

# OpenSees Resources

Silvia Mazzoni  
*University of California, Berkeley*

OpenSees User Workshop

14 August 2006



# OpenSees user resources

- <http://OpenSees.berkeley.edu/>
  - Both an executable version and the source code are publicly available
  - User Command Manual
  - Examples Manual
  - e-mail technical support
  - The OpenSees Community Forum
- Annual User Workshops



# http://OpenSees.berkeley.edu/

**OpenSees** Open System for Earthquake Engineering Simulation  
Pacific Earthquake Engineering Research Center

Quick Links

- [Main Page](#)
- [About](#)
- [Projects](#)
- [User Pages](#)
- [Developer Pages](#)
- [FAQ](#)
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**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 in 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](#)

**Register!**

For information about new releases we encourage you to register with us at the [OpenSees Registration Center](#).

**Need Support?**

If you need assistance or have any bugs to report, send an e-mail to [technical support](#)

**Latest News**

**January 31, 2005**  
Finally, the [Workshop Material](#) presented at the September workshop is available for download.

**Nov 30, 2004**  
A Version 1.6.1 [binary](#) is now available.

**Sept 1, 2004**

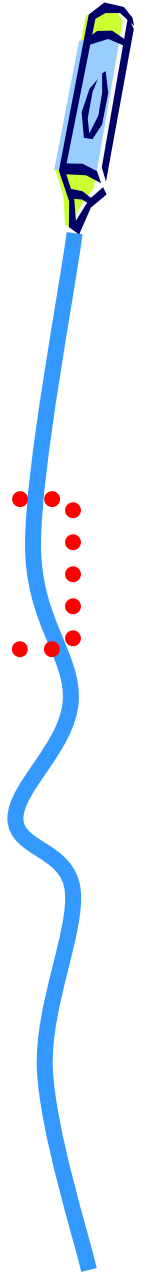
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# download documentation



**http://opensees.berkeley.edu/**

## OpenSees

Open System for Earthquake Engineering Simulation  
Pacific Earthquake Engineering Research Center

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**Latest News**

**August 25th, 2003**  
A [User's Workshop](#) was held August 21-22, 2003. The [Workshop Presentations](#) can be found here.

**May 15th, 2003**  
Version 1.5 [binaries](#) and [source code](#) distributions are now available.

# documentation

<http://opensees.berkeley.edu/OpenSees/user.html>

## OpenSees

Open System for Earthquake Engineering Simulation  
Pacific Earthquake Engineering Research Center

Quick Links

- [Main Page](#)
- [About](#)
- [Documentation](#)
- [Download](#)
- [Examples](#)
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- [Message Board](#)
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Welcome! This page contains some useful information for people who wish to use the OpenSees interpreter.

