THEORETICAL STUDY OF AIRCRAFT IMPACT ON REACTOR CONTAINMENT STRUCTURES

D. CARLTON, A. BEDI

*Taylor Woodrow Construction Limited,
345 Ruislip Road, Southall, Middlesex UB1 2QX, United Kingdom*

SUMMARY

This paper describes the application of a finite difference program to the study of the effects of missiles striking reinforced concrete slabs.

In containment design there is a requirement to protect the reactor system from damage resulting from the effects of external hazards, such as aircraft impact, pressure from gas cloud explosions or bombs planted by saboteurs. Early hand computation work by Bartley and Davies indicates a possible suitable wall thickness and amount of reinforcement. In order to prove and further investigate the effects, experimental work has been undertaken by the U.K.A.E.A. as part of their study of damage caused by missile impact.

The finite difference code used for the analytical study is based upon Dynamic Relaxation initially developed to study static problems using damped dynamic response to achieve equilibrium. This code has been extended into the non-linear range and with the damping factor removed becomes suitable for the study of impulse loading problems. The code, at present, models the concrete 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 code allows for the reinforcement, modelling this as uniaxial bar elements with a non-linear stress/strain relationship. Within reasonable limits, changes in geometry are taken into account and variably spaced finite difference mesh can be specified.

The physical models being tested are circular concrete discs and the parameters which are varied are the thickness and amounts of reinforcement both on the faces and through the thickness. For the range of parameters studied to date under simulated M.R.C.A. loading the analysis predicts deflections approximately twice as big as the dynamic elastic response. The non-linearity can be mainly attributed to cracking of the concrete. Under certain circumstances, such as in the case of hard missiles or when the slabs are reduced in thickness, yielding comes into play and the stresses become more localized causing a punching failure. Increases in the amount of face reinforcement tends to reduce the deflections but the unloading of a steel net can cause lamination of the concrete which can only be countered by the provision of through thickness steel. The paper illustrates the consequences of variations in the parameters stated above and also the effects of varying some of the concrete modelling assumptions such as tensile capacity, yield criteria and aggregate interlock.