OpenSees & DesignSafe: OpenSeesEXPRESS

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OpenSees applications on DesignSafe

as well as data analysis and visualization tools including Jupyter, MATLAB, Paraview and VisIt.
OpenSees applications on DesignSafe

The Open System for Earthquake Engineering Simulation (OpenSees) is a software framework for simulating the static and seismic response of structural and geotechnical systems. It has advanced capabilities for modeling and analyzing the nonlinear response of systems using a wide range of material models, elements, and solution algorithms. One sequential (OpenSees EXPRESS) and two parallel interpreters (OpenSeesSP and OpenSeesMP) are available on DesignSafe. Please select the desired interpreter for more details.

Select a version of OpenSees from the dropdown:

- Please Select
- OpenSees-EXPRESS
- OpenSeesMP (V 2.5)
- OpenSeesMP (V 3.0)
- OpenSeesSP (V 2.5)
- OpenSeesSP (V 3.0)
**OpenSees applications on DesignSafe**

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**DATA DEPOT BROWSER**

*Select data source*

- My Data

*Browsing:*

- sal

**File name**

- .ipynb_checkpoints
- .Trash
- All_Data_Processed
- applications
- apps
- apps_test
- archive
- empty
- sal

---

The **Open System for Earthquake Engineering Simulation** (OpenSees) is a software framework for simulating the static and seismic response of structural and geotechnical systems. It has advanced capabilities for modeling and analyzing the nonlinear response of systems using a wide range of material models, elements, and solution algorithms. One sequential (OpenSees EXPRESS) and two parallel interpreters (OpenSeesSP and OpenSeesMP) are available on DesignSafe. Please select the desired interpreter for more details.

Select a version of **OpenSees** from the dropdown:

- OpenSees-EXPRESS

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**RUN OPENSEES-EXPRESS** ver. 2.5.0.6248

OpenSees-Express provides users with a sequential OpenSees interpreter (version 2.5). It is ideal to run small sequential scripts on DesignSafe resources freeing up your own machine.

[OpenSees-EXPRESS Documentation](#)

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**Inputs**

**Input Directory**

- **Select**

  Click to select input data

The directory containing your OpenSees input files as well as your OpenSees TCL script. You can drag the link for the directory from the Data Browser on the left, or click the ‘Select Input’ button and then select the directory. To try out sample data copy and paste ‘agave://designsafe.storage.default/mock/examples/opensees/FreefieldAnalysisEffective’ above.

**TCL Script**

The filename only of the OpenSees TCL script to execute. This file should reside in the Input Directory specified. To try this...
Why OpenSeesEXPRESS?

OpenSees-Express is a sequential interpreter.

**Pros:**
- It runs on Virtual Machine freeing up your own machine;
- No queue.

**Cons:**
- Not ideal for very large models.
Problem: effective stress site response analysis of a layered deposit of cohesionless soil underlain by an elastic half-space.

Model: A single column of soil is modeled in 2D (with periodic boundary conditions to emulate a 1D analysis) and is subject to an earthquake excitation. Nine node quadrilateral elements with both displacement and pore pressure degrees of freedom enable the model to track changes in pore pressure and effective stress during the earthquake excitation. A Lysmer-Kuhlemeyer (1969) dashpot is utilized to account for the finite rigidity of the underlying elastic medium.
Upload files in My Data

![Image of Data Depot with highlighted options: Add, New Folder, New Project, File upload, Folder upload.]
OpenSeesEXPRESS analysis: *Run the analysis*
OpenSeesEXPRESS analysis: *Run the analysis*
OpenSeesEXPRESS analysis: Run the analysis

WORKSPACE

Learn About the Workspace.

DATA DEPOT BROWSER

Select data source
My Data

Browsing:
mypb

File name Size

.pyrj_backup 4 kB

Trash 16 kB

Trash_h58981 4 kB

.commands 4 kB

Comparison_toomode2 4 kB

Examples 4 kB

Fixed_base 4 kB

FreeFieldAnalysisEffective 4 kB

RUN OPENSEES-EXPRESS

OpenSees-Express provides users with a sequential OpenSees interpreter (version 2.5). It is ideal to run small sequential scripts on DesignSafe resources freeing up your own machine.

