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SUPPLEMENTARY RISK ASSESSMENT RELATED TO SEISMIC LOADS ON AREAS AFFECTED BY LIQUEFACTION PROCESS

C. Dobrescu and I.Siminea, E.Calarasu
National Institute for Building Research
E-mail : corneliadobrescu@yahoo.com

Abstract

In the present paper, supplementary risk elements linked to seismic loads on potentially unstable sites are presented. Seismic actions may lead to an essential change of strength conditions and instability of the soil massifs, which eventually have negative impacts against constructions and also the environmental impact.

The interaction of constructions elements with a natural environment characterized by large heterogeneity imply not only to support this environmental influence which is often aggressive, but also to limit its impact on the superstructure. Thus, liquefaction potential assessment related to supplementary risk elements represents a necessity in order to reach reliable and feasible solutions to improve the foundation soil characteristics prior to execution stage of constructions.

The critical moment in designing of the soil - foundations system subject to dynamic loads is given by the soil properties evaluations, which have to be determined for the specific site conditions because those are dependent on strains and deformations distribution developed in the soil massifs. The constructions affected by dynamic actions may suffer settlements bigger than static actions. Those settlements, generally non uniform, results in appearance of very big strains in constructions elements, which lead to partially or totally damage of above mentioned elements.

The manner in which the dynamic effect trough soils is dependent of the soil structure, elastic and amortization characteristics and its effect on construction superstructure behavior and in generally on the construction - soil foundation system.

Keywords: risk, liquefaction, soil, foundations, constructions

1. INTRODUCTION

Developments in the construction field in the past decades has required a fast pace design, which led to unstable land areas to the emergence of issues that involve risks and uncertainties in the field. The interaction between construction elements to a natural environment characterized by great heterogeneity often involves not only influence to the aggressive environment, but also limiting its impact on the superstructure [6].

Moreover a large size of the territory is characterized by a high degree of seismic activity, increasing the difficulty of the foundation problems, especially when the in-situ geotechnical conditions are difficult. Seismic actions can lead to a substantial change in the strength and instability conditions of the soil mass, producing negative effects on construction, default on the environment.

The critical phase on soil-foundation system design to dynamic loads is gave by the soil evaluation on which specific conditions of the site must be determined, because these properties are dependent on the efforts and strains distribution developed in massive ground [3]. The constructions under dynamic actions settlements may suffer much higher settlements compared with those occurring in conditions in which only static loads act. These settlements, generally uneven, leads to damage the efforts in building elements particularly large, which can lead to damage of such elements or to the whole construction. How to propagate dynamic effect depends on the nature of soils, elastic and damping characteristics, also depends of the additional risks related to seismic strains and their effect [8].

2. SOILS AND LIQUEFYING MATERIALS

By definition, liquefiable soils are composed by low-density, material particles ranging from very fine sand to fine sandy silt and saturated silty sand. For these kind of materials is very difficult to harvest samples, specimens for

laboratory tests without disturbing of the soil structure within [1].
Peek (1975) claims to be "practically impossible" to obtain a sample of this range of soils and to whom one can say that the soil is undisturbed.
Since the deposit formation (located either in thick layers or in lenses of different shapes and volumes), taking into account the over consolidation process, any preferential manner of cementing adding to their historical existence of tensions that have passed liquefaction strength, we can affirm the existence of mixtures in their stable layer.
Ishihara (1985) says that specimens harvested from these soil types - and whom needed to be modeled in the laboratory - and then subjected to cyclical attempts have higher resistance values versus liquefaction potential by „in-situ" tests versus those from the surface. Consequently in the following years estimating liquefaction potential tended to be performed by in-situ tests [11].

3. QUANTIFIABLE VALUES IN THE CASE OF LIQUEFACTION RESISTANCE

At the moment, there is no direct way to measure the liquefaction potential. What can be quantified by indirect methods or adapted, are approximations to the liquefaction resistance under seismic loads.
Before examining the result obtained from tests carried out in in-situ and from the soil particles motion point of view is important to understand the phenomenon of variation of some parameters as a result of liquefaction of the soil under cyclic loads [7].
Soaks at depths close to the underground water level usually generate soil settlements, or landslides, if they are arranged and supported on clay slopes and / or waterproof limestone.

4. ADDITIONAL RISK ELEMENTS

If the risks of seismic loads are defined by:
- unacceptable risks;
- intolerable risks;
- tolerable risk;
- acceptable risks.

Then one can make these comments acquired by nationally scale achieved experience.

