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Shear capacity of ferrocement plates in flexure

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ABSTRACT

An experimental study on 18 simply supported ferrocement plates having a span/depth ratio of 2.0 was conducted. Various wire mesh types were used as web reinforcement. Flexural steel was designed to preclude failure in modes other than flexure. Two groups, A and B, were tested under central uniform loads covering 10% and 67.5% of the clear span respectively. It was observed that, the percentage increase of shear capacity over the reference specimen is remarkable for group A and nearly equal to 40%. Moreover, a hexagonal mesh, V_f of 0.15%, improves the shear capacity than those of diamond and square meshes of 0.25% and 0.38% volume fraction respectively. Specimens of group B demonstrate a slight increase of the ultimate shear capacity than those of group A despite that the web reinforcement is less effective as pointed out by comparing the results of each group with its associated reference specimen. A good agreement between the classical shear equations prediction and the experimental values is obtained for group A specimens whereas the ultimate shear capacity for group B is underestimated. It is also indicated that the strut and tie model is an inappropriate technique for the ferrocement plate design compared to the classical shear equations of deep beams.

1. Introduction

It is possible to build walls and floors of a dwelling using local materials. Buildings of such types were destroyed during the recent rainfall happened in Egypt and badly affected Aswan and Sinai in the beginning of year 2010. Therefore, there is an urgent need for using materials that are economical for building of single family dwellings. The success of ferrocement for self-help housing is well-documented in which construction of hundreds of ferrocement roofs for poorer areas are constructed. Since the stresses produced by dead load are critical in the design of roofs, thin ferrocement shells should be economical for roof structures. It is not possible to make any general conclusion regarding the economic viability of ferrocement construction since its cost can vary significantly from country to country. The cost will depend on the method of fabrication (for example shotcrete versus hand plastering) and many other economic parameters [1]. Another factor frequently held responsible for its slow growth is the lack of design codes and specifications, without which building authorities are reluctant to accept a new material.

Ferrocement deep beams, with rigidity due to the form and not to the quantity of the material, often appear in form of folded plate roof structures. Floor slabs under horizontal loads and some shear walls are also examples. They are characterized as being relatively short and deep, having a thickness that is small relative to their span or depth, and being primarily loaded in the plane of the member. They are two dimensional members in a state of plate stress in which shear is a dominant feature. The internal stresses cannot be determined by ordinary beam theory, and ordinary design procedures for determining strength do not apply. The significant parameter of the deep beams which should be taken into account is the shear resisting mechanism, as the diagonal cracks that develop in the beams are considerably wider than the flexural cracks and the abrupt failure without advanced warning is distinctly different from the failure in flexure. In addition, at the final failure state of deep beams, the compressive arch connecting between the loading and supports usually observed, together with concrete crushing due to compression at the upper portion of the beams in the vicinity area under the loading point or nearby the supports.

Several attempts have been conducted to study the shear behavior of reinforced concrete deep beams [2–11], but a few to the author's best knowledge to the ferrocement deep beams. Although adequate design information and field experience have been acquired for many types of ferrocement structures, the shear behavior is still questionable. A few researches undergone in this area [12–15] relying on increasing dowel action effect by increasing the number of mesh layers or volume fraction consequently lead to an increase of shear capacity.

Mansur and Ong [13] studied the behavior and strength of ferrocement in transverse shear. They tested ferrocement beams reinforced in tension and compression sides with layers of galvanized square wire mesh under four point load pattern. In a later

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