



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Experimental Investigation on Liquefaction Mitigation using Shredded Plastic and Geosynthetics: A Review

S. V. Bansod, S. V. Sabale, A. I. Dhattrak, S. W. Thakare

M. Tech Student, Department of Civil Engineering, GCOE Amravati, Maharashtra, India

PhD Research Scholar, Department of Civil Engineering, GCOE Amravati, Maharashtra, India

Associate Professor, Department of Civil Engineering, GCOE Amravati, Maharashtra, India

Associate Professor, Department of Civil Engineering, GCOE Amravati, Maharashtra, India

ABSTRACT: In geotechnical engineering, shaking tables are laboratory instruments used to simulate earthquake motions and assess how soil or materials resembling soil respond to seismic loads. The flat surface of the shaking table can be manipulated to vibrate horizontally in order to simulate the ground motions that occur during an earthquake. When pore water pressure rises as a result of cyclic loading, such as seismic waves during an earthquake, saturated soil temporarily loses its strength and stiffness. This phenomena is known as liquefaction in soil dynamics. This study uses a shake table setup to examine the effects of geosynthetics and shredded plastic in reducing the effects of liquefaction. In this study, the free field boundary condition is simulated during shaking using a laminar shear box, yielding more precise results. Monitoring the settling brought on by the shaking process, pore water pressure, and soil acceleration are utilized to assess the effect. Based on the findings of several shaking table tests conducted at initial relative densities of 30% and 60%, the efficacy of suggested mitigation strategies against settlement issues is assessed. The combination of shredded plastic and geotextile boosts liquefaction resistance, according to the data.

KEYWORDS: Liquefaction, Shredded Plastic, Shake Table, Pore Pressure, Acceleration

I. INTRODUCTION

When saturated soil loses cohesiveness and compactness as a result of high pore water pressure brought on by seismic vibrations during an earthquake, the condition is known as liquefaction. The soil's shear strength is decreased by the dynamic pore water pressure, keeping the particles apart. This condition turns the soil into a liquid-like substance that is prone to running down mild slopes and unable to sustain its own weight. Because liquefaction reduces the effective stress between soil particles, it is a significant phenomenon in geotechnical engineering. Structural damage results from the reduction's inconsistent settlement. Because of the excess pore water pressure (EPWP) that occurred and subsequent effective stress reduction, soil stiffness is significantly decreased. Even though pore water pressure is frequently raised by earthquakes, other events, including blasting, can also raise pore water pressure. The strength of the soil and a soil deposit's capacity to sustain structures above it both decrease with liquefaction. In addition to increasing strain on retaining walls, soil liquefaction can also cause them to tilt or slide. Structures on the ground surface may be destroyed by this movement, and the residual soil may settle.

II. TYPES OF REINFORCEMENT

Geotextiles are visibly woven, porous geosynthetic materials that offer a substantial, blanket-like feel. Depending on the application, geotextiles are frequently used to reduce soil erosion and enhance soil quality over which roads, embankments, pipelines, and earth retaining structures are situated. Fig. 1 and 2 shows woven and non-woven geotextiles respectively. Shredded plastic is made of plastic that has been mechanically crushed into smaller, broken bits. Since shredded plastic minimizes plastic waste and encourages more ecologically friendly business practices across a variety of industries, it is crucial to recycling and waste management initiatives. Fig. 3 shows shredded plastic.



Fig. 1. Woven Geotextile



Fig. 2. Nonwoven Geotextile



Fig. 3. Shredded plastic

III. LITERATURE REVIEW

Several researchers have conducted analytical and experimental work on the topic of mitigating liquefaction through the use of different geosynthetics, sand compaction columns, deep soil mixing, sheet piles, and other techniques. when evaluating these works, the methodology, basic principles and several components of experimental and analytical research for the improvement of liquefied soil are taken into considerations.

Darshan D. M. *et al.* in 2022 carried out an investigation to study the impact of geosynthetics along with pumice aggregate to mitigate the effect caused by liquefaction employing a shake table setup. The results concluded that excess pore water pressure can be effectively reduced up to 58% with geotextile and pumice aggregate inclusions in soil. The settlement can be effectively reduced up to 67% with geotextile and pumice aggregate inclusions in soil. The cyclic stress ratio can be effectively reduced up to 92% with geotextile and pumice aggregate inclusions in soil.

