MAPS OF CORNER PERIOD (Tc) OF RESPONSE SPECTRA IN CITY OF JAKARTA

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ABSTRACT: The seismic response of deep soil surface layers is of concern in developing the seismic microzonation in Jakarta. The present studies show that the thick sedimentary layer in Jakarta may locally up to 750 m, which means the effect of bedrock depth on site characterization for this typical of site is importance. To develop design response spectra for structures, the present building codes are now based on short-period (0.2 sec) and long-period (1.0 sec) spectral accelerations instead of basing design spectra on the effective peak acceleration (EPA) and effective peak velocity (EPV). For differences in this basing design spectra, the corner period (Tc) of the response spectra provides the most stable information on the frequency contents of the ground motion. From our study, for 2475 years design response spectra, the general tendency appears to consist in larger values of Tc (Tc > 1.0 sec) in the several parts of Jakarta, in particular in the eastern region. These results are based on 1-D site response analysis performed at 383 borehole sites. The modified earthquake acceleration time histories were adopted in this study.
Keywords: Deep soil layer; site response analysis; design response spectra; corner period.

1. INTRODUCTION

To construct the smooth response spectra for design purposes, the use of a constant Sa for short periods of response, constant Sv for the mid range, and constant Sd for long period response had been compensated for the peaks, valleys, and shape variations in actual response spectra (Newmark and Hall, 1982). In earlier, ATC-3-06 proposed the effective peak acceleration (EPA) and effective peak velocity (EPV) to account the differences in the high and low frequency characteristics of ground motions to be used in developing of the design response spectra for structures. In present time, the building codes are now based on short-period (0.2 sec) and long-period (1.0 sec) spectral accelerations. For example, S_{D1} and S_{DS} are the spectral response design values adopted in FEMA 302. The value of corner period (Tc) and the spectral acceleration value (SA) in mid range of design spectrum shall be as given by the following equation:

$$Tc = S_{D1}/S_{Ds} \quad (1)$$

$$Sa(T>Tc) = S_{D1}/T \quad (2)$$

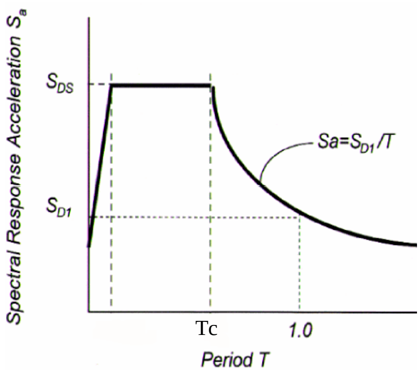
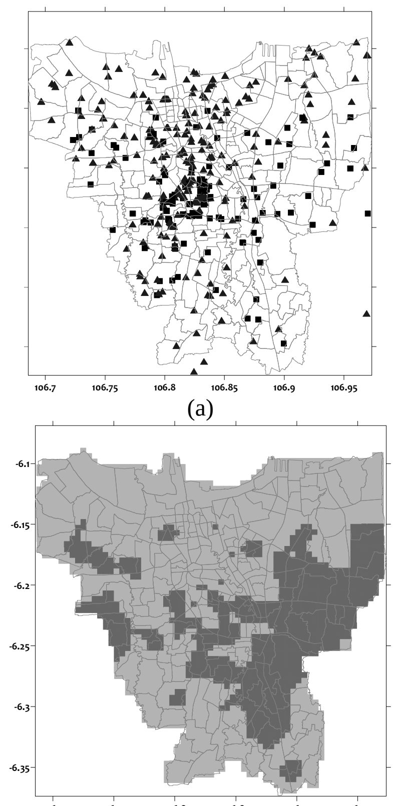


Figure 1 Design response spectrum (FEMA, 1997)

Then, the curve will be constructed from the parameter above. The equation force the S_{d1} value to be lower than S_{ds} value. So, Tc value will not greater than 1.0. From our study, for 2475 years design response spectra, the general tendency appears to consist in larger values of Tc (Tc > 1.0 sec) in the several parts of Jakarta. These results are based on 1-D site response analysis performed at the borehole sites.

2. METODOLOGY

For estimating ground acceleration at ground surface in Jakarta, the site response analysis is performed. One of the most important steps in the analysis is site characterization. The average of standard penetrate blow count numbers (N) value up to 30 metres is a common parameter for classifying sites. The classifications according to the Indonesian seismic building codes (SNI-1726-2012) show that most of location in Jakarta (based on 383 geotechnical boring sites) is classified as the soft soil site (SE) and medium soil (SD) with average N value less than 15 and ranging from 15 to 30 respectively (Figure 2).



(b)

Figure 2 The distribution of borehole points in Jakarta and the contour of site classification based on N values (SE site = triangle symbol or grey colour; SD site = square symbol or black colour)

The shear wave velocity (Vs) distribution with depth determined by utilizing available N in boreholes is established using the empirical relationship proposed by Ohta & Goto (1978), Imai & Tonouchi (1982). These empirical relationships have been selected since they involve all soil types. The variations of Vs values with depth for formations in 383 borehole sites are then given in Figure 3.

