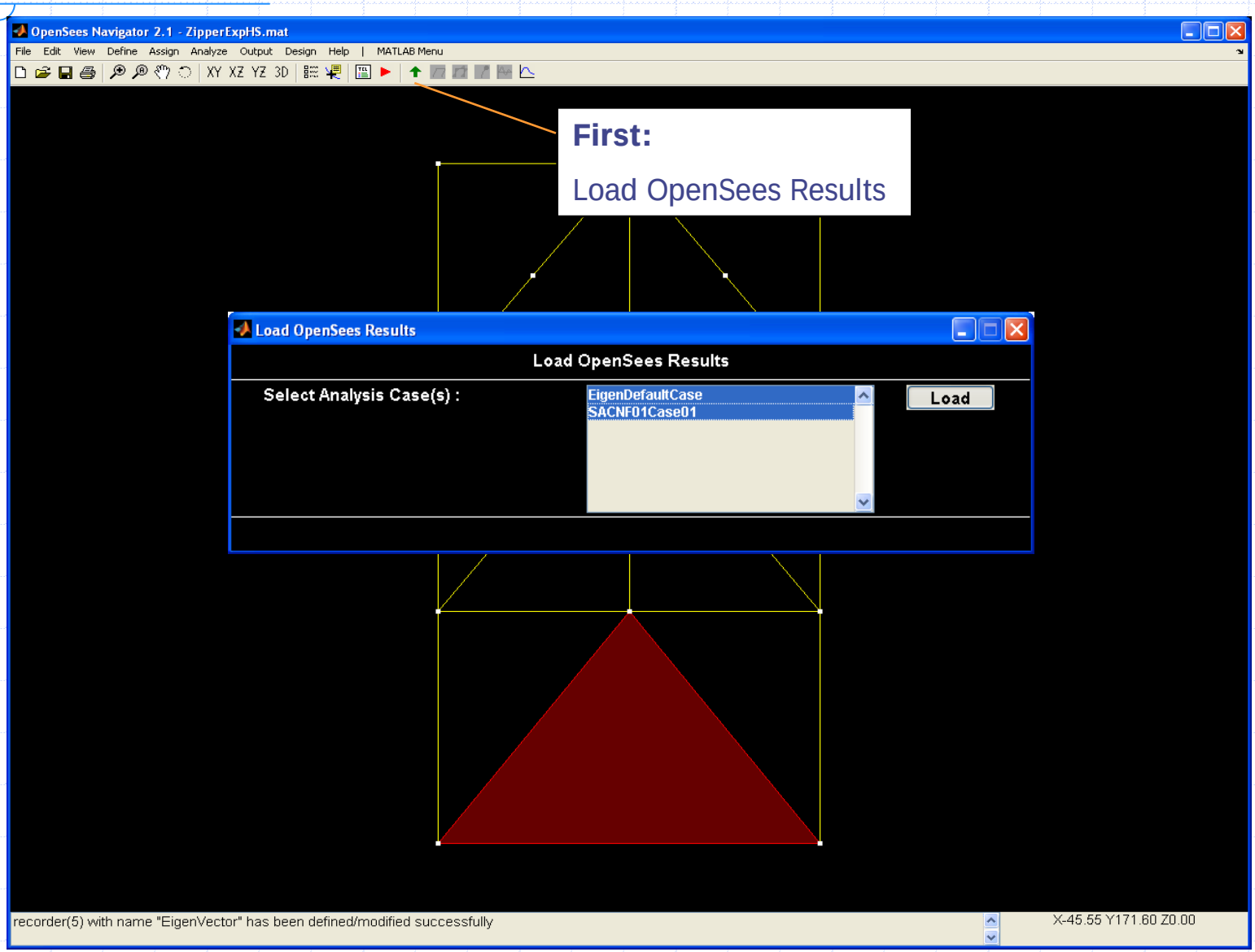
Steps:

