PERFORMANCE OF SYLOMER® AND SYLODYN® IN FLOATING FLOORS OF RAIL CARS

EXPERT ARTICLE

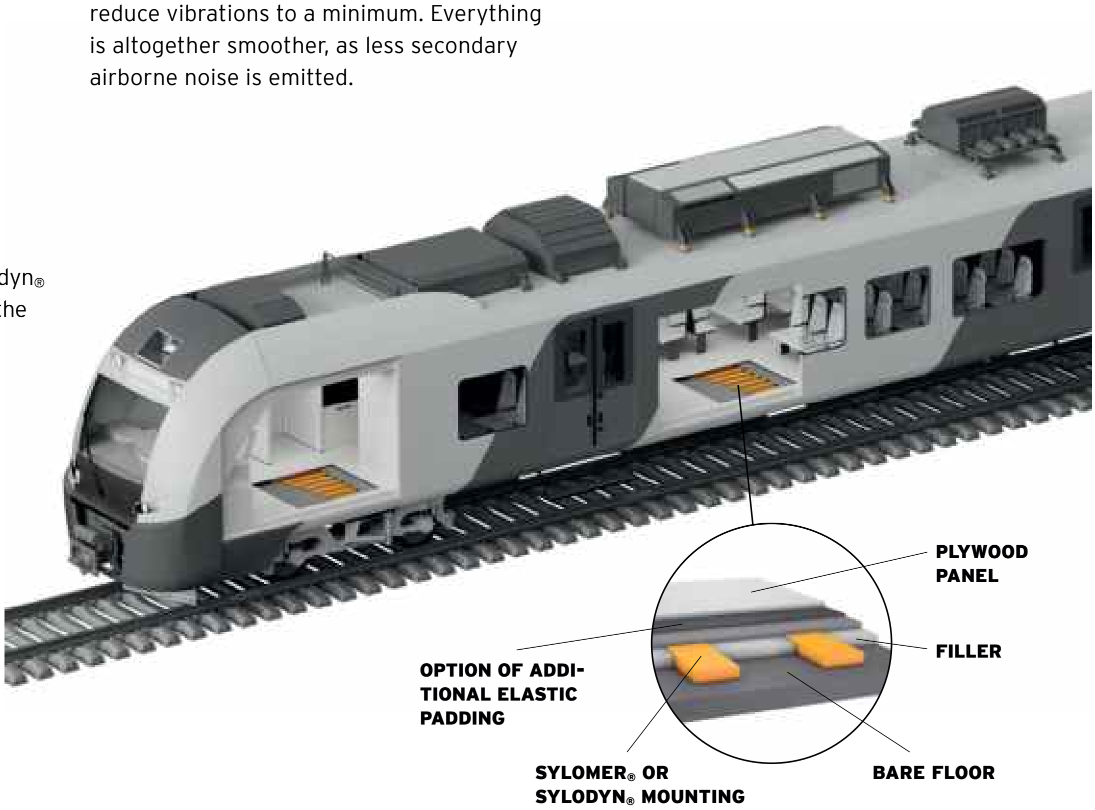
Today the challenge for network operators is to offer appropriate added value for users and to convince people that the choice to take public transport should not focus solely on the cost. Reasons such as reliability, comfort, time savings and safety are crucial here – a massive challenge for rolling stock manufacturers, because profitability sets boundaries.

Getzner materials, Sylomer® and Sylodyn®, can be used for floating floors, which are designed to reduce vibrations. This increases travelling comfort for passengers and staff and also increases the service life of the carriage and its components. Shudders that occur because of the wheel/rail contact are less noticeable to passengers and crew and the elastic-mounted floor constructions reduce vibrations to a minimum. Everything is altogether smoother, as less secondary airborne noise is emitted.

Sylomer® and Sylodyn® have been used since beginning of the Nineties as elastic bearing for floating floors in rail cars. Elastic polyurethane bearings are used in the floor construction to reduce vibration. This vibration is caused by the wheel-track contact and transferred via the bogie into the carbody which leads to secondary airborne noise. Sylomer® and Sylodyn® have a high efficiency, compared with other materials and help to reduce and minimize this noise. This noise level is depending on the car design, floor panel, floor covering and the complete design.

1. Installation

Mainly Sylomer® and Sylodyn® are used in stripes below the floor panel.



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Vibration mitigation with Sylomer® FR floating floors for rolling stock

For fixing the stripes bonding is recommended. It is important that no mechanical fastenings are drilled through which could create sound bridges. A bonding recommendation for different adhesive partners is available.

