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Cross laminated timber plates with a notch at the support

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The work presents different fracture mechanics approaches to model the crack propagation in notched cross laminated timber (crosslam) plates. The background, see [1], relates to the question of the applicability to crosslam plates of the Eurocode 5 (EC5) design equations for notched members, [1]. This involves the so-called Gustafsson approach [3], one of few design formulae in EC5 with a theoretical basis in fracture mechanics. Figure 1 below defines the basic geometry for a notched member.

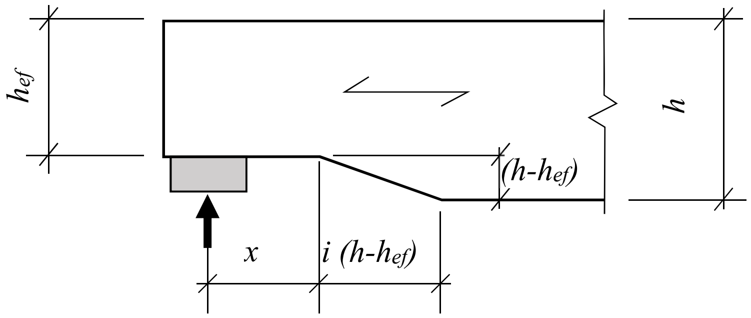

Figure 1: Geometry of a Beam Notched at the Support

In EC5, the shear force capacity of a notched member is given as a function of, *i.a.*, the material shear strength, although the underlying theory does not. This reformulation of the pure fracture mechanics approach of Gustafsson was done in order not to introduce new material parameters into EC5. The EC5 design equation for shear stress is written as:

$$\tau_d = \frac{1{,}5V}{b_{ef}\,h_{ef}} \le k_v f_{v,d}\ ;\ k_v = \min\left\{\begin{array}{c}1\\ \dfrac{k_n\left(1+\frac{1{,}1\,i^{1{,}5}}{\sqrt{h}}\right)}{\sqrt{h}\left(\sqrt{\alpha(1-\alpha)}+0{,}8\frac{x}{h}\sqrt{\frac{1}{\alpha}-\alpha^2}\right)}\end{array}\right. \qquad (1)$$

where b_{ef} is the effective width, $f_{v,d}$ is the design shear strength and where k_n is a material (calibration) parameter, $\alpha=h_{ef}/h$ and h, h_{ef} and x are defined in Figure . According to EC5, the material (calibration) parameter should be as follows: k_n = 4.5, 5 and 6.5 for LVL, structural timber and glued laminated timber, respectively. Although not explicitly stated in EC5, the parameter k_n represents the relation between the material parameters $G_{f,I}$ (the Mode I fracture energy), G (the shear modulus), and $f_{v,d}$, and where the factor 0.8 represents the relation between G and E (the modulus of elasticity). Thus the shear capacity is (implicitly) a function of *only* geometry, material stiffness and fracture energy and *not* strength (as expected for a linear elastic fracture mechanics theory).

The presentation discusses the design of notched crosslam plates from a theoretical point of view, including current design approaches as given in European Technical Assessments or Design Handbooks, see *e.g.* [4] and [5]. Those design approaches involve different, more or less straightforward, applications of Eq. 1 although several of the basic assumptions of that equation are not applicable for crosslam plates with a notch. Also, results from finite element analyses, using different theoretical frameworks to model crack propagation, are compared with the design approaches found in [4] and [5] and with experimental results from [6].

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