Hendra S. *et al.* in 2018 studied the influence of geosynthetics along with gravel usage to reduce the vertical soil displacement caused by liquefaction using a shake table equipment. They conducted test in different initial relative densities which are 50% (loose sand conditions) and 90% (dense sand conditions). The results conclude that the vertical ground displacement decreased by the use of geosynthetics and gravel up to 54% and 32% for loose sand and dense sand states, respectively. Furthermore, test results also show that there is a decrease in the differential settlement between loose sand and dense sand conditions, around 62%.

Ali G. et al. in 2020 carried out an investigation to study the effect of Lightweight Expanded Clay Aggregate (LECA) on the mitigation of liquefaction was examined using shaking table tests. They used LECA content from 0–20% at an initial relative density of 50%. The tests were performed under a sinusoidal base acceleration with 0.2 g acceleration amplitude and 2 Hz frequency. The results also concluded that the reduction ratio of the transmitted acceleration (r_a) values equals 10%, 19%, and 31% for LECA content of 5%, 10%, and 15%, respectively. The maximum reduction of the transmitted accelerations was 45% for the sample containing 20% LECA. Excess pore pressure ratio were reduced by up to 16%.

Beena K. S. et al. in 2021 carried out an investigation to study the development of a laminar soil container for shaking table tests in Kerala, and the response of the excess pore water pressure at various locations of the contained sand. They try to understand the effect of gradation of soil and amplitude of base shaking on the generation of excess pore water pressure at varying relative density of soil (30%, 40% and 50%) but at a constant frequency of shaking (1 Hz) with 0.16 and 0.20 base acceleration. The results concluded that maximum excess pore water pressure ratio was 0.97, 0.81 and 0.85 at 0.20 base acceleration as compared to 0.16 base acceleration for soil 1,2 and 3.

Vivek B. et al. in 2021 carried out an investigation to study design, commissioning and calibration of a uniaxial laminar soil box suitable for use on a low base shear capacity shake table. The results concluded that the acceleration value 1.41 which was maximum at 0.380 base acceleration as compared to others values. The experimental results were compared with equivalent-linear SHAKE analysis and nonlinear finite element ground response analysis of the free-field soil using OpenSees which shows that Shake analysis shows higher 2.33 base acceleration as compared to OpenSees analysis.

Deshmukh S. M. et al. in 2021 carried out experimental investigation on soil susceptible to liquefaction by using geosynthetics and Lightweight Expanded Clay Aggregate (LECA). They performed 1 g shaking table test on a liquefied sensitive sand bed under dynamic loads of varying amplitudes and frequencies. The results shows that the excess pore water pressure can be effectively reduced up to 52% with geotextile and 100% with LECA inclusions respectively. The settlement can be effectively reduced up to 31% with geotextile and 48% with LECA inclusions respectively. The acceleration can be effectively reduced up to 25% with geotextile and up to 33% with LECA inclusions in soil. The cyclic stress ratio can be effectively reduced up to 25% with geotextile and LECA inclusions in soil.

Madabhushi S. P. et al. in 2021 carried out experiment on liquefaction mitigation by using Rubble brick to study earthquake drains. They shows that foundation in terms of its settlement was improved by the rubble brick drains by directly comparing them to the foundation on unimproved, liquefiable ground. The result shows the presence of earthquake drains can reduce the ultimate settlement of the foundations. The result shown that smaller excess pore pressures were observed below the foundation in the improved region compared to unimproved region. The horizontal accelerations felt by the foundation block are marginally higher compared to the foundation on an unimproved soil block.

IV. CONCLUSION

As increases in excess pore water pressure and stress reduction may leads soil to lose its stiffness and strength. As the frequency and the amplitude of dynamic loading increases, the pore pressure, settlement, and cyclic stress ratio increases. Combination of geotextile with shredded plastic show greater percentage reduction in the pore pressure, settlement, and cyclic stress ratio as compared to the sand bed when provided with single layer of geotextile, double layer of geotextile, single layer of shredded plastic, double layer of shredded plastic. Thus, geotextile with shredded plastic is most effective inclusion for the improvement in liquefaction susceptibility of soil. As the amplitude of base shaking increases and the relative density of soil decreases, soil liquefaction resistance decreases.

From the brief review, it is clear that while a lot of research has been done analytically and experimentally to reduce soil liquefaction using a variety of conventional techniques, more research is required to determine the effects of liquefied soil using more modern techniques.

Therefore, the performance of geosynthetics (geotextile, geogrid, and geotextile-polymer core composite) and plastic waste such as shredded plastic in liquefied soil should be the main focus of future research.

