Protection of infrastructures against explosions using ductile blast energy-absorption connectors

Summary

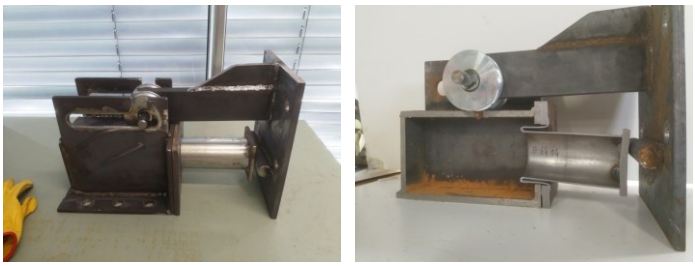
The studies developed in several projects (SI4E - Security and Integrity of Strategic Buildings under Accidental or intentional Explosions or PRINSEF - protection of Infrastructures and Physical Security), based on an extended numerical and experimental campaign, allowed, among other findings, to realize that the effects of an explosion outside a building, primarily affect local elements (e.g.a column) and then might develop into a global failure (progressive collapse). This finding constitutes the motivation for the development of protective systems for structural elements directly exposed to the explosion.

The research carried out involves the use of a shielding system linked to the structure using ductile connectors to absorb part of the energy of the explosion (impulsive) and to transfer the residual part to the floor levels, protecting the columns or walls that, in normal situations, are not designed for protective purposes. The high-performance energy-absorbing system concept intends to ensure that the surface that receives the energy from the explosion is not in direct contact with the structure to be protected, using Energy-Absorbing Connectors at floor-level with a sufficient stroke to accommodate (by shortening) the intensity of a given explosion.

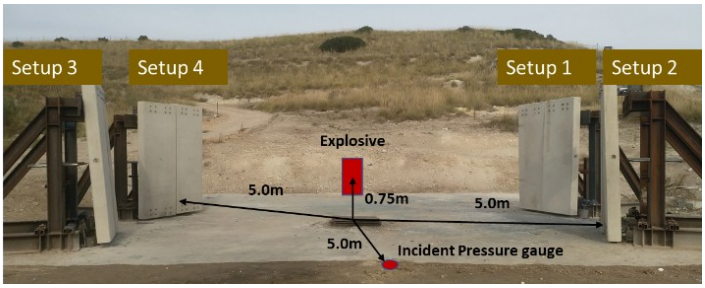
Energy-absorbing connectors based on a free external inversion mechanism allow the designer to choose from a wide range of available diameters, thicknesses, steel properties and stroke. When combined with the properties of the façade panels, the resulting protective solution can be customised to respond to the desired level of protection for a given blast threat. Two full-scale blast tests were performed with an explosive load of 60kg MAXAM's RIODIN Dynamite, 5 m away from the panels. Each blast test comprised 3 sample panels equipped with energy-absorbing connectors and one reference panel equipped with rigid connectors. As expected, the first observation was a significant reduction in deflections on panels equipped with EACs in the tests.

Keywords

Energy absorbing connectors, blast protection, blast mitigation, inverted tubes, façade elements, blast testing.



Prototype of the proposed connector (view of the body and a section through the vertical middle plan).



Blast testing infrastructure.

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