SPICE Task Group Meeting
New Methods and Digital Library
München July 18 – 20, 2005

The SPICE Code Validation

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SPICE Code Validation

Zürich meeting March 10 - 11, 2005

- Local Scale Task Group (coord. Martin Mai)
- Focus Group – Code Validation (coord. Peter Moczo)

Bratislava "meeting" May 18 - 20, 2005

- Jean-Paul Ampuero, Jozef Kristek, Martin Gális, Peter Moczo
- review of the SCEC Code Validation
- elaboration of the SPICE Code Validation

General Remarks
on
SPICE Code Validation

The SPICE Code Validation and the Model Sets
should serve as a long-term basis
(even after the SPICE project is completed)
for possible tests and comparisons

The possibility to test methods/codes
should be open and user-friendly
for anybody interested
in the use of the SPICE Code Validation models

The Model Sets should be designed such that
new models could be added
in correspondence with progress
in the numerical modeling methods

General Remarks
on
SPICE Code Validation

Elaboration of the SPICE models
started with the evaluation of the SCEC Code Validation

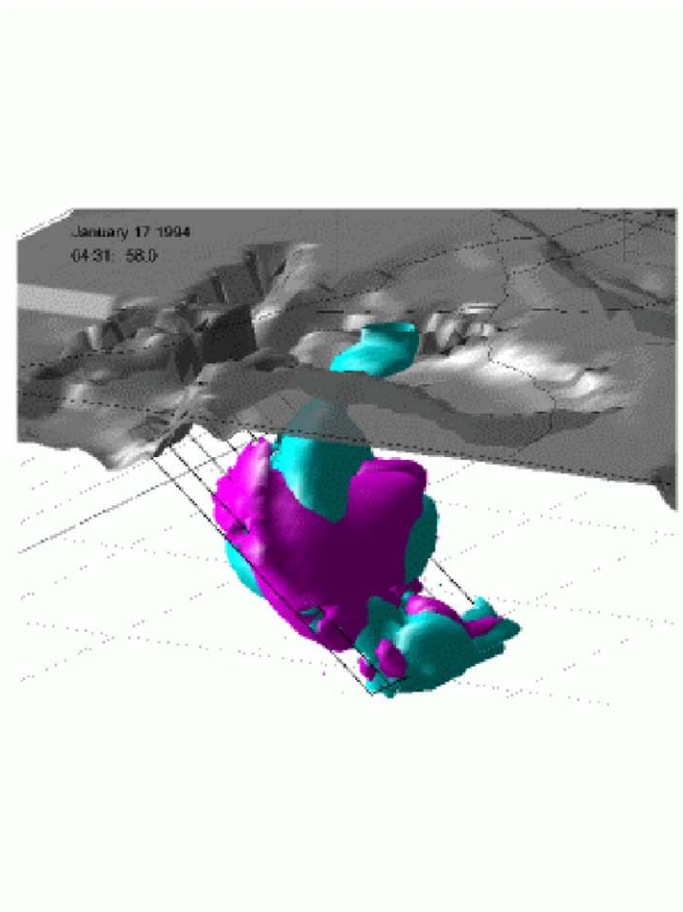
Based on the evaluation of the SCEC Code Validation
and
capabilities of recent numerical-modeling methods
two model sets were elaborated:

Wave Propagation (WP) Model Set

Source Dynamics (SD) Model Set

SCEC

3D Numerical Simulation Code Validation Project



The purpose of this project is to validate 3D earthquake ground motion simulation methods and to foster their integration into engineering applications. This is a coordinated, multi-institutional investigation funded by the Pacific Earthquake Engineering (PEER) Center and the Southern California Earthquake Center (SCEC). It involves researchers from Carnegie-Mellon University (CMU), University of California, Berkeley (UCB), Lawrence Livermore National Laboratory (LLNL), URS Corporation (URS), San Diego State University (SDSU), and University of California, Santa Barbara (UCSB).

Numerical simulations of wave propagation can now be done in three dimensions for models with sufficient realism (e.g., three-dimensional geology, propagating sources, frequencies approaching 1 Hz) to be of engineering interest. However, before numerical simulations can be applied in the context of engineering studies or seismic hazard analysis, the numerical methods and the models associated with them must be thoroughly validated.

