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A gradient-extended damage and fracture model for long fiber reinforced plastics

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This presentation focuses on a new material model that describes the damage evolution in matrix and fiber of unidirectional CFRP. The material model is based on the assumption of a distinction between damage of the matrix and damage of the fibers.
The key feature of the material model is the distinction between the matrix stiffness, which is considered to be isotropic, and the fiber stiffness, which is considered to only act in fiber direction. Based on this material model, a brittle damage model is constructed, which discribes the damage of the matrix and fiber in terms of two independent scalar damage variables. The damage variables are used in the framework of micromorphic damage to avoid pathological mesh dependence.
The derived material model is tested on results of RUC simulations and experimental data of tensile tests of CFRP specimens. Furthermore, simulations based on an implementation in the finite element simulation program FEAP [1] will be shown.

Goal of this material model is to describe the behavior of CFRP during shear cutting, to make CFRP available in cost efficient mass production. Depending of the type of carbon fiber and the arrangement of carbon fibers within the matrix, CFRP can provide excellent material parameters in regards of stiffness and load bearing capacity. The density of CFRP on the other hand is much lower in comparison to steel or aluminum. Therefore, CFRP is considered as an ideal material for manufacturing (e.g. electric cars). A major drawback when using CFRP as construction material is the high cost for the material itself and its processing. In Regards of car manufacturing, fast and automatable material processing is desired for high cost and time effectiveness. Therefore, new processing technologies have to be considered for processing of CFRP.
Shear cutting (in the means of blanking) meets exactly the aforementioned requirements of fast and automatable material processing. Unfortunately, there is little to no knowledge of the material behaviour of CFRP during shear cutting. To pave the way for blanking of CFRP in material processing it is indispensable to gain more knowledge about the material response of CFRP (damage evolution in matrix and fiber, debonding,) during shear cutting.

REFERENCES

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