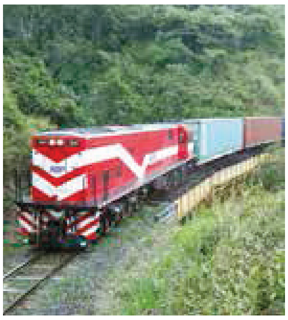
Railway Gazette

INTERNATIONAL



LATIN AMERICA

Colombia

Concessionaires invest to revitalise Ferrocarril del Pacifico

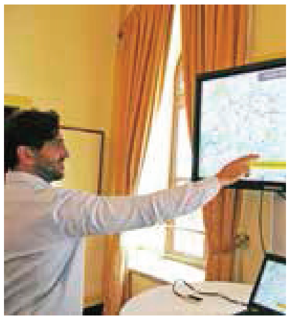
PAGE 30

STATIONS

Los Angeles Union

Master plan to modernise downtown rail hub follows surge in ridership

PAGE 49



IN FOCUS

'Click, click, ticket'

Train operators are not making the most of digital distribution

PAGE 65

www.railwaygazette.com

August 2014

Confirming the effectiveness of thinner sleepers

A 120 mm thick FFU sleeper developed by Sekisui has been successfully tested by Technische Universität München.

DR GÜNTHER KOLLER
Koocoo Consulting

With FFU synthetic wood sleepers being used in Japan for almost 30 years, they are now supporting almost 1 400 km of track and turnouts in an increasing number of countries around the world. Today almost all turnouts and bridge bearers on the Tokaido Shinkansen are made from FFU, carrying 270 km/h trains every 3 to 5 min.

An FFU sleeper has nearly the same specific gravity as natural wood, but a much higher life expectancy and resistance to weathering. Based on 15 years' experience with up to 100 million load cycles, the Railway Technical Research Institute estimated in 1996 that FFU sleepers could potentially last for up to 50 years, and further tests in 2011 based on 30 years of service confirmed this life expectancy.

European applications have continued to increase, since the first trials in Austria in 2004 and Germany in 2008 (RG 8.10 p42). Recently, ÖBB used FFU bearers to support a double-slip turnout in the new Wien Hbf. The first application in the Netherlands was installed in 2012, when ProRail used FFU bearers on three bridges. That year also saw FFU bridge timbers installed on a private mining railway in the USA, carrying axleloads up to 38 tonnes.

This year has seen the first synthetic sleepers used in Switzerland, with the installation of two turnouts on BLS (RG 6.14 p20) and bearers for two bridge projects on the Rhaetische Bahn. In the UK, Network Rail has fitted two bridges with long FFU bearers of 380 x 380 x 5 700 mm and two with standard timbers for comparative trials.

Thin, thinner, thinnest

For most of these applications, the FFU 'timbers' are made to the same dimensions as the wooden sleepers or bearers that they are replacing. However, in a growing number of applications it has been possible to capitalise on the strength of the synthetic material by installing thinner sleepers to reduce the height of the track structure. This has been particularly beneficial in locations with restricted clearances, such as metro networks, tunnels and level crossings, where steel sleepers have traditionally been used as they require less ballast. Replacing them with FFU sleepers means the ballast height can be increased, reducing maintenance costs as the need for manual tamping is eliminated.

Back in 2009, Wiener Linien installed 100 mm deep FFU sleepers on Line U1 at Stephansplatz, and subsequently on sections of U4; these were deployed in rubber boots as part of a mass-spring anti-vibration trackform. Similar 100 mm sleepers 2010 mm long were used on tram route 31 where it crosses the Danube on the Floridsdorf Bridge. Over the past five years, WL has installed around 5 000 low-depth sleepers. In 2012 German tram operator Bogestra began a switch trial of 100 mm FFU sleepers on a section of ballasted track.

For main line applications, Germany's Südostbayernbahn has been using 120 mm deep sleepers under level crossings for some time, in order to permit a reduced ballast depth. Similar sleepers were laid on a bridge on the Rhätische Bahn earlier this year.

DB Netz has been testing 120 mm deep sleepers near Hannover for the past 18 months, on a line which carries around 100 000 tonnes of traffic per day.

Laboratory testing

Following discussions with the EBA, DB AG commissioned Technische Universität München to undertake

100 mm deep FFU sleepers have been used on several sections of Wien U-Bahn lines U1 and U4.

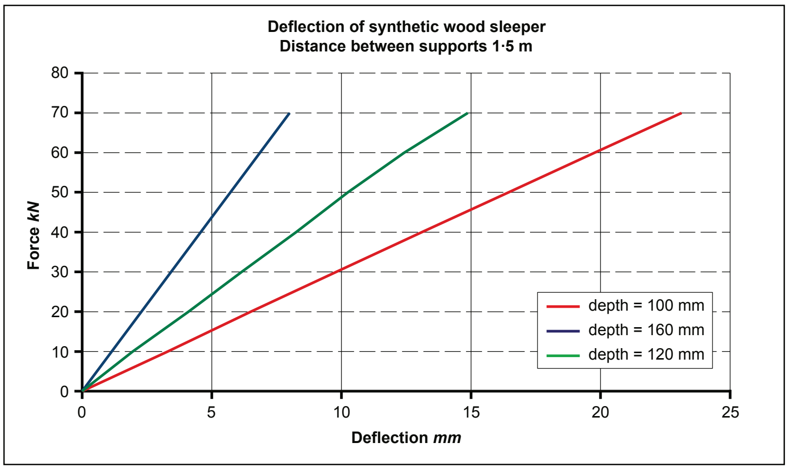


Fig 1. Force-deformation curve for sleepers of 100 mm, 120 mm and 160 mm depth.

