European
Wood Protection
Association

Recommendation for the modern wooden sleepers

Foreword

EWPA
European Wood Protection Association

1951
Established in

Brussels
Based in

+ 140
Member companies across Europe

Introduction

The evolution towards alternative preservatives for the treatment of wood in the production of railway sleepers has led to new treatment technologies that are now ready for deployment. These wood preservatives meet the requirements of both authorities and end-users. Due to the unavailability in some countries of current technical specifications, the EWPA , in collaboration with industries and manufacturers, has formulated this recommendation.

Modern wooden sleepers offer a long service life and excellent performance. In this chapter, we discuss the possibilities for recycling and end-of-life management, and how these processes contribute to a sustainable circular economy.

Scope

This recommendation is aimed to standardise the quality requirements for the preservation of railway sleepers (further referred as 'impregnation') of wooden sleepers so as to ensure a quality level for end customers throughout the treated wood industry.
EN 13145+A1 remains unaffected by the provisions of this recommendation.

1. Incising

To enable good preservative penetration as well as reduce checks and splits sleepers may be incised. Incising should be applied **before storing** of raw sleepers. The incising must be done on **all four long sides** and must be distributed even over the surface. Incising should be agreed between customer and supplier.

2. Storage of raw wooden sleepers

Raw, unprocessed wooden sleepers should be **stored at the impregnation plant for natural wood drying in order to reach impregnation moisture content.** Technical drying can also be used in some cases.

3. Technical data of preservation

The following parameters, regarding species, must be agreed between the supplier and the customer:

- Moisture content of raw sleepers
- Wood preservative absorption
- Wood preservative penetration
- Concentration of wood preservative
- Impregnation process with impregnation diagram
- Active ingredient limit values with the corresponding analysis zones
- Safety factors for active ingredient concentrations

4. Moisture content

Moisture content of sleepers (to ensure good quality treatment)

< 28%
Pine

< 31%
Beech - Oak - Tropical wood

Experience shows that wood that has dried down to these weights ensures good impregnation results

- **Raw beech sleepers ≤ 800 kg/m³**
- **Raw oak sleepers ≤ 900 kg/m³**
- **Raw pine sleepers ≤ 590 kg/m³**
- **Tropical sleepers ≤ 1050 kg/m³**

Scope

5. Used preservatives

- Any approved oil-borne wood preservative (natural or mineral-based) for use class (UC) 4 for single treatment of wooden sleepers or
- Any approved water-borne (wood preservative) for use class (UC) 4 and any approved oil borne wood preservative (natural or mineral-based) for use class (UC) 4 for double treatment of wooden sleepers or
- Any approved water-borne for use class (UC) 4 and approved treatment oil borne (natural and mineral-based) for proven water-repellence and stabilising characteristics.

Sleepers in these use classes have great performance in these areas :

- For wood in permanent contact with the ground
- Preventively effective against fungi - rot protection
- Preventively effective against insects
- Resistant to weathering and moisture
- Conductivity through sleeper

A pressure impregnation must be an application method for sleepers' treatment. The safety data sheet and the technical data sheet must be provided. Some markets have local quality schemes with specific demands, customers can include these.

The active ingredients must be approved by ECHA in Product-Type 08 (PT08) - Wood Preservatives.

6. Retention

To measure the wood preservative retention, the sleepers must either be weighed before and after impregnation or the retention needs to be automatically measured by the impregnation process. Wood preservative retention must be recorded. After the impregnation process, the minimum retention requirements for treated wooden sleepers must be met in accordance with the minimum quantities for hazard class 4 of the wood preservative used - kg/m³ in the treated area in accordance to preservative retention of producer recommendation.

Scope

7. Penetration

Wood preservatives and wooden sleepers must be evenly distributed in the impregnatable parts of the sleeper. The impregnated wooden sleepers must meet the requirements of the penetration - class NP5 (complete sapwood penetration) of EN 351-1.

- For wood in permanent contact with the ground
- Preventively effective against fungi - rot protection
- Preventively effective against insects
- Resistant to weathering and moisture
- Conductivity through sleeper

8. Impregnation process

A. Beech sleepers

A two-step impregnation process :

Step 1 : A vacuum-pressure process is used with a water-borne wood preservative

Step 2 : Use of a simple Rüping process with an oil borne wood preservative

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Single-step impregnation process :
100% Oil-borne wood preservative

B. Oak sleepers

For an impregnation of oak sleepers, use a simple Rüping process with pre-air pressure or a Lowry process without pre-air pressure with a Oil-borne wood preservative should be use.

