

## SUB BALLAST MATS & BEARINGS FOR MASS-SPRING SYSTEMS

made of rubber granulate & polyetherurethane foam

Products for reducing noise and vibration emissions in the rail sector



MADE IN GERMANY



## KRAIBURG HOLDING

GLOBAL PLAYER IN ELASTOMERS

### Rubber mixtures

*Ideas and solutions  
in rubber compounding*

Gummiwerk KRAIBURG GmbH & Co. KG, D  
KRAIBURG Bulgaria EOOD, Bulgaria  
KRAIBURG Rubber Co. Ltd., Korea  
KRAIBURG Rubber (Suzhou) Co. Ltd., China

### Composite applications

*Rubber improves composites*

Gummiwerk KRAIBURG GmbH & Co. KG, D

### TPE compounds

*Custom-engineered TPE & more*

KRAIBURG TPE GmbH & Co. KG, D  
KRAIBURG TPE Corp., USA  
KRAIBURG TPE (M) SDN, BHD, Malaysia  
KRAIBURG TPE China Co. Ltd., China  
KRAIBURG TPE (Shanghai) Co. Ltd., China  
KRAIBURG TPE Pvt. Ltd., India  
KRAIBURG TPE Italia Srl, Italy  
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### Tyre retreading materials

*We power your retreads*

KRAIBURG Austria GmbH & Co. KG, Austria

### ERGOLASTEC® Anti-Fatigue Matting

KRAIBURG Austria GmbH & Co. KG, Austria

### Flooring systems for animal housing cattle/pig/camel BELMONDO® Rubber Floorings for Horse Farms

Gummiwerk KRAIBURG Elastik GmbH & Co. KG, Germany

### STRAIL® Track Crossing Systems STRAIL®astic Track Damping Systems

KRAIBURG STRAIL GmbH & Co. KG, Germany  
STRAIL® France S. A. S., France

### Products made from PU foam for construction, transportation, railway, automotive and health care

KRAIBURG PuraSys GmbH & Co. KG, Germany

### Building protection, acoustic and vibration isolation, construction and railway, impact protection, sports floor coverings,

KRAIBURG Relastec GmbH & Co. KG, Germany

### EPDM granules for elastic floor coverings

Gezolan AG, Switzerland

### Rubber rollers and roller coverings

KRAIBURG Walzenfertigung GmbH, Austria



DAMTEC® Project  
Wiener Linien, Austria

## KRAIBURG PRODUCTS IN THE RAILWAY SECTOR

### WORLDWIDE EXPERIENCE IN THE RAILWAY SECTOR



**KRAIBURG Relastec - Expert**

**solutions for acoustic and vibration reduction**

**in railway transportation**

For more than 40 years, the KRAIBURG group has been dealing with solutions for reducing emissions in the rail sector. As part of KRAIBURG Holding, KRAIBURG Relastec and its DAMTEC® division has specialised in ballast mats and bearings for mass-spring systems on sand can look back on nearly 20 years of experience.

Consequently, KRAIBURG Relastec has been established on the international market for a long time as a result of many projects using DAMTEC® products to solve acoustic and vibration problems caused by railway transportation.

DAMTEC® products have been tested against the often very stringent requirements at recognised external testing institutes and meet the approval criteria of the Deutsche Bahn.

KRAIBURG Relastec is of course certified to ISO EN 9001, thus guaranteeing consistently high quality and total traceability of its products. The company has also been certified and audited by DB and also approved as a supplier.



**DB Netz AG**  
HEADQUARTERS

**Approval (series / user approval)**  
- As instructions in accordance with general guideline 138.0202 –  
**TN: 4-2015-10511 I.NPF 1**

<b>Subject-related guidelines:</b>	804 820 824

**TN title / Action required:**  
**4-2015-10511 I.NPF 1 re. Guidelines 804,820,824: DAMTEC SBMK10V sub ballast mat from KRAIBURG**

Enactment on:	13.07.2015		
Deadline for			
Feedback by:		To:	

This TN comprises pages 1 to 2 (excluding enclosures).

Co-signature:		Specialist line:	
I.NPF 1	<input checked="" type="checkbox"/>	signed 06.07.2015	LST <input type="checkbox"/>
I.NPF 2	<input checked="" type="checkbox"/>	signed 30.06.2015	Tk <input type="checkbox"/>
	<input type="checkbox"/>		EA <input type="checkbox"/>
	<input type="checkbox"/>		Superstruc <input checked="" type="checkbox"/>
	<input type="checkbox"/>		Carriagew <input type="checkbox"/>
	<input type="checkbox"/>		KIB <input type="checkbox"/>
	<input type="checkbox"/>		Operations <input type="checkbox"/>
	<input type="checkbox"/>		Other <input type="checkbox"/>

**Approved by:**  
signed





## REDUCING ACOUSTIC AND VIBRATION EMISSIONS

### GENERAL EXPLANATION OF TERMS

**Sound** (German "Schall" from Old High German: scal) is the term generally used for noise as it can be perceived audibly by humans through the sense of hearing. Sound represents the propagation of the smallest pressure and density fluctuations in an elastic medium (gases, liquids, solids).

**Noise** (German "Lärm", derived from Alarm, from the Italian call to arms "all'arme"; also disorganised noise) refers to sounds that by their structure have a disruptive, irritating or harmful effect on the environment. Whether sounds are consciously perceived as noise depends particularly on the assessment of the sound source by the listener.

**Airborne sound** is caused by sound waves that propagate through the air. In physiology, this is called air conduction. Airborne sound consists of pure longitudinal waves, since fluids (gases) do not transmit shear forces. In a narrower sense, the term "airborne sound" is used for the frequency range of human hearing that begins at about 16 Hz, with an extreme upper limit of 20 kHz depending on age.

**Structure-borne sound** is sound that propagates in a solid object. This includes various phenomena such as tremors and earthquakes, the transmission of vibrations in buildings, vehicles, machinery, etc., or the ultrasonic waves used for material testing.

**Active isolation (emission)** is the reduction of the transmission of vibrations of an machine or other source into the environment directly at the source.

**Passive isolation (immission)** is the shielding of machines, equipment or buildings against vibration influences from the environment.



