6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Shape Optimisation for Damage Control

Fabian Guhr[1,*], Franz-Joseph Barthold[1] and Andreas Menzel[2]

[1] TU Dortmund, August-Schmidt-Str. 8, D-44227 Dortmund, {fabian.guhr, franz-joseph.barthold}@tu-dortmund.de, www.bauwesen.tu-dortmund.de/nmi
[2] TU Dortmund, Leonhard-Euler-Str. 5, D-44227 Dortmund, andreas.menzel@udo.edu, www.iofm.de

Keywords: *Structural Optimisation, Sensitivity Analysis, Non-Local Damage, Gradient Enhanced*

Metal forming is of high importance in the current industry due to its possibilities of low weight but robust products, used in eg. car manufacturing. For large deformations, this leads to the accumulation of damage in the finished product. Even though damage does not mean immediate failure, the material of the final design may posses lower material properties than the undamaged one, which then may cause failure under critical loads. To predict the damage state of a finished product, finite element simulations, in combination with suitable damage models, can be used instead of costly experiments.

An isotropic, non-local, gradient enhanced damage model is used, in order to predict the damage evolution in the simulation. A global damage variable is introduced at each finite element node and furthermore enhanced by its gradient, see [1], which leads to mesh-independent behaviour - an often found problem in damage modelling with only local damage quantities. The underlying Karush-Kuhn-Tucker conditions are then solved using a Fischer-Burmeister approach on the global scale and the damage values calculated alongside the displacements.

Using this model, the solutions can then be used in order to improve the lifetime of the finished product. Applying shape optimisation, the design can be optimised with regards to the damage state. Choosing the damage as the objective function or incorporating it as a constraint into the minimisation, designs can be generated, which yield a lower damage state for the given load. Utilising gradient based methods, e.g. SQP, the sensitivies of the structural response are required, which are calculated by a variational approach, as shown in [2]. By choosing control points as the structural design controlling quantities, minimisation with respect to these design variables leads to the generation of an optimised design, where a reduced damage state is present.

REFERENCES

[1] Liebe, T., Steinmann, P., and Benallal, A. (2001). Theoretical and computational aspects of a thermodynamically consistent framework for geometrically linear gradient damage. *Computer methods in applied mechanics and engineering*, 190:6555-6576.

[2] Barthold, F.-J.: Zur Kontinuumsmechanik inverser Geometrieprobleme. Habilitation. Braunschweiger Schriften zur Mechanik 44-2002, TU Braunschweig (2002).