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Modelling the post-elastic behaviour of a prefabricated wood pannel

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Abstract

The aim of this study is to develop a nonlinear behaviour design model for panel wood structural elements. The work is based on an experimental test performed on wood panels subjected to static horizontal loads.
The results obtained following the nonlinear static analysis are comparable with the results recorded during the laboratory tests for the wood panels.

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1. Introduction

Wood prefabricated panels have a complex structure consisting of a number of layers of different materials (resinous wood, plywood, gypsum board) joined and working together by means of different types of fasteners like nails and bolts.

The work presented in this paper aims to define a nonlinear design model whose behaviour reproduces as close as possible the behaviour of a prefabricated wood panel structural wall that was experimentally tested for the action of horizontal loads.

This study starts from an experimental study performed at the Steel Structures Laboratory of the Technical

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University of Constructions Bucharest, Romania, referring to the determination of strength properties of several prefabricated wood panels with different constructive detailing.

In order to model the behaviour of the prefabricated wood panel for a structural analysis computer program in a way similar to the behaviour obtained through the experimental test, a simplified model was chosen. Thus, the panel was defined as a linear element, a column, whose performance respects the behaviour curve P-D experimentally obtained.

The post-elastic analysis was performed by introducing a plastic hinge at the column base.

Such a simplified analysis neglects the behaviour of the components of the panel ensemble and the way of how plastic hinges are formed in the joints between the slab and the frame and also between the frame elements.

In order to perform a detailed analysis of the entire panel, considering each element forming the ensemble, a three dimensional finite element model that follows the behaviour of each component and of the joints must be generated. This analysis is the subject of a different research at it is not presented in this paper.

Modelling the prefabricated wood panel as a linear element (a column) implies the empirical definition of some material characteristics and the use of an M-θ type plastic hinge which is also empirically defined. The use of these hypothesis aims to obtain a Push Over curve that reproduces as close as possible the experimental test results.

Along the experimental study the panel was considered to be a surface element, such that for defining the computer model the behaviour in the plan perpendicular to the panel was neglected. The structural analysis was performed using the ETABS computer program.

2. Test specimen and materials

For the purpose of this study a 1200x2500 mm panel, the most common type used in Romania, was chosen (Fig. 1):

Framing:

Lumber used for framing in tests is resinous wood –first quality class

- Studs (central and lateral): 44x120mm
- Plates (top and bottom): 44x120mm
- Intermediate plates: 44x120mm

Wall sheathing:

- Exterior sheathing: Agglomerated wood panels – 12 mm thickness
- Interior sheathing: Gypsum wall boards – 10 mm

Fasteners:

- Nails 3.5 mm diameter/200mm and screws 3 mm diameter, L = 40mm/200mm alternatively positioned for fastening the exterior sheathing. There were more than 100 nailed or screwed connections between the sheathing and the frame.

Stiffeners and anchorages:

- 80x80x10 steel angle profiles fixed with five nails on the exterior studs and with one 10 mm bolt on the bottom plate, thus assuring the anchorage in the foundation

3. Test set-up and procedure. Results

For performing the tests, a horizontal rack was used. The panel bottom plate was attached to the test fixture on a steel rigid profile fixed in the flooring (label 9, fig. 2) for simulating the concrete foundation. Two pipe cross-section rolling supports allow the free sliding of the top end of the panel (label 6, fig. 2). These rolls, together with the pumps (label 5, fig. 2) and the dynamometers for force measurement (label 2, fig. 2) are supported by another steel rigid profile. The pumps have 6tf capacity, and the dynamometers have a weighing precision of 10 kg. The deformations and displacements of the panel are measured by means of 5 fleximeters (F1…F5) located as shown in fig. 2.