C. Pine sleepers

A two-step impregnation process :

Step 1 : A vacuum-pressure process is used with a water-borne wood preservative.

Two possibilities for the second step :
- Use of a simple Rüping process with an oil-borne wood preservative
- **Use of a hot oil process with a water repellency and stabilizing oil**

Single-step impregnation process :
100% Oil-borne wood preservative

Scope

9. Sustainability / CO_2 - Environmental Benefits of treated wood

Using modern wooden sleepers provides significant benefits during its service life and at the end-of-life stage :

Sustainability

The treatment process extends the wood's lifespan, reducing the need for new wood and preserving forests.

Safe Disposal

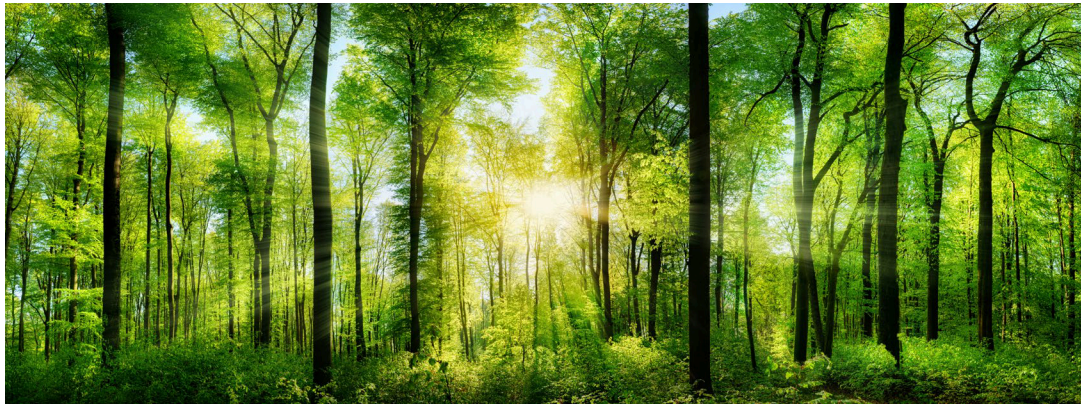
Environmentally friendly end-of-life solutions ensure that the wood is recycled or processed safely, without harmful impacts on the environment.

Circular Economy

Through recycling and energy recovery, treated wood contributes to a circular economy where resources are optimally utilized and waste is minimized.

The climate is warming up due to the emissions of greenhouse gases into the atmosphere, with carbon dioxide (CO_2) being a main contributor. Reducing global warming requires a range of measures adopting a multi-faceted approach. **The main approaches to reduce global warming are through reducing CO_2 emissions, and by removing it from the atmosphere by storing it.**

Biogenic materials, such as wood, have stored carbon in them and act as carbon sinks. The importance of reducing and saving carbon, and immediately, was emphasized by the **IPCC Sixth Assessment Report (AR6) published in March 2023.** Using low embodied impact materials and particularity biogenic materials is important in the battle against climate change.



Scope

EN 16449:2014 Wood and wood-based products – Calculation of the biogenic carbon content of wood and conversion to carbon dioxide provides a calculation method below to quantify the amount of atmospheric CO_2 stored in wood. The calculation is based on the atomic weights of carbon and carbon dioxide, and specific information like the carbon fraction and mass of biomass. EN 16449 suggests a figure of 0.5 as the carbon fraction of woody biomass (oven dry mass) as the default value.

$$P_{CO_2} = \frac{44}{12} \times 0.5 \times \frac{\rho_\omega \times V_\omega}{1 + \frac{\omega}{100}}$$

Where :

PCO_2
is the carbon dioxide sequestered in the timber or timber product ($KgCO_2$)

44
is the molecular mass of carbon dioxide (CO_2) and 12 is the atomic mass of carbon (C)

0.5
is the assumed carbon fraction of the timber (KgC /kg wood)

Pω
is the density of the wood at the specified moisture content (kg/m3)

Vω
is the volume of wood (or the wood proportion of the product) at the specified moisture content (m3)