**DAMTEC® VIBRATION ISOLATION**  
for the construction industry





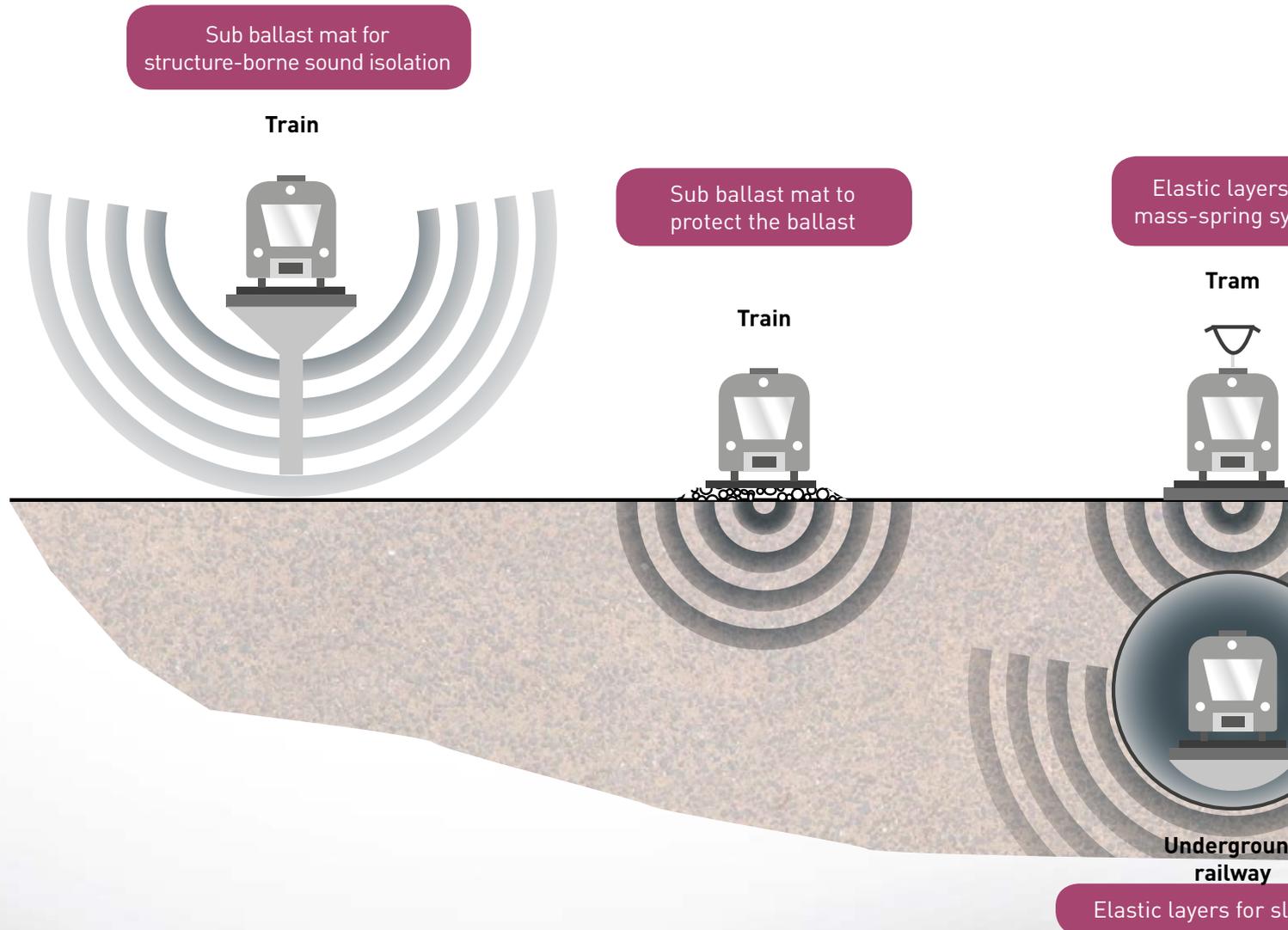
## REDUCING ACOUSTIC AND VIBRATION EMISSIONS

### NOISE SENSITIVITY AND PERCEPTION

	Source of noise	Sound power W	Sound level dB
Acute, irreversible damage	Saturn rocket	100,000,000	200
	Jet fighter engine	100,000	170
	Jet plane taking off	1,000	150
	Propeller plane taking off	100	140
Pain threshold	Machine gun	10	130
	Orchestra Jet fighter from passenger ramp Heavy thunder	1	120
	Accelerating motorcycle Heavy metal, hard rock concert Chainsaw	0.1	110
Danger to the ears	Car at highway speed Helicopter, passing train at distance of 25 m	0.01	100
	Traffic jam in the city Aircraft cabin during normal flight	0.001	90
	Alarm clock	0.0001	80
Impact on communication	Toilet flushing Loud office	0.0001	70
	Restaurant/Canteen Hairdryer	0.00001	60
Audibility threshold	Quiet office	0.000001	50
	Quiet home Birds chirping	0.0000001	40
	Quiet conversation	0.00000001	30
	Rustling of leaves Whispering	0.000000001	20
	Breathing	0.0000000001	10

Rail transport is a major source of noise. Representative surveys show that a third of the population feels disturbed or bothered by noise caused by rail transport. "Hot spots" along the railway routes with high freight traffic are especially problematic. A primary goal of improving the quality of life is therefore to reduce noise emissions through appropriate measures both in the planning and expansion of railway tracks, as well as the existing rail network.

