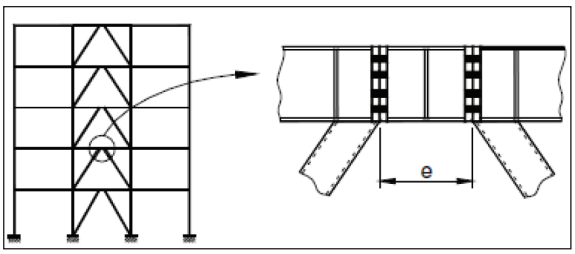
Full-scale experimental validation of dual eccentrically braced frame with removable links (DUAREM)

Goal of the project:
The proposed research aims at reducing the repair costs and downtime of a structure hit by an earthquake, and consequently more rational design approach in the context of sustainability.

Short description of the project: The objectives mentioned above are to be attained through removable dissipative members and re-centring capability of the structure. These concepts are to be implemented in a dual structure, obtained by combining steel eccentrically braced frames with removable bolted links with moment resisting frames.

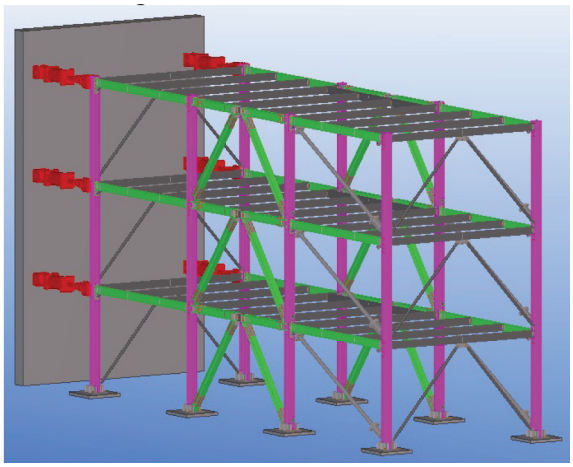


The bolted links are intended to provide the energy dissipation capacity and to be easily replaceable, while the more flexible moment resisting frames would provide the necessary recentring capability to the structure. The columns are to be realised from high strength steel, in order to keep these members in the elastic range even under strong seismic input. The validation of the proposed solution is to be realised through a pseudo-dynamic test of a full-scale model of a dual eccentrically braced structure.

Project implemented by: The Research Centre for Mechanics of Materials and Structural Safety (CEMSIG), Department of Steel Structures and Structural Mechanics, Faculty of Civil Engineering.

Implementation period:
01.06.2010 – end of 2013

Main activities:
•Numerical simulations on the test structure and links were done in order to investigate the possibility to replace bolted links following significant inelastic deformations and the practical feasibility of the replacement procedure;
•Practical solutions regarding order in whichbolted links need to be replaced were developed;



•A solution that uses temporary braces with viscous dampers mounted on the structure during link removal was analysed and chosen in order that the link removal process to be a safe one;
•Some experimental tests on one-storey onespan frames were used in order to calibrate the numeric model of the DUAREM test structure, before applying the link removal procedure.

Results:
Experimental tests on a one-story frame concluded that both the web and flanges have to be flame cut and proved the concept to be feasible, while these results were used in order to calibrate an improved numerical model of the eccentrically braced frame with removable links.

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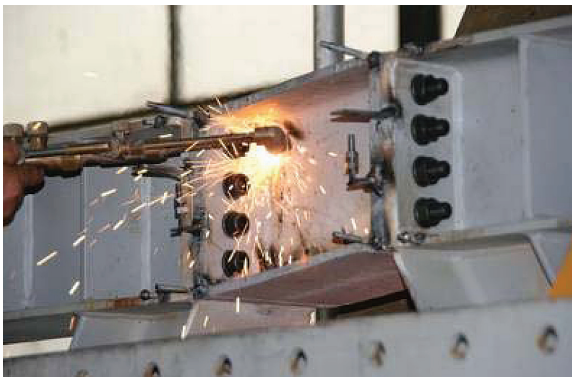
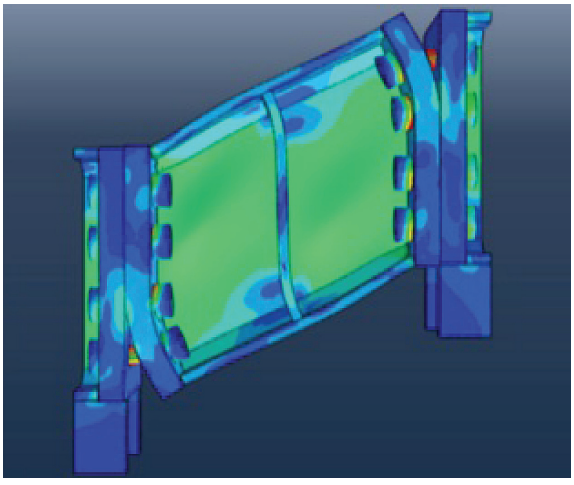
Freeman Dyson

Numerical simulation of the link removal order showed that there is negligible redistribution of forces among stories.



Therefore, the link replacement procedure can be performed on a story by story basis, starting from the least to the most loaded ones (from the upper story toward the lower one). As a concern of operating personnel safety during the flame cutting of links (possible sudden release of link shear force) there was analysed and adopted an alternative solution. It employs some temporary bracing and damper systems that are installed in the moment resisting bays prior to link removal.



Once all links from a story are removed, all structural components from that story are in elastic range of response.

As the brace forces are released through braces with dampers, the structure recovers its initial (plumb) position.

Fields of interest: Design of steel structures in seismic areas.

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Research team:
- "Politehnica" University of Timisoara, Romania (coordinator)
- University of Liege, Belgium
- University of Naples "Federico II"– Faculty of Architecture, Italy
- University of Ljubljana, Slovenia
- University of Coimbra, Portugal

Research centre: Research Centre for Mechanics of Materials and Structural Safety (CEMSIG), Department of Steel Structures and Structural Mechanics, Faculty of Civil Engineering.

Applicability and transferability of the results:
After the experimental validation of the main concepts, the system can be applied to new, multistorey, dual steel structures in seismic areas and extended to buckling restrained braced (BRB) and steel plate shear walls (SPSW) systems.

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