

BuildingTcl

a Real-Time Interface for Numerical Simulation in OpenSees

Silvia Mazzoni,

Structural Consultant,
Degenkolb Engineers

OpenSees Days 2010

Silvia Mazzoni, OpenSees Days 2010



BuildingTcl & BuildingTclViewer

- BuildingTcl and BuildingTclViewer provide a library of Tcl/Tk procedures that can be used within OpenSees to
 - build a simulation-model library via scripting modules or interactively
 - run simulations via scripting modules or interactively
 - visualize real-time structural response during numerical simulation

Interactive OpenSees simulation via:

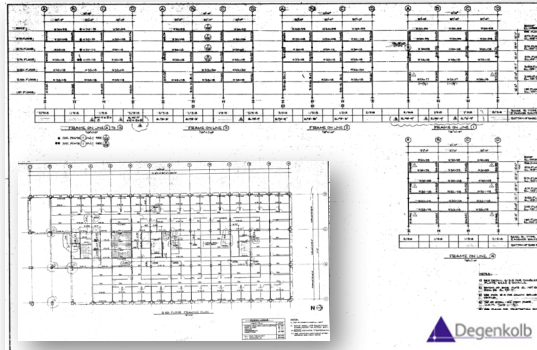


- BuildingTclViewer is a Tcl/Tk widget (program) that provides a graphical user interface to create the BuildingTcl database interactively, run the numerical simulations using OpenSees interactively, and view the results interactively.
- While BuildingTcl and BuildingTclViewer were developed on a Windows platform, they can be made to work on other platforms, even Mac.

Silvia Mazzoni, OpenSees Days 2010

Objective of BuildingTcl & BuildingTclViewer

- Generate numerical-simulation input in a manner consistent with architectural/structural drawings
- Create a database of all structure and simulation data
- The implementation of OpenSees to do the analysis is natural here, but not restrictive
- Be able to run on a number of platforms, just as OpenSees can



Silvia Mazzoni, OpenSees Days 2010

Features

BuildingTcl:

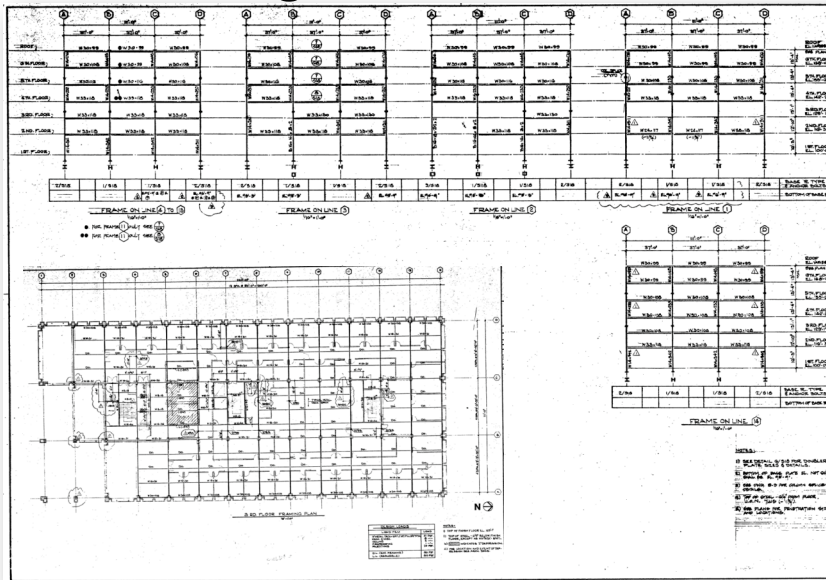
- High-level scripting tool
- Generate building-model data
 - Materials
 - Sections
 - Element Types
 - Analysis Models
 - Loads (Gravity & Lateral)
 - Load Combinations
 - Models
 - Elevations
 - Plan
 - 3D Frames
- Generate analysis-model data
- Generate loading and load-combination data
- Generate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

BuildingTclViewer:

- 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
- Pause and/or stop OpenSees analysis real-time
- Visualize simulation results interactively
- Export simulation results

Silvia Mazzoni, OpenSees Days 2010

Drawings: Elevations & Plans



Silvia Mazzoni, OpenSees Days 2010

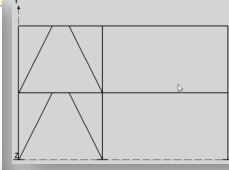
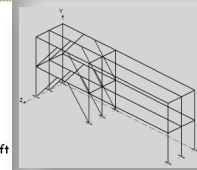
Model Input

```

# 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 4.4'\$ft
addModelData SupportBC fix
addModelData OutOfPlaneSupportBC pin
addModelData RigidFloor Off
addModelData JointOffsetsSwitch on
addModelData TributaryWidth 5.4'\$ft
addModelData -GravityLoad LoadLabel DL1 FloorRange "2 3" DistributedLoad 100.4'\$psf
addModelData -GravityLoad LoadLabel LL1 FloorRange "2 3" DistributedLoad 74.4'\$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 5.4'\$ft
addModel
    
```

Silvia Mazzoni, OpenSees Days 2010

Material, Section & Element Types

```

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

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

```

```

# ELEMENT SECTION -----
addSectionData SectionLabel 30x30RCRectFiber
addSectionData SectionDescription "Square Rectangular RC Section"
addSectionData SectionModelLabel RCRectFiber:
addSectionData H 30.*$in:
addSectionData B 30.*$in:
addSectionData NBarBot 6: # number of bottom longitudinal
addSectionData NBarTop 6: # number of top longitudinal
addSectionData NBarInt 6: # total number of intermediate
addSectionData BarSizeBot #9:
addSectionData BarSizeTop #9:
addSectionData 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

```

Silvia Mazzoni, OpenSees Days 2010

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: # -----

```

Silvia Mazzoni, OpenSees Days 2010

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 Gfactor \${g}; # ground-motion input-u
addLoadData Gdirectory "GMfiles"; # directory where ground
addLoadData FileType "PEER"; # ground-motion file type
addLoadData Gfilename "H-E12140.at2"; # ground-motion filename
addLoadData Gdirection X; # lateral dof for ground m
addLoadData Gfactor 1.; # scaling of ground motion
addLoad
addLoadData LoadLabel EQ1Bidirect; # EQ T
addLoadData LoadTypeLabel UniformEQ2D;
addLoadData Gfactor \${g}; # gro
addLoadData Gdirectory "GMfiles"; # direct
addLoadData FileType "PEER"; # ground
addLoadData GfilenameX H-E01140.at2; # ground-motion filename for input
addLoadData GfilenameZ H-E01140.at2; # ground-motion filename for input
addLoadData GfactorX -15; # scaling of ground motion for input
addLoadData GfactorZ 10; # scaling of ground motion for input
addLoad

```

Silvia Mazzoni, OpenSees Days 2010

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

```

Silvia Mazzoni, OpenSees Days 2010

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
```

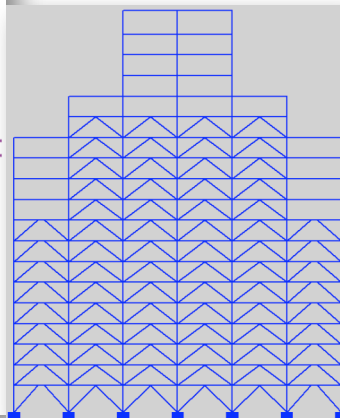
```
addLoadCombinationData LoadCombinationLabel MaxEQ1shorter
addLoadCombinationData -GravityLoad LoadLabel DL1 LoadFactor 1
addLoadCombinationData -LateralLoad LoadLabel EQ1 AnalysisModelLabel ShortDynamicTimeHistoryAnalysis LoadFactor 3
addLoadCombination
```

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

Silvia Mazzoni, OpenSees Days 2010

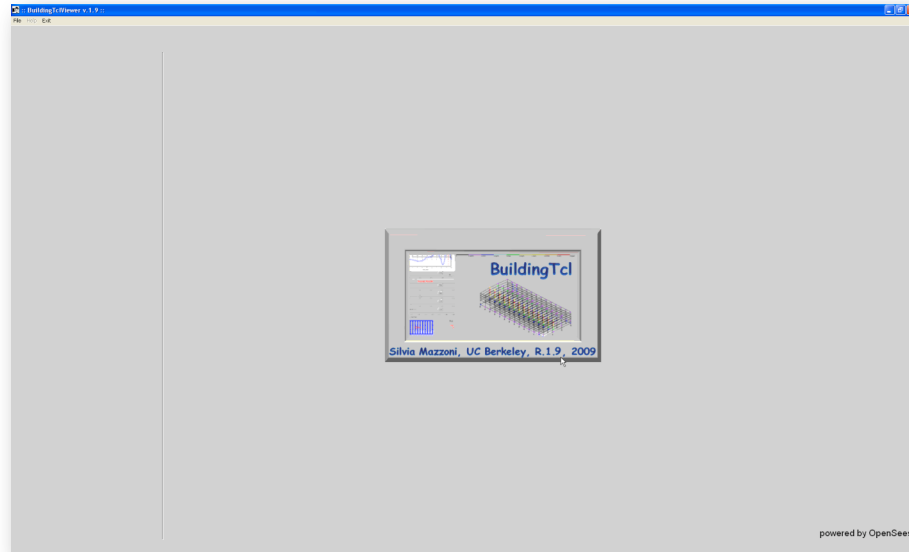
Interesting Example

```
addModelData ModelLabel "5MRFsetbacks"
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 W24x279 ColumnLine "2 6" StoryRange "2 15"
addModelData -Columns SectionLabel W24x279 ColumnLineRange "3 5" Story "1"
addModelData -Columns SectionLabel W24x290 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 Bay "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
```