OpenSees-EXPRESS Documentation

Inputs

Input Directory

Select Click to select input data

The directory containing your OpenSees input files as well as your OpenSees TCL script. You can drag the link for the directory from the Data Browser on the left, or click the ‘Select input data’ button and then select the directory. To try out sample data copy and paste
‘agave://designsafe.storage.default/mock/examples/opensees/FreefieldAnalysisEffective’ above.

TCL Script

The filename only of the OpenSees TCL script to execute. This file should reside in the Input Directory specified. To try this cut copy and paste in ‘FreefieldEffective.tcl’.

Job details

Maximum job runtime

02:00:00

In HH:MM:SS format. The maximum time you expect this job to run for. After this amount of time your job will be killed by the job scheduler. Shorter run times result in shorter queue wait times. Maximum possible time is 48:00:00 (48 hours).

Job name

A recognizable name for this job.

Job output archive location (optional)

Select

Specify a location where the job output should be archived. By default, job output will be archived at:

Run Close
OpenSeesEXPRESS analysis: *Run the analysis*

**WORKSPACE**

1. Learn About the Workspace.
2. Visualization [7]
3. Data Processing [3]
4. Partner Data Apps [4]
5. Utilities [2]

**DATA DEPOT BROWSER**

Select data source

- My Data

Browsing:

- margod / Examples / OpenSeesEXPRESS

**RUN OPENSEES-EXPRESS** ver. 2.5.0.6248

OpenSees-Express provides users with a sequential OpenSees interpreter (version 2.5). It is ideal to run small sequential scripts on DesignSafe resources freeing up your own machine.

- OpenSees-EXPRESS Documentation

**Inputs**

**Input Directory**

Select: 

```
agave://designsafe.storage.default/margod/Examples/OpenSeesEXPRESS
```

The directory containing your OpenSees input files as well as your OpenSees TCL script. You can drag the link for the directory from the Data Browser on the left, or click the "Select Input" button and then select the directory. To try out simple data copy and paste `agave://designsafe.storage.default/mock/examples/opensees/FreefieldAnalysisEffective` above.

**TCL Script**

```
freeFieldEffective.tcl
```

The filename only of the OpenSees TCL script to execute. This file should reside in the Input Directory specified. To try this out copy and paste in `freeFieldEffective.tcl`.

**Job details**

**Maximum job runtime**

01:00:00

In HH:MM:SS format. The maximum time you expect this job to run for. After this amount of time your job will be killed by the job scheduler. Shorter run times result in shorter queue wait times. Maximum possible time is 4800000 (48 hours).

**Job name**

OpenSeesEXPRESS

A recognizable name for this job.

**Job output archive location (optional)**

Select: 

```
<username>/archive/jobs/${YYYY-MM-DD}/$[JOB_NAME]-$[JOB_ID]
```

Specify a location where the job output should be archived. By default, job output will be archived at: 

```
<username>/archive/jobs/${YYYY-MM-DD}/$[JOB_NAME]-$[JOB_ID]
```

**Run**
OpenSeesEXPRESS analysis: Check job status

RUN OPENSEES-EXPRESS

OpenSees-Express provides users with a sequential OpenSees Interpreter (version 2.5).

Job Submitted Successfully
Your job OpenSeesEXPRESS has been submitted. Monitor its status on the right.

OpenSees-Express provides a sequential OpenSees Interpreter (version 2.5).

