OpenSees Days 2008 Summary Report

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University of California Berkeley

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Introduction

OpenSees is a software framework for structural and geotechnical simulation applications in earthquake engineering using finite element methods. The framework has been developed as an open-source, object oriented software framework. These two characteristics of OpenSees have been embraced by the research community, initially by PEER and subsequently by NEES, as they allow direct implementation of state-of-the-art simulation technology by individuals other than the core OpenSees Development Team. To support community use and development the first OpenSees User Workshop was held in 2001.

The primary objective of the OpenSees workshops is to introduce OpenSees to new users, research academics as well as industry practitioners, via the OpenSees User Workshop. The OpenSees Developer Workshop is offered every other year (the latest one was held in 2007). The objective of the Developer workshop is to instruct developers on how to introduce a new material or element within the OpenSees object-oriented framework. The OpenSees Modeling workshop is offered in the alternating years. The objective of the Modeling Workshop is to present more advanced applications of OpenSees by users and developers outside of the core OpenSees Development Team at UC Berkeley. Based on a qualitative assessment of the needs of current OpenSees users, a 2-hour lecture on nonlinear structural modeling was introduced at the 2008 OpenSees Modeling workshop. This lecture was received with a lot of enthusiasm.

OpenSees Days are supported by PEER & NEES/NEESit. All workshop presentations can be downloaded from the OpenSees Web site, specifically:
http://opensees.berkeley.edu/workshop/OpenSeesDays2008/OpenSeesDays2008.html

Workshop Overview

PEER and NEESit hosted OpenSees Days 2008 at the University of California, Berkeley Richmond Field Station (RFS) in Richmond, CA in September 2008:

- **Monday, September 8: OpenSees User Workshop**: The annual one-day workshop on how to use OpenSees. This workshop is intended for beginning and intermediate users. This workshop introduces users to the Tcl scripting language and basic modeling and analysis techniques using OpenSees
- **Tuesday, September 9: OpenSees Modeling Workshop**: A one-day workshop with presentations by current OpenSees users on various modeling techniques. Models discussed include reinforced concrete, steel, soils, and soil-structure interaction.

Users and developers at all levels were encouraged to attend the workshops. Students, researchers, and practitioners were invited to attend any of the days. Registration was free and lunch was provided.

The User Workshop started with an introduction to OpenSees and NEESit simulation, as well as an overview of available user resources. The core of the workshop was a detailed

overview of the structural and geotechnical modeling commands as well as the various analysis commands. Because the audience was evenly distributed between new and intermediate users there numerous questions raised during this session that covered a diverse range. The last part of the workshop focused on individual examples for both structural and geotechnical implementations. The geotechnical component of the User Workshop was presented by Professor Pedro Arduino of University of Washington.

The first session of the Modeling Workshop consisted of a two-hour lecture on nonlinear modeling and analysis, given by Professor Filip Filippou of UC Berkeley. This lecture was followed by an overview of the parallel version of OpenSees, given by Frank McKenna. During the lunch break a number of engineers from the California Department of Transportation (CalTrans) requested to have the presentation on bridge modeling moved forward in the agenda. Therefore, the two comprehensive presentations on geotechnical applications of OpenSees were given in the first session after lunch. The second session in the afternoon consisted of three presentations on structural-modeling applications.

A detailed agenda (original) and a list of speaker are given in Appendix A.

Metrics

A total of 125 people initially registered for the workshop. Registration was done via the EventBrite web site (http://www.eventbrite.com), which allowed an automated collection of registration data. Use of this site is free if event registration is free.

A total of 81 individuals attended: 69 on Day 1, 70 on Day 2. These numbers are similar to those of 2007. Of the total number of participants, 7 indicated that they are associated with a NEES-R project (9%), 20 with NEES (25%) and 13 with PEER (16%).

While the data was not collected in 2007, there was a noticeable increase in the presence of international participants (19%), as well as practicing engineers (30%) – there were 11 engineers from the California Department of Transportation (CalTrans). The distribution of US participants was diverse and spread across the US – a realistic representation of the distribution of numerical-simulation efforts in earthquake engineering. A total of 9 students, researchers and professors came from Myongji University in Korea, as well as 3 researchers and students came from Sherbrooke University in Canada.

More specific data is given in Appendix B.

Survey Results

A survey evaluation was conducted following the workshop, on-line. 38 of the 81 individuals participated in the voluntary survey. The rating of the workshop overall and the individual workshops was quite high: 8.3/10 for the overall and 3.7/5 and 3.6/5 for the User and Modeling workshops, respectively. Eleven aspects of the workshop were surveyed with an average rating of 4.3/5. Based on the comments associated with these ratings, it is evident that it is difficult to satisfy the diverse interests of the participants and their varying levels of knowledge.

When asked what they liked best about the workshop, a significant number of respondents liked the overall organization of the workshop (34.2%). A large number of respondents expressed an appreciation of the Nonlinear Modeling & Analysis presentation given by Professor Filippou (23.7%). Respondents also appreciated the introduction to the basics of OpenSees and the Tcl scripting language (21.1%) and the opportunity to interact with the OpenSees users and developers (10.5%).