The current phase of this project focuses on validation of the underlying numerical methodologies and computer programs employed in numerical modeling of earthquake ground motion from propagating earthquakes in 3D earth models. This involves testing through a sequence of problems of increasing complexity. These range from idealized sources in flat-layered earth structures through propagating earthquake sources in a complex 3D seismic velocity model. The various problems are described in detail in a separate section, together with results of the simulations, for possible use by interested readers.

	WCC1	CMU	UCSB	WCC2	LLNL/UCB
Type	Finite Difference	Finite Element	Finite Difference	Finite Difference	Finite Difference
Mesh structure	structured	unstructured	structured	structured	structured
Mesh geometry	cubic lattice (variable grid option) staggered	linear tetrahedra	cubic lattice, staggered	cubic lattice (variable grid option) staggered	cubic lattice, staggered
Accuracy (space/time)	4/2	2/2	4/2	4/2	4/2
Free surface boundary	zero-stress	natural b.c.	zero-stress	zero-stress	zero-stress
Artificial boundaries	plane-wave approximation	plane-wave approximation	Perfectly-matched layers	plane-wave	paraxial approx.
Anelastic attenuation	Maxwell solid OR coarse-grain M.V.	Rayleigh damping	coarse-grain M.V.	Maxwell solid	standard linear solid
Key References	A	B	C	D	E
Author contact	R. Graves Robert_Graves@ URSCorp.com	J. Bielak jbielak@ cmu.edu	K. Olsen kbolsen@ crustal.ucsb.edu	A. Pitarka Arben_Pitarka@ URSCorp.com	S. Larsen larsen8@ llnl.gov

Show the table with the SCEC models !

SCEC_review.xls

SPICE Wave Propagation Model Set

SPICE Subset WP I

Simplest canonical models designed to test accuracy of the schemes/codes with respect to individual factors/features of the models including ABCs

(*includes SCEC_UHS1 and SCEC_UHS2*)

SPICE Subset WP II

Canonical models combining two or more basic structural features

(*includes SCEC_LOH1 and SCEC_LOH3*)

SPICE Subset WP III

Realistic models

(*includes SC_2.1 and SC_2.2*)

SPICE Subset WP I

Simplest canonical models designed to test accuracy of the schemes/codes with respect to individual factors/features of the models including ABC (includes SCEC_UHS1 and SCEC_UHS2)

- homogeneous elastic space : dispersion, local error

- homogeneous viscoelastic space : incorporation of attenuation

- 2 homogeneous halfspaces : planar interface

    coinciding with a grid plane
    parallel with a grid plane
    non-parallel with a grid plane

    elastic interface
    viscoelastic/pure_Q interface

- homogeneous halfspace : free surface

- homogeneous anisotropic elastic space : anisotropy

SPICE Subset WP II

Canonical models combining two or more basic structural features
(includes SCEC_LOH1 and SCEC_LOH3)

- layer over halfspace : planar interface + free surface

  coinciding with a grid plane
  parallel with a grid plane
  non-parallel with a grid plane

  elastic and viscoelastic

  source inside layer, source in the halfspace

- layer over halfspace : gradient in velocity / Q

- layer over halfspace : random velocity distribution

- soft inclusion in a halfspace : lateral heterogeneity

  interfaces coinciding with a grid plane
  parallel with a grid plane
  non-parallel with a grid plane

SPICE Subset WP II – *Continued*

Canonical models combining two or more basic structural features
(includes SCEC_LOH1 and SCEC_LOH3)

- vertical (fault) layer in a halfspace

- free-surface topography :

  Gaussian hill
  cliff
  slope

SPICE Subset WP III

Realistic models

(includes SC_2.1 and SC_2.2)

- Colfiorito, Central Italy : laterally bounded sedimentary basin

- Grenoble, France : deep Alpine valley

- ?

