WAVE PROPAGATION IN SOLIDS CAPABLE OF PHASE TRANSITIONS

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Summary The present work is devoted to modeling of structural transformation in solids with complicated internal structure. The model is based on a special stress-strain dependence, which includes a decreasing segment. The obtained solution gives a possibility to demonstrate the penetration of structural conversion inside the material.

FORMULATION OF THE PROBLEM

The present paper deals with dynamics of solids that can undergo a phase transition. It is clear that it is a very complicated process that depends on many factors. But here the problem is formulated for a simple 1D model, and only mechanical impact is taken into consideration.
Generally, it is accepted that description of phase conversion is based on non-monotone stress-strain relation [1, 3]. Following this approach, we consider a semi-infinite homogeneous rod with a piecewise linear constitutive curve [2], including a decreasing segment which separates two stable phases A and B (see Fig. 1). Initially the whole material is in the unstressed state that corresponds to phase A. At time t=0 a constant force P is applied to the left butt of the rod. Our aim is to investigate the wave motion in the model and to determine the stress-strain state.

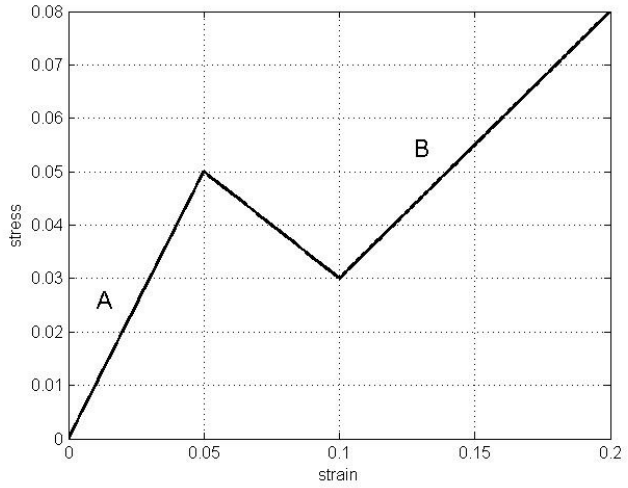

Figure 1: Constitutive Curve

NUMERICAL EXPERIMENT

Dynamics of the rod is described with a following equation, satisfying the necessary boundary condition

$$\rho\ddot{u} = \frac{\partial \sigma}{\partial x}, \quad \sigma\big|_{x=0} = P.$$

Finite difference method is used to integrate the equation. The essence of this numerical method consists in meshing the domain of unknown function and replacing derivative expressions with approximately equivalent difference quotients. Consequently, recurrence algebraic equation is received instead of differential one. The result of numerical solution is depicted in Fig.2. It demonstrates the strain distribution at two moments of time.

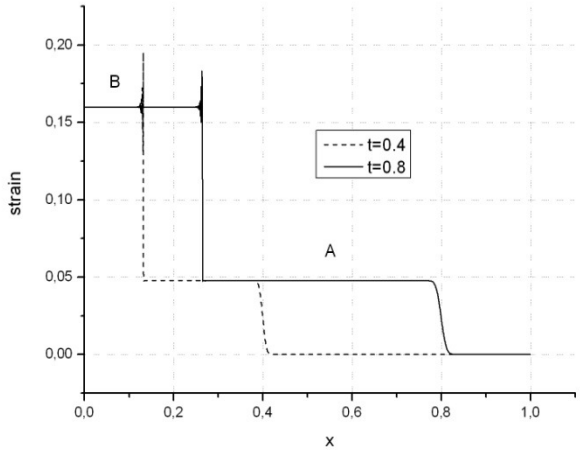

Figure 2: Numerical Solution

The obtained solution demonstrates the propagating of two-front travelling wave. The second front marks the border between phases A and B. As a result, the penetration of phase B inside the rod is observed.

CONCLUSIONS

In this paper the possibility of modeling structural transformation in solids is demonstrated. The dynamic of the system is taken into consideration.

References

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