Physics-based constitutive models of low alloy steels

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ABSTRACT

Physics or mechanism based constitutive models do obtain their mathematical format from consideration of the underlying processes of the specific material response. The notation can be illustrated for plasticity models. An engineering type of model may be of a curve fitting type meaning that the mathematical format is based on the appearance of the stress-strain curves. A mechanism based model utilises knowledge about the underlying processes, i.e. dislocation motions, for plastic deformations. Then the mathematical format is obtained from more fundamental understanding. In the end the model can be very similar to an engineering type of model. A power law relation can be derived either way. However, the author reserves the notation of explicit physics based models where observed variables are used to characterise the material response. A model starting with a mechanism but then utilising effective plastic strain as a hardening parameter, like in the Zerilli-Armtrong model, is denoted an implicit physics based model. Then immobile dislocation density may replace the use of effective plastic strain as hardening parameter [1]. It can be noted that even these models need be calibrated. It is only their format that is obtained by considering the physical phenomena. However, it is expected that these models have a larger range of applicability. Furthermore, they do in some respects have a natural handshake with microstructure models.

Models of heat capacity and conductivity [2], thermal expansion and elastic [3] and plastic properties are shown for low alloy steels. The models account for temperature as well as variations in chemical composition in a limited sense.

REFERENCES

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