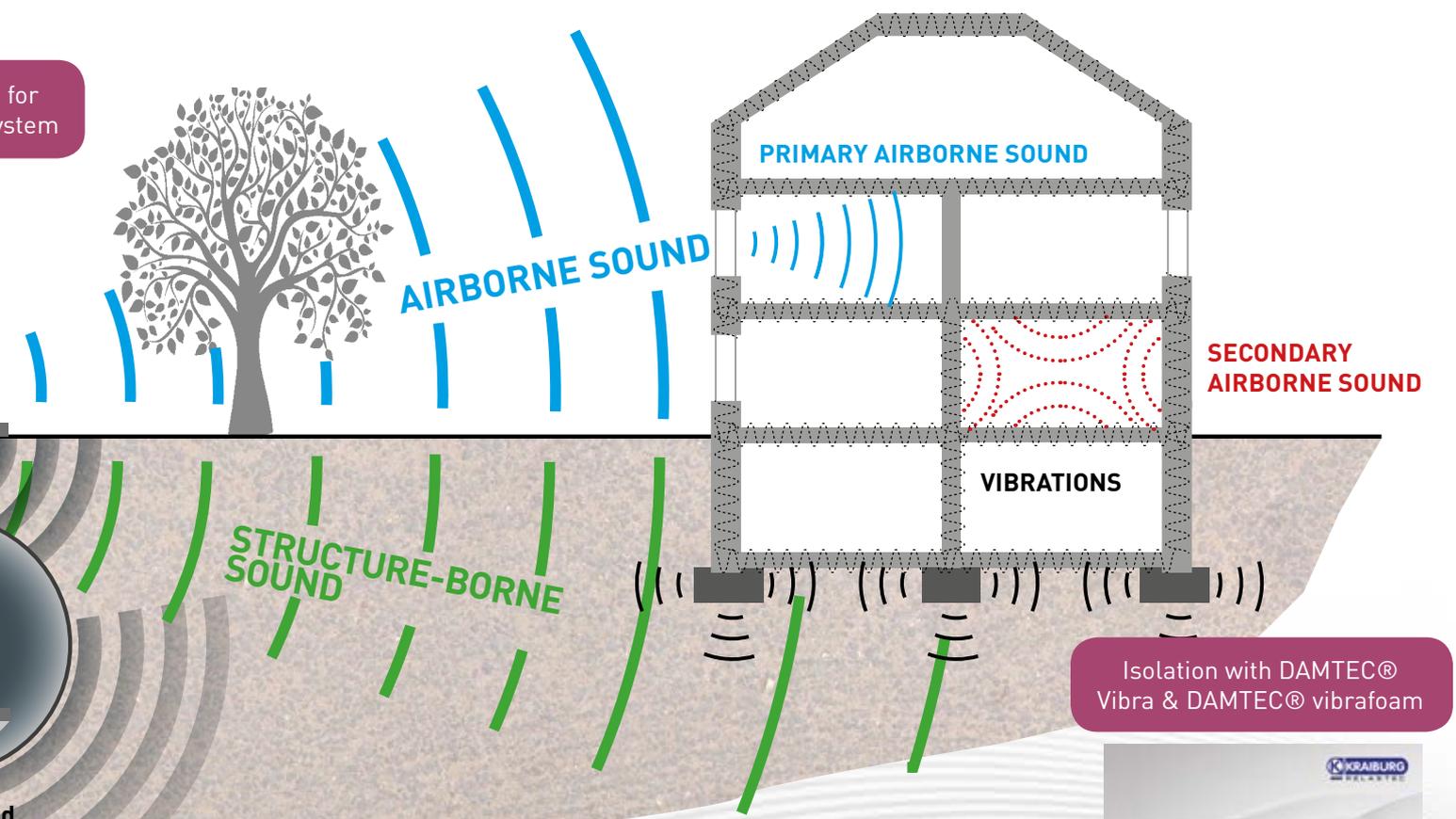
Rail vehicles generate rolling noise and vibrations during vehicle operation. The reasons for this are roughness and imbalance both on the wheels and on the rail running surfaces. Surface defects such as head checks, grooves and rail corrugations on the rails are among the most common sources of disturbance.



**Typical sources of acoustic and vibration emission and the generation and effect of primary and secondary immissions by rail transport**

These vibrations are transmitted to the substrate via the track system and spread out from there as structure-borne sound. If buildings are located beside or in close proximity to the track system, a transfer also takes place via their foundations. The buildings begin to vibrate, and if this becomes intense enough, it is also perceived by the people as a noticeable vibration or disturbing noise.

Another consequence of this transmission chain is the emission of vibrations from parts of buildings, for example ceilings and walls, to the environment. This takes place through the air, which itself starts to vibrate and then becomes audible as "secondary airborne sound".

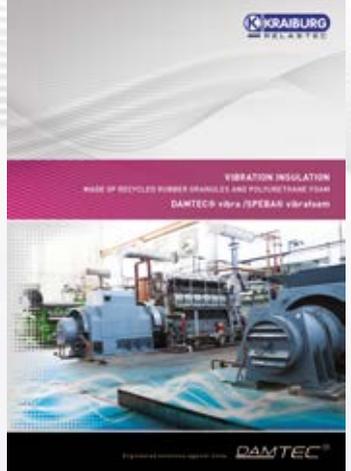


for  
stem

Isolation with DAMTEC®  
Vibra & DAMTEC® vibrafoam

ab track

**DAMTEC® VIBRATION  
INSULATION  
for the  
construction industry**





DAMTEC® Sub Ballast Mat K  
(rubber granulate)

**DAMTEC® MATERIALS**

REDUCING ACOUSTIC AND VIBRATION EMISSIONS



DAMTEC® vibrafoam® &  
DAMTEC® vibradyn®  
(Polyetherurethane)

**DAMTEC®** rubber and elastomer products **DAMTEC® Sub Ballast Mat K**, **DAMTEC® vibrafoam®** and **DAMTEC® vibradyn®** consist of a special rubber compound, a cellular polyetherurethane foam with open or closed pores. These products can be used to minimise both static and dynamic forces occurring during vehicle operation. They effectively counteract the multifrequency oscillations and vibrations that are transmitted to the environment.

**DAMTEC®** products for track construction are made of high quality elastomer materials. With the exhaustively tested formulas, the products meet specific requirements associated with the stresses and strains in the track area. **DAMTEC®** is produced in rolls or sheets, and can therefore be used as a point, strip or surface layer.

These elastomeric materials are also used in other demanding fields, such as civil engineering and tunnelling. Particularly noteworthy is the long-term performance that ensures consistently high effectiveness for decades.

In this way, these products counteract the multifrequency oscillations and vibrations that are transmitted to the environment.

### **DAMTEC® Sub Ballast Mat K**

High quality rubber granules, granules made of foamed rubber and polyurethane are used as part of the waste management cycle for this product. Only good-as-new material that originates from faulty batches or punching waster is used. As a result, any aging effect on the rubber granules can be ruled out. Here in particular, end-of-life tyres are not used.

### **DAMTEC® vibrafoam® and DAMTEC® vibradyn®**

**DAMTEC® vibrafoam®** (made of open-cell PU foam) and **DAMTEC® vibradyn®** (made of closed-cell PU foam) are cellular elastomers and consist of a special polyetherurethane. **DAMTEC® vibrafoam®** elastomers have excellent properties both as a compression-loaded and thrust-loaded springs. Basic types with various properties are available for nearly every application case. Adaptation to individual application cases is simple and is done by selecting the **DAMTEC® vibrafoam®** type, the shape and the contact area.



