

Long Destruction of Structurally Damaged Composite Pipe

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ABSTRACT

Composite materials represent the important class of anisotropic materials. Unlike the previous works of authors in which estimations of long durability of an anisotropic pipe are given within the bounds of criterion of the destruction being generalization of the first theory of durability on the maximal stretching or compressing strain on the account of the process of damageability, in the given work the estimation of long durability is given within the bounds of the structural criterion of durability offered in work of one of the authors. According to him, destruction of a material is defined by the greatest level of the accumulated volume of damageability on some of proper stress-strain states. A problem in revealing stages of scattered destruction of an anisotropic pipe with the use of the simplified variant of criterion of durability, has been solved in the given work.

Keywords: Anisotropy, Composite, Composite Materials, Damaging, Dispersed Failure

INTRODUCTION

The main task which needs to be solved at designing is to avoid destruction of projected elements of constructions and objects in course of the expected period of operation. The majority of constructions works in conditions of the complex strained state. The estimation of longevity in these cases is difficult, and when the material of constructions possesses viscous properties sometimes it is problematic. First of all it is connected with distinction in time of destruction of separate parts of constructions. Expansion of the destroyed parts changes border of section of the destroyed and undestroyed parts. The concept of destruction front is connected with the last one, for the first time

entered by Kachanov (1974). The similar situation arises for the non-uniform strained state of constructions. Existing theories of durability are unsuitable for research of destruction of such bodies for the element of a material for which the criterion of destruction is carried out, is considered destroyed, and the description of the further behaviour of such element at proceeding loading within the bounds of theories of durability is absent. Theories of damaging or theories of the dispersed destruction open greater opportunities here.

One of the ways of the analysis of destruction of the body being in a non-uniform strained state, in the way based on concept of front of destruction. Thus besides the defining equations and criterion of destruction, the additional as-

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sumptions which are not following from model of deformation and destruction are required.

As at the non-uniform strained state levels of pressure in different points are various, then according to it, degrees of damaging of these points also differ. The equations connecting strains with deformations, defining equations in each point will be fair until the corresponding criterion of destruction will not be executed for it. Since at this moment given particle of material is not in a condition to carry out the functional duty to bear the certain loading, and is being destroyed. In consequence of it happens the redistribution of strains resulting in further to destruction of the next particle of a material. Eventually the destroyed part of a body increases until all construction entirely will not lose the bearing ability.

Thus, two stages of the dispersed destruction are singled out. The first stage is called a stage of the latent destruction or the incubatory period, extends till the moment of time t_0 when the destroyed area in a body which can consist even of one point of a body for the first time is formed. Subsequently this area of a body increases. The motion of destruction front describing increase in the destroyed area, passes till the moment of time t_p when the construction loses the bearing ability and completely fails. This period of time from t_0 up to t_p is called a stage of distribution of destruction. Definition of the moment of time t_p demands additional assumptions. So, for example, the conditional conversion of speed motion of destruction front to infinity is possible. However such condition is comprehensible not always for some constructions speed of motion of destruction front in the course of all stage of distribution of destruction remains finite.

The equation of the motion of destruction front is defined by criterion of destruction.

As base model of a damaged body model (Akhundov, 1991) considering destruction as some final stage of deformation of a material is convenient. Convenience consists of that the same operators describing process of accumulation of damages enter both into deformation parities, and in criterion of destruction.

In general case research of process of destruction is connected with definition for a present moment of time of the strained state with the subsequent check of feasibility of criterion of destruction for all undestroyed part of a body. Usually similar one it is possible to do only by numerical way, but it also is connected with the certain mathematical problems. For dynamic problems, in comparison with static, difficulties increase repeatedly. But also for static problems, even for cases proceeding with loading, it is not possible to avoid mathematical difficulties.. Though even in those cases, in view of that that the operator of damageability behaves as the usual operator of viscous current and strained states is managed to be defined analytically, for the equation of motion of destruction front turns out nonlinear integrated Volter's equation of the second type. The similar one takes place, when strains represent rational functions from operators of damageability which decoding is made on the basis of parities of algebra of resolvent operators (Rabotnov, 1977). For anisotropic bodies it takes place only for materials for which anisotropy of mechanical properties is shown through their instant characteristics.

In the given work the problem in revealing stages of the dispersed destruction of an anisotropic pipe in view of process of damageability is solved.

HISTORY OF PROBLEM

Bases of the phenomenological description of behaviour of the materials which are based the concept of accumulation of damages, are incorporated in Rabotnov (1979), Kachanov (1974), and Ilyushin (1967). Various directions of development of these theories have been given (Bolotin, 1984; Novozhilov, 1975; Suvorova, 1979; Tamujh & Kuksenko, 1978; Shesterikov & Lokoshenko, 1980; Kondarov, Muhamediyev, Nikitin, & Ryjak, 1987). In Suvorova, Akhundov, and Ivanov (1987) and Akhundov (1988) the model of deformation and destruction of isotropic materials in conditions of the complex strained state, based on heredi-

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