EFFECTS OF WATER TABLE FLUCTUATION ON THE VARIATION OF LIQUEFACTION POTENTIAL IN SEDIMENTARY DEPOSITS

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INTRODUCTION

Soil liquefaction often occurs in sedimentary deposits when loosely packed sandy or silty materials saturated with water are shaken hardly enough to lose their strength and stiffness. Liquefaction depends mainly on two factors, namely the nature of shaking (intensity and duration) and the material susceptibility to liquefaction. Liquefaction-related ground failure historically has caused extensive structural and lifeline damage in urbanized areas around the world. Recent examples of these effects include damage produced during the 1989 Loma Prieta (USA), the 1994 Northridge USA), the 1995 Kobe (Japan), the 1999 Izmit Earthquake (Turkey), the 2010-2011 Christchurch Earthquakes (New Zealand) and the 2011 Off the Pacific Coast of Tohoku Earthquake (Japan). These and other historical earthquakes revealed that the distribution of liquefaction-induced damage is not random, but generally is restricted to susceptible layers including reclaimed fill, non-engineered fill, alluvial Holocene deposits, beach deposits, recent fluvial deposits, and floodplain deposits. Each of these depositional environments generally produces a loose deposit of sand and contain low-density saturated, granular sediments. Any area may be characterized as a high liquefaction or low liquefaction potential depending on the specific soil properties, water table level, and earthquake motion characteristics. In this study all the factors are keep constant, in order to analyze the role of water table fluctuation on the liquefaction potential of sedimentary deposits. Furthermore, this study compute the aging effects of soil on the liquefaction potential.

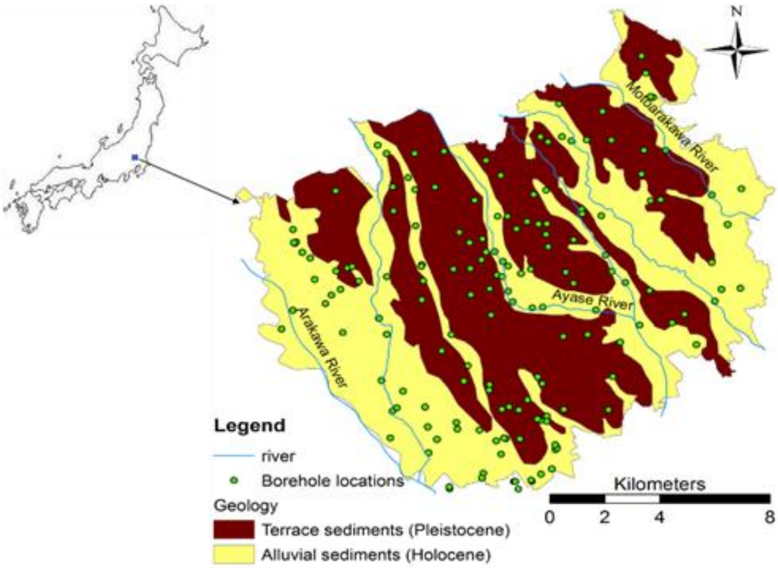

Fig. 1 Study area with locations of borehole points.

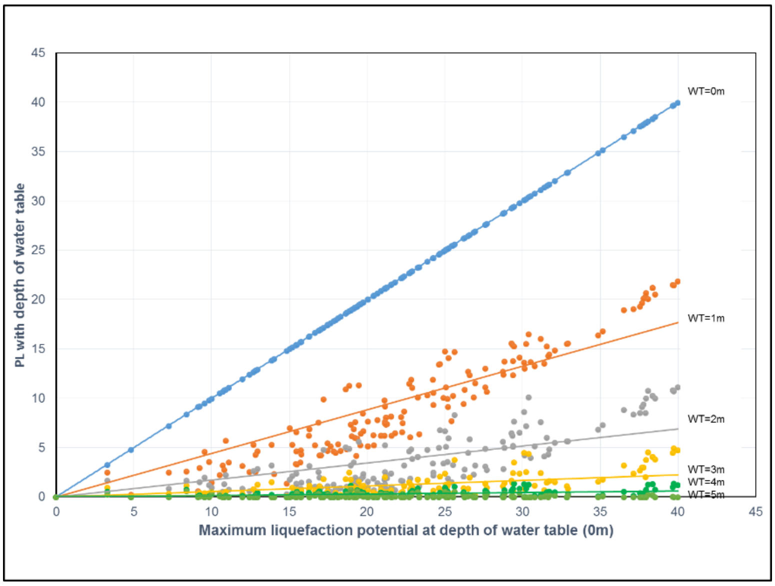

Fig. 2 Change in liquefaction potential with depth of water table

METHODOLOGY, RESULT AND DISCUSSION

Saitama city, the capital and most populated city of the Saitama prefecture in Japan, was selected as the study area. Geologically the city is a sedimentary basin composed of Neocene and quaternary formations surrounded by pre-Neocene and early Miocene formations in the Kanto mountains. There are two distinct types of lithology in the study area: Holocene alluvial sediments and Pleistocene terrace sediments as shown in Fig.1.