Silvia Mazzoni, OpenSees Days 2010

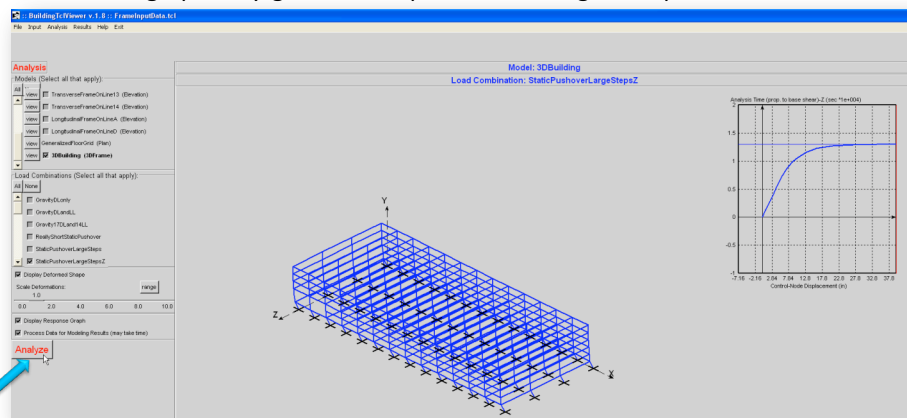
BuildingTclViewer^{1.9}



Silvia Mazzoni, OpenSees Days 2010

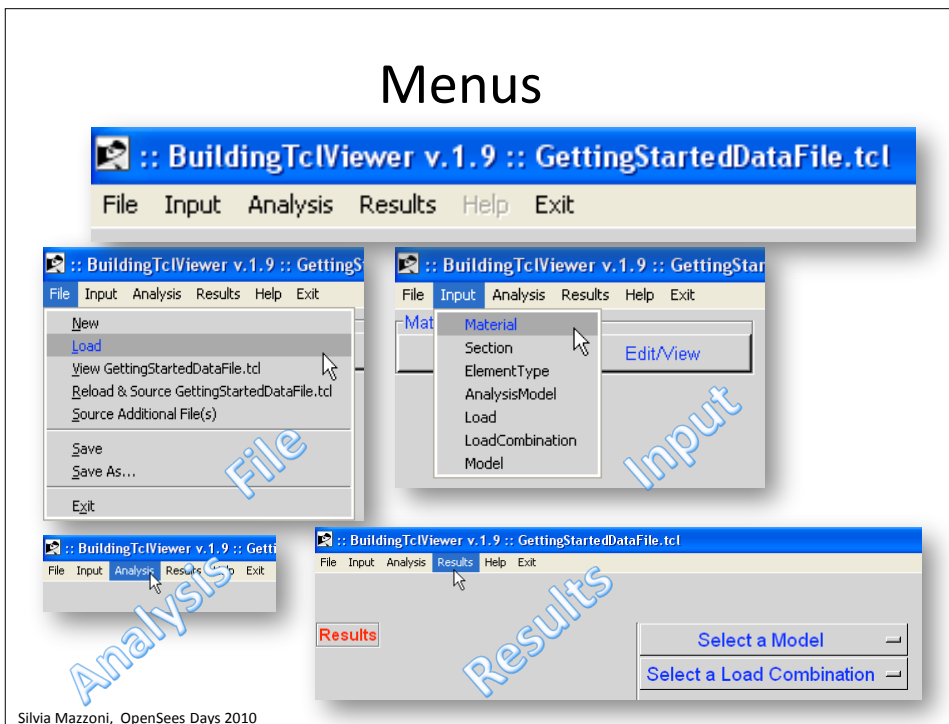
Objective of BuildingTclViewer

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



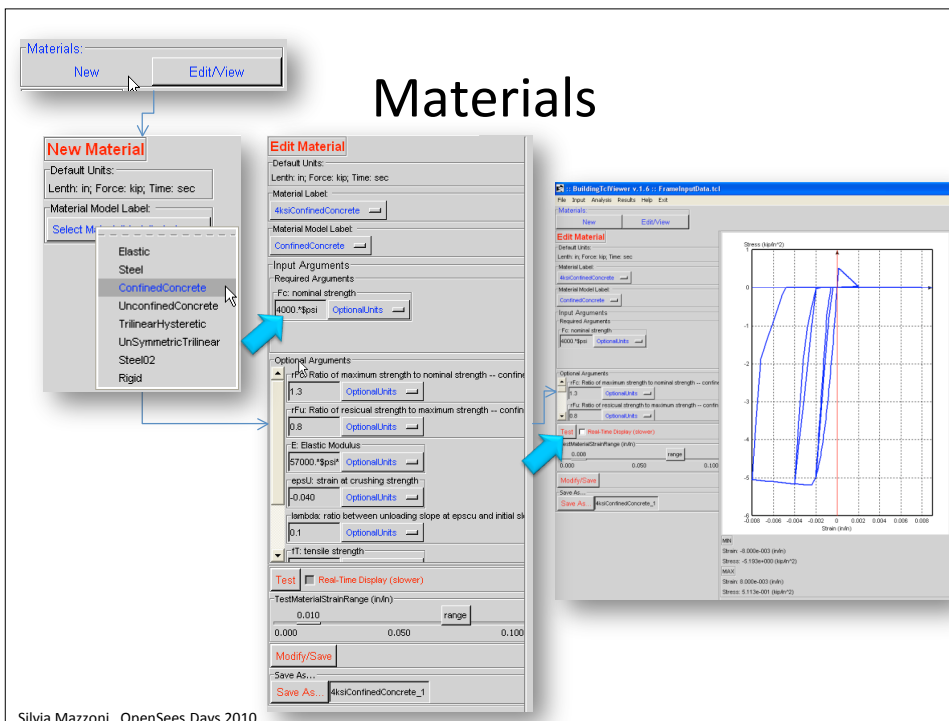
Silvia Mazzoni, OpenSees Days 2010

Menus



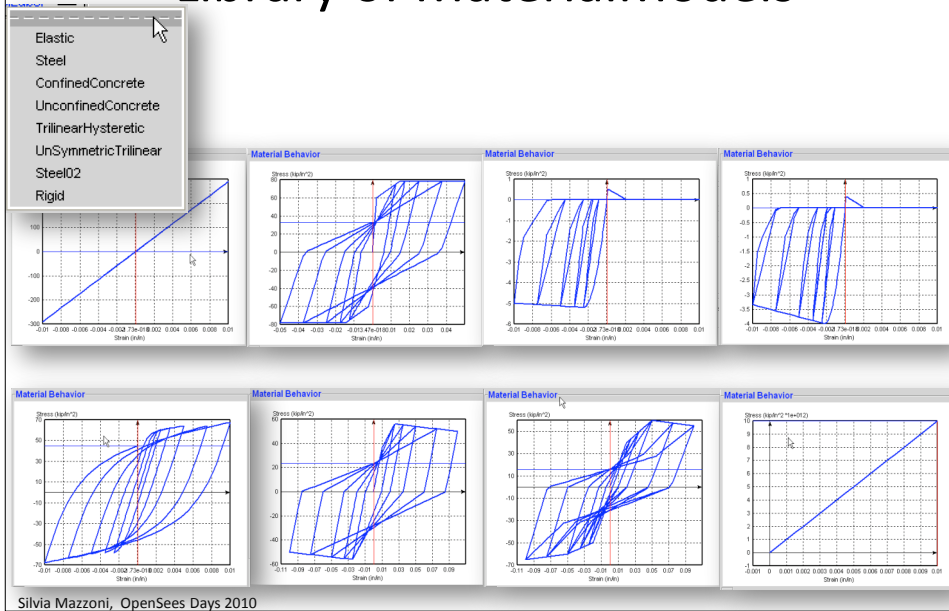
Silvia Mazzoni, OpenSees Days 2010

Materials



Silvia Mazzoni, OpenSees Days 2010

Library of Material Models



Silvia Mazzoni, OpenSees Days 2010

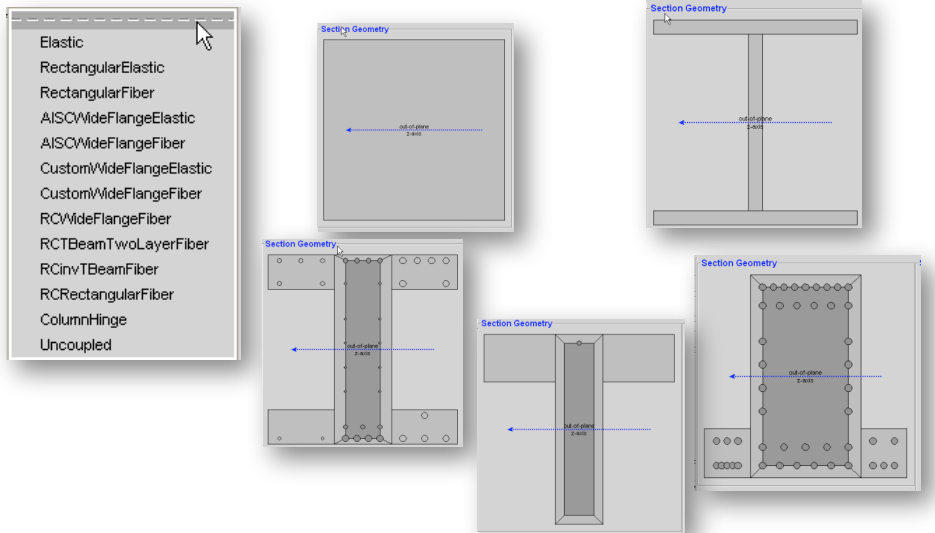
Sections

The figure shows the software interface for defining sections. It includes three main windows:

- New Section:** A dialog box for creating a new section. It has a 'Default Units' section (Length: in, Force: kip, Time: sec) and a 'Section Model Label' field. A 'Select Section' dropdown menu is open, showing options: Elastic, ElasticRectangular, RCRectangularFiber (highlighted), AISOWideFlangeElastic, AISOWideFlangeFiber, CustomWideFlangeElastic, and CustomWideFlangeFiber.
- Edit Section:** A dialog box for editing an existing section. It includes fields for 'Section Label', 'Section Model Label', and 'Input Arguments'. Under 'Input Arguments', there are sections for 'Section Width' (B, H), 'Section Depth' (D), 'Cover Material Label', 'Core Material Label', and 'Reinforcement Material Label'. There are also 'Optional Arguments' for reinforcement bars (NBarTop, NBarBot, NBarInt, BarSizeTop, BarSizeBot, BarSizeInt) and a 'Test' section with 'TestSectionAxisForce (kip)' and a 'Test' button highlighted with a blue arrow.
- Test:** A window showing the results of a section test. It displays a stress-strain curve and a diagram of the section geometry.

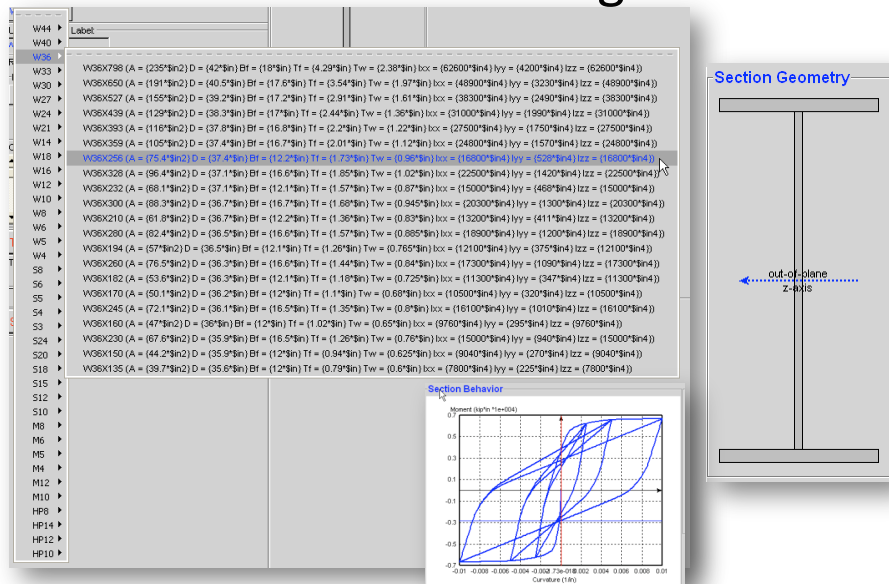
Silvia Mazzoni, OpenSees Days 2010

Library of SectionModels



Silvia Mazzoni, OpenSees Days 2010

AISC StandardWideFlange Sections



Silvia Mazzoni, OpenSees Days 2010

RC WideFlangeFiber

The screenshot displays the OpenSees GUI for configuring an RC WideFlangeFiber section. The 'New Section' dialog is open, showing the following details:

- Section Model Label:** RCWideFlangeFiber
- Unique Section Label:** RCWideFlangeFiberSec1
- Required Arguments:**
 - Fl Flange Thickness
 - tw Web Thickness
 - CoreMaterialLabel: Previously-Defined Material Label for Concrete
 - ReinMaterialLabel: Previously-Defined Material Label for Reinforcing Steel
- Optional Arguments:**
 - ncoreDepth: Number of core fibers along depth (16)
 - ncoreWidth: Number of core fibers along width (16)
 - ncoverDepth: Number of cover fibers along depth (4)
 - ncoverWidth: Number of cover fibers along width (4)
 - IT Torsional Moment of Inertia
- Section Arguments:**
 - OpenSees Section: Fiber
 - tf = 33
 - d = 33
 - tf = 6
 - tw = 10
 - CoverMaterialLabel = 4ksiUnconfinedConcrete
 - CoreMaterialLabel = 4ksiConfinedConcrete
 - ReinMaterialLabel = 50ksiReinforcingSteel
 - FlangeReinMaterialLabel = 4ksiUnconfinedConcrete
 - NBarTop = 4
 - BarSizeTop = #7
 - NBarTopL = 2
 - BarSizeTopL = #4
 - NBarBot = 4
 - BarSizeBot = #9
 - NBarBot = 3
 - BarSizeBot = #6
 - NBarInt = 4
 - BarSizeInt = #9
 - NBarTopFlangeL = 3
 - BarSizeTopFlangeL = #6
 - NBarTopFlangeU = 2
 - BarSizeTopFlangeU = #6
 - NBarTopFlangeR = 4
 - BarSizeTopFlangeR = #9
 - NBarTopFlangeRI = 2
 - BarSizeTopFlangeRI = #9
 - NBarBotFlangeL = 2
 - BarSizeBotFlangeL = #4
 - NBarBotFlangeU = 0
 - BarSizeBotFlangeU = 3
 - NBarBotFlangeR = 3
 - BarSizeBotFlangeR = #9
 - NBarBotFlangeRI = 1
 - BarSizeBotFlangeRI = #9
 - LayerSpacingTop = 4
 - LayerSpacingBot = 2

The 'Section Behavior' graph shows Moment (kip-in) vs. Curvature (1/in) with a peak moment of approximately 1.5 kip-in. The 'Section Geometry' diagram shows a wide-flange cross-section with dimensions and reinforcement layout.

Silvia Mazzoni, OpenSees Days 2010

Uncoupled-Response Sections

The screenshot shows the 'New Section' dialog for a ColumnHinge section. The configuration is as follows:

- Section Model Label:** ColumnHinge
- Unique Section Label:** ColumnHingeSection
- Optional Arguments:**
 - ShearModelLabel: Previously-Defined Material Label for Shear (Rigid)
 - BendingModelLabel: Previously-Defined Material Label for Bending (Rigid)
- Section Description:** [Empty]

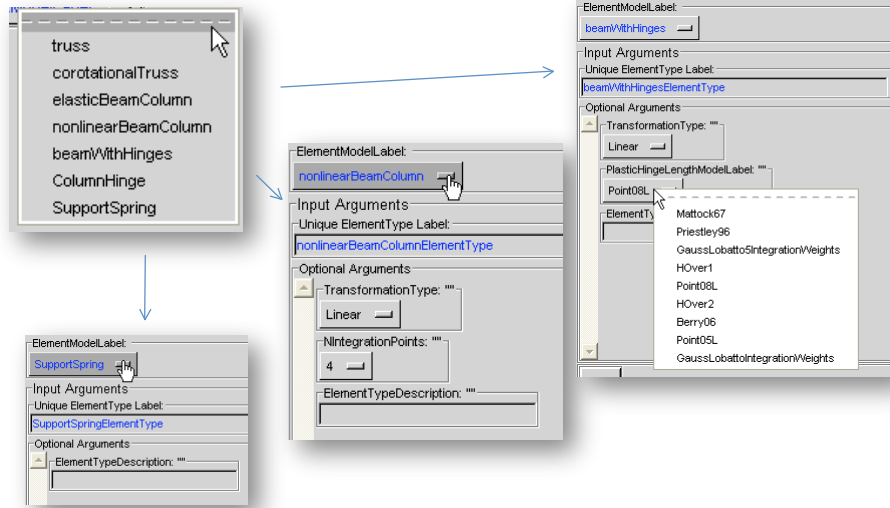
The screenshot shows the 'New Section' dialog for an Uncoupled section. The configuration is as follows:

- Section Model Label:** Uncoupled
- Unique Section Label:** UncoupledSection
- Optional Arguments:**
 - xForceModelLabel: Previously-Defined Material Label for Axial (Rigid)
 - yForceModelLabel: Previously-Defined Material Label for Shear (Rigid)
 - zForceModelLabel: Previously-Defined Material Label for Shear (Rigid)
 - xMomentModelLabel: Previously-Defined Material Label for Torsion (Rigid)
 - yMomentModelLabel: Previously-Defined Material Label for Bending (Rigid)
 - zMomentModelLabel: Previously-Defined Material Label for Bending (Rigid)

