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Review of Liquefaction Potential of Sand with Plastic and Non Plastic Fines

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Abstract: ***Soil in the field or on reclaimed land usually has less silt or clay than pure sand. The effect of fraction of plastic and non-plastic fines within sand matrix on liquefaction resistance was studied in many research works. In this review paper discuss about, clean sand was mixed with plastic and non-plastic fines having different plasticity indexes (PI) and the effect of liquefaction resistance was evaluated in terms of cyclic stress ratio and Laboratory-Based Correlation between Liquefaction Resistance with fines content. A series of undrained cyclic triaxial tests were carried out on loose, medium, and dense specimen. The results shows that liquefaction resistance tended to decrease as the plasticity index of fines in the specimen increased. Liquefaction resistance of loose sample had a small effect on the plasticity index of the fines.***

Keywords: Liquefaction potential; plastic fines; non-plastic fines; cyclic stress ratio (CSR)

1. Introduction

Liquefaction phenomenon is the one of the most complex topic in geotechnical engineering. Many modern man-made structures collapsed during the earthquake without any damage to the structure. The matter was highlighted the importance of focusing on the problem of liquefaction and influencing parameters more than ever. During liquefaction, the soil mass are subjected to high pressures due to dynamic loading and acts as a fluid subjected to major deformations. Soil failure is caused by a sudden increase in pore water pressure. Saturated loose sands, which is subjected earthquake shaking, creates additional pore water pressure due to its limited density and dissipation restraint from the surrounding soils which gradually reduces its confining pressure. Eventually the confining pressure reaches zero and the loose soil the strength, liquefy and expand. The soils will later regain its strength as the excess pore water pressure decreases and stabilize. However, during the transition, the top soil and superstructure formed in the soil will be affected great distress or failures. For the past 50 years, there has been a great deal of research attention and excellence on liquefaction issues, so several attempts were made to understand the phenomena of liquefaction. However, because of the liquefaction complexity and spread issues, soil liquefaction remains a hot research topic in the geotechnical engineering profession. Particularly fine content effect soil liquefaction resistance, reliable and accurate predictive methods have to be developed.

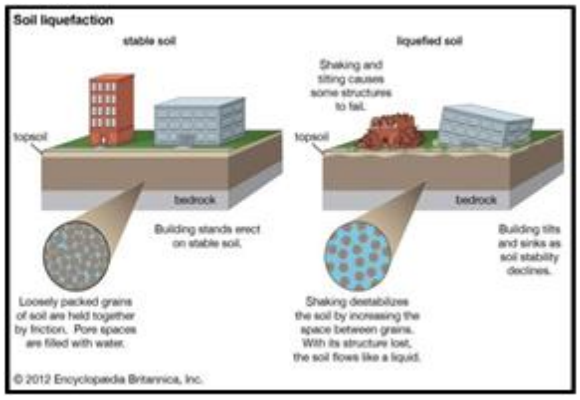

Figure 1: Soil Liquefaction

2. Literature Review

The published results of geotechnical studies were examined in order to determine the state of knowledge on the effect of fines content and plasticity on the liquefaction resistance and pore pressure generation characteristics of sandy soil.

a) The effect of plasticity index of fine content and plasticity on liquefaction resistance

Sunita Kumari and Sufyan Ghani., (2021) have provide Effect of Plasticity Index on Liquefaction Behavior of Silty Clay. Due to the dilitative character of clayey soil, the presence of plastic particles tends to increase the liquefaction resistance of a soil. Summarizes the current paper, effect of plasticity index on liquefaction alluvial soil deposit in River Ganges. Yassine Benghalia et al. (2013) have provided Liquefaction susceptibility study of sandy soils: effect of low plastic fines. The purpose of this research is to give a cyclic triaxial test investigation on the mechanical behavior of three Algerian sands, with an emphasis on the effect of fines contents. The materials employed in this study came from two separate parts of the world. When comparing clean and natural sands, the test findings show that fines have a considerable impact on liquefaction resistance.

b) The effect of non-plastic fine content

The influence of the Cyclic Stress Ratio and Critical Non-Plastic Fines Content on the Liquefaction Potential of Sandy Silt was investigated by Nabi-allah Ahmadi and Sina Safargholitabar marzuni., (2021). The current study intends to determine the effects of CSR, backpressure, the proportion of non-plastic fine-grain contents, and the influence of pressure on the saturated soil using a cyclic triaxial experiment at a constant confining pressure. According to the data, a 30 percent increase in sand was associated with a decline in liquefaction resistance, but a further increase of silt into the 60 percent sandy soils was associated with an increase in resistance to liquefaction. Layal Jradi et al., (2020) have provide Influence of low fines content on the liquefaction resistance of sands. The soils utilised in this investigation are described first, followed by the results of undrained monotonic liquefaction tests on sand specimens comprising various fine fractions. Experiments suggest that

