

STRESS-STRAIN STATE OF UNIDIRECTIONAL FIBROUS COMPOSITE WITH CRACKS IN MATRIX

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The stress-strain state of a unidirectional fiber composite with a crack in the matrix adjacent to the fiber has been investigated. The composite is under tension along the fiber direction. It is proposed to utilize the asymptotic method developed by authors, the primary concept of which involves decomposing the stress-strain state of an orthotropic body into two components with distinct properties linked by boundary conditions. The obtained analytical solutions allow taking into account the structural heterogeneity of the material. The distribution of contact stresses valid everywhere except the area around singular points is determined. Together with the constructed singular solution, these presentations provide a uniform solution of the problem applicable throughout the domain.

Keywords: fibrous composite materials, stress-strain state, crack, anisotropy, analytical solutions

Introduction. Structural composite materials are increasingly being utilized across various domains of modern technology. However, the comprehension of the mechanics underlying such composites often lags behind the advancements observed in their technical applications. Practical problems in construction, medicine, and mining frequently involve heterogeneous materials where the impact of reinforcing fibers within the matrix on the fracture process needs consideration at the macro-mechanical level.

For example, in [4], the investigation delved into the influence of fiber-reinforced composites and overlays on the stability against fracture of pre-cracked teeth demonstrating through conducted experiments the considerable efficacy of composites in averting the destruction of pre-cracked teeth. Numerous experimental inquiries were undertaken concerning construction materials; in [21], the creep behavior of composites based on sisal fiber cement was explored.

High-performance fiber-reinforced cement composites (HPFRCC) featuring a significant volume of conductive steel fibers hold promise as a building material for shielding against electromagnetic interference. The study [18] focused on the deliberate creation of cracking areas in HPFRCC with two varying matrix strengths (100 and 180 MPa) and two different volume contents of carbon fibers (0.1% and 0.3%). The findings revealed that lower-strength composites exhibited superior shielding effectiveness in both non-cracked and multi-cracked states attributed to the presence of iron (III) oxide and lower silica fume contents.

The primary goal in designing composite materials is often to increase the strength of the matrix material rather than to enhance the stiffness. This is typically relevant when the matrix is made of a brittle and low-strength material. The objective of the study [1] is to investigate how matrix cracking affects the mechanical properties of FRP (Fiber Reinforced Polymer)

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