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

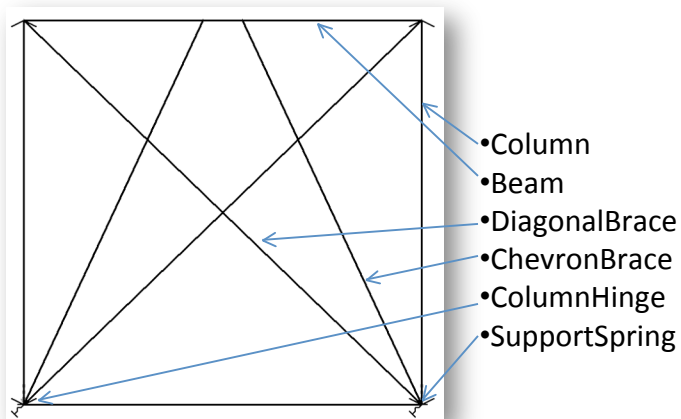
Silvia Mazzoni, OpenSees Days 2010

ElementTypes



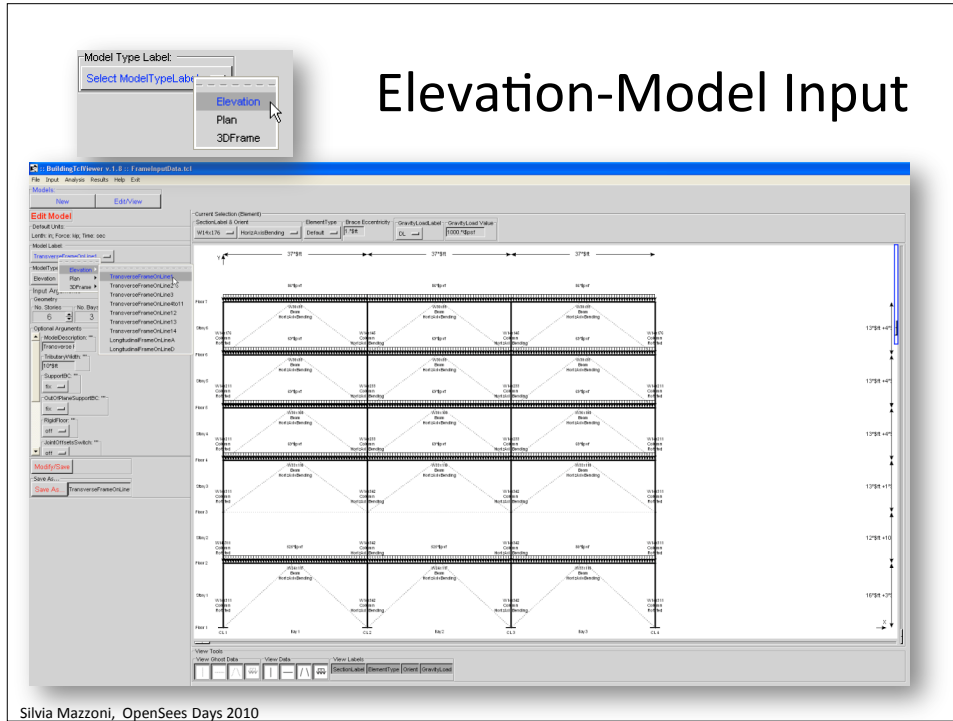
Silvia Mazzoni, OpenSees Days 2010

StructuralElements



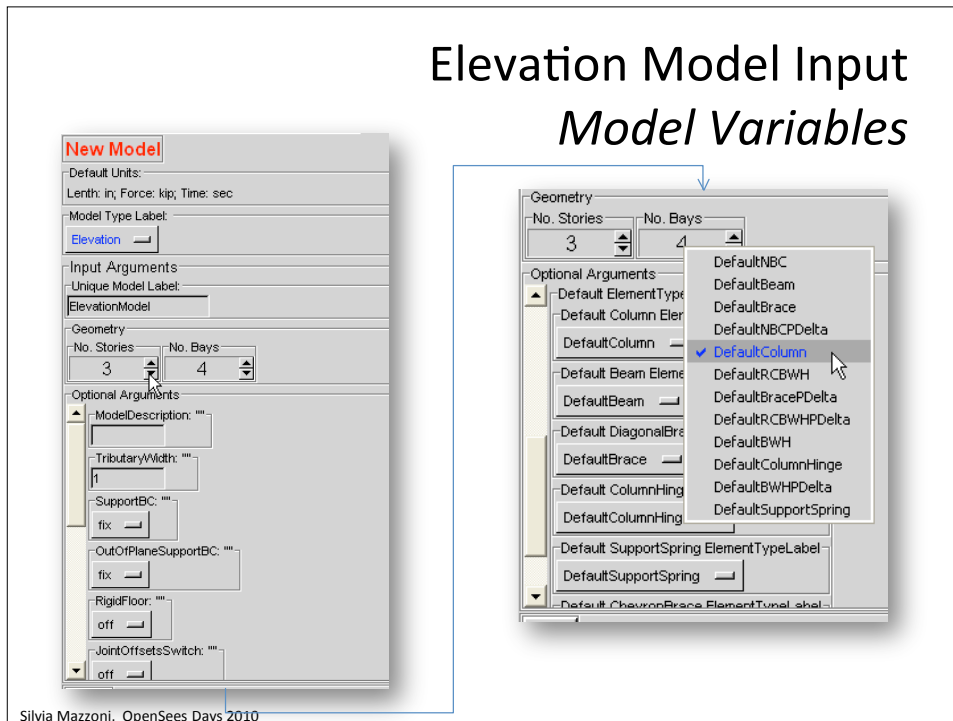
Silvia Mazzoni, OpenSees Days 2010

Elevation-Model Input



Silvia Mazzoni, OpenSees Days 2010

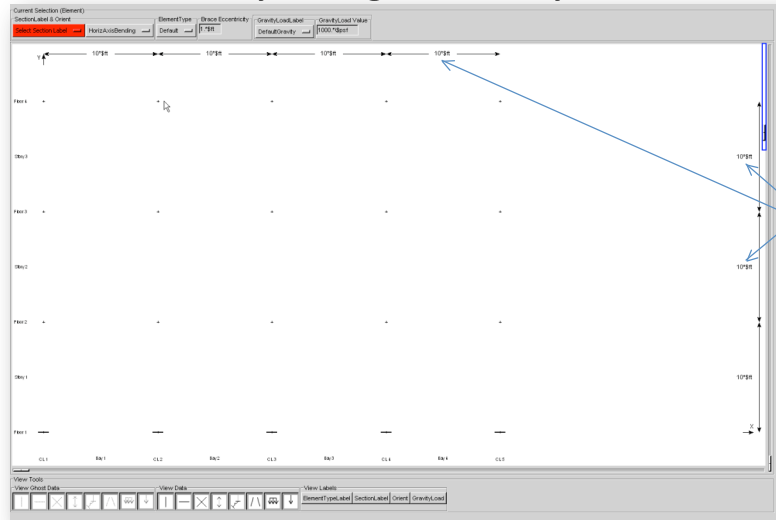
Elevation Model Input *Model Variables*



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

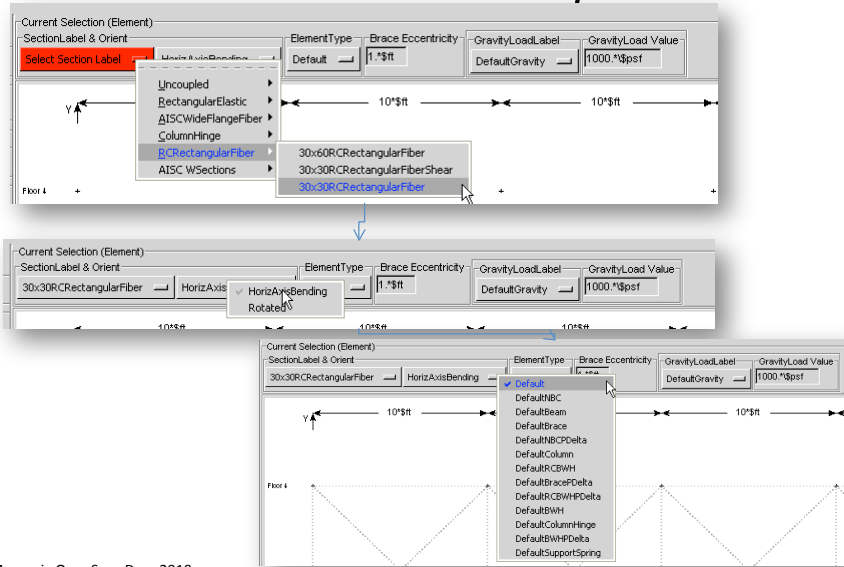
Story Height & Bay width



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

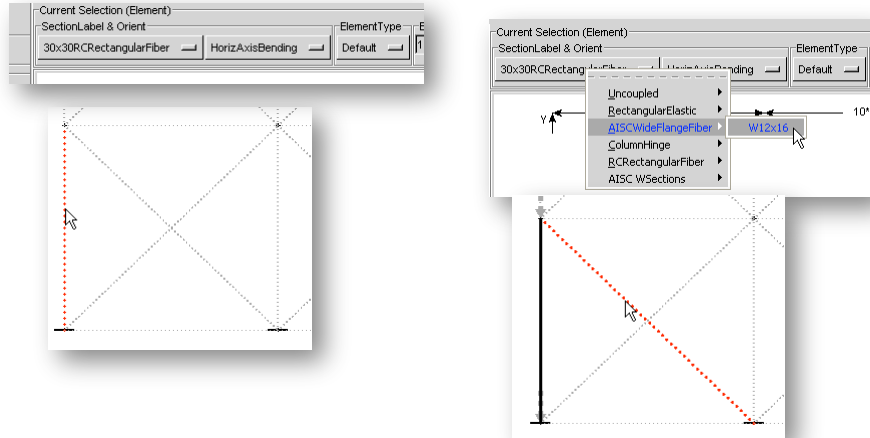
Current-Selection Properties



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

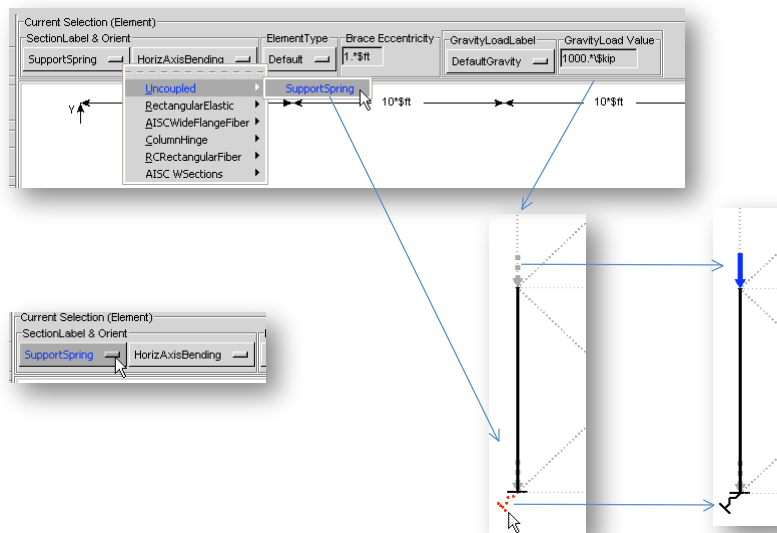
Columns & Diagonal Braces



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

Support Springs & Nodal Loads appear



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

ColumnHinge

Current Selection (Element)

SectionLabel & Orient: SupportRevision, HorizAxisBending

Element Type: Default

Brace Eccentricity: 10'ft

GravityLoadLabel: DefaultGravity

GravityLoad Value: 10000 *\$kip

Uncoupled

RectangularElastic

AISCWideFlangeFiber

ColumnHinge

RCRectangularFiber

AISC WSections

ColumnHinge

Current Selection (Element)

SectionLabel & Orient: HorizAxisBending

Element Type: Default

Brace Eccentricity: 10'ft

GravityLoadLabel: DefaultGravity

GravityLoad Value: 10000 *\$kip

Node 2

Node 1

Node 2

Node 1

Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

Beams

Current Selection (Element)

SectionLabel & Orient: HorizAxisBending

Element Type: Default

Brace Eccentricity: 10'ft

GravityLoadLabel: DefaultGravity

GravityLoad Value: 10000 *\$kip

Uncoupled

RectangularElastic

AISCWideFlangeFiber

ColumnHinge

RCRectangularFiber

AISC WSections

30x60RCRectangularFiber

30x30RCRectangularFiberShear

30x30RCRectangularFiber

Node 2

Node 1

Node 2

Node 1

Once Beam has been defined, user can define:

- Distributed gravity loads
- Chevron Braces

Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input *ChevronBraces*

Brace Eccentricity: 1.5ft

Brace Eccentricity: 2.5ft

BuildingTcl rebuilds beam element
Both braces are created simultaneously

Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input *Distributed Loads*

GravityLoadLabel: LL1

GravityLoadLabel: DL1

GravityLoadLabel: DL2

GravityLoadLabel: DefaultGravity

GravityLoad Value: 1000.0psf

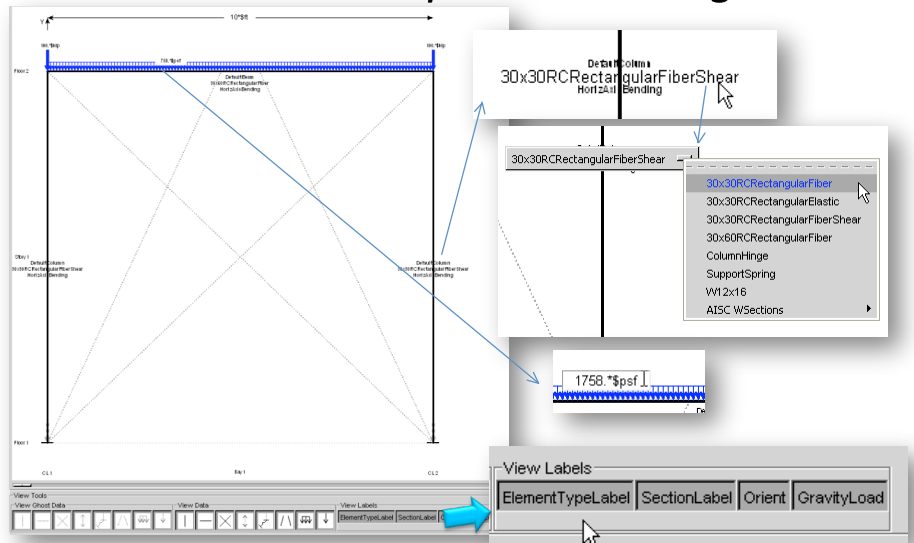
GravityLoad Value: 750.0psf

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

Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

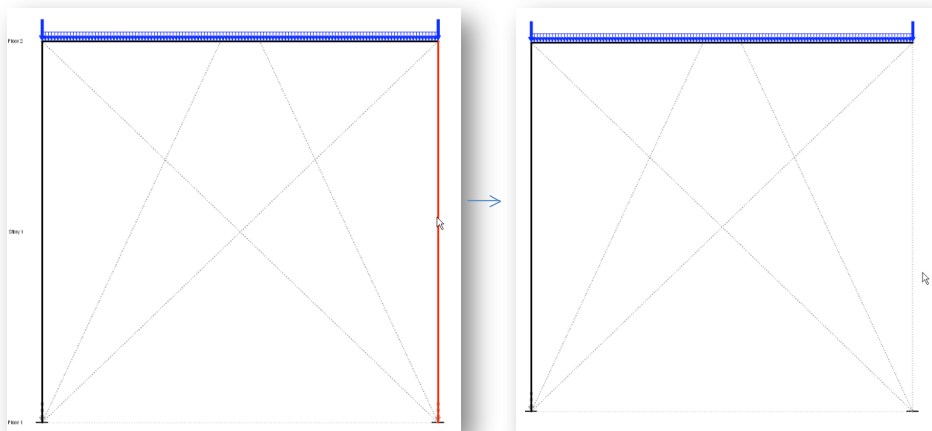
Element-Properties Editing



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

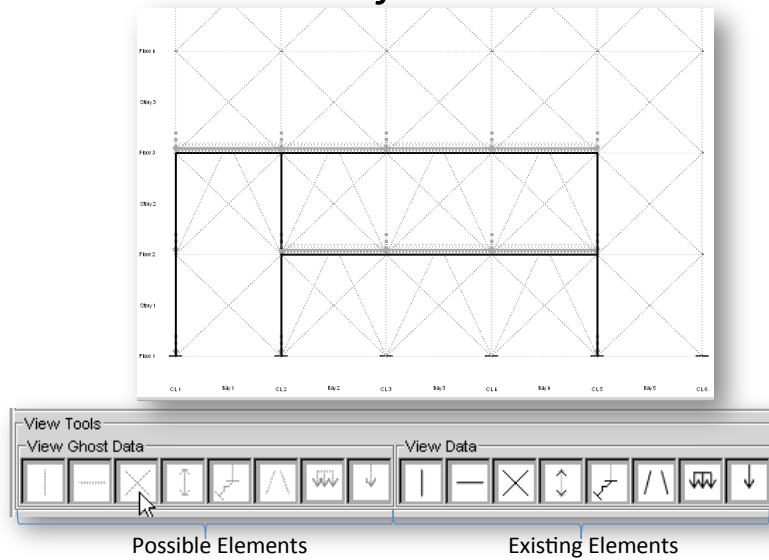
Element/Load removal: Ctrl-key



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

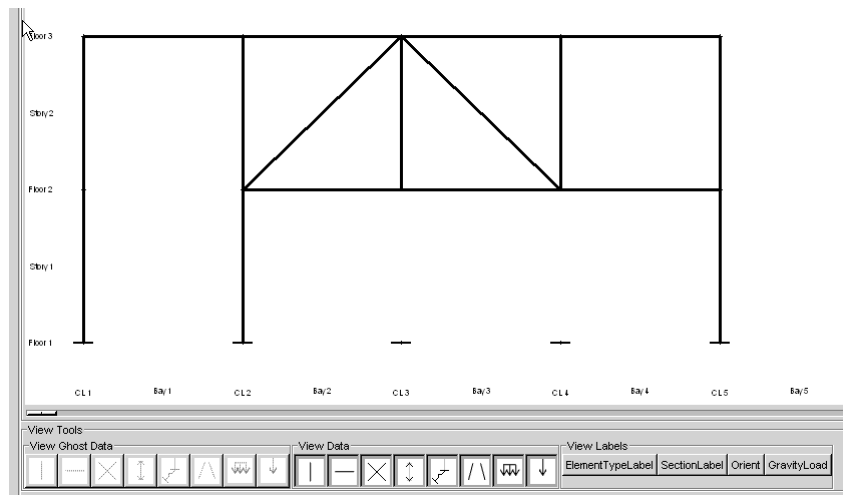
View-Object Selection



Silvia Mazzoni, OpenSees Days 2010

Elevation-Model Input

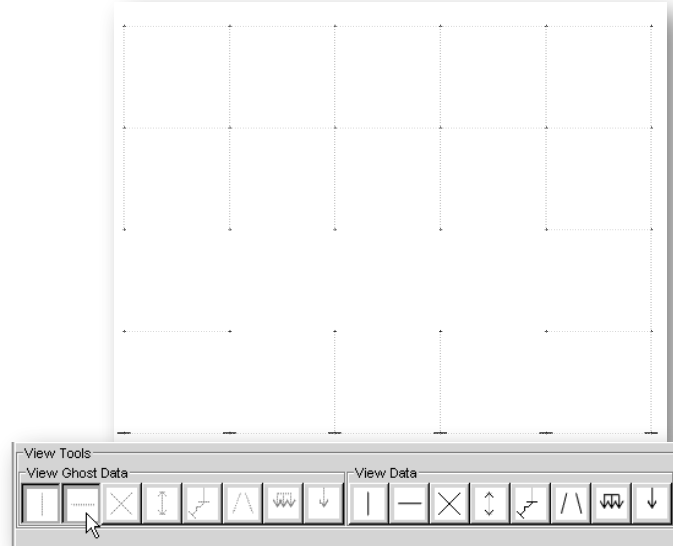
View Existing Elements only



Silvia Mazzoni, OpenSees Days 2010

Elevation-Model Input

View Possible Columns & Beams only



Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

Multiple-Object Creation: Shift-key

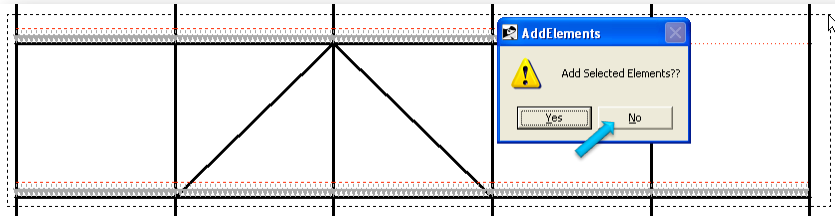
1. Drag mouse to top-right window corner
2. Release mouse button
3. Release shift key

1. Press & hold shift key
2. click and hold mouse button on bottom-left window corner

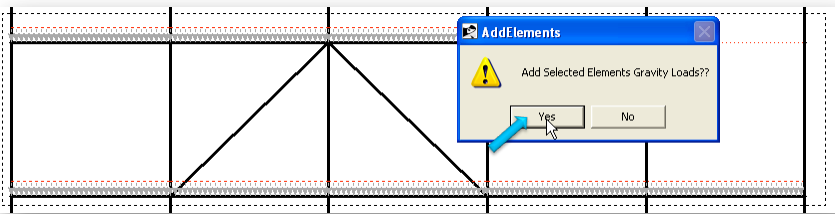
Silvia Mazzoni, OpenSees Days 2010

Elevation Model Input

Multiple-DistributedLoad input

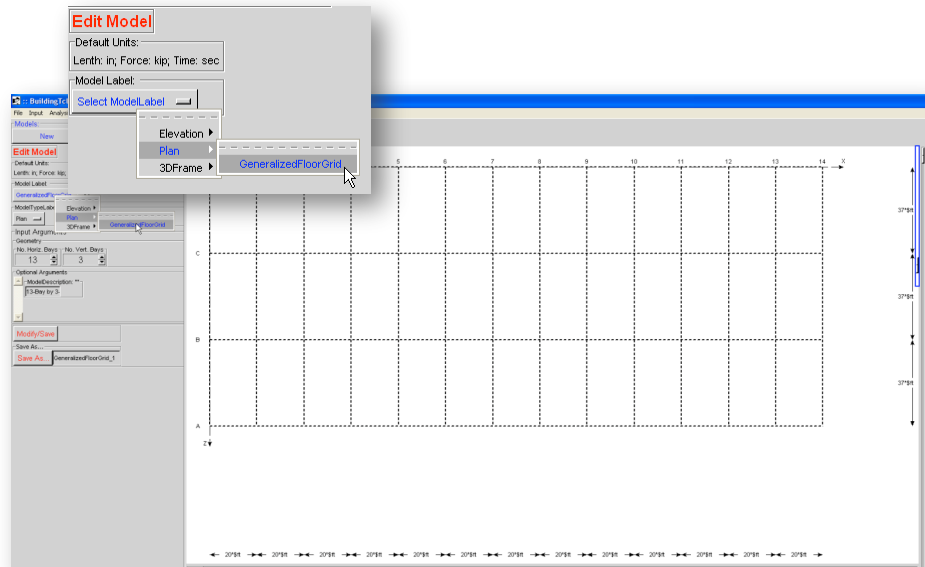


NO to element, YES to load



Silvia Mazzoni, OpenSees Days 2010

Plan-Model Input



Silvia Mazzoni, OpenSees Days 2010

Plan-Model Input

edit plan

Number of Bays

Model Label: GeneralizedFloorGrid

ModelTypeLabel: Plan

Input Arguments

Geometry

No. Horiz. Bays: 13 No. Vert. Bays: 3

Optional Arguments

ModelDescription: 13-Bay by 3:

Column-Line Labels

Plan Bay widths control

3DFrame Bay Widths

Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input

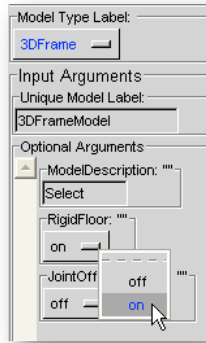
Model Type Label: Select ModelTypeLabel

- Elevation
- Plan
- 3DFrame**

Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input

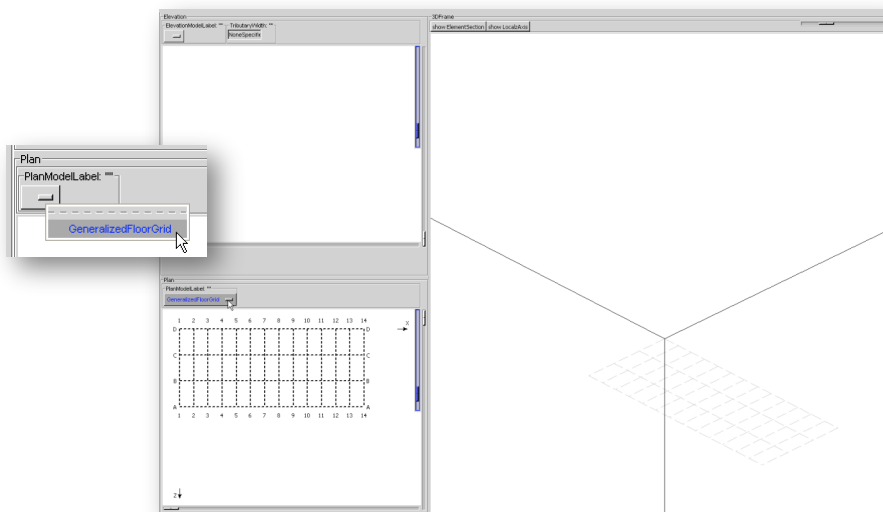
Model Variables



Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input

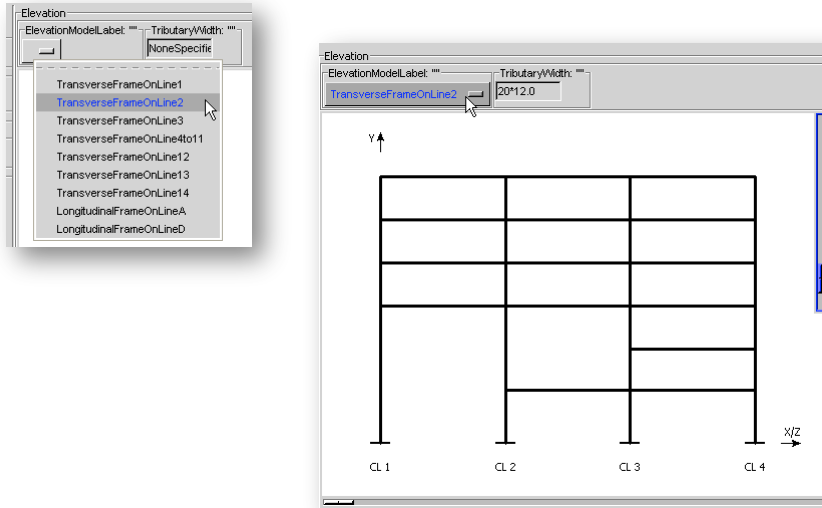
1. select plan



Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input

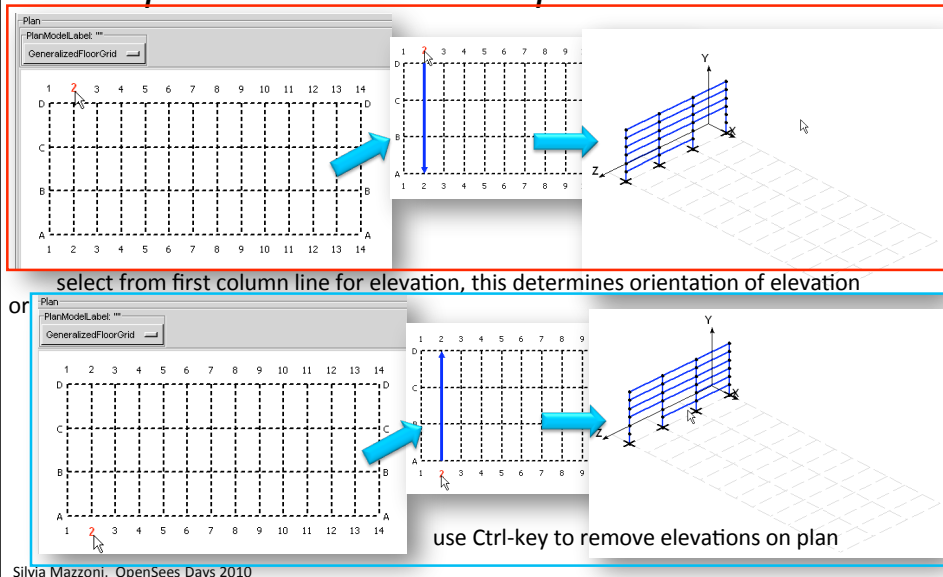
2. select elevation



Silvia Mazzoni, OpenSees Days 2010

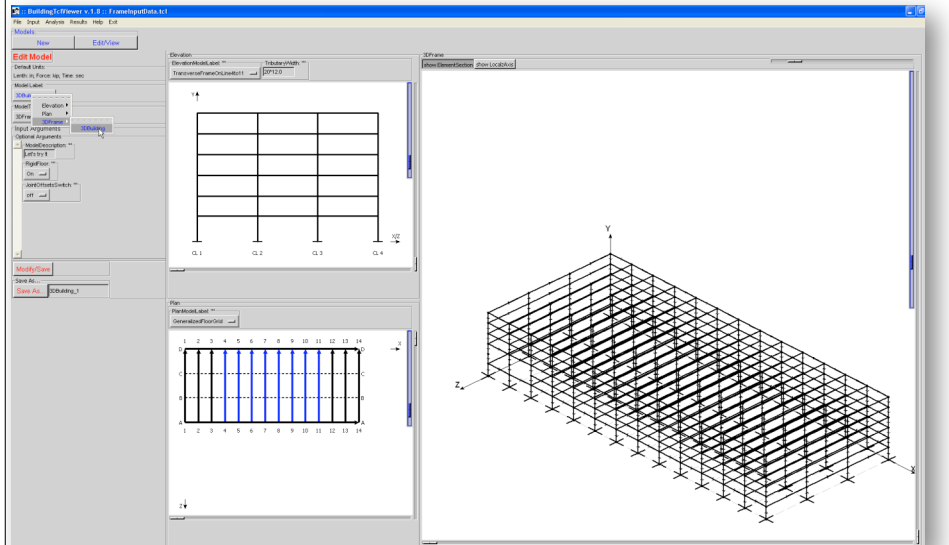
3DFrame-Model Input

3. place elevation into plan column-line



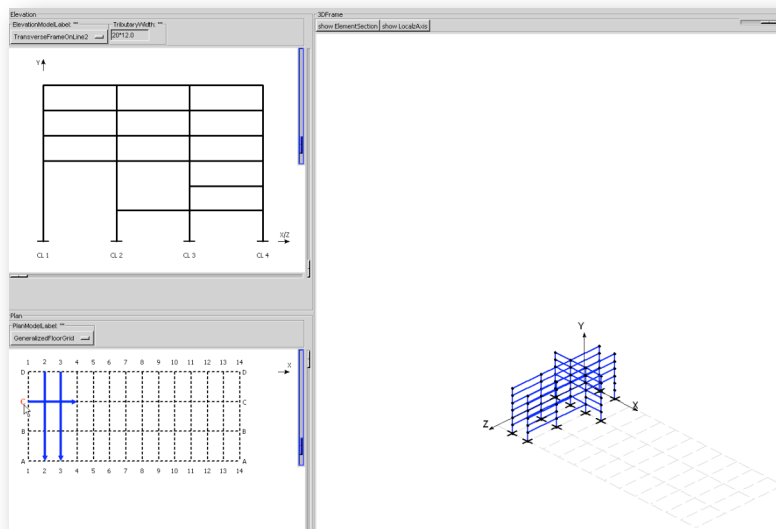
Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input



