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І ДУНАЙ)

PHYSICAL AND MATHEMATICAL SCIENCES

УДК 514.85

PERIODIC REINFORCEMENT OF THE PRESTRESSED STRIP WITH ELASTIC RECTANGULAR ADJUSTMENTS

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Abstract. In the article, within the framework of the linearized theory of elasticity, the law of influence of initial (residual) stresses on the distribution of contact stresses in an elastic strip reinforced by periodically placed elastic rectangular overlays investigated. The study carried out in general for large (finite) initial deformations in the case of elastic potentials of an arbitrary structure.

Keywords: contact problems, linearized elasticity theory, initial (residual) stresses.

Introductions. In the article, within the framework of the linearized theory of elasticity, the law of influence of initial (residual) stresses on the distribution of contact stresses in an elastic strip reinforced by periodically placed elastic rectangular overlays is investigated. The study was carried out in general for large (finite) initial deformations in the case of elastic potentials of an arbitrary structure.

The studies carried out and published in this article are of significant national economic importance. Which consist in the development of a methodology for taking into account the regularities of the influence of initial (residual) deformations on the law of distribution of contact forces with an assessment of the need to take into

account these effects in engineering calculations when calculating the latter for strength. This problem is especially acute now, when it is necessary to improve the reliability of machines in various branches of modern industry with a simultaneous reduction in their material consumption and the conservation of energy resources for their manufacture.

Improving the reliability and durability of engineering structures and machines is one of the most urgent tasks of modern construction and mechanical engineering. Its successful solution largely facilitated by extensive scientific research in the field of mechanics of a rigid deformed body, in particular in the study of the problem of load transfer in structures and machine parts. The emergence of new materials, the need to increase operational structures and machines, reduce their weight, increase their service life, reduce cost and achieve economic compatibility - all this depends on the calculation methods.

Aim. Investigation of the influence of initial (residual) stresses on the law of distribution of contact stresses along the contact line supported by elastic face linings.

Materials and methods. The study of the distribution of contact stresses along the contact segments of periodically placed elastic overlays with an elastic isotropic half-plane and a strip in the classical theory of elasticity is devoted to the works of A.N. Guz, in the case of the linearized theory of elasticity – the works of V.S. Sargsyan, V.B. Rudnytsky, M.M. Dikhtiaruk, and others.

The problem of transferring an arbitrarily distributed load (Fig. 1) from periodically placed thin overlays to an elastic strip with initial stresses pinched by one face is considered.

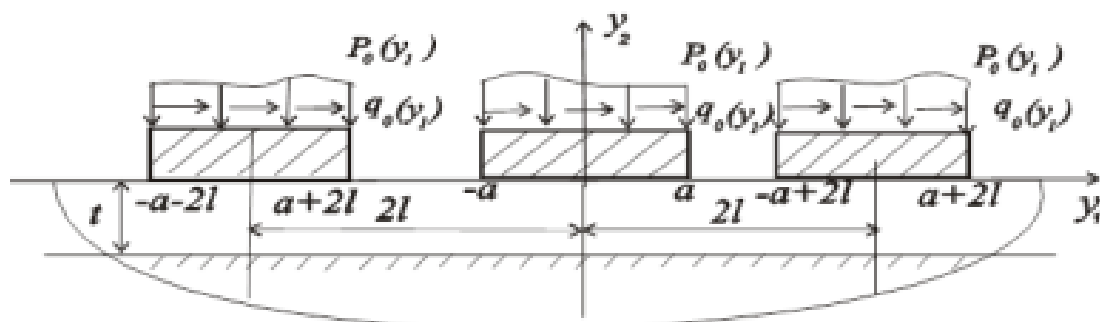


Fig. 1

The solution of the problem reduced to the solution of a singular integro differential equation with a Hilbert kernel, which can be represented as the sum of two nuclei: a special part and a regular part [1, 2].