OpenSees-Express provides users with a sequential OpenSees Interpreter (version 2.5).
OpenSeesEXPRESS analysis: Check job result

File Preview: openseesexpress.err

File name: openseesexpress.err
File path: /marqod/archive/jobs/2018-10-25/openséesexpress-4974937107357503976-242ac11b-0001-007/openséesexpress.err
File size: 2.6 KB
Last modified: 10/24/18 6:24 PM

+++ dirname ./openséesexpress.ipcexe
++ cd .
++ pwd
++ WRAPPERDIR=/home/tg45981/agave/home/margod/job-4974937107357503976-242ac11b-0001-007-openséesexpress
++ echo 'InputScript is freeFieldEffective.tcl'
++ INPUTSCRIPT=freeFieldEffective.tcl
++ echo 'INPUTSCRIPT is freeFieldEffective.tcl'
++ TCLSCRIPT=freeFieldEffective.tcl
++ echo 'TCLSCRIPT is freeFieldEffective.tcl'
++
++ docker run --sig-proxy=true --rm -it --name opensées_margod_4974937107357503976-242ac11b-0001-007 --volume /home/tg45981/agave/home/margod/job-4974937107357503976-242ac11b-0001-007-openséesexpress:/data/steinemog/designsafe-opensées-express /bin/sh -c 'cd /data ; OpenSees < /data/freeFieldEffective.tcl'
Usage of loopback devices is strongly discouraged for production use. Either use `--storage-opt dm.thinp odev` or use `--storage-opt dm.no_warn_on_loop_devices=true` to suppress this warning.

OpenSees -- Open System For Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center
Version 2.5.0 (rev 6248) 32-Bit

(c) Copyright 1999-2016 The Regents of the University of California
All Rights Reserved
(Copyright and Disclaimer @ http://www.berkeley.edu/OpenSees/copyright.html)

size: 0.5
size: 0.5
size: 0.5
number of nodes in layer 1: 80
number of nodes in layer 2: 32
number of nodes in layer 3: 10
total number of nodes: 122
Finished creating all -ndf 3 boundary conditions...
Finished creating element for core pressure node.
### OpenSeesEXPRESS analysis: Check job result

#### DESIGNSAFE-CI
NHERI: A NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE

- **Research Workbench** - **Learning Center** - **NHERI Facilities** - **NHERI Community** - **About** - **Help**

#### Data Management

- **Find in My Data**
- **Tag**
- **Rename**
- **Move**
- **Copy**
- **Preview**
- **Preview Images**
- **Download**
- **Move to Trash**

#### Add

- margod / archive / jobs / 2018-10-25 / openseesexpress-49749371073575033876-242ac11b-0001-007

#### My Data

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<th>Size</th>
<th>Last modified</th>
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<tr>
<td>.agave.log</td>
<td>406.0 bytes</td>
<td>10/24/18 6:24 PM</td>
</tr>
<tr>
<td>OpenSeesEXPRESS</td>
<td>--</td>
<td>10/24/18 6:24 PM</td>
</tr>
<tr>
<td>openseesexpress.arr</td>
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<td>10/24/18 6:24 PM</td>
</tr>
<tr>
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</tr>
<tr>
<td>openseesexpress.pid</td>
<td>5.0 bytes</td>
<td>10/24/18 6:24 PM</td>
</tr>
</tbody>
</table>

#### Curation Tutorials

- [A Natural Hazards Engineering Community](#)
- [Texas A&M University](#)
- [TACC](#)
- [Rice University](#)
- [Florida Tech](#)
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<thead>
<tr>
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<th>Size</th>
<th>Last modified</th>
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<td>10/24/18 6:24 PM</td>
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<td>10/24/18 6:24 PM</td>
</tr>
<tr>
<td>displacement.out</td>
<td>2.0 MB</td>
<td>10/24/18 6:24 PM</td>
</tr>
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<td>elementInfo.dat</td>
<td>1.0 kB</td>
<td>10/24/18 6:24 PM</td>
</tr>
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<td>10/24/18 6:24 PM</td>
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<td>17.3 kB</td>
<td>10/24/18 6:24 PM</td>
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<td>10/24/18 6:24 PM</td>
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<td>10/24/18 6:24 PM</td>
</tr>
<tr>
<td>nodesInfo.dat</td>
<td>2.2 kB</td>
<td>10/24/18 6:24 PM</td>
</tr>
</tbody>
</table>
Post-processing alternatives

- Work on the Cloud using the tools available on DesignSafe (Data Processing Tab):
  - Jupyter Notebook;
  - Matlab.

