IMPLEMENTATION INTO ROMANIAN SEISMIC RESISTANT DESIGN PRACTICE OF BUCKLING RESTRAINED BRACES (IMSER)

Goal of the project:

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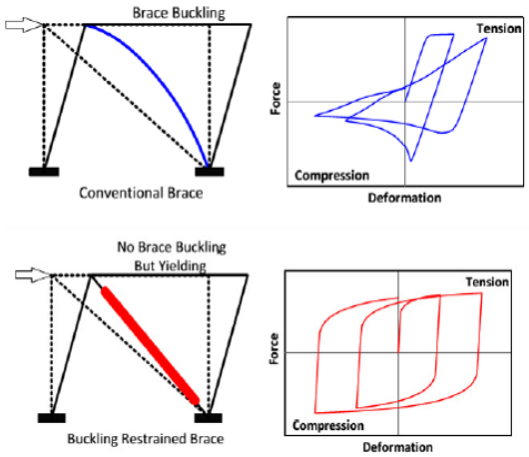
Short description of the project:

The latest version of the Romanian seismic design provisions (P100-1/2013) have introduced, for the first time in Europe, design provisions for buckling restrained braced frames (BRBF). Buckling restrained braces have a great potential in the field of seismic design of structures due to their large ductility and symmetrical cyclic response, as compared with conventional braces.



BRBF can be used both for new construction, as well as for strengthening of existing reinforced concrete, steel or masonry structures. BRB frames are able to provide two key properties of a seismic resistant structure: stiffness (for reducing interstorey drifts under moderate earthquakes) and ductility (for energy dissipation capacity under large earthquakes). BRBs were studied extensively worldwide over the past 30 years and have many practical applications especially in Japan and United States. Though researched in Europe as well, BRBs were applied in a very few applications here. The main reasons for lack of application into practice are believed to be the absence of design provisions in EN 1998-1, not enough acquaintance with the system by practicing structural engineers, need for experimental validation, and proprietary character of most BRB devices.

Project implemented by

- Project implemented by: CEMSIG - The Research Center for Mechanics of Materials and Structural Safety, Research and Technical Development unit of Politehnica University Timisoara, at the Faculty of Civil Engineering, Department of Steel Structures and Structural Mechanics.

Implementation period:

01.07.2014 – 30.06.2016

Main activities:

- Development of two different types of BRB prototypes: "conventional" (steel core / mortar / steel casing) and "dry" (without mortar), followed by a prequalification testing program on a set of BRBs of different capacity. This will provide an initial database on prequalified BRBs, rendering project-specific experimental programs unnecessary, at least for most common design situations;
- Transfer of the "know-how" on design and production of two types of BRBs to the industrial partner, who will be able to set up quantity production of these devices;
- Development of design guidelines for buckling restrained braces (at the device level). It will allow production of generic BRBs by local producers at more competitive prices than imported ones. "Dry" (or "steel-only") BRBs are believed to be especially suited for this purpose, as they can be easily adopted by steel fabricators;
- Development of design guidelines and design examples for steel BRB frames (at system level).
- Dissemination of the project outcomes to practising engineers, through presentations in annual conferences of the Association of Structural Engineers (AICPS) and through two workshops organised in Bucharest and Timisoara.

Results:

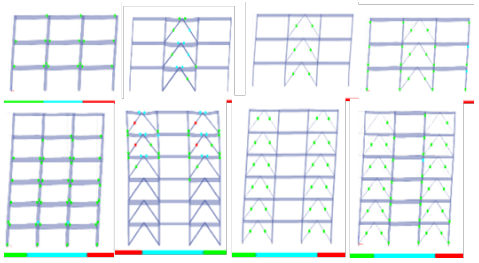
The following results were achieved up to the present date:

- Design of prototype structures for two building typologies (low-rise and mid-rise), which are located in two different seismic zones (Bucharest, TC = 1.6 s and Timisoara, TC = 0.7 s). There were designed 16 structures: MRFs, BRBFs, D-BRBFs, and CBFs according to Eurocode 3, Eurocode 4 and P100-1 /2013. The low-rise structures were 3 storey-high (H = 10.50 m) and the plan layout was 3 spans of 7.5 m by 5 bays of 7.5 m. The mid-rise structures were 6 storey-high (H = 21.00 m) and had the same plan layout. BRBs were disposed in chevron configuration. MRF structure will be used for comparative assessment of analysed structures from the economic and technical point of views

- Selection of typical capacities of BRBs. Two typical BRB capacities were selected (300 kN, respectively 700 kN), which together can cover a range of demands in BRBs ranging from 136 kN to 839 kN.

- Synthesis of existing information on performance and design of BRBs. A comprehensive literature review was performed identifying options for component materials, technology and design methods. These will serve as a starting point for developing a set of "dry" and "conventional" BRBs to be prequalified through an extensive numerical and experimental program.

- Seismic performance evaluation of structures was accomplished using nonlinear static analyses for three seismic performance levels: serviceability (SLS), ultimate (ULS) and collapse prevention (CP), corresponding to seismic hazard levels characterised by 42, 224 and 975 years return period.



Applicability and transferability of the results:

- A Design Guide for both "dry" and "conventional" BRBs for manufacturers, as well as a Design Guide (including examples) for steel BRB frames for practising engineers will be produced within the project. Moreover, a set of BRBs will be prequalified, eliminating the need of project-specific testing. The design guidelines and the prequalification will facilitate the use of BRBs in the Romanian design practice.

Financed through/by

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Research Center

The Research Centre for Mechanics of Materials and Structural Safety – CEMSIG, Politehnica University of Timisoara.

Research team

- Politehnica University of Timisoara, (coordinator);
- SC Popp & Asociaţii SRL, Bucharest;
- SC HYDOMATIC SISTEM SRL, Timisoara.

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