Seismic Fragility of a Single Pillar-Column Under Near and Far Fault Soil Motion with Consideration of Soil-Pile Interaction

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ABSTRACT

The soil-structure interaction is a significant challenge faced by civil engineers due to the complexity potential in terms of seismic fragility evaluation. This paper presents a seismic fragility estimation of a single pier considering seismic ground motion types. Furthermore, sand type, pile diameter, pier height, and mass variation were considered to estimate their effect on the seismic fragility of the concrete pier. Incremental dynamic analysis was performed using a beam on a nonlinear Winkler foundation model. The analysis model condition compared near- and far-ground motion effects. Dynamic analysis and fragility assessment of the single-pier structure showed that low mass center produced less vulnerability of the concrete pier in the two cases of the sand type under near- and far-ground motions. The near and far earthquake simulations at complete failure probability had a difference of less than 5% when $0.65s<T_1<1s$ and $2.4<T_1/T_2$, but the opposite was shown when $T_1<0.5s$ and $3<T_1/T_2$ were present together.

Keywords-soil-pile-structure interaction; incremental dynamic analysis; BNWFmodel; ground motion types; seismic fragility

I. INTRODUCTION

Under seismic loading, liquefiable soil increases the seismic fragility of expansion bearing, piles, and embankment soil. The fragility of common components, such as columns, depends on the overlying liquefiable sand. The effect of soil strength for clay and sandy sites on the seismic performance of skewed bridge components and its relation with the skew angle was studied in [1, 2]. The seismic fragility of a pile was studied with different seismic demands in [3]. The nonlinear Winkler foundation model is widely used to study soil-pile and soil-pile-structure interactions using nonlinear dynamic analysis [4]. In [5], a comparison of soil-structure interaction and fix-base model effects on a structure's seismic fragility was presented.