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GROUND DENSIFICATION FOR LIQUEFACTION MITIGATION USING GGBS COLUMNS ENCASED WITH GEOTEXTILE

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Abstract: The process known as liquefaction, which occurs when there is an excess of "pore water pressure" and a drop in the frictional resistance of the soil after an earthquake, is what causes the solid ground to change into a liquid condition. Sands that are loose or somewhat wet and have poor drainage, such clayey or silty sands, are susceptible to liquefaction. The standard penetration test (SPT) and the cone penetration test (CPT), which are favoured to evaluate the liquefaction potential of soil, are examples of in-situ tests that are the foundation of common liquefaction evaluation techniques. Rearranging the soil particles into tighter arrangements increases density and is known as densification. Using the stone column strategy, soil stability is increased as part of the ground-up improvement process. To compress the soil and raise its density, drop a large weight onto the ground several times from a considerable height.

Index Terms - densification, liquefaction, mitigation, stone column, pore water pressure.

I. INTRODUCTION

When an applied stress, like shaking during an earthquake or other abrupt change in stress condition, causes a cohesionless saturated or partially saturated soil to significantly lose strength and stiffness, it is known as soil liquefaction. In this situation, material that is normally a solid behaves like a liquid. Allen Hazen used the word "liquefied" in soil mechanics to describe the 1918 collapse of the Calaveras Dam in California. Soil and pore spaces combine to form granular soils. The collapse of the water-filled pore spaces the process known as "soil liquefaction" occurs when saturated and cohesive soil loses strength as a result of elevated pore water pressure; as a result, dynamic loading reduces effective stress. Water pressure rises to a level during liquefaction that effectively suspends or floats soil particles by opposing their gravitational attraction.for this crisis is the climatic change due to drought or floods s they became more frequently. The soil deposit's capacity to sustain building and bridge foundations is subsequently diminished as a result of the soil particles moving freely with respect to one another. Flow liquefaction: This phenomenon occurs when static or dynamic forces break the static equilibrium. loads in a coating of soil that has little residual strength. It happens when the liquefied soil's shear strength is less than the static shear stresses in the soil. Cyclic mobility: Deformation resulting from cyclic mobility develops gradually because of static and dynamic stresses that exist during an earthquake. Cyclic mobility is a liquefaction phenomenon, triggered by cyclic loading, occurring in soil deposits with static shear stress lower than the soil strenght. By using these techniques, soil liquefaction can be avoided. • soil replacement technique. • Compaction by vibration. A novel geotechnical engineering approach called ground densification for liquefaction mitigation utilising GGBS (Ground Granulated Blast Furnace Slag) columns aims to reinforce soil to avoid liquefaction during seismic events. To increase the earth's strength and stability, this technique entails driving vertical columns composed of GGBS material into the ground. It is important to provide a thorough review of the issue of liquefaction during earthquakes and the necessity of appropriate mitigation measures in the introduction as a whole. When pore water pressure builds up during seismic shaking, saturated soil liquefies, losing its strength and rigidity. This can have disastrous effects on buildings erected on the soil. Highlighting the benefits of GGBS material—a byproduct of the iron industry with superior cementitious and pozzolanic properties—involves introducing GGBS columns as a solution. When placed in liquefiable soil, these columns interact with the surrounding soil particles to strengthen the soil's mechanical characteristics and resistance to liquefaction. The introduction should also discuss the state of liquefaction mitigation technique research and practice at the moment, highlighting any drawbacks or difficulties with the current approaches. This prepares the ground for GGBS columns to be presented as a viable substitute with possible benefits like affordability, environmental sustainability, and simplicity of use. Additionally, using GGBS columns to describe the goals and extent of the ground densification study or project is essential. Talking about the precise study questions, the experimental design, and the anticipated results may fall under this category. Giving a summary of the paper's or presentation's structure also makes it easier for the audience or reader to navigate the sections that follow.