**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.

**Download**  
Download a precompiled binary from the latest build.

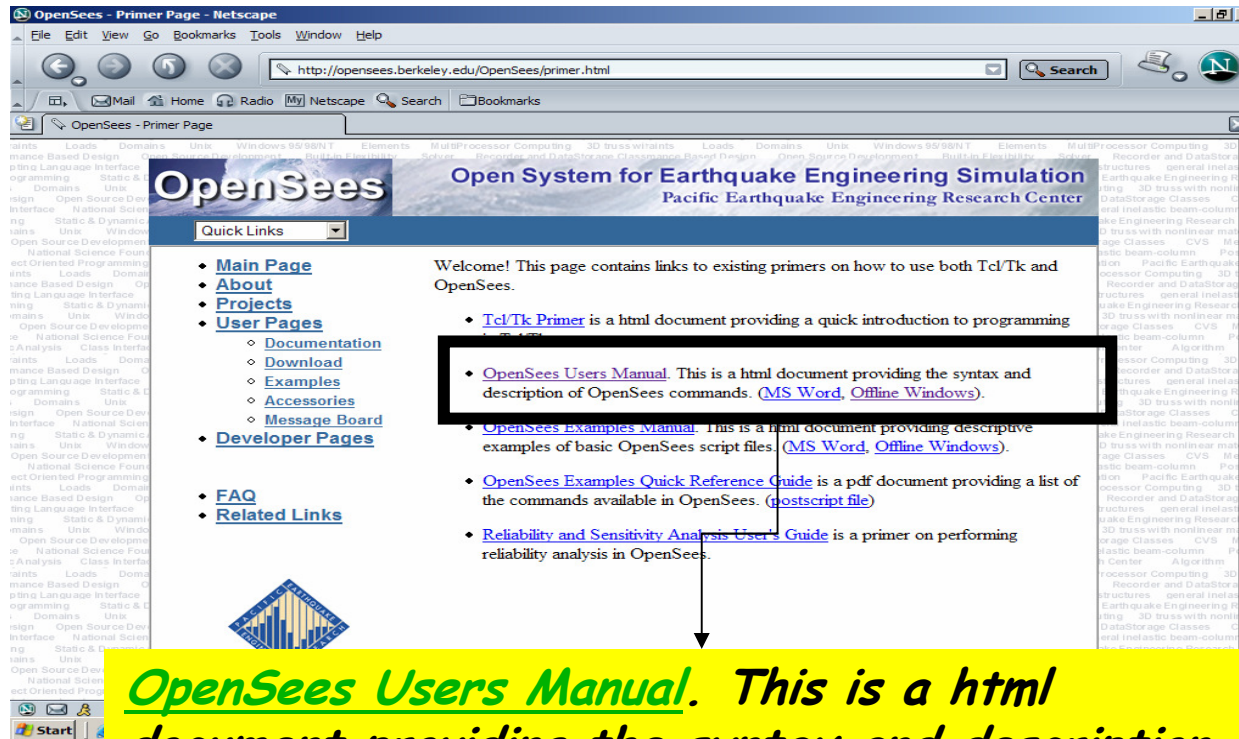
**Examples**  
Here are some simple and some not-so-simple examples to get you started.

**Accessories**  
Download accessory programs which are available for OpenSees.

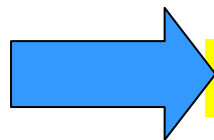
**Message Board**  
To talk to other users who may be able to assist you with problems leave a message on our users message board. We encourage all users to visit the message board often to see what others are working on and to assist others who may be having problems.

Pacific Earthquake Engineering Research

# download User Manual



***[OpenSees Users Manual](http://opensees.berkeley.edu/OpenSees/manuals/usermanual/)***. This is a html document providing the syntax and description of OpenSees commands. ([MS Word](#), [Offline Windows](#)).



***<http://opensees.berkeley.edu/OpenSees/manuals/usermanual/>***





# OpenSees User Manual

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

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



# 1. HTML on-line format

OpenSees User Manual version 2.0 - Netscape

http://peer.berkeley.edu/~silvia/OpenSees/manual/html/

OpenSees Open System for Earthquake Engineering Simulation Pacific Earthquake Engineering Research Center OpenSees

Contents

- title
- Introduction
- OpenSees
- Getting Started on OpenSees
- Getting Going (under development)
- Model-Building Objects
- Recorder Objects
- Analysis Objects
- Miscellaneous Commands
- How To....
- References
- Index

Open System for Earthquake Engineering Simulation User Manual

Software Authors: Frank McKenna, Gregory L. Fences, *et al.*

Manual Authors: Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fences, *et al.*

Pacific Earthquake Engineering Research Center

University of California, Berkeley

version x.

please send questions and comments about the manual to

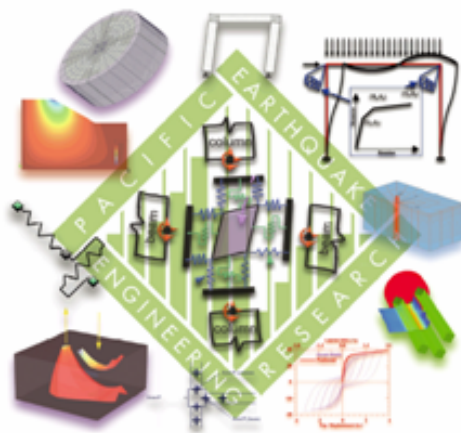
on-line HTML document, residing on OpenSees server. Always going to be the most current.

