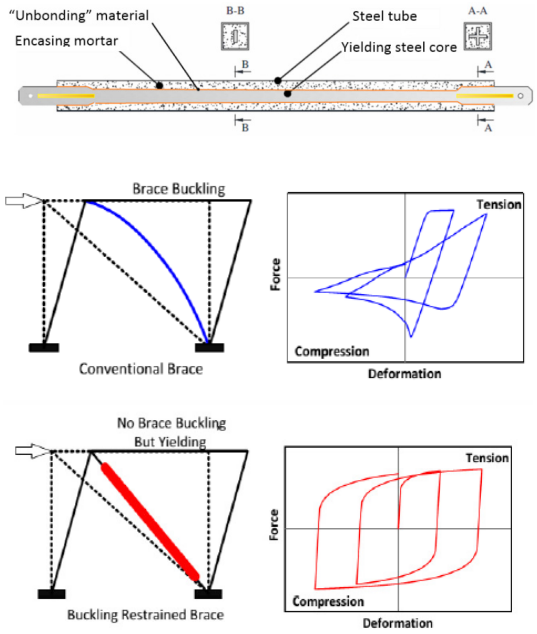
IMPLEMENTATION INTO ROMANIAN SEISMIC RESISTANT DESIGN PRACTICE OF BUCKLING RESTRAINED BRACES (IMSER)

Goal of the project:

The goal of the project is to create the background for quick implementation of the steel frames with buckling-restrained braces (BRB) into Romanian practice design.

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

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 - 30/09/2017

Main activities:

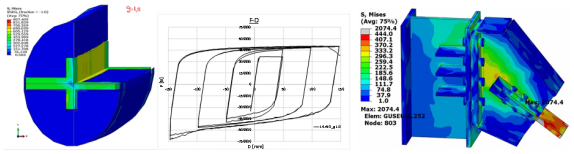
- Development of two different types of BRB prototypes: "conventional" (steel core / mortar / steel casing) and "dry" (without mortar), followed by a prequalification testing program on a set of BRBs of different capacity. This will provide an initial database on prequalified BRBs, rendering project-specific 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.

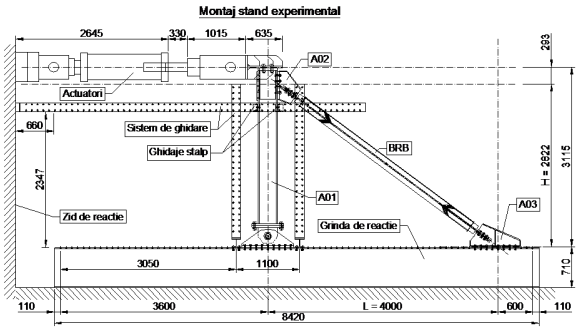
Results:

The following results were achieved up to the present date:

1. Design of prototype structures. There were designed 16 structures (MRFs, BRBFs, D-BRBFs, and CBFs), located in Bucharest and Timisoara.
2. Selection of typical capacities of BRBs. Two typical BRB capacities were selected (300 kN, respectively 700 kN).
3. Synthesis of existing information on performance and design of BRBs was performed identifying options for component materials, technology and design methods.
4. Seismic performance evaluation of structures was performed using nonlinear static analyses for different seismic performance levels.

5. Development and design of BRBs. Different BRB concepts were analysed and numerically tested. A total of 14 BRBs (conventional and "dry") were designed. Code-based design and FEM analyses were performed for the parts of the experimental stand (connections, column).





6. Manufacturing. 14 BRBs, 9 specimens for investigating the transition zone, experimental stand, and specimens for material testing were manufactured.
7. Experimental pretesting. 9 specimens were tested cyclically in order to investigate the behaviour of different BRB concepts, cutting technology.

Applicability and transferability of the results:

A Design Guide for BRBs for manufacturers, as well as a Design Guide 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

Financed through/by

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Research Center

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

Research team

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

Contact information

Assoc.prof. Aurel Stratan, PhD.
Politehnica University Timisoara
Faculty of Civil Engineering
Department of Steel Structures and Structural Mechanics
Str. Ioan Curea nr. 1
300224 Timisoara, Romania
Phone: +40 (0) 256 403 923
Fax: +40 (0) 256 403 917
E-mail: aurel.stratan@upt.ro
Web: http://www.ct.upt.ro/centre/cemsig/imser.htm