II. RELATED WORK

Anil Kumar Sahu and Istuti Singh-www.ijitee.com-May 2019 Stone Columns used for ground improvement of soft soil-volume 8-issue 7C2-page no 2278- 3075.

The experiments were conducted for varying diameter of columns at varying depth. Various types of geotextiles were also to used enhance the strength of soft soil. Stone columns repeatedly used for stabilization of soft soils. For the support of different structures, use of stone columns is increasing day by day. Stone columns are used for the improvement of settlement and bearing capacity of soft soils in reasonable fare and friendly towards the environment. To analyse the behaviour of stone columns used in different types of constructions such as oil storage tanks, embankments, buildings etc.

Ali k , Shahu J T-www.ijprems.com-December 2010- Reinforced Stone Columns in Soft Soil-volume.03-issue 04-page no 150-155.

Ali k et al (2010) studied by conducting laboratory tests on stone columns to study bearing capacity and settlement characteristics of soil with and without encasement. The experiments were conducted for varying diameter of columns at varying depth. The results were verified by numerical method. Various types of geotextiles were also to used enhance the strength of soft soil. construction is being carried out on sites having extremely poor ground conditions like soft clays which pose serious problems like excessive settlements. For rigid structures such as multi-storeyed buildings, pile foundation is the best but for low rise buildings and, structures such as liquid storage tanks, bridge abutments, road/rail embankments, factories etc. Since stone columns having lengths more than six times their diameter do not contribute much to bearing capacity therefore, floating columns should be preferred in situations where hard strata is at a depth more than this length. The columns should be wrapped around with some geosynthetic material, by doing so the bearing capacity of improved ground is increased by manifolds.

III. MATERIALS AND METHODOLOGY

COLLECTION OF MATERIALS

1. GGBS : The method of obtaining ground granulated blast furnace slag (GGBS) involves quenching molten iron slag, which is a by-product of manufacturing steel and iron, in water or steam. This results in a glassy, granular product that is then dried and ground into a fine powder.

Fig - 1.1 GGBS

2. GEOTEXTILE : Geotextile textiles have extensive subterranean uses. In addition to isolating various types of soil from one another and draining water, geo fabric also strengthens soil. Water is allowed to pass through geotextiles, but other tiny particles and dirt are kept out. Geotextile fabric efficiently carries out a number of tasks, such as drainage, protection, filtration, strengthening, and separation.

