30 years old, as good as new for 30 more

Excavated ballast showing intact mats

Track engineers often express doubts about the longevity of properly engineered ballast mats, used to overcome earth quality or, in this case, noise isolation problems. An effective investigation on mats installed 30 years ago in a Munich tunnel for noise isolation of an under-construction music hall have demonstrated that age need not wither the physical characteristics or the functionality of such mats. Technologies have further evolved in these three decades and current fitments can be lifelong. Sylomer® B851 mats easily withstood the extremely high loading of more than 1,300 mt imposed on it and the high structure-borne noise insulation requirements placed continue to be fulfilled. With the mats immersed in water and low ballast depth (min. 18 cm around the top of the sleeper), the resulting higher specific load and the mechanical stress apparently had no adverse effects on the effectiveness of the under ballast mat. From this investigation and other long-term studies and that the measured static/dynamic characteristics reveal only slight differences over the when-installed values, it can be assumed that the under ballast mats will remain fully functional for at least another 30 years. If the under ballast mats were not present, higher operating costs would be incurred due to the more frequent maintenance of the track and it is quite possible that the entire superstructure would have had to be replaced.

Wolfgang Daiminger
Müller-BBM,
Munich

Mirko Dold
Product
Management,
Getzner Werkstoffe

Getzner Werkstoffe Sylomer® (static bedding modulus of 0.008 N/mm³) under ballast mats were retrofitted in 1983 over a 345 m length in both tunnel sections using a specially developed process. The superstructure consists of standard ballasted track with S 54 rails, timber sleepers at 60 cm intervals, about 30 cm ballast bed height under the sleeper, axle load of 160 t and 80 kph maximum speed using the E420 trainsets (since replaced by E 423). Study results from a 2003 check are also available for comparison.

Measurements of the structure-borne noise show no significant changes till now in the effectiveness of this particular method for reducing levels of structure-borne noise.

Laboratory verifications

A 1200 x 1200 mm² sample of the product, taken at approx. 18 cm of ballast depth, was subject to visual and lab checks to compare with as-installed parameters and included a DIN 45673-5fatigue test, plus static and dynamic stiffness. The under-ballast mats, lying in water on the floor of the tunnel, were dried before testing. Surface indentations caused by the ballast were clearly visible and the load distribution layer in contact with the ballast was in very good condition, exhibiting some insignificant plastic ballast grain impressions, but was not damaged, and no perforations. The increase in the contact area minimises the specific load between the ballast and the floor of the tunnel and the two resilient layers underneath are also completely intact.

Stiffness

200 x 200 mm² sample for static load deflection curve (load range up to 0.25 N/mm² at a 0.16 kN/s test velocity revealed that the bedding modulus determined was within the 1983 specification.

The dynamic stiffness, determined using the so-called direct method according to ISO 10846-2 under the conditions specified lies just below that obtained in 2001. The laboratory tests show that the effectiveness of the structure-borne noise measurements carried out in 1983 remains undiminished.

For verifiable and reliable results, all the peripheral parameters that might influence the generation of structure-borne noise like effects of consolidation, water, quality of the sleepers and rail fastening, must be kept as constant as possible. Special attention was paid to the roughness of the rail surface that becomes a decisive factor when comparing the measurements eg. short-pitched corrugation can increase the level of structure-borne noise by up to 20 dB at a frequency of around 200 Hz. The rails in the vicinity of the measuring points were simply reground, not replaced.

The marks caused by the rotating grinding discs of the rail grinding train were also clearly visible along the outer side of the rail beyond the running surface. A major change in the peripheral conditions, however, was caused by the complete changeover in the type of train units, ET 420 only units were in use, but by 2003, all the light-rail traffic was ET423 units, so the evaluation after 30 years of operation has to be confined to units of this type.

Comparison of static/dynamic stiffness characteristics

	2012	2000	1983
Static	0.0090	0.0087	0.0083
Dynamic	0.0392	0.0396	0.0388

Ballast mats: protecting their charges

The measurements

Rail grinding in Jan 2013 was followed by measurements in May, with four points representing a selection of the 1983/2003 measuring points. It was possible to fit the sensors to the fastening points as originally used in 1983 (aluminium plates bonded to the tunnel wall).

The individual train movements were evaluated in the form of Max-Hold third octave spectra (rms, time constant "Slow" 1 second), exactly the same as the one earlier. For each measuring point, energetic mean values of the Max Hold third octave spectra were calculated from the individually evaluated train movements, with velocity level third octave spectra between 4 and 315 Hz. The effectiveness (insertion loss) of the implemented measure, represented by difference in velocity levels, is computed from the difference of the results before and after installation. The arithmetic means of the velocity level differences for three measuring points, studied in 2001 and 2013, were also compared.

Positive values indicate a reduction, negative values an increase in the level of structure-borne noise (measurements in 1983 and 2001 involved ET420 trainsets, whereas ET423s were in use by 2013). However, a few movements with ET423s were also measured in 2001. The vibration results on the tunnel wall from the 2001 measurements on ET423 units displayed lower levels in the frequency range below the 63 Hz third octave band. In the higher frequency range above the 63 Hz third octave band, somewhat higher levels for movements involving ET420 units were recorded. The differences in level between the results of movements with ET420 and ET423 units were determined and the arithmetic mean calculated for the measuring points and one reference point from 2001.

Clearly, ballast mats offer modern solutions to track issues and wider application, with engineered solutions for specific problems is a key option.

RB