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# Experimental and Numerical Analysis of Concrete Slender Columns by Stability Failure

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**Abstract:** The European Standard [1] for design of concrete compressed slender members shows a significant deficit in global reliability. The contribution present the results of experimental and numerical verification of slender concrete columns made of different concrete strength classes - C45/55 and C100/115. A basic aim of the analysis was to design concrete columns subjected to bending moment and axial force where the stability failure proceeds at the compression strain 1.5 ‰. In the contribution will be presented the first of three series of experimental and numerical analyzed columns with the verification of global reliability. The experiments were realized at the Faculty of Civil Engineering SUT in Bratislava with cooperation of ZIPP Bratislava Company.

## Introduction

Semi-probabilistic method of reliability of structural members and structures according the Eurocodes is based on the use of partial coefficients of reliability. The required reliability index and therefore the probability of failure, is ensured by partial coefficients of reliability. In ULS the effect of loads is increased by partial coefficient of reliability $\gamma_F$ and the resistance of materials is reduced by partial coefficients of materials $\gamma_M$. Increasing of compressive normal force by slender concrete columns leads to raise of deformation and then to increase of total eccentricity of normal force in critical section. The raise of the eccentricity of the second order can be so significant that the stability failure can precede the material failure of critical cross-section.

Application of non-linear analysis is defined in [1] chap. 5.7 (4)P: *„The use of material characteristics which represent the stiffness in a realistic way but take account of the uncertainties of failure shall be used when using non-linear analysis...“*. The partial safety factor for stability failure of the concrete columns is not defined. Practical usage of the non-linear general method is available according [1] chap. 5.8.6 (3) with using of design values of the materials. In this case is questionable if the total reliability of the compressed structural member is sufficient.

## Experimental verification

The task of the upcoming experiment was to design material and geometric characteristics and initial eccentricity of the normal force applied on reinforced concrete column that the value of strain of compressed concrete fibers in the critical cross section would reach approximately $\varepsilon_{c1}$ = 1,5 ‰ by the stability failure of the column. The columns were made of concrete C45/55 and reinforced by steel bars B500B. The experimental samples - columns were realized in the Prefa plant Sereď with support and cooperation ZIPP Bratislava s.r.o.

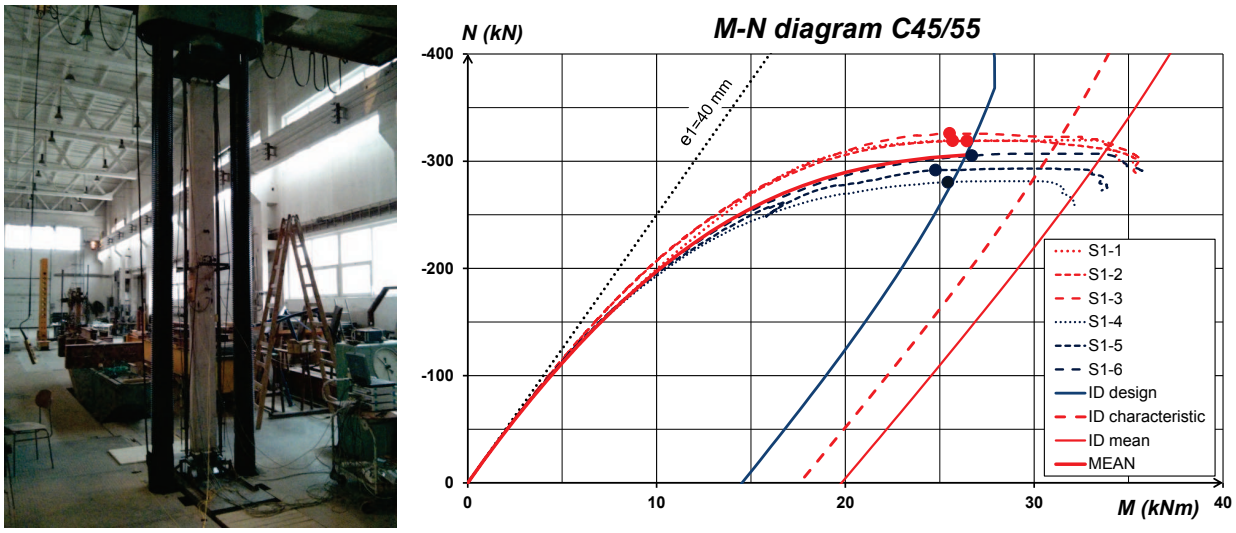


Fig. 1: Setting of the tests and M-N diagrams of the experimental columns S1 - 1 to S1 - 6

## Summary

The planned experimental tests confirmed the predicted results of the authors and the nature of the behaviour of the slender columns during the tests. The columns failed by stability loss before design resistance was reached, i.e. the stability failure occurred in the domain of the interaction diagram M-N of the column cross section when strain of the compressed part of critical cross section was above 1.5 ‰ (Fig.1). According the authors, it is necessary to define the partial safety factor for stability failure of slender compressed member for such cases.

The importance of correct definition of the partial reliability coefficient for stability failure of compressed members is increased by the fact that this type of failure is sudden without warning and significant deformation. That is why by this type of the stability failure we need enhanced global reliability in comparison with classical ductile failure.

The recommended partial reliability coefficient of stability failure is not included in Eurocodes especially EN 1992-1-1, but only in Austrian National Annex [2]. EN 1992-1-1 [1] didn't treated this significant deficit of global reliability by stability failure of concrete columns even after years of experimental results proving the above mentioned fact [3, 4].

## References

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