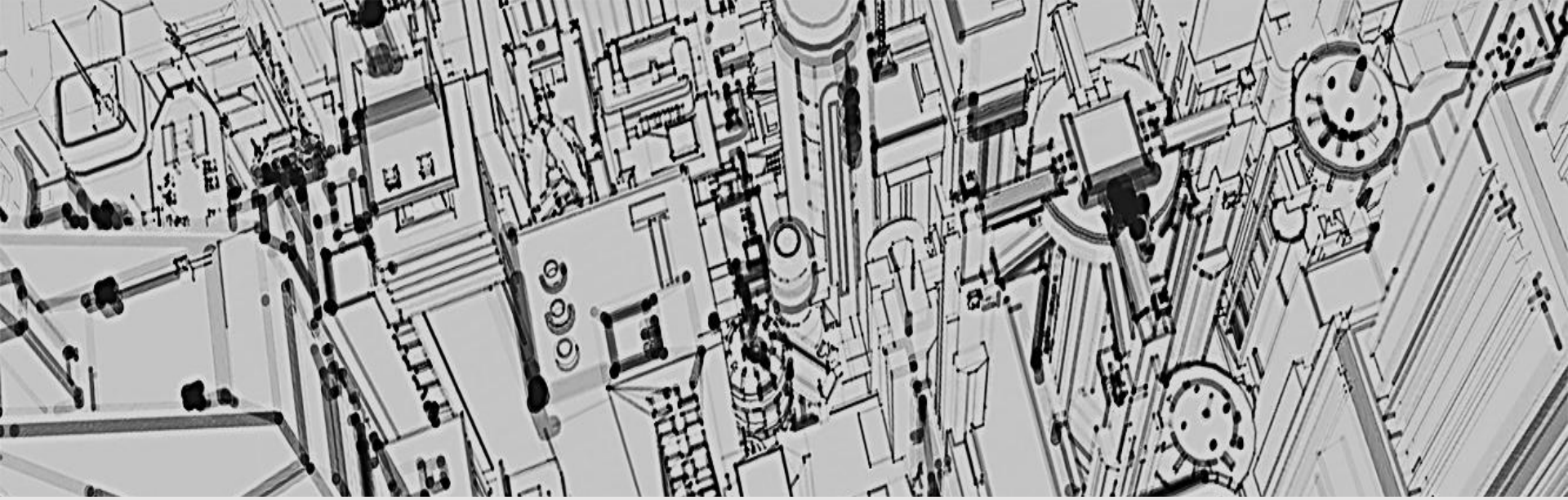
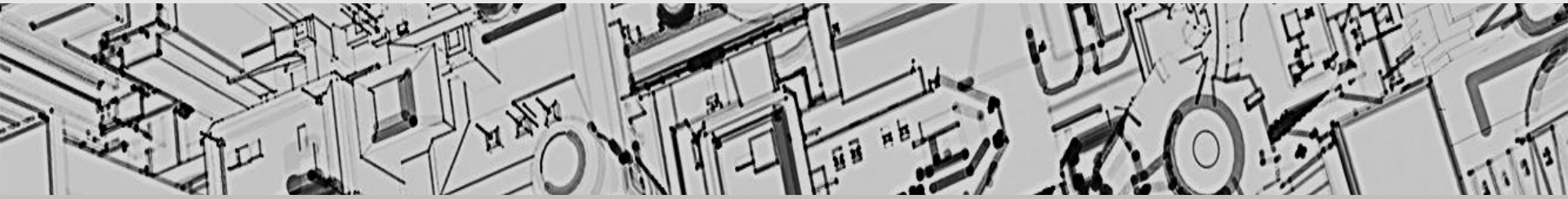


BuildingTcl

Real-Time Graphical & Scripting User Interface for OpenSees

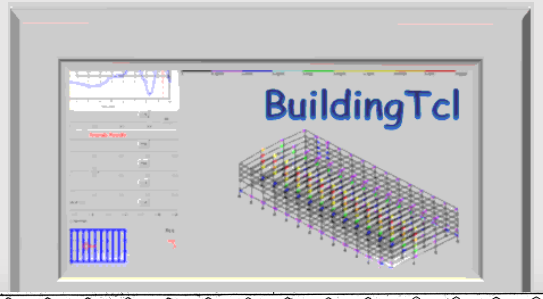
Silvia Mazzoni, PhD

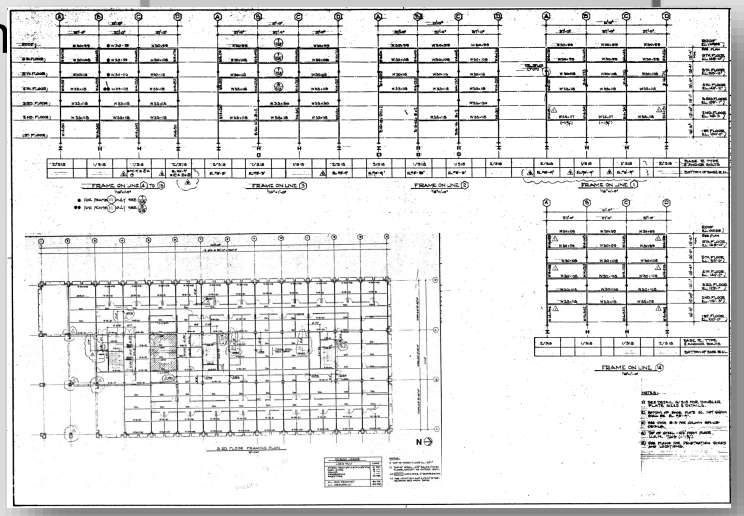
Earthquake and Structural Engineering Consultant



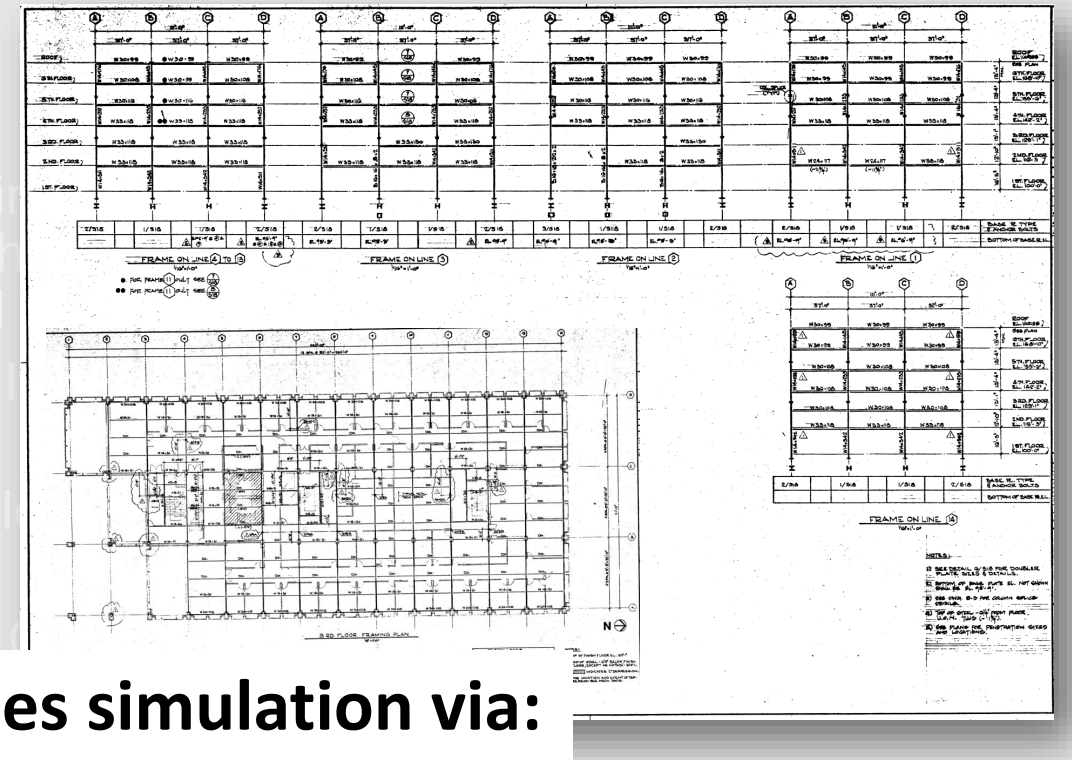
BuildingTcl: a Real-Time Scripting and Graphical User Interface for OpenSees

- Objectives:
  - Generate numerical-simulation input in a manner consistent with architectural/structural drawings
  - Interchangeable User Interface: scriptin and graphical
  - Programmable input file via Tcl script commands
  - Direct integration with OpenSees – run OpenSees real-time
  - Create a database of all structure and simulation data
  - Maintain flexibility and power of OpenSees while keeping it simple
  - Be able to run on a number of platforms, just as OpenSees can





BuildingTcl



Interactive OpenSees simulation via:

- **Scripting Interface**
- **Graphical User Interface**

Interchangeable

OpenSees File

Features

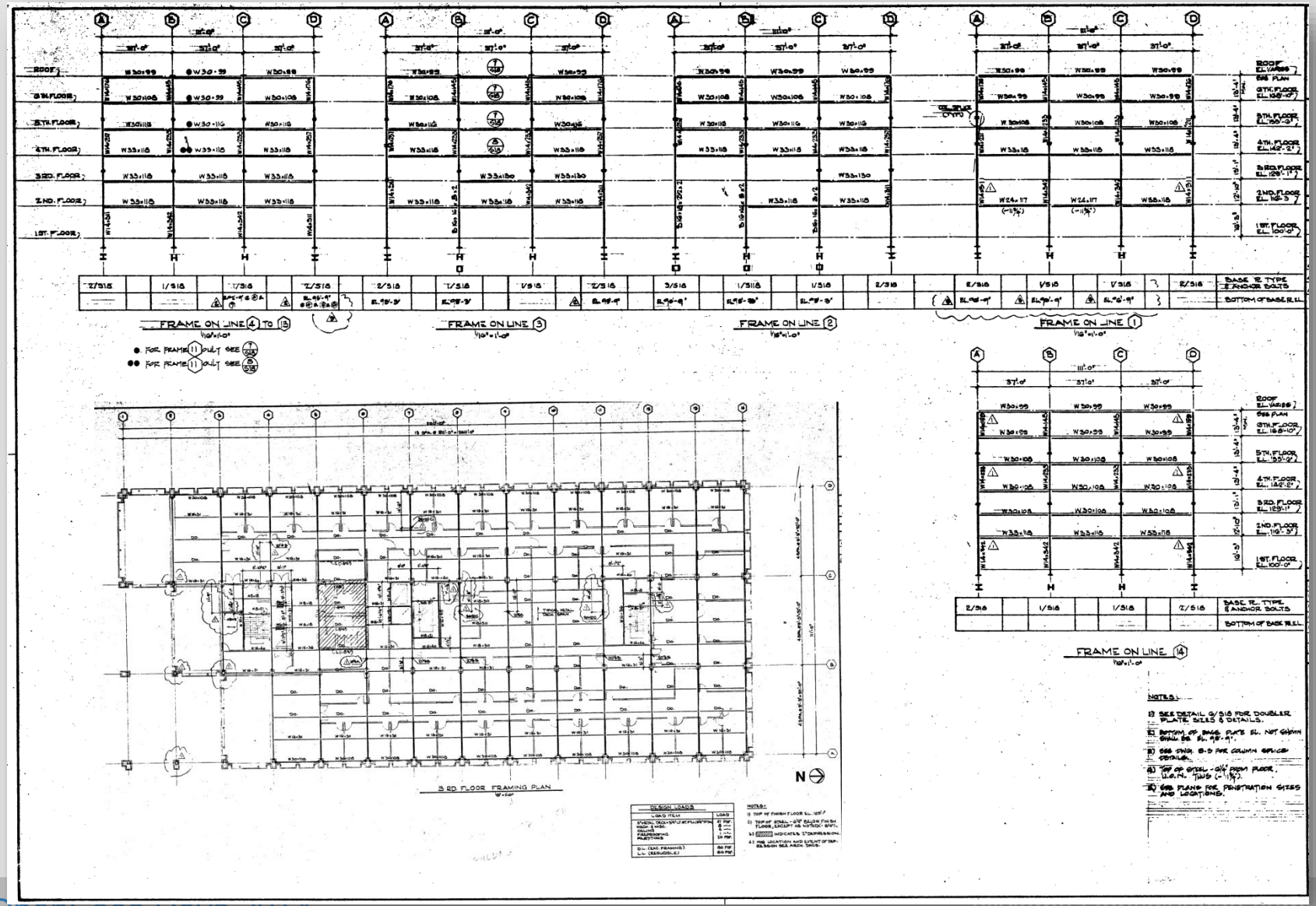
BuildingTcl:

- High-level scripting tool
- Generate building-model data
  - Materials
  - Sections
  - Element Types
  - Analysis Models
  - Loads (Gravity & Lateral)
  - Load Combinations
  - Models
    - Elevations
    - Grids
    - 3D Frames
- Generate analysis-model data
- Generate loading and load-combination data
- Generate OpenSees model of building
- Perform OpenSees numerical simulations
- Post-Process OpenSees recorder output into formatted data
- Generate OpenSees input files

Viewer:

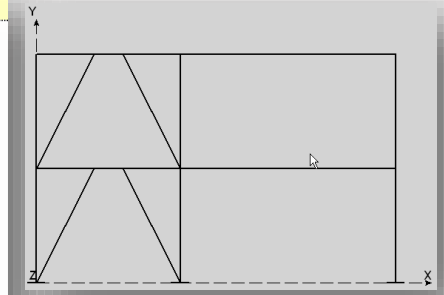
- Graphical User Interface (GUI) for BuildingTcl
- generate and/or visualize ALL BuildingTcl input graphically
- Save ALL input into BuildingTcl script
- Perform numerical simulations using OpenSees interactively
- Visualize OpenSees simulation real-time
- Visualize simulation results interactively
- Export simulation results

Drawings: Elevations & Plans



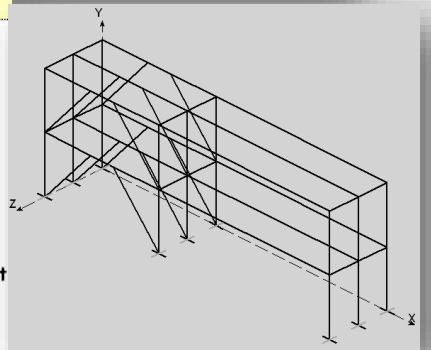
Model Input

```
# Elevation
addModelData ModelLabel RCTestFrame2Story2BayBbraced
addModelData ModelDescription "RC MRF, 2-Story, 2-Bay"
addModelData ModelTypeLabel Elevation
addModelData -Geometry Height 16*\$ft StoryRange "1 2"
addModelData -Geometry Width 20*\$ft Bay 1
addModelData -Geometry Width 30*\$ft Bay 2
addModelData -Columns  SectionLabel 30x30RCRectangularFiber ColumnLineRange "1 3" StoryRange "1 2" Orient Rotated
addModelData -Beams  SectionLabel 30x60RCRectangularFiber BayRange "1 2" FloorRange "2 3"
addModelData -ChevronBraces SectionLabel W12x16 BayRange "1 1" Story "1 2"  Eccentricity 4.*\$ft
addModelData SupportBC fix
addModelData OutOfPlaneSupportBC pin
addModelData RigidFloor Off
addModelData JointOffsetsSwitch on
addModelData TributaryWidth 5.*\$ft
addModelData -GravityLoad LoadLabel DL1  FloorRange "2 3" DistributedLoad 100.*\$psf
addModelData -GravityLoad LoadLabel LL1  FloorRange "2 3" DistributedLoad 74.*\$psf
addModel
```



```
# Plan
addModelData ModelLabel 2x2Floor
addModelData ModelDescription "1-Bay by 1-Bay Floor Plan"
addModelData ModelTypeLabel Plan
addModelData iVerticalGridLineLabel "0.0 10.0 25.0"
addModelData iHorizontalGridLineLabel "A B C"
addModelData -HorizontalBayWidth Bay 1 Width 20*\$ft
addModelData -HorizontalBayWidth Bay 2 Width 30*\$ft
addModelData -VerticalBayWidth BayRange "1 2" Width 5*\$ft
addModel
```

```
# 3D Frame
addModelData ModelLabel 3DBuildingFrameRC
addModelData ModelDescription "Let's try It"
addModelData ModelTypeLabel 3DFrame
addModelData PlanModelLabel 2x2Floor
addModelData RigidFloor Off
addModelData -addElevation ElevationModelLabel RCTestFrame2Story2BayA iGridLineLabel "0.0"
addModelData -addElevation ElevationModelLabel RCTestFrame2Story2BayA iGridLineLabel "10.0" TributaryWidth 12.5*\$ft
addModelData -addElevation ElevationModelLabel RCTestFrame2Story2BayA iGridLineLabel "25.0"  TributaryWidth 7.5*\$ft
addModelData -addElevation ElevationModelLabel RCTestFrame2Story2BayBbraced iGridLineLabel "A C" TributaryWidth 2.5*\$ft
addModelData -addElevation ElevationModelLabel RCTestFrame2Story2BayBbraced iGridLineLabel "B" TributaryWidth 5.*\$ft
addModel
```



Material, Section & Element Type

```
# MATERIALS ----------------------------------
# Core Concrete (Default confinement effects)
addMaterialData MaterialLabel 4ksiConfinedConcrete
addMaterialData MaterialModelLabel ConfinedConcrete;
addMaterialData Fc 4000.*$psi;
addMaterial
```

```
# ELEMENT SECTION ----------------------------------
addSectionData SectionLabel 30x30RCRectFiber
addSectionData SectionDescription "Square Rectangular RC Section"
addSectionData SectionModelLabel RCRectFiber;
addSectionData H 30*$in;
addSectionData B 30*$in;
SectionData NBarBot 6;              # number of bottom longitud
SectionData NBarTop 6;              # number of top longitudinal
SectionData NBarInt 6;              # total number of intermedic
SectionData BarSizeBot #9;
SectionData BarSizeTop #9;
SectionData BarSizeInt #9;
addSectionData CoverBot 2.6*$in;
addSectionData CoverTop 2.6*$in;
addSectionData CoverInt 2.6*$in;
addSectionData CoreMaterialLabel 4ksiConfinedConcrete;
addSectionData CoverMaterialLabel 4ksiUnconfinedConcrete;
addSectionData ReinforcementMaterialLabel 60ksiReinforcingSteel;
addSection
```

```
# RC Column ElementType
addElementTypeData ElementTypeLabel RCColumn;
addElementTypeData ElementModelLabel beamWithHinges;
addElementTypeData PlasticHingeLengthModelLabel Priestley96
addElementTypeData TransformationType Linear
addElementType ;     # ----------------------------------------
```

Analysis Models

```
# Gravity Analyses
addAnalysisModelData AnalysisModelLabel GravityAnalysis;
addAnalysisModelData AnalysisTypeLabel LoadControl;
addAnalysisModelData Tolerance 1e-8;
addAnalysisModelData Nstep 12;
addAnalysisModel;
```

```
# Pushover Analyses
addAnalysisModelData AnalysisModelLabel PushoverAnalysisVerySmallSteps
addAnalysisModelData AnalysisTypeLabel DisplacementHistory
addAnalysisModelData DisplacementIncrement 0.01*\$in
addAnalysisModel                                    # --------------------------

addAnalysisModelData AnalysisModelLabel PushoverAnalysisSmallSteps
addAnalysisModelData AnalysisTypeLabel DisplacementHistory
addAnalysisModelData DisplacementIncrement 0.1*\$in
addAnalysisModel                                    # --------------------------
```

```
# Dynamic Analyses
addAnalysisModelData AnalysisModelLabel ShortDynamicTimeHistoryAnalysis;
addAnalysisModelData AnalysisTypeLabel TimeHistory
addAnalysisModelData Tolerance 1e-6;
addAnalysisModelData DtAnalysis 0.1*\$sec
addAnalysisModelData TmaxAnalysis 10*\$sec
addAnalysisModel;                                   # ----------
```

Lateral Loads

```
addLoadData LoadLabel StaticPushover;        # STATIC PUSHOVER
addLoadData LoadTypeLabel LateralPushover;       # options: LateralPushover, UniformEQ, UniformSine
addLoadData DMax 1.*\$in;                      # maximum displacement
addLoadData ControlNodeFloor top;
addLoad
```

```
addLoadData LoadLabel StaticCyclic;          # STATIC REVERSED CYCLIC LOADING
addLoadData LoadTypeLabel LateralPushover;
addLoadData CycleType Full;                  # full cycles. Options: Push, Full, Half
addLoadData DMax "0.005 0.01 0.05 0.075 0.1"; # List of peaks, set as a factor of
addLoadData DMaxFactor BuildingHeight;       # building height
addLoadData ControlNodeFloor top;
addLoad
```

```
addLoadData LoadLabel EQ1;                   # EQ TIME-HISTORY
addLoadData LoadTypeLabel UniformEQ;
addLoadData GMfactor \$g;                      # ground-motion input-u
addLoadData GMdirectory "GMfiles";           # directory where ground
addLoadData FileType "PEER";                 # ground-motion file type
addLoadData GMfilename "H-E12140.at2";       # ground-motion filename
addLoadData GMdirection X;                   # lateral dof for ground m
addLoadData GMfactor 1.;                     # scaling of ground motion
addLoad
```

```
addLoadData LoadLabel EQ1Bidirect;       # EQ TI
addLoadData LoadTypeLabel UniformEQ2D;
addLoadData GMfactor \$g;                  # gro
addLoadData GMdirectory "GMfiles";       # direct
addLoadData FileType "PEER";             # groun
addLoadData GMfilenameX H-E01140.at2;      # ground-motion filename for input
addLoadData GMfilenameZ H-E01140.at2;      # ground-motion filename for input
addLoadData GMfactorX -15;               # scaling of ground motion for input
addLoadData GMfactorZ 10;              # scaling of ground motion for input
addLoad
```

NOTE: Gravity Loads are defined within the model

Pushover LoadCombinations

```
# STATIC PUSHOVER LOAD COMBINATIONS ------------------------------------
addLoadCombinationData LoadCombinationLabel ReallyShortStaticPushover
addLoadCombinationData LoadCombinationDescription "This is my favorite one!!!"
addLoadCombinationData -GravityLoad LoadLabel DL1
addLoadCombinationData -GravityLoad LoadLabel DL2
addLoadCombinationData -LateralLoad LoadLabel StaticPushover DMax 0.02*\$in
addLoadCombination
```

```
addLoadCombinationData LoadCombinationLabel InterestingStaticPushover
addLoadCombinationData LoadCombinationDescription "This is my favorite one!!!"
addLoadCombinationData -GravityLoad LoadLabel DL1
addLoadCombinationData -GravityLoad LoadLabel DL2
addLoadCombinationData -LateralLoad LoadLabel StaticPushover DMax 0.1*\$in DMaxFactor 1.
addLoadCombinationData -LateralLoad LoadLabel StaticPushover DMax 1.9*\$in DMaxFactor 1. \
                                    DisplacementIncrement 0.25
addLoadCombinationData -LateralLoad LoadLabel StaticPushover DMax 10*\$in DMaxFactor 1. \
                                    DisplacementIncrement 0.5
addLoadCombination
```

```
addLoadCombinationData LoadCombinationLabel PushToTenPercentDriftZ
addLoadCombinationData LoadCombinationDescription "This is my favorite one!!!"
addLoadCombinationData -GravityLoad LoadLabel DL1
addLoadCombinationData -GravityLoad LoadLabel DL2
addLoadCombinationData -GravityLoad AnalysisModelLabel GravityAnalysis
addLoadCombinationData -LateralLoad LoadLabel StaticPushover AnalysisModelLabel PushoverAnalysisLargeSteps\
                                    LateralDirection Z DMax 0.1 DMaxFactor BuildingHeight
addLoadCombination
```

EQ Load Combinations

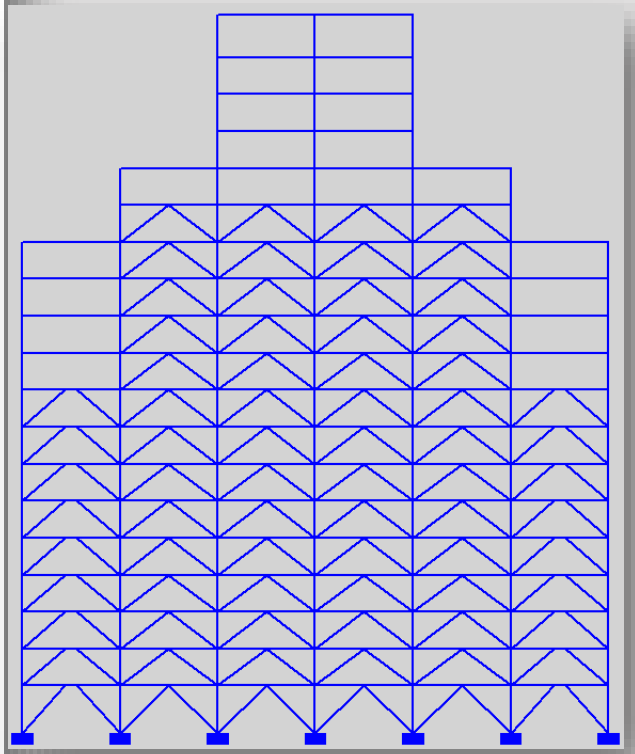
```
# DYNAMIC LOAD COMBINATIONS ----------
addLoadCombinationData LoadCombinationLabel DesignEQ1
addLoadCombinationData -GravityLoad LoadLabel DL1 LoadFactor 0.9
addLoadCombinationData -GravityLoad LoadLabel DL2 LoadFactor 0.9
addLoadCombinationData -LateralLoad LoadLabel EQ1
addLoadCombination
```

```
addLoadCombinationData LoadCombinationLabel MaxEQ1shorter
addLoadCombinationData -GravityLoad LoadLabel DL1 LoadFactor 1.
addLoadCombinationData -LateralLoad LoadLabel EQ1 AnalysisModelLabel ShortDynamicTimeHistoryAnalysis LoadFactor 3
addLoadCombination
```

```
addLoadCombinationData LoadCombinationLabel MaxEQ2bidirect10sec
addLoadCombinationData -GravityLoad LoadLabel DL1 LoadFactor 0.9
addLoadCombinationData -LateralLoad LoadLabel EQ2 GMfilenameX H-E01140.at2 GMfilenameZ H-E12140.at2 \
                       TmaxAnalysis 10.*\$sec
addLoadCombination
```

Interesting Example

```
addModelData ModelLabel "SMRFsetbacks"
addModelData ModelDescription "SMRF Elevation at Grid Line A and D with Setbacks"
addModelData ModelPlaneType Elevation
addModelData -GridLines GridLine "A" GridColumnLines "3.5 4.5 5.5 6.5 7.5 8.5 9.5"
addModelData -GridLines GridLine "D" GridColumnLines "9.5 8.5 7.5 6.5 5.5 4.5 3.5"
addModelData -Geometry Height 18*\$ft Story "1"
addModelData -Geometry Height 14*\$ft StoryRange "2 18"
addModelData -Geometry Height 16*\$ft Story "19"
addModelData -Geometry Width 40*\$ft BayRange "1 6"
addModelData -Columns SectionLabel W24x370 ColumnLine "1 7" Story "1"
addModelData -Columns SectionLabel W24x335 ColumnLine "1 7" StoryRange "2 13"
addModelData -Columns SectionLabel W24x279 ColumnLine "2 6" Story "1"
addModelData -Columns SectionLabel W24x250 ColumnLine "2 6" StoryRange "2 15"
addModelData -Columns SectionLabel W24x279 ColumnLineRange "3 5" Story "1"
addModelData -Columns SectionLabel W24x250 ColumnLineRange "3 5" StoryRange "2 18"
addModelData -Columns SectionLabel W24x192 ColumnLineRange "3 5" Story "19"
addModelData -Beams SectionLabel "W30x124 W30x173 W30x173 W30x173 W30x173 W30x108" FloorRange "2 4"
addModelData -Beams SectionLabel "W30x124 W30x173 W30x173 W30x173 W30x173 W30x124" FloorRange "5 7"
addModelData -Beams SectionLabel "W30x173 W30x173 W30x173 W30x173 W30x173 W30x124" Floor "8 9"
addModelData -Beams SectionLabel W30x132 BayRange "1 6" FloorRange "10 14"
addModelData -Beams SectionLabel W30x132 BayRange "2 5" FloorRange "15 16"
addModelData -Beams SectionLabel W30x148 BayRange "3 4" FloorRange "17 19"
addModelData -Beams SectionLabel W30x148 BayRange "3 4" Floor "20"
addModelData -ChevronBraces SectionLabel "W30x148" Bay "1 6" StoryRange "1 9"   Eccentricity "5.*\$ft"
addModelData -ChevronBraces SectionLabel "W12x14" BayRange "2 5" StoryRange "1 14"
addModelData SupportBC fix
addModelData TributaryWidth 7*\$ft
addModelData -GravityLoad LoadLabel DL1 Floor "2 3" DistributedLoad 74*\$psf
addModelData -GravityLoad LoadLabel DL1 FloorRange "4 19" DistributedLoad 74*\$psf
addModelData -GravityLoad LoadLabel DL1 Floor "20" DistributedLoad 60*\$psf
addModelData -GravityLoad LoadLabel DL2 FloorRange "2 19" DistributedLoad 74*\$psf
addModelData -GravityLoad LoadLabel DL2 Floor "20" DistributedLoad 60*\$psf
addModelData -GravityLoad LoadLabel LL1 FloorRange "2 19" DistributedLoad 74*\$psf
addModelData -GravityLoad LoadLabel LL1 Floor "20" DistributedLoad 60*\$psf
addModel
```



The Viewer

- Provide a graphical user interface for BuildingTcl input
- Provide capability of running OpenSees **real-time**
- Visualization of Input / real-time response / output
- Save GUI-generated input into BuildingTcl script file &/or OpenSees script

New Input-Menu Format

File Input Analysis Results Help Exit

Material Section ElementType Model Load AnalysisModel LoadCombination

New Edit

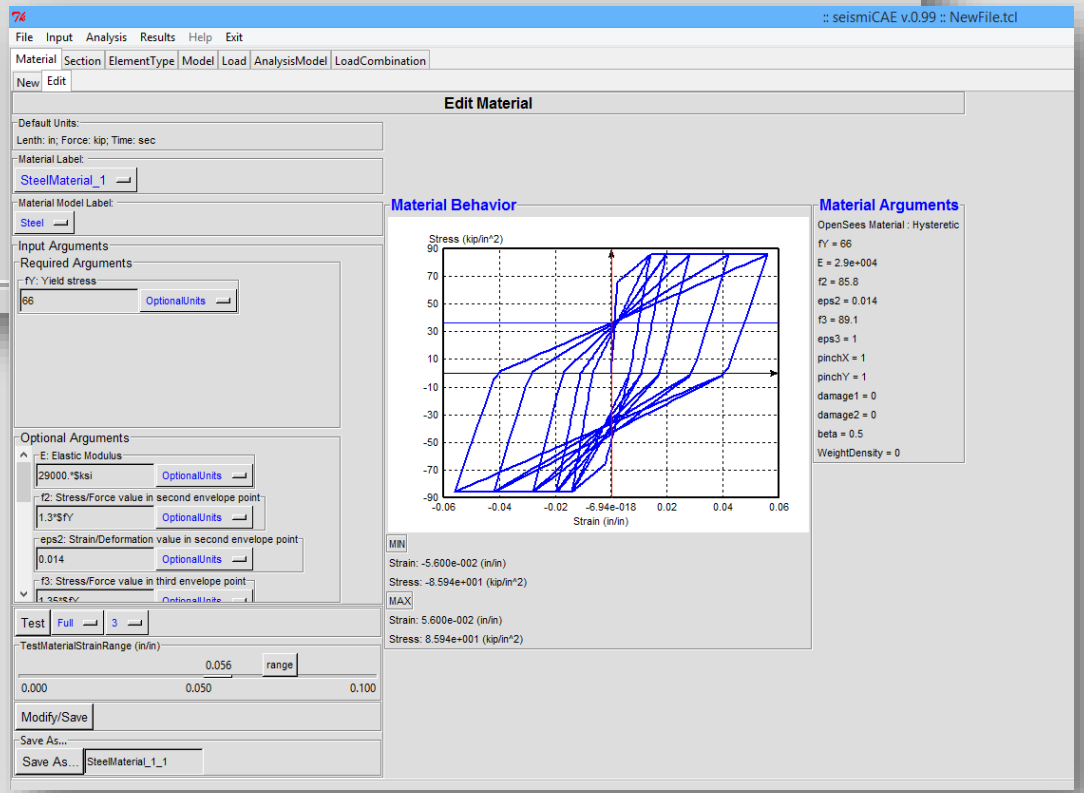
New Material

Default Units:

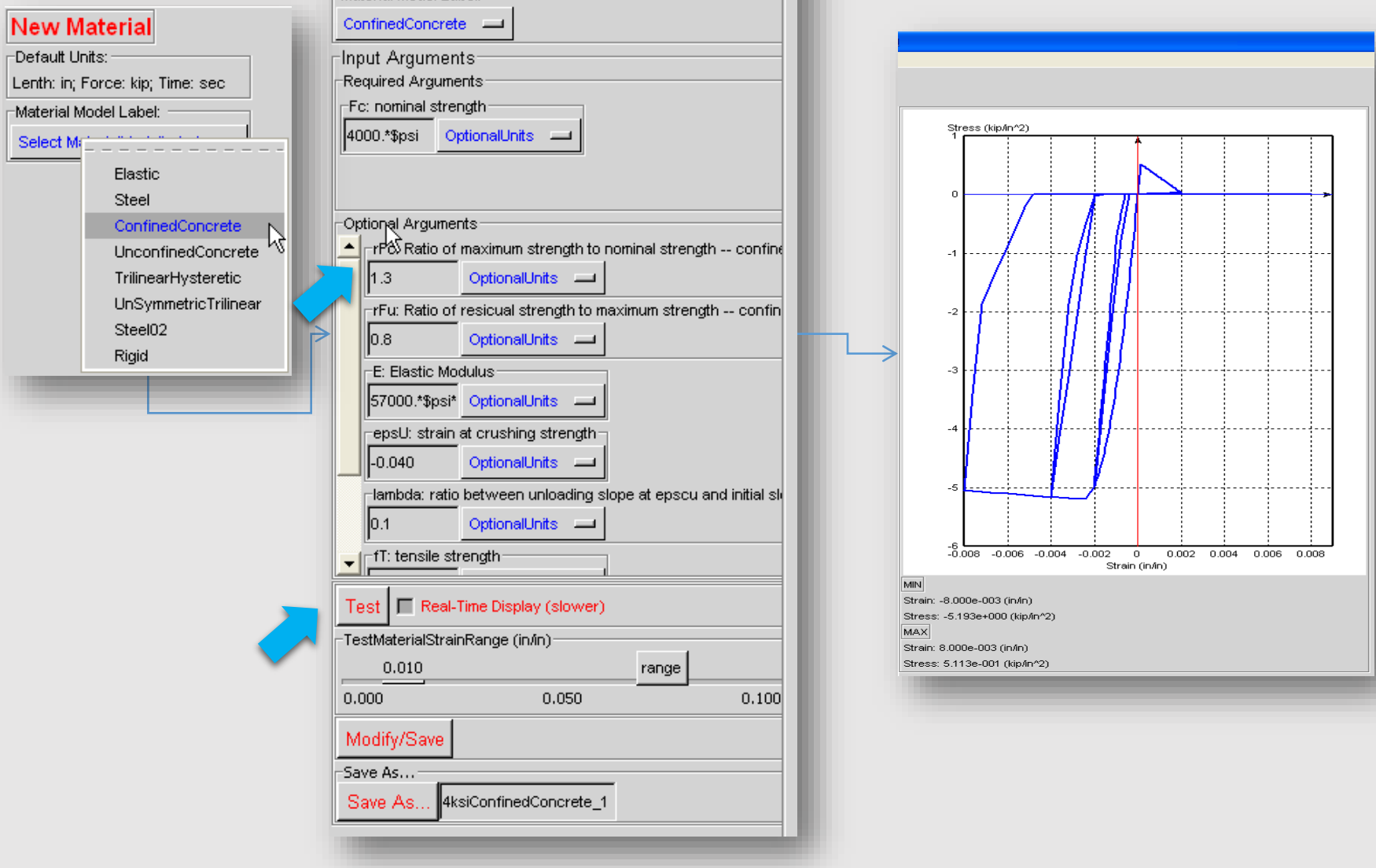
Lenth: in; Force: kip; Time: sec

Material Model Label:

Select MaterialModelLabel

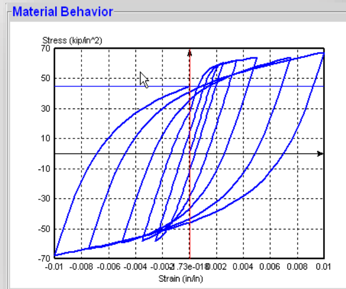


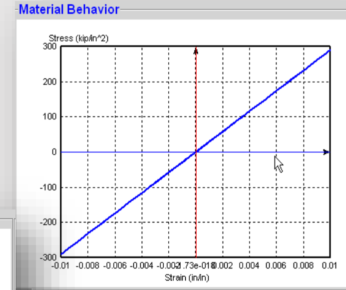
Materials

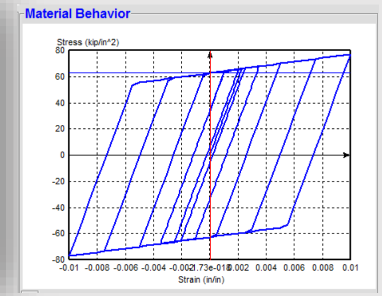

New Material
Default Units:
Lenth: in; Force: kip; Time: sec
Material Model Label:
Select Ma
Elastic
Steel
ConfinedConcrete
UnconfinedConcrete
TrilinearHysteretic
UnSymmetricTrilinear
Steel02
Rigid
Edit Material
Default Units:
Lenth: in; Force: kip; Time: sec
Material Label:
4ksiConfinedConcrete
Material Model Label:
ConfinedConcrete
Input Arguments
Required Arguments
Fc: nominal strength
4000.*$psi
OptionalUnits
Optional Arguments
rPc: Ratio of maximum strength to nominal strength -- confine
1.3
OptionalUnits
rFu: Ratio of resicual strength to maximum strength -- confin
0.8
OptionalUnits
E: Elastic Modulus
57000.*$psi*
OptionalUnits
epsU: strain at crushing strength
-0.040
OptionalUnits
lambda: ratio between unloading slope at epscu and initial sl
0.1
OptionalUnits
fT: tensile strength
Test
Real-Time Display (slower)
TestMaterialStrainRange (in/in)
0.010
range
0.000
0.050
0.100
Modify/Save
Save As...
Save As...
4ksiConfinedConcrete_1
Stress (kip/in^2)
Strain (in/in)
MIN
Strain: -8.000e-003 (in/in)
Stress: -5.193e+000 (kip/in^2)
MAX
Strain: 8.000e-003 (in/in)
Stress: 5.113e-001 (kip/in^2)

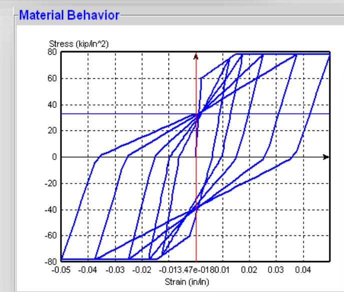
Material Library

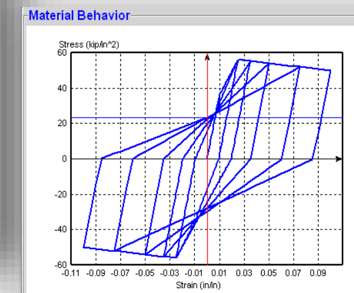
- Elastic
  - Elastic
  - ElasticNoTension
- Multilinear
  - Steel*
  - Bilinear & Multilinear
    - symmetric & not, define Ks or points
  - Steel01
  - Steel02
- Concrete
  - Confined Concrete*
  - Unconfined Concrete
  - Concrete01,02,03,04,06,07
- Additional
  - Viscous
  - SelfCentering
- Combined
  - Series
  - Parallel
- nDMaterial
  - Elastic Isotropic
  - Etc.

