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To cite this article: Soewignjo Agus Nugroho *et al* 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **316** 012033

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STUDY GRADATION AND MOISTURE CONTENT OF SAND EMBANKMENT ON PEAT SUBJECTED VIBRATION POTENTIAL LIQUEFACTION

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ABSTRACT

In recent years large earthquakes often occur on the island of Sumatra. There is a phenomenon of the damage occurred during the earthquake, one of the effects is a phenomenon of loss of soil strength due to vibration called liquefaction. Some cases of liquefaction occur in some areas in Aceh, Nias Island, Padang and Pariaman. Pekanbaru is located close to the fault area that causes the occurrence of earthquake wave propagation. Pekanbaru are also at risk for geotechnical problems because of earthquake such as liquefaction. Evaluation of liquefaction potential could using by in-situ test and by laboratory test. The laboratory test to evaluation liquefaction potential among which method of experiment shaking table. In this study, liquefaction phenomenon was conducted by creating a physical model of a laboratory scale using a one-way vibration machine, with a review of how big the influence of sand gradation, sand shaped and grain-size, and surface water level in the sand against liquefaction potential. Evaluate of liquefaction potential based on the surface reading of the soil movement, elapsed time for final settlement and an excess pore water dissipation (EPD) during testing. Based on the results of performed test, indicated that fine sand on fully saturated conditions have the potential of maximum settlement for 20.67% and maximum ascend of pore water for 46.67%. This result mean that poorly graded fine sand on fully saturated conditions has more liquefaction potential than medium sand, coarse sand, and well graded sand

Keywords: liquefaction; settlement; excess pore water pressure; gradation; grain size.



1. INTRODUCTION

Indonesia lies between three tectonic plates, Eurasian plate, Pacific plate and Indian-Australia plate. Geologically, the islands of Indonesia are in a meeting two main earthquake belt, namely Sircum Pacific earthquake belt and earthquake belt Alpid Trans Asiatic. This led to Indonesia, including areas that have relatively high earthquake activity.

Pekanbaru is in the fault area that caused the earthquake wave propagation and also at risk of earthquake and liquefaction. Liquefaction is a phenomenon of loss of power ground layer due to vibrations emanating from earthquakes and explosions. When subjected to vibration properties of the soil layer becomes like a liquid and is unable to sustain the burden of buildings in or on it.

Intensive Study on liquefaction occupied after the earthquake that occurred in Alaska (April, 1964) and the earthquake in Niigata, Japan (June, 1964). Knowledge and liquefaction study is very important in order to understand the potential and the characteristic of liquefaction in an earthquake-prone region. Establish liquefaction concepts and theories about this, various studies were conducted in order to find a method that can explain this phenomenon of liquefaction, including the laboratory model test.

This study was conducted simulating the phenomenon of liquefaction by creating a physical model laboratory scale using the machine vibrating one-way analysis, the study of how much influence the variation of gradation, grain size and condition of the water table in the sand against liquefaction potential and how the relationship between these variations to the time required that can lead to liquefaction.

2. METHODOLOGY/ EXPERIMENTAL

Liquefaction is a process of loss of soil strength due increasing in pore water pressure caused by the cyclic load, so that the total overburden pressure is almost entirely replaced by pore water pressure. Liquefaction can cause ground movement direction of the horizontal (lateral spreading) or sand boiling.

Seed et al. [1], based on laboratory and field tests, and stated that the majority of cohesive soils are not liquefaction after earthquake. Soil at risk of liquefaction during an earthquake found in soil layers comprising a small grained sand to medium grained sand and silt with low plasticity [2]. Kramer [3] concluded that most of the incident occurred in the soil liquefaction were graded poorly. Poulos et al. [4] states that if a layer of soil is dense, it is not necessary in the evaluation of liquefaction, liquefaction occurs in saturated sand and silty sand with relative density less than 50% (loose sand) to limit of 70% (medium sand). Limit of earthquake acceleration value can result in liquefaction at a location of the liquefaction potential and relationship between these variations to the time required so as to cause liquefaction is 0,10g, and local magnitude is 5.0 [2]. The liquefaction potential is increasing when intensity of earthquakes and periods of vibration also increased. Saturated sand at a depth of more than 15-18 m is not easy to liquefaction. Saturated sand is not liquefaction if effective vertical overburden pressure value is 190 kN/m² or more.