- Download all the output and post-process data locally.
Post-processing alternatives

- Work on the Cloud using the tools available on DesignSafe (Data Processing Tab):
  - Jupyter Notebook;
  - Matlab.

- Download all the output and post-process data locally.
Post-processing alternatives: Jupyter Notebook

DATA DEPOT BROWSER

Select data source

Browsing: merged

File name | Size
---|---
jupyter_checkpoints | 4 kB
jms | 16 kB
jms-55619f1 | 4 kB
archive | 4 kB
Comparison_stamped02 | 4 kB
Examples | 4 kB
fixed_base | 4 kB
fixed_base委会 | 4 kB
FreeField85 kontrol | 4 kB
FreeField85|clap | 4 kB

DESIGNSAFE - CI JUPYTER NOTEBOOK

The Jupyter Notebook is a web application that allows you to create and share documents that contain live code, equations, visualizations and explanatory text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, machine learning and much more.

NOTE: This Jupyter instance will terminate after being idle for 3 days.
Post-processing alternatives: *Jupyter Notebook – OpenSeesEXPRESS* (Community Data/Workspace Applications Examples / OpenSees/ freeFieldEffectiveJupyter_postprocessing.ipynb)
Post-processing alternatives: Jupyter Notebook – OpenSeesEXPRESS

Free Field Analysis Example

This example shows how to postprocess the output results of OpenSeesEXPRESS analysis using python scripts.

The site response analysis discussed in this article is for a soil profile consisting of a 10 m thick layer of loose sand (D = 49%) above a 20 m thick layer of dense sand (D = 25%). A schematic representation of the analyzed soil profile is shown in the figure below. The entire soil profile is underlain by an elastic half space which represents the finite rigidity of an underlying medium such as bedrock. The groundwater table is located at a depth of 2 m, therefore, saturated unit weights are used for the soil below this point and effective stress analysis is considered through the use of nine-node quadrilateral elements which are able to simulate fluid-solid coupling.

The results are presented in terms of:

a) Acceleration time series at base and the surface and corresponding response spectra;
b) Profiles of maximum displacement, PGA, maximum shear strain, and stress ratio;
c) Stress strain plot and evolution of pore water pressure for the point that experienced the maximum shear strain.

Postprocess Results

```
Out[1]: The raw code for this Jupyter notebook is by default hidden for easier reading. To toggle on/off the raw code, click here.
```

Import python libraries

```
/home/jupyter/CommunityData/Workspace Application Examples/OpenSees
```

Change directory

```
/home/jupyter/CommunityData/Workspace Application Examples/OpenSees/OpenSeesEXPRESS
```
**Post-processing alternatives:** *Jupyter Notebook – OpenSeesEXPRESS* (Community Data/Workspace Applications Examples / OpenSees/ freeFieldEffectiveJupyter_postprocessing.ipynb)

---

**Free Field Analysis Example**

This example shows how to postprocess the output results of OpenSeesEXPRESS analysis using python script.

The site response analysis discussed in this example is for a soil profile consisting of a 10 m thick layer of loose silt (9%); above a 30 m thick layer of more dense sand (E = 35 GPa). A schematic representation of the analyzed soil shown in the figure below. The entire soil profile is underlain by an elastic half-space which represents the finite of an underlying medium such as bedrock. The groundwater table is located at a depth of 2 m, therefore, seepage weights are used for the soil below this point and effective stress analysis is considered through the use of finite element models which are capable of simulating fluid-solid coupling.

The results are presented in terms of:

- a) Acceleration time series at base and the surface and corresponding response spectra;
- b) Profiles of maximum displacement, PGA, maximum shear strain, and stress ratio;
- c) Stress-strain plot and evolution of pore water pressure for the point that experienced the maximum shear strain.

---

**Postprocess Results**

The raw code for this Jupyter notebook is by default hidden for easier reading. To toggle on/toggle off the raw code, click here.