When asked to give recommendations for future OpenSees workshops, the most popular recommendation was to have more hands-on exercises (15.8%). Additional recommendations were for more emphasis and time on basics, better documentation and separating geotechnical and structural days (7.9% each).

Detailed survey results are given in Appendix C.

Recommendations for Future OpenSees Days

Based on both qualitative and quantitative analyses of OpenSees Days 2008, workshop participants would like to have a more comprehensive and detailed set of workshops. The diverse OpenSees community would like to see more hand-on workshops with more attention paid to basics, as well as more presentations on practical applications.

If time were not a limiting factor, both for preparation and delivery, OpenSees Days should be made up of 5 days:

- Day 1: OpenSees User Workshop, Part I: The annual one-day introductory workshop.
- Day 2: OpenSees User Workshop, Part II: An advanced-modeling session and a hands-on session. To include Professor Filippou's lecture on Nonlinear Modeling and Analysis.
- Day 3: OpenSees Developer Workshop: The Developer workshop as it has been done in the past, with an introductory session and a hands-on session.
- Day 4: OpenSees Applications in Structural Systems: Presentations by the OpenSees developers and users on structural applications.
- Day 5: OpenSees Applications in Geotechnical Systems: Presentations by the OpenSees developers and users on geotechnical applications.

The solution to providing a comprehensive set of OpenSees Days would be to host the User Workshops annually, and to alternate years between the Developer Workshop and the Applications workshops. This is the current plan of execution; more extensive agenda will be developed and implemented.

OpenSees Days has also been an opportunity for the core OpenSees Development team to interact directly with users and developers. This enables the team to manage its main objectives following a continuous evolution pattern.

Images of the workshop are given in Appendix D. The registration page is shown in Appendix E.

List of Appendices

Appendix A
Original Agenda

OpenSees User Workshop

Monday, 8 September 2008

9:00am – 5:00pm

9:00 – 9:15	Welcome and Introduction to OpenSees & NEESit Simulation	– Gregory L. Fenves
9:15 – 9:30	NEESit Services	– *Steve McCabe*
9:30 – 10:15	Getting Started with OpenSees	– *Frank McKenna*
10:15 -- 10:30	**Break**	
10:30 – 11:00	Introduction to the OpenSees User Resources	– *Silvia Mazzoni*
11:00 – 12:00	Structural Models (Parameter Definition, Nodes, Constraints, Materials, Sections & Elements, Geometric Transformation, Recorders, Loads)	– *Silvia Mazzoni*
12:00 – 1:00	**Lunch**	
1:00 – 1:45	Introduction to Analysis Commands (System, Integrator, Algorithm, Numberer Analyze)	-- *Frank McKenna*
1:45 – 2:15	When Things Go Wrong: Modifying the Script in the Event of Non-Convergence	-- *Frank McKenna*
2:15 – 2:45	Geotechnical and Solids in OpenSees	– Pedro Arduino
2:45 – 3:30	Structural Example –Building the Model	-- *Silvia Mazzoni*
3:30 – 3:45	**Break**	
3:45 – 4:15	Structural Example –Static, Cyclic and Dynamic Analyses, Multiple-Support Excitation	-- *Frank McKenna*
4:15 – 4:45	Geotechnical and Solids Examples	– Pedro Arduino
4:45 – 5:00	Questions and Wrap-up Discussion	

OpenSees Modeling Workshop

Tuesday, 9 September 2008

9:00am – 5:00pm

9:00 – 9:15 Welcome and Introduction -- Silvia Mazzoni, UC Berkeley

Session 1. Modeling & Analysis

9:15 – 10:15 Nonlinear Modeling & Analysis -- Prof. Filip Filippou, UC Berkeley

10:15 -- 10:20 Break

10:20 – 11:20 Nonlinear Modeling & Analysis -- Prof. Filip Filippou, UC Berkeley

11:20 -- 11:30 Break

Session 2. OpenSees Applications

11:30 – 12:30 Parallel OpenSees -- Frank McKenna, UC Berkeley

12:30 – 1:30 Lunch

1:30 – 2:00 Advanced Modeling Techniques in OpenSees -- Silvia Mazzoni, UC Berkeley

Session 3. Structural Modeling & Analysis

2:00 – 2:20 Numerical Simulation of Bridge Model -- Matthew Dryden, UC Berkeley

2:20 – 2:40 Numerical Simulation of Building Model -- Colleen McQuoid, UC Berkeley

2:40 – 3:00 Structural Example – Performance-Based Seismic Evaluation of Cantilevered Reinforced-Concrete Structure -- Sigmund Freeman, Marie Verdoux and Mahmoud Hachem, WJE

3:00 – 3:15 Break

Session 4. Geotechnical Modeling & Analysis

3:15 – 3:45 Lateral Spreading Models -- Prof. Pedro Arduino, U of Washington

3:45 – 4:30 PEER Testbed: Nonlinear Soil-Foundation-Structure Interaction Transverse and Longitudinal Response -- Prof. Ahmed Elgamal, UC San Diego

