

RAILWAY INDUSTRY MAGAZINE

International Solutions for the Railway Industry



6 Partnership with Potential
What began between Bellotti and
Angst+Pfister at the InnoTrans 2012,
is soon to be seen worldwide

10 For Passengers' Comfort
Air-conditioning equipment on the
carriage roof, dampening vibration,
but still very securely installed

14 High Economic Viability
Sophisticated fluid technology reduces
the weight, simplifies installation
and increases the service life

Editorial



Dear readers and valued customers,

When I catch the train to work early in the morning, I am always deliberately aware of the vibrations under my feet. The amount of vibration and acoustic noise that my fellow passengers and I feel and hear depends on factors such as the state of the track superstructure, the bogie suspension, the floating floor construction and, last but not least, the number of passengers.

We at Angst+Pfister can do a lot to enhance the comfort and safety of train passengers as well as to extend the service life of rail vehicles and entire track systems.

To isolate the vibrations of moving trains and to absorb shocks caused by wheel and rail surface irregularities, we manufacture floor suspension elements made of PUR, CR or EPDM, for example. Our engineers, specialized in antivibration technology, work together with clients to develop customized solutions precisely tailored to their needs.

Practically all of our solutions already comply with the new pan-European fire protection standard EN45545, which entered into force in October 2013, replacing the respective national safety regulations of the individual EU member states. Our antivibration solutions for floating floors, and our window profiles as well, are fire- and smoke-resistant in accordance with EN 45545. We are experienced in maneuvering through oftentimes complicated certification processes and are not daunted by this task even with regard to other regions and countries.

One major European rail vehicle manufacturer has entrusted us with developing safety-relevant elastomeric components for bogies. After successful trial testing, these parts are now being installed in prototype vehicles. We expect series production to begin shortly.

However, vibration isolation starts in the track superstructure: with sub-ballast mats, under sleeper pads or mass-spring systems. We calculate, specify, test and produce track superstructure solutions with profound expertise and with the same commitment that we devote to railway vehicles.

Antivibration technology, engineering plastics technology – and just as equally sealing technology and fluid-handling technology, such as corrugated metal hoses for fuel or coolant lines. For every technology area, we staff a specialized international team of engineers that passionately and innovatively finds the right solution. And we have the global production platform that it takes to manufacture those solutions exactly in the desired quality. For another internationally operating rail vehicle manufacturer, we have just designed and produced a metal hose line system used to cool transformers that minimizes weight and maximizes production and operational efficiency as well as service life.

We are delighted to share our enthusiasm for well-engineered mobility with you. Turn the pages and read on!

Erich Schmid
Chief Technology Officer

Content



Solutions for the Railway Industry

Belotti
is building vibration-absorbing floors for the Milan metro and beyond, a co-development partnership **6**

Liebherr-Transportation Systems
installs air-conditioning equipment on the roof with the help of APSOVib® antivibration technology **10**

Bombardier
was looking for something more durable and chose the reliable ASSIWELL® metal hoses **14**

Stadler Rail AG
reduces weight and maximizes the cost-efficiency of double-decker trains with innovation plastic window profiles **18**

SNCF
uses railway sleeper pads which protect the sleepers and lower the life-cycle costs **28**

APSOPUR®
absorbs vibrations and noise, reduces the service and maintenance requirements and increases the service life **30**

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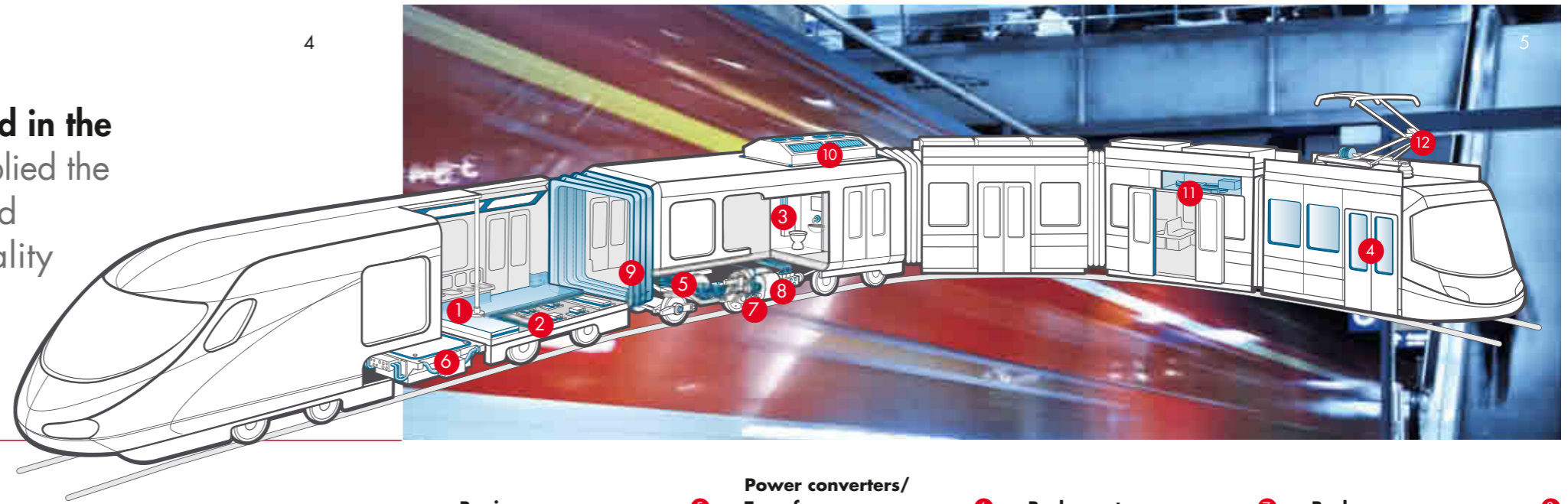
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Do you have any further questions on one of the topics in the magazine?

Please send an e-mail to engineering@angst-pfister.com or call +41 44 306 62 57. We will contact you immediately.

Ensuring smooth operation on the tracks and in the carriages Since 1953, Angst+Pfister has supplied the railway industry's leading manufacturers and operators with uncompromisingly high quality products and comprehensive engineering solutions.



Railway manufacturers, maintenance organizations and track installers all benefit from our long-standing industry experience and our engineering expertise. Industry leaders rely on Angst+Pfister for standard as well as custom-designed components that meet the highest technical specifications and railway norms. Let Angst+Pfister bundle all the components you need and ship them just-in-time to your international manufacturing facilities.

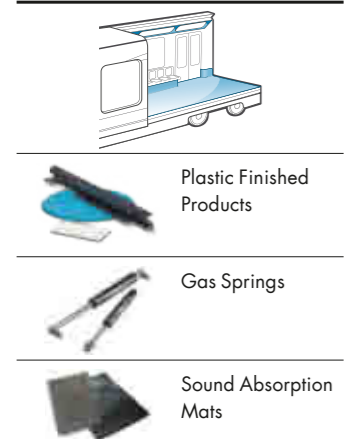
Engineering, standards and certifications Angst+Pfister's engineering team patents every year new products specifically designed for railway industry in the Antivibration, Sealing and Hosing product areas. Our solutions for railway are all compliant to

the most advanced and updated standards, such as DIN EN 45-545 or other nation-specific Smoke and Fire Standards. Our representatives take part in various Standards Committees to ensure our readiness for any upcoming technical requirement.

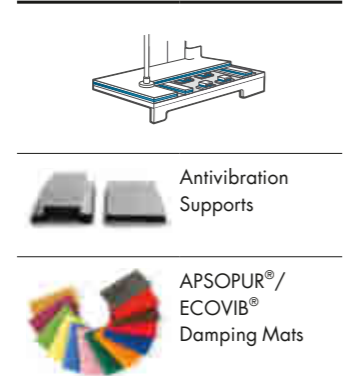
Our customers benefit from these competitive advantages through a solid partnership with Angst+Pfister which proves time and again that co-design projects are the best solutions to reduce Time-To-Market.

SNCF laboratories, TU Munich, LAPL and LNE: We test and certify our innovations at laboratories which are recognized globally for their expertise. Furthermore, we are proud of our Quality Management process, making Angst+Pfister a market leader in product conformity within the railway industry.