4.1. Unacceptable risks

In the light of the present paper, the unacceptable risk implies that action that accepts and allows the execution of construction works in well known areas as unstable even under soft seismic loads. Here are some examples:
- civil buildings constructions under slopes that were subjected to repeated landslides (Seimeni commune - Constanta county);
- construction completed on top of former mine galleries, and which at the occurrence of natural vibrations (or even collapse of some gallery areas), local land slides on surface, micro or medium-tectonic earthquakes or artificial vibrations can generate uncontrollable damage (Ghelari City Church – Hunedoara County);
- thickening of the buildings above lands where rock salt is present at shallow depth or even may appear in the existing component, liquefying layers.

4.2. Intolerable risks

Intolerable risk concept includes the accepted complex of actions and who do not consider the unfavorable soil liquefaction potential in the newly created situations can illustrate:
- massive deforestation in areas that had not a seismic history in the past, but today they have (Busteni, Sinaia - Prahova county);
- preservation of sites in the vicinity of ash landfills or mining sterile, ponds - built and abandoned without being stabilized by a technique or another as protection against seismic shocks;
- geotechnical study project failure in the case of interception of layers or lenses of potentially liquefiable material in the sense of tightening and extension of field and laboratory research to technological depletion (Adapazari 1999 - Turkey);

- design of buildings on sites whose foundations soil was notified by geotechnical studies, potentially liquefiable without undertaking specific measures to improve the lands (Istanbul, Düzce in Turkey);
- building design and implementation of underground utilities works to carry fluids under high pressure at distances over improper fund built which are to close to them.

Because of the pipelines damage occurrence (cracks, seals erosion etc..) can occur violent explosions that can spray the ground out, and if it has the liquefaction capacity, the affected area can be stretched (Satu Mare County).

4.3. Tolerable risks

Normal use is dependent on the time limit of existence of the elements from which are made up the buildings. The use of each item depends on the nature of the material from which is made and the usual operating conditions, and the general use of the building is given by a weighted average of the use of different components [5].

Taking into account our country's conditions, we have buildings that were well executed and well maintained and are still operating after more than 100 years.

The life span of the office buildings is a function of the quality of the materials used exploitation conditions and in particular of the way it was and it is maintained the building.

In terms of service times normal building elements and facilities that comprise residential buildings provided the normative, is divided into three groups, namely:

Group I comprises buildings with "load-bearing walls, wood or wooden frame, adobe, stabilized ground, with service duration of 25 years.

Group II comprise buildings with "load-bearing brick walls, brick replacement, stone, wood floors, with a duration of 70 years service.

Group III comprise buildings with "load-bearing brick walls, brick replacement, stone, floors of reinforced concrete, reinforced concrete panels, monolithic bearing walls, reinforced concrete frame and steel profiles, with a service life span of 90 years [4].

The phenomenon of construction damaging is particularly complex due to the extreme complexity of factors that influence the damaging processes depending of the near constructive structure, execution way and the time behavior of the foundation ground. Considering the existing fund and the lack of maintenance and repair which can develop settlements, tilting, cracking due to differential settlements and taking into account the probabilities of the possible occurrence of earthquakes and other kinds of vibrations when their safety is jeopardized.

4.4 Acceptable risks

In the of risk accepted category, are included generally fortuitous cases represented by emerging of potentially liquefiable layers in atypical areas, large variations in the hydrostatic and hydrodynamic level (see floods situations), eruptions of oil, water or borehole gas produced from wells that are either in phase of drilling or operating stage and finally, the lack of equipments, known tools and technology existing on the market or retired from the market that should be designed and executed protected under international laws [9].

5. CONCLUSIONS

Liquefaction is a process in which the seismic shear waves cause an increase in the pore water pressure in cohesionless soil strata. The reduction in effective confining stress causes a reduction of shear modulus of the soil, which in turn, results in increased soil deformation. Also associated with liquefaction, is a loss in bearing strength. In the case of full liquefaction, when the increase in pore water pressure reduces the confining stress to zero, the soil experiences a full loss of strength and undergoes large viscous deformations. Large lateral deformations are possible when liquefaction occurs on ground having even minimal slope [10].

Safe and effective seismic design requires establishment of performance goals, specification of the earthquake load levels and given that loading, definition of the expected acceptable structural response limits.

Design of structures shall include provisions to evaluate and resist liquefaction of the foundation and account for expected potential settlements and lateral spread deformation.

Thus, estimation of liquefaction potential due to additional risk factors is a necessity for reliable and feasible solutions to improve the soil foundation characteristics in their application before the execution building [2].

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