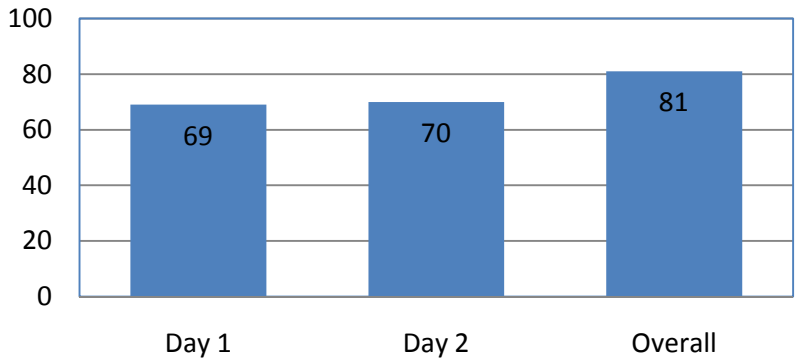
4:30 – 5:00 Discussion & Closing

List of Speakers

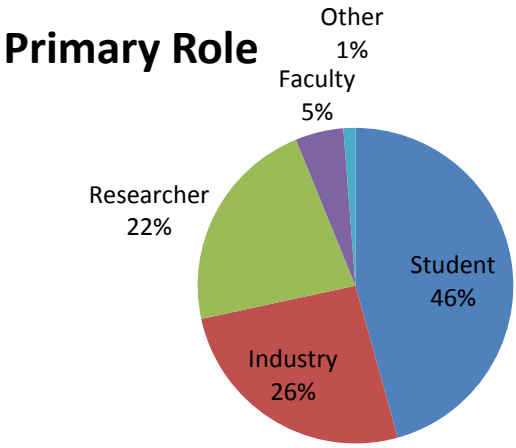
Gregory L. Fenves	UC Berkeley	fenves@berkeley.edu
Frank McKenna	UC Berkeley	fmckenna@ce.berkeley.edu
Silvia Mazzoni	UC Berkeley	mazzoni@berkeley.edu
Pedro Arduino	University of Washington	parduino@u.washington.edu
Filip Filippou	UC Berkeley	filippou@ce.berkeley.edu
Sigmund Freeman	WJE	SFreeman@wje.com
Colleen McQuoid	UC Berkeley	cmcquoid78@yahoo.com
Matthew Dryden	UC Berkeley	dryden@berkeley.edu
Ahmed Elgamal	UC San Diego	aelgamal@soe.ucsd.edu
Steve McCabe	NEES	Steve.McCabe@nees.org

Appendix B
Participant Metrics

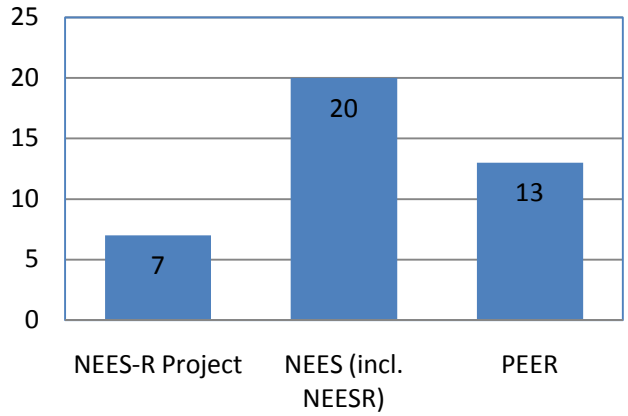
Attendance	
Day 1	69
Day 2	70
Overall	81



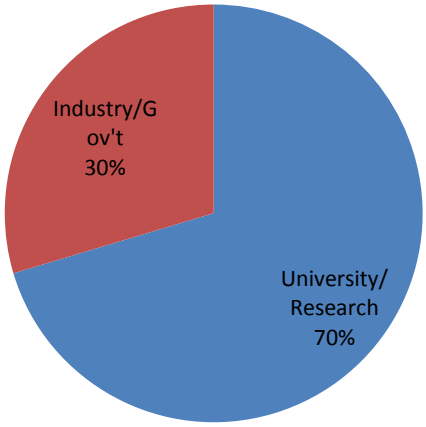
Primary Role	
Student	37
Industry	21
Researcher	18
Faculty	4
Other	1



NEES-R, NEES & PEER	
NEES-R Project	7
NEES (incl. NEESR)	20
PEER	13



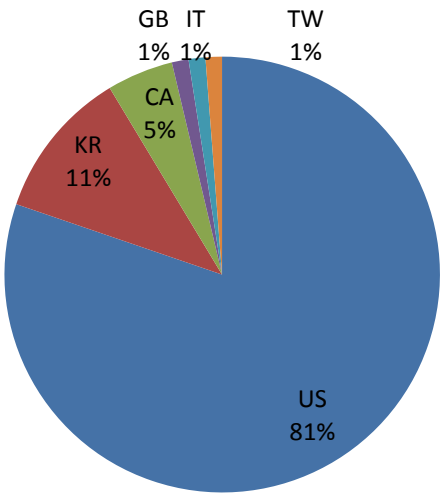
Affiliation	
University/Research	57
Industry/Gov't	24