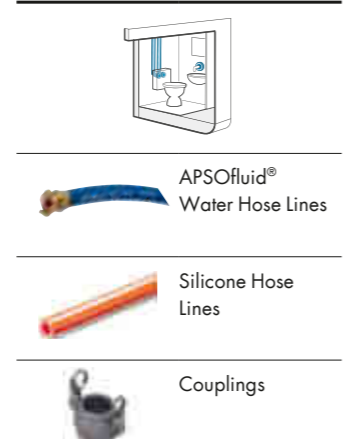
Floors and interiors 1



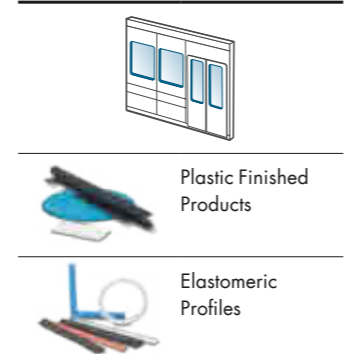
Floating floors 2



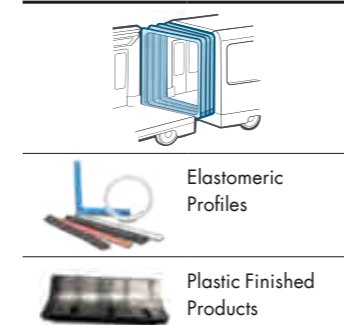
Bathrooms and fixtures 3



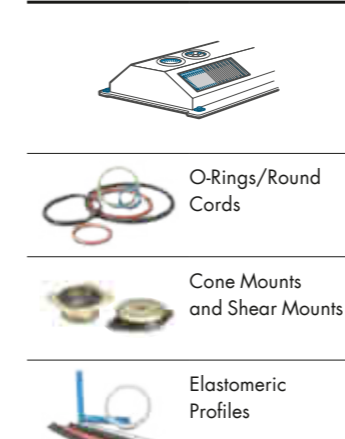
Windows and doors 4



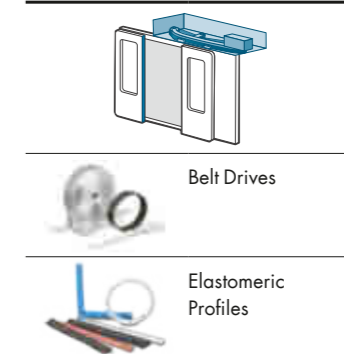
Train junctions 9



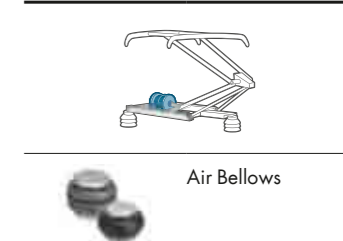
HVAC 10



Doors opening systems 11



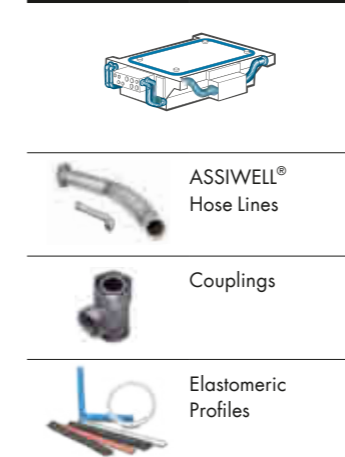
Pantographs 12



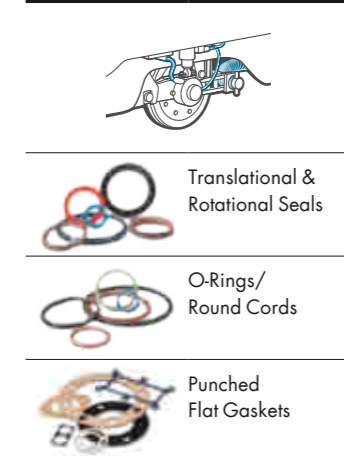
Bogies 5



Power converters/ Transformers 6



Brake system 7



Brake compressor 8





Milan World Expo 2015: a witness to an intensive partnership

A city is preparing to make history. A city is bringing the world together. Milan is building for the 2015 World Exposition. AnsaldoBreda S.p.A. is supplying state-of-the-art rolling stock for the extended Milan Metro lines M1 and M2, Bellotti S.p.A. is providing vibration-absorbing flooring for the subway trains, and Angst+Pfister is supplying the antivibration elements. The partnership between Bellotti and Angst+Pfister has its own history: a fast-paced and exciting one that spans multiple continents and is continually evolving.

Pietro Bellotti remembers it exactly. It was at the 2012 InnoTrans exhibition. The world's leading trade fair for transportation technology is a permanent fixture in the professional agenda of the chief executive officer of Bellotti S.p.A. So it was in Berlin, in September 2012, that he personally encountered Angst+Pfister for the first time. Bellotti S.p.A., which was founded in 1927 as a company anchored in the timber industry specialized in the production of plywoods, had already long since gotten involved in additional lines of business. "Our firm has been supplying the railway industry with floor panels for around 30 years now," Mr. Bellotti explains. But mere floor panels alone are not enough. That's why he enlisted the Rome-based AGT Engineering group several years ago as a partner to design the entire floor construction. And here's where the contact with Angst+Pfister comes in. A new vibration-damping concept is needed. Mr. Bellotti's

initial contact person, Angst+Pfister Italy's managing director Jean-Pierre Baroni, shows him examples of work done for railway technology suppliers like Siemens and Bombardier. The chemistry between Bellotti and Angst+Pfister resonates, and the companies start to collaborate shortly after the 2012 InnoTrans show.

The Copenhagen Metro: new solution for new trains. The timing is ideal because Mr. Baroni is already in contact anyway with AnsaldoBreda S.p.A. precisely in a matter concerning vibration isolation, one of Angst+Pfister's many specialties. The rolling-stock engineering specialist with production facilities in Naples, Reggio Calabria, Pistoia and Palermo is a subsidiary of Finmeccanica, one of the largest industrial groups in Italy, with 75,000 employees. AnsaldoBreda is gearing up to build 28 subway trains for the Metro in Denmark's capital city of Copenhagen. The trains consist of three articulated cars and, like all of the trains employed in Copenhagen's Metro system, will operate fully au-

Embarking on the next chapter

"The vibration-absorbing floor construction concept used in the trains also lends itself to yachts and cruise liners, and is suitable in general for boats, barges and ships. By isolating vibrations and noise, we enhance passenger comfort, on land and soon also on water.

So, together with Angst+Pfister, we are embarking on a new chapter in our partnership and creating possibilities that benefit both companies. Angst+Pfister's engineering solutions help us not only to penetrate the manufacturing sector of the railway technology industry more deeply, but also to develop new markets. That ultimately benefits both companies."

Pietro Bellotti, Managing Director,
Director of Transportation sector, Bellotti
S.p.A., Cernenate, Italy

"Angst+Pfister's engineering solutions help us to penetrate the railway technology market more deeply and to develop new markets. It's a win-win situation."

Pietro Bellotti, Managing Director,
Director of Transportation sector, Bellotti S.p.A.,
Cernenate, Italy



tomatically without any drivers. AnsaldoBreda was awarded the order for the carriage flooring along with the antivibration system to Bellotti.

Within the span of just one year, a partnership grows between Bellotti and Angst+Pfister based on mutual profound expertise and trust. This lays the foundation for their collaborative work for the Copenhagen Metro: the antivibration system from Angst+Pfister is integrated into the flooring supplied by Bellotti. The plywood floor panels with an integrated elastic, vibration-absorbing core layer rest on aluminum/vulcanized chloroprene rubber conical mounts that isolate the vibrations of the moving train and absorb shocks caused by wheel and rail surface irregularities. The conical mounts are screwed to the plywood floor panels and are adhesively bonded to an underlying metal frame. The floor panels effectively insulated this way are covered with a rugged rubber mat.

"Be it conical mounts or pads, chloroprene or polyurethane – we find the right technically sound solution for isolating vibrations."

Jean-Pierre Baroni, Managing Director,
Angst+Pfister Italy

EN 45545 fire and smoke resistance guaranteed The solution proposed by Bellotti, AGT Engineering and Angst+Pfister meets all of AnsaldoBreda's specifications. It is also fire- and smoke-resistant in compliance with the new European standard EN 45545, that has replaced the respective national safety regulations of the individual EU member states.

Milano Metro: Vibration insulation for 30 trains In parallel with the order for the Copenhagen Metro, the modernization of Milan's Metro lines M1 and M2 has moved onto the radar screen. The city in northern Italy is starting to get ready for Expo 2015. AnsaldoBreda is building 30 six-car subway

trains and holds an option for 30 more. And Bellotti once again is manufacturing the floor construction. So, whoever will be traveling on the Metro though Milan to the Expo grounds between 1 May and 31 October 2015, will assuredly be setting foot on a floor that provides smooth ride comfort with the help of antivibration elements from Angst+Pfister.

Work on Milan's M4 Metro line is also already underway, with 47 four-car subway trains envisaged for the line. AnsaldoBreda will once again leverage its expertise in building fully automated, driverless trains. And Bellotti, together with Angst+Pfister, will once again contribute its state-of-the-art solution. Meanwhile, Pietro Bellotti is already putting out feelers to South America. In the beginning, floor constructions accounted for only a few percentage points of Bellotti S.p.A.'s total sales, but today they generate one-fifth to a quarter of the company's consolidated revenue.

Supply chain: delivery to the deep south within 48 hours Jean-Pierre Baroni and his team frequently double-check the supply chain because that's also a part of Angst+Pfister's product and service offerings. As a precaution, Angst+Pfister's internation-

al logistics center in Embrach, Switzerland, always maintains a reserve stock of conical antivibration mounts. These are manufactured at the Angst+Pfister Group's own factory in Bursa, Turkey. Pietro Bellotti can thus always rest assured that Angst+Pfister controls the quality along the entire production process and is capable of delivering within 48 hours. Even to Reggio Calabria in the deep south of Italy where, at the AnsaldoBreda plant facility there, a Bellotti team installs the flooring systems in the trains.

Spaced at points or planar

"Society's mobility is directly linked to damping vibrations and noise: no tram, no subway, no regional train, and certainly no high-speed train can do without vibration isolation. The need for sophisticated, highly effective solutions will increase further in the years ahead as mobility further expands.

While some railway technology companies favor vibration isolators spaced at points, others prefer planar isolation elements. Be it conical mounts or pads, chloroprene or polyurethane – our engineering department devises the right technically sound solution in accordance with customers' wishes. We team up with the customer's engineering department right from the start, thus also minimizing development costs. Furthermore, Angst+Pfister staffs experts who are specialists in adhesive bonding of railway vehicles and parts, such as bonding elastomeric materials to aluminum, and we have the DIN 6701-2 certification to prove it."

Jean-Pierre Baroni,
Managing Director,
Angst+Pfister Italy



Carriage construction: Elastic mountings absorb vibrations and noise The field of railway carriage construction is discovering the benefits of rigid but elastic and malleable polyurethane: As a floor mounting, the elastomer isolates vibrations and absorbs noise. Siemens is currently at work in Vienna fitting 190 carriages with elastomer strips. Angst+Pfister has built up specific know-how in affixing these safety-relevant parts, and also places this expertise at the disposal of other customers.



The Angst+Pfister production facility in Zoetermeer, Netherlands. One of the European Adhesive Specialists at work.

Anyone who makes his way through a modern train is most likely moving along a double floor. Elastic mountings between the underfloor, on the one hand, and covered plywood floor, on the other, make it possible

to forget any unevenness in the wheels and in the tracks. The mountings not only dampen vibrations, but also reduce noise and sound.



An aluminum plate is bonded to the polyurethane blocks. The adhesive bond is just as safety-relevant as the elastomer itself.



The elastomers in Angst+Pfister's product range are increasingly being used as the material for these flooring structures. They significantly increase passenger comfort, and above all also extend the useful life of the carriages and their components, thereby facilitating an overall reduction in life-cycle costs.

