Materials for technical innovations

Ballast mats

sylomer®
sylodyn®

getzner
WERKSTOFFE
Principle of Function

Sylomer® and Sylodyn® ballast mats limit the static and dynamic forces exerted by rail traffic in ballast superstructures.

Areas of Application:
• Attenuation of structure-borne noise for railway lines in densely populated areas: subways, urban railway lines, light rail lines and standard lines in the vicinity of buildings.
• Protection of vibration-sensitive structures and buildings requiring enhanced noise protection, such as concert halls, museums, hospitals, historical structures or sensitive laboratory, testing or measurement equipment.
• Reduction of airborne noise emissions from bridges.
• Enhancement of track stability, reduction of ballast compression, resulting in lower maintenance costs for heavily-used lines.

Getzner ballast mats feature a multi-layer construction:
• Load Distribution Layer
  The upper layer of the mats consists of a geo-textile or webbed material with excellent resistance to stretching and tearing. This layer deforms under the load of the ballast. The ballast is pressed into this layer and stabilised due to the resulting increase in the load bearing surface area. Forces affecting the mat are distributed over a greater area and are transmitted to the underlying elastic isolation layer.
• Elastic Isolation Layer
  The isolation layer consists of highly elastic micro-cell PUR materials. These materials are volume compressible – thus no profiling or cavities are necessary for deformation. Depending on the type of mat, the isolation layer may be made up of one or two layers, the density of which is selected so that the overall static and dynamic stiffness is achieved.
A highly reliable prognosis of the vibration attenuation which can be achieved with Getzner ballast mats is made possible using an internally-developed calculation model.

Multiple trial runs conducted under a range of test conditions by the German Federal Railways have shown that the test results and the prognosis calculations correspond closely. A prognosis is prepared for each individual application and type of mat. This is just another one of the many services that Getzner provides to its clients.

A state-of-the-art testing facility, preparation of installation diagrams using CAD technology, specific calculation models for determining rail deflection, on-site supervision and installation instructions are also among the many services that Getzner makes available to its clients.

Working together closely with our clients and with research and testing institutions world-wide, Getzner Werkstoffe is continuously modifying and testing its products. Our sales, engineers, product managers and physicists are constantly dealing with client and market needs in their day-to-day work. Over recent years, Sylomer® and Sylodyn® have been repeatedly and thoroughly tested, both in the field and in the laboratory.

Testing and field measurements have been carried out by the following institutions:

- Chair and Institute of Road, Railway and Airfield Construction, Munich University of Technology
- TÜV Rheinland, Cologne, Central Office for Vibration and Vibration Attenuation
- Testing Institute of the German Federal Railway, Munich
- Federal Testing and Research Institute, Arsenal, Vienna, Austria
- Hübner BM GmbH, Planegg by Munich
- IGES Spa., Bergamo, Italy
- Institute for Road and Rail Transportation, Technical University of Berlin
- Civil Engineering Working Group Stehno, Vienna – Innsbruck, Austria
- Univ. Prof. Dr. Peter Steinhauser, Civil Engineer for Technical Physics, Vienna, Austria
- Raabauer Engineering Office for Construction, Transportation and Environmental Protection, Zurich, Switzerland
- EMPA, Cantonal Materials Testing and Research Institute, Dübendorf
- Fritsch, Chiel & Partner, Civil Engineers, GmbH., Vienna, Austria

Research and testing reports are available on request.
Technical Product Specifications

BEDDING MODULUS AND STATIC STIFFNESS

The proper level of stiffness for the mat depends on the type of application, the track construction (ballast depth, surface area and spacing of the sleepers, rail type) and the operational conditions (axle loads, maximum speed).

The unit of measurement for stiffness is the bedding modulus as stated in N/mm³. This figure essentially defines the level of rail deflection occurring when the track is used. If all recommendations are followed the level of rail deflection is usually less than 3 mm, and less than 1.5 mm for high-speed lines. Getzner Werkstoffe determines the actual rail deflection for individual cases by calculating the bending line of the rail.

EFFICIENCY AND INSERTION LOSS

"Efficiency" for a ballast mat is measured in terms of the reduction in the level of structure-borne noise which is achieved by installation of the ballast mat.

The so-called "insertion loss" is defined as the difference in 1/3 octave band spectra level (total level in the frequency range of 1/3 of an octave), as a function of the average 1/3 octave band frequency. Efficiency is not only a characteristic of the ballast mat itself, but is rather a parameter of the entire system from the vehicle through to the subgrade.