Liquefaction usually occurs in saturated soil [5]. Resistance to liquefaction decreases with increasing degree of saturation, and soil with a small degree of saturation can only liquefaction with a great earthquake tremor and a long duration [6]. A small portion of liquefaction occurs in unsaturated soil. Liquefaction does not occur on dry land, but only deflection in soil.

2.1. Method of Shaking Table

Shaking table during the test to move in the direction of the tool length alternating with the steps that remain. Steps that remains is a model of acceleration of the shear forces that occur in the soil layer in an earthquake. With certain acceleration, it can be evaluated whether the soil samples the water-saturated sand, occurs whether or liquefaction, based on a reading of pore water pressure in the test sample.

Test do to evaluate the liquefaction based dynamic cyclic loading by shaking table made by [7].

Some of the advantages obtained in the shaking table test [8], among others:

- Box where soil samples placed, were made of thick glass or flexi glass so that all processes and phase voltage during the test can be seen and read.
- Allows the presence of a water-saturated sand samples were homogenized in large quantities, so it is closer to the real situation on the ground.
- Effect of stress concentration can be limited and occurs only in a relatively small location, so that its effects can be ignored.
- Allows to be equipped with recording equipment (transducer) is adequate, so that the distribution of pore water pressure that occurs during the test and after the test can be observed and recorded carefully

2.2. Test procedure sequences

Sand taken from district Kampar, Riau Province. Research conducted at the Soil and Rock Mechanics Laboratory University of Riau. Soil classified by varied of grained size according to gradation. Some Data testing of physical characteristic, soil properties, and particle-size distribution, specific gravity (G_s), minimum dry unit weight (γ_{min}) and maximum dry unit weight (γ_{max}).

Test vibrating box 1-direction can be seen in Figure 1.

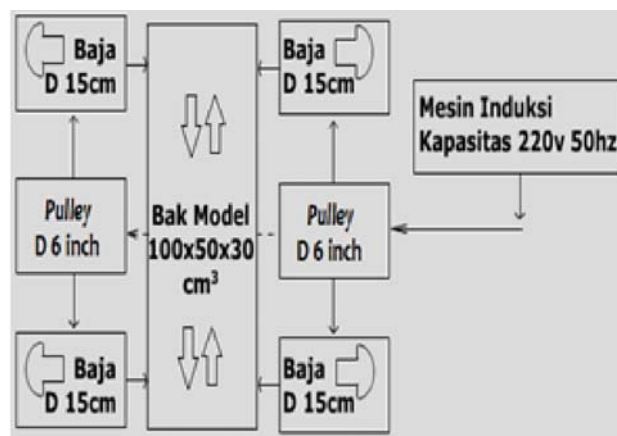


Figure 1 Vibration Table 1-direction

3. RESULTS AND DISCUSSION

Grain size distribution curve based on gradation analysis results for samples of coarse sand, medium sand, fine sand, and well graded-sand shown in Figure 2