Siemens is using a high-performance elastomer for the large-scale order which has received from Russia: This material is required to withstand the harsh climate and large temperature differences that prevail there. In addition, the polyurethane must meet the DIN 5510-2 fire protection standard.

Safety-relevant adhesive bond An aluminum plate is mounted on the polyurethane blocks. What makes this adhesive bond between the polyurethane and the metal so special is that it is just as safety-relevant as the elastomer itself. It is for this reason that Chief Technology Officer Erich Schmid, who is personally taking care of Siemens out of our headquarters in Zurich, has trained as a European Adhesive Specialist (EAS).

The adhesive work is carried out in the Netherlands, at Angst+Pfister's production facility in Zoetermeer, where an additional four colleagues have completed EAS training.

The elastomer blocks and the aluminum plates must be completely clean before being affixed.

Absolute precision and reliability "For the flame-retardant two-component epoxy adhesive to be applied, both the elastomer blocks and the aluminum plates must be completely clean," explains Erich Schmid. The staff must wear silicone-free gloves during production.

There is not even the slightest breeze to be felt in the production hall, because the wind could blow up dust. Additionally, temperature fluctuations are kept to an absolute minimum. Throughout the entire production process, members of our staff are accompanied at all times by at least one of the European Adhesive Specialists. They record the stages of the work in painstaking detail in a logbook so that every single step can be retraced. The fact that the Angst+Pfister operation in Zoetermeer meets high standards of precision and reliability is highlighted by its certificate from the Fraunhofer Institute for Manufacturing Technology and Advanced Materials: Upon completion of the corresponding training of specialist staff, it awards Angst+Pfister a certificate of suitability for adhesive work in connection with rolling stock and rolling stock parts in accordance with DIN 6701-2.

Know-how that benefits the customer "This process has enabled us to acquire new know-how and additional skills," explains Erich Schmid. "This in turn also enables other customers to benefit." And here, he is thinking not only in terms of professional diligence – the focus in the development of the adhesive process is also on efficiency. "If a customer involves us at an early stage of a project, this has a positive impact on production," says

Erich Schmid. "We feel responsible – not only for the final result, but also for the manufacturing processes. In engineering, we often succeed in taking a customer's wishes and translating them into solutions that simply no one had previously thought of."

A brief question to conclude: How are the polyurethane blocks installed together with the aluminum plates? Siemens attaches the floor mounts, which vary in length and height, to the underfloor at clearly defined intervals and at right angles to the longitudinal axis of the carriage. The aluminum plate is screwed to the plywood floor, enabling the elastomers to exert their full effect in absorbing vibrations and noise.



Certificate Fraunhofer class A2 as specified in DIN 6701-2.

Soft suspension – that always stays connected

In order to adapt climatic conditions to the passenger's comfort, trains carry state-of-the-art air-conditioning systems. In this dynamic application, soft suspension is called for. Angst+Pfister has developed tear-proof suspension elements for Liebherr-Transportation Systems GmbH&Co KG. Soft and at the same time completely secure – it doesn't have to be a contradiction.

For the comfort of passengers, the air-conditioning units are mounted on elastomeric and metal components. Liebherr-Transportation Systems expects a lot from these components.

Anyone hearing the name Liebherr is likely to first think of cranes, construction machinery and refrigerators. But Liebherr-Transportation Systems is another important company within the Liebherr Group, internationally active with manufacturing sites in Korneuburg near Vienna, in Maritsa, Bulgaria, and in a joint venture in Zhuji, China. The company is a leader in the development, production and maintenance of air-conditioning technology and hydraulic activation systems for the railway industry.

The air-conditioning units are installed either inside the carriages, on their underside, or on the roof. In order to avoid transmitting the unavoidable vibrations emanating from the compressors to the carriage structure, the compressors must always be suspended inside the unit in complete vibration isolation. The equipment therefore is mounted on elastomeric and metal compo-

nents, designed specifically for this application. These components need to be capable of withstanding environmental stresses like extreme cold and heat, rain, snow and ultraviolet radiation, as well as the cleaning agents that are in standard use. The high levels of ozone which can result from the running of large electrical engines also put the elastomer and metal components under strain.

Maximum stability essential

Liebherr has just developed an innovative new type of compact air-conditioning unit for installation on the carriage roof. This project of the rail-operating company makes exceptional demands on the bearing elements. Not only do they have to be specially designed for use in rail vehicles; an important additional feature is that they cannot be torn away from the roof.

High resistance to corrosion is critical, as these components will be heavily exposed to extreme environmental influences and railway-specific cleaning agents. With a view to meeting all these requirements, Liebherr decided to use stainless steel for the metal components. Additionally, EPDM has been selected instead of natural rubber, so that the elastomeric components can measure up to this application's rigorous requirements. EPDM is significantly more durable in comparison with natural rubber – as shown by the table on this page.

Keeping the unit in the mount A special system ensures that the unit remains in the mount even if the rubber and metal bonding gives

way. With the use of standard elements, the Angst+Pfister engineers created a design that ensures that the air-conditioning unit can never be accidentally uncoupled from the train. The basis for their solution was the APK tool bearing from Angst+Pfister's standard range. With its compact size and equally modest cost, it is highly efficient in isolating vibrations. The technicians developed a new kind of bearing to go with this standard component by adding a specially designed metal plate. Together with a modified bushing at the center, this constitutes the tear prevention safety system.

The new APK bearing is the same – and yet different The bearing for the air-conditioning systems of Liebherr-Transportation Systems

GmbH&Co KG has the same suspension properties as a standard bearing. In addition it is rust-proof, the rubber mixture is highly resistant to environmental influences and the suspension travel is restricted in all directions. But above all, it is not going to tear loose. The basic principle of this tear prevention safety system can be transferred with relative ease to most standard bearing systems.

The principle of this tear prevention safety system can be transferred with relative ease to most standard bearing systems.

Stability a top priority

	EPDM	NR
Rebound elasticity	6	5
Acid resistance	6	3
Alkali resistance	6	5
Oil resistance	2	1
Fuel resistance	2	1
Temperature of use min./max. [°C]	-40/+130	-30/+70
Steam resistance	6	4
Resistance to weather conditions	6	3
Hot water	6	4

On a scale of 1 (= poor) to 6 (= excellent), EPDM generally scores very much better than natural rubber in all respects.



Angst+Pfister's solution: An additional metal plate makes the standard bearing into a bearing that is not going to tear loose.

“And the Oscar goes to...” First-class product quality, speedy delivery and personalized customer service with quick response times – these attributes are self-evident principles in the eyes of Angst+Pfister. For the Knorr-Bremse group, a tradition-rich international manufacturer of braking systems, long-standing satisfaction with its supplier of a wide array of sealing, fluid handling and plastic components is worthy of a special accolade: Angst+Pfister has been awarded the “Knorr-Bremse supplier Oscar”.



The ÖBB railjet is equipped with braking systems from Knorr-Bremse.

Angst+Pfister supplies standardized as well as specialized O-rings and seals for products produced by Knorr-Bremse.



Stars and glamour are usually associated with Hollywood. Oscars as a rule are awarded to actors, directors and other artists in recognition of outstanding cinematic achievements. But why not also pay tribute to exceptional performances in the industrial sector as well? The Knorr-Bremse group posed this question and came up with a “supplier Oscar” that it awards each year to a dependable supply partner. The awarding of this trophy to Angst+Pfister acknowledges the good teamwork between the two companies. The world’s leading manufacturer of braking systems for rail and commercial vehicles more than doubled its volume of orders for components from Angst+Pfister compared to the previous year.

O-rings with a special feature Angst+Pfister supplies Knorr-Bremse with flat gaskets and O-rings from its standard product assortment, but also with a variety of custom-fabricated ones. The components must meet extreme demands in some cases. Knorr-Bremse braking systems are installed in commercial and rail vehicles that are not just underway in central European latitudes. A train that wends its way through the Siberian tundra has to withstand lower temperatures than trains here at home. The same goes for its countless individual components. The seals

from Angst+Pfister possess a special property: They are resistant to frigid temperatures down to -40°C , surpassing conventional seals on the market by 10°C . They additionally meet the strict quality specifications set by Knorr-Bremse and the Deutsche Bahn (German Rail) corporation. For example, the time elapsed between the fabrication of a seal and its moment of delivery may not exceed one year.

Innovative brakes thanks to sophisticated seals The Knorr-Bremse group employs more than 15,000 personnel in more than 60 locations in 25 countries. Extensive investments in research and development have made the Knorr-Bremse name synonymous with innovative brakes and modern onboard systems. But a product always is only as good as its individual components. Sophisticated seals contribute to the functionality and reliability of Knorr-Bremse products. And Knorr-Bremse itself has been relying on Angst+Pfister already for more than a decade. High product standards and fast delivery make Angst+Pfister a compelling supply partner.

Highly efficient supply system Whether in Europe, America or the Asia-Pacific region, Knorr-Bremse always has an adequate supply of O-rings and flat gaskets on hand thanks mainly to an efficient Kanban system that keeps supply replenishments from grinding to a halt. Near-empty bins are replaced by full ones before they run out. The fully automatic supply system not only safeguards the brake manufacturer from O-ring shortages, but also saves the company money because it substantially reduces inventory carrying costs and eliminates time-consuming inspection of incoming goods at Knorr-Bremse.

Wishes fulfilled promptly Isabel Schwacha, an internal sales assistant at Angst+Pfister Austria, makes sure that the contents of the bins are correct. She is the brake manufacturer’s direct liaison for all matters. She takes note of the customer’s wishes and immediately sets about fulfilling them. Angst+Pfister’s worldwide span of operations has enabled the group over the years to attain an increasingly important position in Knorr-Bremse’s supplier network. In the area of sealing technology, multiple component orders have been bundled and transferred to the Oscar-award-winning partner. The “Knorr-Bremse supplier Oscar” fills Angst+Pfister with ambition and confidence: Bit by bit, we aim to capture new untapped ground.



Electromagnetic track brake.



The “supplier Oscar” went to Angst+Pfister.

