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Study of the mechanical model of the process of pre-destruction near the end of a crack reaching the media-separating unsmooth boundary

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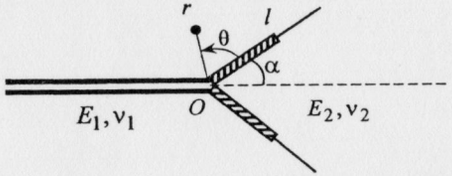
A calculation of region of pre-destruction at the end of a crack reaching the media-separating unsmooth boundary in an isotropic elastic body is being implemented in this work under the conditions of a plane symmetrical problem within the framework of a model with 2 lines of displacement rupture.

A piece-homogeneous isotropic elastic region with an angle's sides shaped media-separating boundary is being considered under the plane strain conditions within the framework of a symmetrical problem; the region has a crack emerging from the vertex. The material of a connecting layer is a homogeneous isotropic elastic one, more fragile than materials of the parts that compose the region. Even at the external loadings as small as one may wish a region of pre-destruction appears at the end of a crack. Let us study only initial stage of its development assuming external loadings to be small enough. Due to the property of material of the connecting layer the pre-destruction zone will develop along the media-separating boundary as a pair of narrow strips that emerge from the end of the crack. The connecting layer is assumed to be as thin as a line where the proper boundary conditions are being formulated.



As priority strains at the pre-destruction zone develop in accordance with the mechanism of tear-off, we will model the strip-zone by the line of normal-displacement rupture on which the normal stress equals to the given constant of material of the connecting layer σ.

Taking into account the small size of the pre-destruction zone we have the correspondent static problem of a theory of elasticity for the plane with a semi-infinite crack (fig).

At infinity an asymptotic which is a known solution of similar problem without lines of rupture at the media-separating boundary is realized; the solution is generated by the least root of the problem's characteristical equation at the]-1;0[interval. The arbitrary constant in this solution is considered to be pre-defined. It defines an intensity of external field and should be found from external problem's solution.

In order to construct the solution of the problem of a theory of elasticity with proper boundary conditions a Wiener-Hopf method in combination with a Mellin's integral transform is applied.

The law of development of pre-destruction initial zone near the end of the crack has been established.

Principal terms of the expansion of stresses in asymptotic series with $r \to 0$ have been defined.

Analysis of the gained results allows us to make the following conclusions. In a certain intervals of variation of parameters the corner point O is a singular point of the problem of theory of elasticity in question. It is a concentrator of stresses with a power function singularity. Approaching of stresses to infinity when $r \to 0$ corresponds to the fact that the part of pre-destruction zone at the end of a crack is that domain of destruction of material where the stress level is very high. An exponent of singularity of the stresses depends on the angle α and elastical constants of materials composing the composite (E_1, ν_1, E_2, ν_2).

There exist intervals of variation of parameters, in which the corner point O is not a concentrator of stresses.

When angle α increases the concentration of stresses in the region of destruction of material becomes greater.