

以有效應力法探討因大地震所引起土壤液化造成樁基礎破壞之實例分析

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摘要

本文使用三維有效應力分析法，針對日本神戶縣某群樁基礎建物在1995 Kobe earthquake中受損的狀況進行數值模擬與受損機制探討。本文採用FE-FD雜交解法，對於單元的孔隙水壓力用有限差分法求解，於位移則採用有限元素法的插值形函數表示。樁受震時的非線性行為，是採用能考慮受震時樁身軸力變化對樁剛性變化影響的AFD model，並以反覆彈塑性砂土模型模擬砂土動態行為。數值分析結果與現地調查結果皆顯示樁頭及液化與非液化土層交界處之樁身，皆在此大地震中產生嚴重損壞。

關鍵字：土壤液化、樁基礎、三維數值分析。

A case study of liquefaction-induced damage on piled foundation due to a major earthquake by using effective stress analysis

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Abstract

A case study of damaged piled foundation due to 1995 Kobe earthquake was carried out in this study using a numerical tool. An effective stress analysis was conducted on investigating the failure mechanism of this building during this major earthquake, of which FE-FD staggered solution was adopted in the numerical scheme, AFD model was used to represent the nonlinear behavior of pile, and a cyclic elasto-plastic soil model was used for reproducing the dynamic soil behaviors. This numerical result shows the failure of pile of this building system gathered at pile head and the segment between liquefied and non-liquefied soil layers, which were also observed in the site investigation.

Key Words : soil liquefaction, pile foundation, 3 dimensional numerical analysis.

一、前言

群樁基礎為橋梁工程及重要建築物經常使用的基礎型式之一，其所在之地盤若為軟弱地盤或飽和砂層時，常易因地震外力產生大變形，或因土壤液化發生而導致下部樁基礎發生破壞。在多次大地震中，皆有因地震時土壤液化與基礎樁

身斷裂而造成上部結構物傾倒或掉落的重大災難。因此有許多專家學者藉由數值分析、離心機實驗、震動台實驗等各種方式，針對地震情況下土壤-樁-結構物間的互制關係進行模擬(Lin與Liao,1997；Takewaki,1998；Brandenberg等,2004；Chang等,2008)，以求能確保人民之生命財產安全。

針對數值分析方法模擬土壤-樁-結構體受震