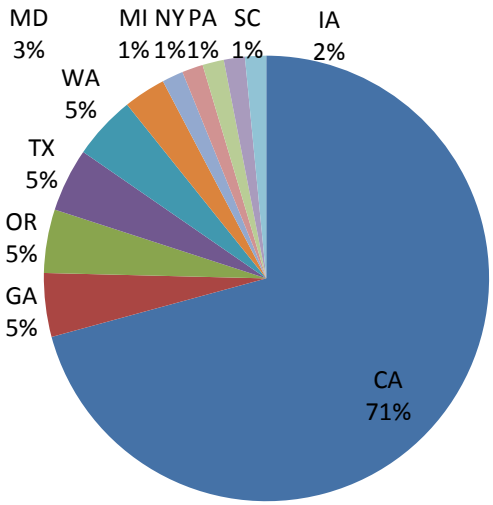
University	
UC Berkeley	17
Myong-Ji U	9
Georgia Tech	3
U of Washington	3
U. de Sherbrooke	3
Rice U	2
U of Maryland, College Park	2
UC Irvine	2
UC San Diego	2
Caltech	1
Clemson U	1
Iowa State U	1
McGill U	1
NCREE	1
Oregon State U	1
Portland State U	1
The U of Texas at Austin	1
U of Basilicata, Potenza, Italy	1
U of Michigan	1
U of Pittsburgh	1
UC Davis	1
UC Los Angeles	1
USC	1

Industry/Gov't	
Caltrans	11
Arup	2
Hinman Consulting Engineers	2
OSHPD	2
CERIC	1
Mott MacDonald	1
NEES Consortium	1
PB Engineering	1
SOHA Engineers	1
T.Y. Lin International	1
Wiss, Janney, Elstner Associates	1

