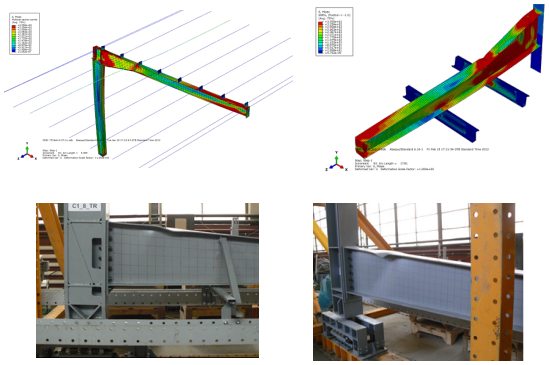
STABILITY OF STEEL FRAMES MADE OF ELEMENTS WITH VARIABLE SECTIONS: INFLUENCE OF IMPERFECTIONS AND LATERAL RESTRAINTS

Goal of the project

The objective of the project is to bring to the attention of structural engineers, manufacturers and contractors, the importance of initial imperfections and lateral restraints in the real behavior of the steel frame, in order to obtain well configured and erected steel structures and prevent component elements stability loss, an unacceptable aspect.

Short description of the project

Steel structures in form of members, plates and shells must frequently be investigated by advanced numerical methods, in order to take into account specific cases of loadings, boundary conditions, geometrical and material imperfections. The aim of the present research program is to find some answers to the following answer: What is more important, the shape or the size of the initial imperfection?
For this purpose parametric studies made by performant computer programs were used. Experimental tests were performed in the CEMSIG laboratory, in order to calibrate numerical models. The obtained results will be thereafter compared with the analytical ones, following the design methods/specifications of SR-EN1993-1-1.



Applicability and transferability of the results

The results obtained during the project emphasize in a more realistic manner the behavior of tapered elements, made of plated steel, when lateral restraints and initial imperfections apply. Besides this the actual design (not covered very clear by the codes) of these types of elements can be made accounting for all external influences and boundary conditions.

Main activities

Imperfection influence study on isolated members with variable cross section (beams, columns) under combined bending and compression. The influence of different type lateral restraining on the element behavior - variable cross-section columns.
Imperfection influence study on single storey steel frames with slender elements under gravitational loading (permanent, technological and snow load) and extreme horizontal loading. Experimental testing of laterally retrained single storey steel frames. Calibration and parametrical study on the behavior of steel frames with elements of variable cross section.

Project implemented by

CEMSIG research Center, Department of Steel Structures and Structural Mechanics, Politehnica University of Timisoara.

Implementation period

01.09. 2010-31.07.2013

Results

The out-of-plane buckling of the frame elements was noticed to be the main failure mode indifferent of the applied lateral restraints. There were cases for which the global lateral- torsional buckling of the frames was coupled with local buckling of the web. This was mainly observed when the restraints applied on the frame element are more effective against overall buckling (e.g. type 3 restraints). It was noticed that the considered imperfections has a low to significant influence on the final capacity of the frame, function of the applied lateral restraints. The difference between considered imperfections is significant mainly for the combined cases. The difference between elastic (actual) and rigid lateral restraints increases by the span increasing, a maximum 10 % difference was recorded.

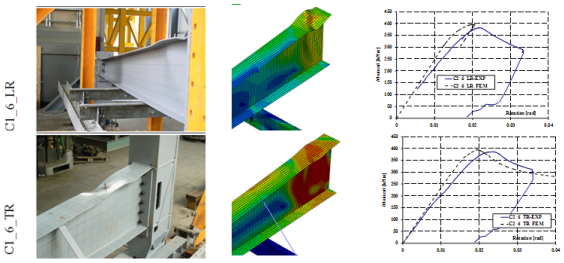
In what concerns the seimic behavior, even though the obtained behavior factor for type 1 and 2 lateral restraints characterizes the frames as low dissipative, this value can be improved significantly if more effective lateral restraints are applied.

The finite element modeling is reliable in predicting the ultimate capacity of the elements with tapered web under both compression and bending with sufficient accuracy.

From the experimental results - the restraining contribution from the purlins alone is reduced (their effect is mall) for all specimen series. This might be explained by the small influence of the axial compressive force on the behaviour of beam-column elements with variable cross sections. The cross section twists rather than buckles laterally, due to the distribution of the normal stresses on the height of the cross section. The ultimate capacity can be improved by applying a supplementary restraining at the compressed flange, but this is only possible with the use of thicker web element (i.e. t=8mm).

Research centre

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



Fields of interest

The main filed of interest, connected with the aim of the project, could be considered as follows: the stability and ductility of steel structures, design of steel structures, behavior of steel structures under extreme loadings, behavior of thin walled structured made of plated elements, reliability analysis of steel structures

Financed through/by

Ministry of Education, Research and Innovation. The National Authority for Science Research

Research team

Phd. Eng, Senior Lecturer Mircea Cristutiu
Phd. Eng, Senior Lecturer Adrian Dogariu
Eng, Research assistant, Daniel Nunes
Phd. Eng, Assitant, Sorin Bordea

Contact information

Assist. Prof. Mircea CRISTUȚIU, PhD
Faculty of Architecture
Address: Str. Traian. Lalescu, No 2. , RO300223 Timisoara
Fax: (+40) 361 814 159
Mobile: (+40) 723 281 859
E-mail: mircea.cristutiu@.upt.ro
Web: www.arh.upt.ro