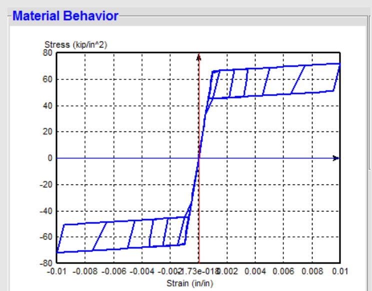


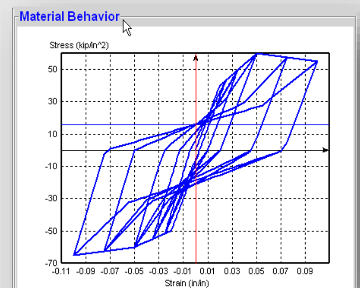


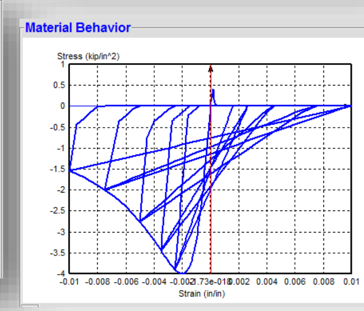


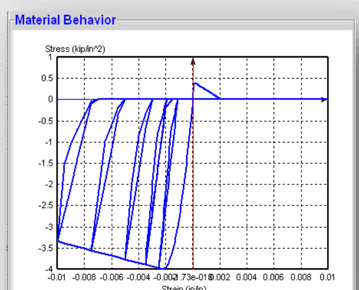


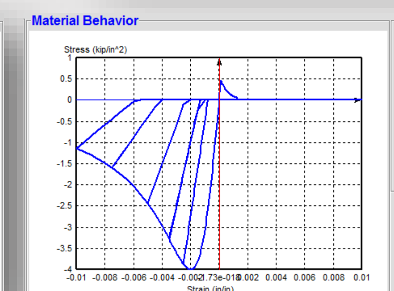


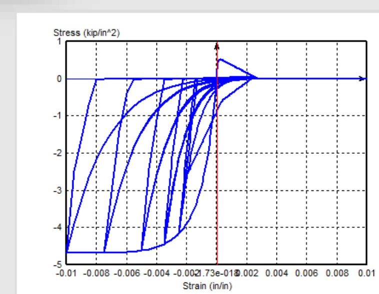












Simplified Input

Material Model Label:

Concrete04

Input Arguments

Unique Material Label:

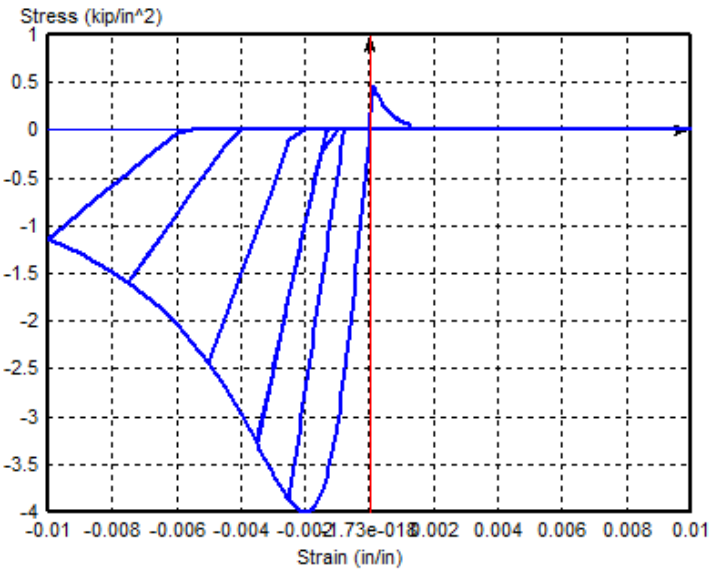
Concrete04Material

Required Arguments

Fc: nominal strength

4 ksi

Material Behavior



Optional Arguments

rFc: Ratio of maximum strength to nominal strength -- confinement

1.0 OptionalUnits

ec: strain at maximum strength

-pow($rFc*abs($Fc)/$ps OptionalUnits

ecu: strain at crushing strength

0.2 OptionalUnits

Ec: initial stiffness

57000.*$psi*sqrt($rFc*ab OptionalUnits

fct: maximum tensile strength

7.5*$psi*sqrt($rFc*abs($ OptionalUnits

et: ultimate tensile strain

5.*2.*$fct/$Ec OptionalUnits

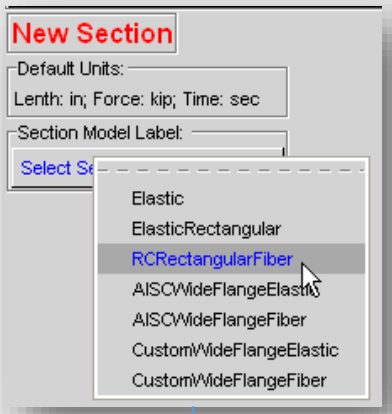
beta: exponential curve parameter to define the residual stress (a

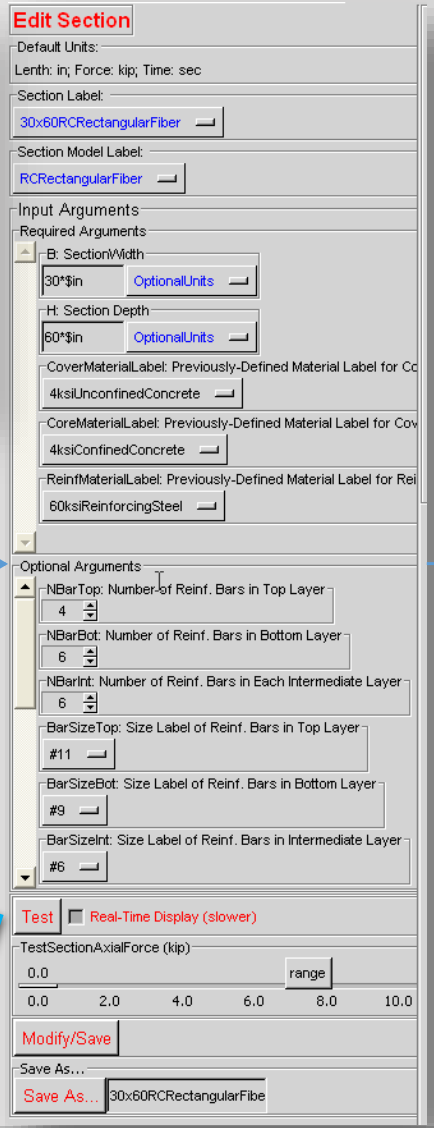
0.1 OptionalUnits

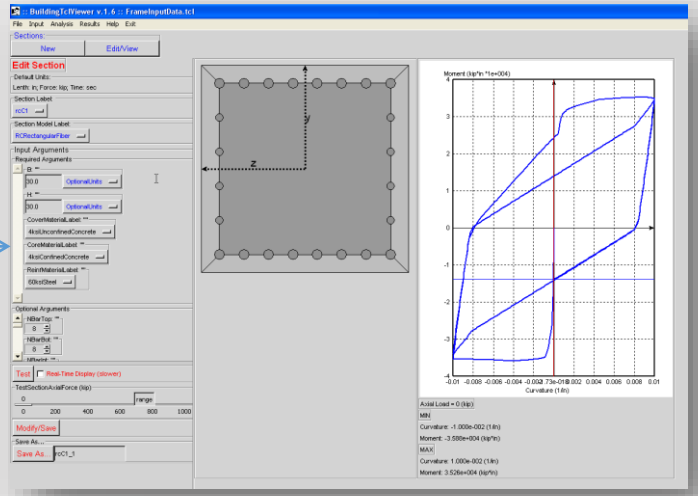
MaterialDescription: ""

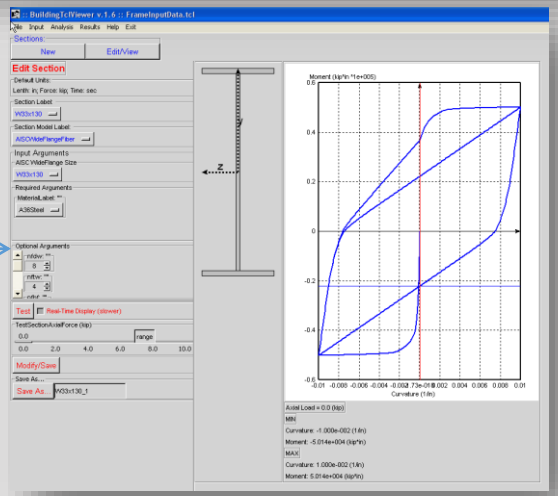
OptionalUnits

BuildingTcl Viewer – Sections









Minimal Section Input

Section Model Label:

RCRectangularFiber

Input Arguments

Unique Section Label:

RCRectangularFiberSecti

Required Arguments

B: Section Depth

40 in

H: Section Width

60 in

CoverMaterialLabel: Previously-Defined Material Label for Core

UnconfinedConcreteMaterial

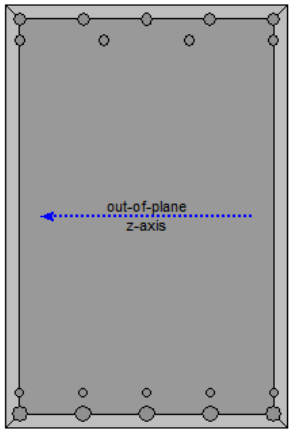
CoreMaterialLabel: Previously-Defined Material La

ConfinedConcreteMaterial

ReinfMaterialLabel: Previously-Defined Material L

SteelMaterial

Section Geometry



Optional Arguments

NBarTop: Number of Reinf. Bars in Top Layer

0

BarSizeTop: Size Label of Reinf. Bars in Top Layer

#9

NBarTopl: Number of Reinf. Bars in Second Top Layer

0

BarSizeTopl: Size Label of Reinf. Bars in Second Top Layer

#9

NBarBot: Number of Reinf. Bars in Bottom Layer

0

BarSizeBot: Size Label of Reinf. Bars in Bottom Layer

#9

NBarBotl: Number of Reinf. Bars in Second Bottom Layer

0

BarSizeBotl: Size Label of Reinf. Bars in in Second Bottom Layer

#9

NBarInt: Number of Reinf. Bars in Each Intermediate Layer

0

BarSizeInt: Size Label of Reinf. Bars in Intermediate Layer

#9

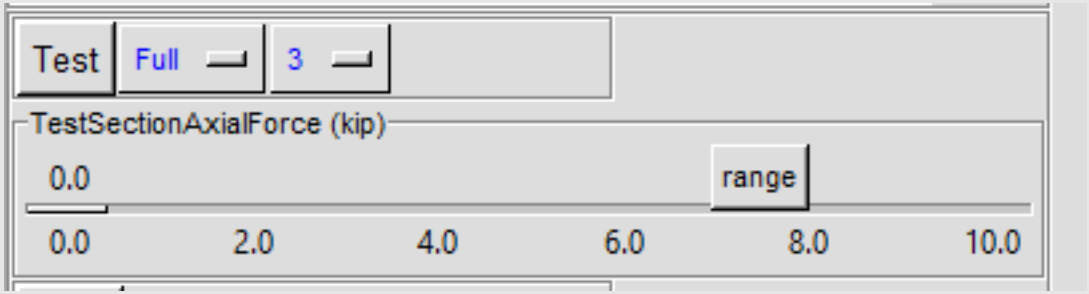
LayerSpacingTop: Spacing Between Top Reinforcing Layers

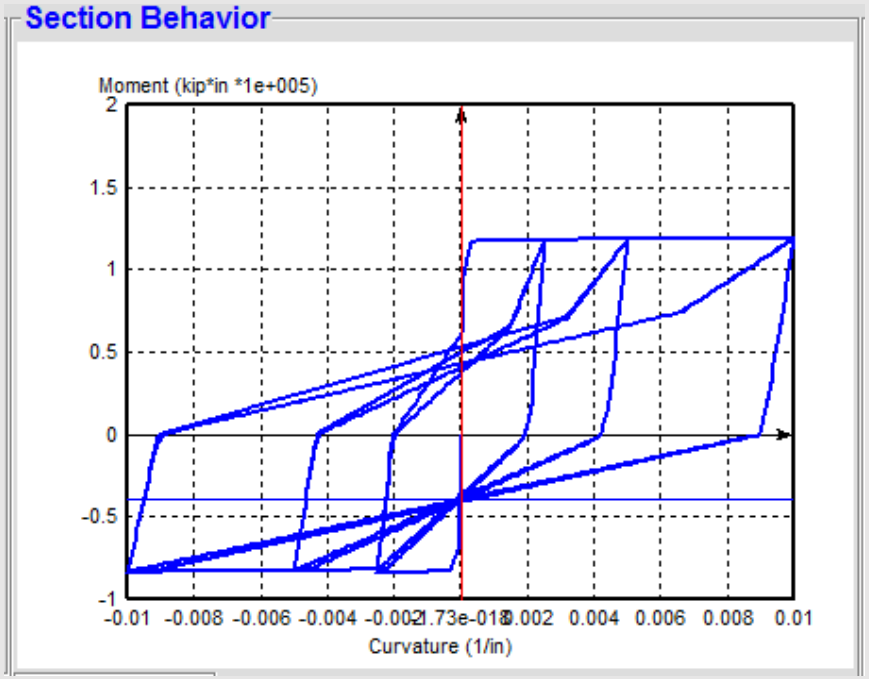
3.*$in OptionalUnits

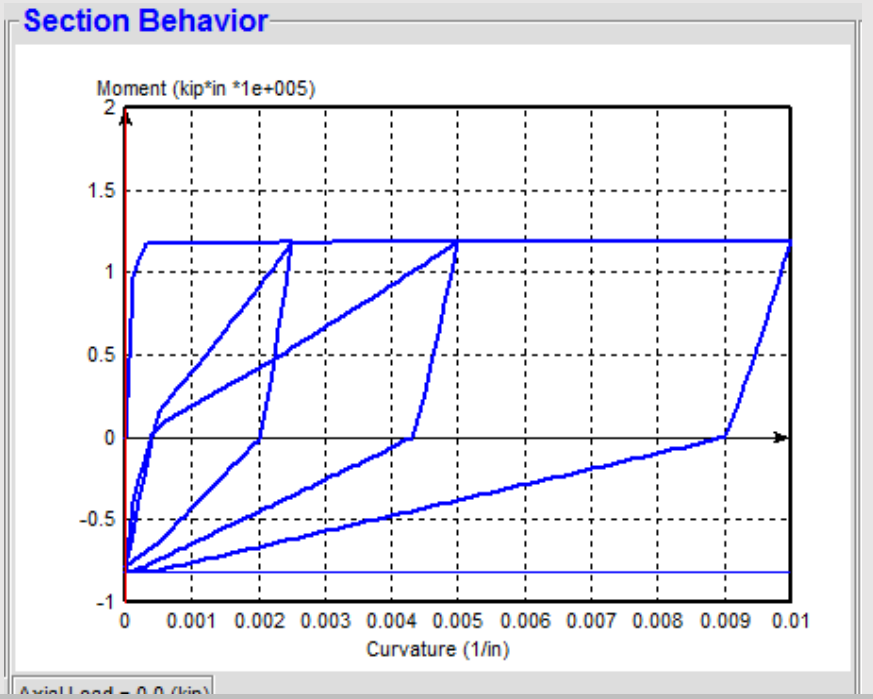
LayerSpacingBot: Spacing Between Bottom Reinforcing Layers

3.*$in OptionalUnits

Test Section Behavior

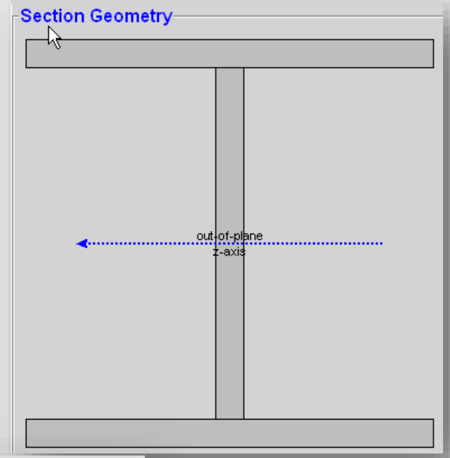


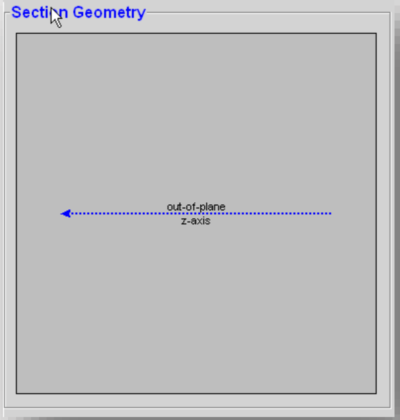


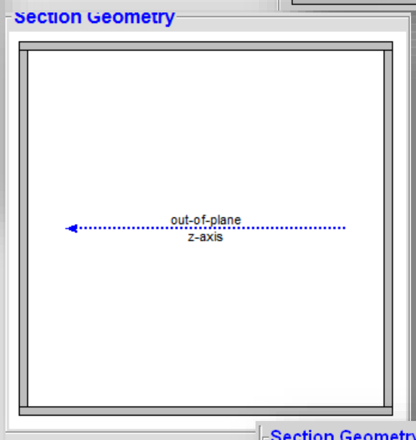


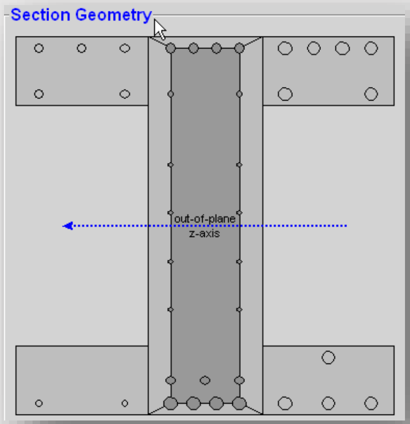
Library of Section Models

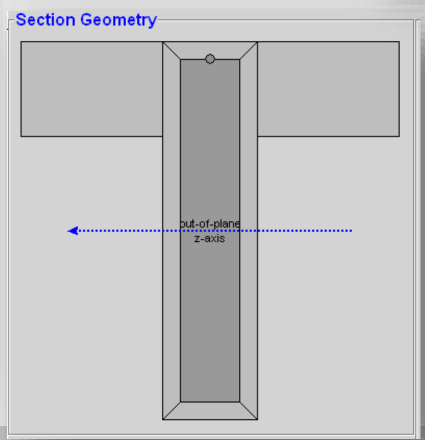
- Aggregator
- RectFiber
- RC
- Uniaxial
- AISCWideFlange
- Custom WideFlange
- HSS
- Etc.

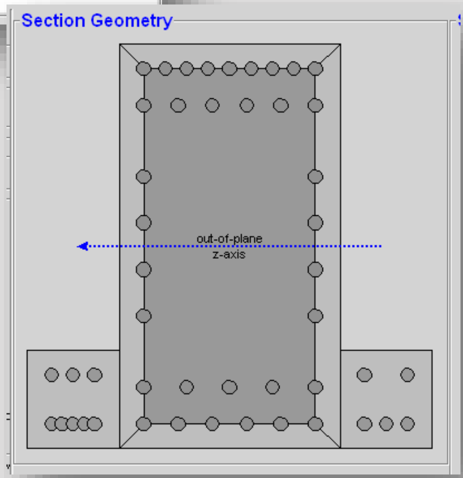












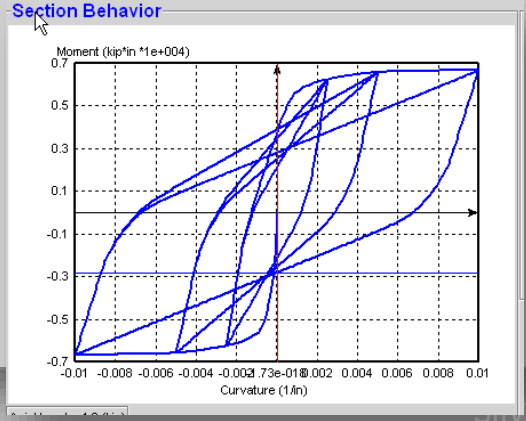
AISC StandardWideFlange Sections

W44
W40
W36
W33
W30
W27
W24
W21
W14
W18
W16
W12
W10
W8
W6
W5
W4
S8
S6
S5
S4
S3
S24
S20
S18
S15
S12
S10
M8
M6
M5
M4
M12
M10
HP8
HP14
HP12
HP10

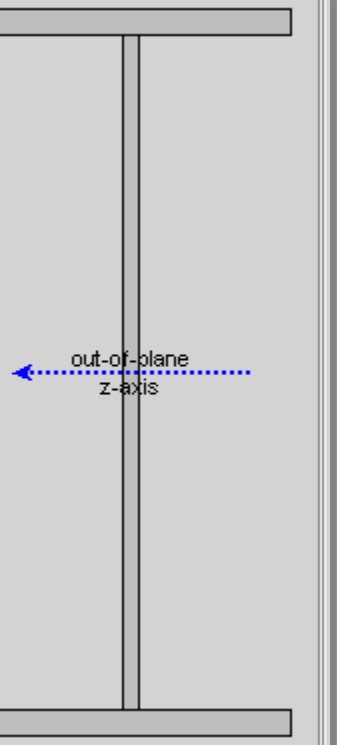
Label:

W36X798 (A = {235*$in2} D = {42*$in} Bf = {18*$in} Tf = {4.29*$in} Tw = {2.38*$in} Ixx = {62600*$in4} Iyy = {4200*$in4} Izz = {62600*$in4})
W36X650 (A = {191*$in2} D = {40.5*$in} Bf = {17.6*$in} Tf = {3.54*$in} Tw = {1.97*$in} Ixx = {48900*$in4} Iyy = {3230*$in4} Izz = {48900*$in4})
W36X527 (A = {155*$in2} D = {39.2*$in} Bf = {17.2*$in} Tf = {2.91*$in} Tw = {1.61*$in} Ixx = {38300*$in4} Iyy = {2490*$in4} Izz = {38300*$in4})
W36X439 (A = {129*$in2} D = {38.3*$in} Bf = {17*$in} Tf = {2.44*$in} Tw = {1.36*$in} Ixx = {31000*$in4} Iyy = {1990*$in4} Izz = {31000*$in4})
W36X393 (A = {116*$in2} D = {37.8*$in} Bf = {16.8*$in} Tf = {2.2*$in} Tw = {1.22*$in} Ixx = {27500*$in4} Iyy = {1750*$in4} Izz = {27500*$in4})
W36X359 (A = {105*$in2} D = {37.4*$in} Bf = {16.7*$in} Tf = {2.01*$in} Tw = {1.12*$in} Ixx = {24800*$in4} Iyy = {1570*$in4} Izz = {24800*$in4})
W36X256 (A = {75.4*$in2} D = {37.4*$in} Bf = {12.2*$in} Tf = {1.73*$in} Tw = {0.96*$in} Ixx = {16800*$in4} Iyy = {528*$in4} Izz = {16800*$in4})
W36X328 (A = {96.4*$in2} D = {37.1*$in} Bf = {16.6*$in} Tf = {1.85*$in} Tw = {1.02*$in} Ixx = {22500*$in4} Iyy = {1420*$in4} Izz = {22500*$in4})
W36X232 (A = {68.1*$in2} D = {37.1*$in} Bf = {12.1*$in} Tf = {1.57*$in} Tw = {0.87*$in} Ixx = {15000*$in4} Iyy = {468*$in4} Izz = {15000*$in4})
W36X300 (A = {88.3*$in2} D = {36.7*$in} Bf = {16.7*$in} Tf = {1.68*$in} Tw = {0.945*$in} Ixx = {20300*$in4} Iyy = {1300*$in4} Izz = {20300*$in4})
W36X210 (A = {61.8*$in2} D = {36.7*$in} Bf = {12.2*$in} Tf = {1.36*$in} Tw = {0.83*$in} Ixx = {13200*$in4} Iyy = {411*$in4} Izz = {13200*$in4})
W36X280 (A = {82.4*$in2} D = {36.5*$in} Bf = {16.6*$in} Tf = {1.57*$in} Tw = {0.885*$in} Ixx = {18900*$in4} Iyy = {1200*$in4} Izz = {18900*$in4})
W36X194 (A = {57*$in2} D = {36.5*$in} Bf = {12.1*$in} Tf = {1.26*$in} Tw = {0.765*$in} Ixx = {12100*$in4} Iyy = {375*$in4} Izz = {12100*$in4})
W36X260 (A = {76.5*$in2} D = {36.3*$in} Bf = {16.6*$in} Tf = {1.44*$in} Tw = {0.84*$in} Ixx = {17300*$in4} Iyy = {1090*$in4} Izz = {17300*$in4})
W36X182 (A = {53.6*$in2} D = {36.3*$in} Bf = {12.1*$in} Tf = {1.18*$in} Tw = {0.725*$in} Ixx = {11300*$in4} Iyy = {347*$in4} Izz = {11300*$in4})
W36X170 (A = {50.1*$in2} D = {36.2*$in} Bf = {12*$in} Tf = {1.1*$in} Tw = {0.68*$in} Ixx = {10500*$in4} Iyy = {320*$in4} Izz = {10500*$in4})
W36X245 (A = {72.1*$in2} D = {36.1*$in} Bf = {16.5*$in} Tf = {1.35*$in} Tw = {0.8*$in} Ixx = {16100*$in4} Iyy = {1010*$in4} Izz = {16100*$in4})
W36X160 (A = {47*$in2} D = {36*$in} Bf = {12*$in} Tf = {1.02*$in} Tw = {0.65*$in} Ixx = {9760*$in4} Iyy = {295*$in4} Izz = {9760*$in4})
W36X230 (A = {67.6*$in2} D = {35.9*$in} Bf = {16.5*$in} Tf = {1.26*$in} Tw = {0.76*$in} Ixx = {15000*$in4} Iyy = {940*$in4} Izz = {15000*$in4})
W36X150 (A = {44.2*$in2} D = {35.9*$in} Bf = {12*$in} Tf = {0.94*$in} Tw = {0.625*$in} Ixx = {9040*$in4} Iyy = {270*$in4} Izz = {9040*$in4})
W36X135 (A = {39.7*$in2} D = {35.6*$in} Bf = {12*$in} Tf = {0.79*$in} Tw = {0.6*$in} Ixx = {7800*$in4} Iyy = {225*$in4} Izz = {7800*$in4})

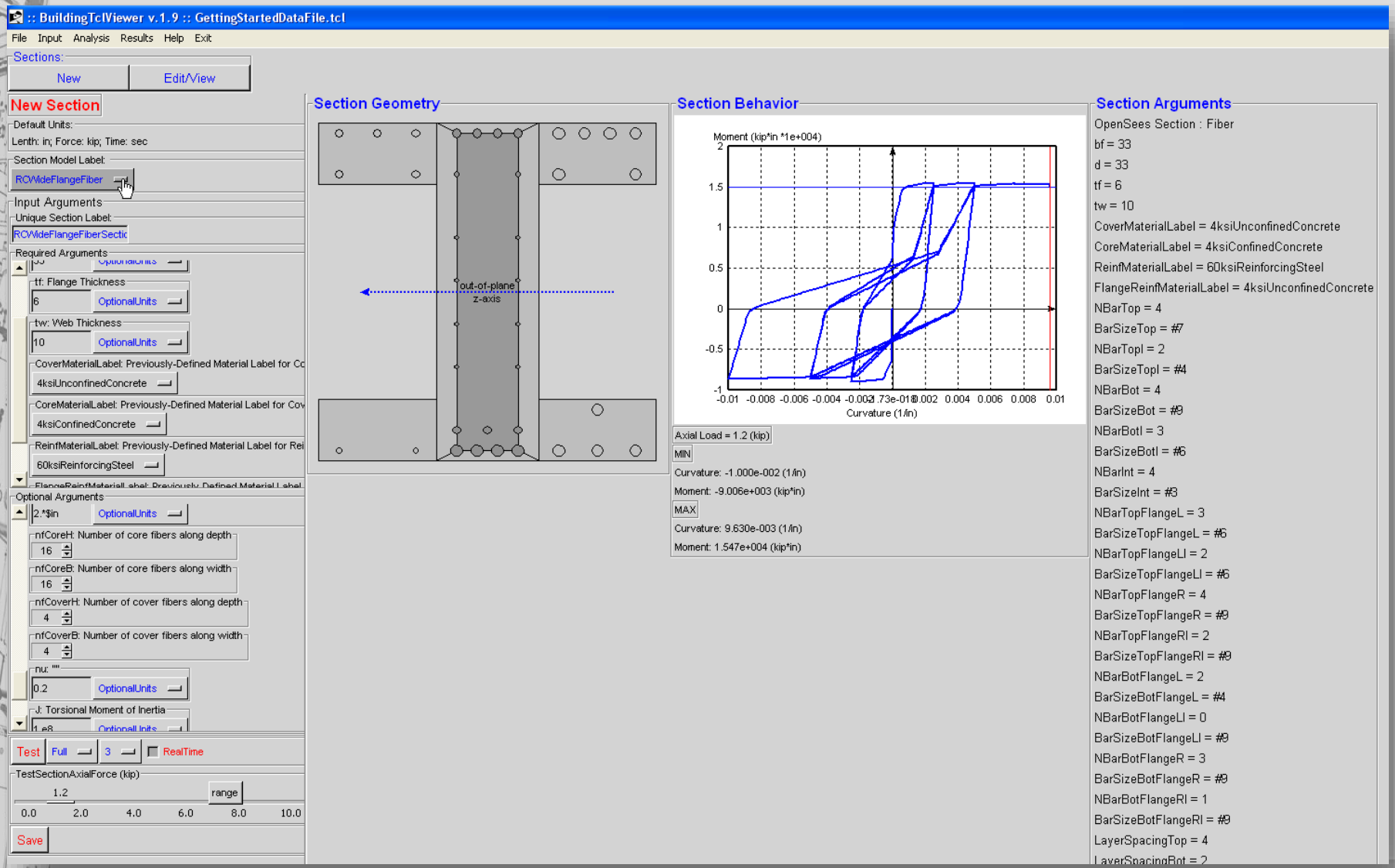
Section Behavior



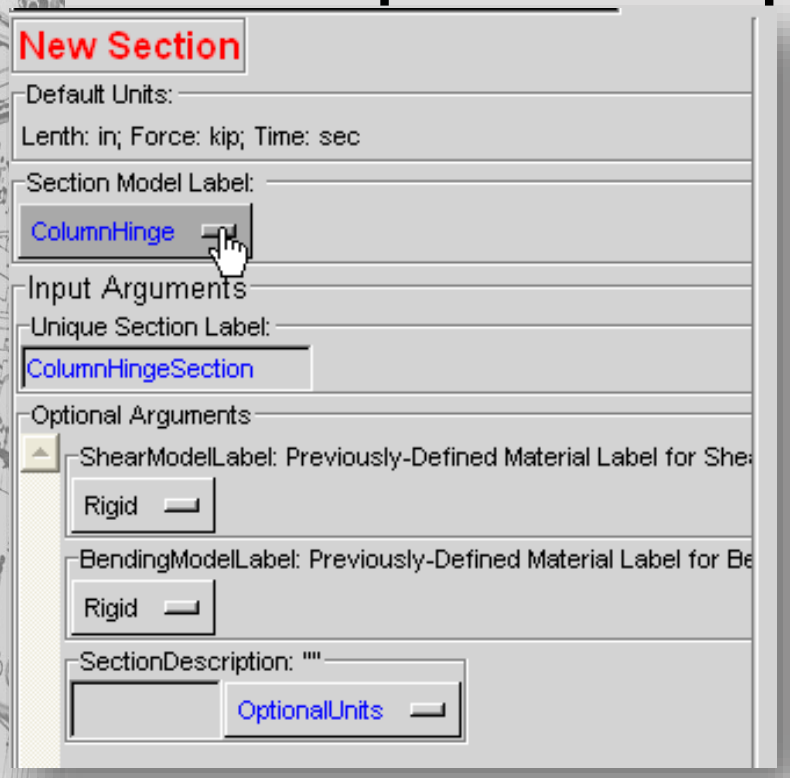
Section Geometry

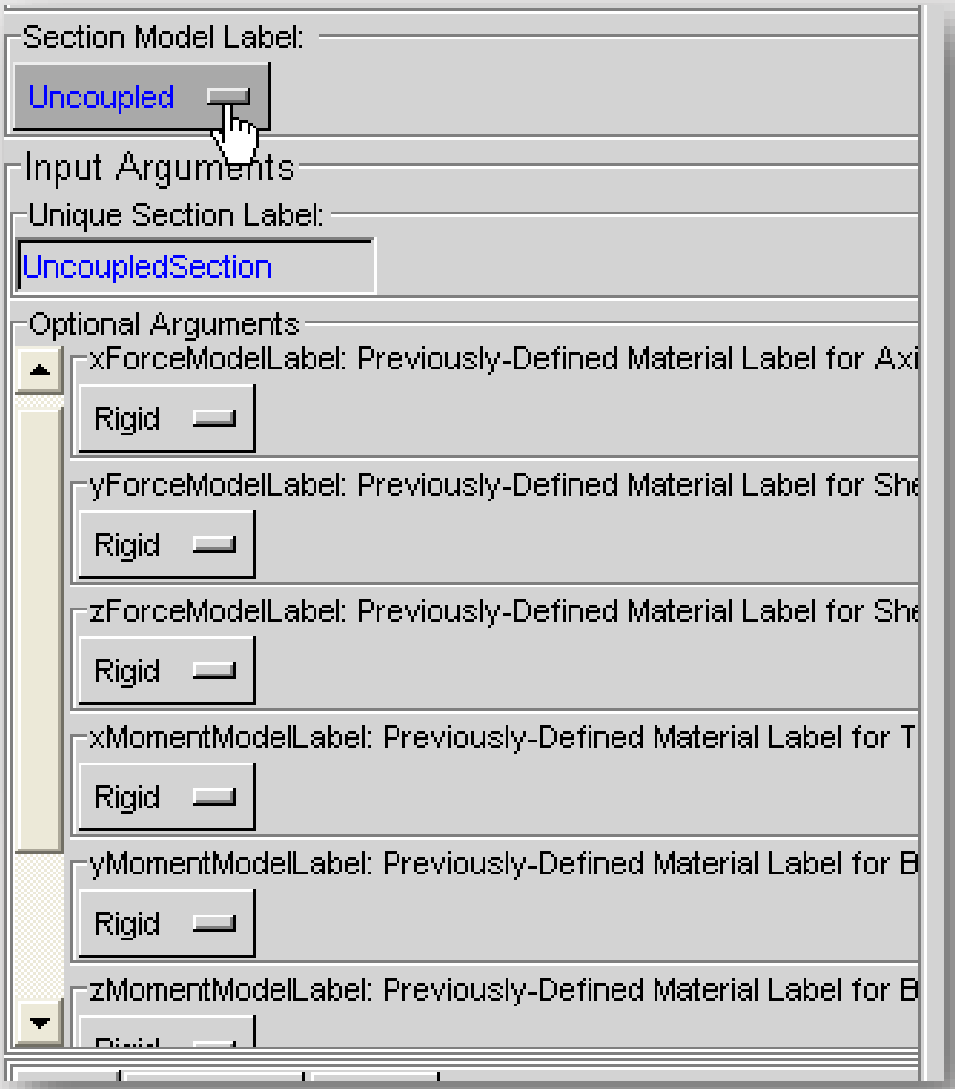


RC WideFlangeFiber



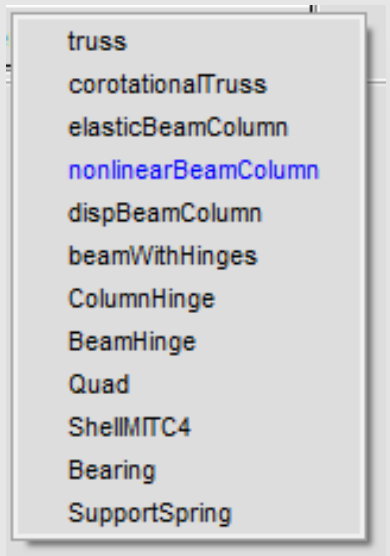
Uncoupled-Response Sections

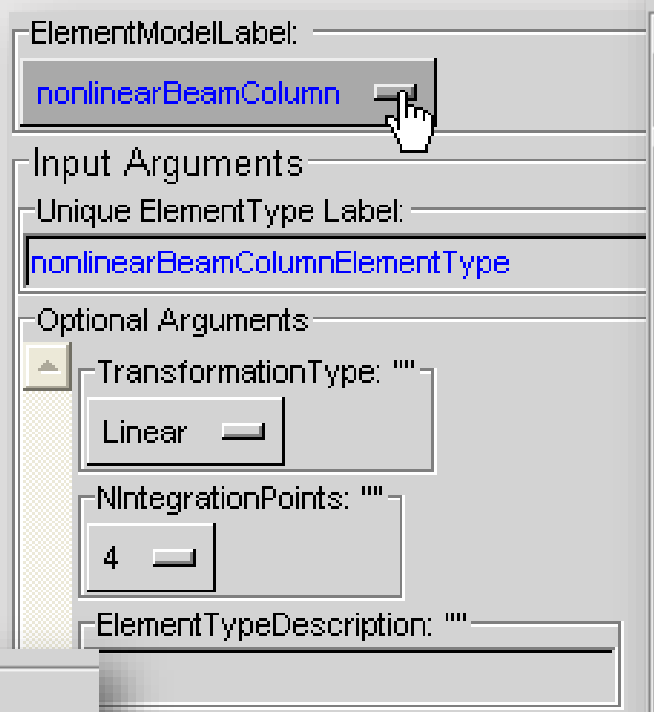


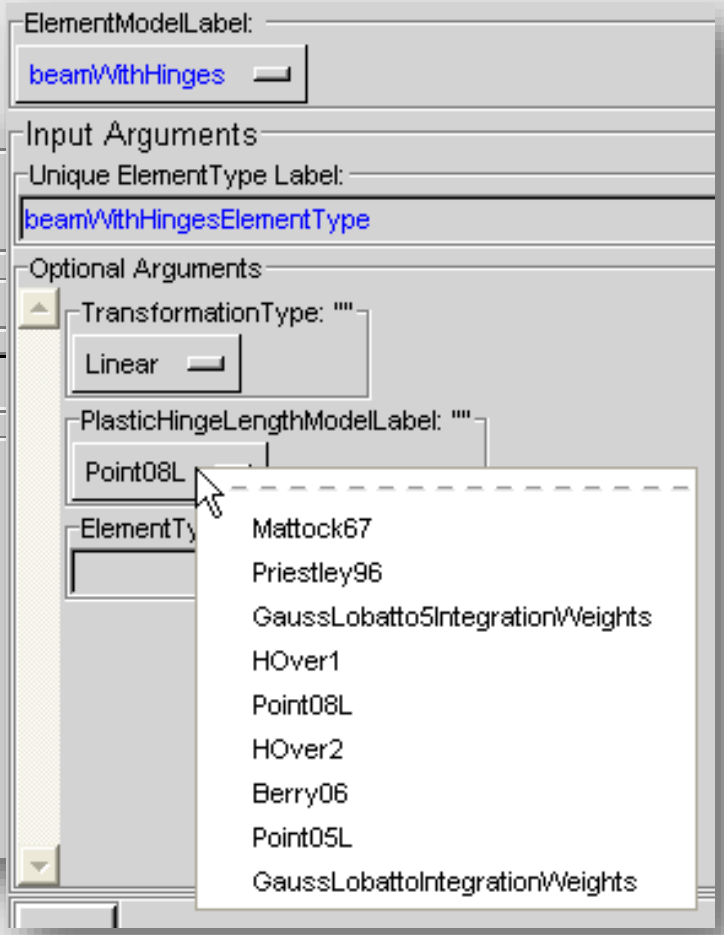


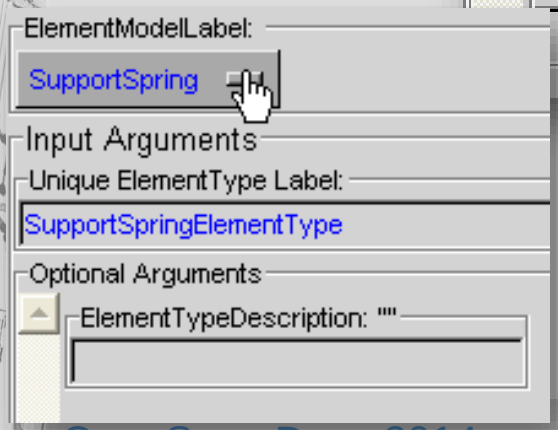
- Support Springs
- Column-End Hinges (Bending &/or Shear)