To simulate the efficiency of a floating floor with Sylomer® and Sylodyn® stripes, Getzner made two tests in external laboratories in Finland (2014) and in Spain (2015). As there is no rule how to test elastic floor components under different load conditions, different regulations, like DIN EN ISO 3381:2011, TSI NOISE (EU) 1304/2014 and DIN 45635 have been taken into consideration.

2. Test results

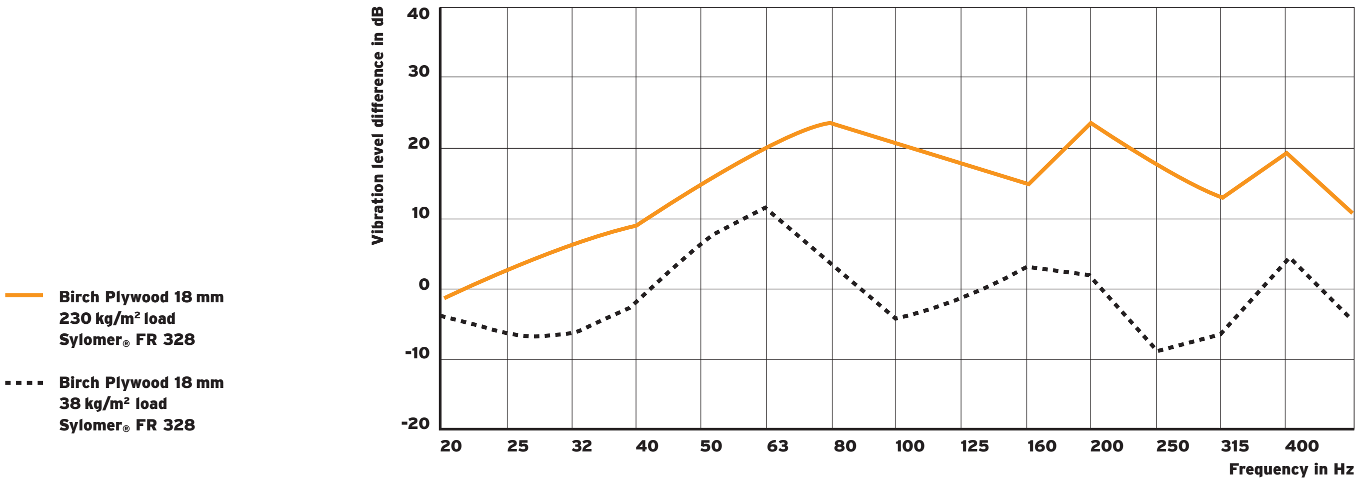
The test done in Spain in 2015 shows a comparison between a phenolic resin panel, rubber pads and Getzner Sylomer® as point and stripe bearing.

The table shows the tuning frequency of the bearings in different load conditions. The lower Hz-value, the more elastic and efficient is the bearing. The phenolic resin panel is 3.9 times dynamic stiffer and the silent block 1.75 times dynamic stiffer than Sylomer® FR 3110 (Q Factor).

Thus, Sylomer® is significantly more efficient than either the phenolic resin panel or the rubber pads, in any load condition. The test condition with 250 kg/m² load shows a difference of up to 9.09 Hz (between phenolic resin panel and Sylomer® FR 328) and enables to reduces the tuning frequency – with Sylomer® FR 328 – to 9.22 Hz.

This graph of a test in Finland in 2014 shows the difference in performance for the different load cases. For low traffic loads (empty rail car) the performance of Sylomer® is lower, than with the working load. For large traffic loads the elastic isolation shows good results over a large frequency range. Polyurethane has a non linear elastic behavior and therefore the applied load has a large influence on the dynamic performance. This material property is a major benefit of foamed polyurethane (Sylomer®) and offers a much better vibration isolation than stiffer materials like rubber.

From Getzner's experience, most of the tests are done in empty rail cars. A test in an empty car shows a complete different result compared to a test done on a fully loaded rail car. This should always be taken into consideration.



The table shows the resonance frequency of the bearings under the load conditions "no load", empty waggon"50 kg/m²" and work load "250 kg/m²". The lower the Hz-value, the more elastic and the more efficient is the bearing. Thus, Sylomer is significantly more efficient than either the phenolic wad or the silent block, in any load situation.

