EFFECTS OF SELF-TAPPING SCREWS AS REINFORCEMENTS IN BEAM SUPPORTS ON THE DETERMINATION OF THE GLOBAL MODULUS OF ELASTICITY IN BENDING

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ABSTRACT: The dimensions of cross-sections of structures are very often influenced by the requirements of the serviceability. Especially the modulus of elasticity in bending is a decisive parameter for the limits of the permissible deformations and vibrations in structures. Therefore a high-precision calculation of this parameter is necessary. The use of self-tapping screws as reinforcements in the support areas of beams, leads to a higher compression loading perpendicular to the grain and also increases the modulus of elasticity perpendicular to the grain of wood. Compliance with certain conditions these reinforcements show an increase of the global elastic modulus in bending according to EN 408 by minimizing mainly local deformations in the beam support areas.

KEYWORDS: global and local modulus of elasticity in bending, shear modulus, self-tapping screws

1 INTRODUCTION

For many structural timber parts the stiffness of the material is a crucial parameter for the dimensions of the cross sections. Especially in ceiling systems of civil engineering structures the analysis of deflections and vibrations are mostly decisive. Therefore, care must be taken on an accurate determination of the physical parameters entering into the calculation models of the serviceability limit state. The determination of these parameters is carried out in accordance with EN 338 [2] and EN 408 [1]. For structural engineers, these parameters are - summarized in strength classes - provided by the EN 338 respectively EN 1194 [4]. The global modulus of elasticity in bending is determined by 4-point bending tests with measuring the elastic deflection in the middle of the beam (see figure 1). By this experimental setup one summates the parts of deformations - shown in equation (1) - caused by bending, shear and local deformations in the bearing areas. By using reinforcements with self-tapping screws in timber support areas, local deformations can be minimized by increasing the modulus of elasticity perpendicular to the grain of wood [5].

\[ W_{\text{global}} = W_{\text{bending}} + W_{\text{shear}} + W_{\text{local}} \] (1)

Figure 1: Parts of deformation (a) local, (b) bending and (c) shear deformation

Figure 2: Timber support: unreinforced and reinforced

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2 PROJECT DESCRIPTIONS

2.1 MATERIAL AND METHODS

A total of approximately 80 bending tests are carried out. Of these 80 specimens, 40 are unreinforced and 40 reinforced with self-tapping screws (see figure 2). To avoid the influence of typically inhomogeneities of wood only clear wood specimens of spruce wood are used. The dimensions of the test specimens are 25/65/1100 mm. The selected method of the test procedure is shown in figure 3.

![Figure 3: Method and test procedure](image)

2.2 DETERMINATION OF THE MODULUS OF ELASTICITY IN BENDING AND SHEAR MODULUS

The global and local moduli of elasticity in bending are determined in accordance to EN 408 [1]. The local modulus of elasticity in bending is determined by measuring the differential deformation in the middle third of the bending-stress section beams. In contrast to the global modulus of elasticity in bending, the influences of local and shear deformations are eliminated. To consider the influence of the shear deformations on the global modulus of elasticity in bending, the shear modulus is additional determined [1].

2.3 DETERMINATION OF THE REINFORCEMENT WITH SELF TAPPING SCREWS WITH CONTINUOUS THREADS

To determine the effect on the modulus of elasticity perpendicular to the grain of wood by using self-tapping screws as reinforcements, the axial bearing capacity and slip modulus in accordance to EN 1380 [6] are carried out.

3 RESULTS

The results obtained show a significant impact, when using reinforcements in timber supports on the global modulus of elasticity in bending in compliance with certain geometric constraints. As shown in figure 4, increases of the global modulus of elasticity up to 8 % are possible. In addition, the results are evaluated by numerical calculation models. Currently in progress is the comparison with the calculation of the physical parameter in accordance with EN 384 [2].

![Figure 4: Global modulus of elasticity in bending: reinforced and unreinforced specimens](image)

REFERENCES