ElementTypes







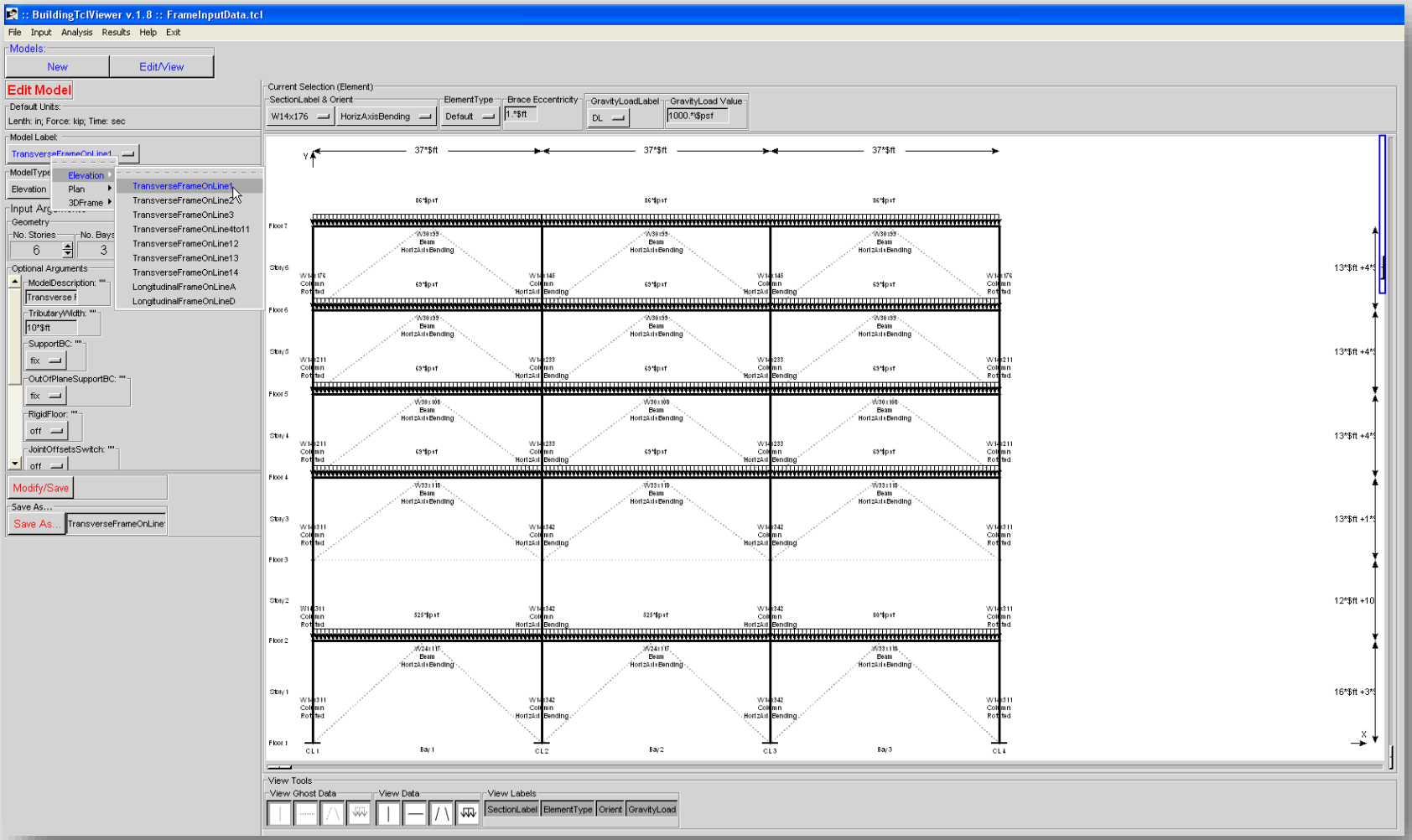


Structural Model

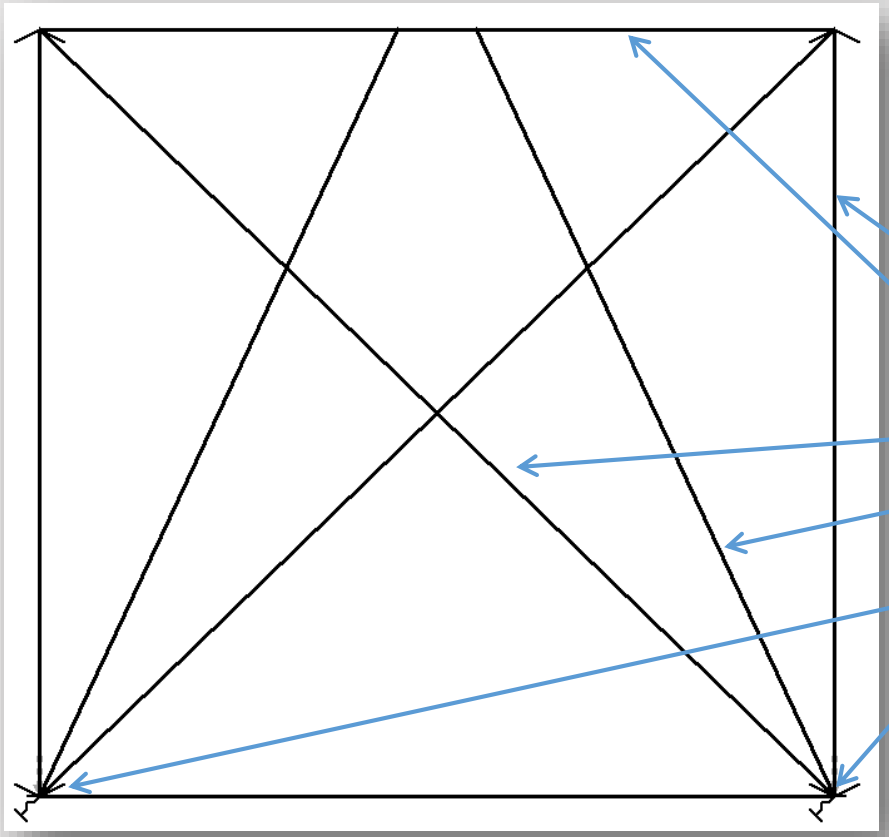
Three components

- Elevation – 2D, vertical
- Grid – 2D, horizontal
- 3DFrame
  - Assemble 2D Elevations on a 2D grid

Elevation Input

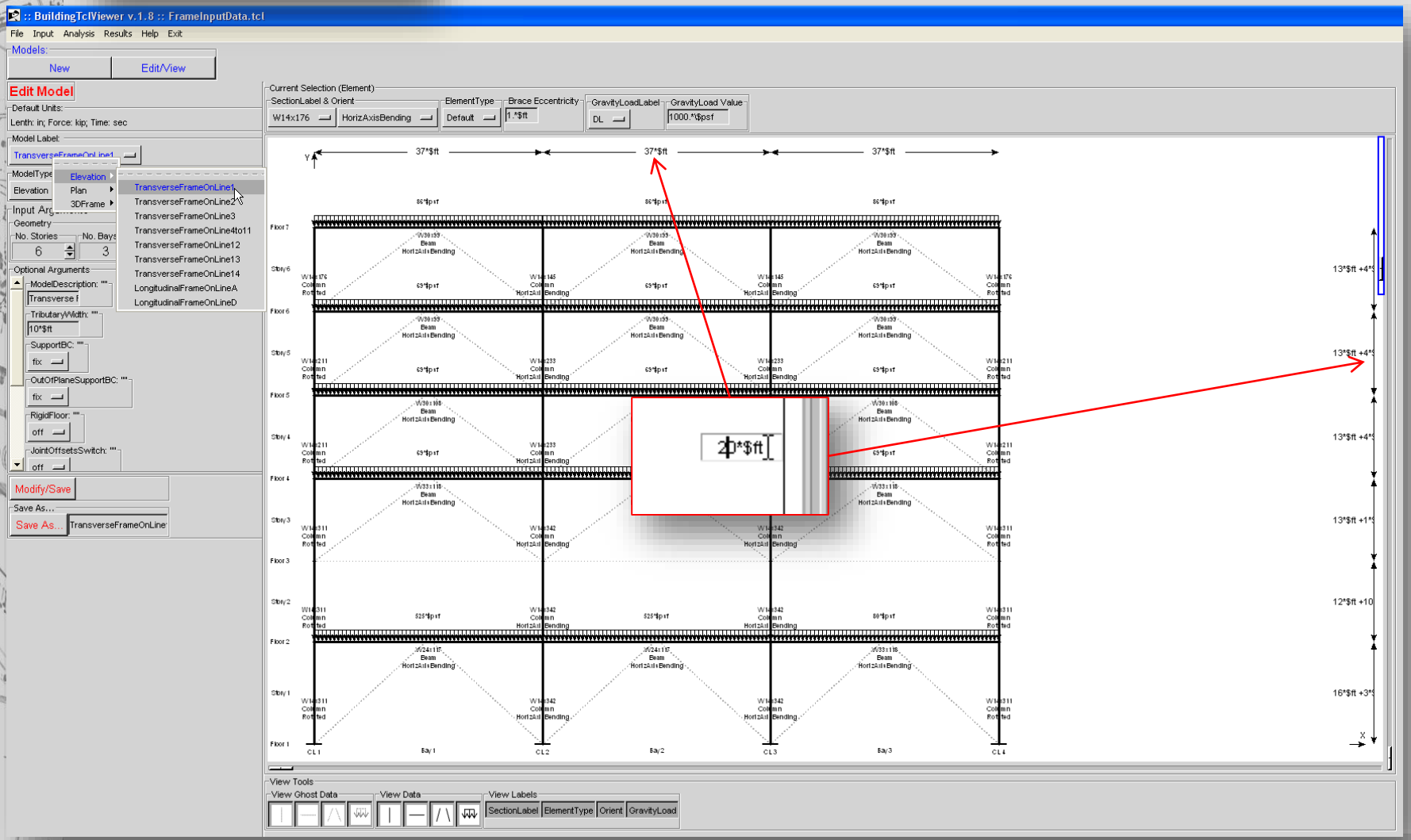


Structural Elements

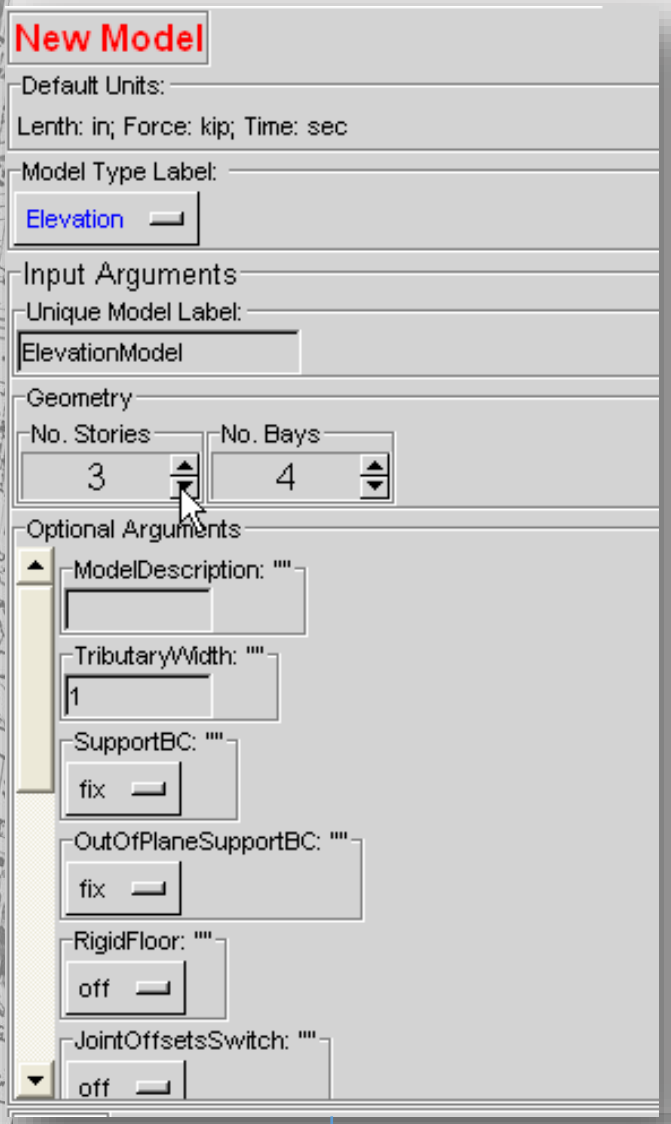


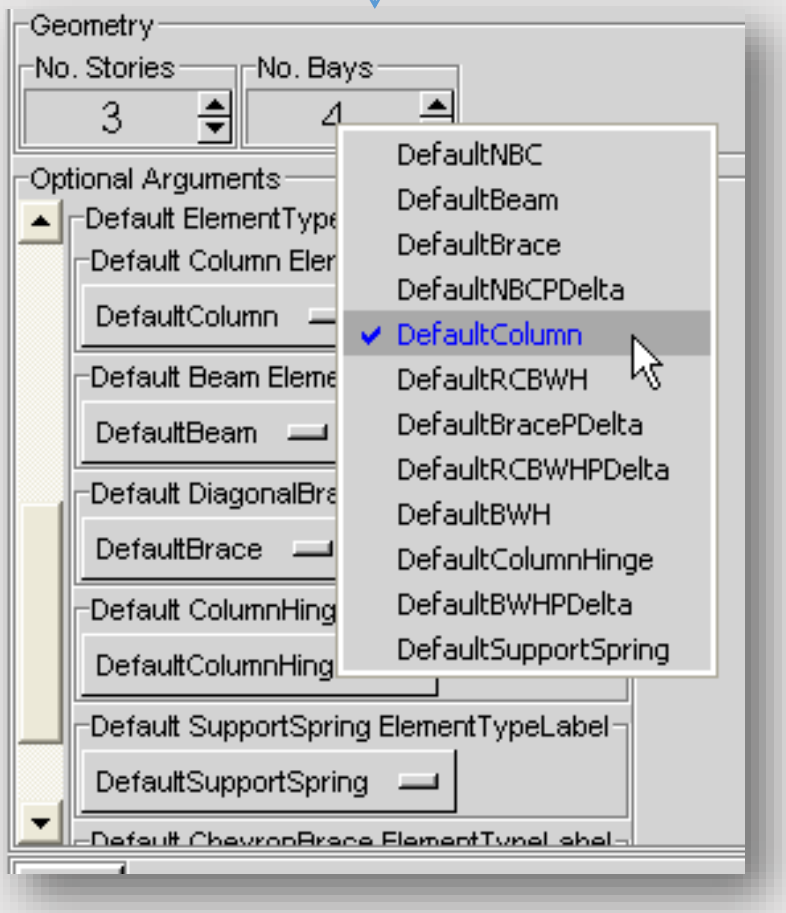
- Column
- Beam
- DiagonalBrace
- ChevronBrace
- ColumnHinge
- SupportSpring

Elevation-Model Input

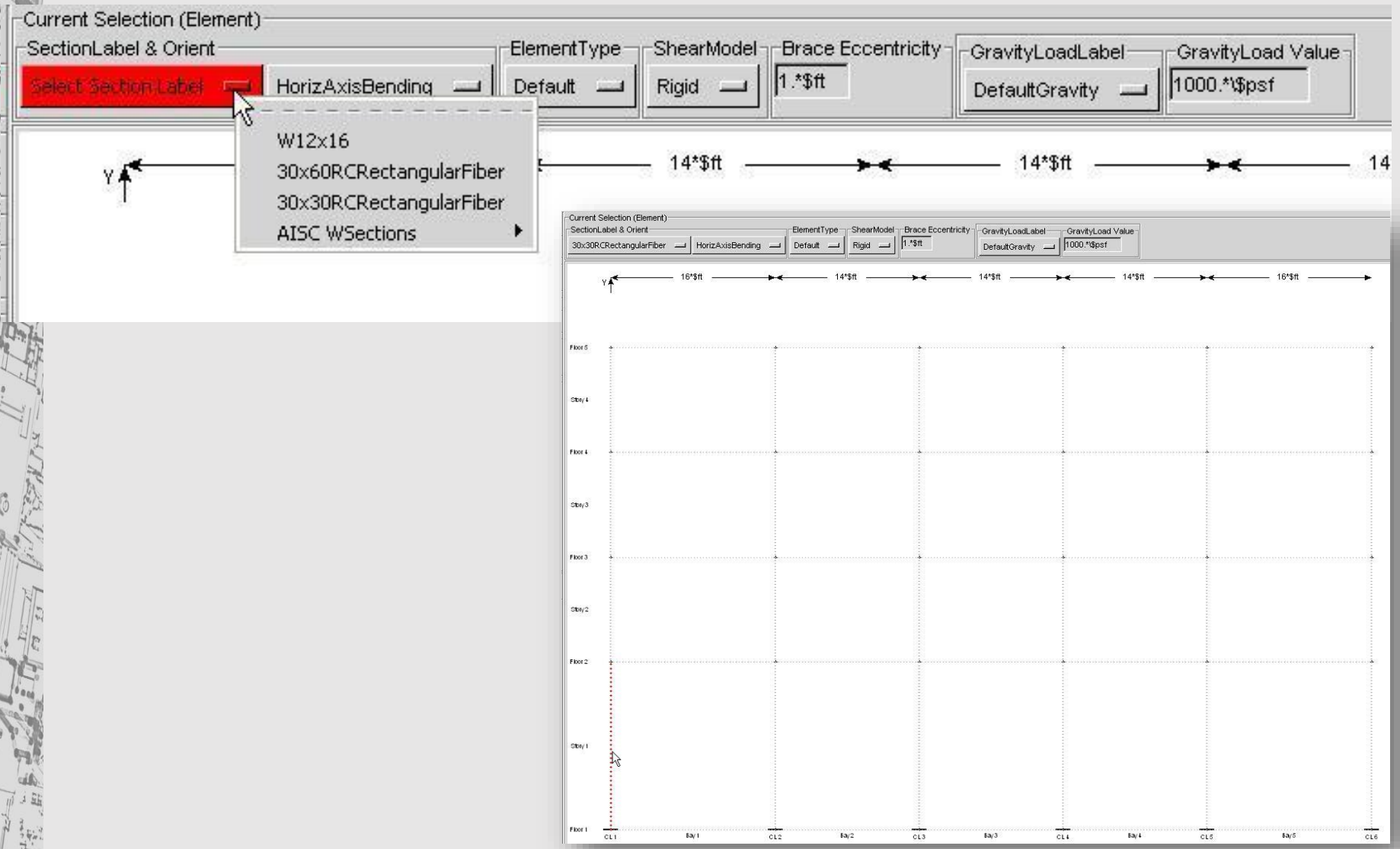


Elevation Model Input
Model Variables

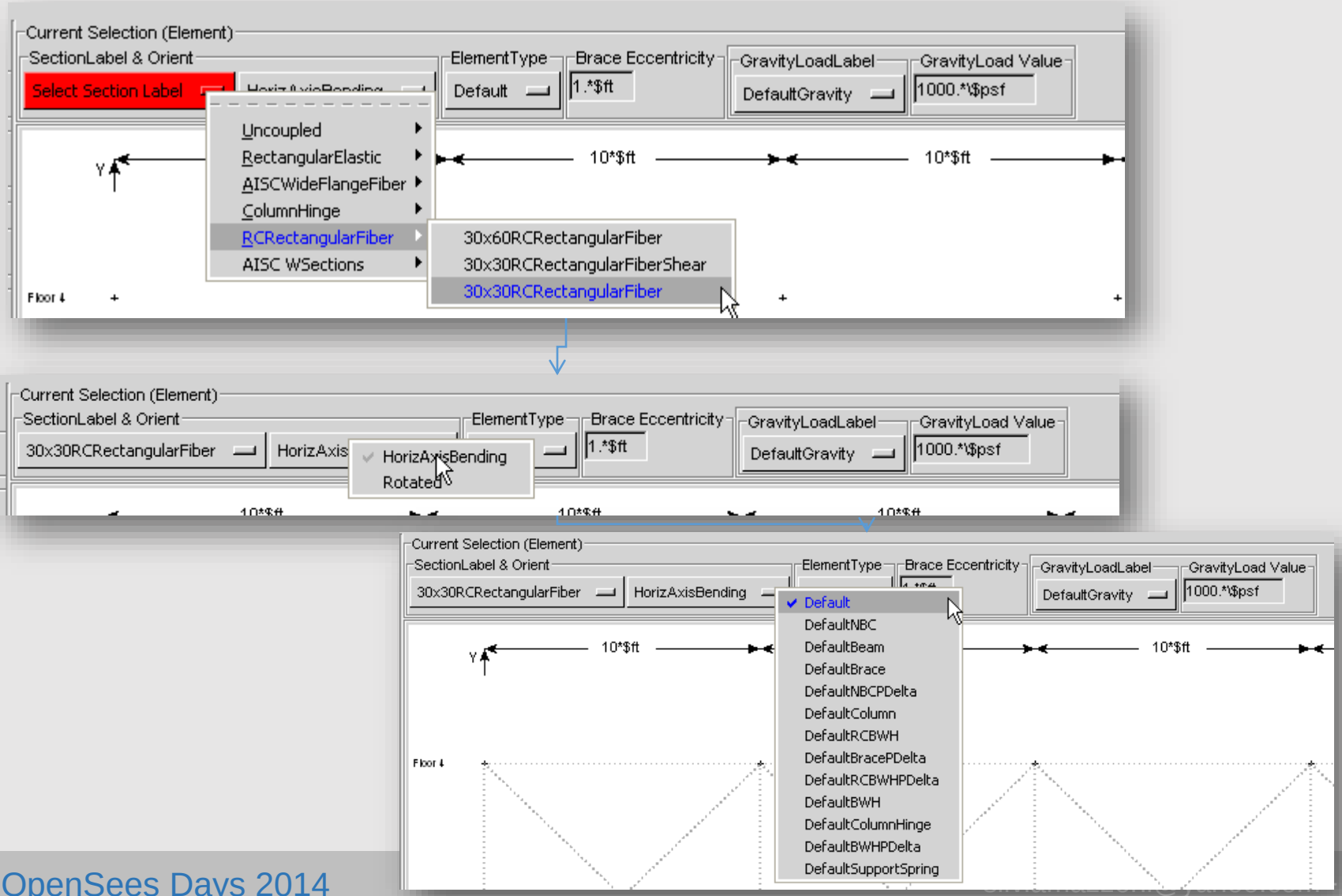




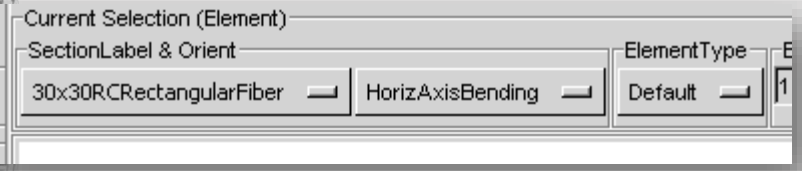
Elevation-Model Input: Elements

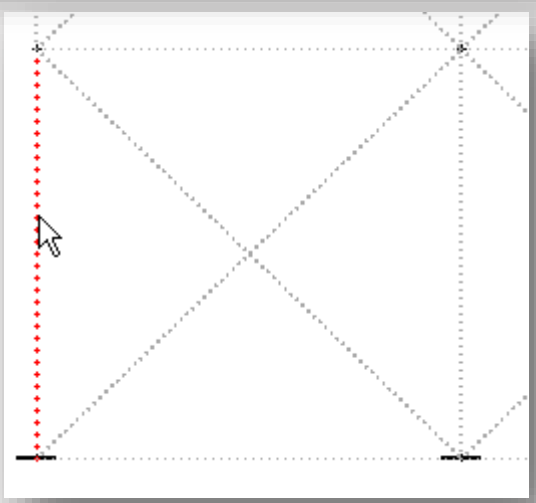


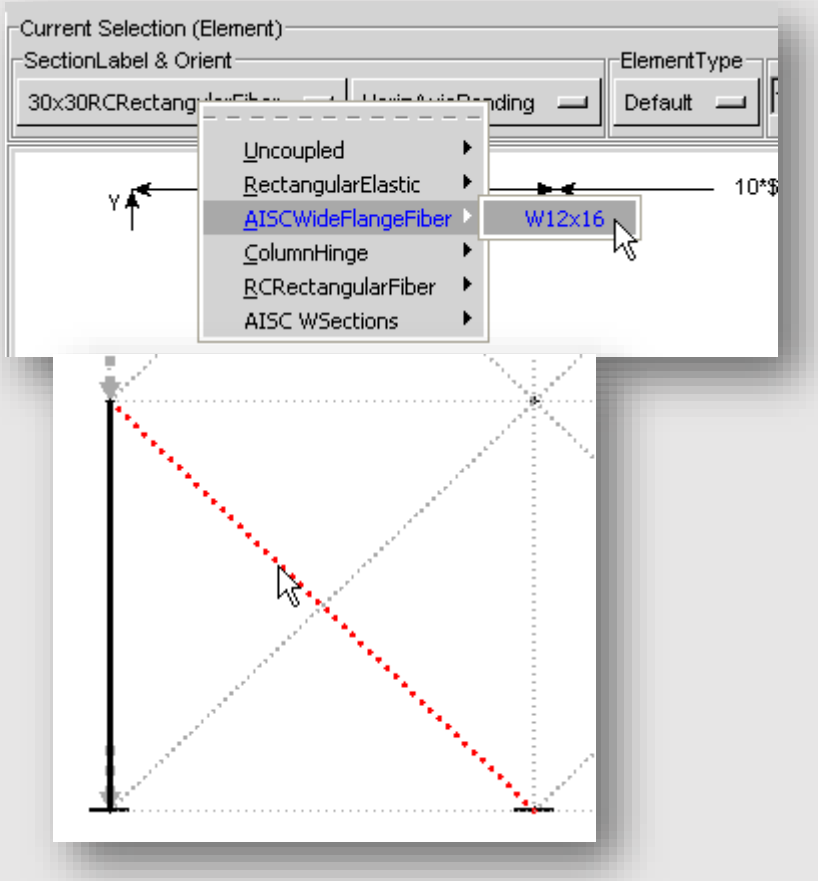
Elevation Model Input
Current-Selection Properties



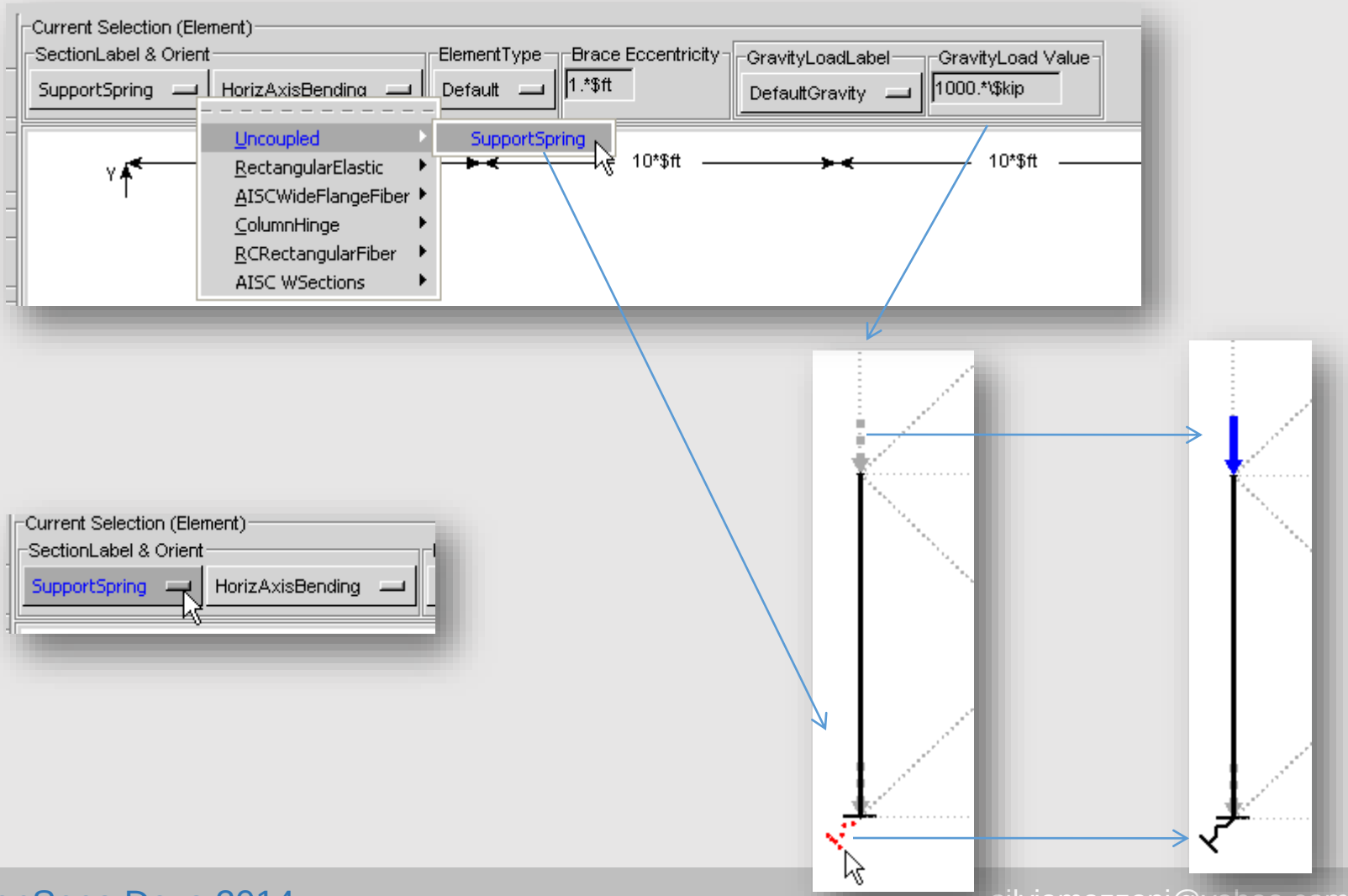
Elevation Model Input
Columns & Diagonal Braces



