FAILURE ANALYSIS OF NUCLEAR REACTOR CONTAINMENT SHELLS

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The nuclear containment vessels or safety buildings are meant to protect the environment in case of a malfunction of the reactor. These structures are considered as of high responsibility and risk.

Static analysis of a nuclear containment vessel treated as an axisymmetric shell is presented.

The structure is subjected to the following loads: external pressure caused by prestressing and a monotonic increase in internal pressure until the failure of the structure occurs.

The behaviour of the structure is highly nonlinear in the postcracking range. To reflect the material behaviour, two different constitutive models are used. The postcracking behaviour of concrete is described by means of an isotropic damage model. Elasto-plastic behaviour with isotropic hardening is assumed for the steel.

The structure is discretised by axisymmetric shell composite layered finite elements based on the Reissner - Mindlin theory. Orthotropy in the meridional and circumferencial directions is introduced. This possibility is reserved only for steel reinforcement equivalent layers. The internal steel layer is modelled as an isotropic layer of steel with no slip between itself and concrete.

To solve the finite element equilibrium equation the initial stiffness method is used. To follow the postfailure path of equilibrium the displacement control method is applied.

The proposed methodology allows us to follow the behaviour of the structure up to a constant value of the internal pressure, while simultaneously increasing displacement are obtained. This phenomenon is considered as a complete failure of the structure. The point corresponds to the highest level of finite element damage indices and the overall damage index which is evaluated for the entire structure. In conclusion it is stated that the applied methodology provides a good approximation of the failure load, and the global behaviour of the structure is also well reflected at relatively low costs.