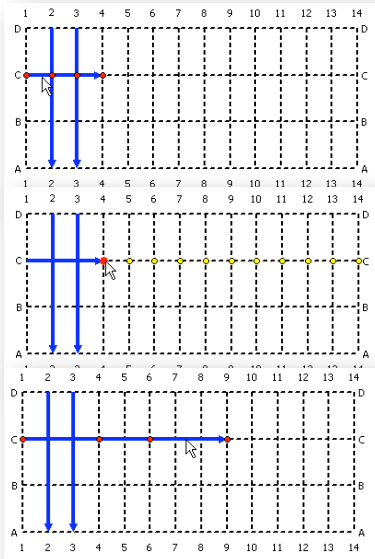
Columns of intersecting elevations are placed on a first-come first-served order.
Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input *Placing elevations*



Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input *Placing elevations*



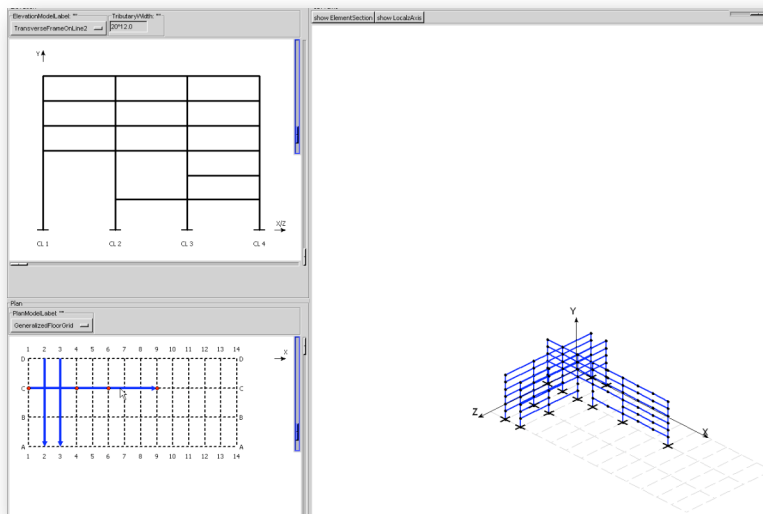
1. select elevation on plan by

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.

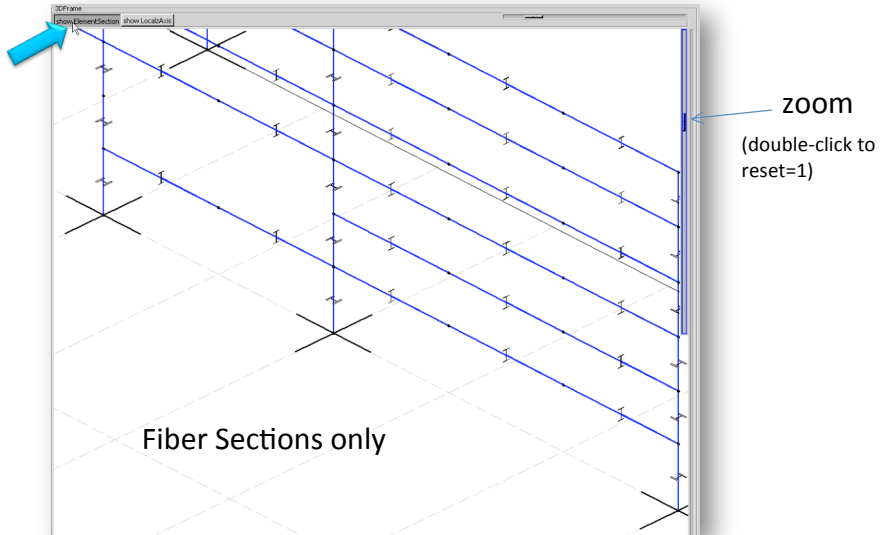
Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input placed elevation



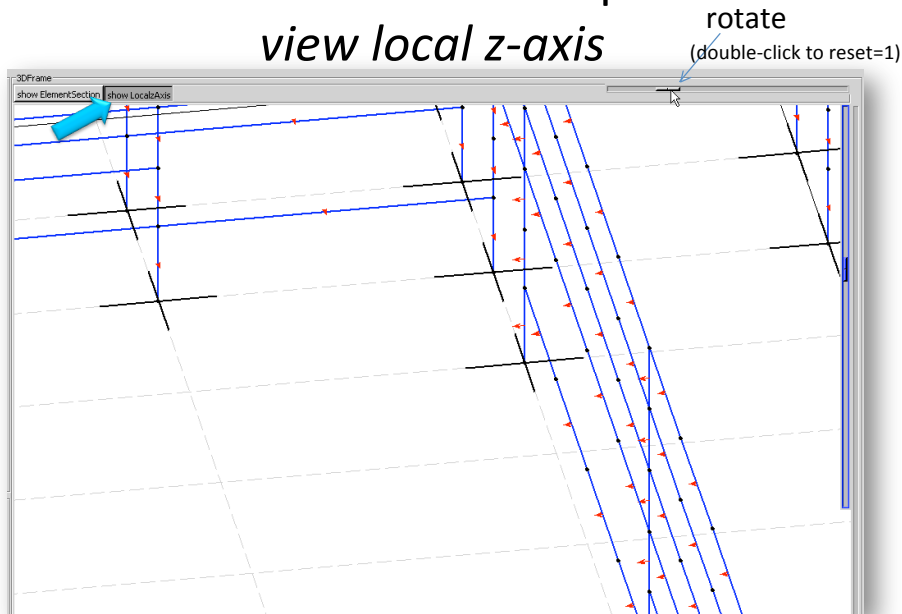
Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input *view Element Cross Sections*



Silvia Mazzoni, OpenSees Days 2010

3DFrame-Model Input *view local z-axis*



Silvia Mazzoni, OpenSees Days 2010

Analysis Models

The image displays the 'New AnalysisModel' dialog box on the left, which includes a 'Select AnalysisTypeLabel' dropdown menu. Three blue arrows point from this menu to three separate configuration windows for different analysis models:

- TimeHistory Analysis Model:** Shows parameters such as `DtAnalysis` (0.01), `TmaxAnalysis` (50), `Tolerance` (1e-8), `DampingRatio` (0.02), and `constraintsType`.
- DisplacementHistory Analysis Model:** Shows parameters such as `DisplacementIncrement` (0.01), `Tolerance` (1e-8), `constraintsType` (Plain), `alphaSP` (1e6), and `alphaMP` (1e6).
- LoadControl Analysis Model:** Shows parameters such as `Nstep` (10), `Tolerance` (1e-8), `maxNumber` (5), `numberType` (RCM), and `testType` (EnergyIncr).

Silvia Mazzoni, OpenSees Days 2010

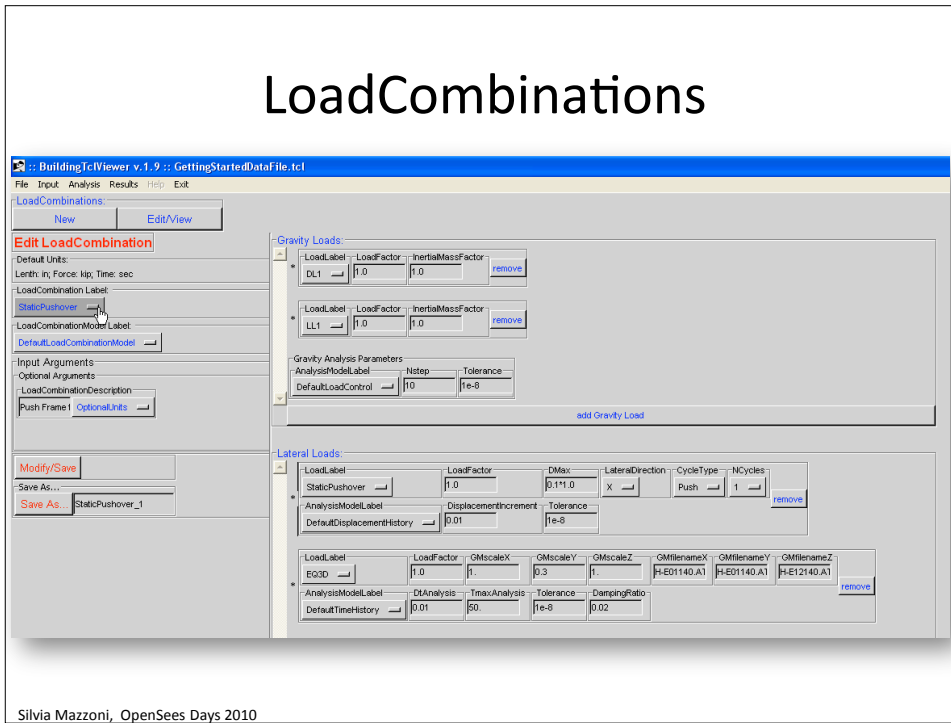
Loads

The image displays the 'Load Type Label' dropdown menu on the left, which includes options like Gravity, LateralPushover, UniformEQ, UniformEQ2D, UniformEQ3D, and UniformSine. Three blue arrows point from this menu to three separate configuration windows for different load types:

- Gravity Load Type:** Shows parameters such as `LoadDescription` and `InertiaMassFactor` (1.0).
- UniformEQ3D Load Type:** Shows parameters such as `GMfilenameX`, `GMfilenameY`, `GMscaleX`, `GMscaleY`, `GMscaleZ`, `GMdirectory`, `FileType` (PEER), and `GMfact` (1g).
- LateralPushover Load Type:** Shows parameters such as `LateralDirection` (X), `CycleType` (Push), `NCycles` (1), `ControlName` (Top), `ScaleFactor` (1.0), and `DmaxFactor` (1.0).

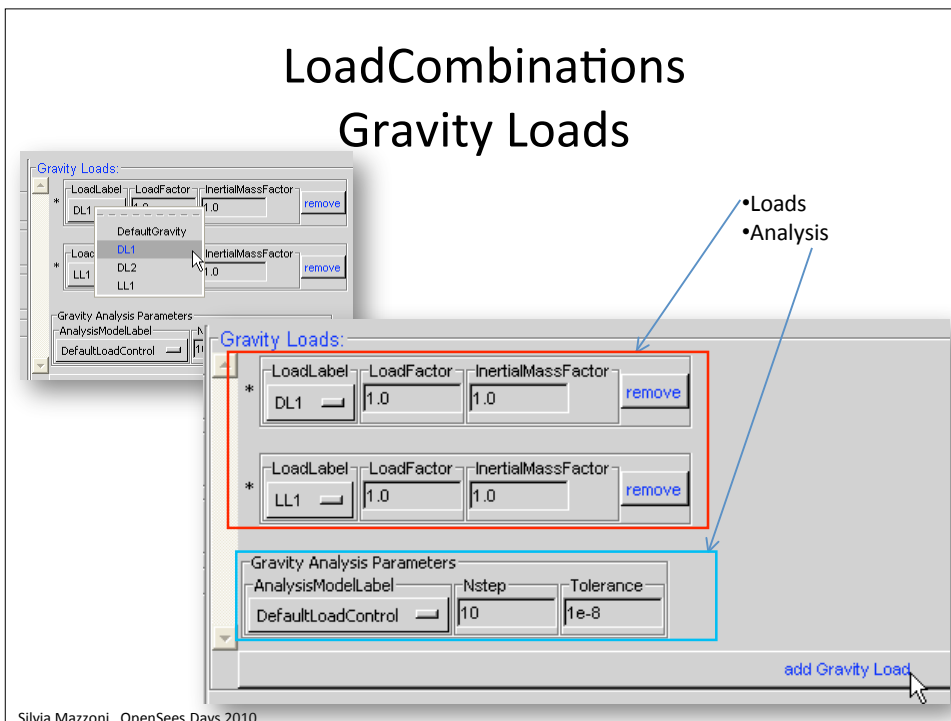
Silvia Mazzoni, OpenSees Days 2010

LoadCombinations



Silvia Mazzoni, OpenSees Days 2010

LoadCombinations Gravity Loads



Silvia Mazzoni, OpenSees Days 2010

LoadCombinations

Lateral Loads

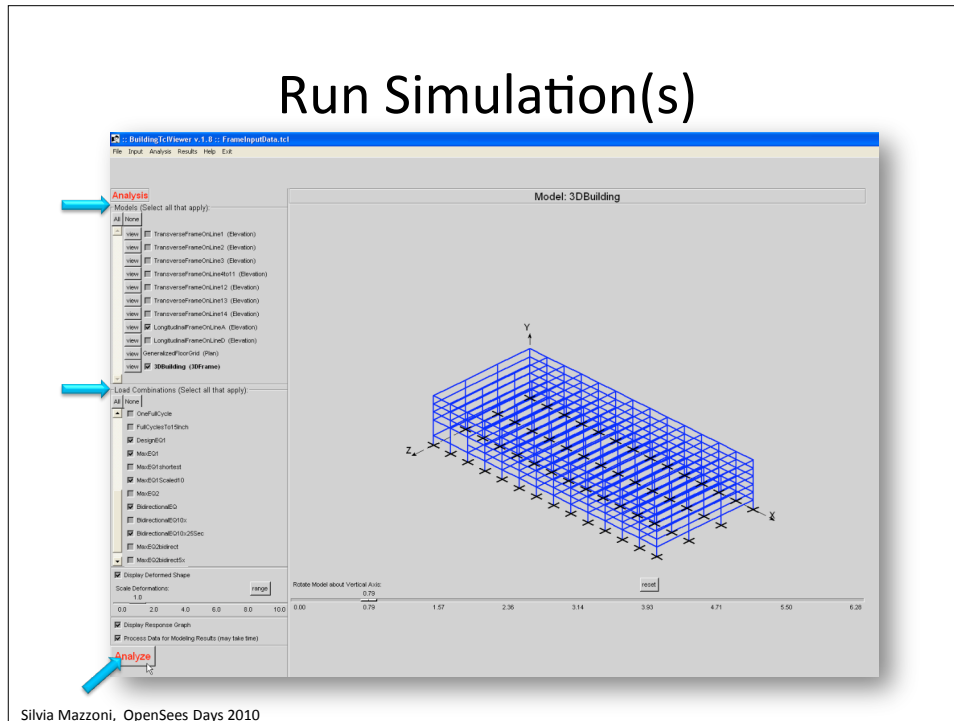
•Loads
•Analysis

Silvia Mazzoni, OpenSees Days 2010

Did you notice the smart Units?

