NONLINEAR ANALYSIS AND APPLICATIONS

April 2–4, 2009, Kiev, Ukraine

Book of Abstracts

Nonlinear Analysis and Applications

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In the collection questions of the nonlinear analysis, multiple-valued reflection, theories of optimisation, the management and modelling theory, and also application of mathematical methods are considered.

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В сборнике рассматриваются вопросы нелинейного анализа, многозначных отображений, теории оптимизации, теории управления и моделирования, а также применения математических методов.

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Contents

Variational problems for damage accumulation models of heritable type

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On the basis of scalar model of damage accumulation at hot deformation

$$\psi(t) = \int_0^t \varphi(t-\tau; I(\tau)) f(\dot{\varepsilon}_u(\tau)) d\tau, \tag{1}$$

(where $0 \leqslant \psi \leqslant 1$, $\psi(0) = 0$, $\psi(t_*) = 1$; t_* — limiting time which corresponds to the specimen destruction; t, τ — time; $\varphi(t-\tau; I(\tau))$ — heredity kernel; f — some function) and taking into account the dependence of cumulative deformation ε_u on strain rate $\dot{\varepsilon}_u$

$$\varepsilon_u = \int_0^t \dot{\varepsilon}_u(\tau) d\tau, \tag{2}$$

two important for practice variational problems of isoperimetric type are formulated. The first problem is formulated as follows: to define the strain rate change law $\dot{\varepsilon}_u = \dot{\varepsilon}_u(t)$ at which preset cumulative deformation ε_* is achieved in the shortest time t_* provided that $\psi(t_*) = 1$

$$\begin{aligned} & t_* = t_*(\dot{\varepsilon}_u(t)) \to min, \\ & \varepsilon_* = \int_0^{t_*} \dot{\varepsilon}_u(\tau) d\tau, \\ & \int_0^{t_*} \varphi(t_* - \tau; I(\tau)) f(\dot{\varepsilon}_u(\tau)) d\tau = 1. \end{aligned} \tag{3}$$

The problem (3) is not a classical problem of isoperimetric type because value of define integral is known, but the upper bound of definite integral is being minimised. The second problem formulation: to define the strain rate change law $\dot{\varepsilon}_u = \dot{\varepsilon}_u(t)$ at which for preset time t_* the material gets the greatest deformation ε_* provided that $\psi(t_*) = 1$

$$\begin{aligned} & \varepsilon_* = \int_0^{t_*} \dot{\varepsilon}_u(\tau) d\tau \to max, \\ & \int_0^{t_*} \varphi(t_* - \tau; I(\tau)) f(\dot{\varepsilon}_u(\tau)) d\tau = 1. \end{aligned} \tag{4}$$

Euler's equation for problem (4) is not differential. Necessary conditions of extremum existence are carried out only in trivial cases which have no practical importance. In the statement (4) an important condition which from the physical point of view displays that destruction of material cannot occur till t_* was not taken into account, i.e.

$$\int_0^t \varphi(t-\tau; I(\tau)) f(\dot{\varepsilon}_u(\tau)) d\tau \leqslant 1, \forall t \in (0, t_*). \tag{5}$$

By feasible functions region reduction to the piecewise constant functions class, specifically for two-level schemes

$$\dot{\varepsilon}_u(t) = \begin{cases} \dot{\varepsilon}_{u1}, 0 \leqslant t \leqslant t_1; \\ \dot{\varepsilon}_{u2}, t_1 \leqslant t \leqslant t_*, \end{cases} \tag{6}$$

the problem (4) subject to (5) is converted to the nonlinear programming problem

$$\begin{aligned} &\varepsilon_* = \dot{\varepsilon}_{u1} \cdot t_1 + \dot{\varepsilon}_{u2} \cdot (t_* - t_1) \to max, \\ &\left(\frac{t_*}{t_{*1}}\right)^n + \left(\frac{t_* - t_1}{t_{*2}}\right)^n - \left(\frac{t_* - t_1}{t_{*1}}\right)^n = 1, \\ &t_1 \leqslant t_{*1}, \end{aligned} \tag{7}$$

in which efficiency function depends on three unknown variables $\dot{\varepsilon}_{u1}$, $\dot{\varepsilon}_{u2}$, t_1. Here $t_{*i} = t_{*c}(\dot{\varepsilon}_{ui}), i = 1, 2$; t_{*c} — known function which characterises the material properties.

By the instrumentality of the LagrangTs multipliers method the problem (7) has been convert to the problem of finding of one-variable function optimum value. According to the found solution optimum scheme is the one where $\dot{\varepsilon}_{u1} > \dot{\varepsilon}_{u2}$. The received result allows to assume, that optimal resolution of the variational problems (3) and (4) exist for many other feasible functions classes.