The following parameters are of key importance:

- Unsprung Bogie Mass
- Dynamic stiffness, attenuation and mass of the ballast superstructure without the ballast mats
- Dynamic stiffness and attenuation of the mats (dependent of load, frequency and amplitude)
- Vibration isolation of the subgrade (impedance)

The system observations explained above and the use of the various structural parameters allow Getzner to calculate the efficiency of the planned measures using a calculation model. The model assumes that the dynamic characteristics of the ballast mat in the pertinent load and frequency range is almost fully described by two values: the dynamic stiffness and the loss factor. Getzner ballast mats fulfill these conditions, as the dynamic stiffness is only minimally dependent on frequency, load and amplitude. A particularly high level of efficiency is achieved by Getzner ballast mats in the frequency range of the so-called "wheel-rail track resonance" for tracks without ballast mats (approximately 50 Hz to 80 Hz, depending on the bedding modulus). For most applications efficiency in the range below 80 Hz is especially important as these low frequency vibrations are excited very strongly and because buildings and parts of structures are particularly susceptible to excitation in this frequency range (e.g. natural frequencies of ceilings and walls).

Field experience and prognoses of the efficiency of Getzner ballast mats cannot be applied for ballast mats with different constructions (e.g. compact elastomer mats with profiles or internal cavities).

Load and frequency dependence of dynamic stiffness

(From Müller-BBM, Report No. 3224/12)
Long-term Behaviour

LONG-TERM BEHAVIOUR UNDER HARSH CONDITIONS

Getzner ballast mats exhibit superior efficiency even after years of operation, as is verified by an analysis of the long-term characteristics of Getzner ballast mats.

After more than 16 years of operation and daily loads of roughly 150,000 effective tons, samples were taken and subjected to thorough analysis. This analysis indicated that the ballast mats retained their excellent functional characteristics and exhibited an almost completely constant behaviour in stiffness throughout the entire operational life span of the material.

Control measurements in samples taken from used ballast mats have shown that no contamination of the inside of the mats occurs even after 20 years of use under muddy conditions (caused by ballast disintegration).

Hence, Getzner ballast mats do not lose their functional qualities even under extremely tough operating conditions, such as total submersion from flooding, sub-freezing temperatures and strong soiling of the ballast bed due to ballast degradation or sand deposits.

To quote a testing report of an external testing institute:

"... it can be stated that Sylomer® B 851 ballast mats endured extremely well an exceptional high strain of 760 million load tons over a time frame of more than 16 years."

Installation Techniques

DELIVERY AND INSTALLATION

Getzner ballast mats are delivered in a uniform width of 1.5 meters. Usually the rolls are factory-cut to the appropriate track width (site specifications).

Then they are rolled up, marked with the installation position and delivered to the installation site. For 35-mm and 40-mm thick mats, sometimes it is expedient to roll the mats in two separate layers, making them easier to handle. The mats are placed in the installation area according to their designations and unrolled. Fine adjustments are carried out using fitting pieces or by trimming the mats to the location. For example, this is required in curves.

The mats are fully functional immediately after being installed, i.e. there is no need for bonding the mats to the subgrade. If ballast is not applied to the mats immediately following installation, it is sometimes expedient to partially affix the mats to the substrate by bonding them into place (to prevent movement due to site traffic, or water contamination). Solvent-free glue such as dual component PUR adhesives are used. The mats should be bonded to the subgrade in such a manner that any water penetrating the mats can flow off to the nearest drainage area.
Retrofits

The full surface area of Getzner ballast mats lies on the subgrade. As the mats are flexible and elastic in all directions, the mats almost completely conform to the surface of the substrate.

Sharp-edged depressions or protrusions in the installation area should be avoided. Concrete track slab substrates should be roughly levelled or finished.

Getzner ballast mats can be installed without special preparation on substrates of compressed gravel (subgrade), a cement-hardened substrate layer or on a bitumen layer. If old ballast is used as an installation substrate, as is frequently the case in retrofits of lines with ballast mats, it has proven effective to install a load distribution layer on both sides of the mats.

If continuous presence of significant amounts of water is expected, strip-shaped drainage mats can be installed under the mats. In order to prevent noise bridges in the water flow areas, the meshes or grates are filled with perforated mat material or the meshes or grates can be elastically mounted as well.

If the wear on the superstructure components after years of operation without ballast mats is not too great, it is sometimes possible to re-use all components. Hence, it is not necessary to replace all rails, sleepers and rail fasteners, as is the case with other methods of retrofitting for the reduction of vibrations.

Getzner's Sylomer® and Sylodyn® ballast mats have proven extremely effective, in particular for sensitive areas with high vibration protection requirements and under very difficult track conditions.

Try and trusted retrofitting procedures allow work to progress rapidly. As the entire track does not need to be removed, it is possible to minimise traffic disruptions due to track closures.

As the installation specifications cannot be determined in advance for retrofits, the mats must be cut to fit the exact length on site.

SUBGRADE REQUIREMENTS

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Naturally, the delivery program for Getzner ballast mats also includes a detailed set of written installation instructions and the adhesives required for installation. If the installation surface is coated with synthetic materials (e.g. epoxy resins on steel bridges) no special preparations are required. Sylomer® and Sylodyn® contain no softeners or oils. If bonding the mats is necessary, the installation surface must be swept clean and must be dry.