1. Set OpenSees.exe Path (needs to be done only once)

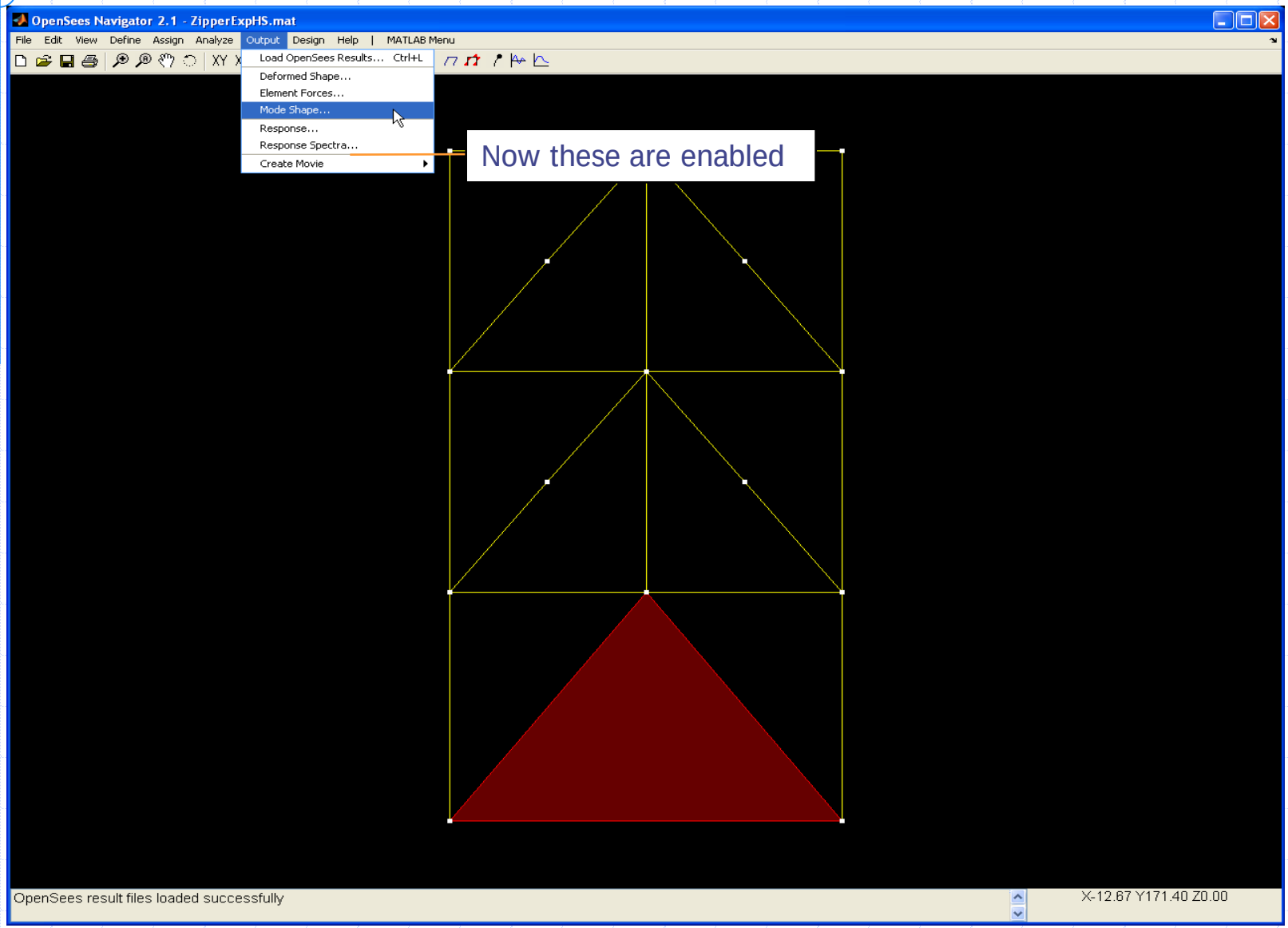
Run OpenSees: write TCL files



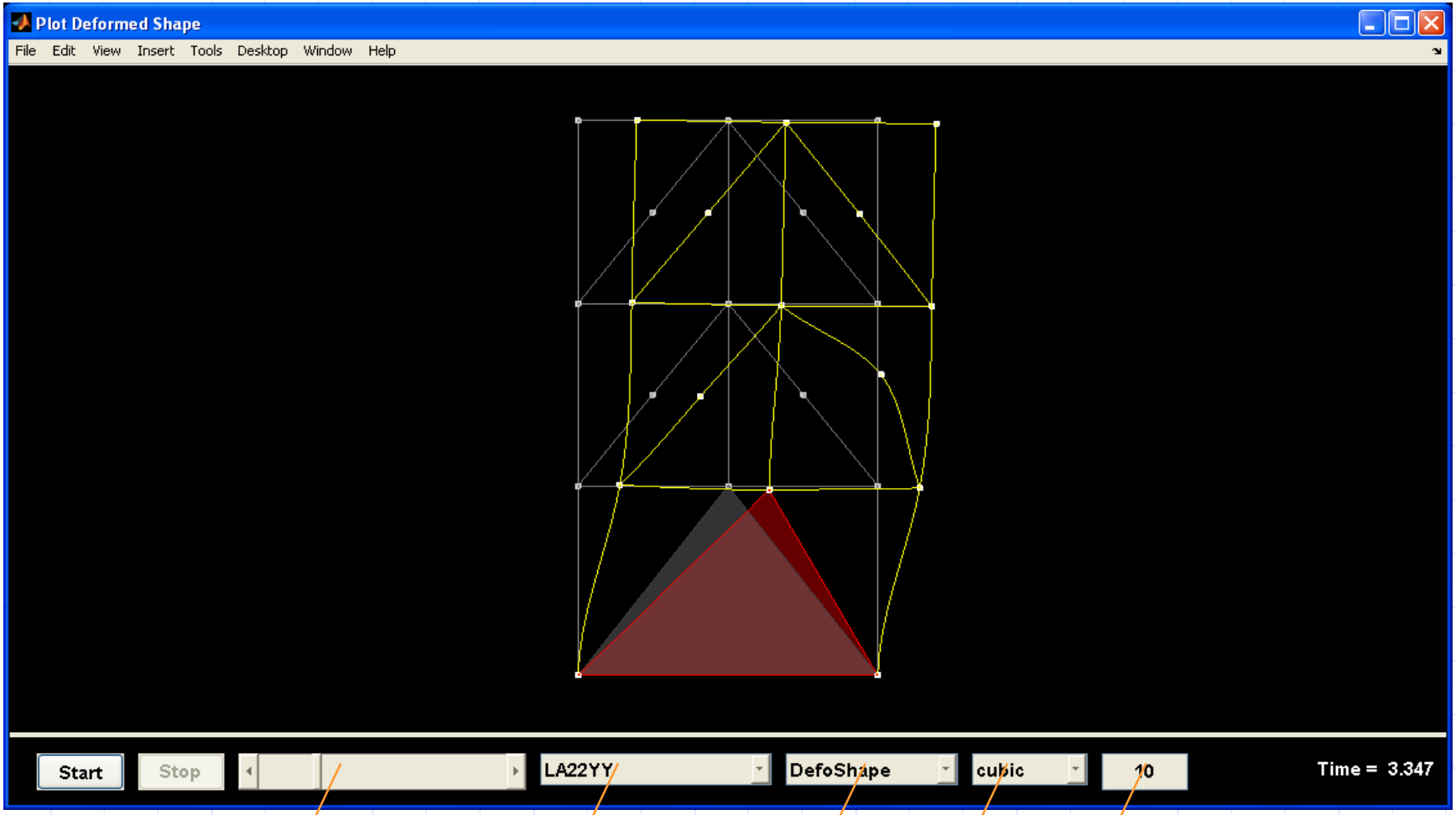
Post processing: load results



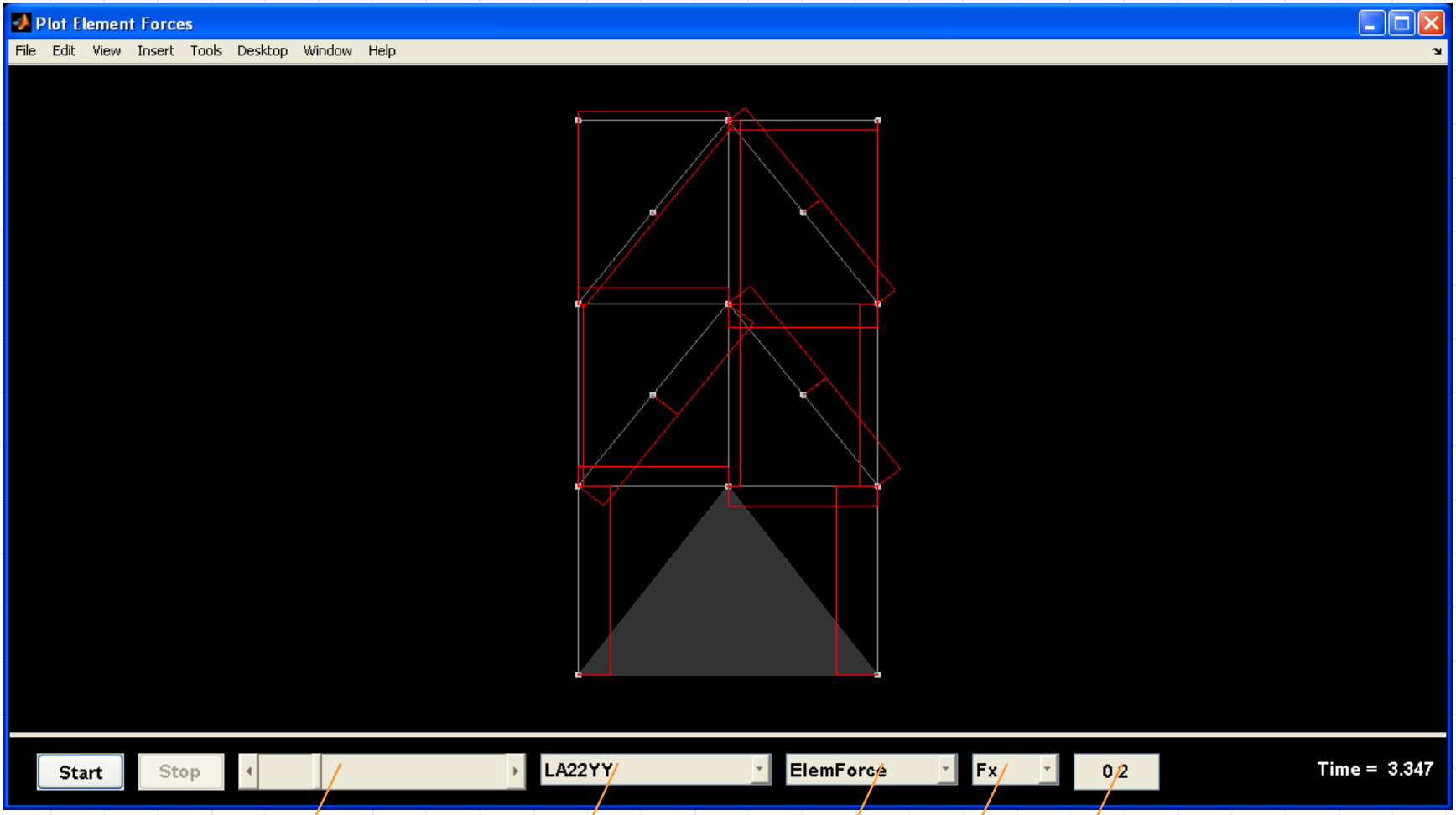
Post processing: output



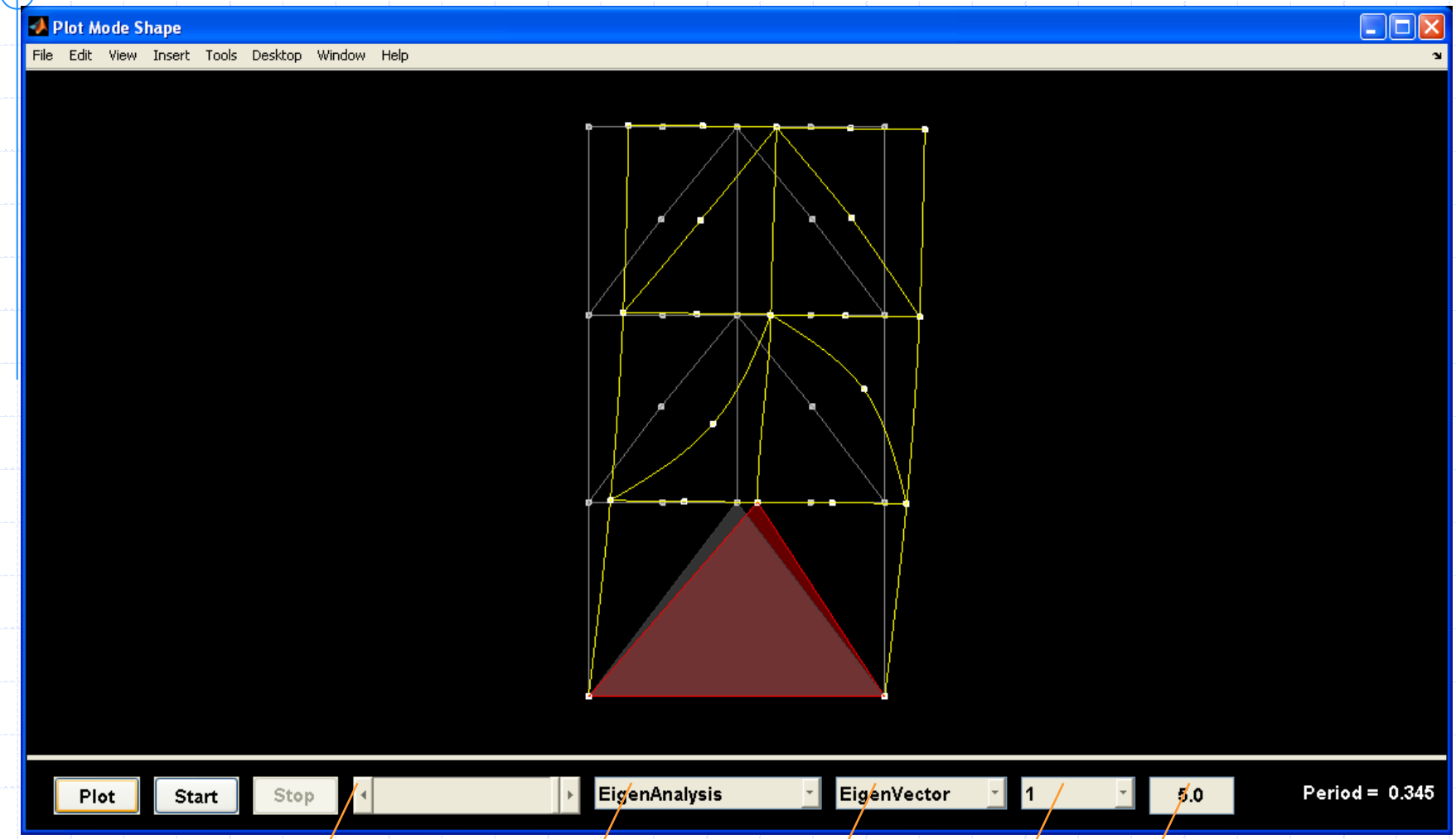
