

# OpenSees Navigator

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The George E. Brown, Jr. Network for Earthquake Engineering Simulation



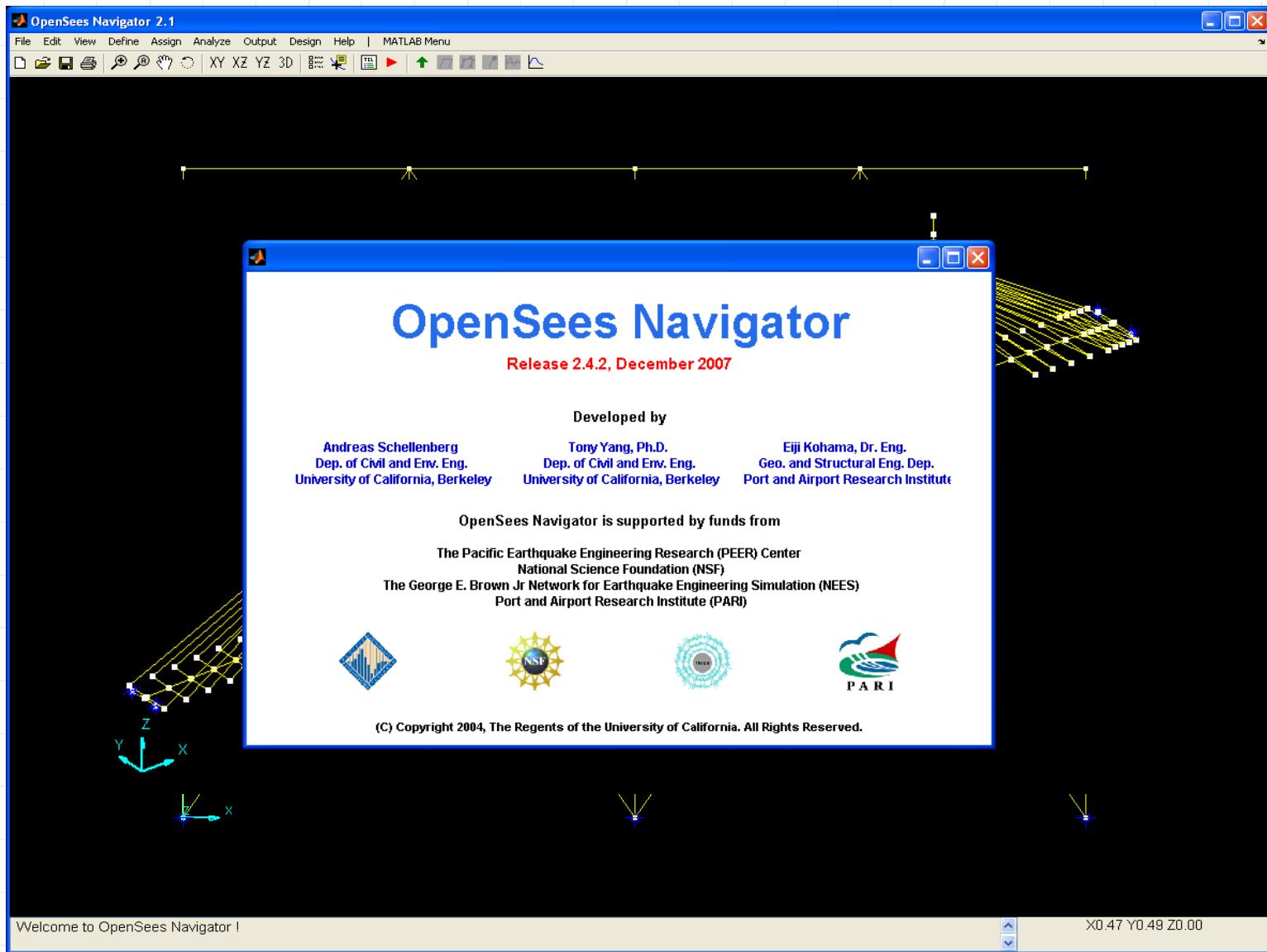
# Introduction

- ◆ 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.
- ◆ Being used by researchers from Asia, US, Canada, south America and Europe.

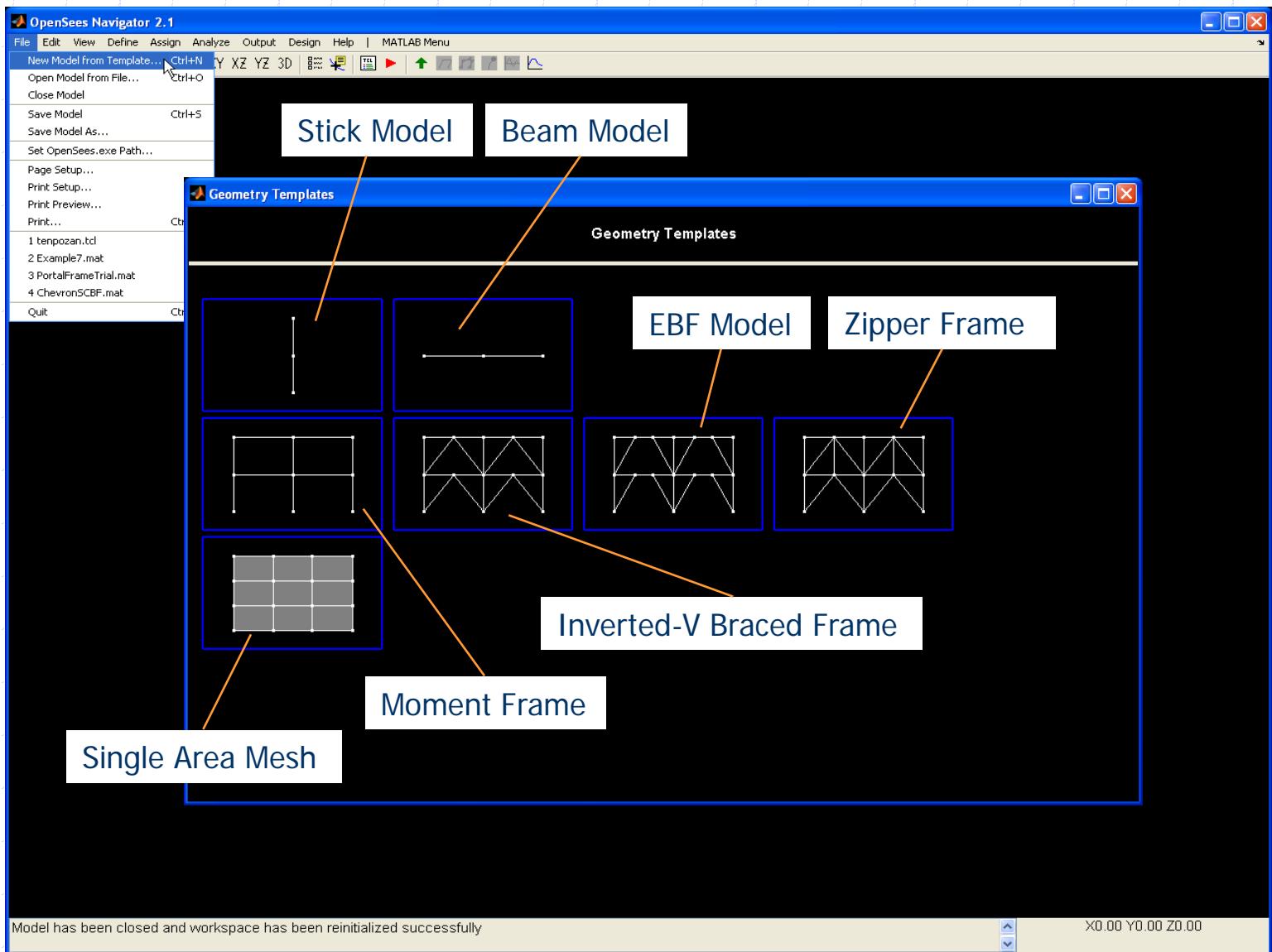
# Motivations

- ◆ Graphical input is more flexible than TCL text 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.
- ◆ Flexible to use and requires no programming skill.

# OpenSees Navigator



# Define geometry: new model template



# Define geometry: Zipper braced frame

 Define Zipper Frame Geometry

Define Zipper Frame Geometry

Dimension (ndm) :	2d	Generate
Number of Stories (NOS) :	3	
Number of Bays (NOB) :	1	
Story Height (SH) :	52	
Bay Width (BW) :	80	
Boundary Condition (BC) :	pinned	
Brace Bay Config (BraceBay) :	BraceBay	
Num Segments in Col (NSC) :	1	
Num Segments in Beam (NSB) :	1	
Num Segments in Brace (NSBR) :	2	
Num Segments in Z-Col (NSZC) :	1	
Brace Offset (BraceOffset) :	None	

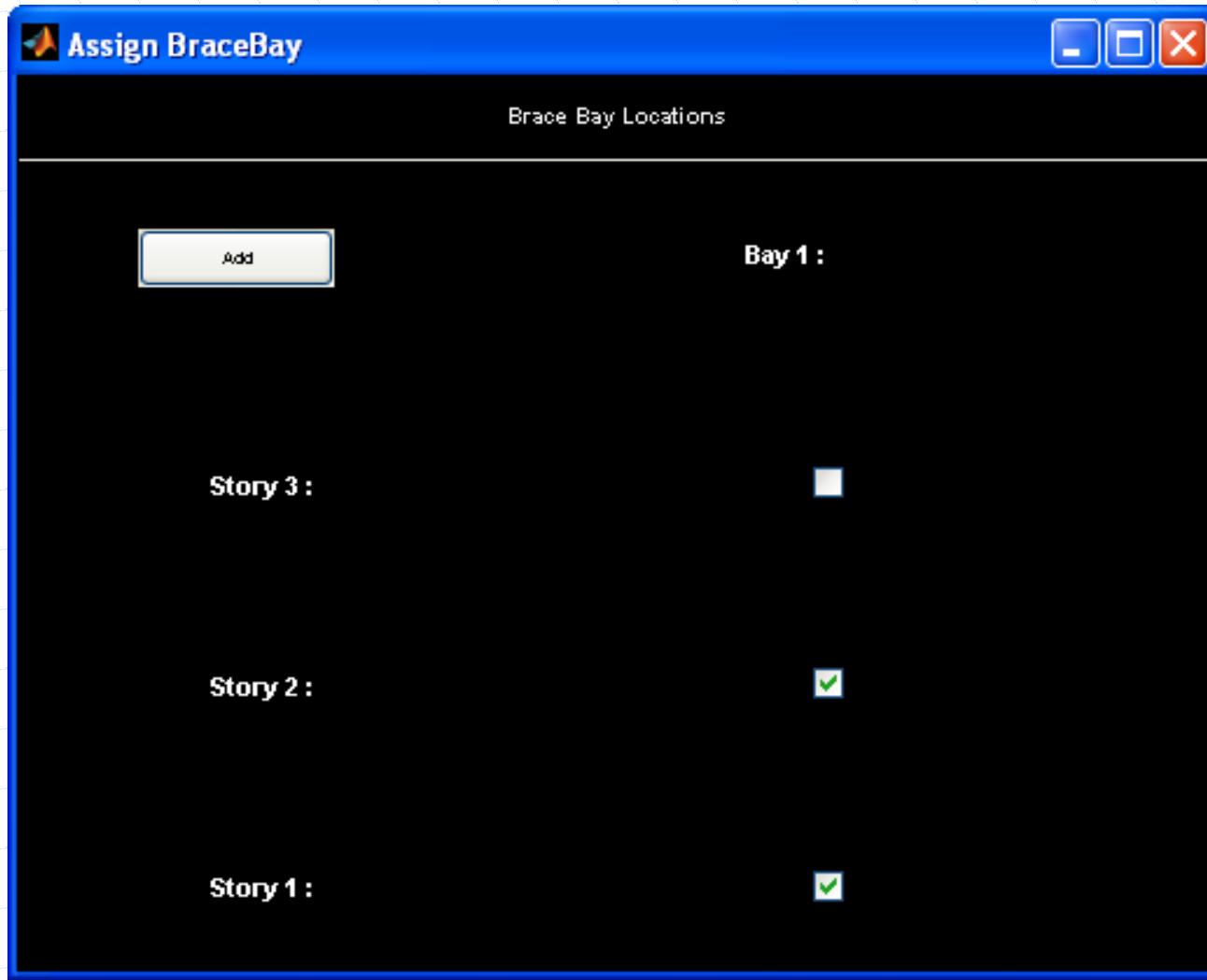
# Define geometry: Zipper braced frame



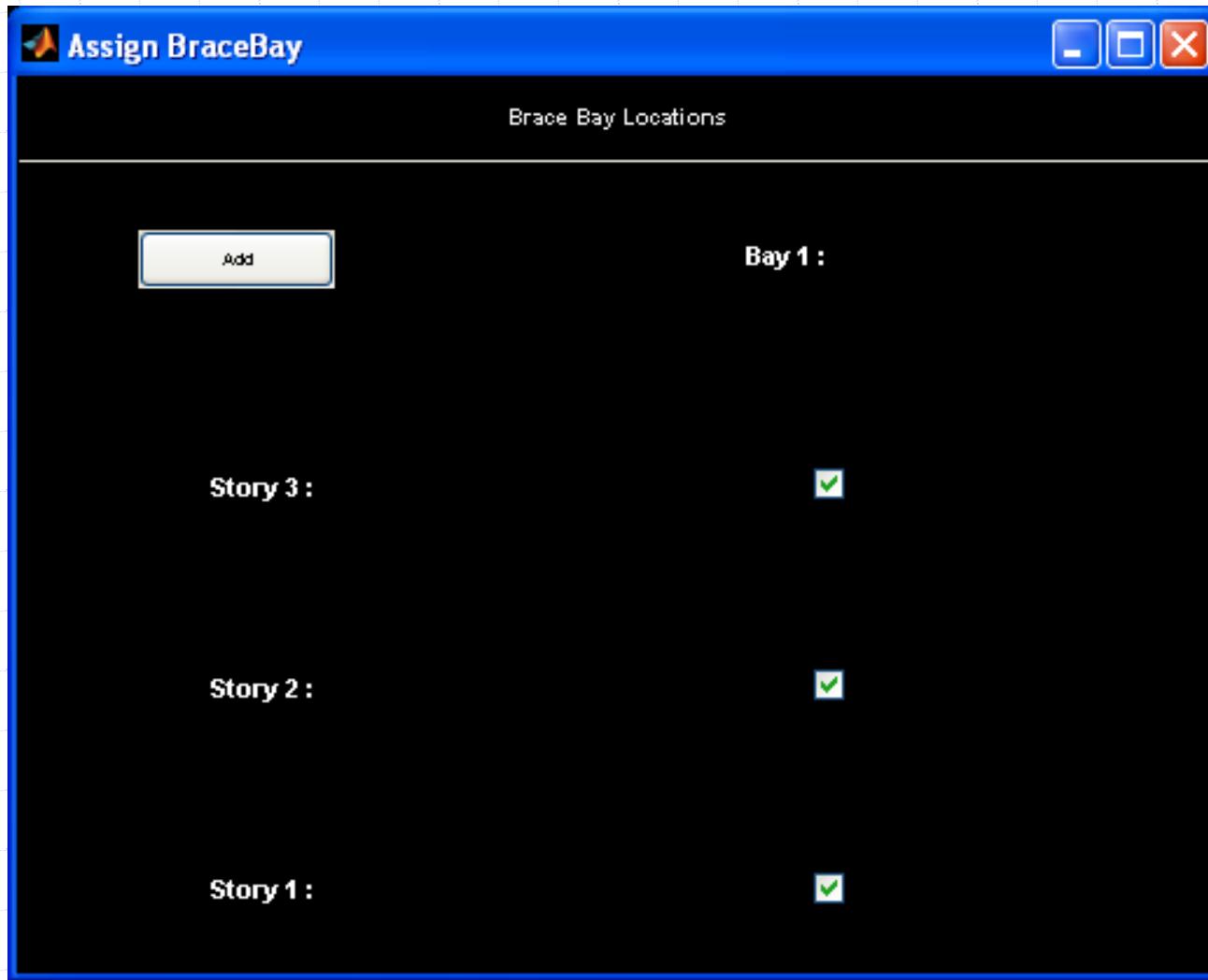
# Define geometry: Zipper braced frame



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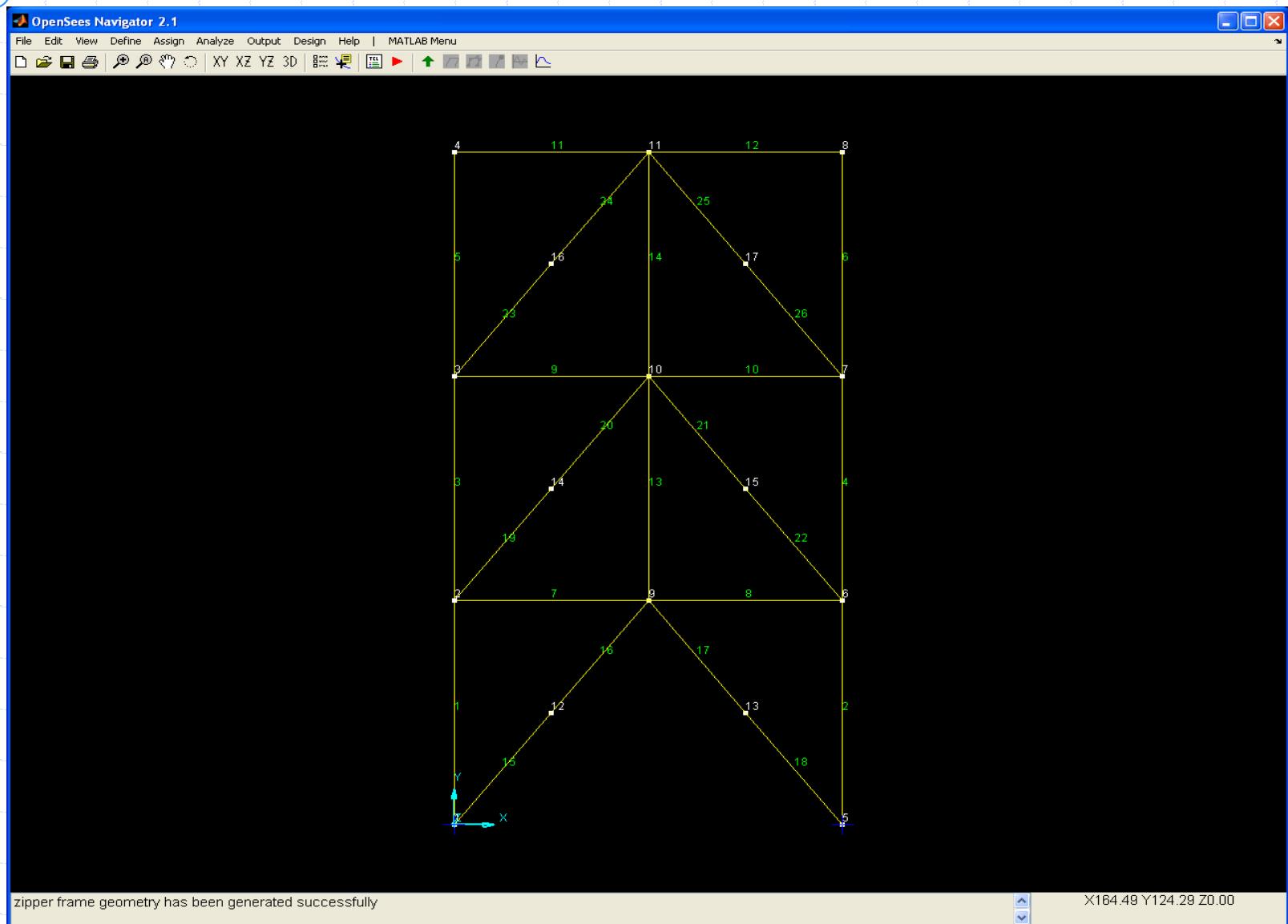


# Define geometry: Zipper braced frame

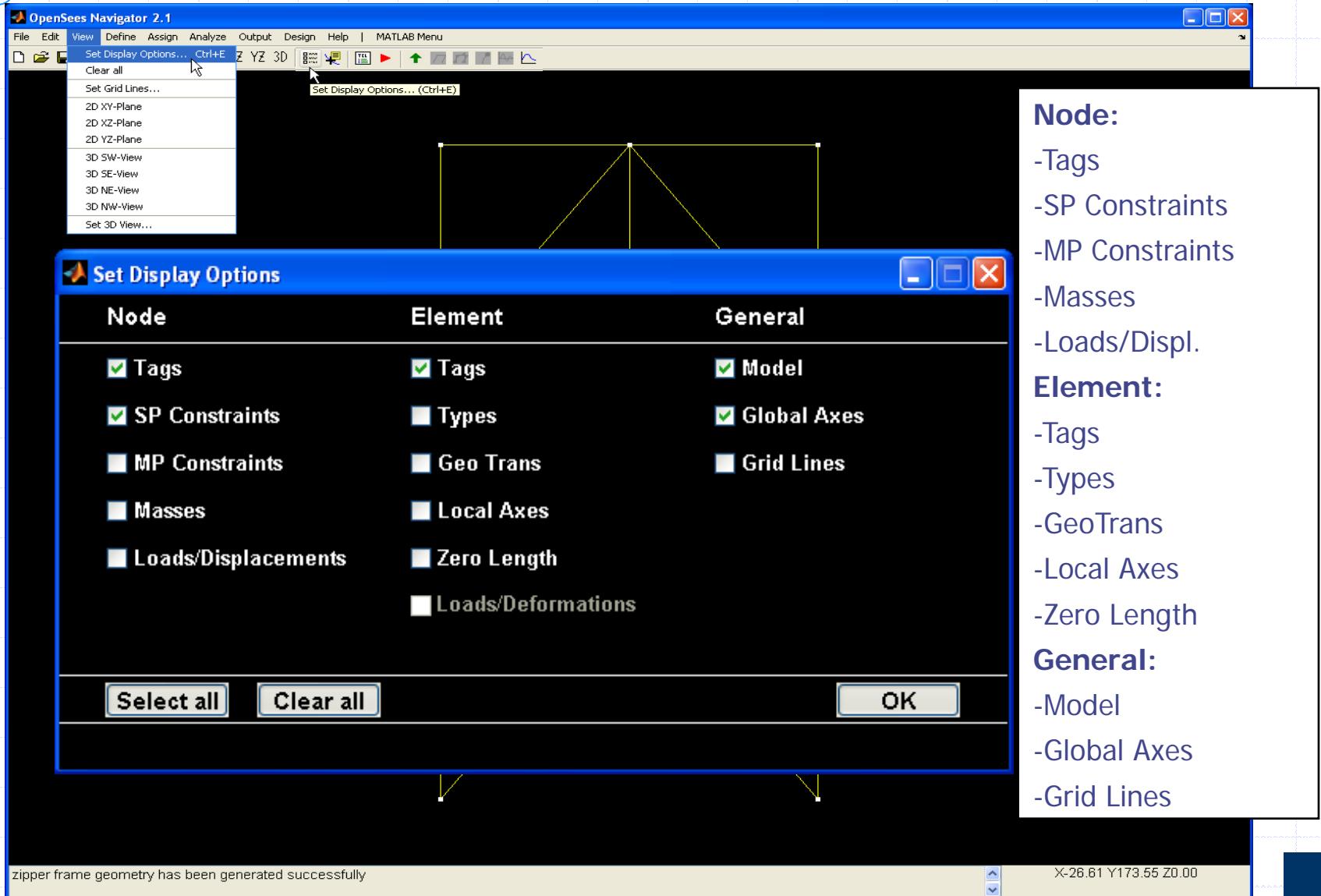
Define Zipper Frame Geometry

Dimension (ndm) :	2d	Generate
Number of Stories (NOS) :	3	
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Story Height (SH) :	52	
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Brace Bay Config (BraceBay) :	BraceBay	
Num Segments in Col (NSC) :	1	
Num Segments in Beam (NSB) :	1	
Num Segments in Brace (NSBR) :	2	
Num Segments in Z-Col (NSZC) :	1	
Brace Offset (BraceOffset) :	None	

