Inelastic Response of Extended Pile Shafts in Laterally Spreading Ground during Earthquakes

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Topic

A common cause of damage to bridge structures during earthquakes is liquefaction-induced ground movement.

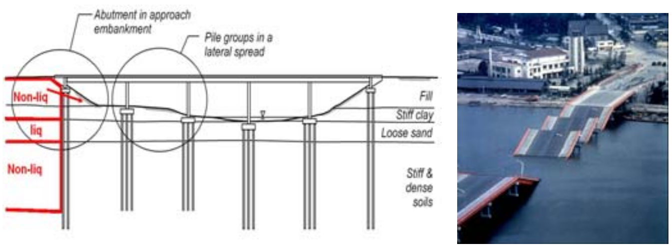

Fig. 1: Bridge foundation subjected to lateral spreading and superstructure inertial load

The objective of this research is to develop equivalent static analysis (ESA) procedures that account for the inelastic response of large diameter (2m to 3m), extended pile shafts subjected to both superstructure inertial load and horizontal lateral spreading load during an earthquake.

Background

Prior research does not provide guidance on appropriate ESA procedures for the inelastic response of bridge structures subjected to lateral spreading during earthquakes. Chang (2007) developed ESA guidelines for combining lateral spreading and inertial loads for structures that remain elastic. Hutchinson et al. (2004) studied the effect of yielding in RC extended pile shafts due to superstructure inertial loads alone. Various studies have involved dynamic analyses of inelastic structural response during lateral spreading, but have not provided guidance on ESA procedures.

Draft Caltrans design guidance (2004) for type-I extended pile shafts requires the max moment due to lateral spreading forces being kept lower than 20% of the plastic moment capacity (M_p) of the RC pile. Local ductility and global displacement demands are not explicitly calculated.

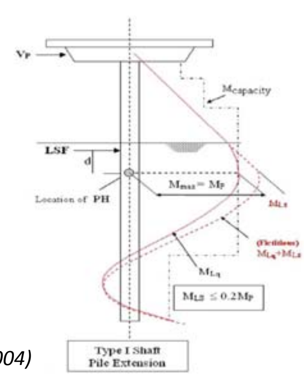

Fig. 2: Draft Caltrans guideline (2004)

Scope and Timelines:

The research plan includes the following steps:

1- Preparation of an inelastic dynamic model using FE platform, OpenSees, employing Multi-Yield-Surface-Pressure-Dependent and Multi-Yield-Surface-Pressure-Independent constitutive models by Yang and Elgamal.

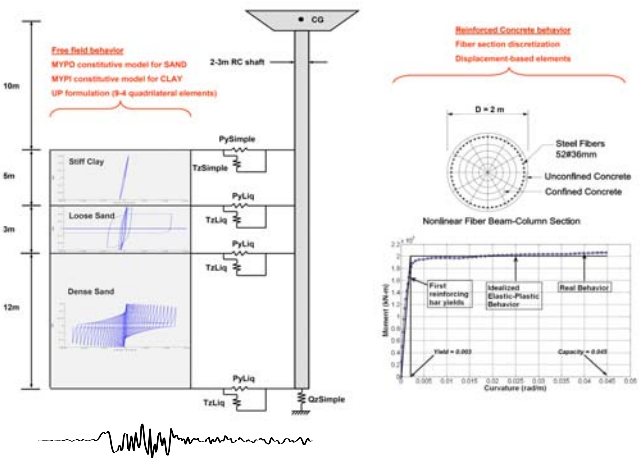

Fig. 3: Inelastic Dynamic Analysis

2- Parametric study of the inelastic dynamic response of extended pile shafts in laterally spreading ground.

3- Development of ESA procedures, based on the dynamic analysis results, for estimating local ductility and global displacement demands during lateral spreading. The main question for producing the ESA would be:

Q: Can we uncouple the inertia and kinematic loads?

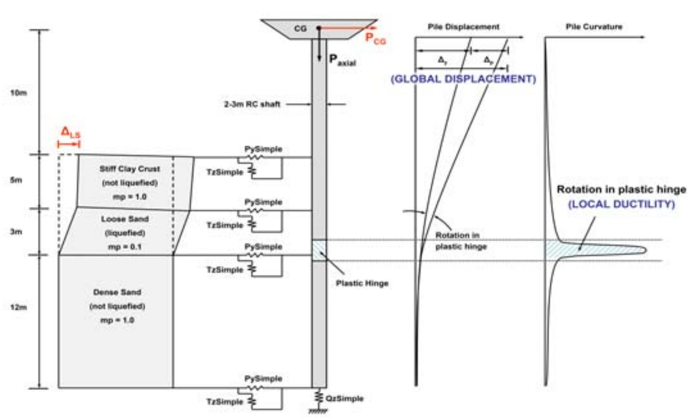

Fig. 4: Draft ESA procedure (pushover)

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