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Effect of Earthquake Induced In Lateral Soil Movement on Lateral Pile Resistance

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Abstract— The performance of piles in liquefying ground under earthquake loading is a complex problem due to the effects of a progressive build-up of pore water pressures in the saturated soils. The loss of soil strength and stiffness due to liquefaction may develop large bending moments and shear forces in piles, possibly leading to pile damage. The significance of liquefaction-related damage to pile foundations has been clearly demonstrated by the major earthquakes that have occurred during past years. The present investigation is to find out the effect of earthquake induced lateral soil movement on piles in sloping ground. The present study was carried out by numerically. In this, 1995 Kobe earthquake data (Japan) is used. Parametric study has been done on the same model by varying slope in the soil layers and L/D ratio of the pile. The dynamic analysis was carried out for slope angle of 1V:1.5H in with L/D=16, L/D=25 & L/D=33. In each case, bending moment and displacement variation with depth of the pile is noticed. Based on the study, it is concluded that for a constant slope and constant depth of liquefiable layer lateral displacement and bending moment is significantly increased for L/D=16 when compared to higher L/D ratio's of 25 and 33. However, further increase in L/D ratio is not having any significant effect in the lateral displacement.

Keywords: Liquefaction, Large Lateral Flow, Pile Groups

1.INTRODUCTION

The seismic waves generated due to earthquake cause the ground to vibrate and create severe natural disasters. Various types of ground deformations occur during vibration and such deformations leading to failure can be recognized as ground failures. The dramatic response of saturated loose sand deposit due to earthquake can be hazardous to constructed facilities in the seismic regions where such soil deposits exist. One of the most common causes of ground failure. During earthquakes is the liquefaction phenomenon, which produces severe damage to property. Although methods are available for seismic analysis of pile foundations, most of them consider soil to be an elastic material. Collapse of piled foundations in liquefiable areas has been observed in most recent strong earthquakes despite the fact that a large

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margin of safety is employed in their design. Lateral spreading of gently-sloping deposits of liquefiable sand is a cause of much damage in earthquakes, reportedly more than any other form of liquefaction-induced ground failure. The present investigation finds the effect of earthquake induced lateral soil movement on lateral pile capacity.

Parametric study is carried out on the same model by changing the ground surface to differentslopes on the top of the non liquefiable layer and by changing the length of the pile in the bottom layer of the non liquefiable layer. The paper focuses on the behaviour of pile under lateral soil movement due to earthquake. The bending moment and displacement behaviour of pile is studied in detail for different slope conditions. In liquefiable soils, earthquake excitation shall induce the development of excess pore pressure and when the excess pore pressure reaches the initial overburden effective stress, the soil is liquefied. Liquefaction behaviour was observed during a number of earthquakes in the past. During Alaskan Earthquake (1964), liquefaction was the main cause of severe damage to 92 highway bridges, moderate to light damage to another 49 highway bridges, and moderate to severe damage to 75 railroad bridges. During Niigata Earthquake-Hamada (1964) liquefaction induced damage to the foundation piles of Yachiyo and Showa bridges and Niigata Family Court House building (NFCH) building and underground pipelines. During that same earthquake, girders of Showa Bridge toppled as the support structure and piles moved excessively due to liquefaction. During Kobe Earthquake (1995), liquefaction was the primary cause of damage to many pile supported or caisson supported bridges and structures. For example, Shin– Shukugawa Bridge was subjected to excessive pile foundation movement due to liquefaction. It has caused the collapse of the Daikai subway station. In the 1995 Kobe earthquake, massive liquefaction of reclaimed fills caused serious damage to numerous pile foundations of buildings, storage tanks and bridge piers.

2. Literature Survey

Lateral spreading past bridge foundations was observed in the 1999 Chi-Chi earthquake in Taiwan. During the 1999 Chi-Chi, Taiwan earthquake, many sand boiling phenomena were observed in central Taiwan, which caused severe ground settlement and structure damages.

