1. Introduction

The technique of laminated wood was born at the beginning of the XX century. The 1901 Swiss patent was related to straight beams, where blades are positioned parallel to each other. In 1890 this new building construction material was first used in the Berlin at the building of Reichstag, where 10 m long beams were constructed. In 1906, Germany patented the curved laminated beams, it opened new possibilities for the construction of the timber. Till 1920, more than 200 buildings had been made of either straight or curved laminated wood. In Hungary usage of laminated wood started from the 1970’s.

The durability of laminated structures, assuming the usage of quality materials and proper installation, operation, is very good. A growing number of damages or destructions occur before the time of durability in cases of usage laminated structures. Complete roofs have become life threatening (swimming pool of Pécs, swimming pool of Berettyóújfalu, the No3 pool in Harkány, where several photos were made during the breakdown (Fig.1-2).

Fig. 1: The structures of swimming pool of Harkány, which has already been broken down

Fig. 2: One of the main spars of swimming pool of Harkány

Possible tensions in a beam: The first kind of tensions arise in beams due to the external loads and scalings are usually done based on these. The second type is the so-called residual stresses. Calculating tensions from external loads in a slightly different way. If we examine the behavior of wood, we can say that wood is an anisotropic material (it shows different properties in different directions). However if we make static calculations we do it as if it were not anisotropic. We apply this assumption at both calculations and scalings. How could we consider anisotropy in our work? In 1972 Walter von Roth derived anisotropic stress calculation of curved laminated beams. The calculations are not easy. The final formulas:

\[
\sigma_{rr} = \frac{M_R + N_R}{W} \cdot K_{rr}^M + \frac{Q_0}{R} \cdot \sin \phi \cdot K_{rr}^Q + \frac{N_s}{R} \cdot \cos \phi \cdot K_{rr}^N
\]

\[
\sigma_{\phi\phi} = \frac{M_R + N_R}{W} \cdot K_{\phi\phi}^M + \frac{Q_0}{R} \cdot \sin \phi \cdot K_{\phi\phi}^Q + \frac{N_s}{R} \cdot \cos \phi \cdot K_{\phi\phi}^N
\]

\[
\sigma_{r\phi} = \frac{N_0}{F} \cdot \sin \phi \cdot K_{r\phi}^N + \frac{Q_0}{F} \cdot \cos \phi \cdot K_{r\phi}^Q
\]

\[
K_{rr}^M, K_{rr}^N, K_{\phi\phi}^M, K_{\phi\phi}^N, K_{r\phi}^Q, K_{r\phi}^N, K_{r\phi}^Q, K_{r\phi}^N
\]

factors which can be determined using the given
formulas (if we know the geometry of the beams and the material properties of wood).

![Figure 3: The geometry of the beams and what it means to the stresses.](image)

Residual stresses: The reasons for the occurrence of these residual stresses are partially due to deformations which are hampered. The residual stresses accumulate with the stresses of external loads. The effects of the residual stresses can be either favorable or non-favorable for the behavior of elements of the structures. Grouping can be done depending on the origins of deformations:

- Temperature residual stresses
- Moisture content residual stresses
- Deformability residual stresses
- Transformational residual stresses

These residual stresses usually occur simultaneously so their distinction is not easy. In wooden materials and structures mostly the first 3 types have basic importance.

During the manufacturing of curved laminated beams both in the wood and in the adhesive layer tensions can be generated which can lead to the breakdown of the unloaded beams before installation. Using proper manufacturing technology and good planning these deformability residual stresses do not cause breakdown in themselves but after installation they accumulate with the stresses of external loads and their combined impact can become dangerous.

Residual tensions generated by the climatic stresses. From the perspective of wooden materials the most important mechanical characteristics are the temperature and the humidity of the environment (mostly these data for the surrounding air). Changing these climatic properties of the environment causes alterations in the temperature and humidity of the body which leads to alterations in the volume of an arbitrary elementary block of volume and in the length of an arbitrary directed segment. The fundamental problem in the calculations of these residual tensions due to the climatic changes is to define the distributions of temperature and humidity of the structure. We can discuss these problems both in the terms of daily and annual cycles.

2. Conclusions

Increasing number of places use laminated beams.

During the scaling it is important to consider all the possible tensions (accumulating)

Resizing should be done considering the maximal actual tensions.

The residual tensions which were not considered till now can be so strong that they lead to the breakdown of the holder.

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4. References