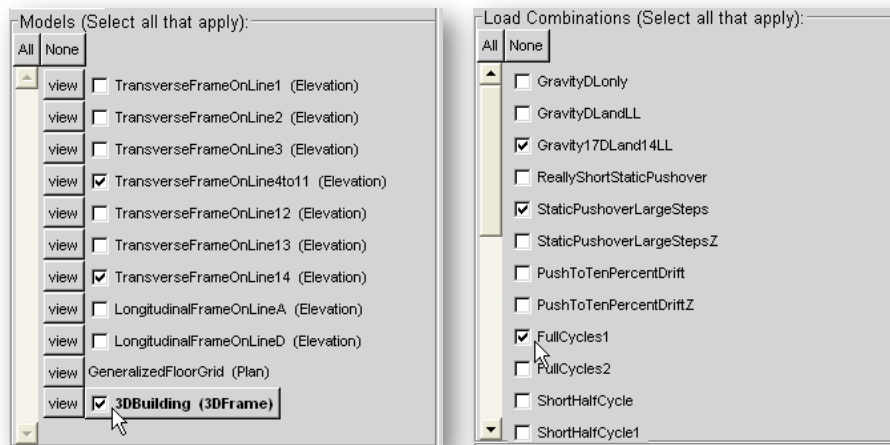
Silvia Mazzoni, OpenSees Days 2010

Run Simulation(s)

