

RECENT ADVANCES OF STRUCTURAL-CONTINUAL APPROACH IN FRACTURE THEORY

Arseny Kashtanov*

*Elasticity Department, Faculty of Mathematics and Mechanics, St.-Petersburg State University,
St.-Petersburg, 199034, Russia

Summary Recent advances of structural-continuum approach based on the notion of incubation time will be delivered. Proposed approach operates with the damage function which can be considered in fracture problems as instant local microfracture state. It makes possible to construct the kinetic description of abrupt structural changes in continuum. The main results can be generalized to describe sudden structural transitions in other problems of solid mechanics.

STRUCTURAL-TEMPORAL APPROACH

Attempting to understand the phenomenon of dynamic material strength the scientific community has focused the main efforts on definition of functional strength parameters (dynamic material strength and dynamic fracture toughness) by analogy with quasistatic fracture theory. Nowadays, such approach looks unviable and inconvenient for engineers due to necessity to define material strength functions experimentally for every shape of loading pulse. In 1988 Morozov, Petrov and Utkin have proposed a new criterion of crack initiation under high-rate loading [1] extended to describe the spalling phenomenon in 1990 [2]. It is based on the notion of incubation time – the characteristic time of microfracture (relaxation) processes anticipating the macrofracture event. The new incubation time approach become powerful in different problems of fracture dynamics and many peculiarities of dynamic strength phenomenon was soon explained (see, e.g., [3]). Later, the incubation time criterion was extended to other dynamic transient processes in solid mechanics. Among them one can mention the pulsed electrical breakdown in insulators [4], cavitation in liquids [5, 6], initiation of yielding [6] and melting under high-rate loading [7].

STRUCTURAL-CONTINUAL APPROACH

But incubation time criterion [1-7] allows an integral consideration of relaxation processes and does not provide their continual description at the microscale. The kinetic description of abrupt structural changes in continuum based on the notion of incubation time (called structural-continual approach) will be presented [8, 9]. Proposed approach operates with the damage function which can be considered in fracture problems as instant local microfracture state (this function describes the microfracture evolution including the processes of nucleation, interaction and following coalescence of microfracture – microcracks, microdamage and so on). The main results can be generalized to describe sudden structural transitions in other problems of solid mechanics.

CONCLUSION

Exploitation of proposed structural-continuum approach will be illustrated on a range of dynamic and quasi-static fracture problems including new results obtained for crack initiation and propagation under before-threshold pulses of dynamic loading.

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