ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 10, October 2017

Liquefaction Remedial Measures

[1] Jastaran Singh Grewal, [2] Jagatjeet Singh Bawa
[1][2] B.Tech Student (Guru Nanak Dev Engg. College, LDH)

Abstract: **Response of sandy soil to vibrate force emerges our as a mainstream issue that depends upon a number of factors. Earth failure under foundation, due to the liquefaction phenomenon, has been responsible for great loss of life and property in last few decades, all over the world. To tackle this issue geotechnical engineers are doing their best to find out the conditions or environment that favors this liquefaction phenomena. So, to minimize this loss a thorough study and discussions needed to be carried out by geotechnical societies. As frequency of earthquakes are on rise it's becomes more compulsory to understand this phenomenon. This paper reviews the liquefaction phenomenon and its remedial ways to tackle things, which cause liquefaction. This research is carried out by analyzing several published papers and books..**

***Index Terms*— Liquefaction, Protective ways, Soil, Geotechnical Methods.**

1. INTRODUCTION

Geotechnical Engineers all over the world are doing in-depth study to find some way, in order to tackle liquefaction of soil. That is why; a plethora of methods have been developed, and are working effectively. After, some major earthquakes the scope of subject has evolved to a large extent and become an integral part of Geotechnical engineering Practise. Loosely packed sand and un-drained silts are the most susceptible soils to liquefaction. Other soils like Clayey soil also shows liquefaction failure in some exceptional cases. Considering the importance of damage caused by liquefaction failure leads Geotechnical Engineer to propose some protective measures. Numerous protective measures are discussed in detail to tackle this issue.

II. WHAT IS LIQUEFACTION PHENOMENON?

Liquefaction refers to "the phenomenon in which soil mass loses its shear capacity when subjected to monotonic and cyclic loading until its shear resistance becomes equal to shear stress". Simply, liquefaction is the transformation of soil mass from solid state to liquefied state which is caused by reduced effective stress and excessive pore water pressure.

III. NON-STRUCTURAL PROTECTIVE WAYS AGAINST SEISMIC FORCES

A. Soil Densification

Soil densification is the most common technique used to make soil liquefaction resistance and to increase its strength by employing techniques that can make it dense. Basic techniques used for liquefaction resistance are Vibratory and Dynamic techniques.

Vibratory Compaction, this technique make the use of two equipment's that is vibroflotation and vibro probe, but these are only effective up to the depth of 30 meters.

Vibroflotation (Vibratory compaction technique), this technique involves the use of vibroflot of 2m diameter fitted with jet at top and bottom, which slowly percolates into the soil by creating momentary quick sand conditions. Horizontal vibrations are developed by the use of a rotating eccentric mass and a tube is connected to of required depth to reach the desired depth. This method is employed in grid pattern and compact soil mass of 1.5m radius around the hole. Rising and back filling is done at same time.

Vibro probe (Vibratory compaction technique), this is similar to vibroflotation method in terms of operation. It consists of open tube, about 75 cm diameters, vertical vibrations are given by vibratory pile and sometimes water jet is also used to speed up the work. This method is effective up to depth of 20m and radius of 1.5m.

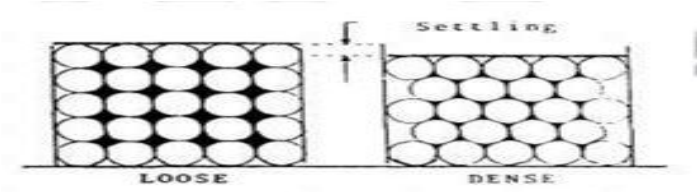
Dynamic Compaction, in this heavy weight of 6 to 36 tons is dropped from the height of 12 to 40m in order to make the soil dense. This is the most economical technique and is effective to the depth given by Lukus formulae,

$$Dmax=n\sqrt{(wH)} \quad \ldots\ldots\ldots(1)$$

Where n is degree of saturation

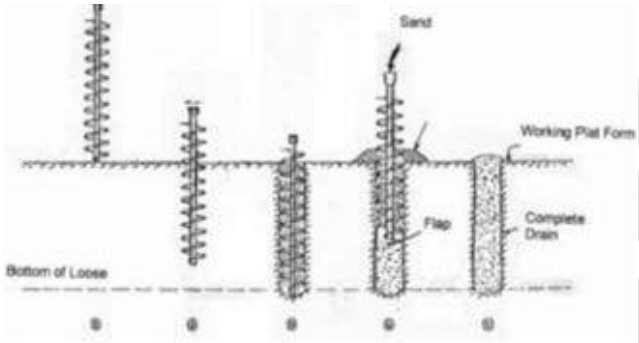
ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 10, October 2017



B. Dissipation of pore water pressure

Studies suggest that high water table is mainly responsible for liquefaction in soil, so it becomes extremely important to dissipate that pore water pressure. This mainly done by vertical sand drains or sand wicks, in this a hole is made into the soil which is filled with permeable material, in order to increase its permeability.



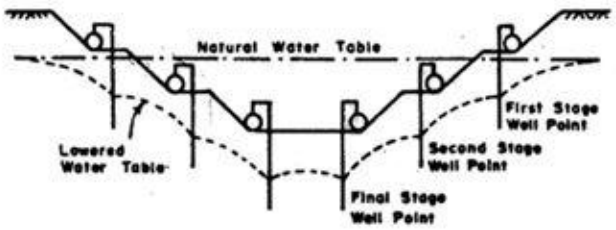
Firstly, mandrel is putted into the soil with the help of hammer, after which sand drain is constructed with help of geosynthetic rope. Diameter of hole varies from 15-30cm, and spaced 2 to 3m apart.

