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Enhanced strut-and-tie model for reinforced concrete pile caps

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Abstract

Strut-and-tie models provide a simple and rational way to design discontinuity regions in reinforced concrete structures. However, when it comes to three-dimensional concrete elements such as pile caps, enhancements are needed to ensure a reliable and not overly conservative design. This paper presents an enhanced strut-and-tie model adapted to the analysis and design of reinforced concrete pile caps. The model is based on consistent geometries of three-dimensional nodal zones and struts and integrates a strength criterion for confined bottle-shaped struts. An iterative process is used in order to optimize the position of the members by refining the dimensions of the nodal zones. The model is validated by experimental results from tests on four-pile caps reported in the literature, showing effective predictions of their ultimate capacities. This enhanced strut-and-tie model can lead to safe and less conservative design of pile caps.

Keywords: strut-and-tie model, pile caps, reinforced concrete, three-dimensional.

1 Introduction

Pile caps are common structural elements for piled foundations of bridges or buildings located in areas where the superficial layers of the soil cannot provide sufficient bearing capacity. The function of pile caps is to transfer the loads from columns or walls of the superstructure, in a safe manner, to a group of piles into the ground.

A specificity of pile caps, compared to most of the other types of structural elements (e.g. beams, slabs, walls, etc.), is that they typically have large dimensions in all three directions and a pronounced three-dimensional stress field.

Because of this geometrical feature, pile caps are often in a range of dimensions where the whole pile cap constitutes a discontinuity region and assumption of plane sections is not valid.

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