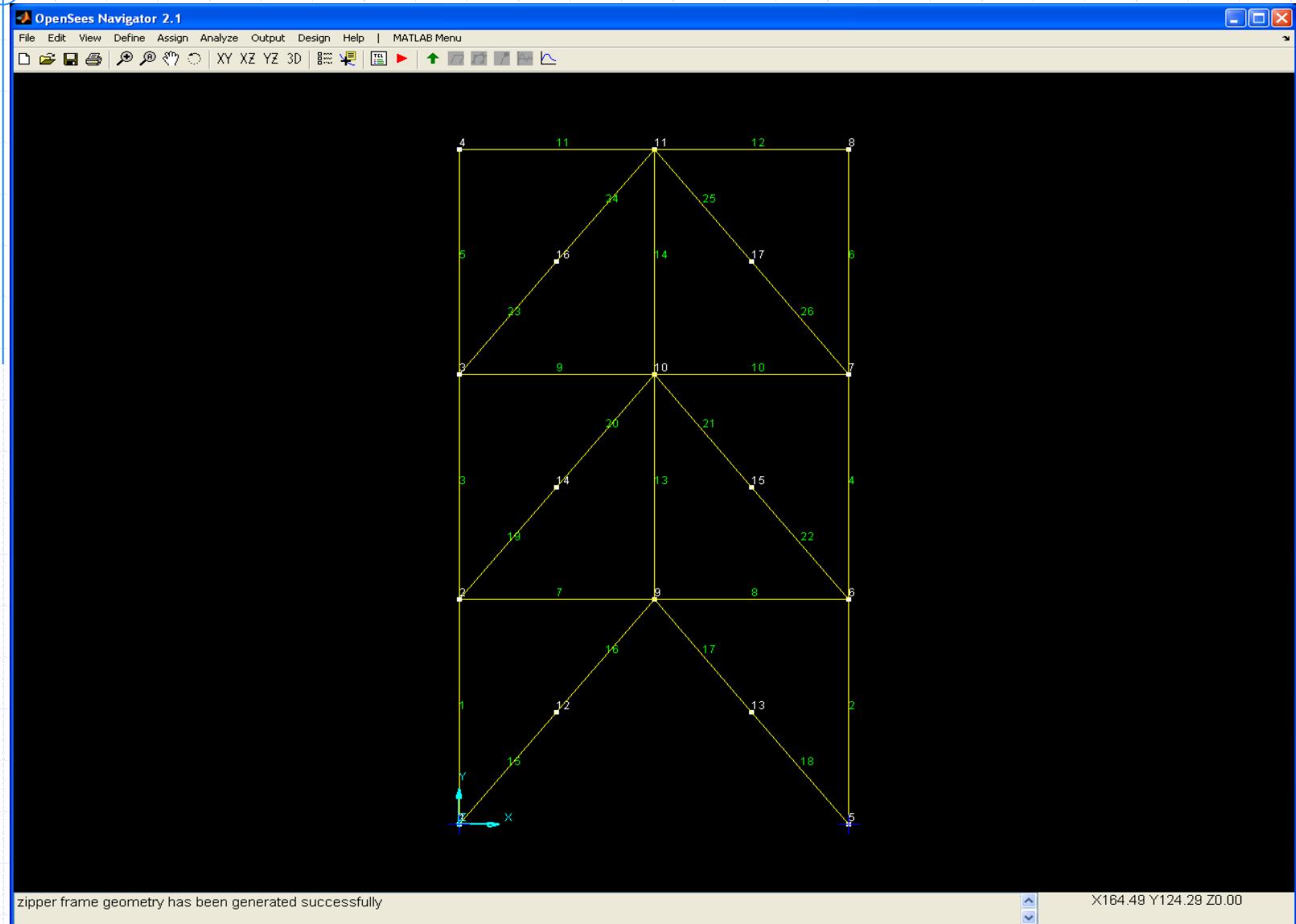
# View geometry: display



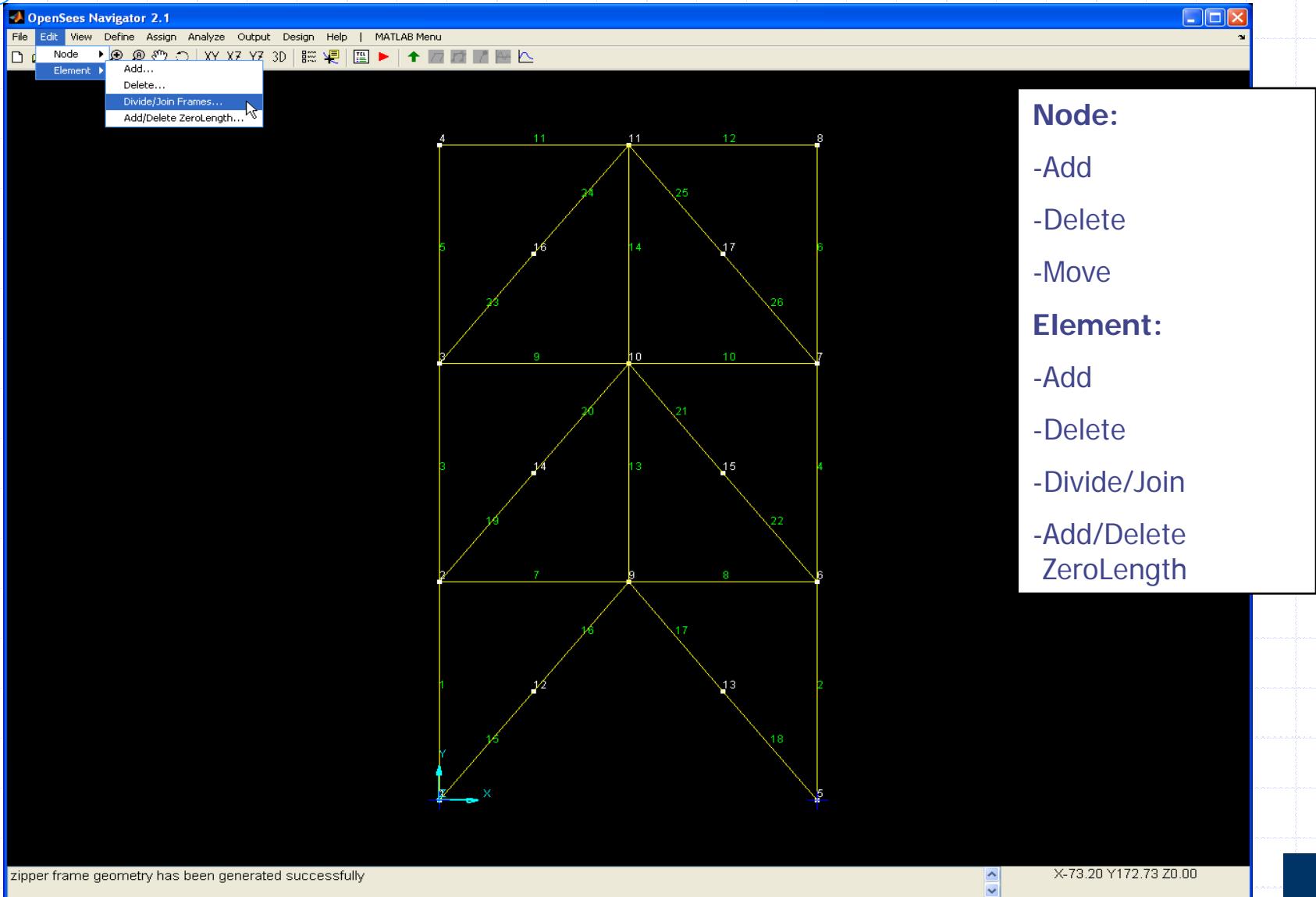
# View geometry: set display options



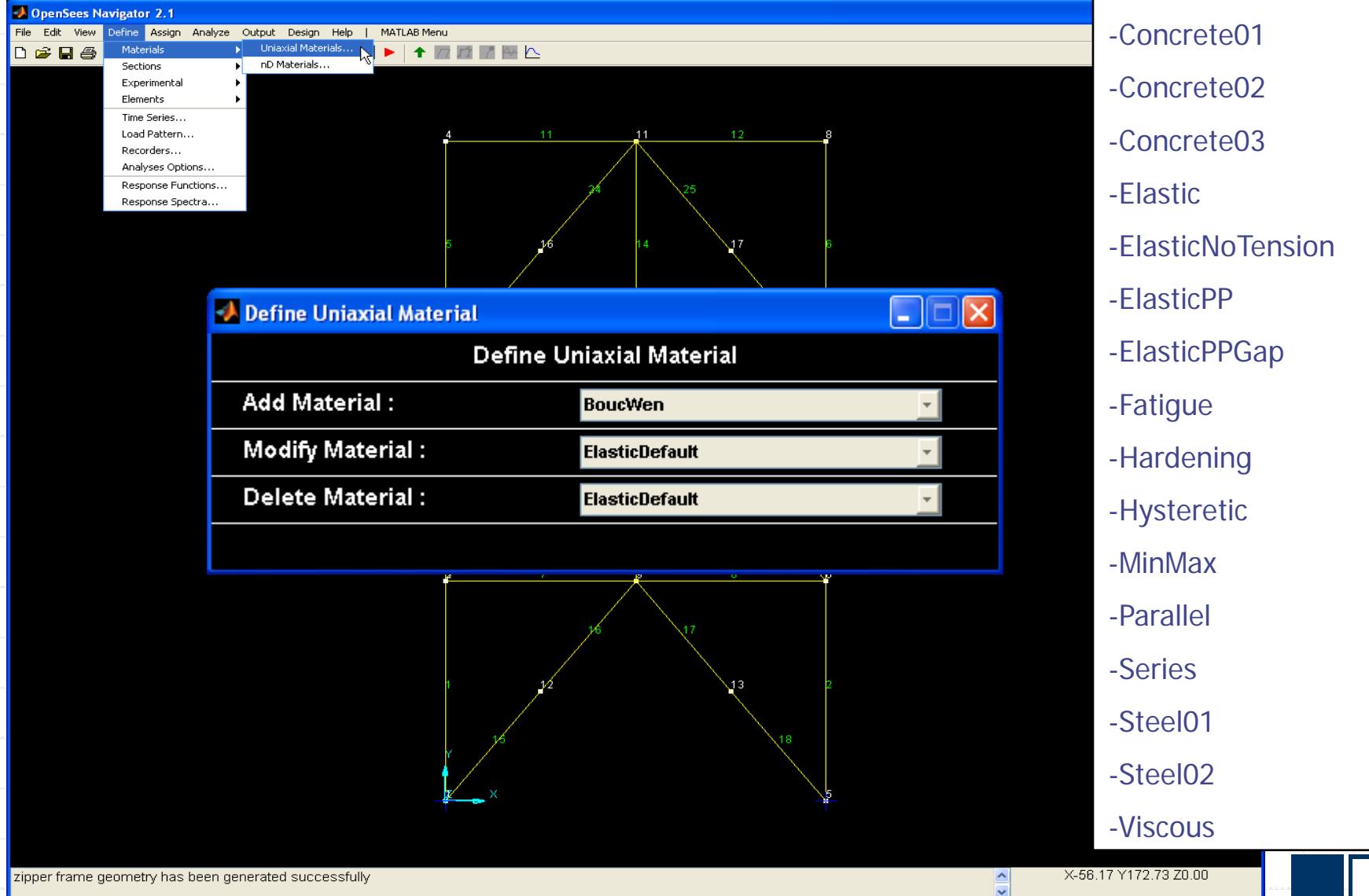
# View geometry: display



# Edit geometry



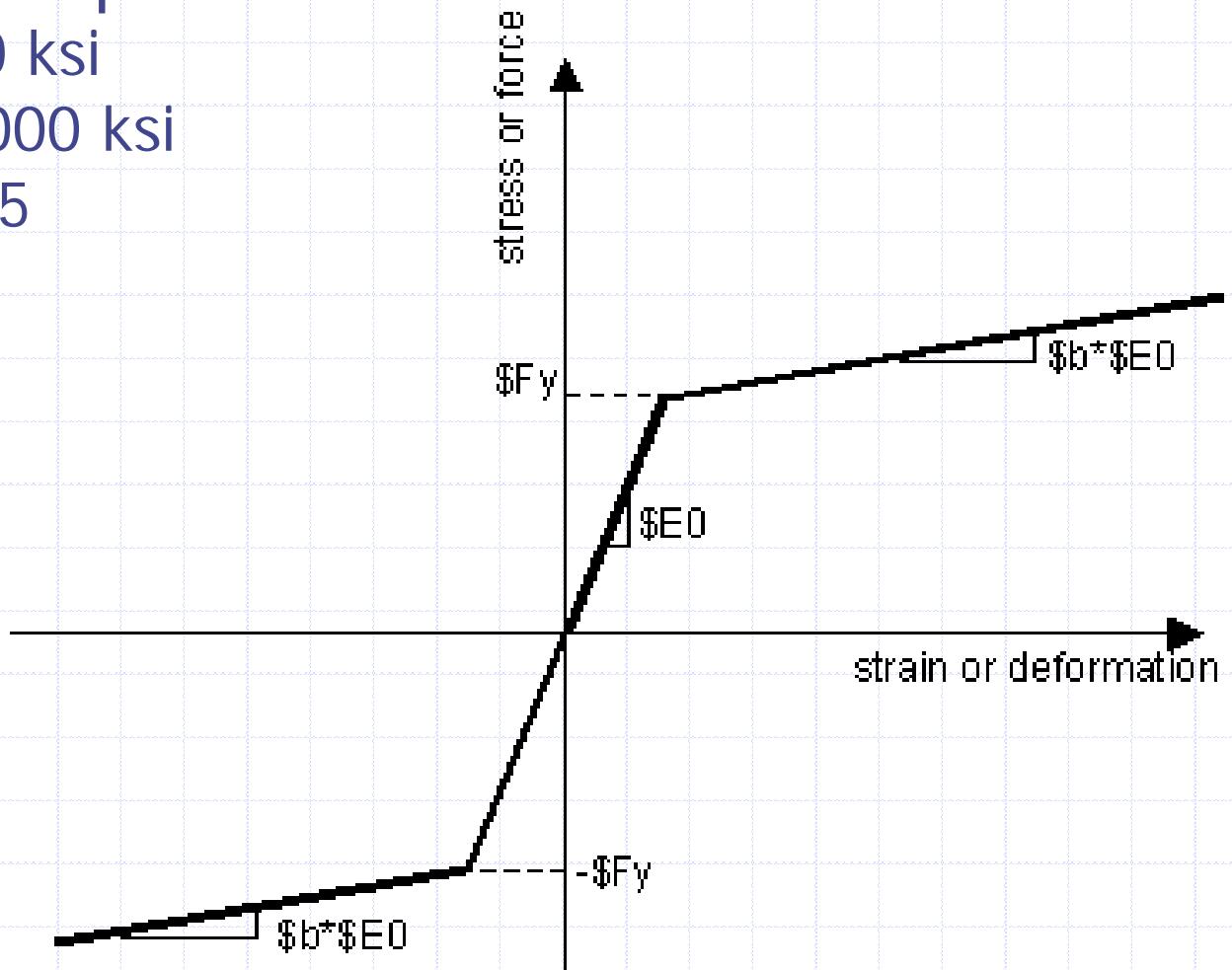
# Define material: uniaxial materials



# Define uniaxial material: Steel01

## Material properties

- $F_y = 50 \text{ ksi}$
- $E = 29000 \text{ ksi}$
- $b = 0.05$

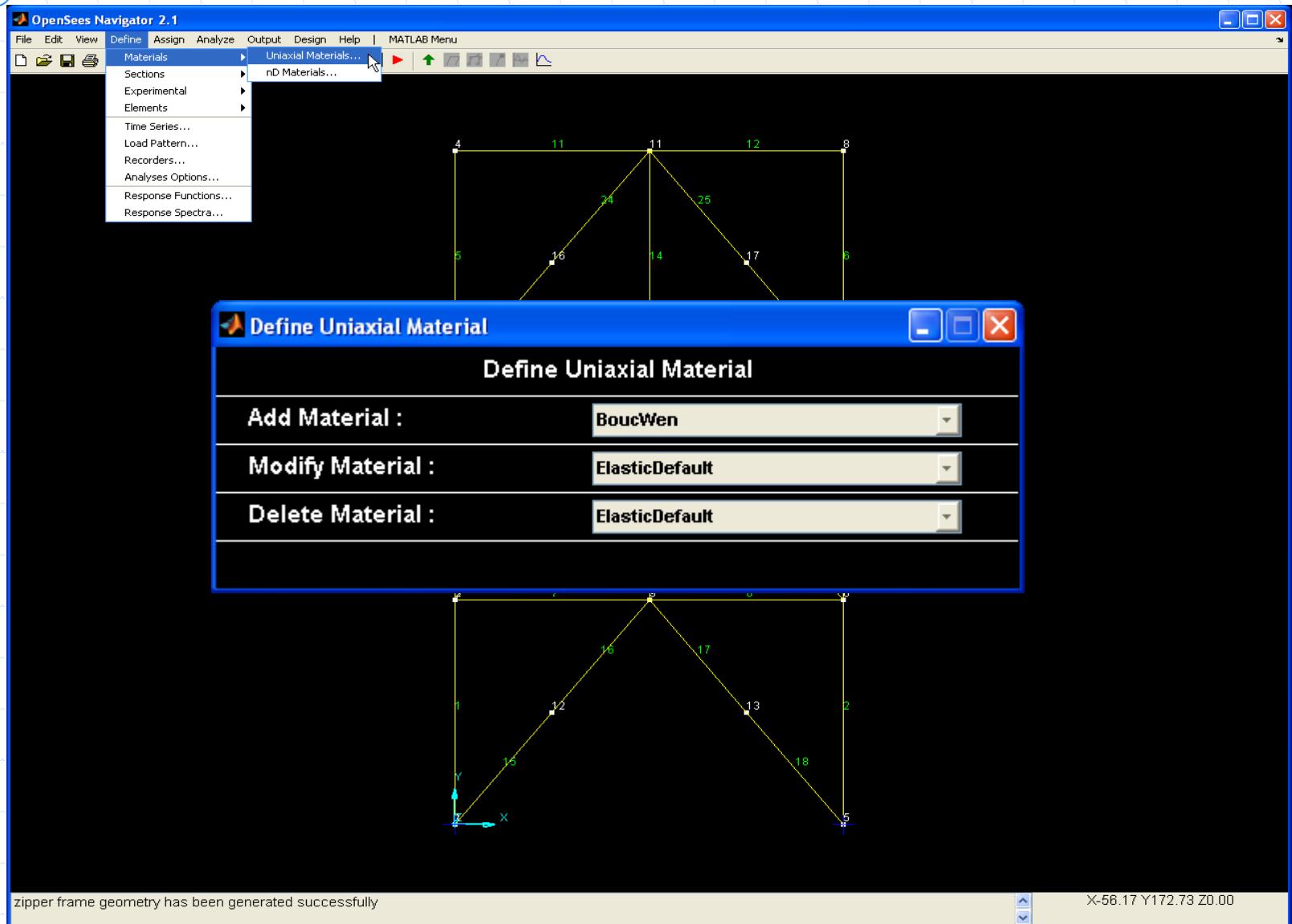


# Define uniaxial material: Steel01

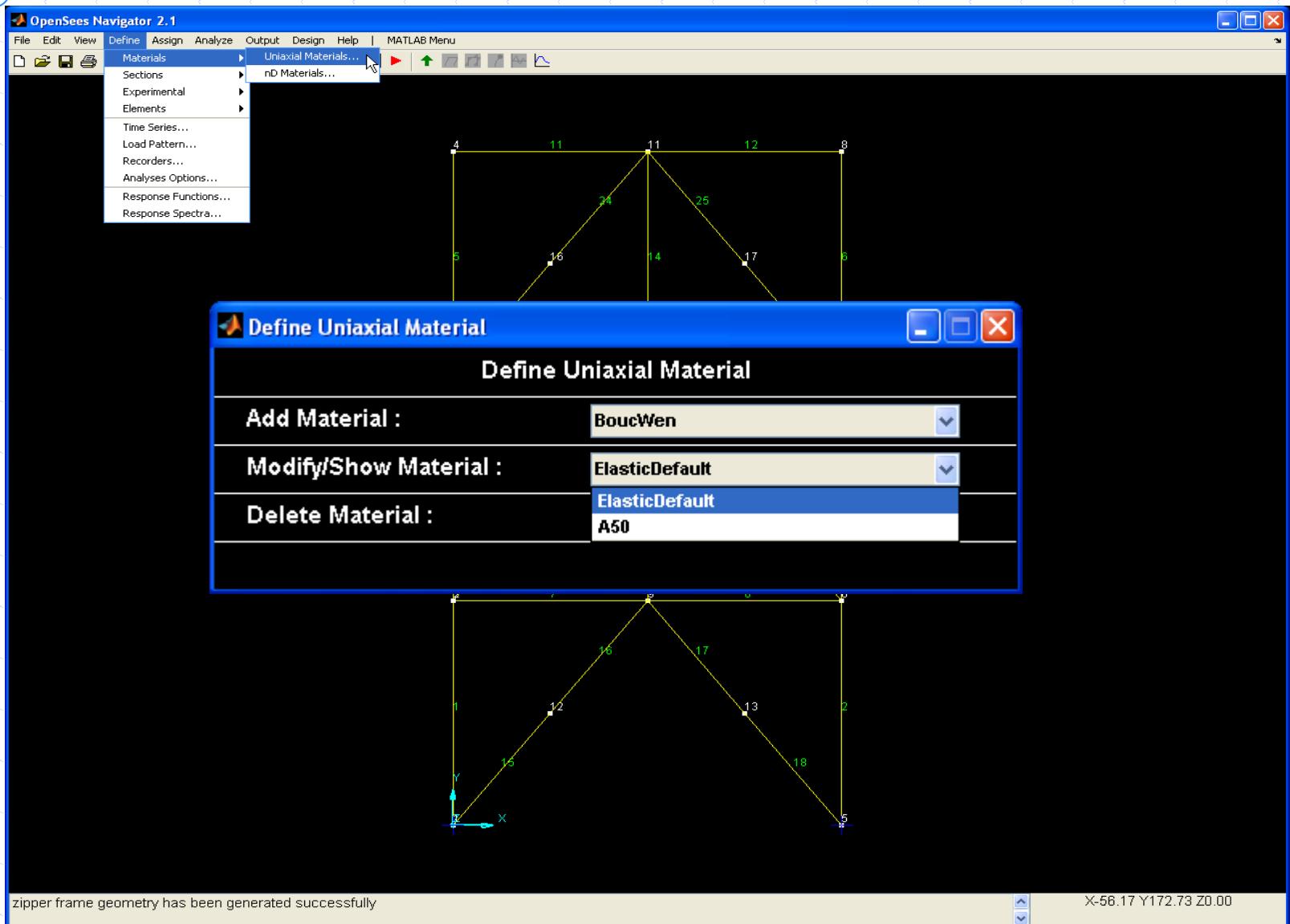
Define Steel01 Material

Material Name :	A50	Add
Yield Stress (Fy) :	50	
Modulus of Elasticity (E) :	29000	
Hardening Ratio (b) :	0.05	
<i>Optional Parameters :</i>		
Iso Hardening Parameter (a1) :	0.0	
Iso Hardening Parameter (a2) :	1.0	
Iso Hardening Parameter (a3) :	0.0	
Iso Hardening Parameter (a4) :	1.0	

# Define material: uniaxial materials



# Define material: uniaxial materials

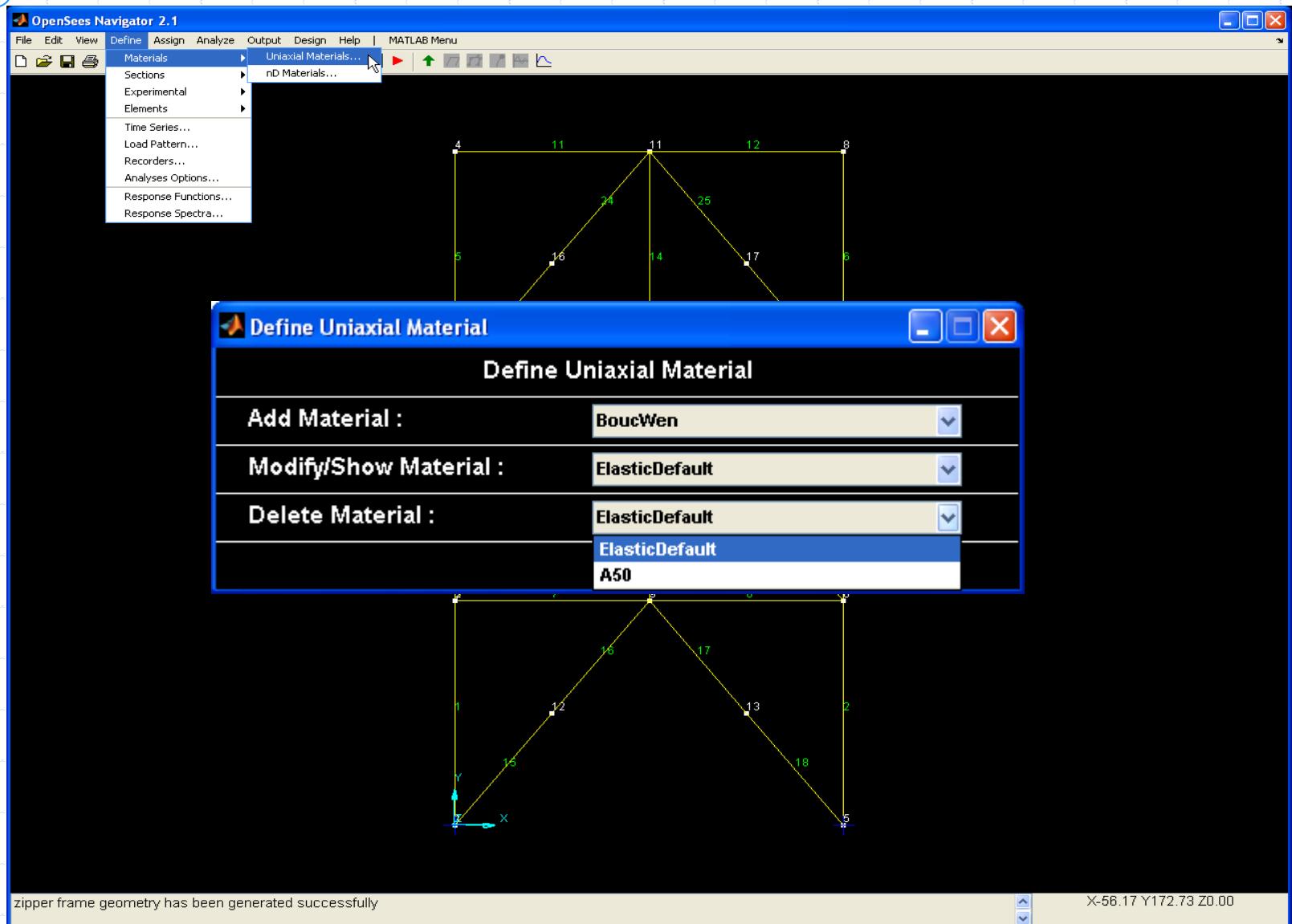


# Define uniaxial material: Steel01

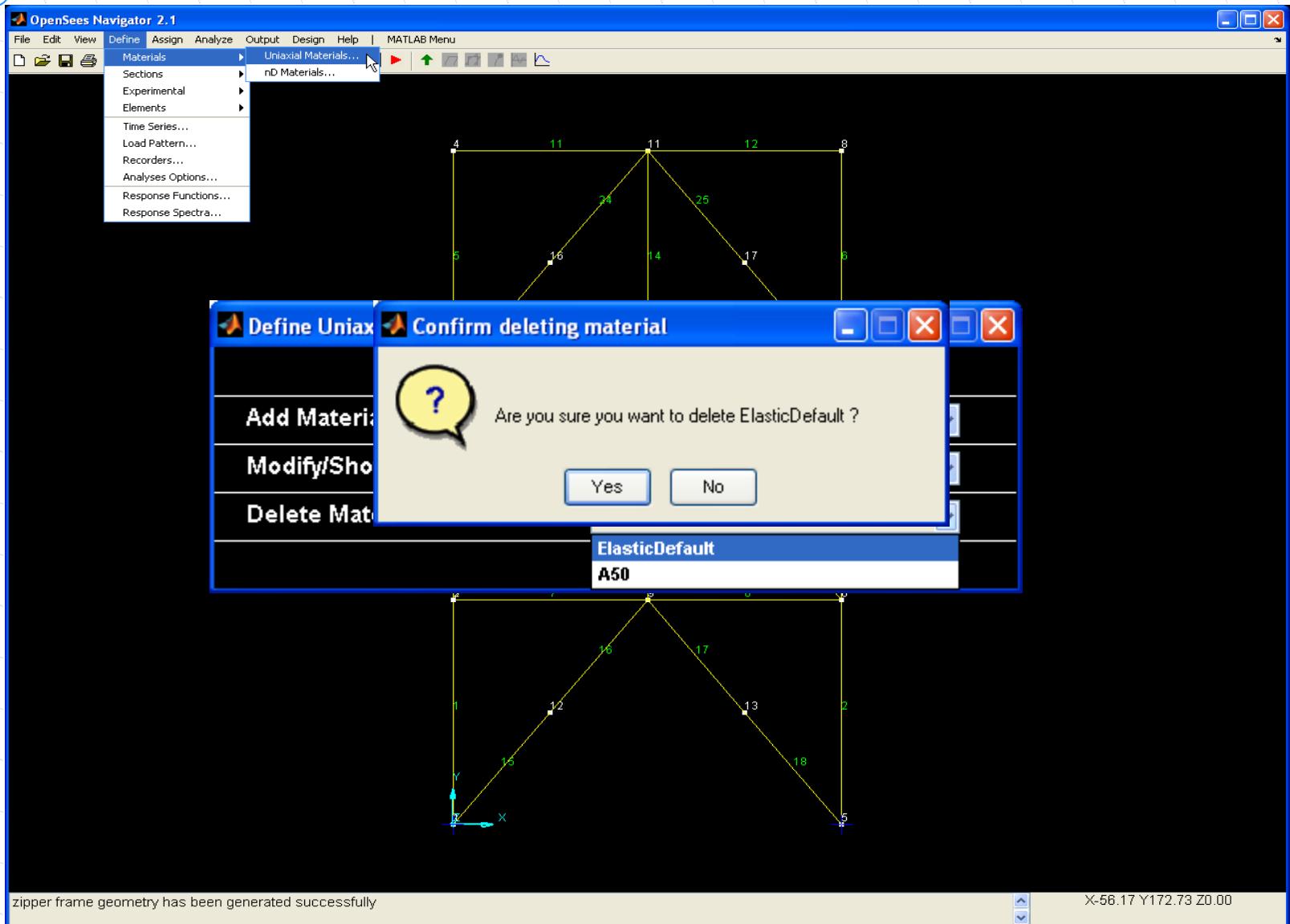
Define Steel01 Material

Material Name :	A50	Add
Yield Stress (Fy) :	50	
Modulus of Elasticity (E) :	29000	
Hardening Ratio (b) :	0.05	
<i>Optional Parameters :</i>		
Iso Hardening Parameter (a1) :	0.0	
Iso Hardening Parameter (a2) :	1.0	
Iso Hardening Parameter (a3) :	0.0	
Iso Hardening Parameter (a4) :	1.0	

