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Assessment of Soil Liquefaction Potential at Before and After Earthquake by using the variations of Vp and Vs

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In 2010 and 2016, there were two earthquakes of magnitude Mw 6.4 occurred at different locations in Southern Taiwan but both caused soil liquefaction at a same location. Recurrence of the soil liquefaction at that same place provided us an opportunity to compare the geological variance and safety factor for evaluating soil liquefaction potential at before and after the earthquake. We conducted many seismic surveys at the same site, after both of the two earthquakes and before the earthquake of 2016. The seismic methods consisted of P wave refraction and multi-channel active source surface wave analysis (MASW) for obtaining P and S wave velocities distribution. Seismic lines were deployed across the sand boil areas and at non-liquefaction areas, respectively. The individual profiles of Vp and Vs variations were used to analyze the water-table depth, elastic modulus, porosity and safety factor values. The results were effective within 18 m deep from surface. In the S-wave velocity profiles, we may find low velocity zones (LVZs) beneath the sand boil areas but not in the P-wave profiles. The calculated water-table depths, according to the water seismic index (WSI) were confirmed by logging. Subsequently, the Poisson's ratio, shear modulus and porosity were derived from the velocity profiles. Surprisingly, at the places of sand boil area after the earthquake, LVZs and lower shear modules were observed at the lower porosity areas. Although at the sand boil area where the sand grains had been rearranged after earthquakes and should have higher velocity existed; however, we found that the property of sand with a higher Poisson's ratio could make the velocity become lower. In general, when the safety factor that commonly used to evaluate the liquefaction potential smaller than 1 would indicate where might have liquefaction occurred. As we may see from the results, right after the earthquake, the area of the safety factor values smaller than 1 migrated upward in the profiles. In addition, the phenomena could be recovered at a certain period after the earthquake. Comparing Poisson's ratio with safety factor distributions, we also found that liquefaction assessment conducted right after the earthquake could be biased. The results obtained before and after the earthquake demonstrated that properties of soil could be changed and recovered after a certain period, the safety factor values would be changed as well; potential of soil liquefaction should not be assessed right after the earthquake.