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STRAIN SOFTENING OF MATERIALS IN TENSION-TORSION TESTS

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ABSTRACT

The work is devoted to study of behaviour of materials at a postcritical deformation stage. Problems of implementation of the strain softening stage of materials during testing where considered. Issues of limit states depending on the stiffness of loading systems under uniaxial tension experimentally were studied. In uniaxial and biaxial (tension and torsion) tests shown the possibility of obtaining diagrams with advanced stage of strain softening and complete strain curves of materials with sufficient high stiffness of loading system.

Keywords: experimental mechanics, strain softening, non-local failure conditions, tension-torsion tests.

INTRODUCTION

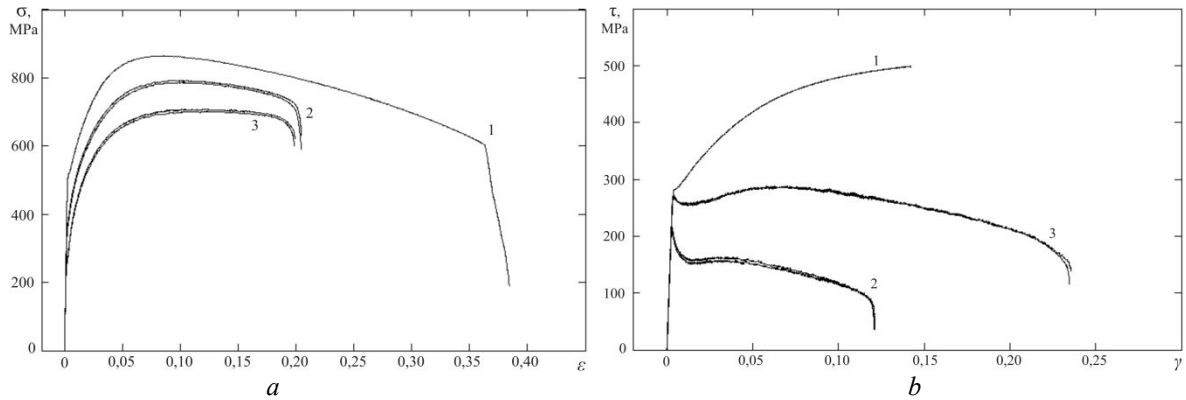
Dissipative processes of inelastic deformation, including the processes of structural failure and fracturing, reflected on the deformation curve as nonlinearity. At the final stage this leads to softening materials and appearance loss of strength section on deformation curve. Study of the basic laws of this phenomenon, as well as their mathematical modeling allows for more accurately forecasting the conditions of deformed bodies destruction and analysis of the fracture process management capabilities. Issues of experimental and theoretical study of the postcritical strain laws are attract the attention of researchers in connection with the possibility of materials deformation reserves, increasing the carrying capacity and survivability of constructions (Vildeman, Sokolkin, Tashkinov, 1997, Struganov, 2004).

In emergency situations, the most important property of materials is survivability. Accounting for the postcritical deformation stage in the more exact calculations is reveals reserve load-carrying capacity of structures. Completeness of the load-carrying capacity implementation of critical constructions and buildings is determined by the degree of postcritical deformation.

On the postcritical stage of deformation is the formation of macro-destruction conditions. They, unlike the traditional view that defines the use of force or deformation criteria are not definitely related to the stress-strain state at the point of a deformed body. During the transition from the stage of equilibrium damage accumulation to non-equilibrium stage of destruction the key role plays the interaction between a deformed body and the loading system. As a result, depending on loading conditions, each point on the descending branch of stress-strain curve can correspond to the time of the loss of bearing capacity as result a transition from stable to non-equilibrium stage of the damage accumulation process. Thus, the rigid loading system may contribute to the "adaptation" of the object in the process of destruction due to local dissipation of elastic energy (Vildeman, 1997, 2008, 2011).

RESULTS AND CONCLUSIONS

Tests carried out on universal biaxial servohydraulic test system Instron 8850. Strain in test part registered by dynamic extensometer Instron 2620-601 with gauge length 12.5 mm and biaxial extensometer Epsilon 3550-010M with gauge length 10 mm. On figure 1 are shown the strain curves of steel 40X at different stress state types. Uniaxial tension tests carried out on solid cylindrical specimens with diameter of test part is 5 mm, length of test part is 8 mm. Torsion and proportional tension with torsion tests carried out on thin-walled tube specimens with length of test part is 14 mm, outside diameter is 10 mm, wall thickness is 1 mm.



a *b*

Fig. 1 - Stress-strain curves of steel 40X: *a* - axial stress - axial strain (*1* - uniaxial tension, *2* and *3* - proportional tension with torsion with rate ε/γ=1.6 and ε/γ=0.8), *b* - shear stress - shear angle (*1* - torsion, *2* and *3* - proportional tension with torsion with rate ε/γ=1.6 and ε/γ=0.8)

The work outlines that material deforms equilibrium on the strain softening stage up to destruction of specimen with sufficient stiffness of loading system at different stress-strain states.

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