Cross laminated timber plates with a notch at the support

Serrano, Erik

2019

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Cross laminated timber plates with a notch at the support

Erik Serrano*

Division of Structural Mechanics, Lund University, Sweden, Erik.Serrano@construction.lth.se

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.

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:

\[
\tau_d = \frac{3.5V_b}{b_eff h_{eff}} \leq k_n f_{v,d} ; k_n = \min \left\{ \frac{1}{\sqrt{\frac{\alpha(1-\alpha)}{G(1-E) + 0.8 k_n \frac{1-\alpha^2}{G_f,I}}}} \right\}
\]  

(1)

where \( b_{eff} \) is the effective width, \( f_{v,d} \) is the design shear strength and where \( k_n \) is a material (calibration) parameter, \( \alpha = h_{eff}/h \) and \( h, h_{eff} \) and \( x \) are defined in Figure 1. 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].

References