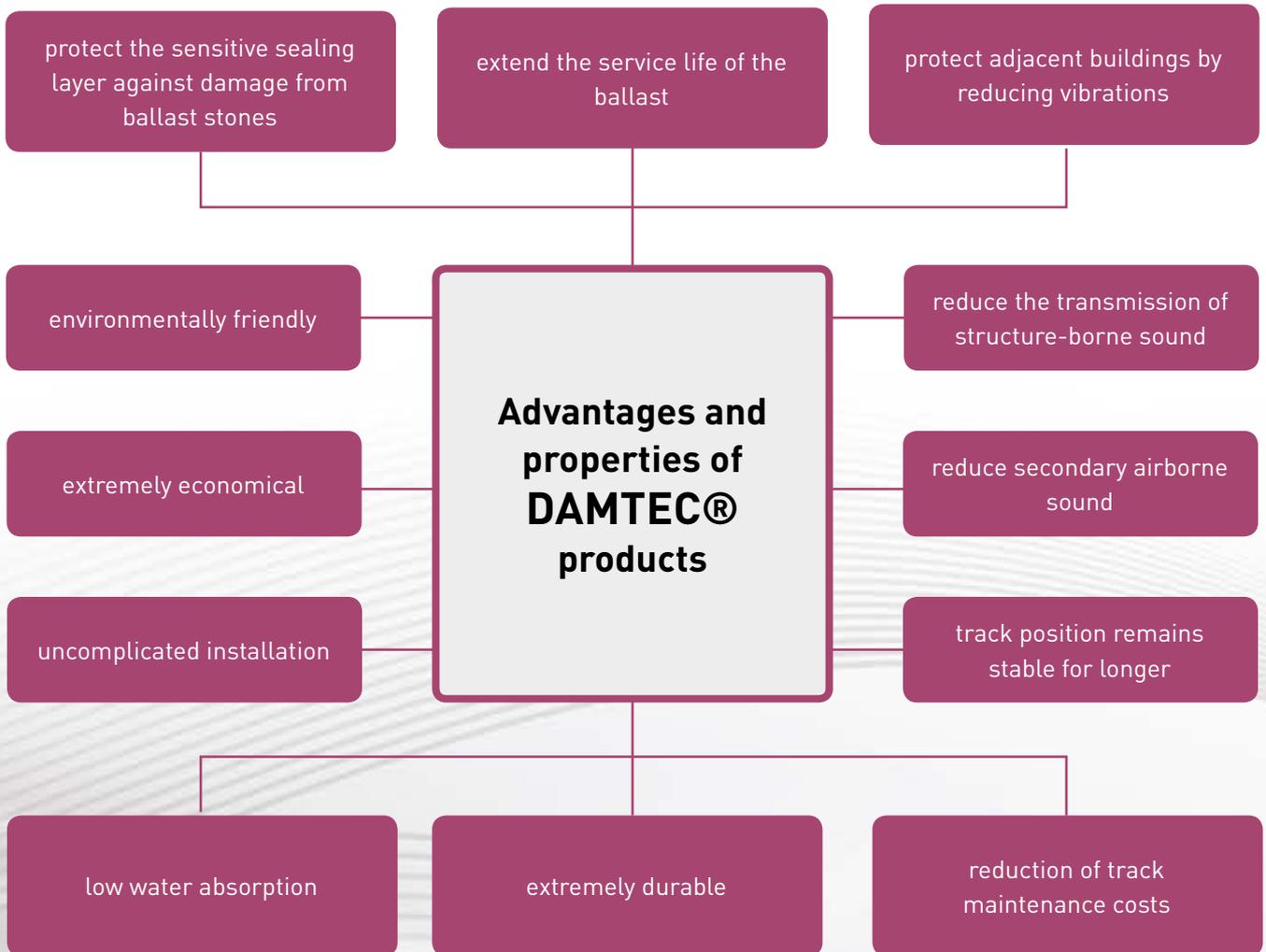


**PROPERTIES, PERFORMANCES AND APPLICATIONS**  
REDUCING ACOUSTIC AND VIBRATION EMISSIONS



DAMTEC® Project  
Ostkreuz, Berlin, Germany

## PROPERTIES AND ADVANTAGES OF DAMTEC® PRODUCTS





DAMTEC® Project  
Berlin Hauptbahnhof, Germany

## OUR COMPREHENSIVE SERVICES FOR YOU WE SUPPORT YOU THROUGHOUT THE RAIL PROJECT

### Solution development & detailed solutions

Our many years of experience and know-how with products for noise and vibration reduction are a guarantee for solving even the most complex problems. Together with you, our specialists will develop effective systems for eliminating or minimising disturbing factors in the problem areas. Besides standard solutions based on experience, of course we have the personnel and technical capabilities to create completely new solutions that are precisely matched to your requirements.

### Calculations, simulations and efficiency forecasts

You do not have to wait until the measures have been implemented to find out how successfully they are dealing with an emission problem. After a first inspection and analysis of the local conditions, our specialists are capable of initially creating a mathematical model, in which all relevant factors relating to vibration generation and damping behaviour are taken into account for different material properties. This results in a realistic simulation that allows fine tuning of these factors and enables our engineers to develop the optimum solution. At the end of the planning stage, you will receive proof of the expected effectiveness of the system. This efficiency forecast gives you the assurance in advance that your expectations will be met successfully.

### All services at a glance

- Material testing and measurement on our large in-house test bench
- Project support from the start
- Installation consulting and acceptance
- Vibration-related, mechanical and acoustic measurements
- Solution development
- Detailed solutions
- Calculation and simulation
- Effectiveness forecasts



## TYPES OF TRACK DESIGN

### BALLASTED AND SLAB TRACKS - USING ELASTIC ELEMENTS

Track systems for rail transportation consist of tracks, switches, junctions and railway crossings. Construction can be divided roughly into three levels: **superstructure**, **substructure** and **substrate**, in which the superstructure can also be divided further into **ballasted** and **slab track**. The substrate can be an earth structure or an engineered structure (bridge, tunnel). Figures 01 and 02 show the schematic structure of both superstructure constructions and the possible applications of elastic elements to reduce sound and vibration emissions.