	Load	Tuning frequency	Q Factor	f1	f2
Phenolic Resin Panel					
	–	149.41 Hz	11.161	141.76 Hz	155.15 Hz
	250 kg/m²	18.31 Hz	6.036	16.45 Hz	19.48 Hz
Rubber Pads					
	–	34.08 Hz	10.791	32.89 Hz	36.05 Hz
	250 kg/m²	12.31 Hz	7.554	11.81 Hz	13.44 Hz
Sylomer® FR 3110					
	–	19.49 Hz	7.556	18.00 Hz	20.58 Hz
	250 kg/m²	9.31 Hz	4.185	8.19 Hz	10.42 Hz
	50 kg/m²	12.53 Hz	3.566	11.13 Hz	14.65 Hz
Sylomer® FR 328					
	–	16.57 Hz	5.495	15.07 Hz	18.09 Hz
	250 kg/m²	9.22 Hz	3.849	7.89 Hz	10.38 Hz
	50 kg/m²	14.74 Hz	1.232	9.88 Hz	21.85 Hz

In practice three different load cases should be taken into consideration*:

Empty rail car:	20 kg/m²
Working load:	360 kg/m²
Maximum load:	500 kg/m²

Getzner is always designing the stripe dimension according to the working load indications of each project, considering the influence of the maximum load condition. Depending on the train type and country of usage different load indications are assumed. There is no special norm indications for this, but the assumption is 4 persons à 90 kg as working load and 500 kg/m² during the rush hour.

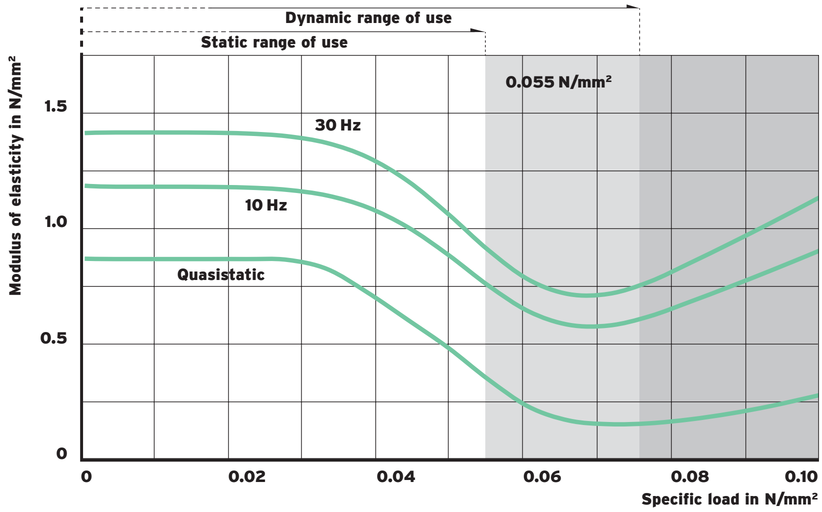
* This is an example. This information should be provided for each project from the rail car manufacturer or rail operator.

3. Softer dynamic range

The speciality of elastic floor bearings made of Polyurethane is a non linear elastic behavior and therefore the applied load has a large influence on the dynamic performance. Sylomer® and Sylodyn® are designed to be most efficient at the working load.

These materials get softer (and not stiffer compared to other products) in the calculated dynamic range (working load). This allows the most efficient vibration mitigation which leads to a lower noise level.

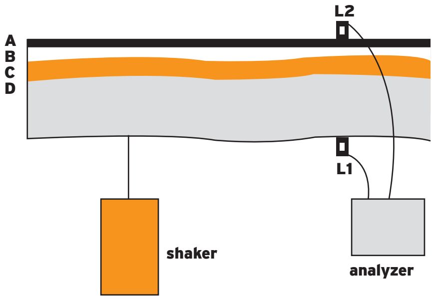
Modulus of elasticity



4. Test conditions and details

4.1 Birch plywood with Sylomer® FR

The purpose of this test in Finland was to determine the vibration level difference (dB) of different test specimens in the third octave bands from 20 to 500 Hz.



A Floor panel
B Vibration isolator
C Steel grid frame
D Vibrating vehicle body

The steel grid frame was attached rigidly to the concrete block (simulating the vehicle body) and vibrates according to the vehicle body and the floor board.

The test mock-up consisted of a vibrating concrete slab (1200 mm × 800 mm × 200 mm), a steel grid frame, the Sylomer® vibration isolation stripes and the floor panel.