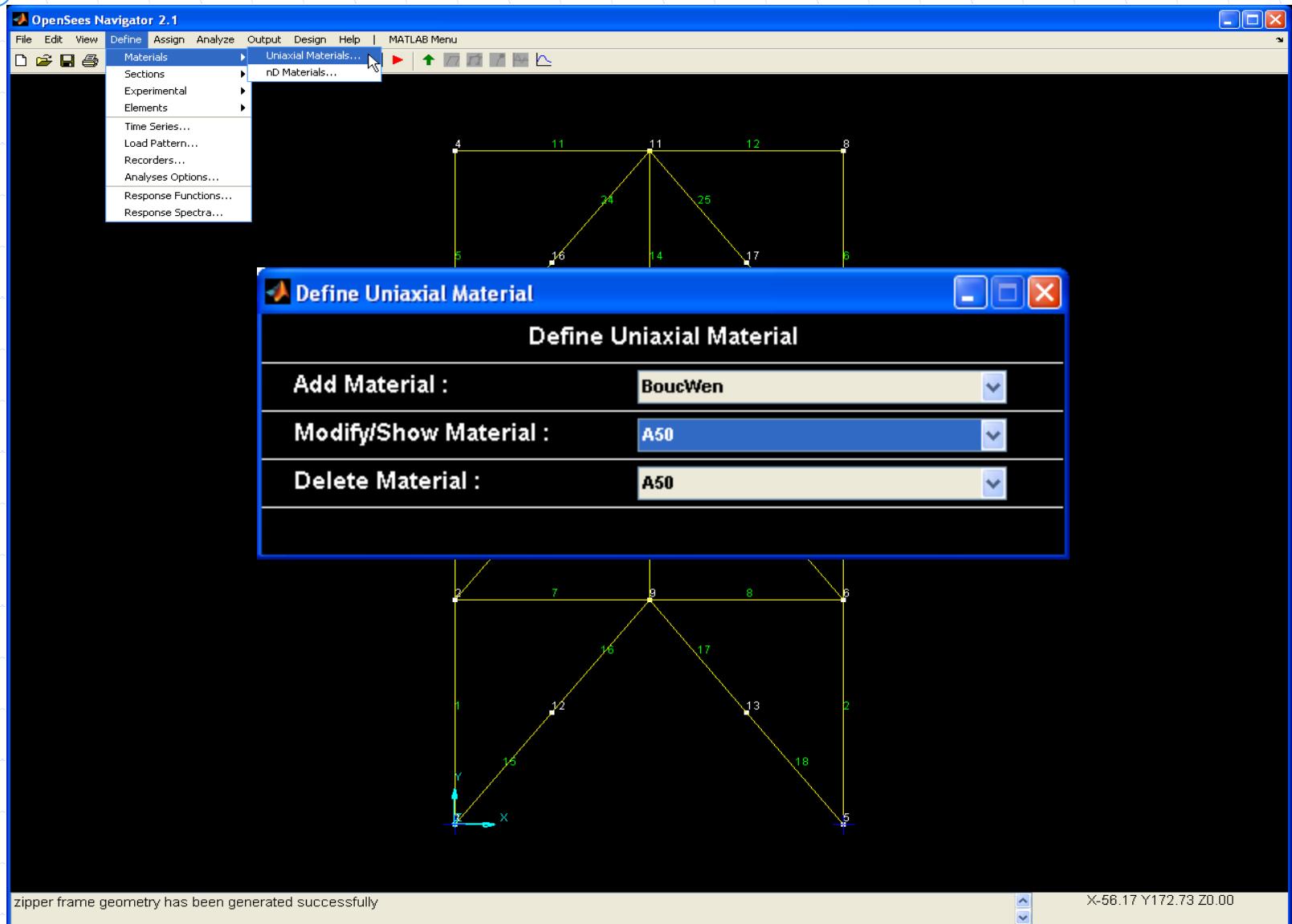
# Define material: uniaxial materials



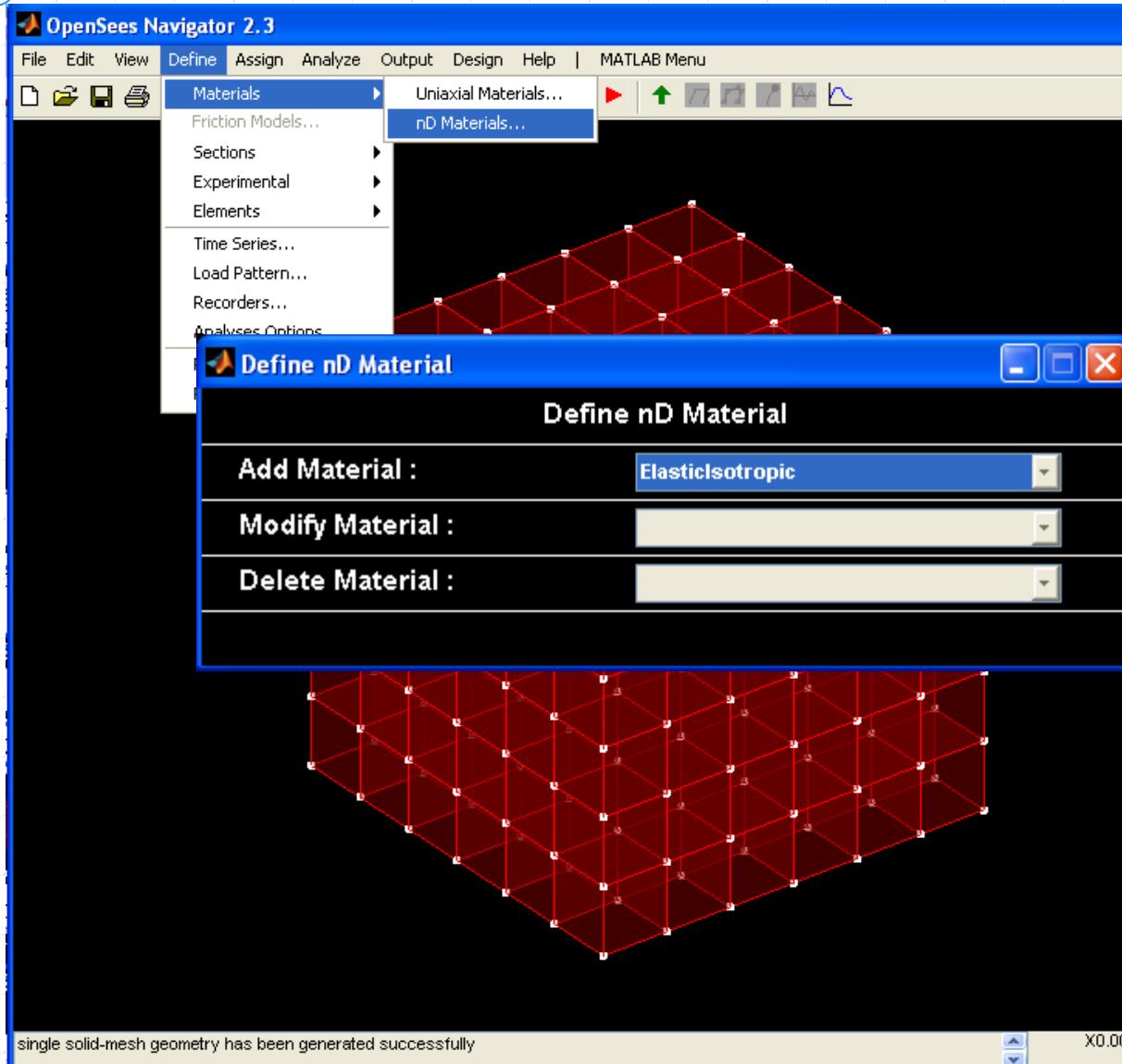
# Define material: uniaxial materials



# Define material: uniaxial materials



# Define material: nD materials



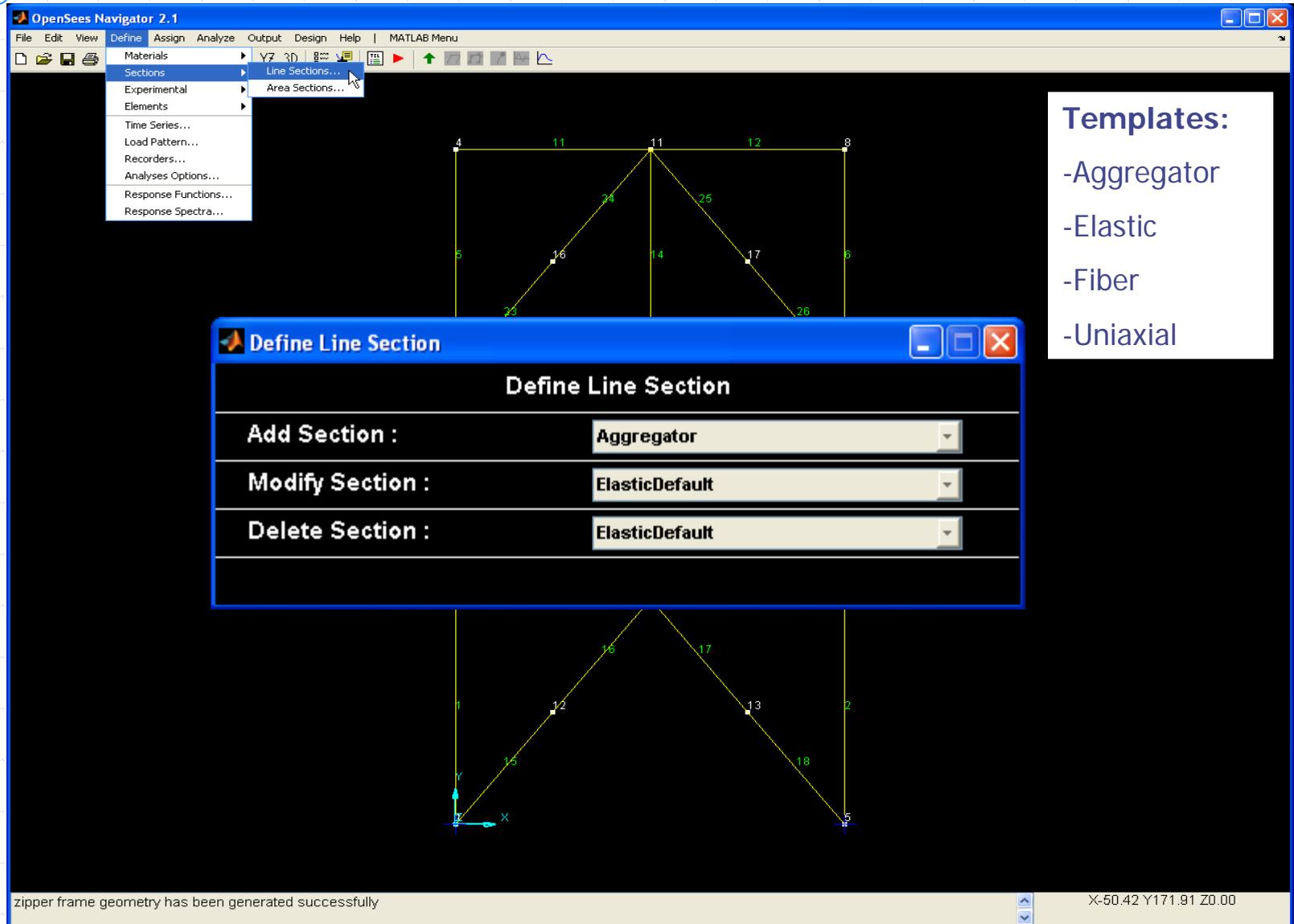
## Templates:

- ElasticCrossAnisotropic3D
- ElasticIsotropic
- FluidSolidPorous
- J2Plasticity
- MultiaxialCyclicPlasticity
- PlaneStress
- PlateFiber
- PressureDependMultiYield
- PressureDependMultiYield02
- PressureDependentElastic3D
- PressureIndependMultiYield
- Template3DElastoPlastic

## Under development:

- NewTemplate3DElastoPlastic
- ModelsLargeDeformation

# Define section: line sections



# Define line section: elastic section

Define Elastic Section

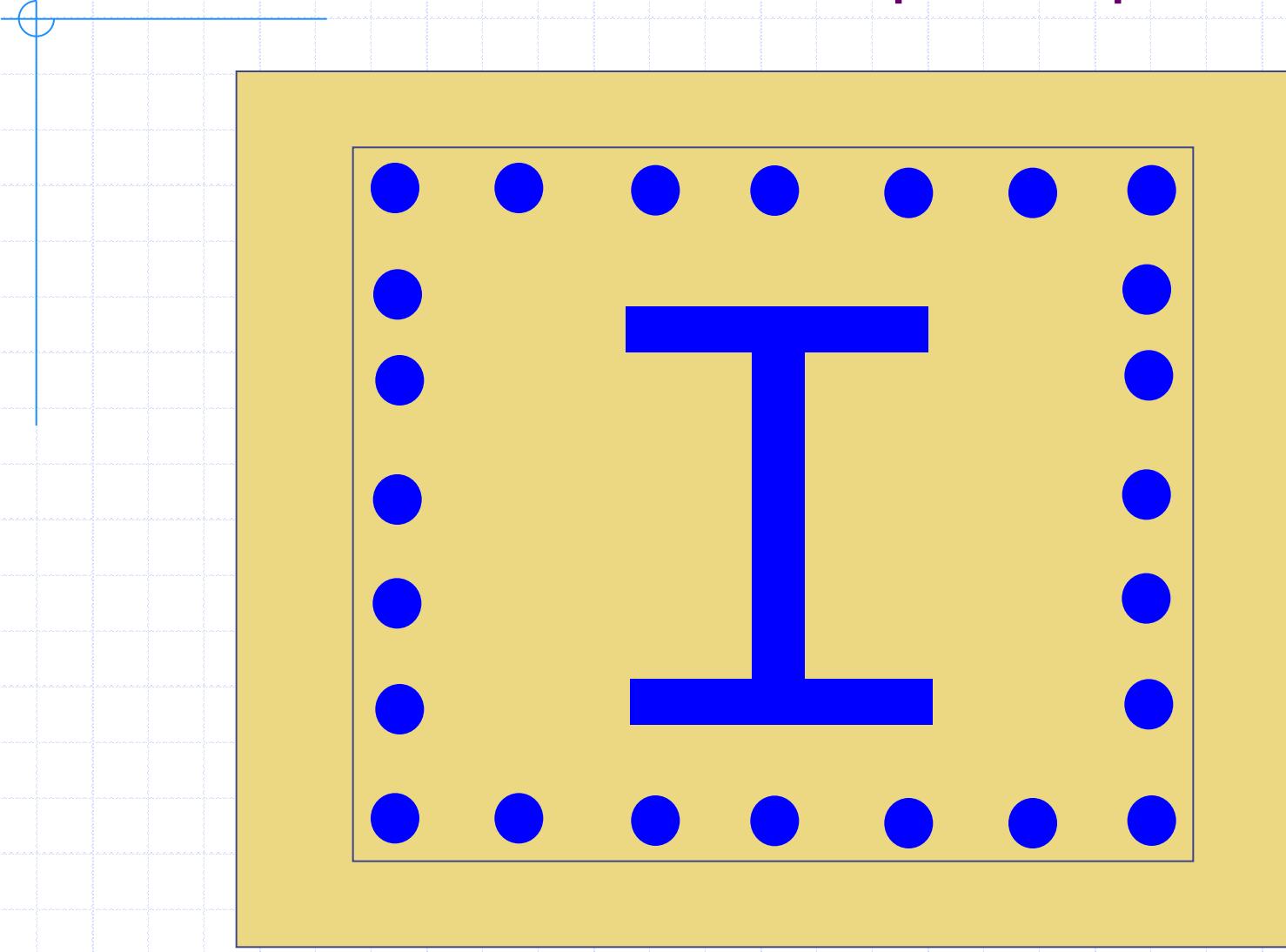
Section Name :	Section01	Add
Modulus of Elasticity (E) :	29000	Database
Cross-Sectional Area (A) :	20	
Moment of Inertia (Iz) :	2000	

If the model is 3D

Define Elastic Section

Section Name :	Section01	Add
Modulus of Elasticity (E) :	29000	Database
Shear Modulus (G) :	29000	
Cross-Sectional Area (A) :	20	
Torsional Moment of Inertia (J) :	1.87	
Moment of Inertia (Iy) :	2000	
Moment of Inertia (Iz) :	2000	

# Define fiber section: Composite patch



# Define line section: fiber section

Define Fiber Section

Section Name :	<input type="text" value="1stStoryColumn"/>	<input type="button" value="Add"/>
Add Fiber :	<input type="button" value="Fiber"/>	<input type="button"/>
Modify Fiber :	<input type="button"/>	<input type="button"/>
Delete Fiber :	<input type="button"/>	<input type="button"/>
Add Patch :	<input type="button" value="Quadrilateral"/>	<input type="button"/>
Modify Patch :	<input type="button"/>	<input type="button"/>
Delete Patch :	<input type="button"/>	<input type="button"/>
Add Layer :	<input type="button" value="Straight"/>	<input type="button"/>
Modify Layer :	<input type="button"/>	<input type="button"/>
Delete Layer :	<input type="button"/>	<input type="button"/>

# Define line section: quadrilateral patch

Define Quadrilateral Patch

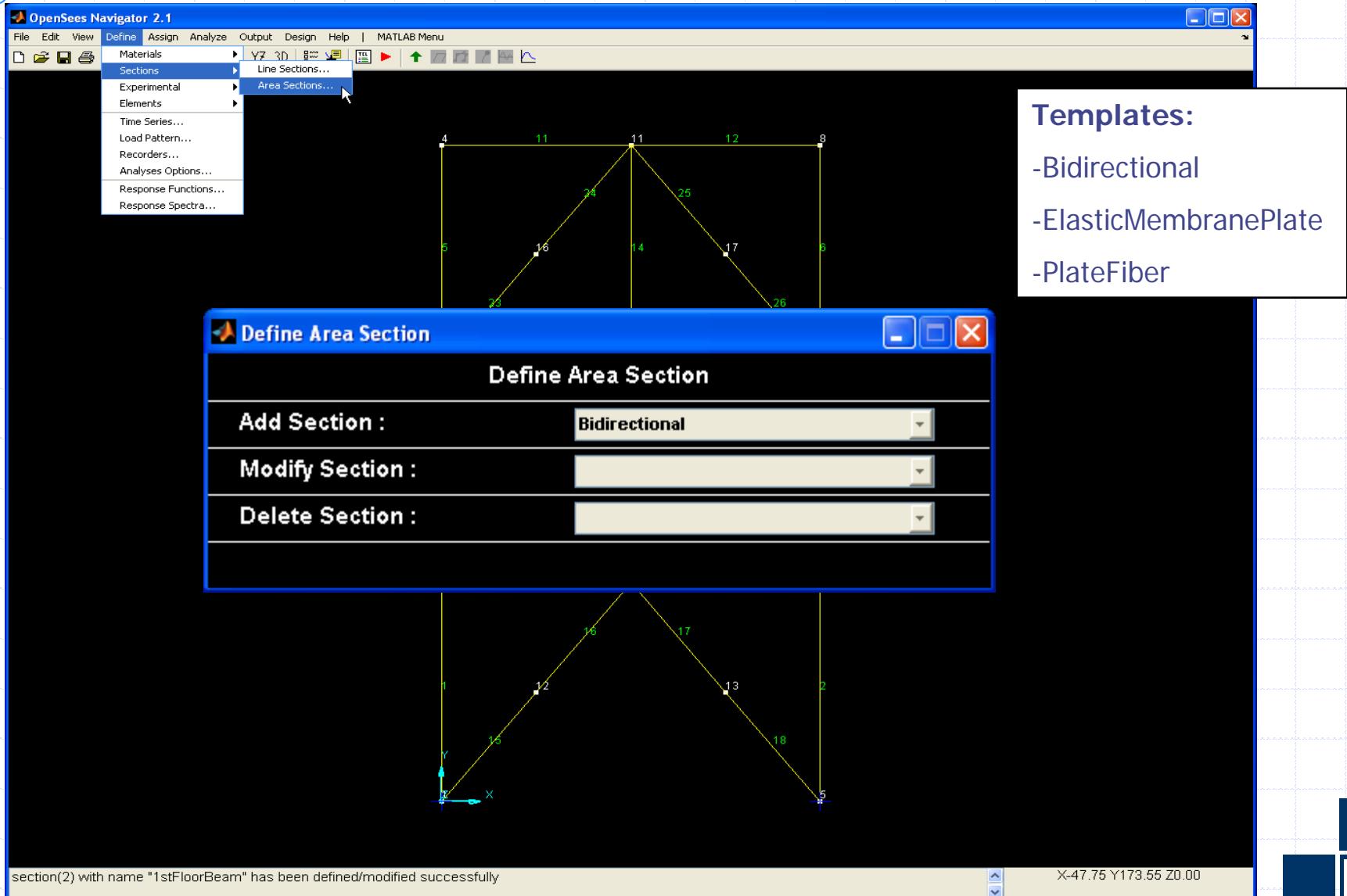
Patch Name :	CoreConcrete	Add
Material Type :	ConfinedConcrete	
Lower Left Corner (yL,zL) :	A50	
	ConfinedConcrete	
	UnconfinedConcrete	
Lower Right Corner (yJ,zJ) :	[0 0]	
Upper Right Corner (yK,zK) :	[0 0]	
Upper Left Corner (yL,zL) :	[0 0]	
Number of Fibers in I-J dir (nfIJ) :	1	
Number of Fibers in J-K dir (nfJK) :	1	
<i>Optional Arguments :</i>		
Counter-Clockwise Rot (Theta) :	0.	

# Define fiber section: AISC patch

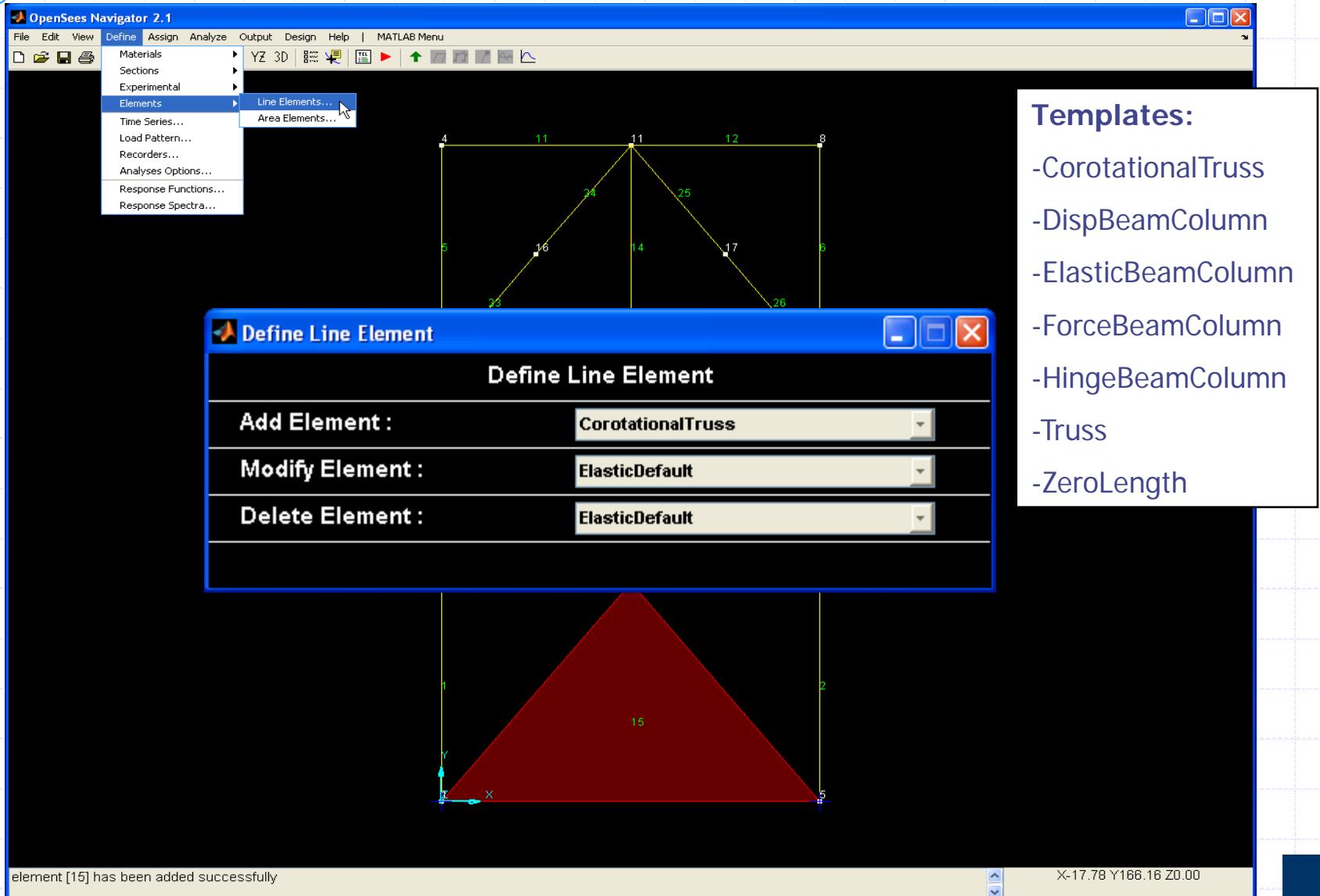
Define AISC Patch

Patch Name :	Patch01	Add
Material Type :	A50	
AISC Section Name :	W24X68	
Number of Fibers along dw (nfdw) :	10	
Number of Fibers along tw (nftw) :	1	
Number of Fibers along bf (nfbf) :	10	
Number of Fibers along tf (nftf) :	1	
<i>Optional Arguments :</i>		
Counter-Clockwise Rot (Theta) :	0.	