RETROFITTING OF EXISTING RAILWAY LINES

Extremely low weight and easy installation are only two of the reasons that Getzner ballast mats are often used for retrofitting of existing track.

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1000 mm Drainage Solution, e.g. using geo-textile Drainage Holes bored on site

Drainage principle: Sylomer® and Sylodyn® ballast mats

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Getzner Werkstoffe has developed a comprehensive range of products for various fields of application, ranging from urban transportation to high-speed lines, with the aim of reducing vibration and improving track stability. These product groups take into account the differing operating conditions as well as the various vibration-related aspects of the specific areas of application.

The area of application is defined by the maximum axle load, maximum train speed and the resulting static bedding modulus \( C_{\text{stat}} \). This allows Getzner to offer the most cost-effective solution for each specific situation.

For special requirements Getzner can also produce customised ballast mats.

### Product Range

**THE SYLOMER® AND SYLOODYN® BALLAST MAT PRODUCT GROUP**

#### URBAN TRANSPORT

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Thickness</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban Rail/Subways</strong> ≤ 130 kN axle load ( C_{\text{max}} = 0.007 \text{ N/mm}^3, v ≤ 100 \text{ km/h} )</td>
<td>28 mm</td>
<td>7.8 kg/m²</td>
</tr>
<tr>
<td>Sylomer® A 728</td>
<td>28</td>
<td>7.8</td>
</tr>
<tr>
<td>C_{max} = 0.01 \text{ N/mm}^3, v ≤ 100 km/h</td>
<td>28 mm</td>
<td>7.8 kg/m²</td>
</tr>
<tr>
<td>Sylomer® B 118</td>
<td>19</td>
<td>4.8</td>
</tr>
<tr>
<td>Sylomer® B 135</td>
<td>35</td>
<td>7.5</td>
</tr>
<tr>
<td>Sylodyn® DN 140</td>
<td>40</td>
<td>12.5</td>
</tr>
</tbody>
</table>

| **Light Rail lines** ≤ 160 kN axle load \( C_{\text{max}} = 0.02 \text{ N/mm}^3, v ≤ 120 \text{ km/h} \) | 25 mm | 8.0 kg/m² |
| Sylomer® C 219 | 19 | 6.3 |
| Sylodyn® CN 225 | 25 | 8.0 |
| Side mats for urban transport lines \( C_{\text{max}} = 0.01 \text{ N/mm}^3 \) | 25 mm | 8.0 kg/m² |
| Sylomer® DN 119 | 19 | 4.8 |

#### MAIN LINE

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Thickness</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&gt;160 kN axle load ( C_{\text{max}} = 0.03 \text{ N/mm}^3, v ≤ 120 \text{ km/h} )</strong></td>
<td>19 mm</td>
<td>6.3 kg/m²</td>
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<tr>
<td>Sylomer® D 219</td>
<td>19</td>
<td>6.3</td>
</tr>
<tr>
<td>Sylomer® D 227</td>
<td>27</td>
<td>10.0</td>
</tr>
<tr>
<td>Sylodyn® DN 219</td>
<td>19</td>
<td>6.3</td>
</tr>
<tr>
<td>Sylodyn® DN 225</td>
<td>25</td>
<td>9.0</td>
</tr>
<tr>
<td>Sylodyn® DN 235</td>
<td>35</td>
<td>12.0</td>
</tr>
</tbody>
</table>

| **>160 kN axle load \( C_{\text{max}} = 0.06 \text{ N/mm}^3, v ≤ 200 \text{ km/h} \)** | 19 mm | 7.5 kg/m² |
| Sylomer® D 619 | 19 | 7.5 |
| Sylodyn® DN 619 | 19 | 8.6 |

| **>160 kN axle load \( C_{\text{max}} = 0.10 \text{ N/mm}^3, v ≥ 200 \text{ km/h} \)** | 19 mm | 8.6 kg/m² |
| Sylomer® D 1019 | 19 | 8.6 |
| Sylodyn® DN 1019 | 19 | 8.6 |

| **>160 kN axle load \( C_{\text{max}} = 0.15 \text{ N/mm}^3, v ≥ 200 \text{ km/h} \)** | 19 mm | 10.5 kg/m² |
| Sylomer® D 1519 | 19 | 10.5 |

| **Side mats for main lines** \( C_{\text{stat}} = 0.02 \text{ N/mm}^3 \) | 19 mm | 5.0 kg/m² |
| Sylomer® DN 219 | 19 | 5.0 |

The efficiency of the specific ballast mats type increases from top to bottom within the individual groups listed above. Static bedding modulus \( C_{\text{stat}} \) was determined between flat steel plates according to DB BN(TL) 918 071. Dynamic characteristics can be found in the individual product data sheets. Product data sheets for individual ballast mats types can be obtained upon request.