ABSTRACT

A COMPUTATIONAL MODEL AND EXPERIMENTAL INVESTIGATION OF FERROCEMENT FLAT PLATES UNDER FLEXURE

Richard P. Clarke

A computational model based on Classical Lamination Theory was developed for the analysis of ferrocement plates subjected to flexural loading as a means of investigating the potential applicability of Lamination Theory in general to ferrocement. The effects of certain variables on the response of ferrocement slabs under biaxial and uniaxial flexure were also investigated. These variables were chosen mainly via Lamination Theory and included: the through-the-thickness orientation pattern of the meshes; symmetry of the properties of the mesh layers about the slab's mid-plane, and span-to-thickness ratio.

Ferrocement is shown to be a typical member of the general class of composite materials called laminated fibrous composites which includes non-cementitious composites such as graphite/epoxy. The advantages of such a Composite Materials approach to ferrocement analysis are discussed. Composite Micromechanics is presented and equations derived for a particular type of ferrocement. Linear and non-linear laminate macromechanics are discussed and the governing equations and their solutions to certain problems are presented for the linear case. Approaches to the strength analysis of composite laminates are also discussed and a model which generalises and extends previous approaches is presented.

The experimental program consisted of biaxial flexure tests on 23 square slabs and uniaxial tests on 6 slabs each of which incorporated the previously mentioned variables plus others. The Classical Lamination Theory strength analysis was observed to have a mean ratio of test to predicted strengths of 1.007, within certain constraints, for the slabs tested under biaxial flexure. The experimental results with respect to the previously mentioned variables were observed to be contrary to expectation if based on conventional ferrocement analysis approaches whereas the lamination theory approach provided reasonable explanations. Such results stated in effect (a): that for any two slabs which were identical in every respect except for the pattern of their meshes through the thickness, when all the meshes of both slabs were equally aligned to the direction of load, their strengths and toughnesses would be different and, (b): whether the number of layers of mesh is an odd or an even number affects a ferrocement slab's strength and toughness under certain conditions. It was also observed that transverse shear deformation effects were negligible for span-to-thickness ratios above about 25.