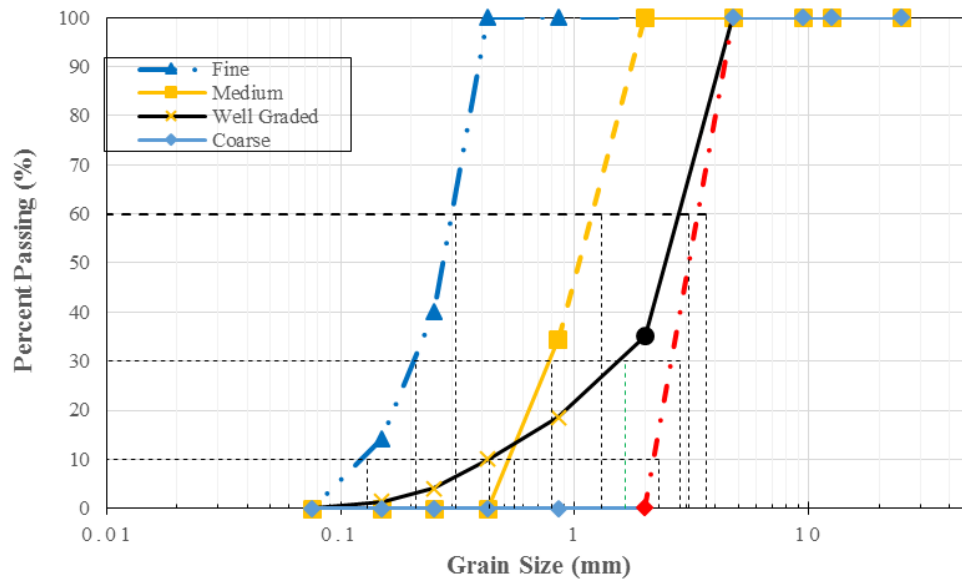


Figure 2 Grain Size Distribution Curve of samples

The test results of samples quality control of coarse sand, medium, fine, and well graded sand shown in Table 1

Table 1 Quality Control test Result

G.W.L	Well Graded			Poorly Graded								
				Coarse			Medium			fine		
	w	γ	E	w	γ	e	W	γ	e	w	γ	e
	(%)	(gr/cm ³)		(%)	(gr/cm ³)		(%)	(gr/cm ³)		(%)	(gr/cm ³)	
Dry	0.00	1.762	0.51	0.00	1.599	0.65	0.00	1.669	0.59	0.00	1.506	0.77
	0.00	1.741	0.53	0.00	1.611	0.64	0.00	1.660	0.60	0.00	1.483	0.80
	0.00	1.732	0.54	0.00	1.604	0.64	0.00	1.674	0.59	0.00	1.465	0.82
Unsaturated	5.15	1.722	0.54	4.25	1.552	0.70	5.17	1.623	0.64	7.39	1.462	0.82
	5.12	1.730	0.54	4.25	1.562	0.69	5.14	1.610	0.65	7.19	1.448	0.84
	5.15	1.723	0.54	4.25	1.569	0.68	5.16	1.613	0.65	7.33	1.475	0.81
Saturated	19.00	1.719	0.55	26.9	1.509	0.75	28.40	1.478	0.80	34.17	1.369	0.94
	19.50	1.710	0.55	26.9	1.507	0.75	28.46	1.481	0.79	34.07	1.369	0.95
	18.80	1.727	0.54	26.9	1.505	0.75	28.50	1.479	0.80	34.02	1.368	0.95

Particle size effect

Based on the test results in Table 1 and a density calculation results, obtained that level of density well graded sand samples were in range of 0.298% to 61.919%. This indicates that sample be in loose condition (very loose) to medium dense which range to sand in conditions of very loose to loose is 0% to 70% .

The influence of grain size reduction, time reduction, and excess pore water pressure dissipation shown in Figure 2 for the condition of dry sample, Figure 3 on the condition of the sample is not saturated (unsaturated) and Figure 4 for samples submerged conditions (saturated).

Uniform gradation condition of Fine graded sand has larger potential for decline than uniform graded of medium graded sand and uniform graded of coarse graded sand. Figure 1 also demonstrated the magnitude of decline in the sample maximum occurs in fine graded sand, on dry condition is 1.4 cm, 1.5 cm conditions are not saturated and saturated conditions is 3.1 cm. This is due to the fine graded sand void ratio greater than medium graded sand and coarse graded sand

