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A NOVEL WAY TO SIMULATE THE BEHAVIOUR OF TIMBER COMPOSITE CONNECTION JOINTED THROW DOWELS

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Abstract

This paper presents a novel way to simulate, with the finite element method, the behaviour of timber composite connection jointed throw dowels. The main originality of this study is the demonstrated ability to avoid the detailed 3D finite element modelling of dowels using solid elements, which is costly ineffective. The authors developed recently a beam-to-solid approach (BTSA), where the dowels were modelled using one-dimensional beam element, while the assembled timber members were modelled using solid elements. The effectiveness of the numerical model developed was verified experimentally showing several advantages by comparison to the existing models in the literature.

1. Introduction

Composite timber connections through dowels have, and continue to be, thoroughly studied by several researchers in different laboratories due to their efficiency. To investigate the full potential of such composite systems, experimental tests need to cover as many scenarios as possible which is expected to be very expensive and time consuming. Thus, in order to understand extensively the behaviour of composite timber connections, a numerical modelling with the finite element method is used, validated against experimental result [3]. Generally, the timber and dowels was modelled using 3D solid finite elements accounting for frictional contact conditions between the timber and the dowels. However, this required to use hundreds of thousands or even small size finite elements in the model, involving unacceptable extensive computing times, in particular in general three-dimensional industrial applications. In addition, this way of modelling often leads to divergence [5], which is caused, probably, by the excessive element distortions. It is, therefore, of extreme important to develop fast and accurate numerical models to predict the behaviour of such connections.

The authors developed recently a beam-to-solid approach (BTSA), which has been successfully applied to predict the load-slip curves of timber-to-timber [1] and timber-to-concrete connections [2], in the context of single plane push-out shear tests. In that approach, the dowels were modeled using one dimensional beam elements, while the timber was modelled in detail using solid elements. Since the degrees of freedom (d.o.f.) differ from the beam element to the solid element, the authors have modified the existing 2-node beam element, involving in a 4-node beam element with only translational d.o.f. [4]. The aim of the present paper is to evaluate the appropriateness of the beam-to-solid approach, developed

previously, on full-scale simply supported timber-to-timber composite multi-layer beam, where the timber layers were interconnected with welded wood dowels providing interlayer shear resistance. [3].

2. Finite Element Modelling

The ABAQUS finite element code was used to investigate the behavior of the jointed connected members through dowels. Since the connection geometries admit two plans of symmetry, only one quarter was modelled. 3D finite element model was assumed and eight-node solid elements have been used for the discretization of the timber. The dowels have been modelled using 4-node one-dimensional beam element.

3. Result and discussion

Figure 1 shows the predicted load–deflection curves for the studied timber composite beam. A fairly good agreement is found between numerically predicted results and those published in [3].

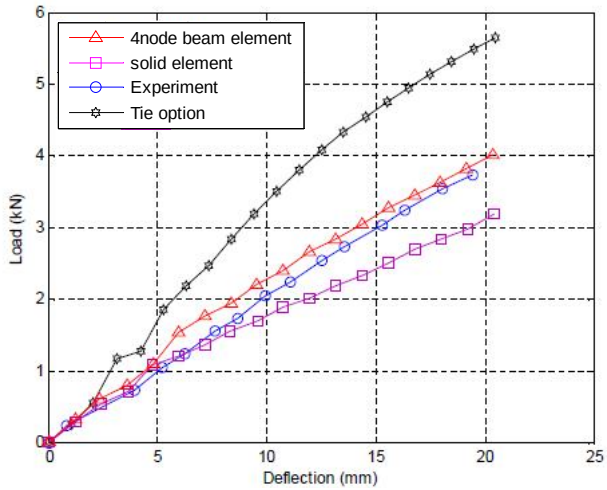

Fig. 1: Numerically predicted load–deflection curves: comparison with experiment

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