Post processing: plot deformed shape



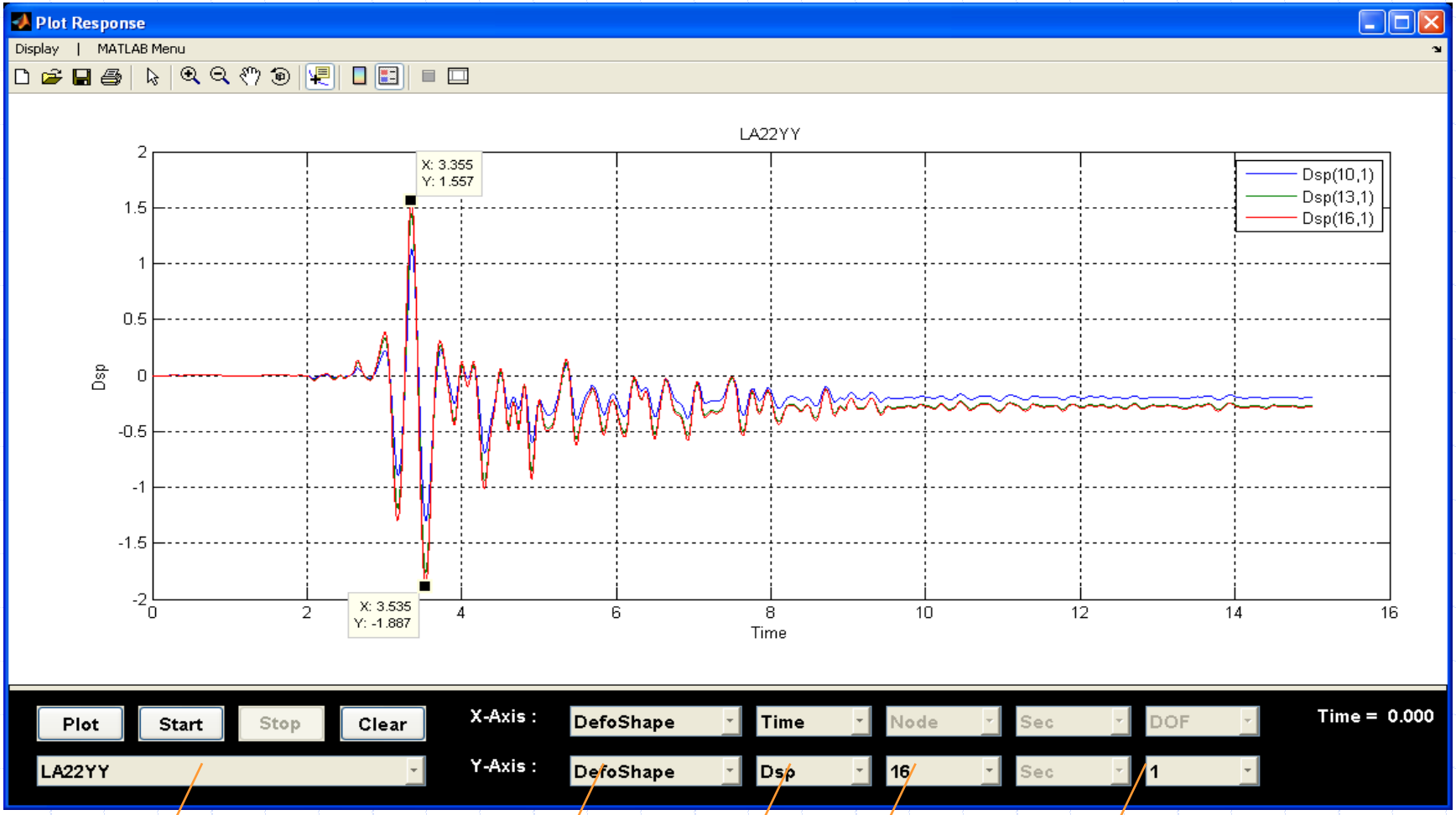
Post processing: plot element forces



Post processing: plot mode shape



Post processing: plot response histories



AnalysisCase

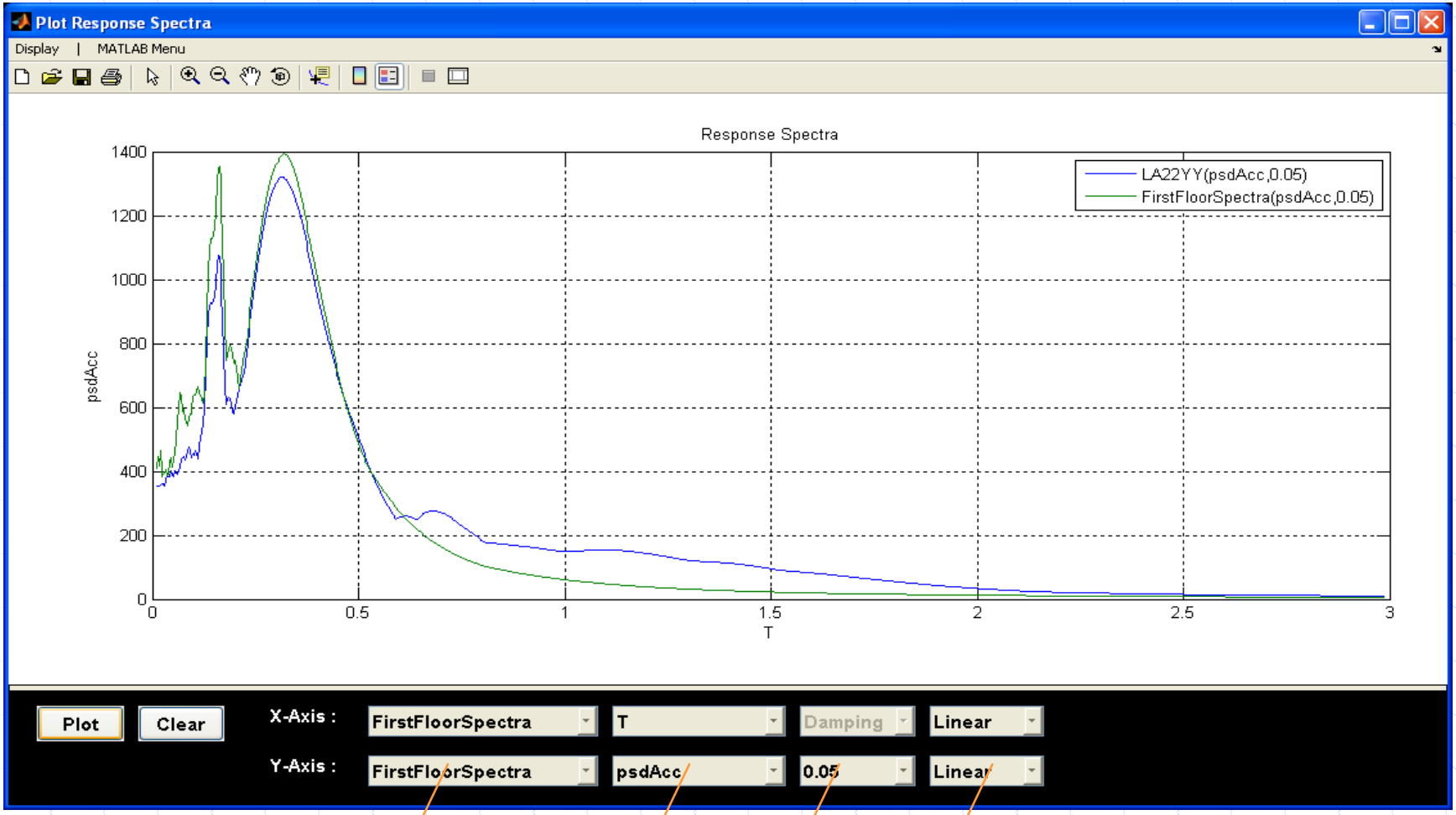
Recorder

Parameter

Node/Element