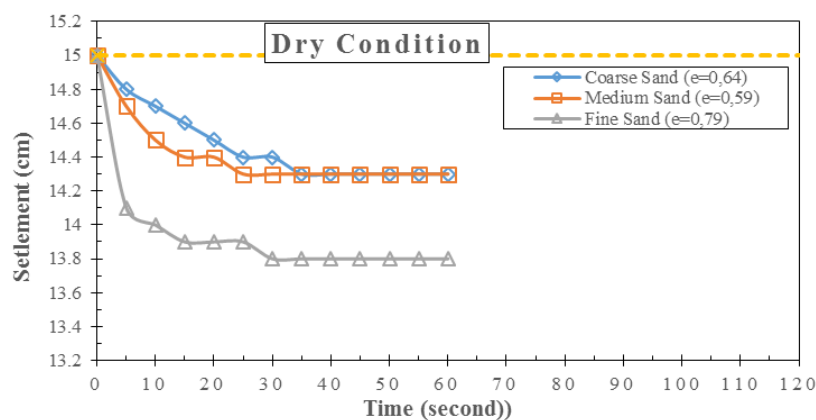


Figure 3 Particle Size Dry Condition

Total settlement soil on a fine sand tend to take longer than medium sand and coarse sand. Proved by length of time the maximum decrease occurred in the fine sand, the dry conditions in 35 seconds, unsaturated condition is 20 seconds, and saturated condition is 90 seconds. Void ratio also affects the total reduction of time. Large void ratio on fine sand will cause the time required is greater

Measurement of excess pore water pressure dissipation shows that in unsaturated and saturated condition, fine graded sand has a potential increasing pore water greatest. Proved by increasing maximum pore water pressure occurs in fine sand, on the condition of unsaturated 1 cm, and saturated 7 cm. When vibrated, settlement on soft sand is large where sand was compacted and volume was reduced. So, water in pores of the soil was receives stress, pore water pressure increasing result. While the abrasive of coarse graded sand pore water flow relatively quickly without causing significant pressure.

Excess pore water pressure dissipation on fine graded sand tend to take longer than the medium and coarse graded sand, proved the length of time the maximum pore water rise

occurs in fine sand. Coarse sand so smaller total reduction of excess pore water pressure quicker exit than fine sand and sand being shorter for water passage.

The test results in terms of the influence of grain size is consistent with the results of the liquefaction study [2], that the risk of soil liquefaction during earthquakes are found in soil layers comprising a small grain of sand to medium sand and silt that contain low plasticity

