Calibration and experimental validation of FE numerical models for adhesive Bonded-in-Rod (BIR) connections in timber structures

Chiara Bedon

Reference: E-COST-GRANT-CA18120-910c2ea5
Dates: from 2022-01-23 to 2022-01-29
Beneficiary Institution: University of Trieste, Italy
Hosting Institution: University of Zagreb, Croatia
Contact Name: Vlatka Rajcic, Croatia
Relevant Working Groups: WG2

Objectives / Description / Main outcomes

Main goal of the present STSM was to investigate with enhanced Finite Element numerical models the load-bearing behaviour of Bonded-in-Rods (BiR) connections in use for timber structures (ABAQUS / Explicit). As known, adhesive properties and degradation can severely affect the expected load-bearing capacity of this tupe of solution. At the same time, simple analytical models are not able to capture the complexity of damage mechanisms. In this study, a refined FE modeling procedure based on Cohesive Zone Modelling techniques and dedicated damage models was calibrated to past BiR experiments.

The attention was given to pull-out BiR specimens characterized by :

- 2 adhesive types (Epoxy, Polyurethane),
- 3 moisture contents (9%, 18%, 27%),
- 2 grain orientations for timber (parallel, perpendicular).

Calibration of input FE parameters of interest (namely the CZM interface stiffness, ultimate strength and failure displacement) was based on iterative fitting of 60 experimental force-displacement curves of literature, for 12 configurations in total (Figure 1).

The availability of validated FE models was able to capture realistic failure mechanisms for BiR connection was used for local and global analysis of damage propagation in each component (Figure 2), as well as for an extended parametric analysis able to include the effects of :

- Screw length / anchorage length (60 mm, 100 mm, 200 mm, 400 mm)
- Screw diameter (10 mm, 14 mm, 20 mm)

The collected FE parametric results show that the use of experimentally calibrated FE models can support the definition of charts and empirical expressions in support of design, so as to overcome the limits of existing formulations. Among the investigated parameters, moisture content was found to severely affect the overall load-bearing capacity of BiR connections, due to degradation in adhesive bonding potential. The present outcomes are currently under rearrangement for the preparation of an extended joint journal paper.

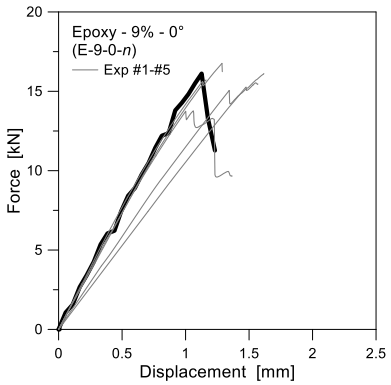

Figure 1: *Force-displacement calibration of FE models to experiments (example)*

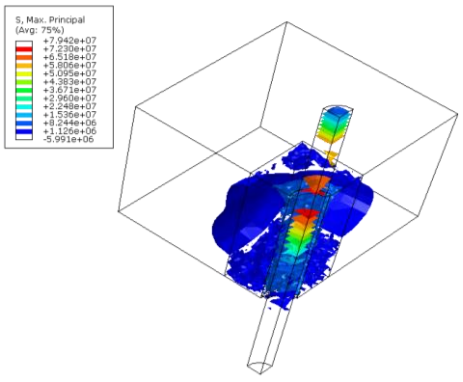

Figure 2: *Stress analysis at failure (example)*

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY
Funded by the Horizon 2020 Framework Programme of the European Union