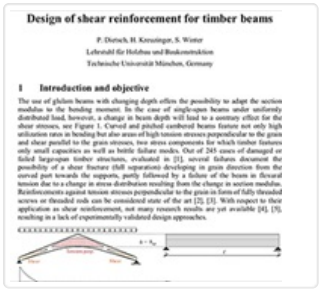
Design of shear reinforcement for timber beams

P. Dietsch, H. Kreuzinger, S. Winter

Lehrstuhl für Holzbau und Baukonstruktion

Technische Universität München, Germany

1 Introduction and objective

The use of glulam beams with changing depth offers the possibility to adapt the section modulus to the bending moment. In the case of single-span beams under uniformly distributed load, however, a change in beam depth will lead to a contrary effect for the shear stresses, see Figure 1. Curved and pitched cambered beams feature not only high utilization rates in bending but also areas of high tension stresses perpendicular to the grain and shear parallel to the grain stresses, two stress components for which timber features only small capacities as well as brittle failure modes. Out of 245 cases of damaged or failed large-span timber structures, evaluated in [1], several failures document the possibility of a shear fracture (full separation) developing in grain direction from the curved part towards the supports, partly followed by a failure of the beam in flexural tension due to a change in stress distribution resulting from the change in section modulus. Reinforcements against tension stresses perpendicular to the grain in form of fully threaded screws or threaded rods can be considered state of the art [2], [3]. With respect to their application as shear reinforcement, not many research results are yet available [4], [5], resulting in a lack of experimentally validated design approaches.

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	Kreuzinger, Heinrich
	Winter, Stefan
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Summary:

The use of glulam beams with changing depth offers the possibility to adapt the section modulus to the bending moment. In the case of single-span beams under uniformly distributed load, however, a change in beam depth will lead to a contrary effect for the shear stresses, see Figure 1. Curved and pitched cambered beams feature not only high utilization rates in bending but also areas of high tension stresses perpendicular to the grain and shear parallel to the grain stresses, two stress components for which timber features only small capacities as well as brittle failure modes. Out of 245 cases of damaged or failed large-span timber structures, evaluated in [1], several failures document the possibility of a shear fracture (full separation) developing in grain direction from the curved part towards the supports, partly followed by a failure of the beam in flexural tension due to a change in stress distribution resulting from the change in section modulus. Reinforcements against tension stresses perpendicular to the grain in form of fully threaded screws or threaded rods can be considered state of the art [2], [3]. With respect to their application as shear reinforcement, not many research results are yet available [4], [5], resulting in a lack of experimentally validated design approaches.

Within this paper, approaches to design shear reinforcement for glulam beams in the unfractured and the fractured state are presented, validated and discussed. The moment of failure, i.e. the transition from the unfractured to the fractured state is characterized by dynamic effects. This situation is not covered in this paper. A possible approach is given in [1]. The same applies to the subject of moisture induced stresses, resulting from the reinforcement restricting the free shrinkage or swelling of the glulam beam.

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