C. Lowering the Ground Water Table

Water is the main element that gives rise to liquefaction, so one must lower ground water level in order to minimize liquefaction failure. A number of techniques have been developed out of which deep wells are most popular and ditches are also used sometimes.

Level of ditches is kept more than the level of work for proper penetration and pumps are installed at suitable locations to remove collected water.

One of the limitations of this method is that it cannot be employed for clay soil. A single stage well point is the elementary type but now a day's multistage well point is used and it is effective to a depth of 6 meters and above

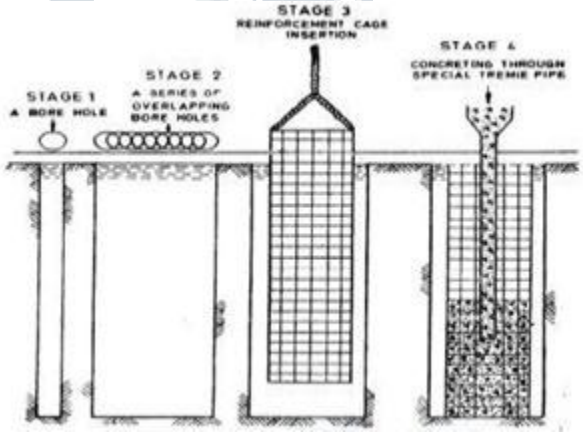


D. Shear Strain Method

In this method diaphragm walls are constructed to increase the performance of soil. This wall is made up of reinforced concrete, bentonite slurry is also used during excavation to support trench.

Basically, 7 meter panel lengths are used but there length can vary according to the type of soil. Excavation is done by loading reinforcing cage filled with slurry for panel construction. After which, trench is filled with concrete by using trench pipes.

0.50m, 0.60m, 0.80m, 1.00m and 1.20m of diaphragm walls are most commonly used.



IV. STRUCTURAL PROTECTIVE WAYS AGAINST SEISMIC FORCES

A. Pile Foundation

A pile is something which is pushed into the ground and a superstructure is built on it. Wooden, concrete or steel are commonly used for the manufacturing of piles in the shape

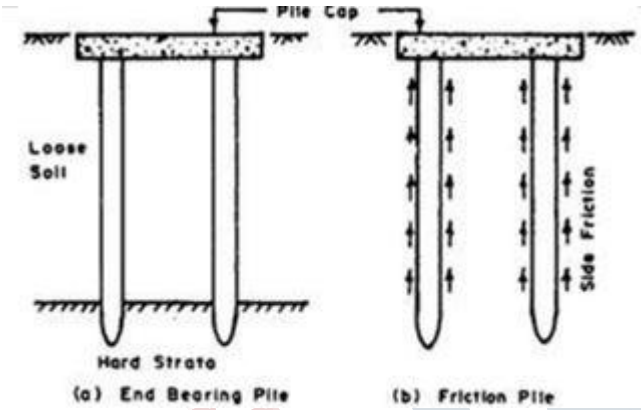
ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 10, October 2017

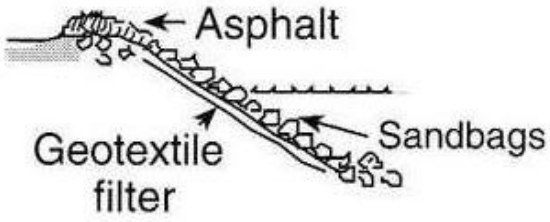
of long cylinder.

There are mainly two type of pile foundation i.e.
End bearing piles, in this case, pile is driven through loose soil to make its lower end rest on strong strata. By this mean load is transferred onto strong layer, by passing the weak layers.

Friction piles, in this case, the load are transferred by friction.



B. Revetments
These are constructed on the banks of river to stop the percolation of water which affects the conditions favoring liquefaction. Revetments make the slope of river bank stable to a great extent, and improve the stability of structures and building during earthquakes.



V. CONCLUSION

These methods can be applied, if someone encounters highly susceptible to avoid liquefaction failure. As water is the chief element for liquefaction, so one should firstly apply dissipation of pore water pressure and lowering water table to decrease water content in soil mass.

REFERENCES

[1] J.A. Sladen, R.D. D'Hollandes, and J. Krahn, "The liquefaction of sand, a collapse surface approach," Canadian Geotechnical Journal, Vol 22, No. 4, pp. 564-578, 1985.

[2] T. Mogami, and K. Kubu, "The behavior of soil during vibrations," proceedings, 3rd International Conference on soil mechanics and foundation engineering, Zurich, vol. 1, pp. 152-155, 1953.

[3] L.K. Steven, "Liquefaction," in Geotechnical Earthquake Engineering, 6th ed. Noida: U.P, India, 2011, pp. 348-417.

[4] K.R. Arora, "Compaction of soil," in Soil Mechanics and Foundation Engineering, ed. Delhi, India, pp. 357-375, 2011.

[5] R.G. Lukas, "Dynamic compaction for highway construction, Vol. 1, Design and construction guidelines," Federal Highway Administration, No. FHWA/RD86/133, 1986.

[6] R.G. Lukas, "Dynamic compaction" Federal Highway Administration, No. FHWA-SA-95-037, 1995.

[7] G. Besancon, and E. Pertusier, "Soil Improvement by Deep Vibration." Proc. ASCE Symposium on Recent Developments in Ground Improvement techniques, Bangkok, 1982

[8] S.M.H. Kirmani, "Consolidation of soil for foundation by using sand drains," IEP-SAC Journals, Saudi Arabia, 2014-2015.