CHAPTER II

LITERATURE REVIEW

Various investigators have suggested methods for analyzing and study the experimental behaviour of a pile cap under load.

The ACI code (318-63) (1) was to proportion a concrete pile cap elastically for flexure and proceed to check the shear and anchorage requirements in the direction of the main reinforcement. A pile cap is analyzed and designed as an inverted cantilever beam loaded by a series of concentrated pile reactions where the bending moment is assumed to be critical at a face of the column base. Bending theory lead to a uniform stressed in the concrete and the steel throughout the section considered. The reinforcement shall be distributed uniformly across the full width of the pile cap.

The ACI code (318-71) (2) provides information for ultimate strength design of all types of members. However, for pile caps the use of engineering judgement is still required to arrive at suitable proportion.

H.T. Yan (3) proposed the design of pile caps by truss analogy provided the limit of the span-depth ratio of the cap at less than three. It is evident that the ordinary laws of flexure do not apply to the pile cap. The load is assumed to take the shortest line to the supports, and to be transmitted to the pile by inclined compression. These inclined thrusts tend to spread the piles apart, thus a tie-tension is required at the base to hold the piles together. In this respect, the structure is analogous to a three dimensional frame work.

A rigorous analysis of the stress distribution in a rectangular two-pile cap treated as a deep beam was carried out by Hobb and Stein [4] based on the theory of elasticity. A number of different cases have been studied and the results combined into a simple expression giving the tensile forces on the central vertical plane of simple two-pile caps. The mathematical results have been conformed experimentally by tests on about 71 one-third scale model pile caps, which have shown that economics of steel are possible if curved bars are used, and have also shown that with a rigid welded anchorage further economics in volume of steel used can be made without loss of strength. Since the expression of the tensile force is only valid in two-dimensional pile caps, it should not be applied to the design of multi-pile cap.

Wentworth-Sheilds, Gary and Evans [5] found it is more convinient and probably more correct to treat the cap as a truss than as a beam, where the span is small and the concentrated load and consequently the total shearing forces are comparatively great, and to regard the load as being transmitted from the center to the supports by inclined compression in the concrete. The horizontal components of the inclined compression being resisted by the tie action of the horizontal reinforcement.

Henry [6] and Reynolds [7] recognized the function of a pile cap as a short deep beam where inclined compression, analogous arching are major role in transmitting the column load to the piles. However, due to the complex nature of the problem, they analyzed pile cap as a simple beam.

A comprehensive series of tests was carried out by Blévot and Fremy [8] who tested a total of about 100 caps with two, three or four piles. They compared different layouts of steel, in the form of a grid, or bunched over the piles or a combination of both. In general they found that bunching the steel gave approximately 20% higher strengths than the same amount of steel spread in a grid pattern.

The test at the Cement and Concrete Association by Taylor and Clarke [9] were all caps with four piles with pile spacings of three or two times the pile diameter. The different steel layout and anchorage were considered. It was found that bunching the steel in the form of a square lead to failure loads some 15% higher than those of the corresponding caps with grid layouts. Bunching along the diagonal led to no increase in load when compared to a grid layout. It was also found that norminal anchorage increase the load by about 5% when compared with nil anchorage, whilst a full anchorage increased the load by about 30% and the failure occured in flexure rather than in shear.

Whittle and Beattie [10] made proposal for standardization of design and detailing of isolated pile caps with many different opinions concerning (a) the best shape of a pile cap for a given number of piles, (b) the most economical depth, (c) the method of a analysis, and (d) the reinforcement details.