Country	
US	65
KR	9
CA	4
GB	1
IT	1
TW	1

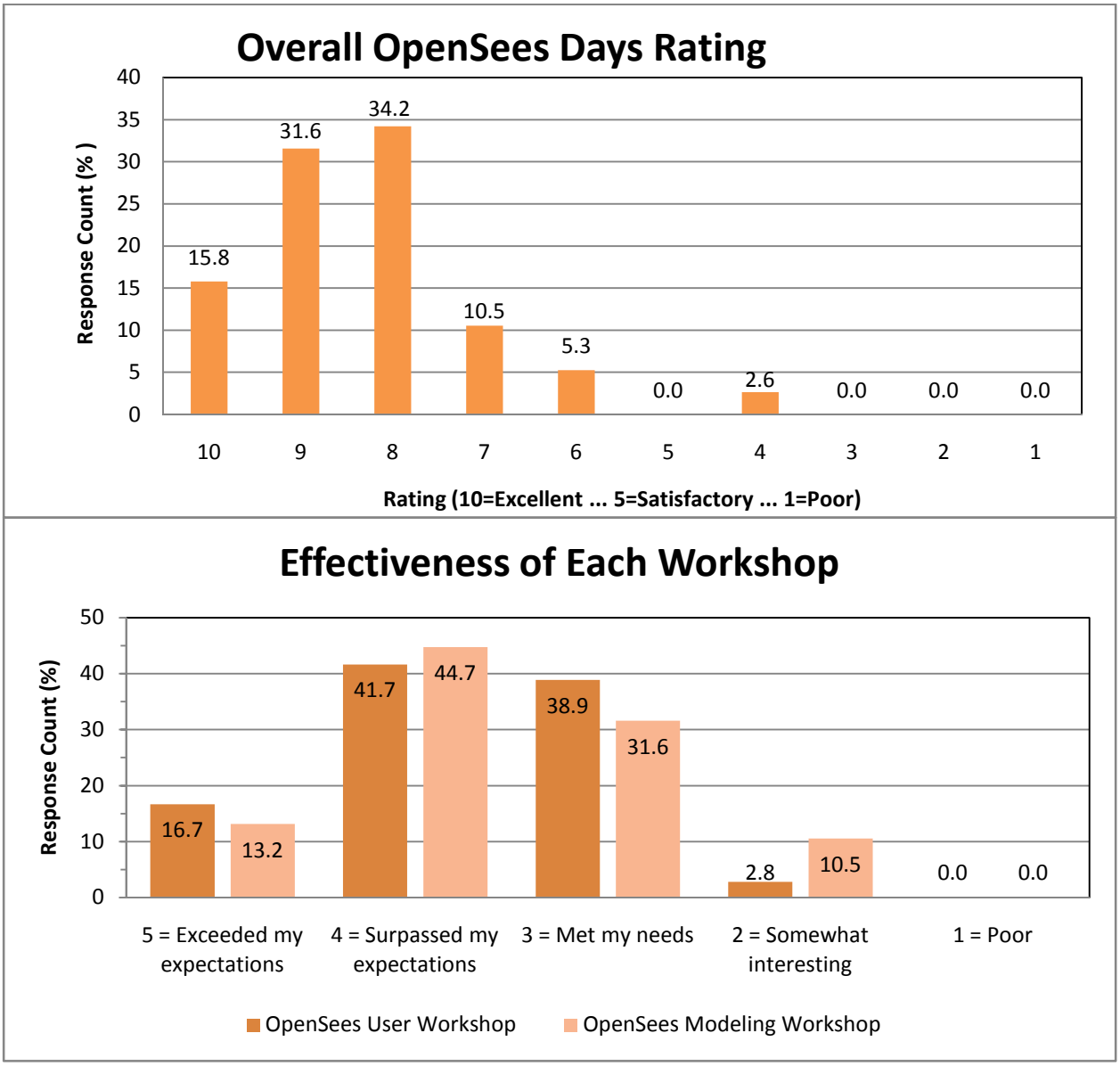


US State	
CA	46
GA	3
OR	3
TX	3
WA	3
MD	2
MI	1
NY	1
PA	1
SC	1
IA	1

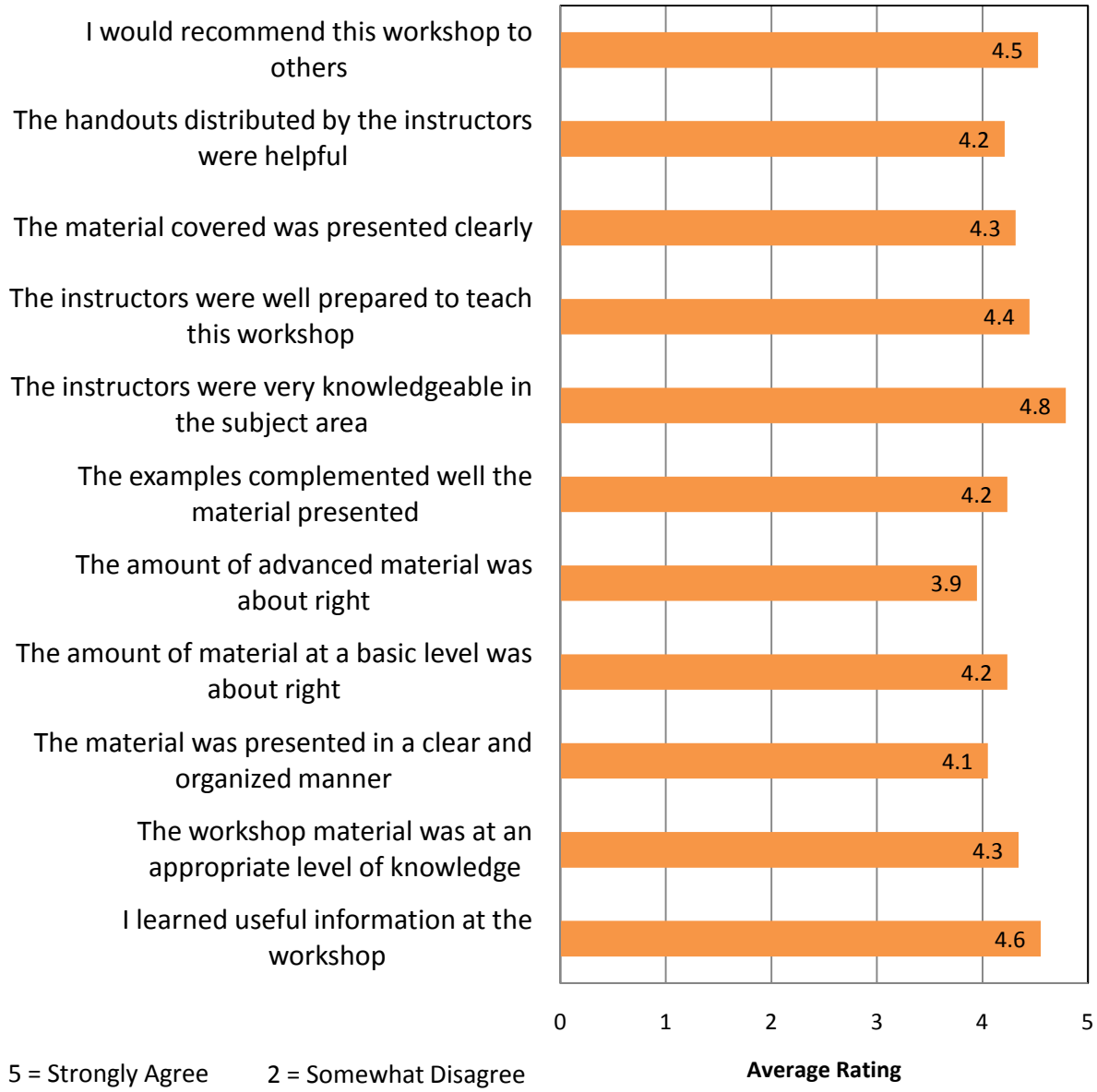


Appendix C.
OpenSees Days 2008 Survey: Graphical Data