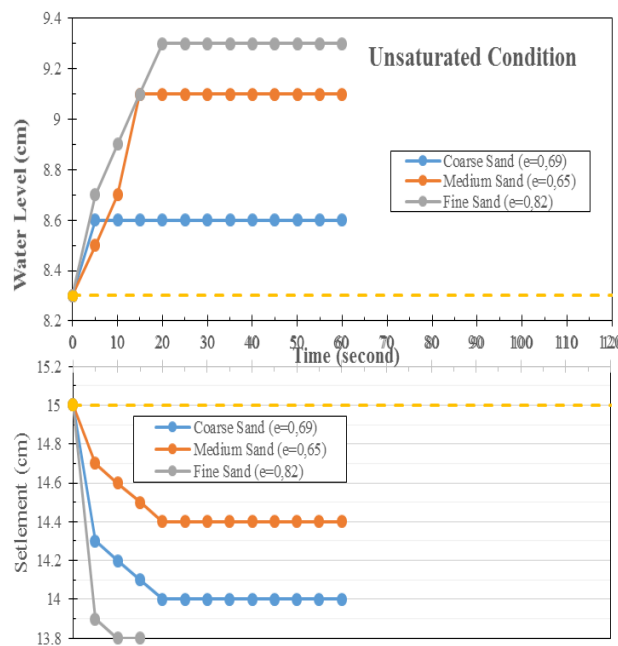


Figure 4 Unsaturated Condition

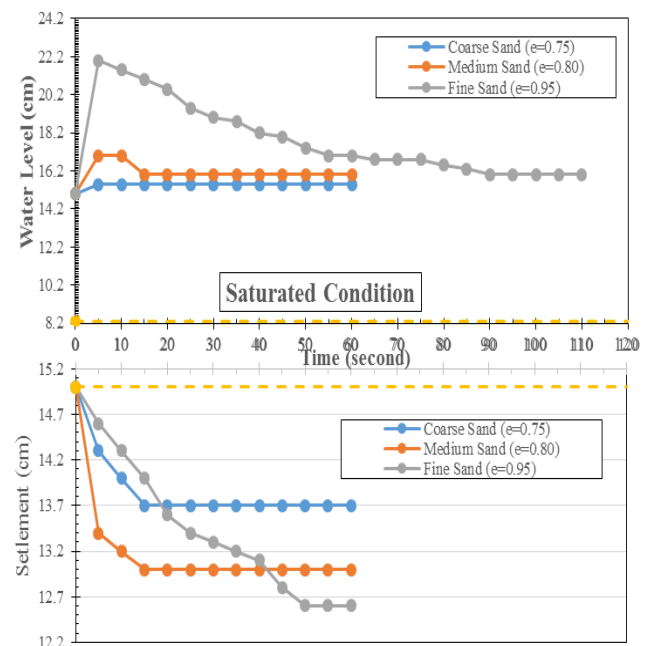


Figure 5 Saturated Condition

Particle size distribution effect

(Influence of gradation on the settlement, a decline, and the excess pore water pressure dissipation shown in Figure 6 to Figure 8

Samples in dry conditions (Figure 6), the condition is not saturated (unsaturated), and saturated, poorly graded sand (fine sand) has the potential for a larger decline than the well graded sand, demonstrated the magnitude of the decline in either poorly graded smaller than fine graded sand, which is dry condition 0.2 cm, 0.2 cm unsaturated and saturated 1.9 cm. This is due to well graded sand, void ratio smaller than coarse sand, medium, and fine. At saturated conditions, when viewed from the void ratio of coarse sand which is larger than the sand gradation is good, but the sand grading both the decline is greater than the coarse sand, resulting samples graded either a mixture of coarse sand, medium, and fine, granular lesser charge cavity that existed at the time the sample is vibrated, so good sand grading denser than the coarse sand.