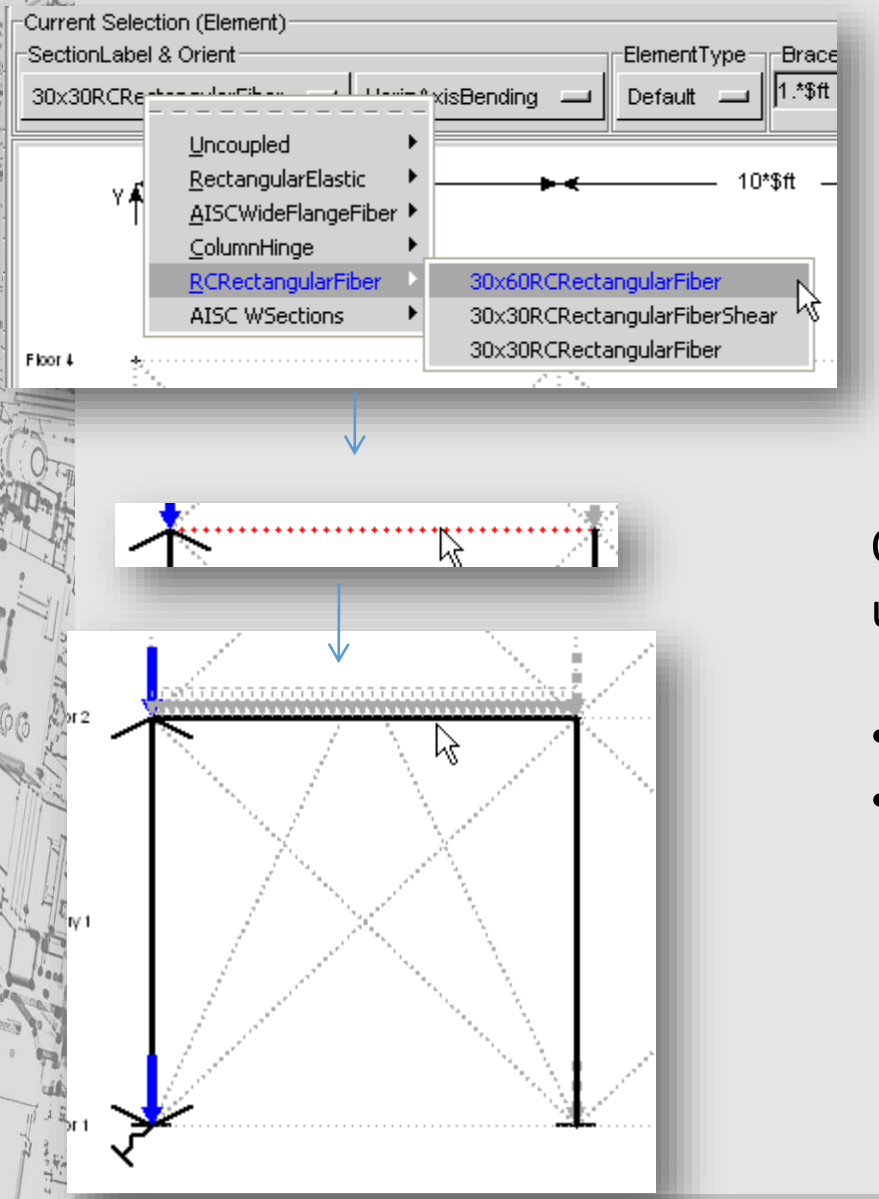




Elevation Model Input
Support Springs & Nodal Loads appear



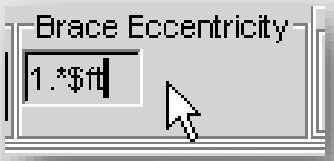
Elevation Model Input
Beams

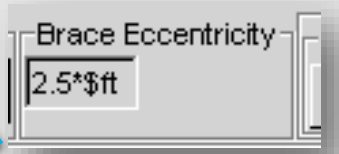


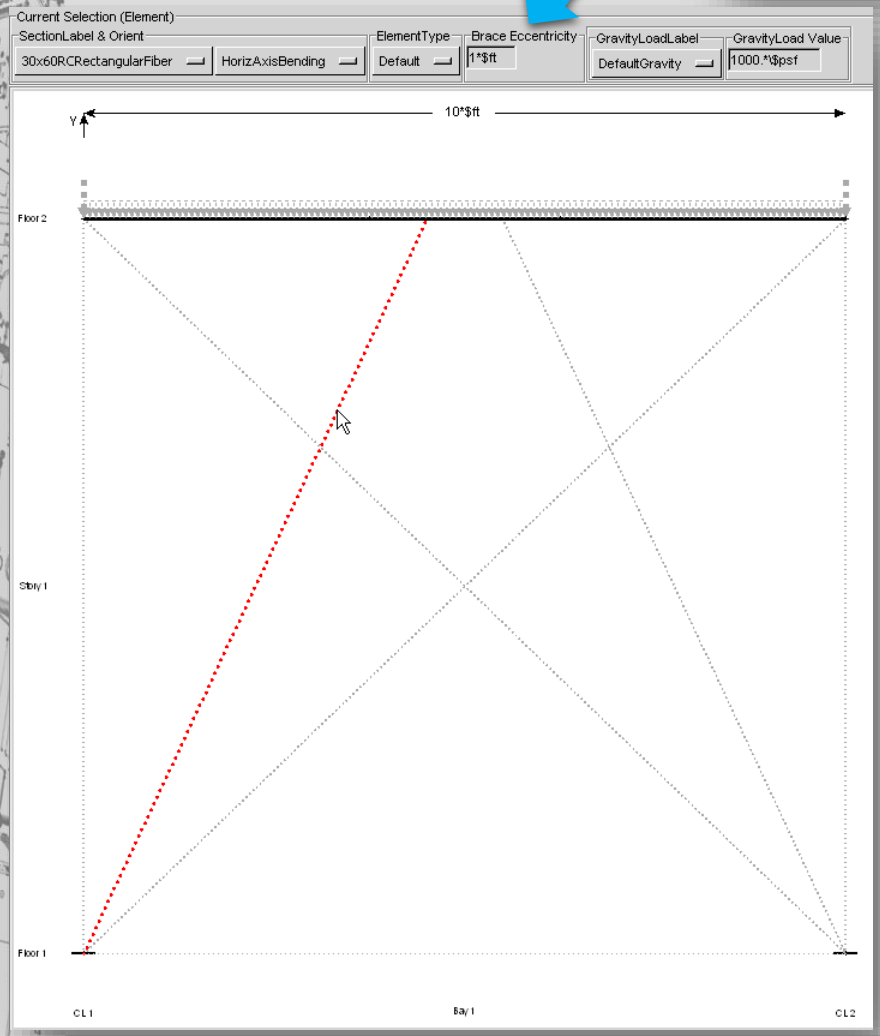
Once Beam has been defined, user can define:

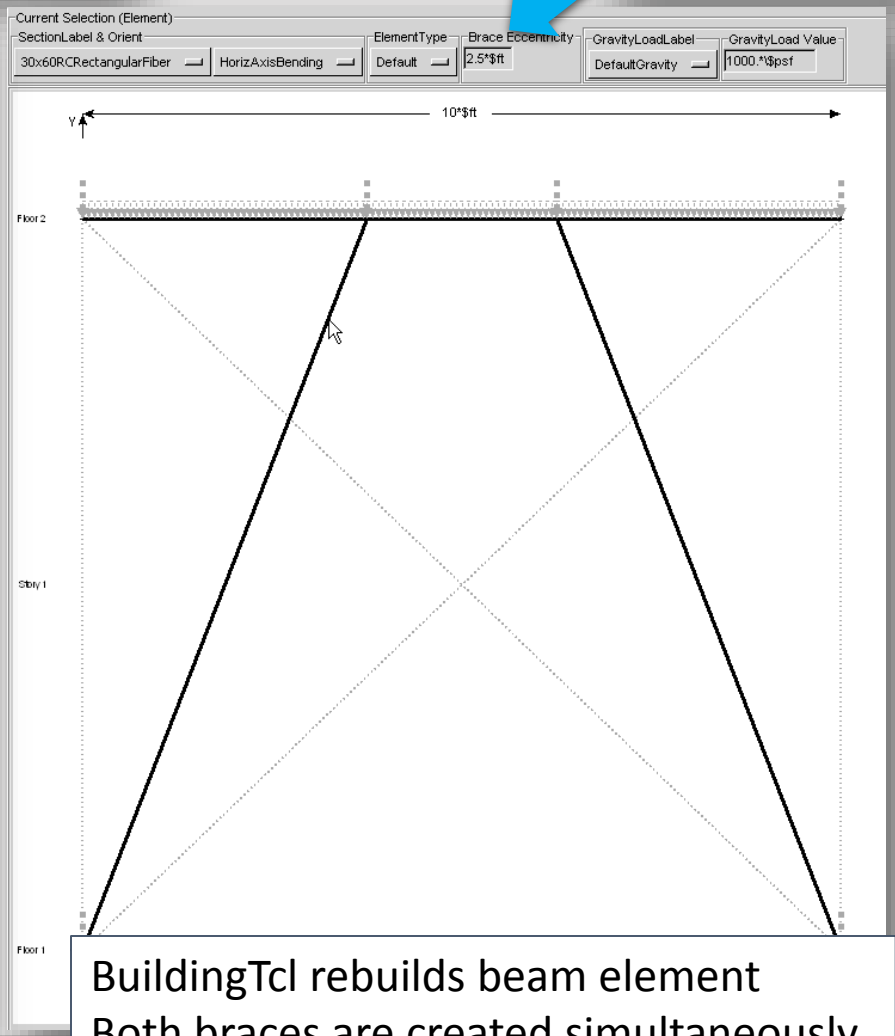
- Distributed gravity loads
- Chevron Braces

Elevation Model Input
ChevronBraces



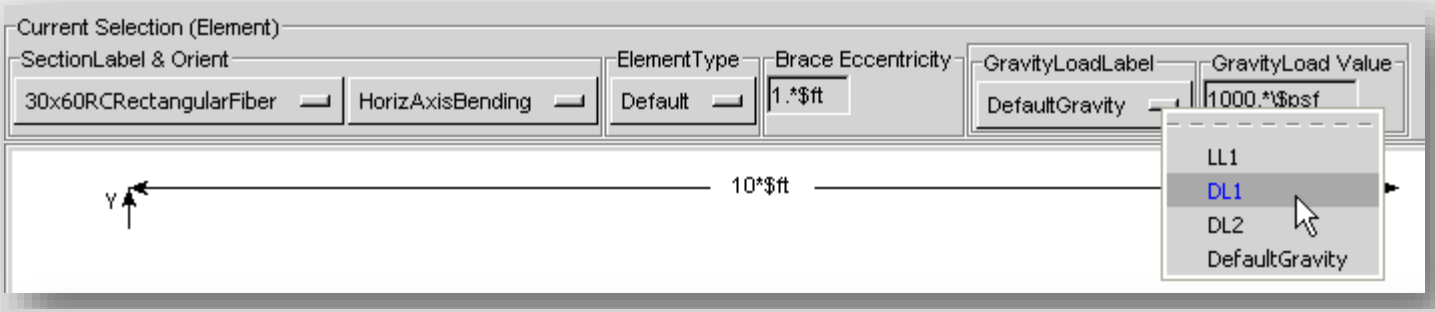


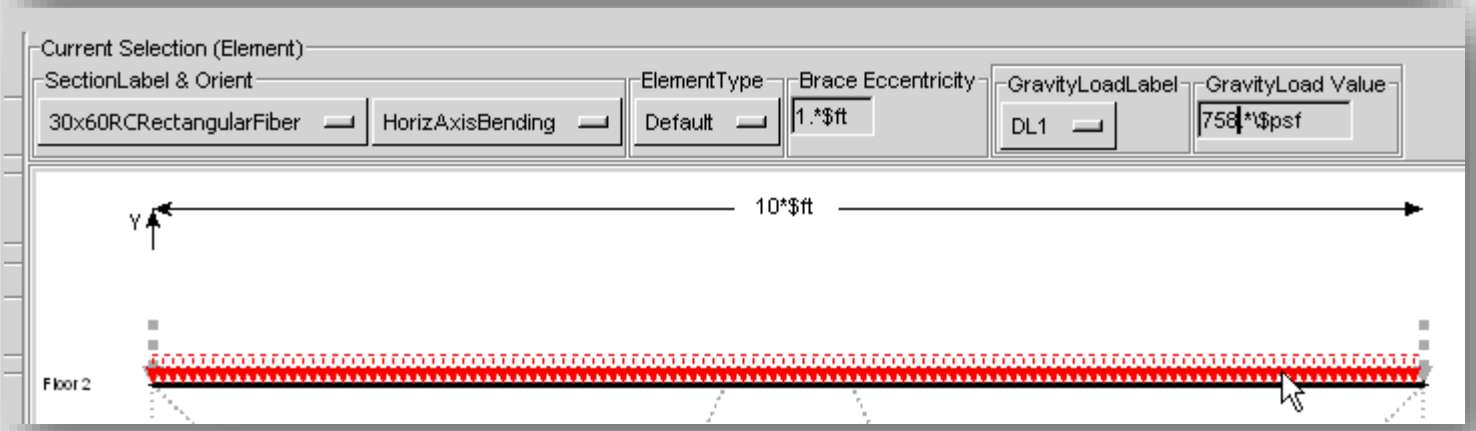


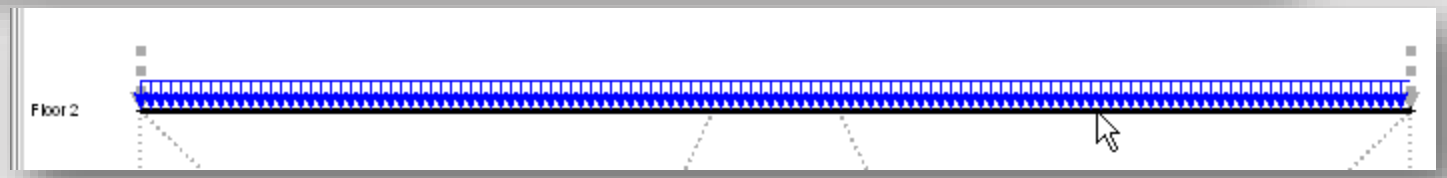


BuildingTcl rebuilds beam element
Both braces are created simultaneously

Elevation Model Input
Distributed Loads

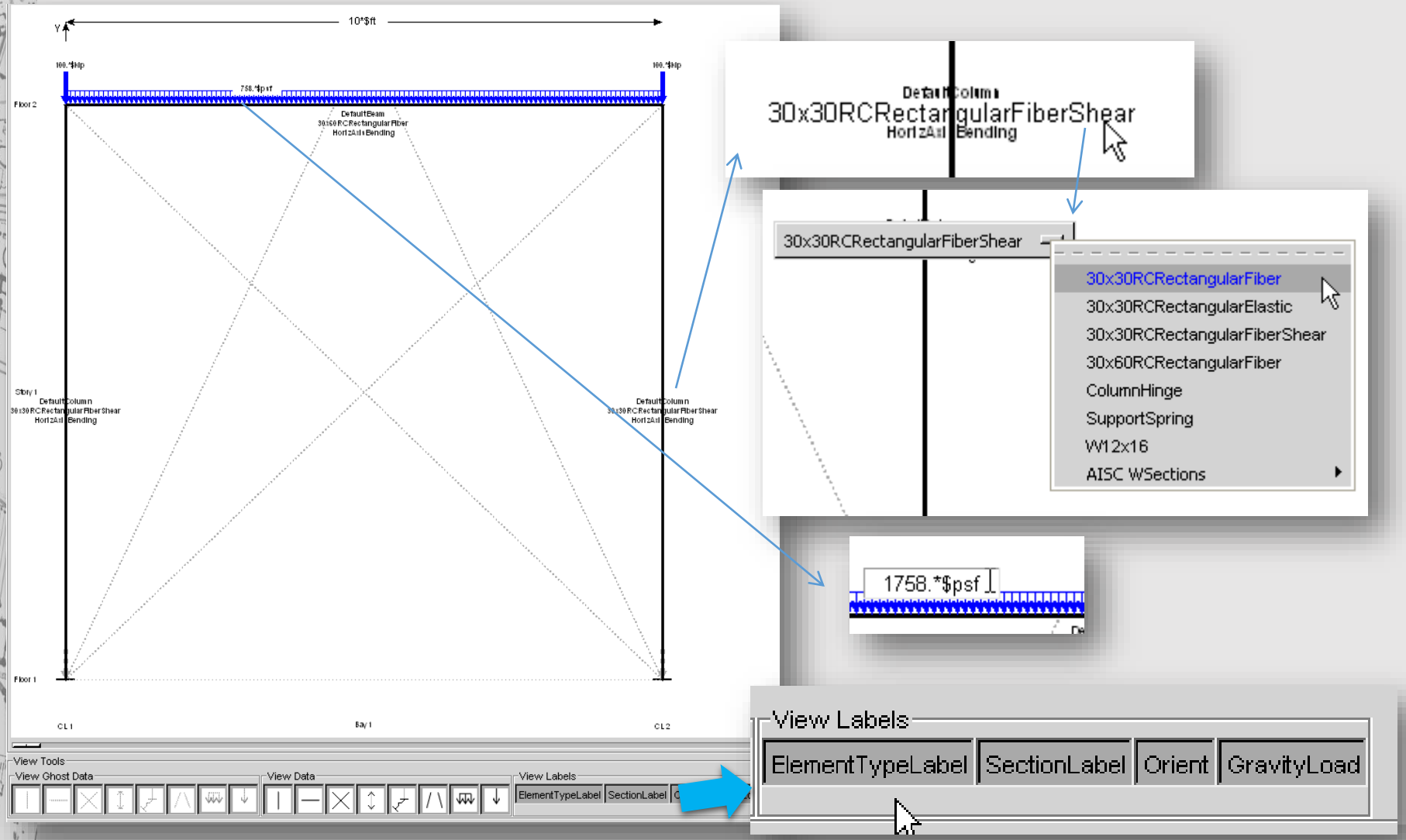




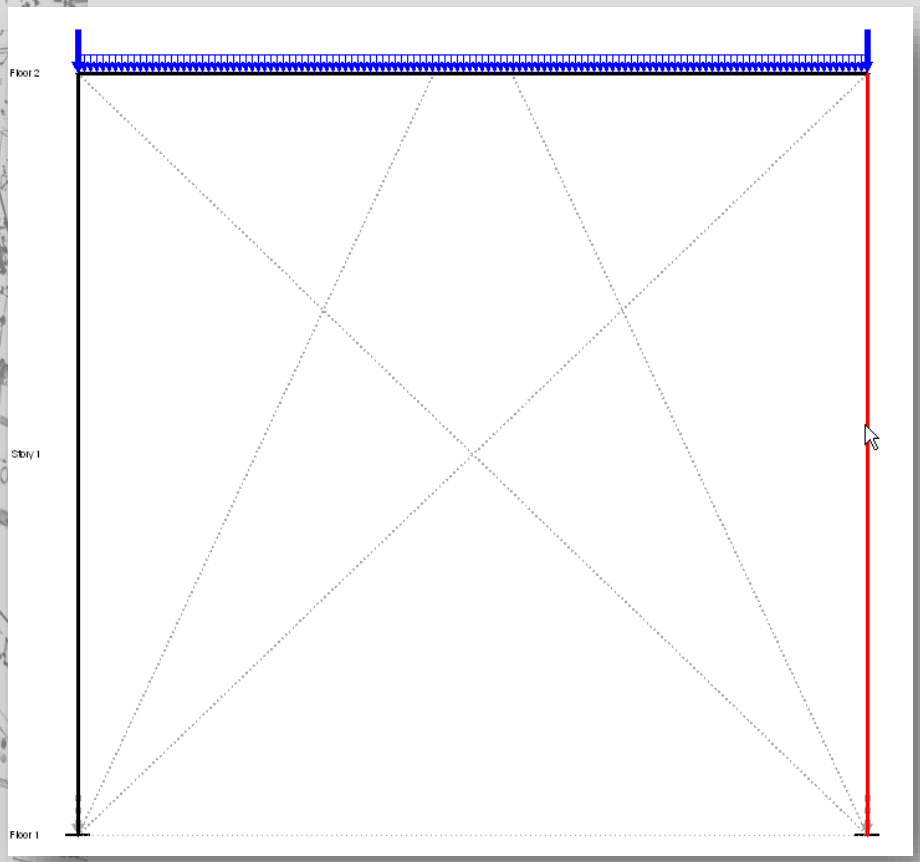


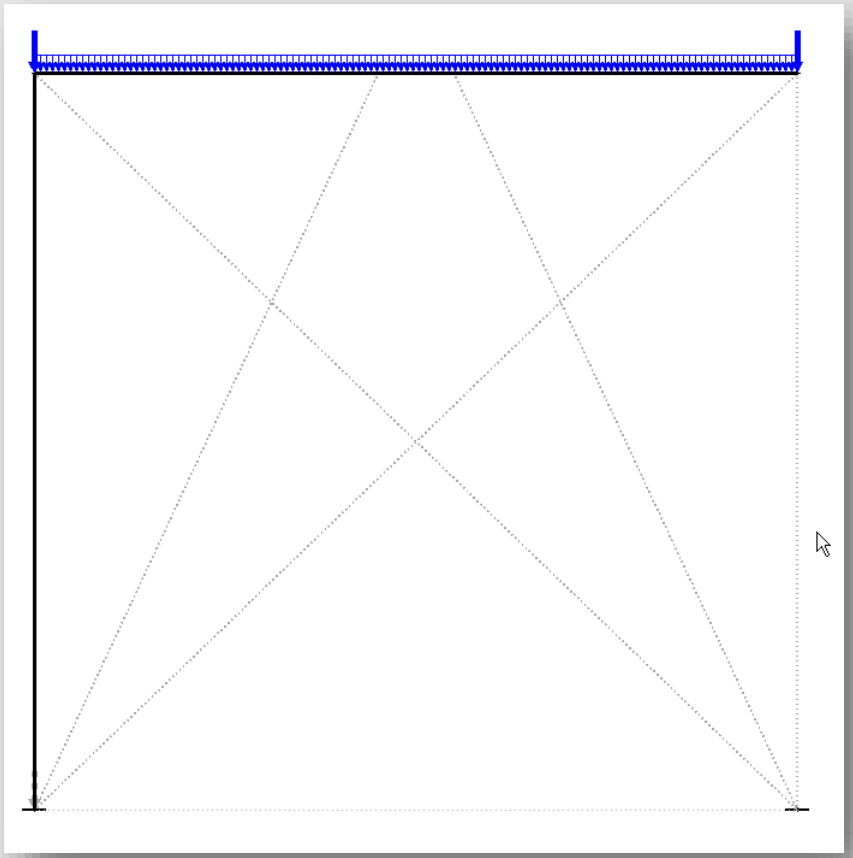
User needs to specify gravity loads for each gravity-load case.

Elevation Model Input
Element-Properties Editing

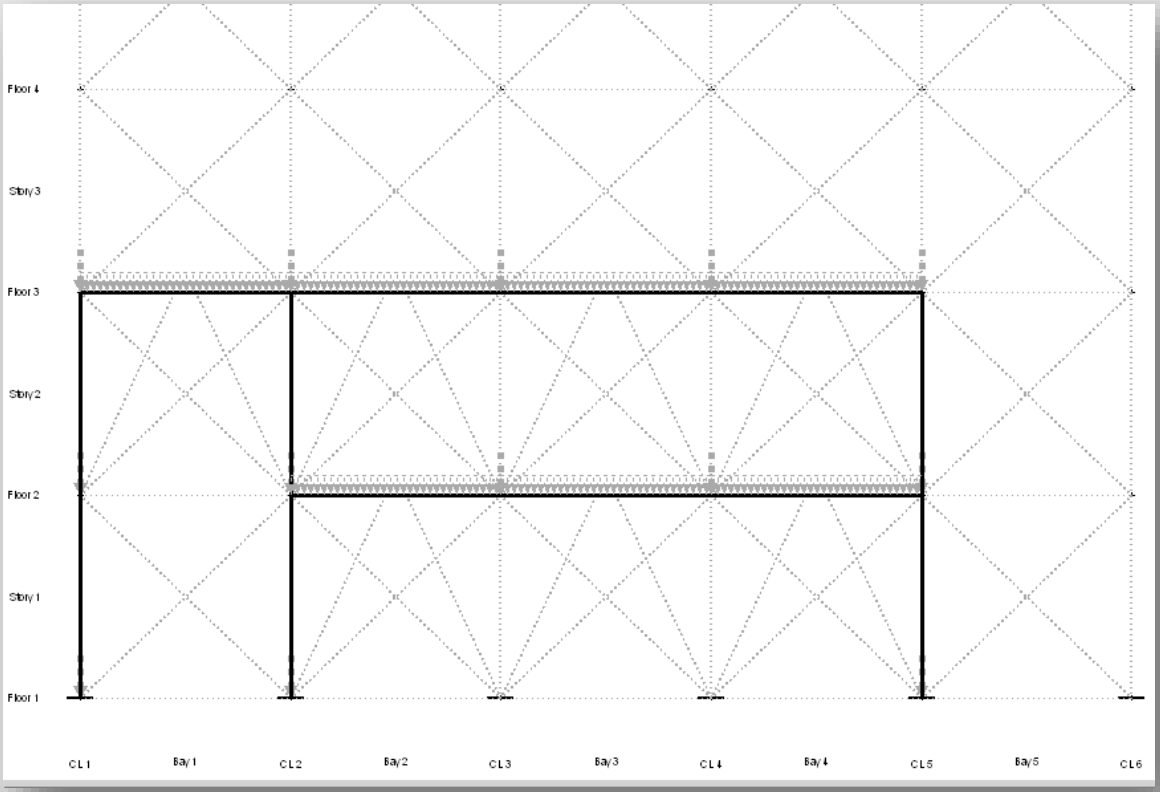


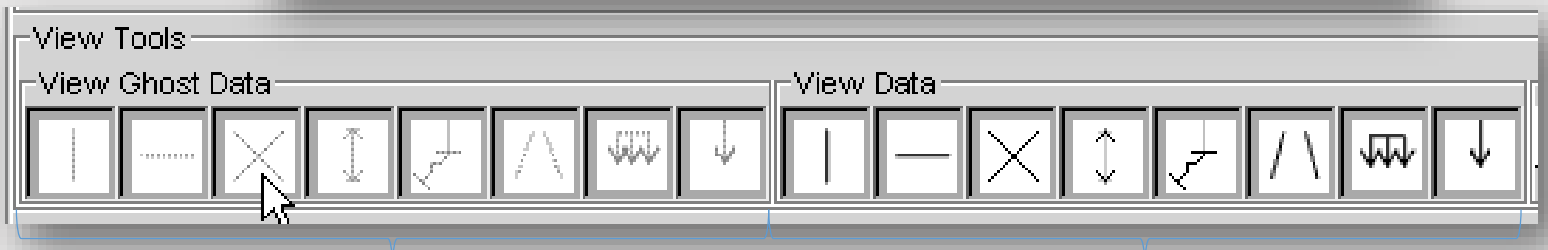
Elevation Model Input
Element/Load removal: Ctrl-key





Elevation Model Input
View-Object Slection

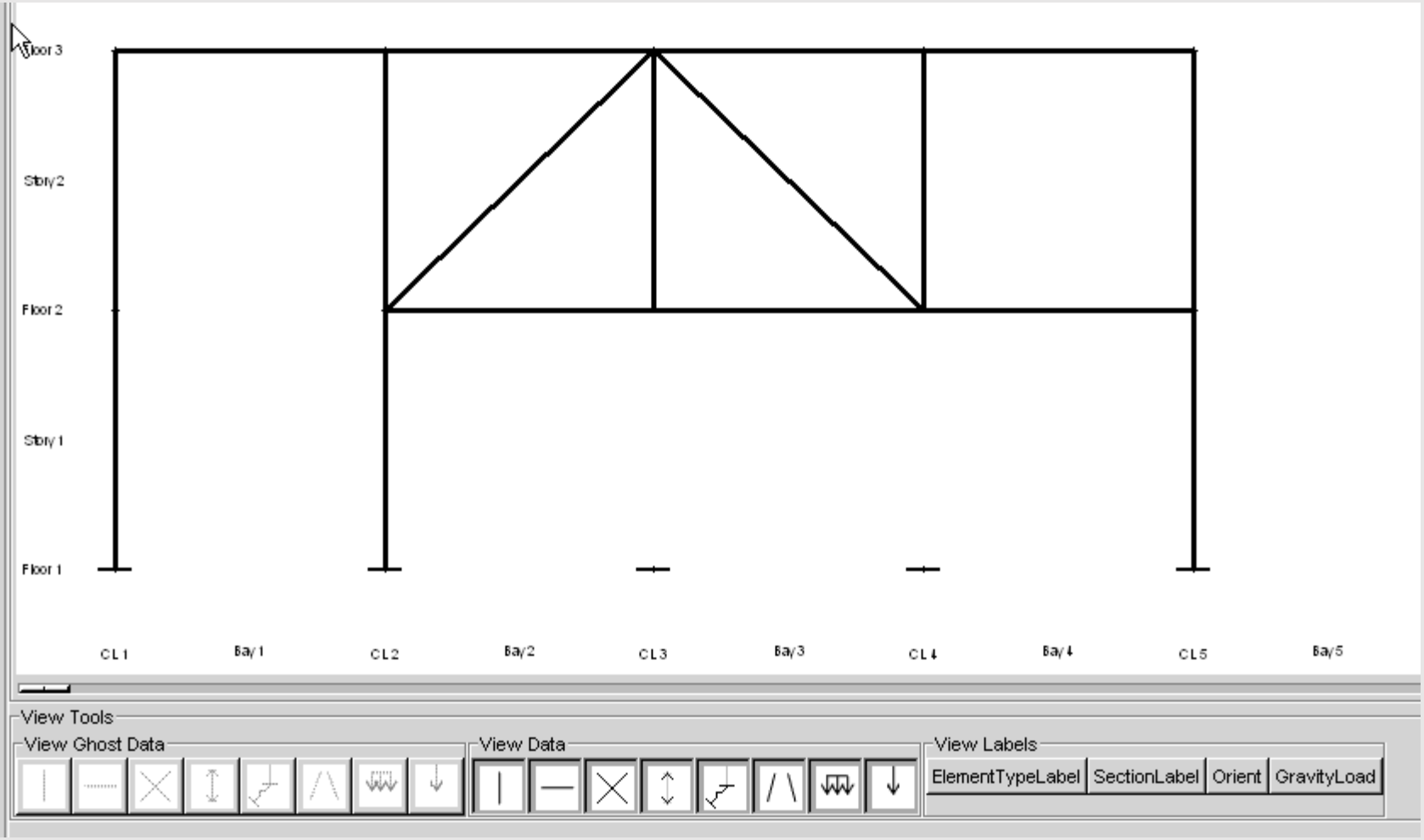




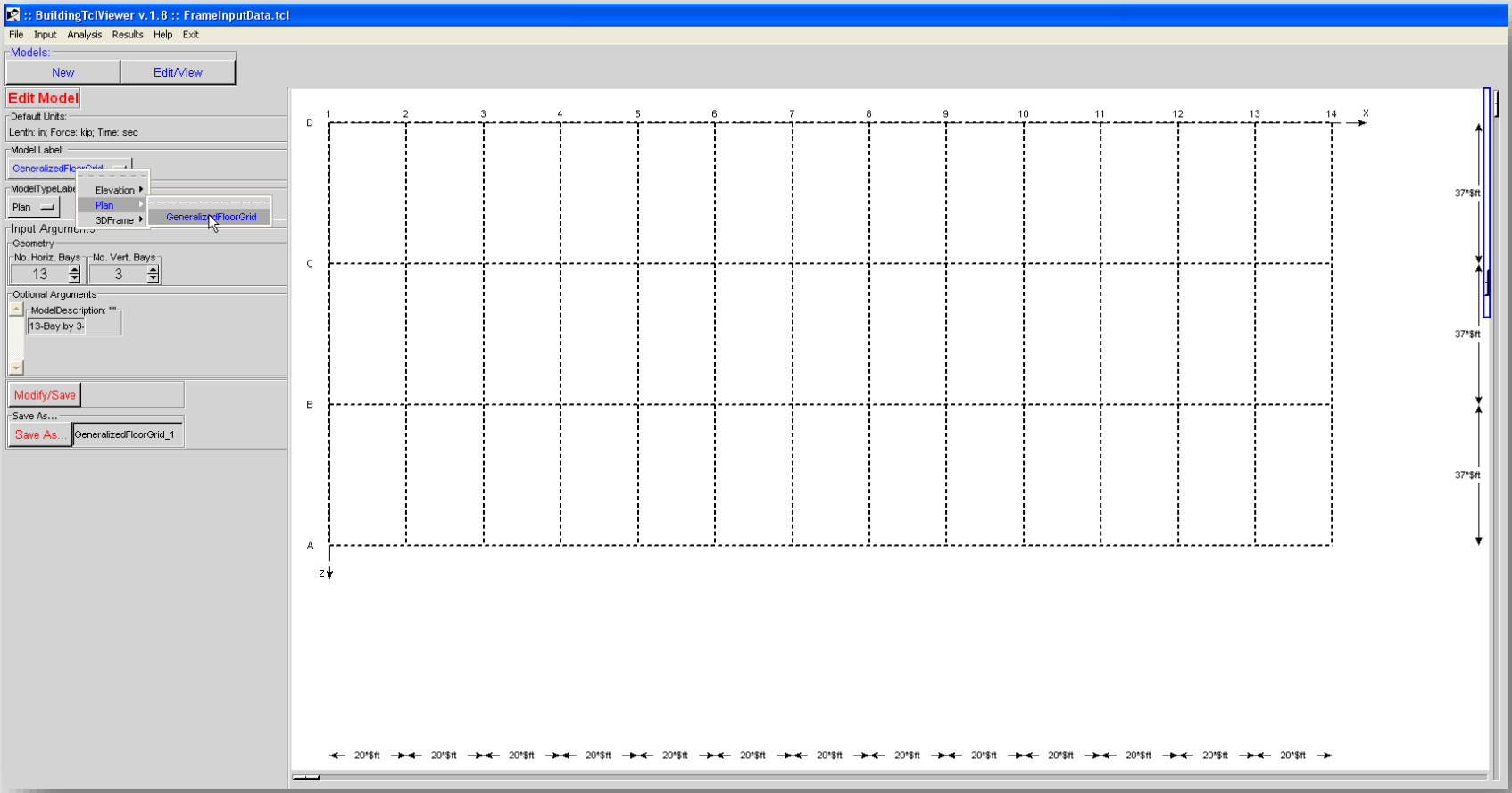
Possible Elements

Existing Elements

Elevation-Model Input
View Existing Elements only

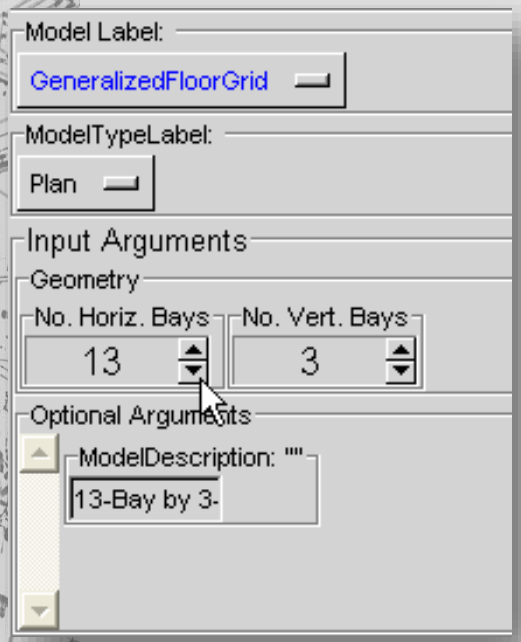


BuildingTcl Viewer – Grid Model

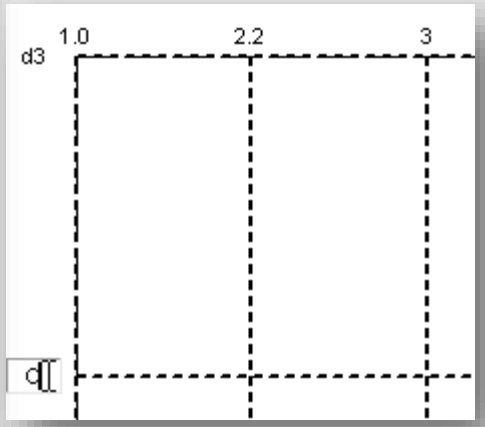


Grid-Model Input
edit grid

Number of Bays

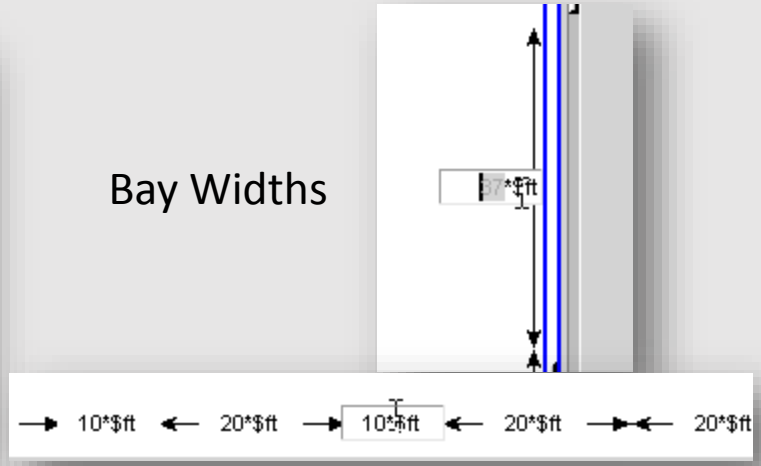


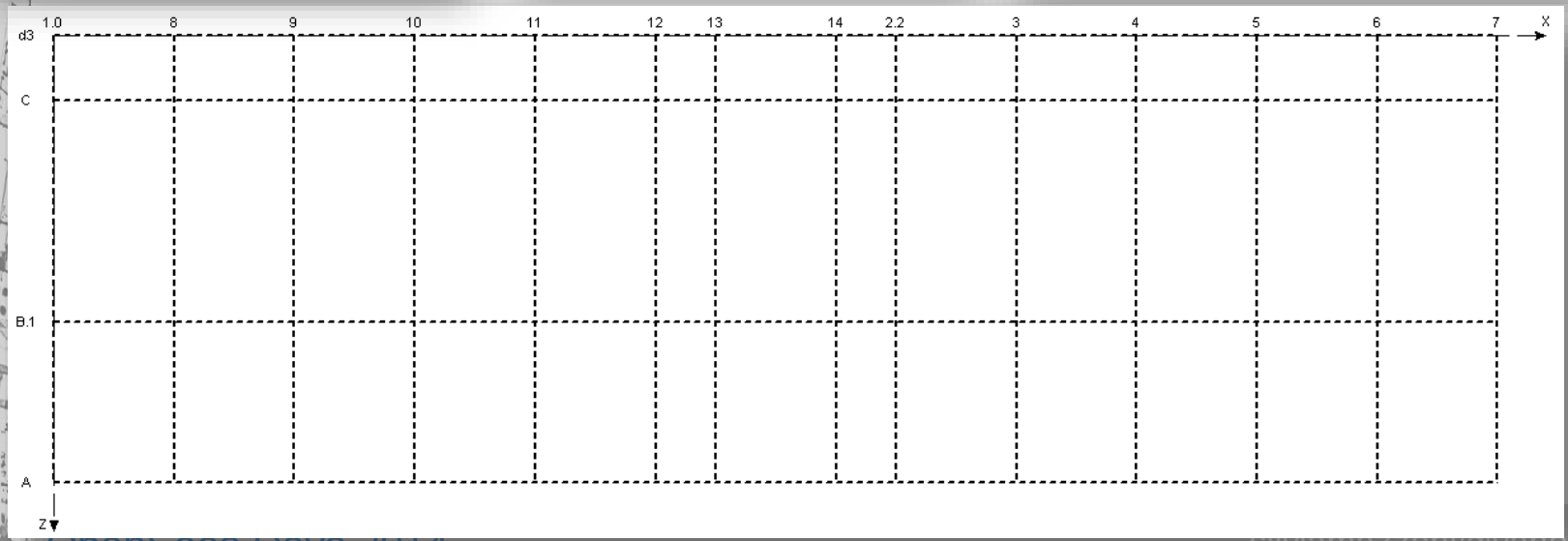
Column-Line Labels



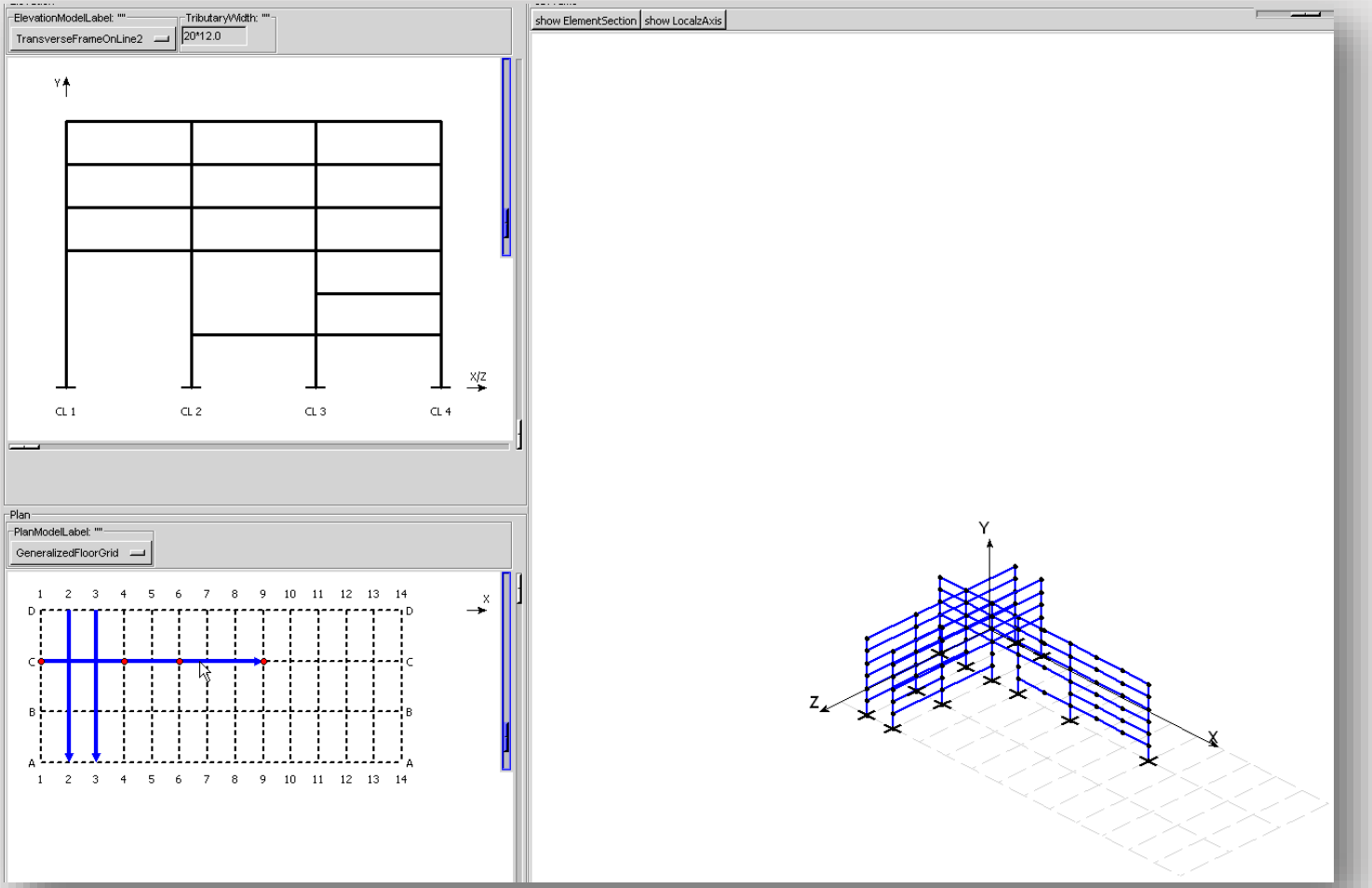
Plan Bay widths control
3DFrame Bay Widths

