Conclusion to seminar X: developments in the design and construction of wood structures

Autor(en): **Edlund, B.**

Objekttyp: **Article**

Zeitschrift: **IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht**

Band (Jahr): **12 (1984)**

PDF erstellt am: **15.09.2024**

Persistenter Link: https://doi.org/10.5169/seals-12226

Conclusions to Seminar X
Developments in the Design and Construction of Wood Structures

B. EDLUND
Prof. Dr.
Chalmers Univ.
Göteborg, Sweden

Six contributions were announced to be presented at the session, but two of the speakers did not show up (without giving any previous notice), so in fact only four papers were presented. The attendance was also rather weak - only about 35 to 40 persons.
But on the other hand the discussion was lively, maybe partly because the audience was small and partly due to the extra time available for discussion.

All the four papers presented treat different aspects of connections between pieces of timber *or* wood and wood panels *or* wood and concrete. The papers by Girhammar and by Fontana show examples of new applications of old types of mechanical joint elements. Gehri presents a new type of space truss of wood. He has studied both glued and bolted metal-to-wood joints as well as the use of high strength hardwoods. Gutkowski and Castillo have analyzed the behaviour of shear walls by use of a computer programme, which can take the nonlinear force-slip relationship of the fasteners (nails) into account.

Even if the problems concerning joints and fasteners are important for timber structures there are also other topics, which were dealt with by the general reporter in his Introductory Report, for example material aspects (including wood fracture), behaviour of different structural elements and the field of wood construction. Some of these topics were introduced and partly treated in an extended closing report by the General reporter, who mainly discussed the following topics.

- Holes in glued laminated beams. Stress concentrations and crack loads.
- The use of fracture mechanics for wood structures and wood joints.
- Moisture effects, especially the strong increase in creep displacements due to moisture cycling.
- Fabrication and erection of wood structures. Examples from volume elements for small houses and from long-span structures such as a dome with a diameter of more than 150 m.

Holes in glulam beams. - Rectangular or circular holes are often made in glulam roof beams before the installation of ducts and pipes for water, ventilation etc. This section will bring some results from a research project at Chalmers University of Technology and from a doctoral thesis by Bengt Johannesson ("Design Problems for Glulam Beams with Holes", Göteborg 1983).

When glulam beams with large holes were loaded in bending with large shear force, cracks always appeared at the "tensioned corners" due to the low tensile strength of wood perpendicularly to grain, cf. Fig.1.

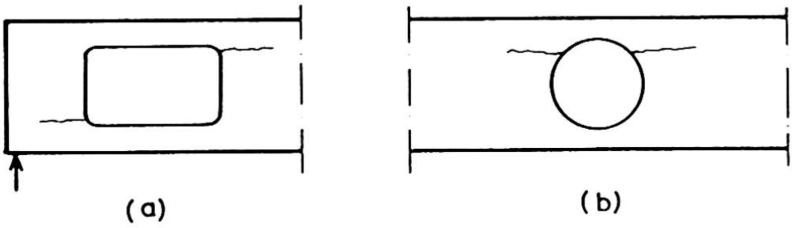

Fig.1 Crack patterns from experiments with glulam beams with a hole in a) the shear region, b) the region of pure bending moment.

Fig.2 shows the principle used for obtaining the strength parameter which should be applied when estimating the crack loads of beams with holes.

It was believed that the stress distribution at the stress concentration should have an important influence on the strength parameter.

The strength parameters were evaluated using tension specimens with notches, see Fig.3. Two different depths of the notches and four different angles between the grain direction and the applied force was used. The stress state in the tension specimen was evaluated by the use of a boundary element method (BEM).

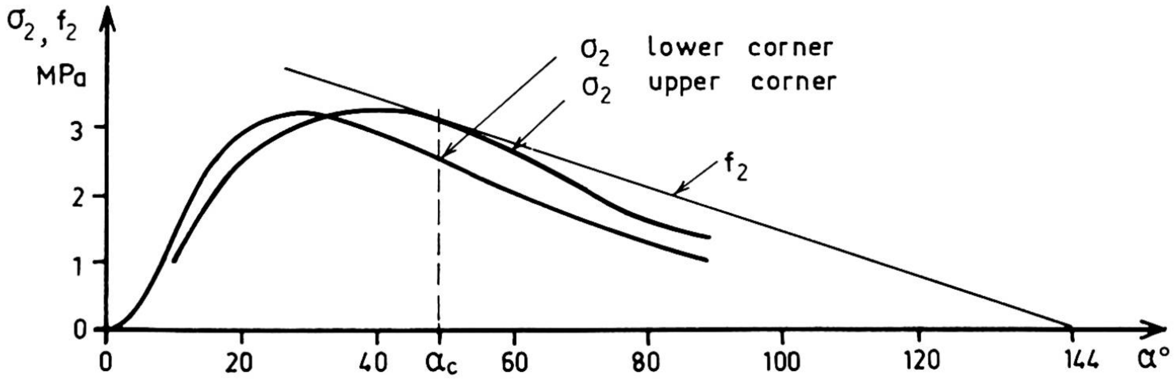

Fig.2 Graphical estimation of the maximum ratio σ_2/f_2. Here σ_2 is the actual stress perpendicular to grain and f_2 is the strength of wood perpendicular to grain.

In many tests it was possible to notice a crack starting from the midplane of the beam and then extending to the sides of the beam. In some cases there was a weak annular ring and in other cases the glue bond was not too good at the midplane. By strain measurements the strain distribution (and strain concentration) at the holes was studied. These measurements supported the calculations by FEM and BEM methods.

