**2nd International Workshop** 

# Long-Period Ground Motion Simulation and Velocity Structures

**Proceedings** 

November 8~9, 2007 at Earthquake Research Institute, University of Tokyo, Japan

Hosted by Strong Motion Seismology Group at ERI, Univ. Tokyo Supported by SCEC-ERI Cooperation Program, Office of International Earthquake and Volcano Research Promotion, ERI, and Grant-in-Aid for Scientific Research (No.19201034)

### Scope

The long-period component of seismic ground motion generated by earthquakes causes damage in near-fault regions through source effects such as the directivity effect of rupture propagation and the near-field term of body wave radiation. In addition, the long-period ground motions attenuate slowly with distance due to some path effects, and site effects amplify them in distant basins, so that they can carry destruction to much greater range.

Large-scale structures such as tall buildings and big tanks can resonate with the long-period ground motions because their own natural periods are in the same frequency band. They can even be damaging in some circumstances; the worst example with over 20,000 fatalities in Mexico City at a distance of 400 km from the 1985 Michoacan earthquake. A further example was provided by the 2003 Tokachi-oki earthquake in Hokkaido, Japan (Koketsu *et al.*, *Seism. Res. Lett.*, 76, 67-73, 2005).

Therefore, the simulation of long-period ground motion is one of the most important parts of strong motion evaluation and prediction. The modeling of velocity structures along propagation path and within sedimentary basins also plays an important role. We would discuss these aspects of the long-period ground motion in the workshop. Topics include numerical simulation, velocity structures, source effect, path and site effects, damage and risk, and other related issues on the long-period ground motion.

> Kazuki Koketsu, Takashi Furumura, and Hiroe Miyake Strong Motion Seismology Group Earthquake Research Institute, University of Tokyo

# **Invited Speakers**

Ralph J. Archuleta	(U.C. Santa Barbara, USA)
Thomas M. Brocher	(U.S. Geological Survey, Menlo Park, USA)
Robert W. Graves	(URS Corporation, Pasadena, USA)
Thomas H. Heaton	(Caltech, Pasadena, USA)
Kim B. Olsen	(San Diego State University, USA)
Arthur J. Rodgers	(Lawrence Livermore National Laboratory, USA)
Toshiro Tanimoto	(U.C. Santa Barbara, USA)

## **Research Members of 2007-2010**

### Grant-in-Aid for Scientific Research (No.19201034)

Kazuki Koketsu	(ERI, Univ. Tokyo) P.I.
Muneo Hori	(ERI, Univ. Tokyo)
Takashi Furumura	(ERI, Univ. Tokyo)
Hiroe Miyake	(ERI, Univ. Tokyo)
Kojiro Irikura	(Aichi Inst. Tech.)
Saburoh Midorikawa	(Tokyo Tech.)
Tsutomu Sasatani	(Hokkaido Univ.)
Tomotaka Iwata	(DPRI, Kyoto Univ.)
Katsuhiro Kamae	(RRI, Kyoto Univ.)
Hiroshi Kawase	(Kyushu Univ.)
Hiroshi Takenaka	(Kyushu Univ.)
Nobuo Fukuwa	(Nagoya Univ.)
Yoshiaki Hisada	(Kogakuin Univ.)
Shinsaku Zama	(NRIFD)
Hiroyuki Fujiwara	(NIED)
Shin Aoi	(NIED)
Sadanori Higashi	(CRIEPI)
Haruko Sekiguchi	(AIST)
Kazuyoshi Kudo	(Nihon Univ.)
Ken Hatayama	(NRIFD)

### Program

#### November 8 (Thursday)

- 13:30 13:50 Registration
- 13:50 14:00 Opening

#### **Ground Motion Simulation**

14:00 - 14:25	Takashi Furumura and Tatsuhiko Saito (ERI, Univ. Tokyo)
	Integrated Simulation of Long-Period Ground Motions and Tsunami
	Generating from Subduction Zone Earthquakes
14.25 14.50	
14:25 - 14:50	Kim B. Olsen (SDSU),
	William J. Stephenson, and Andreas Geisselmeyer
	3D Crustal Structure and Long-period Ground Motions
	From a M9.0 Megathrust Earthquake in the Pacific Northwest Region
14:30 - 15:05	Coffee Break
15:05 - 15:30	Hiroshi Takenaka and Arash JafarGandomi (Kyushu Univ.)
	Multi-Component 1D Viscoelastic FDM for Plane-Wave Incidence
15:30 - 15:55	Robert Graves (URS), Brad Aagaard, and Ken Hudnut
	Large Scale Earthquake Simulations in California
15:55 - 16:10	Coffee Break

### Earthquake Engineering

16:10 - 16:35 Yoshiaki Hisada (Kogakuin Univ.),
 Tomohiro Kubo, Shigeki Horiuchi, and Shunroku Yamamoto
 Application of Earthquake Early Warning System to a High-Rise
 Building in Tokyo, Japan, Considering Long-Period Strong Ground
 Motion

16:35 - 17:00	Thomas Heaton and Anna Olsen (Caltech)
	End-to-End Simulations of Tall Buildings in Large California
	Earthquakes
17:00 - 17:25	Saburoh Midorikawa (Tokyo Tech.),
	Toshiyuki Masatsuki, Michihiro Ohori, and Hiroyuki Miura
	Simulation and Shaking Table Test for Seismic Behavior of Office
	Furniture in Super-high-rise Building due to Long-period Ground
	Motion

