Crash-testing rivets

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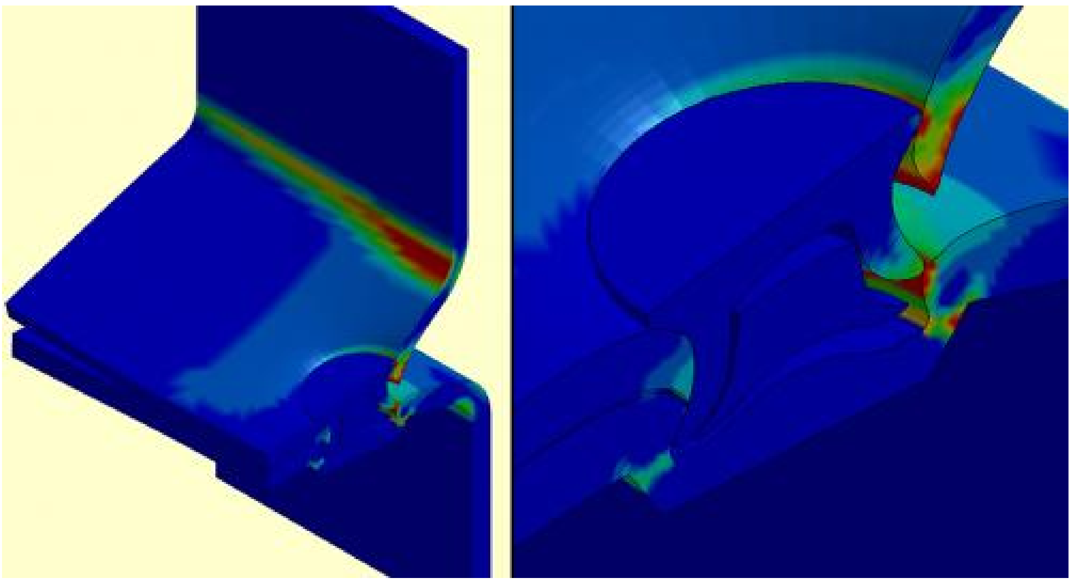

A punch-riveted joint fails under bending load: the red areas were particularly seriously deformed. Credit: Fraunhofer IWM

Rivets have to reliably hold the chassis of an automobile together – even if there is a crash. Previously, it was difficult to predict with great precision how much load they could tolerate. A more advanced model now delivers realistic projections.

Steel, aluminum, magnesium, fiber-reinforced plastics: cars are built from a wide array of materials today. These have to be connected with each other reliably. To wit: even if the joints become loose in a crash, passengers must face no greater risk of injury than before. Manufacturers use their welding equipment for cars made entirely of steel. However, if you want to combine steel together with aluminum, for example, or steel with plastic materials, then conventional welding techniques are entirely unsuited, plain and simple. Automakers therefore resort to mechanical connections instead, such as rivets.

Very often, connections are the weak points: in a crash, they are typically the first thing to fail. And since a car has about 3,000 to 5,000 joints, manufacturers strive to minimize this risk. This is why automakers use simulations to verify if the various connection points sustain these stresses in an accident. Yet how stable are they in the first place? In many cases, the calculations can clearly predict how the individual joining points will perform, but not for every type of strain, though. If the joined components become bent (experts refer to this as a "flexural load" or "bending load"), then the simulations are quite often off the mark. For example, such computations could ascribe a greater load capacity than the rivets can actually bear under real emergency conditions. This uncertainy is something automakers greatly wish to eliminate.

Realistic projections through a new model

Researchers at the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg – working together with their colleagues from the Laboratory for Material and Joining Technology LWF in Paderborn, and the Association for the Advancement of Applied Computer Science GFaI in Berlin – have essentially eliminated this drawback now, at least in the simulations."We have further engineered a model that allows us to forecast rivet performance more reliably – both with slow and fast bending loads, as well as with pull and shear forces that emerge when the joined components become shifted, relative to each other," explains Dr. Silke Sommer, Group Manager at IWM. For this purpose, researchers produced individual "sample components" from a variety of materials, connected them with rivets, and then applied stress. They bent them in a variety of directions, and pulled them and pushed them at varying speeds. They then integrated the performance of the rivet points into the mathematical equations."These equations contain various parameters – to account for the different materials and their densities, for instance," Sommer says. The researchers at IWM and LWF studied about 15 different combinations of materials. Based on these data, their colleagues at GFaI prepared projections for other similar material and density combinations.

If car manufacturers now want to calculate how the rivets perform in the event of an accident, then as a rule, they simulate the crash first. What forces appear at which points on the car? If these data are known, then the engineers can determine – for each rivet – whether it could withstand the strains at precisely this point or in that position. The model is finished and automakers can already use it, and therefore make their cars even safer than before.

Provided by Fraunhofer-Gesellschaft

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