Examples of damage to deep foundations and lifeline utilities due to liquefaction-induced lateral spreading are; the railway bridge foundations during the 1991

Limon earthquake **(Youd et al., 1992);** the batter piles supporting the 7th Street
Terminal Wharf in the 1989 Loma Prieta earthquake

(Benuzca 1990); and the damage to numerous water and gas lines in the 1906 San Francisco earthquake (Bartlettand Youd, 1992). The extent of damage and affected areas in Bhuj earthquake (26th January 2001) has provided a unique

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opportunity to evaluate a wide range of geotechnical issues.

A large area in the Rann of Kutch experienced massive liquefaction resulting in ground subsidence andlateral flow. A large number of dams in the Kutch district suffered moderate to severe damages. Many buildings were damaged and collapsed in the city of Ahmedabad situated on the bank of the Sabarmati River. Dynamic FEM analyses have the potential to better represent certain aspects of pile foundation behaviour during earthquake loading and liquefaction-induced deformations. FEM analyses can explicitly include the effects of progressive liquefaction on seismic response, ground deformations

3. Key Observations and Discussions

In this section the key observations of the experiments are presented and related discussions are addressed. First the general results of small pile groups (3×3) and those of large pile groups (6×6 and 11×11) are given, then the specific finding are delivered. Figures 4 and 5 display the time histories of some of the parameters. According to acceleration time histories, the response acceleration amplitude inside the soil decreased after the onset of shaking; as a result of excess pore water pressure built-up and consequent liquefaction. Pore water pressure records show that high excess pore water pressure developed at the early stage of shaking and was maintained during shaking. Time histories of soil displacement demonstrate a steady increase during the shaking, approaching residual value at the end. Comparison between time histories of soil displacement at the ground surface exhibits that the lateral soil deformation behind the pile group on downstream was greater than that in front of pile group on upstream, and the soil movement inside the pile group was the smallest because of soil-pile interaction.

4. Distribution of Maximum Total Lateral Force in Pile Groups

The distribution of the maximum total lateral force for the group piles in sloping ground was carefully studied, and two examples of the results are given in Figures 8 and 9 for the small (3×3) and large (6×6) pile groups, respectively. These distributions demonstrate that in the sloping ground model both front row (in upstream) and rear row piles (in downstream) carry larger lateral forces in the group than middle row piles (inside pile group)

5. Pile Pinning Effect

Identify the soil layers that are likely to liquefy. 2. Assign undrained residual strengths (Sur) to the layers that liquefy. Perform pseudo-static seismic stability analysis to calculate the yield acceleration, ky, for the critical potential sliding mass. Typically, the slide mass with the lowest ky value is considered as critical. 3. Estimate the maximum lateral spread displacement of the soil. 4. If the assessment indicates that movement of the foundation is likely to occur in concert with the soil, then the structure must be evaluated for adequacy at the maximum expected displacement. This is the mechanism illustrated in Figure 1. The

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structural remediation alternative makes use of the "pinning" action that the piles contribute as they cross the potential failure surface. 5. Identify the plastic mechanism that is likely to develop in the presence of spreading. 6. From an analysis of the pile response to a liquefaction-induced ground displacement field, the likely shear resistance of the foundation is estimated. This increased resistance is then incorporated into the stability analysis, which increases ky. 7. Recalculate the overall displacement on the basis of the revised resistance levels, and iterate until the resistance is consistent with the level of displacement estimated. Once a realistic displacement is calculated, the foundation and structural system can be assessed for this level of movement. If necessary, additional piles can be installed to reduce the seismic displacement further.

6. Soil Properties

Description
Nevada Sand
(Dr=40%)
Slightly Cemented
Sand
Density (kN/m3) 25 28
Φ 32 35
Ψ 2 5
k (m/s) 6.05 × 10-5 3.197 × 10-5
μ 0.25 0.3
E (kN/m2) 38000 49000
Pile Property
Material Concrete
Diameter (m) 0.6
EA (kN) 3.56 × 105
EI (kNm2) 8000

7. Pile Bending Moment

In order to measure bending moment, piles were densely instrumented with several strain gauges at different levels. The strain data were then converted into bending moment using calibration factors (see Motamed 2007 for calibration details). Since the piles were fixed at the bottom while free at the top, the maximum bending moment was observed at the base of piles, being similar to a cantilever beam.

