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Cohesive Zone Models of Single Step Joint damaged due to the Shear Crack

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Being subject to the horizontal thrust from the carpentry, the Single Step Joint (SSJ) may be damaged due to the shear crack in the tie beam, entailing the collapse of the whole timber truss. In order to prevent this failure mode, Verbist et al. [1] proposed to check the related design equation by introducing the reducer coefficient $k_{v,red}$, applied to the characteristic shear strength $f_{v,k}$, which takes into account the heterogeneous shear stress distribution, called Hammock Shape Shear Stress Distribution (HSSSD), along the grain at the heel depth in the tie beam. From previous numerical research [2-4], the HSSSD and $k_{v,red}$ are significantly influenced by two SSJ geometrical parameters: the geometrical proportion between the shear length and heel depth l_v/t_v, and the inclination angle α of the front-notch surface.

The present study aims at determining the values of $k_{v,red}$ by comparing the numerical results from FEM of several SSJ geometrical configurations with the experimental results [1]. To this end, the HSSSD must be assessed through both SSJ geometrical parameters and other ones [3-4] such as the average shear stress τ_{mean}. In order to simulate the shear crack and obtain the suitable HSSSD in the tie beam in accordance to the experimental results, a Cohesive Zone Model has been settled along the grain at the heel depth in the tie beam.

The results have shown a strong dependence between the average shear stress τ_{mean} in the tie beam and both SSJ geometrical parameters previously stated. Hence, the reducer coefficient $k_{v,red}$ has been determined as a product of two factors: $k_{v,\alpha}$ and $k_{v,l/t}$. In addition of meeting both conditions $k_{v,\alpha} \geq 1$ and $k_{v,l/t} \leq 1$, empirical equations have been proposed for both factors of the reducer coefficient in order to enhance the reliability of the design equation against the shear crack for all the SSJ geometrical configurations.

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