In the test mock-up, a mass of 228 kg/m² was placed on top of the floor. This should simulate 3 passengers with approx. 80 kg each. The total length of the isolator stripes between the floor board and the steel grid frame was 4 × 0.75 m = 3 m which were mounted on four transverse beams.

The vibration excitation of the floor construction system was applied using an electromagnetic shaker. The force was transmitted from the shaker to the concrete plate by a push rod.

The vibratory acceleration levels were measured using a piezoelectric accelerometer and was measured at three positions on the lower surface of the concrete plate and at three positions on top of the wood panel. The average time was 20 seconds in every measurement. The measurement system was calibrated before and after the measurement using a calibrated hand-held shaker.

FOLLOWING MATERIALS WERE USED:

- Metsä Wood Birch Plywood floor panel in 18 mm thickness
- Flame retardant Sylomer® FR 328, 40 mm width, 25 mm thickness
- Load of 228 kg was laid on top of the floor (6 pcs. steel bars à 38 kg)
- Air temperature in the test room was 22.1°C, the relative humidity 39 % and the static pressure 1008 hPa

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Phenolic Resin Panel

Rubber Pads

Sylomer® FR 3110

Sylomer® FR 328

4.2 Phenolic Resin Panel, Rubber Pads and Sylomer® FR

The ultimate goal of this test in Spain was to determine the dynamic behavior of different floor systems. The best method was in applying a sinusoidal sweep of sufficient intensity that allows to see this dynamic behavior. This test method is defined in EN 60068-2-6.

The solicitation was performed by an electro-dynamic shaker on which the floor structure was mounted. The size of the tested substructure had a dimension of 1750 mm × 1950 mm.

The test consist to excite the entire construction of the floor with a frequency that gradually went from 5 Hz up to 500 Hz in the vertical direction. The vibration level was 2 m/s² with a sweep speed of 1 oct/min.

The tests were done simulating a rail car without any load, an empty rail car with complete interior (approx. 50 kg/m²) and under a working load condition with approx. 250 kg/m² (three person à 83kg).

FOLLOWING TEST CONDITIONS WERE USED:

- Phenolic resin panel (point bearing)
  Q-Factor: 6.036
  mechanical loss factor: 0.166
- Rubber pads (point bearing)
  Q-Factor: 7,556
  mechanical loss factor: 0,132
- Sylomer® FR3110 (bearing point)
  Q-Factor: 9,31
  mechanical loss factor:0,107
- Sylomer® FR328 (Stripes bearing)
  Q-Factor: 9,22
  mechanical loss factor: 0,108

Q-Factor

The Q-Factor is in the electronic industry a dimension for the damping of a swinging system. The Q-Factor is the reciprocal value of the mechanical loss factor.

- Low damping swinging system = system of high excellence
- High damping swinging system = system with low excellence

f1 and f2 values

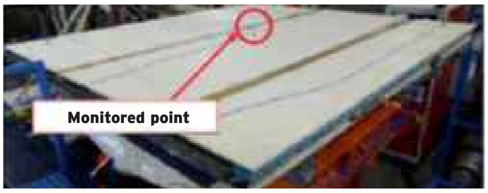
A method to define the excellence of the damping is the usage of half width. The f1 and f2 values are the values on each side of the frequency range, where – 3 dB reduction of the maximum occurs. – 3 dB means $1/\sqrt{2}$ = 70.7 %.

5. Summary

To achieve a significant lower noise level and higher comfort in a rail car, the vibration isolation of the floor is often underrated. There are normed acoustic tests, but no regulations and specified tests regarding isolation of structure borne noise which leads to the unwanted secondary air borne noise.

Considering elastic Polyurethane floor bearings of Sylomer® and Sylodyn® within the design phase, supports lowering the floor level, noise reduction and a decrease of life-cycle-costs over the complete life time of a train. 45 years experience and long time references made Getzner a specialist for floating floor applications in rail cars.

Sylomer® FR 328 – Configuration without load



Getzner Werkstoffe, Bürs

ENGINEERING A QUIET FUTURE

We are proud to be the leading global specialist in vibration isolation and vibration protection in the railway, construction and industry sectors.

Our innovative products are based on our own in-house developed materials such as Sylomer®, Sylodyn® and Sylodamp®, and are complemented by spring elements such as Isotop®.

Our applications effectively reduce noise and vibrations. They reduce wear, extend the service life of bedded components and improve application suitability, quality and comfort.

We specialise in integrated solutions and targeted services for sustainable vibration isolation. Our work is based on intensive research, climate-friendly production and decades of experience.

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