Bay Widths

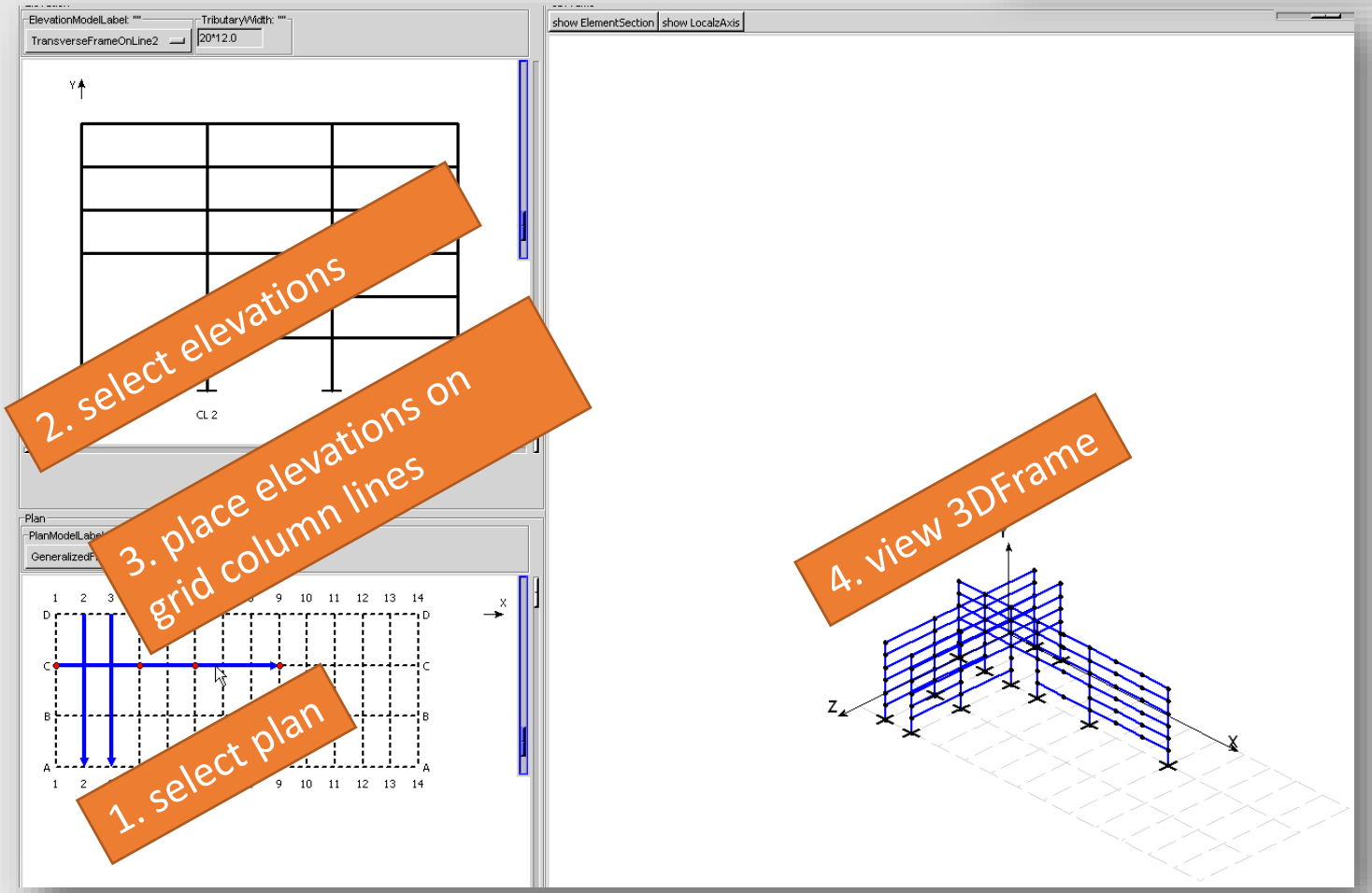




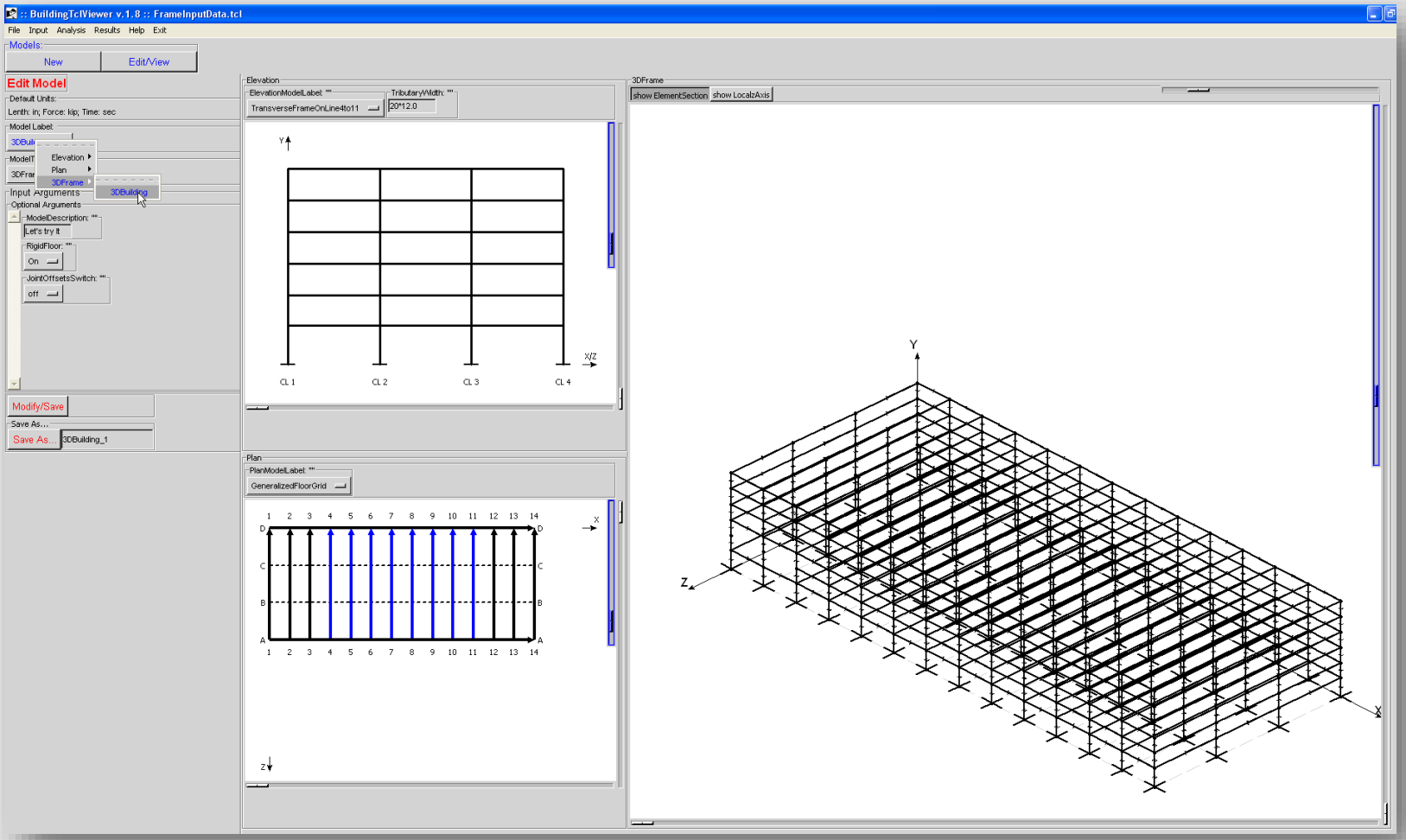
BuildingTcl Viewer – 3D Frame-Model Input



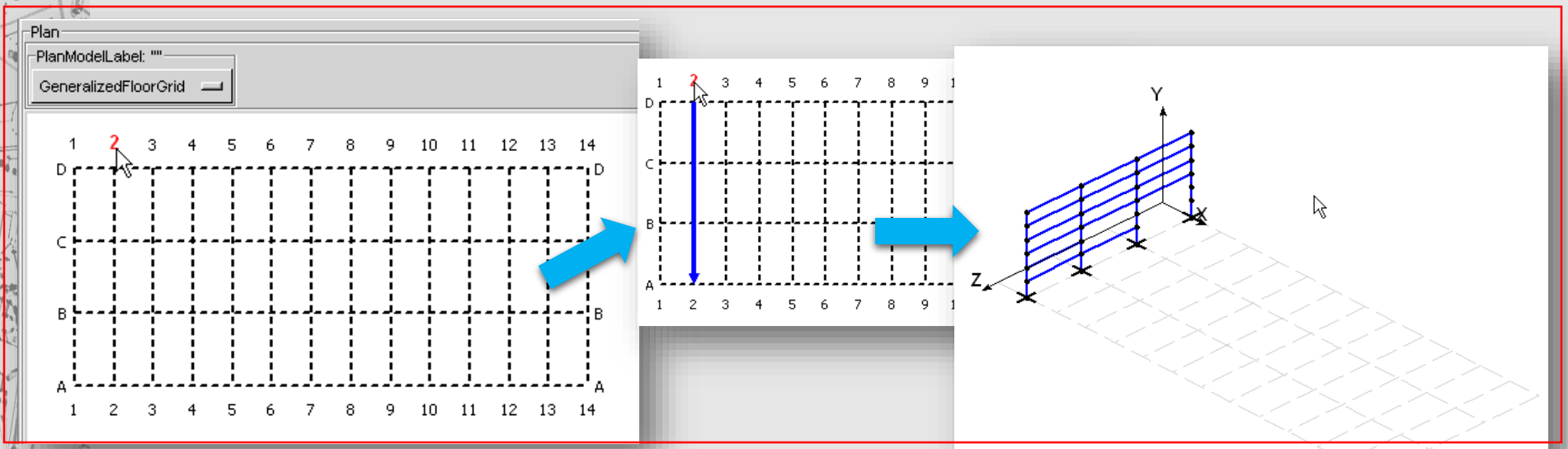
BuildingTcl Viewer – 3D Frame-Model Input



BuildingTcl Viewer – 3D Frame-Model Input

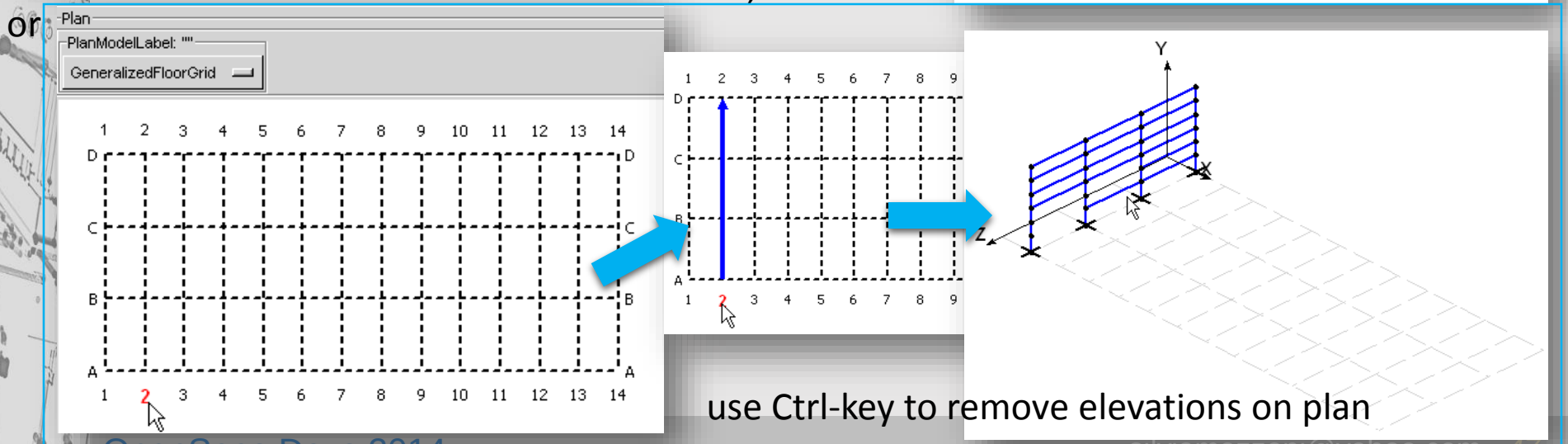


3. place elevation into plan column-line



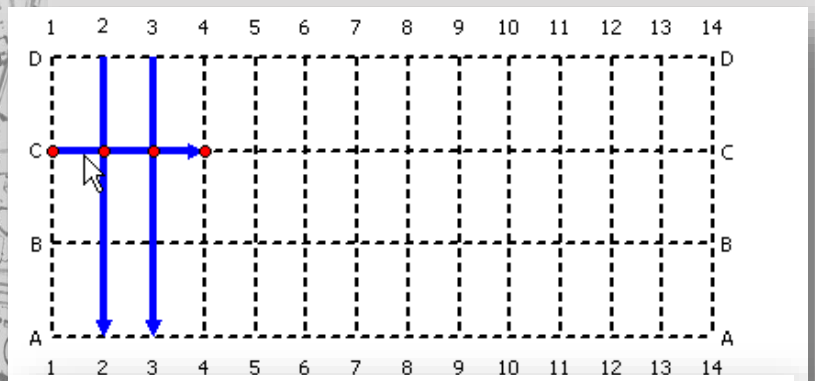
select from first column line for elevation, this determines orientation of elevation

or

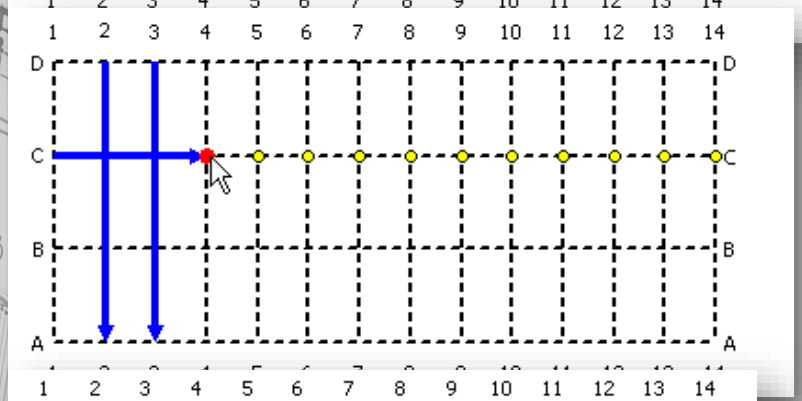


use Ctrl-key to remove elevations on plan

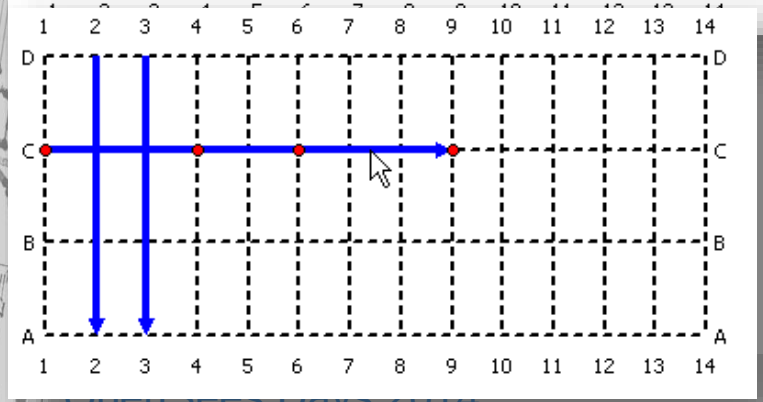
3DFrame-Model Input
Placing elevations



1. select elevation on plan by

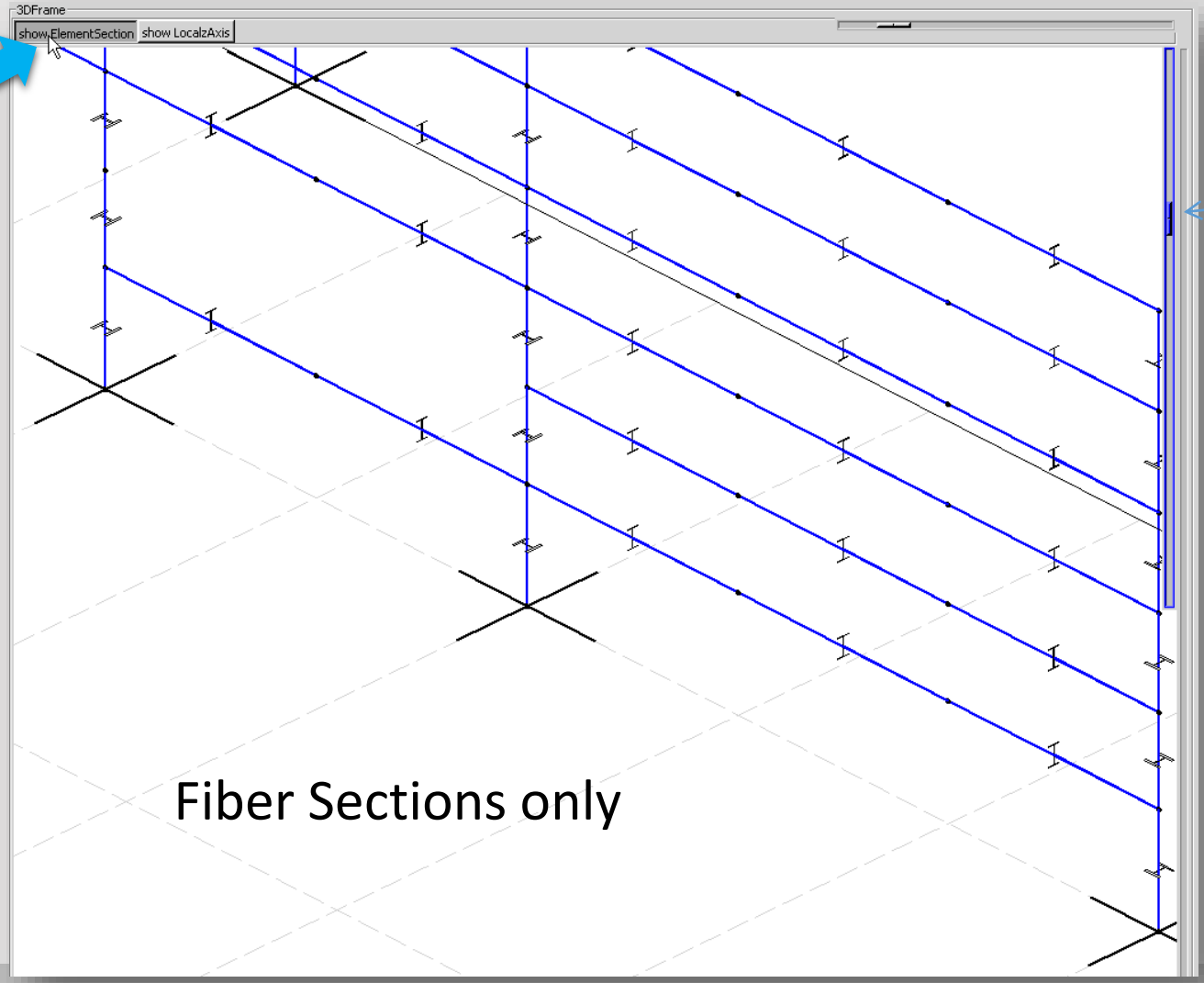


2. select first node to be moved. Nodes can be moved only if there is a free adjacent column-line intersection



3. select one of the possible nodes given
4. move next node.
Nodes can skip column lines.

3DFrame-Model Input
view Element Cross Sections

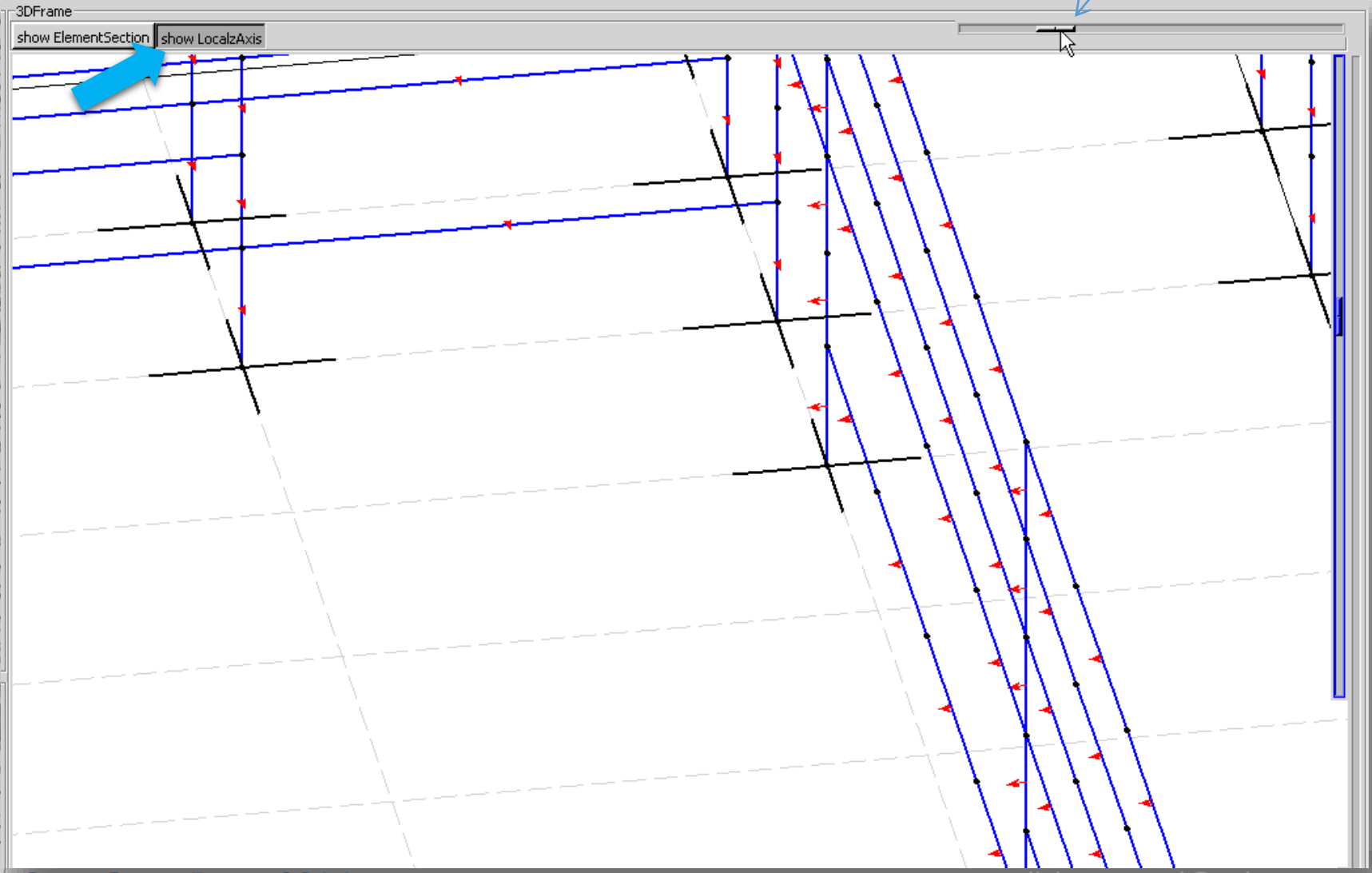


zoom

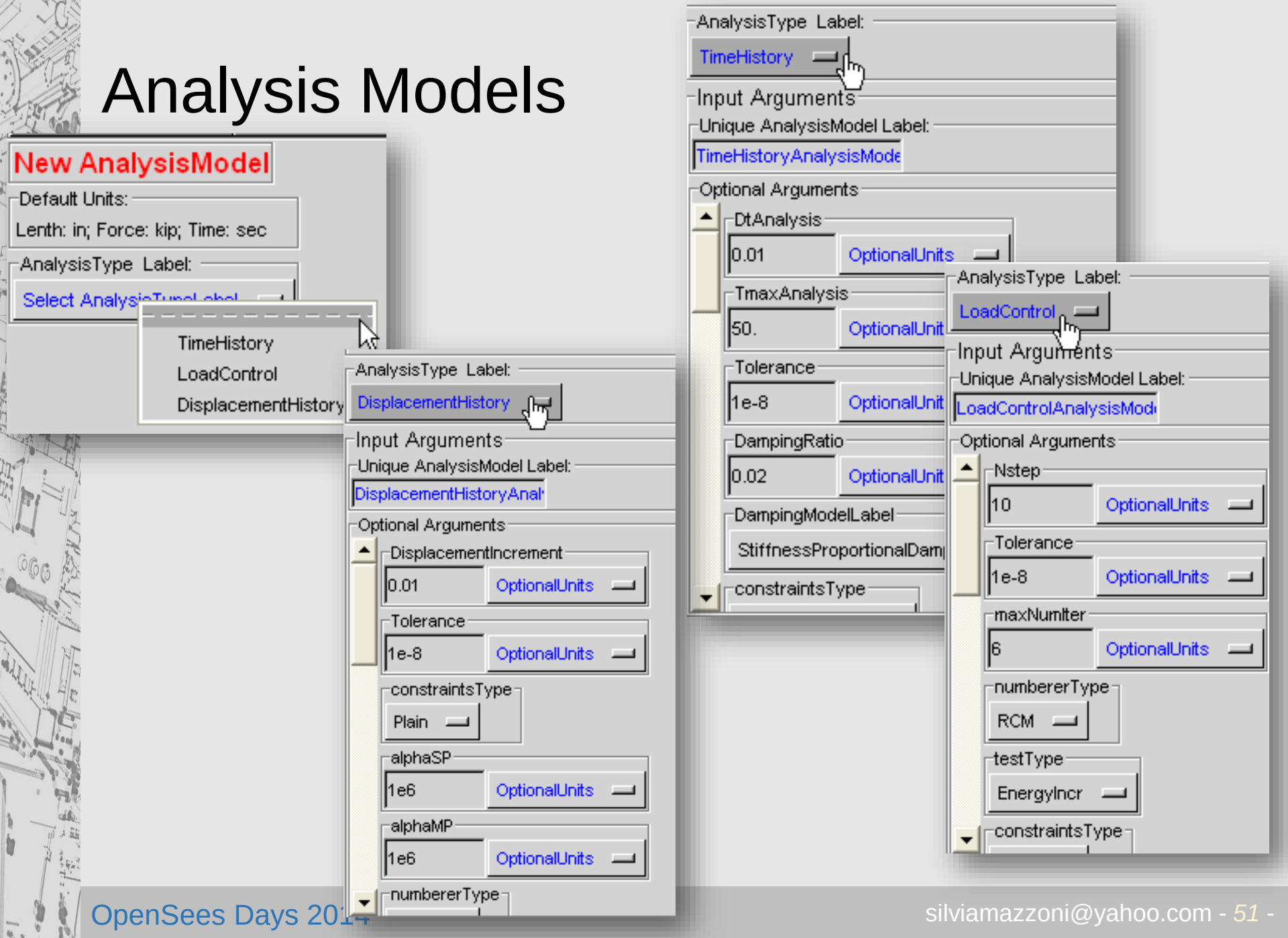
(double-click to reset=1)

3DFrame-Model Input
view local z-axis

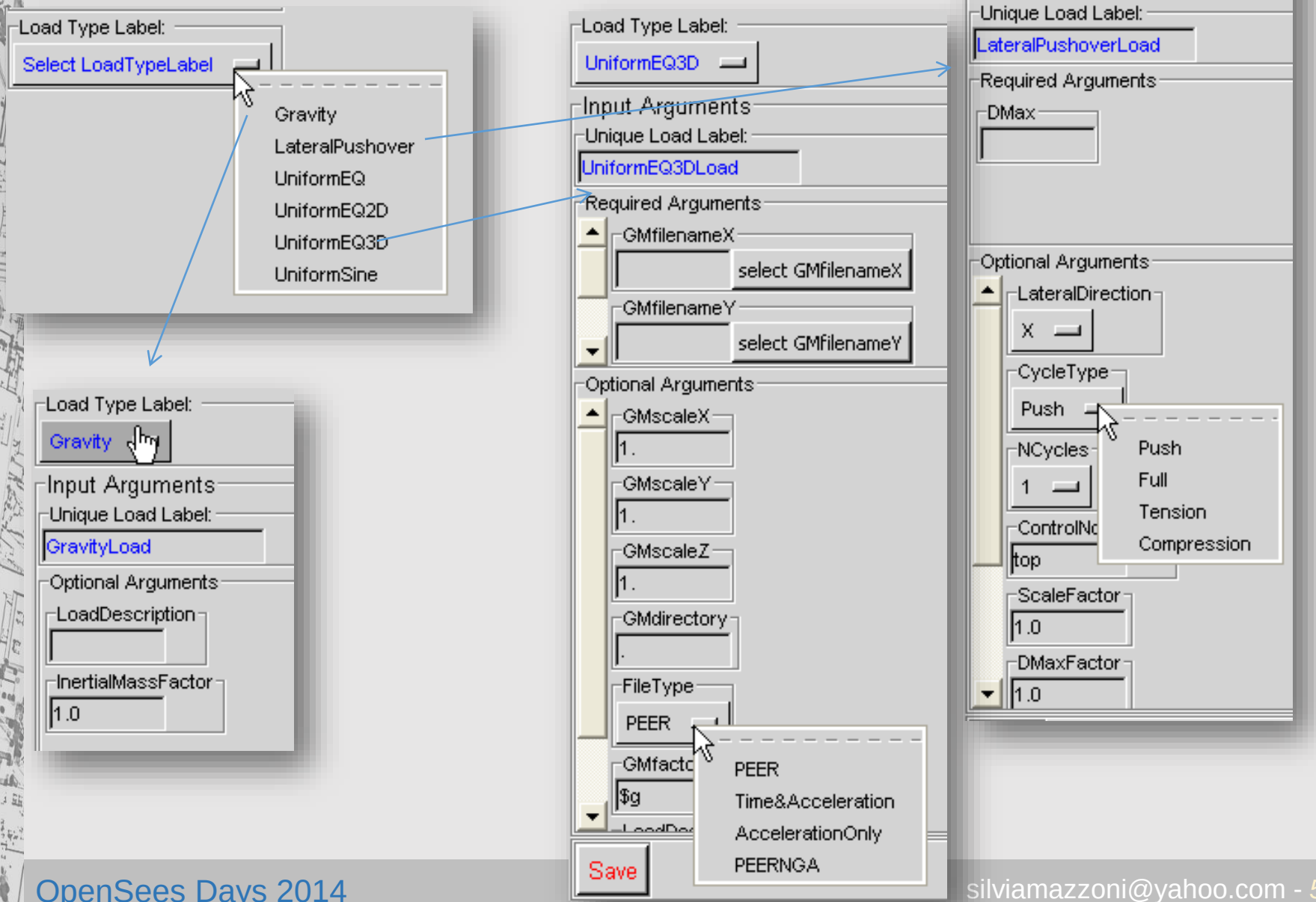
rotate
(double-click to reset=1)



