Talk for ZeTeM (University of Bremen)

PHENOMENOLOGICAL MODELING AND EXPERIMENTS ON CYCLIC PLASTICITY

Lakhdar Taleb
Professor, Head of the Mechanics Research Team
Material Physics Group / INSA of Rouen,
Avenue de l'université, BP 08, 76801 St Etienne du Rouvray Cedex, France
lakhdar.taleb@insa-rouen.fr

The presentation deals with the elasto-visco-plastic behavior of metals subjected to cyclic loading. The most recent experimental observations performed on specimens will be briefly presented and their phenomenological modeling will be discussed.
Under strain controlled, we will see that metals may exhibit cyclic hardening or softening depending not only on the applied amplitude but also on the loading path (proportional or non proportional, [1]). The strain memory effect plays also a significant role for certain steels which means that the steady state may be different for the same applied amplitude and loading path. Furthermore, it is now admitted that for the same equivalent amplitude the material may exhibit an over-strengthening if the loading path is non proportional.
Under stress control, the steady state after cyclic loading may be elastic shakedown, plastic shakedown or ratcheting but the result depends significantly on the stress-strain history and the loading path. The interaction between creep and ratcheting may be essential for certain steels even at room temperature.
The quality of the constitutive equations devoted to the step by step analysis of the cyclic behavior of mechanical structures depends closely on their capabilities to describe the phenomena mentioned above. Today, one can find two classes of phenomenological models: Chaboche and multi-mechanism types. In the first category, all the mechanisms responsible of the plastic strain are described by one variable. Such limitation does not exist in the multi-mechanism model as each mechanism may be described by a different variable (plastic strain rate). However, the responses of such kind of constitutive equations may lead to non physical predictions if the identification of the material parameters is not performed in the frame of the thermodynamic principles [2]. The capabilities of the last version of the multi-mechanism model [3] will be discussed in the light of the experimental responses mentioned above.

References

[1] **Taleb**, **L**., **Hauet**, **A**., "Multiscale Experimental Investigations about the Cyclic Behavior of the 304L SS *". International Journal of Plasticity 25, 1359-138, 2009*
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[3] **Taleb**, **L**., **Cailletaud**, **G.,** "An updated version of the multi-mechanism model for cyclic plasticity*". International Journal of Plasticity. 26, 859-874, 2010*