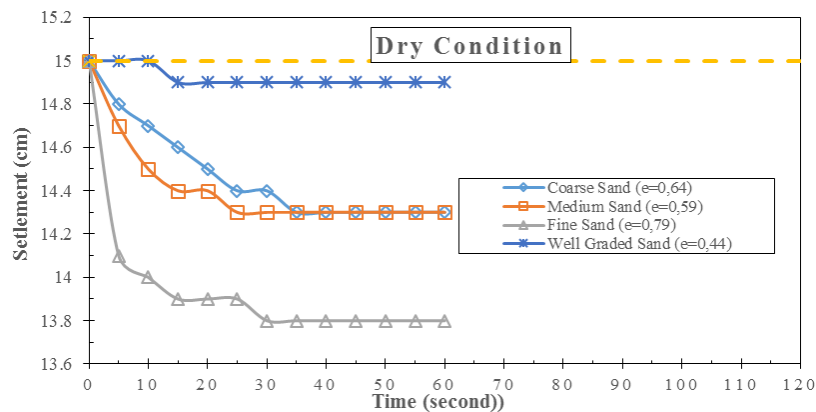


Figure 6 Gradation in Dry Condition

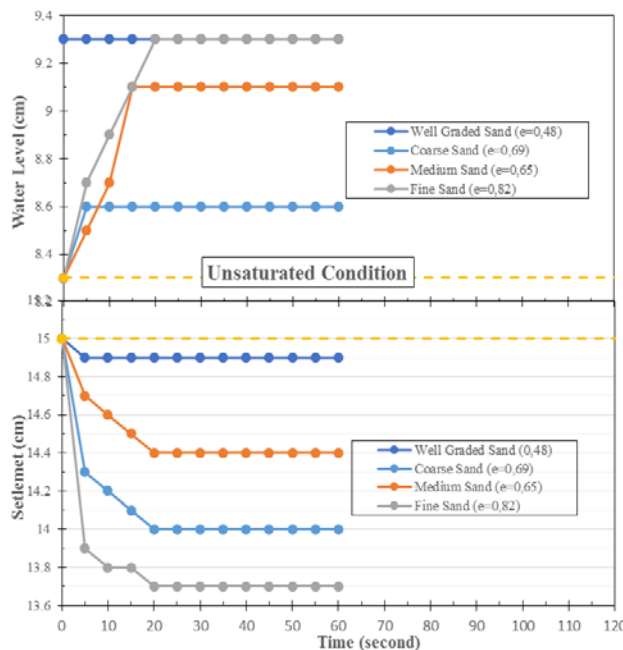


Figure 7 Gradation in Unsaturated Condition

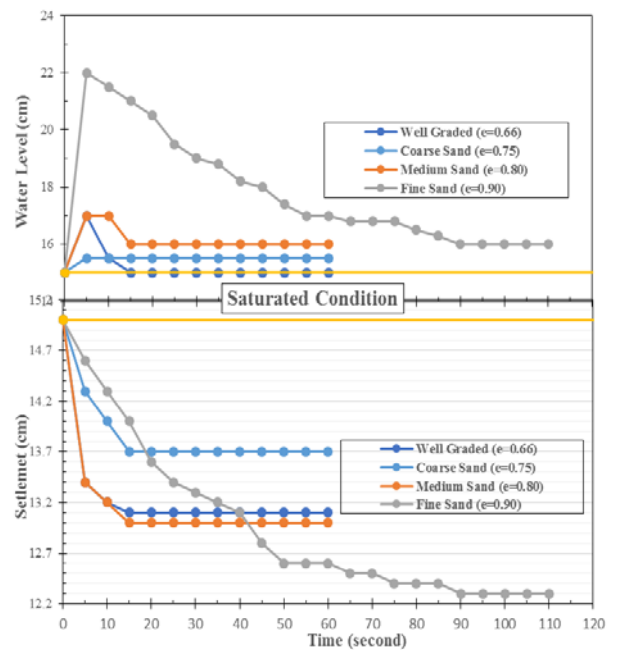


Figure 8 Gradation in Saturated Condition

The decline in total on the sand grading land both also tend to be faster stabilized namely in dry conditions 15 second, 5 second unsaturated and saturated 15 seconds. Figures pore either small sand grading will cause the time required is vanishingly small.

Measurement of excess pore water pressure which dissipation in Figure 6 and Figure 8 shows that the potential increase in pore water on sand grading either smaller than fine sand, proved in conditions not saturated, sand grading either did not experience significant pressure, while at the saturation magnitude increase in pore water sand grading better than fine sand 2 cm to 7 cm.

Excess pore water pressure sand grading both dissipation also tend to be faster than its stable of fine sand, which is the second to 15, compared to the fine sand on the second to

90. Well graded smaller so that the total reduction of excess pore water pressure quicker exit than fine sand because the water path is shorter.

The test results are reviewed gradations consistent with research on liquefaction [3], that most of incident liquefaction occurs in poorly graded soil).

4. CONCLUSION

The discussion can draw Final Conclusions as follows:

Test results of different quality control samples before vibrated, showing the density value are on Range 0.298% to 61.919%. Soil were in Limit Very loose to Medium on range less than 70% means that potentially liquefaction.

Seen From the diameter of the sand, fine graded sand Potential Decrease in air samples and the increase in pore big, proven by fine sand samples saturated condition occurred Decline Maximum 3.1 cm and maximum pore air rise 7 cm, and the length of time the Maximum Decrease Also Occurs on fine sand saturated condition i.e. 90 seconds.

Seen From gradation, poorly graded sand potential settlement and increasing pore water pressure is large, proven poorly graded sand (fine graded sand) on saturated condition shows the maximum decline of 3.1 cm, gradation both saturated 1.9 cm. While well graded sand show a minimum decrease in dry conditions and saturated 0.2 cm. well graded sand Also showed the smallest decrease in time compared poorly graded sand, i.e. at dry conditions 15 seconds, unsaturated 5 seconds, and 15 seconds is saturated.

Sand with emaks and emin wide difference, more Potential decline. Fine graded sand saturated condition, difference of emaks and emin is 0.374, shows Maximum decrease of 3.1 cm. For saturated coarse graded sand, Difference of emaks and emin is 0.272 showed decline 1.3 cm.

5. ACKNOWLEDGEMENT

Thanks for the assistance of the Fund Kemenristekdikti research on competitive grants scheme 2016 through LPPM of University of Riau. Thank you for the good cooperation to Suratman, Andy Hendri, Murialdi, and Resty Vesariany.

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