OpenSees Navigator & Hybrid Simulation

Andreas Schellenberg & Tony Yang

Department of Civil and Environmental Engineering
University of California, Berkeley

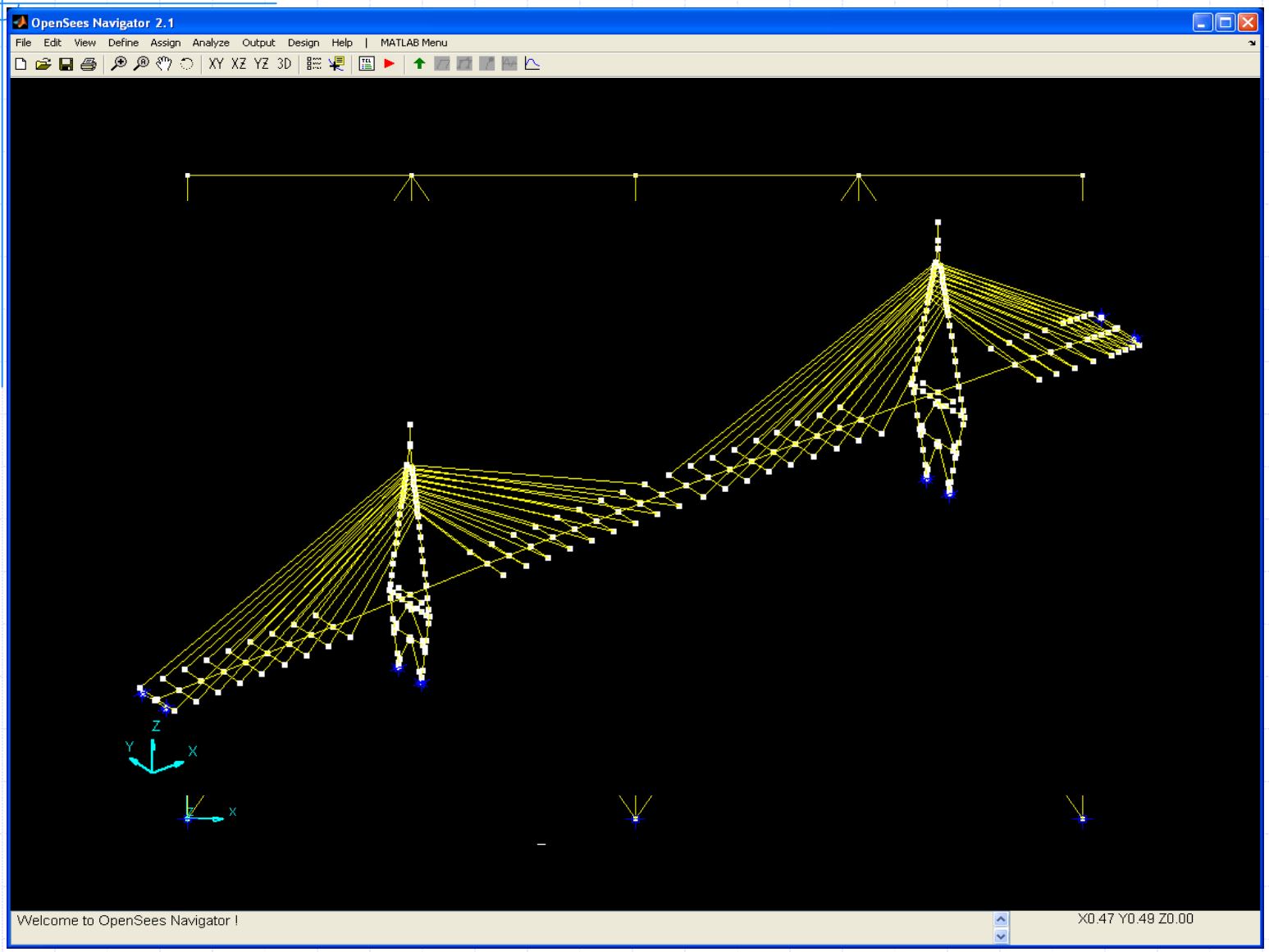
Introduction

- MATLAB based Graphical User Interface
- Pre- and post-processing for OpenSees
- Integration of Hybrid Simulation into the graphical user interface
- Response Spectra generation
- Integrated AISC data base
- Design toolboxes: NSP, AISC design checks, PBEE, …
- Self-executable version available

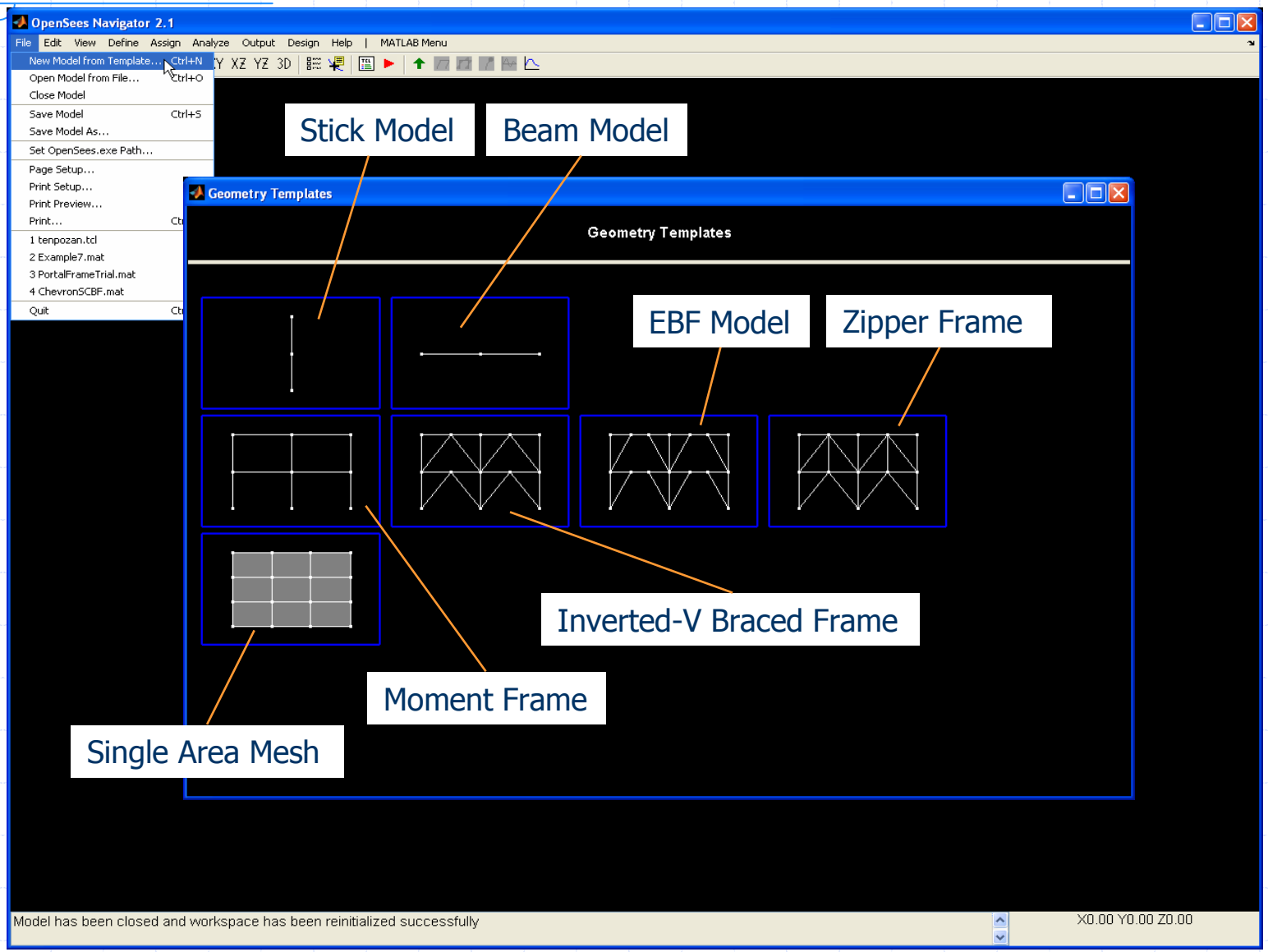
Motivation

- Graphical input is more user-friendly than TCL text input
- Most researchers use MATLAB to do the post-processing, and MATLAB/Simulink is the typical framework for implementing hybrid analyses
- OpenSees Navigator will create the OpenSees (hybrid) model and graphically display results before, during or after a test
- Flexible to use and requires no programming skills

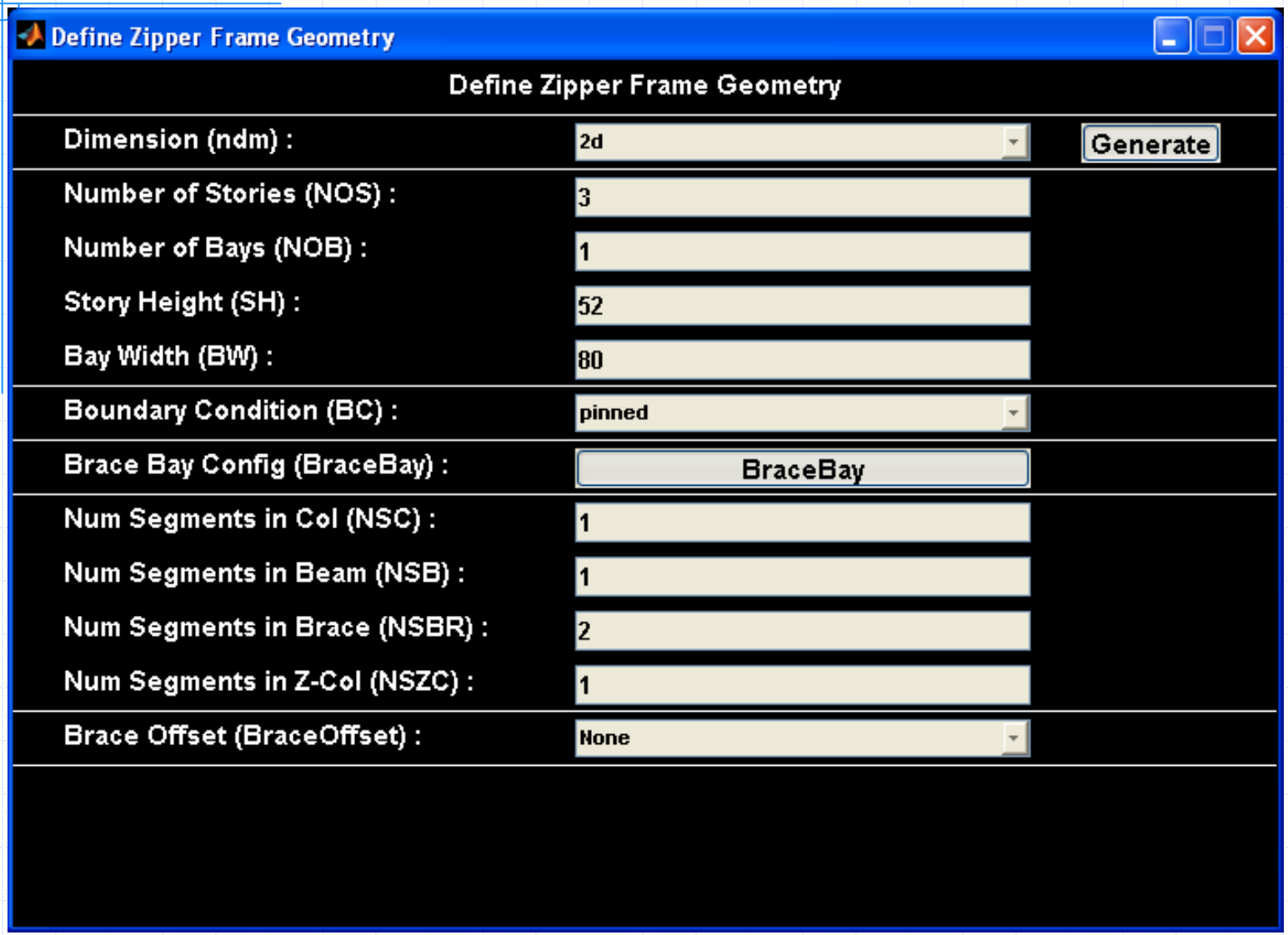
OpenSees Navigator



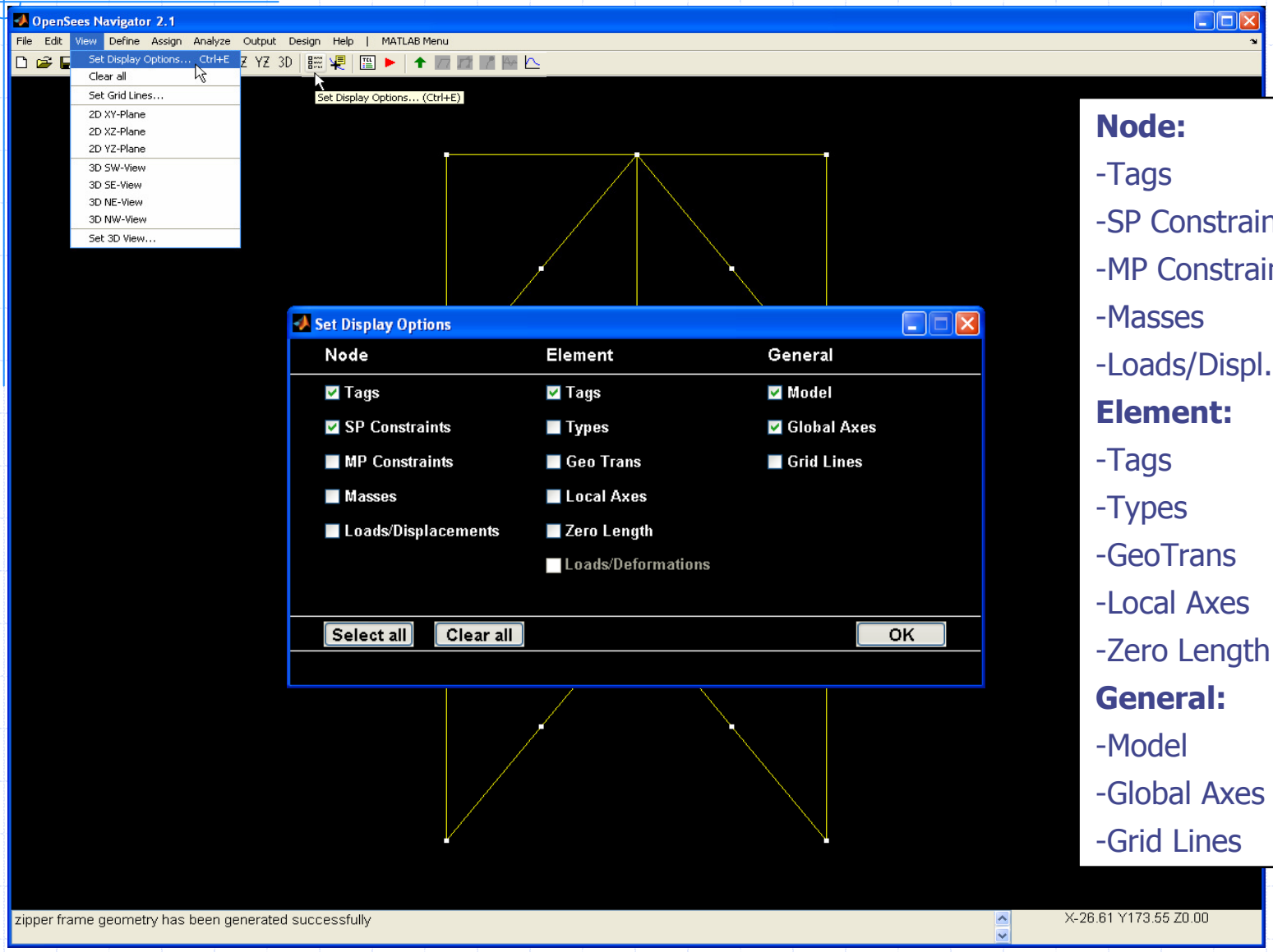
Define Geometry



Define Geometry: Zipper Frame



View Geometry: Set Display Options



Node:

-Tags

-SP Constraints

-MP Constraints

-Masses

-Loads/Displ.

Element:

-Tags

-Types

-GeoTrans

-Local Axes

-Zero Length

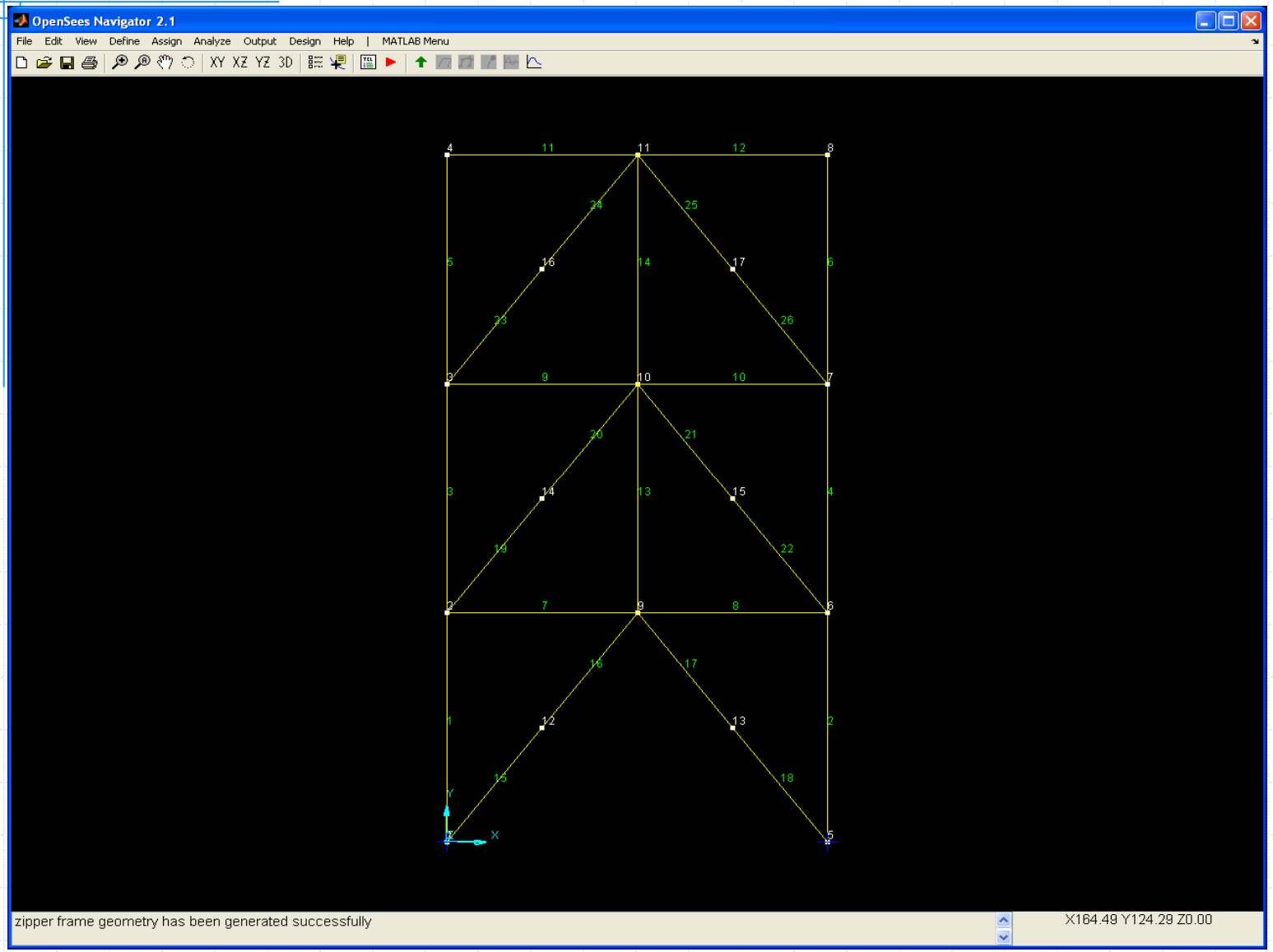
General:

-Model

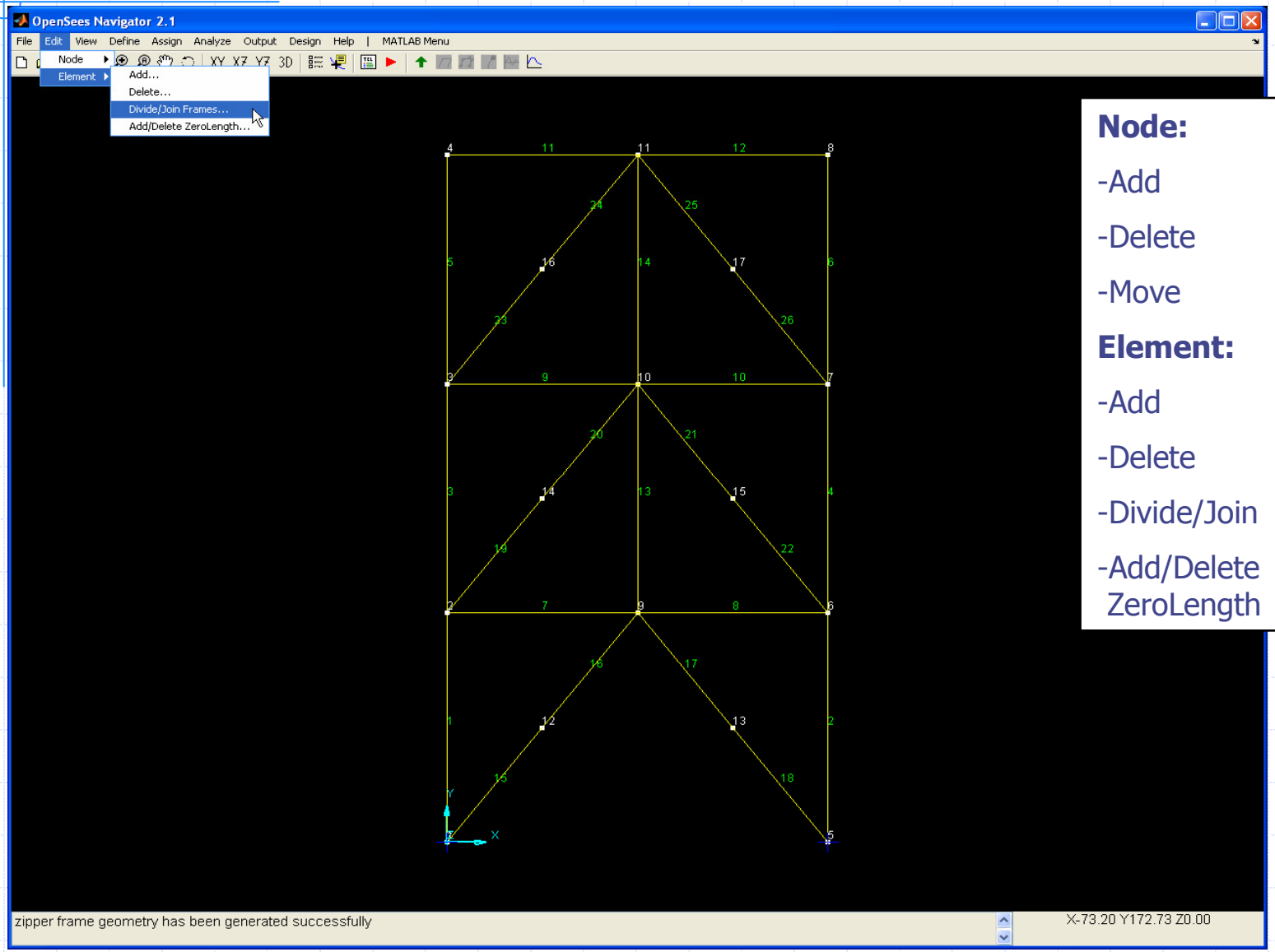
-Global Axes

-Grid Lines

View Geometry: Display



Edit Geometry



Node:

-Add

-Delete

-Move

Element:

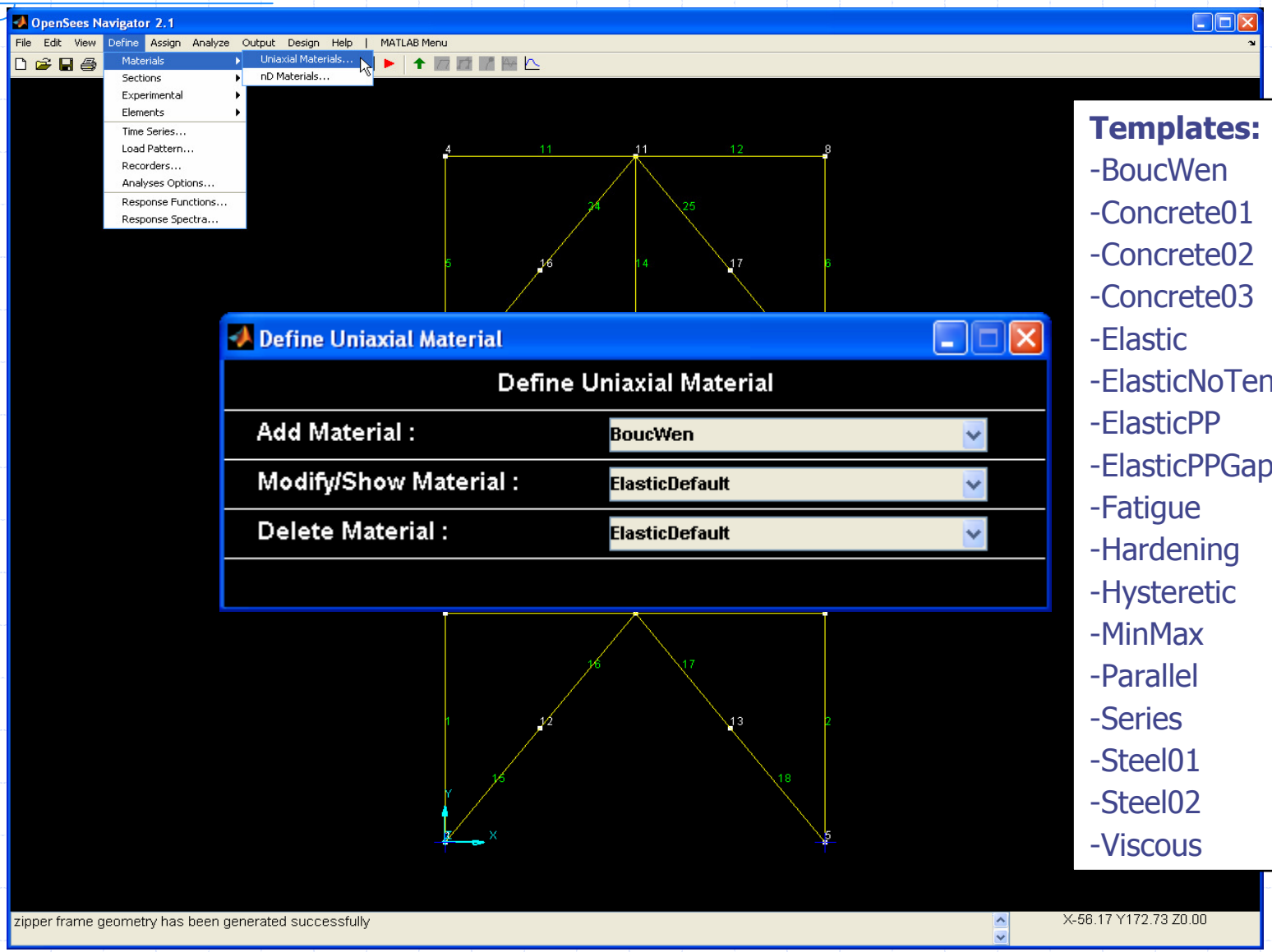
-Add

-Delete

-Divide/Join

-Add/Delete ZeroLength

Define Material: Uniaxial Materials

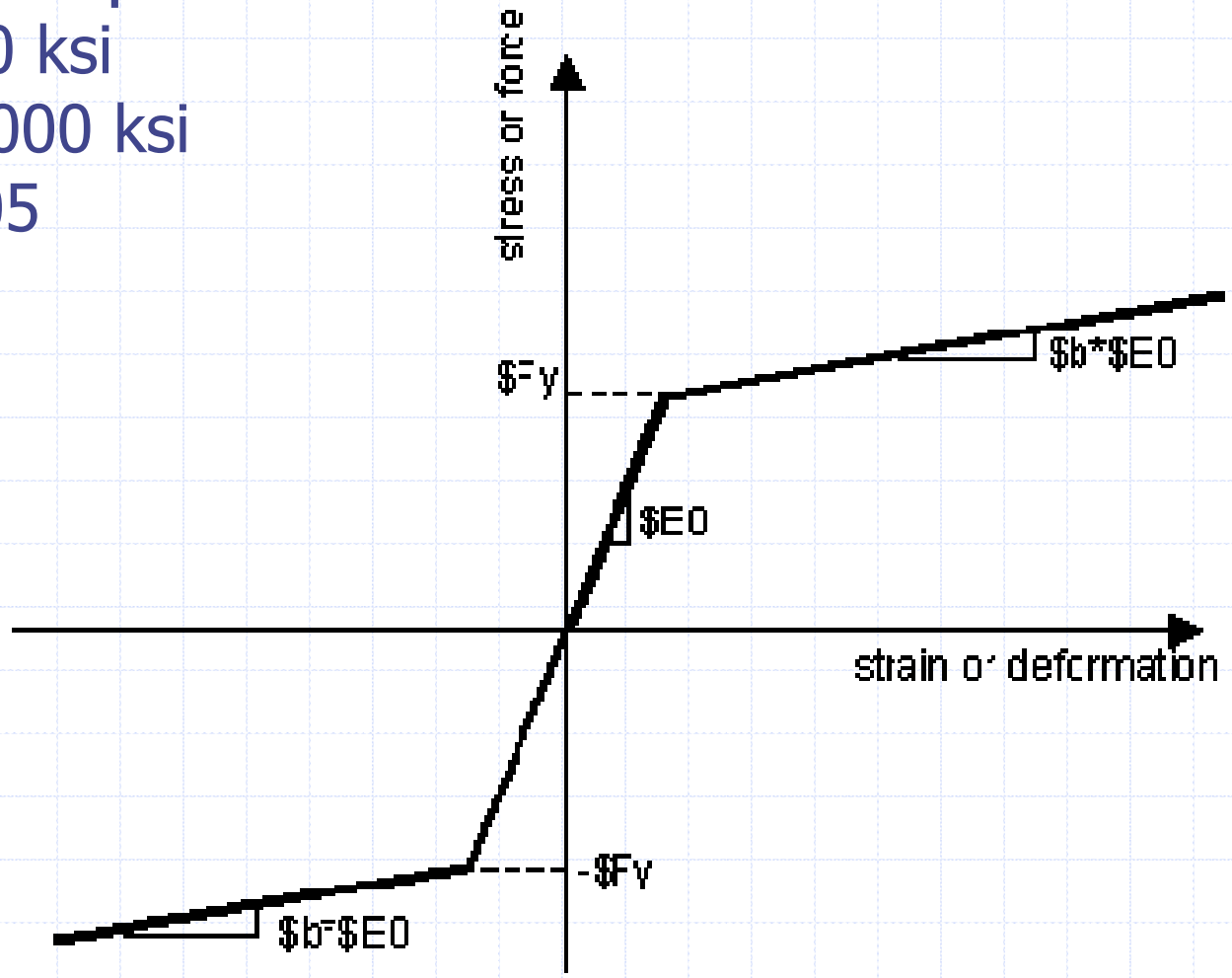


Templates:

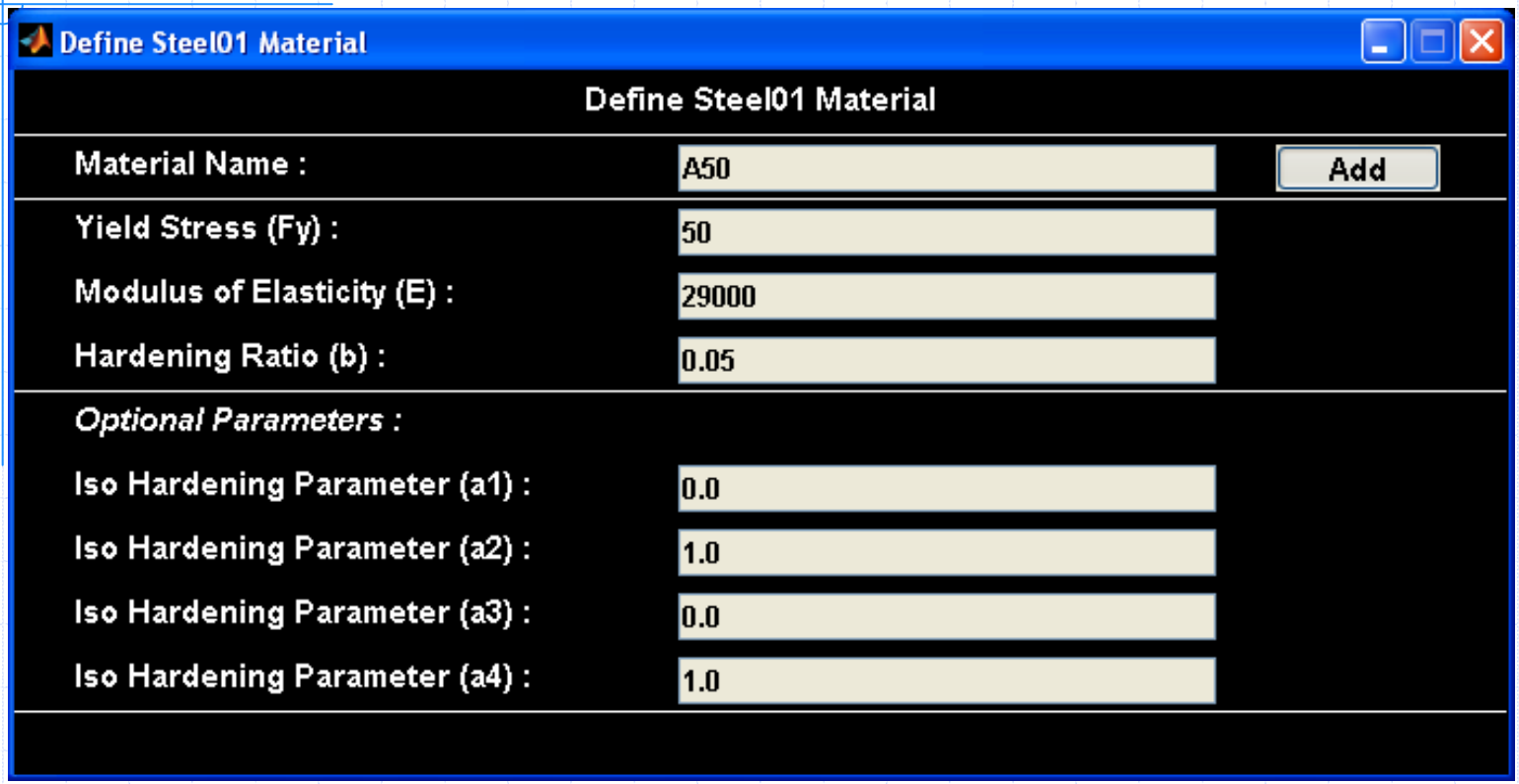
- -BoucWen
- -Concrete01
- -Concrete02
- -Concrete03
- -Elastic
- -ElasticNoTension
- -ElasticPP
- -ElasticPPGap
- -Fatigue
- -Hardening
- -Hysteretic
- -MinMax
- -Parallel
- -Series
- -Steel01
- -Steel02
- -Viscous

Define Steel01 Material: A50

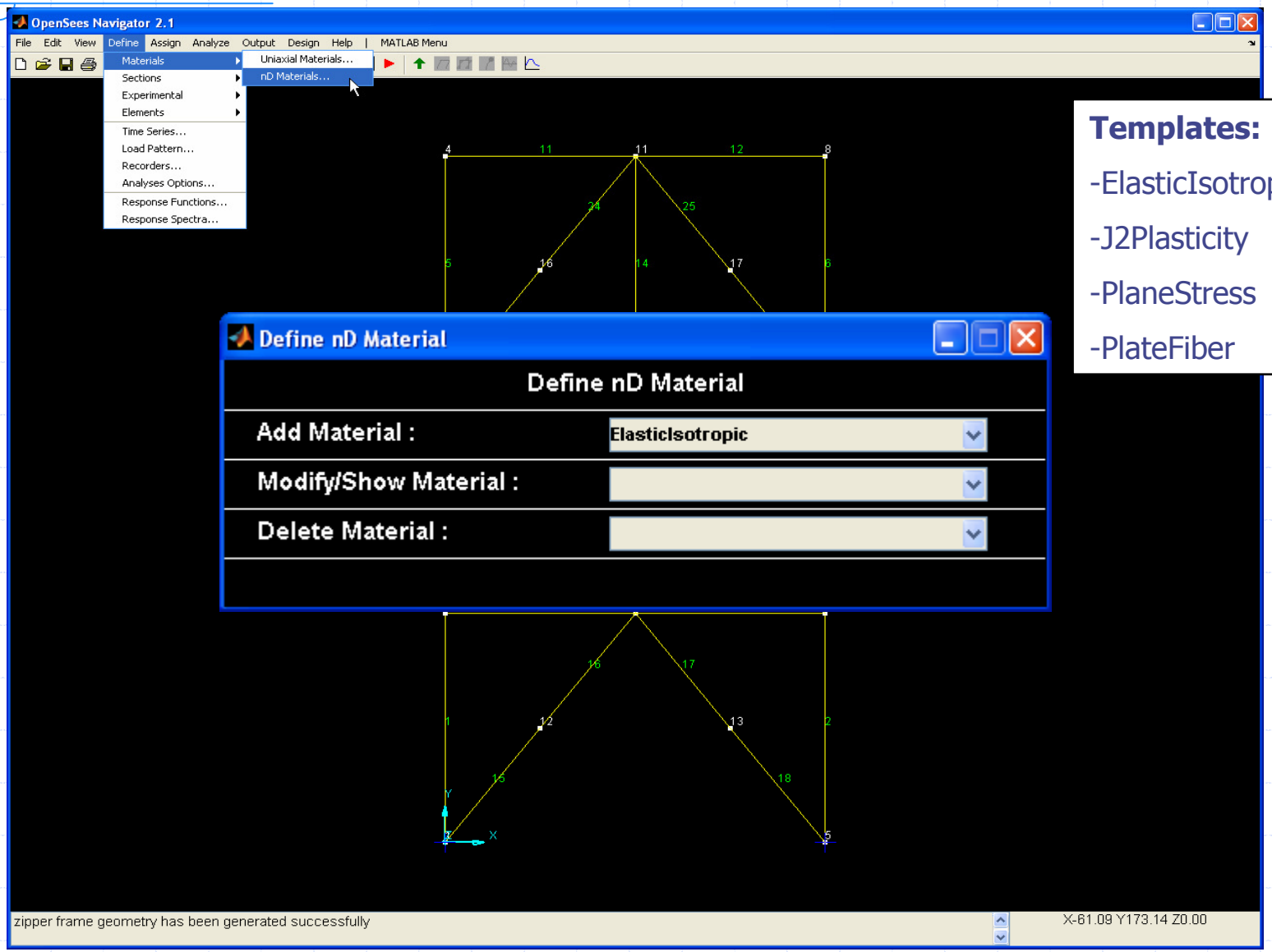
- Material Properties
  - Fy = 50 ksi
  - E = 29000 ksi
  - b = 0.05



Define Steel01 Material: A50



Define Material: nD Materials



Templates:

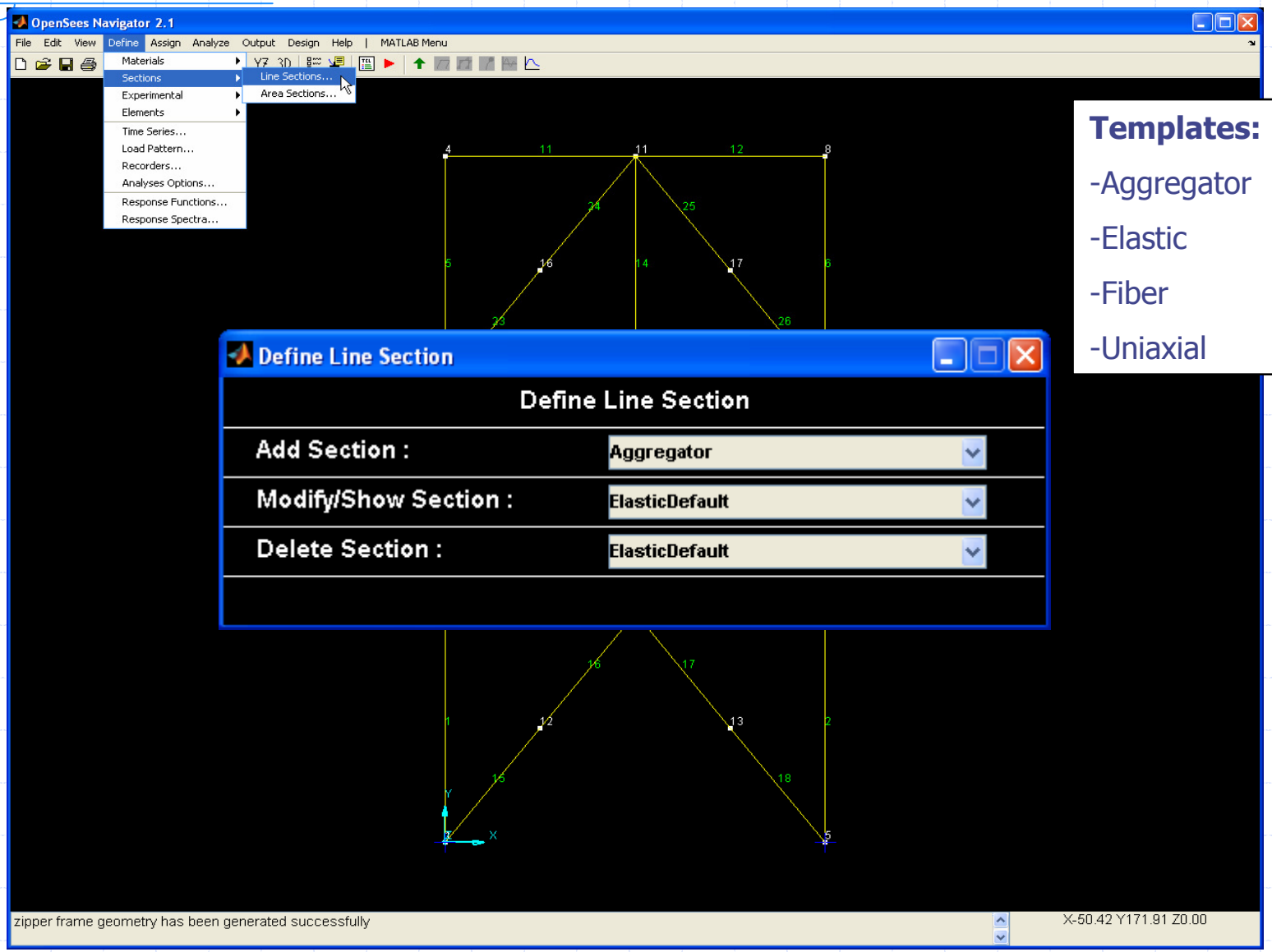
-ElasticIsotropic

-J2Plasticity

-PlaneStress

-PlateFiber

Define Section: Line Sections



Templates:

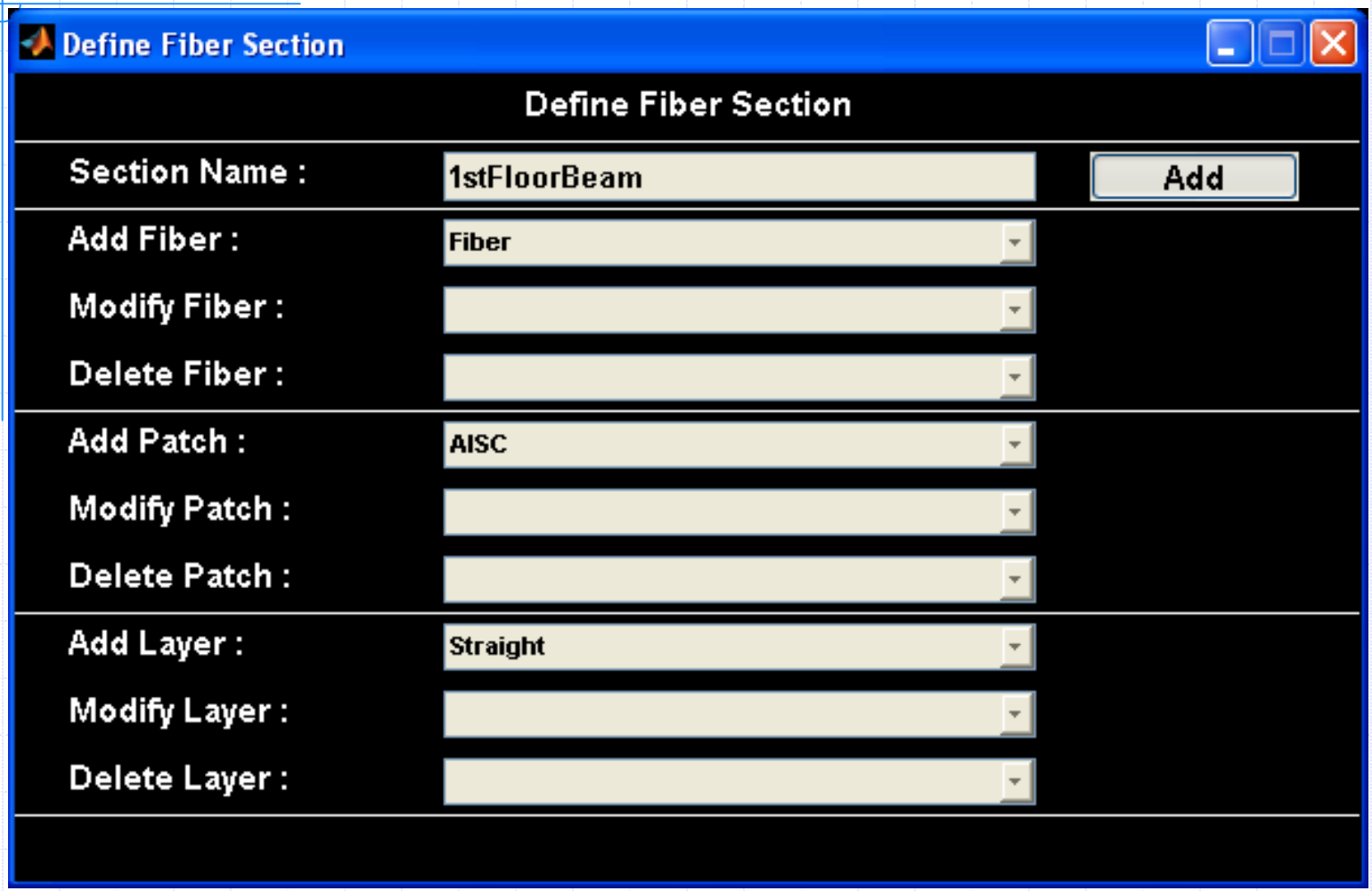
-Aggregator

-Elastic

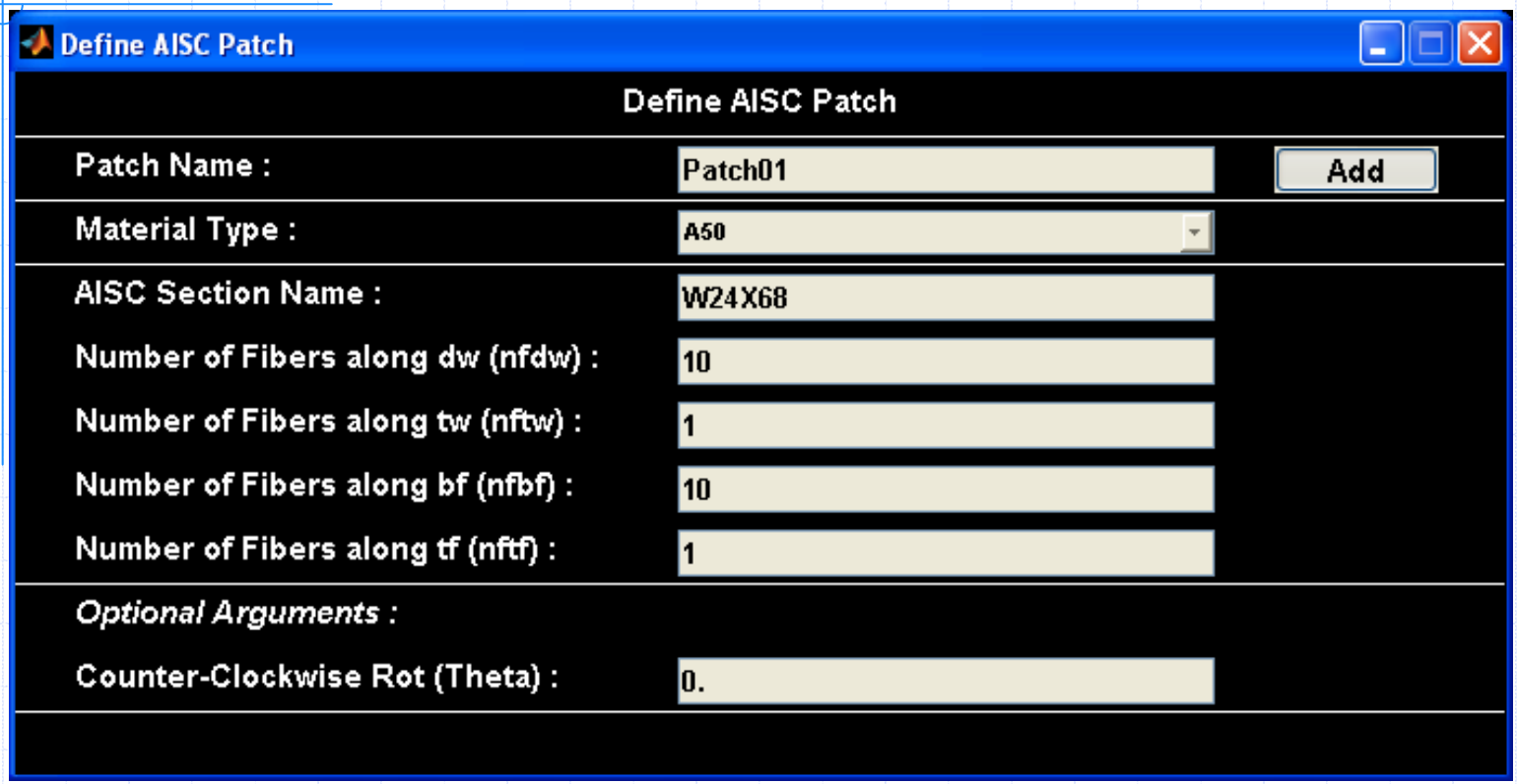
-Fiber

-Uniaxial

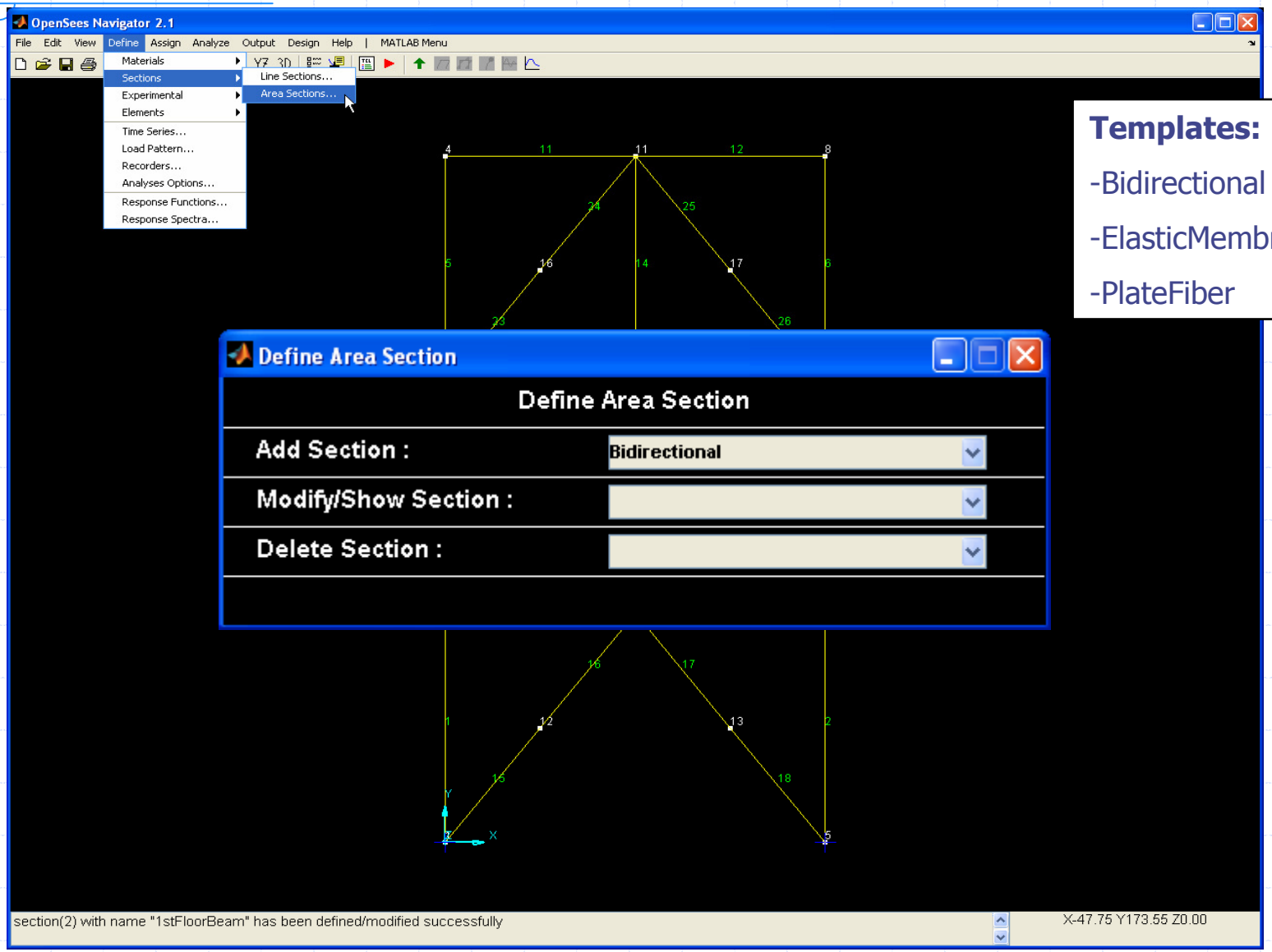
Define Fiber Section: 1stFloorBeam



Define Fiber Section: AISC Patch



Define Section: Area Sections



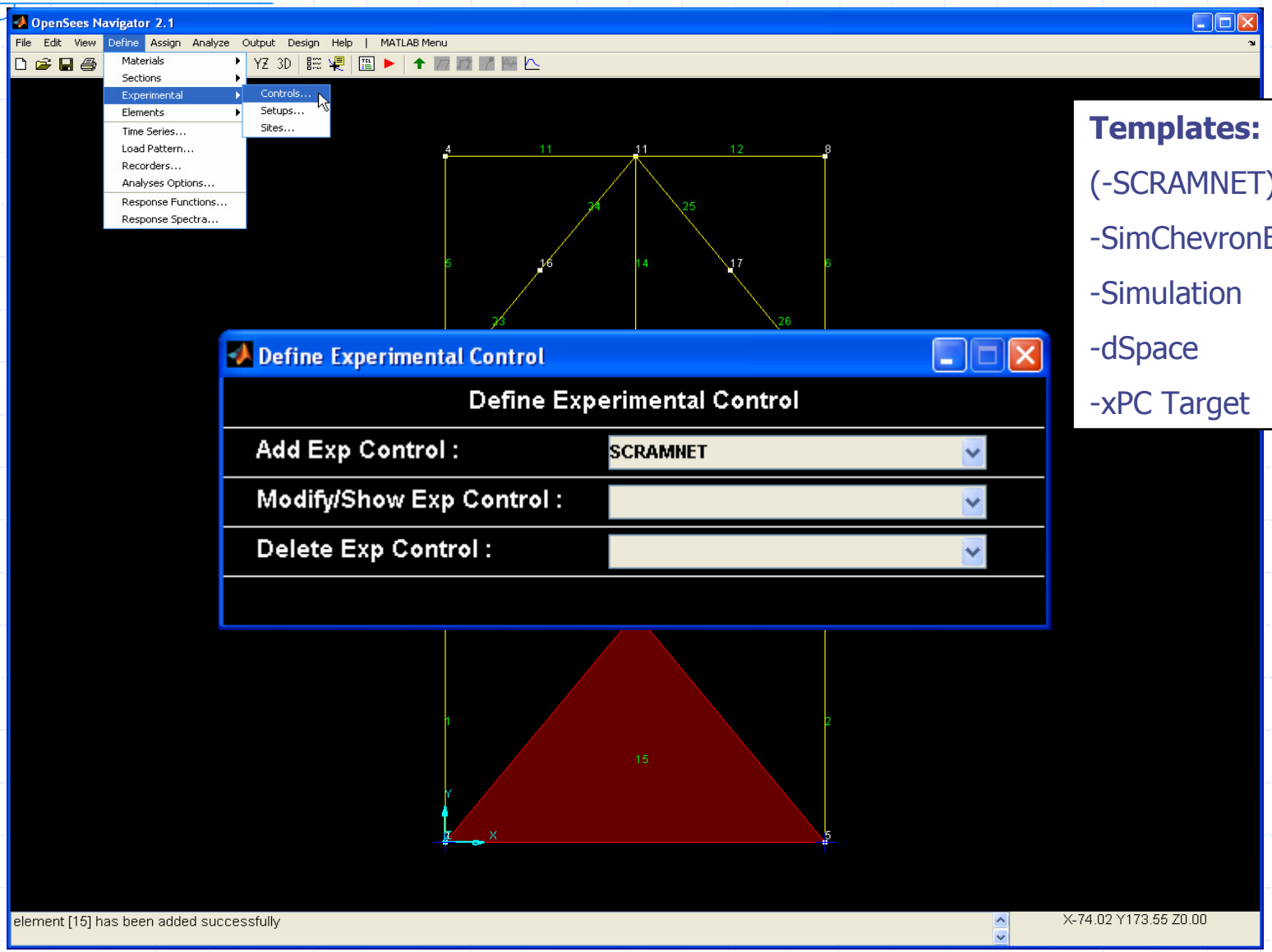
Templates:

-Bidirectional

-ElasticMembranePlate

-PlateFiber

Define Experimental Control



Templates:

(-SCRAMNET)

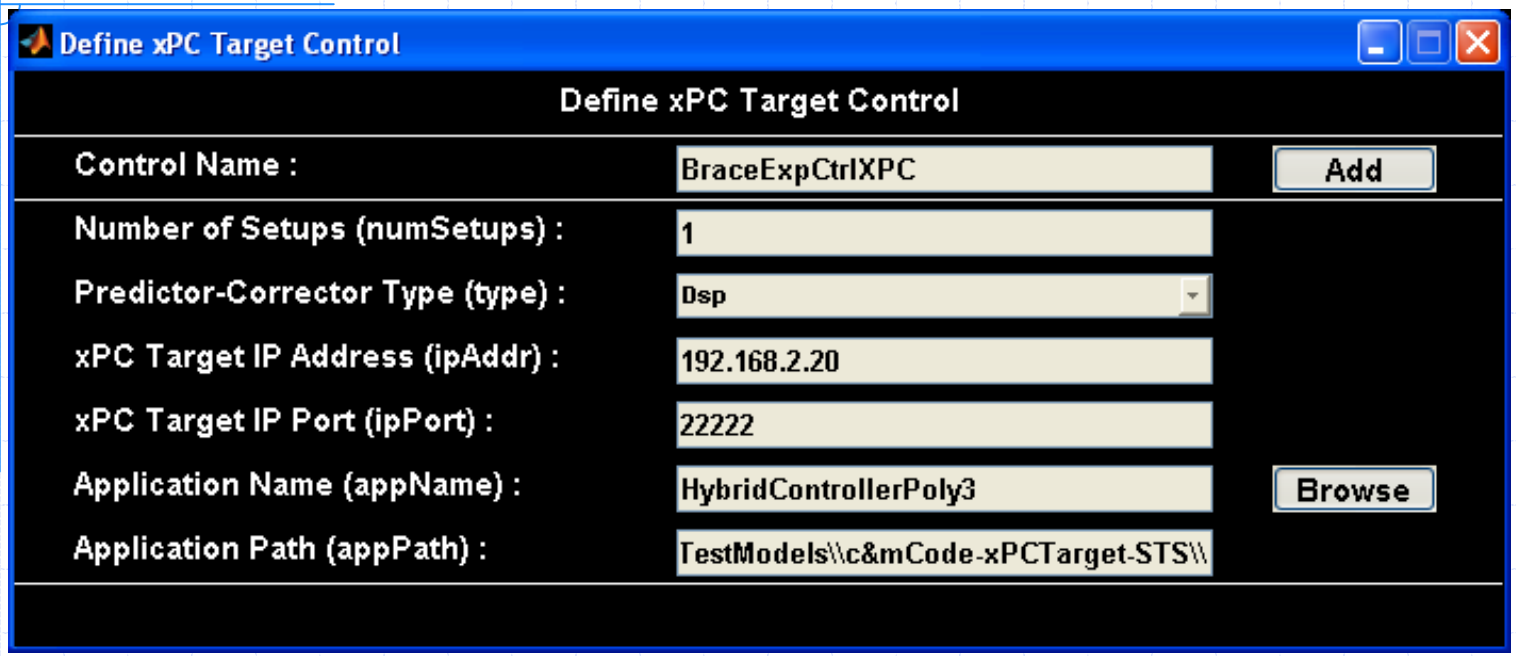
-SimChevronBrace

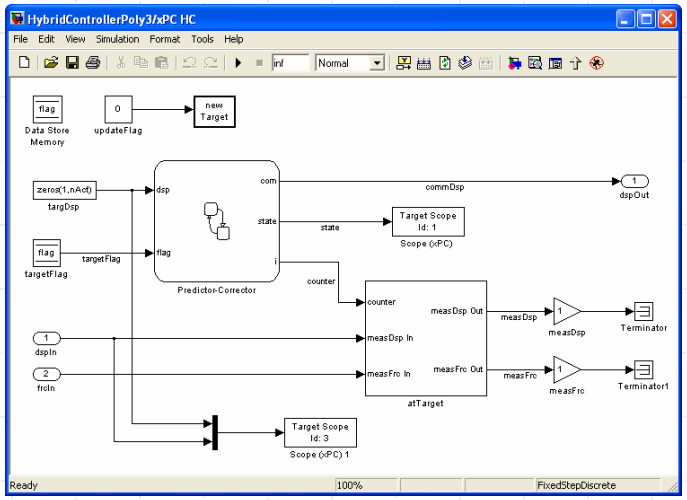
-Simulation

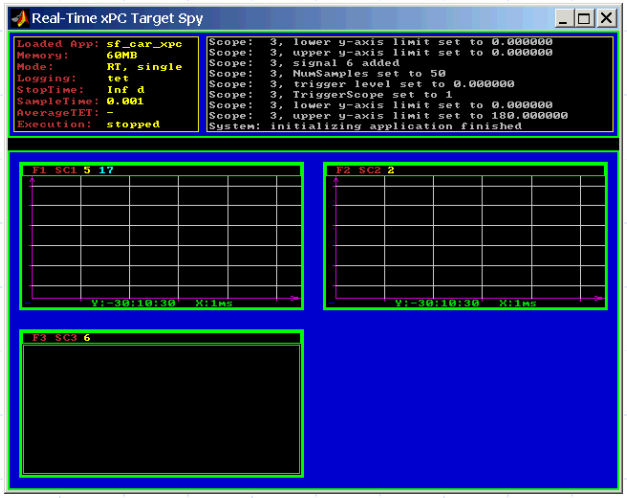
-dSpace

-xPC Target

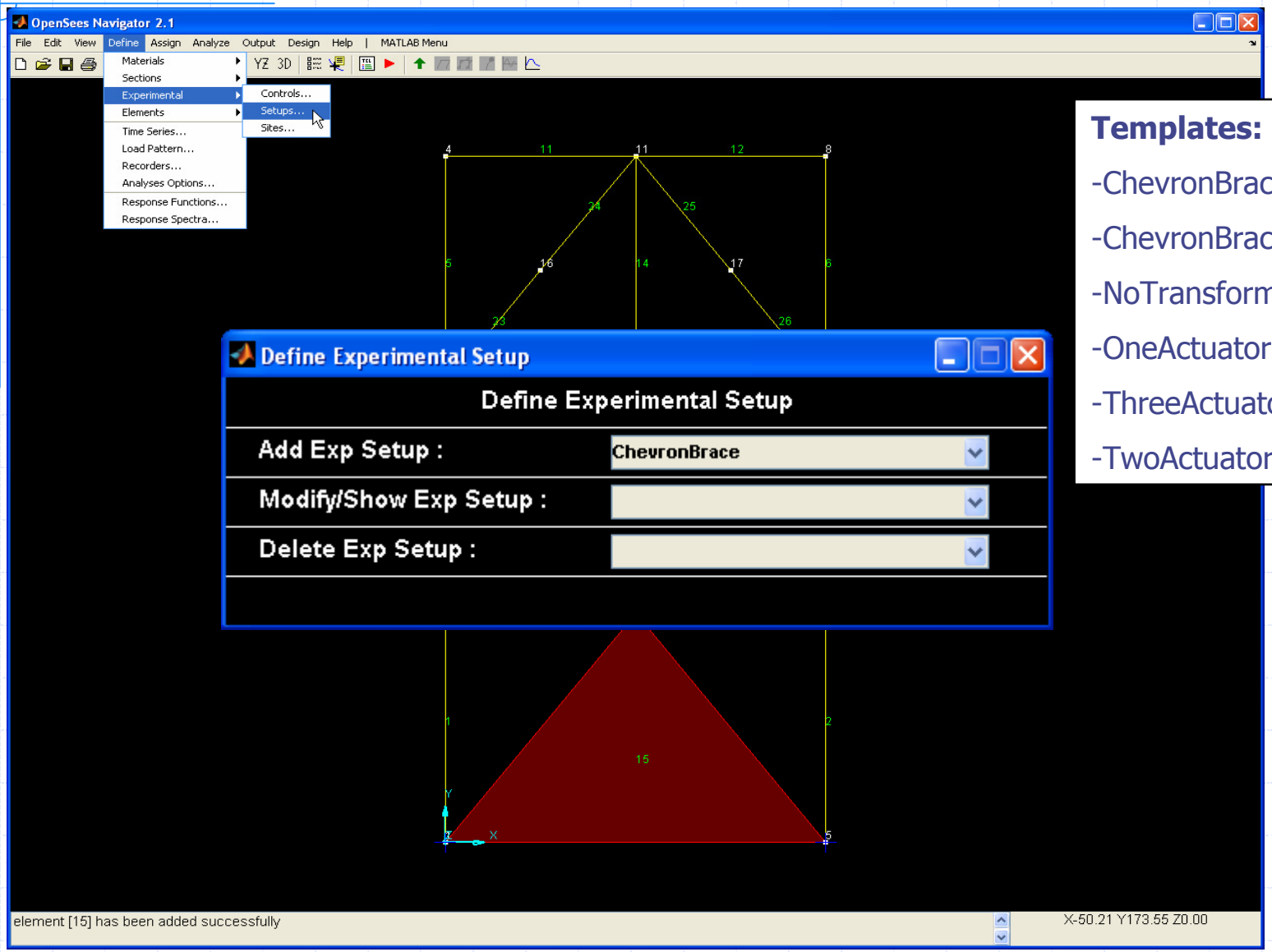
Define ExpControl: xPC Target







Define Experimental Setup



Templates:

-ChevronBrace

-ChevronBraceJntOff

-NoTransformation

-OneActuator

-ThreeActuators

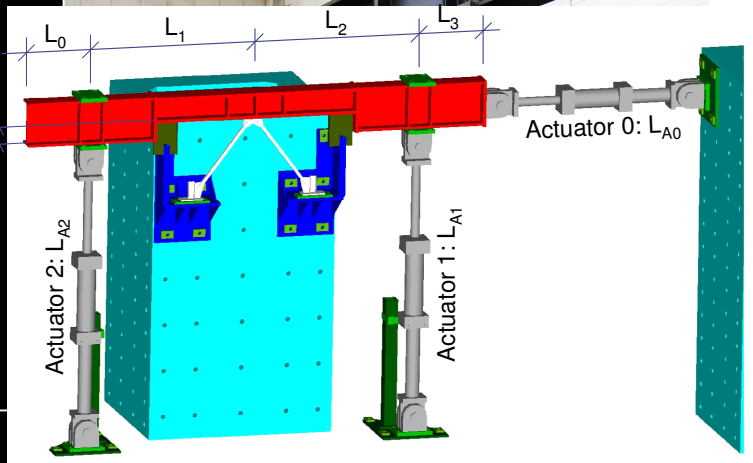
-TwoActuators

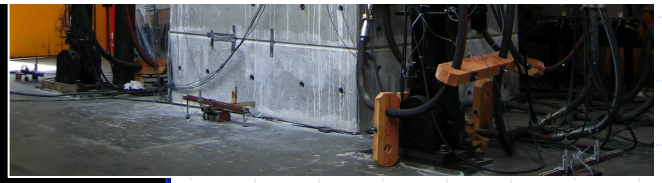
Define ExpSetup: ChevronBrace

Define ChevronBraceJntOff Setup

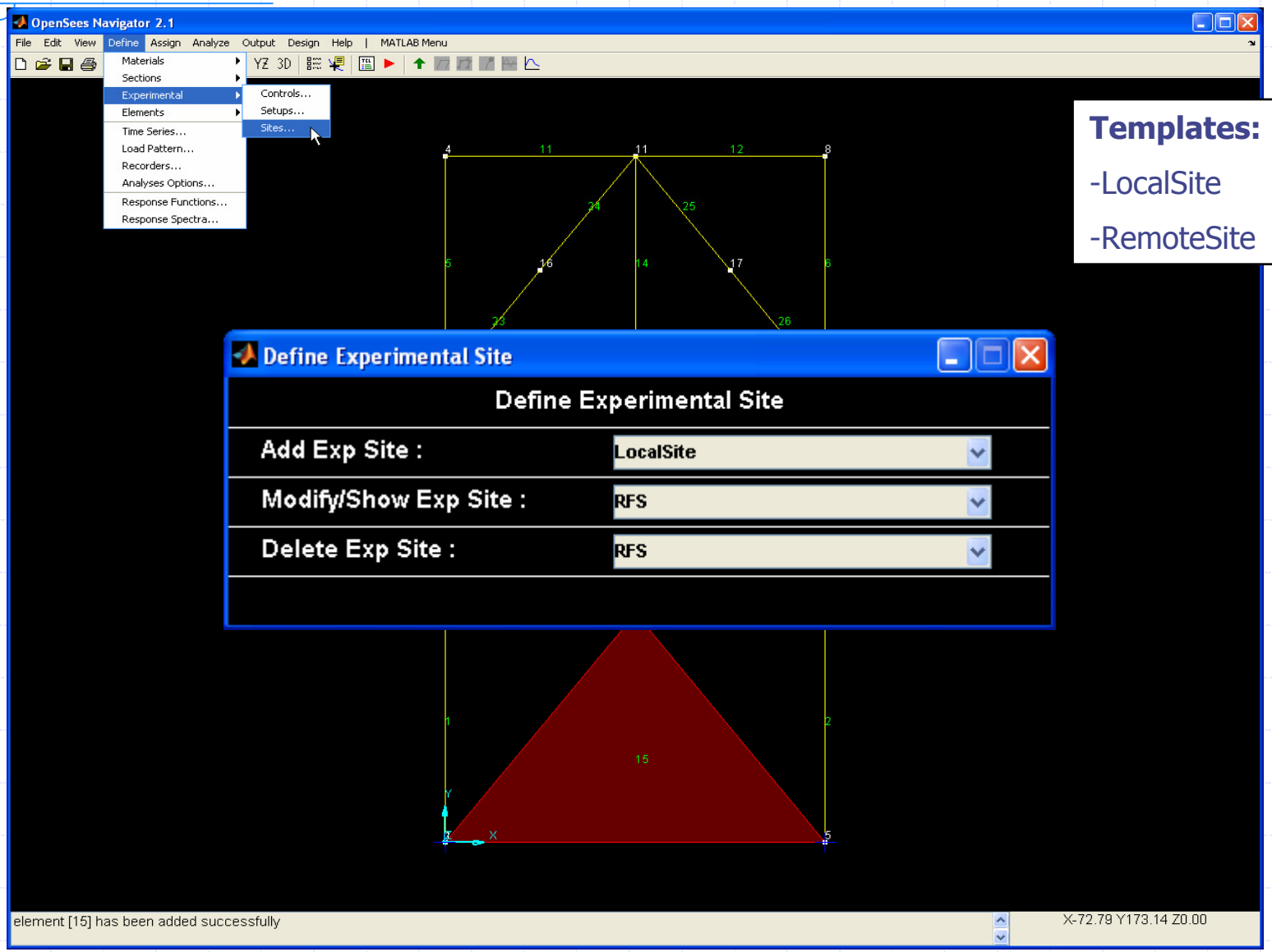
Define ChevronBraceJntOff Setup

Setup Name :	BraceExpSetupJntOff	Add
Experimental Control Type :	BraceExpCtrlXPC	
Geometry Type (nlGeomFlag) :	nonlinear, horizontal right	
Actuator Length 1 (La1) :	124.5	
Actuator Length 2 (La2) :	176.625	
Actuator Length 3 (La3) :	176.625	
Rigid Link Length 1 (L1) :	53	
Rigid Link Length 2 (L2) :	108	
Rigid Link Length 3 (L3) :	108	
Rigid Link Length 4 (L4) :	53	
Rigid Link Length 5 (L5) :	24.625	
Rigid Link Length 6 (L6) :	24.625	
Optional Parameters :		
Dsp Control Factor (dspCtrlFact) :	[1 1 1]	
Vel Control Factor (velCtrlFact) :	[1 1 1]	
Acc Control Factor (accCtrlFact) :	[1 1 1]	
Dsp Daq Factor (dspDaqFact) :	[1 1 1 1 1 1]	
Force Daq Factor (frcDaqFact) :	[1 1 1 1 -1 1]	





Define Experimental Site

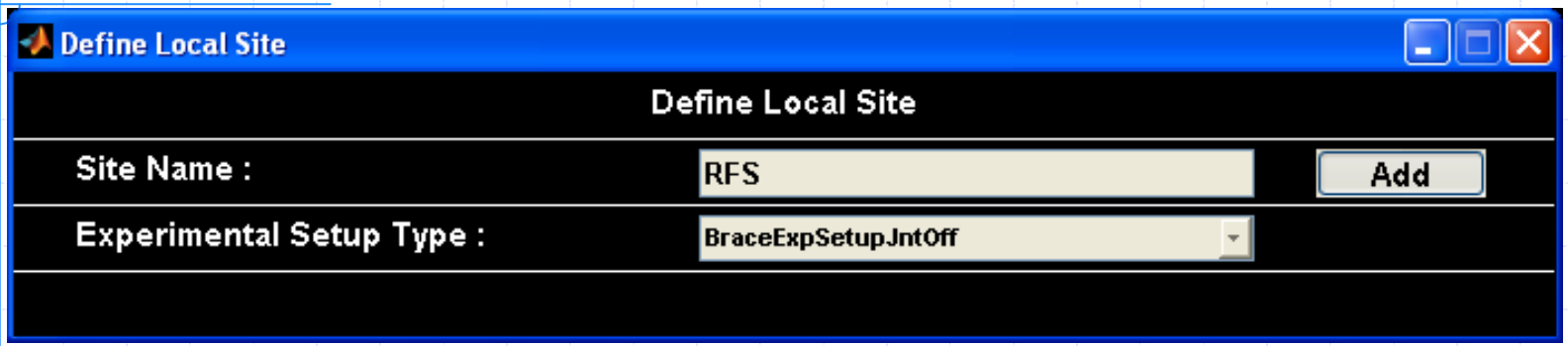


Templates:

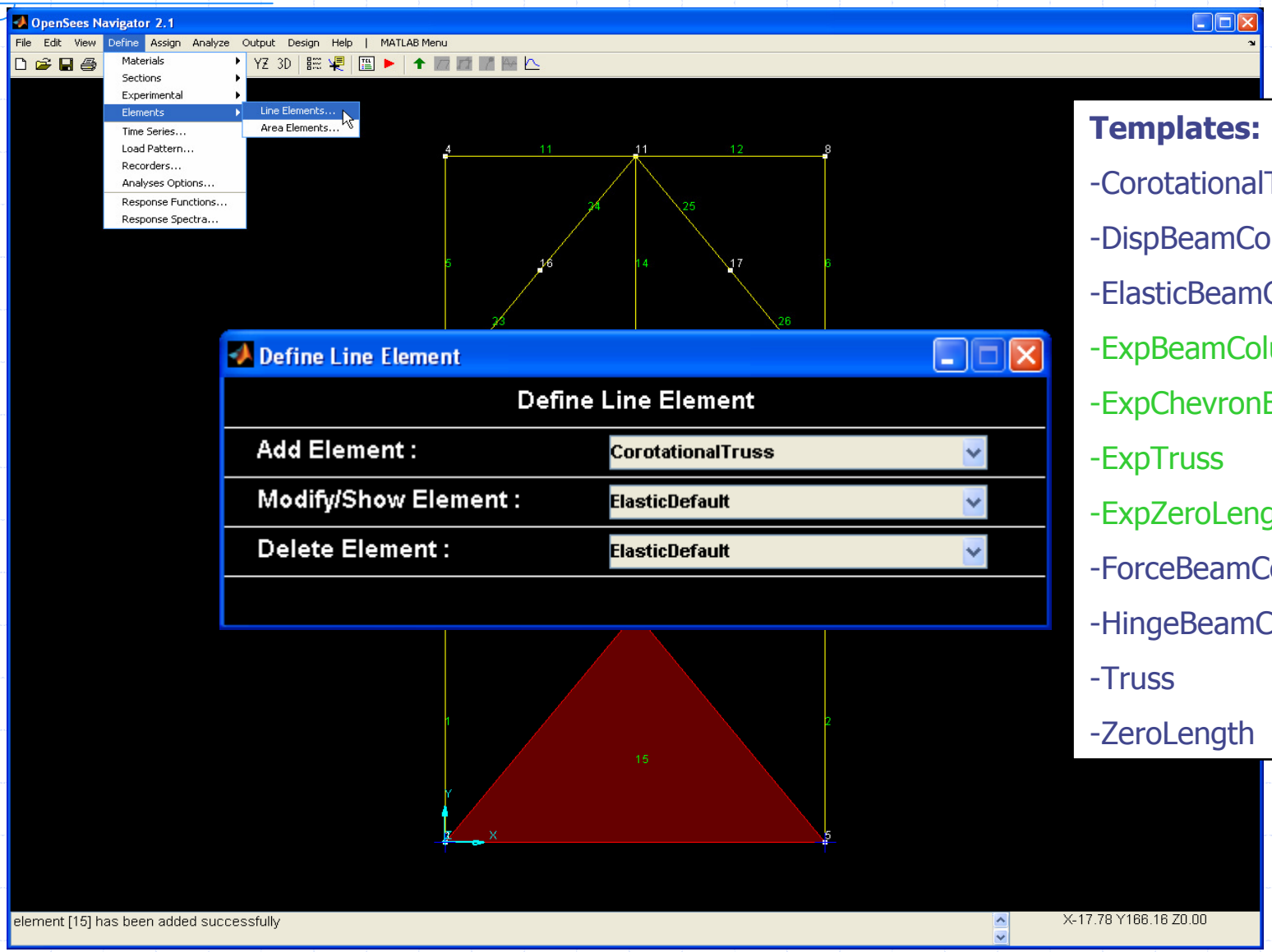
-LocalSite

-RemoteSite

Define ExpSite: RFS



Define Element: Line Element



Templates:

