



Crack generation at wooden sleepers

1. General information - prerequisites for the crack generation/crack types

Wood is a natural, not a homogeneously built material. The subject of **wood moisture** plays an important role for the crack generation:

After the wood harvest, the wood has a wood moisture of up to 80 percent and more (relative to *atmo*). Subsequently, the moisture is released either through natural or technical drying. Wood can also absorb water again from rainfalls, the air (humidity) or the installation medium since it has a high hygroscopic potential due to its cellulose content - and it can continue this process until a condition of equilibrium ("equilibrium moisture") resulting from wood moisture and relative humidity has been achieved.

Dimensional changes of the wood occur below the **fiber saturation**, which is, depending on the wood type, between 28 and 35 percent - on average at 28 to 30 percent: Water molecules will be embedded in the cell wall during the water absorption and will be bonded there - the volume of the wood increases, it swells. In contrast, water molecules will be emitted during drying - the wood volume is reduced, the wood contracts.

The tangential contraction is approximately twice as large as the radial (which results in cross section changes in trimmed timber made of fresh wood) and this results in the **generation of dry cracks**, which always proceed in a radial direction. However, they are generally of no importance with respect to the usage characteristics of the sleeper.

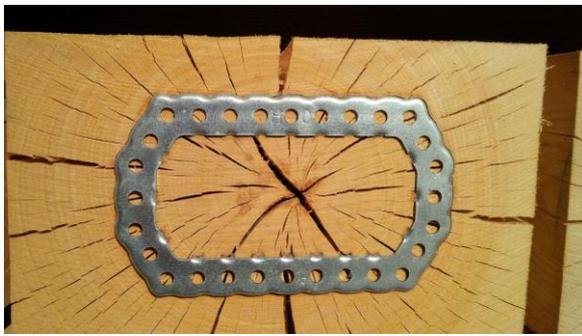
Depending on the location where the cracks occur, a further differentiation is made between *end cracks* (occurrence at the front wood surface, but also continuation at the narrow and the wide sides) and *core cracks* (radial cracks that start in the medullary tube).

A differentiation is made between dry cracks and **tension cracks**. They occur already above the fiber saturation range during the felling or cutting of the green wood and are based on anomalies in the fiber development, the density or the knot sizes of the wood. Depending on the development and position, they may under certain circumstances have an influence on the usage characteristics of the sleeper, e.g. for *horizontal and sloped cracks*.

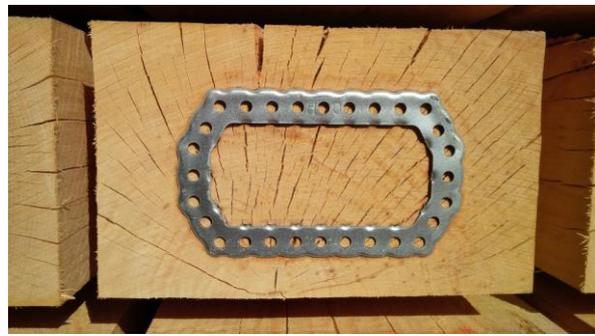
The **frost cracks**, which are progressing radially from the splint to the medullary tube and which are generated at the standing tree due to suddenly occurring frost periods, are viewed as special crack types. The same is true for the **cup shakes**, which are cracks that cover at least 50% of an annual ring limit for which the annual ring detachment was caused by wood destroying fungus. Depending on their characteristic, raw sleepers with frost cracks or cup shakes will be rejected.

2. Influence of the cutting type and the dry crack development

The number and the position of the cracks is determined by the cutting type in the lumber mill: In case of a *dual stemmed cut*, the cracks move to the outer tangential surface. Cracks on all four cutting sides can develop in case of a *single stemmed cut*. However, the *cross cut* generates only a few large cracks.



Single stemmed cut



Dual stemmed cut

3. Permissibility of cracks

The **dry cracks** show the expert that the raw tie has the required soak maturity required for the soaking process. Dry cracks are viewed as positive under technical impregnation view points, because they facilitate the penetration of the wood preservation agent into zones that are otherwise difficult to reach.

In general, current standards and directives are only judged with respect to their **screw pullout resistance**. If the permissible screw pullout resistance is not significantly impaired and if drill holes are neither cut nor tangented, then they are permissible (DBS 918 144:2007-12 and test report Deutsche Bahn No. 441 703 "Influence of wood cracks in wooden sleepers on the screw holding force").

However, certain crack types result in a rejection of the respective raw sleeper even before impregnation. These include: Transverse cracks, sloped incoming cracks and excessive head cracks, because they can weaken the cross section significantly. Shorter tension cracks up to a length of 25 cm (UIC code and EN 13145) are permitted, assumed that they are protected against additional cracks by applying suitable safety measures.

Raw material with **frost cracks** is excluded from the further sleeper processing.

Core cracks are permitted, assumed that they do not reach the upper layer. An additional stratification is recommended if they reach the upper layer.

Cup shake is only permitted on one side, as long as the diameter of the annual ring in which it occurs does not exceed 50 mm.

The bearing side is the side averted from the core. Through cracks at the front or cracks at the front, which cut the drill hole significantly or tangent it, must be bound with sleeper protection bands.

3.1 Permissible cracks (examples)

3.1.1 Dry cracks (beech, cut single and dual stemmed)



3.1.2 Dry cracks (beech, cut single and dual stemmed, secured with sleeper crowns a. protective crack plates, here without stratification - additional protection with sleeper protection bands required!)



3.1.3 Dry cracks (beech, protected with sleeper protection band)



3.2 Cracks that are not permissible (examples)

3.2.1 Crack incoming sloped (beech, cut single stemmed)



3.2.2 Horizontal crack (beech, cut single stemmed)



3.2.3 Strong tension cracks



4. Crack avoidance or restriction

4.1 Processing/storage of the raw sleeper

The raw sleepers are stored in accordance with the relevant rules and standards (DBS 918 144:2007-12, DIN 68811:2007-01, ÖBB-TL 07.09.08).

4.2 Protection/post protection

a) Raw sleeper

Sleepers made of strongly contracting wood types must be protected in the green condition with approved and suitable protection means (e.g. sleeper crowns, crack protection plates/nail plates or nail strips).

Sleepers that are only cracked moderately during drying, assumed that they are not rejected, will be additionally protected or post protected with sleeper protection bands.

In contrast, oak and pine sleepers can be stacked without preventive measures for crack avoidance.

b) Completely impregnated sleepers

Sleepers that are only cracked moderately during impregnation, assumed that they are not rejected, will be additionally protected or post protected with sleeper protection bands.

4.3 Installation in the track bed

The installation of the wooden sleeper should be completed as fast as possible after delivery to the construction site to prevent a progressing dry crack development.

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