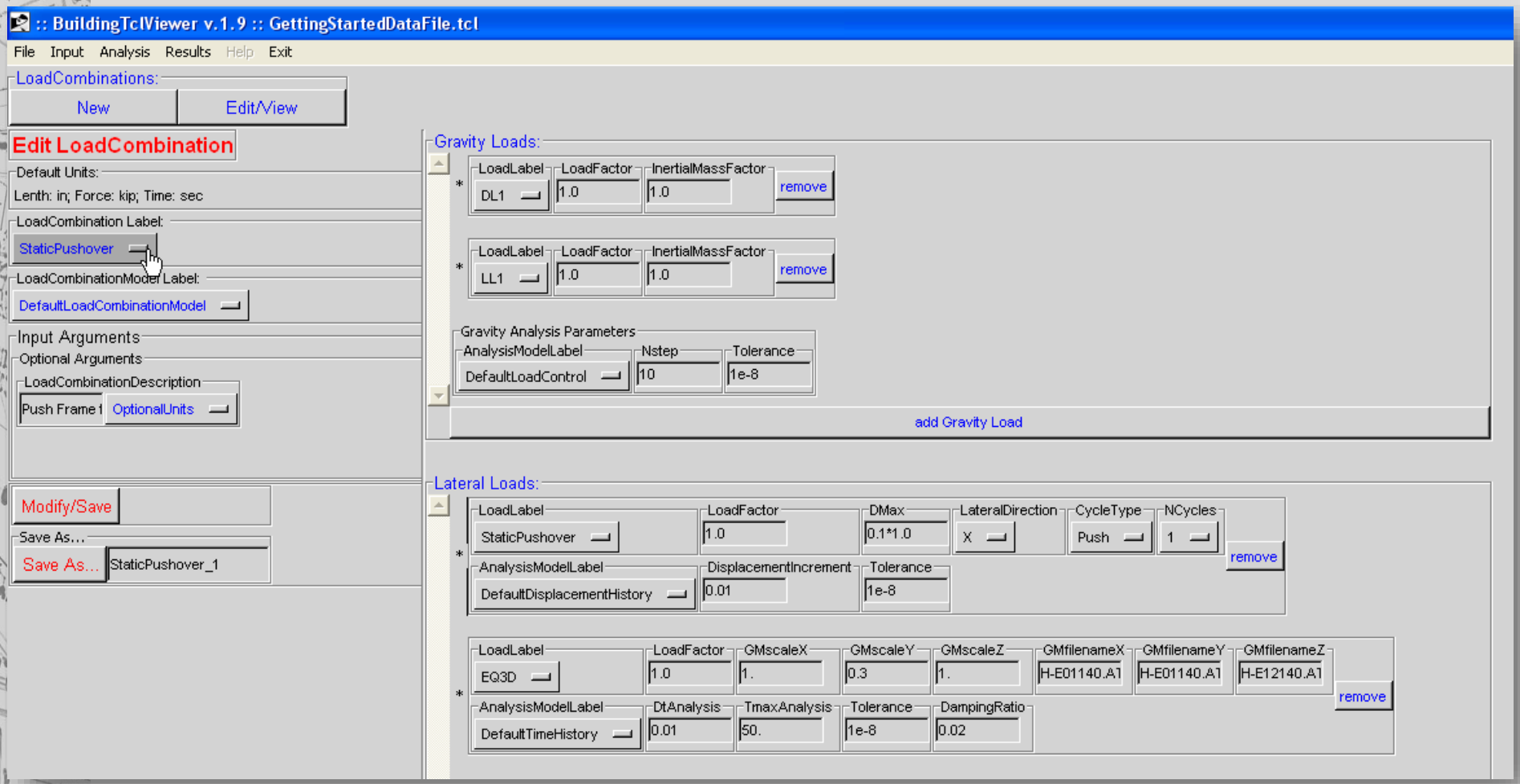
Analysis Models



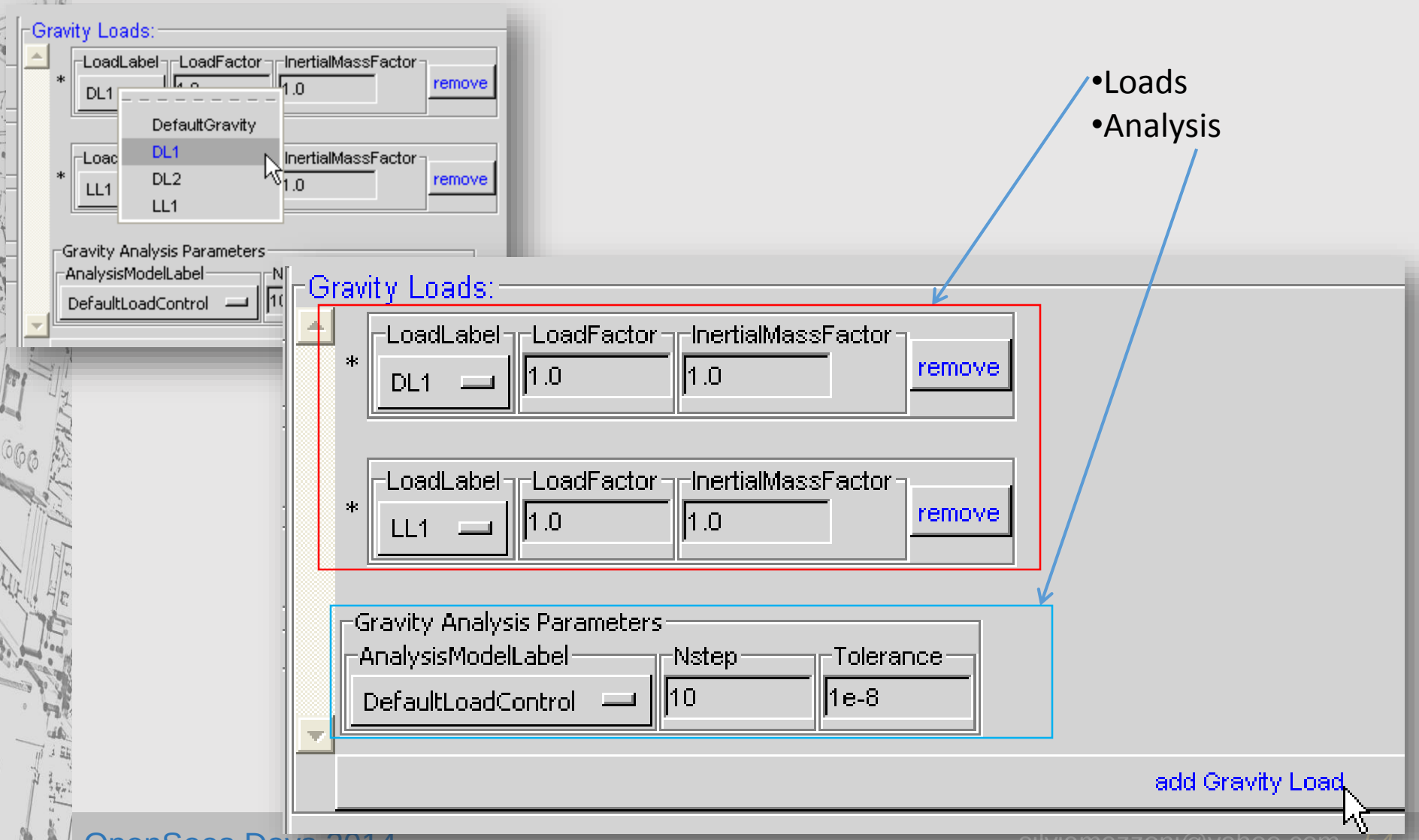
Loads


Load Type Label:
Select LoadTypeLabel
Gravity
LateralPushover
UniformEQ
UniformEQ2D
UniformEQ3D
UniformSine
Load Type Label:
Gravity
Input Arguments
Unique Load Label:
GravityLoad
Optional Arguments
LoadDescription
InertialMassFactor
1.0
Load Type Label:
UniformEQ3D
Input Arguments
Unique Load Label:
UniformEQ3DLoad
Required Arguments
GMfilenameX
select GMfilenameX
GMfilenameY
select GMfilenameY
Optional Arguments
GMscaleX
1.
GMscaleY
1.
GMscaleZ
1.
GMdirectory
.
FileType
PEER
$g
PEER
Time&Acceleration
AccelerationOnly
PEERNGA
Save
Load Type Label:
LateralPushover
Input Arguments
Unique Load Label:
LateralPushoverLoad
Required Arguments
DMax
Optional Arguments
LateralDirection
X
CycleType
Push
Push
Full
Tension
Compression
NCycles
1
top
ScaleFactor
1.0
DMaxFactor
1.0

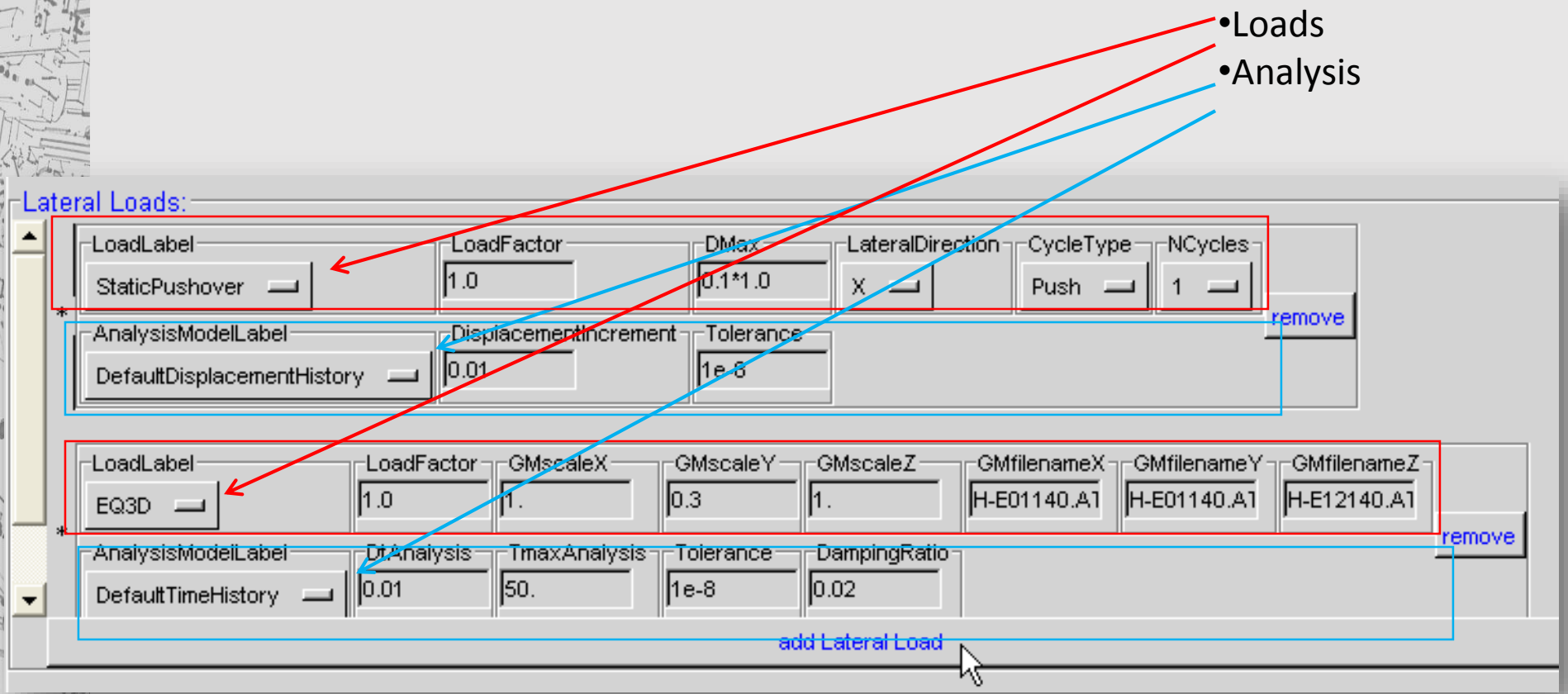
LoadCombinations



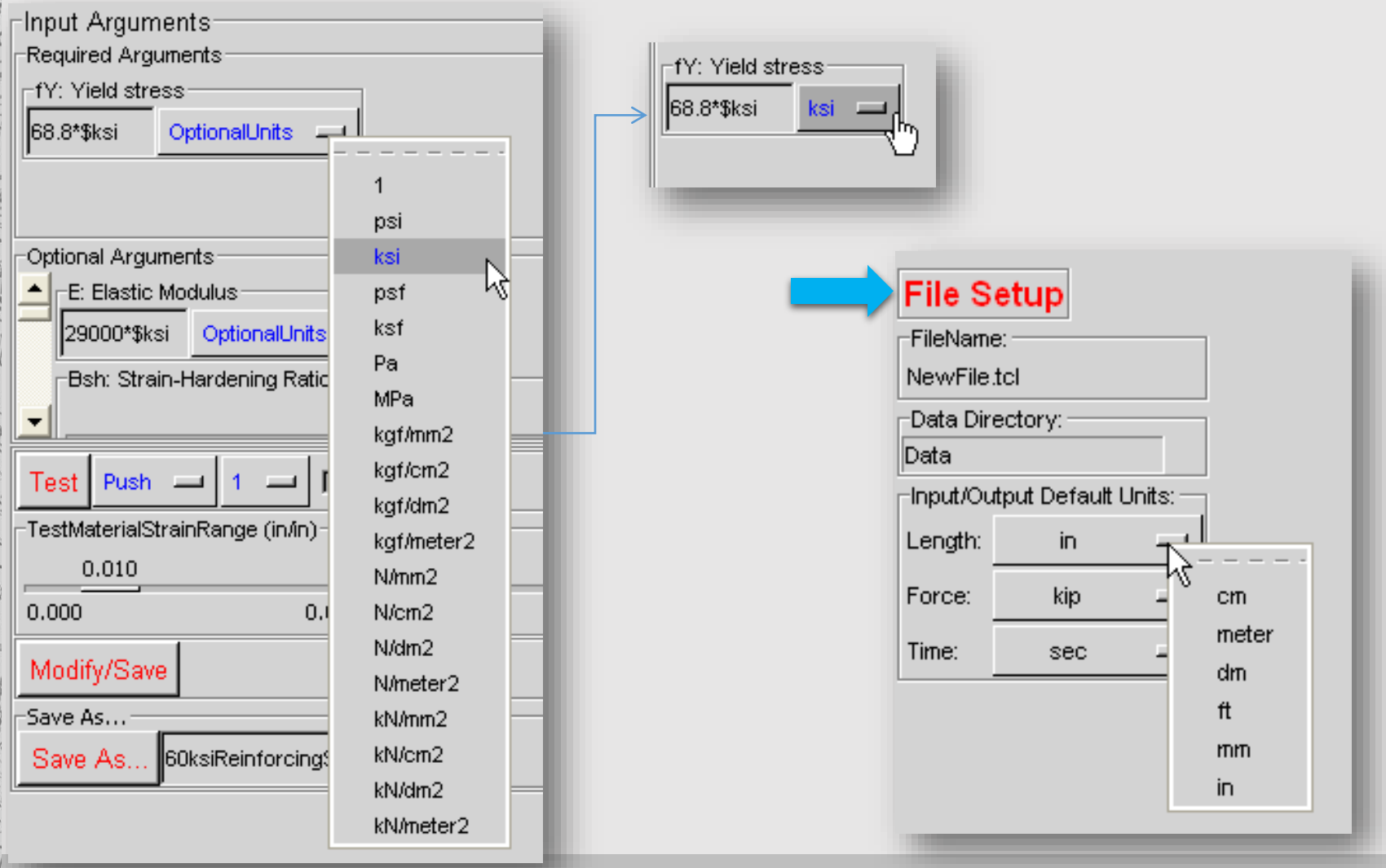
LoadCombinations
Gravity Loads



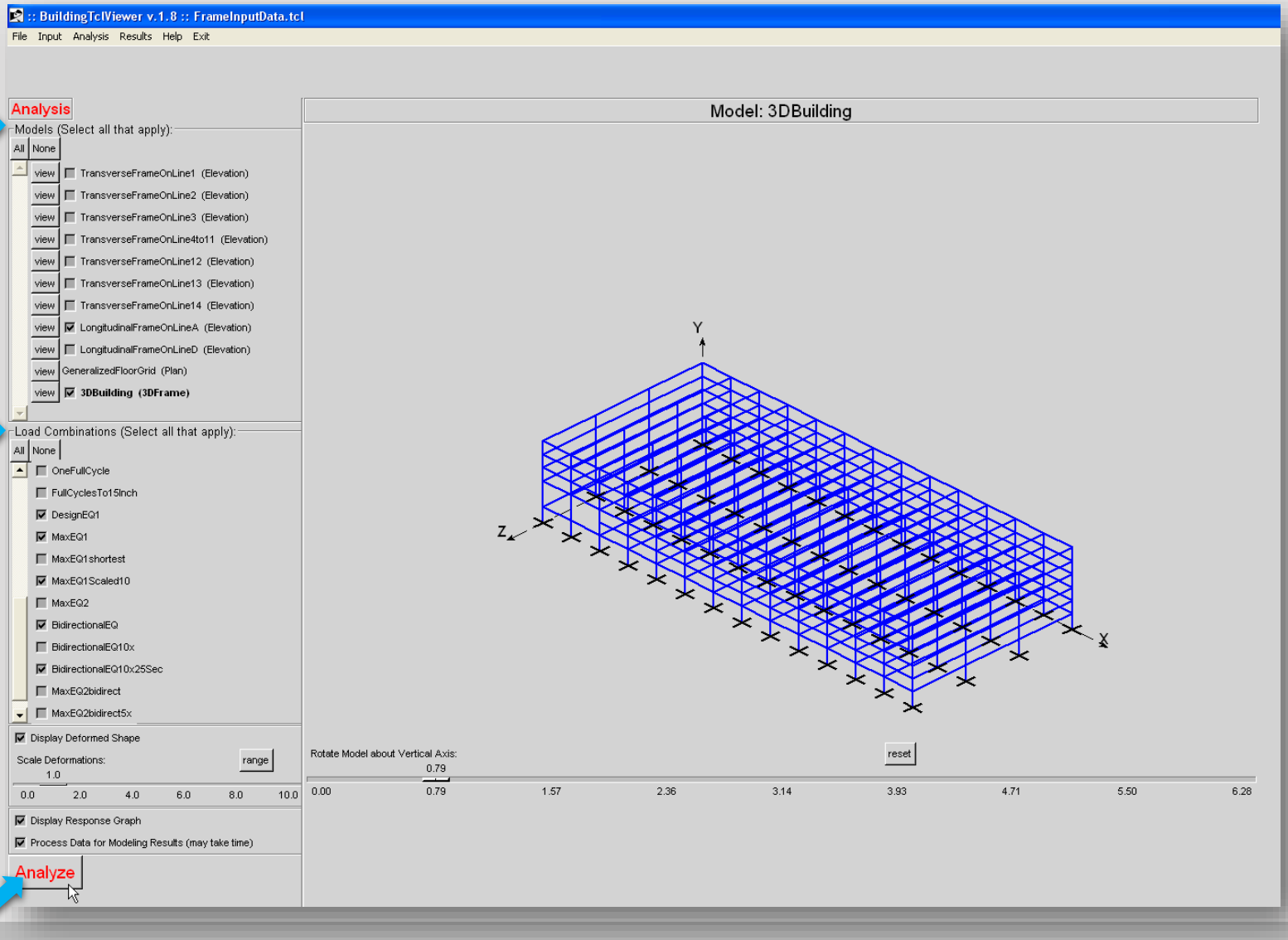
LoadCombinations
Lateral Loads



You can use units



Run Simulation(s)



Select Models and LoadCombinations for Analysis

Models (Select all that apply):

All | None

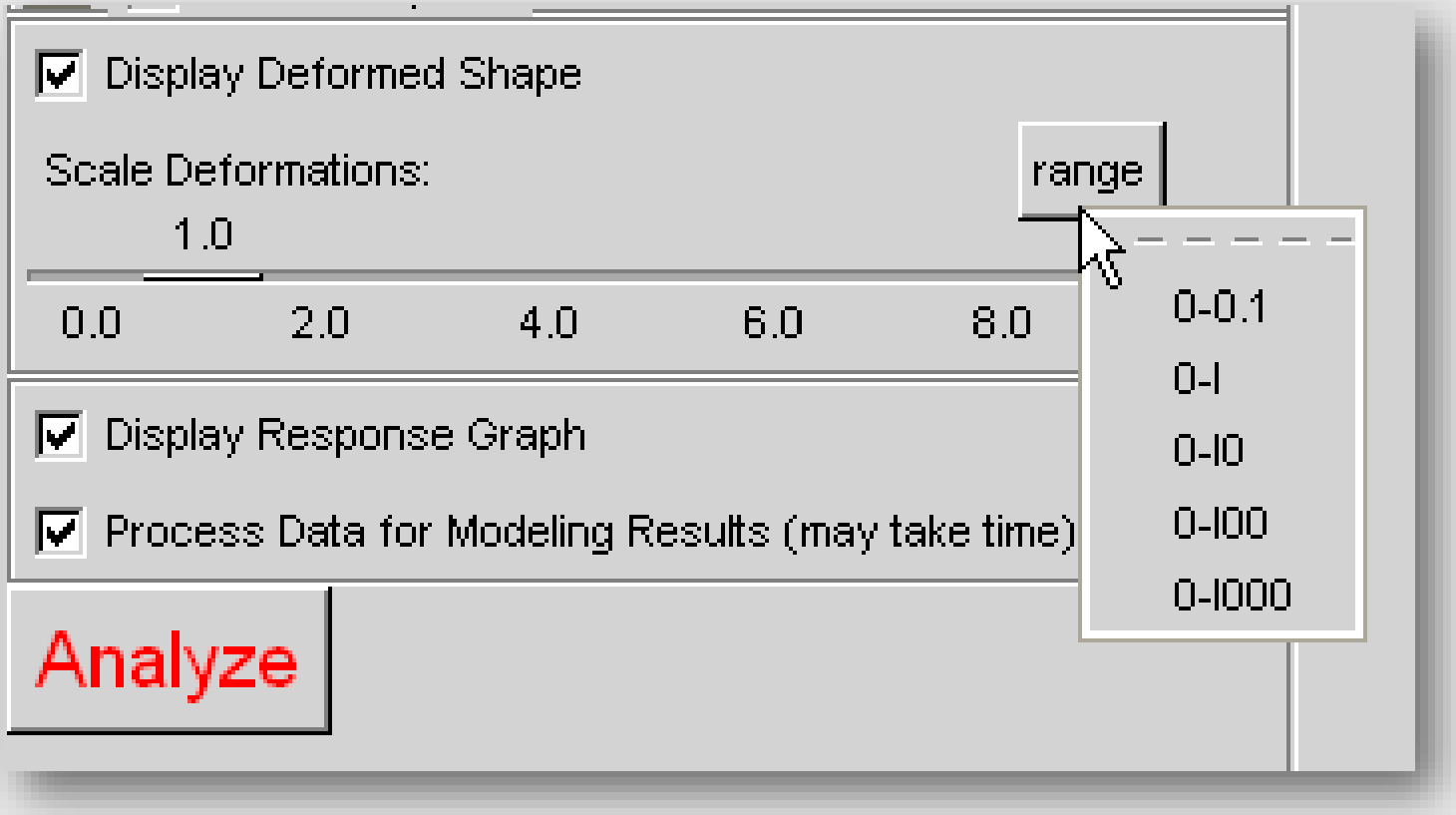
view	☐	TransverseFrameOnLine1 (Elevation)
view	☐	TransverseFrameOnLine2 (Elevation)
view	☐	TransverseFrameOnLine3 (Elevation)
view	☑	TransverseFrameOnLine4to11 (Elevation)
view	☐	TransverseFrameOnLine12 (Elevation)
view	☐	TransverseFrameOnLine13 (Elevation)
view	☑	TransverseFrameOnLine14 (Elevation)
view	☐	LongitudinalFrameOnLineA (Elevation)
view	☐	LongitudinalFrameOnLineD (Elevation)
view		GeneralizedFloorGrid (Plan)
view	☑	**3DBuilding (3DFrame)**

Load Combinations (Select all that apply):

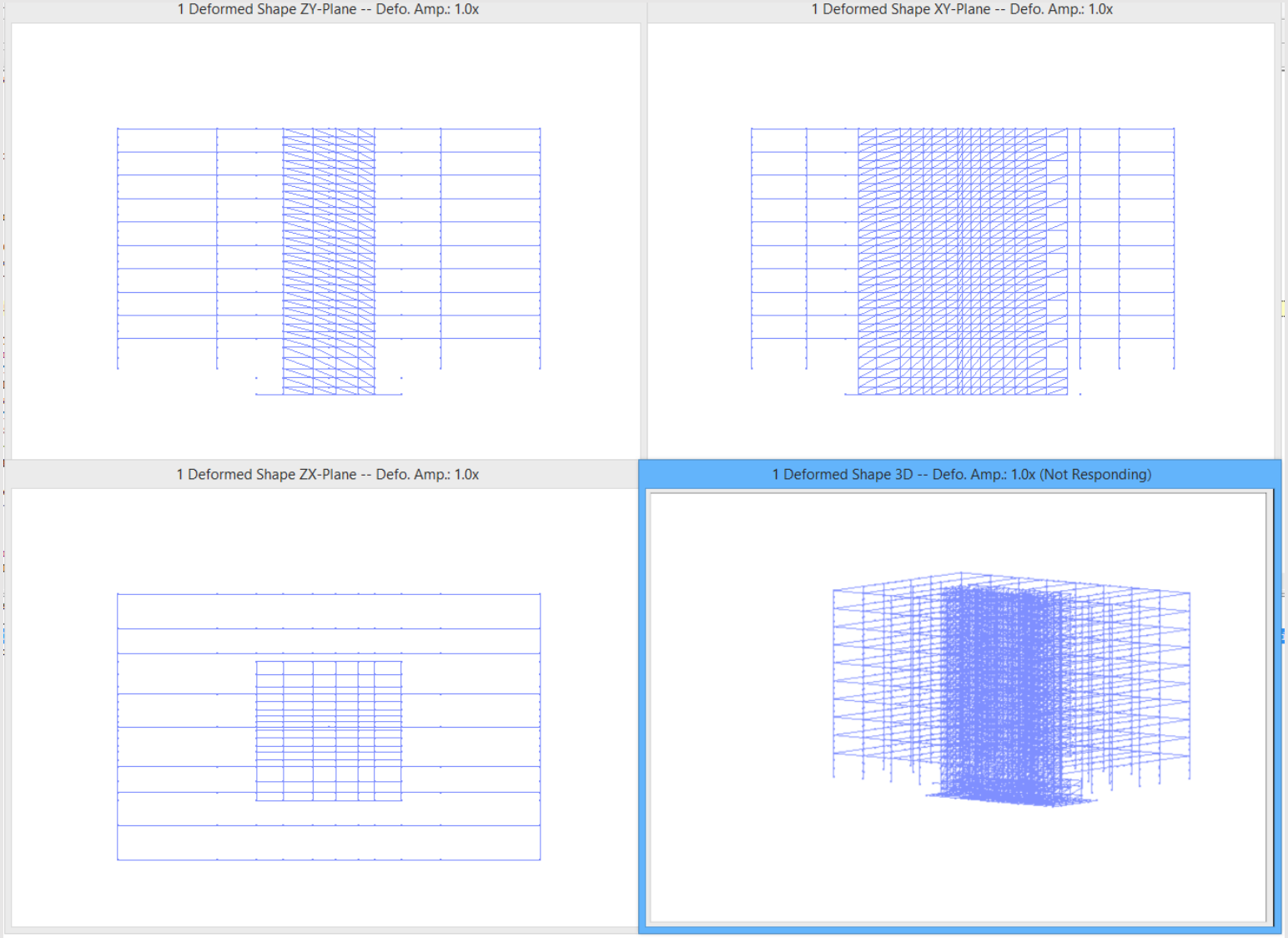
All | None

- ☐ GravityDLonly
- ☐ GravityDLandLL
- ☑ Gravity17DLand14LL
- ☐ ReallyShortStaticPushover
- ☑ StaticPushoverLargeSteps
- ☐ StaticPushoverLargeStepsZ
- ☐ PushToTenPercentDrift
- ☐ PushToTenPercentDriftZ
- ☑ FullCycles1
- ☐ FullCycles2
- ☐ ShortHalfCycle
- ☐ ShortHalfCycle1

