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EFFECTR OF STRIP INSERTS ON THE STRESS AND STRAIN FIELD IN A PLATE WITH AN ELONGATED RECTANGULAR OPENING

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This paper considers the stress and strain field in an elastic square plate with an elongated rectangular opening whose sides are reinforced with rectangular inserts. The aim of this work is to study the effect of the insert parameters and the opening orientation (the orientation of the major and the minor sides of the opening relative to the load direction) on the reduction of the stress and strain intensity in the plate at stress concentration sites. The material of the reinforcing inserts differs from that of the plate. Using the variational grid finite-element method, computer simulation and calculations were conducted to determine the most suitable geometric and mechanical characteristics of the reinforcing inserts and their locations. It was shown that the proper choice of the reinforcing insert parameters reduces the stress concentration in the plate. The results obtained may be used in increasing the strength of structures that include thin-walled plates with rectangular openings at low material consumption for reinforcing inserts.

Keywords: *elastic plate, elongated rectangular opening, reinforcement, stress concentration coefficient, finite-element method.*

1. *Vainberg D. V.* Stess Concentration in Plates near Openings and Round Corners: Handbook (*in Russian*). Kyiv : Tekhnika, 1969. 220 pp.
2. *Hart E. L., Panchenko S. V.* Computer simulation of the stress and strain field in an elastic plate with a rectangular opening reinforced at the corners (*in Russian*). Mathematical Problems in Technical Mechanics – 2015: Conference proceedings (April 14–17, 2015) – Dniprodzerzhynsk, Dnipropetrovsk: Dniprodzerzhynsk State Technical University, National Metallurgy Academy of Ukraine, 2015. P. 81.
3. *Hart E. L., Panchenko S. V.* Numerical analysis of the stress and strain field of a plate with a rectangular opening reinforced with triangular inserts (*in Russian*). Problems in Computational Mechanics and Structural Strength: collected papers. – Dnipropetrovsk: Lira, 2015. Issue 24. Pp. 35–47.
4. *Hudramovych V. S.* Effect of openings on the limiting states of components of metal thin-walled shell-and-plate structures (*in Russian*). Vusnyk Dnipropetrovskogo Universytety. Seriia Mekhanika. 2014. V.2. No. 18. – Pp. 47–60.
5. *Hudramovych V. S., Hart E. L., Riabokon S.* . Simulation and study of the effect of rectangular opening reinforcements on the stress and strain field in a plate (*in Ukrainian*). Mathematical Problems in Inhomogeneous Media Mechanics: 9th International Conference, September 2014, Lviv, Ukraine: proceedings; I. O. Lukovskyi, H. S. Kit, and R. M. Kushnir (Eds.). Lviv : Ya. S. Pidstryhach Institute of Applied Problems in Mechanics and Mathematics of the National Academy of Sciences of Ukraine, 2014. Pp. 43–46.
6. *Guz A. N.* Shall Calculation Methods. In 5 volumes. V. 1. Theory of Opening-Weakened Shells (*in Russian*). Kyiv : Naukova Dumka, 1980. 636 pp.
7. *Zienkiewicz O.* The Finite Element Method in Engineering (*in Russian*). Moscow: Mir, 1975. 541pp.
8. *Mavlyutov R. R.* Stress Concentration in Aircraft Structural Elements (*in Russian*). Moscow : Nauka, 1981. 141 pp.
9. *Mossakovskyi V. I., Kvasha O. M.* Design and calculation of hatches that do not cause stress concentration in spherical shells (*in Ukrainian*). Prykladna Mekhanika. 1959. V. 5. No. 4. Pp. 371–378.
10. *Oden J. T.* Finite Elements of Nonlinear Continua (*in Russian*). Moscow : Mir, 1976. 464 pp.
11. *Preobrazhensky I. N., I. A. Tsurpal.* Openings in Bearing Structures (*in Russian*). Moscow : Mashinostroyeniye, 1984. 112 pp.
12. *Timoshenko S. P., J. Lessels.* Applied Elasticity (*in Russian*). Translated from English. Moscow, Leningrad : ONTI, 1931. 340 pp.