Research Paper Engineering

Identification and Counter Measures Against Liquefaction of Soil

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ABSTRACT

Liquefaction is the process due to which a soil suddenly lose its strength, Generally as a result of ground shaking during great earthquake. When an earthquake shakes loose saturated sand, the grain structure of soil tends to consolidate into more compact packing. Since all these movements happen suddenly, the incompressible pore fluid takes up the entire applied stress and consequently, the effective stress approaches zero and ultimately the deposit "liquefies." Since a liquid has no shear strength, the slope failure, foundation failure may occur. It is most important to identify the liquefaction capability of the soil as well as the remedial steps of these soils.

Keywords :

Determination of Liquefaction potential
A number of approaches are available for determining the potential for initiation of liquefaction. The most common type of approach is cyclic stress approach.

Cyclic Stress Approach
In this procedure, the following two cyclic stresses are determined:

- Cyclic stresses induced in the soil due to earthquake
- Cyclic resistance available in the soil measured either through laboratory tests or field tests.

Cyclic Stress Induced in the Soil
The level of excess pore pressure required to initiate liquefaction is related to the amplitude and duration of the earthquake induced cyclic loading. The loading can be predicted either through site amplification or by a simplified approach. In our country, the simplified approach is preferred. Actual earthquake ground motions recorded have quick irregular time histories. However, laboratory data from which liquefaction resistance is estimated are typically obtained from the uniform cyclic shear stress amplitudes. Hence, the recorded strong motion data are converted to an equivalent series of uniform cyclic stress.

Evaluation of Liquefaction Resistance
To evaluate the susceptibility of liquefaction, after determining the average shear stress due to the earthquake loading, the next important step is to estimate the resistance offered by the soil (shear stress of soil causing liquefaction). In addition to laboratory tests, several field tests (SPT, CPT, etc) have been used for the evaluation of liquefaction resistance. The resistance available in the soil is determined in the cyclic stress ratio (CSR).

Remedial or counter measures against Liquefaction
After determining zone of liquefaction, it can be controlled by various countermeasures. It is appropriate to expel out water from the liquefaction zone as far as possible in order to avoid building up excess pore water pressure during the countermeasures. The common methods of ground improvement techniques that can be applied to counter liquefaction are discussed below.

Densification
Soil densification termed as compaction is one of the most common methods of soil stabilization. It may be natural or artificial process by which soil is made stronger and more resistant to deformation under applied loads. Sand is densified by means of rollers, rammers or vibrators. Compaction involves spreading of sand in thin layers

Blasting
In blasting, explosion of buried charges is responsible for escaping of pore water from the soil mass to facilitate rearrangement of the soil particles and thus leading the sand to more compacted state.

Grouting
Grouting is a technique of inserting some kind of stabilizing agent into the soil voids in a limited space around the injection tube. The agent reacts with the soil to form a stable mass. The most common grout is a mixture of cement and water with or without sand. Grouting is particularly useful where it is desired to increase the soil strength without disturbance to the soil or to any other structure. Permeation through soil by a cementitious grout increases soil cohesion and angle of internal friction. There are various methods of grouting which are described below.

a. Compaction grouting
It is a thick, low mobility grout that remains in a homogeneous mass without entering the soil pores. As the grout mass expands, the installation of casing to the required depth either into a pre-drilled hole or through driving the casing. A stiff grout such as a soil-cement-water mix, is then pumped through the casing until typically one of the three criteria, namely target volume, maximum pressure or surface heave is reached.

b. Jet Grouting
In this, high-pressure fluid jets are used to erode and mix or replace soil with grout. The general installation procedure begins with the drilling of small nozzles, 100mm to 150mm in diameter, to the final depth. Grout is jetted into soil through small nozzles as the drill is rotated and withdrawn.

Filtration (Drainage)
Use of coarse material blanket and artificial drains reduce the length of drainage path and increases coefficient of permeability, thereby speeding up the drainage process. These are considered fully effective if the permeability of material of

drains is about 200 times the permeability of sand in which they are installed. The rate of generation of pore pressure depends on number of cycles of stresses and in turn depends on frequency. Rate of pore pressure built up depends on the rate of dissipation of pore pressure, which is based on drainage. As the number of drains installed is increased, the non-liquefied zone increases. As the acceleration increases, the zone reduces gradually but the increase in time does not reduce the non-liquefied zone. Surface drains effectively prevent the foundation settlement. In order to obtain good results, it must be ensured that adequate depth and width of drains be designed and installed during installation of shallow drains and outside drains. Liquefaction occurs at points too far from the drains. A flexible vertical drain formed by organic fibers like jute can also be used.

Lowering of Ground Water Table

It is well-known that water is the most undesirable element to the soil. Presence of water can reduce the strength, increase the compressibility characteristics and affect the durability behavior of soils. Liquefaction can be completely eliminated if the ground is not fully saturated. Though it is almost impossible to lower ground water, it is possible to lower the water either by pumping or by using gravity drains.

Conclusion

Liquefaction of sandy soil is one of the primary causes of damages to the structures during earthquakes. The damages due to liquefaction during earthquakes include slope failures, foundation failures and floatation of buried structures. Zone of liquefaction must be properly evaluated and various methods to control the liquefaction discussed above should be implemented.

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