SPICE Source Dynamics Model Set

geometry
(visco)elastic parameters
friction laws
initial stress
nucleation

SPICE Subset SD I

simplest canonical models

SPICE Subset SD II

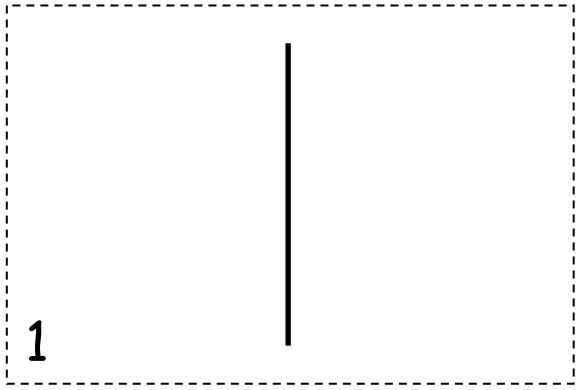
canonical models

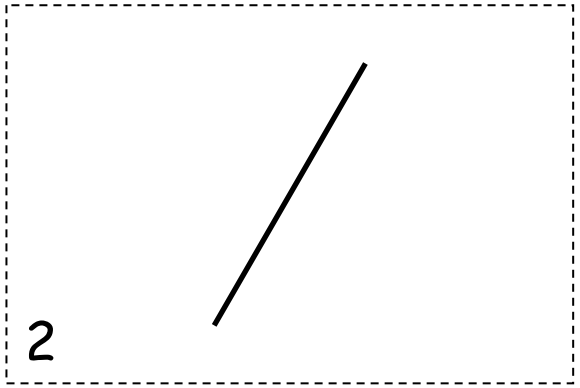
SPICE Subset SD III

realistic models

SPICE Subset SD I

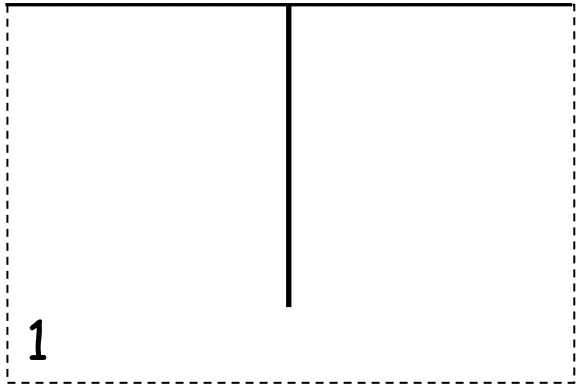
simplest canonical models

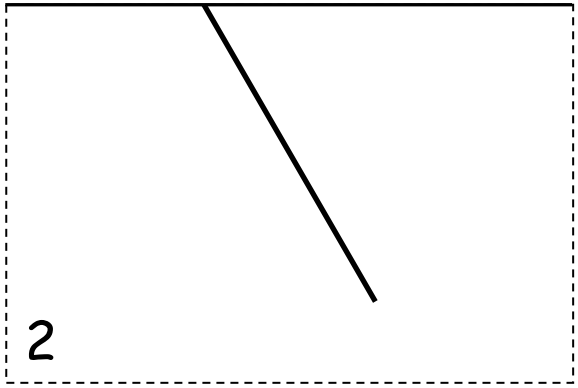