# 2. MS Word format -- PDF

downloadable and printable Word document in PDF format

Open System for Earthquake Engineering Simulation (OpenSees)

## OpenSees Command Language Manual



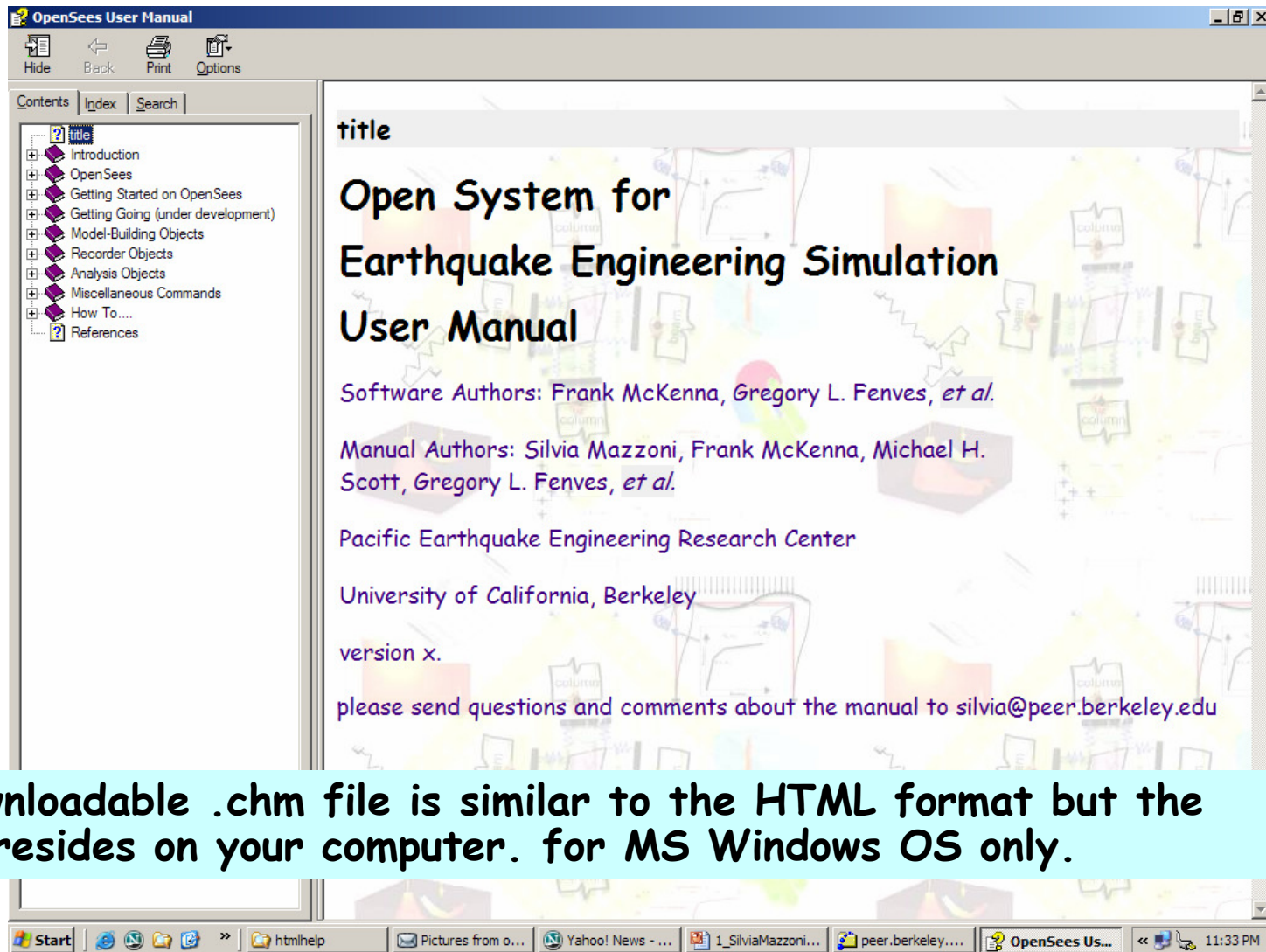
Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves,  
Boris Jeremic

