NUMERICAL SIMULATIONS OF MEPPEN EXPERIMENTS: IMPACT OF SOFT PROJECTILES ON REINFORCED CONCRETE PLATES

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Investigations were performed in Germany (Meppen tests) at the end of the 70' years to determine the ultimate bearing capacity of reinforced concrete slabs which are loaded by the impact of soft missiles. In order to determine the capabilities of the most efficient numerical tools, Electricité de France (EDF) asks to the Centre d'Etudes de Gramat (CEG), with the help of CS-SI company, to perform finite element simulations of experimental tests done at the end of the 70' years at Meppen. This paper describes the 3-D numerical simulations of a 1000 kg missile impacting at about 200 m/s a rectangular reinforced concrete plate of 6.5 m by 6.0 m. Ten experimental tests has been done but only two of them have been simulated. In these tests significant damages and deflections are obtained on the concrete targets. During the impact process, the projectile severely crush on the plate in such way that the 6 meters initial missile length is divided by a factor of two and more. ABAQUS explicit finite element code is used to model these experimental tests (figure 1). The projectile is simulated using shell elements. The concrete plate is modelled using between thirty thousand and forty thousand 3-D 8 nodes solid brick elements. A two scalar concrete damage model is used to simulate the behaviour of concrete. Elastic and plastic models are used to simulate the behaviour of the steel projectile and of the steel reinforcement bars. Several numerical simulations have been done in order to understand the influence of particular material data like the concrete tensile strength or the reinforcement failure strain. Some numerical simulations has been done using a pressure profile load to simulate the projectile loading. All these results are compared to experimental data. Finally conclusions are given about the ability of such finite element codes to model the mean encountered physical phenomena like the bending process, the back face spalling phenomena, the crushing and the concrete plugging ahead of the projectile nozzle. The ability to model more complex structures and projectiles is also discussed.

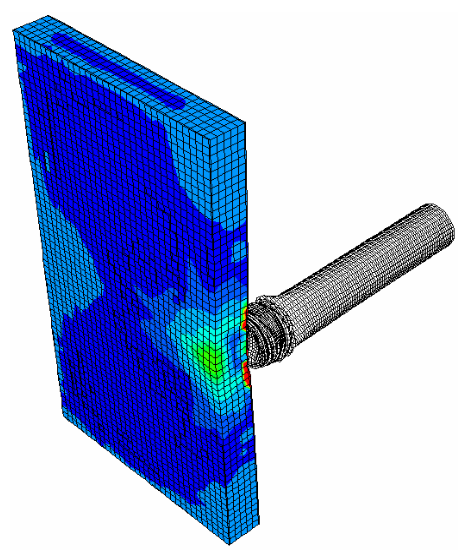

Figure 1 : Finite element analysis of missiles impacting reinforced concrete plates.