increasing the non-plastic fines content of sand by up to 5% increase in its resistance to liquefaction. Asskar Janalizadeh Choobbasti et al., (2020) have provided Effect of fines on liquefaction resistance of sand. A series of undrained static and cyclic triaxial tests were conducted to assess the influence of non-plastic fines on the liquefaction resistance of Babolsar sand. Fine grains were present in varying proportions in the samples: 0%, 10%, 20%, 30%, and 40%. According to the test results and numerical analysis, the behaviour of the sand–silt mixture is similar to that of the clean sand sample at low percentages of silt.

c) Liquefaction susceptibility of central Kerala and effect of fine content

Sankar. N and Rangaswamy. K., (2019) have provide Liquefaction susceptibility of central Kerala. The purpose of this article is to investigate central Kerala's liquefaction susceptibility. For the analysis, field methods were used to obtain information on the soil type and standard penetration test values in the area. The results are given in terms of liquefaction factor of safety, liquefaction likelihood, lateral spreading, and vertical settlement. Studies on the Effect of Fines Content on Liquefaction Resistance Using Shake Table Tests were published by Beena. K.S et al. (2019). The purpose of this study was to conduct model experiments on locally accessible sandy soils with varying percentages of non-plastic silts using a one-dimensional shaking table. As permeability declines, liquefaction resistance improves until the limiting fines concentration is reached. Keshab Sharma et al., (2017) have provided Reconnaissance of liquefaction case studies in 2015 Gorkh (Nepal) earthquake and assessment of liquefaction susceptibility. This study presents the results of typical penetration tests for liquefied and non-liquefied sites, which were used to assess liquefaction potential. At eight liquefied and non-liquefied sites, SPT blow coumts and soil profiles were acquired. The analyses liquefaction potential results were found to be compatible with field observations. Laboratory Liquefaction Test of Sand Based on Grain Size and Relative Density has been provided by Abdul Hakam., (2016). This paper discusses the physical properties of sand soils that are connected to their vibration resistance. Vibration tests were carried out on a shaking table. The acceleration and settling of the samples were measured during shaking. Different soil densities and mean grain sizes were used in the tests. The studies demonstrated that the average particle size and relative density of sand have an impact on liquefaction resistance. The liquefaction resistance for acceleration has a density limit in relation to the mean grain size of the sand particles, which can be determined.

d) Liquefaction resistance of sand and cyclic loading

Liquefaction Resistance of Coarse Sand-FineMixtures Soil under Two-Way Cyclic Loading has been presented by Othman.B.A and Marto. A., (2020). The goal of this research is to show how coarse sand-fine mixtures behave cyclically in terms of liquefaction resistance in a two-way cyclic triaxial loading test. Cyclic loading studies with various percentages of kaolin as fines content were carried out under undrained conditions. The sand-fine mixes were prepared with a 15% relative density and tested at a 100 kPa consolidation pressure. As the fines content increased, liquefaction resistance decreased until it reached the threshold value, after which it increased.

e) The effect of fine content and plasticity on pore pressure generation

Effect of plastic and silty particles on shear behaviour and pore water pressure generation in sands by Nikheel and Rutherford. J., (2020). The purpose of this study was to see how plastic and silty particles affected the Ottawa Sands' shear strength and pore water pressure (PWP) response. The sands were mixed with plastic and silty soils in varying amounts. Fines were added in percentages ranging from 5% to a threshold weight for a constant dry unit weight and sheared in a consolidated undrained triaxial compression at a constant small strain rate (CU). The impact of fines on soil reactivity, according to the findings, varies based on the amount and type of fines employed, as well as the initial relative density of the soil.

3. Conclusion

A review of liquefaction potential investigations of sand containing plastic and non-plastic fines is presented in these publications. Existing liquefaction potential analysis methodologies and factors impacting soil liquefaction resistance were examined. The effect of fines content on soil liquefaction resistance was investigated using isotopically consolidated undrained cyclic triaxial testing. The presence of particles increases the contractive behaviour of the soil, making it more prone to liquefaction under cyclic stress. The liquefaction resistance of the sand decreases as the particles concentration rises. In the cyclic triaxial test, the number of cycles to liquefaction, relative density, fine content, and confining pressure all have a major impact on the cyclic stress ratio. Other parameters such as inter granular void ratio and equivalent intergranular void ratio are evaluated. This is attributed to the low fines percentages. It can assist engineers in better understanding the field evaluation of liquefaction potential of fines in soils and assessing the liquefaction resistance of soils.

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