ω
is the moisture content of the wood as a percentage

Most of wooden sleepers in Europe are made from beech, oak and pine. These three species are widely available from European forests.
Since the dimension and therefore volume of sleepers varies between different countries, the stored carbon varies in the same way.
Below is an example of calculation of stored carbon for one sleeper for different wood species:

Beech sleeper

**800 kg/m3
at 30% moisture content**

$$Biogenic\ Carbon\ (kgCO_2) = \frac{44}{12} \times 0.5 \times \frac{800 \times 0.1}{1 + \frac{30}{100}} = 112.82\ kgCO_2e$$

Pine sleeper

**590 kg/m3
at 28% moisture content**

$$Biogenic\ Carbon\ (kgCO_2) = \frac{44}{12} \times 0.5 \times \frac{590 \times 0.1}{1 + \frac{28}{100}} = 84.51\ kgCO_2e$$

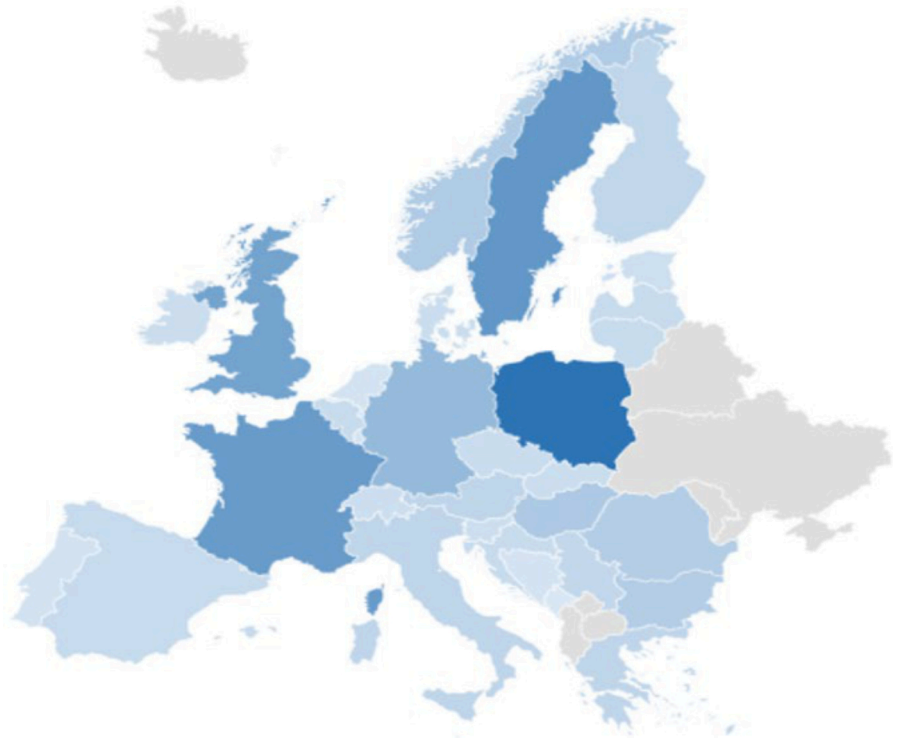
Oak sleeper

**900 kg/m3
at 30% moisture content**

$$Biogenic\ Carbon\ (kgCO_2) = \frac{44}{12} \times 0.5 \times \frac{900 \times 0.1}{1 + \frac{30}{100}} = 126.92\ kgCO_2e$$

Based on the data collected in this study, there are over 195 million wooden sleepers in EU currently in use.
Figure 1 shows the breakdown of wood sleeper population in different countries.

Country	Wood Sleeper population (m)
Austria	5,0
Belgium	3,6
Bosnia and Herzegovina	1,4
Bulgaria	7,0
Croatia	3,5
Czech Republic	3,2
Denmark	3,0
Estonia	2,5
Finland	4,8
France	19,7
Germany	12,0
Greece	5,0
Ireland	3,0
Italy	5,0
Latvia	3,5
Lithuania	3,5
Luxembourg	1,5
Malta	0,0
Montenegro	0,6
Netherlands	1,6
Norway	7,5
Poland	29,9
Portugal	1,7
Romania	7,0
Serbia	4,5
Slovakia	3,0
Slovenia	2,8
Spain	3,7
Sweden	20,7
Switzerland	2,8
United Kingdom	17,8
Zyprus	0,0
Total	198,8



Wood sleeper populations and average volumes of each sleeper in the European countries.