Table I: Comparison of elastic / plastic rail deflections for 100 mm and 160 mm sleepers after 3 million load cycles

	100 mm	160 mm
Elastic deflection, point 1	1·60 mm	2·12 mm
Elastic deflection, point 2	1·60 mm	1·71 mm
Plastic deformation, point 1	0·45 mm	0·42 mm
Plastic deformation, point 2	0·15 mm	0·29 mm

TRACK TECHNOLOGY Testing

120 mm deep FFU sleepers were installed on two bridges on Switzerland's Rhaetische Bahn earlier this year.

Table II. Pull-out tests using SS8 sleeper screws

Hole	Pull-out force *kN*
Diameter 19 mm	
1	55·0
2	59·7
3	54·5
4	58·1
mean	**56·8**
Diameter 20 mm, steel drill bit	
1	53·0
2	56·6
3	49·4
4	51·9
mean	**52·7**
Diameter 20 mm, wood drill bit	
1	44·6
2	51·6
3	48.2
4	53·9
mean	**49·6**

50 years LIFE EXPECTANCY OF FFU SLEEPERS

laboratory testing of FFU sleepers of 100 mm and 120 mm thickness, to ascertain the practical minimum for full-service applications on 1 435 mm gauge lines. In both cases the sleepers were 260 mm wide and 2 600 mm long. The university had previously tested 160 mm sleepers as part of the process leading to their approval by EBA in 2009.

Last year the university reported that 120 mm deep sleepers would be fully suitable for use on main lines carrying 22·5 tonne axleloads at speeds up to 200 km/h.

The test programme covered three main aspects related to the durability of the synthetic wood sleepers:

- behaviour of the sleeper seat under the action of vertical and horizontal loads in a 'scissor lever oscillation test', using a rail fastening system installed in accordance with the requirements of EN 13481-3;
- static and dynamic fatigue tests of the synthetic wood sleeper in accordance with EN 13230-2;
- pull-out tests of the securing screws according to EN 13481-2.

Table I shows the rail deflection for the 100 mm sleeper after 3 million load cycles during the oscillation test, compared to the similar tests on the 160 mm sleepers undertaken in 2008. All of the measured parameters were within the permissible range.

In addition, the horizontal and vertical movement of the baseplate were recorded. After 3 million load cycles a maximum elastic indentation of 0·23 mm and a maximum permanent deflection of 0·18 mm was registered under the rib plate. The horizontal displacement (elastic and permanent) averaged about 0·6 mm.

The sleeper was then removed from the ballast bed and inspected, revealing only slight bruising on the underside.

In order to investigate the behaviour of the sleeper under bending stress, static tests were carried out in accordance with EN 13230-2.

The sleepers were mounted on supports 1·5 m apart, and a load applied to a 100 mm wide plate at the centre of the beam. The test load began at 10 kN, and increased in 10 kN steps while the deflection of the sleeper was measured at four points. This enabled the modulus of elasticity for the FFU sleepers to be determined.

Fig 1 shows the deflection of the sleepers up to a load of 70 kN, with a moment of 24·5 kNm. Here, the deflection of the 100 mm sleeper is 23 mm, which is three times greater than that of a 160 mm sleeper, whereas the deflection of a 120 mm sleeper was only 15 mm. At this stage, it was decided that further testing would be limited to the 120 mm design.

Fatigue resistance

In order to investigate the behaviour of a 120 mm FFU sleeper under repeated loading, a fatigue test was performed in accordance with EN 13230-4. This used load limits of 65 kN and 17 kN, with a frequency of 3 Hz. The resulting moment of 23 kNm corresponds to an axle load of 250 kN and a passing speed greater than 200 km/h.

After 2 million load cycles no damage to the sleeper could be determined, and the elastic deflection was only about 0·25 mm greater than at the start. During the entire experiment, the deformation was almost constant, and there were no signs of fatigue.

The final tests looked at the resistance of the 120 mm sleeper to pull-out forces on the screws securing the rail fastening, as set out in EN 13481-2, appendix A. Tests were undertaken with 12 pattern Ss8-140 screws. Four of these were driven into holes of the recommended 19 mm diameter, but the other eight used 20 mm holes, bored using different drill bits. The load on the screws was steadily increased to ascertain the resistance of the material (Table II).

The mean pull-out force was around 57 kN for a 19 mm hole, reducing to 51 kN for the larger hole. This compared to just 35 kN recorded during tests with traditional wooden sleepers in 1997. ■

Fatigue testing in progress at TU München.