# Define section: area section



# Define element: line element



# Define line element: ElasticBeamColumn

Define ElasticBeamColumn Element

Element Name :	EColumn	Add
Modulus of Elasticity (E) :	29000	Database
Cross-Sectional Area (A) :	13.3	
Moment of Inertia (Iz) :	248	

Select Section from Database

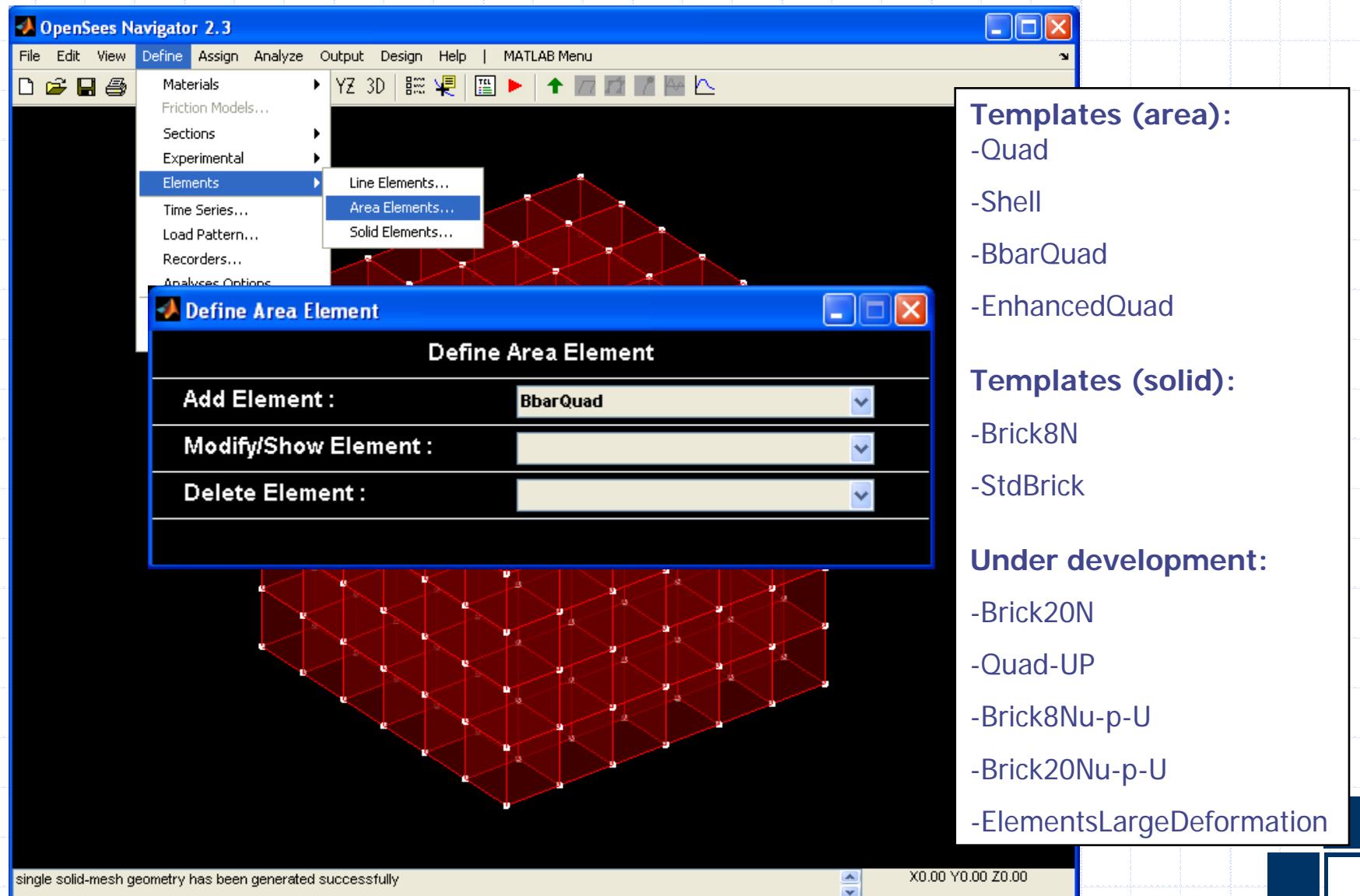
Database :	AISC	Select
Section Name :	W10X45	
Direction :	strong	

# Define line element: ForceBeamColumn

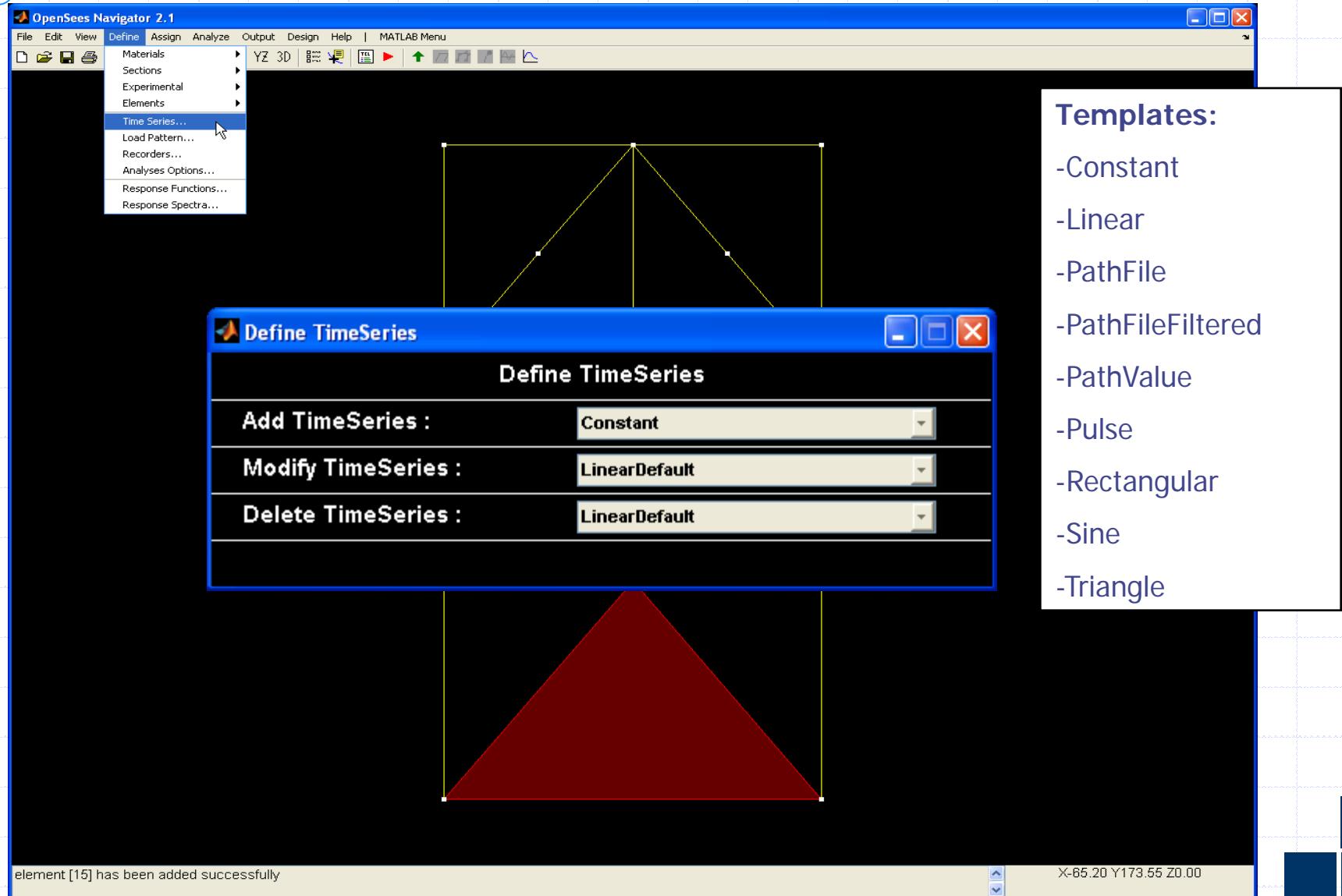
Define ForceBeamColumn Element

Element Name :	1stStoryColumn	Add
Number Intergration Points (NIP) :	5	
Section Type :	1stStoryColumn	
<i>Optional Arguments :</i>		
Mass Density (massDens) :	0.	
Maximum Iterations (maxIters) :	10	
Tolerance (tol) :	1E-8	

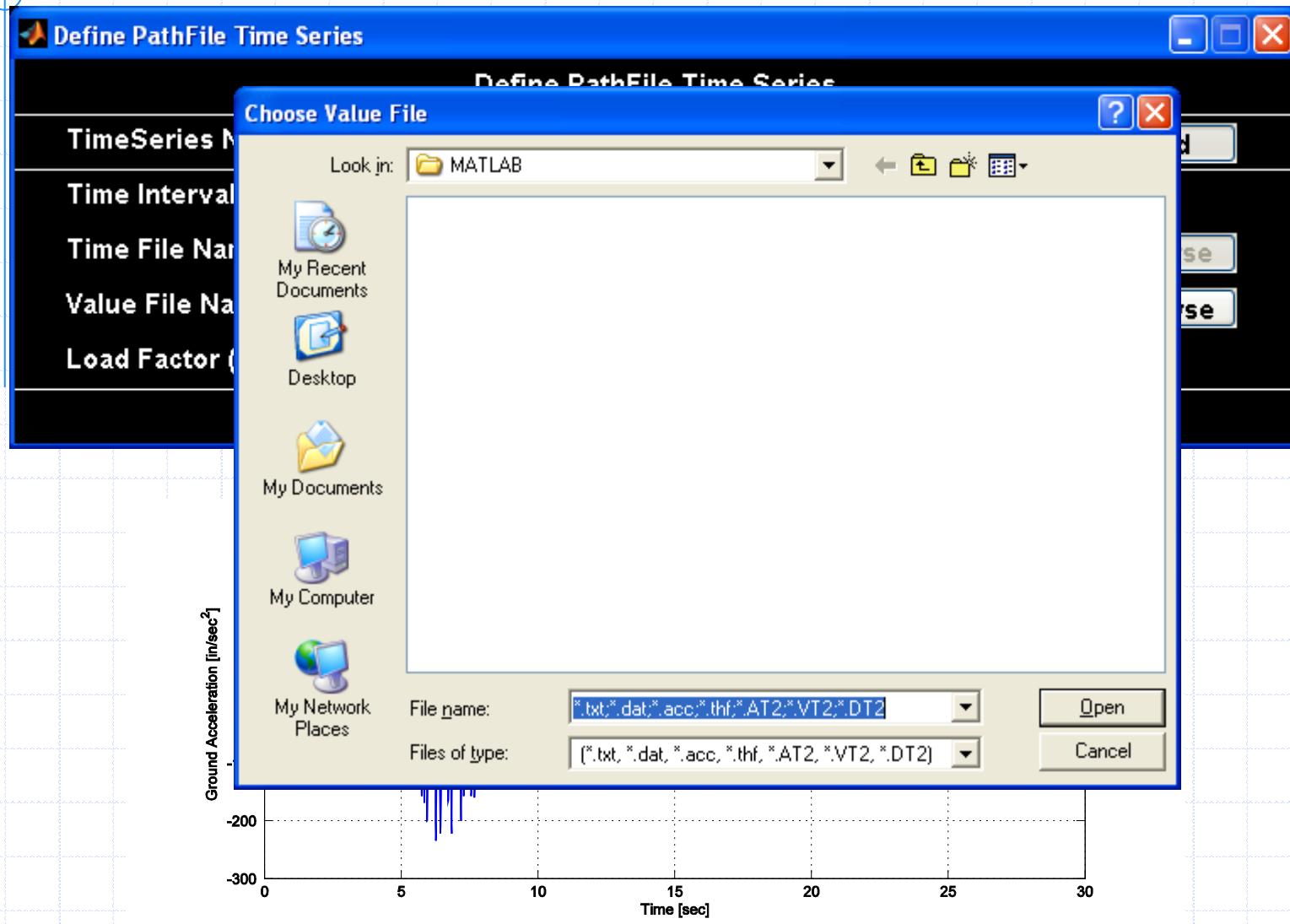
# Define element: area and solid elements



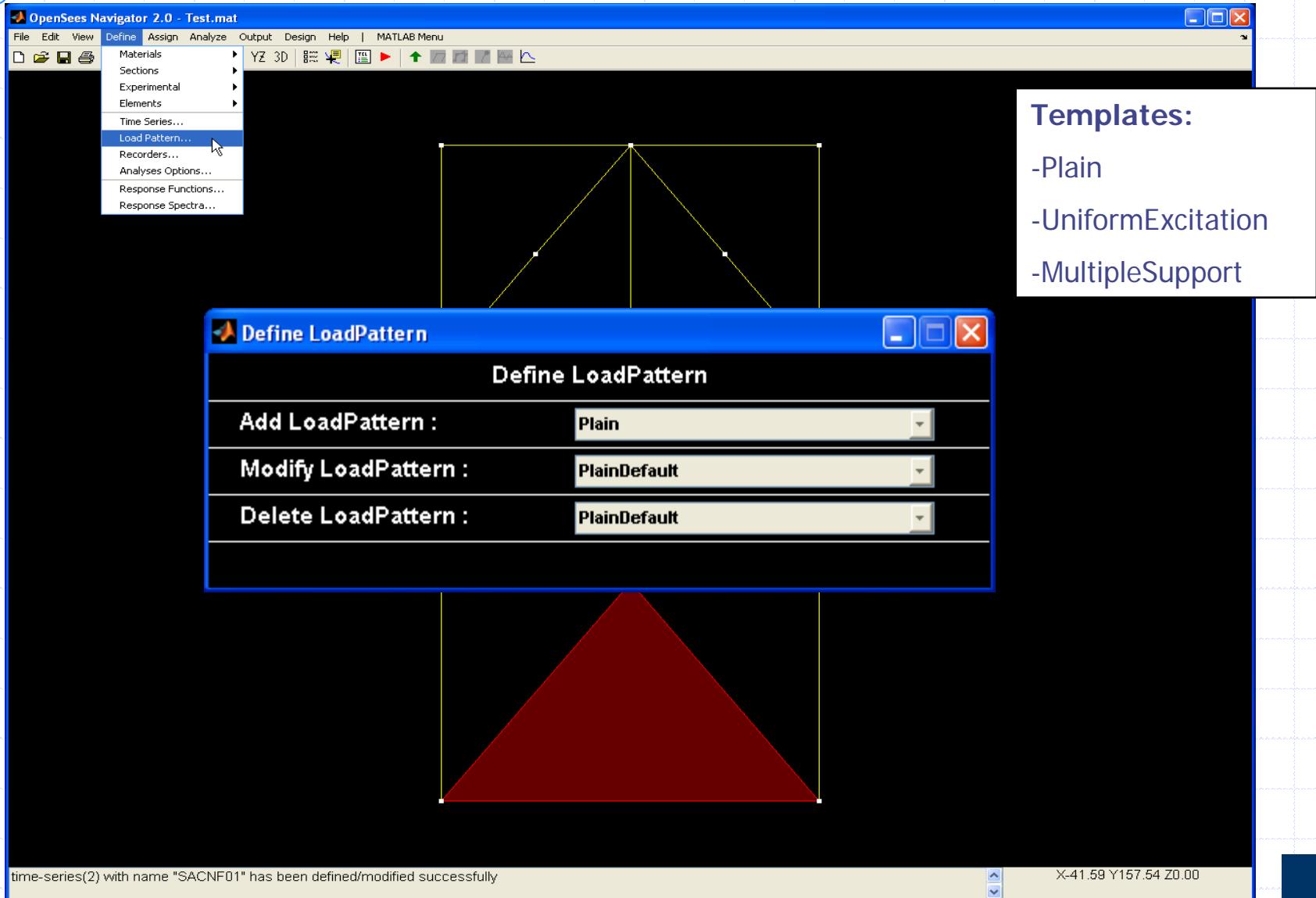
# Define TimeSeries:



# Define TimeSeries: PathFile



# Define LoadPattern:

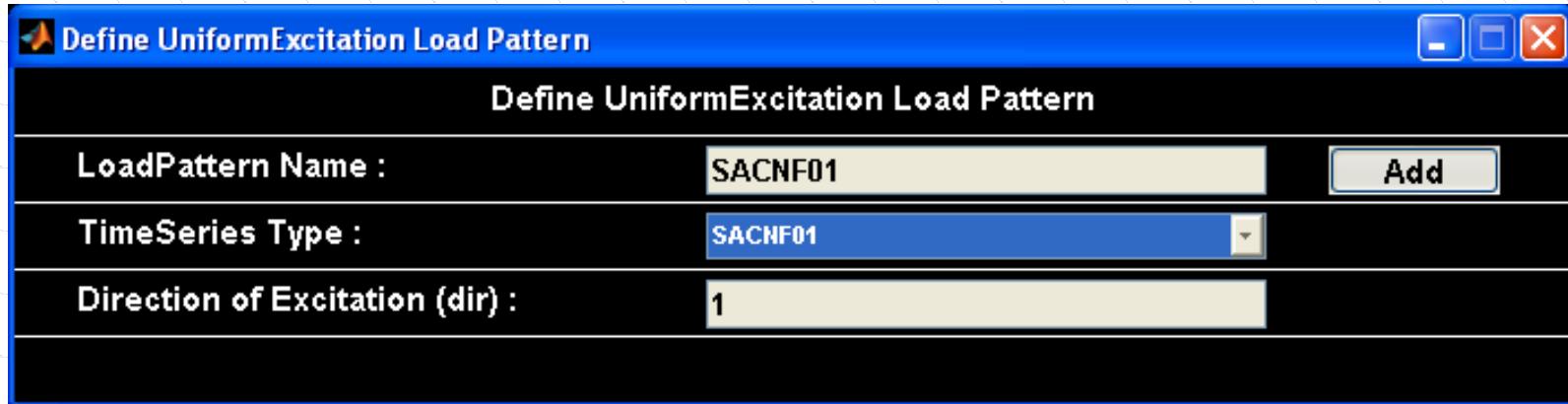


Templates:

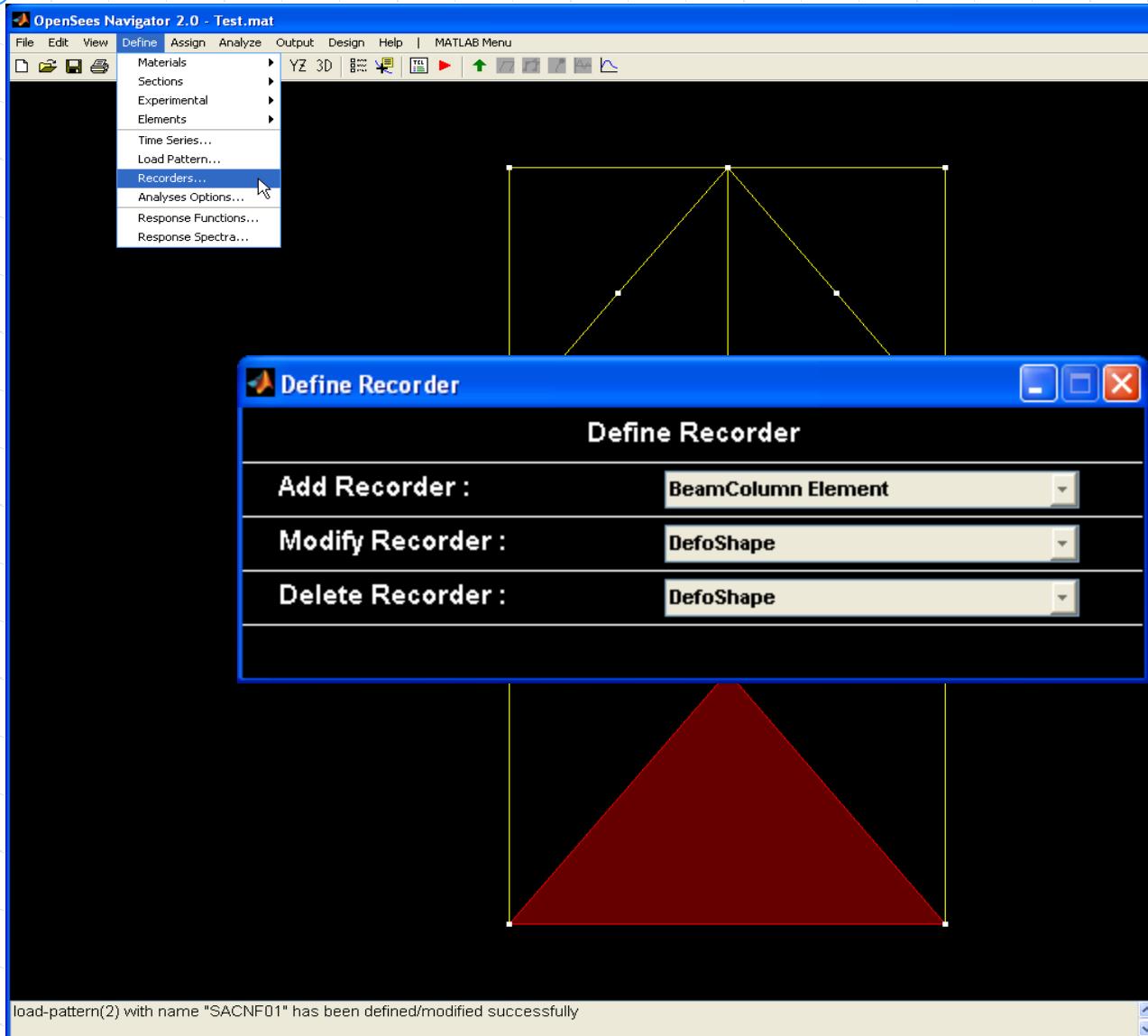
- Plain
- UniformExcitation
- MultipleSupport

X-41.59 Y157.54 Z0.00

# Define LoadPattern: UniformExcitation



# Define recorder



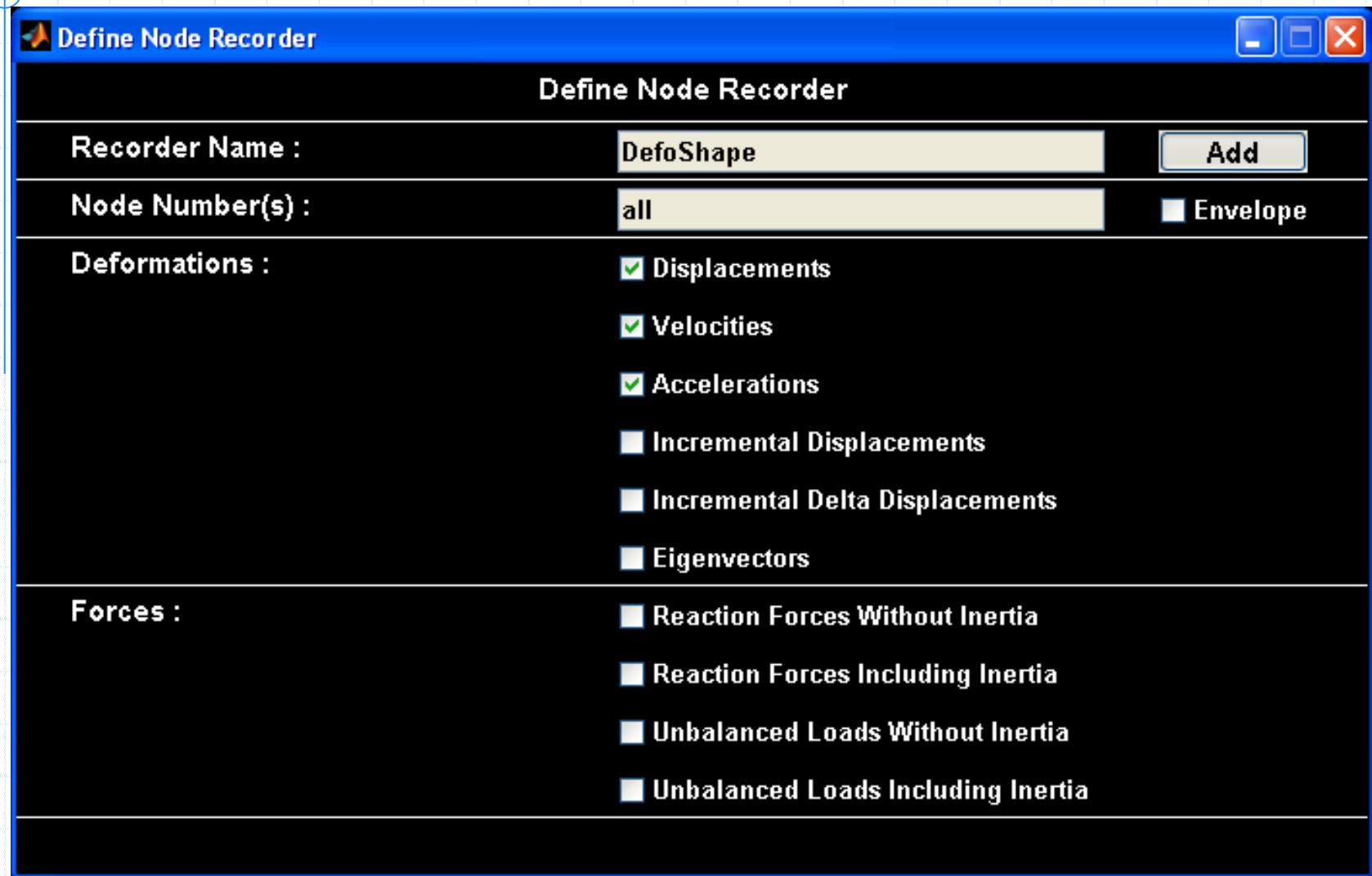
## Templates:

- BeamColumn Element
- Display
- Experimental Element
- Node
- Truss Element
- ZeroLength Element