A simplified lighter metal hose that reduces total life-cycle costs

The new double-decker trains from Bombardier traveling on Switzerland's rail network have cutting-edge technology from Angst+Pfister installed in their railcars: Charged with the task of cooling the transformers, the all-metal ASSIWELL® hose lines transport the heat-transfer oil between the transformer and the cooler. This solution minimizes weight while maximizing both efficiency in production and operations while maintaining durability.



Foto: Rendering Bombardier, © SBB CFF FFS

The new Bombardier double-decker long-distance train.

Wednesday, 12 May 2010, was a historic day for the Swiss Federal Railways (SBB). It will be remembered as the date on which SBB issued its biggest ever rolling-stock order, calling on Bombardier Transportation (Switzerland) AG to build 59 new double-decker trains for long-distance transport. The order was worth around 1.9 billion Swiss francs. The bid submitted by Bombardier made the best impression – in terms of both comfort for passengers and economic efficiency for the company. In its evaluation, SBB considered not only investment costs but also total life-cycle costs, and here Bombardier offered the most favorable conditions overall.

Complementary expertise Economic efficiency goes hand in hand with technical efficiency – which in turn depends not least on weight, and this is where Angst+Pfister came in. Bombardier, one of the world's largest manufacturers of innovative transportation solutions and a global leader in rail transportation equipment, did not have far to go in its search for the necessary competence in fluid technology – the Zurich offices of Angst+Pfister and Bombardier are within walking distance of each other. Angst+Pfister with its DIN EN 15085-2 CL1

certification offers the highest-level welding quality approval for rolling-stock applications. The know-how brought by both sides of this relationship is highly complementary – giving rise to the needed innovation necessary for the railcars of these new double-decker trains.

Highly flexible hose lines The excess heat from the transformers that convert electricity for propulsion must be channeled away. The engineers from Bombardier defined rigid pipes with compensators for the necessary connection between the transformer and the cooler, for both the flow and the return. The fluid handling technology specialists at

Angst+Pfister then suggested ASSIWELL® pipelines with integrated all-metal hose, which performs the role of the compensators – thereby making them superfluous. The flexibility of the corrugated hose, which is covered with braided stainless steel, compensates for both the thermal expansion and the relative movements as well as installation tolerances between the cooler and the transformer.

Flawless durability over 40-year lifespan

Another critical point is that SBB demands a lifespan of 40 years for these train compositions, in order to minimize repair and maintenance costs and maximize operational efficiency. The requirements placed on these materials are extremely high. And ASSIWELL® meets all necessary temperature, pressure and vibration requirements, as the hose lines must perform their services flawlessly for a period of 40 years.

Around 50% lighter This elegant but long-lasting solution offers even more benefits: The continuous ASSIWELL® all-metal hose eliminates the need for the heavy flange connections used in the technical solution initially proposed. One single part takes the place of two separate parts per line, and the all-metal hose weighs just half as much as the original solution. Less weight means lower electricity consumption, lowering the life-cycle costs through greater operational efficiency.

Simplified assembly The assembly process at Bombardier is also more efficient, with the flexibility of the integrated metal hose and the

reduced number of parts significantly simplifying assembly. Each of the rigid pipes originally intended for use in this application, would have had to be adjusted manually in order to achieve the specified measurements. In terms of tolerances, the ASSIWELL® all-metal hose line is clearly more “yielding” and flexible, also speeding up this step in production to provide further savings.

“We have found a simple and long-lasting solution. Less maintenance means greater availability of the railcars.”

Markus Heimberg, Bombardier Transportation (Switzerland) AG, Zurich, Switzerland



Rigid hose line end attached to the radiator.

Fully tested and certified An accredited external laboratory near Berlin carried out the rigorous shock and vibration tests on the all-metal hose lines from Angst+Pfister in accordance with DIN EN 61373. The three five-hour vibration tests also included simulation of the load placed on the line by the transformer, which is mounted on rubber buffers. Bombardier itself runs a test laboratory in Zurich with the aim of testing its newly developed drive systems and thereby ensuring the safe and reliable operation of its rolling stock. The company inspects every conceivable detail, anticipating every eventuality with the strictest quality tests. The ASSIWELL® all-metal hose lines from Angst+Pfister proved to be ideally suited thanks to their sturdiness, flexibility, extremely long lifespan, and durability.

Practical quick couplings Deep fluid handling know-how, complemented by a partner with extensive application experience gives rise to impressively simple solutions. The design team with engineers from Angst+Pfister also went

on to suggest replacing the screw connections originally intended for use on the pipeline for filling, discharge, and oil sampling with quick couplings. The company Walther-Präzision offers suitable, low-weight quick couplings with clean-break technology – using high-performance sealing components from Angst+Pfister. Thanks to these quick couplings, the transformer oil that serves as the heat-transfer medium cannot drip out of the line during filling, bleeding, and oil sampling. The quick couplings are mounted at a low point to enable the heat-transfer oil to flow in gently, making the filling process easier and safer.



Flexible flow and return hose sections attached to the transformer.

Bombardier's engineers are convinced by the integral solution with the ASSIWELL® all-metal hose line between the transformer and the cooler. “Thanks to Angst+Pfister, we have found an extremely simple, long-lasting, and cost-effective solution,” comments Markus Heimberg of Bombardier System Engineering. And the essential issue of “efficiency” is relevant both to Bombardier and to SBB: “Less maintenance means lower costs and greater availability of the railcars.”

ASSIWELL® is a registered and protected brand of Angst+Pfister.



Certificate TÜV Class CL1 in DIN EN 15085-2

Always stay cool – thanks to perfectly welded hose lines There's no telling exactly what grave damage would happen if the power converter on an electric locomotive ceased to be properly cooled. Everything depends on the cooling system, and its hoses' accurate fabrication is critical. Angst + Pfister has standardized its welding processes to the highest quality level – to the benefit also of the Bordline® converters manufactured by ABB, which are used in all types of rail vehicles.

A hose that can do it all is called for here. The solution deployed must reliably endure a service life of 30 or more years at an ambient temperature spectrum ranging from -40°C to +80°C. The heat produced by the power converter as it converts electricity supplied by the overhead catenary wire into three-phase alternating current for the drive motors must be dissipated continuously and efficiently. The connecting hoses in the cool-

ing circuit therefore have to be durable in every respect and under all conceivable circumstances.

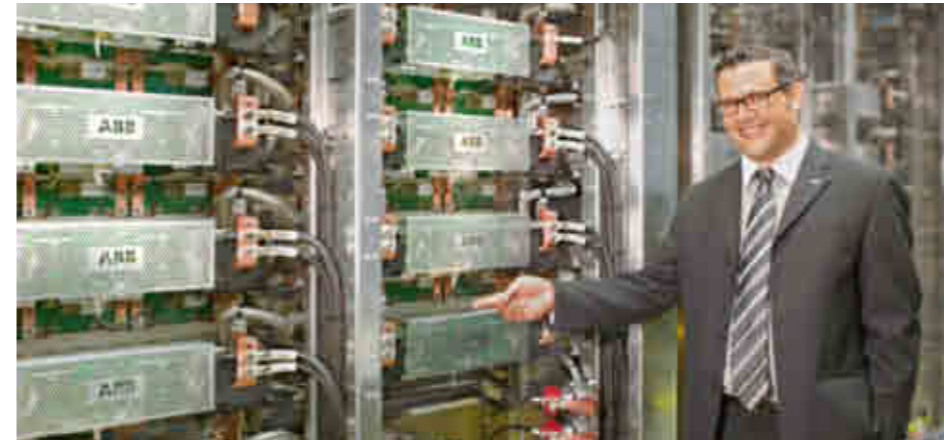
The ASSIWELL® all-metal hose from Angst + Pfister can leverage all of its strengths here. "It is not only resistant to aging and impermeable to diffusion, but also very flexible," explains technical application consultant Urs Nötzli. "This corrugated hose with

its stainless steel braiding tolerates even tight bending radii and is exceptionally fire-resistant to boot."

In short, the ASSIWELL® all-metal hose's properties and durability meet all of the rigorous technical and performance specifications stipulated by the lead product engineers at ABB. Working from that spec sheet, Angst + Pfister and ABB jointly developed the right solution.



In rail transport, precision begins with the technological exactitude of the various individual components. Angst + Pfister masters the art of the mechanized welding of rolling stock parts to the highest certified level.



"Angst + Pfister's reliability and innovativeness, and the joint further development of ideas, products and processes, help us to keep time-to-market short and to reach our goals."

Daniel Sturzenegger, Local Business Unit Supply Manager, ABB Switzerland Ltd.

Perfectly fabricated, flawlessly welded The hose sections and the connector parts both require exact manufacturing precision because only the perfect union between fitting and hose line can be perfectly welded. To avoid residual stress in the material, its structure must be altered as little as possible. The less heat that is applied to the steel during welding, the better the steel's quality and corrosion resistance. The welded joints, after all, have to be as durable as the metal hoses themselves.

Angst + Pfister operates its own welding shop staffed by highly qualified employees.

Angst + Pfister operates its own welding shop staffed by 20 highly qualified employees in Embrach, Switzerland, just a few kilometers away from the group's headquarters in Zurich. The welding shop fabricates prototypes quickly and in precise accordance with customers' specifications. The workers in Embrach weld the connector parts to the

all-metal hose sections. Additionally, Angst + Pfister has two mechanized welding workstations in operation specifically for ABB and other customers with large batch volumes.

Highest certification level rating Automated welding of connector parts onto metal hoses with stainless steel braiding is not exactly a routine task. Angst + Pfister's welding shop and its team of certified welding experts meet the demanding requirements of DIN EN 15085-2 CL1.

This highest certification level rating for mechanized welding of railway vehicle components also requires systematic machine-data logging.

The high degree of automation yields uniform high quality. That lets everyone rest assured – not just the operator of the electric locomotive equipped with the ABB power converter, but all the train passengers as well.

Angst + Pfister's experience and expertise – specifically also in the area of welding metal hose lines – accelerated the evolution of the project and quickly brought about a successful solution despite the complexity involved. Angst + Pfister's contribution to the project also included innovative suggestions for configuring the hose lines. The cooperation with Angst + Pfister has won over Daniel Sturzenegger, a local business unit supply manager at ABB Switzerland: "Angst + Pfister's reliability and innovativeness, and the joint further development of ideas, products and processes, help us to keep time-to-market short and to reach our ambitious goals."

