BLAST ENERGY ABSORPTION OF RECYCLABLE BEVERAGE CANS

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INTRODUCTION

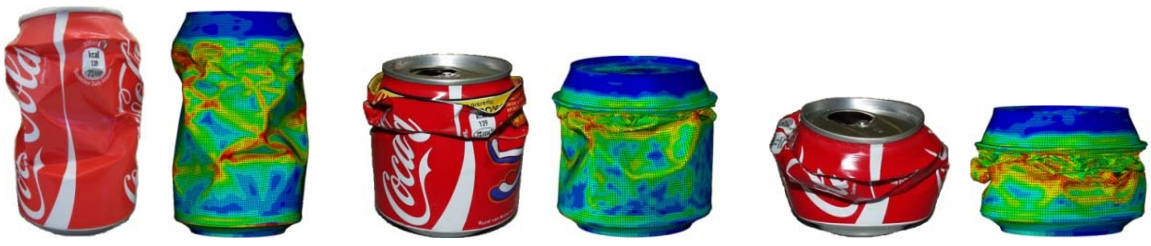
The entire world faces the problem of security for industrial, military and civil engineering structures due to terrorist activities. The failure of the critical load bearing members such as beams, pillars, columns etc., and its debris cause major human casualties. Hence a preventive solution is needed to safeguard the civil engineering structures and to avoid human casualties due to explosion. Out of many proposed solutions, the concept of sacrificial cladding design has attracted more attention in terms of its functionality and predictable behaviour [1, 2]. Any sacrificial structure can have two parts; an outer skin and an inner core. The function of the outer skin is to distribute the blast pressure more uniformly to the inner core and the function of the inner core is to absorb most of the energy from the blast or explosion loading. This study deals with the blast energy absorption characteristics of empty recyclable beverage cans (inner core).

EXPERIMENTAL AND NUMERICAL STUDY

Before designing the sacrificial cladding structure in full-scale the knowledge of the energy absorption of an individual core member (empty cola can) is very important. Small-scale axial impact tests (drop weight test) and close-range free air blast tests have been conducted (with 20g of C4 with a stand-off distance of 30cm) to understand the crushing behaviour of the empty cola cans. To conduct such axial impact tests and air blast tests special small scale test set-ups were designed and manufactured. Using these test set-ups different parameters such as initial impact velocity, inertia of the outer skin, surface roughness, area of the skin plate on the energy absorption of the inner core were studied. In order to understand the crushing behaviour of the cola can in detail numerical models were developed for impact and blast loading conditions. Results from the impact simulations correlated well with the experimental results. However, the results from the blast simulation using experimentally measured pressure-time histories showed much higher deformation length of the cola cans which is observed in the experimental results. These results motivated us to study the interaction of the blast pressure waves with the blast experimental set-up. The numerical study of the interaction of pressure waves with the experimental set-up was carried out using “Hydrocodes”. The results from the Hydrocodes simulation showed the effect of diffraction and the ground reflection on the deformation length and the corresponding energy absorption of the empty cola cans. Based on the results of Hydrocodes simulation the de-coupled analysis was carried out in ABAQUS V6.7-3 using the experimentally measured pressure-time histories. To capture the strain rate sensitivity of the cola can the “Johnson-Cook” material model was used. The results from these analyses were compared with the experimental data. Finally this study also shows the effect of initial geometric imperfections on the energy absorption of empty cola cans.

RESULTS

A comparison of the deformation patterns of the cola cans from the experimental (blast tests) and the numerical study is shown in Figure 1. There was a good correlation of the deformation patterns and the corresponding energy absorption observed between the experimental study and the numerical simulations.



Experimental Numerical Experimental Numerical Experimental Numerical

Figure 1: Comparison of experimental and numerical deformation patterns of empty recyclable beverage cans (cola cans).

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