Printed on 29 August 2004

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# 3 .chm file for MS Windows



the downloadable .chm file is similar to the HTML format but the file resides on your computer. for MS Windows OS only.



# Manual Chapters

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- OpenSees
- Model-Building Objects
- Recorder Objects
- Analysis Objects
- Miscellaneous Commands
- How To....
- Getting Started on OpenSees
- Getting Going (under development)
- References
- Index



# OpenSees

- OpenSees
  - ModelBuilder Object is responsible for building the following objects in the model and adding them to the domain
  - 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
  - Analysis Object is responsible for performing the analysis
  - Recorder Object monitors user-defined parameters in the model during the analysis



# 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



# Miscellaneous Commands

- print Command
- reset Command
- wipe Command
- wipeAnalysis Command
- loadConst Command
- getTime Command
- nodeDisp Command
- video Command



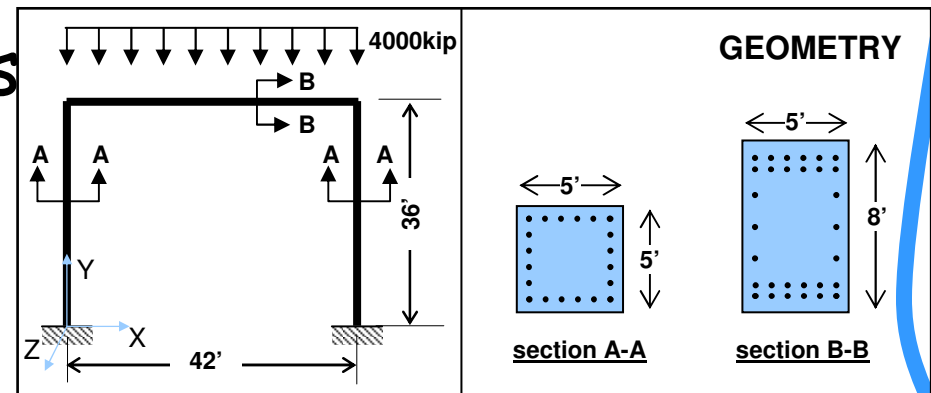
# How To....

- ...Run OpenSees
- ...Define Units & Constants
- ...Generate Matlab Commands
- ...Define Tcl Procedure
- ...Read External files
- Building The Model
- Defining Output
- Gravity Loads
- Static Analysis
- Dynamic Analysis
- ...Combine Input-File Components
- ...Run Parameter Study
- ...Run Moment-Curvature Analysis on Fiber Section
- ...Determine Natural Period & Frequency



# Getting Started on OpenSees

- Download OpenSees
- Run OpenSees
- Problem Definition
- Model Builder
- Nodes & Elements
- Elements & Element Connectivity
- Gravity Loads
- Recorders
- Lateral Loads
  - 1-Step Lateral Load
  - Incremental Static Pushover
  - Dynamic





# Getting Going (under development)



- *Problem Definition*
- *Model Building*
  - *Variables and Units*
  - *Getting Going -- Model Builder*
  - *Nodal Coordinates & Masses, Boundary Conditions*
  - *Materials*
  - *Element Cross Section*
  - *Elements and Element Connectivity*
  - *Gravity and other Constant Loads*
  - *Summary of Defining Structural Model*
  - *Error-Checking Tip for Model Building*
- *Recorders for Output*
- *Analysis Components*