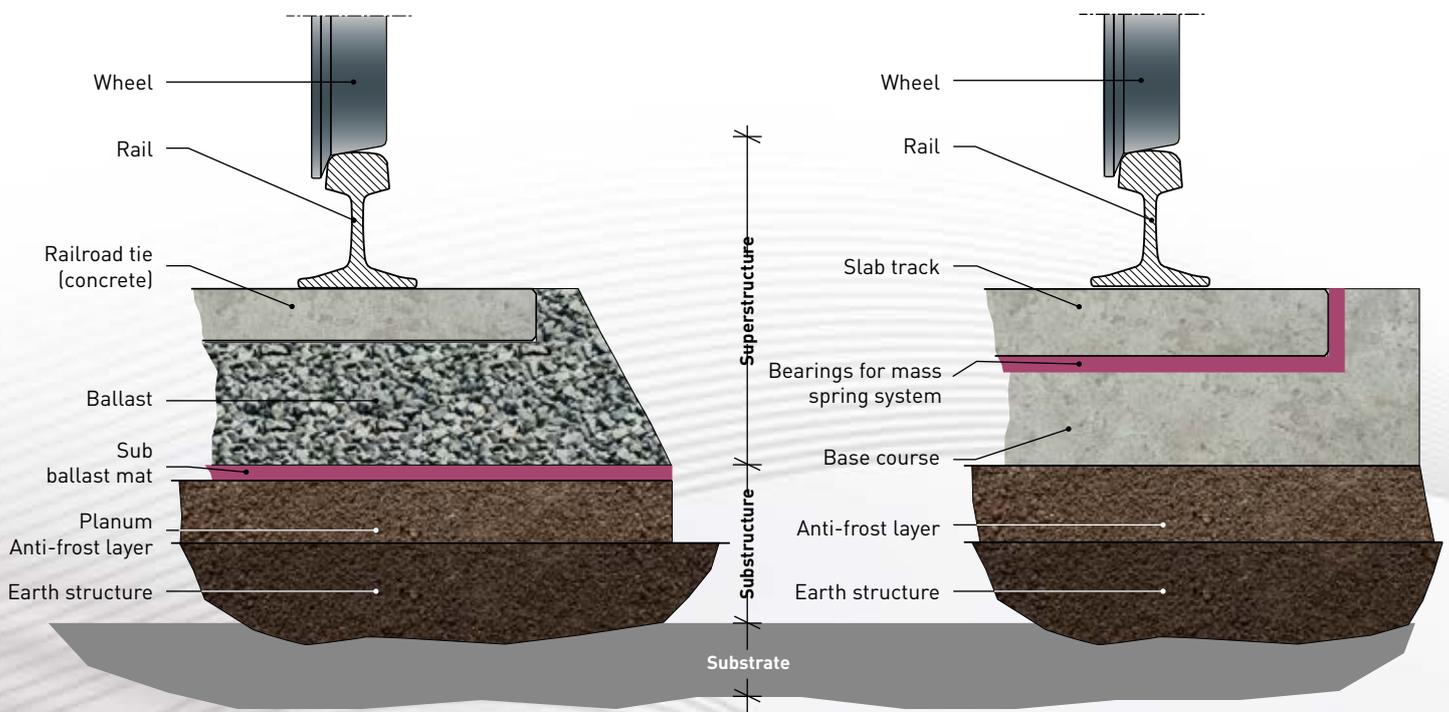


Figure 01: Use of elastic elements in the ballasted tracks

Figure 02: Use of elastic elements in the slab track



DAMTEC® Project  
Hauptbahnhof, Berlin, Germany

## DAMTEC® SUB BALLAST MAT K, DAMTEC® VIBRAFOAM® AND DAMTEC® VIBRADYN® APPLICATION TYPES

### APPLICATION TYPES

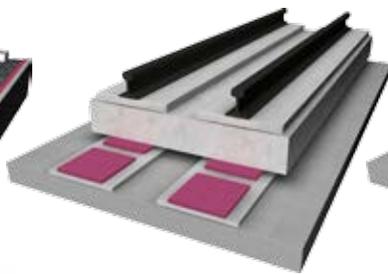
#### Sub Ballast Mat

Sub ballast mat combined with side mat

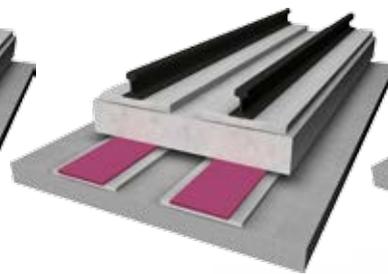


#### Mass-Spring System

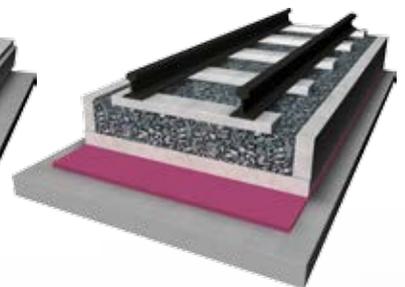
Point-like support



Strip-like support



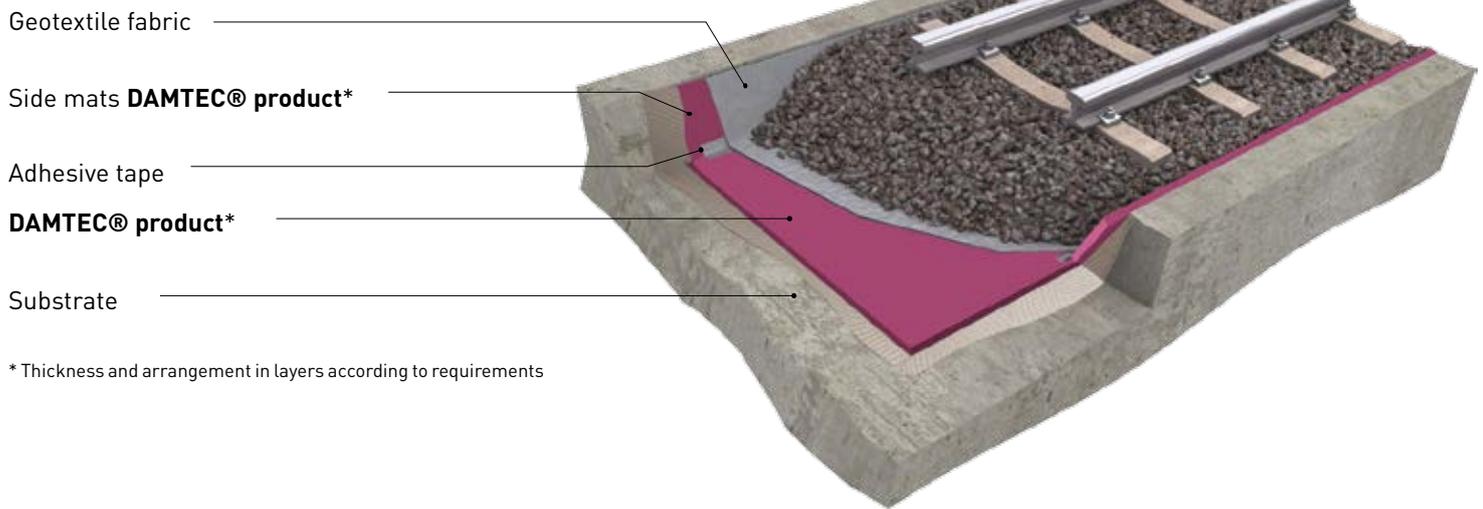
Area support



#### Typical field of application:

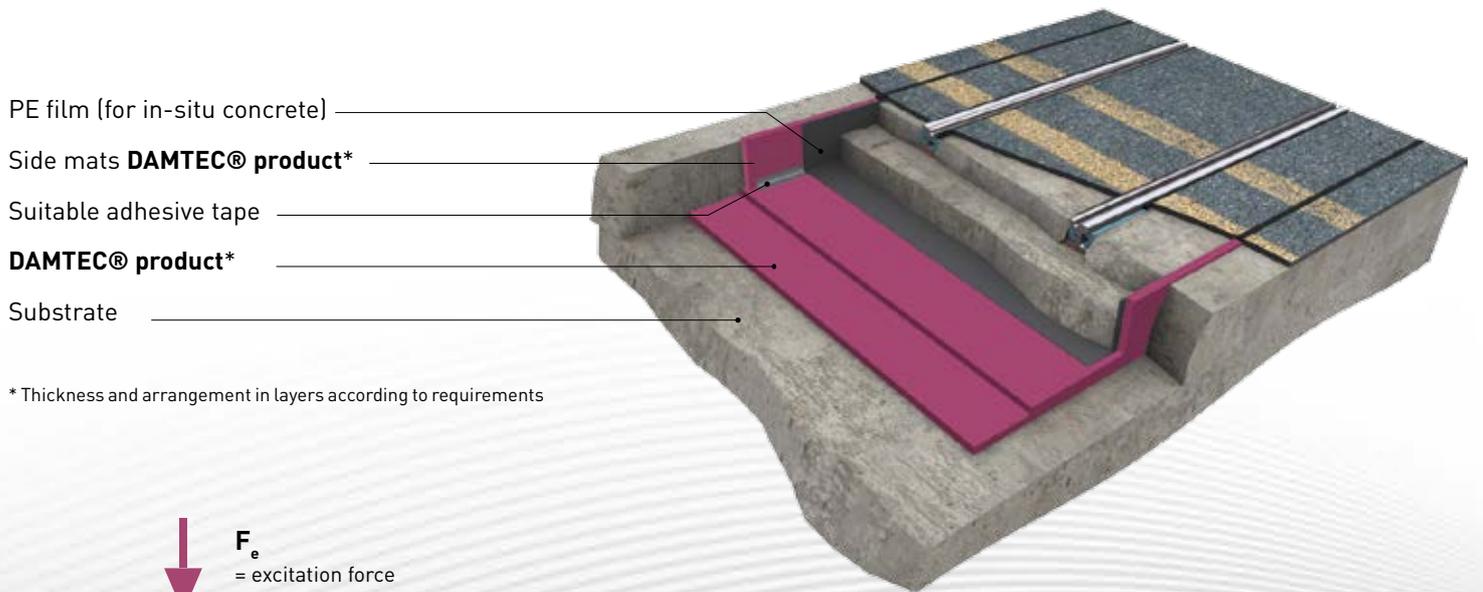
- Structure-borne noise isolation on track systems in urban centres, especially in the immediate vicinity of buildings
- Reducing the noise and vibration emission to buildings with particularly high requirements for noise prevention (for example, opera houses, concert halls, test institutions, hospitals)
- Protecting against low-frequency vibrations caused by space-limiting surfaces (secondary airborne sound)