From the tension tests a relationship was obtained between the strength perpendicular to grain and the angle α between grain and direction of applied load. By calculating the stress along the hole boundary and by comparing it with the strength parameter it was possible to find the weakest point at the boundary and from this calculate the failure load of the beam.

When this technique was applied to all beams tested good agreement was found between the calculated failure loads and those obtained in the tests, see Fig.4. Except for one test in pure bending all results fall within the 90 percent tolerance width.

If no reinforcements are made around the hole the load carrying capacity will be very low at large holes. One method of reinforcing the beams is to use plywood, which is fastened by a nail-glued joint to the vertical sides of the beam.

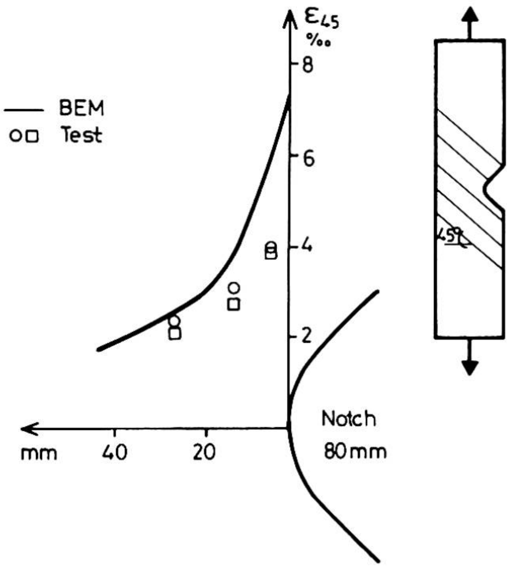

Fig.3 Comparison between calculated and measured strains ε_{45} in a notched tension test specimen. The fully drawn line is the strain distribution calculated with BEM.

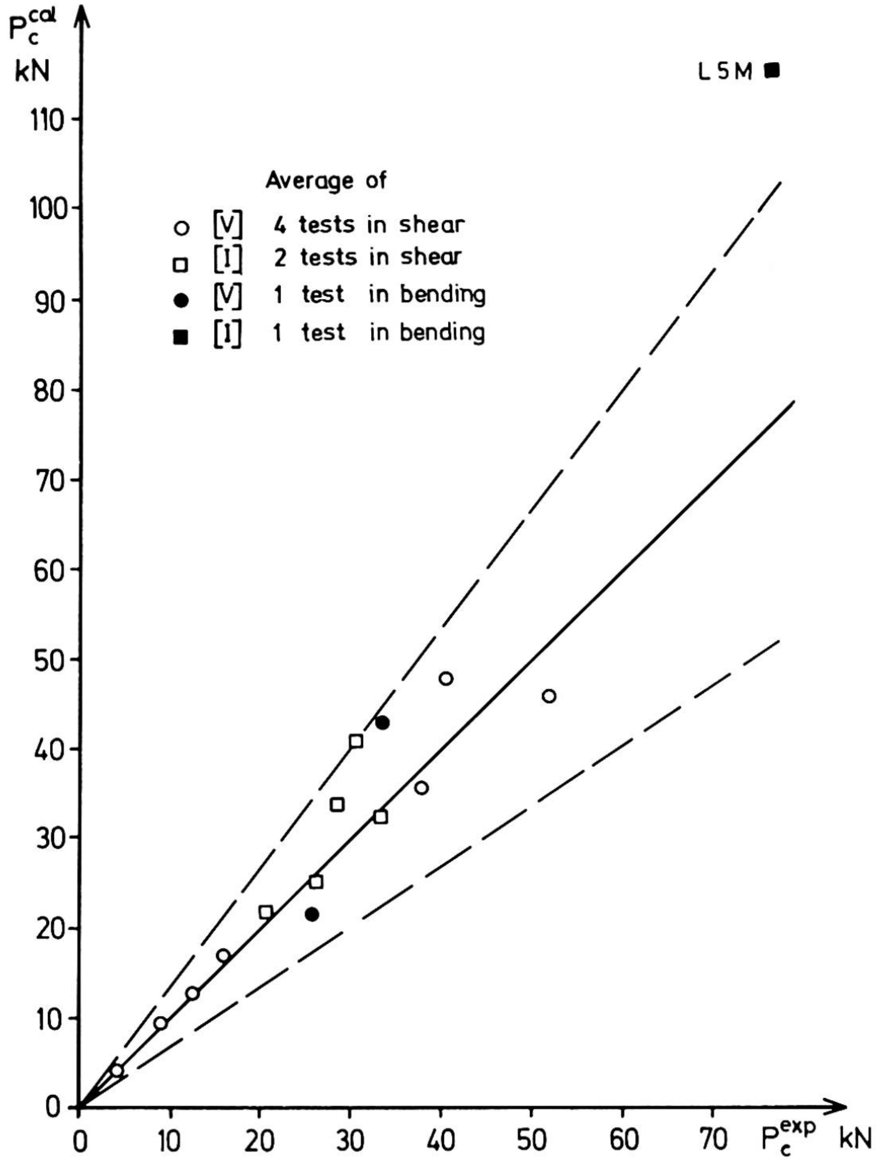

Fig.4 Relation between predicted crack loads P_c^{cal} and experimental crack loads P_c^{exp}. The experimental crack loads are averages of a number of tests. The 90 percent tolerance width is given by the dashed lines.