<b>Column length, Lcol:</b>	<b>36 ft</b>
<b>Column diameter, Dcol:</b>	<b>6 ft</b>
<b>Cover thickness, cover:</b>	<b>6 inch</b>
<b>Longitudinal-steel ratio, rhoL:</b>	<b>1.5%</b>
<b>Superstructure weight, Weight:</b>	<b>3,000 lb</b>
<b>Nominal Concrete Compressive Strength, Fc:</b>	<b>5,500 psi</b>
<b>Nominal Steel Yield Strength: Fy:</b>	<b>60 ksi</b>

**LOAD CASE 1: DISPLACEMENT-CONTROLLED STATIC PUSHOVER**  
A lateral LOAD of increasing magnitude is applied at node 2 until a desired maximum lateral displacement is reached. This load is applied in predefined increments. This is a static analysis.

**LOAD CASE 2: DISPLACEMENT-CONTROLLED REVERSED CYCLIC LOADING**  
A lateral LOAD is applied at node 2 such that a predefined displacement history is achieved at node 2. This load is applied in predefined increments. This, too, is a static analysis. The displacement history is shown in the figure:

**LOAD CASE 3: DYNAMIC GROUND-MOTION-INPUT TRANSIENT ANALYSIS**  
A uniform acceleration history is imposed at all nodes constrained in the horizontal x-direction (node 1). The acceleration history is predefined. This is a transient (dynamic) analysis. A schematic of the acceleration history is shown in the figure:

# note

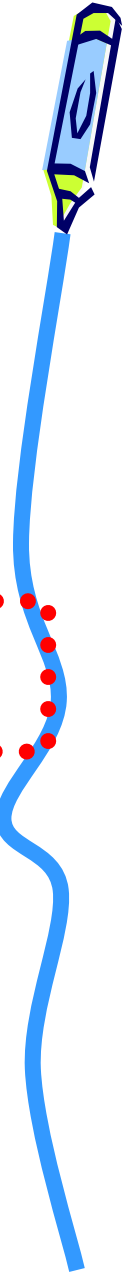
- you can also use the index tab to search specific commands



The screenshot shows a Netscape browser window with the URL <http://peer.berkeley.edu/~silvia/OpenSees/manual/html/>. The browser's address bar and menu bar are visible. The main content area displays the 'OpenSees User Manual' page. The 'Index' tab is highlighted with a red circle and an arrow. The main content area shows a table of contents with the title 'Open System for Earthquake Engineering Simulation User Manual' and authors 'Software Authors: Frank McKenna, Gregory L. Fenves, et al.' and 'Manual Authors: Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves, et al.' The table of contents includes sections like 'Build Model and Define Nodes', 'Define Static Pushover Analysis', 'Define Dynamic Ground-Motion Analysis', etc. The 'Index' tab is highlighted with a red circle and an arrow. The main content area shows a table of contents with the title 'Open System for Earthquake Engineering Simulation User Manual' and authors 'Software Authors: Frank McKenna, Gregory L. Fenves, et al.' and 'Manual Authors: Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves, et al.' The table of contents includes sections like 'Build Model and Define Nodes', 'Define Static Pushover Analysis', 'Define Dynamic Ground-Motion Analysis', etc. The 'Index' tab is highlighted with a red circle and an arrow. The main content area shows a table of contents with the title 'Open System for Earthquake Engineering Simulation User Manual' and authors 'Software Authors: Frank McKenna, Gregory L. Fenves, et al.' and 'Manual Authors: Silvia Mazzoni, Frank McKenna, Michael H. Scott, Gregory L. Fenves, et al.'

