Finite element analyses of a buckling-restrained pile

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Abstract

In existing building renovation projects, the strength of the structure is often limited by the capacity of existing foundations. Foundation strengthening typically consists of expanding existing footings and/or adding piles to supplement load-carrying capacity. These traditional methods are generally not feasible for the retrofit of mat foundations where increasing the mat footprint is unlikely to reduce bearing pressure considerably and adding piles outside the mat will change the distribution of internal stresses and may affect the long-term differential settlement behaviour of the structure.

This paper presents finite element analyses that were performed as part of the development of a new approach to retrofitting mat foundations which consists of enlarging the footprint of the existing mat and adding piles that include an innovative axial capacity-limiting mechanism. The maximum resistance provided by these piles to the existing foundation can be tuned to not exceed the maximum connection capacity that can be achieved at the interface between the existing mat and the new mat extension. The proposed design is unique in that the pile axial load is limited even under significant potential settlements experienced by the rest of the building foundation.

Keywords: Mat foundations, buckling-restrained pile, finite element analysis, retrofit, strengthening, high-rise buildings

1 Introduction

In existing building renovation projects, the strength of structural elements is often limited by the capacity of existing foundations. Foundation strengthening typically consists of expanding existing footings and/or adding piles to supplement load-carrying capacity. These traditional methods are generally not feasible for the retrofit of mat foundations where increasing the mat footprint is unlikely to reduce bearing pressure considerably and adding piles outside the mat will change the distribution of internal stresses and may affect the long-term differential settlement behaviour of the structure.

1.1 Concept

The authors of this paper developed an approach to retrofitting mat foundations that can overcome the abovementioned limitations. It consists of adding piles around the existing building footprint and enlarging the existing mat to connect to these piles. This results in a reduction of soil bearing pressures under the mat. However, where the original mat foundation is grossly inadequate significant settlement may cause the majority of the building load to be transferred to the piles therefore creating a long span condition for the mat that may cause undesirable yielding of the flexural reinforcement and/or shear failures. To limit damage to the mat a new limited-axial-load

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