18:00 - 20:30 Reception

### November 9 (Friday)

### Velocity Structure

09:00 - 09:25	<ul><li>T. M. Brocher (USGS), C. Thurber, H. Zhang, G. Lin, P. Shearer,</li><li>E. Hauksson, F. Waldhauser, D. Schaff, and J. Hardebeck</li><li>Progress Towards a Comprehensive Crustal Seismic Velocity Model</li><li>for the State of California, USA</li></ul>
09:25 - 09:50	Kazuki Koketsu and Hiroe Miyake (ERI, Univ. Tokyo) Proposal for a Standard Procedure of Modeling 3-D Velocity Structures in Japan
09:50 - 10:15	Toshiro Tanimoto, Tomoko Yano, and Melissa Eitzel (UCSB) Using Seismic Noise for the Purpose of Constraining Shallow S-wave Velocity Structure
10:15 - 10:25	Coffee Break
10:25 - 10:50	Ken Xian-Sheng Hao and Hiroyuki Fujiwara (NIED) Sedimentary Thickness in the Eastern Kanto Basin Estimated by All-pass Receiver Function Using Dense Strong-Motion Observations

- 10:50 11:15 T. M. Brocher (USGS), R. W. Simpson, B. Aagaard, S. Hartzell,
  S. C. Harmsen, A. J. Rodgers, and D. Dreger
  Testing the USGS Northern California Seismic Velocity Model
- 11:15 11:40 Arthur Rodgers (LLNL), Morgan Moschetti, Michael Ritzwoller, and Anders Petersson Modeling Long-Period Ground Motions From Moderate Earthquakes and Empirical Green's Functions to Evaluate the USGS Three-Dimensional Seismic Velocity Model of the San Francisco Bay Area
- 11:40 11:50 *Coffee Break*

#### **Future Prospects**

- 11:50 12:15 Kojiro Irikura (Aichi Inst. Tech.)
  Achievements and Overviews of Long-period Ground Motion
  Prediction and Damage Potential Map for Great Subduction
  Earthquakes
- 12:15 12:40 Ralph J. Archuleta, Daniel Lavallée, and Jan Schmedes (UCSB)Why It Is Necessary To Use Dynamic Simulations To GuideBroadband Predictions of Ground Motion
- 12:40 12:50 Closing
- 12:50 13:30 Lunch

# Proceedings

Integrated Simulation of Long-Period Ground Motions and Tsunami	
Generating from Subduction Zone Earthquakes	
Takashi Furumura and Tatsuhiko Saito	
3D Crustal Structure and Long-period Ground Motions	3
From a M9.0 Megathrust Earthquake in the Pacific Northwest Region	
Kim B. Olsen, William J. Stephenson, and Andreas Geisselmeyer	
Multi-Component 1D Viscoelastic FDM for Plane-Wave Incidence	13
Hiroshi Takenaka and Arash JafarGandomi	
Large Scale Earthquake Simulations in California	21
Robert Graves, Brad Aagaard, and Ken Hudnut	
Application of Earthquake Early Warning System to a High-Rise Building	27
in Tokyo, Japan, Considering Long-Period Strong Ground Motion	
Yoshiaki Hisada, Tomohiro Kubo, Shigeki Horiuchi,	
and Shunroku Yamamoto	
Simulation and Shaking Table Test for Seismic Behavior of Office Furniture in	33
Super-high-rise Building due to Long-period Ground Motion	
Saburoh Midorikawa, Toshiyuki Masatsuki, Michihiro Ohori,	
and Hiroyuki Miura	
Progress Towards a Comprehensive Crustal Seismic Velocity Model	35
for the State of California, USA	
T. M. Brocher, C. Thurber, H. Zhang, G. Lin, P. Shearer, E. Hauksson,	
F. Waldhauser, D. Schaff, and J. Hardebeck	
Proposal for a Standard Procedure of Modeling 3-D Velocity Structures in Japan	41
Kazuki Koketsu and Hiroe Miyake	

Using Seismic Noise for the Purpose of Constraining	
Shallow S-wave Velocity Structure	
Toshiro Tanimoto, Tomoko Yano, and Melissa Eitzel	
Sedimentary Thickness in the Eastern Kanto Basin Estimated by	49
All-pass Receiver Function Using Dense Strong-Motion Observations	
Ken Xian-Sheng Hao and Hiroyuki Fujiwara	
Testing the USGS Northern California Seismic Velocity Model	53
T. M. Brocher, R. W. Simpson, B. Aagaard, S. Hartzell, S. C. Harmsen,	
A. J. Rodgers, and D. Dreger	
Modeling Long-Period Ground Motions From Moderate Earthquakes and	59
Empirical Green's Functions to Evaluate the USGS Three-Dimensional Seismic	
Velocity Model of the San Francisco Bay Area	
Arthur Rodgers, Morgan Moschetti, Michael Ritzwoller,	
and Anders Petersson	
Why It Is Necessary To Use Dynamic Simulations To Guide	63
Broadband Predictions of Ground Motion	
Ralph J. Archuleta, Daniel Lavallée, and Jan Schmedes	
Achievements and Overviews of Long-period Ground Motion Prediction and	69
Damage Potential Map for Great Subduction Earthquakes	
Kojiro Irikura	
End-to-End Simulations of Tall Buildings in Large California Earthquakes	71
Thomas Heaton and Anna Olsen	