

OpenSees Workshop

Online Tutoring Course



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Educational Background:

2004-2008 BSc, Civil Engineering, KNT University
2008-2010 MSc, Earthquake Engineering, Sharif University of Technology
2010-Present PhD, Structural and Earthquake Eng., Sharif University of Technology



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Educational Background:

2003-2007 BSc, Civil Engineering, Tabriz University
2007-2009 MSc, Earthquake Engineering, Sharif University of Technology
2013 PhD, Structural and Earthquake Eng., SUNY at Buffalo

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Photos

GROUPS

- OpenSees**
- نقشه برداران ورنالی 20+
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- جامعه نقشه برداران 20+
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- غز سید محمود برقعی... 20+
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 **Hadi Kenarangi**
Sharif University OpenSees Student Group searches for talented volunteers who can contribute in developing new commands, examples, writing tutoring hand outs, developing SOC (SAP2000 to OpenSees Converter developed by this group).

Volunteers are expected to be experienced in OpenSees, MATLAB and Programming Languages. Knowledge in Microsoft Visual Studio will be an advantage.

Please send your CV to Mr. Seyed Mojtaba Hosseini (hosseinigelekolai@gmail.com) or Hadi Kenarangi (hadi.kenarangi@gmail.com).





Thanks



267 members (6 new)

+ Add People to Group

People You May Know See All

-  **Shila Morteza Beigi**
Add Friend
-  **Mostafa Mkz**
10 mutual friends
Add Friend
-  **Hamidreza Alinezhad**
9 mutual friends
Add Friend
-  **Maryami Rezazadeh**
1 mutual friend
Add Friend
-  **Bahman Farahmand Azar**
3 mutual friends
Add Friend
-  **Sevil Marzban**
Add Friend

Recent posts and comments from group members, including profile pictures and text snippets.

SUT OpenSees Group

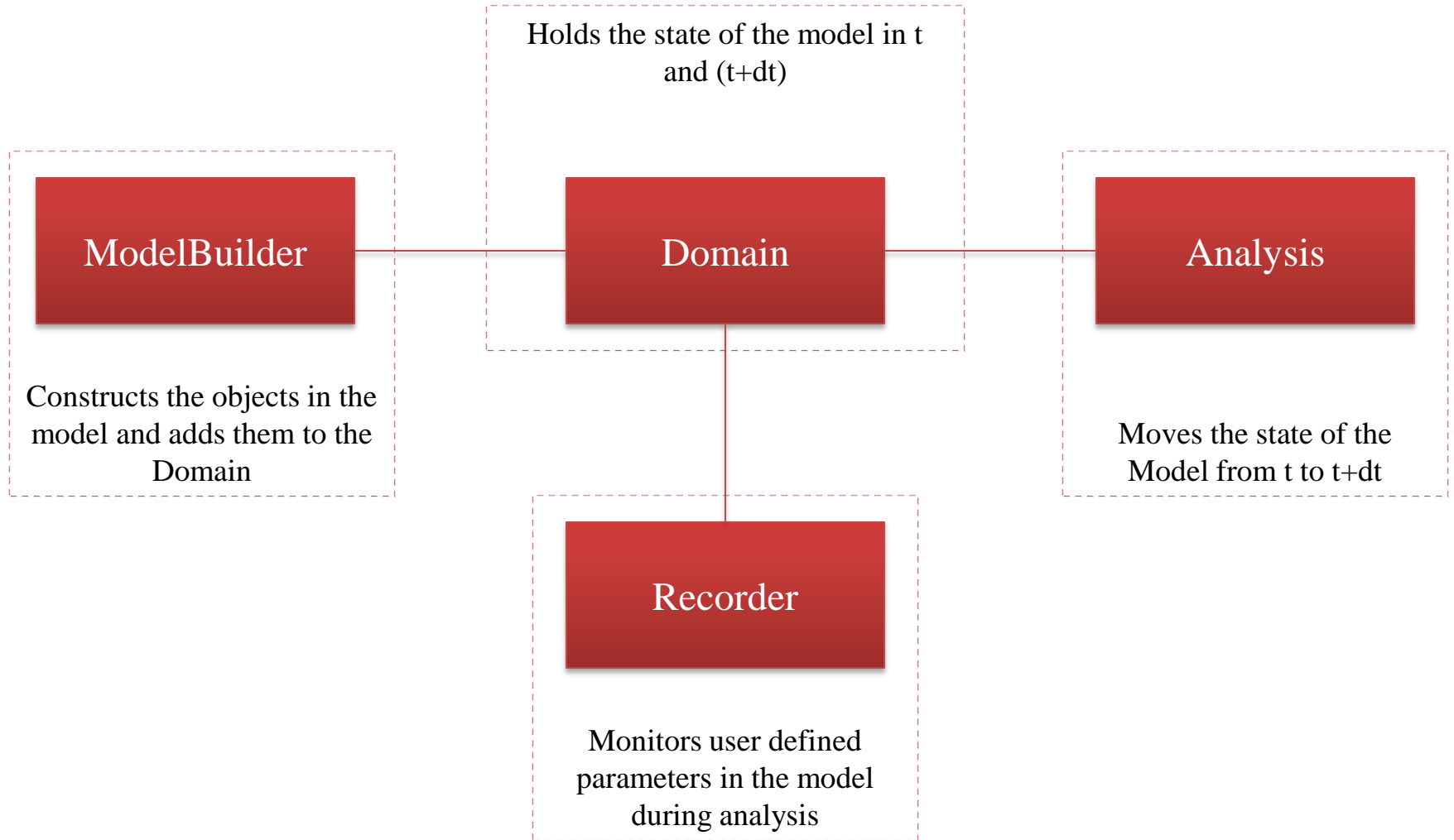
Some of Past works (Since 2007):

- OpenSees Book: coming soon
- OpenSees Tutoring Courses in:
 - Sharif University of Technology, Tehran, Iran.
 - Khajeh Nasir University of Technology, Tehran, Iran.
 - Civil House Engineering Institute, Tehran, Iran.
 - Noshirvani University of Technology, Babol, Iran.
 - 9th International Congress on Civil Engineering, 2012 May 8-10, Isfahan University Of Technology, Isfahan, Iran.
- Development of Related Softwares:
 - SAP2000 to OpenSees Converter (SOC2D), A code developed in MatLab which easily converts SAP2000 models into OpenSees.
 - SOC3D
- Academic and Professional Projects:
 - Modeling various structural models and simulations such as:
 - Bridges, Steel and RC Buildings, Spatial Structures, Passive and Active Control, Masonry Infill Walls, SMA, Wind Turbine, etc.

What is OpenSees?

- A software framework for simulation applications in earthquake engineering using finite element methods. OpenSees is not a code.
- As open-source software, it has the potential for a community code for earthquake engineering.
- OpenSees has been under development by PEER since before 1997.
- Large group of developers and user.
- NEESgrid and NEESit support integration and extension since 2003.
- Open-source and royalty free license for noncommercial use.

OpenSees Framework



OpenSees

- ModelBuilder Object is responsible for building the objects in the model and adding them to the domain.
- Recorder Object monitors user-specified objects of the model during the analysis.
- Analysis Object is responsible for performing the analysis.
- Domain Object is responsible for storing the objects created by the ModelBuilder object and for providing the Analysis and Recorder objects access to these objects.

Model-Building Objects

- model Command
- node Command
- mass Command
- Constraints Objects
- uniaxialMaterial Command
- nDMaterial Command
- section Command
- element Command
- block Command
- region Command
- Geometric Transformation Command
- Time Series
- pattern Command

Recorder Objects

- Node Recorder
- EnvelopeNode Recorder
- MaxNodeDisp Recorder
- Drift Recorder
- Element Recorder
- EnvelopeElement Recorder
- Display Recorder
- Plot Recorder
- Playback Command

Analysis Objects

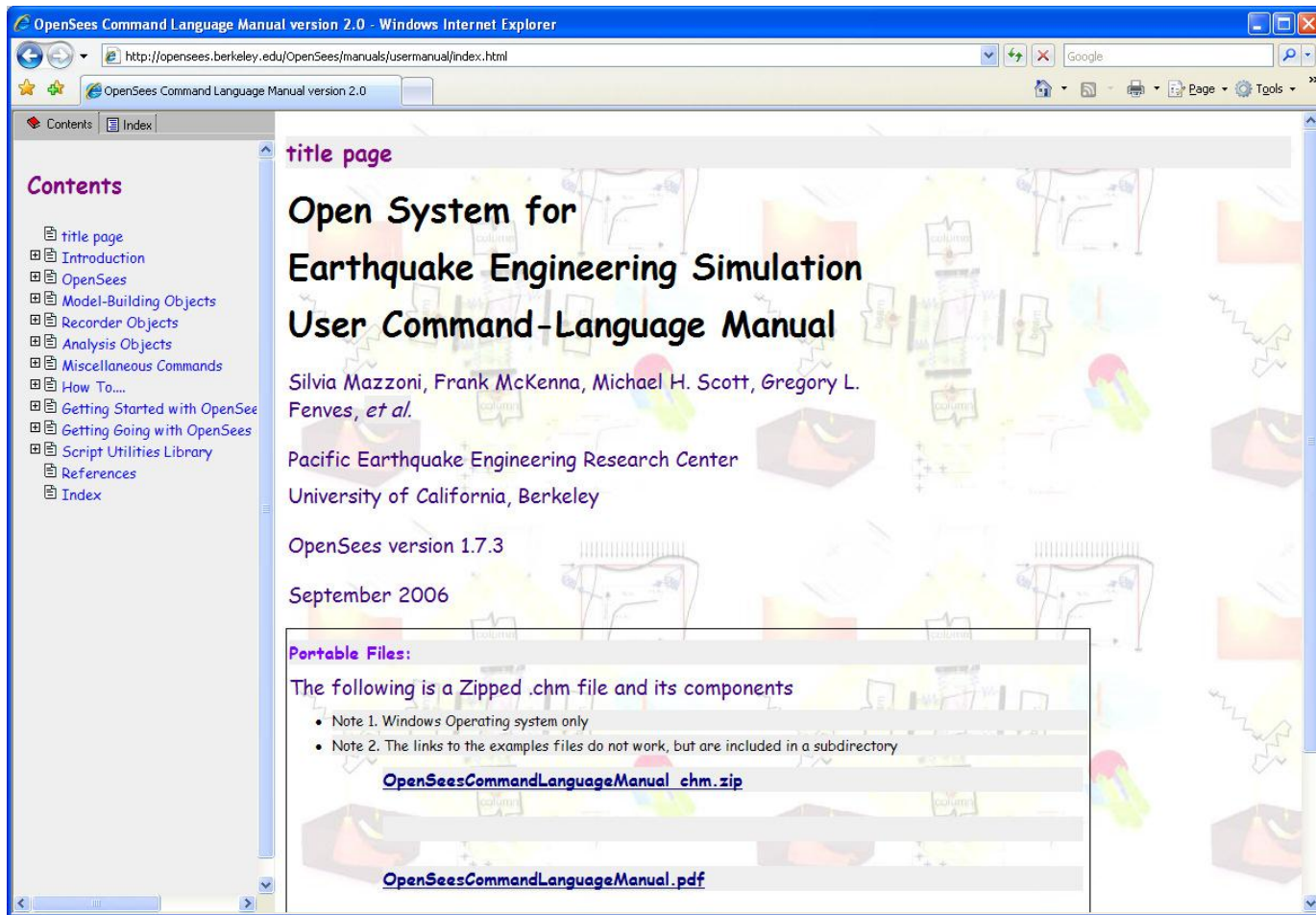
- constraints Command
- numberer Command
- analysis Command
- algorithm Command
- integrator Command
- system Command
- test Command
- analyze Command
- rayleigh Command
- eigen Command
- dataBase Commands

OpenSees User Manual

A document providing the syntax and description of OpenSees commands in 3 formats:

- **HTML Manual** – on-line HTML document, residing on OpenSees server. Always going to be the most current.
- **MS Word** – downloadable and printable Word document in PDF format.
- **Offline Windows** – downloadable .chm file. it is similar to the HTML format, but the file resides on your computer.

1. HTML On-line Format



The screenshot shows a Windows Internet Explorer browser window with the address bar displaying `http://opensees.berkeley.edu/OpenSees/manuals/usermanual/index.html`. The page title is "OpenSees Command Language Manual version 2.0". The main content area features a title page for the "Open System for Earthquake Engineering Simulation User Command-Language Manual". The authors listed are Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves, et al. The manual is published by the Pacific Earthquake Engineering Research Center at the University of California, Berkeley. It is version 1.7.3, dated September 2006. A section titled "Portable Files:" provides information about a zipped .chm file and its components, including two notes and two file links: [OpenSeesCommandLanguageManual.chm.zip](#) and [OpenSeesCommandLanguageManual.pdf](#). A left-hand navigation menu lists various sections of the manual, such as "Introduction", "OpenSees", "Model-Building Objects", "Recorder Objects", "Analysis Objects", "Miscellaneous Commands", "How To...", "Getting Started with OpenSees", "Script Utilities Library", "References", and "Index".

OpenSees Command Language Manual version 2.0 - Windows Internet Explorer

http://opensees.berkeley.edu/OpenSees/manuals/usermanual/index.html

OpenSees Command Language Manual version 2.0

Contents Index

title page

Open System for Earthquake Engineering Simulation User Command-Language Manual

Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves, *et al.*

Pacific Earthquake Engineering Research Center
University of California, Berkeley

OpenSees version 1.7.3

September 2006

Portable Files:

The following is a Zipped .chm file and its components

- Note 1. Windows Operating system only
- Note 2. The links to the examples files do not work, but are included in a subdirectory

[OpenSeesCommandLanguageManual.chm.zip](#)

[OpenSeesCommandLanguageManual.pdf](#)

Contents

- title page
- Introduction
- OpenSees
- Model-Building Objects
- Recorder Objects
- Analysis Objects
- Miscellaneous Commands
- How To...
- Getting Started with OpenSees
- Getting Going with OpenSees
- Script Utilities Library
- References
- Index

2. MS Word Format - PDF

Open System for Earthquake Engineering Simulation (OpenSees)

OpenSees Command Language Manual

Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves, et al.

Elastic Beam Column Element

This command is used to construct an elasticBeamColumn element object. The arguments for the construction of an elastic beam-column element depend on the dimension of the problem, *ndm* (page 29):

For a two-dimensional problem:

```
element elasticBeamColumn $eleTag $iNode $jNode $A $E $Iz $transfTag
```

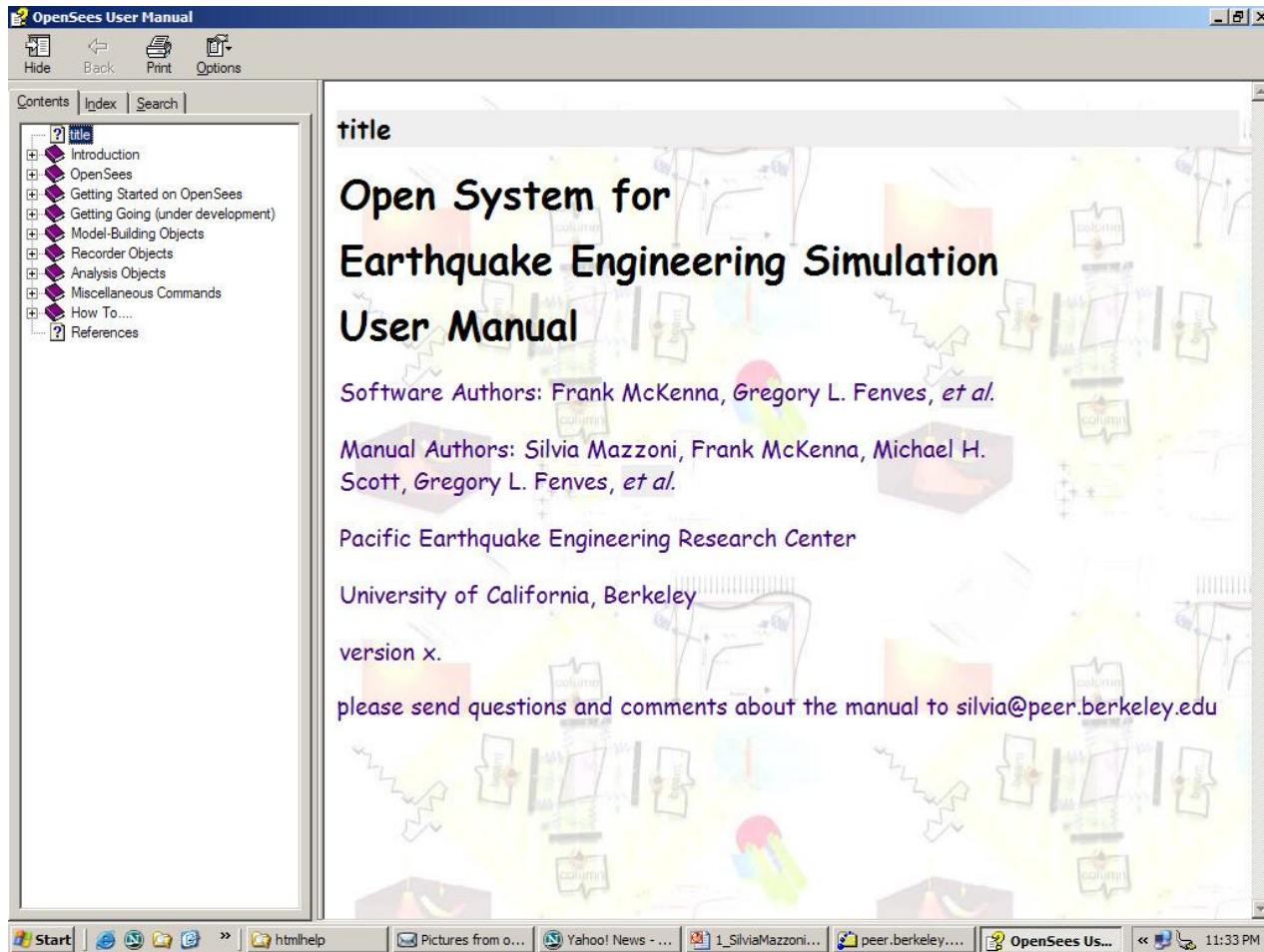
For a three-dimensional problem:

```
element elasticBeamColumn $eleTag $iNode $jNode $A $E $G $J $Iy $Iz $transfTag
```

\$eleTag	unique element object tag
\$iNode \$jNode	end nodes
\$A	cross-sectional area of element
\$E	Young's Modulus
\$G	Shear Modulus
\$J	torsional moment of inertia of cross section
\$Iz	second moment of area about the local z-axis
\$Iy	second moment of area about the local y-axis
\$transfTag	identifier for previously-defined <i>coordinate-transformation</i> (page 280) (CrdTransf) object

The valid queries to an elastic beam-column element when creating an *ElementRecorder* (page 307) object are 'stiffness' and 'force.'

3 .chm file for MS Windows



4 .Quick Reference Guide-PDF

The OpenSees Quick Reference Guide Opensees Student Group, May 8, 2012 Seyed Mojtaba Hosseini Gelekolai and Hadi Kenarangi Sharif University of Technology, Tehran, Iran

1-Modeling Commands

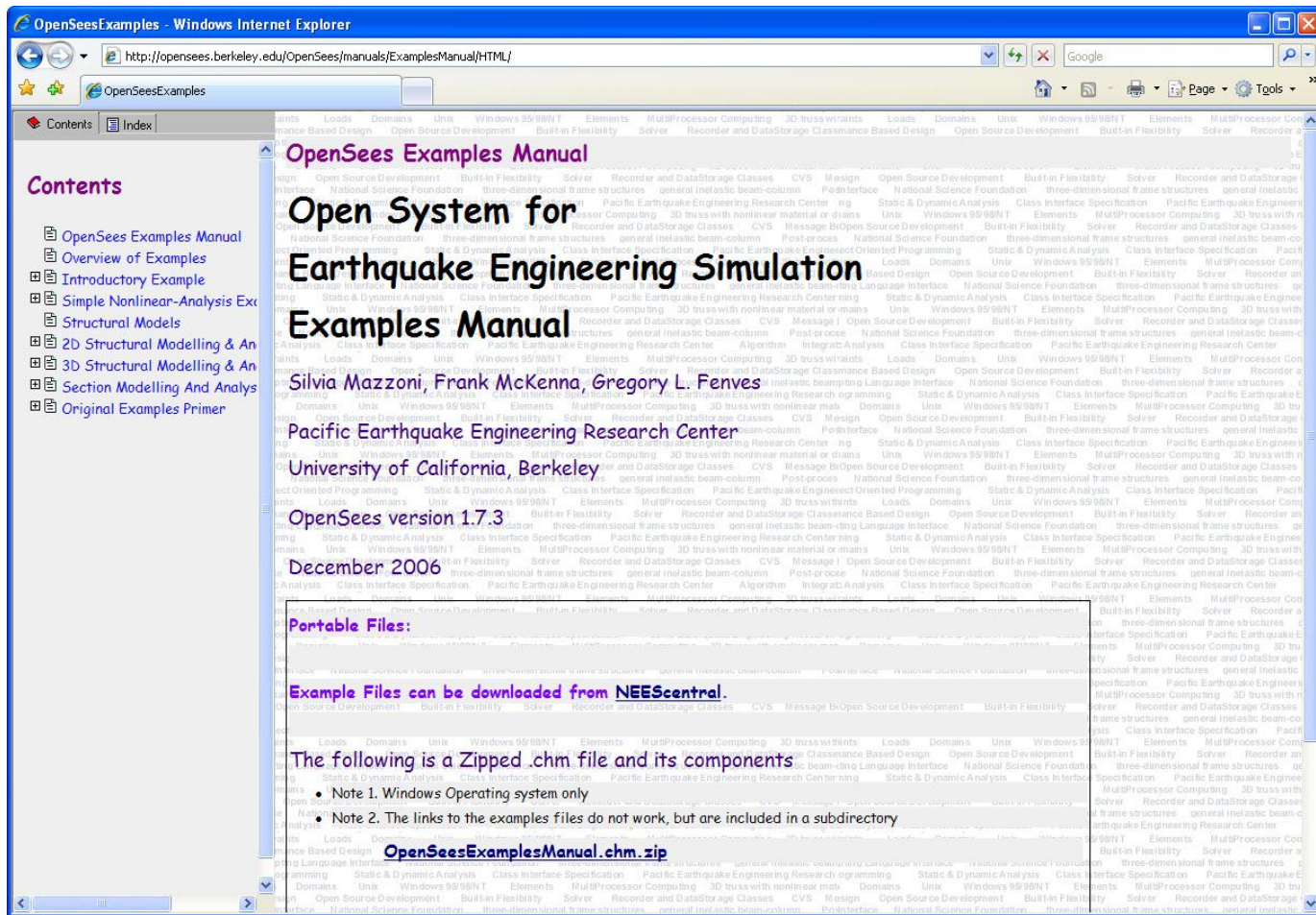
model modelBuilderType <specific model builder args>
 model BasicBuilder -ndm ndm? <-ndf ndf?>

node nodeTag? (ndm coordinates?) <-mass (ndf values?)>

mass nodeTag? (ndf values?)

uniaxialMaterial materialType <specific material args>
 uniaxialMaterial Elastic matTag? E? <eta?>
 uniaxialMaterial ElasticPP matTag? E? ep?
 uniaxialMaterial ElasticPPGap matTag? E? fy? gap?
 uniaxialMaterial Parallel matTag? tag1? tag2? ... <-min min?> <-max max?>
 uniaxialMaterial Series matTag? tag1? tag2? ...
 uniaxialMaterial Hardening matTag? E? sigmaY? H_iso? H_kin?
 uniaxialMaterial Steel01 matTag? fy? E0? b? <a1? a2? a3? a4?> <-min min?> <-max max?>
 uniaxialMaterial Concrete01 matTag? fpc? epsc0? fpcu? epscu? <-min min?> <-max max?>
 uniaxialMaterial Hysteretic matTag? s1p? e1p? s2p? e2p? <s3p? e3p?> s1n? e1n? s2n? e2n?
 <s3n? e3n?> pinchX? pinchY? damage1? damage2? <beta?>

5 . OpenSees Examples Manual-[chm](#)



The screenshot shows a web browser window titled "OpenSeesExamples - Windows Internet Explorer". The address bar contains the URL "http://opensees.berkeley.edu/OpenSees/manuals/ExamplesManual/HTML/". The page content is as follows:

OpenSees Examples Manual

Open System for Earthquake Engineering Simulation Examples Manual

Silvia Mazzoni, Frank McKenna, Gregory L. Fenves
Pacific Earthquake Engineering Research Center
University of California, Berkeley

OpenSees version 1.7.3
December 2006

Portable Files:

Example Files can be downloaded from [NEEScentral](#).

