Research Project: Bending strength of finger-jointed lumber at flatwise and edgewise bending  

-- comparative investigations related to DIN 68140-1 and EN 385  

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The building authority relevant requirements on production and bending strength (factory production and third party controls) of finger joined lumber, increasingly used as a load bearing construction element, are stated in Germany in DIN 68140-1, version 1998. Besides this German standard there is the German-European standard DIN EN 385, also related to finger joints in lumber, hereby specifying performance requirements and minimum production requirements. Both standards comply poorly. According to DIN 68140-1 the verification of conformity of sufficient bending strength is conducted via flatwise bending, assuming a full transferability on the edgewise bending situation. Contrary to DIN 68140-1, bending strength in the European finger joint standard is principally related to edgewise bending. The verification of the minimum requirements on edgewise bending strength in the frame of the factory production control according to EN 385 can however be performed by flatwise bending. In such a case, the declared characteristic bending strength \( f_{\text{d,fix}} \) shall be increased by a factor \( k_e \) representing the ratio of characteristic bending strength in flatwise and edgewise bending, assumed to be known.

The aim of the conducted research project consisted in the safety relevant indicated verification of the \( k_e \)-concept of DIN EN 385:1996. Items of primary importance were the specified \( k_e \)-values, the reproducibility in case of repeated tests and hereby the validity of the \( k_e \)-determination in the frame of a single type test.

The research project comprised 68 comparative test series on finger joint bending strength, each with two sets of 10 specimen of grade S10 (strength class C24 (species: spruce)) tested in flatwise and edgewise bending, respectively. The specimens glued predominantly (71%) with polyurethane, stemmed from 31 different, primarily German production factories. The investigations comprised the two most common finger joint geometries 15/3,8 and 20/6,2. In total 1150 bending specimens with cross-sectional dimensions of 40 x 80 to 120 x 200 mm and about 2300 density specimens were tested. Regarding finger joint geometry, the geometry type 20/6,2 used by 74% of all companies dominated. The flatwise and edgewise bending tests were performed according to DIN 68140-1 and EN 385 in 4-point bending with loads in the 1/4 points of the span. The span was throughout 15 times the specimen thickness \( d \) or the specimen width \( b \) in case of flatwise or edgewise bending.

The test evaluation comprised especially the ratio \( k_e \) of finger joint bending strengths in flatwise and edgewise bending of both respectively compared test series at the level of the mean values \( (k_{e,\text{mean}}) \), of the lognormal 5% fractiles \( (k_{e,5}) \) and at the level of the minimum values \( (k_{e,\text{min}}) \). The highest ratios were throughout obtained for the 5% fractile level \( k_{e,5} \) of the bending strength. The mean \( k_e \) = \( k_{e,5} \) values of 1,25 and 1,32 obtained for the 20/6,2 and 15/3,8 finger joint geometries are in the same range.

The \( k_e \)-values obtained at repeated tests revealed throughout an extreme scatter. This means that the \( k_e \)-value can not be determined in the frame of a single type test. Based on the research results, the \( k_e \)-values for the finger joint geometries 20/6,2 and 15/3,8 were changed according to a German proposal to a unique value of 1,25 in the new version (date 2002) of DIN EN 385. Farther, now the \( k_e \)-determination in the frame of a single type test is permissible solely for such finger joint geometries, as stated in table 1 of EN 385. It remains to point out that also the new procedure for the \( k_e \)-determination in the frame of type testing does not satisfy the found reproducibility fact of the \( k_e \)-values. It is further problematic that the determination of the \( k_e \)-value on the basis of the mean values of the flatwise and edgewise bending strength results, being not correct in principle and leading to non-conservative \( k_e \)-values has been adopted unchanged from DIN EN 385:1996 in DIN EN 385:2002 (Note: At the time of the final draft of prEN 385:2001 the \( k_e \)-reproducibility fact could not be proven definitely due to a too low number of repeated tests at that time). It is perceived necessary with respect to safety to control the reproducibility of the \( k_e \)-value of a new finger joint geometry, whose \( k_e \)-value was determined by single type testing, by a statistical evaluation of flatwise
and edgewise bending tests of the factory production control and of the calibration tests of the certification body. If necessary, the $k_r$-value has to be corrected.