## Defaults:

- DefoShape
- EigenVector

# Define recorder: node recorder

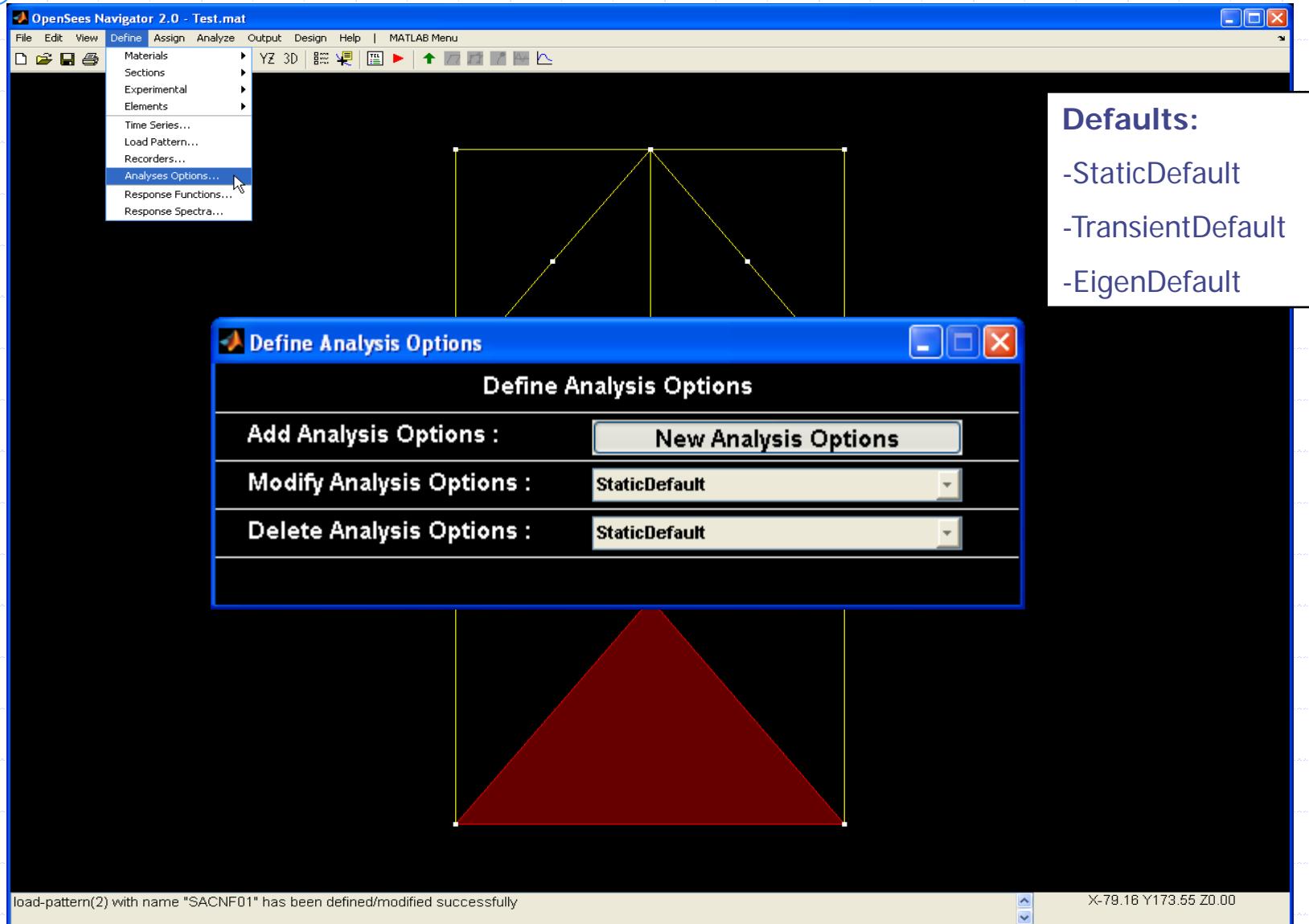


# Define recorder: BeamColumn recorder

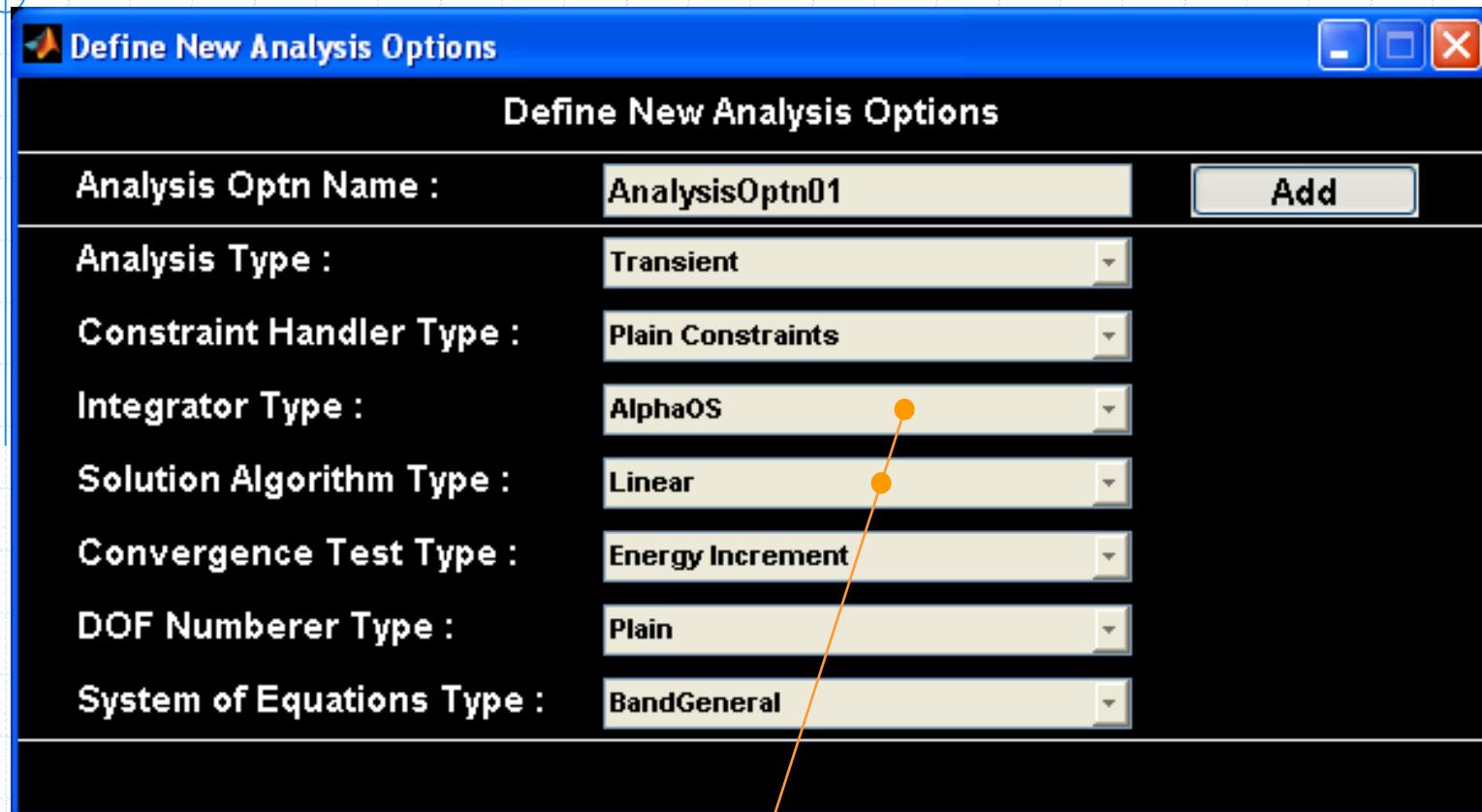
Define BeamColumn Element Recorder

Recorder Name :	ElemForces	Add			
Element Number(s) :	all	<input type="checkbox"/> Envelope			
Arguments :	<input checked="" type="checkbox"/> Global Resisting Forces <input checked="" type="checkbox"/> Local Resisting Forces				
Section Response :	<input checked="" type="radio"/> Section				
Section Number(s) :	1 5				
Arguments :	<input checked="" type="checkbox"/> Forces <input type="checkbox"/> Stiffness	<input checked="" type="checkbox"/> Deformations			
Fiber Response :	<input checked="" type="radio"/> Fiber				
Arguments :	<input type="checkbox"/> Stress/Strain	0.	Y-Coor	0.	Z-Coor

# Define analysis options



# Define analysis options: new analysis



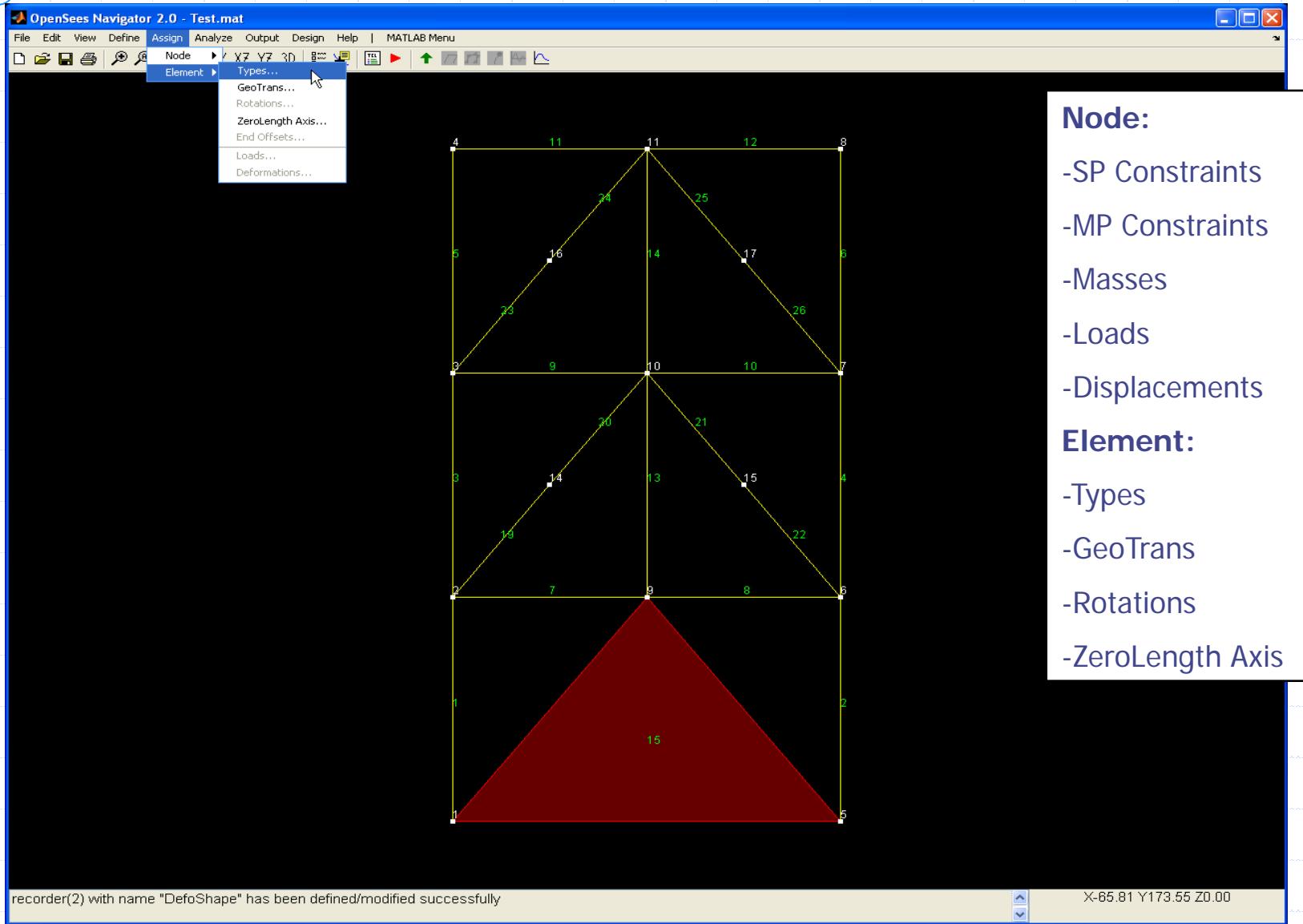
## Integrator Type:

For example use AlphaOS Method for Hybrid Simulation

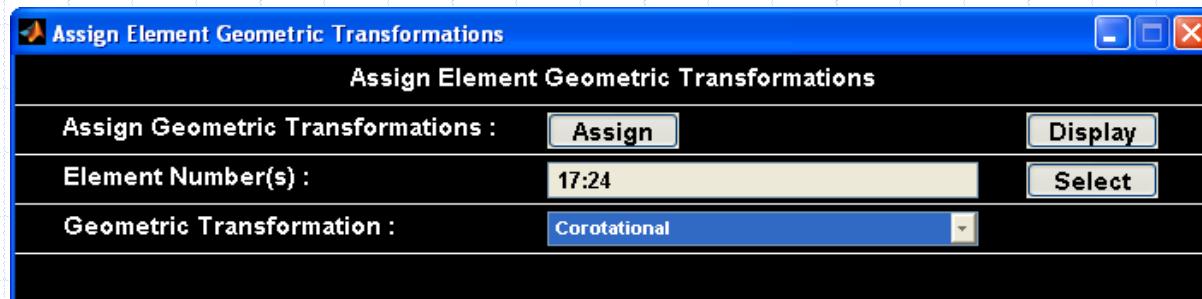
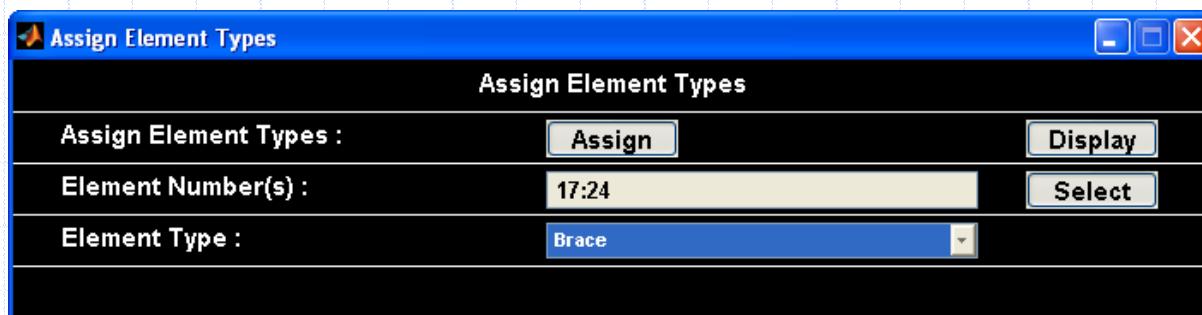
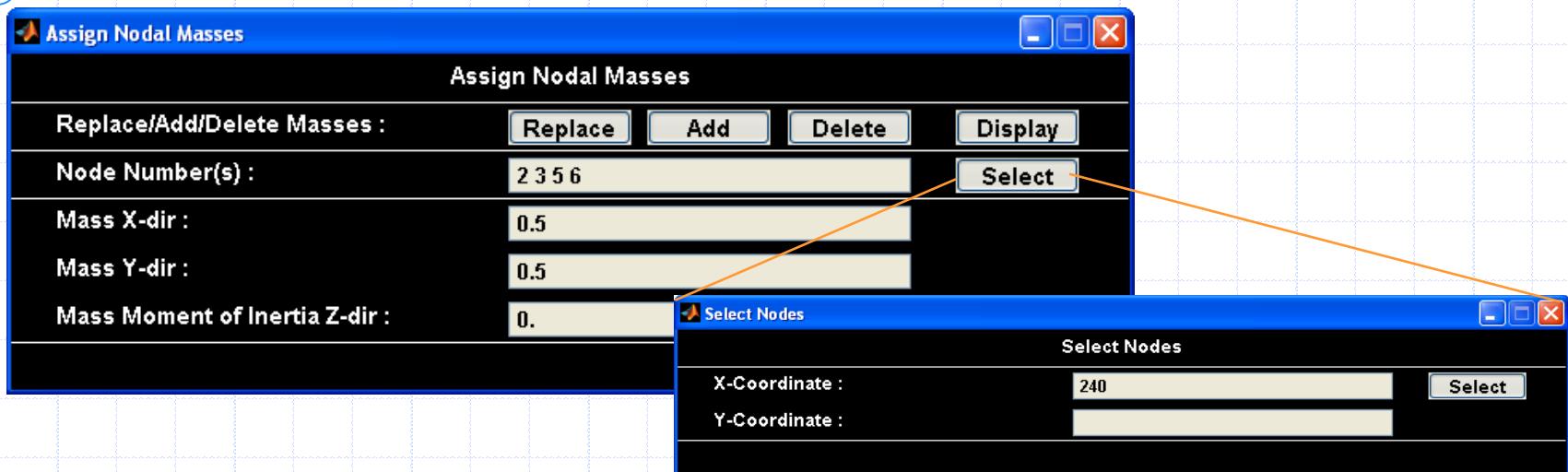
## Solution Algorithm:

The AlphaOS Method requires a Linear solution algorithm

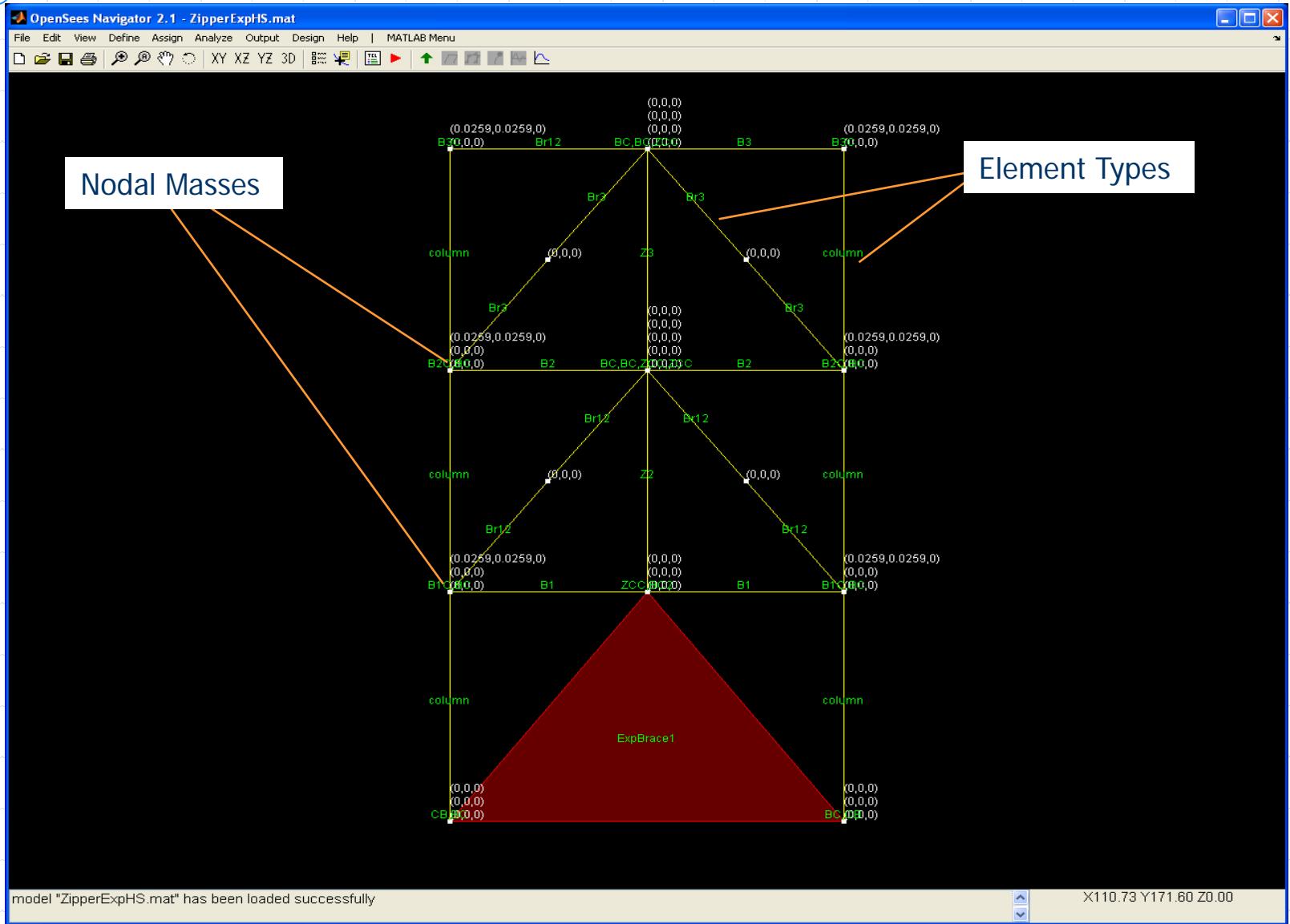
# Assign menu



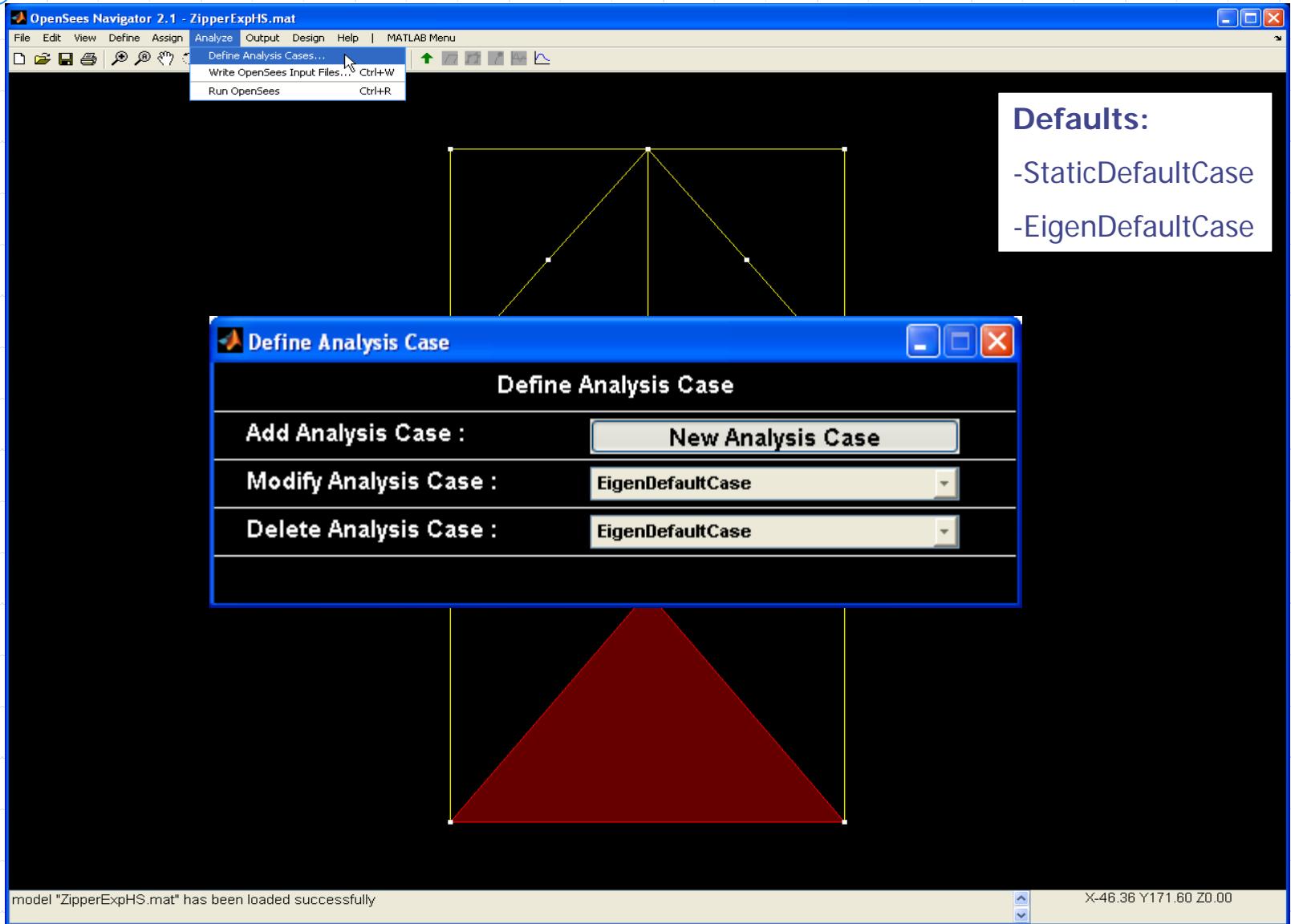
# Assign menu



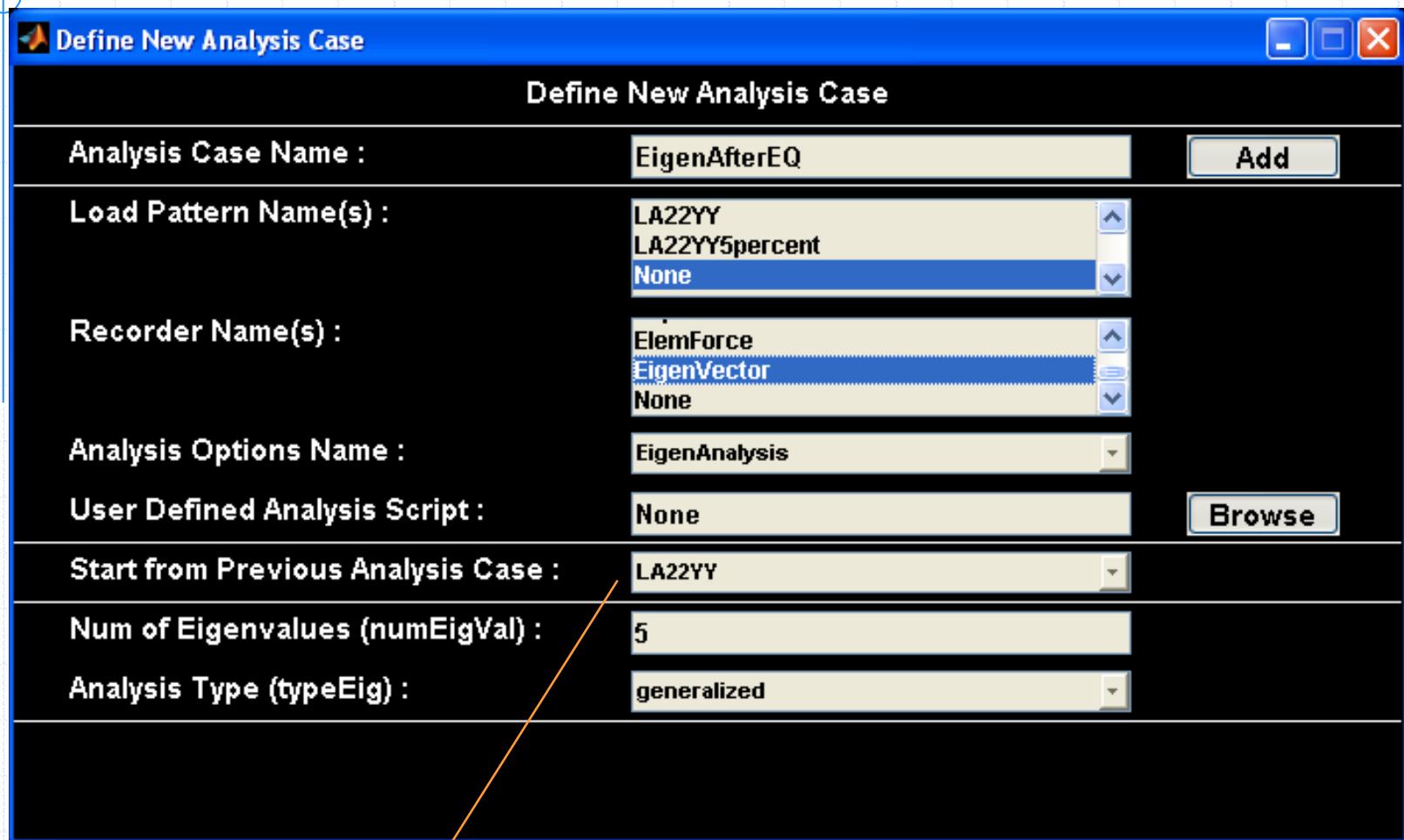
# Display assigned properties



# Define analysis case



# Define analysis case: new analysis case



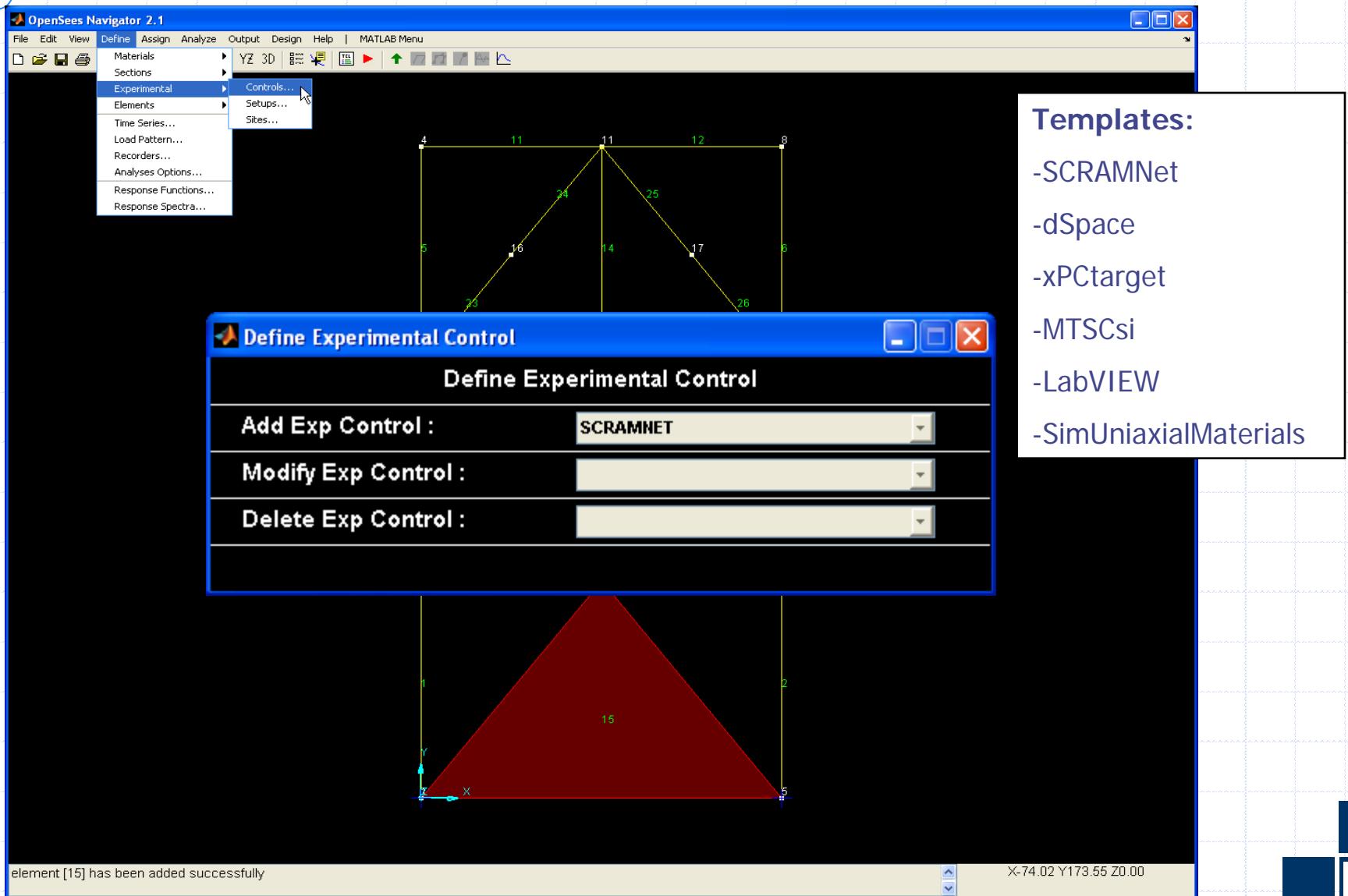
For Example:

Periods and Mode Shapes after Time-History Analysis

# OpenFresco: hybrid simulation

- ◆ expControl
  - Interfaces to the different control and data acquisition.
- ◆ expSetup
  - Transforms between the experimental element degrees of freedom and the actuator degrees of freedom (linear vs. non-linear transformations).
- ◆ expSite
  - Stores data and provides communication methods for distributed testing.
- ◆ expElement
  - Represents the part of the structure that is physically tested and provides the interface between the FE-software and the experimental software framework

# Define expControl:



# Define expControl: MTSCsi

**Define MTS CSI Control**

Control Name : EC\_MTS\_CSI Add

Configuration File Name : OpenFresco\_mNEES.mtscs Browse

Configuration File Path : Fresco/MtsCsi\_Example/OneBayFrame/

Ramp Time (rampTime) : 0.1

**Mats Manager -> Station CT -> OpenFresco\_mNEES.cfg**

**Status Setup 1 -> OpenFresco\_mNEES.cfg**

**Mats 1 -> OpenFresco\_mNEES.cfg**

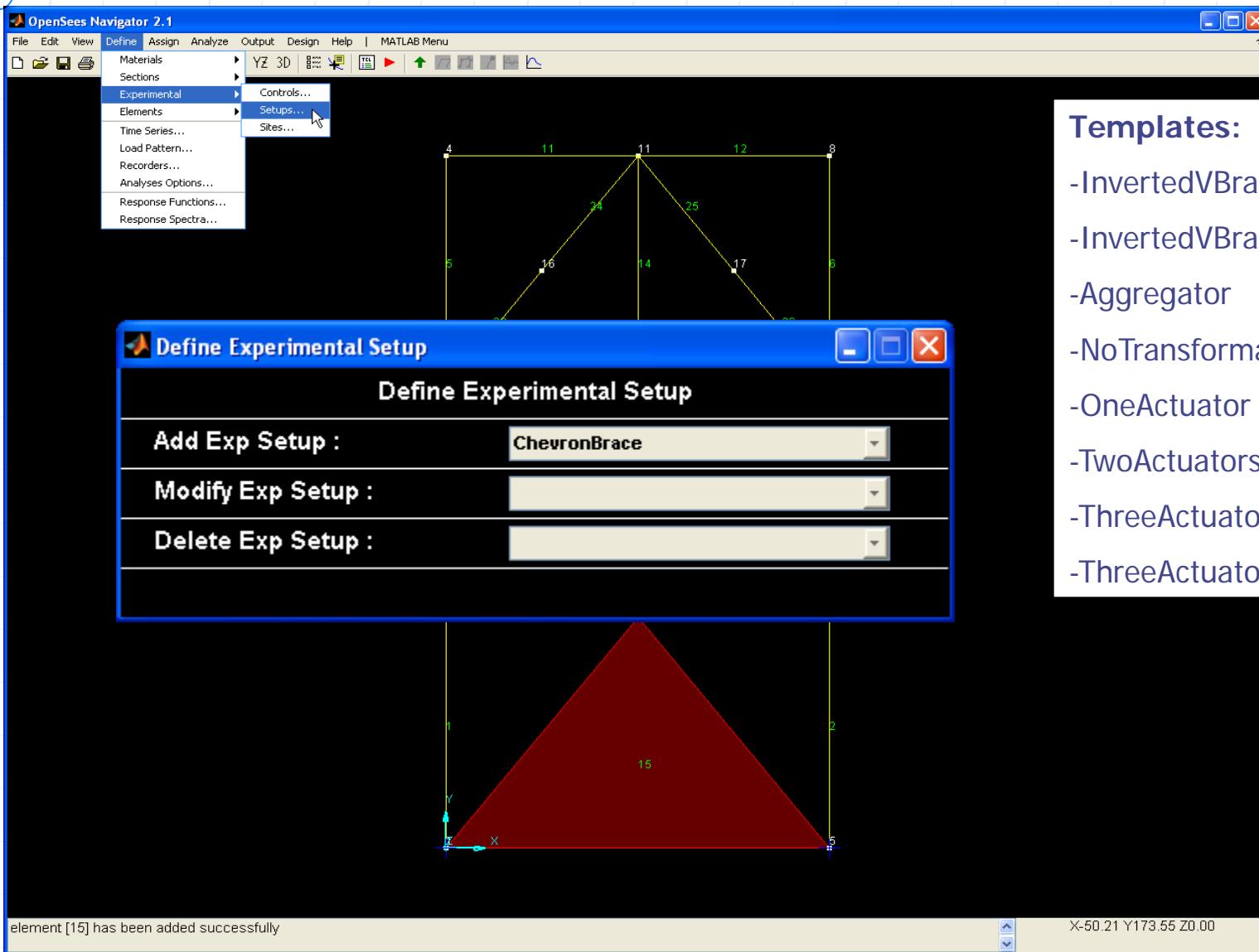
**OpenFresco\_mNEES.mtscs - MTS Computer Simulation Configurator**

Control Points  
Control Point #1

Control Points	Degree of Freedom	Control Channel	Control Mode
Control Point #1	mNEES DOF #1	Ch 1	Displacement

Feedback Signal  
Ch 1 Displacement  
Ch 1 Force

# Define expSetup:



## Templates:

- InvertedVBrace
- InvertedVBraceJntOff
- Aggregator
- NoTransformation
- OneActuator
- TwoActuators
- ThreeActuators
- ThreeActuatorsJntOff

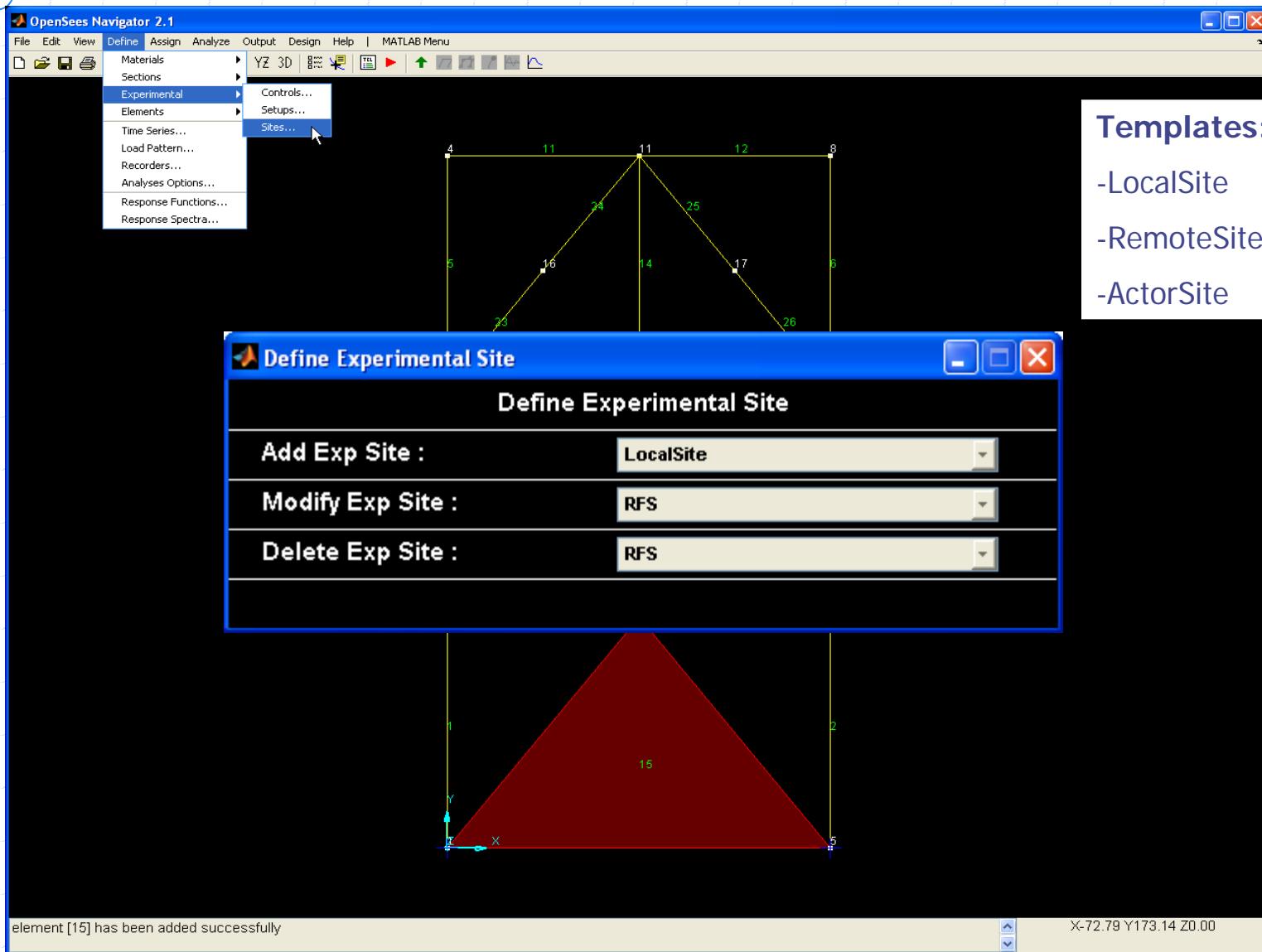
# Define expSetup: InvertedVBrace

**Define ChevronBraceJntOff Setup**

Define ChevronBraceJntOff Setup

Setup Name :	BraceExpSetupJntOff	Add
Experimental Control Type :	BraceExpCtrlXPC	
Geometry Type (nIGeomFlag) :	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	
<i>Optional Parameters :</i>		
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 expSite:



## Templates:

- LocalSite
- RemoteSite
- ActorSite

# Define expSite: LocalSite

Define Local Site

Site Name : RFS Add

Experimental Setup Type : BraceExpSetupJntOff



# Define expElement: InvertedVBrace

Define ExpChevronBrace Element

Element Name : ExpChevronBrace01 Add

Experimental Site Type : RFS

Initial Stiffness (initStif) :

0	0	0
0	0	0
0	0	0

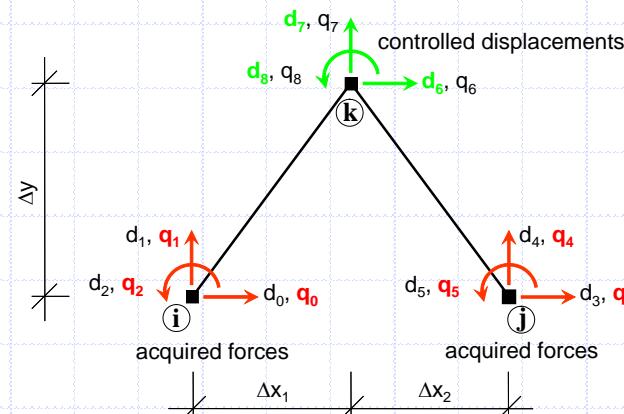
Optional Arguments :

