Shear Capacity of Reinforced Concrete Pile Caps

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Summary
Discrepancies exist between UK design codes for the prediction of pile cap shear strength. A series of reduced scale pile cap experiments to investigate shear strength have been performed. Results from seven samples are presented. Details of test methodology and procedure are shown. Final crack distributions show that pile caps under wall load behave close to simply supported two-dimensional deep beams, except for hogging cracks over the pile head indicating the existence of moment restraint at the piles. Results for failure load indicate that pile cap shear strength is at least two to three times higher than current code predictions from semi-empirical formulae. The truss method is shown to be more reliable to predict pile cap shear strength than bending theory.

Keywords: pile cap; shear; truss method; shear enhancement factor.

1. Introduction
A pile cap (Figure 1) is a stocky reinforced structure which spreads and distributes the load from a column or bridge pier downwards into supporting piles. Unlike standard deep beams, pile caps are relatively wide, with a width comparable to their span, contain relatively low reinforcement and in particular normally no transverse shear reinforcement [1].

Discrepancies exist in the provisions for the design of reinforced concrete pile caps for shear strength between the two UK codes for structural concrete design, BS 8110 and BS 5400. These discrepancies have arisen in the historical development of the codes, and the implication is that one code is unsafe or the other is over-conservative [2]. The overall aim of this research has been to investigate the real shear resistance of pile cap in order to resolve the contradiction between the codes.

A number of laboratory experiments on shear capacity of pile caps have been carried out in the last five decades. A variety of cap forms, reinforcement layouts, loading conditions and pile supporting conditions were used. Clarke [3] tested fifteen full size reinforced concrete pile caps, each with four piles, varying pile spacing, reinforcement layout and type of anchorage (from nil anchorage to full plus bob). Hobbs and Stein [4] tested about seventy one-third-scale two-pile caps to verify a permissible stress design method based on elastic analysis. Blevot and Fremy [5] tested about one hundred caps to verify a truss analogy method. Nine one-third scale four-pile caps were tested by Sabins and Gogate [6] together with finite element analysis. In order to investigate the strut-and-tie models contained in the ACI Building Code and Canadian concrete code, Adebar, Kuchma and Collins [1] tested six full scale pile caps, concentrating on the cap's effective depth factor rather than emphasizing the amount of longitudinal reinforcement.

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