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Performance assessment of a U-shaped dissipative flat bar bending device for blast protection

PhD student
José Pedro Pais de Oliveira Fernandes Basto

PhD program
Civil Engineering (FCT, Nova University of Lisbon)

Supervisor
Cornliu Cismasiu (FCT, Nova University of Lisbon; CERIS, IST, University of Lisbon)

Co-supervisors
David Lecompte (RMA, Royal Military Academy, Belgium) and Válter Lúcio (FCT, Nova University of Lisbon; CERIS, IST, University of Lisbon)

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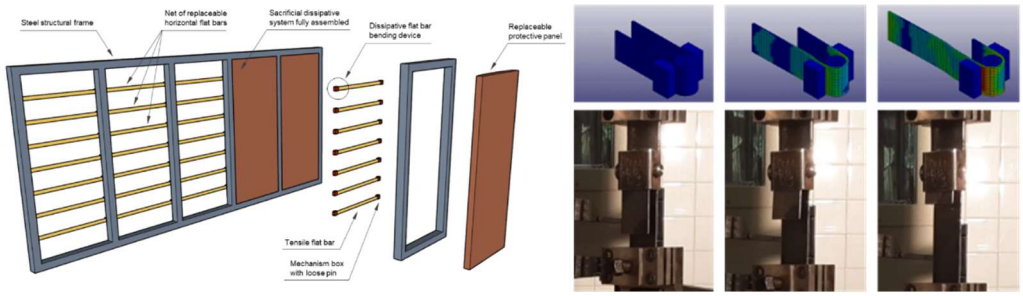
Summary

Container systems are commonly used during the deployment of military forces in operation theaters, as well as in industry and in civil emergencies, with multiple purposes, including physical protection of personnel. These container systems seldom provide the protection required to resist the effects of explosions, namely those resulting from high payload Improvised Explosive Devices (IED). The objective of the research is the development of a sacrificial dissipative system resorting to a U-shaped flat bar bending dissipative device, which could be applied to such container type structures.

The system consists of a net of horizontal flat bars, installed in close contact with the inner face of a panel. Each flat bar terminates with a bend of 180º degrees in both ends. The inner side of the bent bar creates a "cradle" that is locked by a simple pin in a mechanism box, which is in turn, rigidly connected to the structural frame. The panel is rigidly connected to the net of flat bars and its perimeter is simply supported on the structural frame. The flat bars are simply connected and locked to the mechanism box by the pin [Figures (a) and (b)]. A single flat bar connected to a single mechanism box by a single pin is referred in this study as a dissipative flat bar bending device. Initial laboratory tests were conducted to characterize the behavior of the dissipative flat bar bending device and to gather data for the calibration of the finite element models. These initial tests were conducted in quasi-static load conditions, using a standard laboratorial tensile test equipment, with the mechanism box connected to one terminal and the U-shaped flat bar connected to the other terminal. Standard force and displacement were measured for loading speeds ranging from 10 to 50 cm/min. Results from display a good correlation with the preliminary design estimates of the force required to start and maintain the deformation mechanism, with the expected deformation mechanism, as well as with the ideal load-deformation curves [Figure (c)].

Keywords

Explosives, blast protection, flat bar, bending dissipative device, ISO container.



(a) (b)

(c)

(a) Schematic of the protective panel system concept and (b) Dissipative flat bar bending device, unbending/bending phenomena: LS-DYNA initial model simulation (above); Quasi-static laboratorial pre-liminary tests (below) (c) Static load-displacement curves from preliminary tests for specimens of 50x4 mm² at loading speeds of 10.0, 20.0, 40.0 and 50.0 cm/m, displaying a Type I dissipative structure behavior (according to Calladine & English, 1984.