Modelling the thermoplastic material behaviour of a tailored formed joining zone on a macroscopic length scale

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ABSTRACT

Tailored Forming is a manufacturing process where two metallic materials are joined and formed subsequently. This processing order allows for new designs of hybrid material components. However, the joining zone is heavily loaded during forming. To evaluate the possibly occurring damage on a macroscopic length scale, a material model needs to be developed.

The joining zone thickness depends on manufacturing process parameters but is small in general. An initially flat element like a cohesive zone element (CZE) is therefore beneficial for meshing and parameter studies. The material behaviour in CZEs is characterized by traction separation laws (TSLs) for normal and for tangential separation; mixed mode investigations are done combining the occurring separations. TSLs are curves modelled using e.g. the maximum strength and the de-cohesion energy that depend on the stress triaxiality [1], i.e. TSLs phenomenologically describe specific de-cohesion situations. Using TSLs is not sufficient for this application as different not previously known stress triaxialities may arise and further damage causing deformation modes (shearing or size changes of the joining zone) may occur.

Continuum material models are able to take all deformation modes into account and their material parameters are independent of a pre-known stress triaxiality. In contrast to TSLs they use relative variables (strain) instead of absolute ones (separation). Hence continuum material models are not directly combinable with initially flat elements like CZEs. An approach to overcome this limitation is presented along with some examples demonstrating the possibilities a continuum material model for a joining zone may offer.

REFERENCES

[1] K.-H. Schwalbe, I. Scheider and A. Cornec, “Guidelines for applying cohesive models to the damage behaviour of engineering materials and structures.” Springer Science & Business Media (2012).