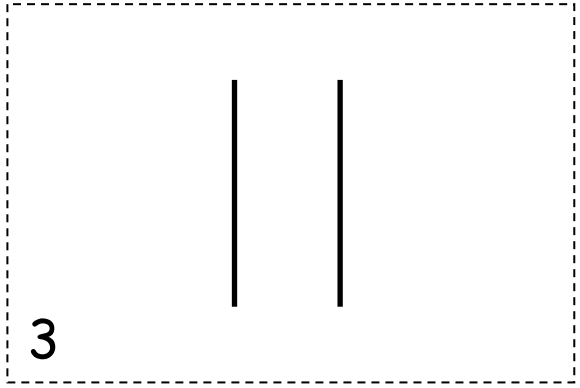


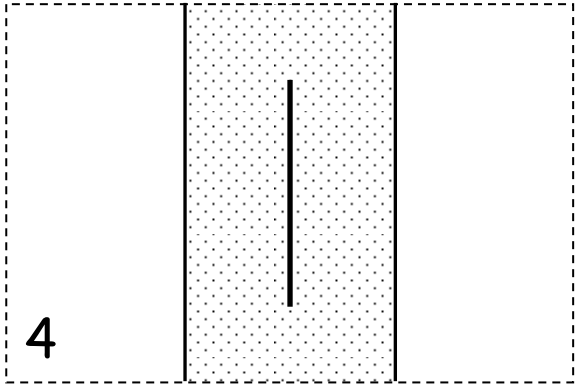
SPICE Subset SD II

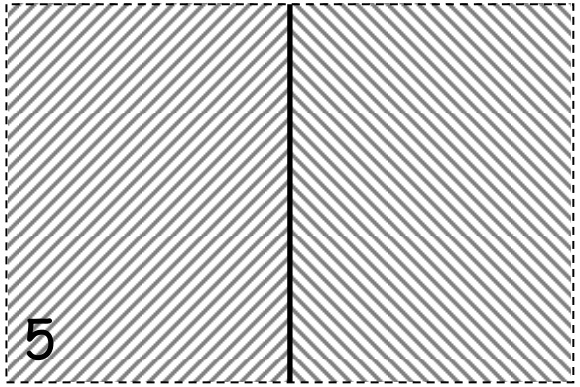
canonical models

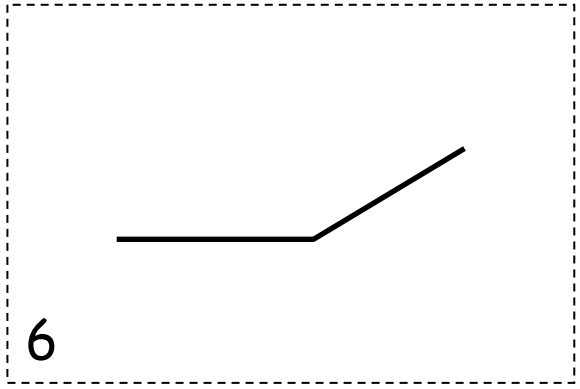


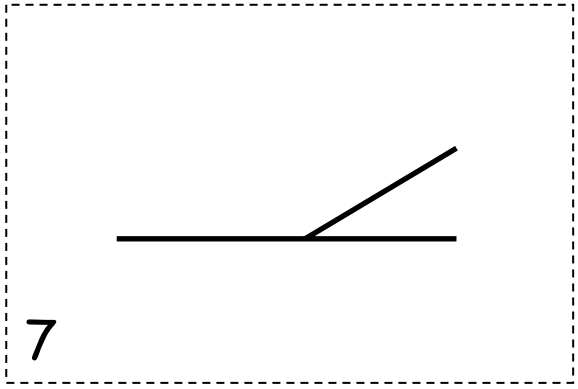


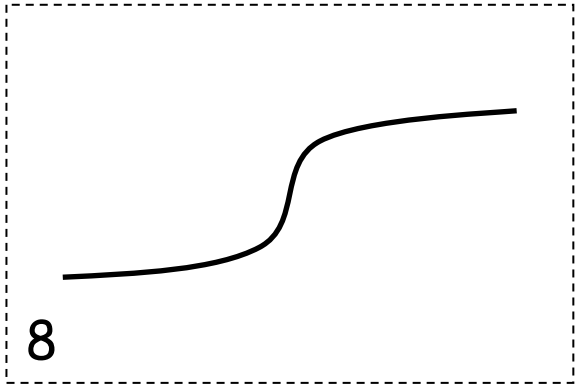






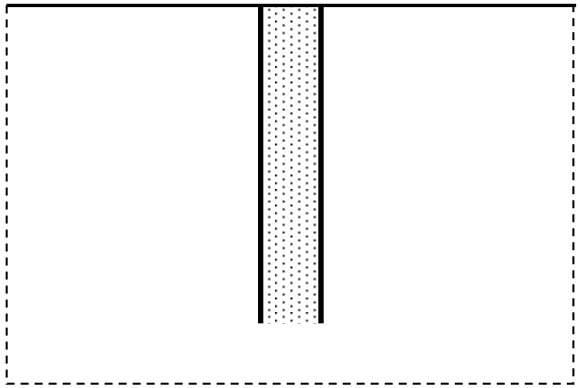






SPICE Subset SD III

Realistic Models



SPICE Code Validation

proposal
will be presented at

the SPICE R&T Workshop II
in Smolenice