ASSIWELL® is a registered and protected brand of Angst + Pfister AG.



Equipped with a flawlessly fabricated hose line system from Angst + Pfister: the ABB propulsion converter for double-deck electric multiple units.

More than just a FLIRT – Stadler Rail Group and Angst+Pfister

FLIRT is the name of one of the successful train models manufactured by the Stadler Rail Group. As an electric low-floor train, the FLIRT is equipped with a power converter that needs to be cooled. Angst+Pfister outfits FLIRT trains with perfectly tailored high-grade cooling conduit systems.

Technical application challenge The coolant fluid needed to cool the power converter circulates through a hose assembly system. Tight bending radii, countless connection points and an enormous temperature spectrum that ranges from -40°C to +80°C put the hose lines to a severe test, especially since a service life of up to 30 years is required. Optimal hose lines must be lastingly impermeable to diffusion and must guarantee trouble-free performance in the face of harsh stresses and strains.

Technical solution Custom-fabricated ASSIWELL® hose lines from Angst+Pfister meet the toughest demands. The all-metal hoses do not become porous when exposed to enormous temperature swings, unlike many conventional elastomer hoses. The corrugated hoses

effortlessly cope with even the tightest bending radii. The hose fittings are professionally welded so that connection points do not pose any potential weak spots. Angst+Pfister possesses the highest certification level rating for welding of components for railway vehicles: CL1 according to DIN EN 15085-2. Whether in the frigid Finnish winter or the sweltering southern summer, ASSIWELL® metal hoses stand up to any challenge.

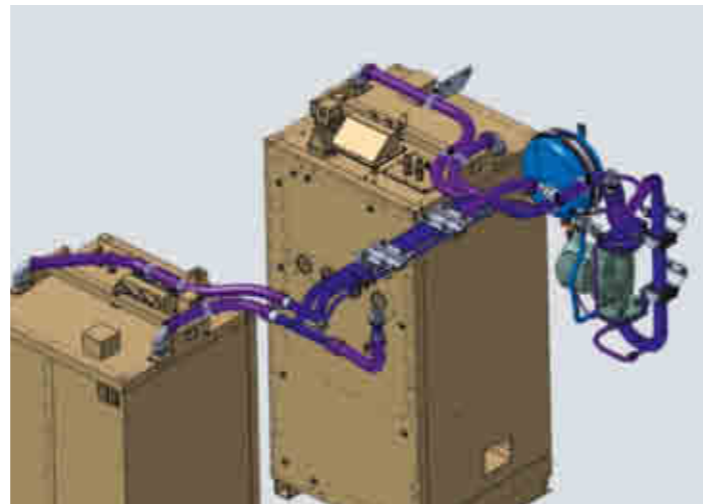
Angst+Pfister – product solutions in the area of fluid-handling technology The customer has access to the entire ASSIWELL® product range, and our APSOfuid® specialists possess the requisite skills to refine the hoses into perfect cooling conduit systems. Long-standing experience in the railway industry enables Angst+Pfister to assist its customers competently, flexibly and with quick response times even during early stages of construc-

tion and to optimize hose lines for individual installation situations. The end outcome is highly dependable hose lines with enormous service lives, which results in long maintenance intervals, minimal downtimes and an excellent price-performance proposition.

ASSIWELL® is a registered trademark of Angst+Pfister.



The fluid technology engineers at Angst+Pfister have developed high-performance hose lines with long service lives.



Tight bending radii, several connection points: In the hose-line circulation system, the fluid circulates in order to cool the transformer.



“Angst+Pfister impresses not just with its extensive know-how, but above all with its exemplary customer support.”

Achim Gallinger, Stadler Rail Group

ASSIWELL® hoses and fittings – the perfect connection

Comprehensive range of high quality ASSIWELL® standard hoses

Depending on the application/requirements, various series of ASSIWELL® standard hoses are available in different dimensions and with specific properties:

ASSIWELL®	Series	Material of bellows	DN	Application
066	Industrial series	1.4404	6–50	static, slightly dynamic
088	Preferred series	1.4541	8–200	slightly dynamic
100*	Performance series	1.4541 1.4404	6–300	dynamic
100W2*	High performance series	1.4404	16–100	highly dynamic, high pressure
133*	Heavy series	1.4571	12–300	dynamic, maximum pressure

* Complies with PED with safety factor four

High-quality standard fittings

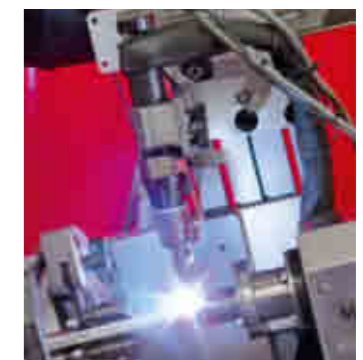
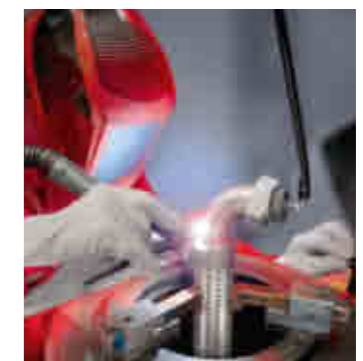
The ASSIWELL® assortment offers high-quality fittings for all individual hose line solutions:

- Tube brackets for cutting ring assembly according to DIN EN ISO 8434-1
- Fittings with external thread according to DIN EN 10226
- Flat sealing screw connections with internal thread according to DIN EN 10226
- 24° screw connections with internal or external threads with weld end
- Loose plate flanges with pressed or weld on collar according to DIN EN 1092-1
- Further connections according to customer specifications

Pre-finished lines

Optimized production and testing processes enable Angst+Pfister to supply pre-finished metal hose lines within short-term:

- Mechanised, semi-automatic TIG welding
- Manual TIG welding of nominal widths of 6–300 mm
- Mechanised TIG tube welding (orbital)
- Mechanised TIG welding of vacuum lines



Custom-fabricated glass-fiber-reinforced plastic profiles for window structure applications in the latest generation of double-deck trains produced by Stadler Rail AG

High mechanical strength is one of the key characteristics frequently cited for construction elements. Additionally, advantages of the Angst+Pfister solution include low weight, thermal insulation, fire protection plus high corrosion and chemical resistance.

The globally operating Stadler Rail Group develops and manufactures innovative mass transportation vehicles. In addition to city, regional and suburban rail transport, the group's area of operations has recently expanded to include interregional and intercity rail vehicles. Stadler Rail's modular vehicle families built using aluminum lightweight construction components optimally satisfy the demands of passengers and the requirements of railway operators.

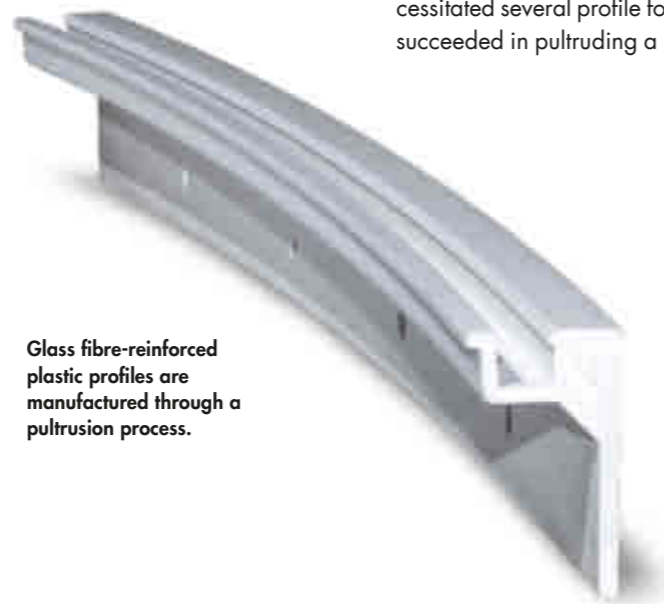
Glass fiber GFK profiles offer many versatile solutions.

Jointly drawing from experience As a long-standing development, supply and logistics partner, Angst+Pfister maintains close contact with the development departments at Stadler Rail AG. Over this period of extensive cooperation, Angst+Pfister has accumulated a deep knowledge about the demands placed on modern railway vehicles within the industry. Angst+Pfister successfully incorporate its multifaceted rail industry experience in the development of the KISS double-decker train, the newest generation of Stadler Rail vehicles.

Demanding material requirements The windows of rail vehicles are subjected to extreme strains particularly at tunnel entrances and railway crossings approached at high speeds. The enormous forces generated by high velocity pressure must be absorbed and safely transmitted to the aluminum coach body. To this end, it is necessary to interrupt the thermal bridges from outside to inside. The load-bearing profile must thus fulfill special material requirements: In addition to having high mechanical strength and good thermal insulation properties, it must keep expansion caused by temperature fluctuations to a minimum. The profile material must be designed in accordance with the geometric requirements (for double-deck coaches) and must also meet extensive fire safety requirements.

Pultrusion UP-GFK plastic profiles can offer many versatile solutions The complex requirement specifications were discussed in close cooperation between Stadler Rail's designers and Angst+Pfister's plastics specialists. Experience in developing the FLIRT and GTW vehicle generations and profound plastics technology expertise with regard to materials and process technology contributed to finding the optimum solution and implementing it successfully. The jointly developed product is based on pultruded UP-GFK profiles from Angst+Pfister. These are glass-fiber-reinforced profiles with a matrix of unsaturated polyester resins.

Special challenge – groundbreaking achievement The innovative profile solution meets all of the mechanical and thermal requirements that were defined in advance. Moreover, this UP-GFK modification meets the strict fire safety requirements pursuant to CEN TS 45545-2 (2009) and DIN 5510-2 (2009). A special challenge was posed by the complex installation situation in the upper passenger deck, whose curved window geometry necessitated several profile forms. Angst+Pfister succeeded in pultruding a UP-GFK profile for



Glass fibre-reinforced plastic profiles are manufactured through a pultrusion process.



Upper deck with curved windows – their geometry poses special design requirements.

the vertical fastening element in the defined radius of the ceiling and window curvature – a groundbreaking achievement for this fabrication process.

