STRUCTURAL CONCEPTION AND COLLAPSE CONTROL PERFORMANCE BASED DESIGN OF MULTISTORY STRUCTURES UNDER ACCIDENTAL ACTIONS (CODEC)

Goal of the project

The main goal of the project is the development of a design methodology for mitigation of progressive collapse of multi-storey steel frame buildings against extreme load events caused by both natural and human-made hazards.

Short description of the project

During their designed lifetime, buildings can be affected by accidental actions, which might result in structural collapse, loss of life, or severe injury to occupants. The existing design codes, standards, or other documents do not contain explicit and consistent provisions and approaches to check the structural integrity of the buildings. In addition, the experimental data are insufficient and further studies are still necessary. The project aims at evaluating the structural components that can reduce the risk of collapse and developing new methodologies for assessing the structural integrity of steel frame buildings. Different structural systems and connection details were tested experimentally under static and dynamic loading conditions, and the main response parameters were quantified. Numerical models were validated against experimental data and used for an extensive numerical parametric study. The numerical simulations allowed us to improve the global response of the steel frame structures by using new or improved structural solutions and methodologies.

Project implemented by

- Coordinator (CO) – Politehnica University Timisoara
- Partner 1 (P1) - Technical University of Cluj-Napoca
- Partner 2 (P2) - URBAN-INCERC (Cluj-Napoca Branch)
- Partner 3 (P3) - INSEMEX Petrosani
- Partner 4 (P4) - SC ACI SA Cluj-Napoca

Fig. 1a. Joint specimen after the test

Implementation period

July 2012 – December 2016

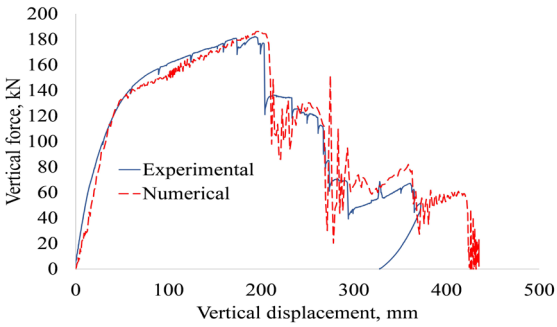

Fig. 1b. Experimental vs. numerical force-displacement curve

Main activities

- Preliminary investigations (Review of existing methods, identification of research needs; Preliminary analysis and selection of case study structures)
- Design of experimental and numerical simulation programs
- Experimental program on materials, weld details and connection macro-components
- Experimental program on joints (column loss scenarios, direct blast conditions)
- Experimental program on sub-assemblies (column loss scenarios)
- Validation of numerical models against experimental tests; Numerical simulation program

Fig. 2a. Experimental T-stub

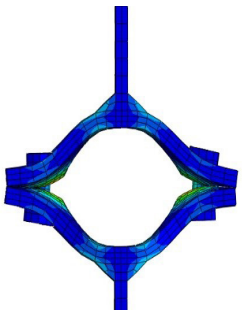

Fig. 2b. Numerical simulation T-stub

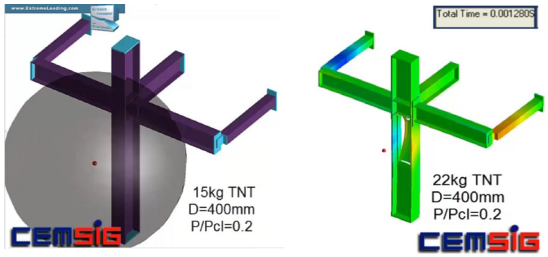

Fig. 3a (left) and 3B (right) Direct blast effect on steel assemblies

Results

- Experimental results (characteristic curves, failure modes, robustness) on T-stubs and weld detail tested in extreme conditions (loading rate, temperature)
- Experimental results on steel joints under column loss scenarios (characteristic curves, failure modes, robustness)
- Experimental results on steel and composite frame systems under column loss scenarios (characteristic curves, failure modes, robustness)
- Direct blast effects on steel elements and connections (influence of stand-off distances, charge size, charge characteristics).
- Numerical models validated against experimental tests
- Numerical simulations on different case study buildings to improve the robustness and mitigate the progressive collapse
- Recommendations for progressive collapse mitigation under column loss scenarios

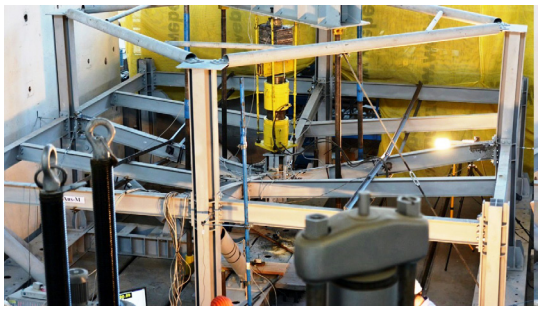

Fig. 4a. Experimental test on 3D steel frame system

Applicability and transferability of the results

- Building construction and design practice; drafting revised guidelines, codes, manuals

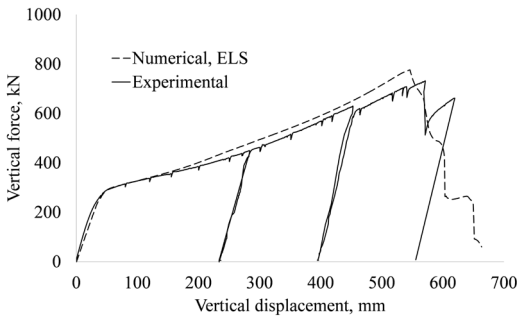

Fig. 4b. Experimental vs. numerical force displacement curve for 3D steel frame system

Fig. 5. Experimental test on 3D composite frame system

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Research Centre

The Research Center for Mechanics of Materials and Structural Safety – CEMSIG (www.ct.upt.ro/centre/cemsig/index.htm)

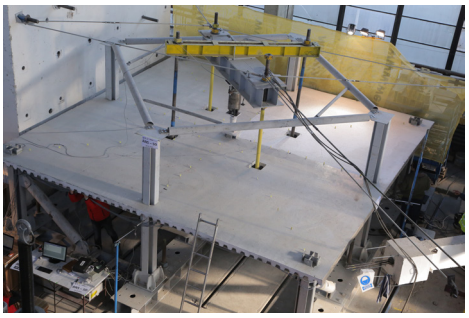

Fig. 6. Composite slab system during construction

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