The desired solution is presented in the form of a series on Jacobi polynomials, and to determine the unknown coefficients of the series, a quasi-regular infinite system of algebraic equations is obtained [3, 4]

$$l_m \tilde{X}_m + \sum_{n=1}^{\infty} [P_{m,n}^{(1)} \tilde{X}_n + P_{m,n}^{(2)} \tilde{X}_n] = -[P_m^{(1)} \tilde{X}_0 + P_m^{(2)} \tilde{X}_0 + P_m^{(3)} + R \cdot P_m^{(1)}] \quad (m=1,2,\dots).$$

Based on calculations, graphs given that characterize the influence of initial stresses in the contact area of periodically placed linings (Fig. 2).

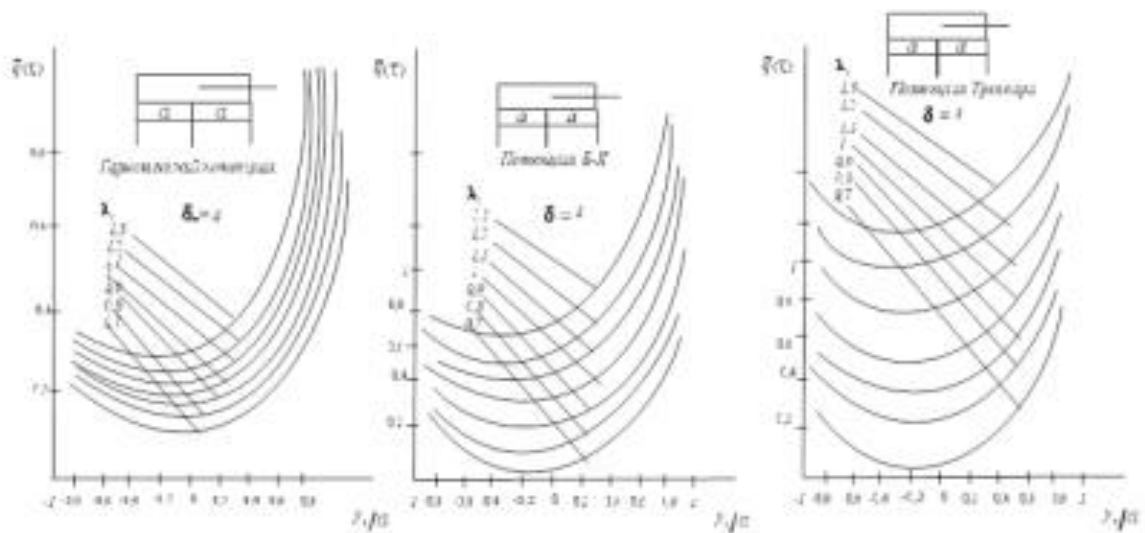


Fig. 2

These figures illustrate the effect of initial (residual) stresses in an elastic strip on the law of distribution of contact stresses under periodically placed overlays from the action of tangential force $q_0(y_1) = Q_0$ for dimensionless quantities.

The graphs show the location of curves for the value of the parameter $\lambda_1 = 1,3; 1,2; 1,1; 1; 0,9; 0,8; 0,7$ – which characterizes the initial (residual) stress-strain state. The value $\lambda_1 = 1$ corresponds to the elastic band without initial (residual) stresses and represented on the graphs by a dotted line, i.e. the value of contact stresses for a similar problem solved within the framework of the classical theory of

elasticity [5].

It follows from the graphs that the regularity of the influence of initial stresses in the elastic band on the distribution of contact tangential stresses significantly depends on the structure of the elastic potential in the latter. Initial stresses have a significant quantitative influence in highly elastic materials compared to rigid ones, and the qualitative effect is the same. When ($\lambda_1 < 1$) compressed, contact stresses decrease, and in the case of tension ($\lambda_1 > 1$), they increase. This result can be used effectively to adjust contact forces in strength analysis of structures.

Conclusions. In this work, the theory of contact interaction of elastic overlays of finite length with an elastic strip is further developed, taking into account the initial (residual) stresses. Within the framework of the linearized theory of elasticity, the problems of contact interaction of an elastic strip with initial (residual) stresses supported by elastic curve overlays are formulated, in a general form for the theory of large (finite) and two variants of small initial (residual) deformations in the case of an arbitrary structure of elastic potential. The basic singular integro-differential equations of the class of problems under consideration are obtained, the solution of which is presented in the form of quasi-regular infinite systems of algebraic equations.

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