Versatile deployment possibilities UP-GFK profiles are not just ideal for use in the KISS trains. The construction elements with their exceptional properties have virtually unlimited application possibilities. The high-quality Angst+Pfister profiles lend themselves as a solution, especially in cases where metals offer the desired mechanical strength but not the necessary corrosion resistance or electri-

cal and/or thermal insulation properties. Their low weight makes them suitable for lightweight construction, and they are exceptionally UV- and weather-resistant and are excellent for bonding. In addition to various standard profiles, customized geometries can be produced as well.

Angst+Pfister will be glad to advise customers on the versatile application possibilities for UP-GFK profiles. Our plastics experts are always open to new tasks and challenges. With constructive collaboration, even innovative new projects can be successfully completed with optimum results using customized plastics solutions.

Advantages of glass-fiber-reinforced plastics



Self-extinguishing & halogen-free



Low weight



Resistant to corrosion and chemicals



High cost-effectiveness



Linear stress-strain behavior



Fast and easy installation



Deployment temperature range of -100 °C to +180 °C



Electrically insulating



High strength



UV- and weather-resistant

Specialist for plastics – French national railway relies on Angst+Pfister

Plastic components are used in the construction of all modern railway vehicles, but severe stress and wear make it necessary to replace them sooner or later. The French National Railway Corporation (SNCF) therefore enlists the services of an excellently diversified parts supplier: St Angst+Pfister, our everyday business also encompasses special custom-fabricated components.



In order that passengers traveling with the TGV feel safe and secure at all times during their journey, the plastic components used need to be robust and able to withstand heavy loads and stresses.

Technical application challenge Whether for brakes, chassis or carriage interiors, SNCF requires a lot of plastic parts for its flagship TGV VI 50 train. Since the rail cars are subjected to extreme stresses day in and day out, the quality of the selected materials used in constructing them has to meet especially high standards. Strict stability criteria have to be met in order to ensure durability and safety. The spectrum of requirements is wide and diverse. SNCF's parts needs range from a variety of special components for brake cylinders and pneumatic door cylinders to plastic glazing in trains and fastening elements for handholds and WC installations.

Technical solution Angst+Pfister supplies the French national railway with a wide array of top-quality finished plastic parts. SNCF has demand for components made of materials with good sliding properties such as fluoroplastics, but also for engineering plastics like POM, PA and PE. Components including PTFE tubes, PUR flat gaskets and O-rings are installed in the pneumatic cylinders used to open doors automatically. UV-blocking PC

panels are fitted over a variety of information boards in the carriages, and transparent viewing panes made of a special PC blend are built into switching relay housings. Angst+Pfister supplies the ideal solution for every need, such as PA 6 bearing bushes for WC sinks and APSoplast® POM for the handhold joint parts.

Angst+Pfister product solutions in the area of engineering plastics technology Angst+Pfister customers like SNCF profit from the perfect combination of product diversity and service provided in high overall quality. As a cross-seller, we are capable of supplying all kinds of parts for complex component assemblies, all the way to complete sets of O-rings for your every need. We stock plastics from a wide array of different manufacturers, which enables corporate customers to bundle their parts procurement needs and to focus on a single supplier. Our strong research and development expertise additionally makes us capable of supplying customized and highly innovative products. Everything from a single source – that's the unbeatable proposition that Angst+Pfister offers to rev up the railway industry.



Angst+Pfister plastics finished parts.

A strong pull into the future – robust drive belts for automated convenience

Passengers value technical comforts – as long as they work. Automatic mechanisms on doors and other equipment are taken for granted on the railway, but are also subjected to a lot of stress. Durable PUR and rubber belts from Angst+Pfister support the sustainability of automated processes.

Application challenge Passageways and accesses to toilets in modern trains are frequently equipped with an automatic sliding mechanism. There is a requirement for robust and reliable toothed belts so that doors can open and close securely. These are also the requirement for simple raising and lowering of window blinds which are often to be found in passenger compartments. To guarantee that the automatic mechanism always operates smoothly, the rail industry depends on high-quality components and, in this regard, reliable suppliers.

Technical solution Opening, closing, raising and lowering mechanisms can be implemented in a technically perfect manner with drive belts from Angst+Pfister: Rubber belts in HTD5 and HTD8 pitches provide fast and at the same time quiet door movements. Steelcord-reinforced T5 or AT 5 PUR toothed belts



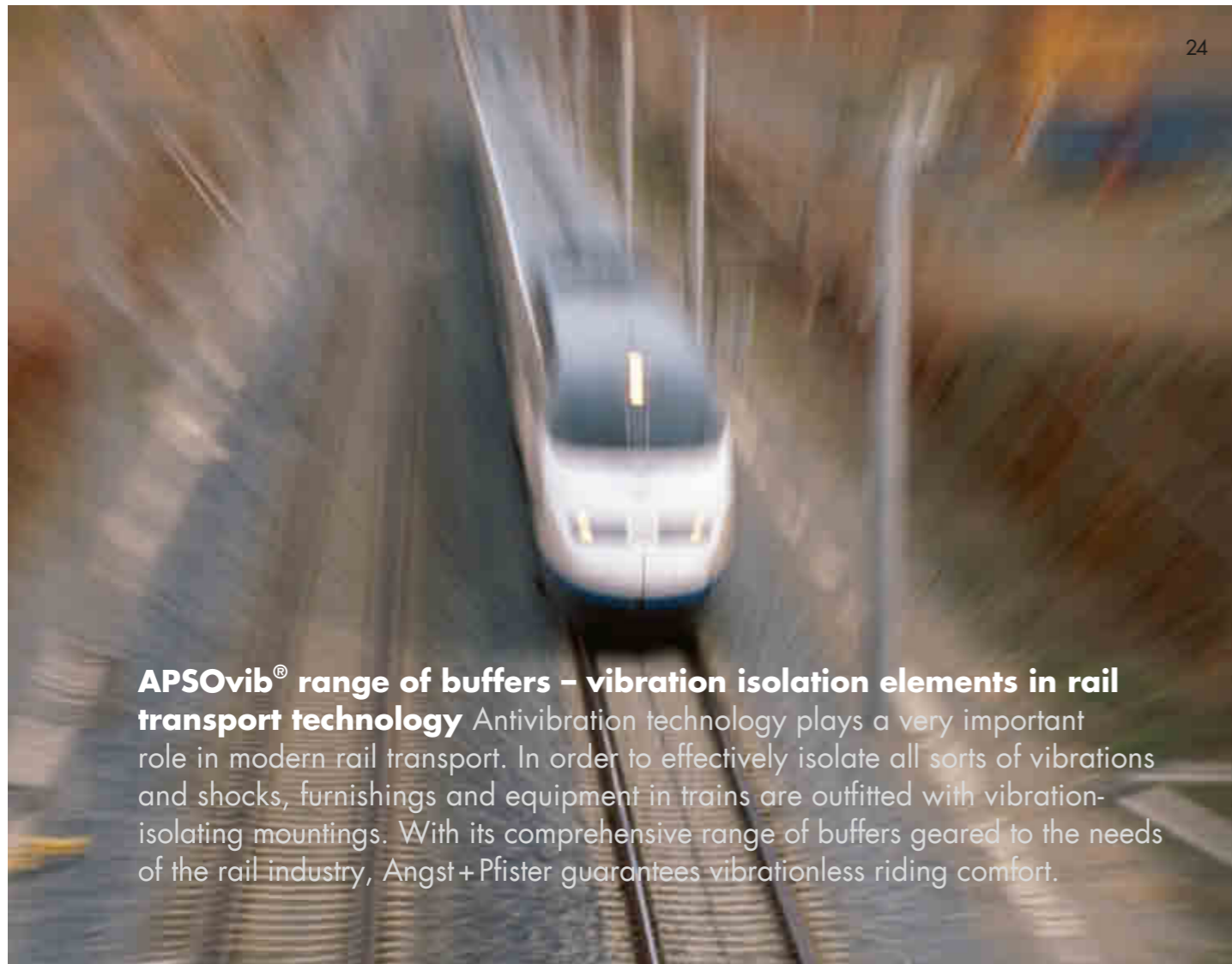
Not only opening and closing, but also lifting and lowering mechanisms can be constructed with drive belts by Angst+Pfister with technical excellence and precision.

are used in window blinds. They exhibit higher stability and are suitable, even with reduced belt widths, for low-speed applications with low tensile loading.

Angst+Pfister – product solutions in drive technology Angst+Pfister customers have access to a comprehensive range of rubber and PUR belts: Numerous pitches, tooth profiles, belt sizes and widths, various machining processes, laminate planes and performance levels underline the outstanding variety that provides the optimum product for every belt drive. The best possible quality is also guaranteed in service: Applications and design engineers develop customer-specific solutions hand in hand, thus making Angst+Pfister a competent partner for the rail industry.



In order to ensure that the doors open and close safely, reliable tooth belts are required. Rubber belts in the divisions HTD5 and HTD8 ensure fast, but also smooth and quiet door operation.



APSOvib® range of buffers – vibration isolation elements in rail transport technology Antivibration technology plays a very important role in modern rail transport. In order to effectively isolate all sorts of vibrations and shocks, furnishings and equipment in trains are outfitted with vibration-isolating mountings. With its comprehensive range of buffers geared to the needs of the rail industry, Angst + Pfister guarantees vibrationless riding comfort.

Technical application challenge Whether it's doors, folding tables, seats, electrical power trains, pumps or transformers in motive power vehicles, train components are subjected to exceptional strains. Vehicular motion gives rise to shocks and vibrations that, if left undamped, not only impair smooth riding comfort, but can also cause damage. In the building of railway vehicles, it is therefore important to minimize potential vibrations to the greatest possible extent through vibration isolation technology measures in order to treat passengers, furnishings and equipment with care.

Technical solution Angst + Pfister supplies solutions in the form of a widely diversified array of mounting elements. Our high-grade buffers absorb vibrations, cushion them and dampen their impact to a minimum. They are

installed on air-conditioning units, control and securing elements, and noise protection products just as appropriately as they are on furniture and doors. APSOvib® buffers are optimally attuned to the static and dynamic load forces acting on a given object or structure. In carriages and locomotives, round buffers serve as vibration-isolating fixing elements. Stop buffers made of natural rubber optimally soften function-related shocks caused by boarding doors, sliding doors and hinged hatches.