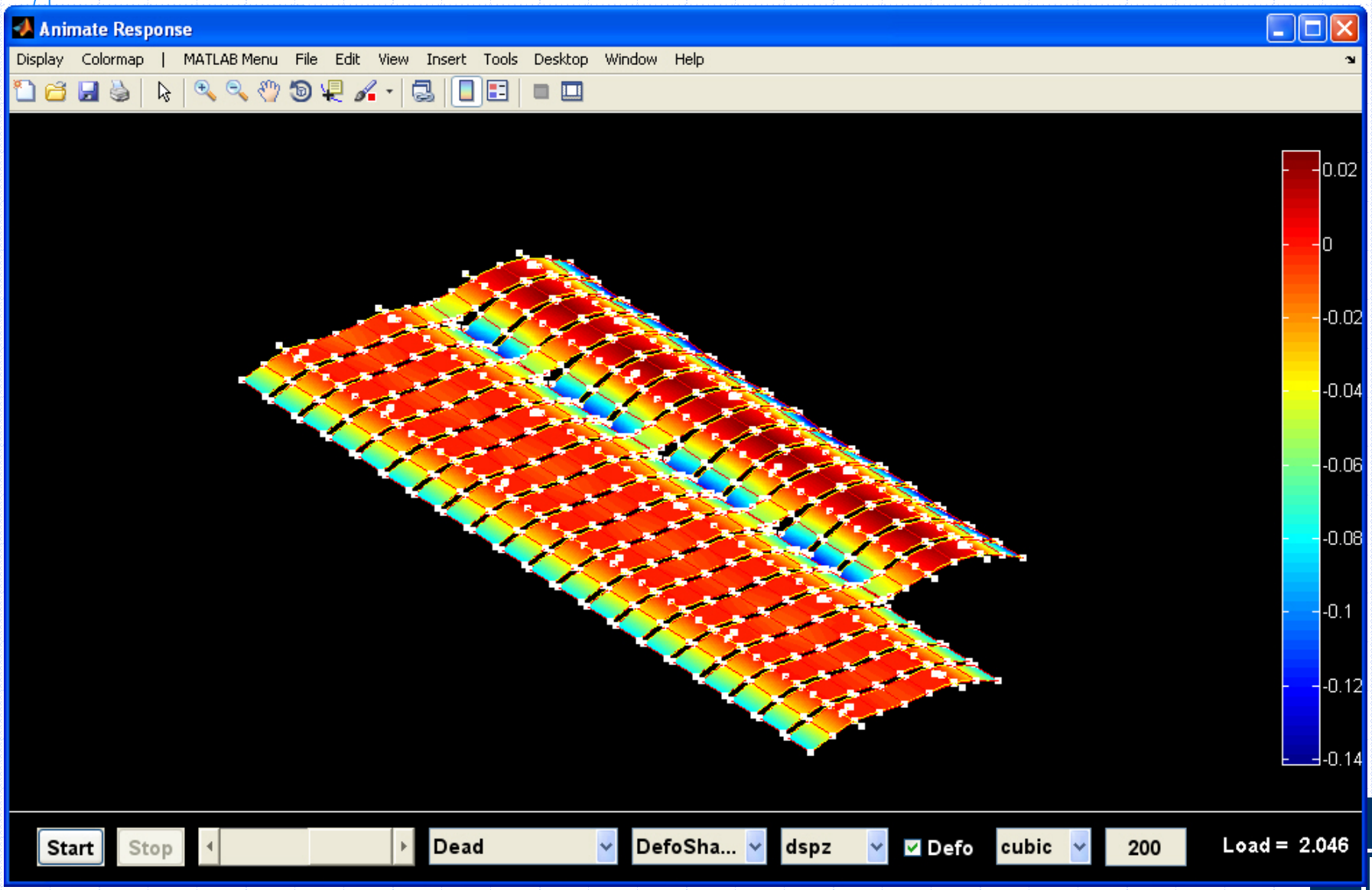
DOF

Post processing: plot response spectra

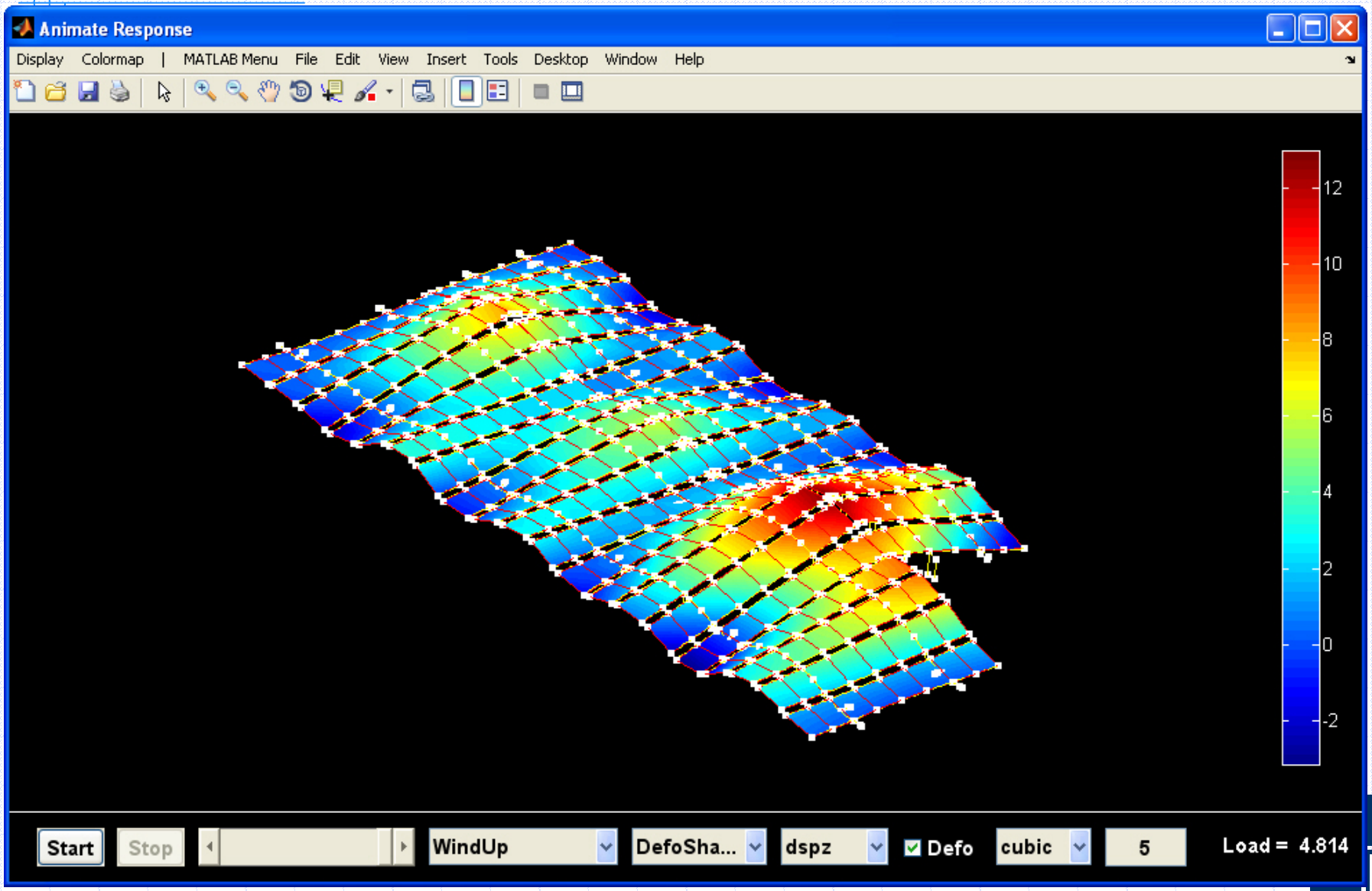


Spectra Name Response Damping Axis Scale

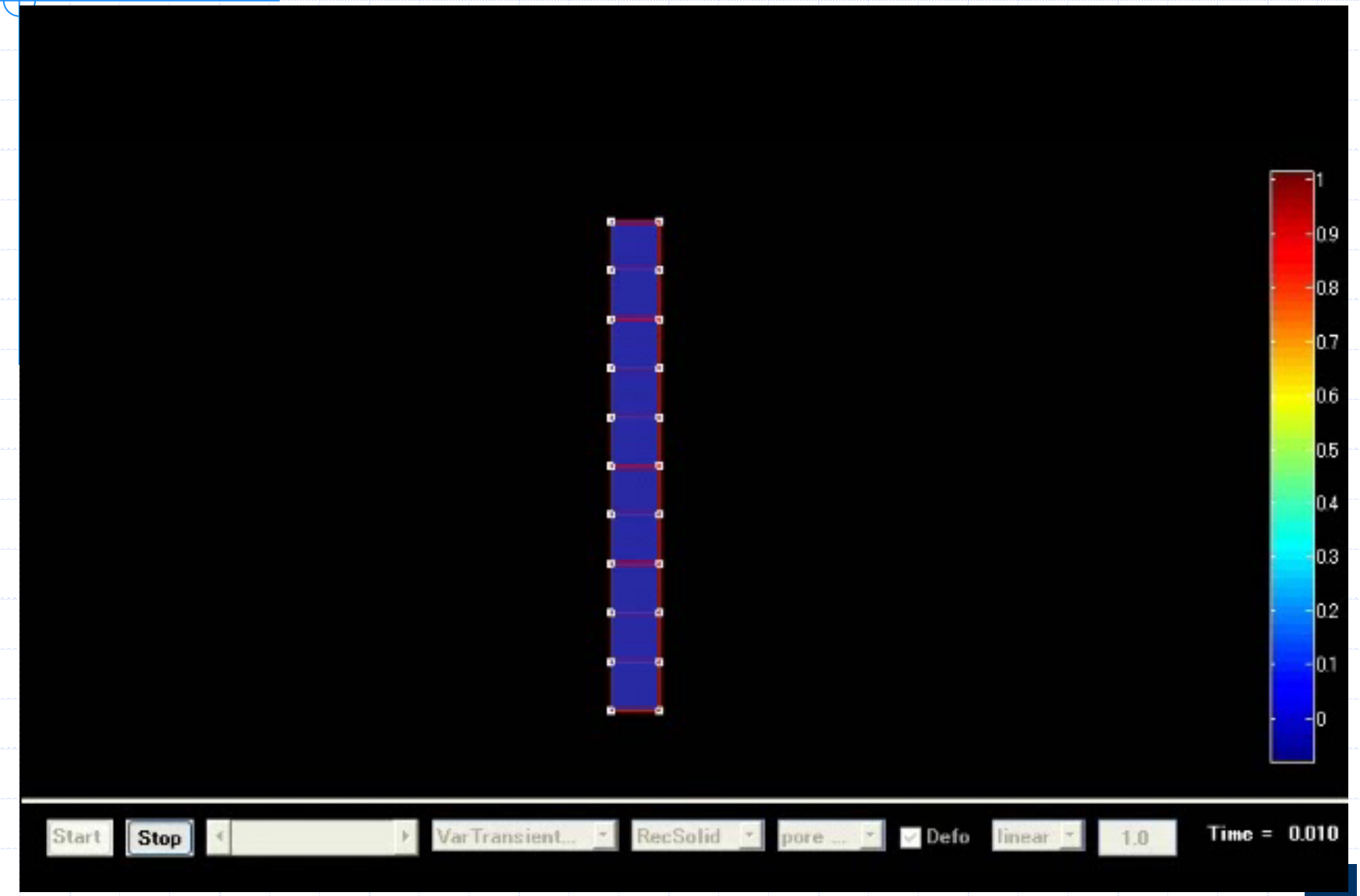
Post processing: animate response



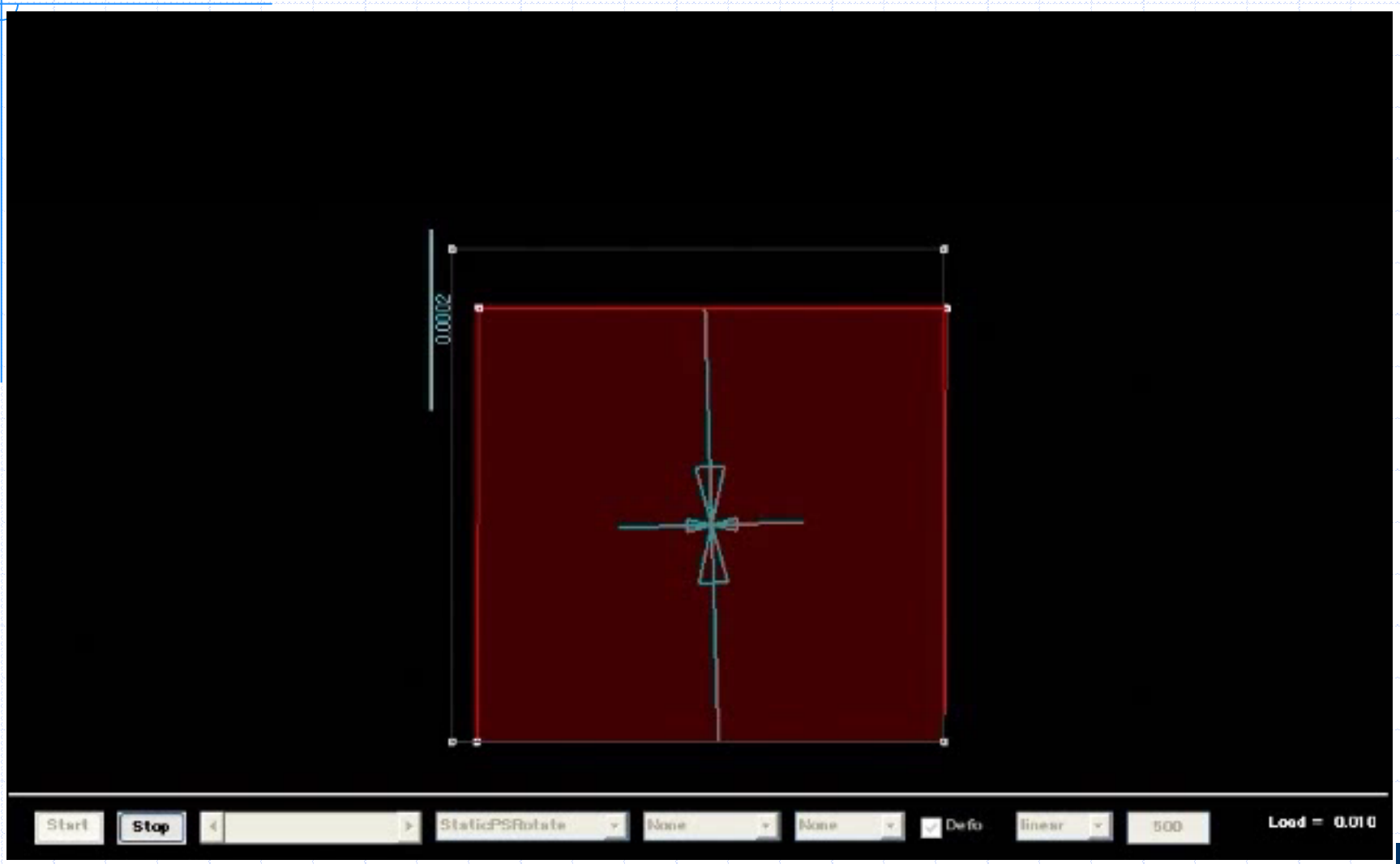