The following is a zipped [.chm](#) file and its components

- Note 1. Windows Operating system only
- Note 2. The links to the examples files do not work, but are included in a subdirectory

[OpenSeesExamplesManual.chm.zip](#)

How to Download OpenSees

<http://opensees.berkeley.edu>



OpenSees PEER NEES NEEScomm

HOME USER DEVELOPER PROJECTS SUPPORT PARALLEL Copyright SITEMAP

About News Calendar Registration

HOME

OpenSees 2.3.2 Released

Version 2.3.2 of the [OpenSees binary](#) is now available for download. Here is the [change log](#).

Discovering OpenSees

The next seminar in the web-based [Discovering OpenSees: Surfing the waves of OpenSees](#) learning series will occur November 17, 2011. This session is titled: **OpenSees and Output** and will occur on November at 4:30 PM Pacific Time. For more information about registration for this event can be found [here](#)

OpenSees in the Clouds!

OpenSees 2.2.2 is now available for use to all on [NEEShub](#) through the [OpenSeesLab](#) tool. For those of you with large models or many runs to perform, the machines on which this tool runs is **very very very fast**.

I have posted a [YouTube video](#) showing how to perform an OpenSees simulation using this tool. An improved version will be available soon. The OpenSees GUI applications, BuildingTcl and OS Navigator, are also available to run.

Try them out, registration and use of the machines are free!

Welcome

Welcome to the website for OpenSees, a software framework for developing applications to simulate the performance of structural and geotechnical systems subjected to [earthquakes](#).

The goal of the OpenSees development is to improve the modeling and computational simulation in [earthquake](#) engineering through open-source development.

OpenSees is under continual development, so users and developers should expect changes and updates on a regular basis. In this sense, all users are developers so it is important to [register](#). More information on [Open Source](#) is available.

The development and application of OpenSees is sponsored by the [Pacific Earthquake Engineering Research Center](#) through the [National Science Foundation](#) engineering and education centers program.

OpenSees has been selected as the simulation component for the [George E. Brown, Jr. Network for Earthquake Engineering Simulation](#) and has being sponsored by [NEESit](#) since 2004. Ongoing work to integrate OpenSees into the NEESit framework includes a web-based portal for simulation services, access to the NEESit data repository, and a visualization tool.

[More info...](#)

Your Email Address

The screenshot shows the OpenSees website interface. At the top, there is a navigation bar with the OpenSees logo and links for PEER, NEES, and NEEScomm. Below this is a secondary navigation bar with links for HOME, USER, DEVELOPER, PROJECTS, SUPPORT, PARALLEL, Copyright, and SITEMAP. A third navigation bar contains links for Capabilities, Docs, Examples, Message Board, Download, Bug Report, and Tools.

The main content area is titled "OpenSees Download" and displays the "Current version is: 2.3.2". A text block explains that users must be registered and provide their email to download the code. Below this is a "Registered User" section with a form containing an "E-Mail:" label, a text input field with the value "hadi.kenarangi@gmail.com", and "Submit" and "Reset" buttons.

A note states: "New users must go to the message board [registration](#) page".

The left sidebar contains a list of links: HOME, OPENSEESWIKI, MESSAGE BOARD, USER DOC, DOWNLOAD, SOURCE CODE, and BUG REPORT. Below these links is a search box and a link to the Site Map.

At the bottom of the page, there are logos for PEER and NEEScomm, and a footer with the text "opensees-support @ berkeley.edu", "©2006, UC Regents", and "Supported by the National Science Foundation".

Now Download

OpenSees



PEER NEES NEEScomm

HOME USER DEVELOPER PROJECTS SUPPORT PARALLEL Copyright SITEMAP

Capabilities Docs Examples Message Board Download Bug Report Tools

[HOME](#)
[OPENSEESWIKI](#)
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[SOURCE CODE](#)
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To customize the quicklinks, go to [Site Map](#)



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OpenSees Executable Distribution

Current version is: 2.3.2

No last download is found

OpenSees executables for Windows 98/2000/NT/XP/Vista are available for download. The current version of OpenSees has been tested and is generally stable. However, users may encounter problems when running a new problem for the first time. For that reason we we strongly encourage you to participate in the various [message boards](#) hosted by OpenSees. And **please** report any [bugs](#) you find! That, of course, is the whole reason we make these binaries available.

OpenSees uses [Tcl/Tk](#), a general purpose scripting language that we have extended with commands for OpenSees. It is necessary to download a DLL for the Tcl/Tk interpreter.

The first step is download the two files below. The first file a zip file containing the OpenSees executable. The second file is a self-installing executable for Tcl/Tk.

Note that for those of you who have downloaded before, YOU WILL HAVE TO INSTALL Tcl/Tk LIBRARIES AND HEADER FILES AGAIN. This is because we have upgraded to Tcl/Tk Version 8.5.8

DOWNLOAD Windows Binaries		
Release_2.3.2	OpenSees2.3.2.exe	tcl/tk 8.5.11

After downloading the Tcl/Tk executable you will need to run it to install the DLL's on your computer. As can be seen in the downloading section of the [Getting Started Manual](#) you will be asked were to install the files. Currently the default is C:\tcl. It is essential that you change this to "C:\Program Files\Tcl" during the course of the installation. If when you start OpenSees, you see an error message to the effect, "Cannot find tcl85.dll", you have skipped this step and must reinstall tcl. Note that you wil probably have to uninstall the version you just installed first.

Finally, locate the opensees.exe in a convenient directory. It is advisable to execute OpenSees from a DOS shell and you are ready to go!

Mac Version

An OpenSees executable for Apple Machines with Intel an processor(s) running OS10.4 or greater is available for download. You can download it [here](#).

OpenSees Tk Applications

OpenSees Tk executables are also available for Windows and Apple Machines with Intel processor(s) running Mac OS10.4 or greater. These applications allow you to build GUIs for OpenSees using the Tk graphical toolkit. The windows application is available [here](#) and The Mac application [here](#).

OpenSees: Open Source

Resources for Developers

Welcome! This page contains some useful information for you brave souls who wish to get involved in the code development of OpenSees.

Documentation



Before you begin and for when you get stuck there is always the documentation. For new users to OpenSees, have a look at the primers to get yourselves more familiar with the overall design. For you programmers who need to understand the inner workings of the classes have a look at the [Class Specifications](#).

Download



Download the source via FTP from our server. Details are on the [Download](#) page. Source drops to the FTP server usually occur monthly!!.

Builds



Look at the build instructions to find out how to compile this beast on your platform. If you are working on a new platform and get the beast to run,

Browse the Source Code



Browse the up-to-the-minute latest version of the source code online.

CVS



Those doing active development can check out the latest source using CVS. This is the preferred method, as it lets you get up-to-the-minute changes and merge them with your own. Details are on our [CVS](#) page.

Contribute



To contribute code, submit your changes to following the [instructions](#). If the code changes are approved they'll be committed.

OpenSees

PEER

HOME USER DEVELOPER PROJECTS SUPPORT SITE MAP

Dev Doc API Source Download Builds Bug Reports Message Board

Click on a directory to enter that directory. Click on a file to display its revision to get a chance to display diffs between revisions.

Current directory: [\[local\]](#) / [OpenSees](#) / [SRC](#)

File	Rev.	Age	API	Last log entry
Parent Directory				
Attic/ [Don't hide]				
actor/				
analysis/				
convergenceTest/				
coordTransformation/				
damage/				
database/				
doc/				
domain/				
element/				
graph/				
handler/				
java/				
machine/				
material/				
matrix/				
modelbuilder/				
nDarray/				
optimization/				
package/				
recorder/				
reliability/				
remote/				

OpenSees Community Forum

PEER NEES NEESit

[HOME](#) [USER](#) [DEVELOPER](#) [PROJECTS](#) [SUPPORT](#) [SITE MAP](#)

[Capabilities](#) [Docs](#) [Examples](#) [Message Board](#) [Download](#) [Bug Report](#) [Tools](#)





OpenSees Community Forums

Register Log out [[silvia](#)] Profile Memberlist FAQ Search

You last visited on Mon Aug 25, 2008 1:54 pm View posts since last visit
 The time now is Mon Aug 25, 2008 2:42 pm View your posts
[The OpenSees Community Forum Index](#) View unanswered posts

Forum	Topics	Posts	Last Post
OpenSees			
OpenSees.exe Users Forum for OpenSees users to post questions, comments, etc. on the use of the OpenSees interpreter, OpenSees.exe Moderator silvia	1873	6750	Mon Aug 25, 2008 10:14 am TWI →
Soil Modelling A forum dedicated to users with questions regarding soil materials and elements.	16	44	Mon Jul 21, 2008 7:41 pm raeger →
Framework For developers writing C++, Fortran, Java, code who have questions or comments to make. Moderator silvia	233	829	Fri Aug 15, 2008 11:42 pm neallee →
Parallel Processing This forum is for issues related to parallel processing and OpenSees using the new interpreters OpenSeesSP and OpenSeesMP	14	33	Wed Jul 23, 2008 10:11 pm hongqi →
Useful Scripts. If you have a script you think might be useful to others post it here. Hopefully we will be able to get the most useful of these incorporated in the manuals. Moderator silvia	27	78	Tue Aug 12, 2008 12:15 am khli83 →
Documentation For posts concerning the documentation, errors, omissions, general comments, etc. Moderator silvia	127	352	Mon Aug 04, 2008 8:22 am pennycorp66 →
Future Directions A forum dedicated to the future direction of OpenSees, i.e. what would you like, what do you need. Moderator silvia	29	104	Mon Aug 18, 2008 1:18 am Andrew →

Seven Forum Categories

Forum		Topics	Posts	Last Post
OpenSees				
	OpenSees.exe Users Forum for OpenSees users to post questions, comments, etc. on the use of the OpenSees interpreter, OpenSees.exe Moderator silvia	1873	6750	Mon Aug 25, 2008 10:14 am TWI →
	Soil Modelling A forum dedicated to users with questions regarding soil materials and elements.	16	44	Mon Jul 21, 2008 7:41 pm riaeger →
	Framework For developers writing C++, Fortran, Java, code who have questions or comments to make. Moderator silvia	233	829	Fri Aug 15, 2008 11:42 pm neallee →
	Parallel Processing This forum is for issues related to parallel processing and OpenSees using the new interpreters OpenSeesSP and OpenSeesMP	14	33	Wed Jul 23, 2008 10:11 pm hongqi →
	Useful Scripts. If you have a script you think might be useful to others post it here. Hopefully we will be able to get the most useful of these incorporated in the manuals. Moderator silvia	27	78	Tue Aug 12, 2008 12:15 am khili83 →
	Documentation For posts concerning the documentation, errors, omissions, general comments, etc. Moderator silvia	127	352	Mon Aug 04, 2008 8:22 am pennycorp66 →
	Future Directions A forum dedicated to the future direction of OpenSees, i.e. what would you like, what do you need. Moderator silvia	29	104	Mon Aug 18, 2008 1:18 am Andrew →

Very Busy Message Board

OpenSees.exe Users

Moderator: [silvia](#)

Users browsing this forum: [silvia](#)

Goto page [1](#), [2](#), [3](#) ... [36](#), [37](#), [38](#) [Next](#)



The OpenSees Community Forum Index -> OpenSees.exe Users

[Mark all topics read](#)

	Topics	Replies	Author	Views	Last Post
	Sticky: First Public Release of BuildingTcl	7	silvia	466	Fri Aug 22, 2008 5:51 am hresquivelo →
	Sticky: OpenSees Days 2008, 8-9 September. Registration open	4	silvia	433	Thu Aug 14, 2008 2:40 pm silvia →
	Is consecutive multiple analysis possible in OpenSees?	8	TWI	130	Mon Aug 25, 2008 10:14 am TWI →
	axial load in pushover analysis and IDA method	1	sheng0122	55	Mon Aug 25, 2008 9:46 am esi opensees →
	how to move the load pattern?	5	zhmkitten	60	Mon Aug 25, 2008 8:03 am zhmkitten →
	dynamic analysis of rocking frame	1	ca493	20	Mon Aug 25, 2008 6:35 am silvia →
	fracture modeling	7	ca493	160	Sun Aug 24, 2008 5:57 pm ca493 →
	Sorry...	4	jk295	136	Sun Aug 24, 2008 10:29 am silvia →
	eigenvalue analysis error	2	mrathore	55	Fri Aug 22, 2008 4:08 pm Prayaq Savani →
	using scale factor	6	jk295	74	Fri Aug 22, 2008 12:48 pm jk295 →
	Model of tallbuilding in opensees	1	dinochen1983	45	Fri Aug 22, 2008 10:42 am silvia →
	nonlinear static analysis	1	susan	28	Fri Aug 22, 2008 10:38 am silvia →

Our OpenSees Facebook Group

The screenshot shows the Facebook interface for the 'OpenSees' group. The browser address bar displays 'https://www.facebook.com/#!/groups/35879611'. The page header includes the Facebook logo, a search bar, and the user's name 'Seyed' with a 'Home' dropdown. The group name 'OpenSees' is prominently displayed at the top of the content area, along with navigation tabs for 'About', 'Events', 'Photos', and 'Docs'. Below the group name, there are options to 'Write Post', 'Add Photo / Video', and 'Ask Question'. A text input field for writing a post is visible. The main content area features a post by Mehdi Farhani Nejad asking about energy-absorb from hysteresis diagrams. Two comments from Seyed Mojtaba Hosseini provide information on calculating damage indices. Below this, a post by Amin Mollazadeh asks about downloading 'Building Tcl'. Another comment from Seyed Mojtaba Hosseini suggests an alternative. On the right side, there are 'Recommended Pages' including 'Shawshank Redemption', 'The Big Bang Theory', 'Bethoven', and 'شهدای حبیش سبز ایران'. The bottom of the page shows a chat window for 'OpenSees' with 7 active members.

facebook Seyed Home

OpenSees About Events Photos Docs Notifications

200 members (1 new) · Chat

Write something...

Mehdi Farhani Nejad
Hi guys
Is there any commwnd in Opensees that give amount of energy-absorb from hysteresis diagram?
Like · Comment · Unfollow Post · Saturday at 2:18pm

View all 3 comments

Seyed Mojtaba Hosseini if you want calculate damage,you can use damage index objects such as park,....search forum
12 minutes ago · Like

Seyed Mojtaba Hosseini if you want calculate damage,you can use damage index objects such as park,....search forum
12 minutes ago · Like

Write a comment...

Amin Mollazadeh
I am a new user of Opensees. I will be happy hearing from you about "Building Tcl". Is it possible to download for free?
Like · Comment · Unfollow Post · Friday at 10:44pm

View all 3 comments

Amin Mollazadeh Mr Hosseini, may I ask you explain alittle about Building Tcl?and where can I download it? thank you
Yesterday at 10:47am · Like

Seyed Mojtaba Hosseini i suggest you not to use it,it is better to

Recommended Pages See All

Shawshank Redemption
Mir Javad Mir Emarati and 23 other friends like this.
Like

The Big Bang Theory
Amin Assareh and 6 other friends like this.
Like

Bethoven
Parham Ziaee and 8 other friends like this.
Like

شهدای حبیش سبز ایران
Mohammad Nahangi and 37 other friends like this.
Like

OpenSees Chat (7)

OpenSees.exe

- OpenSees is an Open-Source Software Framework for developing Nonlinear Finite Element Applications for both sequential and parallel environments.
- OpenSees.exe is an extension of the Tcl interpreter for finite element analysis which uses this framework. It is an example of an application that can be developed using the framework.



What is Tcl

- Tcl is a string-based scripting language.
- Variables and variable substitution
- Expression evaluation
- Basic control structures (if , while, for, foreach)
- Procedures
- File manipulation
- Sourcing other files

TCL Help

The screenshot shows a web browser window titled "ActiveTcl 8.5.11.0 Help". The browser's address bar and navigation buttons (Hide, Back, Print, Options) are visible at the top. The main content area displays the "ACTIVE TCL USER GUIDE" page, which includes the ActiveState logo, a search bar, and a list of topics. The page content is as follows:

ACTIVE TCL USER GUIDE **ActiveState**

WELCOME TO ACTIVE TCL

ActiveTcl is ActiveState's quality-assured distribution of Tcl. The latest Windows, Linux and Mac OS X builds are available for free to the community. Solaris, HP-UX and AIX builds are available in ActiveTcl **Business**, **Enterprise** and **OEM** editions.

ActiveState is committed to making Tcl easy to install and use on all major platforms. This release of ActiveTcl brings you the most stable release of Tcl available in binary form. It also includes several of the most popular extensions pre-compiled and ready to use.

The complete ActiveTcl package contains:

- The binary of the core Tcl distribution
- Popular extensions, pre-compiled
- Self-extracting archives for all platforms
- Complete online documentation

ActiveState's Tcl Productivity Tools

Check out **ActiveTcl Pro Studio**, which includes:

- **Tcl Dev Kit**, the essential toolkit for Tcl programmers. Tcl Dev Kit includes:
 - **Tcl Dev Kit Debugger** A convenient graphical user interface that allows you to debug remote and embedded Tcl applications as well as local ones.
 - **Tcl Dev Kit Checker** A static code analyzer that helps you find syntax errors and other common usage errors quickly, without having to run your program. Tcl Dev Kit Checker makes it easy to update legacy Tcl code.
 - **Tcl Dev Kit Wrapper** Distribute Tcl programs as freestanding executables containing everything needed to run the application.
 - **Tcl Dev Kit Compiler** Protect your intellectual property by compiling your Tcl script into a bytecode representation for distribution.
 - ...and more.
- **Komodo**, ActiveState's cross-platform, multi-language Integrated Development environment, optimized for open source technologies including Tcl, Perl, PHP, Python, and XSLT.

Tcl Support

- For discussions regarding the ActiveTcl distribution, see the **Active Tcl Mailing List**.
- To report ActiveTcl bugs, please see the **ActiveTcl Bug Database**.
- For general Tcl discussions, see the list of **Tcl mailing lists**.

