LABORATORY TESTS AND NUMERICAL SIMULATIONS OF CARPENTRY CORNER LOG JOINTS

A. Pestka[1], and P. Kłosowski[2]

[1,2]*Gdańsk University of Technology, Gdańsk, Poland*

e-mail: [1]*annmlecz@pg.edu.pl,* [2]*klosow@pg.edu.pl*

1. Introduction

Wood is one of the most important building materials and nowadays is very popular. The advantages of wood that cause its popularity are: good strength parameters, weight (wood is much lighter than steel), facility in woodworking and assembling, good thermal and electric insulation. Wood is a natural material and hence it has some disadvantages such as: heterogeneity of the material [1-3] and its sensitivity to moisture, temperature and biological damage [4-7]. Despite numerous disadvantages, the wood is still widely used in civil engineering.

The development of the wooden constructions was mainly related to good strength parameters of wood and its wide availability. The most important role in the wooden structures constructions are carpentry joints. The carpentry connections combine the structure into a whole, transfer the forces and testify highly developed carpentry technique. The paper refers to the corner wall connections. In the historic wooden objects, the most popular were the crowned construction of walls [8]. Two types of joints connecting crowned walls at their corners: short-corner dovetail connection (without protrusion) and saddle notch corner joint (with protrusion) have been analysed in the paper. The carpentry corner log joints are shaped connections, which fulfil the purposes such as transferring the loads and ensuring proper position in relation to each other [8]. The geometry of the joints depends on the place and period of time, where they were used [8-11]. Despite the popularity of the carpentry corner log joints in the historic wooden structures, it is difficult to find research on these carpentry connections (see [12-13]). The knowledge of the behaviour of the carpentry corner log joints is very important due to maintenance, renovation and strengthening of existing elements in preserved historic wooden objects [8, 14].

2. Material and geometry

All the analysed carpentry corner joints models consists of five logs. Each log of the short-corner dovetail connection is 700 mm long. In turn, each log of the saddle notch corner joint is 775 mm long. The cross-section dimensions of both connections are approximately 75 × 135 mm. Due to experimental equipment possibilities, these dimensions are in scale 1:2 to the logs occurring in the real wooden structures [11]. The geometries of the short-corner dovetail connection and the saddle notch corner joint have been presented in Figure 1. All the carpentry connections have been made of the pine wood and most of mechanical properties have been determined during special small scale experiments before the main tests.

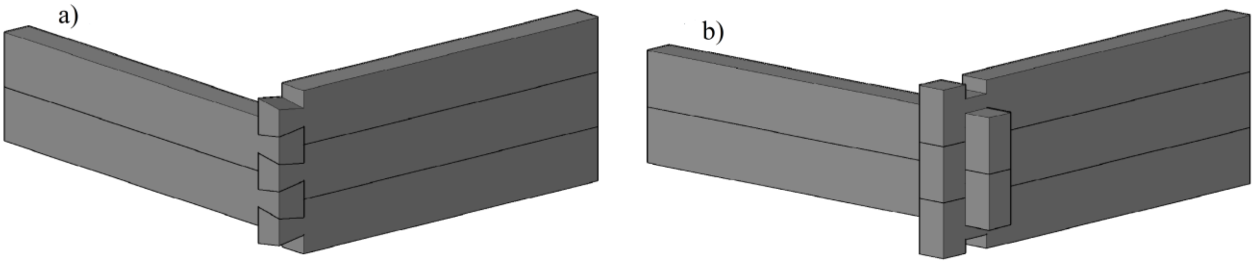

Figure 1: Geometry of carpentry joints: a) short-corner dovetail connection, b) saddle notch corner joint

3. Experimentation and numerical calculation

The laboratory tests have been performed for the short-corner dovetail connection and the saddle notch corner joint. Three tests for both carpentry connections have been carried out using biaxial testing machine. Before testing, each log of a join has been weighted and the wood moisture has been tested using a hygrometer. The displacements of the four joint's points selected at the logs surface have been recorded with an optical extensometer to better describe the connection's deformation.

In order to verify the obtained experimental results, the numerical calculations have been performed. They have been carried out using MSC.Marc software. Both the short-corner dovetail connection and the saddle notch corner joint have been modelled using solid elements. Between logs of the carpentry joints, the contact phenomenon with the proper friction coefficient has been defined. The finite element mesh is more dense in the connections' corners than in the rest of analysed joint to improve the accuracy of stress distribution. The results of experiments and the simulations have been compared and the regions of the potential damages have been established.

More details on conducting experiments and numerical analysis will be presented during the conference.

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