I-Modification (iMod) : no

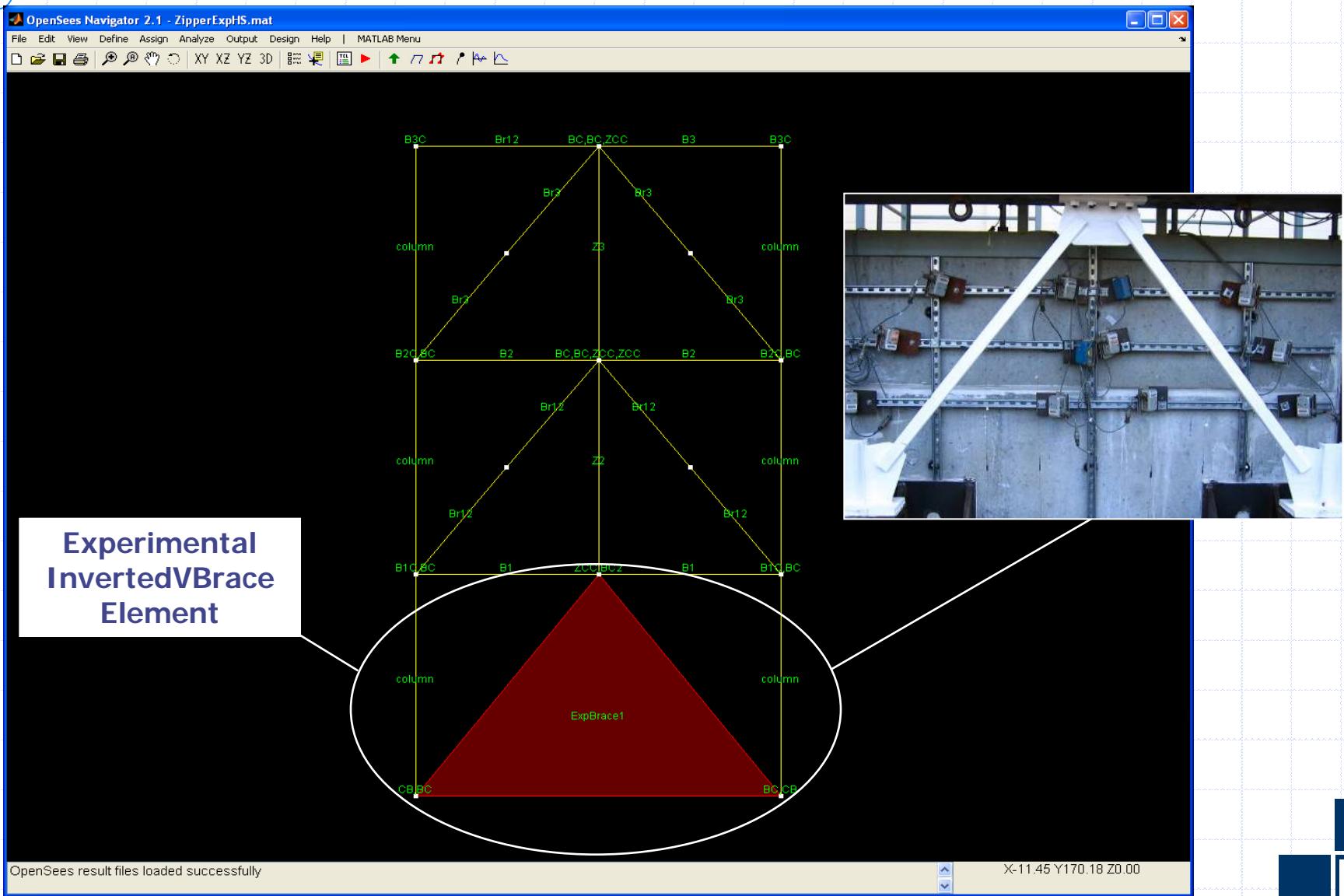
Is Copy (isCopy) : no

Mass Density 1 (massDens1) : 0

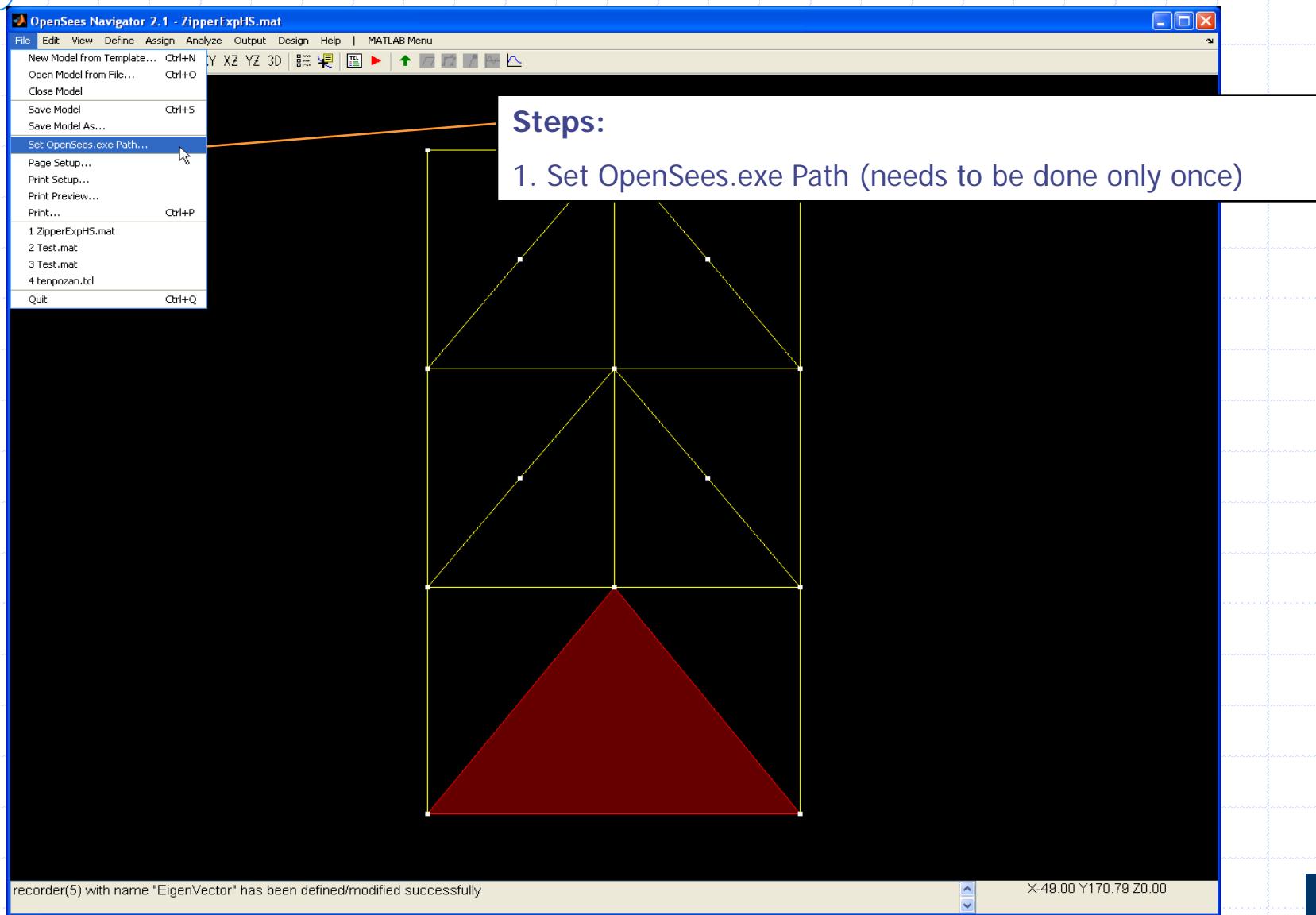
Mass Density 2 (massDens2) : 0



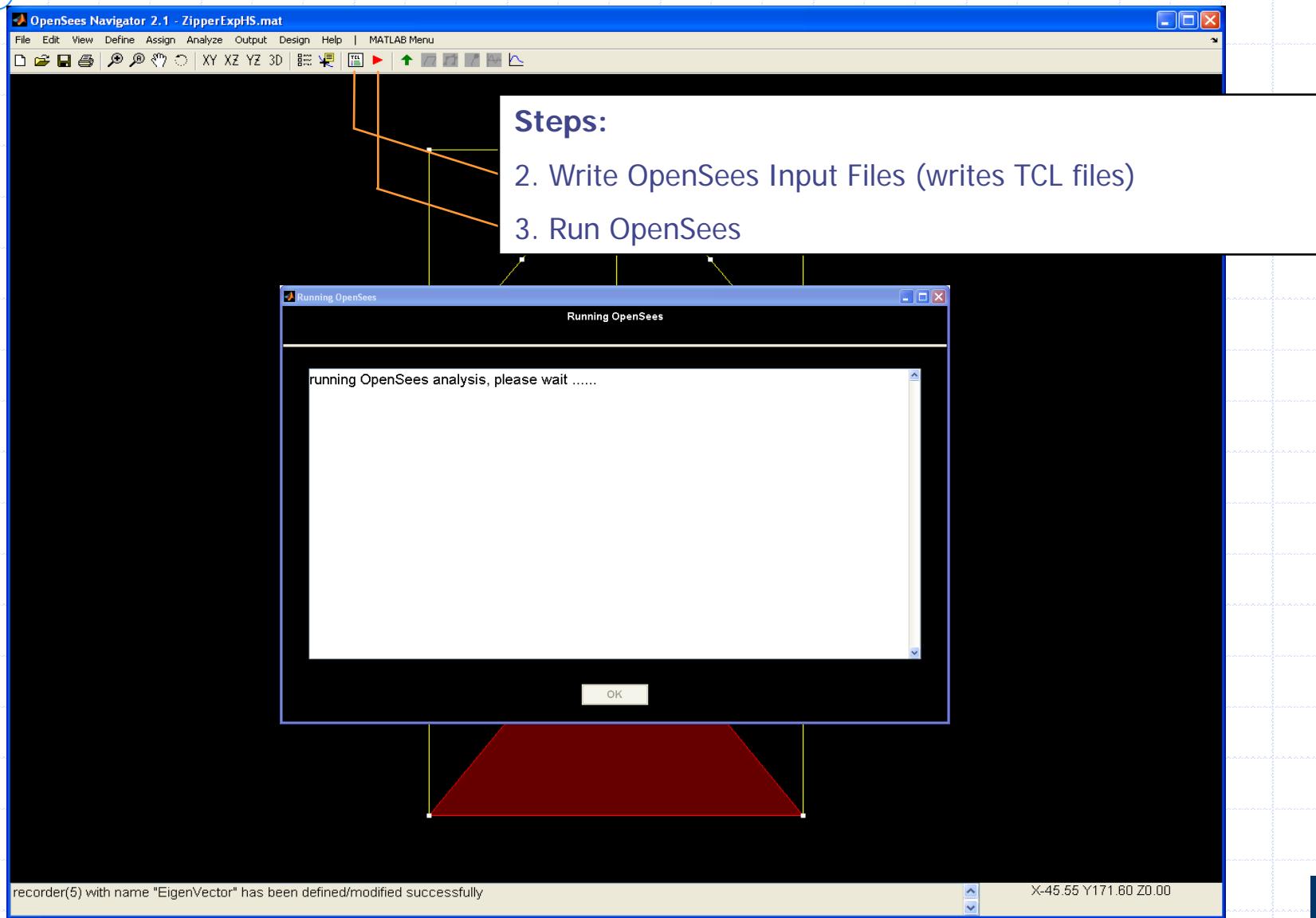
# Define expElement: InvertedVBrace



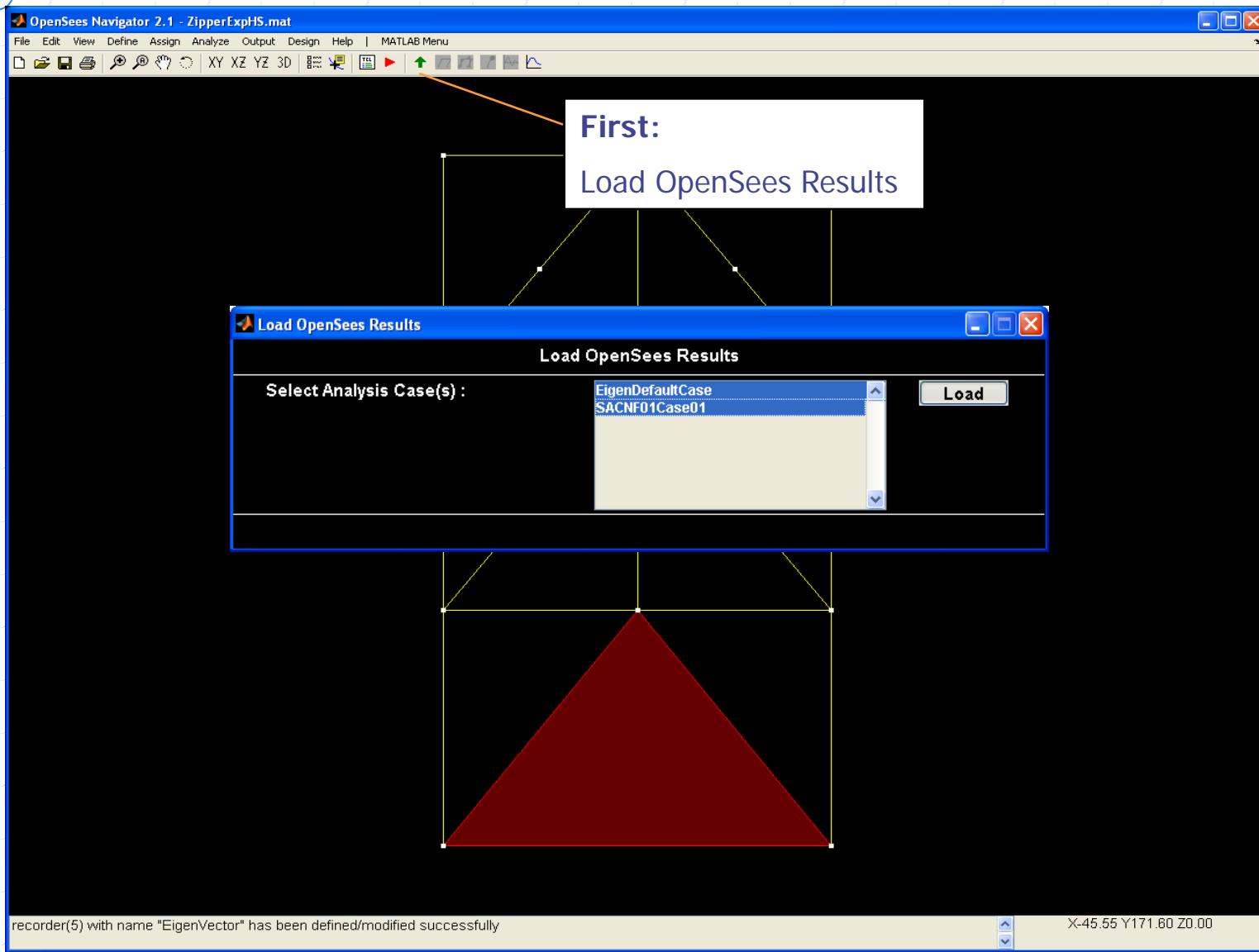
# Run OpenSees: set OpenSees.exe path



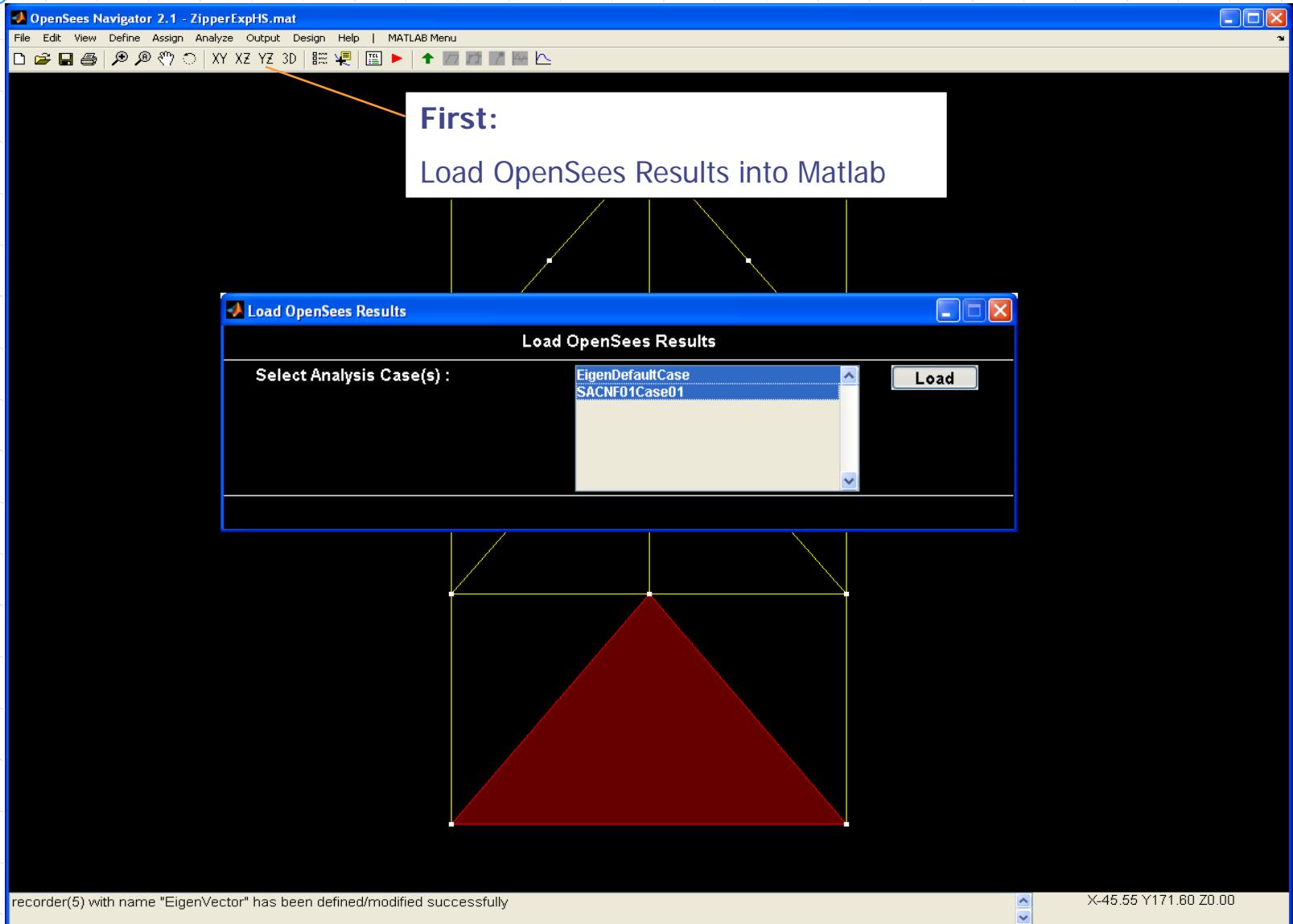
# Run OpenSees: write TCL files



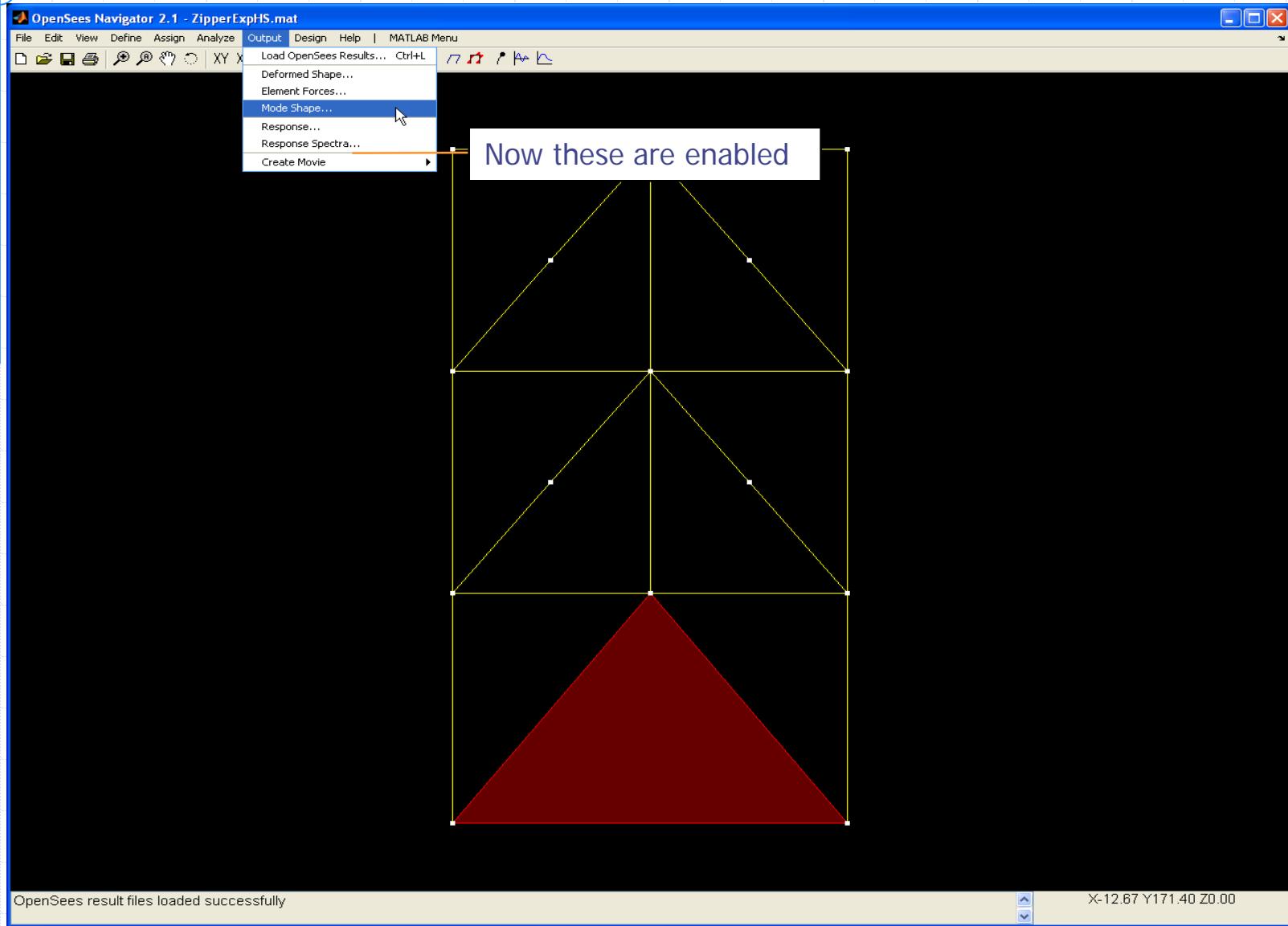
# Post processing: load results



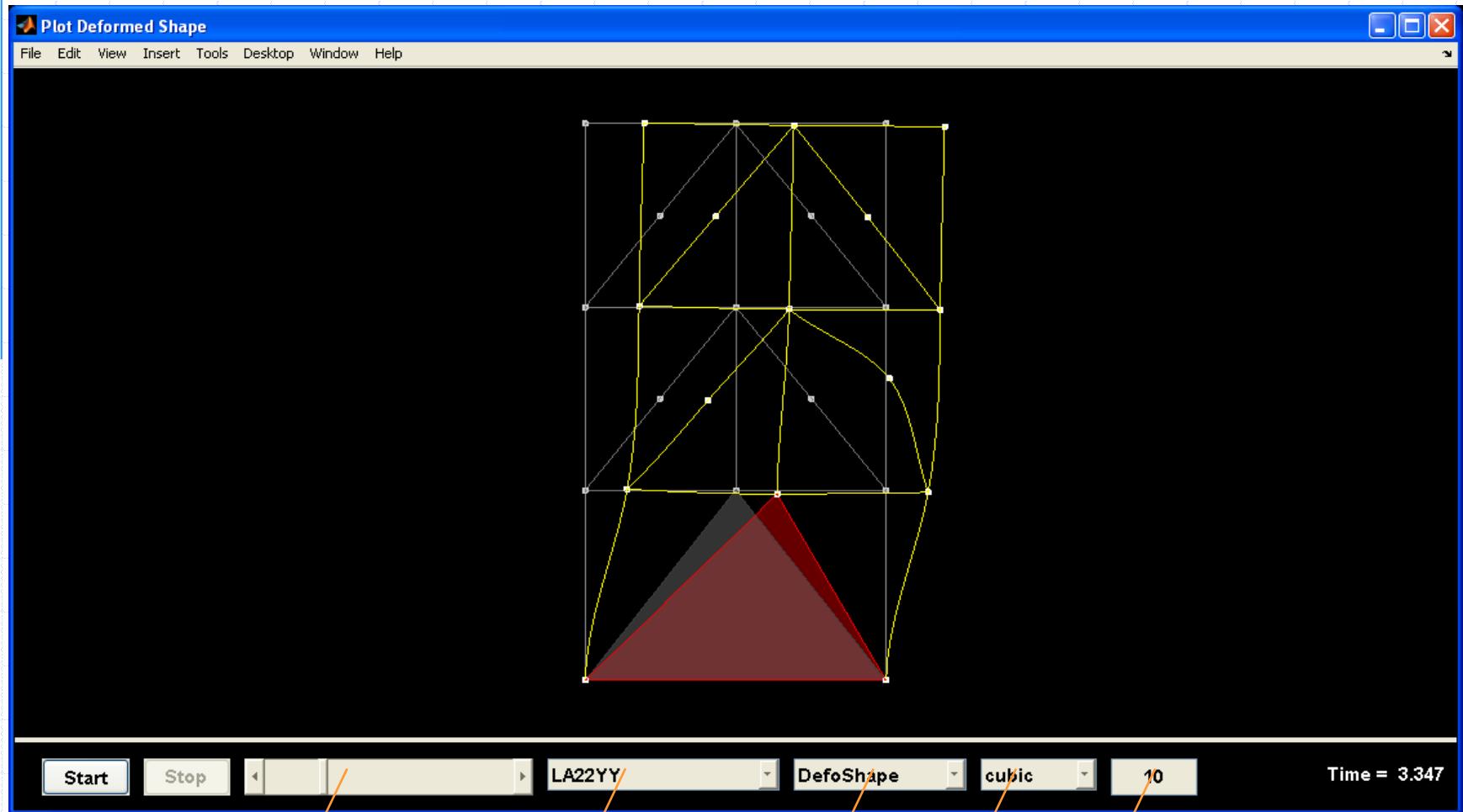
# Post processing: load results



# Post processing: output



# Post processing: plot deformed shape



Time Step

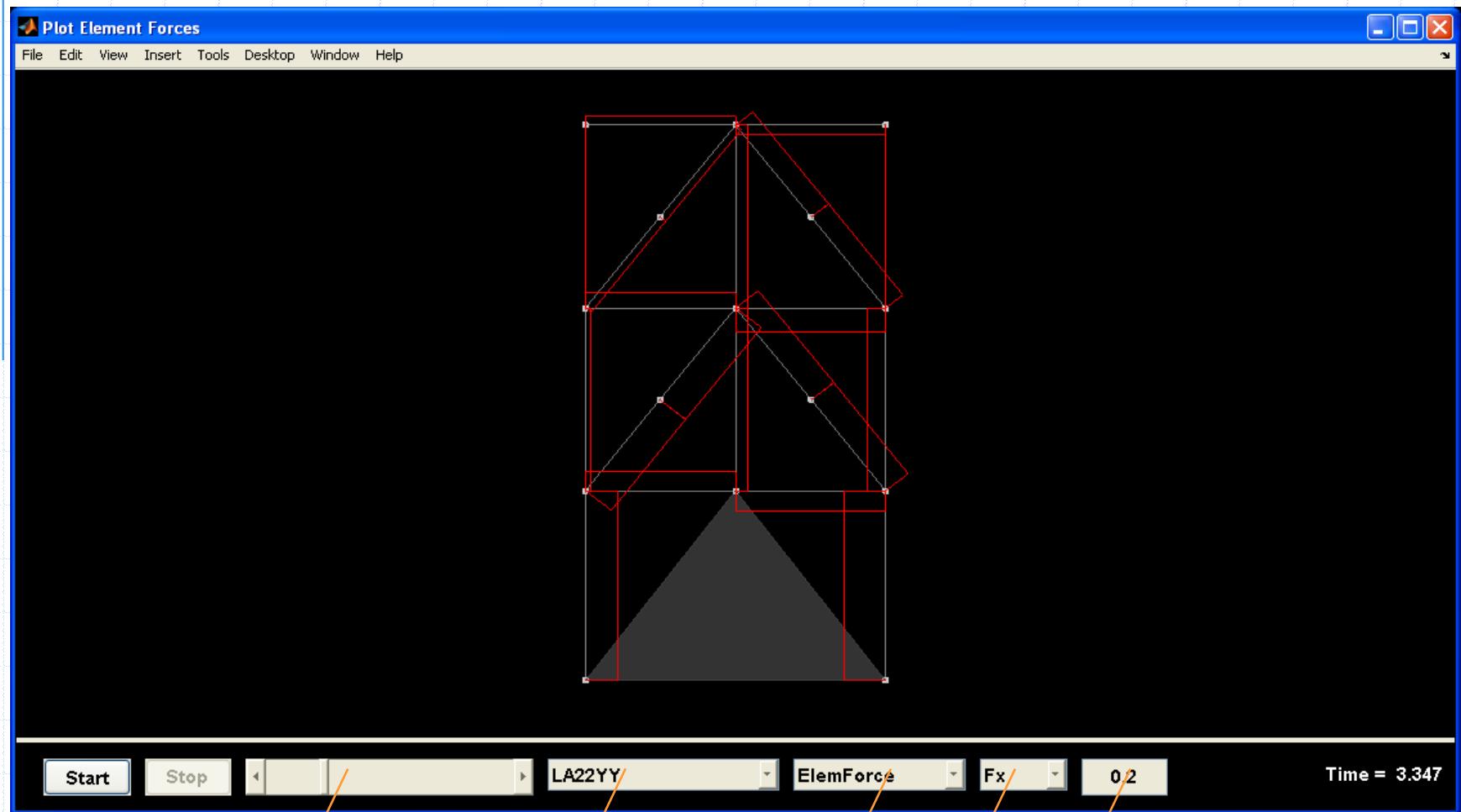
AnalysisCase

Recorder

Order

Magnification

# Post processing: plot element forces



Start

Stop



LA22YY

ElemForce

Fx

0.2

Time = 3.347

Time Step

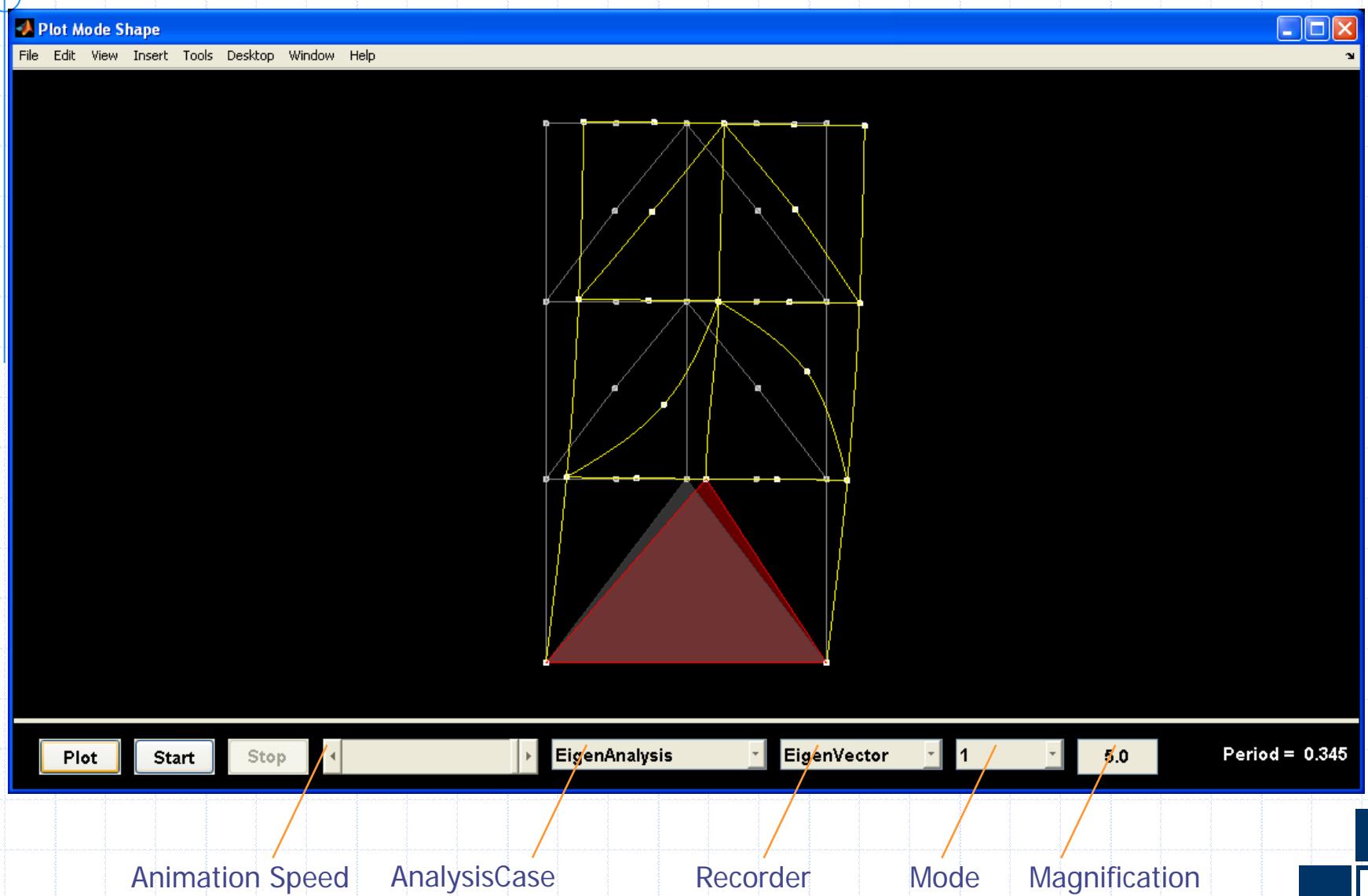
AnalysisCase

Recorder

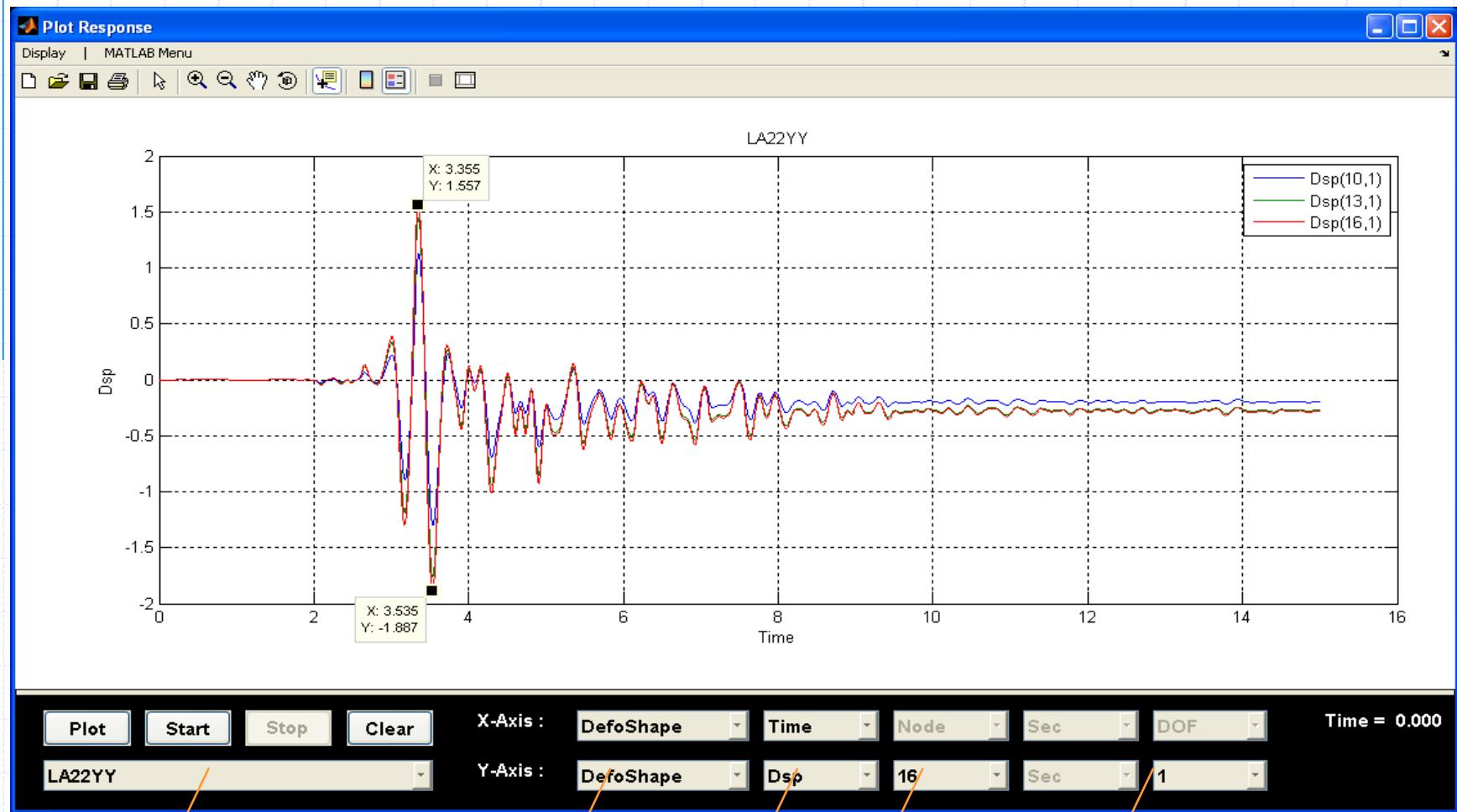
Response

Magnification

# Post processing: plot mode shape



# Post processing: plot response histories



AnalysisCase

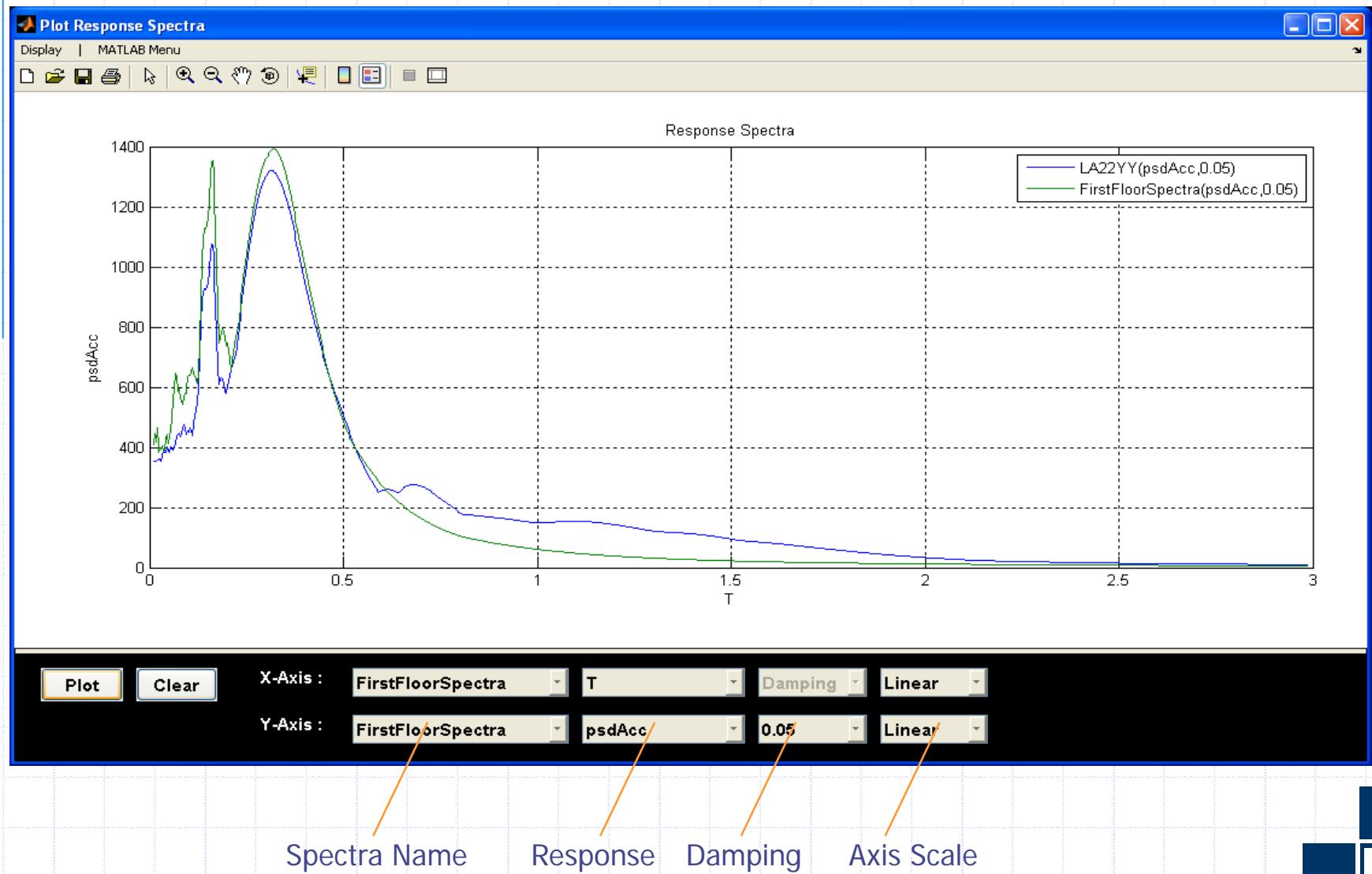
Recorder

Parameter

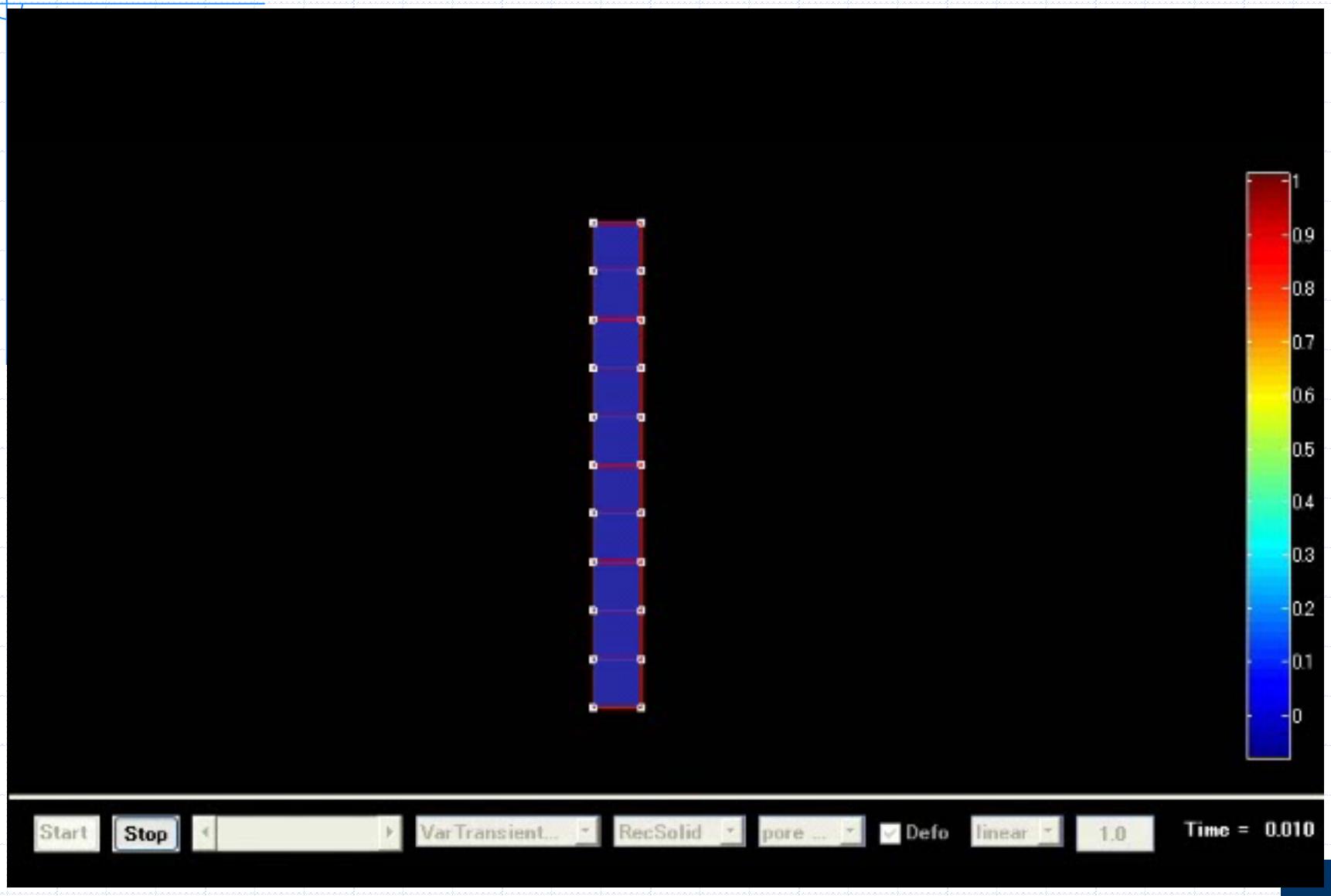
Node/Element

DOF

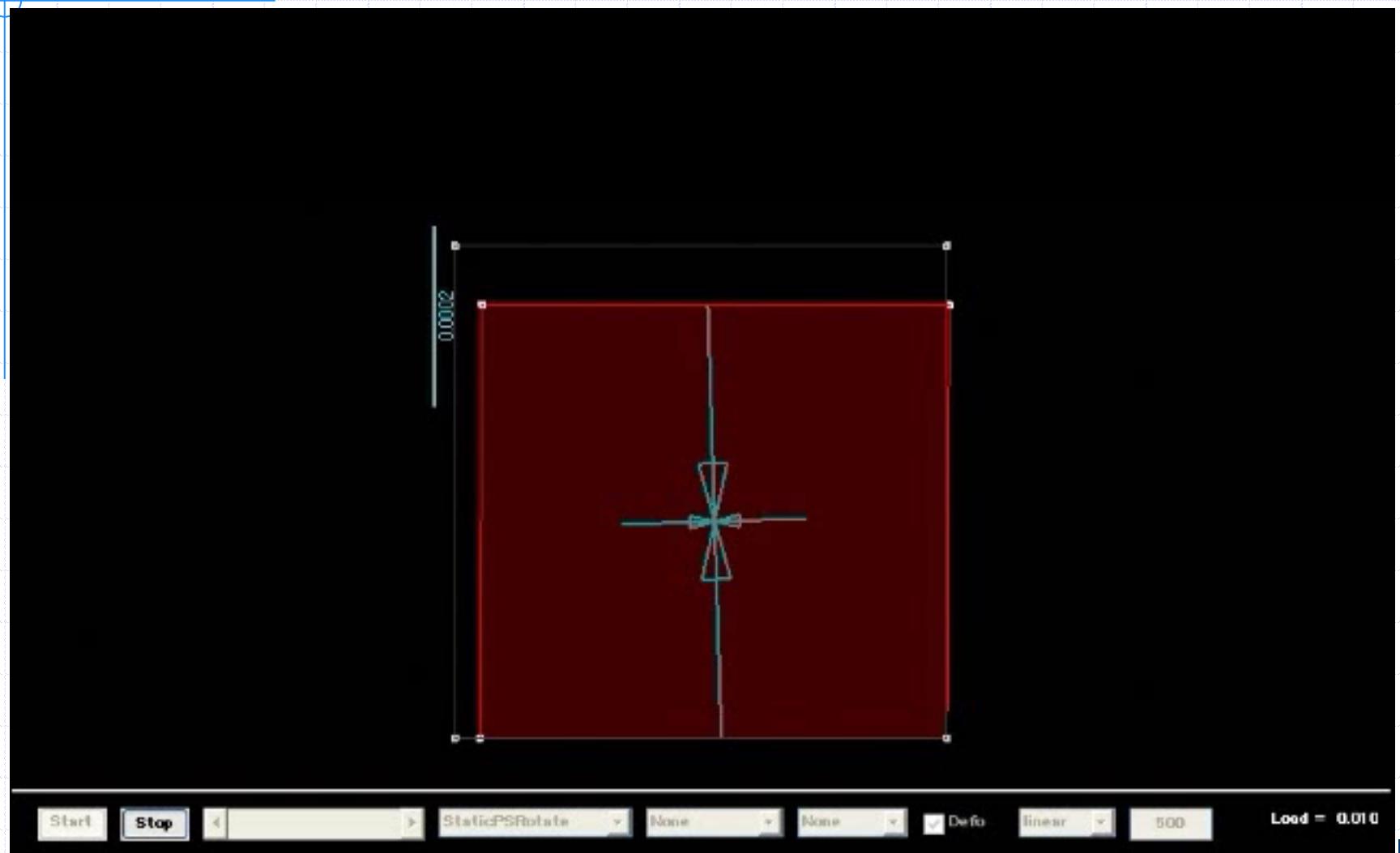
# Post processing: plot response spectra



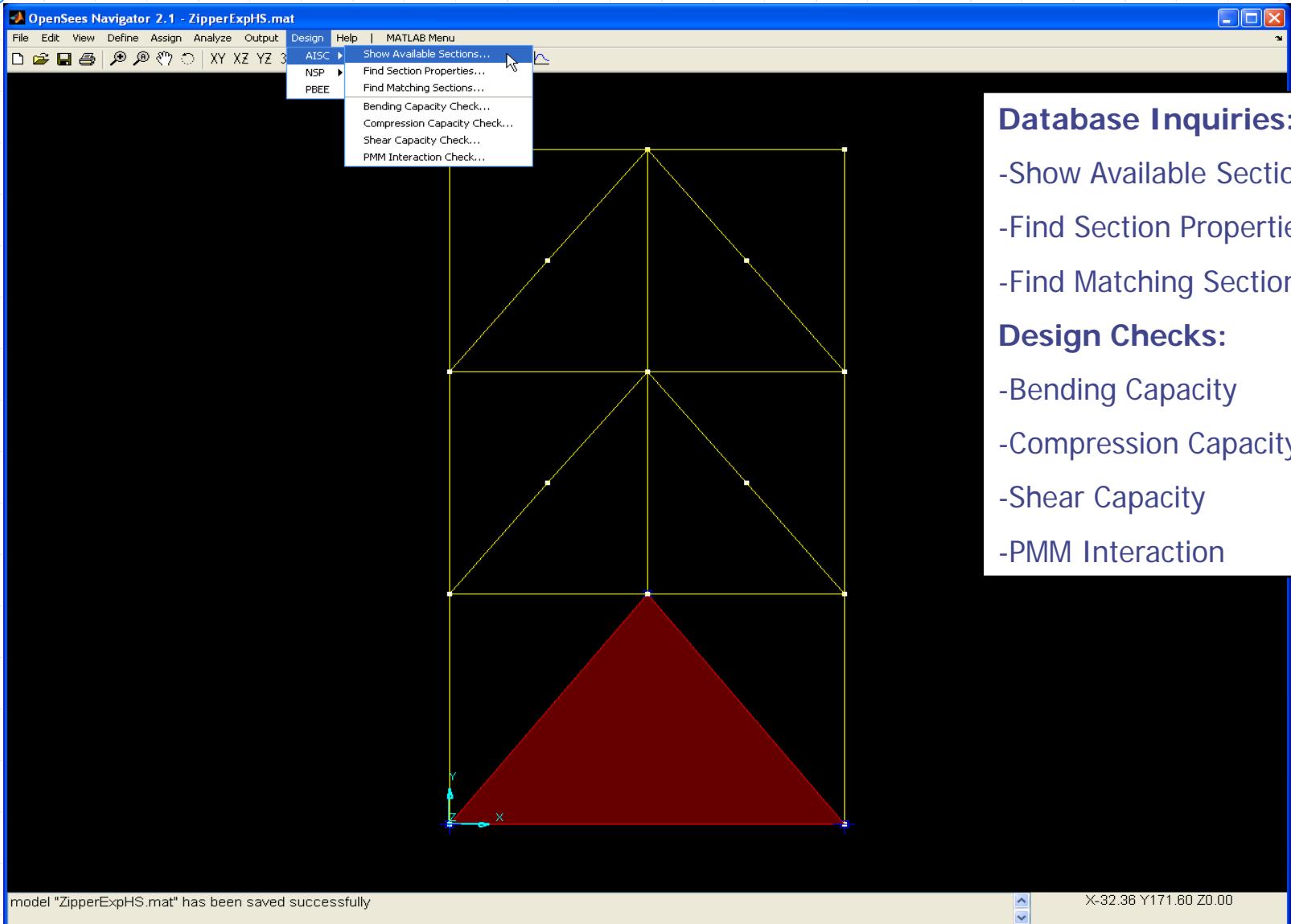
# Post processing: animate response



# Post processing: principal $\sigma$ and $\varepsilon$



# Design: AISC design toolbox



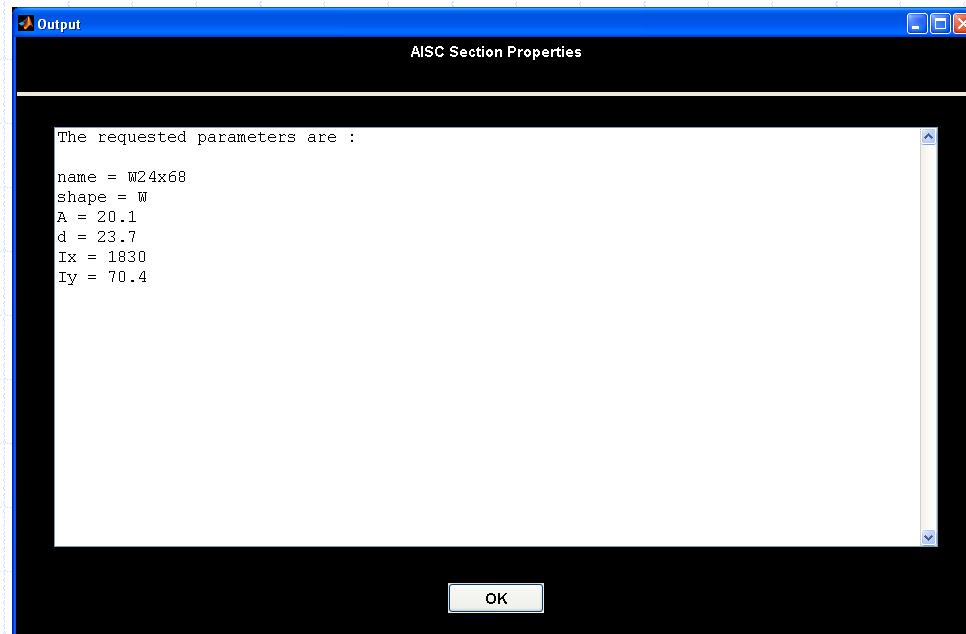
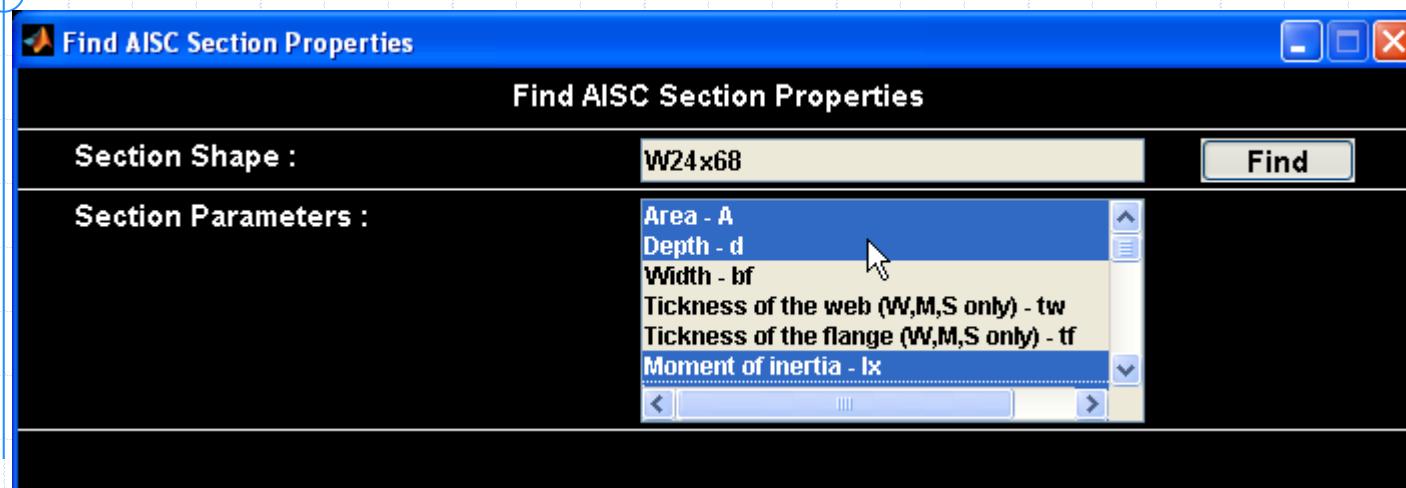
## Database Inquiries:

- 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

**Find Matching AISC Sections**

Find Matching AISC Sections

Select Section Shape : W/S/M Find

Add Parameter : Depth - d Min : 0 Max : 8 Add

Modify Parameter : Area - A Min : 2 Max : 6 Modify

Delete Parameter : Area - A Delete

Sort by Parameter : Area - A

**Output**

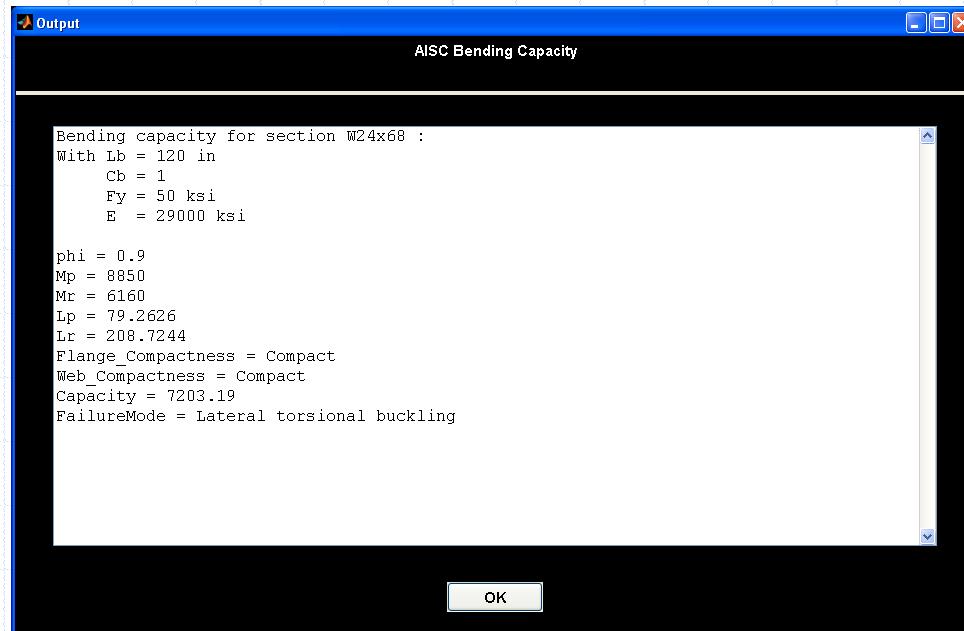
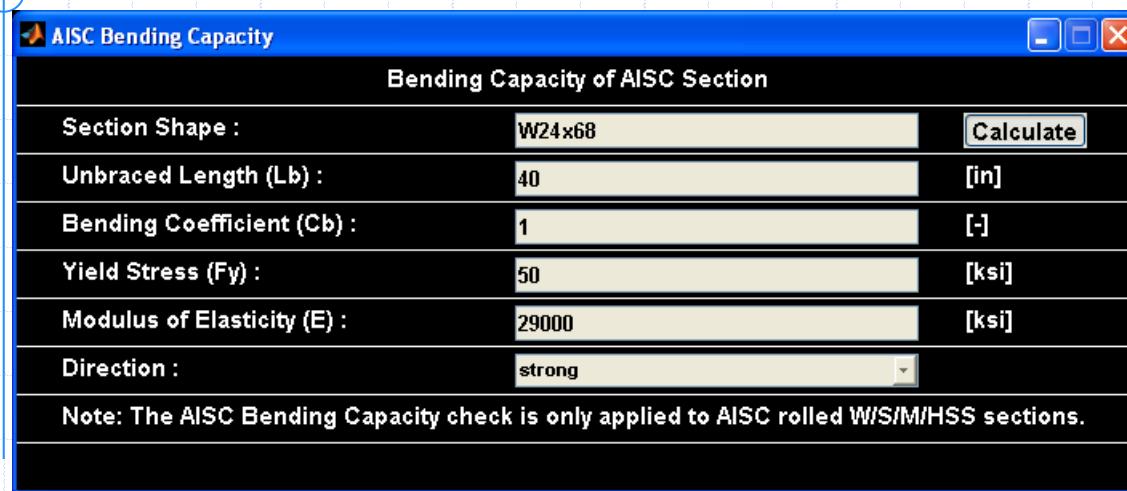
Matching AISC Sections

There are a total of "19" sections available:

- S3X7.5
- S4X7.7
- W6X8.5
- W6X9
- S4X9.5
- S5X10
- W8X10
- W6X12
- S6X12.5
- W4X13
- W8X13
- W6X15
- W5X16
- W6X16
- S6X17.25
- S8X18.4
- M5X18.9
- W5X19
- W6X20

OK

# AISC design toolbox: bending capacity



# AISC design toolbox: compression cap.

**AISC Compression Capacity**

**Compression Capacity of AISC Section**

Section Shape :	W14x68	Calculate
Effective Length (kLx) :	144	[in]
Effective Length (kLy) :	144	[in]
Yield Stress (Fy) :	50	[ksi]
Modulus of Elasticity (E) :	29000	[ksi]

Note: The AISC Compression Capacity check only applied to AISC rolled W/S/M/HSS sections.

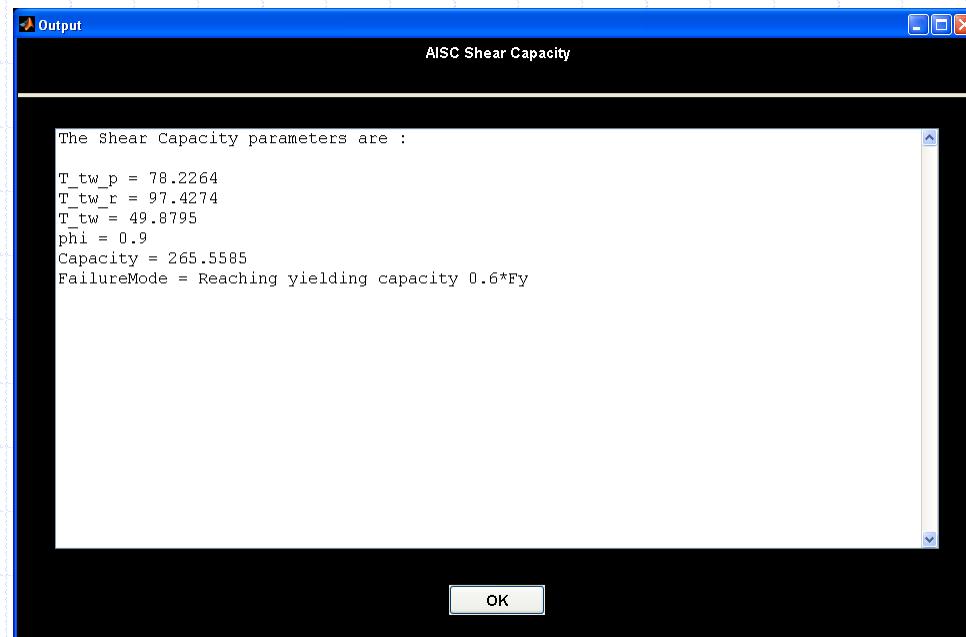
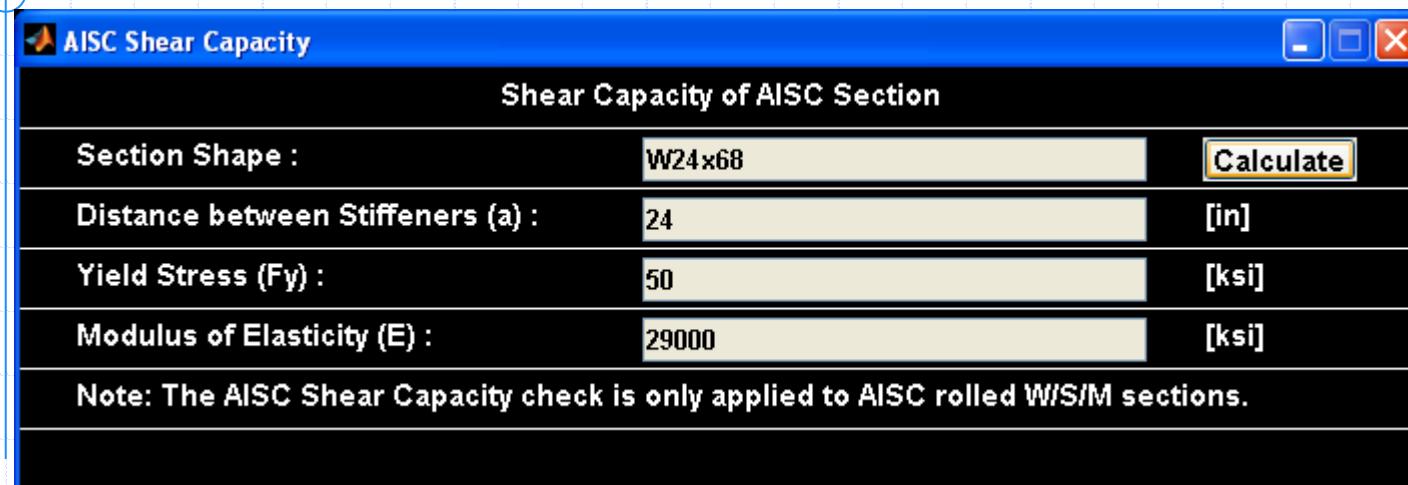
**Output**

**AISC Compression Capacity**

```
Compression capacity for section W14x68 :  
With kLx = 144 in  
    kLy = 144 in  
    Fy = 50 ksi  
    E = 29000 ksi  
  
Section_Slenderness = None Slender  
phi = 0.85  
FailureMode = Inelastic buckling (Qs(flange) = 1, Qs(web) = 1)  
Capacity = 661.6242
```

OK

# AISC design toolbox: shear capacity



# AISC design toolbox: PMM interaction

**AISC PMM Interaction Check**

**PMM Interaction Check of AISC Section**

<b>Section Shape :</b>	<input type="text" value="W24x68"/>	<b>Calculate</b>
<b>Yield Stress (Fy) :</b>	<input type="text" value="50"/>	[ksi]
<b>Modulus of Elasticity (E) :</b>	<input type="text" value="29000"/>	[ksi]
<b>Demand :</b>		
<b>Applied Axial Force (Pu) :</b>	<input type="text"/>	[kips]
<b>Applied Moment about X axis (Mux) :</b>	<input type="text"/>	[kips - in]