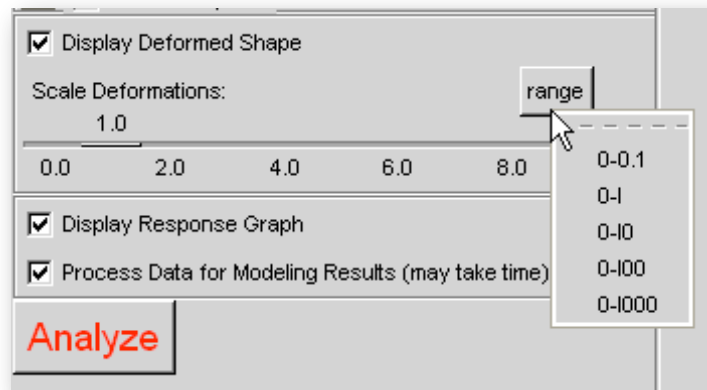


Select Models and LoadCombinations

for **Analysis**

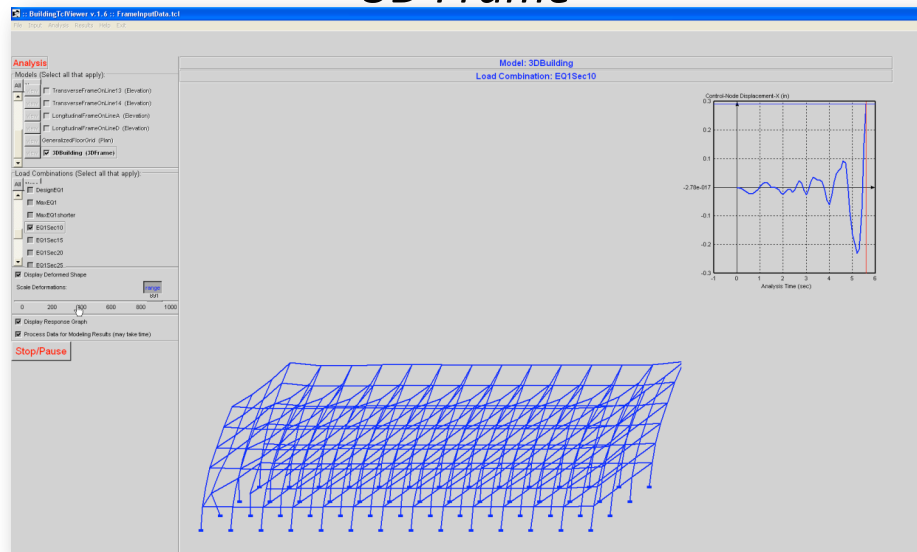


Real-Time Visualization Controls



Silvia Mazzoni, OpenSees Days 2010

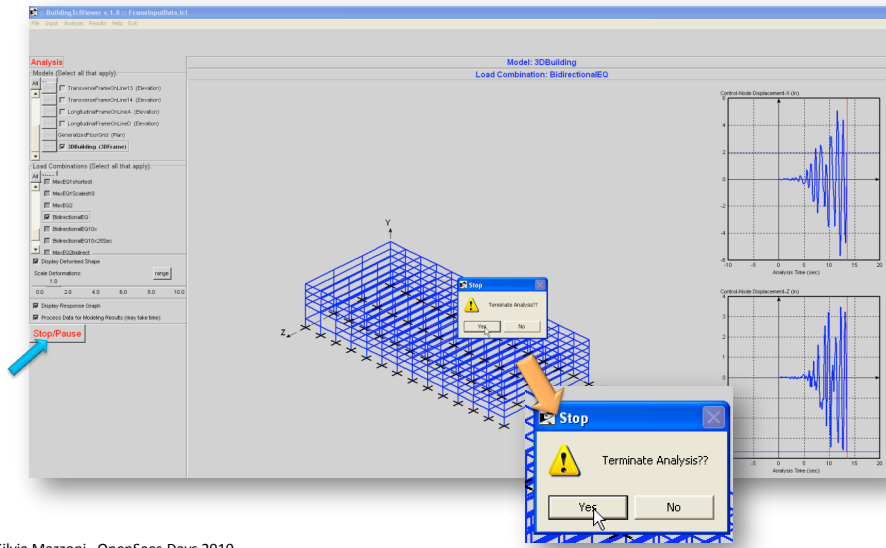
Real-Time OpenSees Simulation 3D Frame



Silvia Mazzoni, OpenSees Days 2010

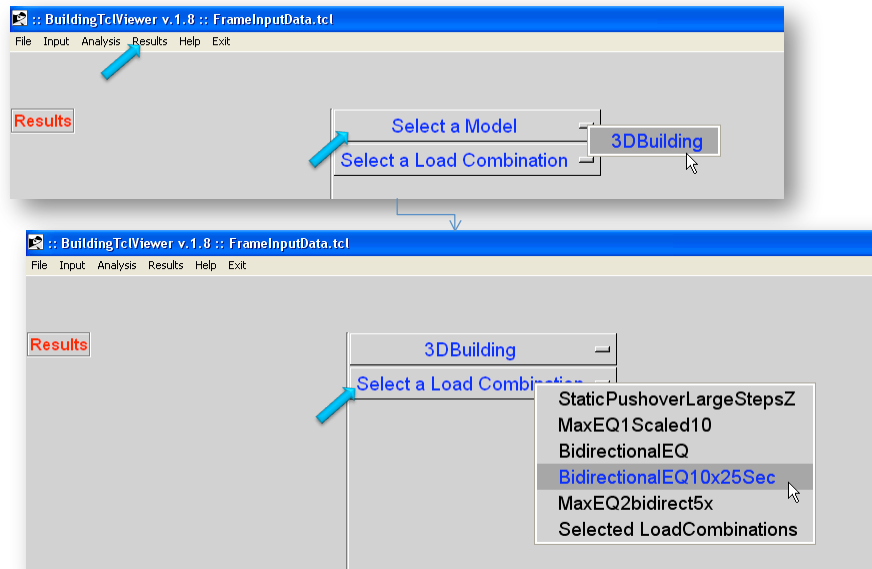
Real-Time OpenSees Simulation

Real-Time Pause/Stop



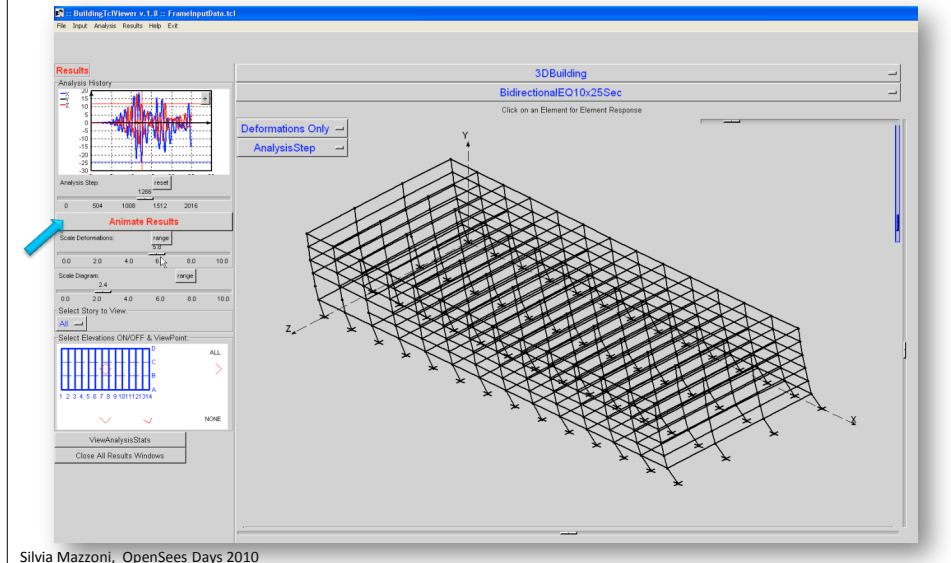
Silvia Mazzoni, OpenSees Days 2010

Visualization of Simulation Results

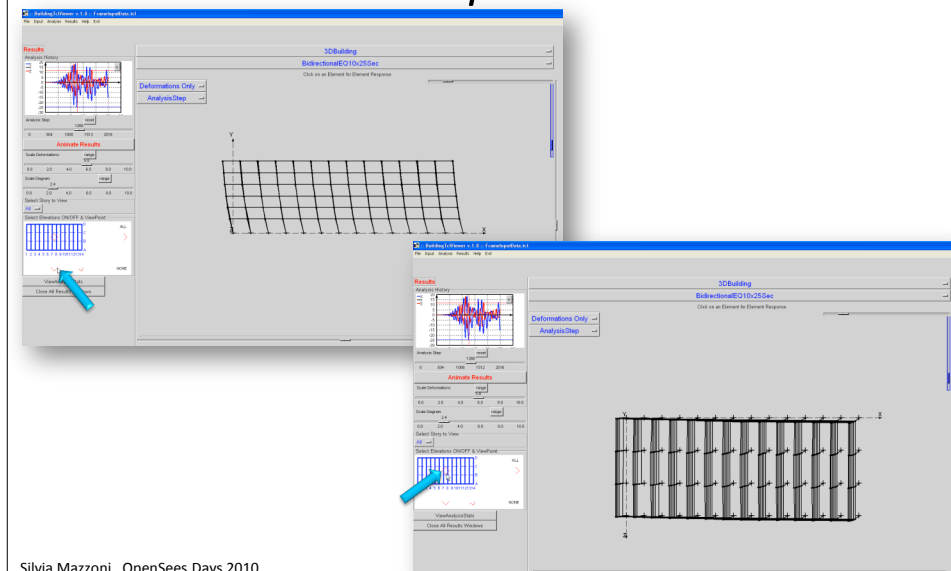


Silvia Mazzoni, OpenSees Days 2010

Visualization of Structural Response *animation*

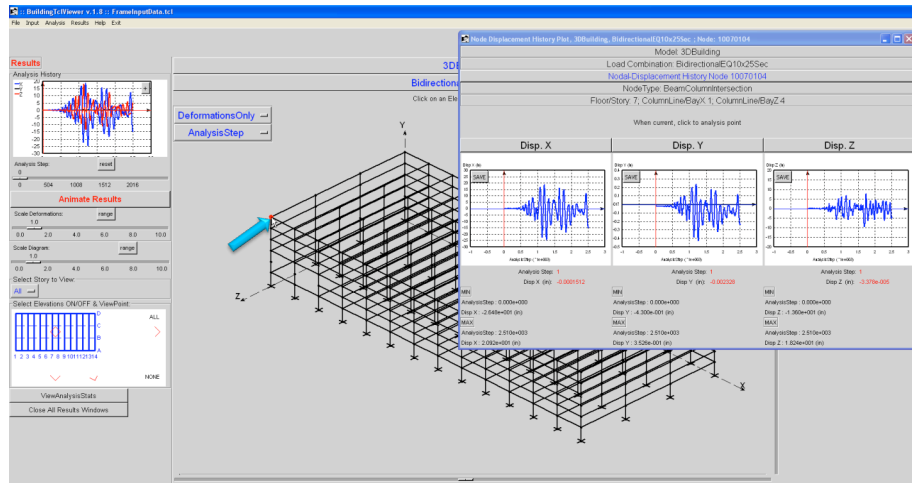


Visualization of Structural Response *viewpoints*



Visualization of Structural Response

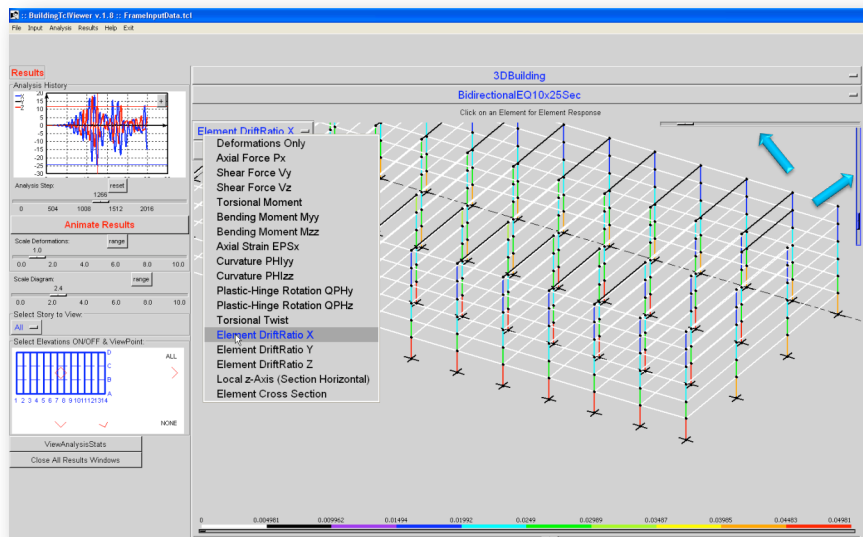
nodal-displacement response



Silvia Mazzoni, OpenSees Days 2010

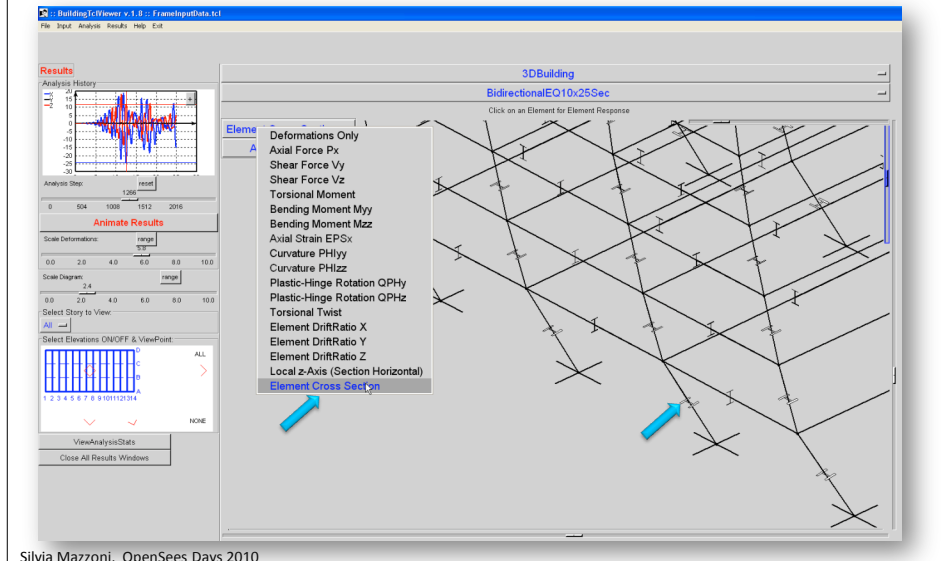
Visualization of Structural Response

zoom & rotate

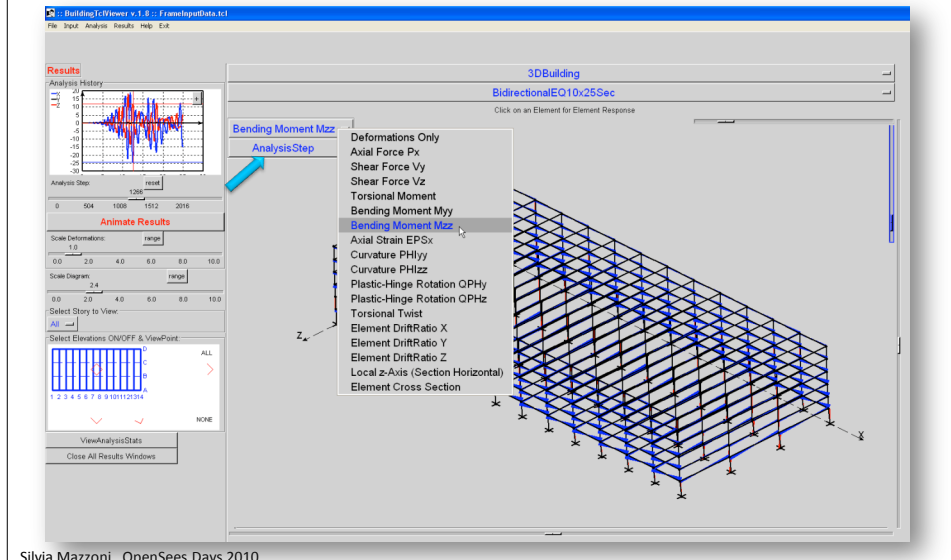


Silvia Mazzoni, OpenSees Days 2010

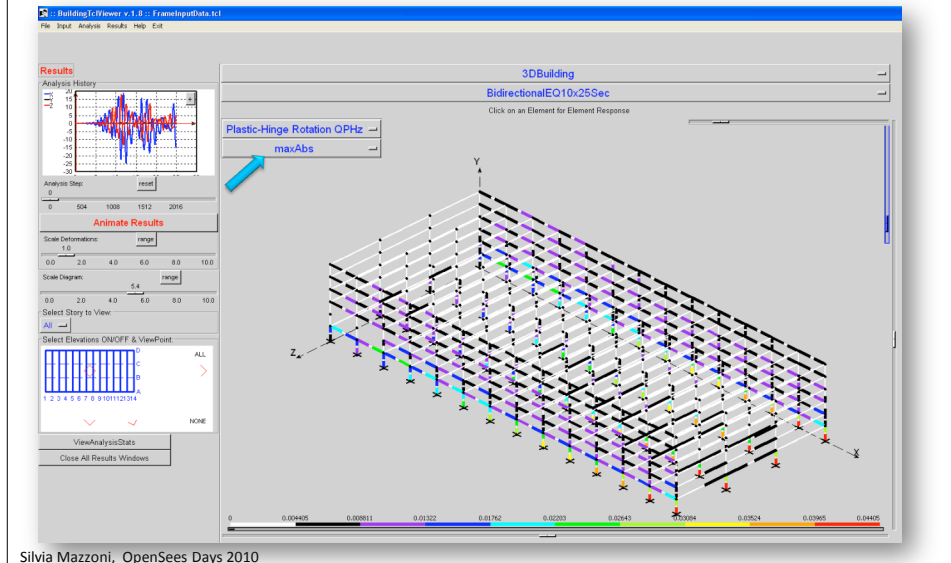
Visualization of Structural Response *element section*



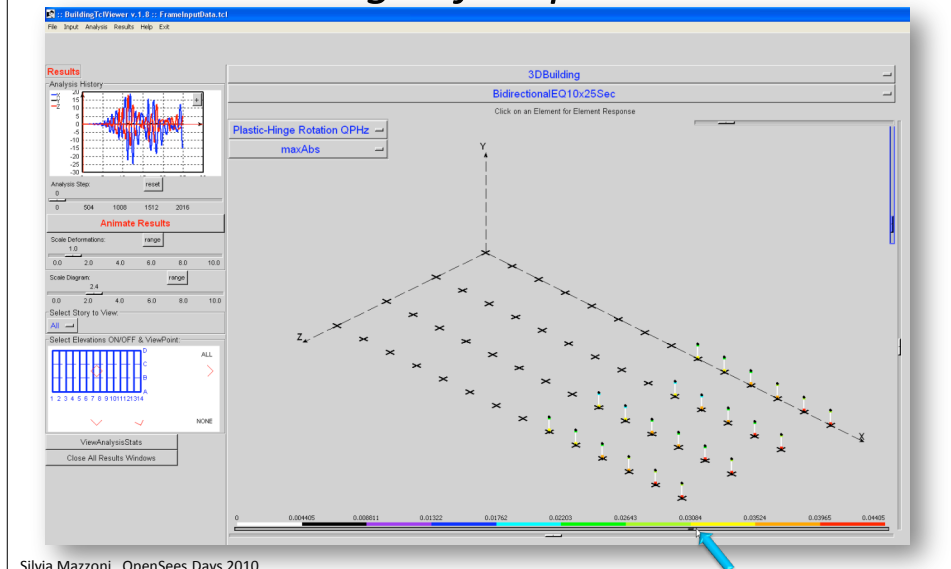
Visualization of Structural Response *@ Analysis Steps*



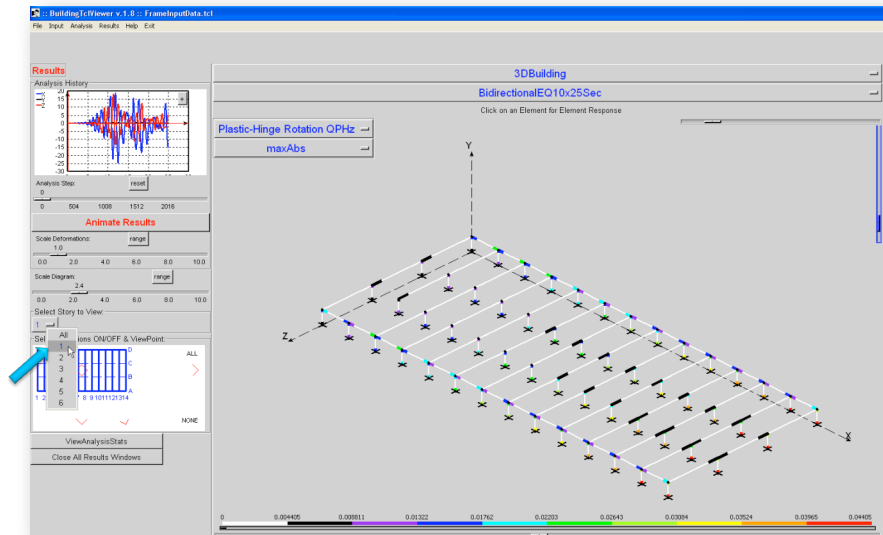
Visualization of Structural Response *envelope values*



