

Application of Strut-and-Tie Model in Structural Concrete Repair

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Summary

The subject of this paper is the structural assessment and repair of multiple large pile cap foundations. A combination of high temperatures during early hydration and inadequate steel reinforcement resulted in large cracking that compromised the structural integrity of the caps to the extent that repair and modification were necessary. New pile caps, placed on top of the existing caps, were designed to support the existing loads and superimposed loads that would result from a future buildout. The new pile caps were designed in accordance with the strut-and-tie provisions of the 2002 ACI 318 Code and constructed with a high-strength, self-compacting concrete.

Keywords: Pile cap foundation, mass concrete, heat of hydration, cracking, strut-and-tie model, self-compacting concrete.

1. Introduction

Structural repairs were performed at a hospital to address severe and widespread structural cracking in the pile cap foundations. The foundations are massive concrete blocks, typically 15 ft by 15 ft in plan and 7 ft deep. The pile caps are reinforced with a single orthogonal mat of steel at the bottom of the cap and had a specified concrete compressive strength of 6,000 psi. Wide cracks had developed in the top and side surfaces of several pile caps as shown in Figures 1 and 2.

The foundations were designed to support a 15-story structure, but only five of the floors were originally constructed. The construction of the remaining floors is tentatively scheduled for a later date. The top of the first-level floor slab is approximately 6 ft above the top of the pile caps. A crawl space underneath the first floor slab provides access to the tops of the pile caps.



Figure 1. Typical cracking on top of pile cap.



Figure 2. Cracking on side surfaces.