<b>Applied Moment about Y axis (Muy) :</b>	<input type="text"/>	[kips - in]
<b>Compression :</b>		
<b>Effective Length (kLx) :</b>	<input type="text"/>	[in]
<b>Effective Length (kLy) :</b>	<input type="text"/>	[in]
<b>Bending :</b>		
<b>Unbraced Length (Lb) :</b>	<input type="text"/>	[in]
<b>Bending Coefficient (Cb) :</b>	<input type="text" value="1"/>	[ $\cdot$ ]
<b>Note:</b> The AISC P-M interaction check is only applied to AISC rolled W/S/M/HSS sections.		

# 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 and self-executable versions are available.

# Website: home

**OPENSEES NAVIGATOR**

**HOME**   **INTRODUCTION**   **MANUALS**   **TUTORIALS**   **PRESENTATIONS**   **DISCUSSION**   **UPDATES**   **DOWNLOADS**   **LINKS**

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Manuals  
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Presentations  
Discussion  
Updates  
**Downloads**   
Links

Dear OpenSees Navigator users,

Thanks for your interest in OpenSees Navigator. This program is intended to be self-explanatory, nevertheless a basic user manual will be added to the website shortly. We are very happy to have the opportunity to distribute this software for OpenSees Navigator users. We encourage everyone to try out all of the functions of the program and send us criticism, corrections or suggestions to improve future versions. We also encourage users to e-mail us at either [andreas.schellenberg@gmail.com](mailto:andreas.schellenberg@gmail.com) or [yangtony2004@gmail.com](mailto:yangtony2004@gmail.com) so that we can add the e-mail addresses to the OpenSees Navigator user list. We will use such list to contact everyone about new releases or major updates. We will try our best to improve the next release.

Thank you.

Please feel free to visit our websites to discover in what other fun research we are involved:

Andreas Schellenberg & [Tony Yang](#)

Hit Counter   OpenSees Navigator ©2004-2006 UC Berkeley. All rights reserved. Please [contact us](#) with any questions or comments.

# Website: download

The screenshot shows the OpenSees Navigator website's 'Downloads' page for Stand-Alone Windows. The top navigation bar includes links for Home, Introduction, Manuals, Tutorials, Presentations, Discussion, Updates, Downloads, and Links. Below the navigation is a breadcrumb trail: Home > Downloads > Stand-Alone Windows. A search bar is also present. On the left, a sidebar lists two files: MCRInstaller.exe and OpenSeesNavigator.zip. The main content area contains the following text:

**Installation Instructions:**

1. Download the two files on the left.
2. Install the Matlab component runtime libraries by executing MCRInstaller.exe and following the on screen instructions (this has only to be done once).
3. Extract OpenSeesNavigator.zip in any folder of your choice and then execute OpenSeesNavigator.exe.
4. If you like you can create a shortcut to OpenSeesNavigator.exe on your Desktop.

At the bottom of the page, there is a hit counter link and a copyright notice: OpenSees Navigator ©2004-2006 UC Berkeley. All rights reserved. Please [contact us](#) with any questions or comments.

# Thank you!

OpenSees Navigator 2.4.2 is available at  
<http://peer.berkeley.edu/OpenSeesNavigator>

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Dr. Tony Yang: [yangtony2004@gmail.com](mailto:yangtony2004@gmail.com)



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The George E. Brown, Jr. Network for Earthquake Engineering Simulation

