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Strengthening of Weak Soil against Liquefaction

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Abstract: **liquefactionis a phenomenon in which the stability, strength and hardness of soil is relapseby sudden changes in stress or earth quake. due to applied stress, cohesion less saturated or partially saturated soil substantially loses strength and stiffness is also effected. due to that reason, solid ground turns into a liquid-like state. in this paper show that how to change inner property of partially saturated soil or weak soil and turn to try develop strength and stability of soil .we major focused on micro piles which change the properties of weak soil. here we used black cotton soil as a liquefaction soil. black cotton soil mostly available in major part of India. as we know India is one of world largest agricultural country so mostly 80-90 % land in India has used as agricultural and other left part land used for building. road and other extra activities.**

for the purpose of this study, identify the liquefiable soil profile and increasing strengthening of weak soil by using any extra materials mixing or changing the property of weak soil. in 1999 kocaeli earth quake after this earthquake we have loses may land due to lack of knowledge about liquefaction. after this occurred we realised that if analysed natural land ground than we can decreased losses there. so in this study analysis results are evaluated and the effectiveness of densification is discussed.

Keywords**: liquefaction, microorganism, soil stabilizer, seismic, soil admixture, bearing capacity**

Purpose: The purpose of this research paper to providing basic knowledge about liquefaction of cohesion less soils under certain loading or seismic loading.
Secondly ,to prefer the most widely accepted methods for evaluating the liquefaction of soils avoiding from liquefaction and for estimating the earthquake-induced settlements in cohesion less soil deposits and also analysing stability of embankments and slops against earthquake.
Develop an improved understanding of the behaviour of sandy soil or saturated soil deposits containing sands and non plastic silt sand and sandy silts during certain loadings.
Establish design and design guidelines for liquefaction in saturated soil using some technique

Introduction: Liquefaction occurs by seismic and rapid loading and decrease the soil strength. Undrain saturated soil with a high risk of earthquake are inquest to liquefaction. During liquefaction the pore water pressure become high and effective stress of the soil is rapidly reduce to zero. These aspects change the properties of soil and its cause of the collapse building

structures and loss of lives. for example, shaking amid a earthquake or other sudden change in pressure condition, in which material that is commonly a strong acts like a liquid [2] . Liquefaction happens in saturated soils, that is, soils in which the space between individual particles is totally loaded up with water. This water applies a weight on the soil particles that impacts how firmly the particles themselves are squeezed together. Before a earthquake, the water weight is generally low. Nonetheless, earthquake shaking can cause the water strain to increment to the point where the dirt particles can promptly move regarding one another. Earthquake shaking frequently triggers this expansion in water weight, yet development related exercises, for example, impacting can likewise cause an expansion in water pressure. In 1995 Hyogoken-Nambu earthquake with a magnitude of 7.2 occurred at 5:47 A.M .on January 17,1995. The earthquake caused ;liquefaction of many reclaimed land area and alluvial plain deposits along Osaka Bay, and severe damage to builing, bridges ,tank, buried pipeline, etc In Kobe city , several waterfront areas and two large island have been constructed with reclaimed land along Osaka Bay.liquefaction occurred in almost all of the artificially reclaimed land and island because the reclaimed soil was loose and the ground shaking was very strong i.e ., more than 400 gals of maximum surface acceleration .some zone in both port and rokko island , did not liquefy and structure in these zones were not seriously .

Many researchers have investigate the strength of liquefaction following the result of standard penetration test (SPT) and cone penetration test (CPT). These study were conduct on the basis of case history of earthquake allover the world. The present state of art in liquefaction evaluation involves in situ-testing rather than the other laboratory testing because it is impossible to find these property in laboratory .degree of consolidation ,age of soil profile, degree of cementation , which affect the strenght of soil to liquefy under seismic or rapid loading .

THE COMMON METHOD OF REDUCE LIQUEFACTION OF SOIL

1. Replacement or physical modification
2. Densification
3. Pore water pressure relief
4. Foundation reinforcement

Improve the ground stability of liquefaction soil by using some admixture

Strenghting of week soil by using some physical method or providing extra strength of structure against liquefaction by using micro piles.

Stability of the ground by biological process

We study the chemical, physical or mechanical process with the purpose of adusting the properties of the soil in order to meet certain requirement. There are five most important properties which define a good soil . these are strength , volume stabilies, permeability, resistance and variability. We mainly focus about how to prevent liquefaction of soil by using different admixture to improve soil quality and reduce its liquefy property. Soil improvement techniques are commonly used at sites to eliminate or reduce the hazard to an acceptable level.

