Are plastic sleepers safe for railway operations?


FFU, Switzerland

Wooden sleepers are increasingly being replaced by plastic sleepers. The main reason is the rapid degradation of non-creosote-treated sleepers (alternative chemical impregnated sleepers also have a limited lifespan) and the decreasing acceptance of using certain tree species on sustainability grounds is also a factor. Plastic sleepers, like wood, are mainly used where concrete sleepers do not offer the necessary wear-reducing elasticity or where greater flexibility is required, such as in track switches, as flat sleepers, or where concrete is completely unsuitable, such as on open steel bridges and brick arched viaducts.

However, for many railway engineers, plastic is a relatively new material for superstructures. Since "plastic" describes a broad family of materials, specific uncertainties arise regarding safety and long-term material aging behaviour.


FFU -65°C test, TU Tampere

The biggest **material safety risk** is embrittlement due to weathering and UV radiation, which can trigger spontaneous fractures.

Equally problematic are unsuitable material mixtures, where the reinforcement breaks under defined bending loads and causes sleeper breakage.

Plastics expand in heat and shrink in cold. If this effect is not limited by appropriate material selection or design measures, the track gauge can change and in extreme cases cause derailment.

Inappropriate material quality can affect durability, for example in terms of screw extraction forces. Regular material and component testing is therefore crucial.

Material properties		Unit	Requirements for sleeper type		
			Type A	Type B	Type C
Material strength	Bending strength	Mpa	≥28	≥18	≥13,8
	Flexural modulus	Mpa	≥6 000	≥2 500	≥1 170
	Longitudinal compression strength	N/mm²	≥40	≥8	-
	Lateral compression strength	N/mm²	-	≥8	≥6,2
	Shear strength	N/mm²	≥7	≥4,5	
	Adhesive shear strength	N/mm²	≥7 base-material breakage	-	-
Electrical characteristics	AC breakdown voltage	kV	≥20	≥20	-
	DC insulation resistance	Ω	$\geq 1 \times 10^{10}$	$\geq 2 \times 10^{4}$	≥2 x 104
Water absorption		%[d]	≤2	≤2	
Mass density		g/cm³	≥0,64	≥0,8	≥0,8
Linear expansion coefficient		K^{-1}	$\leq 5 \times 10^{-5}$	$\leq 6 \times 10^{-5}$	$\leq 1{,}35 \times 10^{-4}$

To minimize these risks, railway companies and expert committees around the world have developed sophisticated test catalogues. These culminated in the **ISO 12856-1 standard** in 2014. Annex B defines limit and target values, test methods and verifications, in particular for compressive strength, thermal expansion and long-term weathering *(see excerpt in the table)*.

Embrittlement tests simulate accelerated aging while recurring serial tests ensure consistent quality.

It is of course up to each responsible infrastructure manager to specify his/her own requirements.

FFU® (Fibre-Reinforced Foamed Urethane) engineered composite sleepers are offered as an alternative to HDPE plastic sleepers. Developed in the 1970s by SEKISUI in collaboration with the Japanese Railways and has been in continuous operation since 1980. The material is certified for drinking water applications and meets the properties of sleepers of types A, B and C according to ISO 12856-1 (2014). Thanks to the endless glass fibre threads, no additional reinforcement is required. The linear expansion coefficient $\alpha = 7.5 \times 10^{-6}\ K^{-1}$ is comparable to wood and concrete, and the tensile strength has been proven down to −65 °C. No embrittlement has been observed in any sleeper to date.

FFU® is therefore considered a global material benchmark. Since 1980, FFU® synthetic wood sleepers have proven to have the longest lifespan of any plastic sleeper on the market to date.

- **Rot-proof, UV-resistant,** extremely **durable** (lifespan >50 years), **recyclable**
- Adhesion in the ballast, no embrittlement, material + dimensional stability for **safe railway operation**
- **Drinking water safe certified,** no impregnation (compared to standard wooden sleepers)
- Linear elastic for **gentle railway operation** (even at extreme temperatures <-65°C)
- **Axle load > 45 tonnes**, used on high-speed tracks **> 300 km/h**
- In continuous operation **since 1980, type-approved, class A sleepers** according ISO 12856-1 (2014), B
- Minimal maintenance and **low life cycle costs**
- **Fire protection**: flame retardant, self-extinguishing, non-toxic, **low smoke level**