How to Install



- Install ActiveTcl8.4.6.1 and ActiveTcl8.5.11 on drive C:\
- Install Install_OSP.exe on drive C:\
- Copy tcleditor folder to C:\
- Go to C:\tcleditor\bin right click on TclEditor.exe select send shortcut to desktop
- Now you can easily use OpenSees by double clicking tcleditor on your desktop

```
wipe
model basic -ndm 2 -ndf 3
node 1 0. 0.
```

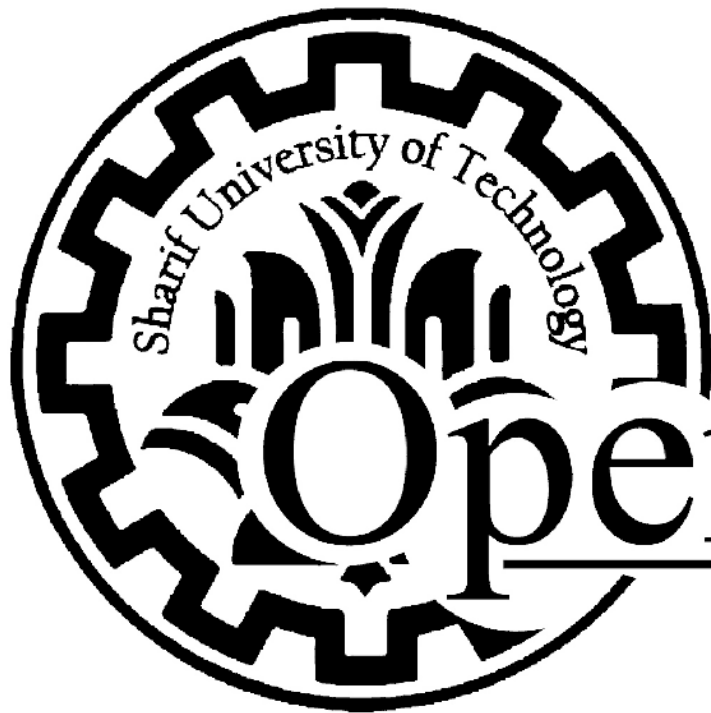
```
OpenSees -- Open System For Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center -- 2.3.2

(c) Copyright 1999,2000 The Regents of the University of California
All Rights Reserved
(Copyright and Disclaimer @ http://www.berkeley.edu/OpenSees/copyright.html)

OpenSees >
```

How to Install

Welcome to SUT OpenSees Pack Installer



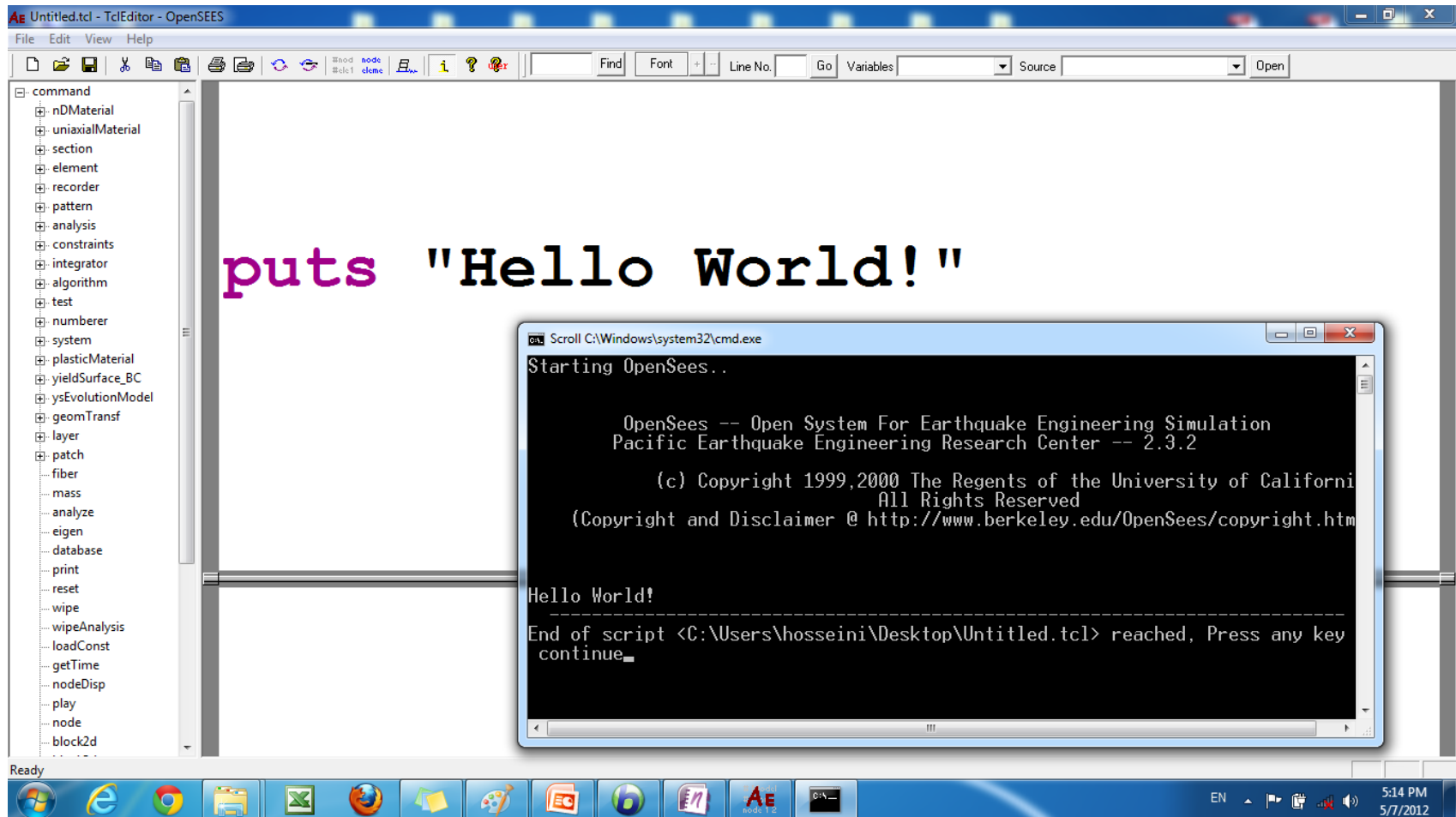
OpenSees

Student Group

by: Hadi Kenarangi hadi_kenarangi@alum.sharif.edu

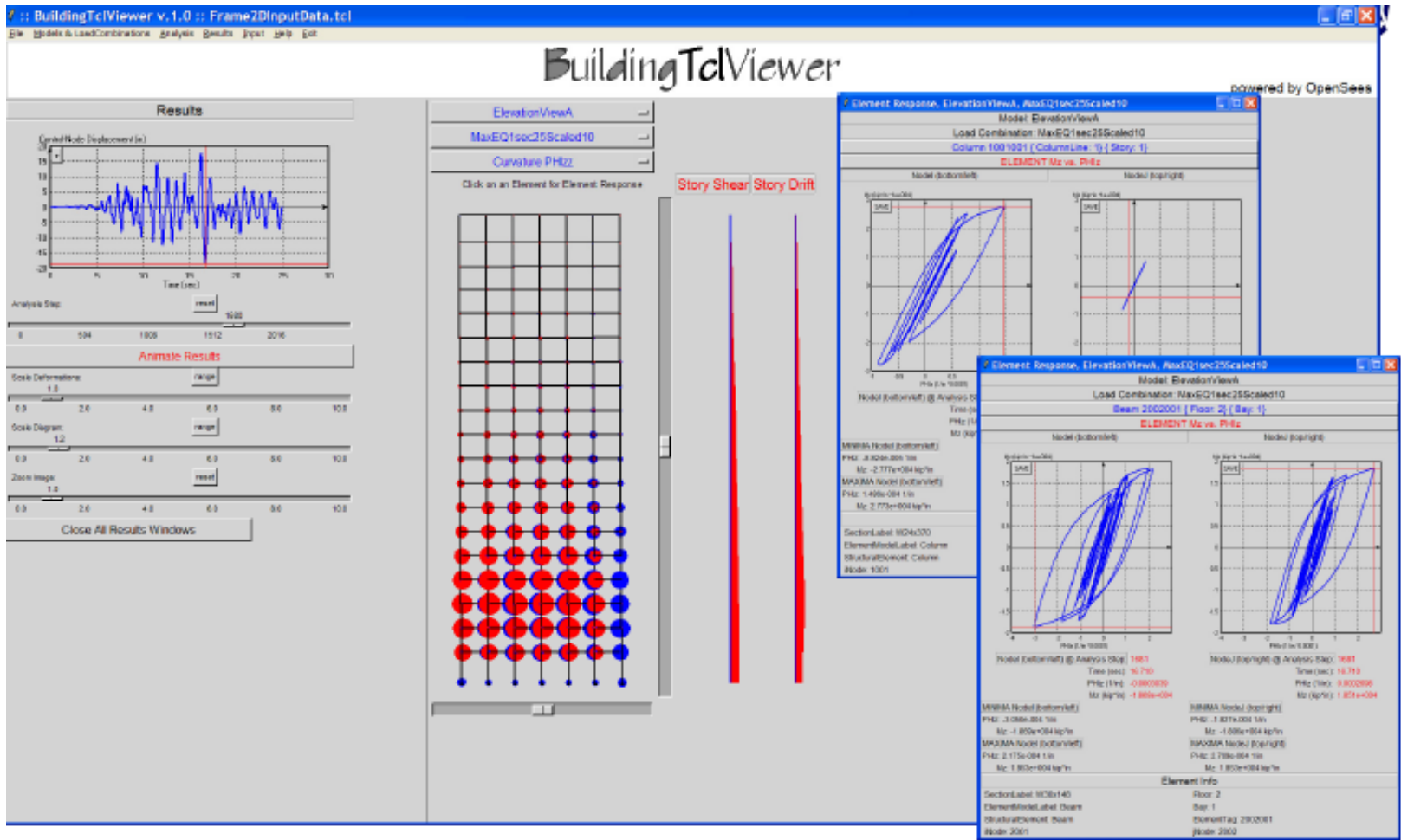
Seyed Mojtaba Hosseini Gelekolai hosseinigelekolai@gmail.com

Hello World! (My First Code)

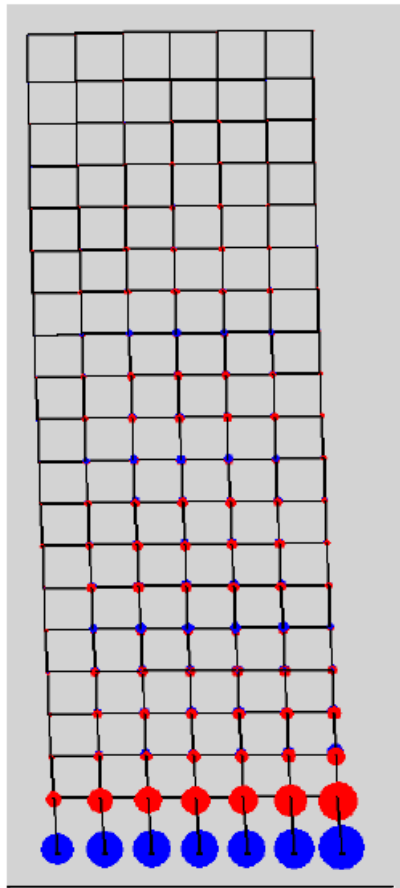


GUIs are possible

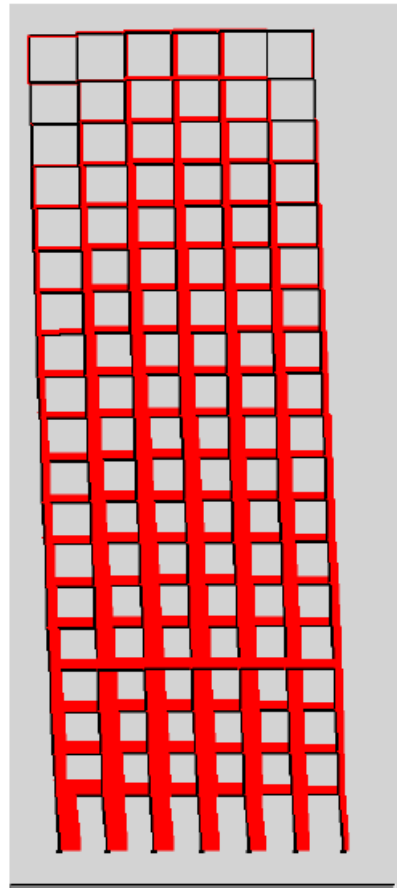
1. BuildingTcl



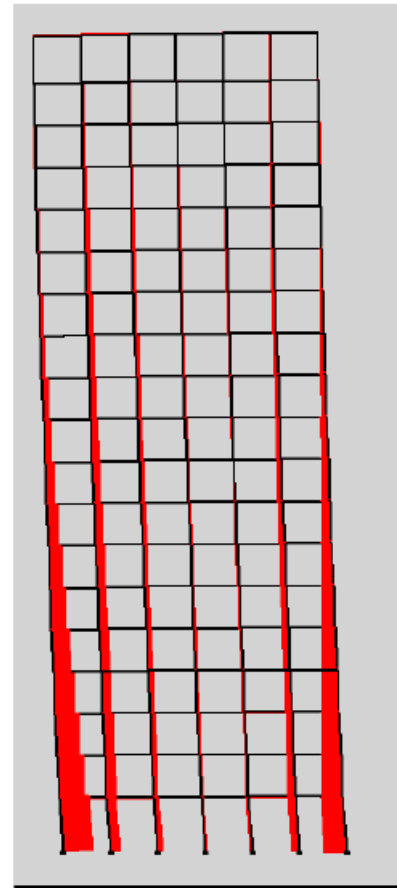
BuildingTclViewer: Results - RC Frame



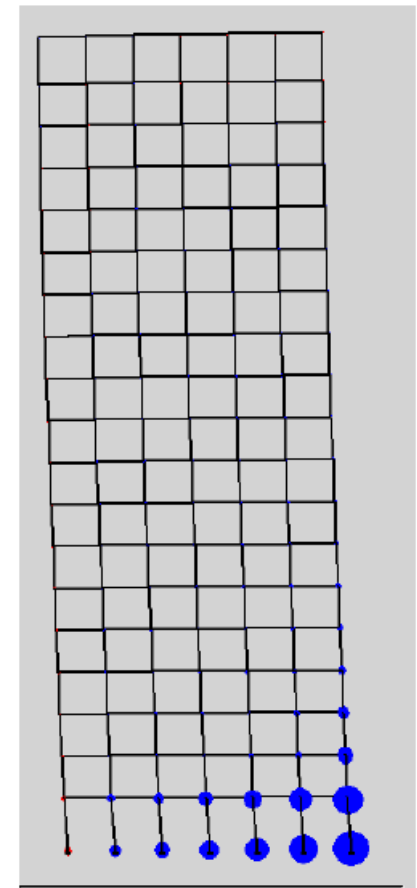
Curvature



Shear Force



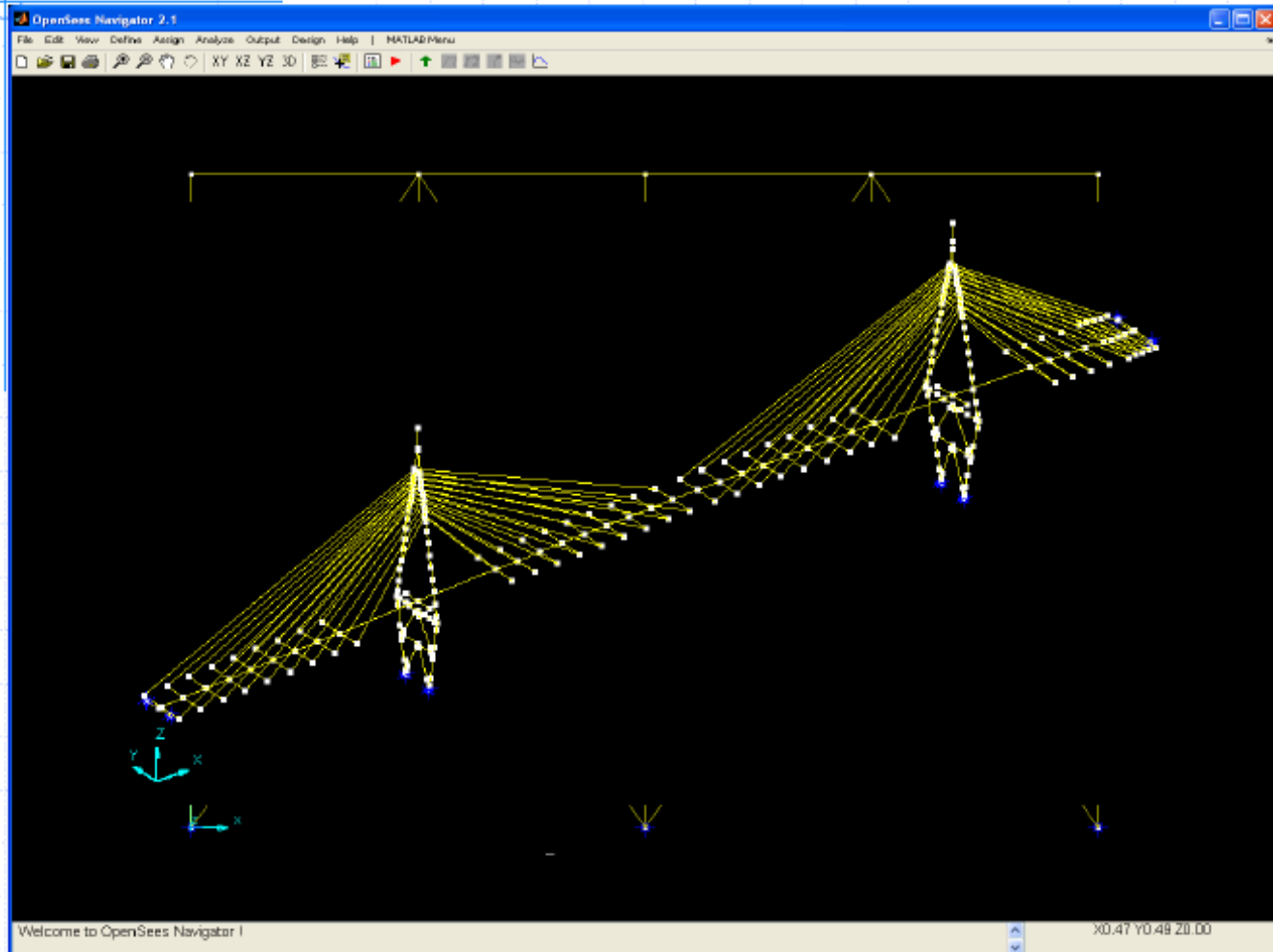
Axial Force



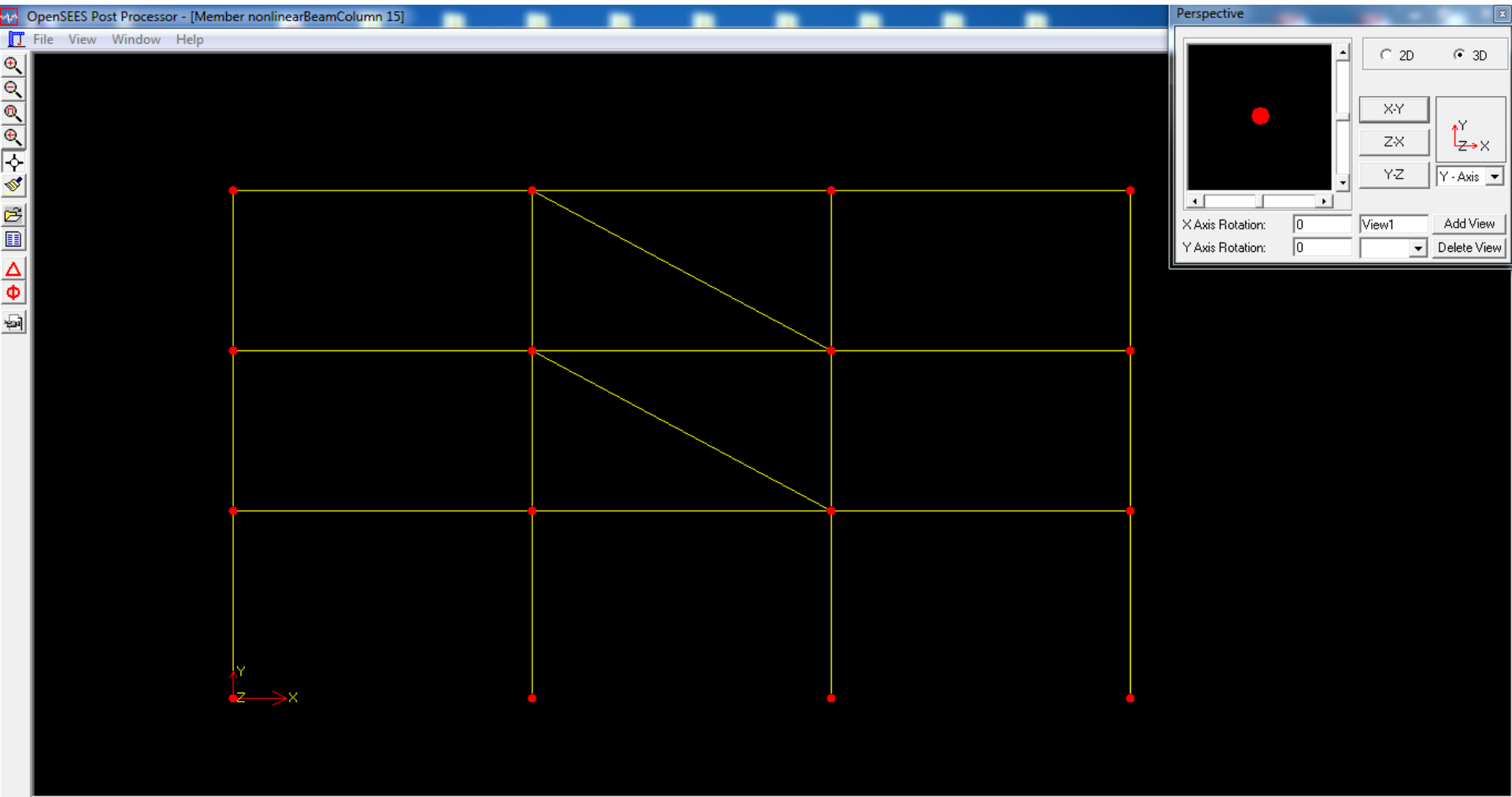
Axial Strain

2. OpenSees Navigator

OpenSees Navigator



3. OpenSees Post Processor (OSP)



4. OpenSeesPL (Soil and Pile Modeling)

OpenSeesPL: <http://cyclic.ucsd.edu/openseespl>

OpenSeesPL - Untitled

File Meshing Analyze Display View Options Help

Model Input

Model Definition

Pile Parameters... Soil Parameters...
Mesh Parameters... Analysis Options...