Many researchers have investigate the strength of liquefied soil following the result of standard penetration test (SPT) and line penetration test (CPT)

1.CONE PENETRATION TEST (CPT)

This test is used for soil liquefaction characterization .In this the cyclic resistance ration (CRR) is compared to the cyclic stress ration (CSR). And the ration of cyclic resistance ration and cyclic stress ration is

called factor of safety for predicting the risk of liquefaction. If the factor of safety value greater than one then liquefaction triggered

The expression for cyclic stress ratio (CSR) is following:

$$\mathbf{CSR_{7.5}=\tau_{cyc}/\sigma_{0v0}}=0.65(a_{max}/g)*(\sigma_{v0}/\sigma_{0v0})*(rd/MSF)$$

(1) Where the variable $\boldsymbol{\tau_{cyc}}$ is the maximum shear stress, $\boldsymbol{\sigma_{v0}}$ and $\boldsymbol{\sigma_{0v0}}$ are vertical effective and total stress, $\boldsymbol{a}_{max}$ is the horizontal ground acceleration, **rd** is the shear reduction coefficient and **MSF** is the moment magnitude.

By the use of above expression find cyclic stress ratio. And cyclic resistance ratio expression is following:

CRR7.5 = 0.833[(qC1N)CS / 1000] + 0.05

If (qC1N)CS < 50

CRR7.5 = 93[(qC1N)CS /1000]3 + 0.08

If 50< $(qC11N)_{CS}$<160

Where the variable (qC11N)CS is penetration resistance.

The available data compared to cone penetration resistance. Resulting graph and empirical curves to define the bearing capacity of soil against liquefaction and noting that liquefaction triggered or not.

[2].Standard penetration test (SPT)

This test is the one of the most tools in assessment of soil liquefaction. In this test the cyclic stress ratio (CSR) equation is same as cone penetration test. CSR7.5 = τcyc/σ0v0 = 0.65(amax/g)*(σv0 /σ0v0)*(rd/MSF) In standard penetration test (SPT) the factor of safety one (1) was considered in calculation. Empirical curves to define the liquefaction were developed based on standard penetration test (SPT) data base in the site. On the basis of previous database compared to the equivalent corrected SPT blows count value (N1)60CS for the soil and the finalized curved for the SPT based liquefaction triggering analysis is presented: (N1)60CS versus CSR7.5. Soil profile and liquefaction risk is evaluated by BOULANGER and IDRIS method and soil liquefaction assessment by using $(N_1)_{60cs}$ values.

Common method to prevent the liquefaction of soil:-

1. Replacement or physical medication
2. Densification
3. Pore water pressure relief
4. Foundation reinforcement
5. Compaction of soil for increase the soil density

5. Stabilizing Agents: - These are hydraulic(primary binder) nd non hydraulic(secondary binders) materials that when in contact with water or in presence of pozzolanic minerals reacts with water to form cemenitious composite materials. The commonly used binders are:

- ★ Cement
- ★ Lime
- ★Fly ash

Fly ash:- Fly ash is a byproduct of coal fired electric power generation facilities; it has little .cementitious properties compared to lime and cement. Most of the fly ashes belong to secondary binders; these binders cannot produce the desired effect on their own. However, in the presence of a small amount of activator, it can react chemically to form cementitious

compound that contributes to improved strength of soft soil. Fly ashes are readily available, cheaper and environmental friendly. There are two main classes of fly ashes; class C and class F (Bhuvaneshwari et al, 2005, FM 5-410). Class C fly ashes are produced from burning sub bituminous coal; it has high cementing properties because of high content of free CaO. Class C from lignite has the highest CaO (above 30%) resulting in self-cementing characteristics (FM 5-410). Class F fly ashes are produced by burning anthracite and bituminous coal; it has low self-cementing properties due to limited.

Silica fume : silica fume is a ultrafine power collected by a silicon metal and ferrosilicon alloy. Its average particle shape is a spherical and size is 0-0.15 micro meter. It is avaible in gray to white coloure. Silica fume is waste of industrial materials, it is most valuable by product pozzolonic materials due to its very active and high pozzzolanic properties. So it beneficial use for cement were 0% , 5% , 10%, and 20% by total weight of solid materials used for the model test.

Conclusion

Liquefaction is occurs during the heavy loading or earthquake or some construction process. We have to prevent liquefaction from above methods are adopted. This Paper review the load carrying capacity of the soil is developed by using admixture. This method is quick and easily controlled after this method are adopted then again apply cone penetration test (CPT) and standard penetration test (SPT) to check liquefaction and compare with initial data . and verifying that these method are superior to mitigate liquefaction from soils.

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