Angst + Pfister – product solutions in the area of antivibration technology As a supply and solutions partner, Angst + Pfister understands the needs of the rail transport industry. Our APSOvib® range of buffers offers a selection of approximately 1,000 different items: round buffers and stop buffers in 13 shapes, countless sizes and three grades of hardness distinguish the balanced and clearly ar-

ranged product portfolio. APSOvib® buffers meet DIN standards 95363 and 95364, are RoHS-compliant, and are available for immediate delivery thanks to our extensive warehouse inventory. Finding the right product – with the help of Angst + Pfister's skilled specialists on request – is also especially easy thanks to the inclusion of spring characteristics in the product specs.



APSOplast® Engineering Plastics Technology

Material/Compound	Norm/Approval
UP GM 203	DIN EN 45545-2 (2013) DIN 5510-2 (05/2009) UNI CEI 11170 (2005) NF F 16-101
UP-GRP Profiles	DIN EN 45545-2 (2013) DIN 5510-2 (05/2009) UNI CEI 11170 (2005) NF F 16-101
EP GC 202	DIN EN 45545-2 (2013)
PA 66 nat.	UNI CEI 11170 (2005)
PA 6 G MO	NF F 16-101
PA 6 G FR	DIN EN 45545-2 (2013)
PE-UHMW FR	DIN 5510-2 (05/2009) NFPA 130
PC, transparent	DIN 5510-2 (05/2009) NF F 16-101
PE-HD	UNI CEI 11170 (2005)

APSOseal® Sealing Technology

Material/Compound	Norm/Approval
EPDM + Clamping profile With Clip	DIN EN 45545-2 (2013) DIN 5510-2 NF F 16-101
Novaphit SSTC	Fire Safe Test Report from Lloyd's register: BS 6755, part 2 API Standards 607

APSOvib® Antivibration Technology

Material/Compound	Norm/Approval
NR	DIN EN 45545-2 (2013)
EPDM	DIN EN 45545-2 (2013)
CR	DIN EN 45545-2 (2013) UNI CEI 11170 AFNOR
APSO PUR®	DIN 5510-2 DIN 4102 B2 DIN EN 13501 E
Acoustic and Absorption Insulation Material	DIN EN 45545-2 (2013) DIN 4102 B UL 94 HF 1 ISO 5660-1 (2002) ISO 5659-2 (2012) ISO 5658-2 (2006) NF X 70-100 (2006) NF X 10-702 (1995) NF F 16-101 (1988) DIN EN 13 (501-1)

Design and process approvals



Material/Compound	Norm/Approval
ASSIWELL®	Welding of rail vehicles to DIN EN 15085-2 CL1
APSO PUR®	Manufacturing adhesive bonds on rail vehicles and parts of rail vehicles Certificate Fraunhofer class A2 as specified in DIN 6701-2

For customized products, additional fire protection approvals are possible on customer request, also for APSOfluid® Fluid Handling Technology and APSOdrive® Drive Technology.

The best solutions for improving life cycle cost below the track Angst+Pfister's track solutions increase effectiveness and efficiency in safety, performance and life cycle cost. Across Europe over the last 30 years, heavy tracks, high-speed rails as well as tramway tracks have all been equipped with Angst+Pfister solutions. We aim to preserve track design, reduce vibration and track life cycle cost. Our experts co-design and produce a vast array of products, to meet your exact specifications, from a wide range of materials. Under Sleeper Pads (USP), Mass Spring Systems (MSS) and Under Ballast Mats (UBM) are three of our expert solutions.

Under Sleeper Pads provide a layer with both elastic and plastic properties under the concrete sleeper and turnouts that are proven to protect both sleeper and ballast. Maintaining the ballast stones prevents concrete attrition and improves the load distribution. Under Sleeper Pads provide a significantly longer life cycle to the track. Angst+Pfister's Under Sleeper Pads are covered by patents, and fulfill the latest European standards, fully certified by both SNCF and DB. Material selection, surface area, concrete contact layer, shape and performance can fit virtually

every axle load and track stiffness. Our technical railway engineers can adjust and adapt the components as required by the track manufacturer's specifications. As a standard, we can deliver them with a bedding modulus from 0.15 to 0.38 N/mm³, other values are available upon request. Angst+Pfister's Under Sleeper Pads are widely used on every kind of track situation and reduce repair intervals and total life cycle costs. It is most advantageous to install our Angst+Pfister solution for the following critical track situations:

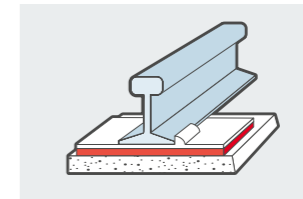
- High-speed rail
- Tunnels
- Ballast under 30 cm high
- Radius below 400 m
- Foundations deemed too hard
- Residential zones

Under Ballast Mats influence both the track's stiffness and the load distribution within the substructure. They deliver an improvement in the track's isolation performance and significantly extend a track's life cycle by decreasing rail corrugation, wheels' false flanges, wear on the ballast and its possible stiffening due to infiltrations of subgrade sand. Angst+Pfister provides solutions in 10 to 50 mm thickness for 13 to 26 tons axle loads and up to 320 km/h – TC1 to TC5 (UCI) trains. Our Under Ballast Mats are available in both mixed cellular polyurethane and high-quality recycled rubber granulates. Typical applications where sub-ballast mats are employed to reduce both acoustic emissions and mechanical vibrations include:

- High-speed rail
- Bridges and tunnels
- Transitions
- Residential zones

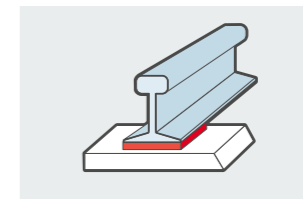
Mass Spring System Angst+Pfister provides easy-to-apply, long lasting and highly economical solutions to effectively damp track vibrations. Our Mass Spring System is ideal for tramway, underground and other low-frequency vibration damping applications. The bearings are available in both mixed cellular polyurethane and high-quality recycled rubber granulates within three main forms:

- Full surface mats solutions can reduce by 25 dB the mechanical noise level for systems with a natural frequency between 14 to 25 Hz
- Strip solutions are a perfect fit with pre-manufactured tracks and on-site concrete track pouring. Efficiency starts for natural frequencies from 8 to 15 Hz
- Pads solutions are preferred for natural frequencies between 5 to 12 Hz, and can also improve the noise reduction by 30 dB



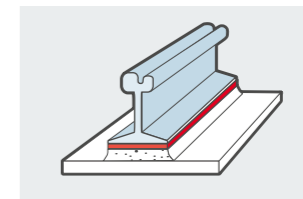
Base plate pads

For the elasticity of slab track systems, Angst+Pfister provides intermediate plates. They are installed between the rib plate and the concrete slab.



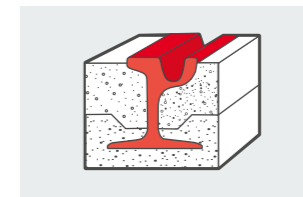
Rail pads

Flexible intermediate layers are installed directly under the rail foot. They have a defined stiffness and increase the elasticity of all ballast superstructures.



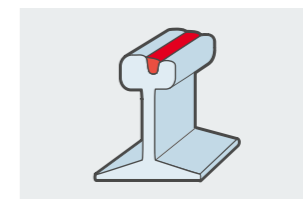
Continuous rail mounting

With the convenient solution of Angst+Pfister for continuous rail pads, different heights resulting from installation-related factors can be compensated.



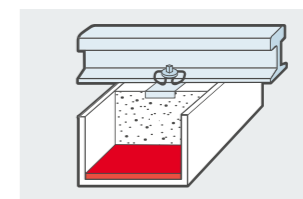
Embedded rail

The embedded rail system is used for electrical insulation of stray current. It ensures the interface between the rail and the platform surface.



Rail groove filler

The rail groove filler is used to close the rail wheel groove of urban rails and tracks and thus eliminate danger points for both, pedestrians and bicycles.



Insert pads for sleeper bases

The Angst+Pfister insert pads are available in any desired stiffness that perfectly meet varied requirements. Preferred areas of application are tunnels of different categories.

PRAG v3®: certified for improving high-speed rail LCC Total life-cycle cost (LCC) improvement is one key topic that drives R&D teams, especially in the capital intensive railway industry. Here it has been proven that under sleeper pads (USPs) can greatly improve LCC. For this reason, Angst+Pfister co-patented a state-of-the-art USP called the PRAG v3® that will be installed in the new high-speed TGV line connecting Nancy to Strasbourg.



PRAG v3® USPs not only ensure track stability, but also reduce track weight. This has enormous implications for infrastructure and opens up new possibilities.

The story starts a few years ago. SNCF invited Angst+Pfister to join a development team that was to create a new standard European USP. Since 1980, SNCF had been using a pad composed of several centimeters of polyurethane covered by a layer of gravel. Those pads were heavy, manually produced, and their production quality was inconsistent. The expansion of the TGV high-speed rail network made it obvious that this technology had become obsolete and that SNCF must quickly develop a new solution. At the same time, Austria, Germany and other countries were also working on new standardized USP solutions. Given the importance of mass transportation, the European Union created a working group within the European Committee for Standardization.

A fully certified USP made with 100% recyclable HVA materials is also available.

Angst+Pfister, as an international engineering-driven company, discovered an opportunity to apply its decades of antivibration know-how within this working group and focused on developing a new USP.

A cross-functional task force created to develop a new solution Our first decision was to create an R&D team composed of a leading railroad cross tie (sleeper) manufacturer, SNCF and a producer of polyurethane mat. After rigorous testing, it was created a patented solution. Based on polyurethane technology, this material is placed under the sleeper and ensures ballast stability during both load and no load cycles. Two years after the project kickoff, we presented our solution for certification in February 2011.

