Co-Design for extreme requirements

Together with Siemens Mobility Austria GmbH (Fahrwerke Graz), Angst+Pfister developed rubber-metal buffers for limiting longitudinal traction in bogies for rail vehicles. The homogenous single-component rubber compound from Angst+Pfister sets standards in combination with the European fire protection regulations. In addition, not only were the excellent sliding properties of the stops required – the engineers also designed a component whose stiffness had to follow an extremely narrowly tolerated characteristic curve.

With their many years of transport expertise, Siemens Mobility sets standards for tomorrow's mobility and is constantly developing new solutions. The rail transport sector comprises vehicles, infrastructure and automation solutions – from light rail through regional transport to high-speed lines.

Damping longitudinal movements and structure-borne noise

Wheelsets of rail vehicles are attached to bogies. They allow rotations in relation to the car body. The primary suspension is provided by dampers between the wheel axles and the bogie. The secondary suspension takes place between the bogie and the car body, which are connected to each other by a pivot bearing. When accelerating or braking, longitudinal movements occur between the car body and the bogie. In addition, structure-borne noise is transmitted. Both would affect the comfort for the passengers in the body. To prevent this, a so-called plunger pin projects from the secondary suspension into two rubber-metal buffers. These are mounted on one side of the bogie by means of an adapter plate and on the other side come into contact with the plunger pin with a slight preload. For this reason, the buffers end there with a plastic plate, which must have good sliding properties with a long operating life.

Siemens Mobility Fahrwerke Graz came to Angst+Pfister in order to jointly develop the buffers in accordance with the European fire protection regulations EN45545 and set the specifications. The Angst+Pfister specialists then checked whether the requirements – also with regard to operating life – were possible and submitted their offer. Then it's on to design: "The fire protection regulations have already severely restricted the choice of materials," says Michael Forrer, Senior Engineer Antivibration Technology at Angst+Pfister in Zurich. Determining the correct rubber compound in this project was, however, also "tricky".

Special characteristic curve as a challenge

The stiffness of the buffers does not require a linear characteristic curve – it demands extreme progression: At the beginning, the stop is supposed to offer a relatively weak resistance, which however increases stron-

The three grooves of the buffer ensure the extreme progression of the characteristic curve.

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gly at a certain pressure - until the stop. Angst+Pfister's solution for this was a special three-stage rubber contour. Three grooves provide the required progression of the characteristic curve: As soon as they are compressed, the resistance increases abruptly – until the built-in stop takes effect. It took a good dozen designs and simulations of stiffness using the finite element method before the correct rubber contour was found. It took the engineers a few weeks to do this and they repeatedly discussed their new proposals with the customer, who brought in his experience. The competence of two strong partners results in products of exceptional quality thanks to close cooperation. "We appreciated Angst+Pfister's transparency in component development."

Testing and universal application

Once the design was right, Angst+Pfister set to work on the prototypes. Some final changes were made to meet the special progression. The prototype then had to go through various tests: With 14 days' heat exposure in a 70°C oven, the stops were subjected to artificial ageing – and an operating life test of several hundred thousand cycles. The characteristic curve of the stiffness is examined before and after. Angst+Pfister also carried out pull-out tests. The adhesive bond between rubber and metal must hold – only the rubber is allowed to tear. Finally, the electrical resistance and corrosion resistance of the coated material were investigated. Once all the tests had been successful, the "Design Freeze" was given as the starting signal for series production. For the series components, random sampling checks were then carried out again before delivery.

"In close cooperation with the customer, we developed a universal rubber-metal buffer that Siemens Mobility is now installing in various vehicles," says Michael Forrer. So the wheel no longer has to be reinvented with every new type of train, which saves development costs.

«Co-design with customers and the exchange of skills lead to products of exceptional quality.»

Michael Forrer, Senior Engineer Antivibration Technology, Angst+Pfister Group