- Stabilising track constructions; particularly in high-traffic routes

Embedding the mass-spring system in our DAMTEC® products reduces the peak pressure in the track ballast, allows the track geometry to remain stable for longer and effectively reduces structure-borne sound.

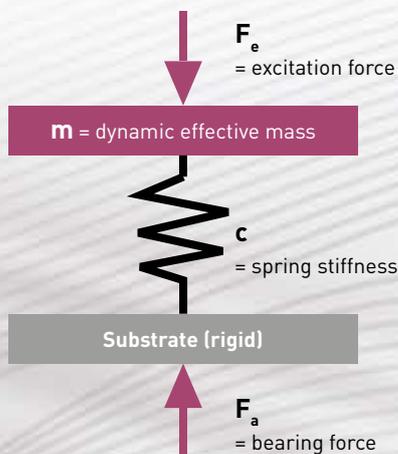


\* Thickness and arrangement in layers according to requirements

Embedding the entire track system into **DAMTEC®** products creates a mass-spring system that with the appropriate dimensions acts as highly effective acoustic and vibration isolation. This effect also occurs with complicated track geometries. In mass-spring systems, **DAMTEC®** products are installed at points, in strips or covering the whole area. The mass-spring systems in the form of track supporting layers and track troughs are generally individual solutions that we are happy to work out for you.



\* Thickness and arrangement in layers according to requirements



If an external force acts on the mass  $m$ , it causes the mass to vibrate at its natural frequency  $f_0$ .