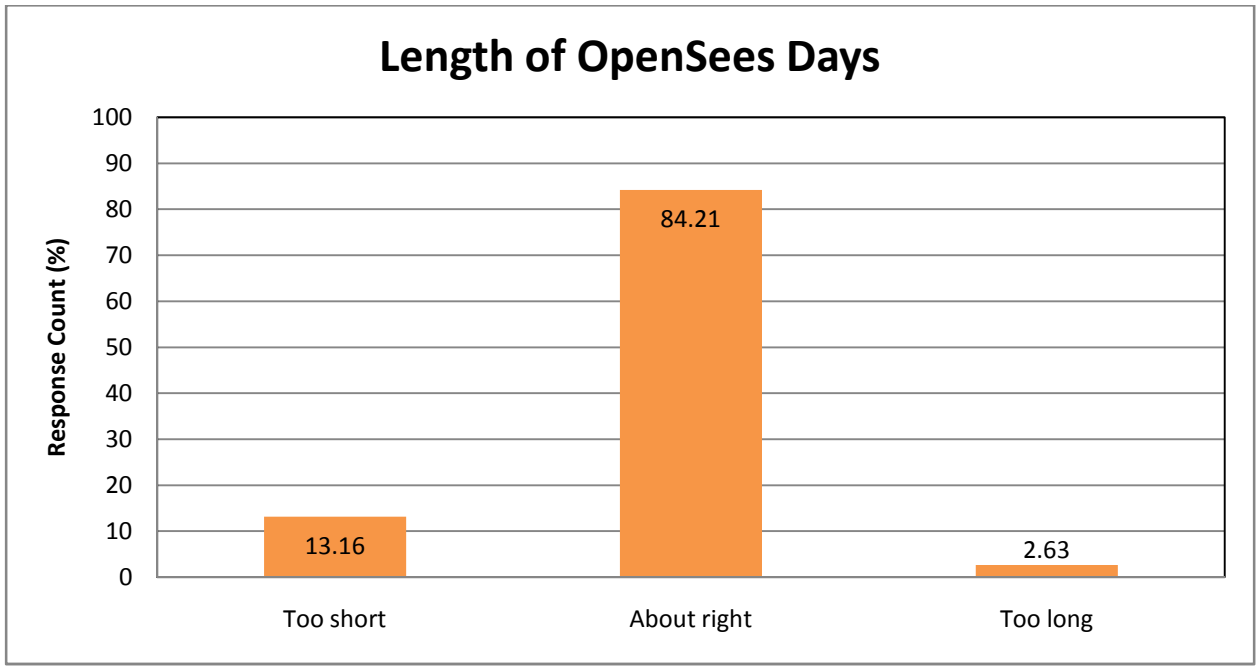
Number of Surveys Submitted: 38

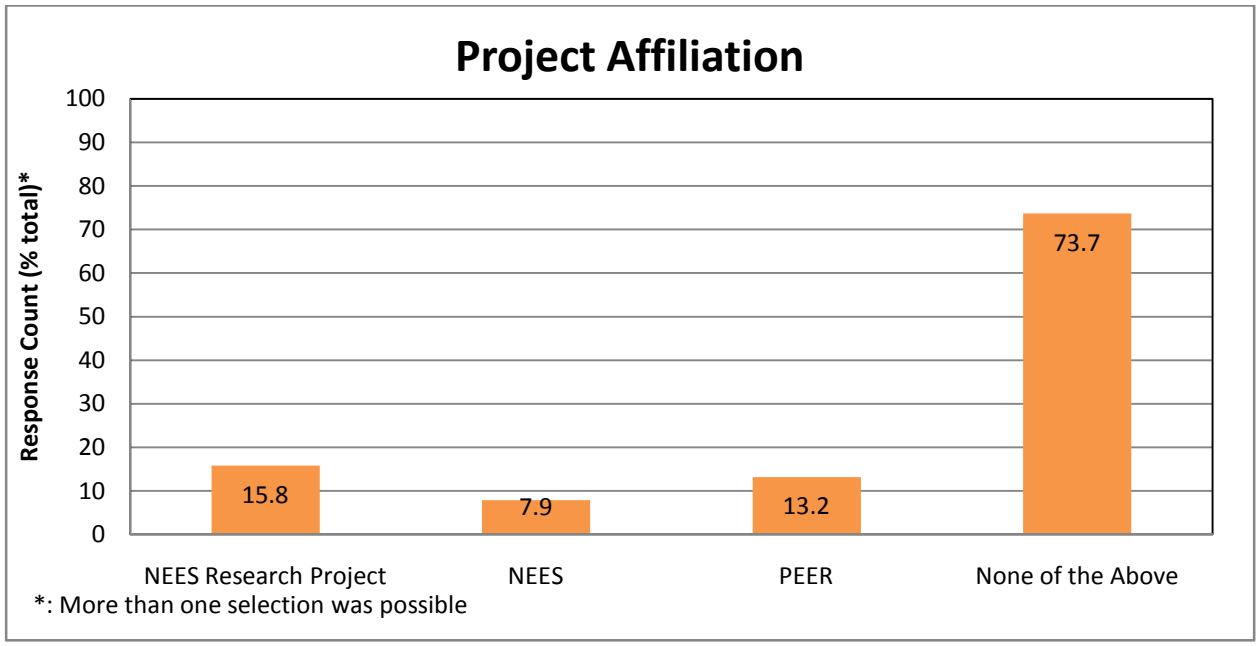


Individual Workshop-Aspects Rating



5 = Strongly Agree
4 = Somewhat Agree
3 = Neutral Opinion
2 = Somewhat Disagree
1 = Strongly Disagree
0 = N/A


