

Abstract

The paper presents a hybrid-Trefftz (HT) element approach for spot-welded car bodies, and focuses on the predictability of spotweld failure under mechanical loads. A variational principle, valid within the framework of Hencky-plasticity with von Mises yield criterion, is the starting point to deduce all required Trefftz solutions for the internal displacement field. To enforce conformity to bi-linear standard shells an auxiliary inter-element displacement frame is employed. The modelling of perfectly plastic deformation accounts for geometrically nonlinear behaviour (stress stiffening) within the metal sheet and permits the forming of plastic hinges along the circumference of the comparatively rigid spotweld nugget. Isotropic hardening is considered by means of a cascaded piecewise perfectly plastic stress-strain curve, leading to a high resolution of the stress and strain field in the vicinity of the spotweld nugget, and enables the introduction of accurate failure criteria. Spotweld failure due to the onset of local necking (instability) in the vicinity of the nugget is investigated in more detail and shows a good agreement with experimental results. Industrial applicability is demonstrated with a representative use case.