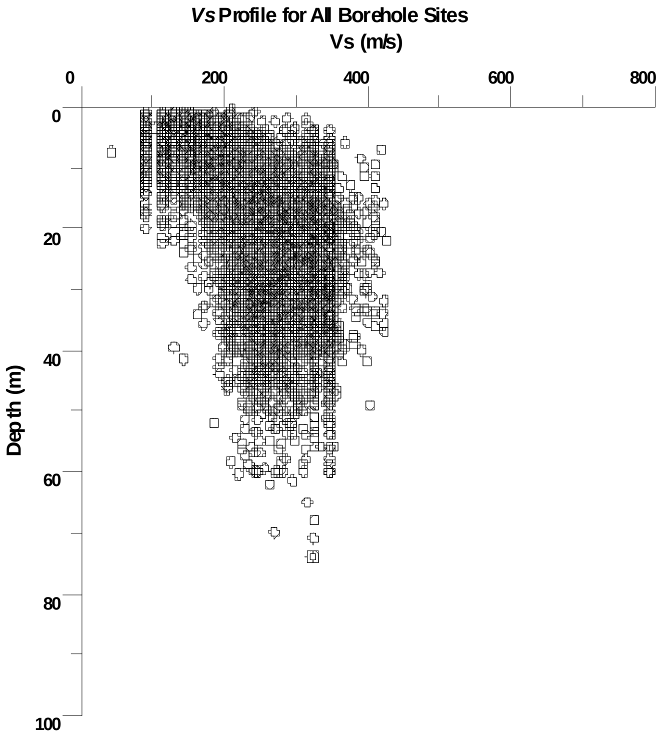


Figure 3 Shear wave velocity profile across Jakarta from all borehole sites

Site response analyses were performed at 383 borehole sites. Representative shear wave velocities were determined for each layer using estimated Vs along boreholes. All of the boreholes failed to reach the engineering bedrock. Therefore a layer representing engineering bedrock deposits was included into each shear wave velocity profile, with Vs of 760 m/s. In this case, extrapolation of Vs values from end of boreholes to layer representing engineering bedrock has to be done. The base of the soil columns constructed down between 350 to 750 m depth as information from the depth to engineering bedrock beneath Jakarta. Borehole sites were modelled by NERA (Bardet & Tobita, 2001). As input data the interval Vs as well as the mass density of soil (ρ) and thickness of each layer were used. For each soil types, the shear modulus reduction and damping ratio curves that default by NERA were used in this study. The strong motion was considered to be the the rock outcropping for modelling purposes.

3. RESULT

The map contour of the effective peak acceleration (EPA) and the effective peak velocity (EPV) at the ground surface are obtained from plots of result of site response analysis on 383 borehole sites. The EPA and EPV are calculated from 0.4 value of the maximum values of the response spectra averaged on a 0.4 s period mobile window. The Tc value then estimates from the following equation:

$$Tc = \frac{2\pi.EPV}{EPA} \qquad (3)$$

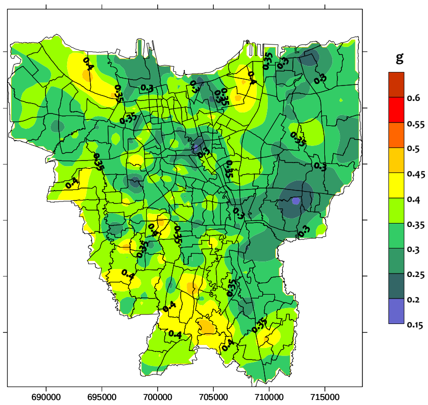


Figure 4 The contour of EPA value at ground surface in Jakarta city with 2% probability of exceedance in 50 years

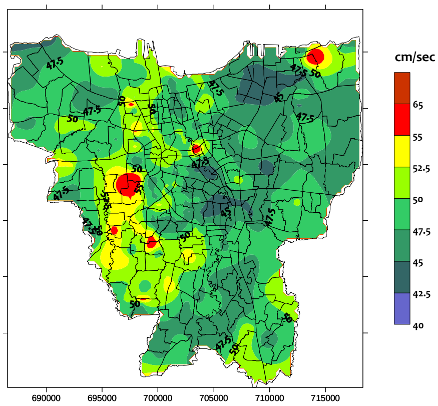


Figure 5 The contour of EPV value at ground surface in Jakarta city with 2% probability of exceedance in 50 years

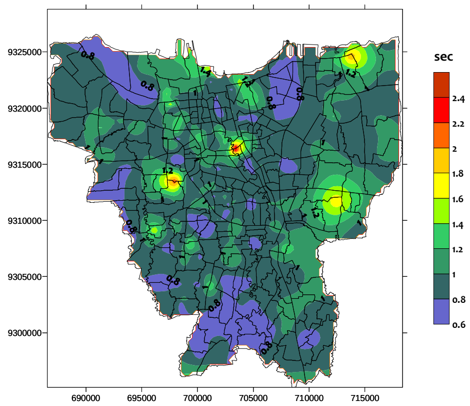


Figure 6 The contour of Tc value at ground surface in Jakarta city with 2% probability of exceedance in 50 years

4. CONCLUSION

The input PGAs of rock outcrop motions are varied from 0.1g to 0.4g and the output EPAs of surface motions are varied from 0.15g to 0.5g. For 2475 years design response spectra, the general tendency appears to consist in larger values of Tc (Tc > 1.0 sec) in the several parts of Jakarta, in particular in the eastern region. Which mean, the larger values of Tc would give the S_{D1} value greater than S_{DS} value that affect the effectiveness of the combination of 2 equations (equation 1, equation 2) adopted by the code for constructing the smooth response spectra for design purposes.

5. REFERENCES

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