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論文題目	Kinematic and inertial loading-based seismic assessment of pile foundations in liquefiable soil （液状化地盤における杭基礎の地盤変位・慣性力に基づく地震時挙動の評価）		

（論文内容の要旨）

The thesis presents various aspects of the performance of pile foundations in liquefied soils. An effort has been made to improve the current understanding of the pile foundations under large non-linear behavior. The thesis presents the major research finding in terms of results obtained from FEM analysis (2-D and 3-D) and total of 16 dynamic centrifuge tests developed. The centrifuge tests were carried out considering varying sloping inclination angles of the ground surface as well as for the cases involving plain ground conditions. The tests were developed considering the uniform and multi-layer soil deposit. The centrifuge experiments were carried out under harmonic excitations and transient waveforms having different earthquake characteristics in order to assess the performance of pile foundations under different conditions. There are eight chapters in total in the thesis.

Chapter 1 presents the introduction, background and fundamentals regarding the performance of pile foundation in liquefied soils.

Chapter 2 presents the studies available in the literature considering the analytical, numerical and experimental research. The performance of piled-foundations during the previous earthquakes is also reported in terms of case-studies. Chapter 2 also outlines the critical appraisal of the literature and limitations associated with the established research in the literature. At the same time, the detailed objectives and motivations associated with the present research are outlined. The methodology adopted to conduct the present research work is presented in terms of 2-D plane strain FEM analysis, Centrifuge model testing and 3-D FEM analysis.

Chapter 3 presents the brief introduction about the strain space multiple mechanism model, which is used further to assess the soil-pile-structural interactions. This chapter shows the applicability of the model by validating the responses involving lateral spreading using LEAP centrifuge database. The strain space multiple mechanism model is found replicate the desired dynamic stress-strain responses obtained during the centrifuge model testing involving lateral spreading events. The dilative response of the soil post-liquefaction was found to be very well captured during the earthquake loading. The degradation in initial stiffness of soil during an earthquake loading due to significant amount of excess pore pressure generation was appropriately simulated. Hence, it can be said that the modeling of soil elements using a strain space multiple mechanism model is effective in capturing the detailed soil response in a correct way during liquefaction. The model can further be used to assess the soil-structure interactions during liquefaction.

Chapter 4 presents the 2-D FEM to study the soil-pile kinematic interactions. Initially, the applicability of the strain space multiple mechanism model towards the prediction involving the liquefied soil is shown validating with the centrifuge test results considering soil-pile kinematic interactions. A frequency based assessment was carried out to study the soil-pile kinematic interactions depending on the varying excitation frequencies associated with an earthquake for two earthquakes having significantly different arias intensity. For the cases involving lesser values of excitation frequency, soil did undergo excessive liquefaction resulting in pile to receive very little lateral displacement as compared to the free field displacement. However, with the increase in excitation frequency, pile undergo increased lateral displacement. The comparison of the obtained results with the BDWF analytical methodology highlighted shortcomings of the analytical solution to consider the non-linear soil-pile kinematic interaction involving the phenomenon of liquefaction. However, the kinematic interaction factor represented by rotation was found to be in a good agreement.

Chapter 5 presents the centrifuge model tests to study the influence of the sloping inclinations of the ground surface, which may lead to considerably different kinematic interactions with the piles. The chapter also shows the varying kinematic loads from larger monotonic to a small magnitude of monotonic moment over the course of multi-shaking events. This chapter also presents the influences of a multi-layer soil deposits involving the lateral spreading of soil. The centrifuge tests were carried out for a single and a 2X2 pile group and it is shown that the pile nearest to the upslope side was subjected to the least bending moments during the lateral spreading.

Chapter 6 presents the centrifuge test analysis, where the results obtained from 12 centrifuge tests are discussed. The tests were carried out considering a plain deposit, an inclined deposit taking into account the homogeneity and heterogeneity of the soil model. The centrifuge tests were carried out for only a soil-pile model, soil-pile-footing model and a soil-pile-footing superstructure model aiming to show the performance of pile foundations under different loading conditions. The tests were carried out for realistic earthquakes possible in real life scenario having different earthquake characteristics which might induce different level of damages on the soil-pile-structure system depending on their intensity. These tests were developed in order to assess the potential failure locations in pile consider various uncertainties associated with the problem. The tests indicated the pile response to significantly differ based on its location in a group

Chapter 7 presents the coupling mechanism of kinematic and inertial loading using a 3-D FEM program. The 3-D FEM code was used to analyze the soil-pile kinematic interactions and soil-pile-structural interactions on a plain ground. The results obtained were validated with the centrifuge experiments which showed reasonable agreement of the developed 3-D FEM meshing. From the analysis, moment was found to increase significantly with the increase in number of stories, with much prominent effects of coupled inertial-kinematic interactions being observed for a building having more no. of floors.

Chapter 8 enlists the conclusions and major research finding achieved from the present study. The future scope is also presented.