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EFFECTS OF STONE COLUMNS ON IMPROVEMENT OF LIQUEFIABLE SOIL LAYERS

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Liquefaction in sand and silty soil layers due to earthquake is one of the important phenomenon in earthquake geotechnical engineering. During the earthquake pore water pressure increases in saturate soil layer until equal to total stress. Then, effective stress decreases and equal to zero. In this condition soil layer loses shear strength and bearing capacity. The results of this phenomenon happens in soil layers are instability, wide settlement in ground level and underground. Main idea in this research is improvement of liquefiable soil with using stone columns. So that, diam of stone column is 0.6, 1.2 and 1.8 m and length equal to 9 m were considered. Also, distance of between stone columns equal to 0.6, 1.2 and 1.8 m assumed. Overburden amount due to building weight effective on soil layers equal to 5 and 15 stories were selected (Figure 1). Flac 2D program used for dynamic analysis and analyses results in liquefiable soil layers were evaluated in 1.5, 4.5 and 6 m depths. It should be noted, Finn and Byrne (1975) constitutive soil model was selected for soil layers. Soil layers and stone columns material properties can be seen in Table 1. Dynamic loading as harmonic based on Tang et al. (2015) research selected and in bedrock considered (Figure 2). In last decade, several researches have been performed about micro pile effects on soil layers improvement can be indicated to Moayedie et al. (2010), Brennan and Madabhushi (2006) and Jiang et al. (2007).

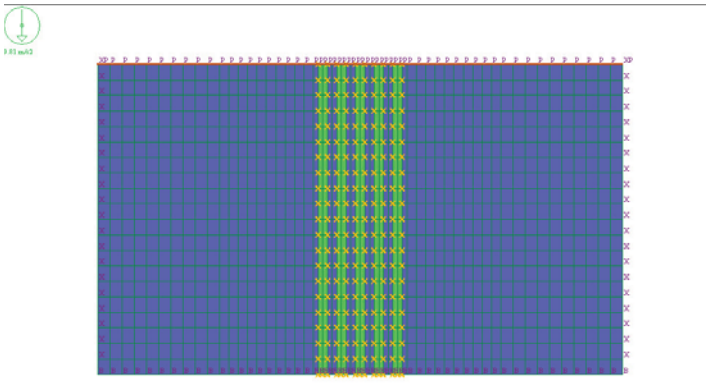

Figure 1. Finite difference model in his study.

Table 1. Soil and stone columns material properties.

Material	Dry Density (ρ) (kg/m^3)	Shear Modulus (Pa) (G_{max})	Poisson Ratio (υ)	Bulk Modulus (Pa) (K)	Friction Angle (degree)
Sand	1800	5.8E7	0.3	1.26E8	37
Stone Column	2000	7.9E7	0.3	1.71E8	37

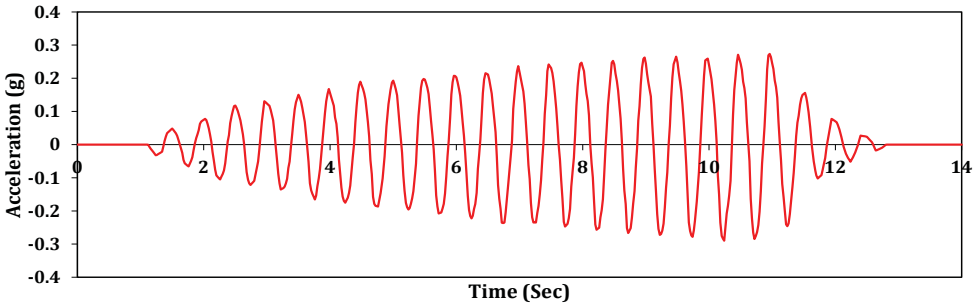

Figure 2. Harmonic loading in his study.

Results of this study showed that in terms of rate of exceed pore water pressure, in 60 cm distance between stone columns and both 5 and 15 story building (overburden), in all of diam liquefaction happens in soil layers. While, distance between stone columns increased 60 to 120 cm, drainage system in saturate soil layers worked properly and in deep down liquefaction no observed. Although, stone columns with 1.2 m diam and distance value 1.2 m between each other's in two overburden have suitable performance in soil layers improvement against liquefaction (Figure 3). So that, rate of exceed pore water pressure during dynamic loading decreased and settlement values declined too. One of the important issues in liquefaction is vertical settlements. Based on data analyses, it was observed with increasing diameter of stone columns and decreasing interval between them settlement due to liquefaction in saturate soil layers is reduced.

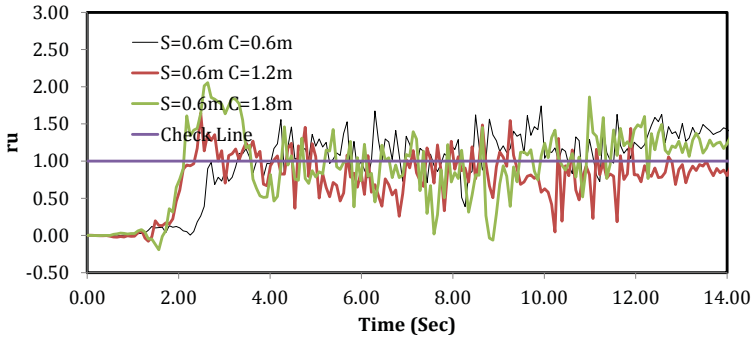

Figure 3. Rate of exceed pore water pressure in 1.5 m depth of soil layers (overburden equal to 5 stories building).

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