-CorotationalTruss

-DispBeamColumn

-ElasticBeamColumn

-ExpBeamColumn

-ExpChevronBrace

-ExpTruss

-ExpZeroLength

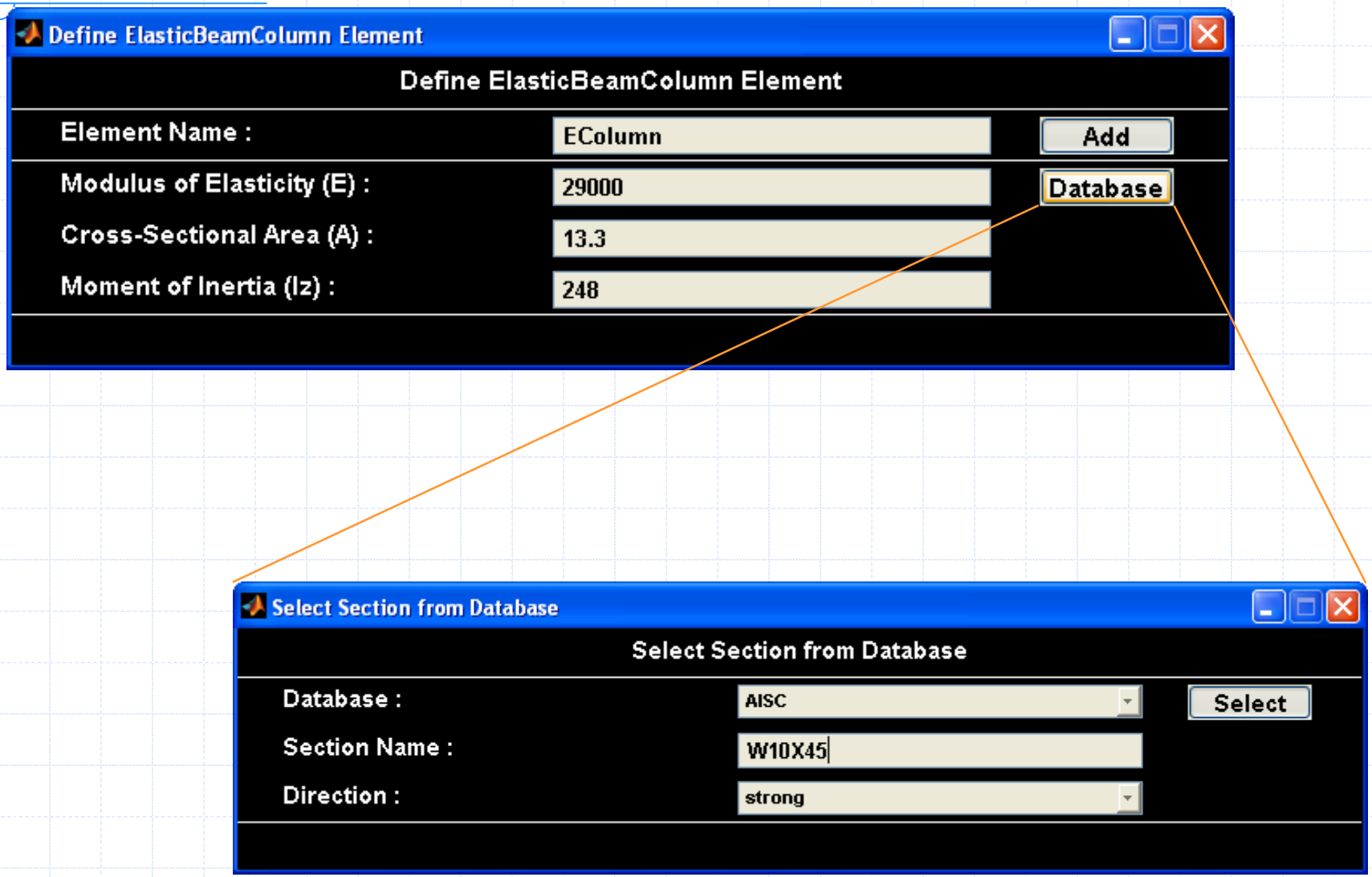
-ForceBeamColumn

-HingeBeamColumn

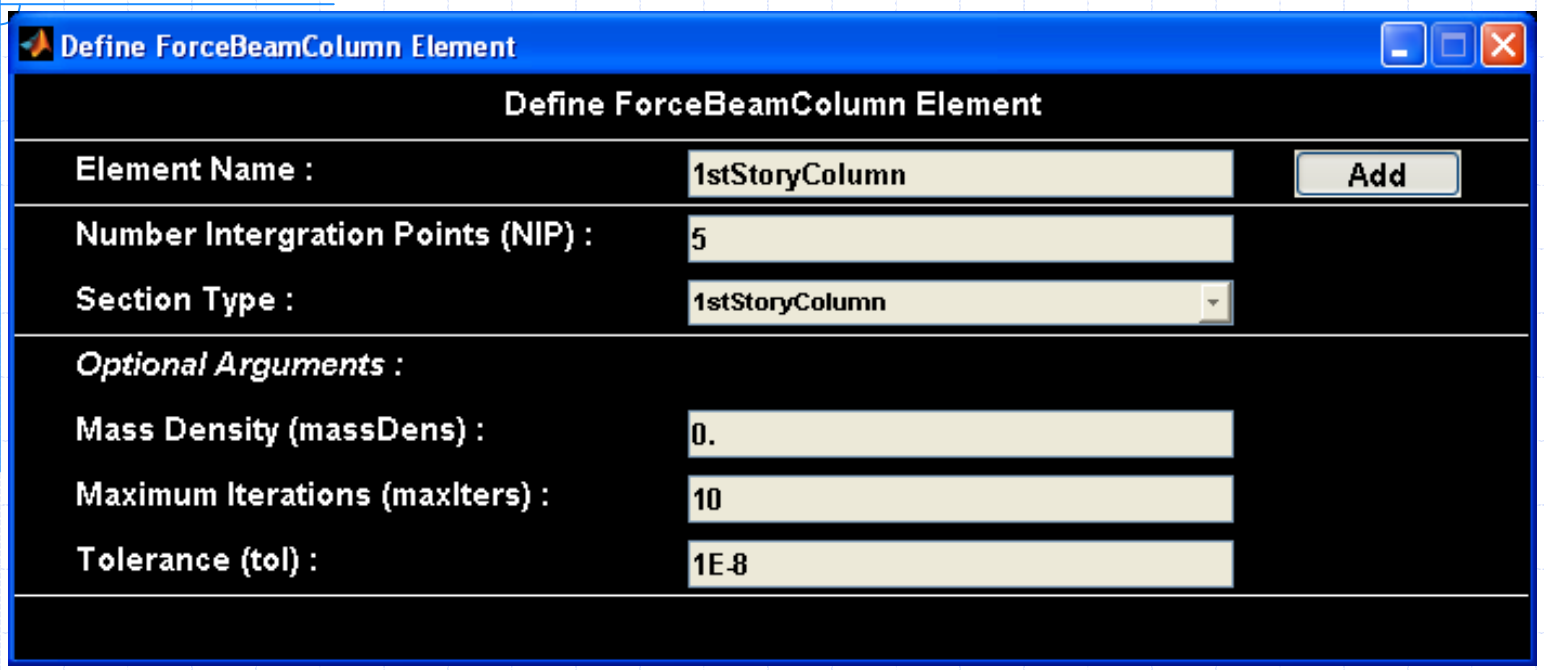
-Truss

-ZeroLength

Define ElasticBeamColumn Element



Define ForceBeamColumn Element

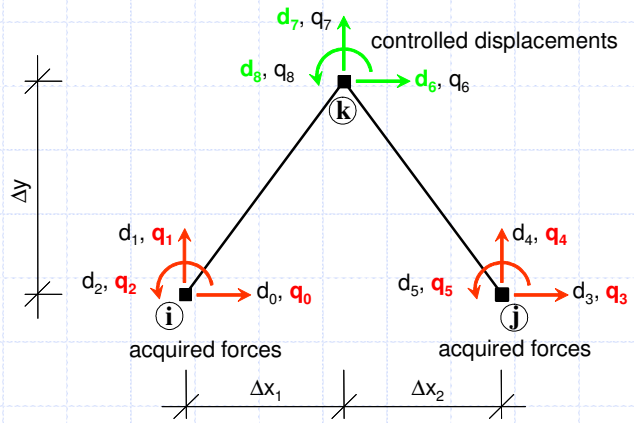


Define ExpElement: ChevronBrace

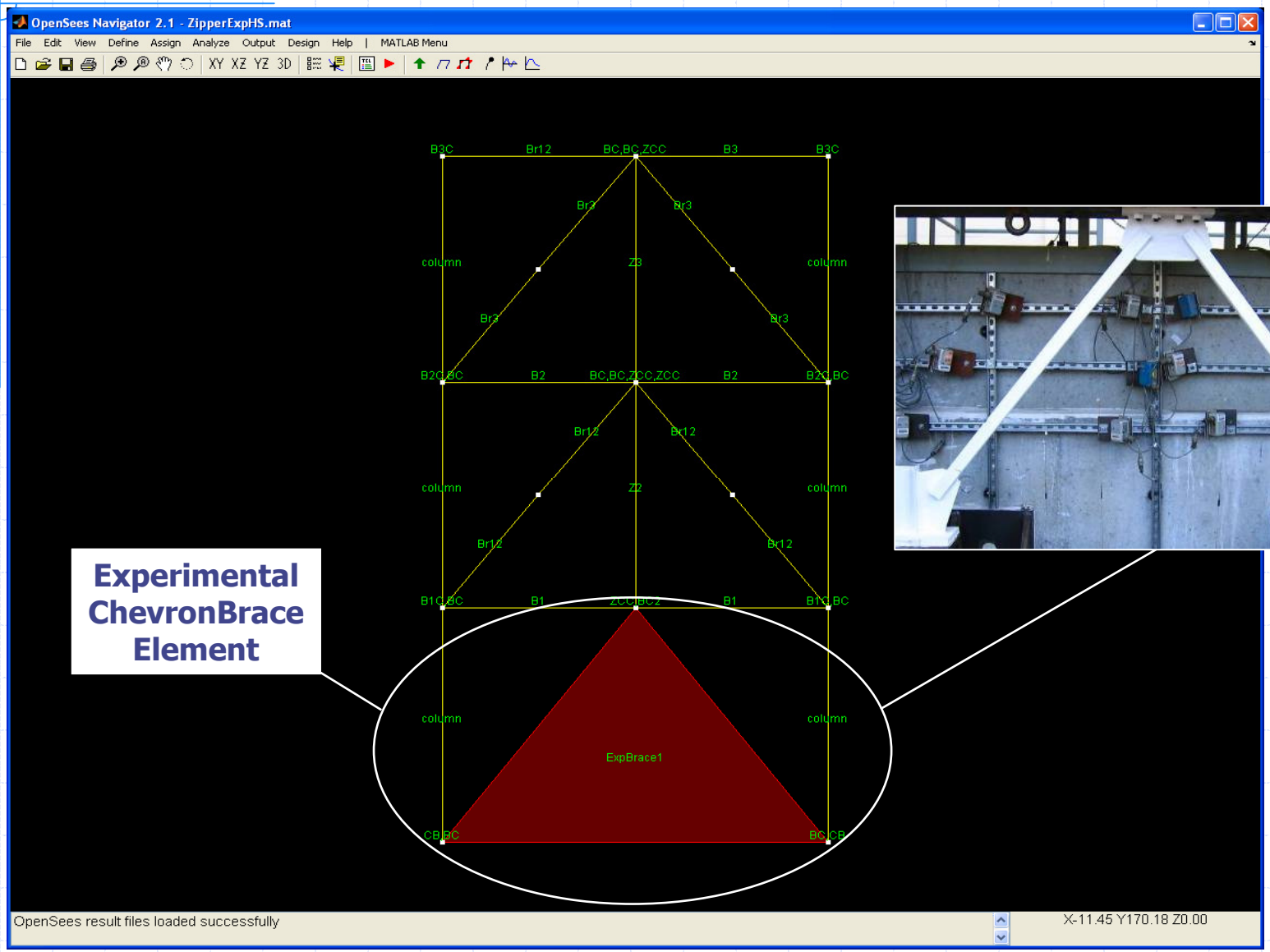
Define ExpChevronBrace Element

Define ExpChevronBrace Element

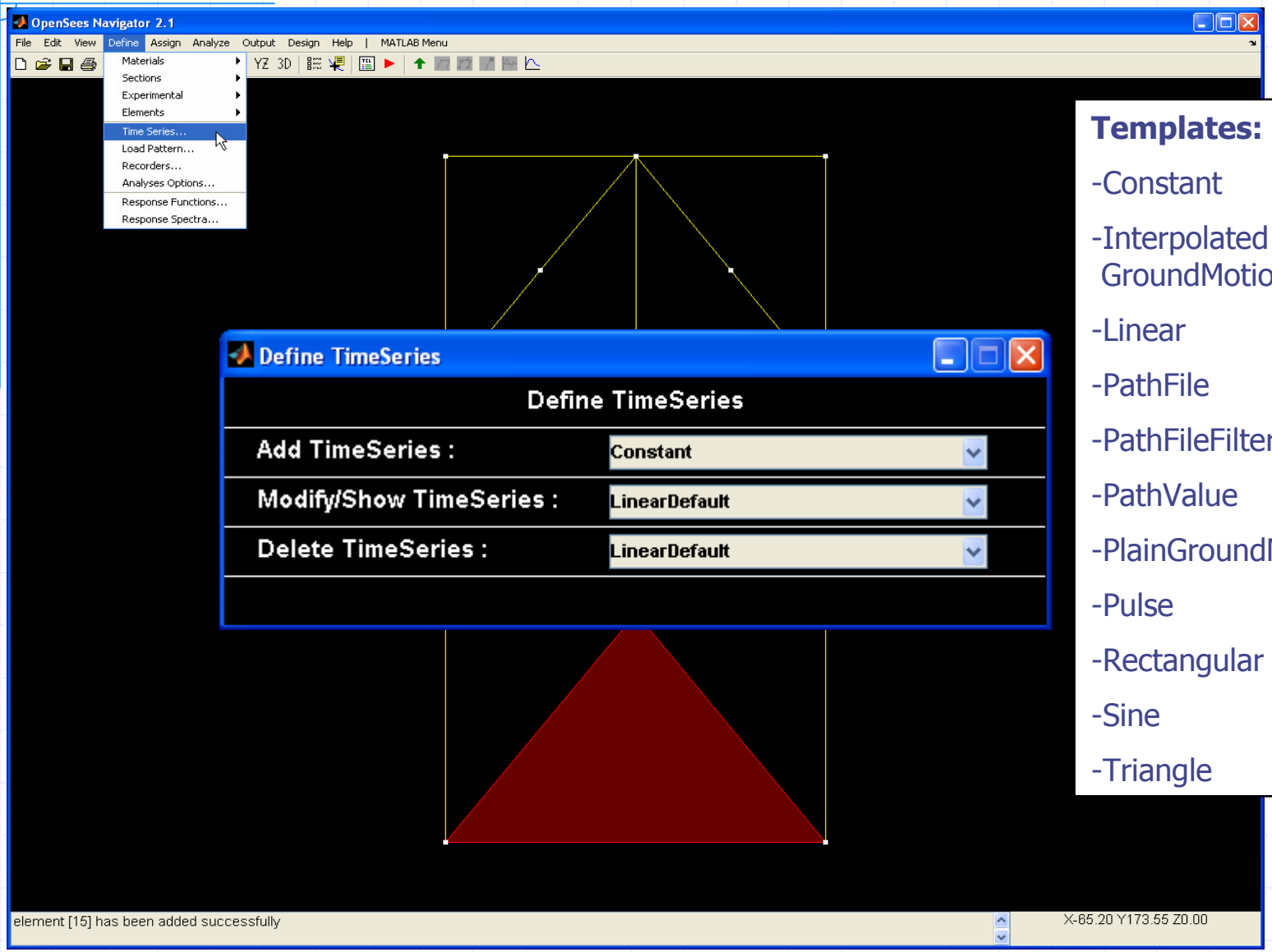
Element Name :	ExpChevronBrace01			Add
Experimental Site Type :	RFS			
Initial Stiffness (initStif) :		0	0	
	0		0	
	0	0	0	
Optional Arguments :				
I-Modification (iMod) :	no			
Is Copy (isCopy) :	no			
Mass Density 1 (massDens1) :	0			
Mass Density 2 (massDens2) :	0			



Define ExpElement: ChevronBrace



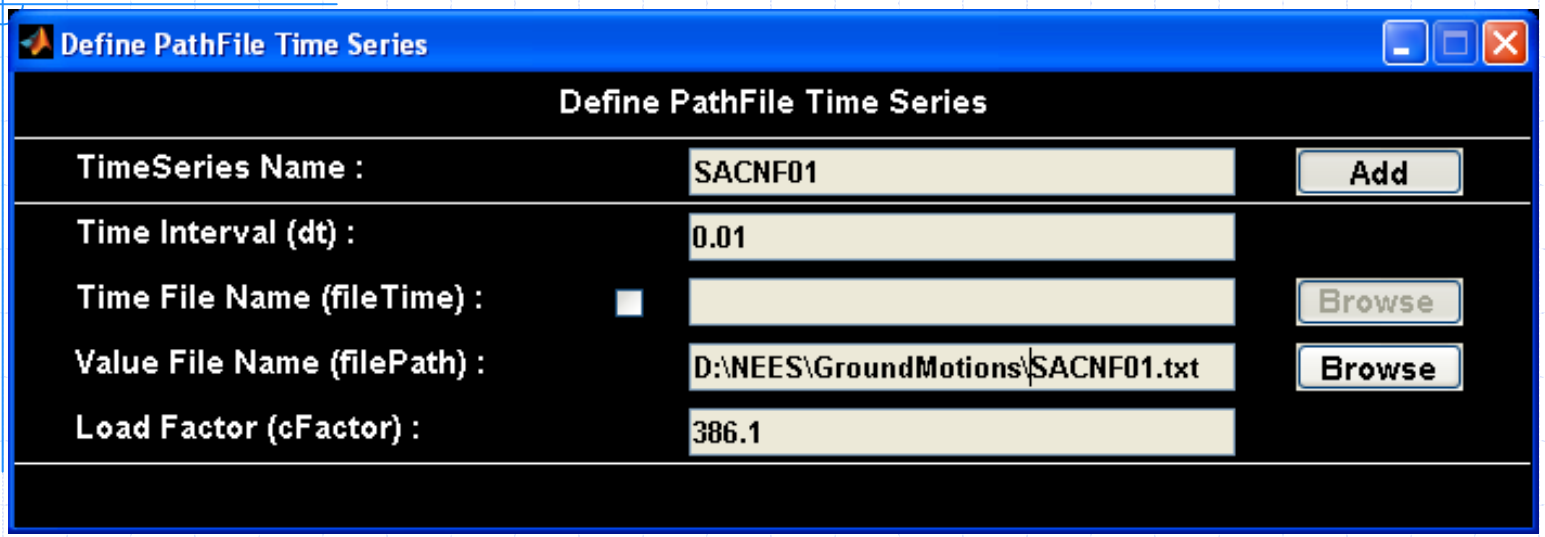
Define TimeSeries

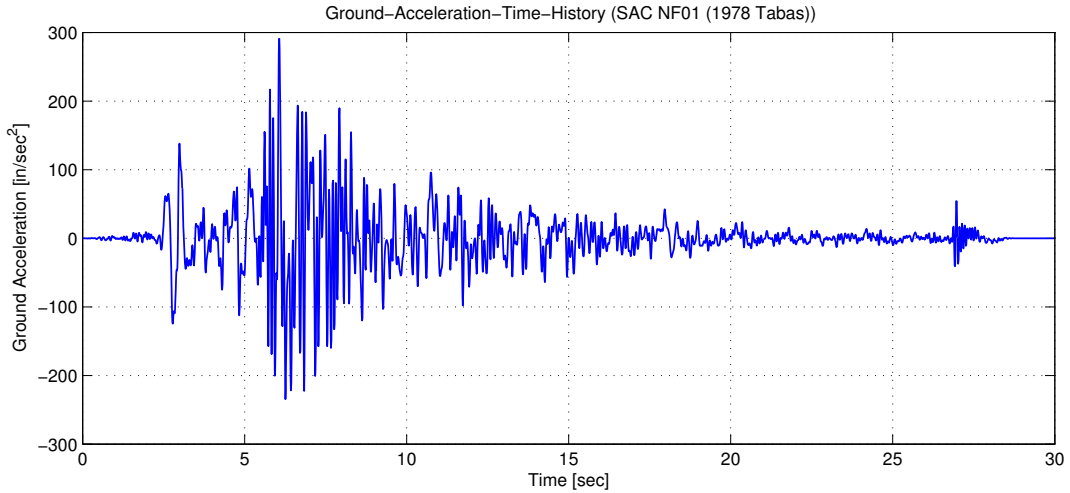


Templates:

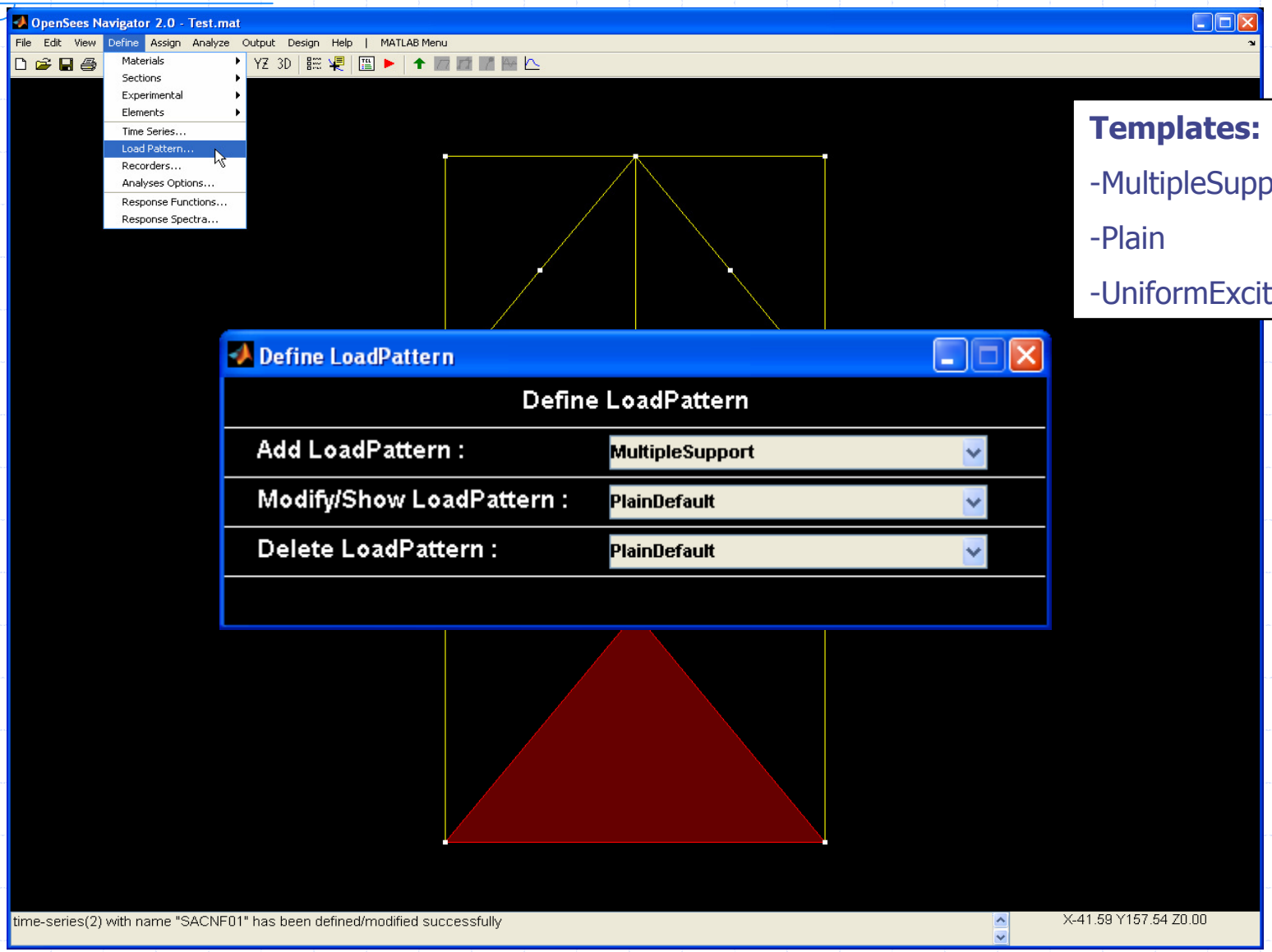
- -Constant
- -Interpolated GroundMotion
- -Linear
- -PathFile
- -PathFileFiltered
- -PathValue
- -PlainGroundMotion
- -Pulse
- -Rectangular
- -Sine
- -Triangle

Define PathFile TimeSeries: SACNF01





Define LoadPattern



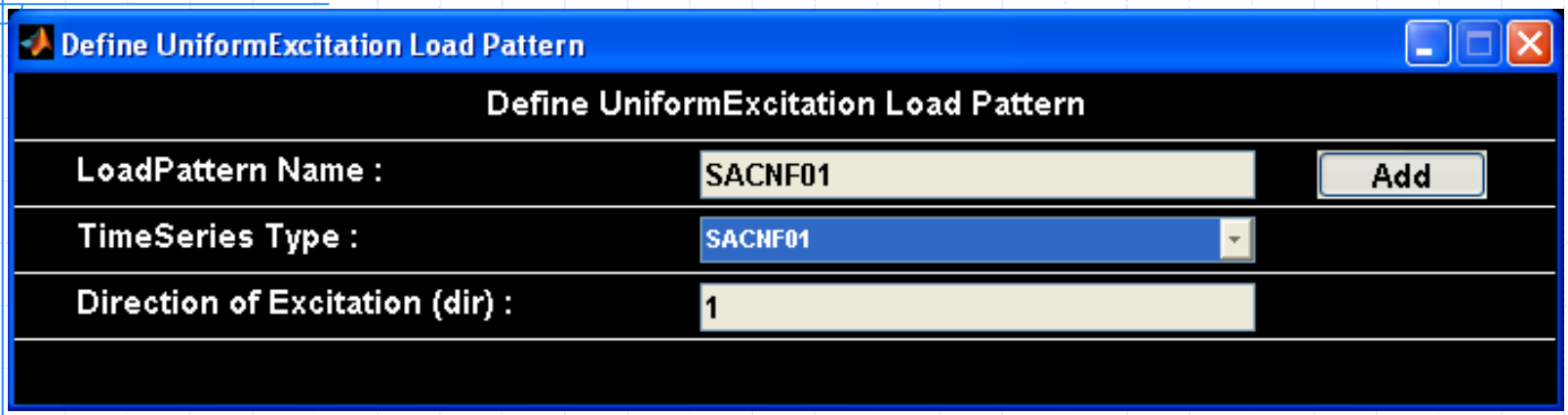
Templates:

-MultipleSupport

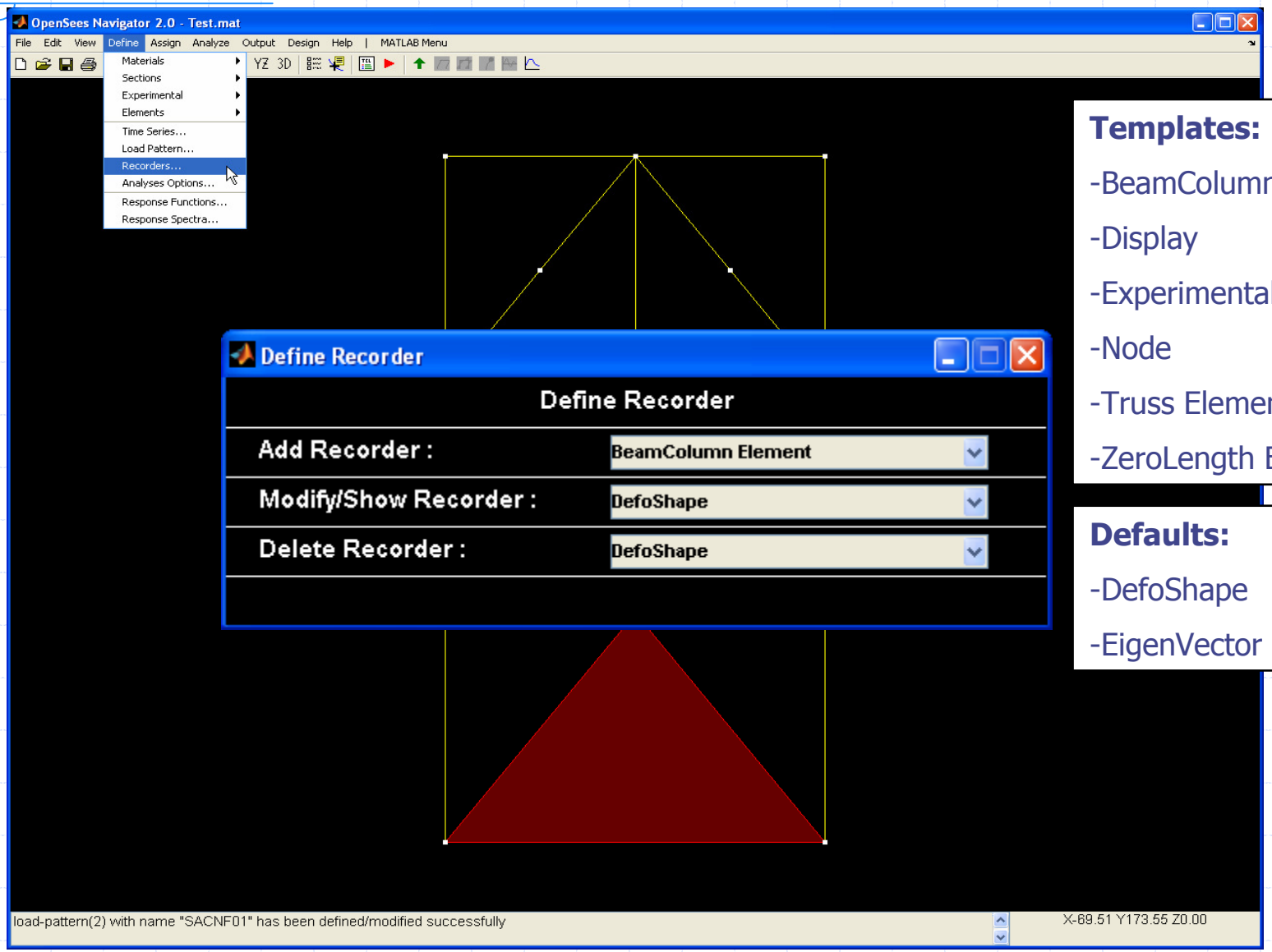
-Plain

-UniformExcitation

Define UniformExcitation LoadPattern



Define Recorder



Templates:

-BeamColumn Element

-Display

-Experimental Element

-Node

-Truss Element

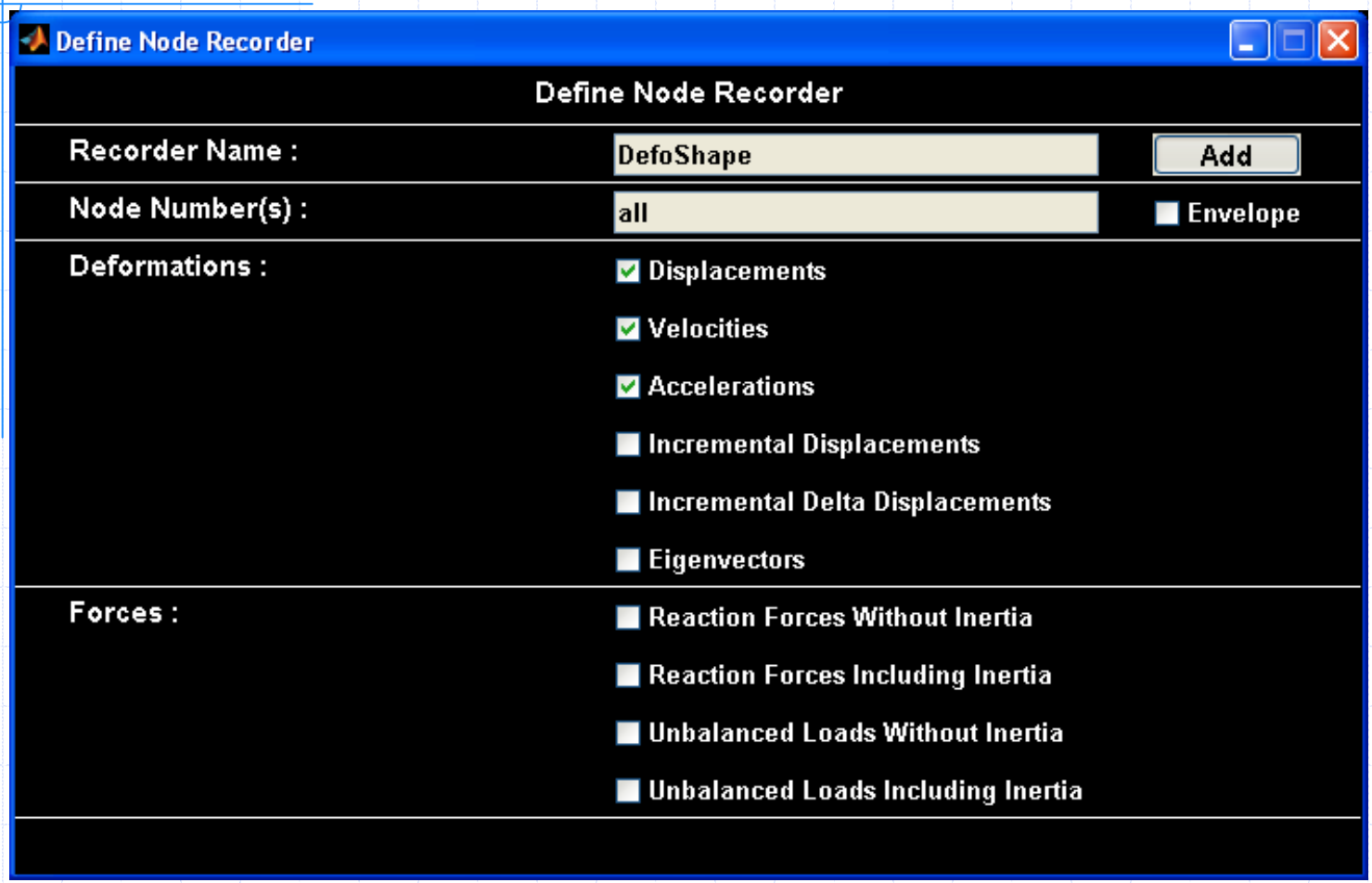
-ZeroLength Element

Defaults:

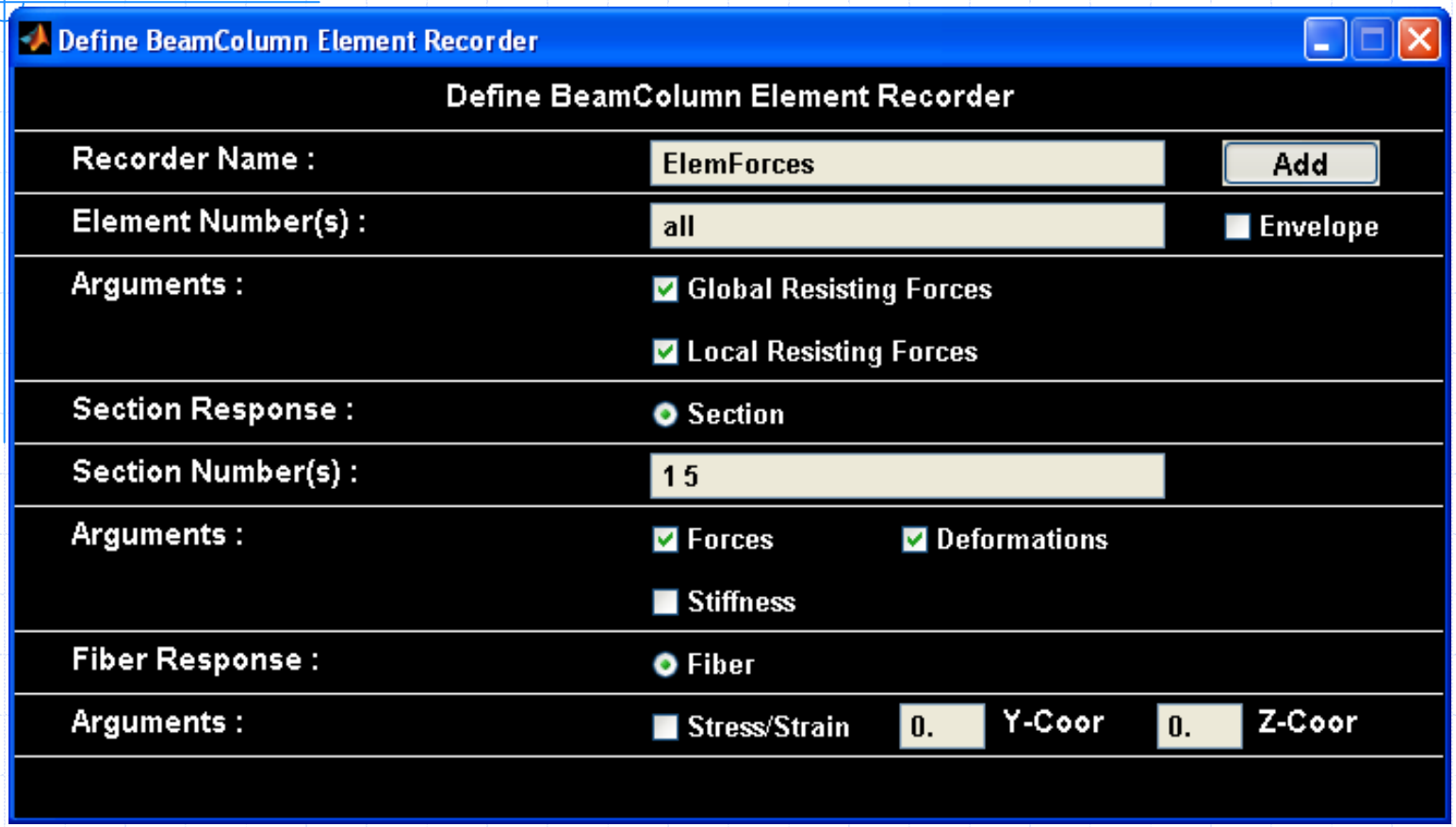
-DefoShape

-EigenVector

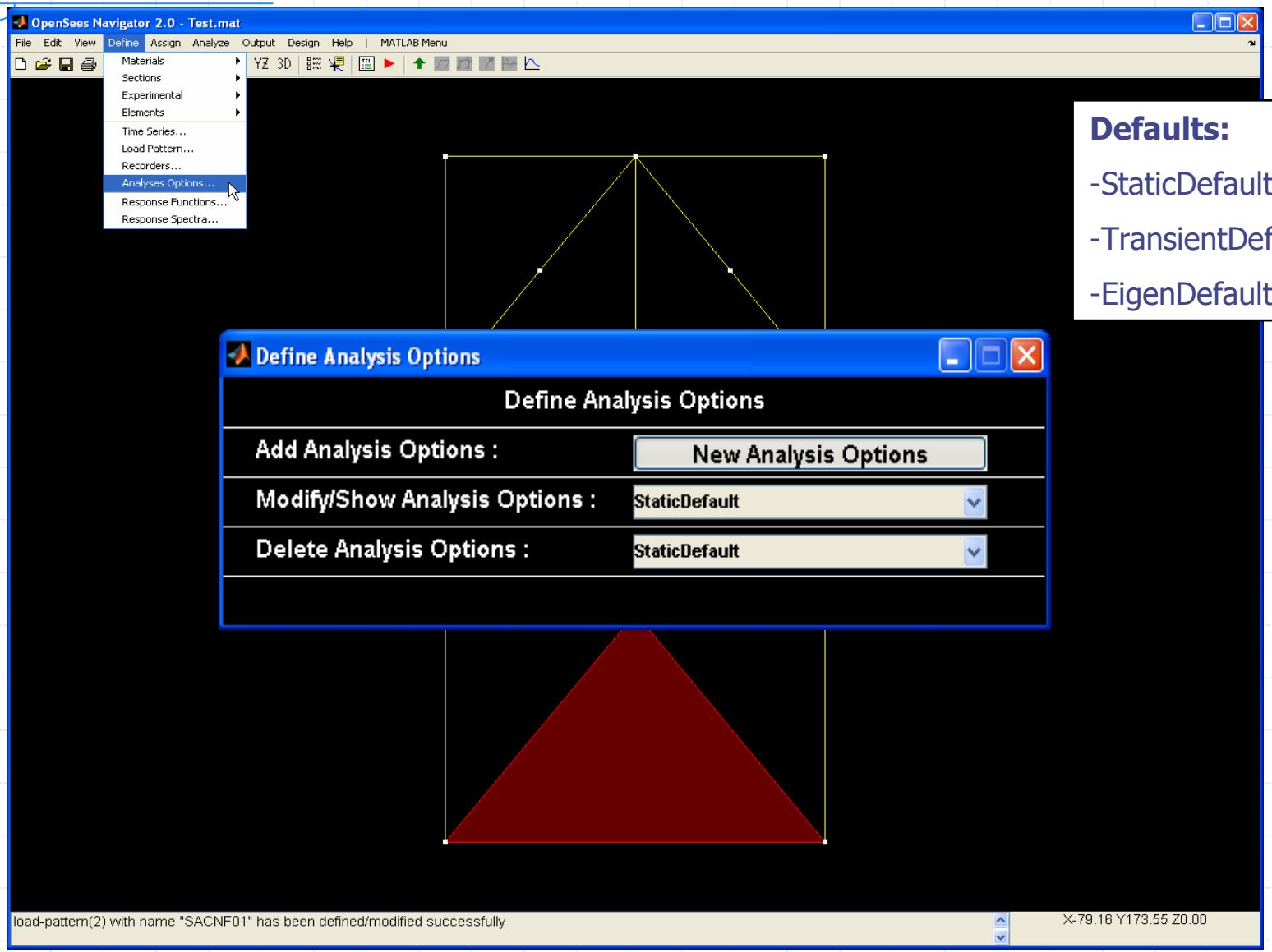
Define Node Recorder



Define BeamColumn Recorder



Define Analysis Options



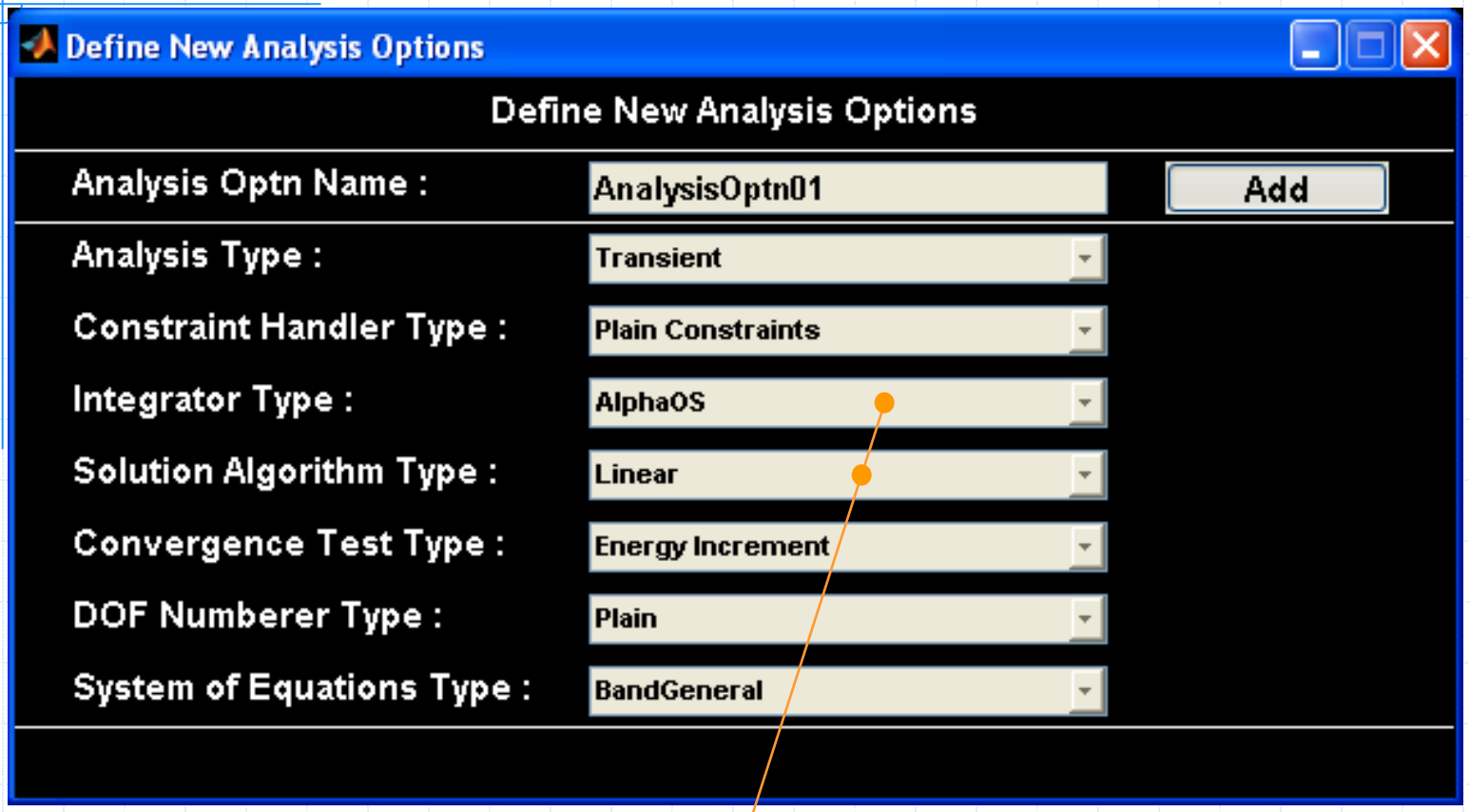
Defaults:

-StaticDefault

-TransientDefault

-EigenDefault

Define New Analysis Options



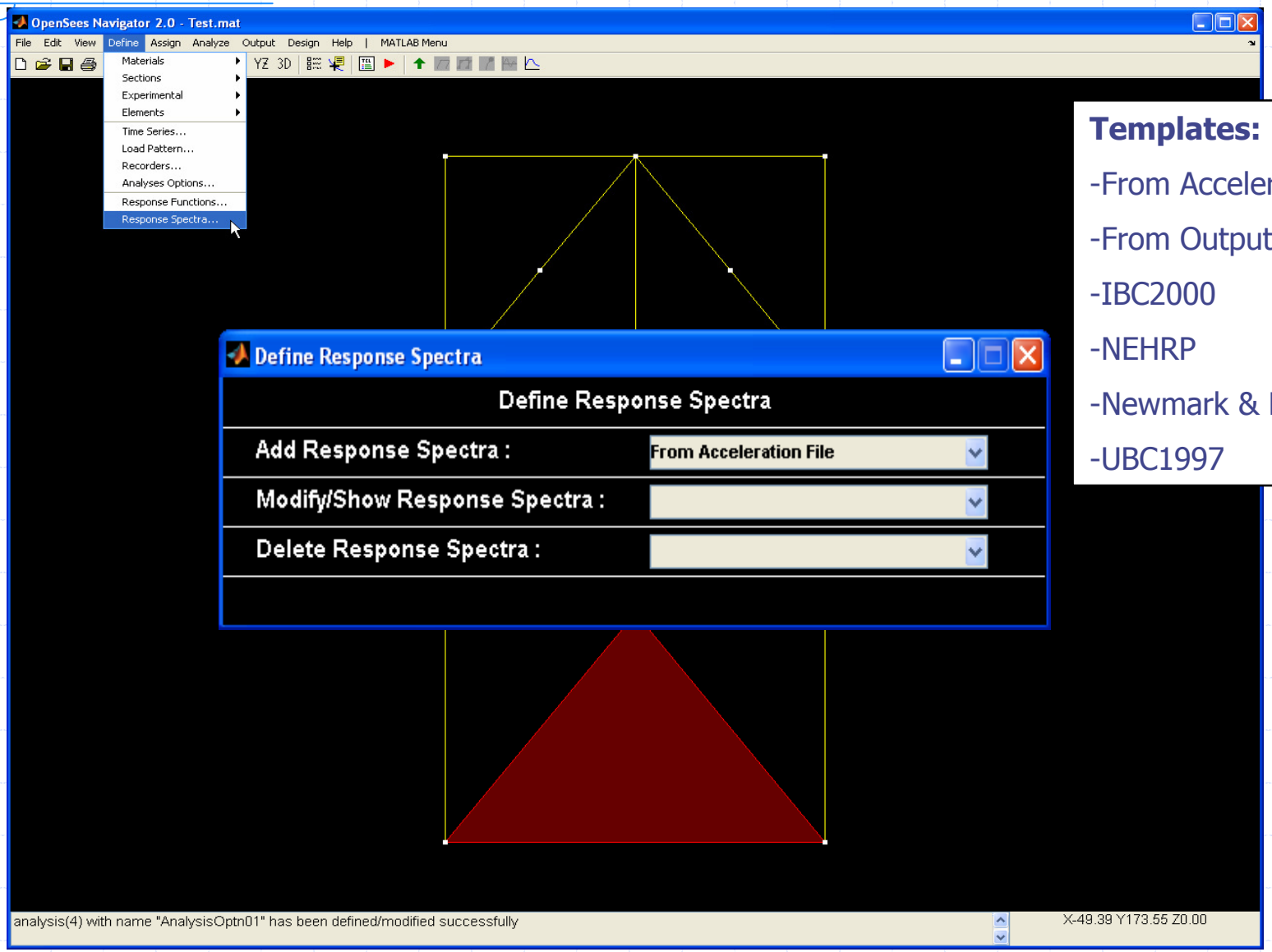
Integrator Type:

For example use AlphaOS Method for Hybrid Simulation

Solution Algorithm:

The AlphaOS Method requires a Linear solution algorithm

Define Response Spectra



Templates:

-From Acceleration File

-From Output

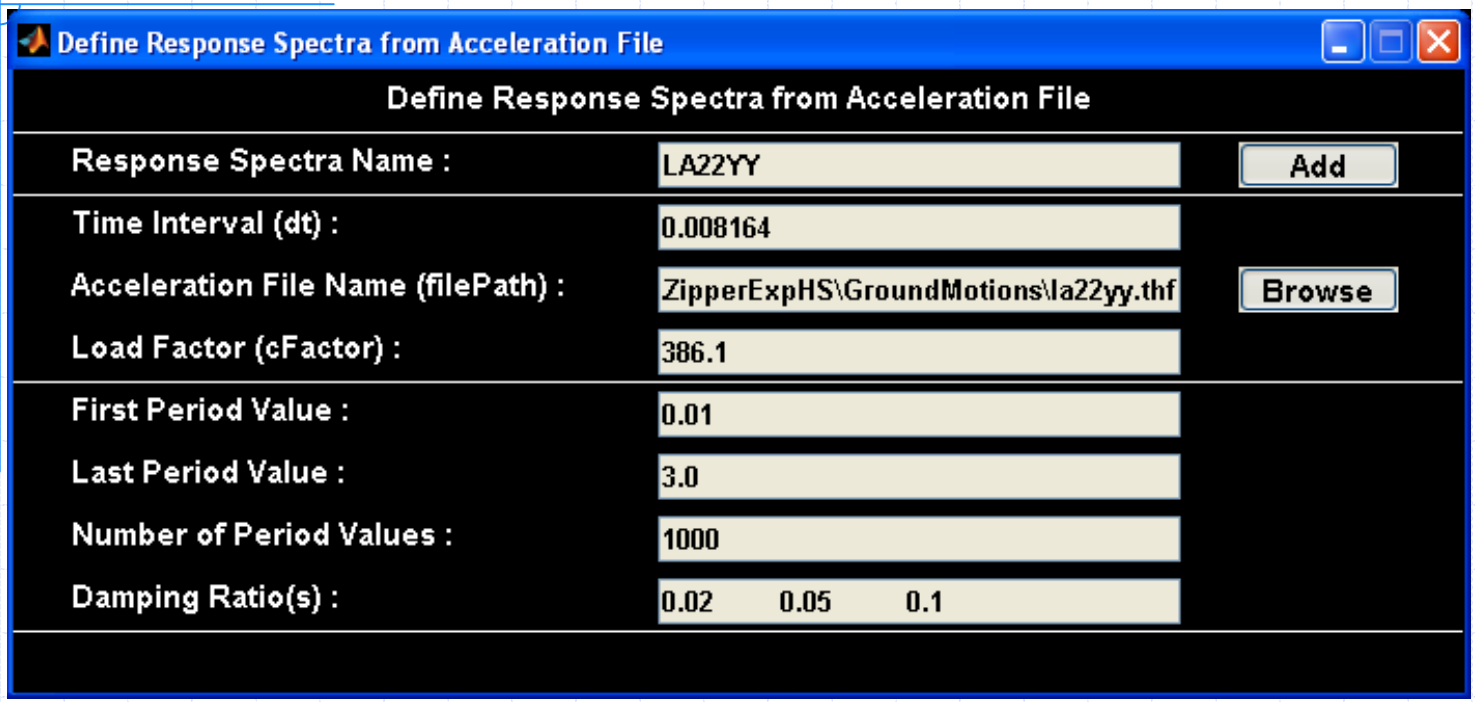
-IBC2000

-NEHRP

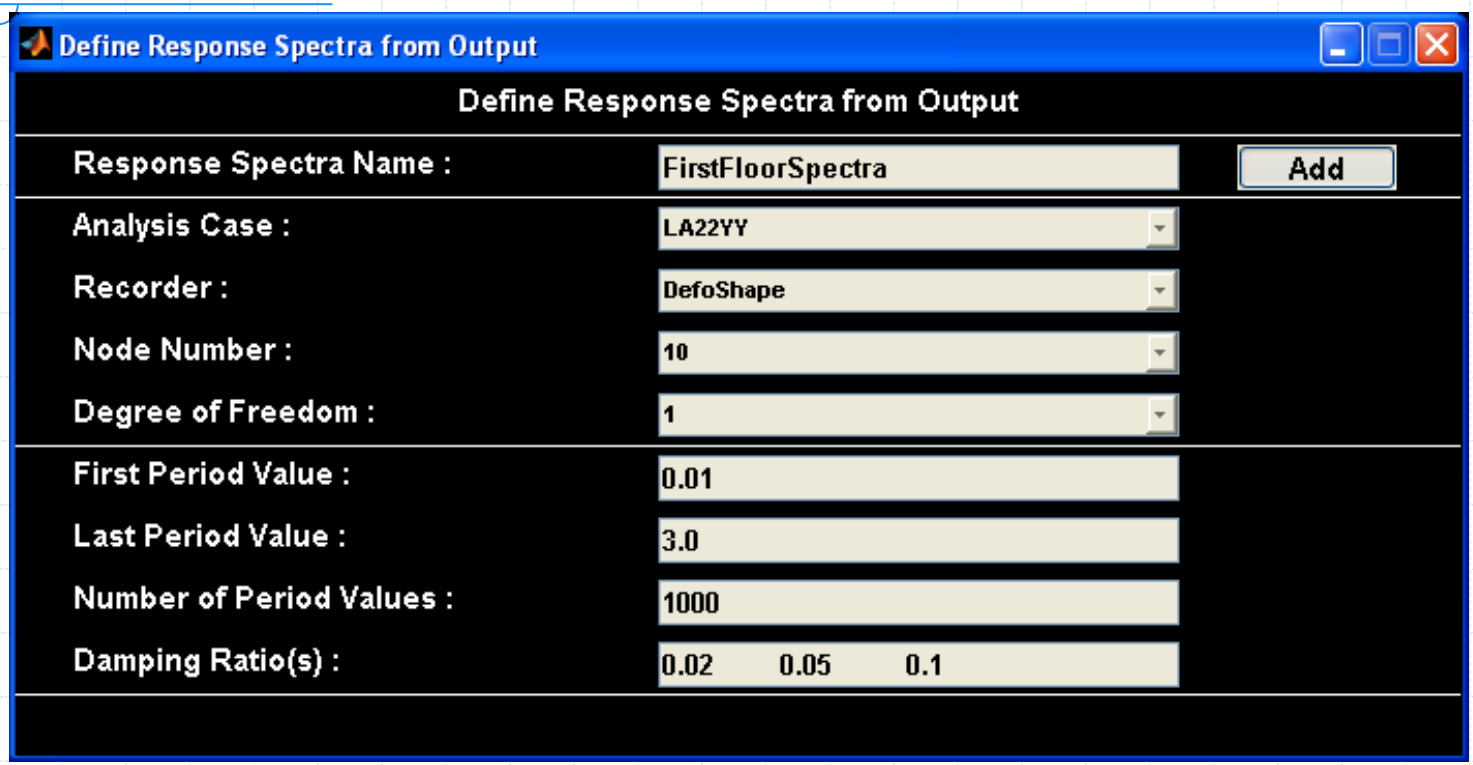
-Newmark & Hall

-UBC1997

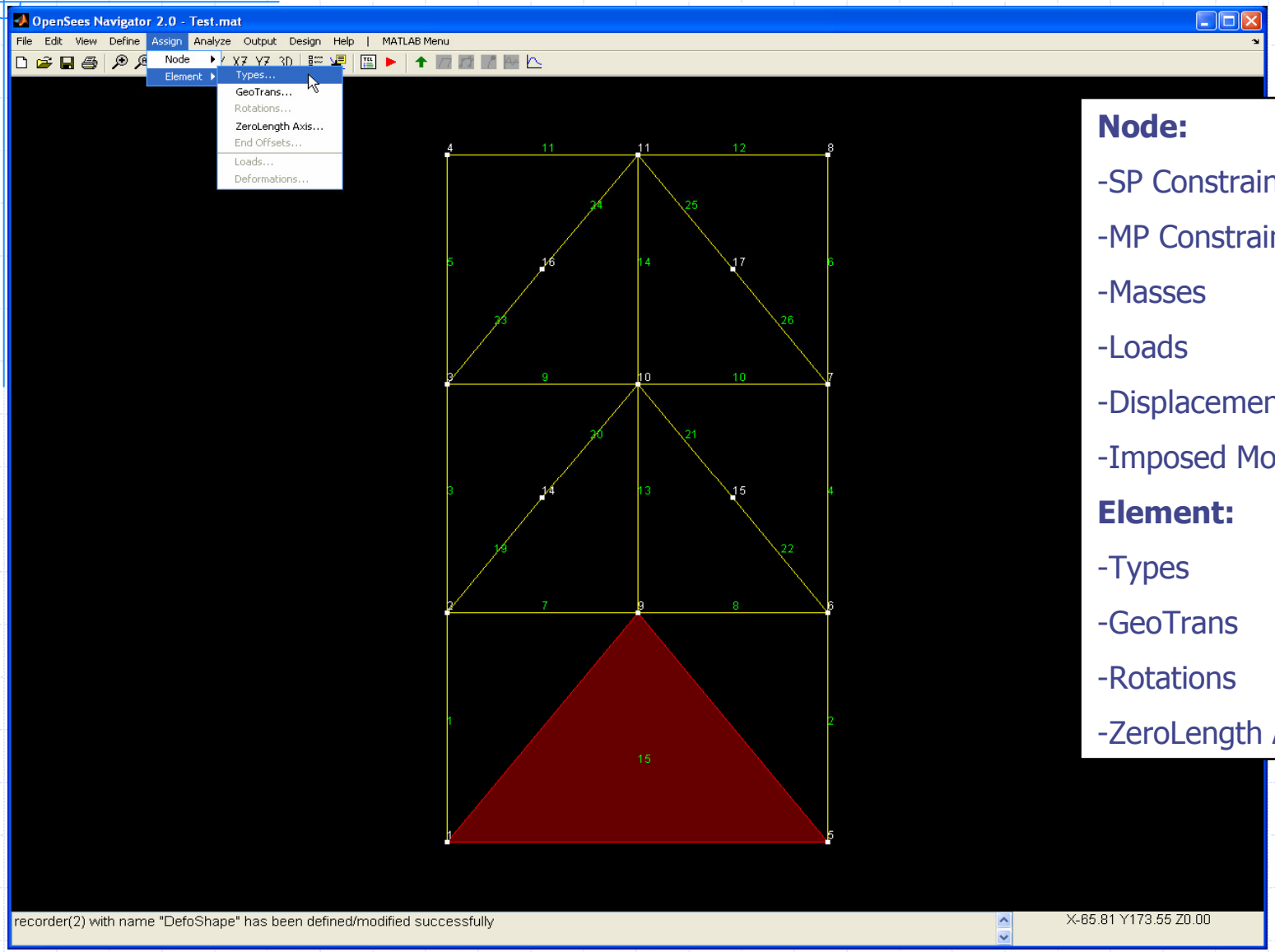
Define From Acceleration File Spectra



Define From Output Spectra



Assign Menu



Node:

-SP Constraints

-MP Constraints

-Masses

-Loads

-Displacements

-Imposed Motions

Element:

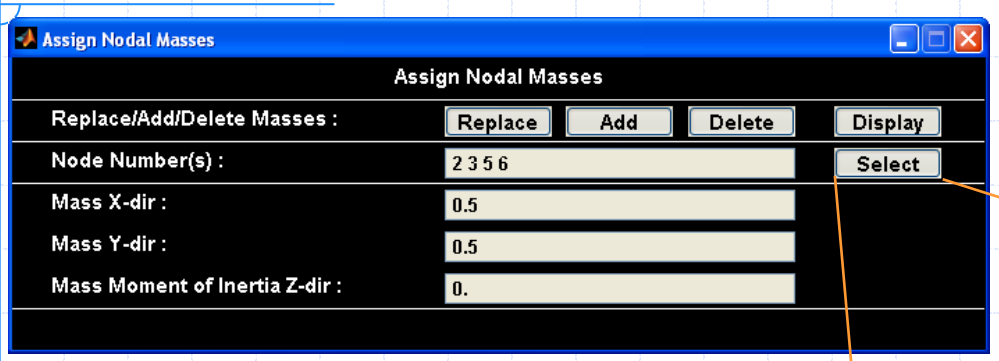
-Types

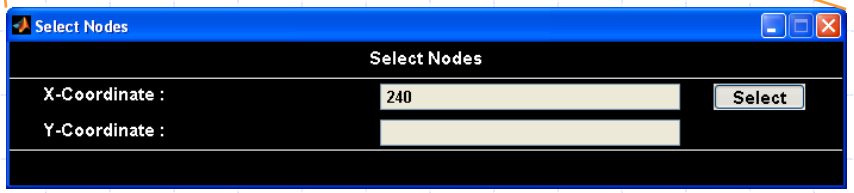
-GeoTrans

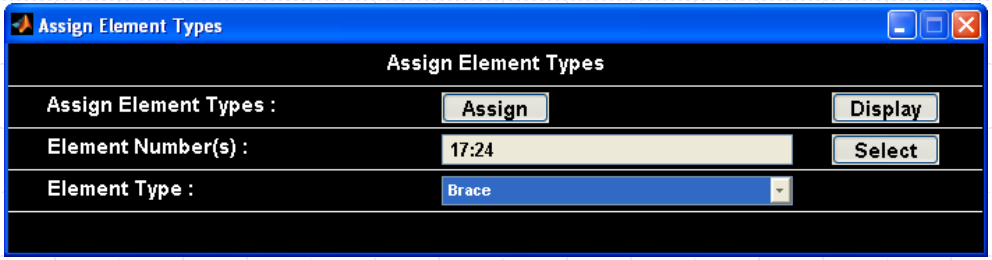
-Rotations

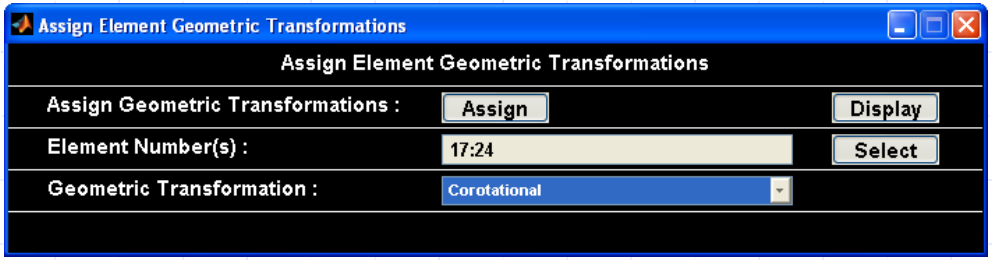
-ZeroLength Axis

Assign Menu

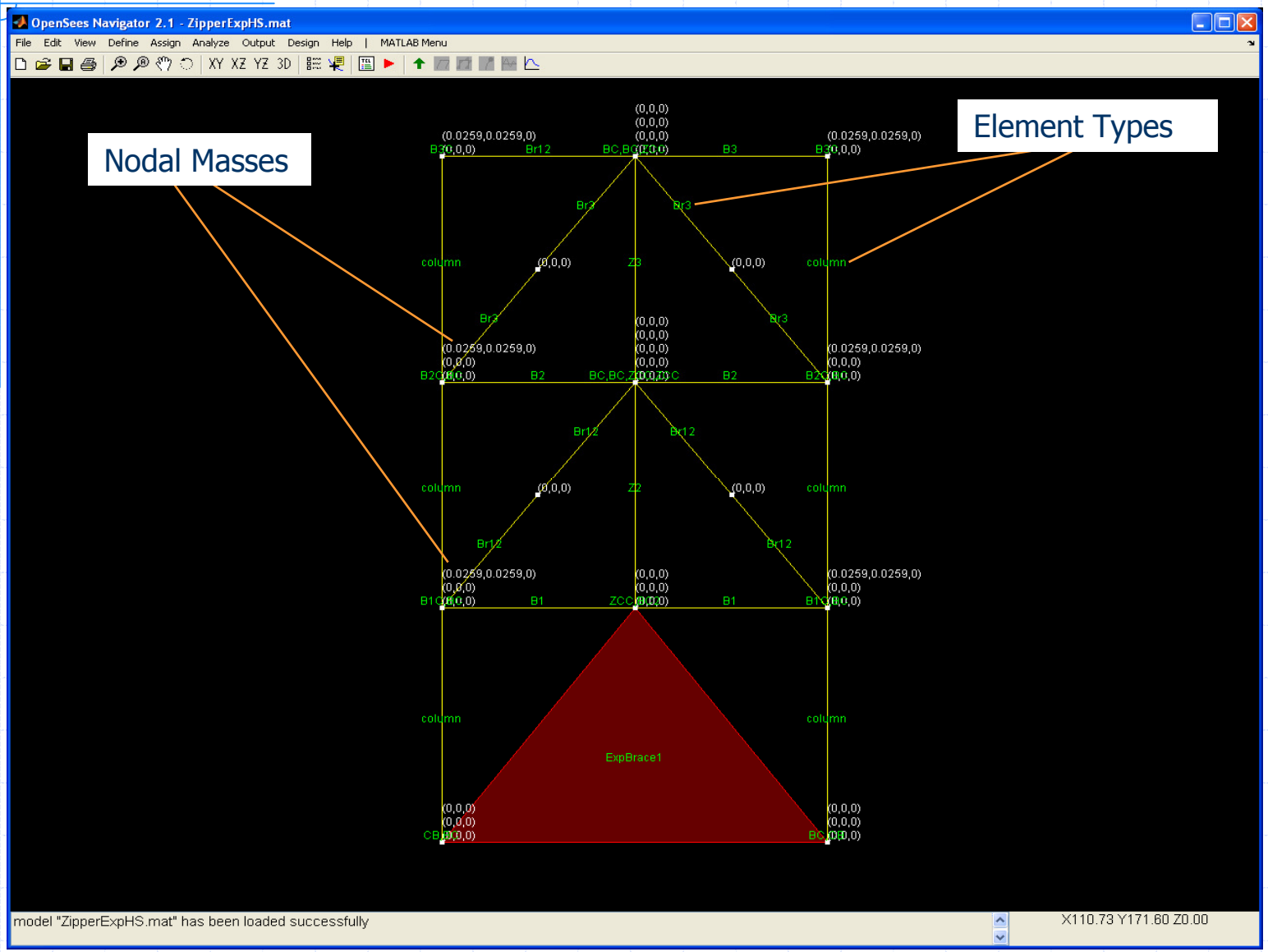

Assign Nodal Masses
Assign Nodal Masses
Replace/Add/Delete Masses :
Replace
Add
Delete
Display
Node Number(s) :
2 3 5 6
Select
Mass X-dir :
0.5
Mass Y-dir :
0.5
Mass Moment of Inertia Z-dir :
0.


Select Nodes
Select Nodes
X-Coordinate :
240
Select
Y-Coordinate :

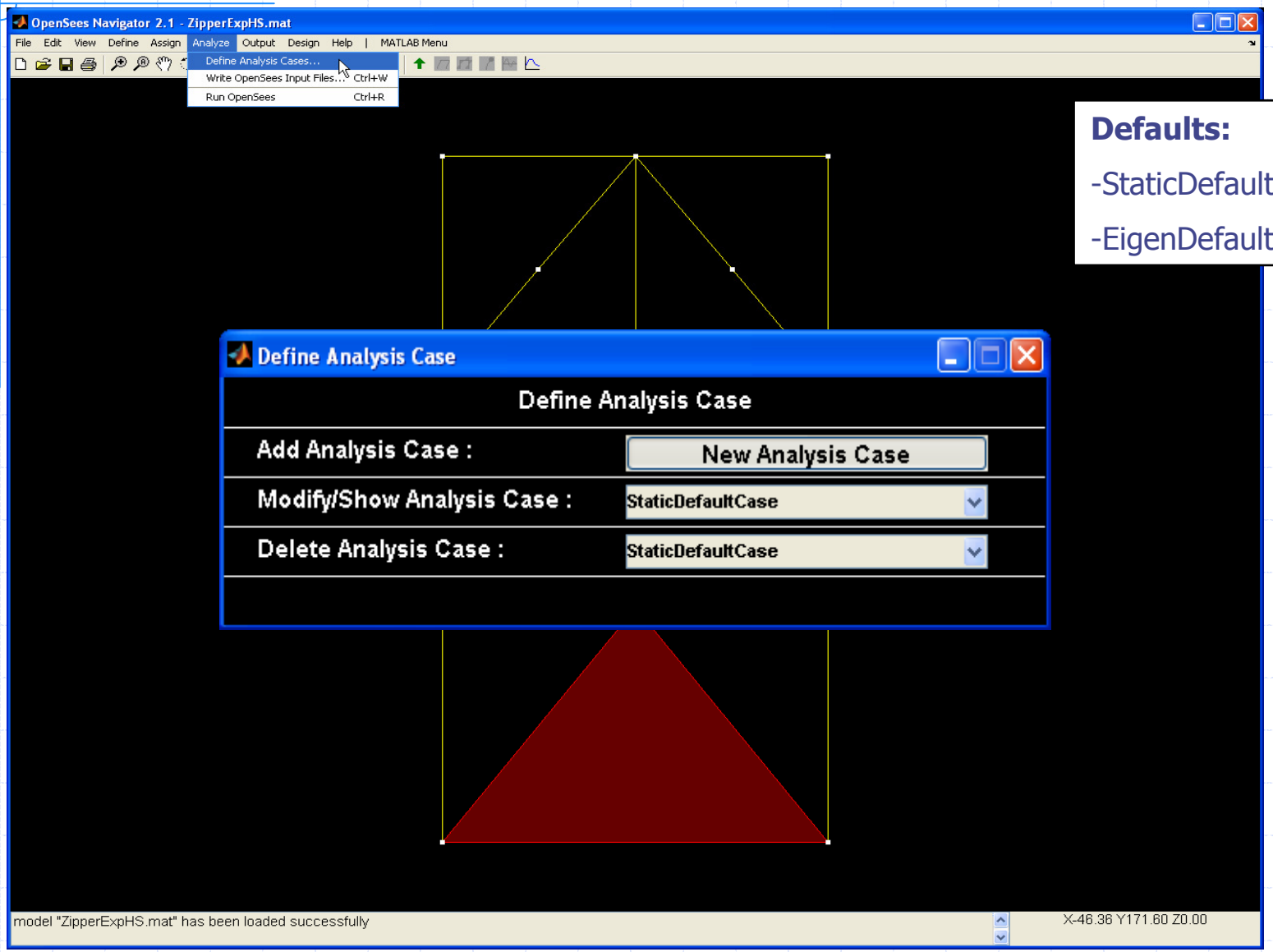

Assign Element Types
Assign Element Types
Assign Element Types :
Assign
Display
Element Number(s) :
17:24
Select
Element Type :
Brace


Assign Element Geometric Transformations
Assign Element Geometric Transformations
Assign Geometric Transformations :
Assign
Display
Element Number(s) :
17:24
Select
Geometric Transformation :
Corotational

Assigned Properties



Define Analysis Cases

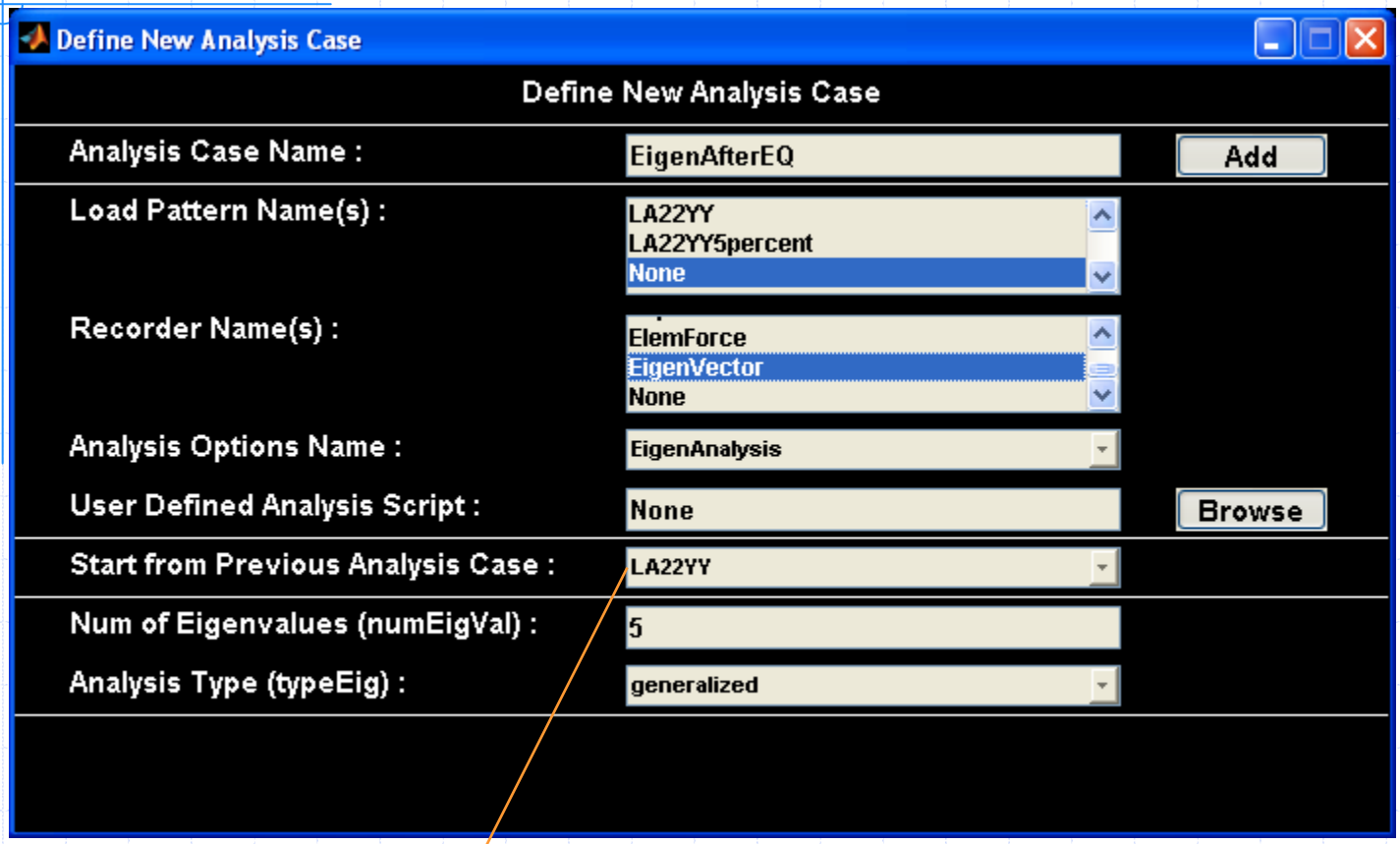


Defaults:

-StaticDefaultCase

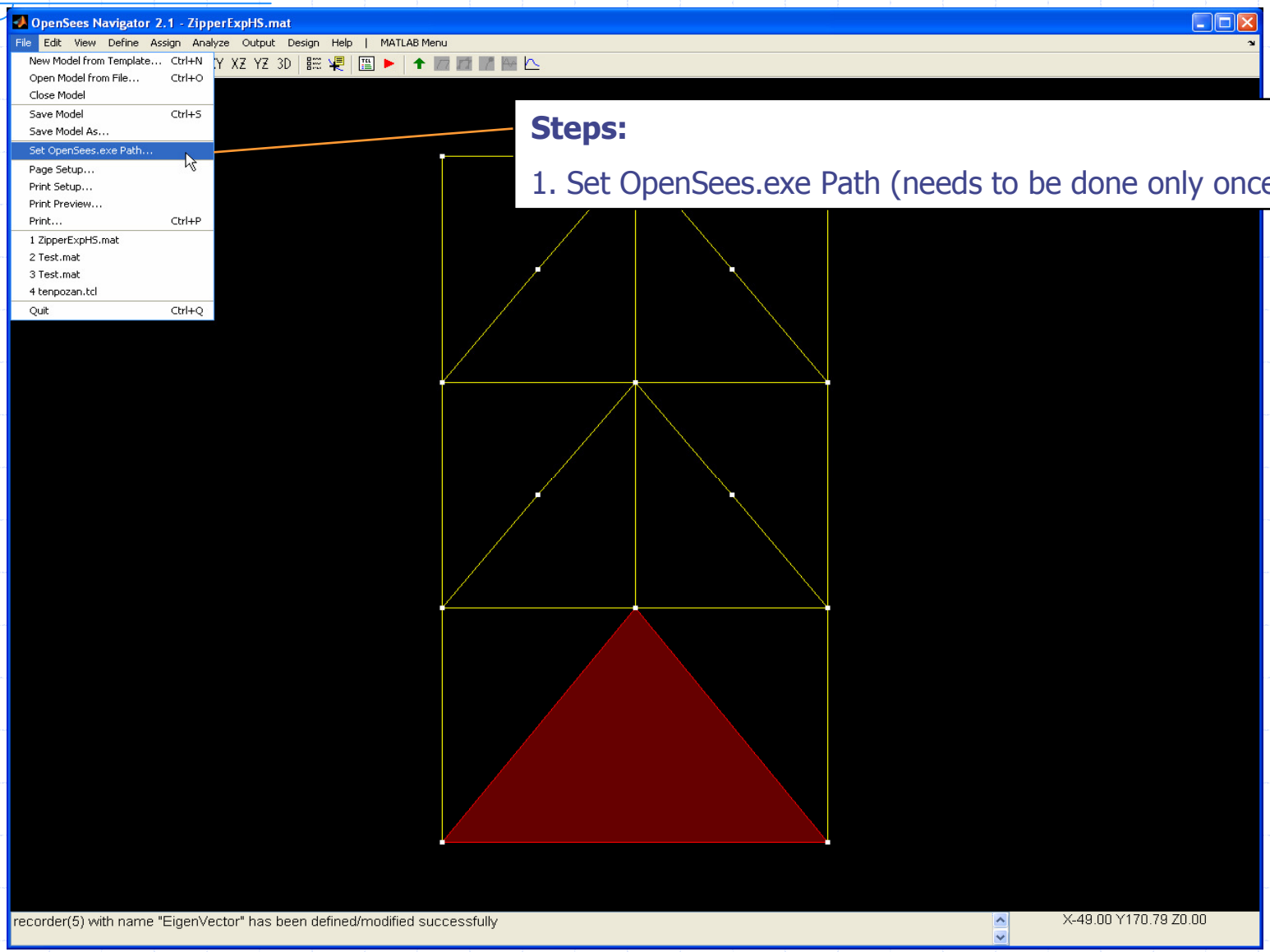
-EigenDefaultCase

Define New Analysis Case



For Example:
Periods and Mode Shapes after Time-History Analysis

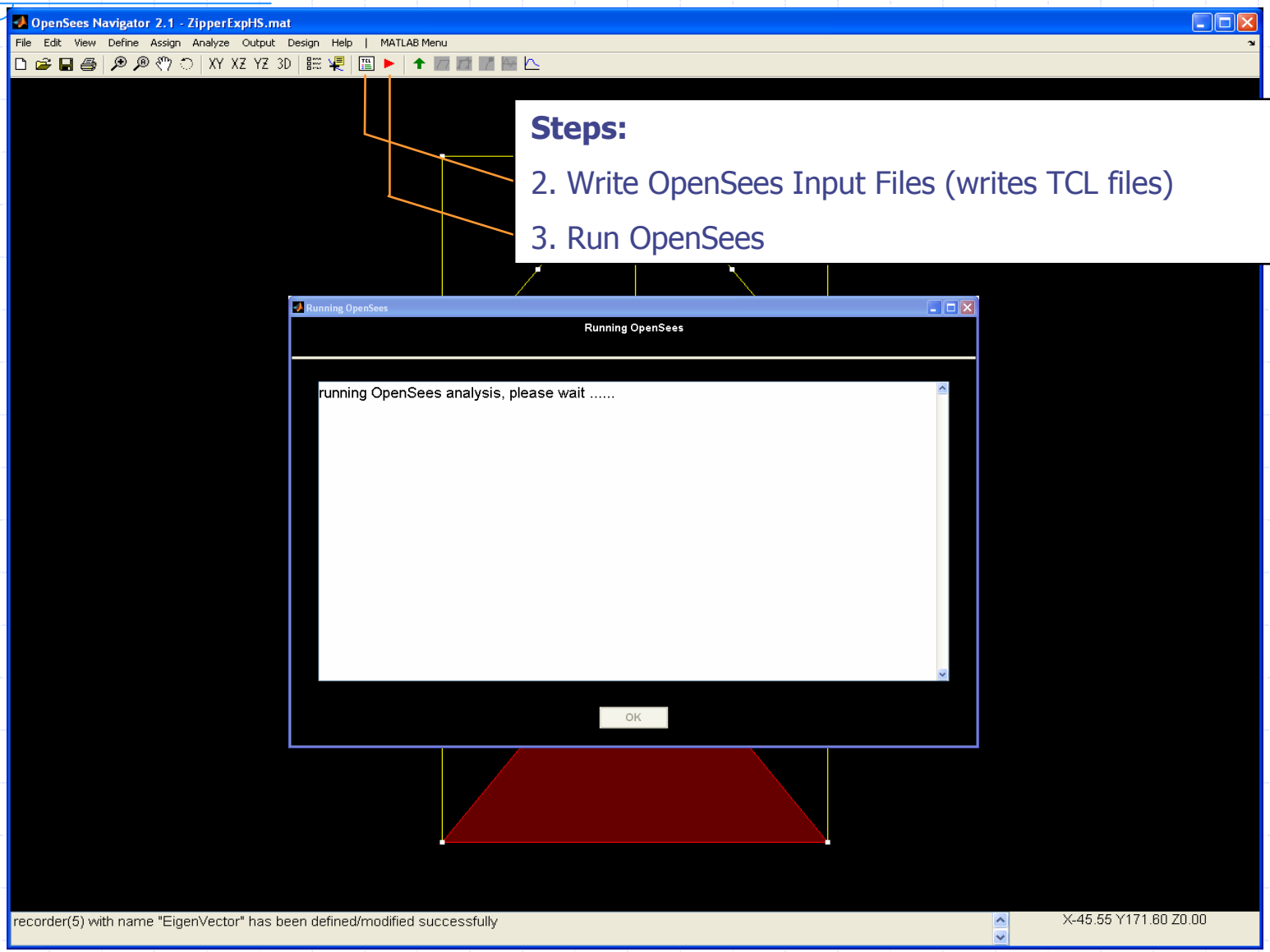
To Run OpenSees



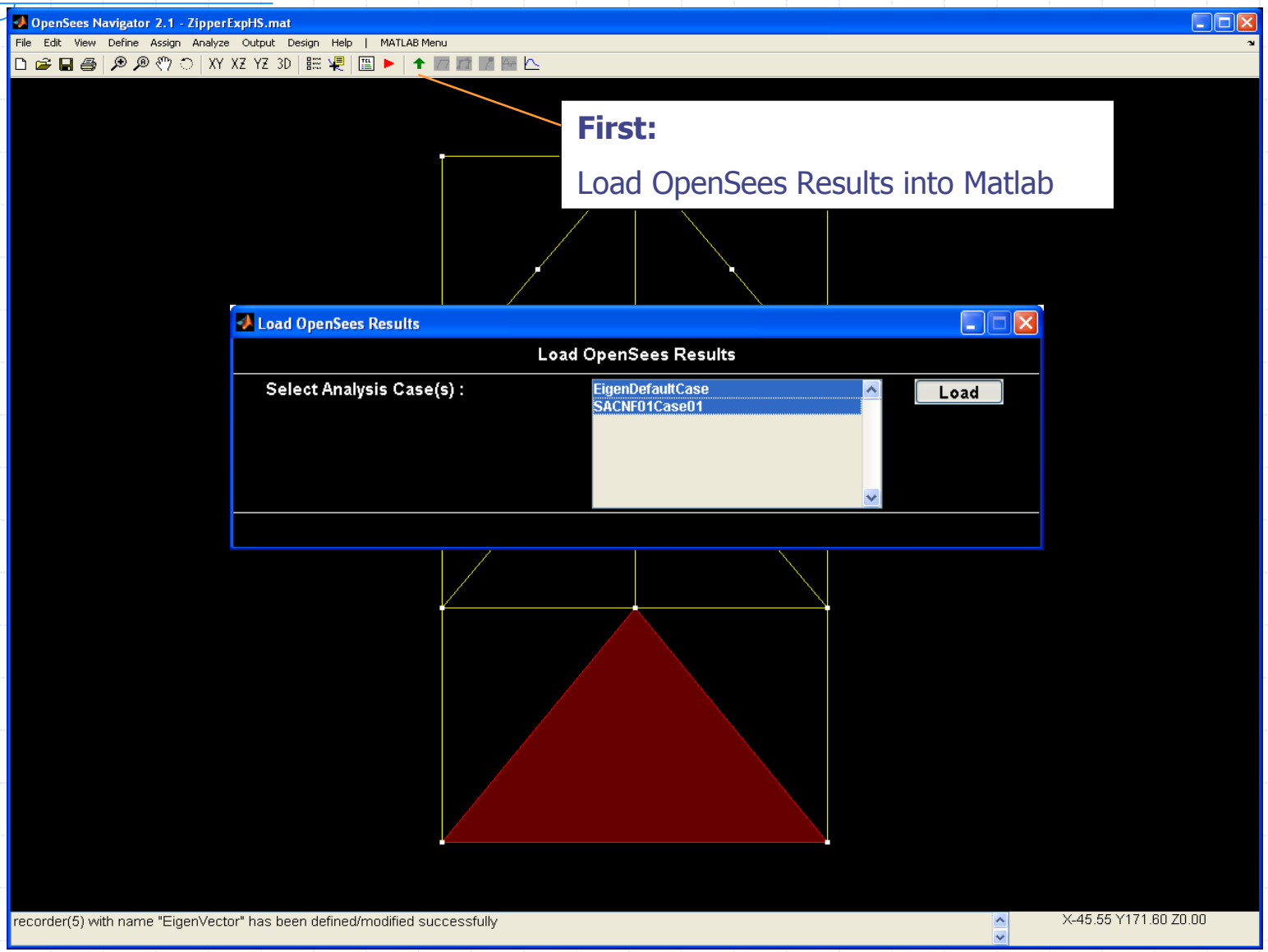
Steps:

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

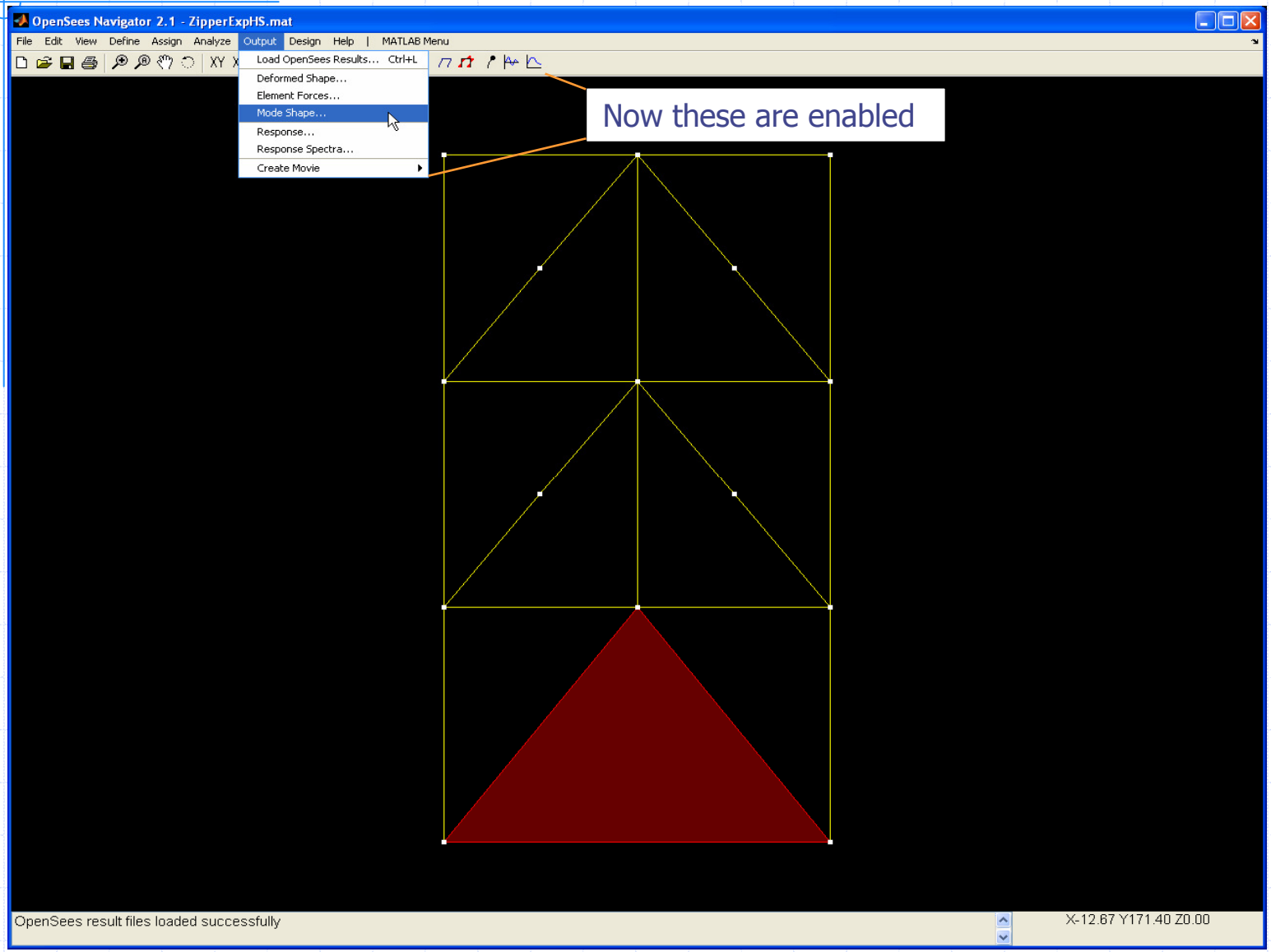
To Run OpenSees



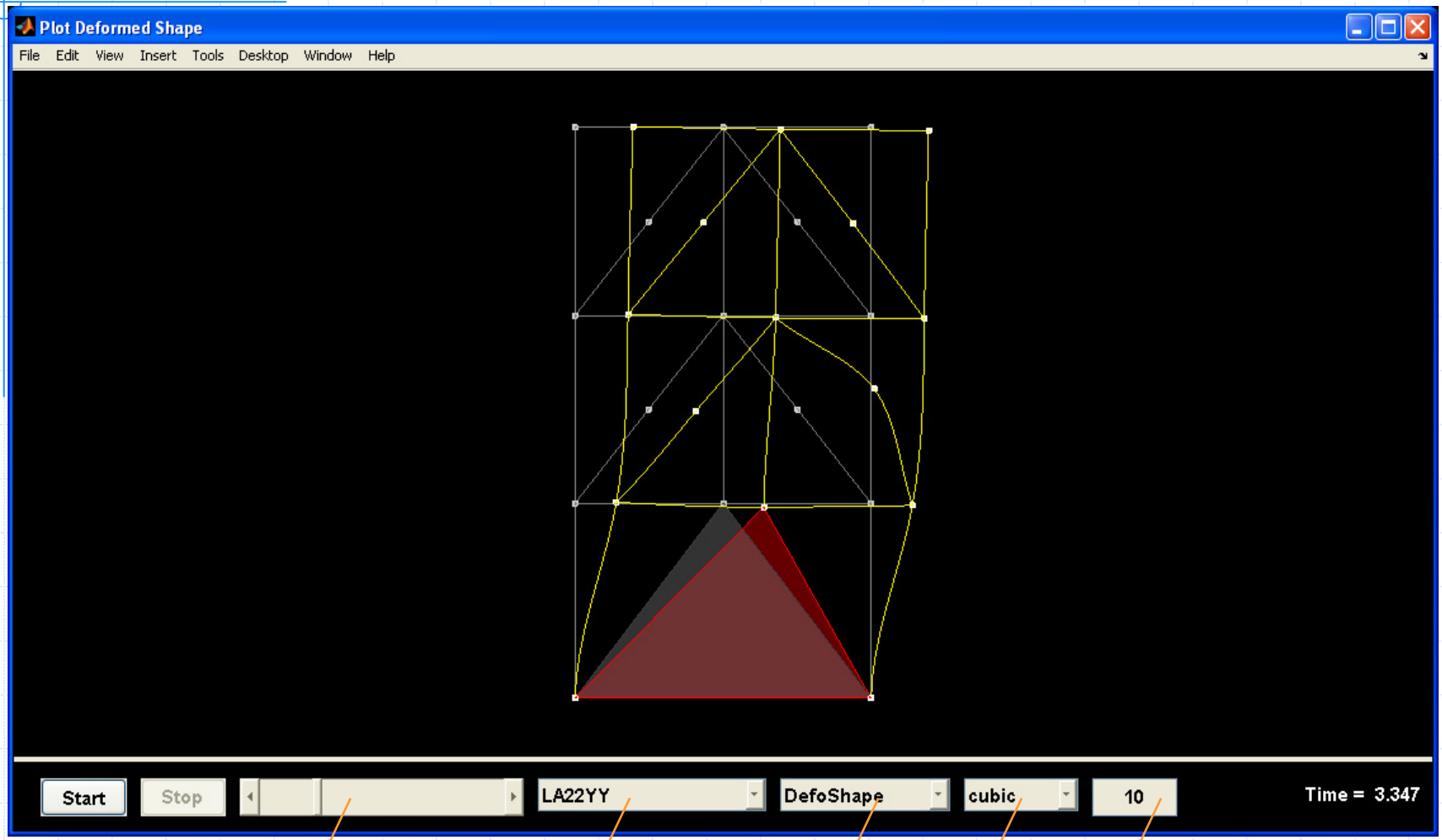
Post-Processing: Output



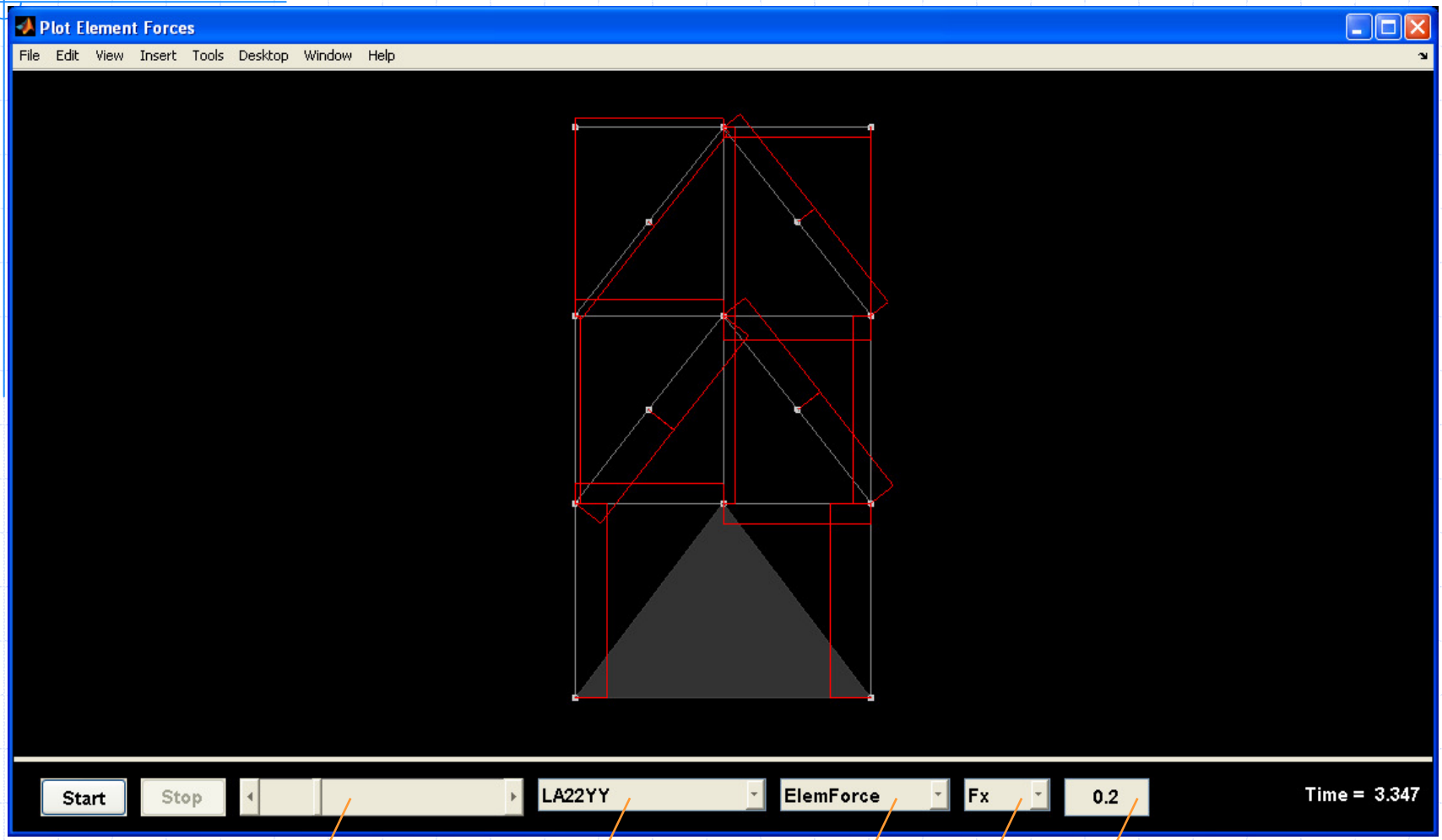
Post-Processing: Output



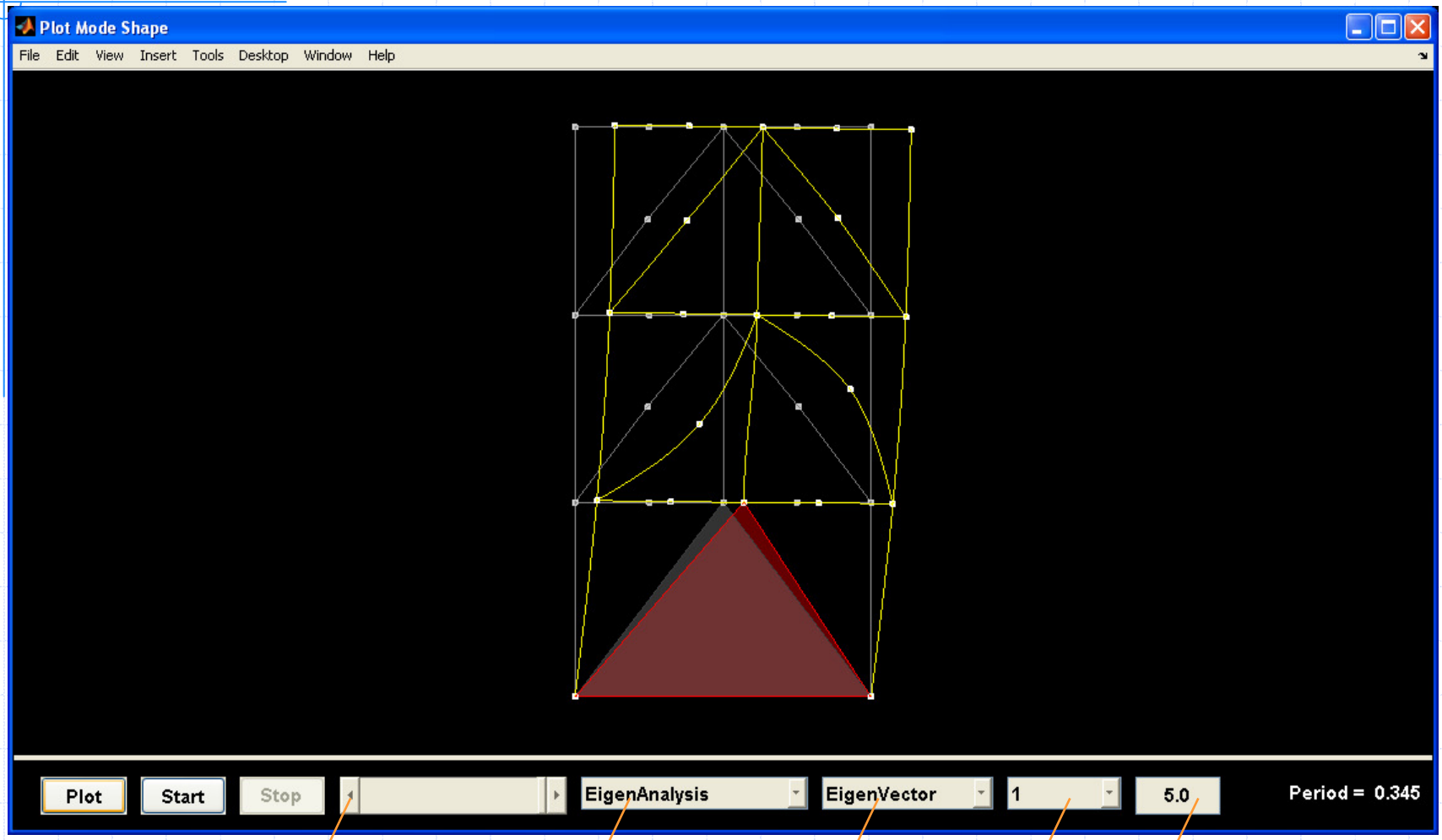
Plot Deformed Shape



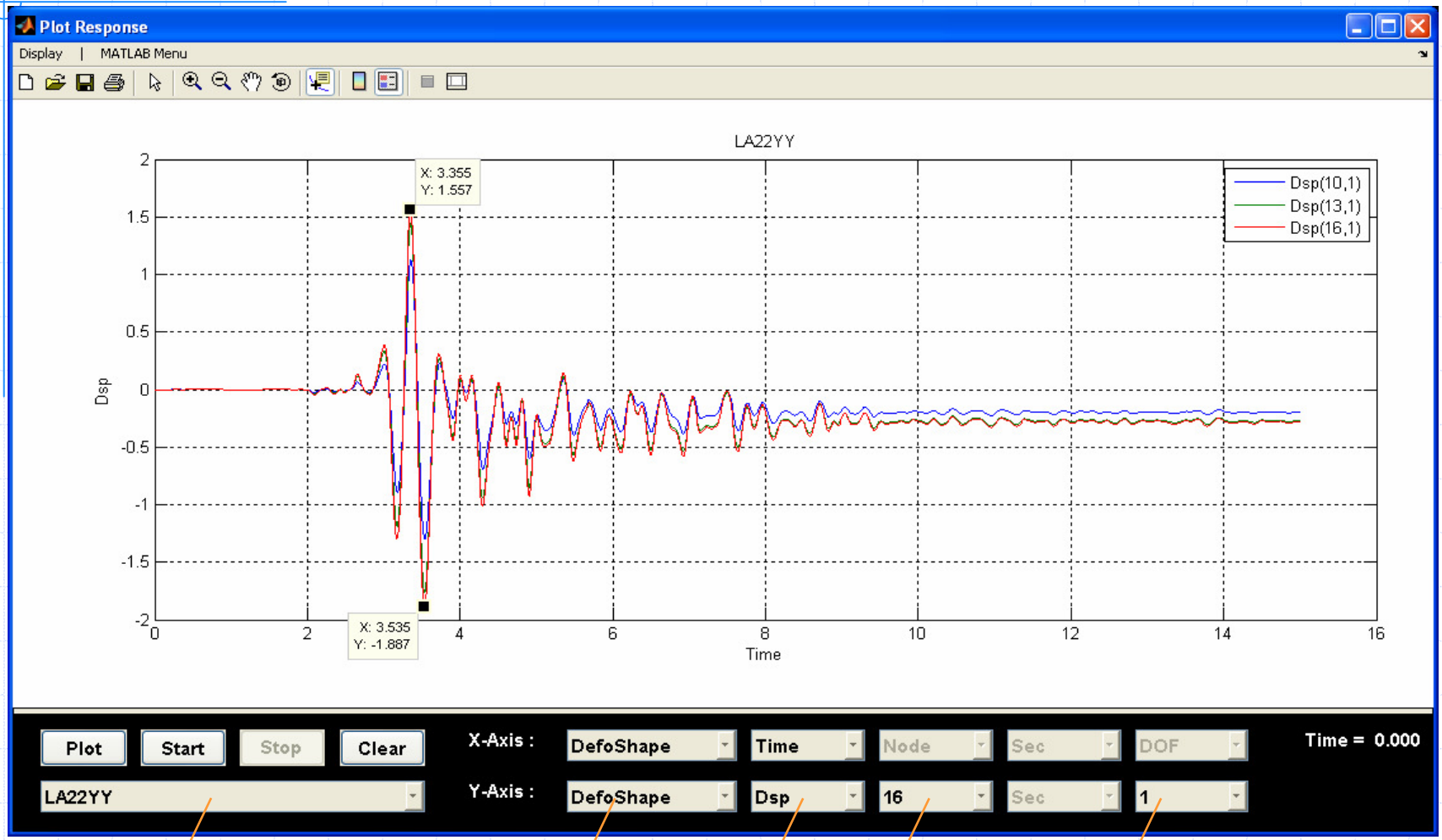
Plot Element Forces: Axial Forces



Plot Mode Shape: 1st Mode

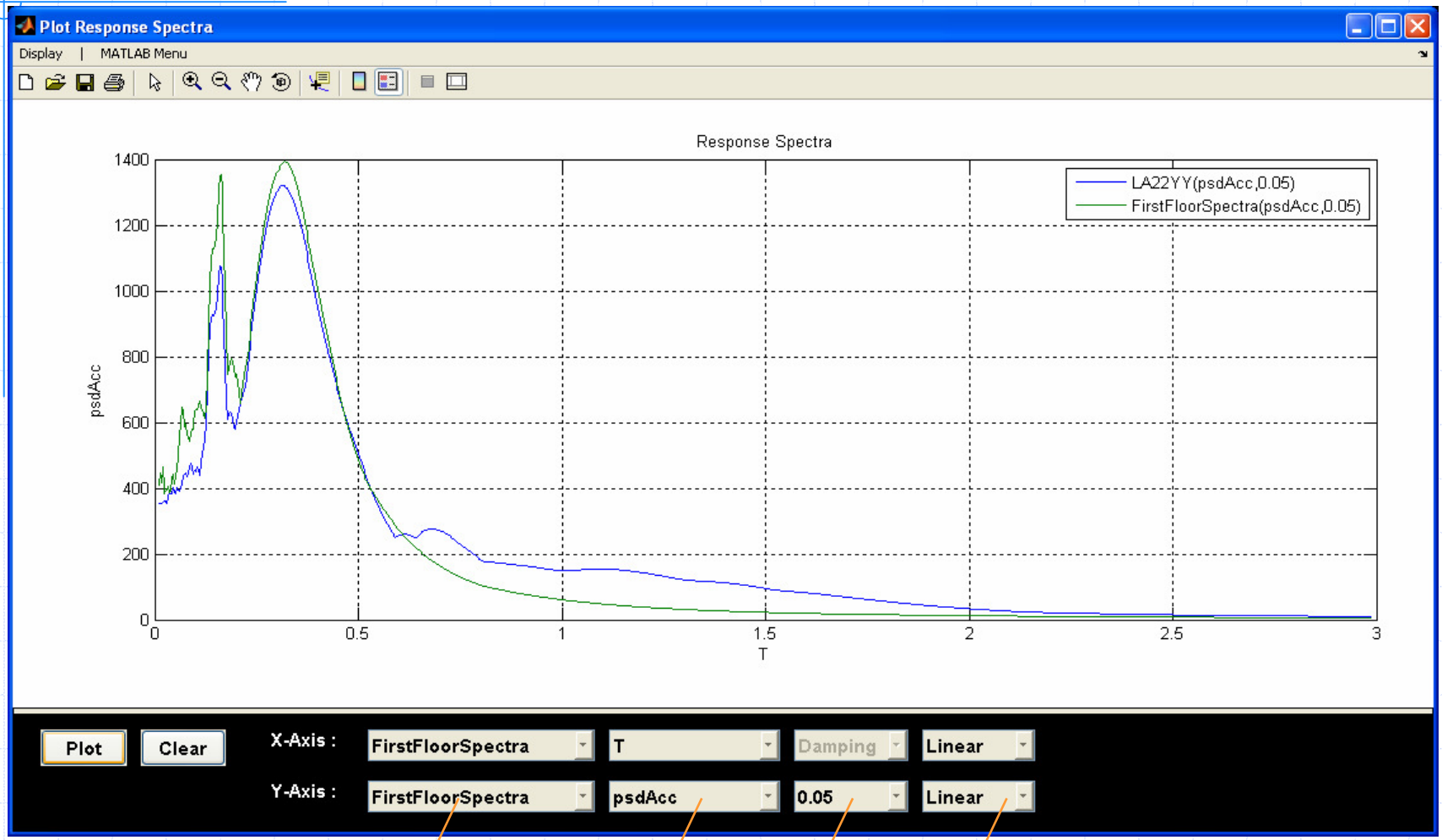


Plot Response



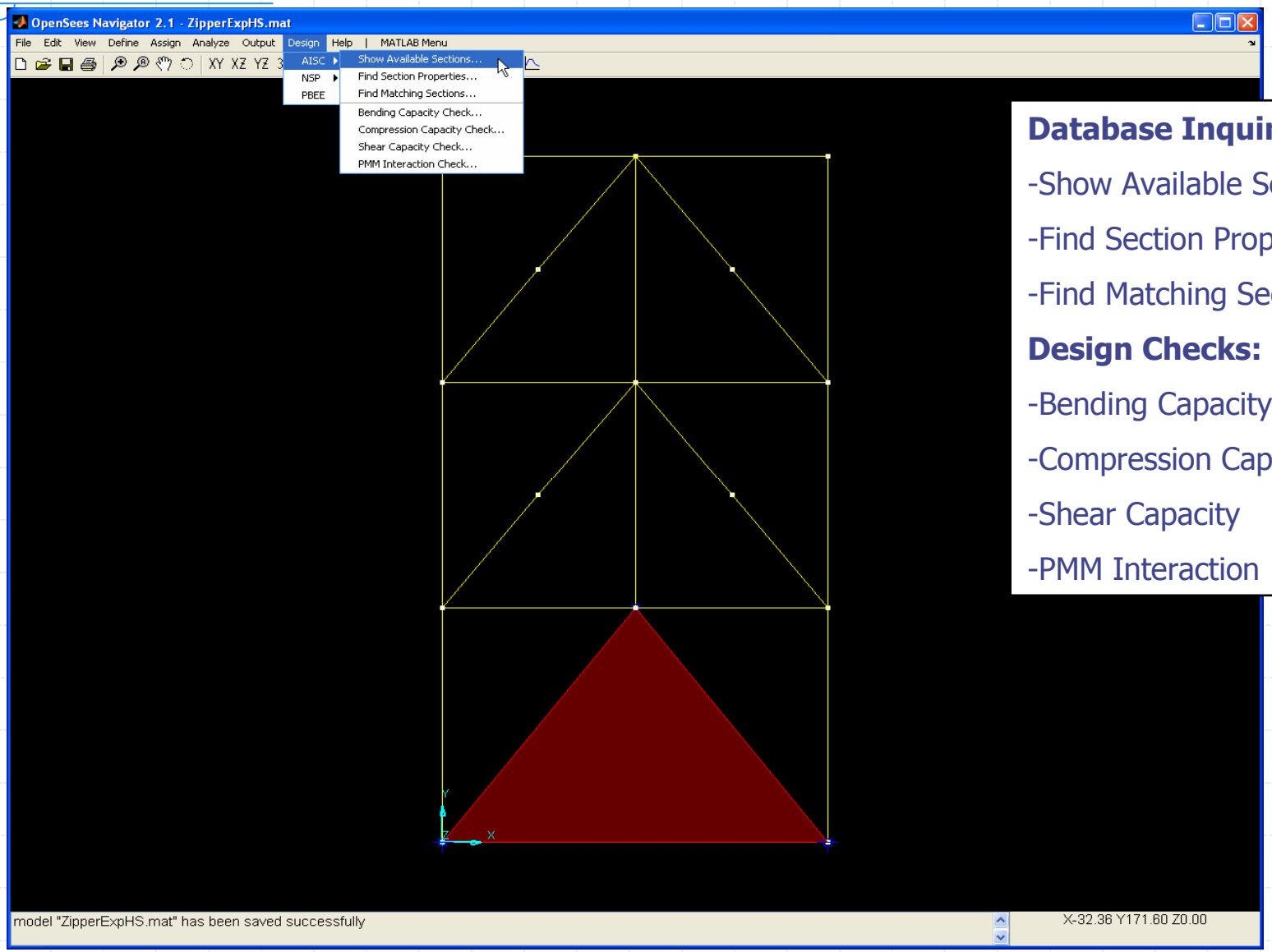
AnalysisCase Recorder Parameter Node/Element DOF

Plot Response Spectra



Spectra Name Response Damping Axis Scale

AISC Design Toolbox



Database Inquiries:

-Show Available Sections

-Find Section Properties

-Find Matching Sections

Design Checks:

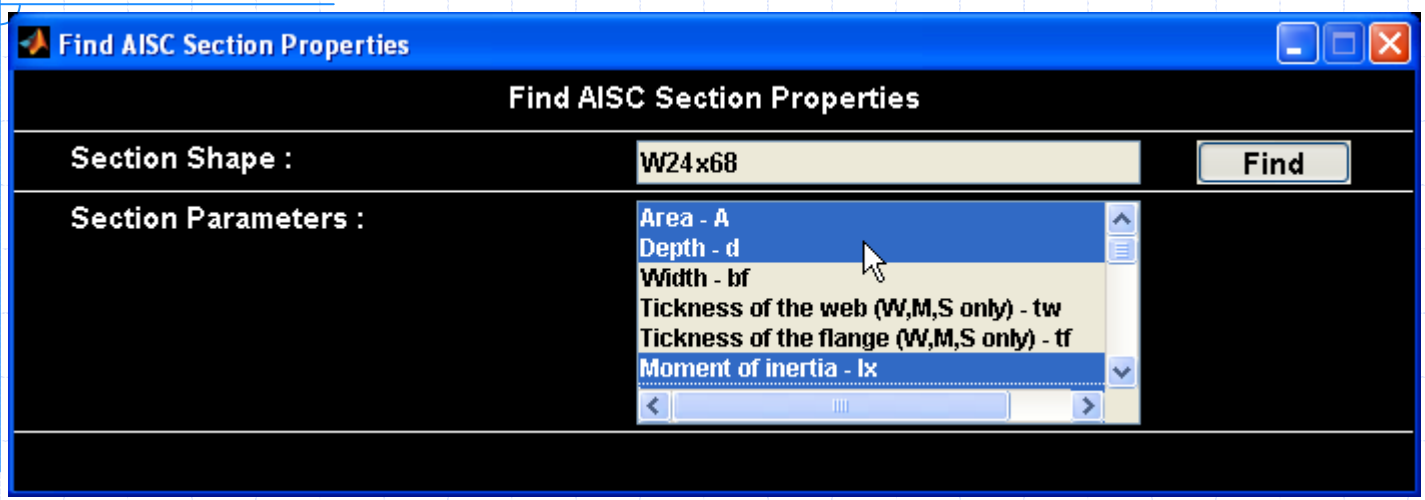
-Bending Capacity

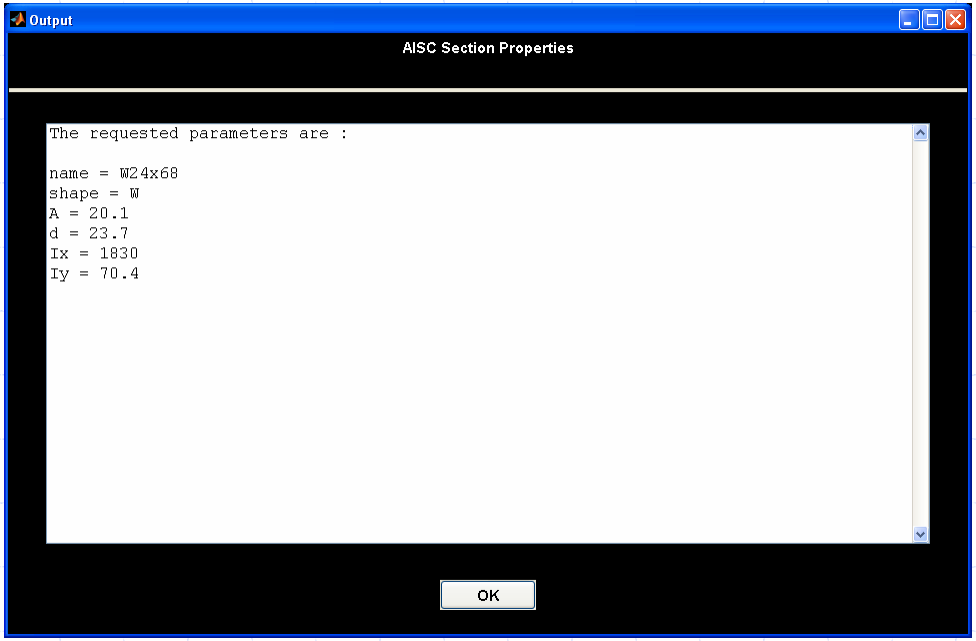
-Compression Capacity

-Shear Capacity

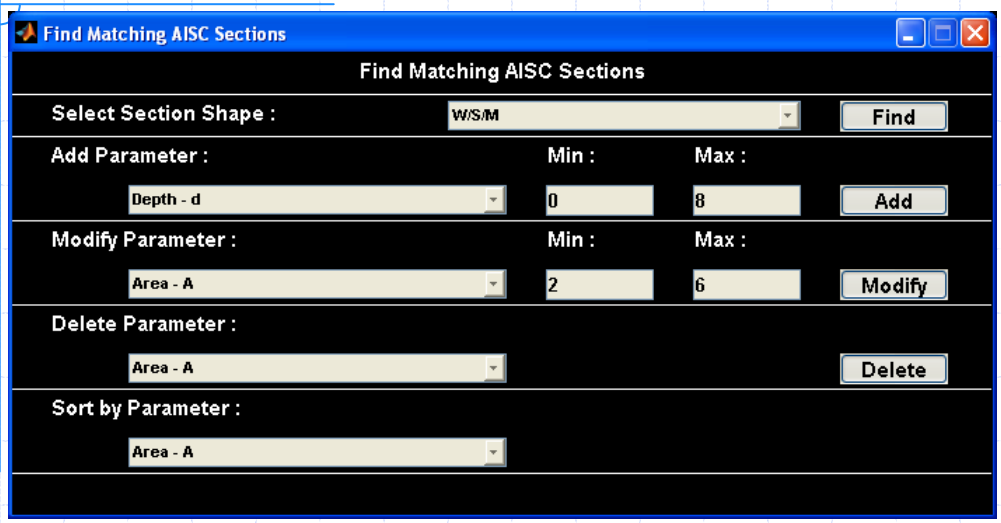
-PMM Interaction

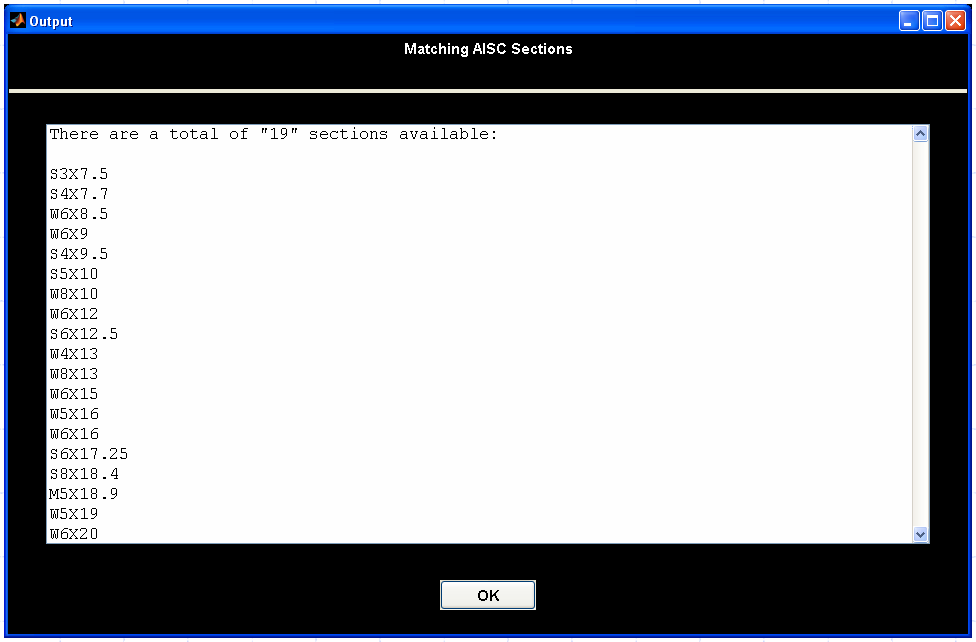
AISC Toolbox: Find Section Prop.



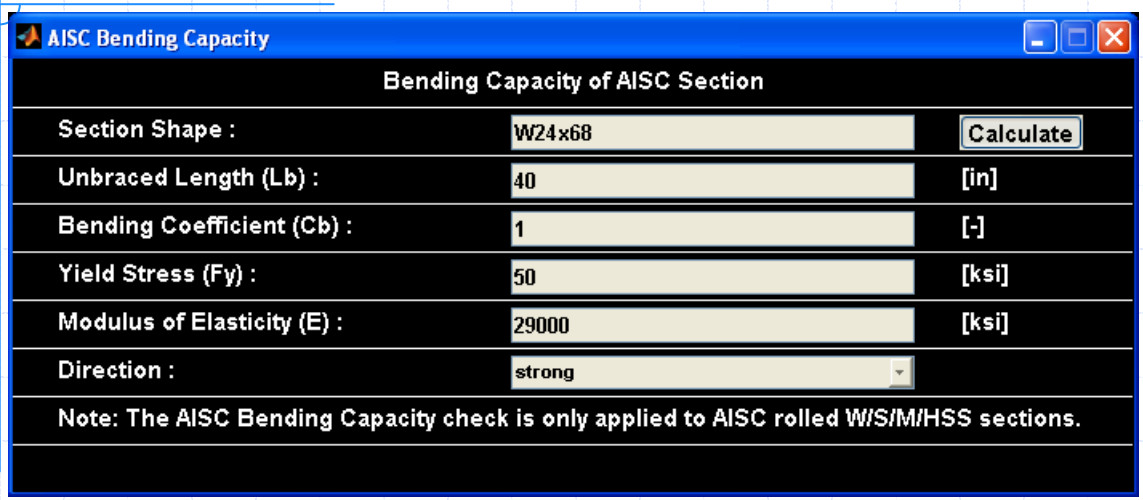


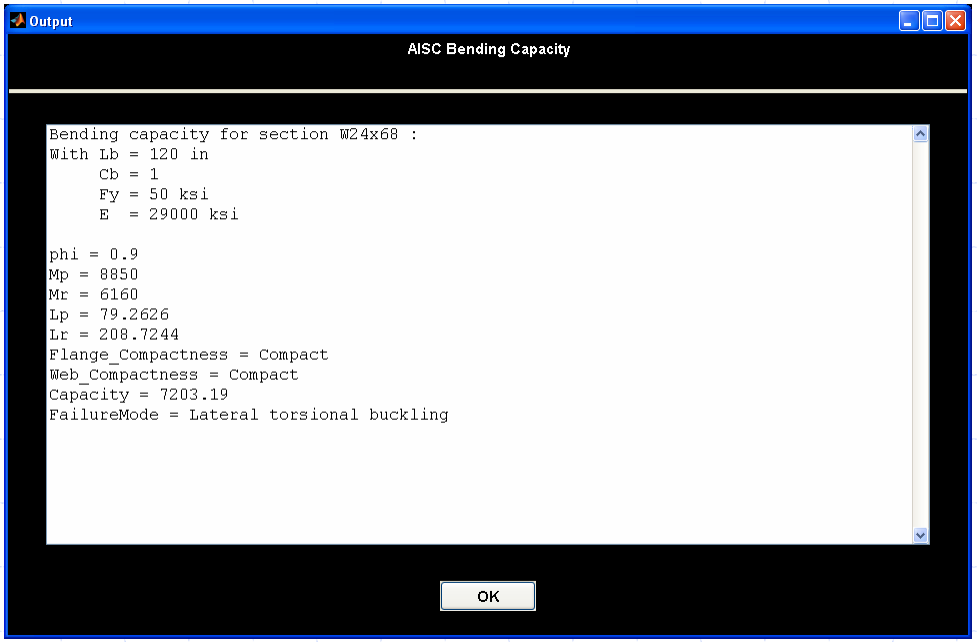
AISC Toolbox: Find Matching Sec.



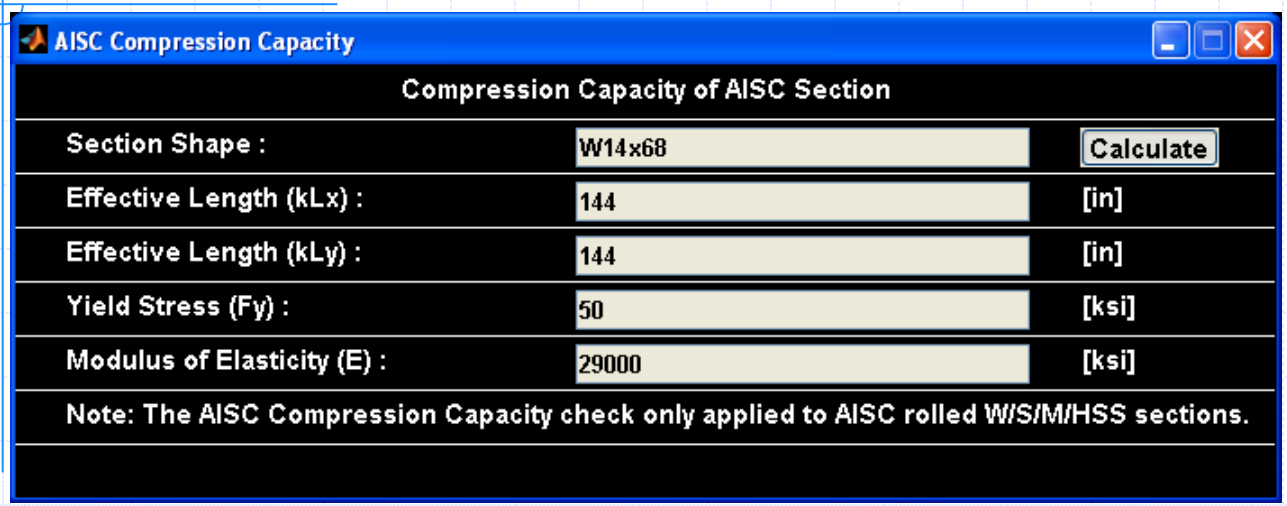


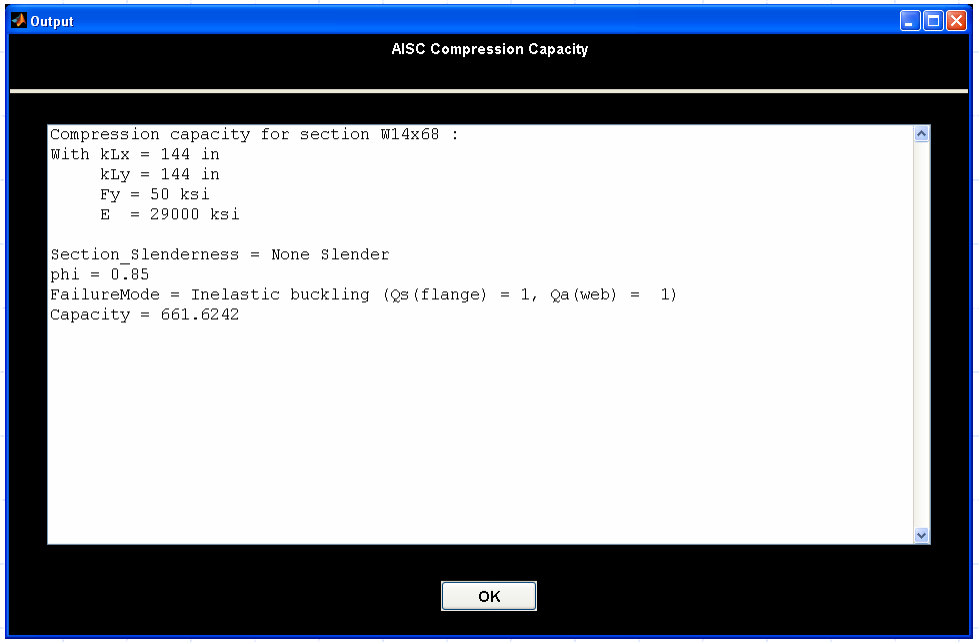
AISC Toolbox: Bending Capacity



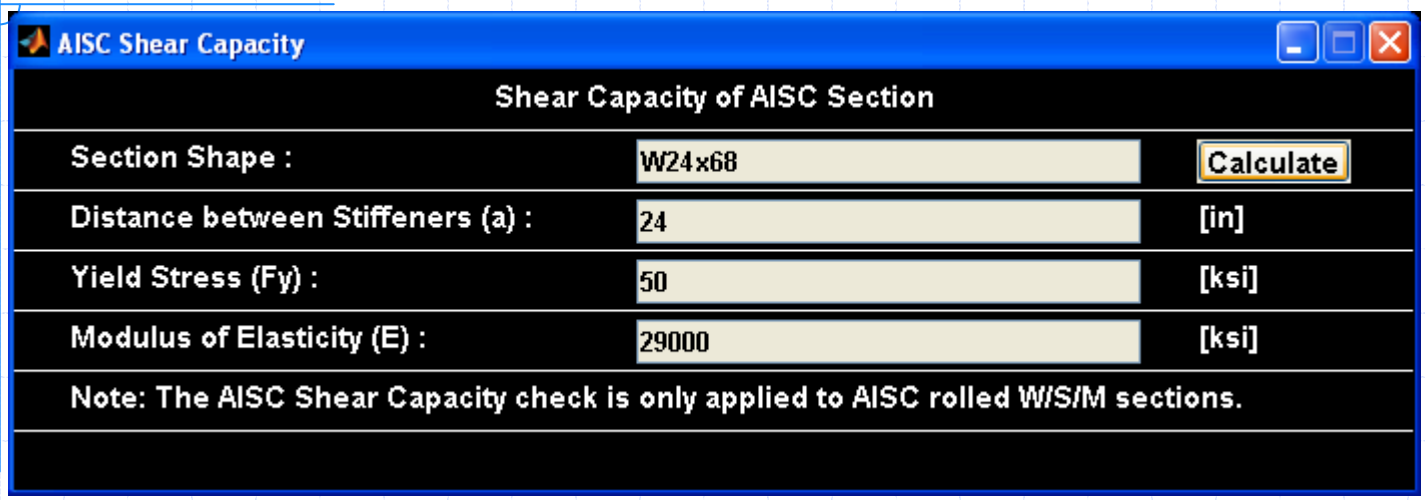


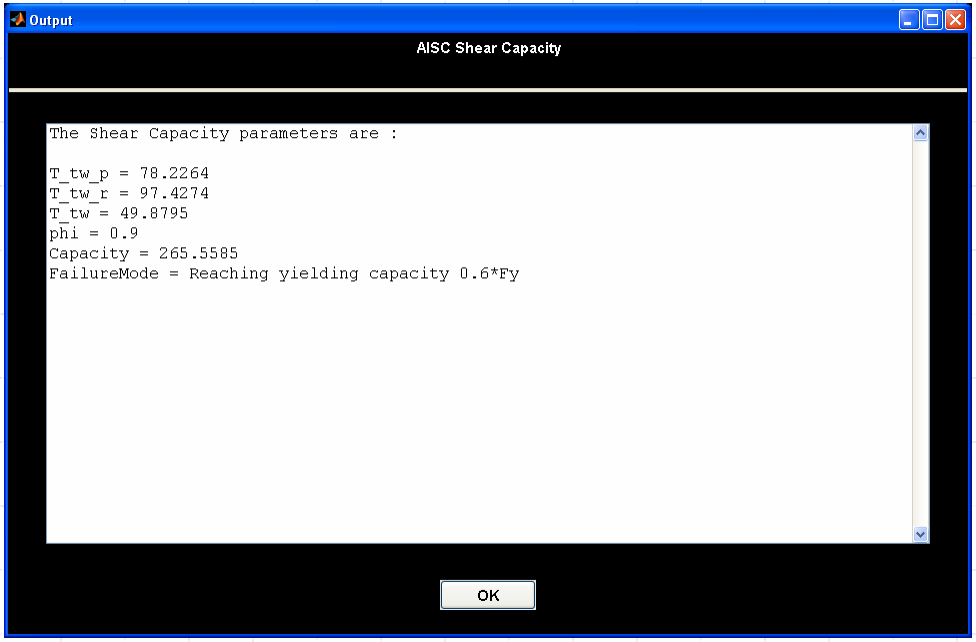
AISC Toolbox: Compression Capacity



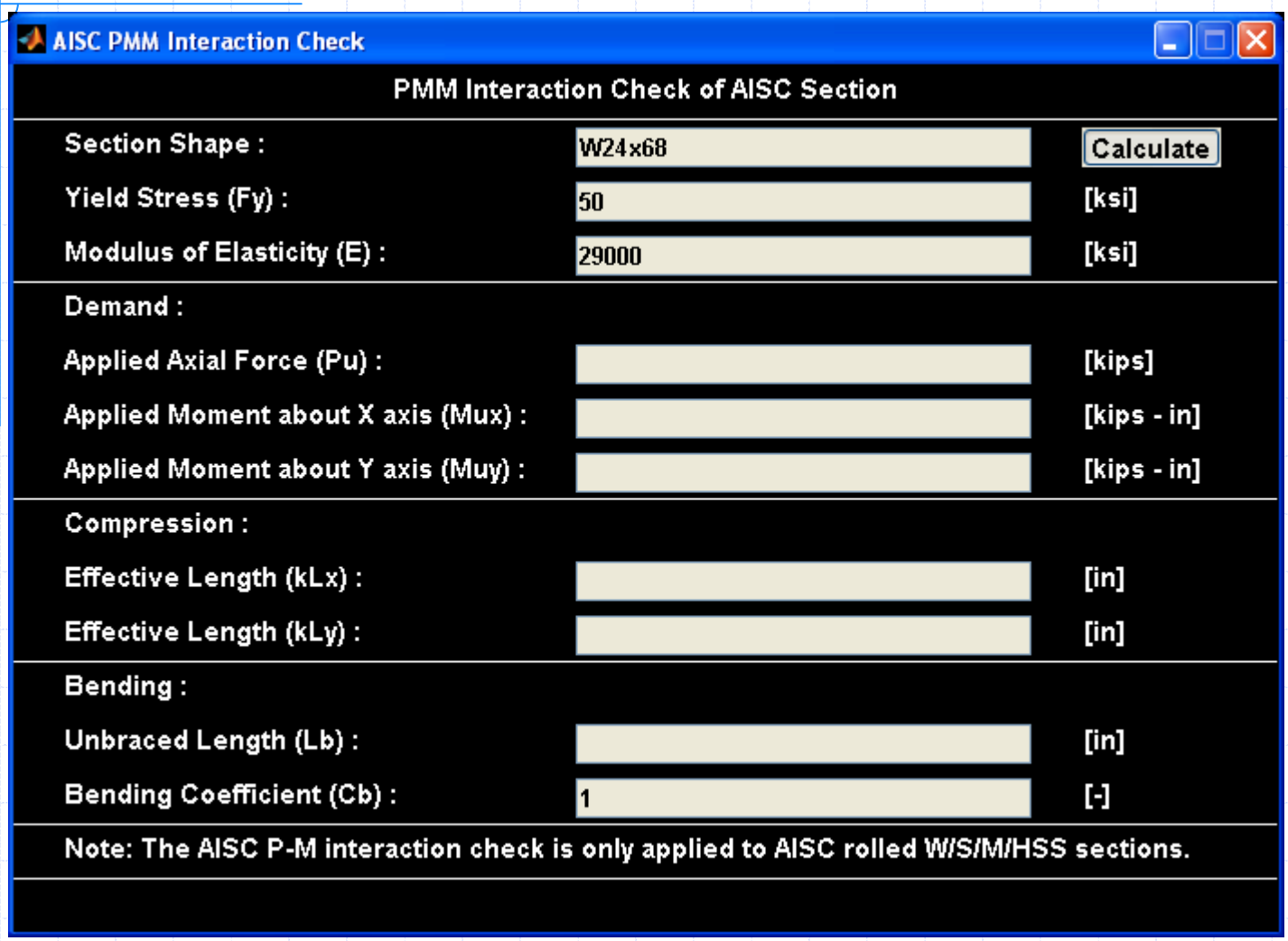


AISC Toolbox: Shear Capacity





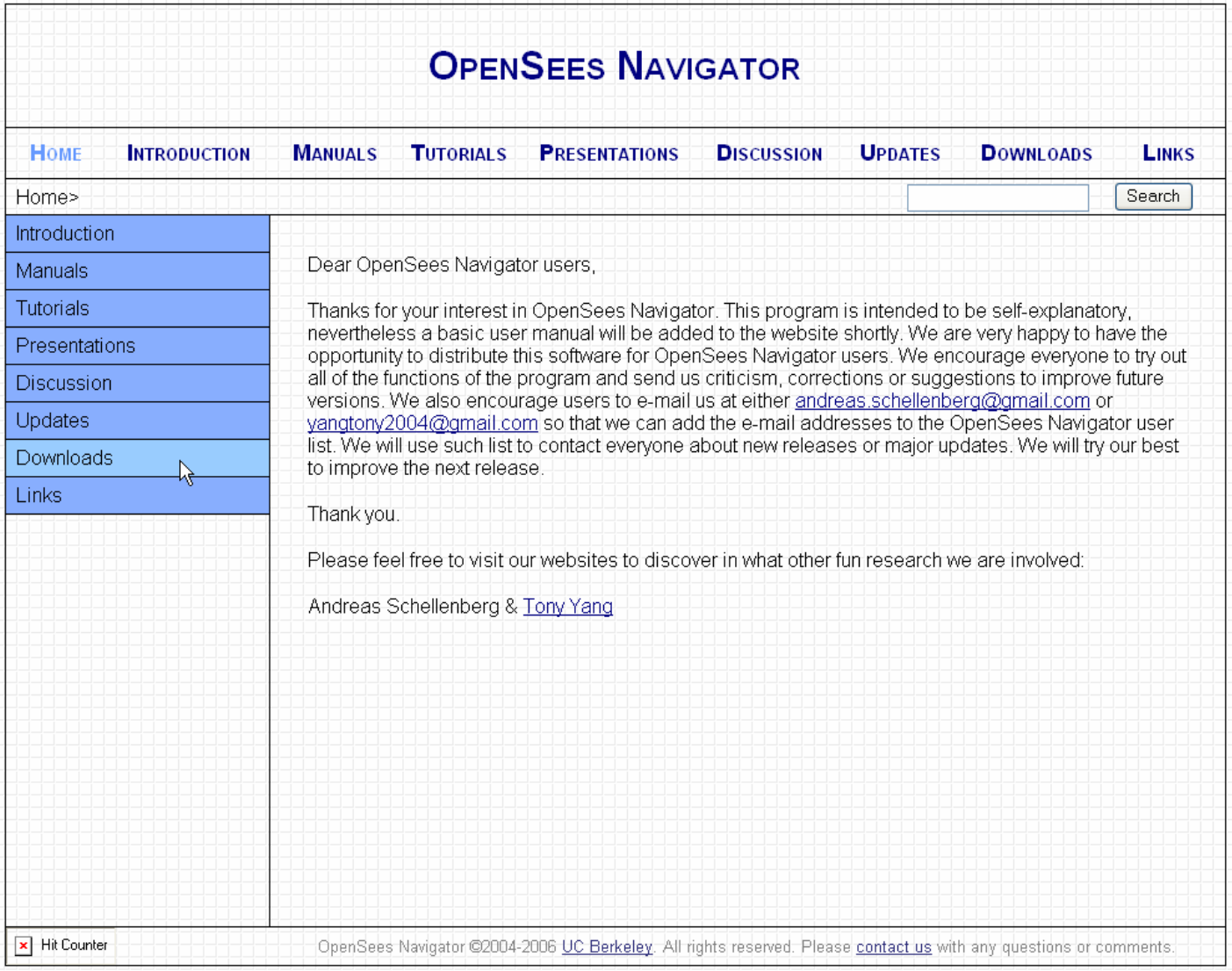
AISC Toolbox: PMM Interaction



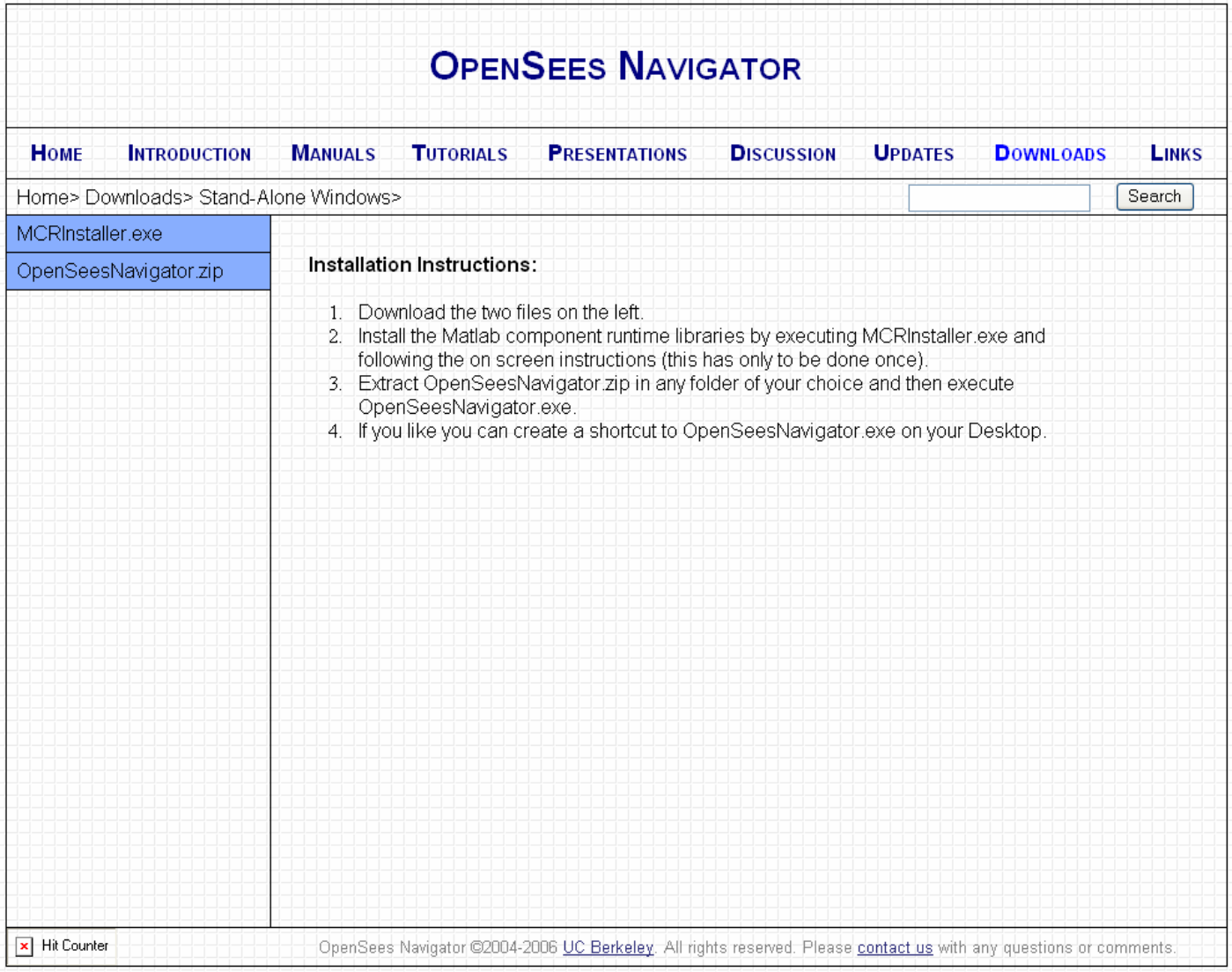
Summary

- OpenSees Navigator provides
  - Flexible and user friendly graphical user-interface
  - Easy way to study material, section, element or system behavior
  - Hybrid Simulation interface
  - Many built in post processing toolboxes
  - Great tool to visualize structural behavior
  - Response Spectra generation
  - Graphical user interface for AISC steel manual
  - Design toolboxes

Website: Home



Website: Downloads



Thank you!

OpenSees Navigator 2.0 is available at
http://peer.berkeley.edu/OpenSeesNavigator

Andreas Schellenberg:
andreas.schellenberg@gmail.com

Tony Yang:
yangtony2004@gmail.com