AN EXPLORATION OF THE DESIGN FOR A PCCV HEAD SLAB WITH VERY LARGE PENETRATIONS USING A DYNAMIC RELAXATION COMPUTER PROGRAM

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A prestressed concrete containment vessel for a Liquid Metal Fast Breeder Reactor has been developed. The current design for the head slab for this vessel differs geometrically from previous head slabs for other reactors. This head slab has a single very large central penetration which is surrounded by an annulus in which there are a number of large and small penetrations. The total area taken by penetrations is in excess of 50% of the total pressurised free area.

This paper presents an analytical investigation which has been carried out in support of the design of the head slab. A Dynamic Relaxation Code has been used to assess the structural behaviour of the head slab. The effects of variations in the geometry and boundary conditions have been examined. The mathematical models considered were based on one of a series of small scale physical models intended to validate the design of the containment structure.

The dynamic relaxation technique adopted to analyse the models allows for non-linear behaviour of materials with the provision for the application of step by step increments of both pressure and prestress forces. Concrete is modelled by assuming that it has a limited tensile stress capacity and once this is exceeded it acts as an orthotropic material. In addition, a yield condition can be specified to allow for triaxial stress states and the possible plastic flow. The method predicts crack propagation, hinge positions if any, tendon forces and overall structural deformations.

The analysis has demonstrated that for a very slender end slab design, using a prestressed upstand ring beam appears to give a greater reserve of strength than a flat slab or slabs with prestressed downstand ring beams in situations in which failure of concrete rather than the prestressing system is the cause of structural collapse.

Comparison between the experimental model results and those of the theoretical analyses indicate general agreement in crack patterns and failure modes. However, there are some discrepancies in actual failure pressures. These differences may however be attributed to some uncertainties that exist in the material parameter values and assumptions in the computer code.