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An Analytical Tool for Predicting Lateral Behavior of Single-Pole Foundations

Seung-Rae Lee, Ho-Young Choi
Department of Civil & Environmental Engineering, Korea Advanced Institute of Science and Technology
Daejeon, KOREA

Yeong-Hun Kim
Hyundai Engineering & Construction
Seoul, KOREA

Dae-Hong Kim
Korea Electric Power Research Institute, Korea Electric Power Corporation
Daejeon, KOREA

Dae-Hak Kim
Unicorn Technical Institute, Institution of Korea Construction Quality Test
Anyang, Kyeonggi, KOREA

ABSTRACT

Single-pole transmission structures which are supported by drilled shaft foundations are usually subjected to large overturning moments with modest vertical and lateral loads. To analyze the behavior of the drilled shaft under such loading conditions, an analytical model was developed based on beam-column and subgrade reaction methods. Field tests were performed to compare the results with those estimated from the developed analytical model which considered additional subgrade spring models. These results were also compared with those calculated by one spring model and other commercial program. According to the comparison study, the developed analytical model was proven to be a useful method to analyze the laterally loaded behavior of foundations for single-pole structures.

KEY WORDS: Analytical model; beam-column; drilled shaft; lateral behavior; single-pole; subgrade reaction

INTRODUCTION

Construction activities of electric transmission line for high voltage are steadily increasing in KOREA to supply the demand for electricity. However, most of transmission structures have lattice tower foundation systems which occupy a large area and cause so much damage in forest area. Single-pole structures which are supported by drilled shaft foundations are attracting attentions as an alternative, not only because the area for construction can be reduced drastically but also because these are convenient for construction and maintenance. Even though single-pole structures gain such advantages over lattice tower structures, there is no specification in design of foundation for those structures. It makes some doubt in the safety and economical efficiency of the foundation design. Therefore there are urgent needs for researches on the behavior of such foundations.

Single-pole structures are usually subjected to large overturning moment with modest vertical and lateral loads. In addition to the lateral passive resistance which undertakes most of lateral and moment loads, frictions developed along the shaft and bearing capacity of the base contributed considerable resistances against such loads. Davison (1982) reported that there is a possibility of overestimation of deflection if other parts except lateral passive resistance are not taken into account.

In this paper, an analytical model considering these additional resistances, on the basis of beam-column and subgrade reaction methods, was developed to analyze the laterally loaded behavior of single-pole foundations. Field tests were carried out to compare the results with those evaluated from the developed analytical model. The results were also compared with those calculated by one spring model and FAD 4.0 (Foundation Analysis and Design) (Ostendorp, 2003).

THEORETICAL MODEL

Four spring model

DiGioia et. al (1981) developed an analytical model which considered all force components mobilized between laterally loaded pier and soil. The model was referred to as a four-spring subgrade modulus model because it used four different springs such as lateral translational springs, vertical side shear moment springs, base shear translational