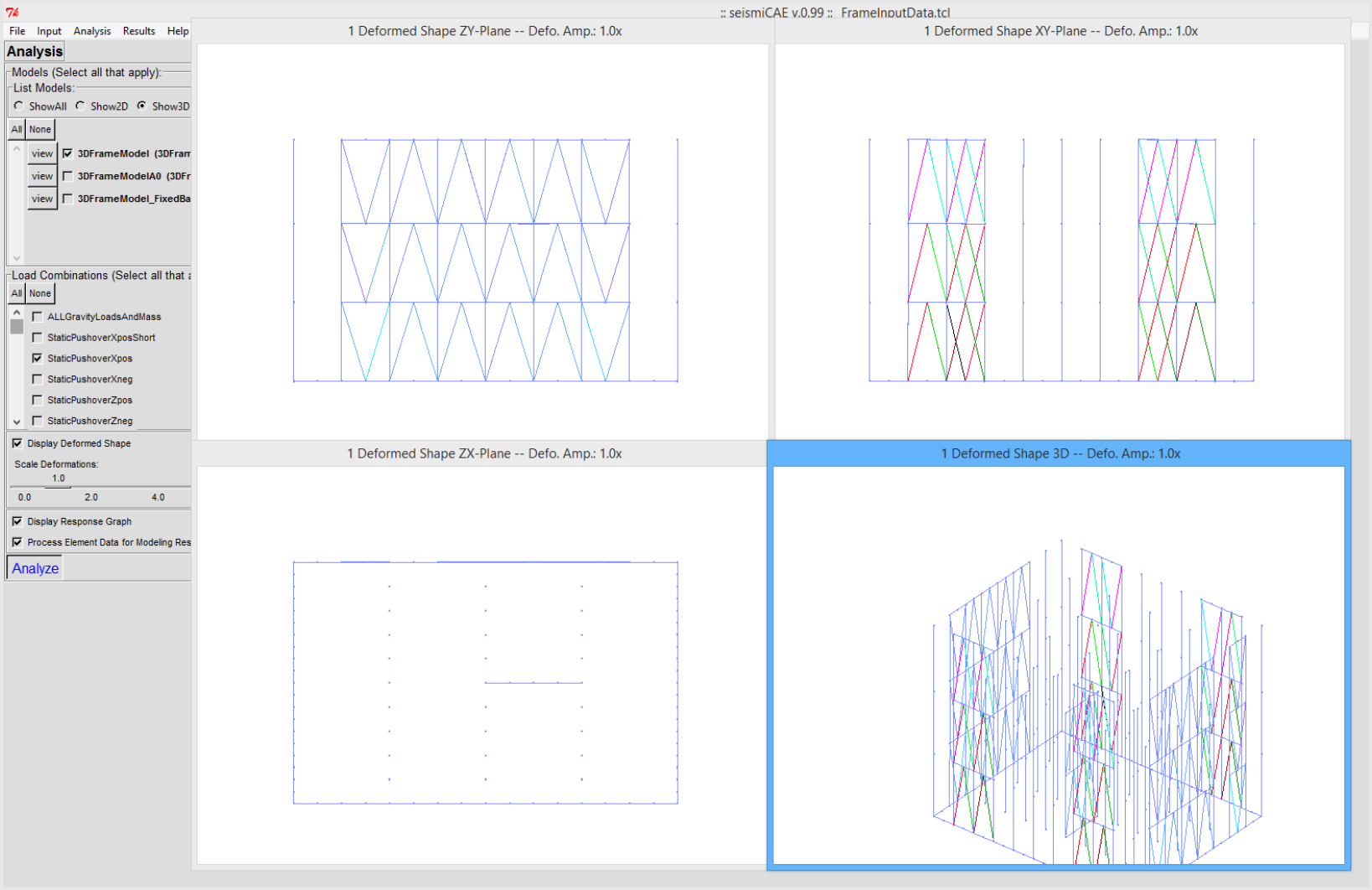
Real-Time Visualization Controls



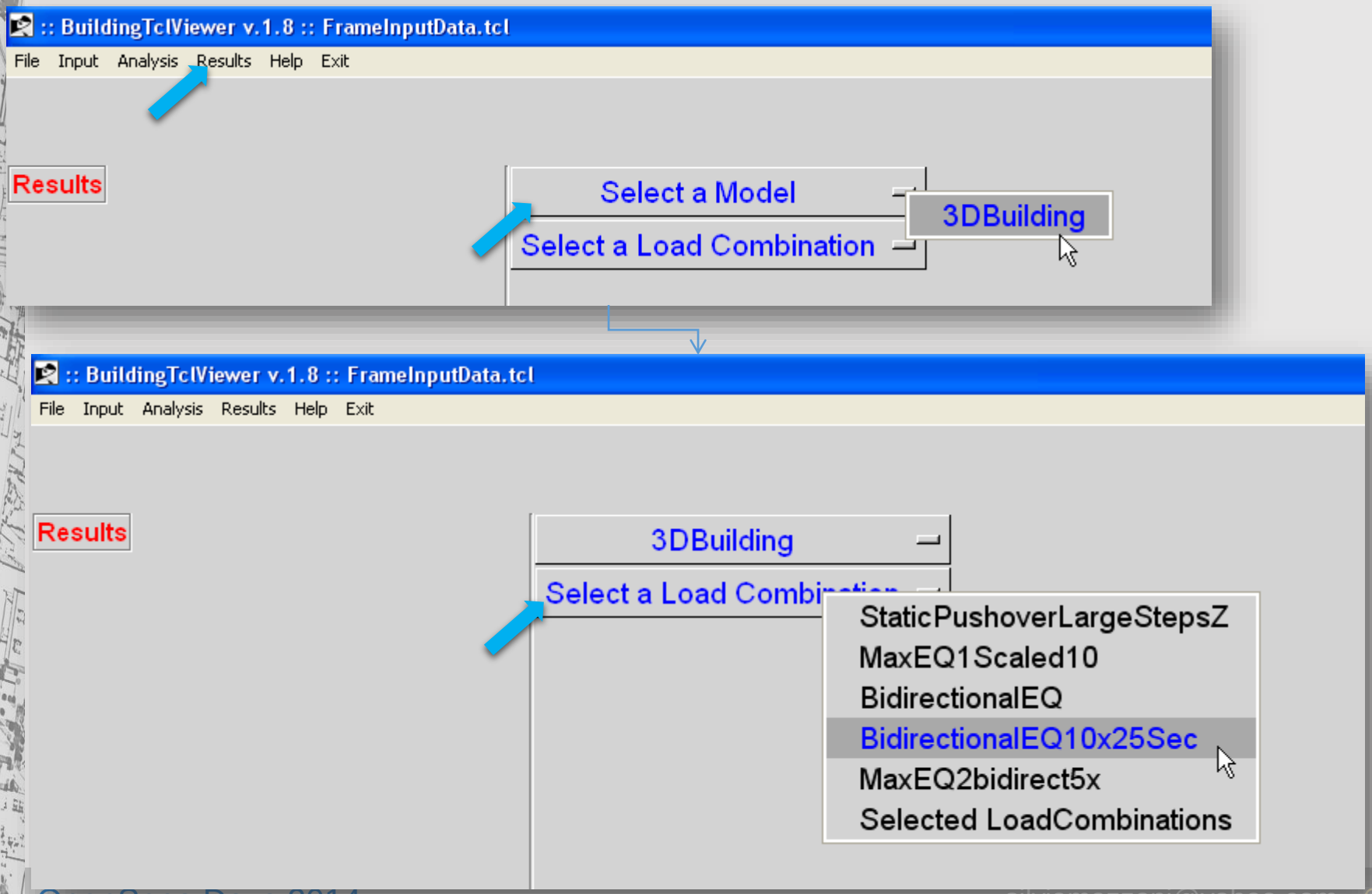
Real-Time Visualization



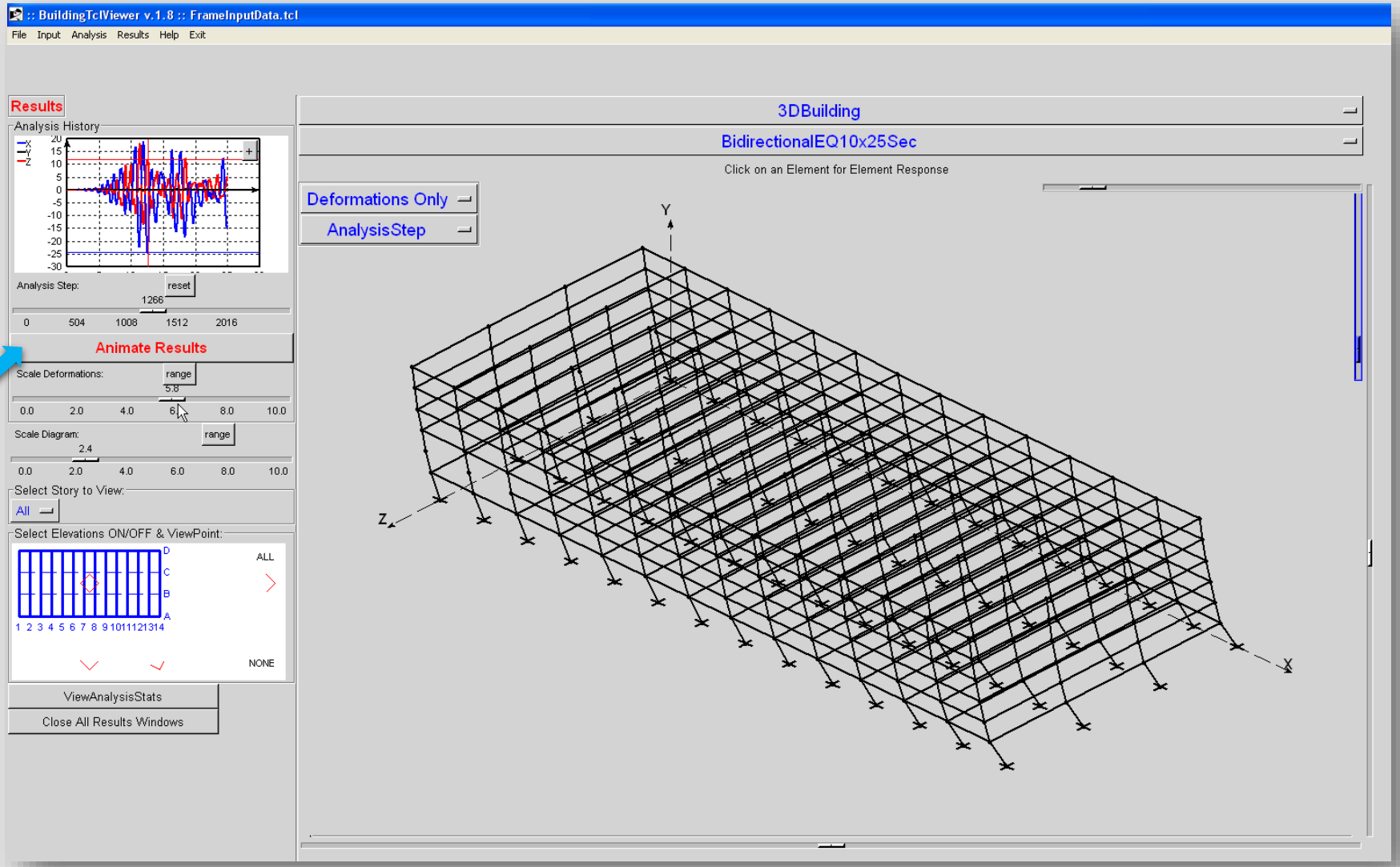
Real-Time Visualization



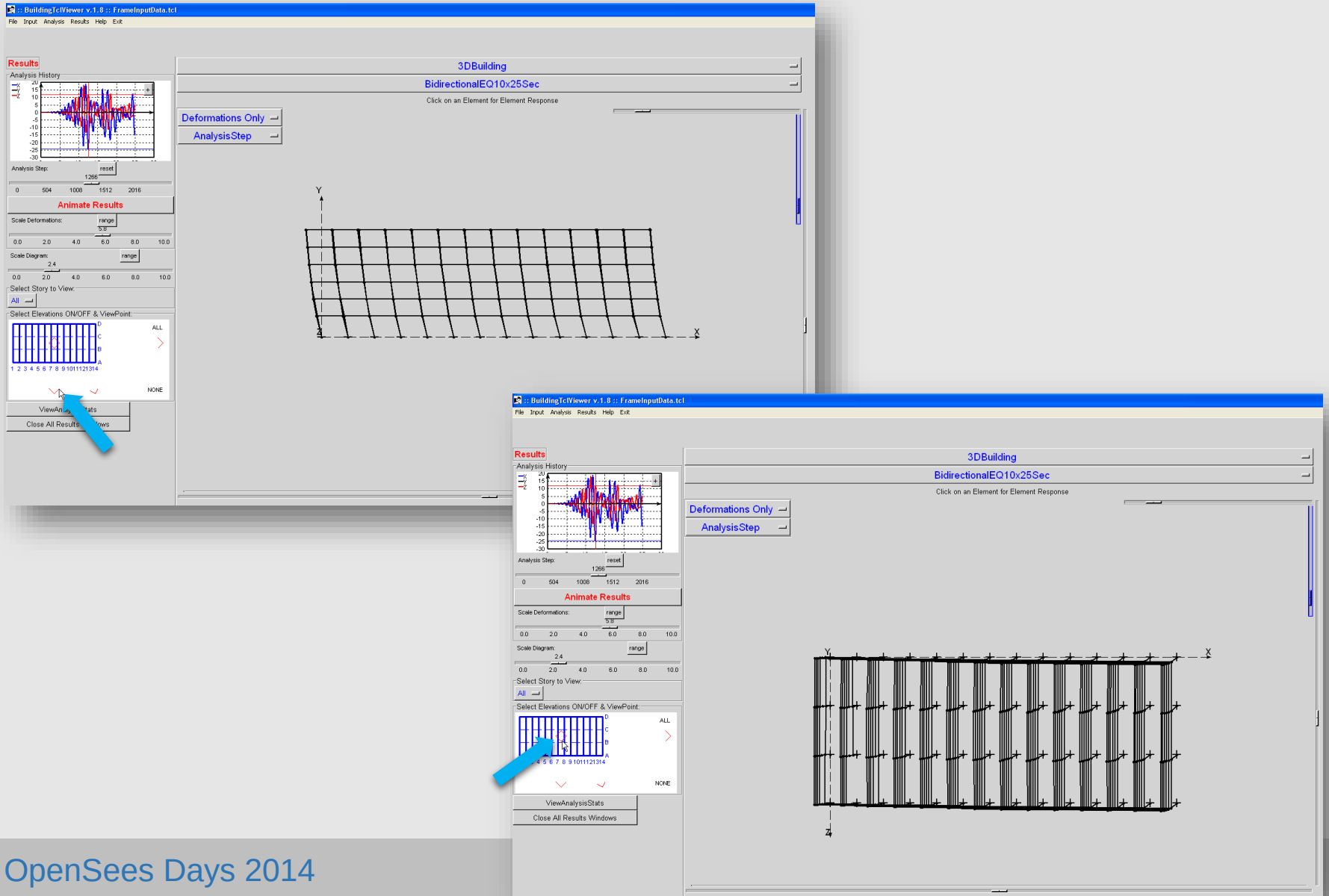
Visualization of Simulation Results



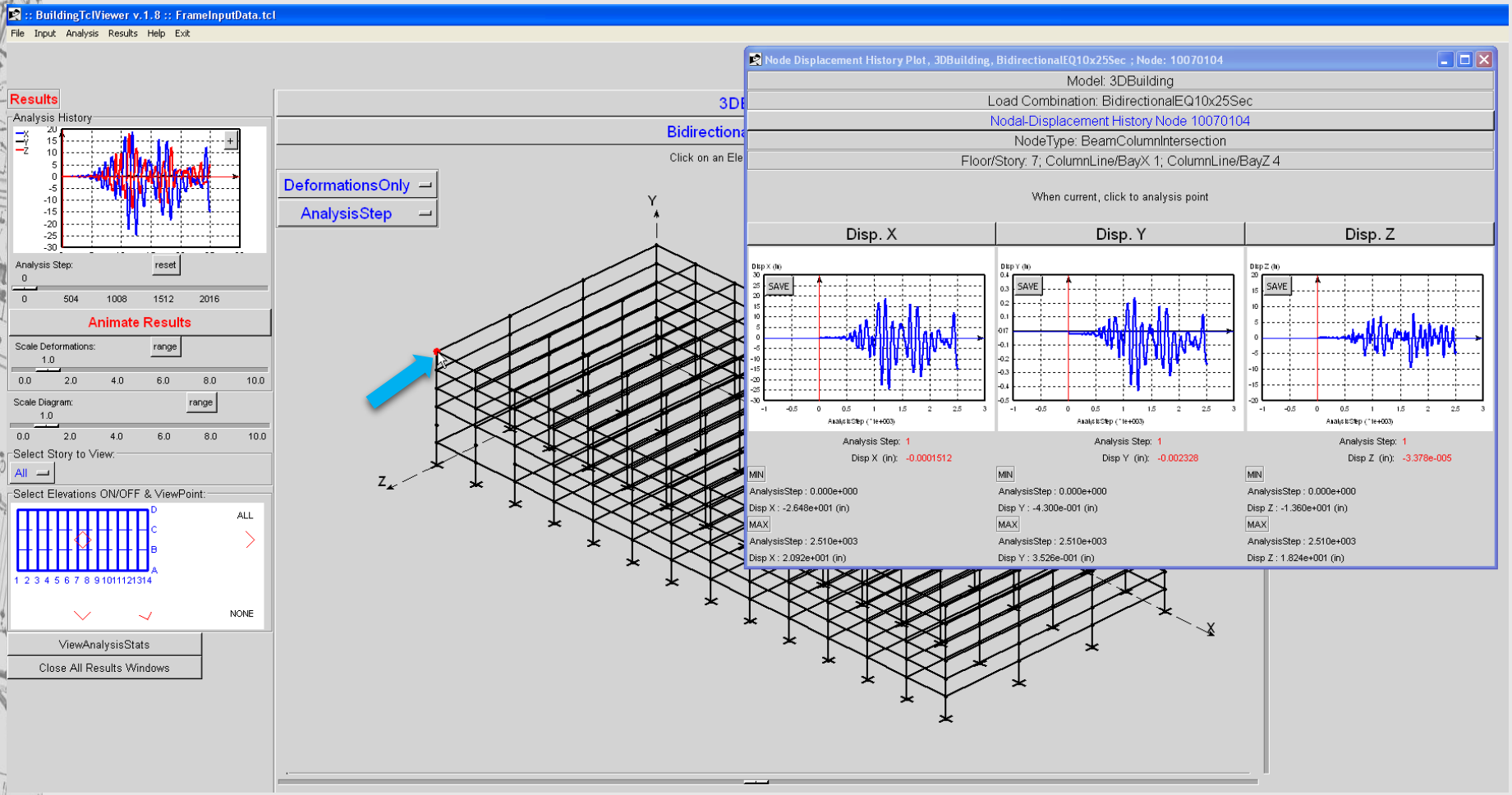
Visualization of Structural Response *animation*



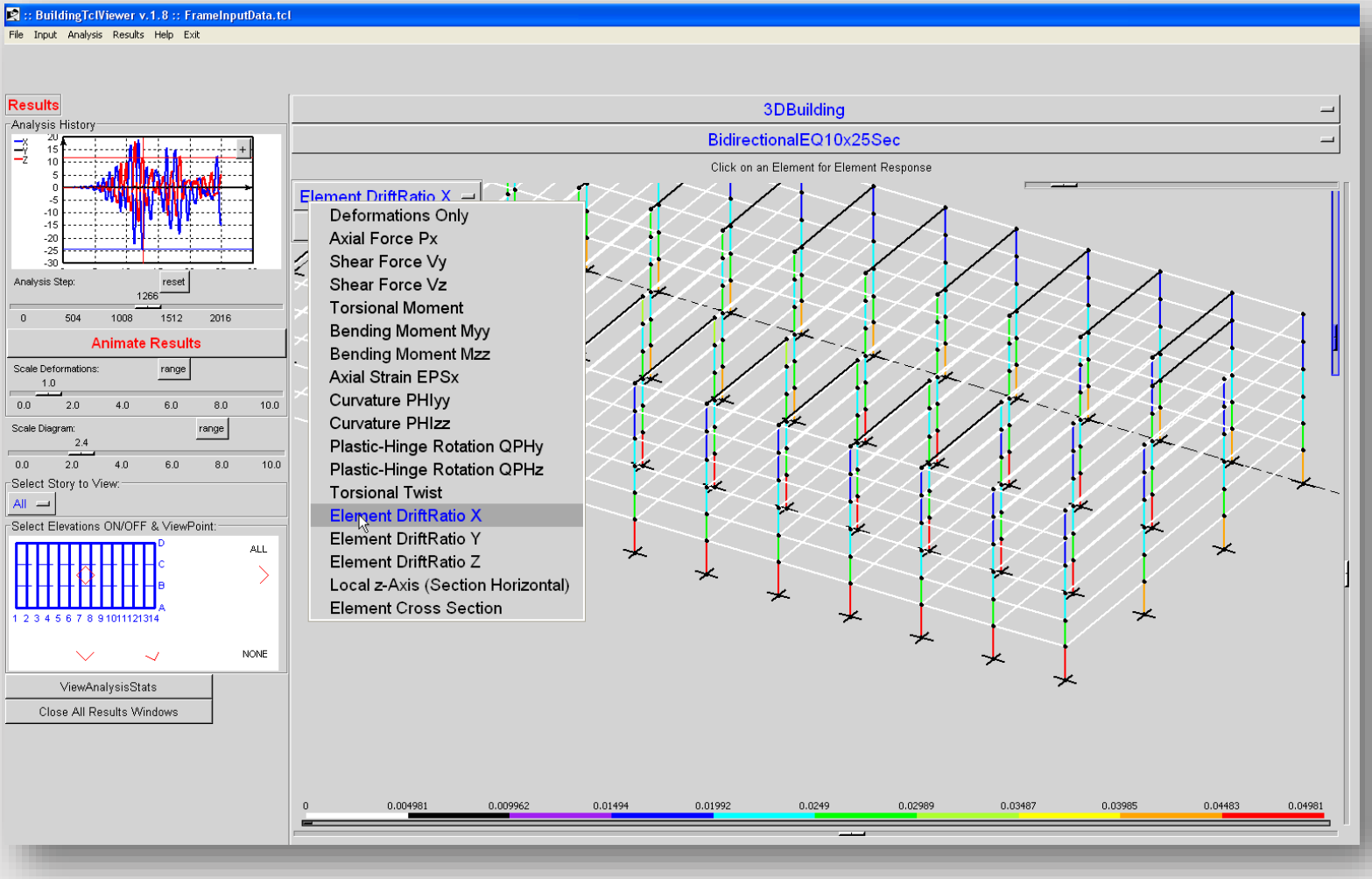
Visualization of Structural Response *viewpoints*



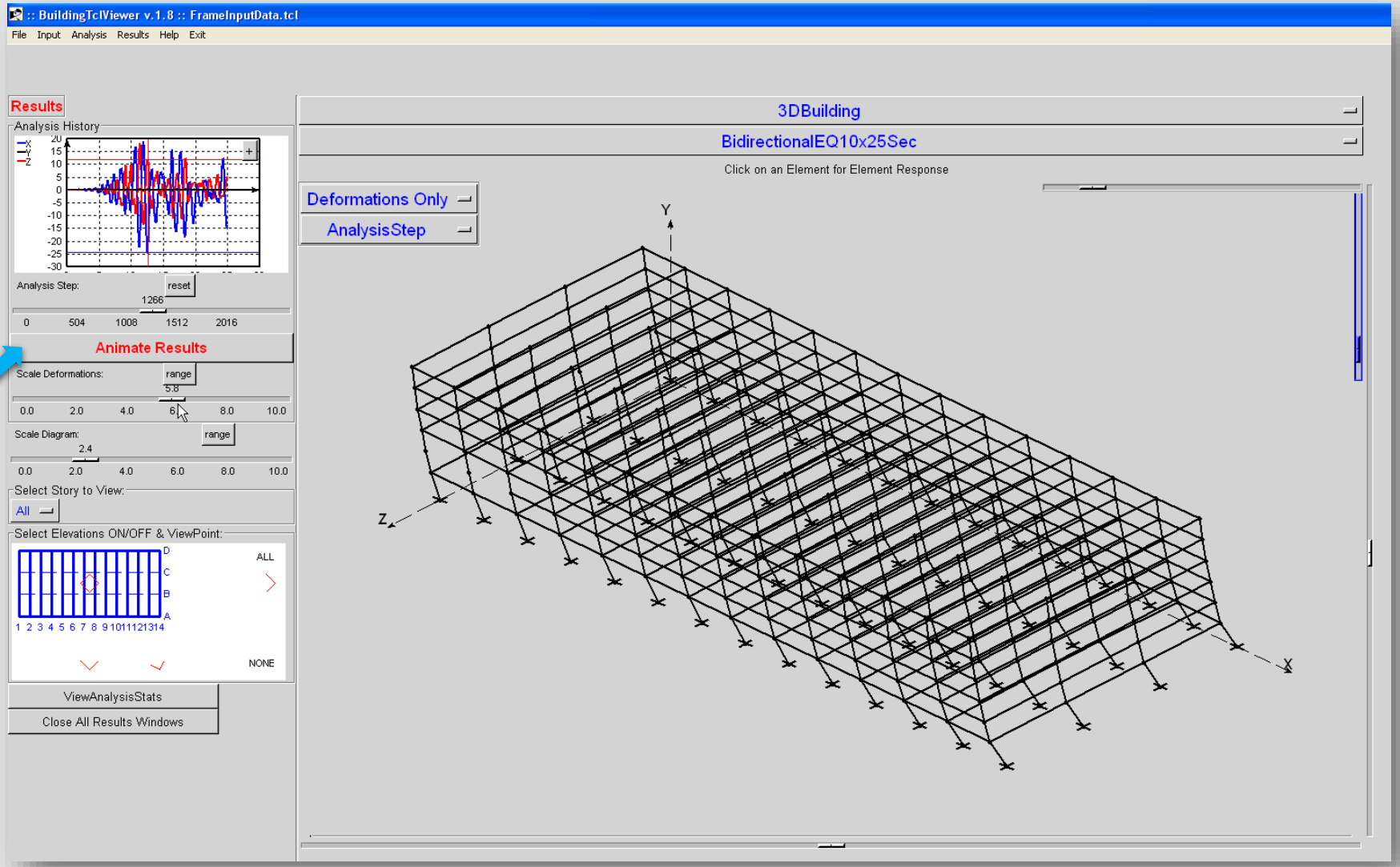
Visualization of Structural Response *nodal-displacement response*



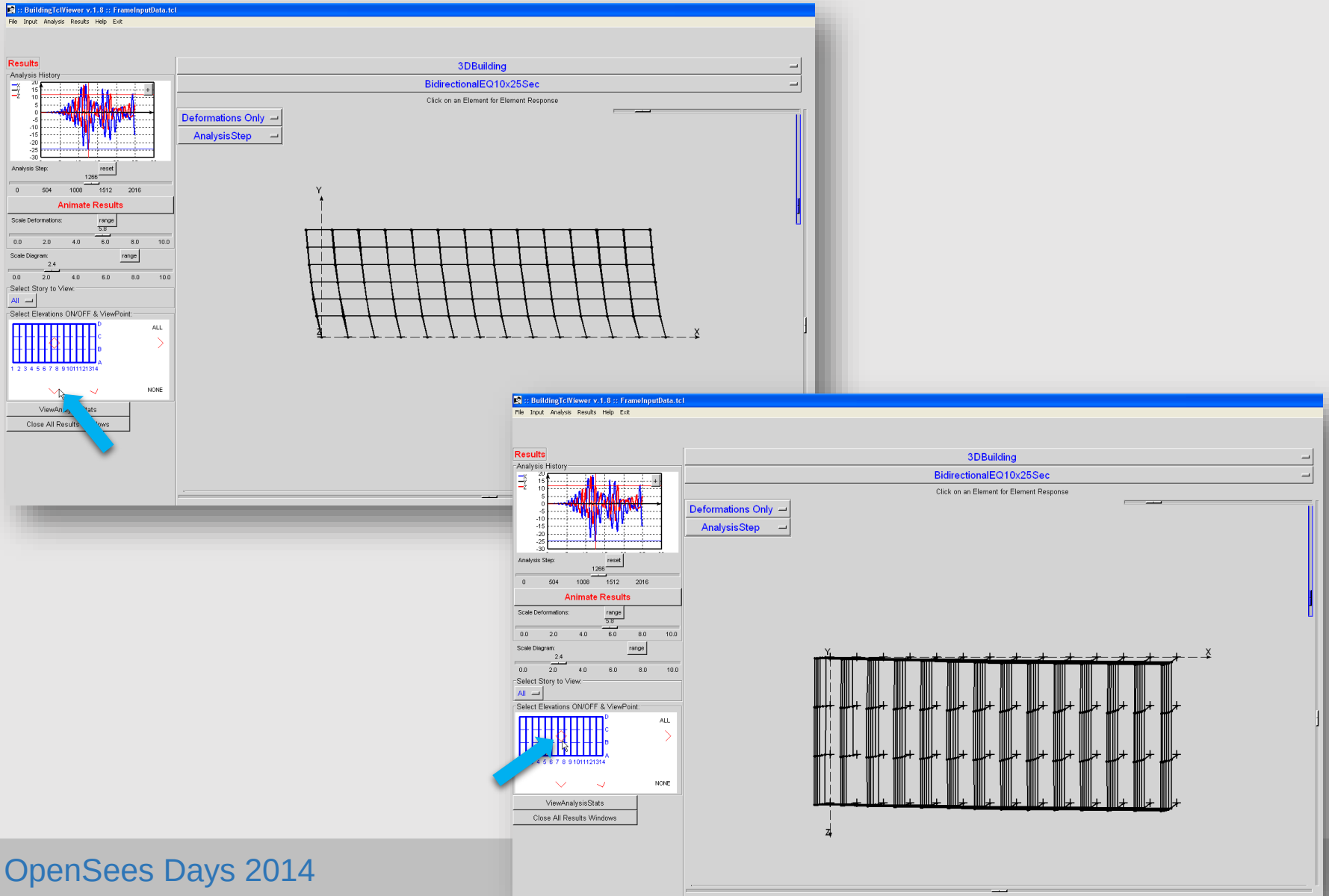
BuildingTcl Viewer – Results Element-Response Visualization



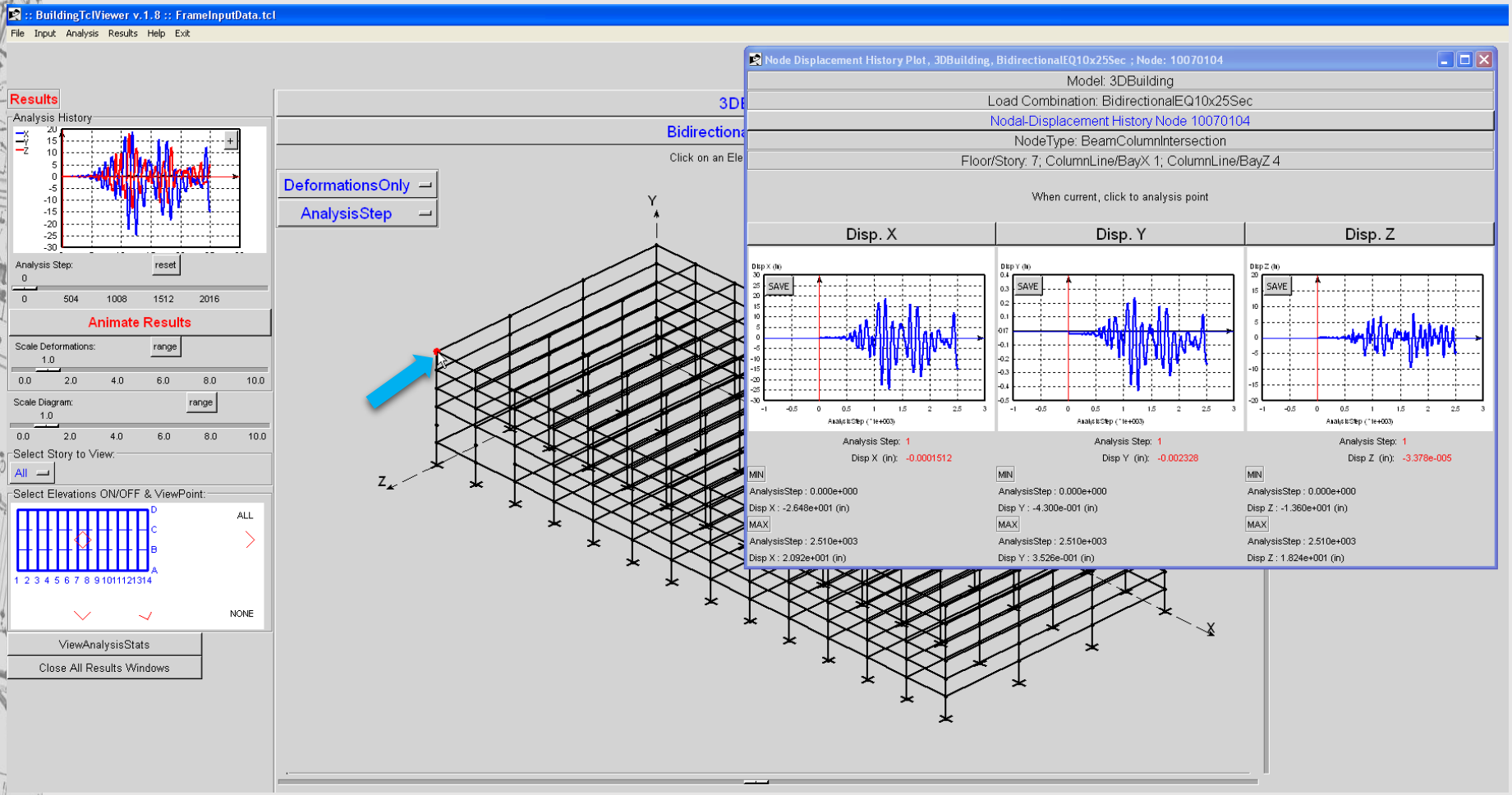
Visualization of Structural Response *animation*



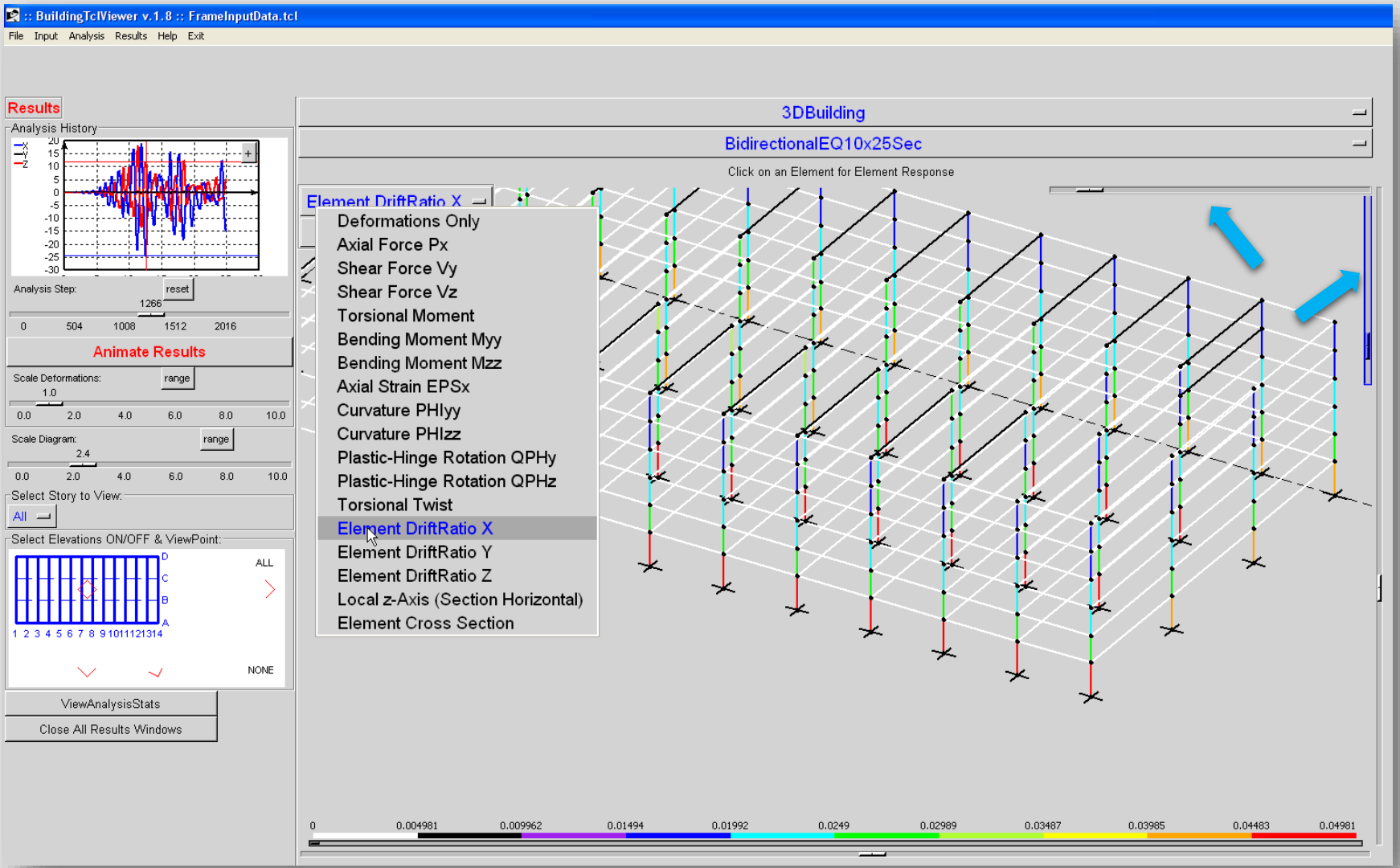
Visualization of Structural Response *viewpoints*



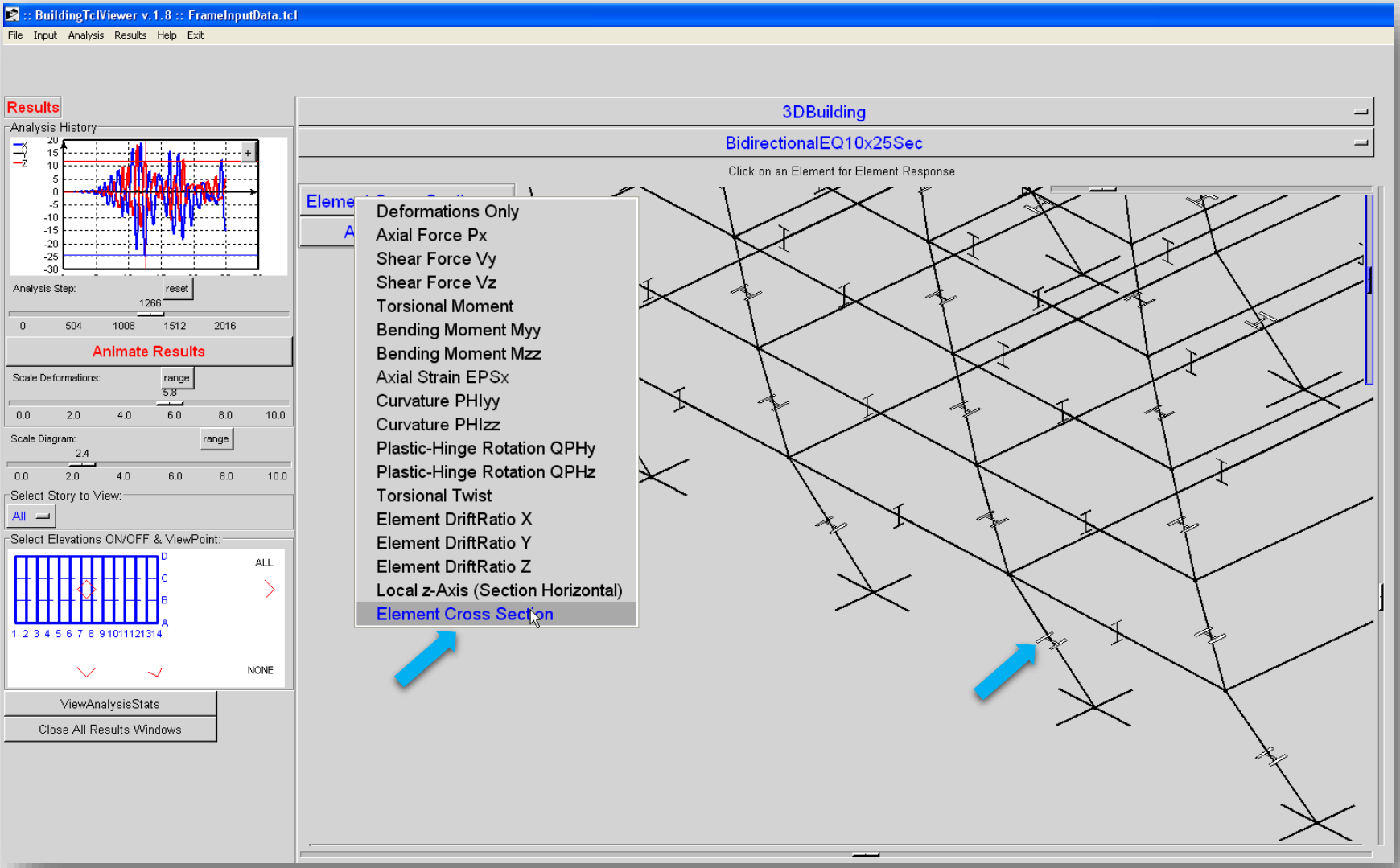
Visualization of Structural Response *nodal-displacement response*



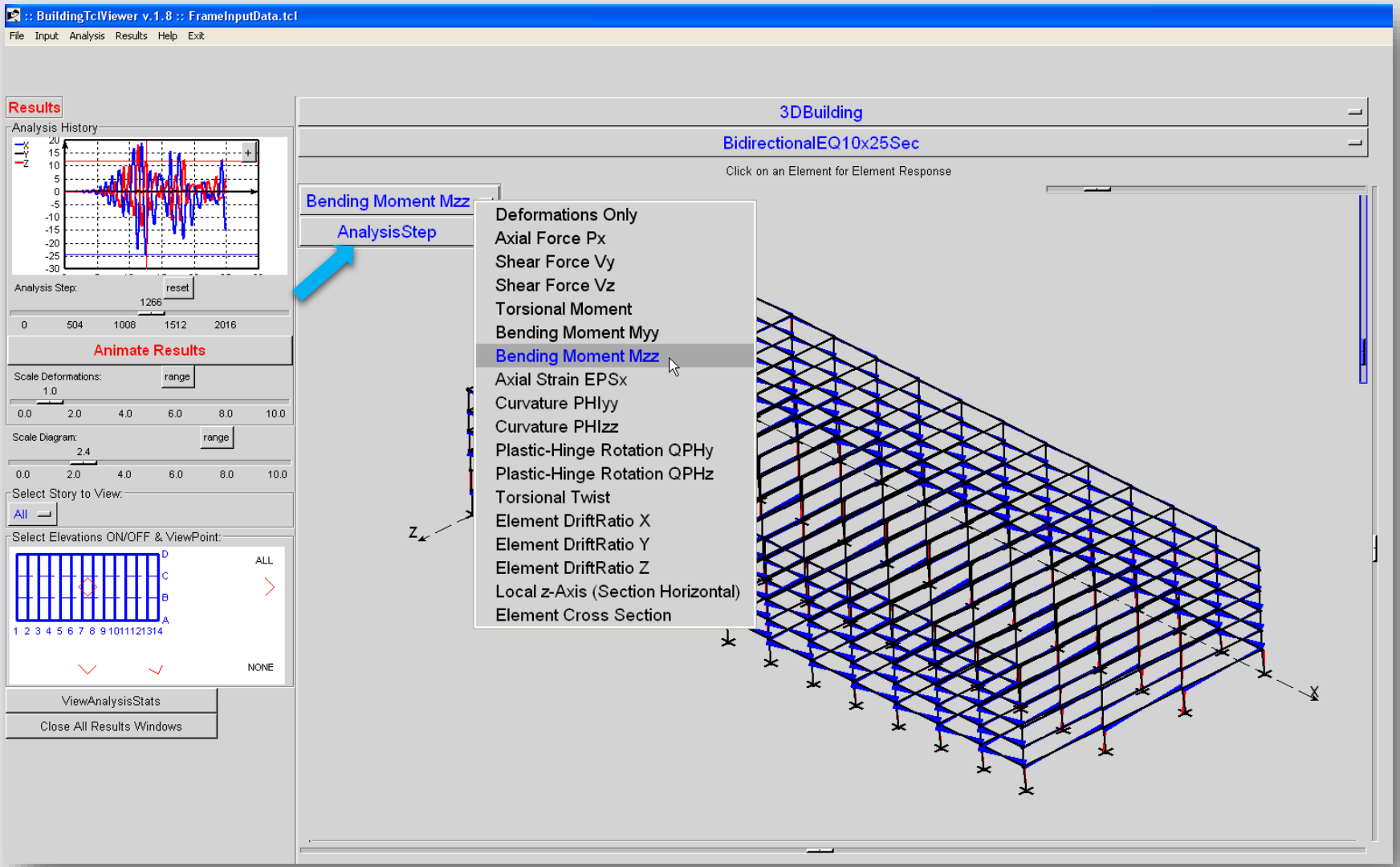
Visualization of Structural Response
zoom & rotate



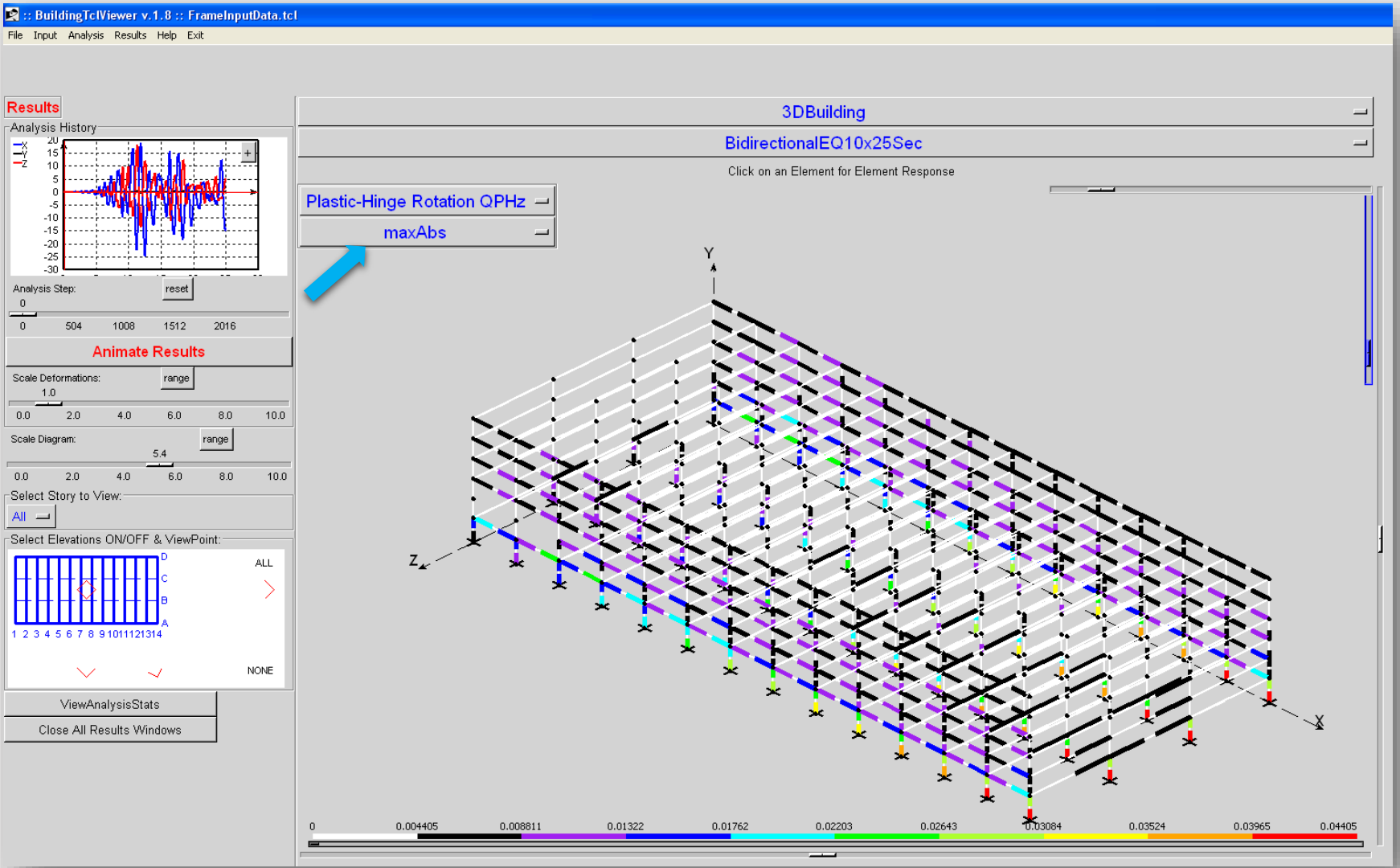
Visualization of Structural Response *element section*



