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This paper studied experimentally the out-of-plane compressive behaviour for a series of aluminium honeycombs of different sizes and base materials (3003 and 5052) under impact loads. The testing results confirmed that there do exist a strength enhancement from 15% to 60% for different alloys (even the 3003 alloy and 5052 alloys have both rate sensitivities around 10%). In order to understand this impact enhancement difference, a comprehensive numerical investigation is performed to reproduce the experimental results for different cell size/wall thickness/base materials. Such simulated tests permit for an inside look of the detailed crushing process. Larger strain near intersectional edges of honeycombs is observed under impact loading. Different strain hardening behaviour between 3003 and 5052 alloys leads to different macroscopic enhancements. It shows that the lateral inertia is the main factor responsible for strength enhancement in impact crushing of aluminium honeycombs.

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SM13: Plasticity, viscoplasticity and creep
13:40–14:25, Thursday, 23 August
Giulio Maier, Italy, Chair
Brian Nyvang Legarth, Denmark, Chair
Room: 211

13:40–211

Conservation laws for materials with a nonlinear power law behavior in antiplane deformation

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Applying Noether's theorem with the help of Lie's infinitesimal invariance criterion to the functional of materials with a nonlinear power law behavior in antiplane deformation, their symmetry-transformations and the related conservation laws are obtained. For this physical nonlinear problem unlike geometrically nonlinear problem, the translation, rotation and scale change of coordinates are symmetry-transformations. Especially, the scale change of coordinates is directly related to the strain hardening coefficient. Moreover, when the strain hardening coefficient is close to 1, the materials turn out to be a linear material and a phenomenon of symmetry breaking occurs. And any conformal transformations in two-dimensional Euclidean space for elastic antiplane deformation are symmetry-transformations, which mean that there are countless symmetry-transformations and related conservation laws in material space. For plane elasticity, there also exists this kind of conservation laws.

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13:43–211

Analyticity and causality of rheological models

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In this paper, the basic transfer functions and time-response functions of linear phenomenological models are revisited. The relation between the analyticity of a transfer function and the causality of the corresponding time-response function is extended for the case of generalized transfer functions. By using the properties of the Hilbert transform and the associated Kramers–Kroning relations it is shown that transfer functions that have a singularity in their imaginary part should be corrected by adding a delta function in their real part. This operation ensures that the resulting time-response function is causal and is consistent with the theory of generalized functions. Accordingly, the transfer functions of classical visoelastic models presented in standard vibration handbooks are revised.

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13:46–211

General criteria of material instabilities

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In this work, we study the joint influences of material constitutive behaviors and loading conditions on the stability of plastic flow for thermal viscoplastic materials. Based on the linear perturbation analysis, a general characteristic spectral equation is deduced from general three-dimensional field equations and a universal criterion to estimate materials instability behaviors is proposed. The criterion shows that the instability takes place once thermal softening surpasses work hardening. Mathematically, it explicitly shows the effects of strain hardening, strain rate sensitivity, thermal softening and heat conduction as well as normal and shear stresses and strain rates on instability behaviors of materials. If specified loading conditions are assumed, corresponding criteria are derived from the criterion. The detail analysis and discussion on the influence of strain rate sensitivities and loading conditions on instability behaviors are performed.

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13:49–211

A proposed indentation scheme for investigating elasto-viscoplastic behaviour of materials at elevated temperatures

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Hot indentation system has been developed recently to study the mechanical behaviour of materials at elevated temperature. The paper proposes an indentation scheme to investigate the high-temperature elasto-viscoplastic behaviour of metallic materials based on a unified constitutive model with a distinct elastic range, a nonlinear isotropic and kinematic hardening of Armstrong-Frederick type and a rate dependent viscous overstress. A multi-step loading history is chosen to separate the rate indepen-