Wooden sleepers
installed in Europe

34%
Oak

31%
Pine

28%
Beech

7%
Tropical Species

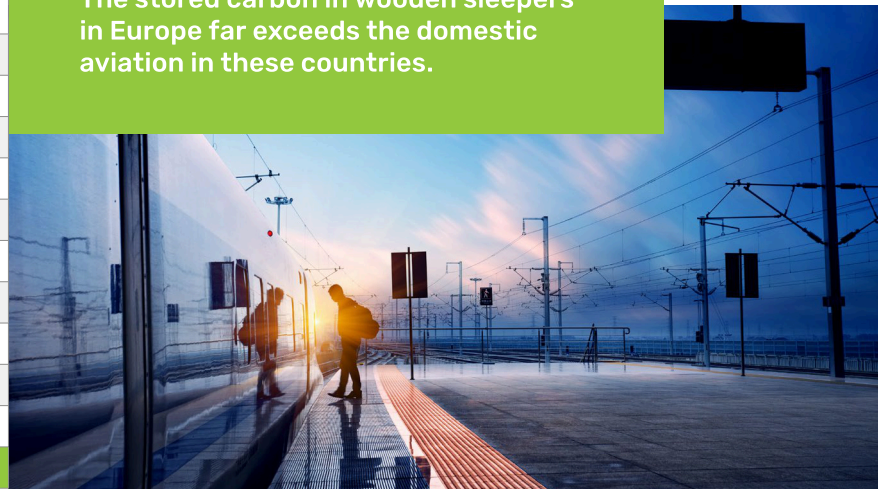
Considering the amount of carbon stored in each sleeper and the amount of sleepers, it is calculated that 21,895,925 tonnes of carbon is stored in the total population of wooden sleepers in European countries today. This amount of stored carbon is equivalent to the carbon emissions of driving an average car for 182,461,871,020 km or building 608,207 new dwellings each of 82 m2.

	Carbon Storage of Sleepers (tCO_2)	Domestic Aviation Emissions in 2021(tCO_2)
Austria	632 077	24 000
Belgium	464 538	8 000
Bulgaria	769 846	14 000
Croatia	431 010	22 000
Czech Republic	409 679	12 000
Estonia	299 679	12 000
Latvia	419 551	12 000
Lithuania	419 551	12 000
Finland	422 526	79 000
France	2 580 769	3 768 000
Germany	1 521 667	732 000
Greece	549 890	320 000
Ireland	348 873	19 000
Italy	634 615	1703 000
Luxembourg	193 558	1000
Poland	2 682 969	54 000
Portugal	184 542	340 000
Romania	839 103	140 000
Slovakia	355 385	1000
Slovenia	359 615	2 000
Spain	469 483	2 175000
Sweden	469 483	190 000
United Kingdom	1 774 940	700 000
Total	18 508 233	10 316 000

Comparison of CO_2 stored by the European wooden sleepers with emissions from civil domestic aviation in different European countries in 2021.

Figure 2 compared the CO_2 stored in wooden sleepers with emissions from domestic aviation in different countries in 2021, obtained from the 2023 Report from the European Environment Agency.

The stored carbon in wooden sleepers in Europe far exceeds the domestic aviation in these countries.



Scope

10. Recycling and Reuse

Modern wooden sleepers, retains its value even after years of use. Through innovative recycling methods, this wood can be reused or commercialized for various applications, such as :

Construction Materials:

Reusing treated wood in construction projects extends the material's lifespan and reduces waste.

Landscaping:

The reuse of treated wood in outdoor projects offers weather-resistant and durable solutions.

11. End-of-Life Solutions

When the wood reaches the end of its lifecycle, environmentally friendly solutions are available that are both efficient and sustainable :

Energy Recovery – Heat and Power Plants : Treated wood can be converted into fuel for energy generation. This is an excellent way to fully utilize the material and maximize energy efficiency, contributing to a sustainable energy supply.

Conclusion

Modern wood sleepers offer for railway infrastructure **not only excellent performance and durability** during their service years but also **an environmentally friendly solution**. Through reuse and energy recovery, the value of the wood is preserved, contributing to a sustainable and circular economy. **Invest in modern wooden sleepers and contribute to a better future for both your projects and the environment.**

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