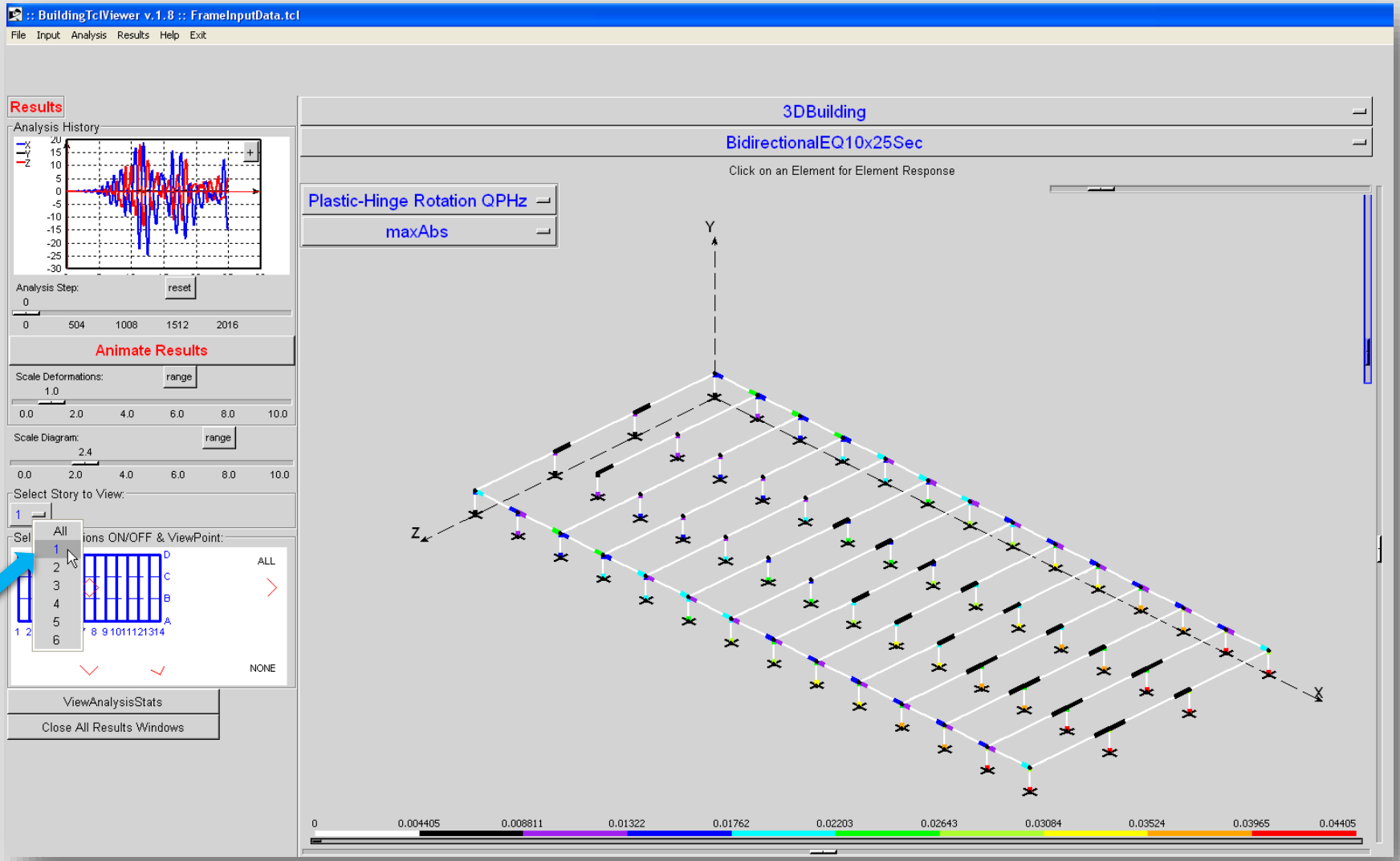
Visualization of Structural Response @ *Analysis Steps*



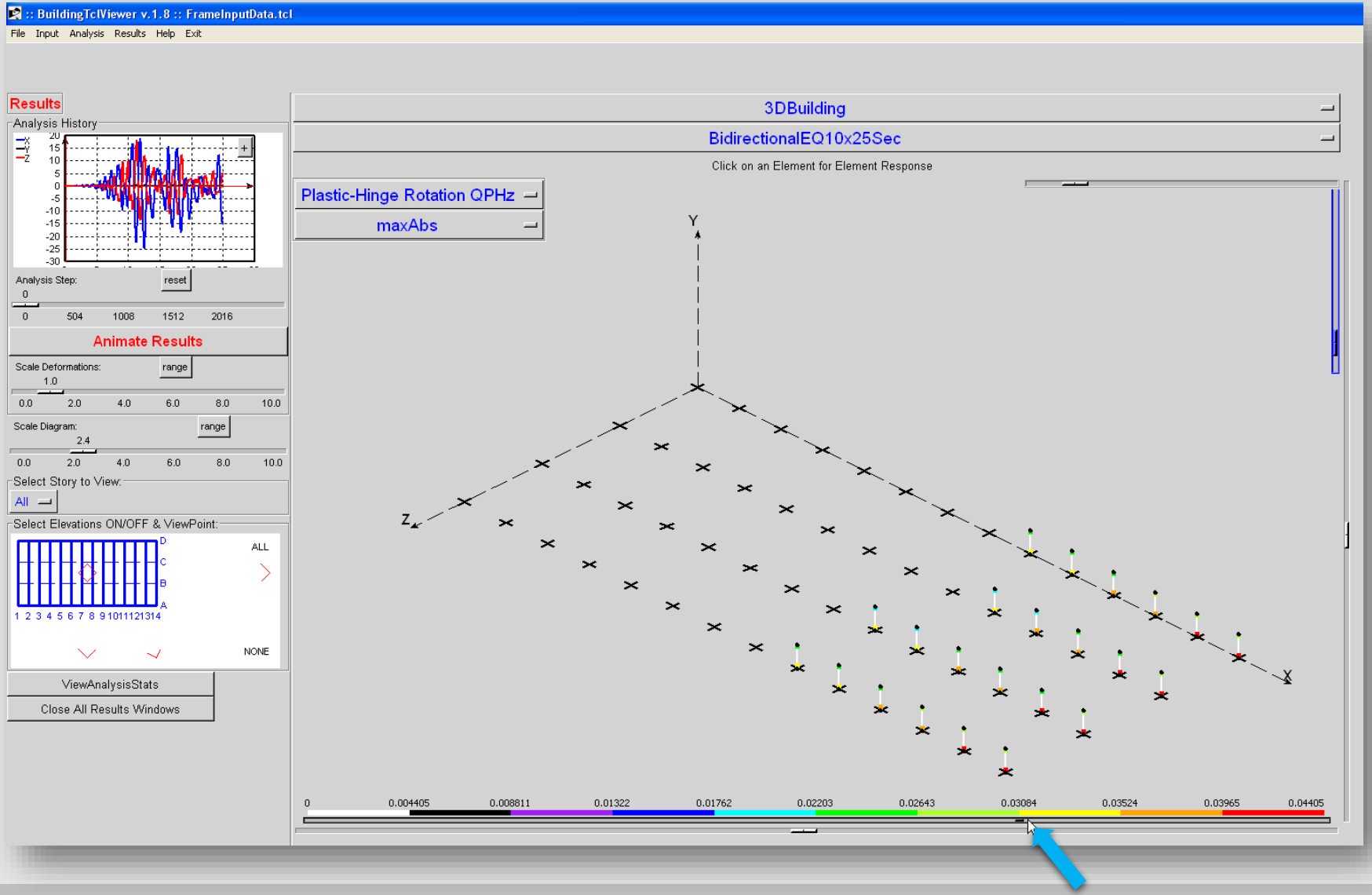
Visualization of Structural Response *envelope values*



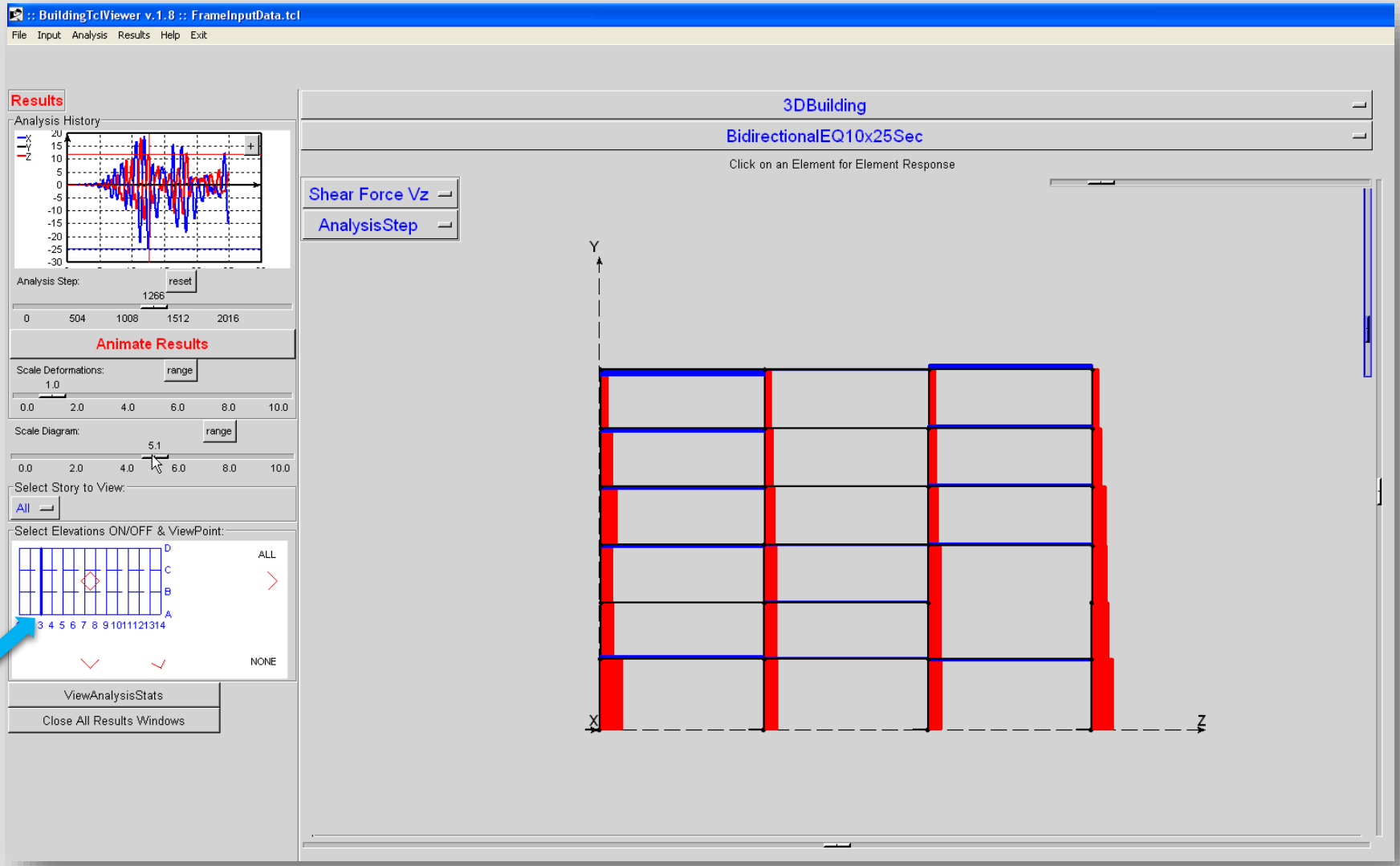
Visualization of Structural Response *individual story*



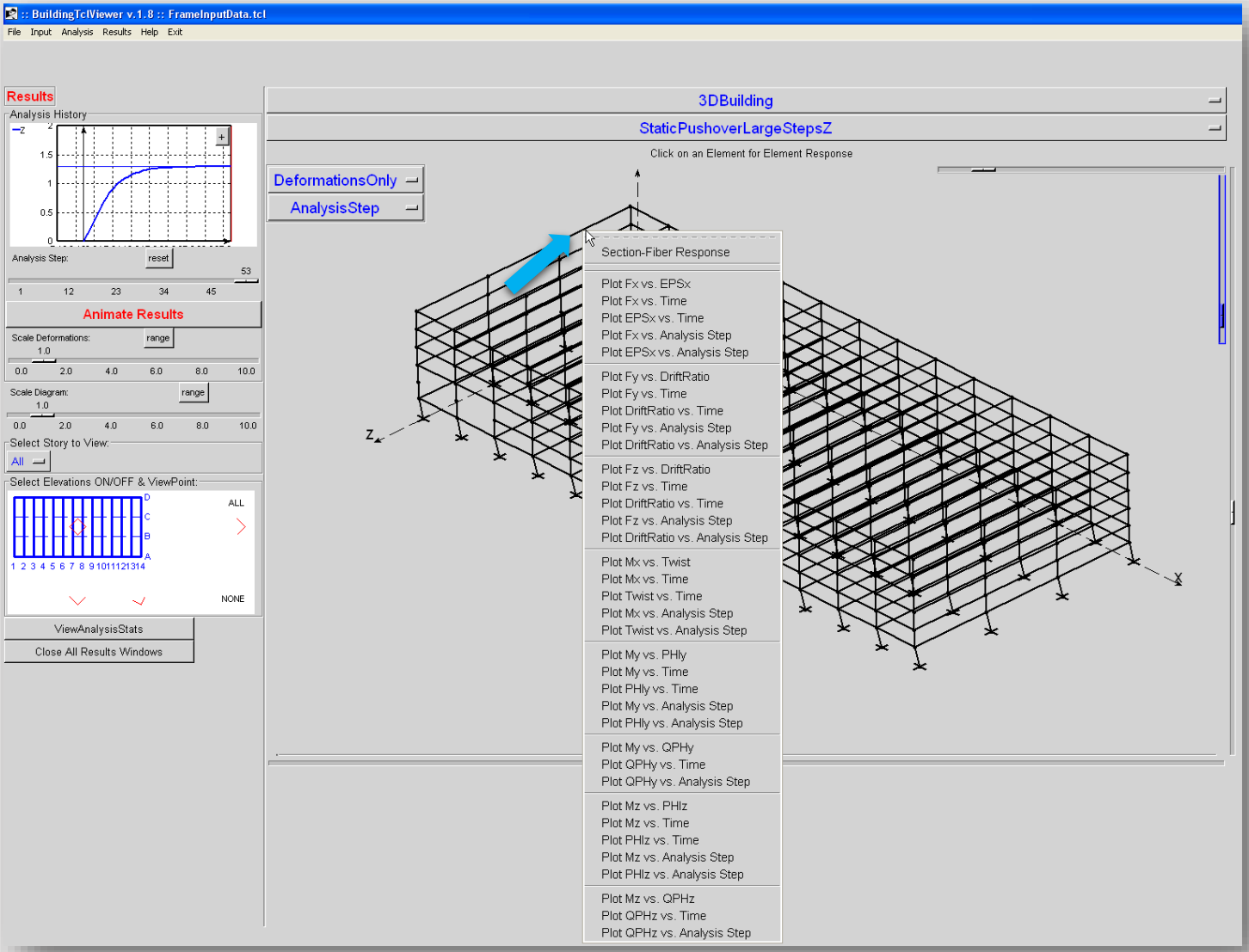
Visualization of Structural Response *range of response*



Visualization of Structural Response *individual-elevation response*



Visualization of Structural Response *selected-element response*



Element-Section Response

Section-Fiber Response

Plot Fx vs. EPSx
Plot Fx vs. Time
Plot EPSx vs. Time
Plot Fx vs. Analysis Step
Plot EPSx vs. Analysis Step

Plot Fy vs. DriftRatio
Plot Fy vs. Time
Plot DriftRatio vs. Time
Plot Fy vs. Analysis Step
Plot DriftRatio vs. Analysis Step

Plot Fz vs. DriftRatio
Plot Fz vs. Time
Plot DriftRatio vs. Time
Plot Fz vs. Analysis Step
Plot DriftRatio vs. Analysis Step

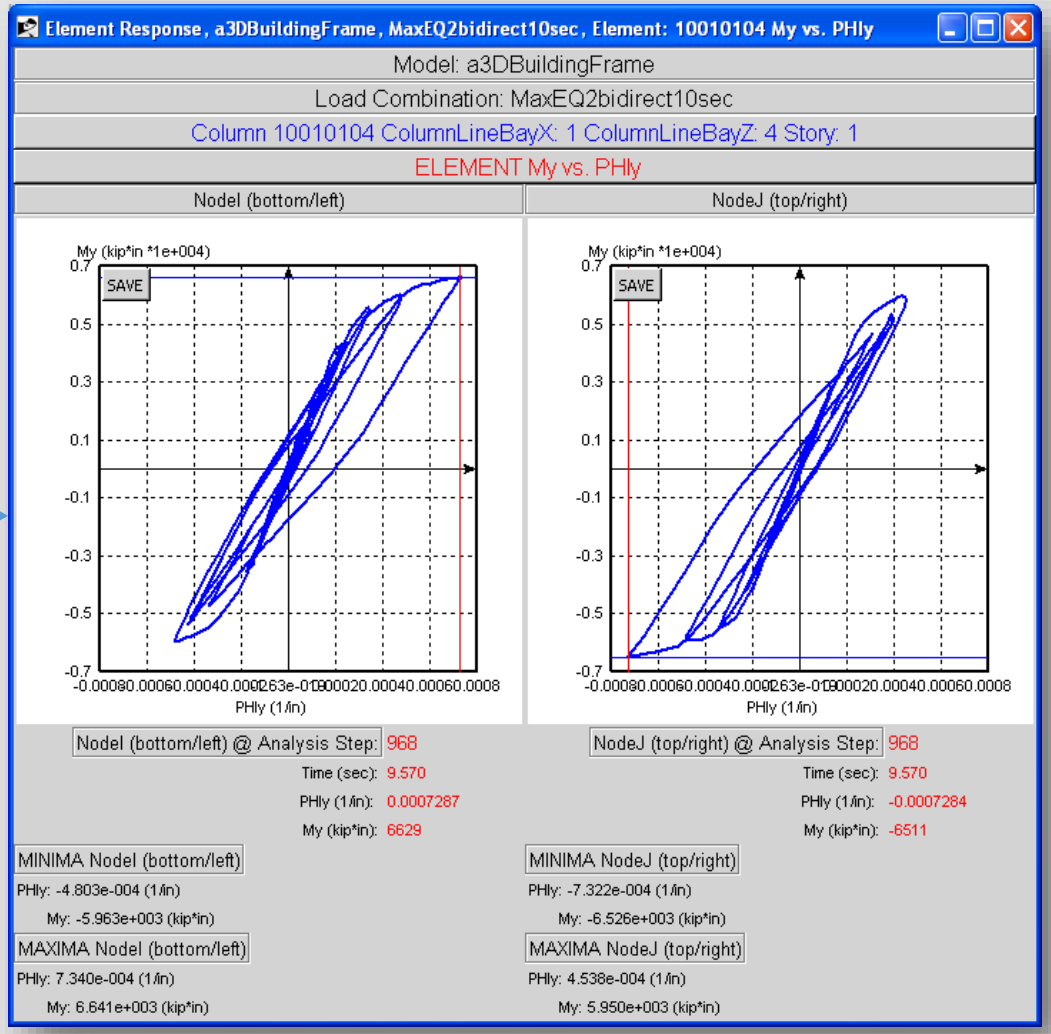
Plot Mx vs. Twist
Plot Mx vs. Time
Plot Twist vs. Time
Plot Mx vs. Analysis Step
Plot Twist vs. Analysis Step

Plot My vs. PHIy
Plot My vs. Time
Plot PHIy vs. Time
Plot My vs. Analysis Step
Plot PHIy vs. Analysis Step

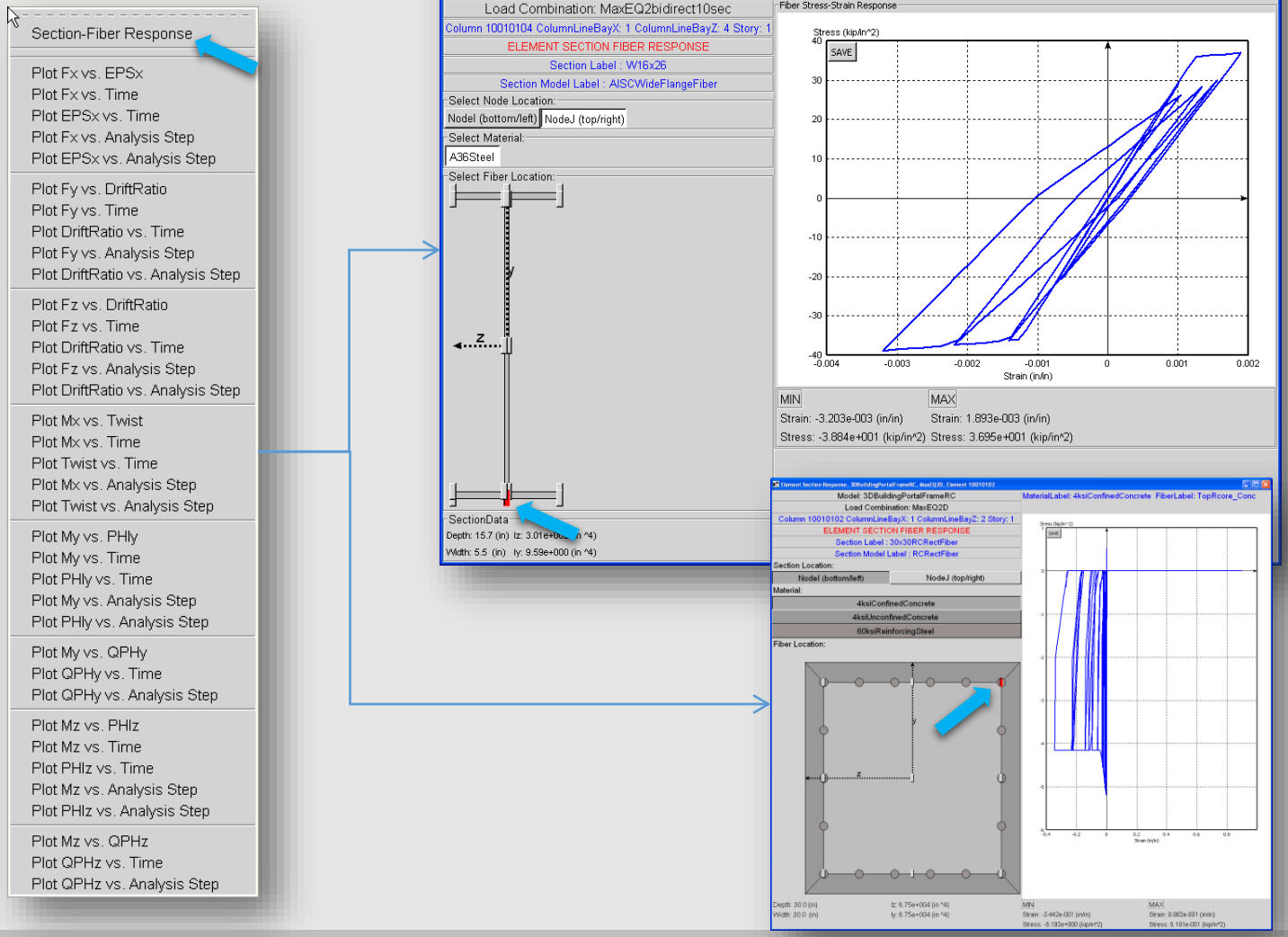
Plot My vs. QPHy
Plot QPHy vs. Time
Plot QPHy vs. Analysis Step

Plot Mz vs. PHIz
Plot Mz vs. Time
Plot PHIz vs. Time
Plot Mz vs. Analysis Step
Plot PHIz vs. Analysis Step

Plot Mz vs. QPHz
Plot QPHz vs. Time
Plot QPHz vs. Analysis Step



BuildingTcl Viewer – Section-Fiber Response



The model gets saved into a tcl file

```
####################################
# __MyModel.tcl
# Mon Sep 22 12:20:05 -0700 2014
####################################
# Set Up
setDataDir Data;
setUnits -Length in -Force kip -
# Material
addMaterialData MaterialLabel
addMaterialData MaterialModel
addMaterialData E 1e9
addMaterialData MaterialDescr
addMaterial
addMaterialData MaterialLabel
addMaterialData MaterialModel
addMaterialData E 1e-9
addMaterialData MaterialDescr
addMaterial
addMaterialData MaterialLabel
addMaterialData MaterialModel
addMaterialData fY 36*1.0
addMaterialData MaterialDescr
addMaterial
# Section
addSectionData SectionLabel M
addSectionData SectionModelLa
addSectionData yMomentModelLabel Loose
```

```
addModelData ModelLabel ElevationModel_multistory
addModelData ModelTypeLabel Elevation
addModelData ModelDescription ""
addModelData DefaultElementTypeArray "SupportSpring DefaultSupportSpring Bearing DefaultBearing BeamHinge DefaultBeamHinge Di
addModelData -Geometry Story 4 Height 120.0
addModelData -Geometry Story 1 Height 120.0
addModelData -Geometry Story 2 Height 120.0
addModelData -Geometry Story 3 Height 120.0
addModelData -Geometry Bay 1 Width 120.0
addModelData -Geometry Bay 2 Width 120.0
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 1 Story 1
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 2 Story 1
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 1 Story 2
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 2 Story 2
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 1 Story 3
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 2 Story 3
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 1 Story 4
addModelData -Columns ElementTypeLabel DefaultNBCPDelta SectionLabel W33X354 Orient HorizAxisBending ColumnLine 2 Story 4
addModelData -Beams ElementTypeLabel DefaultBeam SectionLabel W33X354 Orient HorizAxisBending Bay 1 Floor 2
addModelData -GravityLoad LoadLabel DefaultGravity DistributedLoad 0.0069644444444444000004 Bay 1 Floor 2
addModelData -Beams ElementTypeLabel DefaultBeam SectionLabel W33X354 Orient HorizAxisBending Bay 1 Floor 3
addModelData -GravityLoad LoadLabel DefaultGravity DistributedLoad 0.0069644444444444000004 Bay 1 Floor 3
addModelData -Beams ElementTypeLabel DefaultBeam SectionLabel W33X354 Orient HorizAxisBending Bay 1 Floor 4
addModelData -GravityLoad LoadLabel DefaultGravity DistributedLoad 0.0069644444444444000004 Bay 1 Floor 4
addModelData -Beams ElementTypeLabel DefaultBeam SectionLabel W33X354 Orient HorizAxisBending Bay 1 Floor 5
addModelData -GravityLoad LoadLabel DefaultGravity DistributedLoad 0.0069644444444444000004 Bay 1 Floor 5
addModel
```

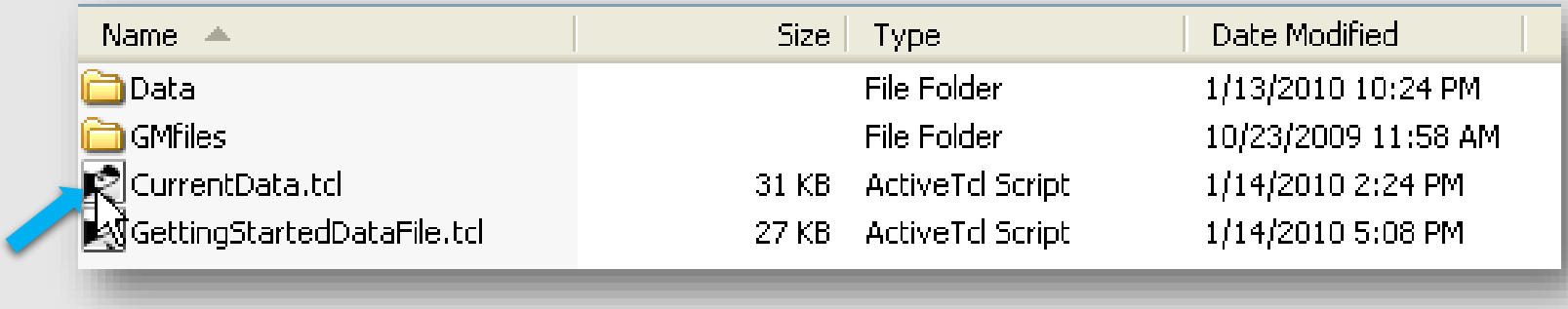
You can take use Tcl commands

```
58 set iVerticalSpringLabel   "0309    0308    0307    0306    0305    0304    0303    0409
59 set iVerticalSpringE "16274.2 17145.3  8157.3 9541.2 11070.6  12643.9  16274.2  22783.9  24003.4
60 set iHorizontalSpringLabel   "X0309  X0308   X0307   X0306   X0305   X0304   X0303   X0409
61 set iHorizontalSpringE "1763.4  1933.5 1732.5 2026.4 2351.2 2536.8 1763.4 2468.8 2707.0 2425.4 2836
62 set iVerticalDashpotLabel "0309    0308    0307    0306    0305    0304    0303    0409
63 set iVerticalDashpotC   "50.421  52.720 20.794 24.321 28.220 33.014 50.421 70.589 73.808 29.111  34.05
64 set iHorizontalDashpotLabel "0309    0308    0307    0306    0305    0304    0303    0409
65 set iHorizontalDashpotC   "8.761 9.607  8.607  10.068 11.682 12.604 8.761  12.266 13.449 12.050 14.09
66
67 foreach VerticalSpringLabel $iVerticalSpringLabel  VerticalSpringE $iVerticalSpringE {
68    addMaterialData MaterialLabel VerticalSpring$VerticalSpringLabel
69    addMaterialData MaterialModelLabel Elastic
70    addMaterialData E $VerticalSpringE
71    addMaterialData MaterialDescription ""
72    addMaterial
73 }
```

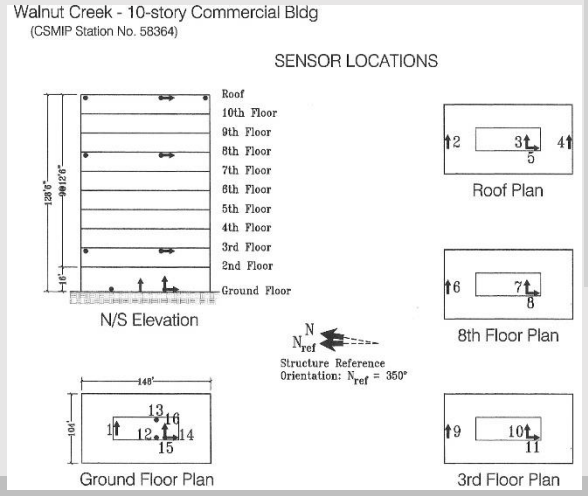
In case you have to hard-exit:

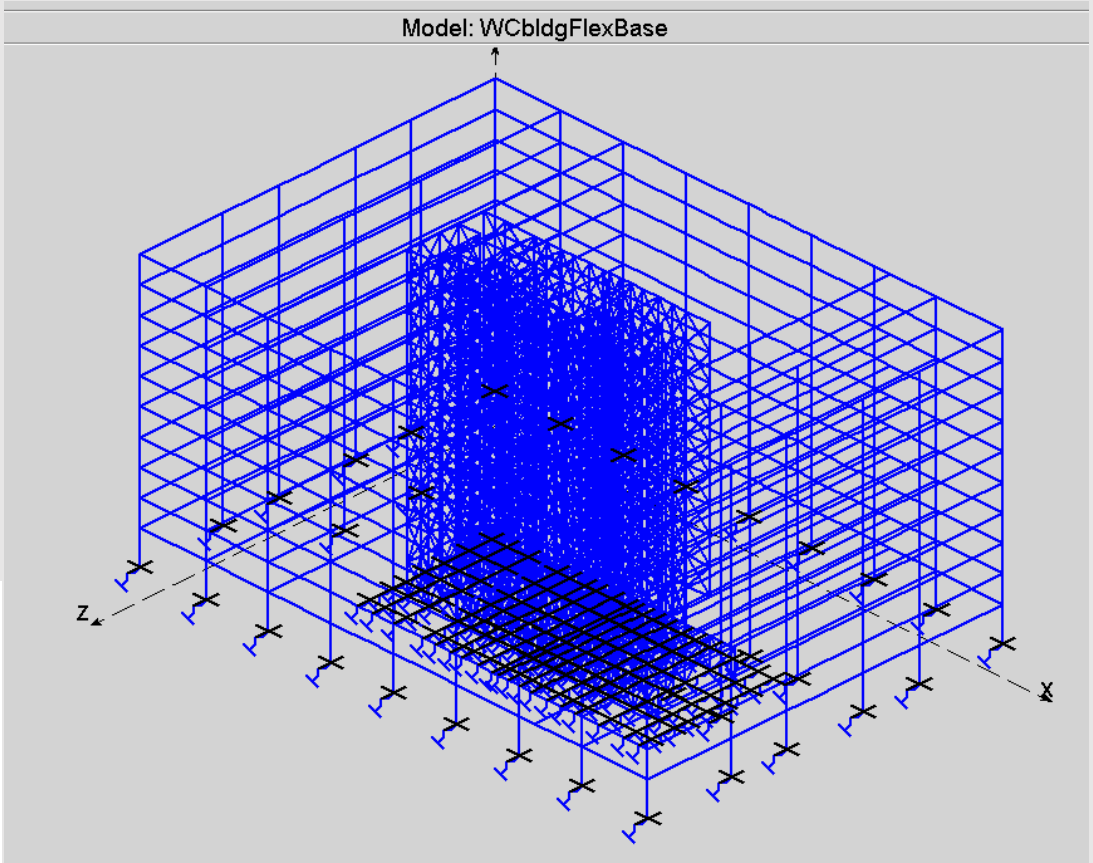
After every time that any object is saved or modified, BuildingTclViewer saves a file in the same directory as the input file:

CurrentData.tcl

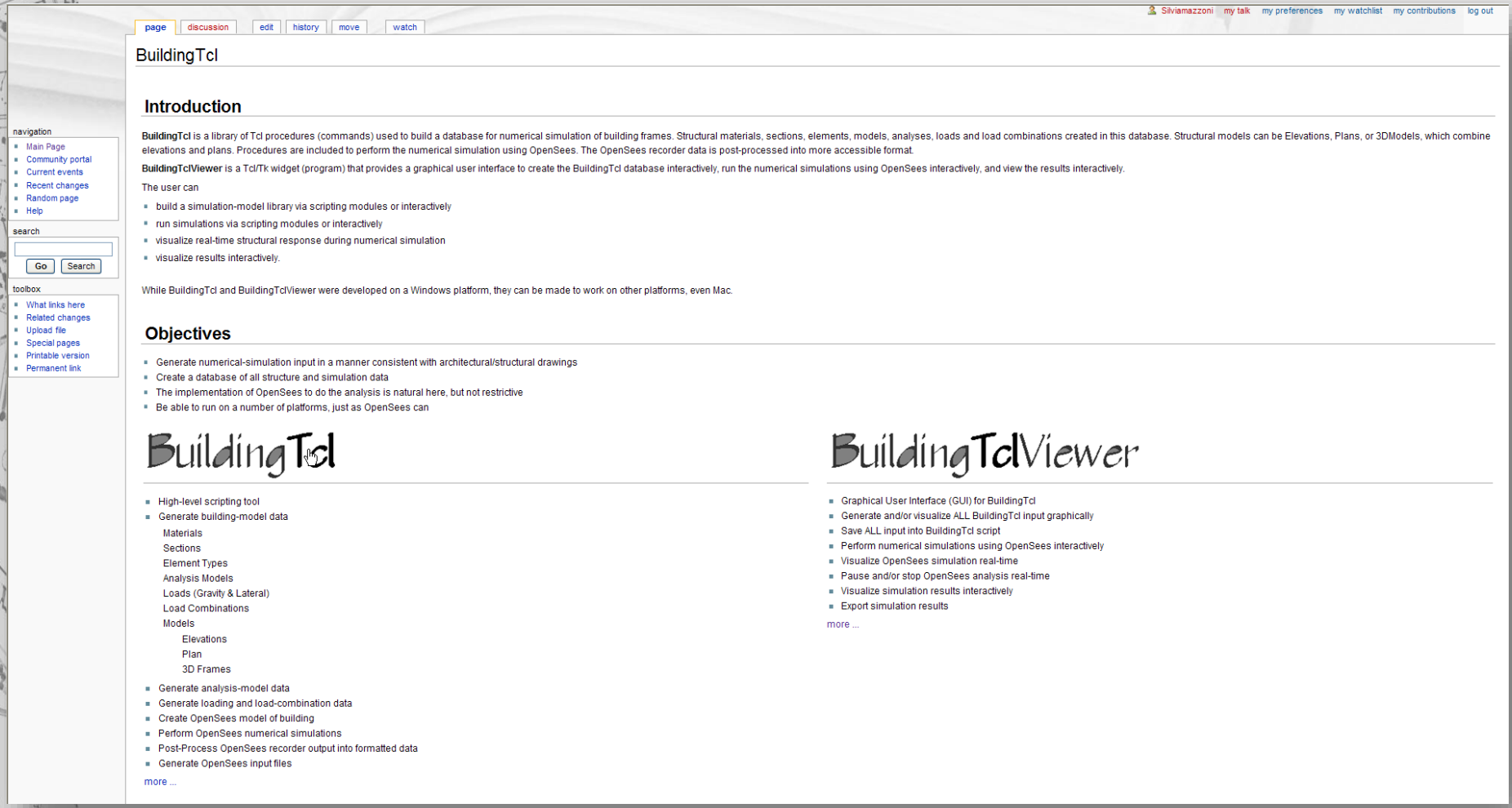


Soil-Structure Interaction: Base Rocking 10-story RC Frame





Documentation: OpenSees wiki



The program is a simple Windows executable file which you can download from the server

Name	Date modified	Type	Size
seismiCAE.exe	9/25/2014 12:19 AM	Application	4,398 KB

Now I just need a good name for it

..... thank you!!!