FFU Synthetic Wood Sleepers

SEKISUI

Since 2004, FFU Synthetic Wood has been used in the European railroad infrastructure, such as for railroad bridges, turnouts, railroad crossings, and bridge planking. In September 2008, Munich Technical University completed its technical testing of FFU Synthetic Wood with very positive results. In July 2009, the Federal Railway Authority (EBA) authorised the utilisation of FFU Synthetic Wood in the German railroad infrastructure.

DEVELOPMENT AND PRODUCTION

In the year 1978, SEKISUI received several awards in the field of technological development in Japan for FFU Synthetic Wood. FFU Synthetic Wood (Fibre-reinforced Foamed Urethane) for railroad construction is a material which features the same positive application, simple handling, and processing properties as natural wood. With approximately the same weight as natural wood, it has a substantially longer life span and superior weathering resistance. After being subjected to a testing period of over five years, which showed superior compliance with all specifications and requirements, FFU Synthetic Wood has been used by Japanese Railways since 1985. Since then, it has become the standard product for the application in steel bearing structures, switches, and tunnels, for the use in ballast tracks as well as in slab tracks. Further testing on a sleeper installed fifteen years ago showed that the durability of FFU extends fifty years. In the course of this period, the sleeper was subjected to 100 million load cycles.

Packing Completed at the Production Plant [koocoo consulting]

The pultrusion process is used for the production of FFU Synthetic Wood. Infinite directional glass fibre strings are passed through an extrusion press, backfilled with polyurethane, and cured to a very high-quality, non-porous material at an elevated temperature level. At the request of the customer, FFU synthetic wood sleepers and bridge sleepers can be pre-fabricated true to form with millimetre precision at the plant; clearly labelled and delivered for on-site installation. Please refer to table 1.

FFU REFERENCES

How many kilometres of rail were fitted with FFU Synthetic Wood since 1985? The sum of all bridge, turnout and tunnel projects in which FFU Synthetic Wood was used since 1985 will add up to a total of more than 1,030 km of track by 2010, generally on LRT track systems and railroad lines with an axle load of up to 45t.

FFU Synthetic Wood is used predominantly on the Shinkansen high speed railroad network, and on regional railways and subways in Japan. In China and Taiwan, it is used in the same way. Since 2004, FFU has been installed on tracks by Wiener Linien, ÖBB, Hamburger Hochbahn (Hamburg Municipal Transport System), Chempark Leverkusen in Germany, and the Serbian National Railroad in Belgrade.

Milled-out recess for belt reinforcements	Drill hole for screw joints
Milled-out recess for longitudinal girders	Surface sanding
Milled-out recess for rivets	Thickness Adjustments for Packing

Table1: Prefabrication at the plant

Turnout Installation at Chempark Leverkusen-Germany-[SEKISUI]

Minimal railroad service interruptions
Minimal substitute transports required
Minimum passenger inconvenience
Maximum operational availability in the future
Economically feasible solution - Basic Life Cycle Costs

Table 2: Customer Specifications for the Application of FFU Synthetic Wood

Rail Replacement	over 30 years
Corrosion Protection	over 30 years
Bridge Sleepers FFU Synthetic Wood	over 50 years
Steel Construction Steel Structures	over 50 years

Table 3: Maintenance Intervals at Wiener Linien for FFU Synthetic Wood

Elastic Rail Head Deflection		Constant Rail Head Deflection	
Right Base Plate	Left Base Plate	Right Base Plate	Left Base Plate
2,12mm	1,71mm	0,42mm	0,29mm

Table 4: Pulsatory Fatigue Test FFU Synthetic Wood - Rail Head Deflections

Sleeper Material	Test Load	Comment
FFU Synthetic Wood	240 kN	No cracks in the bending area
Beech Wood	80 kN	Material failures in the bending area

Table 6: Static Test - Test Loads

ON-SITE DRILLING, MILLING AND CUTTING OF FFU SYNTHETIC WOOD

Drill holes for rail fastening systems with sleeper screws may be carried with conventional drilling tools. The material can be cut, milled and chiselled just like natural wood.

