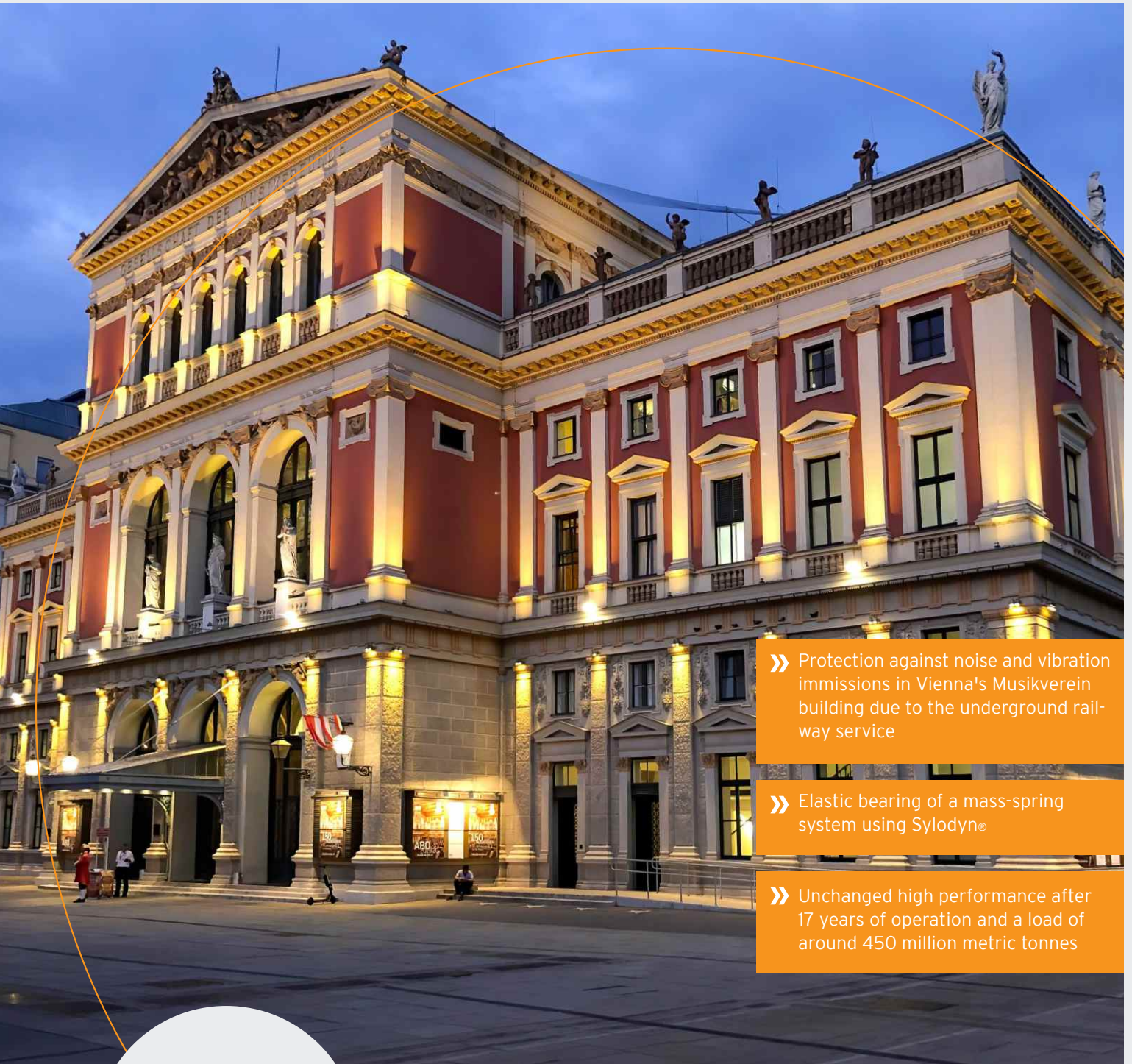


Case Study

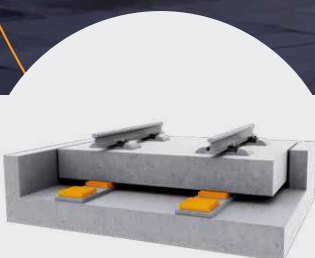
Permanent Sound and Vibration Protection for Vienna's Musikverein Concert Hall (AT)



» Protection against noise and vibration immissions in Vienna's Musikverein building due to the underground railway service

» Elastic bearing of a mass-spring system using Sylodyn®

» Unchanged high performance after 17 years of operation and a load of around 450 million metric tonnes