Length of OpenSees Days
Response Count (%)
100
90
80
70
60
50
40
30
20
10
0
84.21
13.16
2.63
Too short
About right
Too long


Project Affiliation
Response Count (% total)*
100
90
80
70
60
50
40
30
20
10
0
73.7
15.8
7.9
13.2
NEES Research Project
NEES
PEER
None of the Above
*: More than one selection was possible

OpenSees Days 2008 Survey: Summary

Total Number of Surveys:	38	
Q1. Please rate OpenSees Days 2008 overall:		
Overall Rating (1-10)	8.3	/10
Q2. Please rate the Effectiveness of the OpenSees Days Workshops. To what degree did the session topics and content meet your needs?		
OpenSees User Workshop	3.7	/5
OpenSees Modeling Workshop	3.6	/5
Q3. Please rate the following aspects of the workshop:		
Average Rating for 11 Aspects	4.3	/5
Q4. The length of OpenSees Days was?		
Too short	13.2	%
About right	84.2	%
Too long	2.6	%
Q5. What did you like best about the workshops?*		
Good workshop overall	34.2	%
Filippou & Nonlinear Analysis	23.7	%
Tcl & OpenSees Basics & Modeling	21.1	%
Discussions & Interactions with OpenSees Users and Developers	10.5	%
Arduino & Geotechnical	5.3	%
Handouts	5.3	%
Good Instructors	5.3	%
Parallel OpenSees	2.6	%
Examples	2.6	%
Q6. Please give recommendations for future OpenSees workshops:*		
More hands-on exercises	15.8	%
Better documentation	7.9	%
More emphasis and time on basics	7.9	%
Separate geotechnical and structural days	7.9	%
More practical applications	5.3	%
Video on NEEScentral	2.6	%
More OpenSees elements	2.6	%
Some one-on-one time	2.6	%
Present various modeling techniques	2.6	%
Stick to agenda/schedule	2.6	%
Visualization	2.6	%
Q7. With which NEES and/or PEER projects or organizations are you affiliated?**		
NEES Research Project	15.8	%
NEES	7.9	%
PEER	13.2	%
None of the Above	73.7	%

*: Percentage of total number of surveys (34). Some surveyed listed more than one comment

**: Surveyed selected all that applied

OpenSees Days 2008 Survey: Comment Data

1. Please rate OpenSees Days 2008 overall:

- It was very informative
- Second day did not seem as organized as could be

2. Please rate the Effectiveness of the OpenSees Days Workshops. To what degree did the session topics and content meet your needs?

3. Please rate the following aspects of the workshop:

- Handout was not well prepared/organized.
- Recommendation to others would depend upon their background, this application is very powerful but difficult for most to use.
- Some topics may seems easy and simple for instructors but not for all beginners. Explanation on many slides are too short and sometimes i don't know what i should get from that slide. Explaining five or fifty words per slide, the instructor will still understand what the slide is about. On the other hand, explaining 50 words will definitely help learners a lot more than saying 5 words/slide.
- The presentations were great
- waiting to receive the handouts of day 2
- No handouts given the second day

4. The length of OpenSees Days was:

- In my opinion two days workshop is more than enough for "User's Workshop" May be a single day would surface. I would have liked however to see the two day workshop broken down into two single day workshop. One for "User's" and One for "Developers". By Developer I mean those folks that are interested in implementing new alghorithms into the OpenSees Source. The Developer's Workshop could include a step by step procedure to add a new finite element, for example.
- 2 Days is just enough to listen to the theory and some examples. A 3rd day for hands-on activities will be very useful.
- Day 1 (Morning): Great for beginners (me), but too much time was spent talking about subjects that were covered again (in more detail) later in the day. A brief introduction is fine, but then get to the meat right away. Day 2: Given the specialized topics, it's important to stick with the schedule since many people are only interested in certain topics, and may want to come and go instead of staying thru the whole thing.
- Maybe an extra day would be helpful
- Two days is about right, but it would be good to spend part of the time on live examples. Perhaps there could be various second days specific to geotech, bridge , and building