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{c}{m}}$$

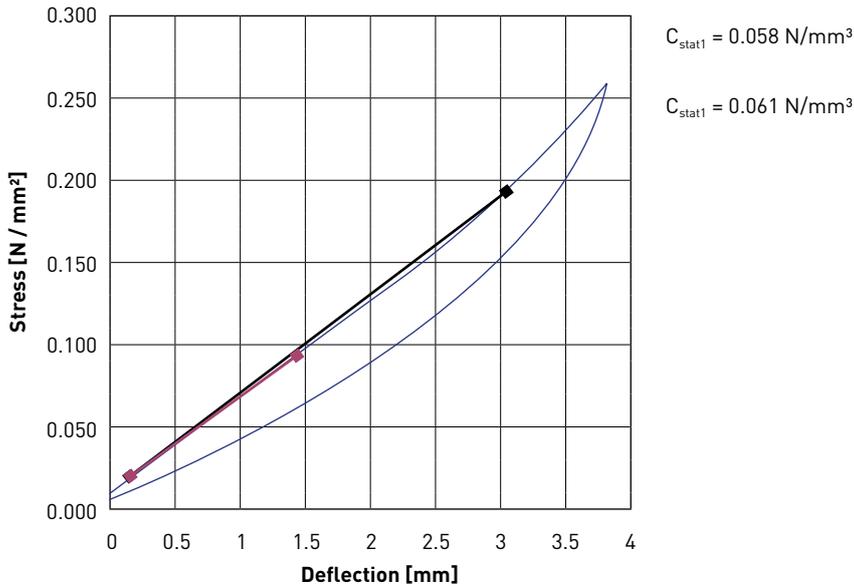
### Mass-Spring System

The interaction between an inertial mass (slab track) with elastic elements (spring) has the effect of isolating the vibration. Therefore one refers to a "mass-spring system" for these kinds of construction. A crucial factor for effectiveness is the exact tuning between mass and stiffness and the spring dynamics of elastic members. This is referred to as the tuning frequency  $f_0$  [deepest vertical natural frequency of the superstructure system that is elastically spring-mounted on the substructure]. These relationships can be explained very well using the model of the "single-mass oscillator".

### Static bedding modulus

With bedding theory, the track is imagined as an infinitely long rod that is laid on a continuous, elastic base. The bedding modulus is the elasticity value of the whole system, rail - railroad tie - ballast - substructure - substrate, and is used to estimate the static deflection of the operating load. This quantity is a measure of the stiffness that must be determined experimentally. The static bedding modulus basically indicates how deep the rail sinks under slow traffic conditions or a stationary train.

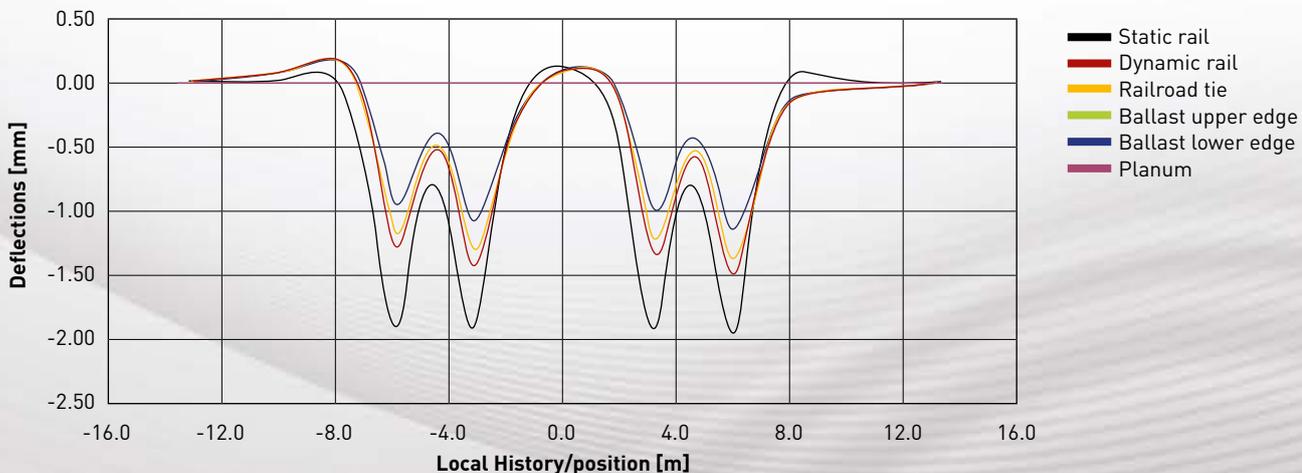
The bedding modulus is the ratio of the stress to the deflection. Usually, the secant modulus is measured, for example, between 0.02 N/mm<sup>2</sup> and 0.10 N/mm<sup>2</sup>. Alternatively, the tangent modulus can be determined.



### Deflection

A distinction must be made between the deflection and subsidence of the elastomer and the rail deflection. The deflection can be determined using the spring characteristics and is the distance in millimetres by which the material is compressed under a certain tension.

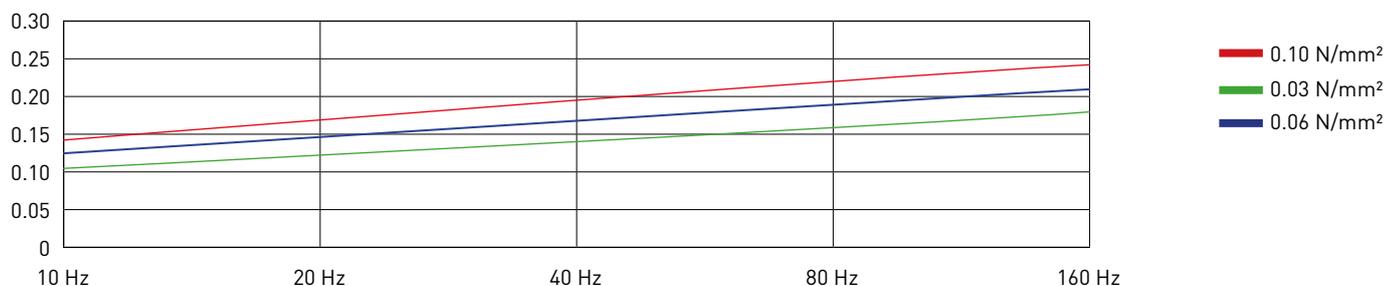
The rail deflection when in use takes into consideration the stiffness in the track superstructure from the vehicle to the substrate. It is calculated statically for the stationary and dynamically for the moving train. Depending on speed, axle load, superstructure type, sub-type and DAMTEC® type, the deflection is usually between 1 mm and 3 mm.