Post processing: animate response



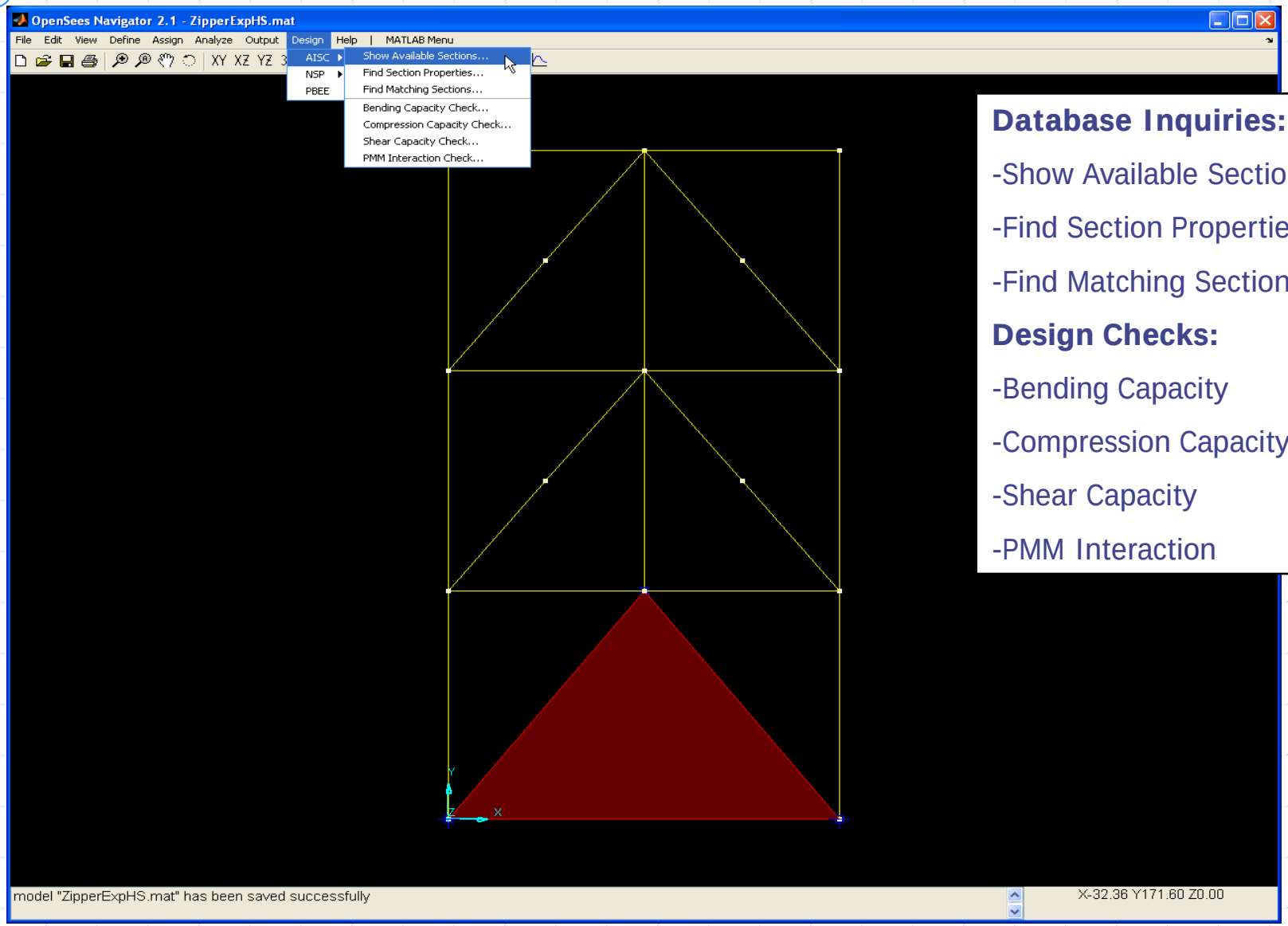
Post processing: animate response



Post processing: principal stress and strain



Design: AISC design toolbox



Database Inquiries:

-Show Available Sections

-Find Section Properties

-Find Matching Sections

Design Checks:

