LAYER GROWING/REMOVING METHOD FOR DETERMINATION OF RESIDUAL STRESSES IN ORTHOTROPIC NON-HOMOGENEOUS CYLINDERS

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In [1] an algorithm of the layer growing/removing method is presented for the determination of residual stresses in the case of the isotropic non-homogeneous cylinder with a central hole. In the present paper the method is extended to the orthotropic non-homogeneous cylinder. It is assumed that elastic parameters depend on the radius only. Layer growing/removing may occur either on the cylinder's external or internal surface. One proceeds from a generalized algorithm [2] by employing differential approach. The suggested algorithm presents interest above all in studying residual stresses in composite cylinders and growth stresses in trees.

According to the general algorithm the mechanical effect of formation of an elementary boundary layer is reduced to radial boundary load and axial edge load. These loads are expressed through the circumferential initial stress and axial initial stress of the surface layer, assuming that initial stress changes only in the radial direction. Residual stresses are found by the summation of the initial stresses of the cylindrical elementary layer and additional stresses arising as a result of adding further elementary layers.

In order to determine additional stresses, the centrally symmetric problem of theory of elasticity is solved for the long orthotropic cylinder with a central hole and elementary surface and edge loads. As a result, the following will be obtained: (1) relations between elementary additional stresses and initial stress; (2) relations between elementary strains on the stationary boundary and initial stresses. Relations (1) allow calculating additional stresses from initial stresses by integration. Initial stresses are determined e.g. by X-ray diffraction measurements on the cylinder's moving boundary, or by strain measurements on the free stationary boundary, where circumferential and axial strains are measured and, proceeding from this, initial stress is calculated using relations (2).

It is shown that under certain conditions the layer growing and layer removing methods can be covered by one algorithm.

A computer program based on the present algorithm is introduced, and an example of application is presented.

References

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