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# OpenSees examples manual

**OpenSees** Open System for Earthquake Engineering Simulation  
Pacific Earthquake Engineering Research Center **OpenSees**

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- EXAMPLE 2 - Moment-Curvature Analysis
- EXAMPLE 3 - Portal Frame Example
- EXAMPLE 4 - Multibay Two Story Frame
- EXAMPLE 5 - Three-Dimensional Rigid Frame
- EXAMPLE 6 - Simply Supported Beam
- EXAMPLE 7 - Dynamic Shell Analysis
- EXAMPLE 8 - Cantilever Beam
- Reinforced Concrete Plane Frame Example
- Steel Plane Frame Examples
- Rigid Floor Diaphragm Example
- Zero Length Element Examples
- Section Analysis Example
- Quad Examples
- Brick Examples
- Reliability Examples
- Script Utilities Library
- Index

## EXAMPLE 1 - Truss Example

The first example is a simple truss structure. The figure shows that the truss in OpenSees can resemble typical finite element programs with elements, materials, elements, loads and constraints. The example also illustrates how analysis objects are built from component objects.

Example1.1.tcl

**Model**

The model consists of four nodes, three truss elements, a single load pattern with a nodal load acting at node 4, and constraints at the three support nodes. Since the truss elements have the same elastic material, a single Elastic material object is created.

$E=3000 \text{ ksi}$   
 $A_1=10 \text{ in}^2$   
 $A_{2,3}=5 \text{ in}^2$



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trying to redirect to:



# OpenSees Community Forum



## The OpenSees Community

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[Profile](#) [You have 5 new messages](#) [Log out \[ silvia \]](#)

You last visited on Wed Aug 09, 2006 10:03 am  
The time now is Wed Aug 09, 2006 9:01 pm  
**The OpenSees Community Forum Index**

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Forum	Topics	Posts	Last Post
<b>OpenSees</b>			
<b>OpenSees.exe Users</b> Forum for OpenSees users to post questions, comments, etc. on the use of the OpenSees interpreter, OpenSees.exe Moderator <a href="#">silvia</a>	670	2312	Wed Aug 09, 2006 9:45 am <a href="#">silvia</a> →
<b>OpenSees Development</b> OpenSees development, the code, the manual, the website, and other miscellaneous general comments Moderator <a href="#">silvia</a>	56	147	Sun Aug 06, 2006 7:14 am <a href="#">W4</a> →
<b>Framework</b> For developers writing C++, Fortran, Java, code who have questions or comments to make. Moderator <a href="#">silvia</a>	94	307	Wed Aug 02, 2006 6:52 pm <a href="#">motalaat</a> →
<b>Useful Scripts.</b> 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 <a href="#">silvia</a>	10	24	Thu Jul 06, 2006 12:55 pm <a href="#">silvia</a> →
<b>Future Directions</b> A forum dedicated to the future direction of OpenSees, i.e. what would you like, what do you need. Moderator <a href="#">silvia</a>	21	70	Wed Aug 09, 2006 9:47 am <a href="#">silvia</a> →

<http://opensees.berkeley.edu/community/index.php>

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All times are GMT - 8 Hours

### Who is Online



Our users have posted a total of **2870** articles  
We have **2437** registered users

The newest registered user is [HeroCat](#)



# five forum categories



Forum		Topics	Posts	Last Post
<b>OpenSees</b>				
	<b>OpenSees.exe Users</b> Forum for OpenSees users to post questions, comments, etc. on the use of the OpenSees interpreter, OpenSees.exe Moderator <a href="#">silvia</a>	670	2312	Wed Aug 09, 2006 9:45 am <a href="#">silvia</a> →
	<b>Documentation</b> For posts concerning the documentation, errors, omissions, general comments, etc. Moderator <a href="#">silvia</a>	56	157	Sun Aug 06, 2006 7:14 am <a href="#">silvia</a> →
	<b>Framework</b> For developers writing C++, Fortran, Java, code who have questions or comments to make. Moderator <a href="#">silvia</a>	94	307	Wed Aug 02, 2006 6:52 pm <a href="#">motalaat</a> →
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# very busy message board



## OpenSees.exe Users

Moderator: [silvia](#)

Users browsing this forum: [silvia](#)

