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Defining Relations in Mechanics of Cross-Ply Fiber Reinforced Plastics Under Short-Term and Long-Term Monoaxial Load

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Abstract—For cross-ply fiber reinforced plastics under short- and long-term loading conditions we prove the defining relations. It was shown that in general case total axial strain consists from residual (irreversible) strain of lateral degradation, reversible strain of material's microrearrangement, and reversible creep strain. We consider issue of experimental determination and problems of identification of mechanical parameters taken into consideration.

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Many researchers devoted their attention to problems of creep strains (see, in particular, [1–3]). They proposed many different theories describing the rheological properties of materials (the simplest theory of aging, the theory of flow and hardening, linear and nonlinear hereditary models). To describe the creep strains of fibrous composites, the most suitable model for experiments is the viscoelastic (hereditarily elastic) solid model. In this case, the scientists often apply the weakly singular Abel kernel. In order to find the parameters of the creep models, the most convenient experiment is the one conducted for a long time at a constant load. This allows us to extract from the total deformation the time-dependent part. The prediction of creep strains for sufficiently long intervals of time inspired appearance of various methods based on mathematical analogies (temperature–time, stress–time, etc.).

In order to develop the indicated directions of the mechanics of composites for experimental studies, we prepared test samples from a unidirectional fibrous composite based on an ELUR-P carbonate and cold-fixing binder CT-118, having the structure $[+45^\circ/-45^\circ]_{2s}$ ($2s = 4$ is the number of monolayers), the average thickness is $h = 0.56$ mm, the width is $b = 24.6$ mm, the length of the working part is $l = 110$ mm. The properties of hereditary viscoelasticity most clearly manifest themselves in such samples under tension conditions (compression). So, the samples were tested by two loading programs. The first of them consists of three stages: stretching to $\sigma_{\max}$ stress by kinematic loading with the speed 0.68 MPa/sec, free unloading to $\sigma = 0$ MPa or $\sigma = 1.5$ MPa with the aim of excluding possible flexural

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