Load

Pushover Base Shaking Earthquake
Define Pattern...
Boundary Condition Type: Shear Beam

Input Motion

Longitudinal (X) Transverse (Y) Vertical (Z)

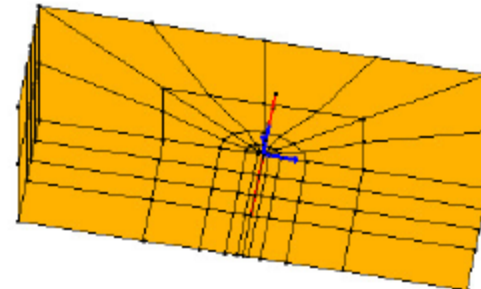
X: Tapered 0.2g sinusoidal motion
Y: Tapered 0.2g sinusoidal motion
Z: Tapered 0.2g sinusoidal motion

	X	Y	Z
Frequency (0.5-5Hz)	1	1	1
Number of Cycles (3-30)	10	10	10
Scale Factor (0.01-1)	1	1	1

Model Inclination along Longitudinal Direction

Ground Surface Inclination Angle (0-30 deg): 0
Whole Model Inclination Angle (0-10 deg): 0

Finite Element Mesh



A. Elgamal Sept 2008

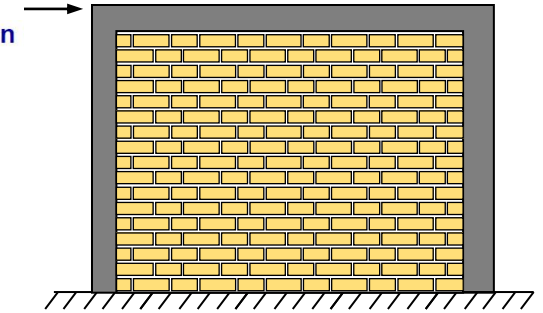
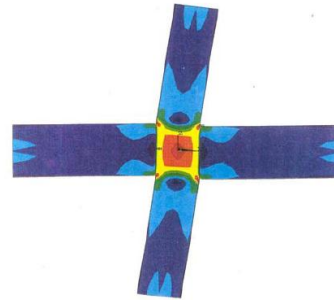
33

Finite Element Analysis Softwares

- **Micro modeling**

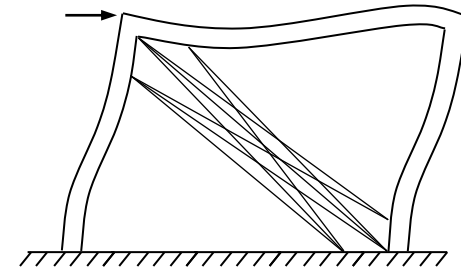
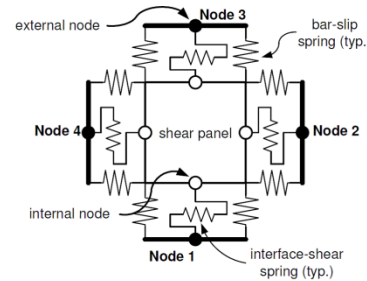
ABAQUS, ANSYS, DIANA
NASTRAN, OPENSEES

Modeling Beam-Column Joint Deformation
In Steel Structures



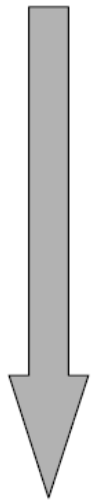
- **Macro Modeling**

ETABS, SAP2000, PERFORM, DRAIN, NONLIN-Pro, IDARC,
OPENSEES



How to Compute Performance-Based Deformation Demands?

Increasing Value
of
Information



- ✗ Linear Static Analysis
- ✗ Linear Dynamic Modal Response Spectrum Analysis
- ✗ Linear Dynamic Modal Response History Analysis
- ✗ Linear Dynamic Explicit Response History Analysis
- ✓ Nonlinear Static “Pushover” Analysis
- ✓ Nonlinear Dynamic Explicit Response History Analysis

✗ = Not Reliable in Predicting Damage

DRAIN-2Dx is old technology, but it represents the basic state of the practice. **The state of the art is being advanced through initiatives such as PEER’s OpenSees Environment.**(Reference: FEMA technical report 15-5-a)

Why OpenSees

- **Advantages:**

- Very Fast=> Timesaver

- Open-source => Adding Some Codes

- Free License => Easy Paper Submission

- Text File Output => Little H.D.D. Space Consumption

- Flexible Programming (TCL) => Easy Parametric Studies

- Very Strong Analysis Engine => Easy Nonlinear Analysis

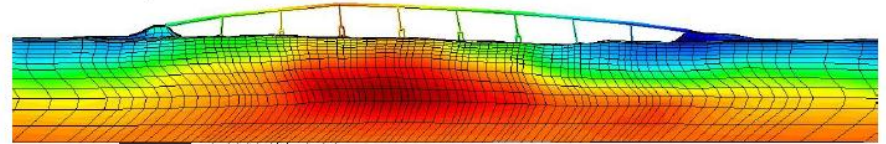
- **Disadvantages:**

- No fully developed pre or post processors yet available for model development and visualization

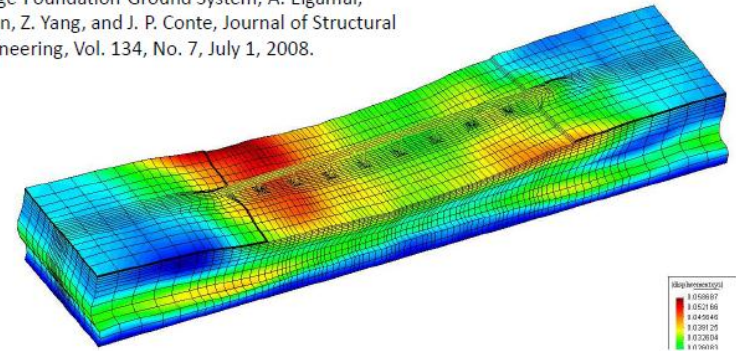
- Code is under development and still being fine-tuned

Bridge-Soil-Pile Modeling

Numerical Analysis



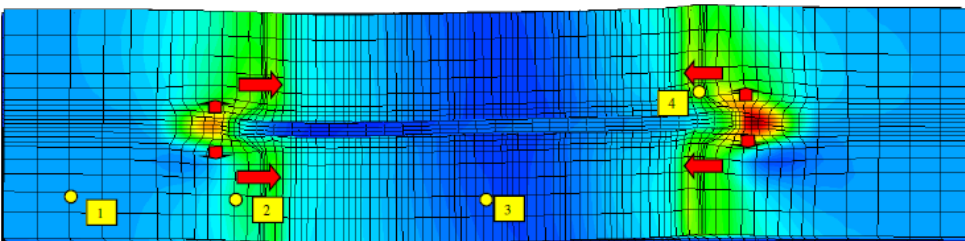
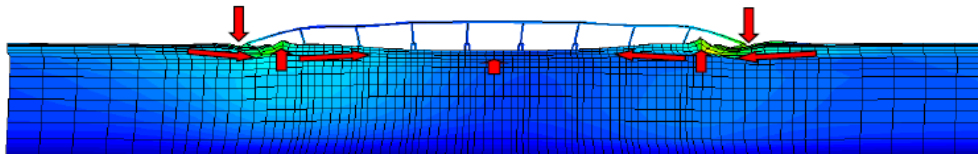
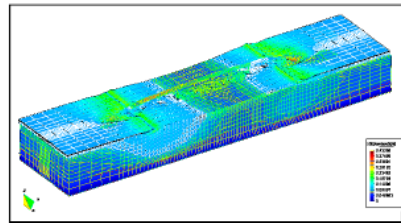
Three-Dimensional Seismic Response of Humboldt Bay Bridge-Foundation-Ground System, A. Elgamal, L. Yan, Z. Yang, and J. P. Conte, Journal of Structural Engineering, Vol. 134, No. 7, July 1, 2008.



A. Elgamal Sept 2008

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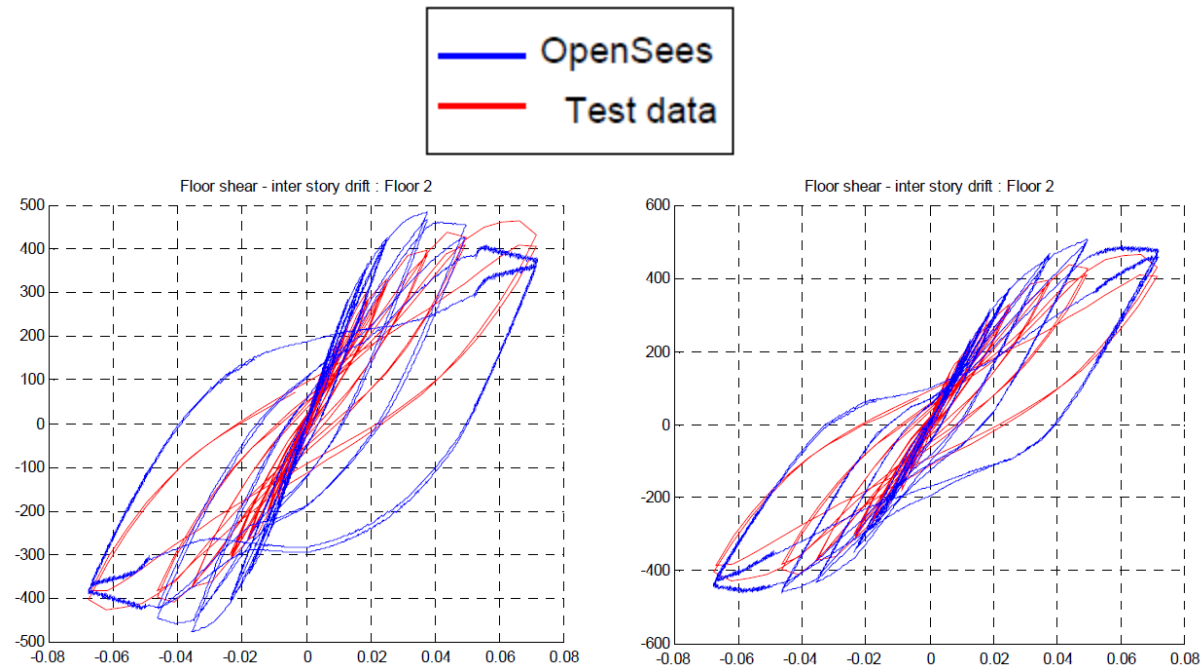
Elevation and Plan View of Residual Deformation (Scaling Factor = 50)



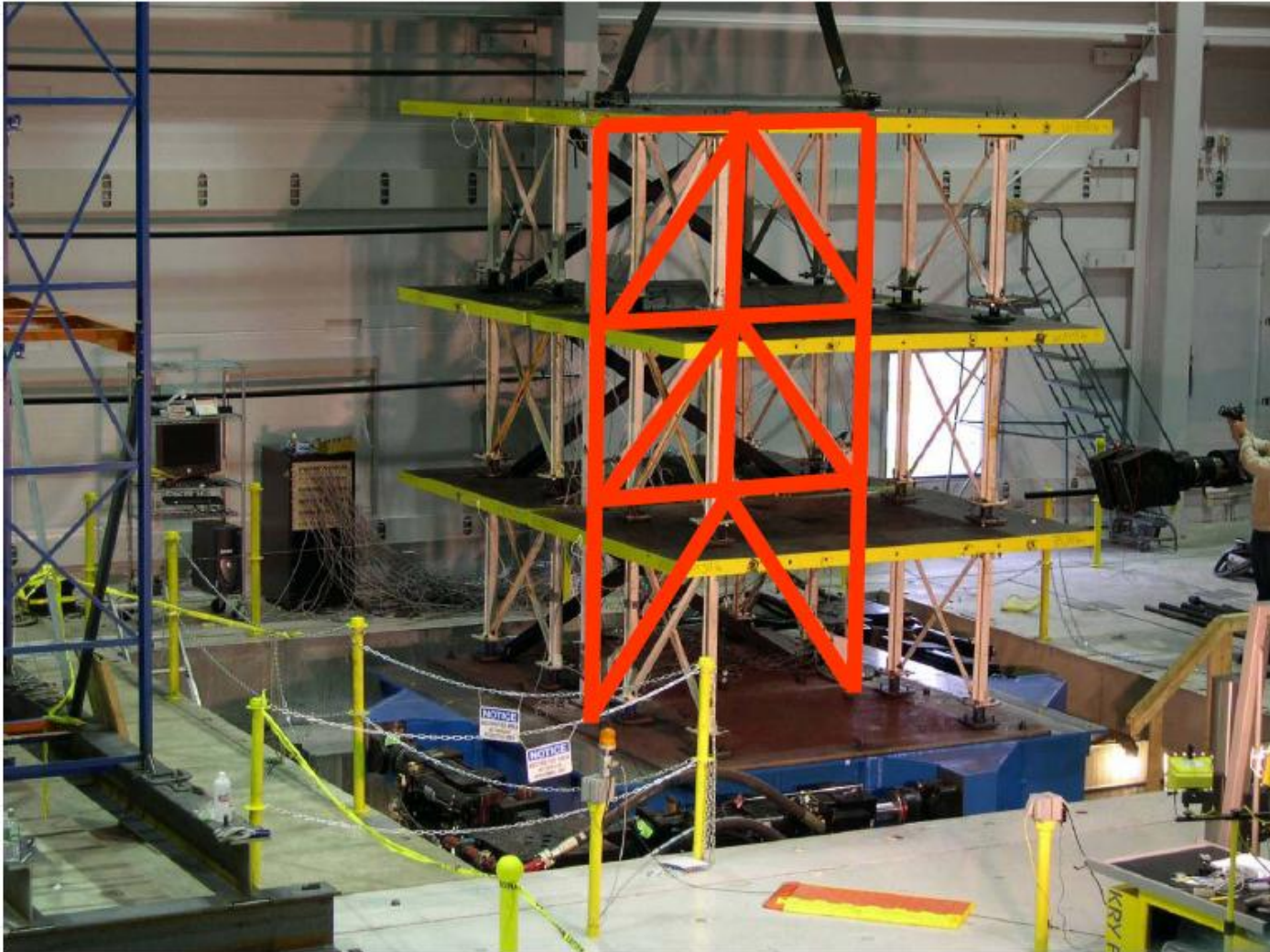
A. Elgamal Sept 2008

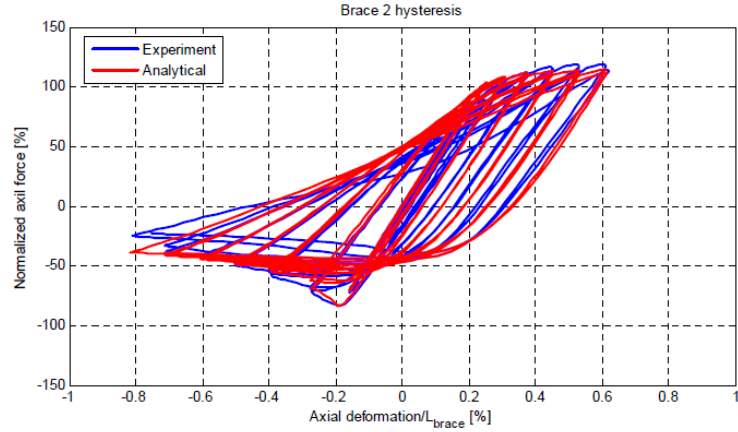
8

And Why do Finite Element Analysis NCEER frame tested at the Taiwan facility

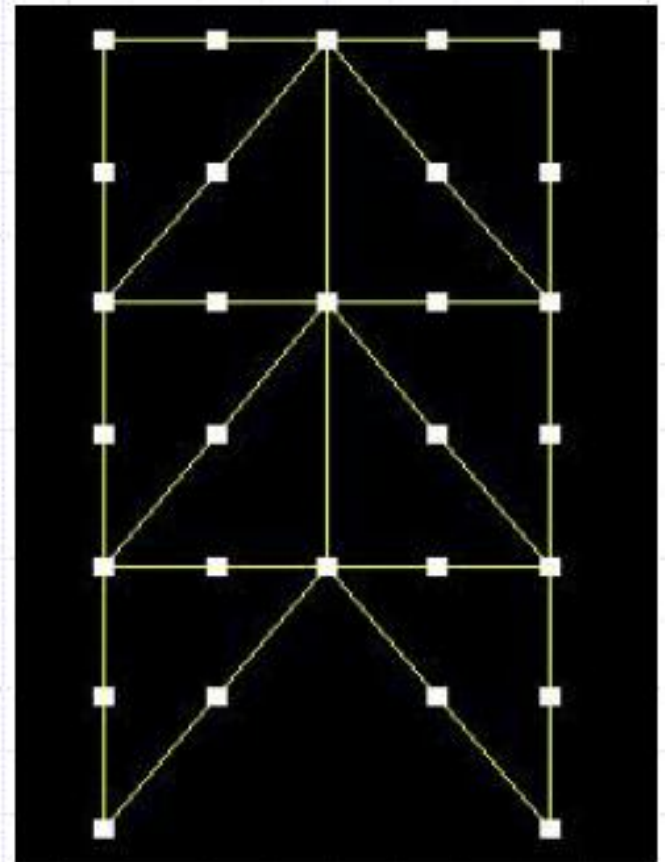


Buffalo Shaking Table Test





Experimental Testing



Analytical Simulation

Objective of User Workshop

- Describe modeling and analysis capability, including: element, section, material.
- Overview of applications, structural not geotechnical.
- Show specific examples of nonlinear analysis.
- Motivation to use OpenSees for your simulation problems....

What Should be Your Expectations?

- OpenSees is a research tool at this time, but fairly stable for regular use.
- As with any nonlinear analysis, it requires careful consideration of model and interpretation of results.
- It is under continual development by students, faculty and other researchers.
- It is not bullet-proof.
- An investment of time and learning is required.
- The OpenSees open-source community requires contributions for the community to succeed.

Any Questions or Statements?

Basic Modeling

What is Tcl

- Tcl is a dynamic programming language.
- It is a string based command language.
- Variables and variable substitution
- Expression evaluation
- Basic control structures (if , while, for, foreach)
- Procedures
- File manipulation
- Sourcing other files.

Comand syntax:

command arg1 arg2 ...

- Help

1. <http://www.tcl.tk/man/tcl8.5/tutorial/tcltutorial.html>

Tcl Scripting

- *Variables* and variable substitution

```
>set a 1
1
>set b a
a
>set b $a
1
>set b $a$a
11
```

- *Expression* Evaluation

```
>expr 2+3
5
>set b [expr 2+$a]
3
>set b [expr 2+$a.$a]
3.1
```

- *Lists*

```
>set a {9 i c c e}
9 i c c e
>set La [llength $a]
5
>set a_0 [lindex $a 0]
9
>lappend a OpenSees
9 i c c e OpenSees
```

- *file manipulation*

```
>set txt [open temp.out w+]
file1792158
>puts $txt "Hello World"
>close $txt
>type temp.out
Hello World
```

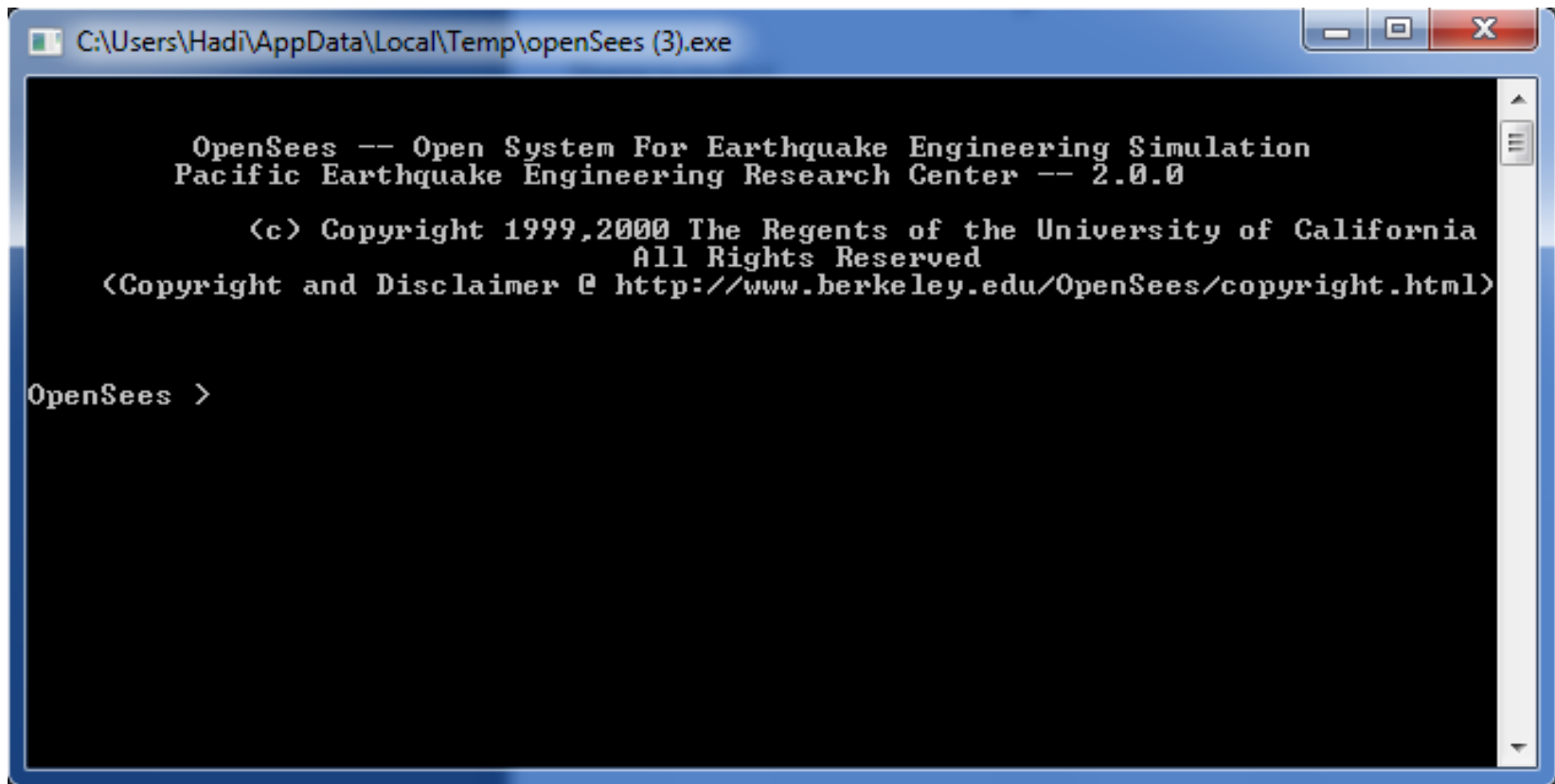
- *procedures & control structures*

```
> for {set i 1} {$i < 10} {incr
i 1} {
puts "i equals $i"
}
>foreach i {9 i c c e} {
puts " i is $i"
}
>proc comp {a b} {
if {$a < $b} {
puts "$a is lower than $b"
} else {
if {$a > $b} {
puts "$a is greater than $b"
} else { puts "$a is equal $b" }
}
}
```

```
>source example.tcl
```

OpenSees.exe

- There is no GUI!