Goto page [1](#), [2](#), [3](#) ... [12](#), [13](#), [14](#) [Next](#)



The OpenSees Community Forum Index -> OpenSees.exe Users

[Mark all topics read](#)

Topics	Replies	Author	Views	Last Post
<a href="#">model buckling of bracing</a>	1	<a href="#">saeedmov</a>	16	Wed Aug 09, 2006 9:45 am <a href="#">silvia</a> →
<a href="#">additional nodes</a>	5	<a href="#">Fakhraddin Ghahremani</a>	50	Wed Aug 09, 2006 9:43 am <a href="#">silvia</a> →
<a href="#">compiling question</a>	8	<a href="#">ahmetalperparker</a>	147	Wed Aug 09, 2006 3:11 am <a href="#">ahmetalperparker</a> →
<a href="#">Convergance Problem!</a>	2	<a href="#">azari</a>	54	Tue Aug 08, 2006 6:04 am <a href="#">QI</a> →
<a href="#">Periods and modes for 3 story frame</a>	0	<a href="#">HBP</a>	21	Mon Aug 07, 2006 5:38 pm <a href="#">HBP</a> →
<a href="#">1 bay 2 story steel frame</a>	2	<a href="#">choi se woon</a>	45	Mon Aug 07, 2006 4:20 pm <a href="#">choi se woon</a> →
<a href="#">The meaning of "integration point"</a>	1	<a href="#">wujianqiu</a>	36	Sat Aug 05, 2006 8:33 am <a href="#">silvia</a> →
<a href="#">Error having rigidLinks and rigidDiaphragms in the same model</a>	1	<a href="#">Aris</a>	29	Fri Aug 04, 2006 9:42 am <a href="#">fmk</a> →
<a href="#">recorders for quad elements</a>	1	<a href="#">endryus</a>	29	Thu Aug 03, 2006 11:57 am <a href="#">fmk</a> →
<a href="#">parallel processing</a>	3	<a href="#">ahmetalperparker</a>	61	Thu Aug 03, 2006 9:29 am <a href="#">ahmetalperparker</a> →
<a href="#">problems with u-p-U &amp; u-p elements</a>	1	<a href="#">Shahir</a>	76	Wed Aug 02, 2006 2:38 pm <a href="#">Boris</a> →

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Annual workshop  
announcement

# OpenSees Days 2006

Open System for Earthquake Engineering Simulation

PEER and NEESit announce:

**The OpenSees User Workshop**.....Monday, August 14, 2006

**The OpenSees Developer Workshop**.....Tuesday, August 15, 2006

**The OpenSees Developer Symposium**.....Wednesday, August 16, 2006

## ABOUT THE EVENT

**The OpenSees User Workshop** – The annual one-day workshop on how to use OpenSees. The workshop is intended for both beginning and intermediate users.

**The OpenSees Developer Workshop** – A one-day workshop for beginning and intermediate developers. The workshop will focus on how to introduce a new material and a new element into the OpenSees framework with hands-on exercises.

**The OpenSees Developer Symposium** – A one-day symposium with presentations and discussions of on-going development of the OpenSees framework. Presentations will be made by the OpenSees team as well as by current developers of OpenSees.

Students, researchers, and practitioners are welcome to attend any of the days. Registration is free, lunch is provided, but space is limited. **Registration closes on August 1, 2006**

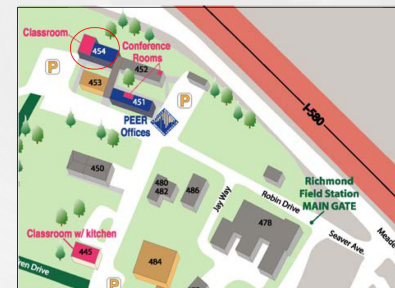
## VENUE / LOCATION

PEER Classroom, Building 454

**Richmond Field Station -  
University of California, Berkeley**  
1301 South 46th Street  
Richmond, California 94804-4698