RESEARCH REPORT TU MUNICH 2008[1]

For this purpose, SEKISUI provided 20 FFU Synthetic Wood sleepers in the dimensions of w/h/l = 26/16/260 cm.

Pulsatory Fatigue Test[1]: Tests were conducted in order to determine the impact of the effect of repeated loading with an axle load of 225 kN, and a curvature radius larger than 150 m. After three million load cycles at room temperature, the following deflections between rail and sleeper were detected (Tab. 4). These values are within the permissible range.

Screw Extraction Test[1]:

Material	Extraction Force Sleeper Screws
Natural Wood Sleeper	35 kN
FFU Synthetic Wood	61 kN

Table 5: Extraction Force on Sleeper Screws

Impact Test[1]:

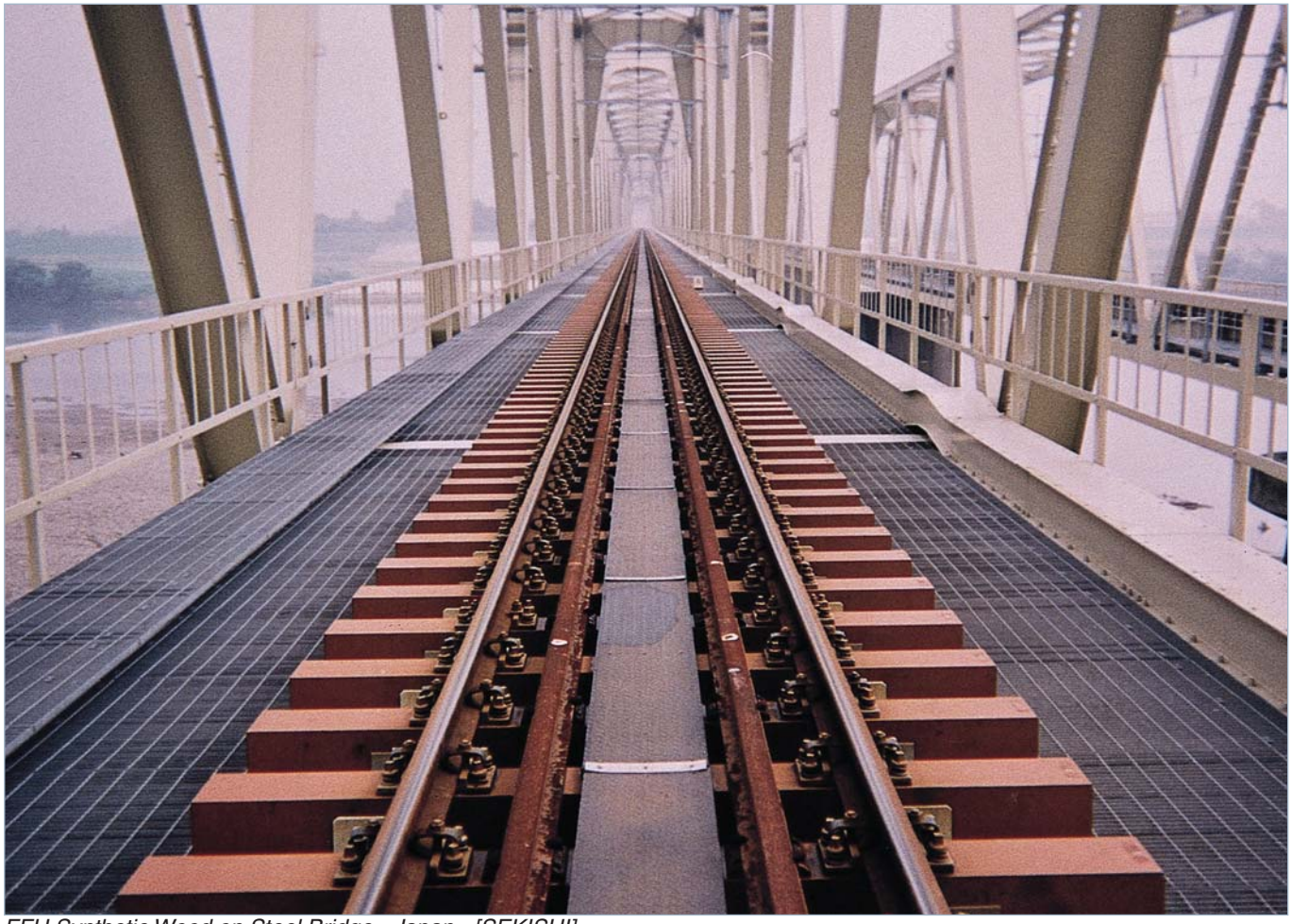
According to the technical specifications of DB - Basic Principles for the Dimensioning, Construction and Certification of Pre-stressed Concrete Sleepers - in Impact Test I, the FFU synthetic wood sleeper merely showed a narrow indentation. No cambering of the synthetic wood sleepers occurred after the impact test.