Import python libraries

```
/home/jupyter/CommunityData/Workspace Applications Examples/OpenSees
```

Change directory

```
/home/jupyter/CommunityData/Workspace Applications Examples/OpenSees/OpenSeesEXPRESS
```
Post-processing alternatives: *Jupyter Notebook – OpenSeesEXPRESS* (Community Data/Workspace Applications Examples / OpenSees/ freeFieldEffectiveJupyter_postprocessing.ipynb)

**Free Field Analysis Example**

This example shows how to postprocess the output results of OpenSeesEXPRESS analysis using python scripts. The site response analysis discussed in this article is for a soil profile consisting of a 10 m thick layer of loose silt (Dr = 69%) above a 20 m thick layer of more dense sand (Dr = 25%). A schematic representation of the analyzed soil is shown in the figure below. The entire soil profile is underlain by an elastic half space which represents the finite of an underlying medium such as bedrock. The groundwater table is located at a depth of 2 m, therefore, aquifer weights are used for the soil below this point and effective stress analysis is considered through the use of thin quadrilateral elements which are able to simulate fluid-soil coupling.

The results are presented in terms of:

- a) Acceleration time series at base and the surface and corresponding response spectra;
- b) Profiles of maximum displacement, PGA, maximum shear strain, and stress ratios;
- c) Stress strain plot and evolution of pore water pressure for the point that experienced the maximum shear strain.

**Postprocess Results**

![Image of code and graphs](image-url)
Post-processing alternatives

- Work on the Cloud using the tools available on DesignSafe (Data Processing Tab):
  - Jupyter Notebook;
  - Matlab.

- Download all the output and post-process data locally.
Post-processing alternatives: *Matlab*

You have to submit a ticket to activate your license on DesignSafe.

Select an application from the tray above.

The Workspace allows users to perform simulations and analyze data using popular simulation codes including OpenSees, ADCIRC, and OpenFOAM, as well as data analysis and visualization tools including Jupyter, MATLAB, ParaView and VisIt.
Post-processing alternatives: *Matlab*

Recommended for standard post-processing analyses.

Run an interactive Matlab 2016a session on a virtual machine. Work directly on your files rather than needing to copy them to and from Stampede.

Run an interactive MATLAB 2017b session on Stampede2.
Recommended for standard post-processing analyses.

**Post-processing alternatives:** *Matlab*

**WORKSPACE**

[Image of MATLAB workspace interface]

**DATA DEPOT BROWSER**

Select data source

- My Data

Select file for Working Directory.

- More info

**RUN MATLAB**

Ver. 0.1

Run an interactive MATLAB 2016a session on a virtual machine. Work directly on your files rather than needing to copy them to and from Stampede.

- MATLAB Documentation

**Inputs**

**Desktop Resolution**

1280x800

Set the desktop screen size for your visualization session.

**Job details**

**Maximum job runtime**

01:00:00

In HH:MM:SS format. The maximum time you expect this job to run. After this amount of time your job will be killed by the job scheduler. Shorter run times result in shorter queue wait times. Maximum possible time is 48:00:00 (48 hours).

**Job name**

Matlab

A recognizable name for this job.

**Job output archive location (optional)**

Specify a location where the job output should be archived. By default, job output will be archived at: <username>/archive/jobs/$(YYYY-MM-DD)/$(JOB_NAME)-$(JOB_ID).

Run
Post-processing alternatives: **Matlab**
Post-processing alternatives: *Matlab – OpenSeesEXPRESS* *(Community Data/Workspace Applications Examples / OpenSees/ OpenSeesEXPRESS /PostProcessing_matlab.m)*
Post-processing alternatives: *Matlab* – *OpenSeesEXPRESS* (Community Data/Workspace Applications Examples / OpenSees/ OpenSeesEXPRESS /PostProcessing_matlab.m)

- **Input Acceleration**
- **Surface Acceleration**
- **Log Spectra**
- **Stress–strain response at 7.75 m**
- **Pore Pressure variation at 7.75 m**
OpenSees & DesignSafe: OpenSeesEXPRESS

...Questions?

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