EXPERIMENTAL VALIDATION OF THE RESPONSE OF A FULL SCALE FRAME BUILDING SUBJECTED TO BLAST LOAD - FRAMEBLAST

Goal of the project

The main goal of the FRAMEBLAST project is to provide an accurate validation of the response of a full scale building structural frame system under internal and external blasts in laboratory environment. The structure is subjected to internal and external blasts from different charge weights and locations (standoff, height above ground), resulting in different loading scenarios.

Short description of the project

Explosions produced in urban areas by the detonation of high explosives are low-probability, but high-risk events. When they occur in the immediate vicinity of buildings, the explosions can affect their structural integrity (local/global failure) and harm people (injuries, death). Because the blast threat can only be mitigated, the risk can be reduced by reducing the exposure and vulnerability (enhanced local strength, allow the development of alternate load paths to prevent progressive collapse).

Project implemented by

The project is implemented by a partnership between POLITEHNICA UNIVERSITY TIMISOARA, project coordinator Prof.dr.ing. Florea Dinu and NATIONAL INSTITUTE FOR RESEARCH AND DEVELOPMENT IN MINE SAFETY AND PROTECTION TO EXPLOSION INSEMEX Petrosani, represented by dr.ing. Attila Kovacs. External experts from TECHNICAL UNIVERSITY of CLUJ-NAPOCA and URBAN-INCERC Cluj-Napoca are also involved.

Implementation period

2017-2018

Main activities

- Preliminary analysis, design and fabrication of full scale experimental model
- Experimental tests on full-scale building model under internal blast. Explosive charges are detonated in different locations to acquire information about blast pressure decay and interaction with the structure
- Experimental tests on full-scale building model under external blast. First explosive charges are detonated in different locations to acquire information about blast pressure decay and interaction with the structure. Second test series use increasing explosive charges (charge weight / standoff distance) to cause the column in proximity to fail.
- Validation of a numerical model using Extreme Loading for Structures (Applied Science International, LLC, ASI).
- The development of a procedure to apply structural identification to components of a full-scale building structure with structural damage resulting from the blast pressure.

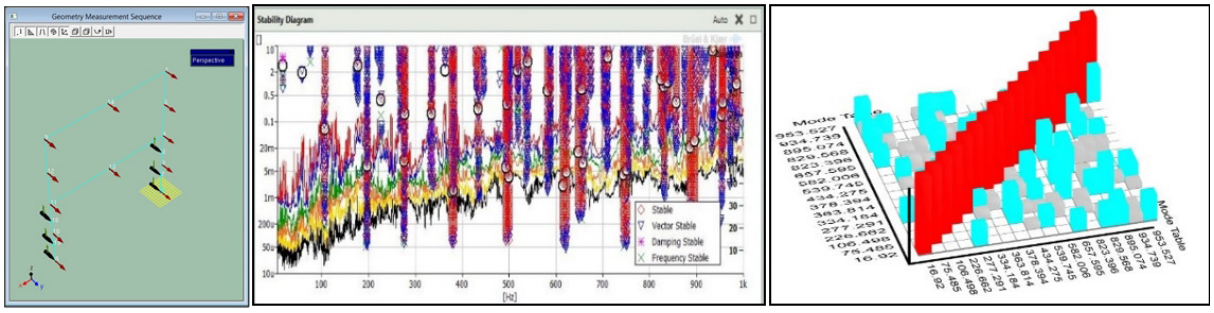
Results

1. Construction phase
- The structure components were brought to the construction site and assembled on-site using bolted connections
- Preliminary internal blast testing were performed using small charge weights (121 g cartridge of explosive)

a) b) c)

Fig. 1 Views with the experimental model:
a) general view; b) view from inside with the position of a test blast charge; c) detailed view of a connection.

2. Experimental modal analysis to assess the dynamic properties of the structure (Bruel & Kjaer vibration measurement technology and equipment
- Experimental modal analyses (EMA) were carried out using hammer excitation and 11 accelerometers
- The modal parameters were verified using the Modal Assurance Criterion (MAC)



a) b) c)

Fig. 2 Modal parameter identification: a) position of the accelerometers and MTC hammer; b) stability diagram; c) modal assurance criterion MAC

3. Preliminary numerical testing using models calibrated against bunker tests
- Blast tests performed on two identical 3D specimen were extracted from a typical moment resisting steel frame structure
- They allowed to make a preliminary calibration of the numerical model of a full scale building structural frame system
- Numerical simulations were performed to evaluate the consequences of close-in detonations on the structural elements

a) b) c) d)

Fig. 3 Numerical simulations using ELS:
a) 3D view of the model tested against external blast; b) relevant blast test inside bunker; c) - d) simulation of local damage for two blast loads

Applicability and transferability of the results

- Experimental validation of an integrated building system in laboratory environment represents the bridge from the scientific research to practical application (structural engineering).
- Experimental database and numerical models are used to upgrade the existing codes for structural design and prevention measures

Financed through/by

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Research Centre

The Research Center for Mechanics of Materials and Structural Safety - CEMSIG

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