Static Test on Sleeper[1]: (Tab. 6)

Up to a load of 240 kN, which corresponds to a force of 74 N/mm^2 on the underside of the sleeper, no crack was detected in the bending area where flexural tension was applied. Analogously to this test, a beech wood sleeper with identical dimensions was analysed.

Static Deflection of the Sleeper at T = RT und T = -10 °C[1]:

Before testing at low temperatures was conducted, the synthetic sleepers were



FFU Synthetic Wood on Steel Bridge - Japan - [SEKISUI]

stored in a freezer for two days at T = -20°C. Test results confirmed that at a test load of up to 200 kN, deformation properties under bending moment strain depend only marginally on temperature. The test analysis showed no noticeable brittleness resulting from a low temperature range.

OPERATING EXPERIENCE AND ADVANTAGES

In contrast to wood, FFU is an industrially produced synthetic wood, which is fabricated according to individual specifications, and delivered true to form with accurate mm precision. Even after installation, FFU Synthetic Wood stays dimensionally stable, as it rests almost on the entire surface of the steel girder belts while retaining its homogeneous structure. On ballast tracks, the same kind of interlocking used on the underside of the sleeper is identical with natural wood. Packings, cutting, and any further required shape adjustments can be pre-fabricated at the production plant on request. Its dimensional stability permits a quick and immediate on-site installation of synthetic wood sleepers on open steel bearing structures. Due to its light weight, - 740kg/m^3 - almost similar to wood, FFU 74 makes possible easy transport to the construction site, and generally provides static advantages when used on steel bearing supports. The distribution of the load derivation structure (glass fibre concentration) is clear and positively existent.

Since the material is non-porous it does not absorb liquids. The material does not react to contact with lubricants or chemicals as conventionally used by railroad operating companies. Simple repairs and the use of conventional cutting and drilling tools are analogous to natural wood. Practical experience with FFU has shown that its excellent load distribution, plus the good interconnection between sleeper screws and synthetic wood, combined with a high weathering resistance and its closed structure, minimise maintenance costs and operating expenses for the railroad operating company.

Should an exchange of the sleepers be required after a period of more than fifty years, the material can be completely recycled at the production plant. The initial investment for track superstructure construction using FFU is a few per cent higher in contrast to natural wood. The service life of the synthetic sleeper in the areas mentioned above is much longer when compared to the life span of natural wood. A life-cycle cost analysis conducted by TU Graz on behalf of ÖBB and Wiener Linien, has helped further to reaffirm to railroad operating companies deciding in favour of FFU. For twenty-five years, railroad operating companies have held FFU Synthetic Wood in high esteem for the easy availability of the rail and the minimisation of maintenance costs. ■

REFERENCES

1) Technical University Munich, Research Report Nr. 2466, dated Sept. 19, 2008, Chair and Testing Department for the construction of traffic infrastructure, Univ. Prof. Dr.-Ing. S. Freudenstein