Visualization of Structural Response *range of response*

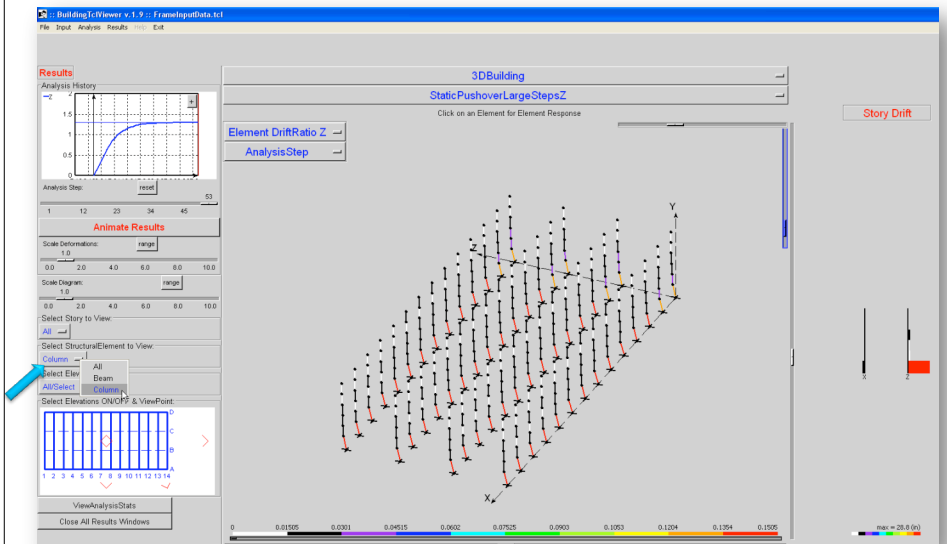


Visualization of Structural Response *individual story*



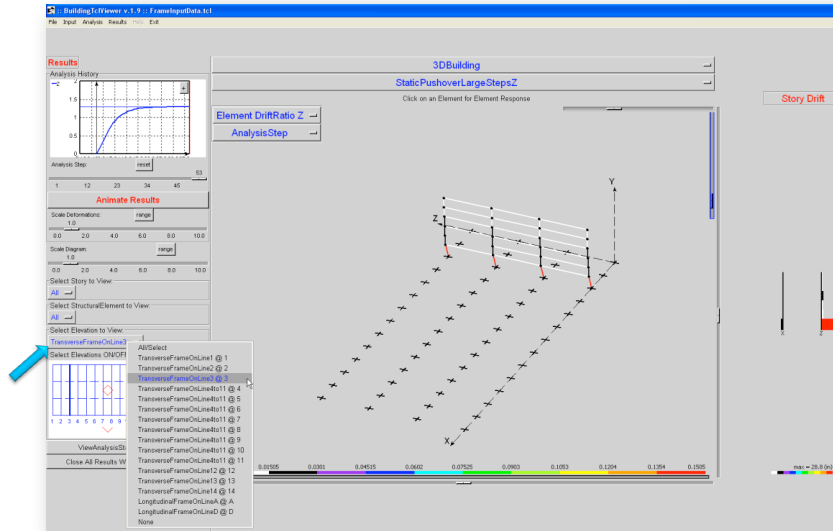
Silvia Mazzoni, OpenSees Days 2010

Visualization of Structural Response *individual StructuralElement*



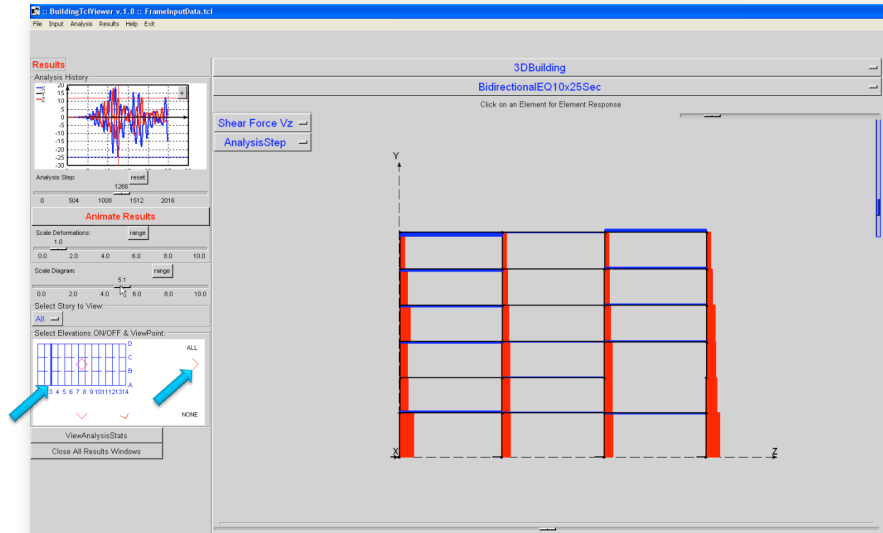
Silvia Mazzoni, OpenSees Days 2010

Visualization of Structural Response *individual-elevation response*



Silvia Mazzoni, OpenSees Days 2010

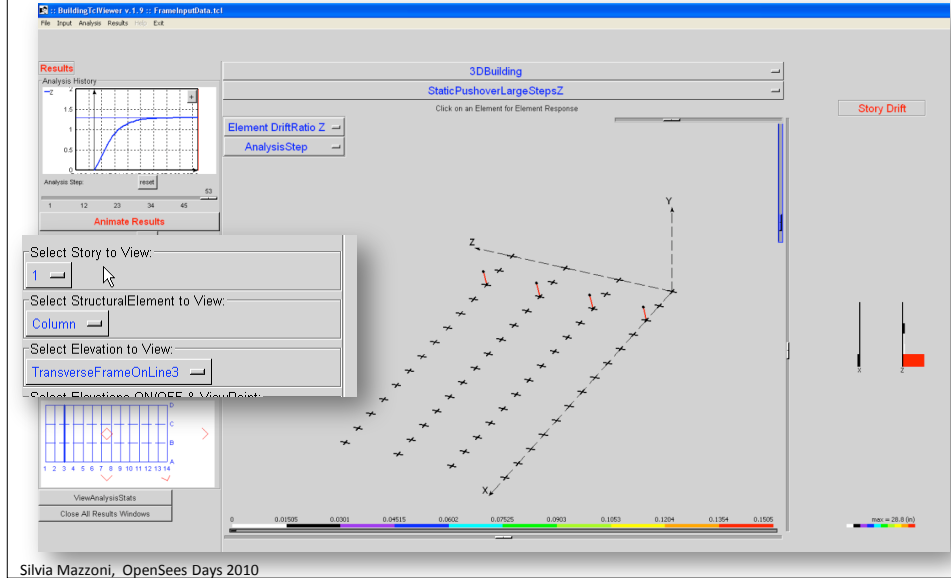
or: Visualization of Structural Response *individual-elevation response*



Silvia Mazzoni, OpenSees Days 2010

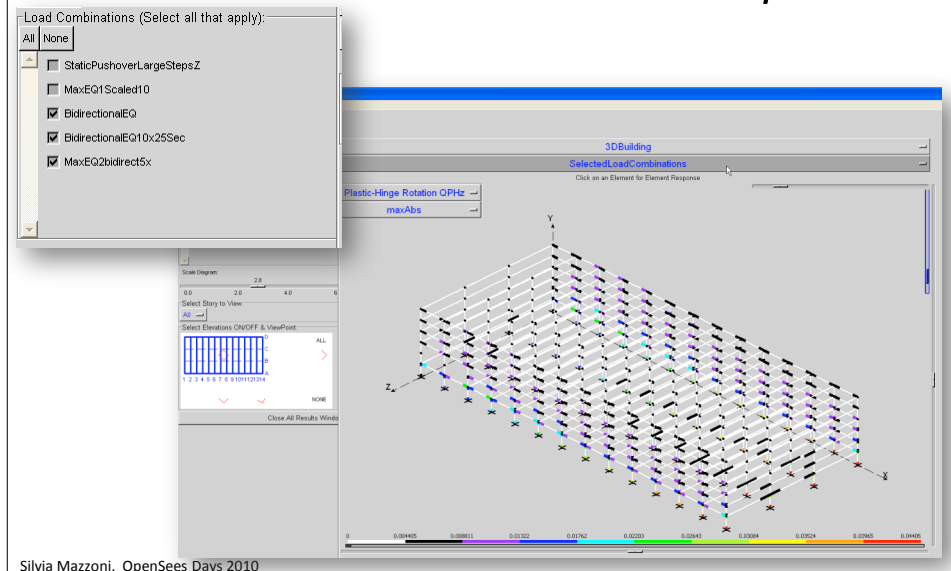
Visualization of Structural Response

Combined selection



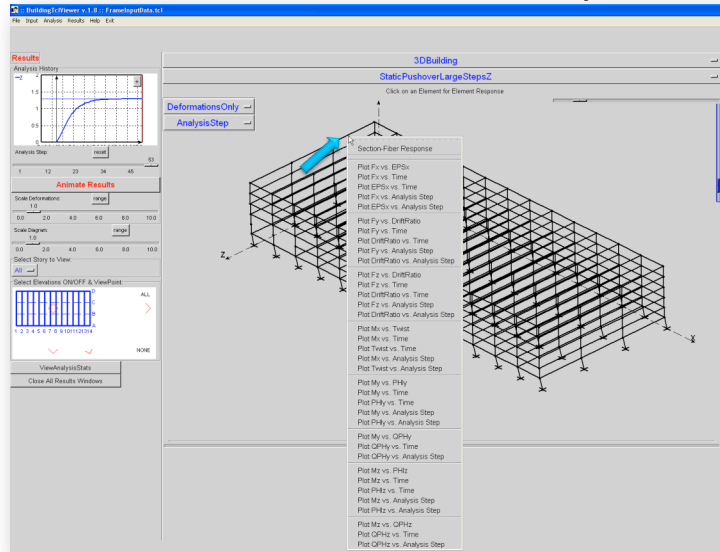
Visualization of Structural Response

N-LoadCombinations envelope



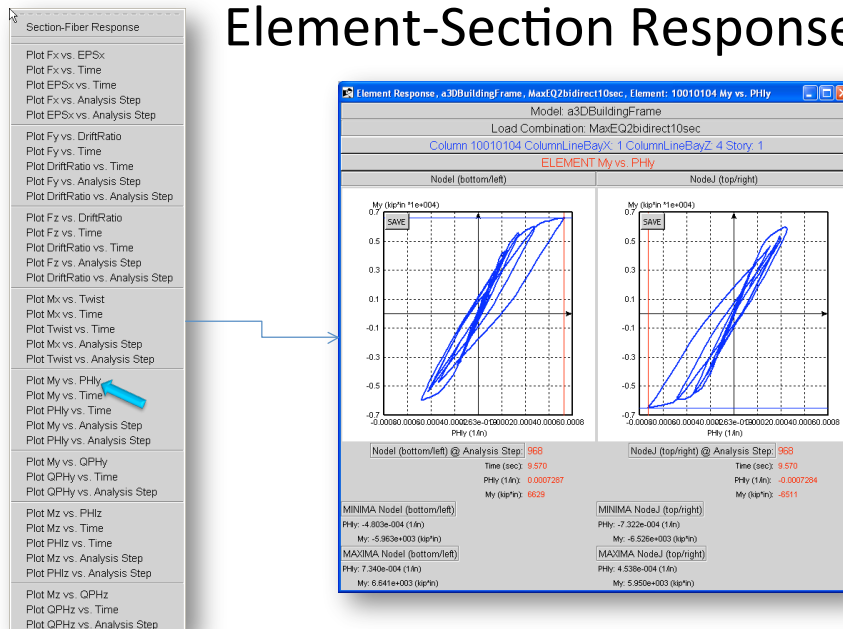
Visualization of Structural Response

selected-element response



Silvia Mazzoni, OpenSees Days 2010

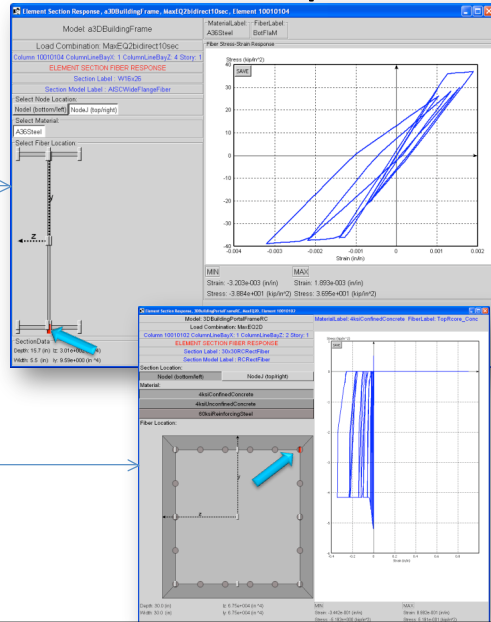
Element-Section Response



Silvia Mazzoni, OpenSees Days 2010

Section-Fiber 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. PHy
- Plot My vs. Time
- Plot PHy vs. Time
- Plot My vs. Analysis Step
- Plot PHy vs. Analysis Step
- Plot My vs. QPHy
- Plot QPHy vs. Time
- Plot QPHy vs. Analysis Step
- Plot Mz vs. PHz
- Plot Mz vs. Time
- Plot PHz vs. Time
- Plot Mz vs. Analysis Step
- Plot PHz vs. Analysis Step
- Plot Mz vs. QPHz
- Plot QPHz vs. Time
- Plot QPHz vs. Analysis Step



Silvia Mazzoni, OpenSees Days 2010

In case you have to hard-exit:

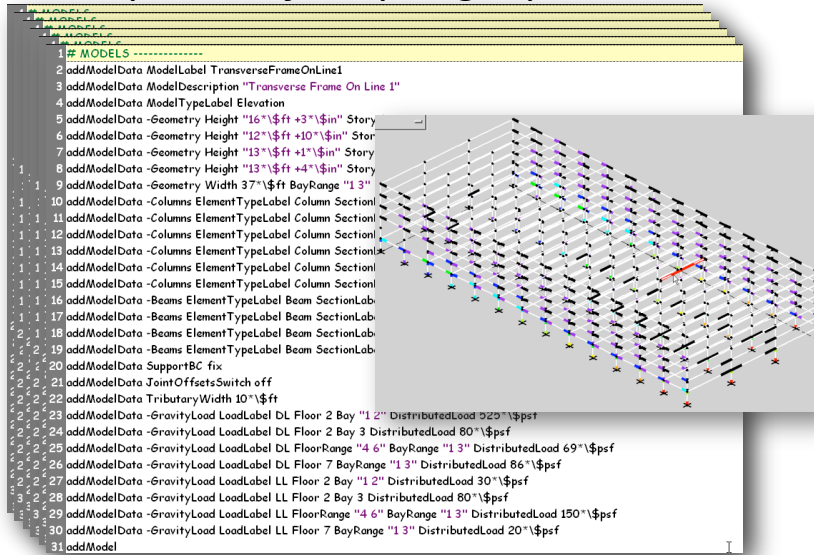
After every time that any object is saved or modified, BuildingTclViewer saves a file in the same directory as the input file:

CurrentData.tcl

Name	Size	Type	Date Modified
Data		File Folder	1/13/2010 10:24 PM
GMfiles		File Folder	10/23/2009 11:58 AM
CurrentData.tcl	31 KB	ActiveTcl Script	1/14/2010 2:24 PM
GettingStartedDataFile.tcl	27 KB	ActiveTcl Script	1/14/2010 5:08 PM

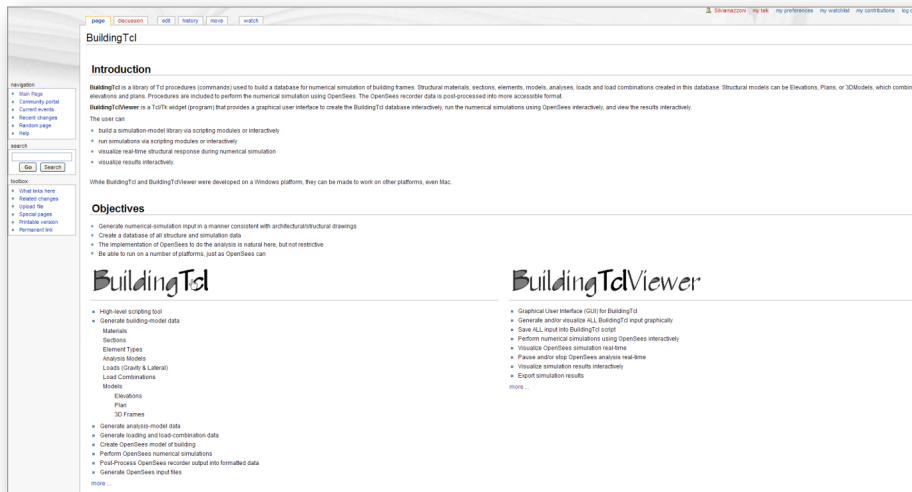
Silvia Mazzoni, OpenSees Days 2010

Conclusions: *BuildingTcl* combines the power of scripting input with a GUI



Silvia Mazzoni, OpenSees Days 2010

Documentation: OpenSees wiki



Silvia Mazzoni, OpenSees Days 2010

Download: neesforge.nees.org/projects/buildingtcl/

The screenshot shows the project page for BuildingTcl on the neesforge.nees.org website. The page includes a search bar, navigation tabs, and a list of project milestones.

Project Milestones:

Package	Version	Date	Notes / Action	Download
BuildingTcl	BuildingTcl 1.0	October 20, 2009	[View All Project Files]	Download
	Version 1.0	SHA-MD5: 2009-10-20 20:11	(0 Comment) [Read More Comment]	
	BuildingTcl 1.0a	SHA-MD5: 2009-10-04 22:27	(0 Comment) [Read More Comment]	
	BuildingTcl and BuildingTcl (Open) now available in 3D	SHA-MD5: 2009-07-04 15:10	(0 Comment) [Read More Comment]	
	First Public Release of BuildingTcl	SHA-MD5: 2009-07-04 12:27	(1 Comment) [Read More Comment]	[View Article] [View All]

Public Issues:

- Project Home Page
- Tracker
 - Bugs (8 open, 0 total)
 - Bug Tracking System
 - Support (0 open, 0 total)
 - Feature Request Tracking System
 - Feature (4 open, 0 total)
 - Feature Tracking System
 - Feature Requests (1 open, 0 total)
 - Feature Request Tracking System
- Public Forums (2 messages in 2 forums)
- Challenges: Project Documentation
- Building Lists (1 public mailing list)
- Task Manager
 - Open Issues
 - To Do
- Surveys (8 surveys)
- SCM Repository (CVS: 0 commits, 0 adds)

.... thank you!!!

Silvia Mazzoni, OpenSees Days 2010