3-DIMENSIONAL SOURCE ZONES PROBABILISTIC SEISMIC HAZARD ANALYSIS FOR JAKARTA AND SITE-SPECIFIC RESPONSE ANALYSIS FOR SEISMIC DESIGN CRITERIA OF 45-STOREY PLAZA INDONESIA II BUILDING

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ABSTRACT

Probabilistic Seismic Hazard Analysis (PSHA) for city of Jakarta and Site-Specific Response Analysis (SSRA) to derive seismic design criteria for 45-storey Plaza Indonesia II Building have been conducted by the authors. The analysis was conducted to provide recommendation of design response spectra of the tower building. The PSHA has been conducted considering 3-Dimensional source zones model using EZ-FRISK computer program. The PSHA has considered the tectonic setting, regional geology, and seismicity of the site of interest. In this analysis, seismic source characterization of both subduction sources in the south and shallow crustal faults within radius of 500km from city of Jakarta has been made. The subduction earthquake sources characterization consist of separate identification of megathrust and benioff geometry. The seismic characterization has provided seismic source zones, each zone representing potential seismic source that will provide probability contribution to the site of interest. Appropriate attenuation functions have been adopted in the PSHA. Young's et al. (1993) attenuation function has been adopted to represent the subduction earthquake source. While, combination of Sadigh et al (1997), Idriss (2004), and Boore et al. (1997) attenuation functions have been adopted for shallow crustal seismic sources. In addition, both exponential and characteristic recurrence models have been adopted. Some uncertainties are minimized through logic-tree methodology.

For the purpose of wave propagation analysis in the SSRA, dynamic soil properties are obtained through Seismic Downhole Test (SDT) to depth of 50 meters at two borehole locations. The SDT has provided shear wave velocity (Vs) profile. Seismic input motions were generated through spectral matching techniques to the target spectra obtained from the PSHA. De-aggregation in the PSHA is the basis for developing scenario earthquake input motion representing subduction and shallow crustal for input to the SSRA.

Results of PSHA and SSRA provide recommendation on design response spectra at ground surface for the hazard level of 475 years return period earthquake. The design response spectra was developed using five input motions with scaling of both subduction and shallow crustal earthquake input motion considering various periods of interest of the structures. The recommended design spectra is compared to that of SNI-1726-2002 and UBC97 for the range of the period of interest of the proposed tower. It is indicated that response spectra resulted from the analysis fall within the range of that of S_D and S_E site class of both SNI-1726-2002 and UBC97.

KEYWORDS: probabilistic seismic hazard, site-specific response, response spectra, wave propagation, subduction, shallow crustal, input motion, seismic down-hole, shear wave velocity.

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ABSTRAK

Probabilistic Seismic Hazard Analysis (PSHA) untuk kota Jakarta dan *Site-Specific Response Analysis (SSRA)* untuk criteria disain seismik Gedung 45-lantai Plaza Indonesia II telah dilakukan oleh penulis. Analisis dilakukan untuk memberikan rekomendasi spectral respon disain dari rencana gedung. PSHA dilakukan dengan mempertimbangkan sumber-sumber gempa geometri 3-Dimensi dengan bantuan program EZ-FRISK. PSHA telah memperhitungkan *tectonic setting*, geologi regional, dan seismisitas dari lokasi. Dalam analisis ini, karakterisasi sumber gempa berupa subduksi di Selatan Jawa dan patahan dangkal dalam radius 500 km dari Jakarta telah diperhitungkan. Karakterisasi dan identifikasi sumber gempa subduksi telah memisahkan antara geometri *megathrust* dan *benioff*. Karakterisasi seismik memberikan pemodelan zoning sumber gempa, di mana setiap zona merepresentasikan potensi sumber gempa yang akan memberikan kontribusi probabilitas ke site Jakarta. Fungsi atenuasi Young's et al. (1993) digunakan untuk merepresentasikan gempa-gempa sumber subduksi dan fungsi atenuasi Sadigh et al (1997), Idriss (2004), dan Boore et al. (1997) merepresentasikan gempa-gempa sumber patahan dangkal. Selanjutnya, hubungan *recurrence* menggunakan model eksponensial dan karakteristik. Usaha meminimalkan beberapa ketidakpastian yang ada dilakukan dengan metoda *logic-tree*.

Untuk perambatan geolombang seismic dalam SSRA, maka telah dilakukan Seismic Downhole Test (SDT) sampai kedalaman 50m untuk mendapatkan parameter dinamik tanah, yaitu cepat rambat geolombang geser tanah. Input motion untuk SSRA dikembangkan dari teknik spectral-matching dari spectra target hasil PSHA. De-agregasi dalam PSHA adalah dasar dari pengembangan scenario input motion gempa yang merepresentasikan gempa sumber subduksi dan patahan dangkal.

Hasil dari PSHA dan SSRA memberikan rekomendasi spektrum respon di permukaan tanah untuk level hazard (periode ulang) gempa 475 tahun. Spektrum respon disain dikembangkan berdasarkan 5 input motion yang diskalakan untuk gempa subduksi dan patahan dangkal dengan juga mempertimbangkan berbagai kemungkinan periode dari struktur. Spektrum respon disain yang direkomendasikan ini dibandingkan dengan spectrum respon SNI-1726-2002 dan UBC97. Ditunjukkan bahwa hasil dari spectrum respon kajian ini berada di antara spectrum respon untuk site class S_D dan S_E baik SNI-1726-2002 maupun UBC97.

KATA KUNCI: *hazard* gempa probabilistik, respon-spesifik site, spektrum respon, perambatan gelombang, subduksi, patahan dangkal, *input motion*, *seismic downhole*, kecepatan rambat gelombang geser.