For a map and driving directions, please visit:

<http://peer.berkeley.edu/PEERCenter/Contact/maps.html>



For more information and to register on-line visit:

<http://opensees.berkeley.edu>



# user workshop agenda

**Welcome and Introduction to OpenSees & NEESit Simulation**

**Getting Started with OpenSees**

**Introduction to the OpenSees User Resources**

**Structural Models I (Parameter Definition, Nodes, Constraints, Materials, Sections & Elements, Block & Region, Geometric Transformation)**

**Structural Models II (Recorders, Loads)**

**Introduction to Analysis Commands (System, Integrator, Algorithm, Numberer Analyze)**

**When Things Go Wrong: Modifying the Script in the Event of Non-Convergence**

**Geotechnical and Solids in OpenSees**

**Structural Example – Reinforced-Concrete Frame: Building the Model**

**Structural Example – Reinforced-Concrete Frame: Static, Cyclic and Dynamic Analyses, Multiple-Support Excitation**


**Parameter Studies Using OpenSees**

**Geotechnical and Solids Examples**

**OpenSees Navigator**

**OpenSees & NEESit**

**Questions and Wrap-up Discussion**

- 
- Gregory L. Fenves
  - Frank McKenna
  - Silvia Mazzoni
  - Silvia Mazzoni
  - Silvia Mazzoni
  - Frank McKenna
  - Frank McKenna
  - Boris Jeremic
  - Silvia Mazzoni
  - Frank McKenna
  - Silvia Mazzoni
  - Boris Jeremic
  - Andreas Shellenberg
  - Holly Hervey, NEESit
  - Gregory Fenves

# developer workshop agenda

- Installed-software check (make sure software is installed properly)
- Welcome to OpenSees Developer's Workshop, Introduction to object-oriented programming
- Introduction to C++ programming
- Introduction to OpenSees software architecture:
  - Model builder, recorders, domain & analysis
- Uniaxial material interface
- Implementation exercise of a uniaxial material
  - Participants will develop new material, add material into OpenSees and test it using a tk script
- Review of Implementation exercise for uniaxial material
- Domain classes & how they interact
- Element interface
- Analysis classes & how they interact.
  - Trace through what happens when 'analyze' is invoked in the interpreter. When element methods, 'update,' 'commit,' 'getTangent,' and 'getResistingForce' are invoked
- Implementation of a new element - set up exercise as homework
  - Participants will develop new element and add element into OpenSees





# developer symposium agenda

**Introduction and Symposium Goals**

**Features and Capabilities of version 1.7.2; Current Status of OpenSees; Development Process**

**Parameter Updating**

**Cyclic uniaxial material model for reinforcing steel bars**

**Modeling Instability of Beam-Column Elements**

**Performance Modeling Strategies for Modern Reinforced Concrete Bridge Columns**

**Development of Modeling Tools**

**Collapse Simulation of RC Frame Buildings**

**SFSI Implementations in OpenSees**

**Frictional 3D Beam-to-Solid Contact Formulation for OpenSees**

**Advanced Geotechnical Capabilities of OpenSees**

**OpenSees, VEES, and XML: Visualization and Model Archiving**

**A User-Friendly Finite-Element Pile Analysis Interface**

**OpenSees & Hybrid Simulation**

**Wrap-Up Discussion and Closing Remarks**

Gregory L. Fenves, UC Berkeley

Frank McKenna, UC Berkeley

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Jon Mohle, UC Davis

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Michel Berry, U Washington

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Peter Mackenzie-Helnwein, U Washington

Boris Jeremic, UC Davis

Alisa Neeman, UC Santa Cruz

Jinchi Lu (UC San Diego) & Zhaohui Yang (URS Corporation)

Andreas Schellenberg, UC Berkeley

Gregory L. Fenves



# Questions, or statements!

The OpenSees Community Forum:

<http://opensees.berkeley.edu/community/index.php>

which can be accessed from:

<http://opensees.berkeley.edu>

