Selection of CyberShake ground motions for engineering practice

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Uses of ground motions in earthquake engineering practice

Seismic sources

- Ground motions

Ground motion hazard analysis

Target response spectrum

- Study this portion
- Using recordings or simulations
- Satisfy ASCE 7-16 requirements for new building design

Structural performance

Ground motions

Response history analysis
Goals

Select time series from the CyberShake database that would satisfy ASCE 7-16 criteria, and evaluate their suitability for this purpose

Select comparable recorded ground motions, for comparative evaluations

Tall buildings are an the envisioned application
• Response history analysis is often used
• Simulations provide greatest insights at long periods
Two considered locations

Pasadena (PAS)
$V_{s30} = 748 \text{ m/s}$

Los Angeles Downtown (LADT)
$V_{s30} = 390 \text{ m/s}$
Record selection

11 two-component ground motions were selected

ASCE 7-16 site-specific MCE$_R$ spectrum from USGS.

A period range of 1 to 10s was matched.

Magnitude/distance somewhat constrained to match deaggregation

CyberShake ground motions were taken from the reference site’s simulations

NGA-West2 ground motions were scaled by up to 4x
Response spectra of all selected ground motions

LA Downtown

CyberShake

NGA-West 2

Pasadena

Target spectrum
Selected spectra

Sa (g)

Period (s)
Deaggregation versus selected records

LA Downtown

Site: LADT, Period: 1s

Site: LADT, Period: 5s

Site: PAS, Period: 1s

Site: PAS, Period: 5s

Pasadena

No. of records

No. of records

Contribution(%)
Some particular CyberShake ruptures produce excessively polarized ground motions. But for the record selection exercise these can be easily avoided.
Example CyberShake record #1 (Newport Inglewood)
Example CyberShake record #2 (Puente Hills)
Example CyberShake record #5 (Sierra Madre)
Example CyberShake record #10 (San Andreas)
Additional documentation

• We have a ground motion selection report with figures for every selected time series and response spectrum, plus tabulated data

• We would love to hear feedback from interested users

<table>
<thead>
<tr>
<th>Fault</th>
<th>Station Name</th>
<th>Magnitude</th>
<th>Distance (km)</th>
<th>Vs30 (m/s)</th>
<th>Scaling Factor</th>
<th>5-75% significant duration (s)</th>
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</table>
Conclusions

• We have selected ground motions from the CyberShake database for sites in Los Angeles Downtown and Pasadena
  – Targeted for tall buildings analysis
  – Compliant with ASCE 7-16 Response History Analysis requirements

• Reference ground motions from NGA-W2 were also selected

• The CyberShake motions appear suitable for engineering use (other than excessive polarization in a few cases) and offer a much richer set of motions for large-magnitude and basin conditions

• Moving forward, we hope to solicit feedback from practicing engineers, and build users’ confidence in the simulations
Thoughts on selecting time series for the UGMS tool

- Site-specific motions or a general suite that can be further searched?
  - **Site-specific**—easier to provide a small suite, but for users with a different site or target spectrum, it may be challenging to use these

  - **General suite**—easier to provide the “large magnitude small distance” motions that are most useful, but may require further searching within the set by a user

- A question to you—how would you envision using CyberShake time series for your projects?