REFERENCES

1. Ashtankar S. R. & Dhattrak A. I. (2021), "A Review Paper on Dynamic effect on tunnel using shake table test", *ijaresm/volume-9-1/issue-9-september-2021*.
2. Beena K. S., Jayakrishnan V., Alex A. & Bindu C. S. (2021), "Analysis of Liquefaction Potential of Coastal Sands Using Laminar Box System", <https://doi.org/10.1007/s40098-021-00503-0>.
3. Denine S. (2016), "Effect of geotextile reinforcement on shear strength of sandy soil: laboratory study", *Studia Geotechnica et Mechanica*, Vol. 38, No. 4, 2016, DOI: 10.1515/sgem-2016-0026.
4. Deoda D. M., Dhattrak A. I. & Thakare S. W. (2022), "Experimental Investigation On Liquefaction Mitigation Using Pumice Aggregate and Geosynthetics", *9IYGEC /IGS Aurangabad/ issue-21-march-2023*.
5. Deshmukh S. M. & Dhattrak A. I. (2021), "A Review Paper on Experimental Investigation On Liquefaction Mitigation using Geosynthetics And Artificial Material", *ijaresm/volume-9-1/issue-9-september-2021*.
6. Ghorbani & Rabanifar H. (2020), "The Effect of Lightweight Expanded Clay Aggregate on the Mitigation of Liquefaction in Shaking Table", <https://doi.org/10.1007/s10706-020-01592-z>.
7. Gopal., Madabhushi S. P. & Torres S. G. (2021), "Sustainable Measures for Protection of Structures Against Earthquake Induced Liquefaction", <https://doi.org/10.1007/s40098-021-00535-6>.
8. Kramer S. L., Mayfield R. T. & Huang Y. M. (2008), "Performance-Based Liquefaction Potential Evaluation", USGS Research Award 06HQGR0041/issue 31 January 2008.
9. N. Seyed., Abolhasan & Z. Eftekhari (2014), "Effect of Geotextile on the Liquefaction Behavior of Sand in Cyclic Triaxial Test", *Scientific Cooperations International Workshops on Engineering Branches 8-9 August 2014, Koc University, ISTANBUL/TURKEY*.
10. Prasad H. N., Chary M. R. & Thangamani K. (2019), "Analysing and Preventing the Problems of Liquefaction in Soils", <http://www.ijert.org/> ISSN: 2278-0181 Vol. 8 Issue 12, December-2019.
11. Rasouli R., Takahashi N., Derakhshani A., Yamada S. & Takaoka Y. (2013), "Experimental Study on Mitigation of Liquefaction-Induced Lateral Displacement Deep Soil Mixing", <https://scholarsmine.mst.edu/icchge/7icchge/session03/38>.
12. Sasaki Y., Kano S. & Tsuji T. (2004), "Embankment reinforcement by geogrid to reduce its settlement during earthquakes", *13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 642*.
13. Salem Z. B., Frikha W. & Bouassida M., "Effects of Densification and Stiffening on Liquefaction Risk of Reinforced Soil by Stone Columns", [https://doi.org/10.1061/\(ASCE\)GT.1943-5606.0001773](https://doi.org/10.1061/(ASCE)GT.1943-5606.0001773).
14. Setiawan H., Serikawa Y., Sugita., Kawasaki H. & M. Miyajima (2018), "Experimental study on mitigation of liquefaction-induced vertical ground displacement by using gravel and geosynthetics", <https://doi.org/10.1186/s40677-018-0115-3>.
15. Tang L., Cong S., Ling X., Lu J. & Elgamal A. (2014), "Numerical study on ground improvement for liquefaction mitigation using stone columns encased with geosynthetics", <http://www.elsevier.com/locate/geotextmem>.
16. Ueng T. S. & Lee C. A. (2015), "Pore pressure generation in saturated sand Induced by one- and two-dimensional shakings:", *Journal of Geo Engineering*, Vol. 10, No. 2, pp. 53-61, August 2015, <http://dx.doi.org/10.6310/jog.2015.10>.
17. Vivek B. & Raychowdhury P. (2019), "Design and calibration of a laminar soil box suitable for a lowcapacity shake table using free-field tests on Ganga sand", <https://doi.org/10.1016/j.sandf.2019.03.010>.
18. Zhang C., Jeng D., Zhang J., Wang L., Jiang Q. & Chen X. (2020), "Experimental Study on Mechanism of Wave-Induced Liquefaction of Sand-Clay Seabed", *Journal of Marine Science and Engineering* doi:10.3390/jmse8020066.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details