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Experimental Verification of the Bending Stiffness of the Wall for the Program for Design of High Walls in Dry Construction

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Abstract. This paper presents the results of experimental determination of the bending stiffness of a high wall made of plasterboard and newly developed calculation tool for the design of high walls. The experiments and the calculation followed the relevant standards and the design of the calculation program is based on the optimization of different approaches.

Introduction

The great boom of the dry construction in the Czech Republic is in progress on since the turn of the 20th and 21st centuries, when this technology has significantly improved here. The dry construction has found application not only in the realization of temporary buildings, but also in reconstruction and new buildings. The plasterboard is used for vertical and horizontal constructions. The main advantages are quick construction, elimination of wet process, good acoustic properties and fire resistance. The disadvantage is higher sensitivity to moisture [1].

The plasterboard is increasingly used for the realization of high walls and partitions. In practice, the limit height is 4 m, a more complex static assessment is needed for the design of higher structures. The design and assessment of the high wall in the Czech Republic are governed by the Eurocode, specifically ČSN EN 1991-1-1 a ČSN EN 1991-1-4 [2,3]. The problem is that this methodology does not take into account some important parameters such as the effect of vibration and pressure (only the line load is considered in the Eurocode). However, these parameters are taken into account by the German standard DIN 4103-1 [4]. Another difference between these methodologies is that the Eurocode does not prescribe an individual assessment for walls higher than 12 m. It is, therefore, necessary to complete the theoretical basis in the Czech Republic and the lack of basic research on the parameters necessary for the relevant assessment. One such parameter is the bending stiffness of the wall. The aim of this project is to compare both methodologies with regard to maximum safety of constructions and to create an optimized experimentally verified calculation tool for design and assessment.

Methodology of experiments

Material and mechanical properties of the individual supporting elements of the panel and fastening devices are normally verified experimentally. But the coupling is verified due to technologically and economically demanding experiments minimally, mostly necessary parameters are calculated. It was, therefore, necessary to carry out several selected experiments to verify our calculation tool. This paper describes a full-scale experiment for determination of the bending stiffness of a high wall.

The experiments were first performed on a test panels with dimensions 1250 × 7000 mm (presented in this paper), then on larger panels, a total of 5 full scale experiments were performed. The static scheme of the experiment corresponded to a four-point bend as shown in Fig. 1. The experiment was prepared according to standards ČSN 73 2030 a ČSN 73 2035 [5,6]. The test setup can be seen in Fig. 2.

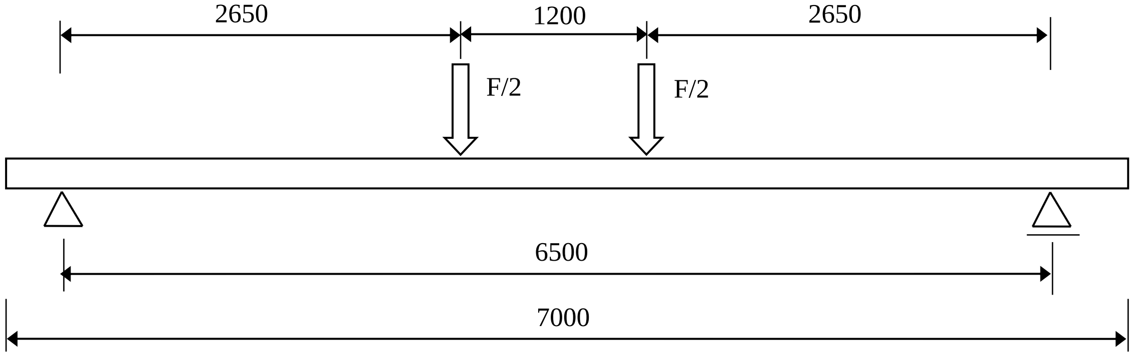

Fig. 1: Static schema of of the bending stiffness of a high wall.