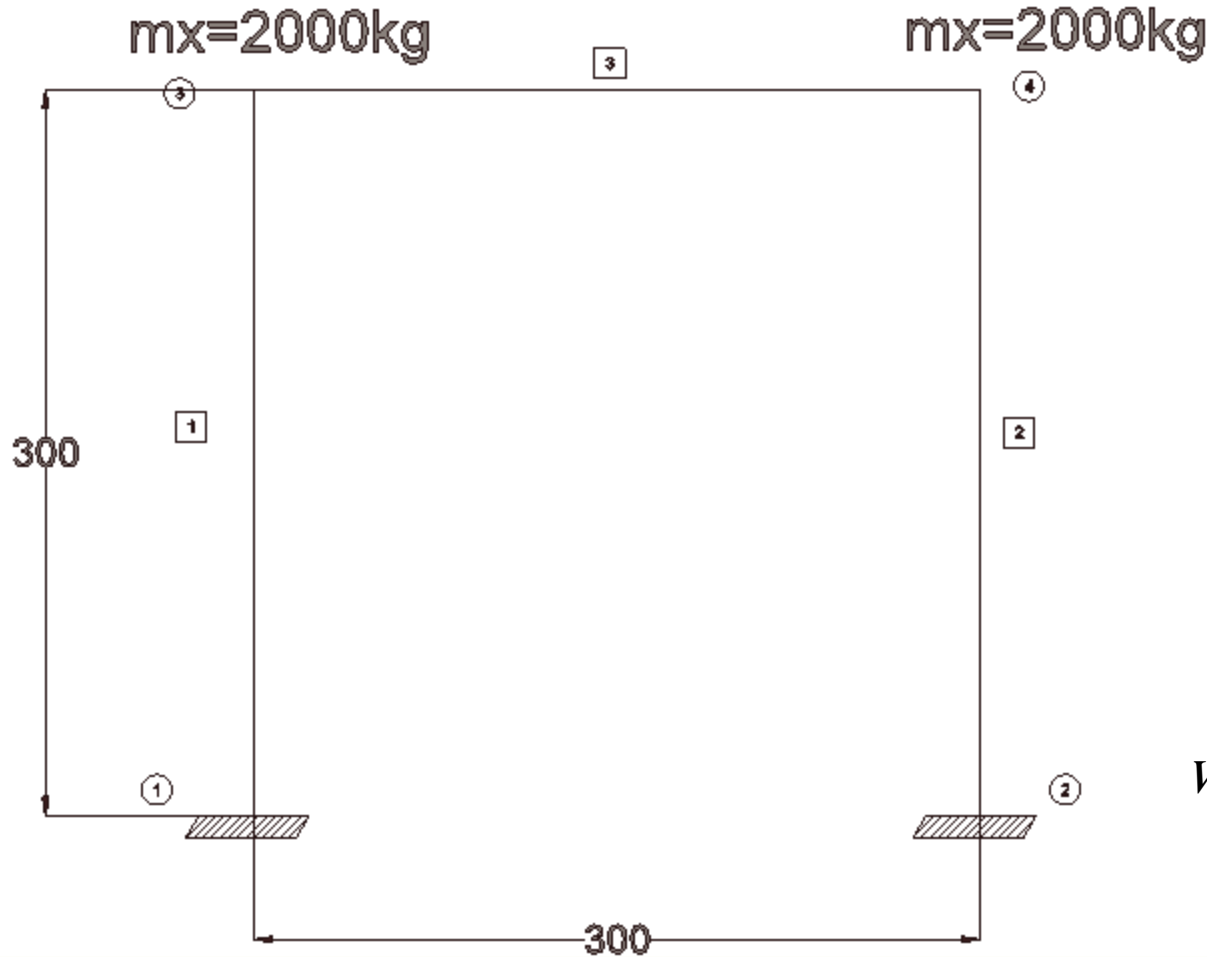
```
C:\Users\Hadi\AppData\Local\Temp\openSees (3).exe

OpenSees -- Open System For Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center -- 2.0.0

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All Rights Reserved
<Copyright and Disclaimer @ http://www.berkeley.edu/OpenSees/copyright.html>

OpenSees >
```


Example 1-Eigen Value Problem



$$I = 1.943e - 5 \text{ m}^4$$

$$A = 2.85e - 3 \text{ m}^2$$

$$E = 2. \text{e}11 \frac{\text{N}}{\text{m}^2}$$

What is First Modal Period?

ModelBuilder Command

Basic ModelBuilder

```
model Basic -ndm $ndm <-ndf $ndf>
```

2D Model:

ndm = 2

ndf = 2 or 3

3D Model:

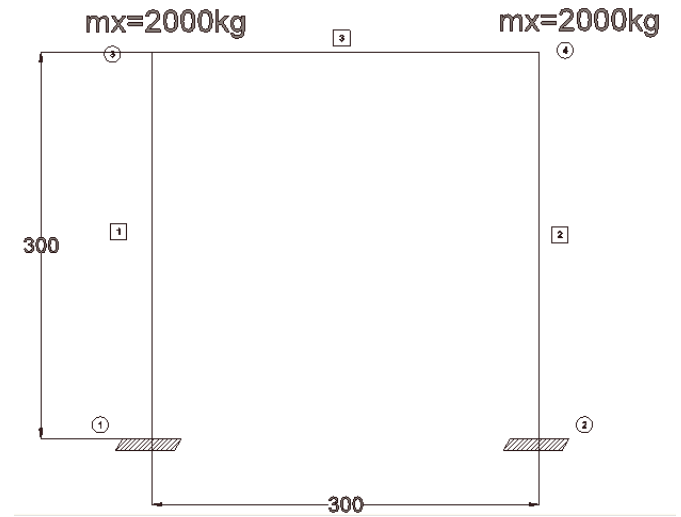
ndm = 3

ndf = 3 or 6

Example 1-Eigen Value Problem

wipe

model basic -ndm 2 -ndf 3



Modeling Commands

Domain

node \$nodeTag (ndm \$coords)

mass \$nodeTag (ndf \$MassValues)

- Geometric Transformation
Linear , PDelta , Corotational

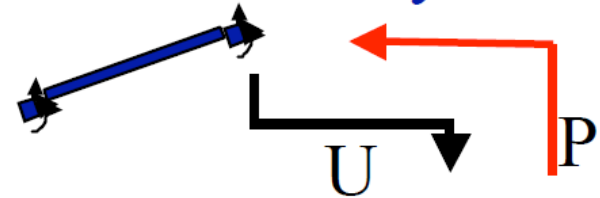
geomTransf Linear \$transfTag

- Single-Point Constraints

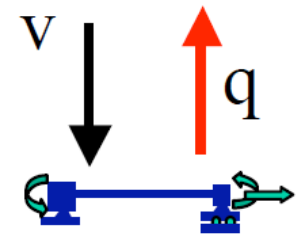
fix \$nodeTag (ndf \$ConstrValues)

- Multi-Point Constraints
equalDOF , rigidDiaphragm , rigidLink

Element in Global System



Geometric Transformation



Element in Basic System

Example 1-Eigen Value Problem

wipe

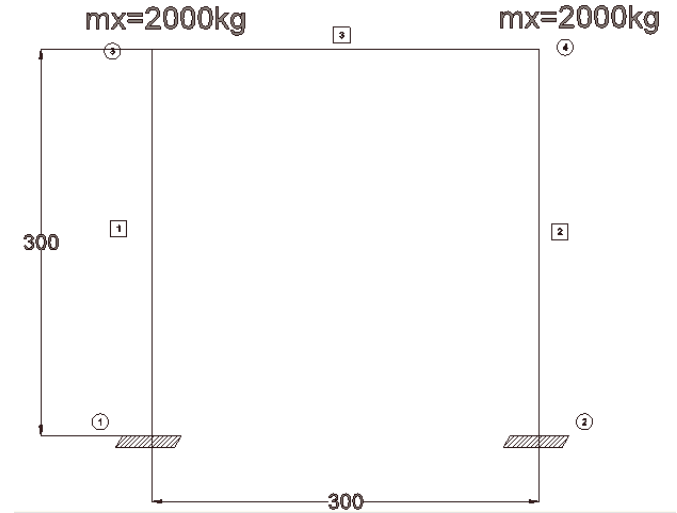
model basic -ndm 2 -ndf 3

```
node 1 0. 0.  
node 2 3. 0.  
node 3 0. 3.  
node 4 3. 3.
```

```
fix 1 1 1 1  
fix 2 1 1 1
```

```
mass 3 2000. 0. 0.  
mass 4 2000. 0. 0.
```

```
geomTransf Linear 1
```



Modeling Commands

- **Materials**

Uniaxial , nD Material , Section

Uniaxial

Elastic
ElasticPP
Hardening
Concrete
Steel
Hysteretic
PY-TZ-QZ
Parallel
Series
Gap
Fatigue
etc.

nD

Elastic
J2
DruckerPrager
TemplateElasto-Plasto
FluidSolidPorous
PressureMultiYield(dependent, independent)
etc.

Section

Elastic
Fiber

(over 250 material classes)

Modeling Commands

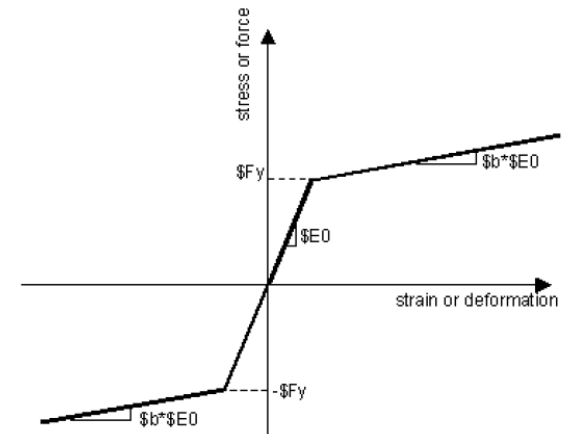
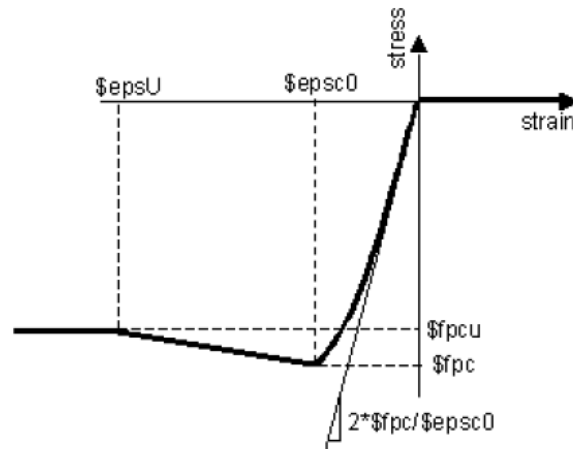
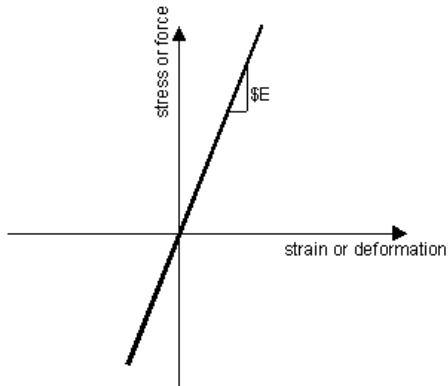
- Materials

Uniaxial

`uniaxialMaterial Elastic $matTag $E`

`uniaxialMaterial Concrete01 $matTag $fpc $epsc0 $fpcu $epsU`

`uniaxialMaterial Steel01 $matTag $Fy $E0 $b`



Modeling Commands

- **Elements**

**Truss , Elastic Beam Column , Zero Length , Nonlinear Beam Column (force, displacement) , Beam With Hinges , Quad , Shell , Brick , Joint , etc.
> 100 element classes**

```
element truss $eleTag $iNode $jNode $A $matTag
```

```
element elasticBeamColumn $eleTag $iNode $jNode $A $E $Iz $transfTag
```

```
element nonlinearBeamColumn $eleTag $iNode $jNode $numIntgrPts $secTag $transfTag
```


Example 1-Eigen Value Problem

wipe

model basic -ndm 2 -ndf 3

node 1 0. 0.

node 2 3. 0.

node 3 0. 3.

node 4 3. 3.

fix 1 1 1 1

fix 2 1 1 1

mass 3 2000. 0. 0.

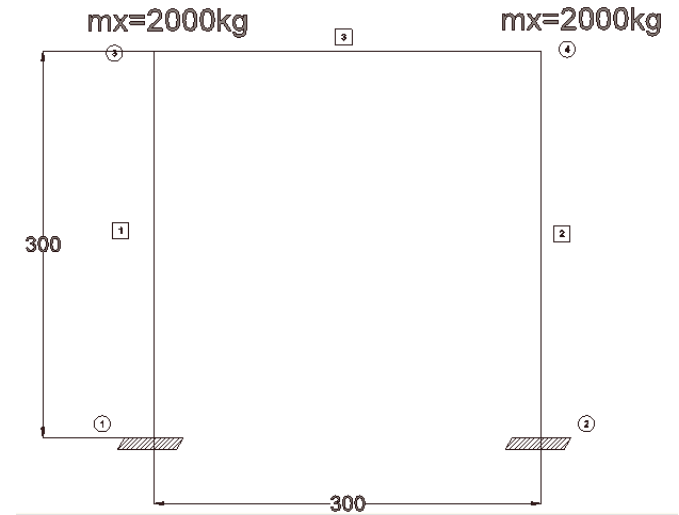
mass 4 2000. 0. 0.

geomTransf Linear 1

element elasticBeamColumn 1 1 3 28.5e-4 2e11 1.943e-5 1

element elasticBeamColumn 2 2 4 28.5e-4 2e11 1.943e-5 1

element elasticBeamColumn 3 3 4 28.5e-4 2e11 1.943e-5 1



Modeling Commands

- **Eigen Command**

```
eigen $numEigenvalues
```

```
wipe  
  
model basic -ndm 2 -ndf 3  
  
node 1 0. 0.  
node 2 3. 0.  
node 3 0. 3.  
node 4 3. 3.  
  
fix 1 1 1 1  
fix 2 1 1 1  
  
mass 3 2000. 0. 0.  
mass 4 2000. 0. 0.
```

```
geomTransf Linear 1
```

```
element elasticBeamColumn 1 1 3 28.5e-4 2e11 1.943e-5 1  
element elasticBeamColumn 2 2 4 28.5e-4 2e11 1.943e-5 1  
element elasticBeamColumn 3 3 4 28.5e-4 2e11 1.943e-5 1
```

```
puts "First Eigen Value is: [eigen 1]  
First Mode Period is: [expr 2*3.1415/pow([eigen 1],0.5)]"
```

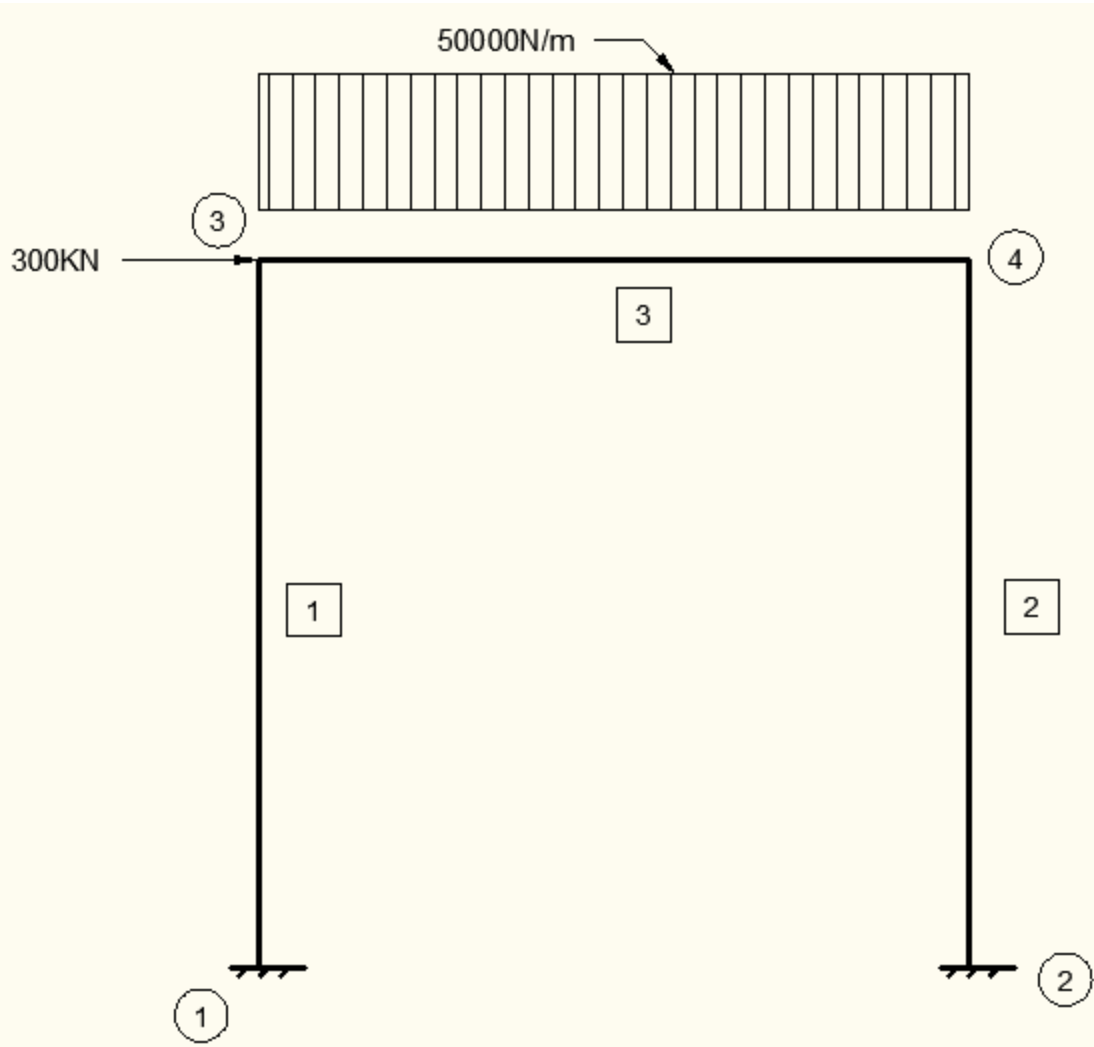


SAP2000

OpenSees



Example 2-1-Gravity Loading



$$I = 1.943e - 5 \text{ m}^4$$

$$A = 2.85e - 3 \text{ m}^2$$

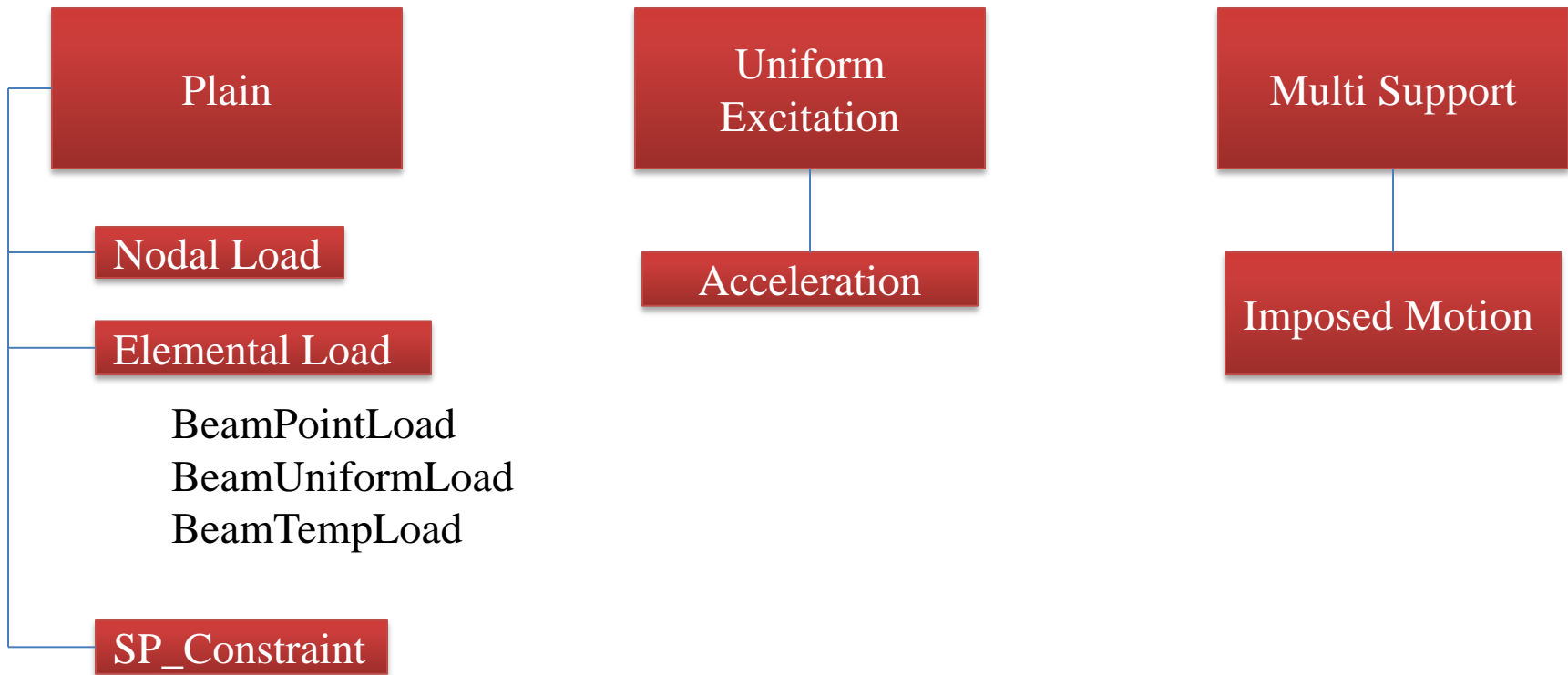
$$E = 2. \text{e}11 \frac{\text{N}}{\text{m}^2}$$

Total Displacement of Node 4?