Consistently high protection against secondary airborne noise and vibrations

The project

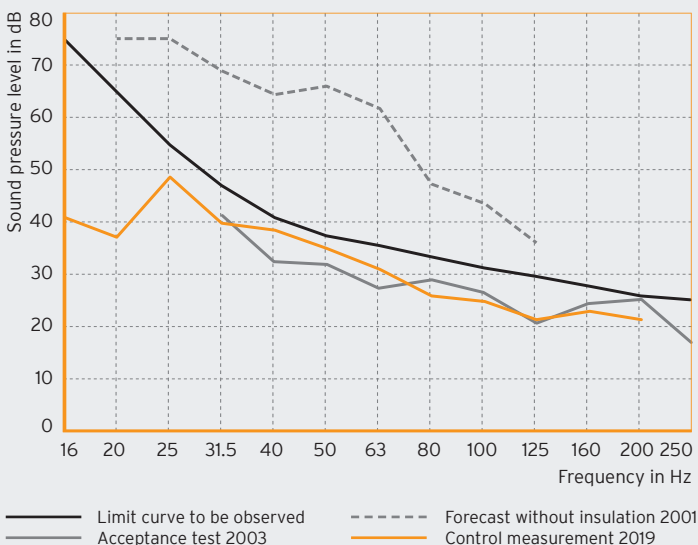
The acoustics in the Vienna Musikverein's "Goldener Saal" hall are among the best in the world. In 2002, an underground tunnel was built just four metres from the building. To minimize the disturbance to the listening experience of visitors in the Musikverein, the decision was made to use a mass-spring system (MSS) with discrete Sylodyn® bearings from Getzner when the underground line was built.

Getzner mass-spring systems are currently being used in more than 40 cities across the world - and Vienna is

one of them. The idea was that visitors of events in the Musikverein building would be protected against disruptive vibrations and noise coming from the nearby underground. Acceptance tests after commissioning in 2003 confirmed that the high requirements set by the Vienna Musikverein had been met.

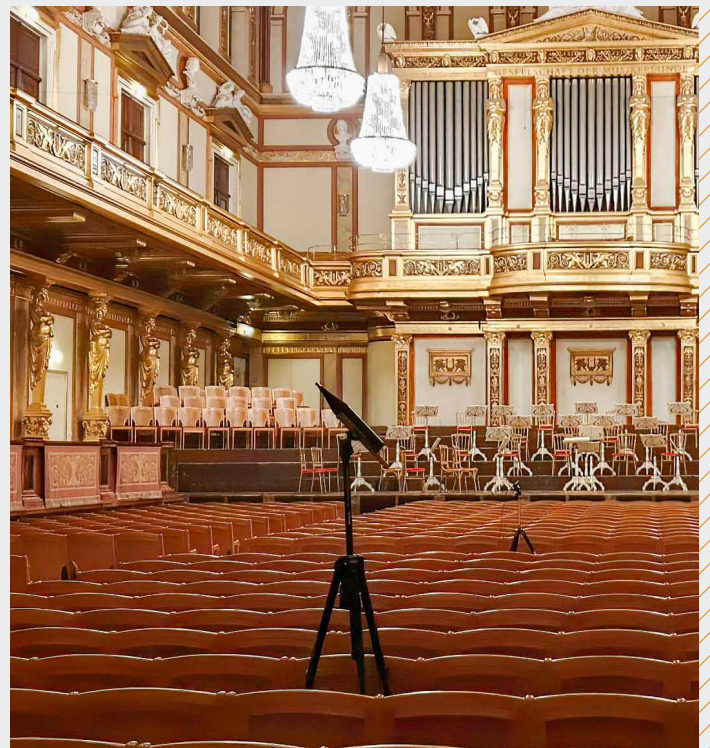
The underground now operates with modern trains that emit sound and vibration in a manner unlike the previous ones. Rooms are also used for different purposes but the structure has undergone changes too, including the installation of new windows. After a total load

of around 450 million metric tonnes caused by 250 trains per track and per day since the tunnel was built, the question of the long-term behaviour of the MSS arose. This was all the more important because there is also a siding for damaged trains, meaning that in addition to the 10-t/m mass of the slab itself, stationary train loads have also been exerting stress on the Sylodyn® bearings over extended periods of time. Therefore, in 2019, various measurements were used to check whether the system still fulfilled the high requirements set during construction for the protection against vibrations and noise.



The most stringent requirements continue to be met: Even after 17 years, the secondary airborne noise (orange line) is well under the set limit (black) in the "Goldener Saal". Dotted line: the predicted level when a standard ballast track is used.

The "Goldener Saal": measurement of the secondary airborne noise immissions at a height of 2.5 m





Undisturbed music enjoyment: The discrete Sylodyn® bearings insulate the immissions from passing trains.



The new V train type (left) causes more emissions in the tunnel than the old U₁₁ train type (right).

The Getzner solution

The slab sits on elastic discrete Sylodyn® bearings spaced two metres apart. The planned natural frequency of the 100-metre mass-spring system is 5.5 Hz, which is the lowest ever vertical natural frequency achieved with an MSS of elastomer bearings so far.

