Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SSS023-05 Room:IC Time:May 23 09:30-09:45

Benchmark Tests for Strong Ground Motion Simulations (Part 8: Stochastic Green's Function Method, Step 3 & 4)

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Since 2009, we performed a benchmark test for the strong motion simulation methods as three years project (Hisada et al., 2011; Yoshimura et al., 2011; Kato et al., 2011). This paper shows the results using stochastic Green's function method.

We have carried out two steps of simple benchmark tests in 2009; one is a point source (step 1) and the other is extended sources (step 2) in homogeneous and two-layered subsurface structures. Radiation coefficient of the source is assumed to be frequency independent, and only SH wave is considered. Site amplification is calculated assuming normal incidence of SH wave. Six groups of researchers/engineers were participated in by using their own methods/codes. Since the simple model is used in the step 1 and 2, all the results calculated by six teams generally show good agreement to each other (Kato et al., 2011).

In step 3 and step 4, more complicated analytical conditions are considered as shown in Table 1. Frequency dependent radiation coefficient of the source is applied, which is the most different conditions in comparisons with step 1 and step 2. Since oblique incidences of both SH and SV waves are considered, vertical component is also generated in addition with horizontal components. All the results of the point source (step 3) and the extended sources (step 4) generally show good agreement to each other in spite of complicated analytical conditions. As for the step 4, we confirmed that the introduction of the random rupture times at the sub-faults are effective to avoid the artificial predominant frequencies caused by the regular intervals of the rupture times. We also found the serious sags in Fourier amplitudes in the middle frequency range around 1 Hz, as compared with the omega-squared model. Since the sags underestimate synthesized amplitude, this problem has to be improved in the future. Synthesized amplitude shows variation in particular frequencies, because random numbers are used in generating time histories and so on. When applying the stochastic Green's function method, this variation should be in mind. Please check the following web site for more details.

http://kouzou.cc.kogakuin.ac.jp/test/home.htm

Acknowledgments:

This project is in part supported by a research fund of Ministry of Education, Culture, Sports, Science and Technology of Japan (MIEXT), the Research Subcommittees on he Earthquake Ground Motion of the Architectural Institute of Japan, and the Research Center of Urban Disaster Mitigation (UDM) of Kogakuin University.

References:

Hisada et al., benchmark tests for strong ground motion prediction methods -Case for theoretical methods (Part 1)-, AIJ J. Technol. Des. Vol. 17, No.35, 43-48, 2011.

Kato et al., benchmark tests for strong ground motion prediction methods: Case for stochastic green's function method (Part 1), AIJ J. Technol. Des. Vol. 17, No.35, 49-54, 2011.

Yoshimura et al., benchmark tests for strong ground motion prediction methods: Case for numerical methods (Part 1), AIJ J. Technol. Des. Vol. 17, No.35, 67-72, 2011.

Table 1　Benchmark tests for stochastic green's function method in 2010

	ステップ3（点震源）				ステップ4（面震源）			
モデル名	S31	S32	S33	S34	S41	S42	S43	S44*
地盤	一様地盤	２層地盤		４層地盤	２層地盤			
入射角	鉛直	斜め入射			斜め入射			
Q値	なし	あり			あり			
震源	点震源				横ずれ断層		逆断層	横ずれ断層
ﾗﾃﾞｨｴｰｼｮﾝ (SH & SV)	振動数(f)一定		振動数(f)依存		振動数(f)依存			任意
破壊開始時間					一定	ランダム	一定	
有効振動数	0～20 Hz				0～20 Hz			
出力点	000, +002, +006, +010（計４点）				000, ±002, ±006, ±010（計7点）			
出力成分	水平2成分	水平・上下3成分			水平・上下3成分			
乱数の設定	各自の乱数３パターン				各自の乱数３パターン			

注*）S44はオプションケースで自由参加。近地項や中間項の考慮など各自のオリジナル手法を考慮

Keywords: Strong motion prediction methods, Benchmark tests, Stochastic Green's function method, Random numbers, Point source, Fault model