Modeling Commands

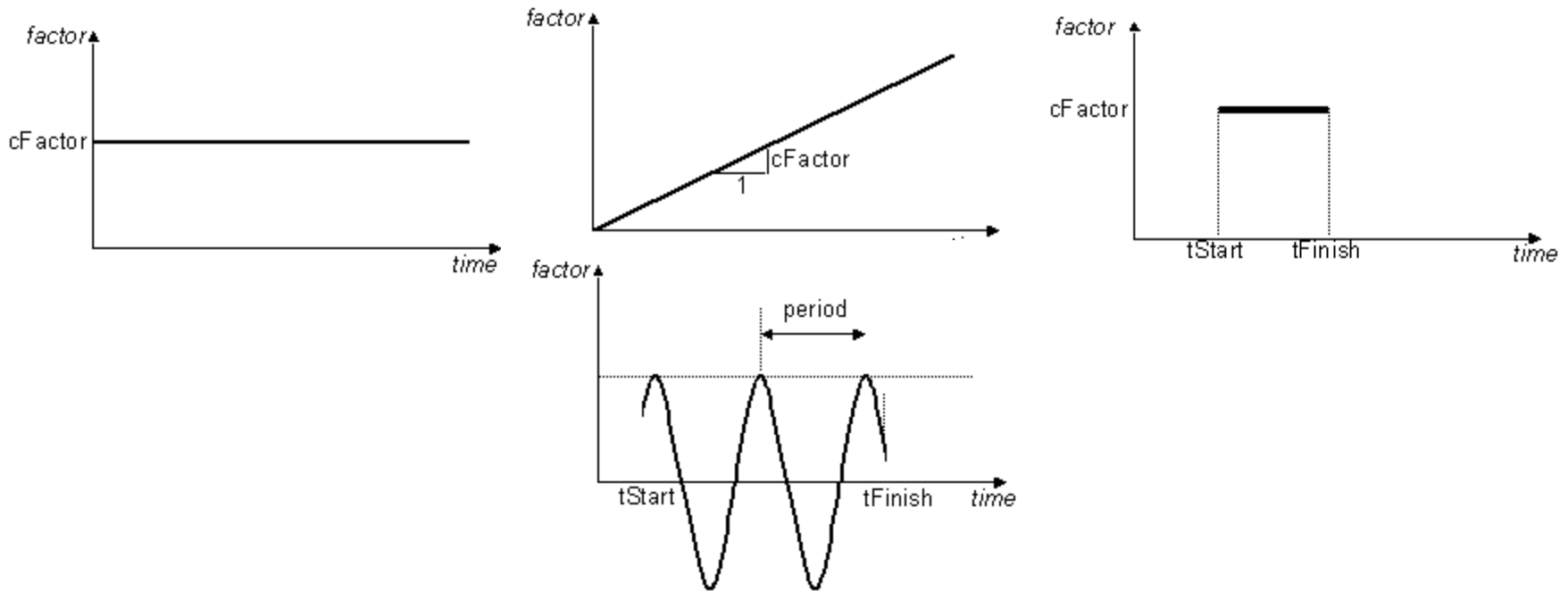
- **Load Pattern**

Plain , Uniform Excitation , Multi Support



Modeling Commands

- **Time Series (Functions)**
Constant , Linear , Rectangular , Sine , Path



- **Series -dt dt? -values {list of points} <-factor cFactor?>**
- **Series -time {list of times} -values {list of points} <-factor cFactor?>**
- **Series -dt dt? -filePath fileName? <-factor cFactor?>**
- **Series -fileTime fileName1? -filePath fileName2? <-factor cFactor?>**

Example 2-1-Gravity Loading

wipe

```
model basic -ndm 2 -ndf 3
```

```
node 1 0. 0.
```

```
node 2 3. 0.
```

```
node 3 0. 3.
```

```
node 4 3. 3.
```

```
fix 1 1 1 1
```

```
fix 2 1 1 1
```

```
mass 3 2000. 0. 0.
```

```
mass 4 2000. 0. 0.
```

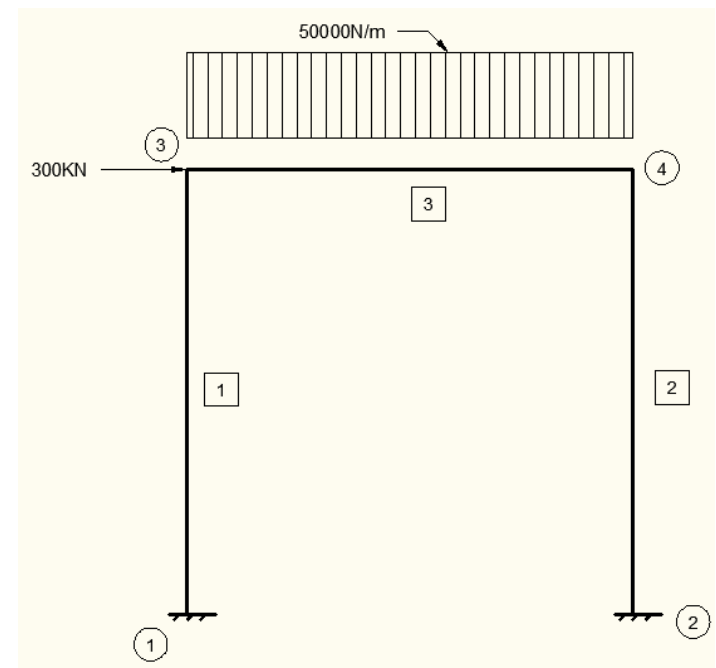
```
geomTransf Linear 1
```

```
element elasticBeamColumn 1 1 3 28.5e-4 2e11 1.943e-5 1
```

```
element elasticBeamColumn 2 2 4 28.5e-4 2e11 1.943e-5 1
```

```
element elasticBeamColumn 3 3 4 28.5e-4 2e11 1.943e-5 1
```

```
pattern Plain 1 Linear {  
  eleLoad -ele 3 -type -beamUniform -5e4  
  load 3 3.e5 0. 0.  
}
```



Output Options

There is NO OUTPUT until you request it from OpenSees!

There are 4 options to obtain output:

1. recorder command

Records a specific output to a file or database

```
recorder $type $arg1 $arg2 ...
```

2. puts command

Puts a specific output or variable to monitor or file stream

```
puts <$fileID> $string
```

3. print command

Prints a specific output or data existed in the domain to monitor or file stream

```
print <-file $fileName> <-node $nd1 $nd2 ..> <-ele $ele1 $ele2 ...>
```

4. recorder display command

Output Options

Element/EnvelopeElement Recorders

recorder Element <-file \$fileName> <-time> <-ele \$stg1 \$stg2 ...> \$arg1 \$arg2 ...

The valid args for different elements

Elastic BCE:

force

Force BCE and BWHE:

force

globalForce

localForce

plasticDeformation

etc.

- The EnvelopeElement takes exactly same args

Example 2-1-Gravity Loading

wipe

```
model basic -ndm 2 -ndf 3
```

```
node 1 0. 0.
```

```
node 2 3. 0.
```

```
node 3 0. 3.
```

```
node 4 3. 3.
```

```
fix 1 1 1 1
```

```
fix 2 1 1 1
```

```
mass 3 2000. 0. 0.
```

```
mass 4 2000. 0. 0.
```

```
geomTransf Linear 1
```

```
element elasticBeamColumn 1 1 3 28.5e-4 2e11 1.943e-5 1
```

```
element elasticBeamColumn 2 2 4 28.5e-4 2e11 1.943e-5 1
```

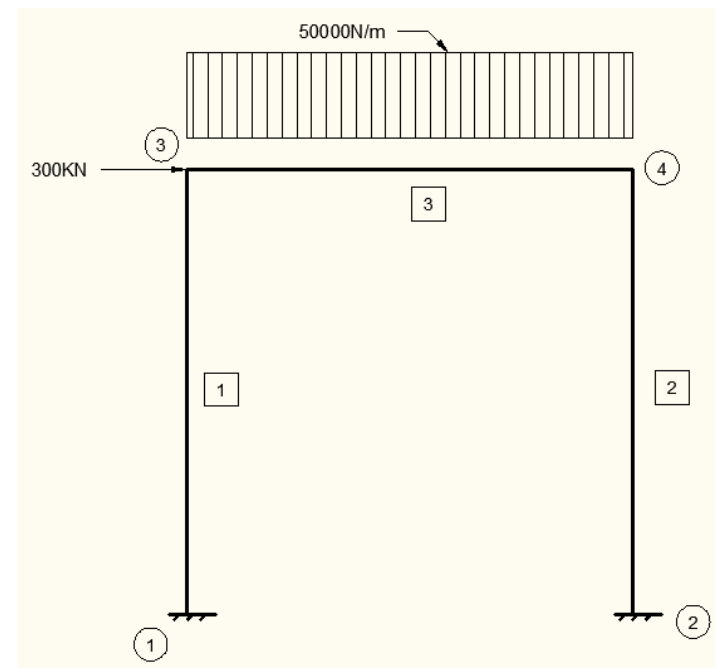
```
element elasticBeamColumn 3 3 4 28.5e-4 2e11 1.943e-5 1
```

```
pattern Plain 1 Linear {
```

```
eleLoad -ele 3 -type -beamUniform -5e4
```

```
load 3 3.e5 0. 0.
```

```
}
```



```
recorder Node -file node4disp.out -time -node 4 -dof 1 2 3 disp
recorder Node -file node1reac.out -time -node 1 -dof 1 2 3 reaction
recorder Node -file node2reac.out -time -node 2 -dof 1 2 3 reaction
```

Example Analysis

Static Linear Analysis with Load Control

constraints Plain
numberer Plain
system BandGeneral
test NormDispIncr 1.e-8 6
algorithm ModifiedNewton
integrator **LoadControl 1**
analysis **Static**
analyze 1
loadConst -time 0.0

Static Nonlinear Analysis with Load Control

constraints Plain
numberer Plain
system BandGeneral
test NormDispIncr 1.e-8 6
algorithm ModifiedNewton
integrator **LoadControl 0.1**
analysis **Static**
analyze 10
loadConst -time 0.0

Example 2-1-Gravity Loading

wipe

```
model basic -ndm 2 -ndf 3
```

```
node 1 0. 0.
```

```
node 2 3. 0.
```

```
node 3 0. 3.
```

```
node 4 3. 3.
```

```
fix 1 1 1 1
```

```
fix 2 1 1 1
```

```
mass 3 2000. 0. 0.
```

```
mass 4 2000. 0. 0.
```

```
geomTransf Linear 1
```

```
element elasticBeamColumn 1 1 3 28.5e-4 2e11 1.943e-5 1
```

```
element elasticBeamColumn 2 2 4 28.5e-4 2e11 1.943e-5 1
```

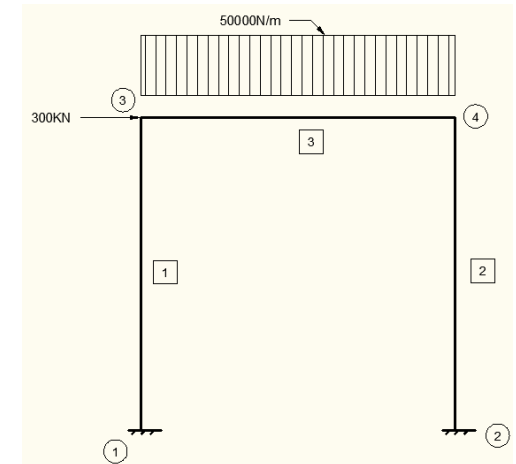
```
element elasticBeamColumn 3 3 4 28.5e-4 2e11 1.943e-5 1
```

```
pattern Plain 1 Linear {
```

```
eleLoad -ele 3 -type -beamUniform -5e4
```

```
load 3 3.e5 0. 0.
```

```
}
```



```
recorder Node -file node4disp.out -time -node 4 -dof 1 2 3 disp
```

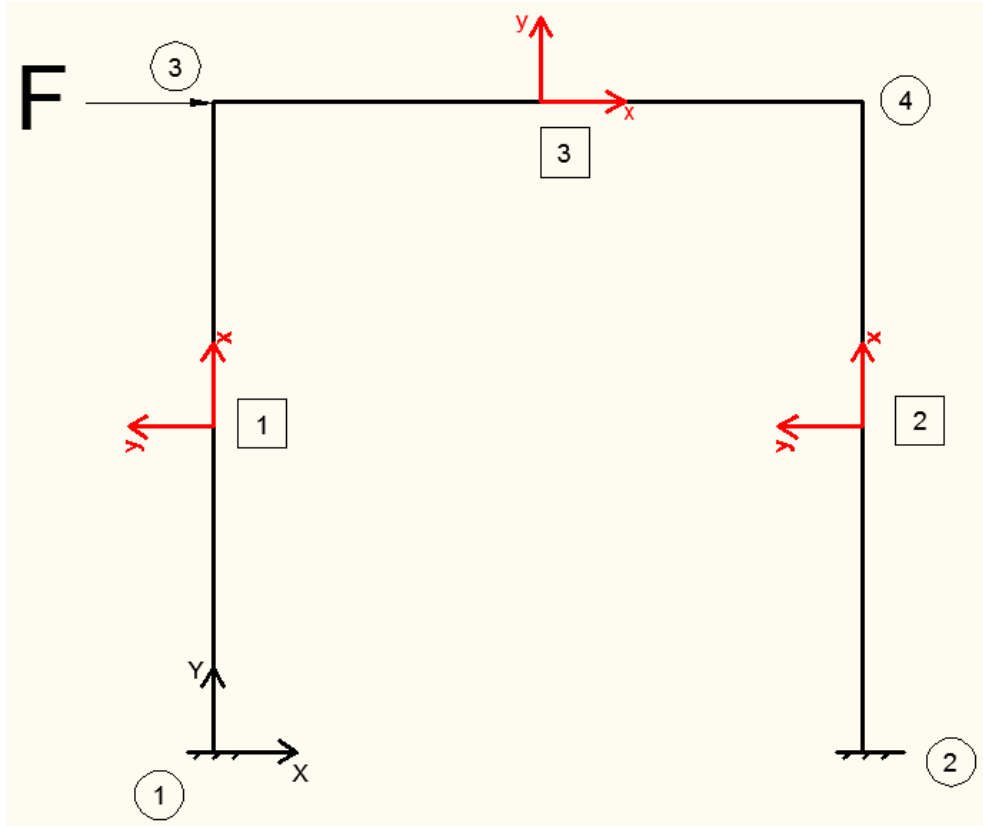
```
recorder Node -file node1reac.out -time -node 1 -dof 1 2 3 reaction
```

```
recorder Node -file node2reac.out -time -node 2 -dof 1 2 3 reaction
```

```
constraints Plain  
numberer Plain  
system BandGeneral  
test NormDispIncr 1.e-8 6  
algorithm ModifiedNewton  
integrator LoadControl 1  
analysis Static  
analyze 1  
loadConst -time 0.0
```



Example 2-2-Linear Pushover



Push the frame to 0.1m displacement of Node 4 in X dir.

Example Analysis

Static Linear Analysis with Displacement Control

constraints Plain

numberer Plain

system BandGeneral

test NormDispIncr 1.e-8 6

algorithm ModifiedNewton

integrator DisplacementControl 4 1 0.001

analysis Static

analyze 100

loadConst -time 0.0

Example 2-2-Linear Pushover

wipe

model basic -ndm 2 -ndf 3

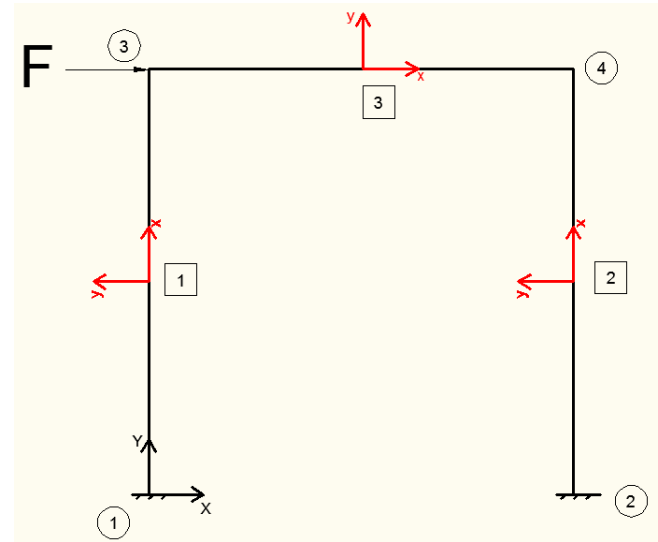
node 1 0. 0.
node 2 3. 0.
node 3 0. 3.
node 4 3. 3.

fix 1 1 1 1
fix 2 1 1 1

mass 3 2000. 0. 0.
mass 4 2000. 0. 0.
geomTransf Linear 1

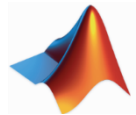
element elasticBeamColumn 1 1 3 28.5e-4 2e11 1.943e-5 1
element elasticBeamColumn 2 2 4 28.5e-4 2e11 1.943e-5 1
element elasticBeamColumn 3 3 4 28.5e-4 2e11 1.943e-5 1

pattern Plain 1 Linear {
load 3 1000. 0. 0.
}



recorder Node -file node4disp.out -time -node 4 -dof 1 2 3 disp
recorder Node -file node1reac.out -time -node 1 -dof 1 2 3 reaction
recorder Node -file node2reac.out -time -node 2 -dof 1 2 3 reaction

constraints Plain
numberer Plain
system BandGeneral
test NormDispIncr 1.e-8 6
algorithm ModifiedNewton
integrator DisplacementControl 4 1 0.001
analysis Static
analyze 100
loadConst -time 0.0



OpenSees

Any Questions or Statements?

Nonlinear Modeling and Analysis

Why Nonlinear Analysis:

- Geometric Nonlinearities
- Material nonlinearities
- Contact nonlinearities

Nonlinear Analysis is Harder

- It requires much more thought when setting up the model
- It requires more thought when setting up the analysis
- It takes more computational time.
- It does not always converge.
- It does not always converge to the correct solution.

BUT Most Problems Require
Nonlinear Analysis

CHECK YOUR MODEL!

Modeling Commands

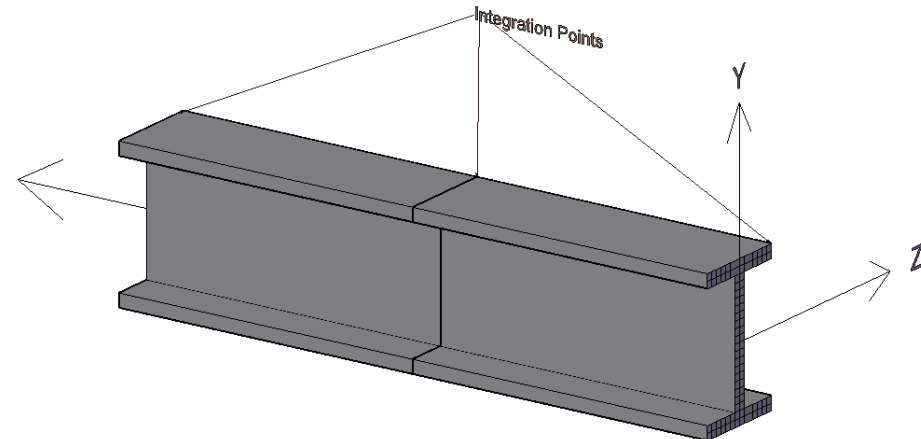
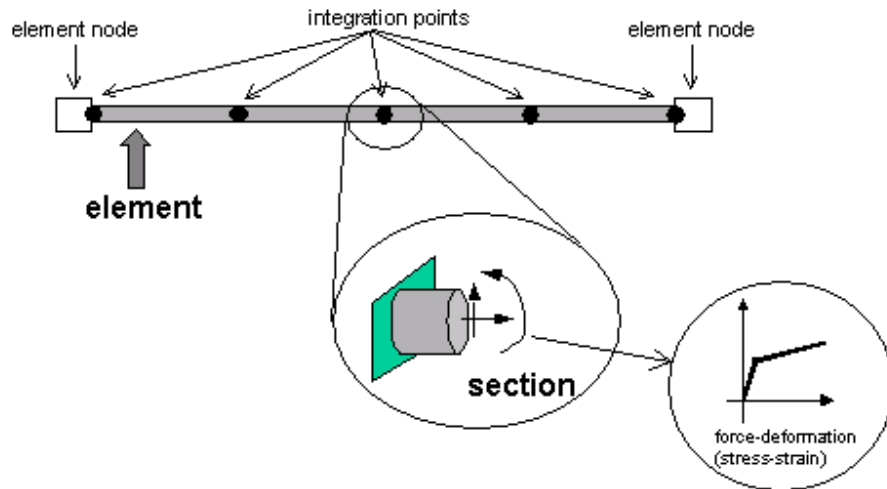
- **Section Command**

What is a section?

