2D computational modeling of the influence of transverse reinforcement on perpendicular to grain stress in double tapered glulam beams

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The present paper focuses on numerical simulation of the influence of reinforcement on the distribution of perpendicular to grain stress in a double tapered glulam beam. Analysis of certain distributions without the reinforcement was shown among others in [1-3], where geometrical parameters and various orthotropic properties were taken into account. The numerical model was created using the finite element method in Abaqus environment. The double tapered beam (Fig. 1) is a simply supported structure with a span of L=36 m, height over the supports 1 m, apex height 3.4 m and width 0.3 m. The beam is loaded with concentrated forces P=125 kN and is made of an orthotropic material corresponding to the glulam GL28h. It was modeled as a 2D plane stress problem within the linear theory of elasticity. The apex zone was reinforced with 6 bars of length 2 m and a diameter varying from 9 mm to 13 mm, which were modeled as bar elements. In the beam 10206 finite elements type CPS8R (eight-node plane stress elements with reduced integration) were defined. Each reinforcing bar was divided into 15 finite elements type B22 (three-node plane beam elements). The translational degrees of freedom of bar elements are consistent with the 2D model of the beam.

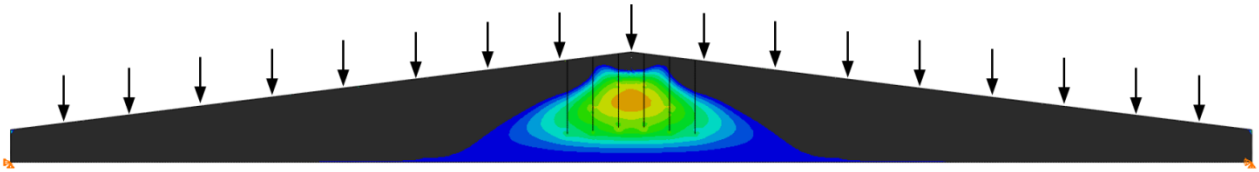

Figure 1: Extensional normal stress distribution in double tapered glulam beam with reinforcement.

Examples of the distributions of positive normal stress perpendicular to the grain are presented in Fig. 2.

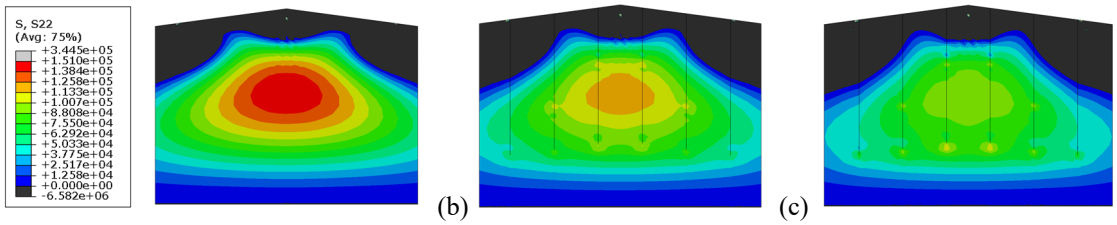

Figure 2: The influence of the reinforcement: no reinforcement (a), 6xϕ9 reinf. (b), 6xϕ13 reinf. (c).

An analysis of perpendicular to grain stress depending on the level of reinforcement (6 bars with diameters 9, 10, 11, 12 and 13 mm) is shown in Fig. 3. Distribution of stress in the apex cross-section (Fig. 3a) and influence of the reinforcement on the maximum value of stress (Fig. 3b) are given. The numerical simulation indicates that it is possible to reduce perpendicular to grain stress by 30%. A wider numerical simulation will be presented at the conference.

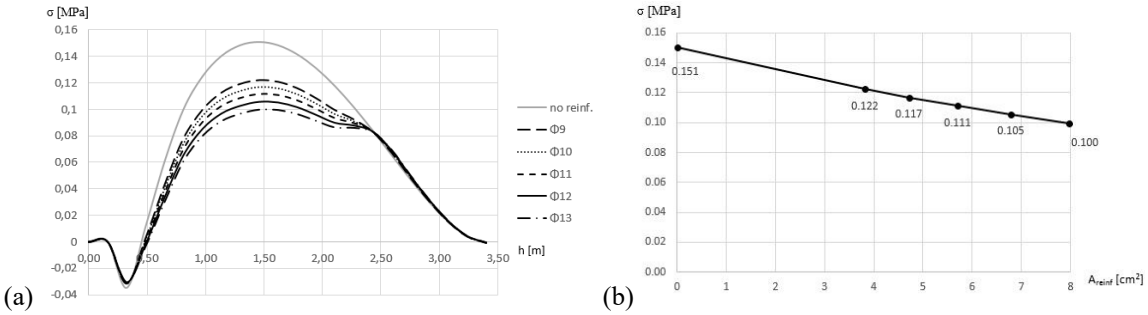

Figure 3: Normal stress analysis: distribution in the apex (a), maximum values against the reinforcement (b).

References

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