Multiscale modeling of pearlitic steel

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Pearlitic steel consists of cementite lamellae embedded in a ferritic matrix. These lamellae are arranged in colonies within which the cementite orientation is (ideally) constant. In this contribution a representative microscale model that captures the behavior of the cementite and the ferrite but also the interaction between these phases is proposed. In the microscale model the ferrite is modeled by using crystal plasticity [1] while the cementite is modeled as elastic.

The homogenized response from the micromodel is passed via the mesoscopic model, using a multiscale modeling approach (see Figure 1), to the macroscale model which represents the structural level. The mesoscale model consists of nodules, with different crystallographic orientations of the ferrite, within which different colonies reside.

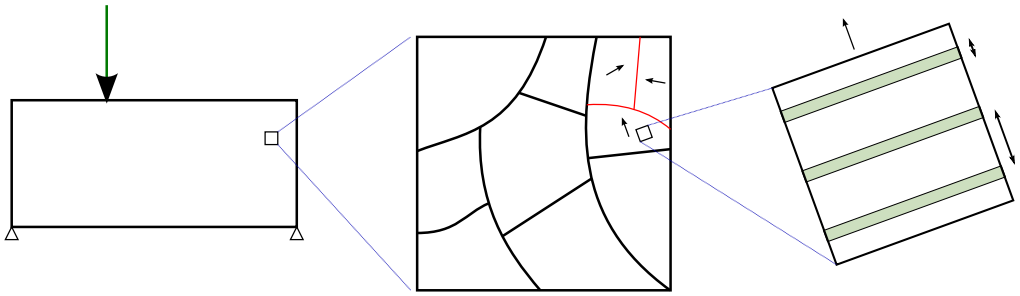

Figure 1: Scales used in the multiscale modeling. Left: the engineering problem. Middle: the mesoscale model with its nodules and colonies (red borders). Right: The microscale model, here depicted with three lamellae.

Different types of prolongation conditions on the micromodel from the mesoscale deformation gradient are discussed and their results are compared. Furthermore, the number of directions of the cementite lamellae and the number of crystallographic directions of the ferrite needed to obtain a representative mesoscale behavior are investigated.

Finally, numerical results for different orientation distributions of the cementite lamellae that give different degree of anisoptropy of the pearlite are given and compared with experimental results in a qualitative fashion.

References

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