A section defines the stress resultant force-deformation response at a cross section of a beam-column or plate element.

Types of sections:

- Elastic
- Resultant
- Fiber

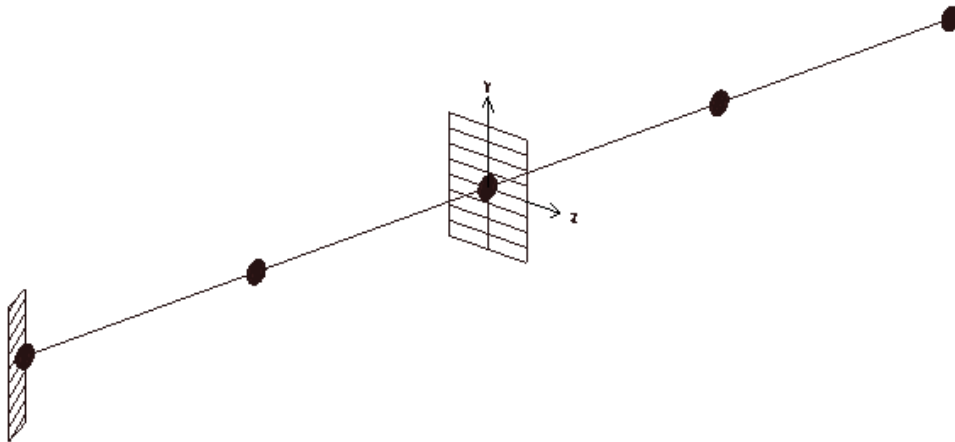
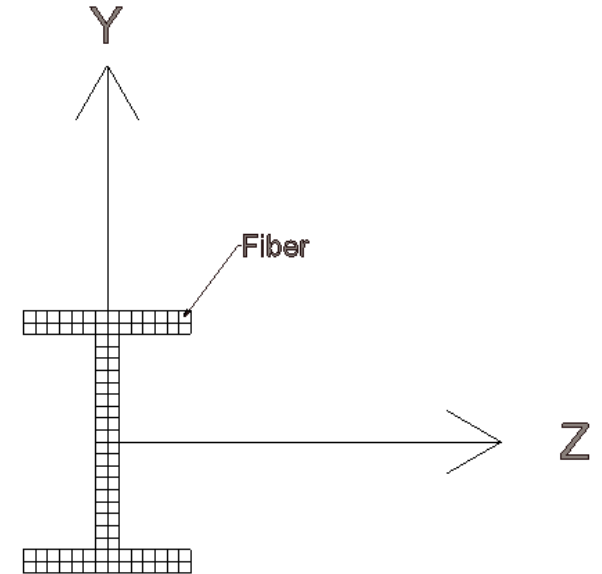


Modeling Commands

- **Fiber Section**

The Fiber Section object is composed of Fiber objects.

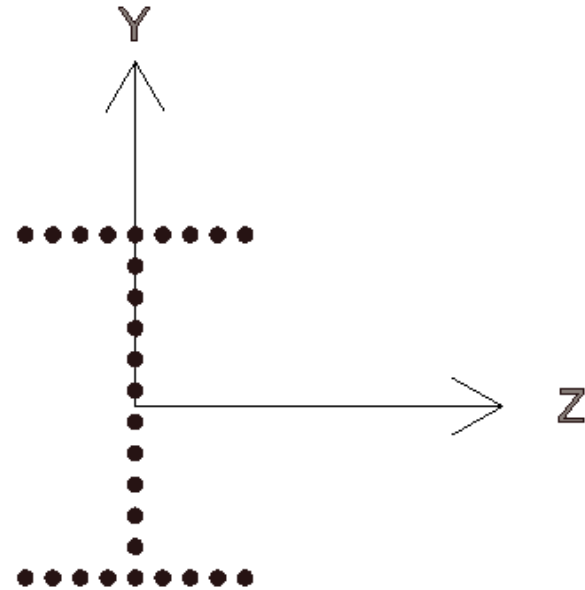
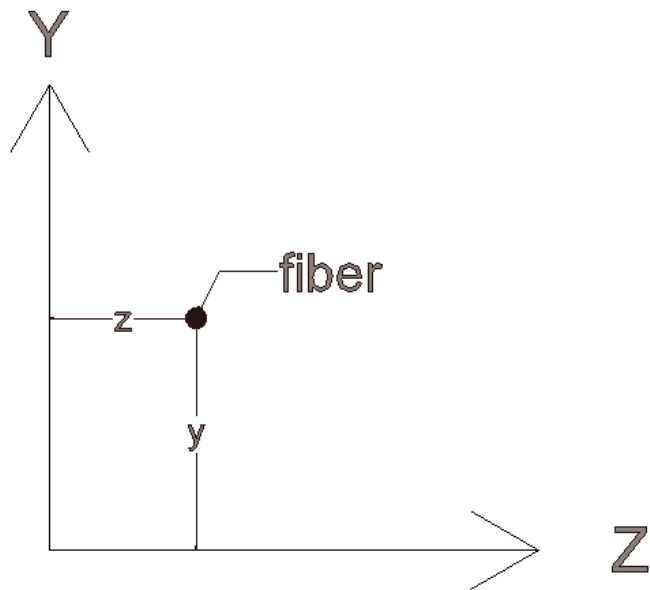
```
section Fiber $secTag {  
    fiber <fiber arguments>  
    patch <patch arguments>  
    layer <layer arguments>  
}
```



Modeling Commands

- Fiber command

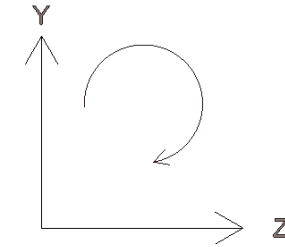
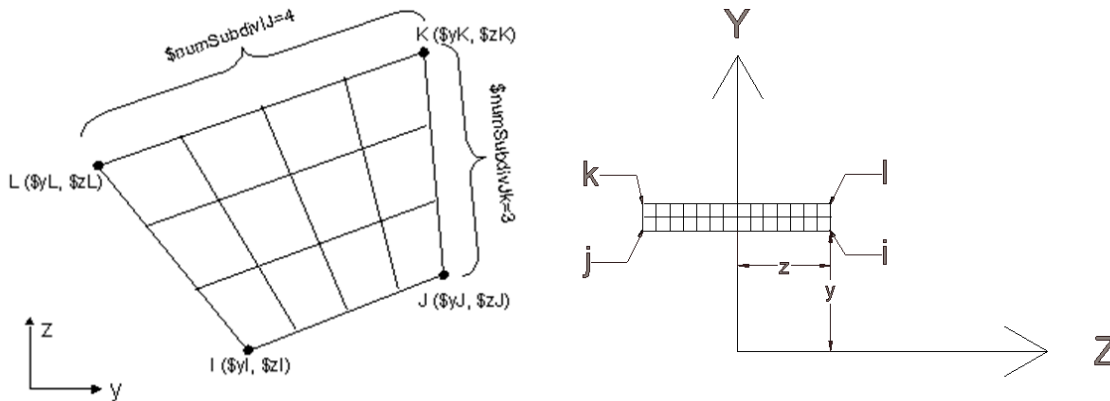
```
fiber $yLoc $zLoc $A $matTag
```



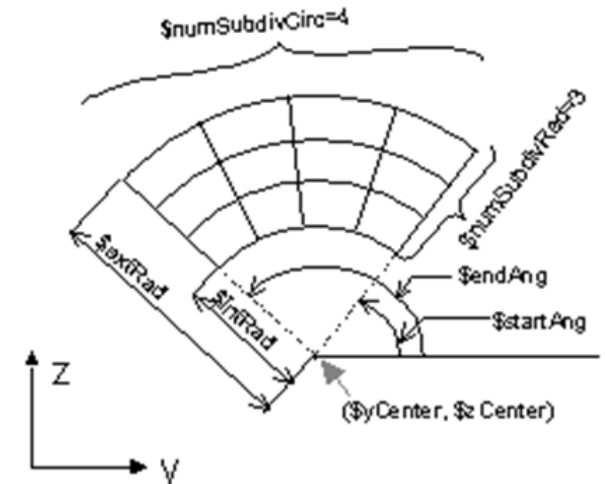
Modeling Commands

- Patch command

patch quad \$matTag \$numSubdivIJ \$numSubdivJK \$yI \$zI \$yJ \$zJ \$yK \$zK \$yL \$zL



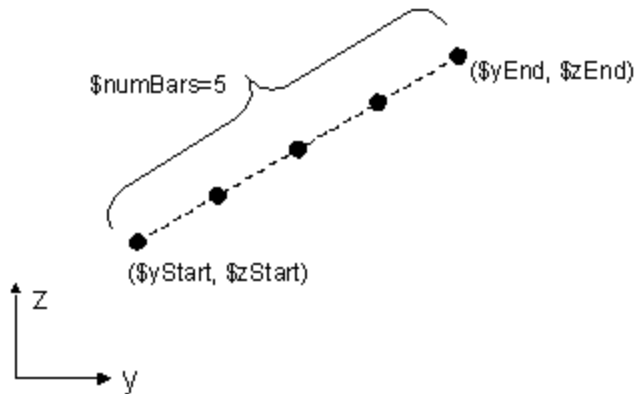
patch circ \$matTag \$numSubdivCirc \$numSubdivRad \$yCenter \$zCenter \$intRad \$extRad <\$startAng \$endAng>



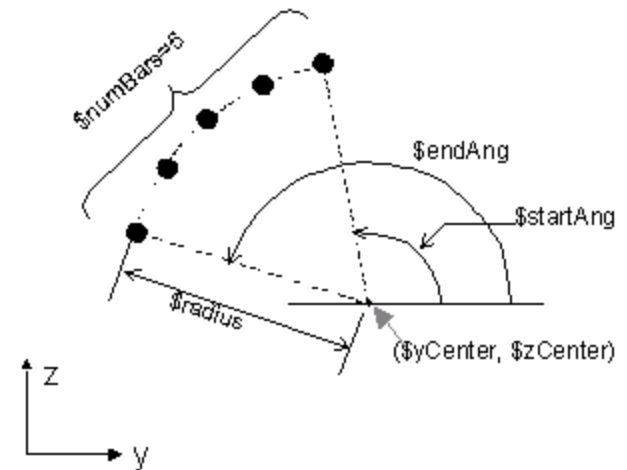
Modeling Commands

- Layer command

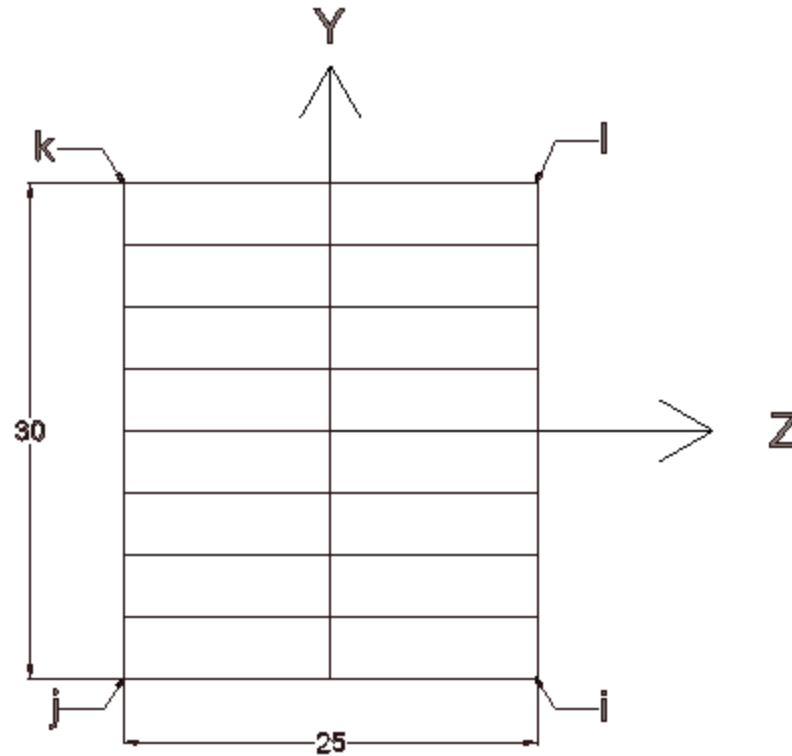
layer straight \$matTag \$numBars \$areaBar \$yStart \$zStart \$yEnd \$zEnd



layer circ \$matTag \$numBar \$areaBar \$yCenter \$zCenter \$radius <\$startAng \$endAng>



Fiber Section Example

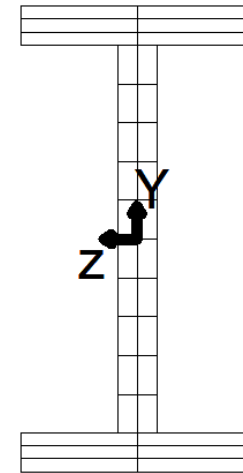
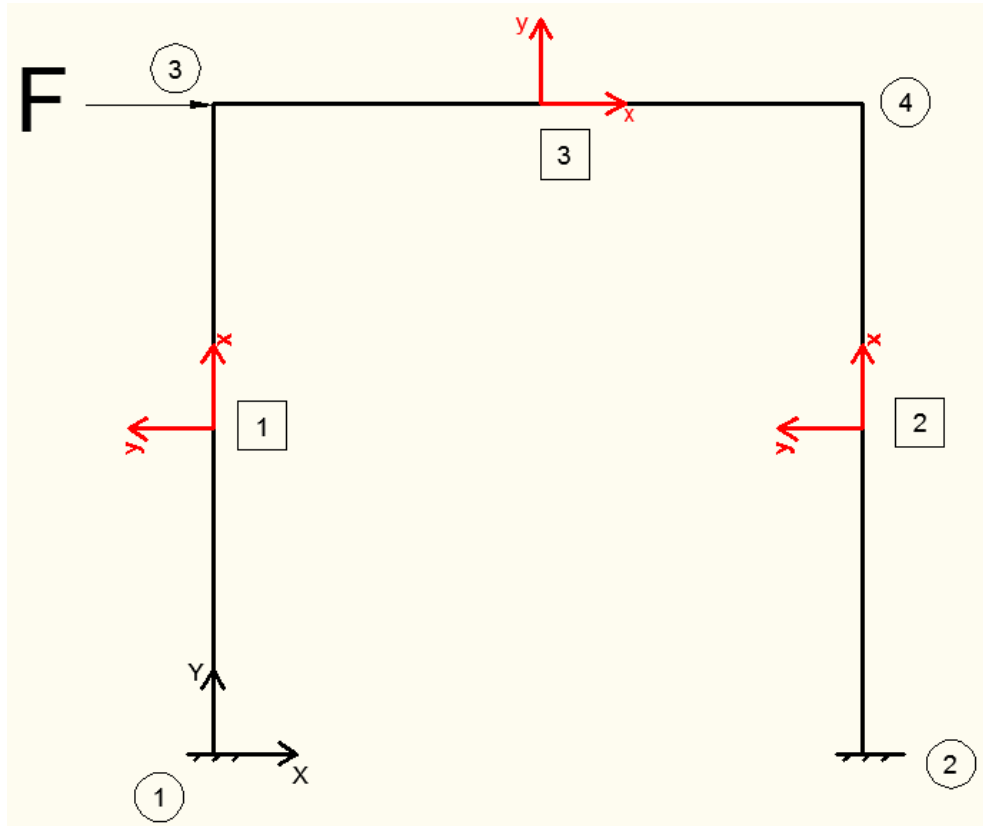


section Fiber 1 {

			yI	zI	yJ	zJ	yK	zK	yL	zL
patch	quad	1 2 8	-0.15	0.125	-0.15	-0.125	0.15	-0.125	0.15	0.125

}

Example 3-NonLinear Pushover



$$bf = 10cm$$

$$d = 20cm$$

$$tf = 0.85cm$$

$$tw = 0.56cm$$

Push the frame to 0.1m displacement of Node 4 in X dir.

Example 3-NonLinear Pushover

wipe

model basic -ndm 2 -ndf 3

node 1 0. 0.

node 2 3. 0.

node 3 0. 3.

node 4 3. 3.

fix 1 1 1 1

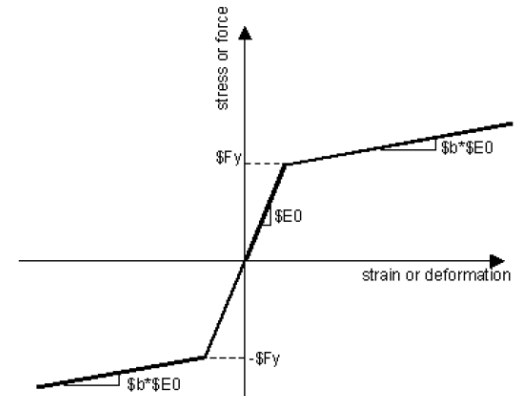
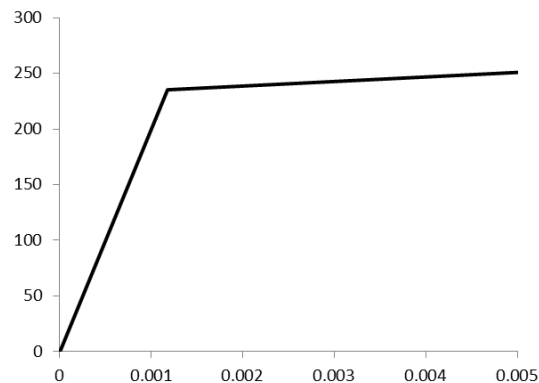
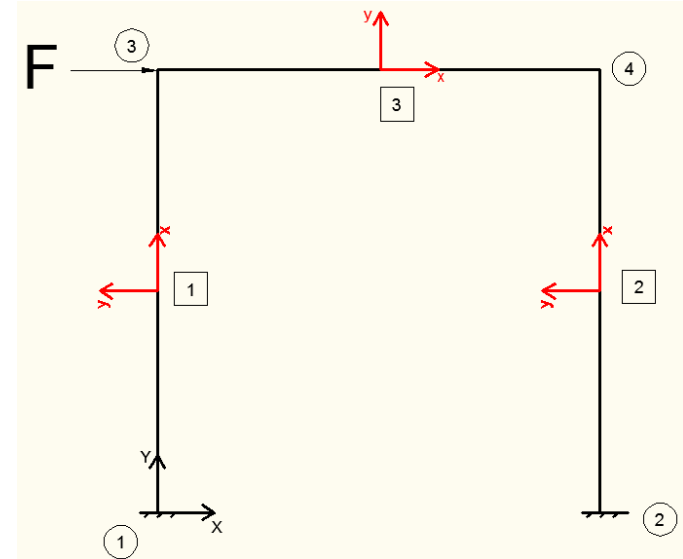
fix 2 1 1 1

mass 3 2000. 0. 0.

mass 4 2000. 0. 0.

geomTransf Linear 1

uniaxialMaterial Steel01 1 2.354e8 2.e11 0.02



Example 3-NonLinear Pushover

wipe

model basic -ndm 2 -ndf 3

node 1 0. 0.

node 2 3. 0.

node 3 0. 3.

node 4 3. 3.

fix 1 1 1 1

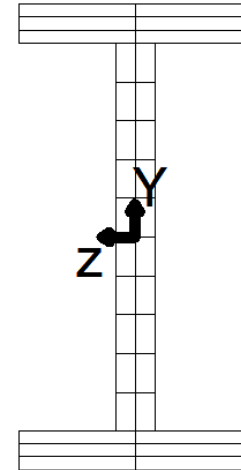
fix 2 1 1 1

mass 3 2000. 0. 0.

mass 4 2000. 0. 0.

geomTransf Linear 1

uniaxialMaterial Steel01 1 2.354e8 2.e11 0.02



$$bf = 10cm$$

$$d = 20cm$$

$$tf = 0.85cm$$

$$tw = 0.56cm$$

section fiber 1 {

patch quad	1 2 3	0.0915	0.05	0.0915	-0.05	0.1	-0.05	0.1	0.05
patch quad	1 2 8	-0.0915	0.0028	-0.0915	-0.0028	0.0915	-0.0028	0.0915	0.0028
patch quad	1 2 3	-0.1	0.05	-0.1	-0.05	-0.0915	-0.05	-0.0915	0.05

}

Example 3-NonLinear Pushover

wipe

model basic -ndm 2 -ndf 3

node 1 0. 0.

node 2 3. 0.

node 3 0. 3.

node 4 3. 3.

fix 1 1 1 1

fix 2 1 1 1

mass 3 2000. 0. 0.

mass 4 2000. 0. 0.

geomTransf Linear 1

uniaxialMaterial Steel01 1 2.354e8 2.e11 0.02

section fiber 1 {

patch quad 1 2 3 0.0915 0.05 0.0915 -0.05 0.1 -0.05 0.1 0.05

patch quad 1 2 8 -0.0915 0.0028 -0.0915 -0.0028 0.0915 -0.0028 0.0915 0.0028

patch quad 1 2 3 -0.1 0.05 -0.1 -0.05 -0.0915 -0.05 -0.0915 0.05

}

element nonlinearBeamColumn 1 1 3 10 1 1

element nonlinearBeamColumn 2 2 4 10 1 1

element nonlinearBeamColumn 3 3 4 10 1 1

pattern Plain 1 Linear {

load 3 10. 0. 0.