Long-lasting effect on the test stand

Several measurements were taken to investigate the ageing effects of the Sylodyn® bearings during trials with different train types: The natural frequency of the MSS, the emissions on the slab, the tunnel floor and tunnel wall, the slab deflection as trains pass over and the immissions due to secondary airborne noise and vibrations in the building.

Lowest immissions in the building

The sound level was measured in the centre of two concert halls, each at a height of 2.5 m. The high level of vibration isolation efficiency required of the MSS still remains intact 17 years later.

The vibration immissions in the centre of the "Goldener Saal" floor were checked. The perception threshold for vibrations is precisely defined and served as an assessment criterion for the perception of vibrations in the building. Even after years of loads on the MSS, the rail traffic does not cause any noticeable vibrations in the hall.

Unchanged natural frequency

The new V train type used in the Vienna underground excites the slab in the MSS natural frequency range more than the old U₁₁ train type, which is still currently in use. Nevertheless, all assessment criteria regarding immissions continue to be met. For Markus Heim, who is responsible for system development at Getzner Werkstoffe GmbH, it is remarkable that the requirements set during the planning of the underground extension are still being met today: "A natural frequency of 5.5 Hz was proposed during planning of the mass-spring system, which resulted in the required sound level reduction." The vertical natural frequency of the MSS, which was determined by impulse excitation, ambient microseismic movements and passing trains, remains unchanged from the 2003 acceptance tests.

No noticeable change in immissions due to the underground traffic

The dynamic properties of the Sylodyn® bearings have remained constant during all these years of use. The vibration immissions from the underground traffic in the concert halls are still far below the perception threshold and neither do passing trains result in an increased idle level. The noise immissions remain well under the limit curve.

Feedback

What does the client say about the project?

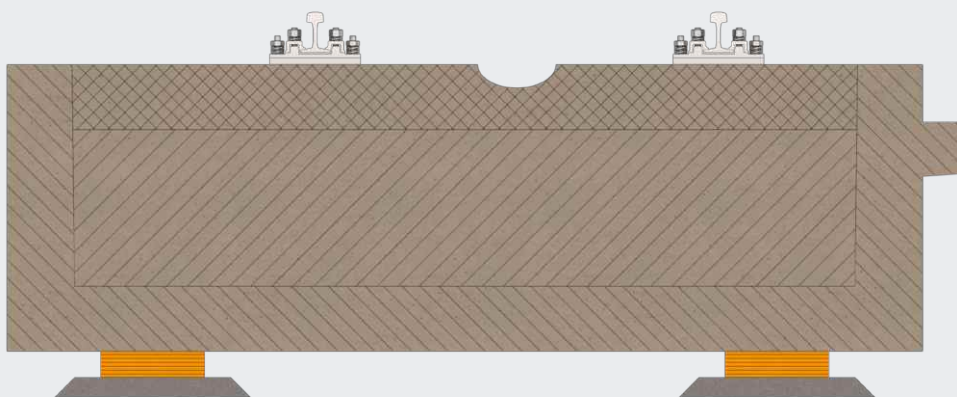
"The one-of-a-kind 'Goldener Saal' demanded particularly careful planning, component selection and implementation to satisfy the Musikverein's extremely stringent immission protection requirements."



Dr. Andreas Oberhauser
Superstructure | Head of Department
WIENER LINIEN GmbH & Co KG

Advantages for customers

- No noticeable noise or vibration immissions due to underground traffic
- Constant spring characteristics of the mass-spring system with discrete Sylodyn® bearings even after 17 years of operation



Cross-section of the mass-spring system with Sylodyn® discrete bearings

Facts and figures

Operating company:	WIENER LINIEN GmbH & Co KG
Implemented:	2002
Scope of the order:	192 bearings along a length of 100 m (lateral and longitudinal clearance of 2 m)
Solution:	Mass-spring system, Sylodyn® NE, dimensions 430×370×100 mm, natural frequency 5.5 Hz
Load:	450 million metric tons in 17 years of operation (as of 2019)
Getzner Project Manager:	Markus Heim
Project support:	Steinhauser Consulting Engineers ZT GmbH, Vienna

Getzner Werkstoffe GmbH

Founded:	1969 (as a subsidiary of Getzner, Mutter & Cie.)
Chief Executive Officer:	Jürgen Rainalter
Employees:	490 (of which 360 in Buers)
Turnover in 2020:	EUR 105.5 million
Business areas:	Railway, construction, industry
Headquarters:	Buers (AT)
Locations:	Peking, Kunshan (CN), Munich, Berlin, Stuttgart (DE), Lyon, Paris (FR), Pune (IN), Amman (JO), Tokyo (JP), Charlotte (US), Melbourne (AU)
Ratio of exports:	91 percent

Railway references (extract)

- Römerberg tunnel (AT)
- Cologne north-south link (DE)
- CEVA Zone Rolex (CH)
- Doha Metro (QA)
- Crossrail C610 London (GB)
- São Paulo Metro L5 (BR)
- Chiclana-San Fernando (ES)