8. Conclusion and Future Work

The pile pinning effect has been employed as a remediation measure in a number of engineering projects to reduce the amount of movement likely to occur as a result of liquefaction-induced lateral spreading. This remediation measure has been formally incorporated in design guidance documents such as MCEER/ATC-49-1 for the design of bridges with pile foundations. Its use is becoming more widespread in highly seismic regions where pile foundations are installed to support wharfs, bridges, and buildings in ground susceptible to liquefaction-induced lateral spreading. Other ground modification techniques can be employed to reduce the liquefaction hazard, however, they can be costly and unnecessary if the piles can be shown to arrest the lateral spreading and achieve acceptable seismic performance. A simplified probabilistic procedure for evaluating

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the seismic performance of pile-supported bridges that are subjected to liquefaction-induced lateral spreading has been developed. The proposed procedure formally incorporates the "pile-pinning" effect. Moreover, the uncertainty in parameters such as the SPT blow counts, the residual undrained shear strength of the critical liquefied soil layer, the distance between points of fixity of the piles, and the probability of occurrence of liquefaction have been incorporated in the proposed procedure so that the uncertainty involved in each of these key parameters can be incorporated in the overall seismic evaluation of the engineered system. A finite element model with three layers of soil and a pile is created and dynamic analysis has performed. The developed FE model has been validated with the similar study which was done by Abodoun and Dobry (2002). The obtained results from the developed FE model are having very good agreement with their centrifuge model results. The increase in L/D ratio is significantly affects the failure mode of the pile. The failure mechanism of L/D=16 pile is like a short rigid pile though the pile is long flexible pile as per soil-pile relative stiffness calculation. However, the increase in L/D ratios (L/D=25 and 33) changes the mode of failure of the piles more towards flexible in nature. The increase in L/D ratio beyond 33 is not much significantly affects the bending moment and lateral deflection of the pile.

9. REFERENCES

1) S.J., Boulanger, R.W., Kutter, B.L., and Chang, D. (2005). "Behavior of Piles in Laterally Spreading Ground during Centrifuge Tests".

2) JGGE, ASCE, Vol. 131, pp. 1378-1391. Bray, J.D. and Travasarou, T. (2007). "Simplified Procedure for Estimating Earthquake-Induced Deviatoric Slope Displacements".

3) Der Kiureghian, A. (2005). "Probability Concepts for Performance-Based Earthquake Engineering". Symposium Honoring Luis Esteva, Mexico City. Duncan,

4) J. M. (2000). "Factors of Safety and Reliability in Geotechnical Engineering". J. of Geotech. and Geoenviron. Engrg., ASCE, Vol. 126, pp. 307-316. Eddy, M.A., and Gutierrez,

5) M.S. (2006). "Probabilistic Liquefied Shear Strength for Post-Liquefaction Analysis". Proc., 8th U.S. Nat. Conf. on Earthquake Engrg., San Francisco, CA, Paper No. 1795.

6) Finn, W.D.L., Ledbetter, R.H., and Wu, G. (1997). "The Stabilization of the Upstream Slope of Sardis Dam Using Driven Prestressed Concrete Piles: Methods of

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Analysis". Proc., 9th Inter. Conf. on Computer Methods and Adv. in Geomechanics, Wuhan, China, J.X. Yuan (Ed.), A.A. Balkema/Rotterdam/Brookfield, pp. 141-150.

7) Finn, W.D.L., Ledbetter, R.H., and Stacy, S.T. (1991). "Dam on Liquefiable Foundation: Safety Assessment and Remediation". Proc., 17th Inter. Conf. on Large Dams, Vienna, pp. 531-553.