}

recorder Node -file node4disp.out -time -node 4 -dof 1 2 3 disp

recorder Node -file node1reac.out -time -node 1 -dof 1 2 3 reaction

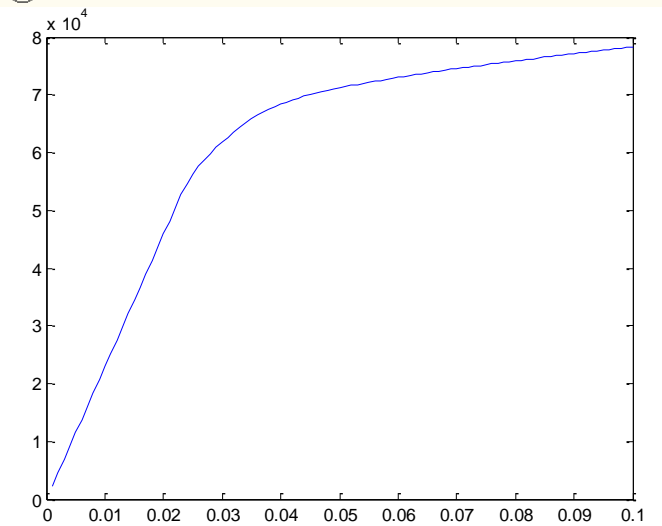
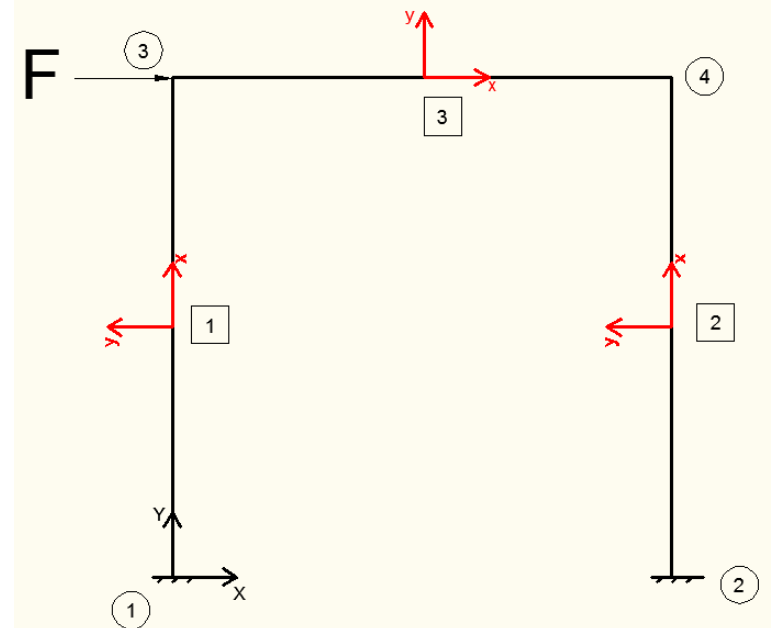
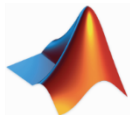
recorder Node -file node2reac.out -time -node 2 -dof 1 2 3 reaction

Example 3 (Analysis)

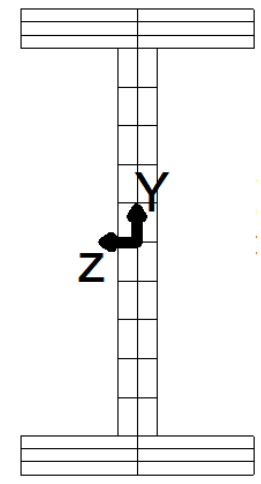
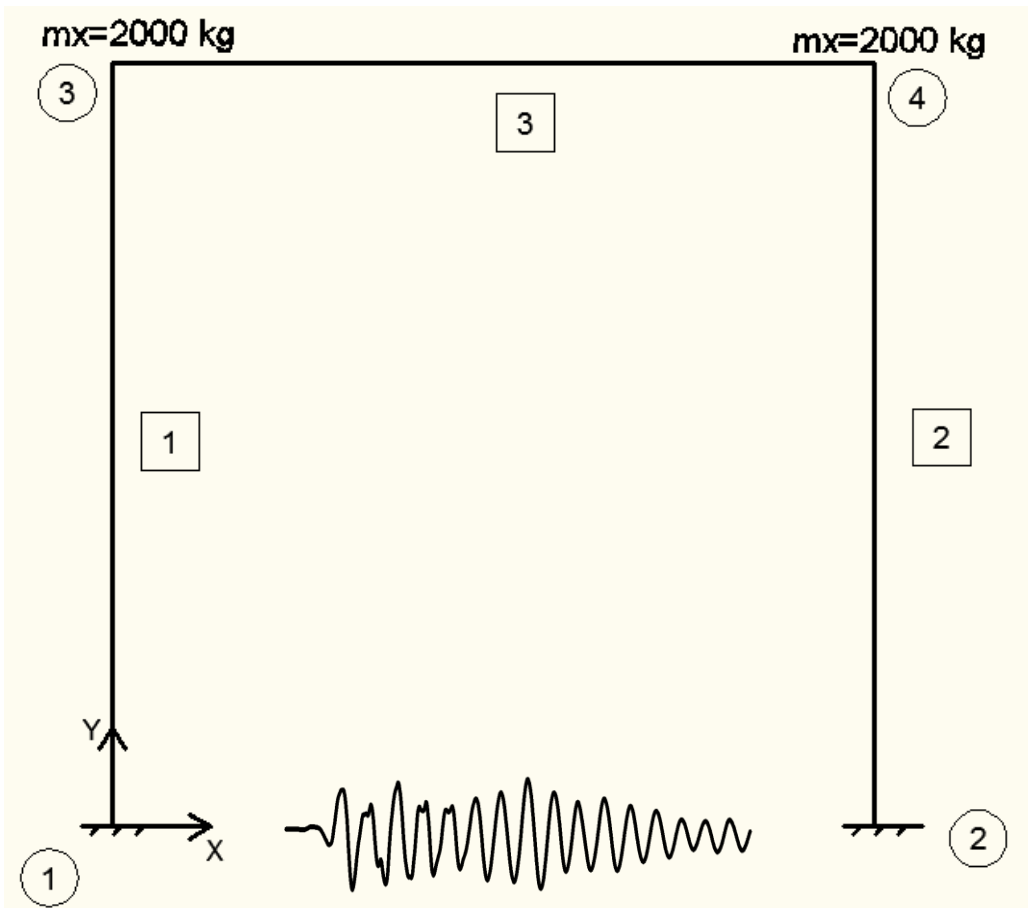
Static Nonlinear Analysis with Displacement Control

```
constraints Plain
numberer Plain
system BandGeneral
test NormDispIncr 1.e-8 6
algorithm ModifiedNewton
integrator DisplacementControl 4 1 0.001
analysis Static
analyze 100
loadConst -time 0.0
```

OpenSees



Example 4-1-NonLinear Earthquake-Without Damping



$b_f = 10 \text{ cm}$
 $d = 20 \text{ cm}$
 $t_f = 0.85 \text{ cm}$
 $t_w = 0.56 \text{ cm}$

Nonlinear Time History Analysis

Example 4-1-NonLinear Earthquake-Without Damping

- **Uniform Excitation Pattern command**

```
pattern UniformExcitation $patternTag $dir -accel (TimeSeriesType arguments) <-vel0 $ver0>
```

```
set accel "Series -dt 0.02 -filePath TabasLN(dt=0.02)PGA=0.4g.txt -factor [expr 9.81]"
```

```
pattern UniformExcitation 3 1 -accel $accel
```

Time History Nonlinear Analysis

```
set dt 0.02
```

```
constraints Plain
```

```
numberer Plain
```

```
system BandGeneral
```

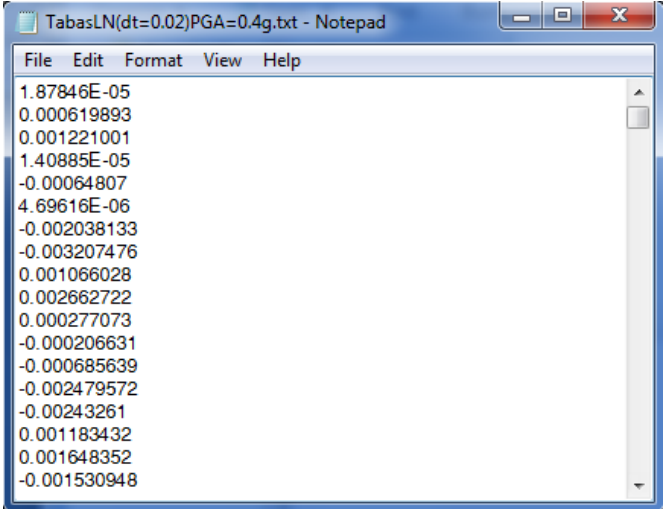
```
test NormDispIncr 1.0e-8 10
```

```
algorithm Newton
```

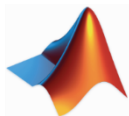
```
integrator Newmark 0.5 0.25
```

```
analysis Transient
```

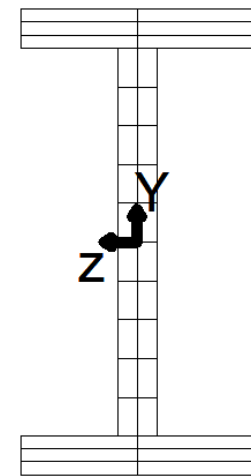
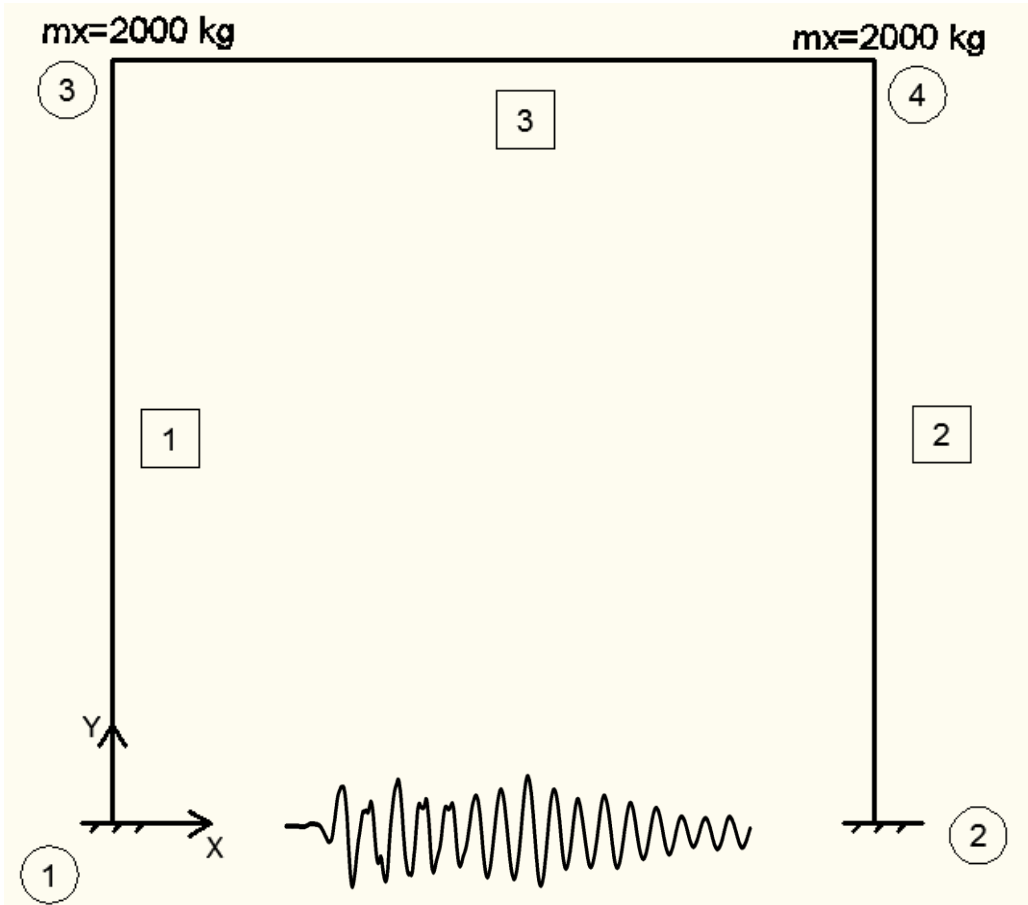
```
analyze [expr int(32.82/$dt)] $dt
```



```
TabasLN(dt=0.02)PGA=0.4g.txt - Notepad
File Edit Format View Help
1.87846E-05
0.000619893
0.001221001
1.40885E-05
-0.00064807
4.69616E-06
-0.002038133
-0.003207476
0.001066028
0.002662722
0.000277073
-0.000206631
-0.000685639
-0.002479572
-0.00243261
0.001183432
0.001648352
-0.001530948
```



Example 4-2-NonLinear Earthquake-With Damping



- $bf = 10 \text{ cm}$
- $d = 20 \text{ cm}$
- $tf = 0.85 \text{ cm}$
- $tw = 0.56 \text{ cm}$
- $\xi = 0.05$

Nonlinear Time History Analysis

Example 4-2-NonLinear Earthquake-With Damping

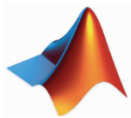
- rayleigh command

```
rayleigh $alphaM $betaK $betaKinit $betaKcomm
```

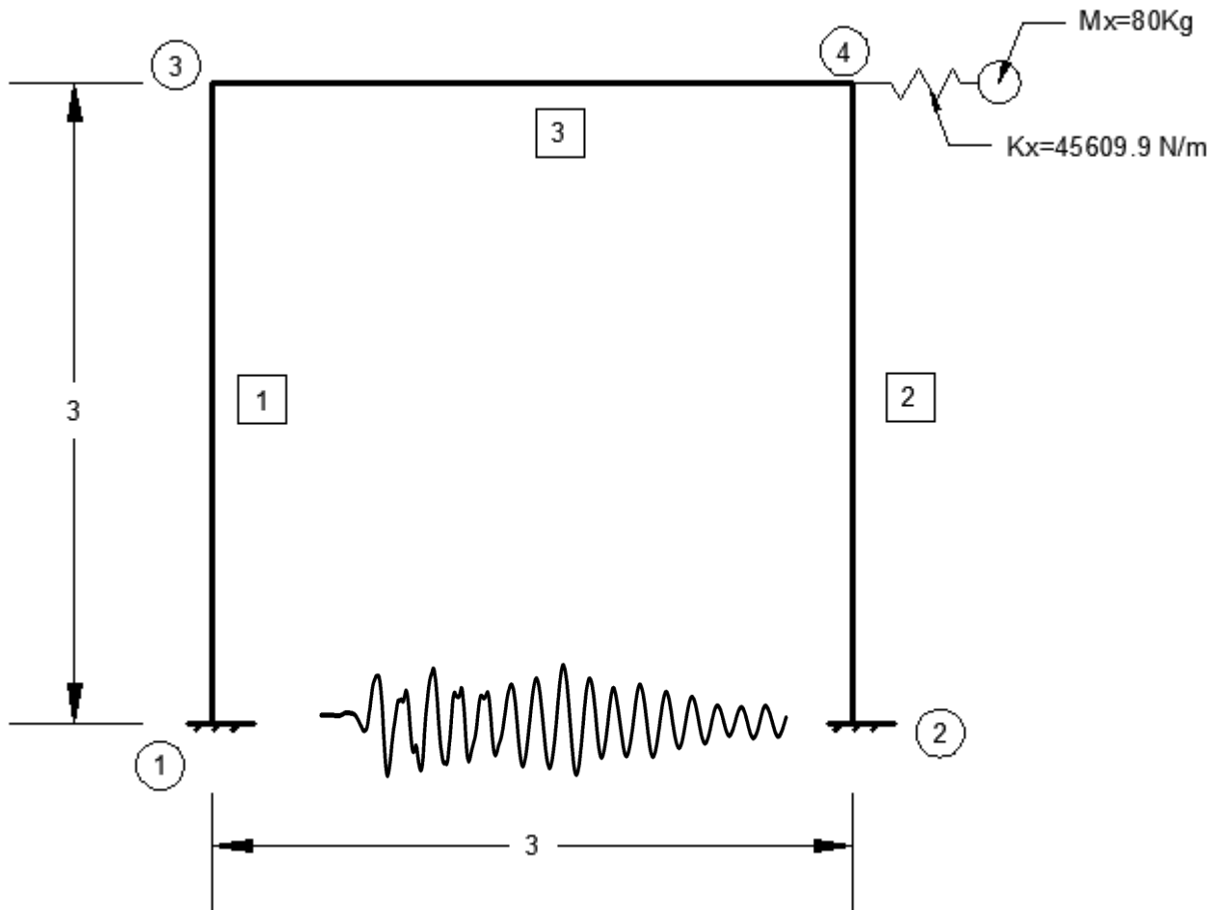
```
rayleigh 1.19 0 0 0.0021
```

$$\alpha = \frac{2\xi\omega_i\omega_j}{\omega_i + \omega_j}$$

$$\beta = \frac{2\xi}{\omega_i + \omega_j}$$



Example 4-4-NonLinear Earthquake-With Tuned Mass Damper



$$M_{tmd} = 80 \text{ Kg}$$

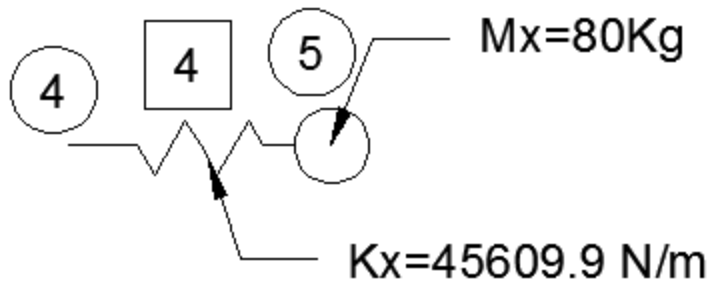
$$K_{tmd} = 45609.9 \frac{\text{N}}{\text{m}}$$

$$C_{tmd} = 0$$

$$C_{structure} = 0$$

Example 4-4-NonLinear Earthquake-With Tuned Mass Damper

How to model a simple Tuned Mass Damper:



$$M_{tmd} = 80 \text{ Kg}$$

$$K_{tmd} = 45609.9 \frac{\text{N}}{\text{m}}$$

$$C_{tmd} = 0$$

node 5 3. 3.

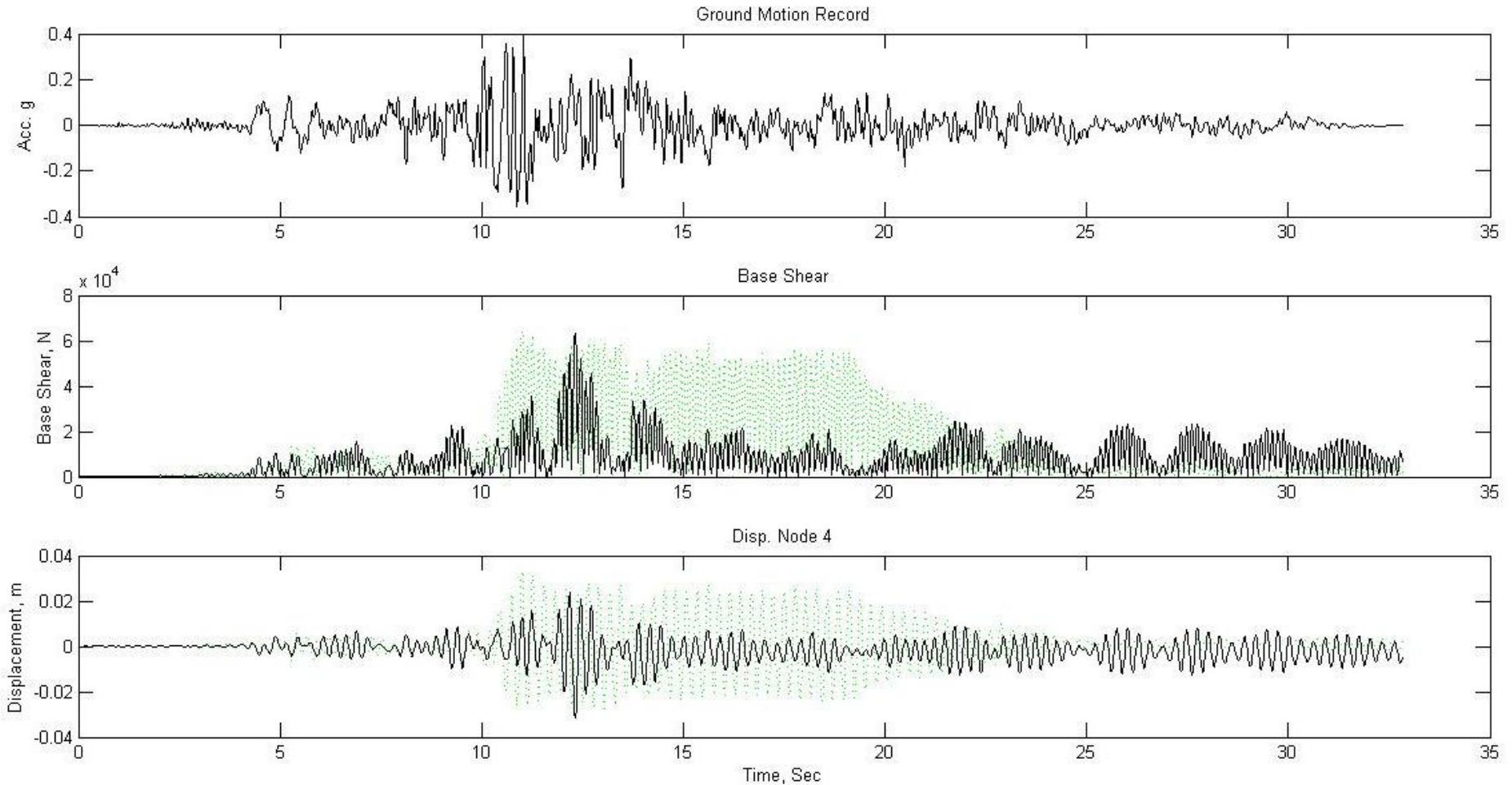
fix 5 0 1 1

mass 5 80. 0. 0.

uniaxialMaterial Elastic 2 45609.9

element zeroLength 4 4 5 -mat 2 -dir 1

Example 4-4-NonLinear Earthquake-With Tuned Mass Damper



Dotted Line: Uncontrolled

Bold Line: Controlled with TMD

Any Questions or Statements?

Earthquake Doesn't Kill People, Buildings Do!

Thank You.

Nov. 2012