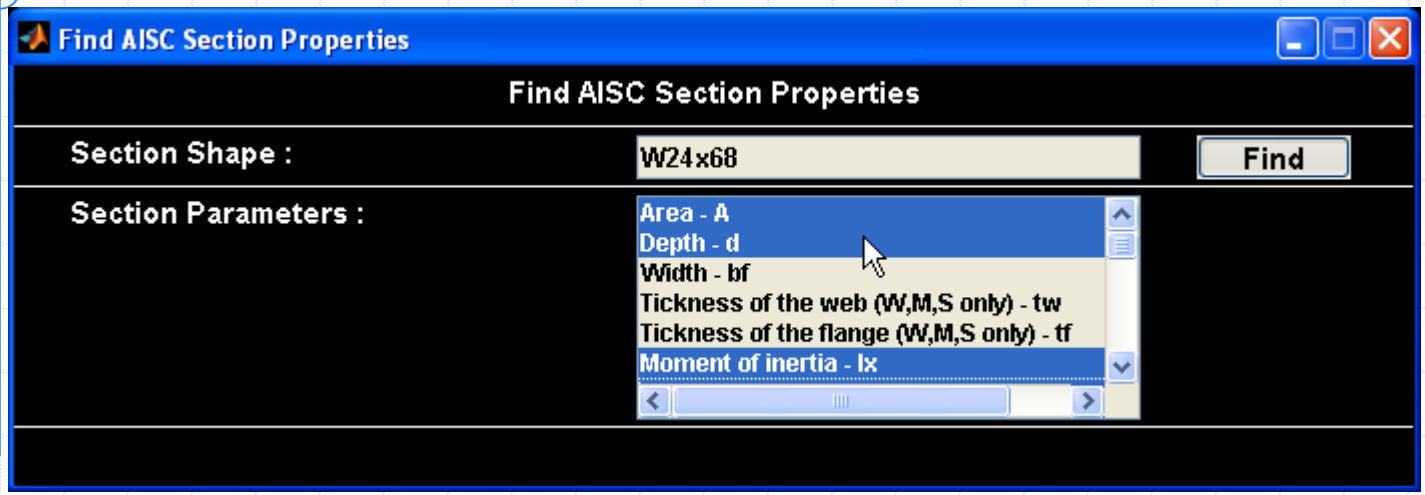
-Bending Capacity

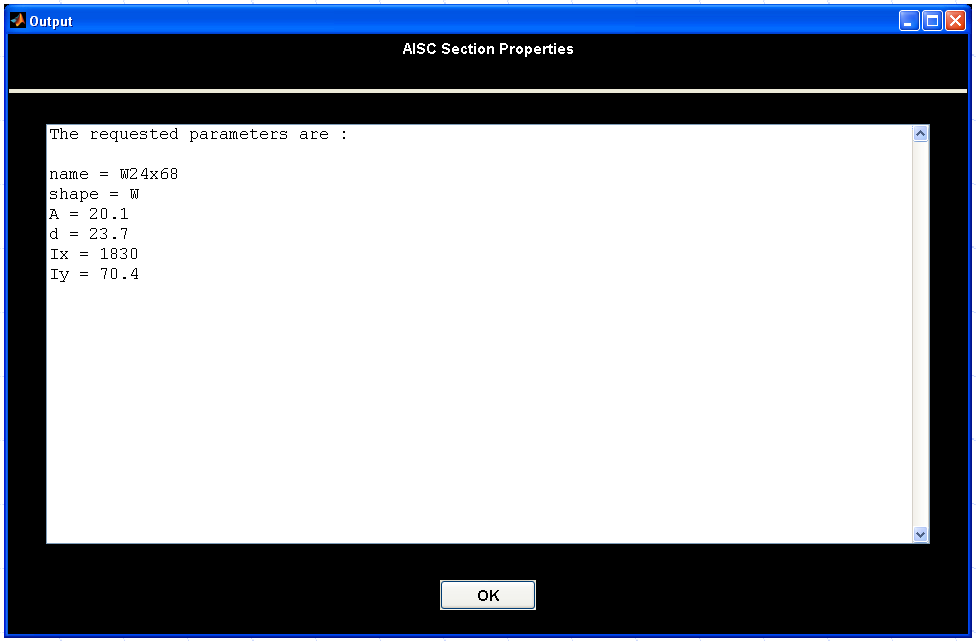
-Compression Capacity

-Shear Capacity

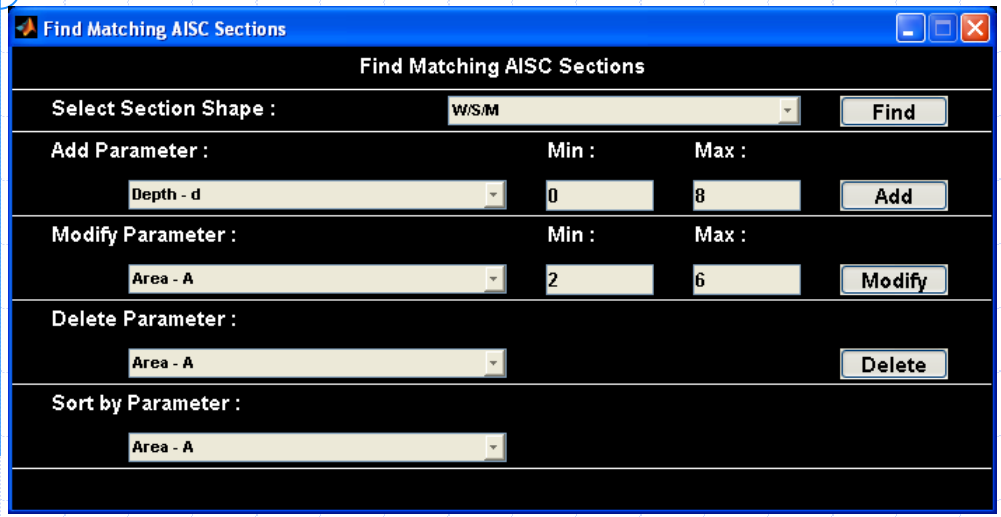
-PMM Interaction

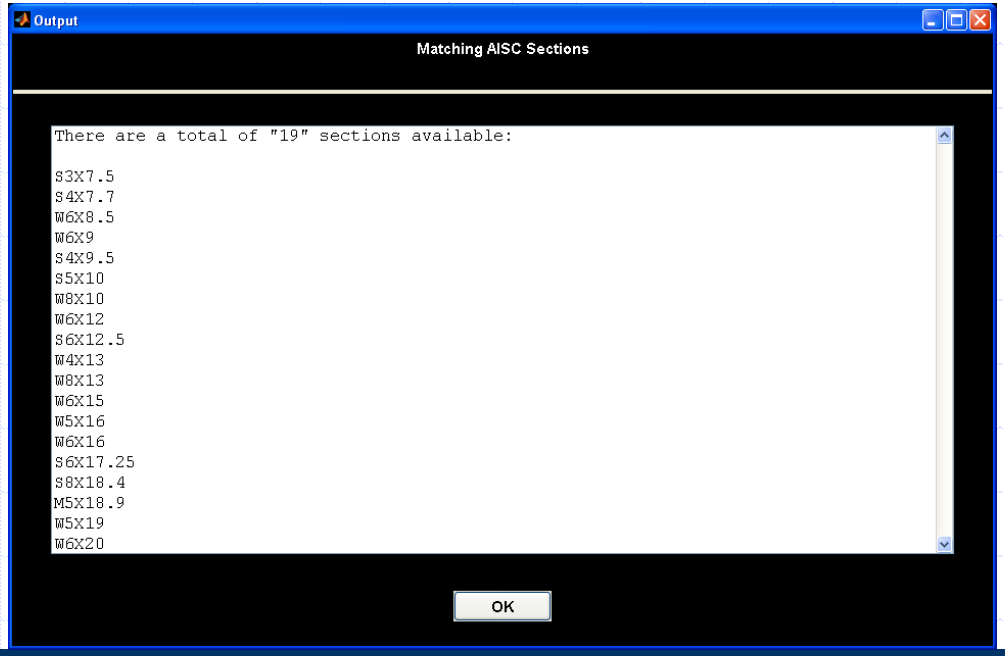
AISC design toolbox: section properties



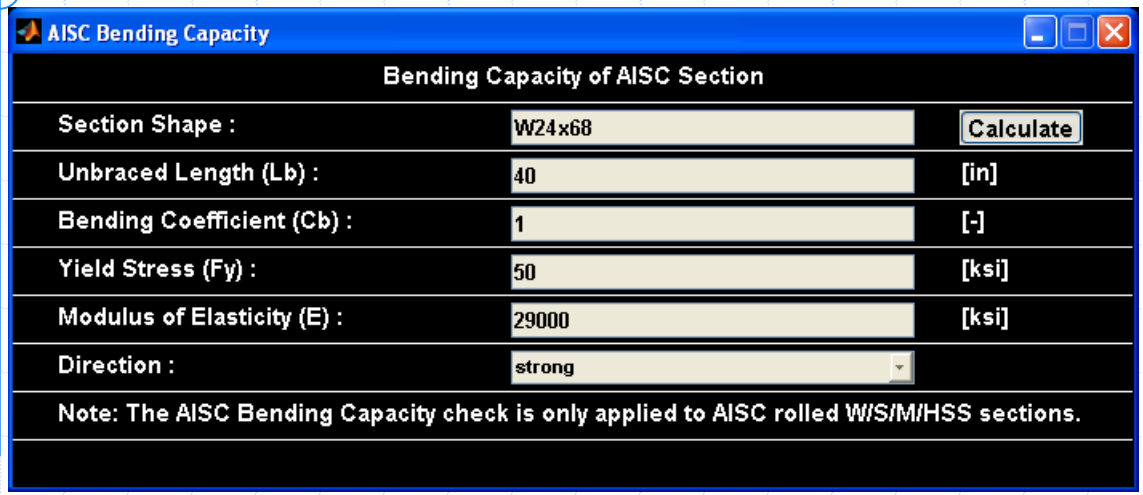


