Use of Shell Elements for the FEM-Simulation of the Welding Process of Sheet Metal Parts

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Abstract. During the joining process of complex body components in the automobile industry, dimensional accuracy is essential. In order to predict the behavior and to improve the geometrical quality of joined sheet metal parts during the welding and cooling process, a simulation method by means of finite elements is applied. This should be done in the early stage of the product's life cycle to reduce process adjustments, which are time and money consuming. In recent years the simulation of welding was basically feasible by models consisting of volume elements. This way the metallurgical phase transformation, which is responsible for the behavior of the treated parts during the cooling process, can be established for a specific material. The use of volumes has a negative influence on the calculation time and it is not applicable for sheet metals. Especially, if effects from previous forming processes are to be considered. Additionally, the application of shells can meet the requirements of an analysis of the effects of welding when the metallurgical material properties are taken into account. In this paper an example of a sheet metal (DC04, former St 14) will be examined with the aid of a finite element analysis. Firstly, a transient temperature field is calculated in a thermal simulation by applying a certain method. In this calculation only the thermal properties of the material are used. Secondly, the transient temperature field is used as the initial load for the thermo-mechanical analysis. The distortion and the residual stresses of the work piece can be calculated using thermo-mechanical properties and material phase transformations.