Development of Material Input Data for Solid Elements under Crash Loads

Materialkartenerstellung zur Versagensvorhersage von Volumenbauteilen unter Crashbelastungen

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Summary:

Heavy trucks have large masses and only small deformation zones. Because of this, they are loaded relatively severe in case of a crash. Under those conditions structural response is characterised not only by plastic deformation but also by failure in terms of cracks or fracture. Hence, failure prediction is essential for designing such parts.

The following article describes the procedure of generating material models for failure prognosis of solid parts in the Commercial Vehicles Division at Daimler.

Sheet metal parts are mostly discretised by shell elements. In this case the state of stress is characterized by hydrostatic pressure over von-Mises effective stress, the so-called triaxiality. For many real-life load cases which can be modeled by thin shells this ratio is between –2/3 and –2/3. Within this range the Gurson material model with the Tvergaard Needlemann addition leads to sufficiently accurate results. Furthermore, the Gurson material model allows considering the effect of element size, which amongst others is important for ductile materials.

Most often however, in the case of solid parts the state of stress is more complex, which results in a triaxiality smaller than –1 or larger than 2/3. Gurson material models are usually validated based on shell meshes and tensile tests with flat bar specimen. If applied to solid parts, these models tend to underpredict failure . Thus, for solid parts the GURSON_JC material model is used.

The Johnson Cook parameters are derived from an existing Gurson material model. Afterwards the material model is adapted to test results by modifying the load curve giving failure strain against triaxiality. This requires tensile tests with grooved and non-grooved round bars, shear tests and validation tests on actual parts.

Keywords:

Damage, failure, commercial vehicle, Gurson, Johnson Cook, casting iron and forge materials,