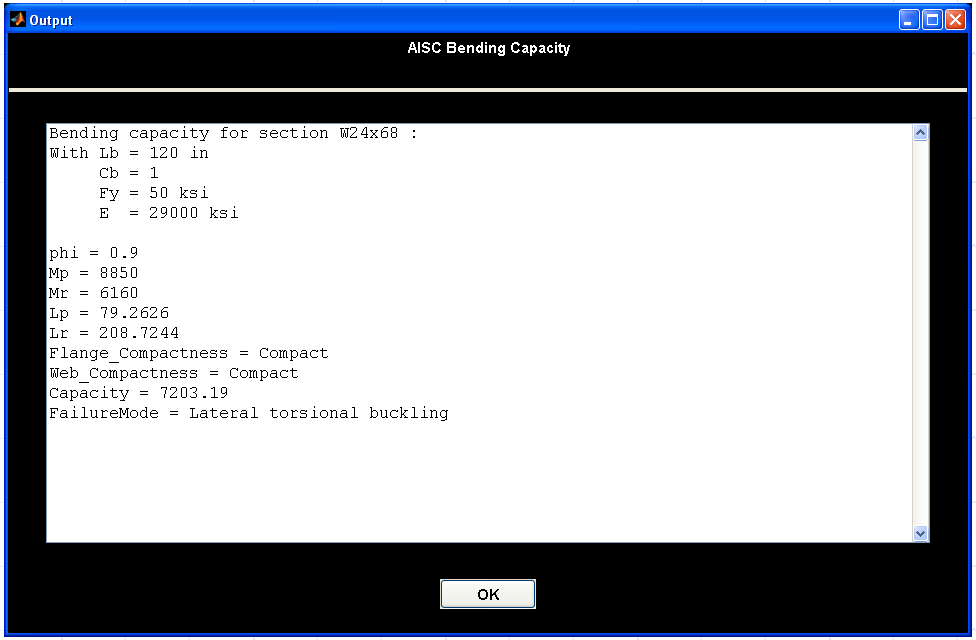
AISC design toolbox: matching sections



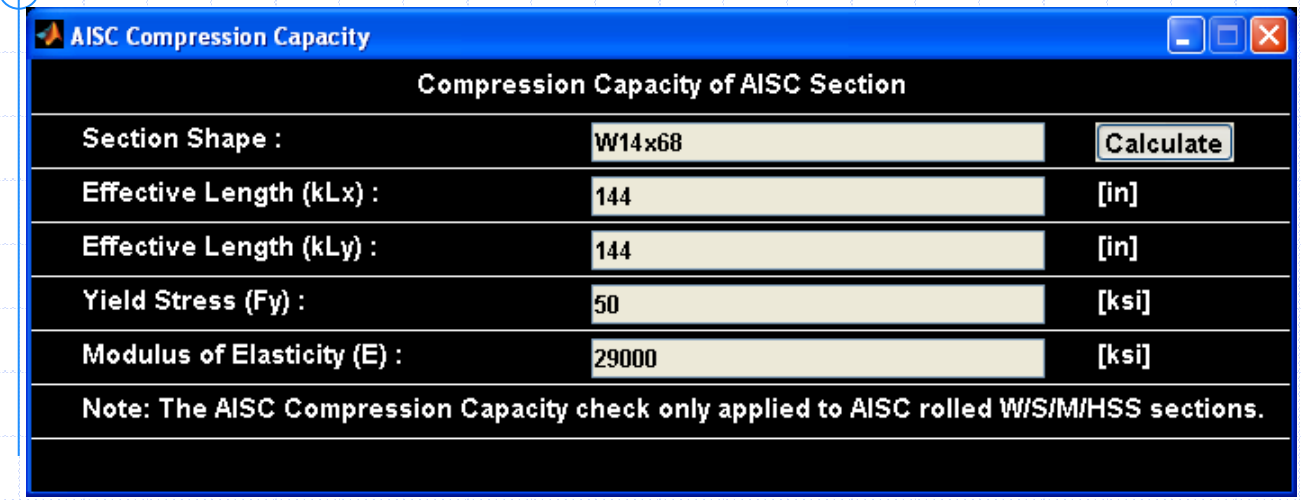


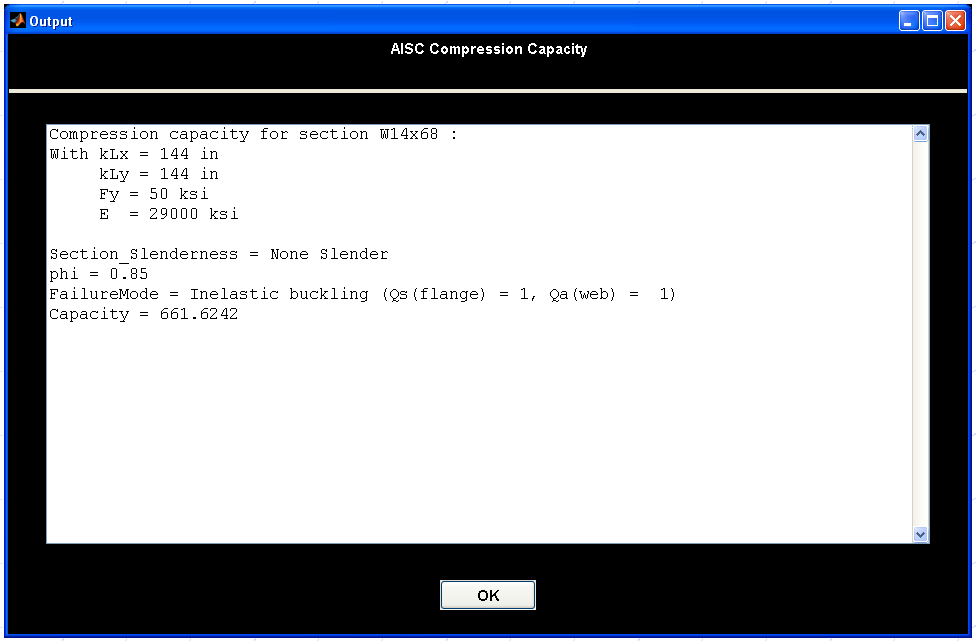
AISC design toolbox: bending capacity



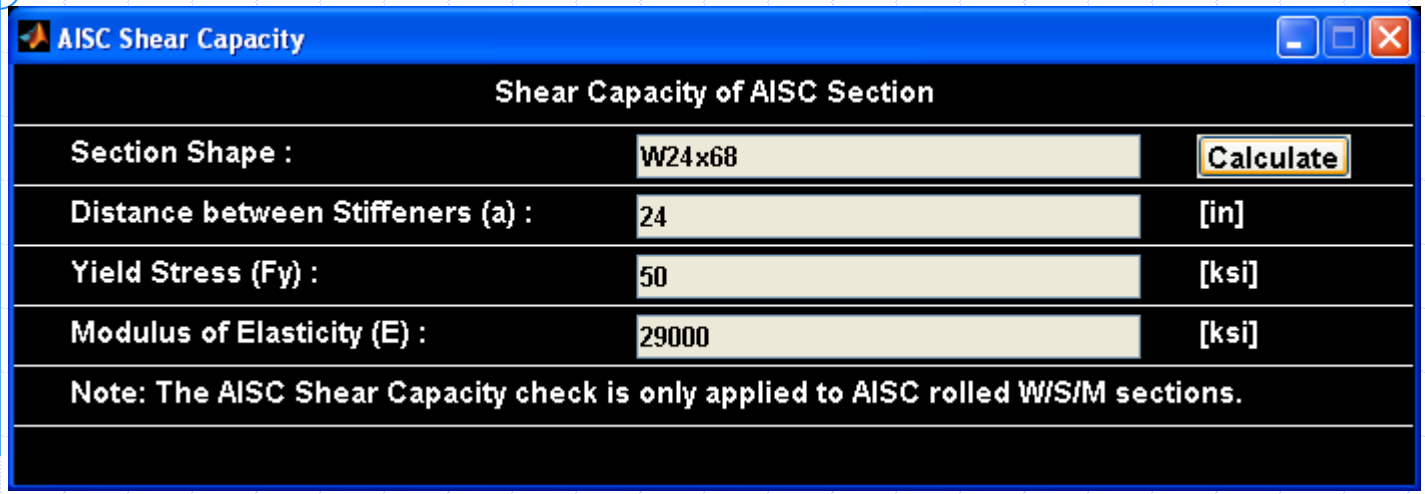


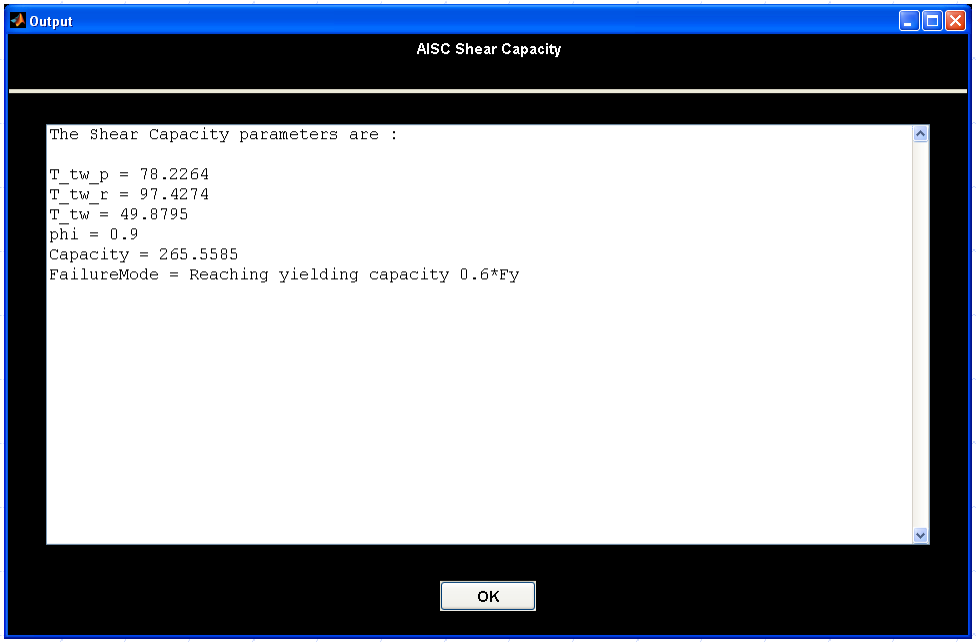
AISC design toolbox: compression cap.



