IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 06, Issue10 (Oct. 2016), ||V3|| PP 01-06

Damages According To Liquefaction And Suggestions

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Abstract: - While designing engineering structures, structure foundation should operate in accordance with the ground as much as possible and should fulfil the design criteria in geotechnical and structural means. Structure-ground interaction should be a non-negligible element of structure design. So far, examinations related to the earthquake indicate that earthquake induced structural damage is significantly affected by soil conditions. One of these is soil liquefaction. After soil became saturated by water, this damages the structures above the ground. This study conducted to determine soil-structure interactions and damage effects that arise from soil liquefaction. Liquefaction damages caused by ground are described and samples were brought for this damage. At the end, suggestions were made based on the obtained results.

Keywords: - *Earthquake, Soil Liquefaction, Soil Condition*

I. INTRODUCTION

The seismic risk of stock of buildings is of growing interest for academia as well as for the decision makers due to the increasing urbanization and concentration of populations in earthquake prone and vulnerable areas. Turkey, especially since 1999, is known as one of the most earthquake prone regions in the world. This is somewhat true considering that the most of the country is under earthquake threat.When designing engineering structures, it is expected to work building foundations compatible as possible with the ground and to fulfill both the geotechnical and structure aspects of design criteria. In general, upper structure and foundation analysis are done separately. The upper structure analyzes columns and shearwalls as fixed support at the lower floor, so it is assumed that foundation is not affected from the structure or vice versa. In this case, the soil-structure interaction is reduced only to the solution of the base element. However, the soil-structure interaction is an important parameter in the design of engineering structures such as superficial and deep foundations, tunnels and retaining walls [1].Studies performed on structures damaged or destroyed in the earthquake shows that damage and destruction was based on several reasons. Usually the cause of the damage revealed from ignorance, lack of soil survey, missing or insufficient building geometry and carrier system. Earthquake forces that may hit to the structures vary depending on the soil class, local earthquake acceleration and structure type [2]. Structures are exposed to static and dynamic (earthquakes) loads. Problems such carrying capacity, settlement, slope stability are geotechnical problems that occur due to both static and dynamic loads; liquefaction and amplification constitutes from dynamic loads problems such earthquakes.

The structure of the soil foundation and the structures built without investigated its physical properties are often faced with significant damages. One of the aims of this study is to provide information about the effects of earthquakes on structures that the earthquakes are considered the biggest natural disasters in the world and in our country. This study was conducted to determine the effects of damage to the structure of the soil-structure interaction and soil liquefaction. Damage caused due to liquefaction is disclosed and samples are given for these damages. Suggestions were made based on the obtained results.

II. EFFECTS OF GROUND-STRUCTURE INTERACTION AND REGIONAL SOIL CONDITIONS ON EARTHQUAKE DAMAGE

Ground and carrier system which has roots in the ground interact with each other. The responses observed from the same structure on different grounds will be different from each other. If the foundation does not comply with open land movements, it will cause the deformation at the structure ground. So, while ground properties affected by the dynamic motion of the structures; structure movements are also affected by the dynamic movement of the ground that this is called the soil-structure interaction.

Subject of the local soil conditions that changing the effect of the earthquake on the structures is being investigated for a long time. Several past studies about the earthquakes show that structural damages which have occurred significantly affected by soil conditions.

Site effects are associated with the phenomenon of the seismic waves travelling into soft soil layers. It is explained firstly by the lower velocity and density between unconsolidated sedimentary layers and the underlying rock. For conservation of energy, this requires larger amplitudes of the seismic waves in the sediments. The shape and frequency content of such waves depends on the geometry and physical properties of the structure. The degree of complexity of predicting a seismic response increases with the complexity of the structure [3].

All the important features of strong ground motions such as amplitude, frequency content and time are greatly affected from local soil conditions. Their degree of impact depends on the geometry of the units underground and lithological characteristics, topography of the study area and the movement of input characteristics [4].

III. LIQUEFACTION

It is known that liquefaction does not occur in all soil layers on the land. Therefore, as a priority in the liquefaction hazard analysis it must be examined whether the necessary conditions exist for the occurrence of liquefaction. The most important of these conditions may be stated as the earthquake distance from the center and its magnitude, composition of the soil layer, geological history, and soil-land stress and compactness cases.

Considering all liquefaction events observed in the field in the past it is observed liquefaction occurs at light earthquake and liquefaction threat restrains between the earthquake magnitude and the distance from center. Geological age, precipitation and hydrological conditions of the soil layers provide important instructions on its liquefaction. Young sediments and geological environments that cause uniform grain distribution and loose settlements at the precipitation process have much higher liquefaction risk. Underground water table depth is also known to have a significant impact of liquefaction [5].

The decrease of carrying capacity by exposing sudden loss of strength and stiffness by strong ground shaking and loose saturated cohesiveness soil ponds can result permanent and large displacements and/or seismic settlement of the ground. This phenomenon usually gets the name of soil liquefaction. Strong ground shaking in saturated or almost saturated soil conditions can cause jams and settlements on the soil. This phenomenon also known as seismic settlement. The occurrence of such formations under or near any structure may result structure damage, stability deterioration and deterioration of structure and its extension's integrity.

Soil liquefaction can be examined in two separate groups. The first of them is flow liquefaction that under the static shear stresses important replacement and strain can be seen since the soil shear stress hits as static state exceeds the liquefied soil shear strength. The second kind liquefaction "rotational movement" not likely as flow liquefaction; it occurs when the static shear stresses are less than liquefied soil shear strength [4].