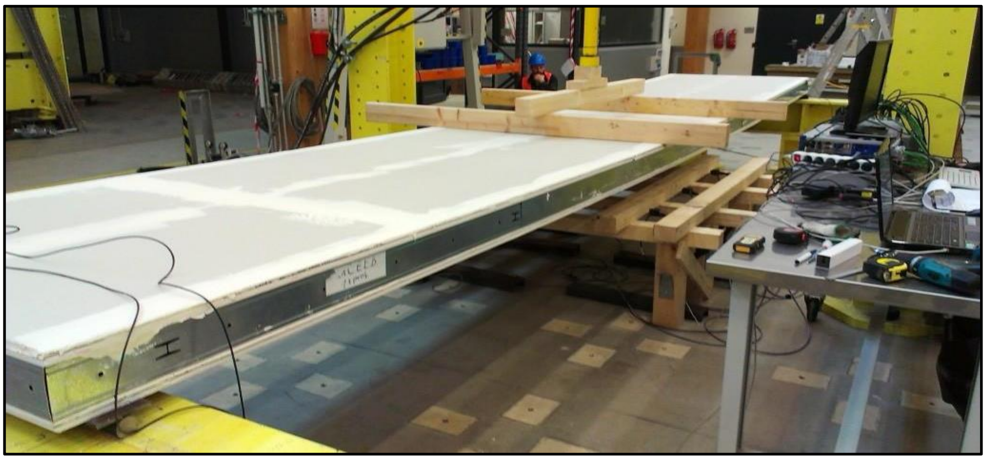

Fig. 2: Set up of experimental verification of the bending stiffness of the wall panel.

Calculation program

The calculation program was created in MS Excel and allows to evaluate the construction of a high wall after entering the basic parameters. The procedure can be divided into 3 phases:

1) input of panel geometry and selection of plasterboard and profile,
2) input load,
3) static calculation and assessment (ultimate and serviceability limit state).

The selection of plasterboard and profile automatically completes the necessary cross-sectional characteristics and other properties from the prepared database. The considered load is a combination of methodologies EN a DIN [2-4].

Evaluation and discussion

The calculation model takes into account the coupling of plasterboard with the profil and the nonlinear behavior of the structure. To correctly determine the effect of coupling, it is necessary to perform experimental tests from which the stiffness of the panel is obtained and then the coefficient of the effect of coupling. Other unknowns are obtained from the working diagram of the load and ultimate strength of the tested element. A nonlinear behavior is derived from these quantities and it is defined in the model as trilinear depending on the ultimate strength of the panel. It should be noted that for high panels, the serviceability limit state, which is located in the first linear part of the diagram, is decisive (Fig. 3).

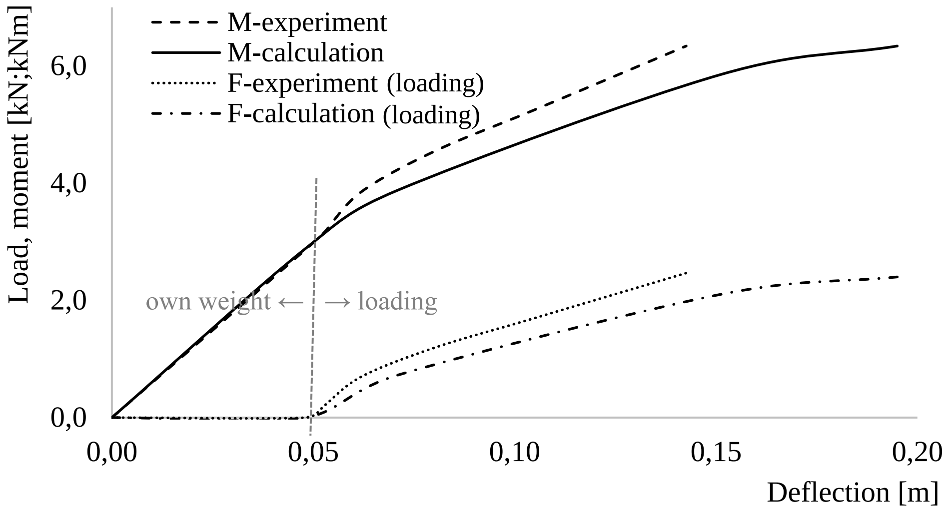

Fig. 3: Comparison of the courses of moments and loads depending on the deflection (average value of experiment vs calculation)

Conclusions

The design and assessment of high walls in the field of dry construction have been optimized based on an analysis of standard used methodologies used in the Czech Republic and Europe (e.g. Germany). Subsequently, a computational program was created, which is verified by selected experiments, such as the presented determination of the bending stiffness of the high wall. Furthermore, these are experiments to verify the frame stiffness of the wall according to ČSN EN 594 [7] and several types of load-bearing capacity of fasteners - ČSN EN 383 a ČSN EN 14 566 [8,9].

Acknowledgement

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