RECENT DEVELOPMENTS IN THE THEORY OF THERMOPLASTICITY

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The object of the survey is to discuss thermal effects in plasticity.

In the first part axiomatic and physical foundations of thermodynamics of continua are discussed. As fundamental concepts we assume the thermodynamic process and the thermodynamic state. The local formulation of thermodynamic laws is given. Methods allowing to describe a thermodynamic state are analysed. The methods lead to different concepts as regards description of the dissipation. A thermodynamic theory of a rheological material with internal changes implied by plastics deformations is discussed. Two methods to describe the dissipation are used, namely by the notion of history and by internal parameters /hidden variables/. An application of these methods to the description of elastic-viscoplastic materials is given. Both a general theory and its physical and experimental motivations are discussed. As a particular case an elastic-plastic material is investigated.

The second part concerns practical thermoplastic stressstrain relations. A variation of yield properties with temperature is considered. Interaction of viscous and thermal effects is analysed. Applications of these results to the description of dynamical behavior of materials is investigated and some aspects of superplasticity are considered. Changes in the material properties due to an irradiation are analysed.

The third part concerns thermoplastic boundary value problems. Solutions and solution methods are discussed. In particular interaction of pressure and temperature is considered for structural parts and fuel elements at various stress-strain relations. Thermal shocks and quenching are discussed. Approximate methods are commented upon.

The final part concerns cyclic loading programs and shakedown analysis in presence of thermal fields. Appropriate theorems relating to the thermal fatigue and incremental collapse are involved. Solutions concerning shakedown analysis for cylindrical vessels as well as plates and shell intersections are discussed. Available experimental data regarding cyclic thermo-plastic behavior are commented upon.

Paper concludes by remarks on actually the most widely used engineering theories and on advances in the theory of thermoplastic constitutive relations.

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