Fig - 2.2 Geotextile

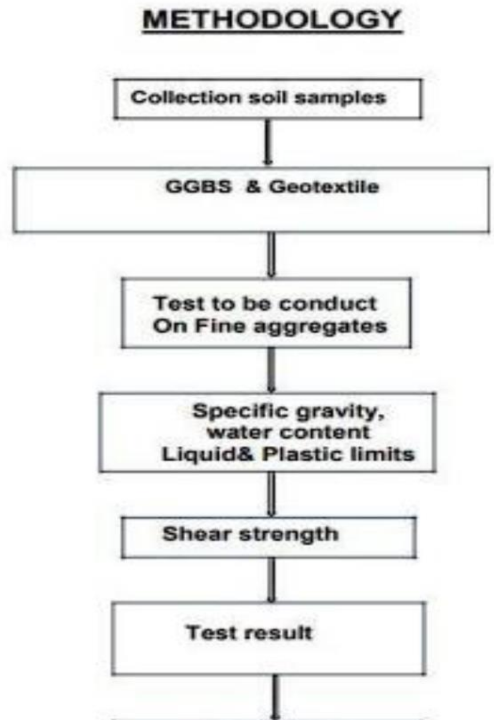
3 SOIL SAMPLES

Fig 1.3 Black Cotton Soil

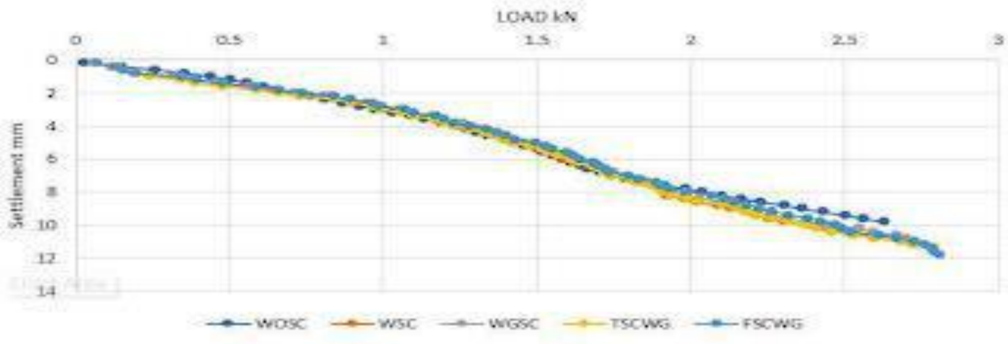
Fig 1.4 : RED Soil

IV METHODOLOGY

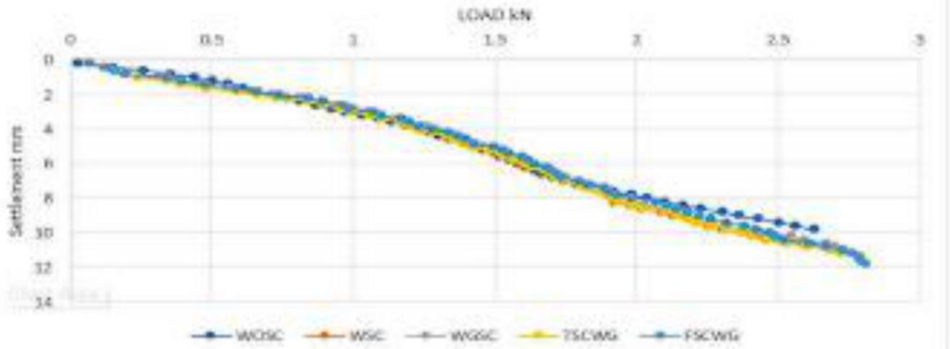
PROCEDURE FOR CONDUCTION OF EXPERIMENTS



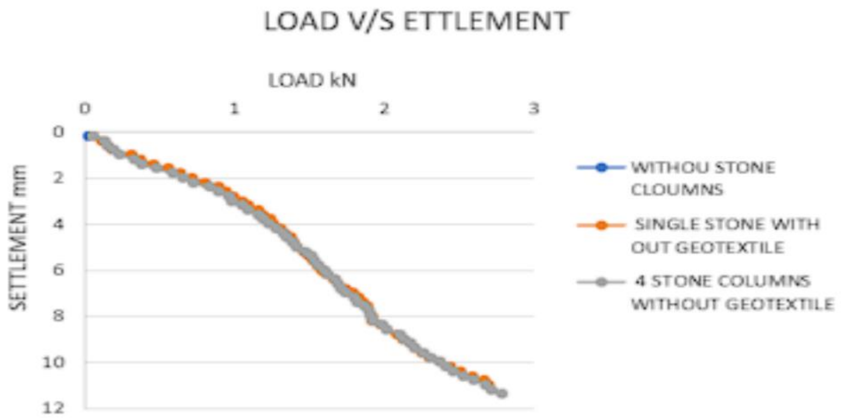
V. LOAD BEARING CAPACITY



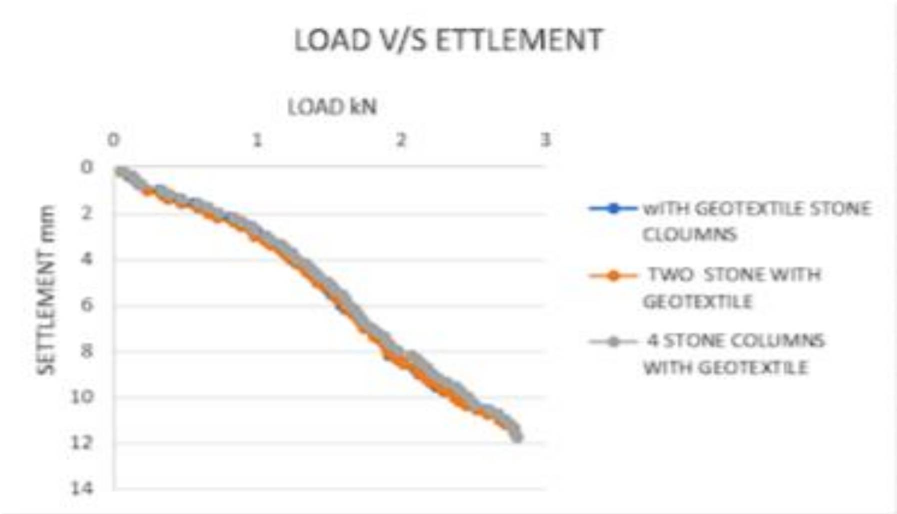
Graph 1. Black Cotton Soil



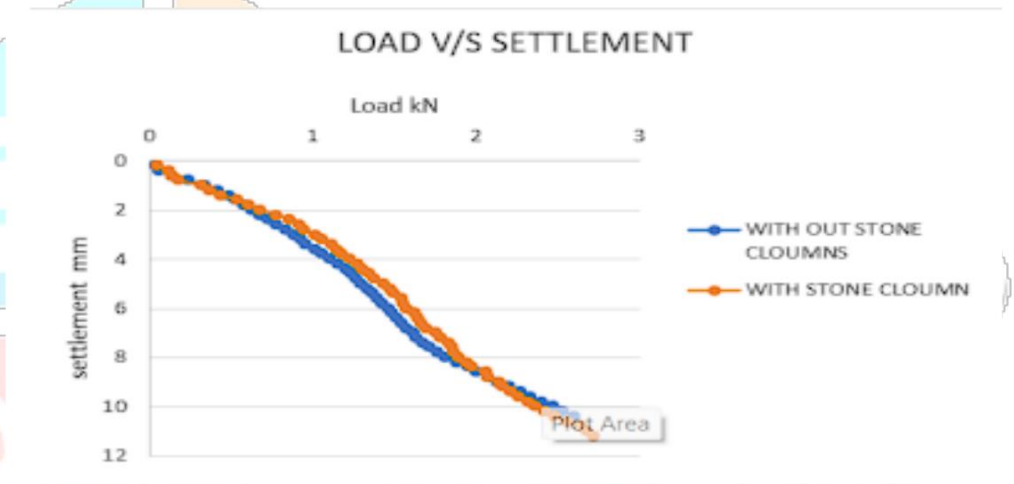
Graph 2 . Red Soil



Graph 3 : Comparing of stone cloumns with out geotextile in black cotton soil



Graph 4 : Comparing of stone columns encased with geotextile in black cotton soil



Graph 5 : Comparing of stone columns with out geotextile in red soil

VI RESULTS

By utilizing GGBS columns covered in geotextile, the ground densification technique significantly enhanced the characteristics of the soil and reduced the risk of liquefaction. Its superiority over other technologies in terms of cost-effectiveness and environmental impact were demonstrated by comparative study. Long-term stability and installation efficiency were improved via geotextile encasement. Nonetheless, issues such as soil fluctuations were identified, indicating potential directions for further refinement. Overall, this study emphasises how effective and promising this method is for reducing earthquake hazards.

VII CONCLUSION

The application of geotextile-encased GGBS (Ground Granulated Blast Furnace Slag) columns for ground densification in liquefaction mitigation offers an option to improve the stability of liquefaction-prone soils. This technique successfully strengthens the soil and lowers the risk of harm from liquefaction. For ground densification, using GGBS columns covered with geotextile is an eco-friendly, economical, and sustainable way to reduce the danger of liquefaction in geotechnical engineering projects. This method improves long-term stability and seismic event resistance in addition to fortifying the soil

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