5. What did you like best about the workshops?

- Discussion about the use of OpenSees by practicing engineers.
- Discussions

- Everything was very interesting but there are few things which interested me most. 1. Dr. Filippou's lecture was very helpful in understanding the beam column elements and their limitations etc.. 2. Dr. Audrino's presentation was amazing.. It showed what one can achieve with the OpenSees. It definitely was one of the most interesting and entertaining presentation. 3. Presentation by Frank on the parallel OpenSees improved my understanding of OpenSees and followed by Silvia's presentation showing Tcl programming etc.. made me better at the understanding Tcl and made me comfortable enough to try Tcl programming. 4. Finally the interactions with the fellow students about the OpenSees were interesting.
- examples
- Excellent package
- Filippou's presentation on Nonlinear Analysis
- FREE! Casual atmosphere, good lunch and snacks
- getting introduced to OpenSees
- Good Instructors
- Handouts
- I had the chance to talk directly with the developers of the materials and elements I have used in OpenSees, so I solved a couple of doubts.
- I like Dr. Filip's presentation.
- Info on nonlinear modeling + What to do when things go wrong. (this section could be extended)
- instructors
- It was a very informative workshop where the emphasis was to educate rather than just impress!
- Modeling & Analysis by Prof. Filip Filippou
- modeling details
- Presentations on "Soil Modeling in OpenSees"
- Prof Filippou's presentation on nonlinear elements and also Frank's presentations.
- The communication with those OPENSEES advanced users.
- The explanations about Tcl/Tk and those about the different analysis tests that can be performed in OpenSees when convergence problems occur.
- The first day was really wonderful and gave a good deal of information and right background
- The first day was very helpful in learning to jump into the program
- The first day.
- The handouts and sessions that focused on the basics of Tcl scripting.
- The instructors were very knowledgeable in the subject area and are willing to answer every question. The atmosphere of the workshop is also impressive.
- The interaction between presenters and attendees.
- The modeling workshop was great. Especially the topics covered in the area of structural engineering.
- The non linear analysis presentation with focus in OpenSees
- The Nonlinear Modeling and Analysis session

- The room had wifi but speaking for myself it would have been nice to know this so I could have brought a laptop.
- The speakers were great, each with their own unique area of expertise.
- The tempo of course.
- Understanding material quickly that would've taken me a lot longer to read through
- Was very helpful for beginners like me
- Well balanced

6. Please give recommendations for future OpenSees workshops:

- Though attending the workshop was very helpful, but I suggest if there is some way one can video tape the workshop and made it available on NEES central, it will be very helpful for future references and also for the people who weren't able to attend. 2. Possibility of webcast of the workshop (similar to other NEES lectures/presentations).
- An updated user's guide would have been helpful. OpenSees Command Summary document needs updating. OpenSees needs a nonlinear inelastic shell or plate element to model squat concrete solid and perforated shear walls for buildings. OpenSees needs commands for better output recorders to view data without plotting (such as headers describing each column of output similar to the Drain series of programs).
- Excellent workshop, about the only suggestion I could give is some hands on time, perhaps help with our specific problems.
- For the OpenSees User, I believe it will be very good if they can get chance to discuss with Frank or Silvia about their OpenSees model about an hour. It might be good to manage this time one day prior to the workshop. However, it is not require to manage time for those who have not modeled problems in OpenSees.
- Giving to the attendants at least one structure to model and run with OpenSees
- Have a hands on day, cover a specific topic/analysis through exploration of various modeling techniques and their pros and cons.
- I think the modeling portion should have a separate workshop in itself. The fundamental stuff should be given somewhat more preference and weightage.
- I will appreciate it if the handout is well prepared.
- I would recommend to have the applied examples researchers and engineers presentations more focused in the program and less in their projects, and also separate the geotechnical with best defined sections
- It would be great to have a hands-on session (3rd day) where one gets to solve questions while writing a script and assembling a model. Geotechnical models are not straight forward, and there are very few simple examples online.
- It would have been more useful to learn about modeling techniques (or see examples constructed in front of the class) than to hear from researchers presenting their work. Focus more on learning how to use the program itself. I also would have liked to learn about how, specifically, to use OpenSees to do a parametric study.

- Please consider presenting more applications to bridge analysis, especially seismic/dynamic analysis of bridges.
- Separate Geotech and structural analysis on different days.
- Should start discussions on some topics like Non Linear analysis from the basics
- The fact that in second day the afternoon schedule changed and the geotechnical aspects were introduced first was not a good idea. Because on the first distributed schedule of the conference I had booked my plane for 6:30 and I thought that I can leave the conference earlier without losing too much which didn't come true and I missed the after 3:00 schedule which was really related to my field. I think it was better to act based on the distributed schedule. By the way I really enjoyed the workshop.
- There should be also presentations on how to visualize OpenSees models and results. Examples on how to visualize OpenSees codes in GiD could be presented.
- Provide hands-on sessions, even if very simple. Let people know to install program on their laptops and bring them in. Put a copy of handouts as PDF on web site to download and cut down the cost of printing. Use breakout sessions for people with specific interest areas: Geotech, Bridge, Building, Concrete, Steel, Programming, etc.

7. With which NEES and/or PEER projects or organizations are you affiliated? (select all that apply)

- California Department of Transportation
- Caltrans
- Graduate Student, McGill University, Canada
- NSF
- T.Y. Lin International
- Thanks.
- Université de Sherbrooke
- University of Pittsburgh. Geotechnical dissertation development
- Caltrans -> periphrally involved with PEER research projects

Appendix D.
Photographs


EXIT

Appendix E.
Registration Page: http://openseesdays2008.eventbrite.com/