EXPERIMENTAL AND ANALYTICAL STUDIES OF SHEAR BEHAVIOUR OF SLABS SUBJECTED TO MULTIAXIAL STRESS CONDITIONS

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Prestressed concrete pressure vessels include structural members which rely for their safety on the knowledge of the capacity of concrete to resist shear stresses. The shear forces developed on some of the structural components under operating conditions may be several times higher than those occurring in conventional structures. Most of these elements are geometrically deep in relation to their span. The span to depth ratios may be in the range of 0.5 to 4.

This paper reviews various experimental programmes which have been completed in recent years on the general shear mechanism and failure of concrete components under a variety of loading conditions. The experimental programmes were carried out to assist in the development of various designs of prestressed concrete pressure vessels and to introduce a more analytical approach for designs of deep members against shear failures.

The particular experimental investigations referred to in the paper include:-

a) Parametric studies on small prestressed concrete elements used to examine the failure of deep end slabs. Major variables considered were loaded diameter to depth ratio, loaded diameter to shear span ratio and the level of hoop prestress.
b) Parametric studies on the general behaviour of realistic end slab models of pressure vessels. In this work the effects of bonded reinforcement, lined and unlined penetrations, span to depth ratio, concrete strength and the level of hoop prestress were examined.

The complexity of the mechanism of shear failure of geometrically deep members has inhibited the development of completely analytical solutions. The results from the various parametric studies have therefore been used to derive emperical formulae which can be used in the design of geometrically deep members against shear failures.

The paper also examines various theoretical techniques and their application to restrained slabs with particular reference to dynamic relaxation. The correlation between the predicted and observed test results are investigated. The particular dynamic relaxation technique referred to allows for non-linear behaviour of materials with the provision for the application of step by step increments of both pressure and prestress forces. The method predicts crack propagation, hinge positions if any, tendon forces and overall structural deformations.