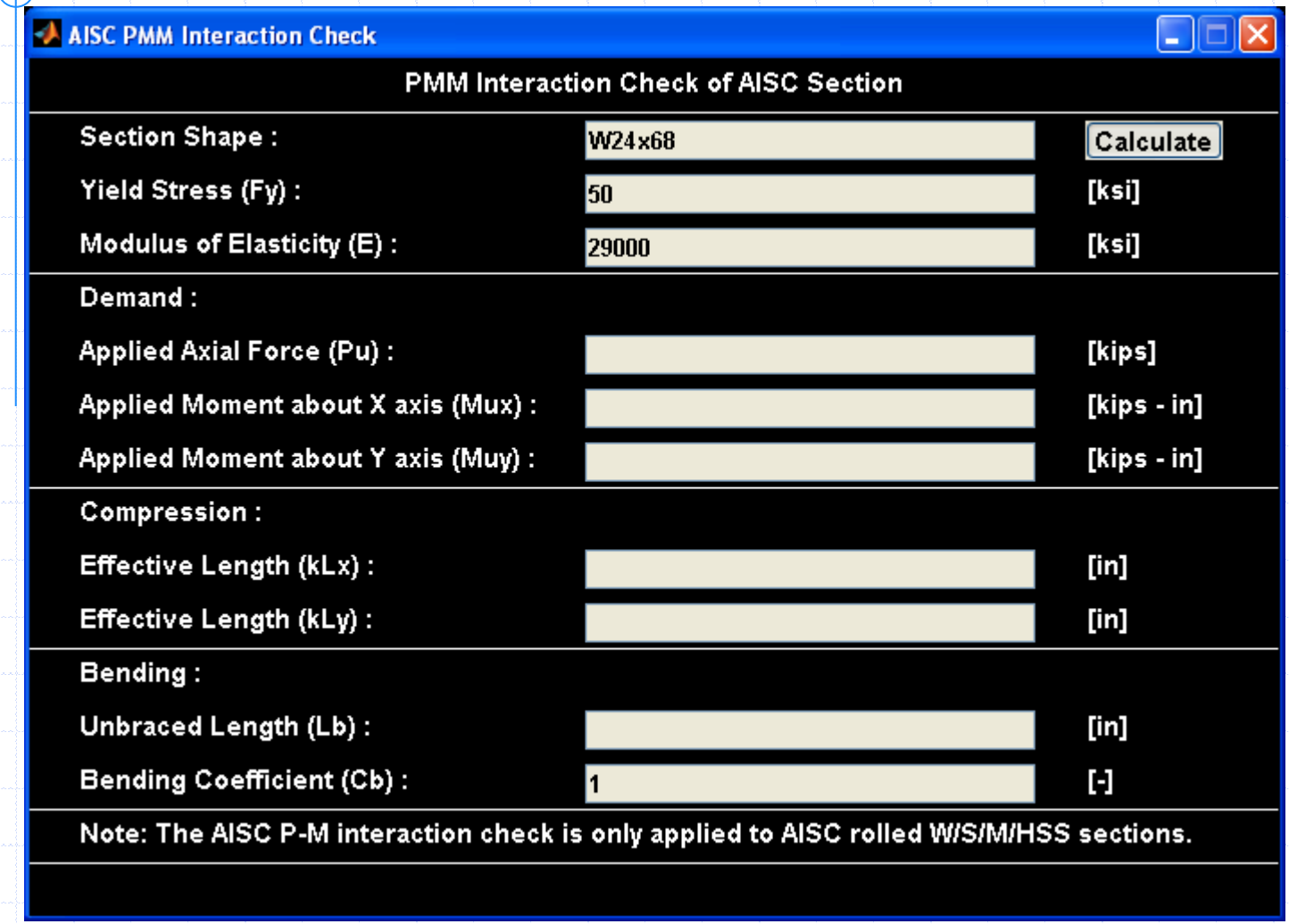


AISC design toolbox: shear capacity





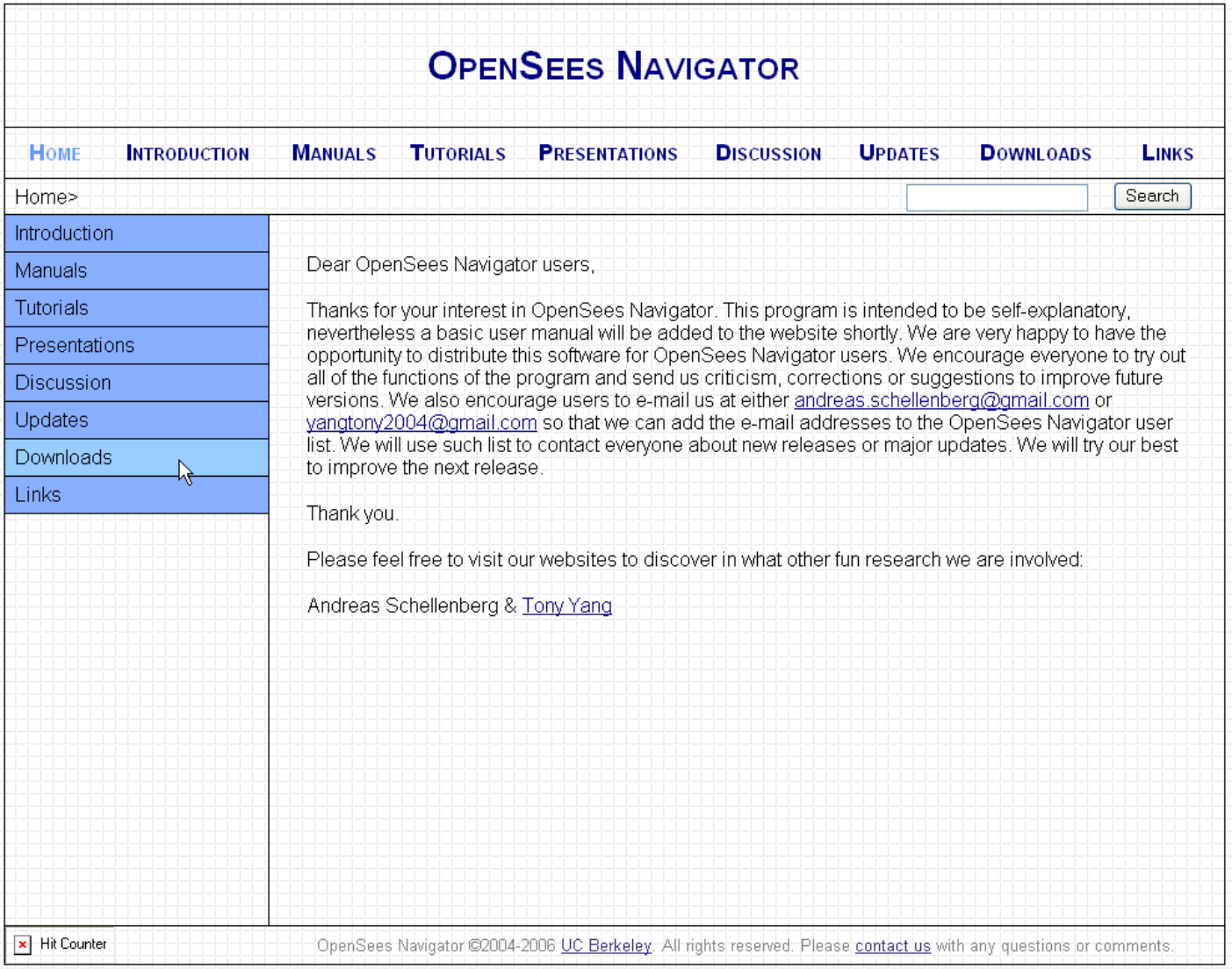
AISC design toolbox: PMM interaction



Summary

- OpenSees Navigator provides
  - Flexible and user friendly graphical user interface.
  - Great tool to visualize structural behavior.
  - Easy way to study material, section, element or system behavior.
- Hybrid simulation interface (OpenFresco).
- Many design toolboxes: NSP, PBEE, AISC design checks, AISC database, response spectra for linear and bilinear systems and signal filtering.
- Both MATLAB Pcode (32 bit and 64 bit) and self-executable versions for Windows & Mac are available.

Website: home



Website: download