Deformation caused by cyclical movement is increasingly developing during the earthquake. In contrast to the flow liquefaction, deformations occur from both cyclical and sheer stresses. These deformations may be seen in a waterfront, slightly sloping or an almost straight terrain. It is called lateral spreading. Structures located in such areas face significant damage by lateral spreading. The special case of the circular mobility is flat ground liquefaction. It is because there are no static shear stresses that may lead to lateral deformation, flat soil liquefaction causes too much movement during earthquake, despite (ground oscillation) poses very little permanent lateral movement. The flat ground liquefaction damages consist from extinction of excess pore water pressure due to a seismic movement towards up. Damages cab be seen after the recent earthquake depending on the length of the time for balance. Excessive vertical sitting and consequently inundation of low-level land and sand boil arise from flat ground liquefaction [6].Foundation soil loses its strength as a result of the liquefaction. It also loses its bearing capacity. Consequently, structures sink, pivot, tilt or overturn. Liquefaction occurring on the ground was shown in Figure 1.

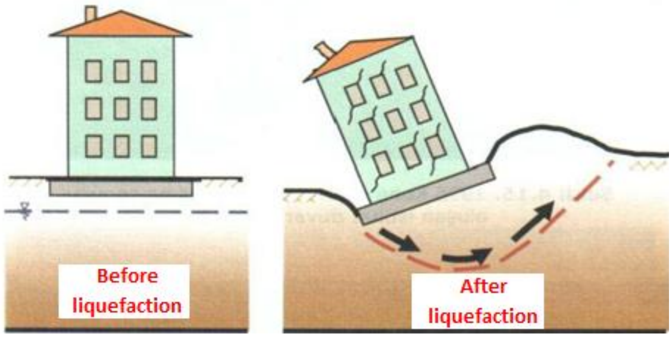

Figure 1. Liquefaction

Liquefaction damage for 1991 Costa Rica earthquake was given in Figure 2

Figure 2. Liquefaction damage after 1991 Costa Rica earthquake [7]

Liquefaction damage for 1964 Niigata, Japan earthquake was given in Figure 3

Figure 3. Liquefaction damage after 1964 Niigata, Japan [8]

Liquefaction damage for 1906 San Francisco earthquake was given in Figure 4.

Figure 4. Liquefaction damage after 1906 San Francisco earthquake [9]

Liquefaction damage after 1999 Turkey earthquake was given in Figure 5.

Figure 5. Liquefaction damage after 1999 Turkey earthquake [10]

Liquefaction damage after 2011 Japanese earthquake was given in Figure 6.

FIGURE 6. LIQUEFACTION DAMAGE AFTER 2011 JAPANESE EARTHQUAKE [11]

Liquefaction damage after 1989 Loma Prieta earthquake was given in Figure 7.

Figure 7. Liquefaction damage after 1989 Loma Prieta [12]

Liquefaction damage after 2010 Darfield earthquake was given in Figure 7.

Figure 8. Liquefaction damage after Magnitude 7.0-7.1 Darfield Earthquake (near Christchurch) September 2010 [13]

IV. CONCLUSION

Regions in earthquake zone can face big earthquakes sometimes and many structure diminish or damage exposing by them. Areas on the seismic line face to large earthquakes from time to time. Many buildings are damaged or demolished by these earthquakes. When the structure damages due to earthquakes are examined, it is observed that the formation of soil properties also play a significant role in this case. In this study, the liquefaction which is one of the ground problems was investigated. As seen in the study, no matter where in the world one of the damage comes from the ground is liquefaction.Problems such as the bearing capacity, settlement, slope (slope) stability are geotechnical problems arise from both static and dynamic loads. Dynamic loads also create problems such liquefaction, amplification, earthquake and etc.It unfolds the necessity of earthquake effects to be kept in mind during construction. Due to seismic risks, the reality of earthquake should not be forgotten in world.Knowing the reasons of earthquakes damage is important to minimize the probable economic and life loses. Recently, modern disaster management emphasized not only disaster preparedness but also the importance of disaster prevention.In projecting of structure systems, it is necessary to take the interaction between structure-foundation-ground triplet into consideration and take the effects of deformations caused on ground layers due to loads transmitted to the ground on inner forces and load distribution in foundation element and superstructure load bearing system into account. While designing engineering structures, structure foundation should operate in accordance with the ground as much as possible and should fulfill the design criteria in geotechnical and structural means.The vast majority of the deep foundation failures related to the earthquake have been the result of seismic liquefaction of the ground around or under the foundation. If the liquefaction occurs around the foundation, occurring support loss may cause excessive lateral movement and tilting renovation. If the liquefaction occurs under the base, there may be excessive sitting or turning the pile cap. If the grounds that may liquefy limited with shallow depths and there is no danger of lateral spreading, it may be possible to neglect the load-carrying capacity and design deep foundations accordingly. The foundation design should be done after the ground improvement works in wide areas.Data related ground must be calculated caring the original region's condition. Realistic soil characteristics make easier the calculation of the soil-structure interaction. In this context, soil-structure interaction should be defined correctly and it should not be neglected in the calculations. Not only in earthquakes but also the ground effects in static conditions must be taken into consideration by the designer. For this purpose, soil parameters required for static calculations should be made on the basis of the necessary measurements and tests required parameters should be established. On the ground research, especially research depth, structure type, foundation type and determination of the stress affects the structure are safe building design, and they should be performed as needed engineering work.

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