## Dynamic bedding modulus

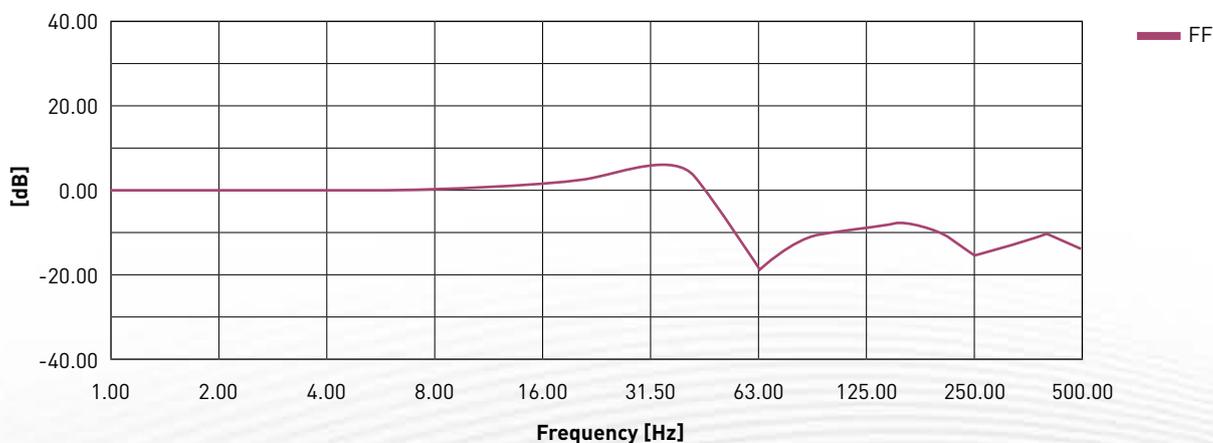
A distinction must be made between the low-frequency (superstructure dynamics) and the high-frequency dynamic bedding modulus (damping of structure-borne noise). With the first-mentioned characteristic value, the bending deformation of the rail under the rolling wheel can be estimated from the interaction of bending elasticity of rails and railroad ties, including ballast.

The higher-frequency dynamic bedding modulus of a ballast mat influences the natural frequency of the elastically mounted superstructure as a vibratory system as a whole and thus the insertion loss. The test is performed with a static preload.



## Insertion loss

The insertion loss  $\Delta L_e$  (in dB) is a characteristic value that expresses the extent to which inserted measures contribute to reducing the structure-borne noise introduced into a system. The insertion loss  $\Delta L_e$  is the ratio of the structure-borne sound power "without installed measures" to "with installed measures". It is a characteristic value of the entire system - from the vehicle to the substructure.



## Forecast calculations

Since the mechanisms for the generation and propagation of structure-borne sound associated with rail transport are widely known, the expected effect of mitigation measures can be calculated in advance after a thorough evaluation of the system in the way they are to be used. There are many tried and tested calculation models available for this purpose. The combination of advanced materials that meet all modern requirements for effective sound and vibration protection, as well as the vast experience in implementing more effective measures make DAMTEC® the ideal partner for sound and vibration reduction in the railway sector.



DAMTEC® Project  
Wiener Linien, Austria



DAMTEC® Project  
Harbour Bridge, Sydney



DAMTEC® Project  
Berlin Hauptbahnhof, Germany

# KRAIBURG reference products in the railway sector

**DAMTEC® Project**  
Lichterfelde, Berlin, Germany



**DAMTEC® Project**  
Lichterfelde, Berlin, Germany



**MADE IN GERMANY**



**DAMTEC® Project**  
Chaussee de Charleroi, Brussels, Belgium



**DAMTEC® Project**  
Lichterfelde, Berlin, Germany



## ENVIRONMENTAL MANAGEMENT AT KRAIBURG RELASTEC

### HIGH QUALITY PRODUCTS MADE OF RUBBER, PRODUCED IN HARMONY WITH NATURE

**KRAIBURG Relastec** is one of the most famous and important specialists in the recycling of industrial rubber materials worldwide. In a long tradition of commitment to the environment, we recycle about 85,000 tons of cellular rubber, spew and punchings made from rubber materials per year for the purposes of the rubber cycle. More than 90% of the raw material basis is used for our finished products. From this we manufacture high quality rolls and sheet goods according to proprietary formulas developed in-house. All products are fully recyclable and are fed back into the manufacturing process with no loss of quality.

At **KRAIBURG Relastec**, environmental protection is a key strategic role. We are fully aware that sustainable growth is only possible if we meet our obligations and responsibilities with regard to environmental protection. Therefore, **KRAIBURG Relastec** has developed a systematic approach for this: Environmental protection is part of our daily routine!

Our environmental logo "**pro environment**" not only stands for 40 years of sustainable and consciously lived use of our resources and high product quality, but also for our unceasing commitment to continuous improvements in environmental performance beyond legal requirements.



-  We process excess rubber materials to make a new raw material and new products, and so make a valuable contribution to environmental protection.
-  We are committed to investing in environmentally friendly production.
-  Our products are subject to continuous testing and further development in terms of environmental protection and we are continuously looking for more environmentally acceptable alternatives to further reduce emissions and conserve resources.
-  All employees of **KRAIBURG Relastec** are committed to implementing an environmentally friendly operation.
-  Our suppliers are also subjected to continuously monitoring.



DAMTEC® Project  
Wiener Linien, Austria

## DAMTEC® ACOUSTIC AND VIBRATION ISOLATION

### FURTHER INFORMATION

Under the brand name **DAMTEC®** our customers can find a variety of products for sound reduction and vibration isolation for various requirements and areas of application. Additionally, brochures on these areas are available for you which we will be happy to provide on request, Additional information can also be found on our website [www.kraiburg-relastec.com/damtec](http://www.kraiburg-relastec.com/damtec)



- Flyer

**DAMTEC®  
INSTALLATION  
UNDERLAYS**  
for all floor coverings
- Brochure

**DAMTEC®  
IMPACT SOUND**  
solutions  
for above and  
below  
floor screed
- Brochure

**DAMTEC® system**  
Solutions for  
timber beam ceiling  
constructions
- Brochure

**DAMTEC®  
VIBRATION  
ISOLATION FOR  
CONSTRUCTION**
- Brochure

**DAMTEC®  
IMPACT SOUND  
INSULATION UNDER  
FLOOR SCREED**

**DAMTEC<sup>®</sup>**

**SOUND AND  
VIBRATION ISOLATION**  
made of recycled rubber granulate

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