In this study, geotechnical data such as *N*-value, soil types, average density, depth of water table etc., were collected from 126 boreholes (Fig. 1) and used them to calculate the liquefaction potential. Then, the

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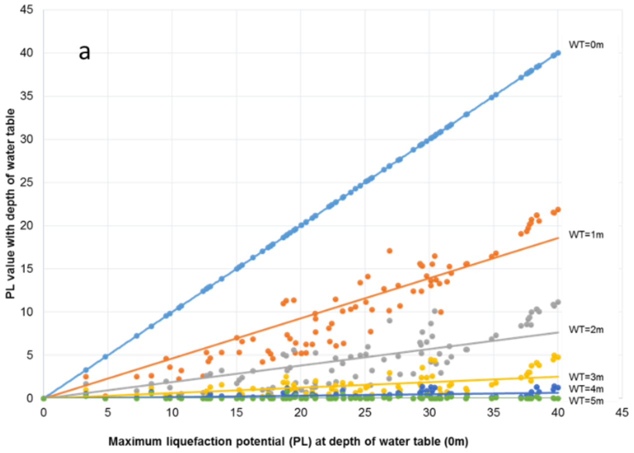

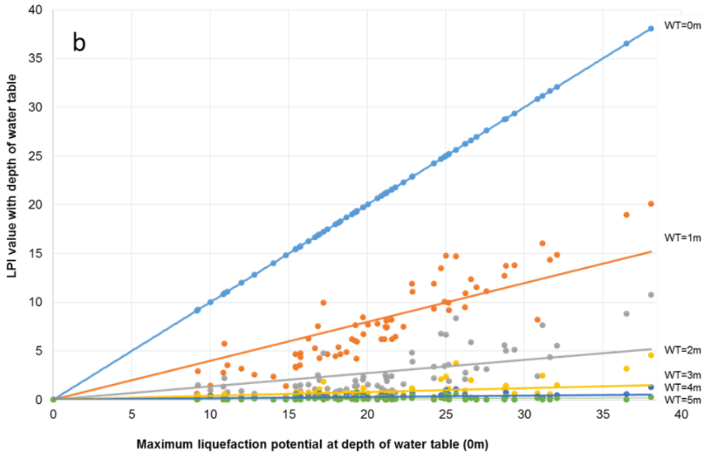

Fig. 3 Typical change in liquefaction potential with depth of water table: (a) Terrace land (b) Lowland

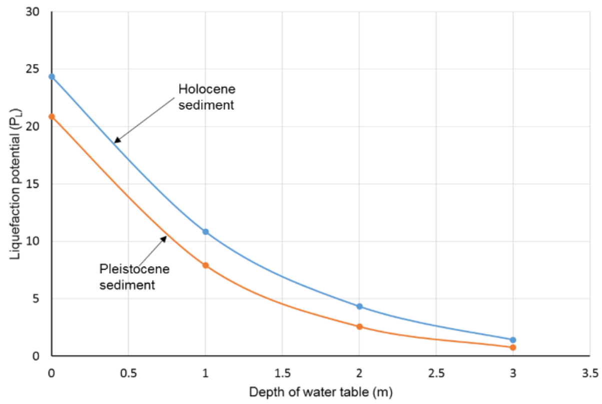

Fig. 4 Change of liquefaction potential with depth of water table for different aged soil

liquefaction resistance (F_L) was evaluated according to the Road Bridge manual (2012). In the analysis, the fine contents of the soil was estimated by using the relationship proposed by Kamai et al. (2002) for the Kanto lowland area. Moreover, the liquefaction potential at each sampled borehole location was quantified by an index called the liquefaction potential index (P_L) proposed by Iwasaki et al. (1982). Usually, liquefaction potential value is calculated based on the water table level measured at the time of in-situ N-value measurement. However, in this study, P_L calculation was made considering the seasonal variation of water table level. During the rainy season, the water table level was assumed to be at the ground surface level (i.e. depth of 0m below the ground surface) and during dry season the water level was considered to be much lower. The liquefaction potential was then calculated considering the water table depth of 0m, 1m, 2m, 3m, 4m and 5m below ground surface for each borehole. The relation of variation of P_L with water table depth is plotted in Fig.2, where the x-axis represents the maximum possible P_L for water table at 0 m below the ground surface and y-axis shows the corresponding P_L with change in water table depth. The data set shows clear trends. A 1:1 line passing through the origin is the maximum liquefaction potential line for 0m water table depth. The other trend curves with different depth of water table clearly show that the liquefaction potential decreases for lower water table depths. This suggests that if we can lower the water table, the effects of liquefaction can be drastically decreased. This result was separately analyzed for different geology units such as terrace sediments and alluvial sediments as shown in Fig 3. Both the geological units show same trend. The average value of the liquefaction potential for all the boreholes in each geological units are computed and plotted against water table shown in Fig.4. The result shows two separate curves for different aged soil. The Holocene soil shows higher liquefaction potential then Pleistocene soil for all level of water table.

CONCLUSION

The role of water table fluctuation on the liquefaction potential was analyzed by considering different depth of water table below ground surface. The liquefaction potential significantly decreases by the lowering of the water table both the types of sediments found in the study area. It was also found that the liquefaction potential calculated from the different geological unit shows higher liquefaction for Holocene soil than Pleistocene soil (age effects). Holocene alluvial sediment has very loose sediments but Pleistocene terrace sediments has comparatively denser sediments. Therefore, the characteristics of Holocene alluvial sediments are more liquefiable than terrace sediments.

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