Angst+Pfister under sleeper pads (USP)

Direct advantages:

- protects the sleeper against ballast abrasion
- prevents fast internal ballast abrasive wear
- preserves ballast geometry
- preserves track design
- prevents rail corrugation
- ensures a better load distribution inside the ballast under the train axle

Indirect advantages:

- reduces ballast thickness
- reduces life-cycle cost
- reduces infrastructure cost
- extends maintenance interval

Angst+Pfister had to create the PRAG v3® with a thickness of 5 mm in order to fulfill all of the technical requirements. In addition, we implemented a new solution to ensure adhesion between the PRAG v3® USP and the concrete. The project team chose a specific mesh that is casted inside the polyurethane and is then laid on the fresh concrete during the sleeper manufacturing process. This patented solution provides a real benefit by optimally binding both components and saves time in the manufacturing process.

Most of the European national railway organizations are currently in the process of testing USPs with the goal of equipping their tracks with them soon. Angst+Pfister's added value was the key enabler of this success story: We combined long-standing market experience with technical expertise in antivibration and sealing technologies, which were crucial for linking all of the partners together.



Pull-out test process.



Final inspection.

Angst+Pfister is unique in offering a comprehensive range of railway solutions From underneath the track all the way up to the catenary, we supply the railway industry with the best components from our five different core product groups.

APSOfluid® Fluid Handling Technology designs and produces metal hoses for transformer cooling system to DIN EN 15085-2 plus WCs and drinking water.

APSOseal® Sealing Technology is developing new sealing profiles for train doors and windows in accordance with the latest Fire Protection Certificates and is an important partner for train brake manufacturers.

APSOplast® Engineering Plastics Technology supplies the railway industry with a wide range of plastic solutions such as hinges, pulleys and transparent screens, and even sliding parts for bogies compliant to many critical norms like DIN 5510-2:2009.

APSOdrive® Drive Technology designs and supplies the right belts, pulleys and other parts needed for sliding doors, conveyors and other positioning devices.

APSOvib® Antivibration Technology has expertise in track filtration, air conditioner vibration reduction and floor insulation with critical approvals like DIN 6701-2, DIN 4102 B2 and UL 94 HF1.

New: APSOPUR® and ECOVIB® absorb vibrations and sound

Insulating machines so they don't cause vibrations in their surrounding environment? Insulating light or heavy rail tracks? Or even protecting entire buildings from external vibrations? Angst+Pfister has the right people for the job: Entire engineering teams are specialized in antivibration technology and currently expanding our already wide product range with our new APSOPUR® high-performance polyurethane foams and ECOVIB®, a complete range of elastomeric spring mats made from environmentally friendly recycled rubber granulates.



APSOPUR® railway applications: technically competent solution that increases passenger comfort and safety while remaining economically attractive.

Every train track, every tram track and the bottom of almost every carriage are insulated for passenger comfort and safety. Professional antivibration technology both dampens the sound and increases the smoothness of the ride as well as the life span of the equipment and vehicles. It is proven that the correct insulation saves money by decreasing maintenance costs and downtime. The noise and vibrations felt by end users are recognized as an important part of the manufacturer's brand experience. For these reasons, the demand for innovative antivibration solutions is steadily increasing. More and more often, the building construction industry and above all the machine and motor industries are demanding high-quality solutions that can differentiate them from their competition. Buildings that are close to train lines or tram lines are put on floating floors to provide passive insulation. In the industrial world, pumps and generators are well insulated just like agricultural machines and lifts.

Therefore, the requirements are becoming more complex. Angst+Pfister is responding to these trends, by leveraging its many years of proven technical experience in this field – and a state-of-the-art product assortment. APSOPUR®: The products, made from polyurethane foam, come in twelve different grades from soft to hard: Depending on the chemical formulations, they absorb static loads between 0.011 and 2.50 N/mm². Standard thicknesses of 12.5 and 25.0 mm are immediately available from stock. To simplify installation, each performance grade of APSOPUR® has its own color.

The complete range of antivibration mats
New ECOVIB®: assortment of elastomer spring mats, produced from high-quality environmentally friendly recycled rubber granulates. This product comes in a variety of six different hardnesses: five flat mats for static loads between 0.1 and 1.50 N/mm² and one mat with an undulating 3-D profile for surface loads up to 0.05 N/mm². The thickness ranges from 5.0 to 20.0 mm or amounts to 17.0/9.0 mm for 3-D mats. The commercial advantages of ECOVIB® make this prod-

uct the preferred solution for many building construction and heavy machine insulation applications. For sustainable and profitable antivibration solutions ECOVIB® is the right choice for both ecological and economical reasons.

For industry, rail construction and building construction "With these two new comprehensive product lines, we can cover the entire spectrum in industry, track and building construction," says Philippe Kirsch, International Profit Center Leader for antivibration technology at Angst+Pfister. "We provide our customers with innovative customized solutions. The projects we deliver are meeting our customers' technical demands and are economically advantageous at the same time."

Antivibration technology for industry, rail construction and building construction

Industry

- Carriages, railcars, locomotives
- Heating, lighting, air conditioning
- Pumps, valves
- Tractors, agricultural machinery
- Cabins, cable cars
- Motors, generators, emergency generators
- High-voltage engineering
- Logistic systems, conveyors
- Shipbuilding
- Elevators, escalators

Rail construction

- Elastic bedding of thresholds
- Extensive spring matting under the ballast bed or the non-ballasted track
- Mats and strips for spring-mass systems

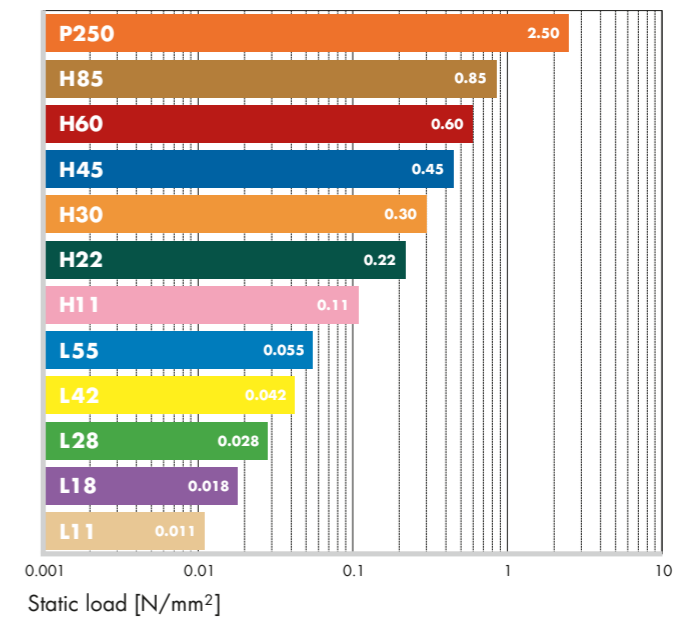
Construction

- Foundations
- Sprung and floating floors
- Walls

The correct solution thanks to our know-how

The application engineers who specialize in antivibration technology at Angst+Pfister are able to accurately determine and calculate the exact mass and deflection thanks to their know-how and experience. They make use of effective numerical simulation and carry out on-site tests and measurements. "We take the accuracy of our insulation solution very seriously," says Philippe Kirsch who makes reference to the scope of this responsibility: If a building has not been professionally insulated before the concrete foundations are set, it has potentially enormous cost implications.

With both these new innovative products we cover the complete spectrum of industry, railway and building construction applications.



Tailoring included Angst+Pfister trims the insulation mats, strips and blocks according to the customers' exact specifications in order to be able to deliver components that are ready to use and assemble. If desired, our product application engineers can come directly to the place of assembly or the construction site. Customers happily make use of this technical and production service that requires specific tools. In addition, the professionals at Angst+Pfister know from experience how they can keep waste as low as possible, and this of course further helps our customers save money.

The gluing specialists Smart clients also leave the adhesive bonding between two insulation blocks or between the elastomer and steel, aluminum or plastic up to the specialists at Angst+Pfister. Recognized European adhesive practitioners and Fraunhofer certified adhesive specialists have undergone specific training and further education at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials in Bremen, Germany. Both Angst+Pfister's plant in Zoetermeer, Netherlands, and Global Logistics Centre in Zurich, Switzerland, are well equipped for production.

Up to what static load per mm² can ECOVIB® and the different APSOPUR® grades insulate vibration? Simple summaries in the material data sheets reliably demonstrate it and offer a first basis for a decision.

Philippe Kirsch: "With APSOPUR® and ECOVIB®, along with our application expertise, we are prepared for any vibration-related challenge. With us, the customer gets everything from a single source – even local on-site assembly training, if necessary."

APSOPUR® und ECOVIB® are a registered and protected brand of Angst+Pfister.

Technical data at a glance

Which APSOPUR® grade is the right one for me? The engineer wants to know more. Angst+Pfister has therefore created individual material data sheets for each of the twelve different APSOPUR® and six ECOVIB® products. These contain information about immediately available standard formats, behaviors under static and dynamic loads, as well as further properties according to European and international norms. Graphical chart information about the spring characteristics of different thicknesses, of the natural frequencies and the vibration insulation is also available. These material data sheets are available on request at www.angst-pfister.com. The engineers at Angst+Pfister are happy to help.

Swiss quality
made in Europe



www.angst-pfister.com

APSOPUR® ECOVIB®
we catch your vibration

Angst + Pfister Group: The Leading Supply and Solutions Partner for Industrial Components We help our manufacturing clients to save hundreds of thousands of euros every year by providing custom-engineered components, a vast product range comprising more than 100,000 standard items and integrated supply chain solutions.

Our core product divisions



APSOplast®
Engineering Plastics
Technology



APSOseal®
Sealing
Technology



APSOfluid®
Fluid Handling
Technology



APSOdrive®
Drive
Technology



APSOvib®
Antivibration
Technology

The Angst + Pfister Group serves its customers internationally with uncompromisingly high-quality products and comprehensive solutions. Our global supplier and distribution platform enables us to guarantee the

same product quality and price regardless of whether you are manufacturing across Europe or Asia. The breadth of our standard product assortment makes us a one-stop shop that not only simplifies your search, but also enables you to consolidate suppliers. Our

engineering solutions are designed to seamlessly interface with your R&D in ways that save you research time and money in the product development stage.

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