UDC 539.3

V. S. HUDRAMOVICH, V. M. LEVIN, E. L. HART, A. V. REPRINTSEV, S. A. RYABOKON, YE. V. SAMARSKAYA, S. V. SHABELNIK

SIMULATION OF STRAINING PLATE MEMBERS OF REINFORCED CONCRETE STRUCTURES FOR HEAT-POWER ENGINEERING CONSTRUCTIONS USING FINITE-ELEMENT METHOD

The work objective is to study of a stressed-strained state of plate members of reinforced concrete constructions for heat power engineering with arbitrarily oriented extended inclusions depending on a combination of the stiffness parameters of inclusions, their sizes and orientation, relations of stiffness of inclusions and the plate. Projection-iteration modifications of the finite-element method are employed. Parametric characteristics of stressed-strained states of a concrete matrix and reinforcement bars of plate constructions with a rectangular cut are obtained for different compressible loads and reinforcement coefficients. Problems of the determination of the limiting load values resulting in plastic strains and cracks are discussed. Programs for calculating the above parameters are developed.

Keywords: *reinforced concrete constructions for heat power engineering, plate members, extended inclusions, plastic strains.*

1. *Karpenko N. I.* General Models for Reinforced Concrete Mechanics *(in Russian) / N. I. Karpenko.* – Moscow : Stroyizdat, 1996. – 416 p.
2. *Levin V. M.* Reinforced Concrete Tower Constructions. Studies, Computations *(in Russian) / V. M. Levin.* – Makeevka: DonGASA, 1999. – 230 p.
3. *Korsun V. I.* Stressed-Strained State of Reinforced Concrete Constructions under Conditions of Temperature Effects *(in Russian) / V. I. Korsun.* – Makeevka: DonGASA, 2004. – 153 p.
4. Scientific Fundamentals for Providing Reliability and Economical Operation of Mine Head-Gears *(in Russian) / V. N. Kushchenko, V. M. Levin, V. F. Mushchanov et al.* – Makeevka: DonGASA, 2012. – 462 p.
5. Progressive failure of reinforced concrete constructions (in Russian) / *V. M. Levin, V. S. Hudramovich, V. A. Mitrakov et al.* // Prostranstvennye Konstruktsii Zdaniy i Sooruzheniy. – Moscow: Devyatka Print, 2009. – Is. 12. – P. 214 – 223.
6. *Pinfold G. M.* Reinforced Concrete Chimneys and Towers / *G. M. Pinfold.* – London : Press Limited, 1975. – 233 p.
7. *Leongardt F.* Preloaded Reinforced Concrete: translated from German / *F. Leongardt.* – Moscow : Stroyizdat, 1983. – 235 p.
8. Reinforced Concrete Walls of Earthquake-Proof Buildings. Studies and Designing Principles (in Russian) / Edited by *Ashkinadze G. N., Sokolov M. Ye.* – Moscow : Stroyizdat, 1988. – 499 p.
9. Stressed state of reinforced viscous elastic- plastic plate in complex loading *(in Russian) / V. M. Levin, V. S. Hudramovich, V. A. Mitrakov et al.* // Teoreticheskaya i Prikladnaya Mekhanika. – 2008. – Is. 44. – P. 118 – 124.
10. Analysis of stressed-strained state of plastic reinforced members of tower constructions with holes *(in Russian) / E. L. Hart, Yu. V. Gritsuk, V. S. Hudramovich, V. M. Levin, S. A. Ryabokon* // Problemy Obchyslyuvalnoi Mekhaniky i Mitsnosti Konstruktsiy. Transactions. – Dnipropetrovsk : Lira. – 2012. – Is. 19. – P. 54 – 64.
11. *Geniev G. A.* Theory of Plasticity of Concrete and Reinforced Concrete *(in Russian) / G. A. Geniev, V. N. Kissyuk, G. A. Tyupin.* – Moscow : Stroyizdat, 1974. – 316 p.
12. *Grasse P.* Concrete in compression: a plasticity theory with a novel hardening law / *P. Grasse, K. Landgren, K. Gylltoft* // Int. I. Solid Struct. – 2002. – V. 39, Issue 20. – P. 5205 – 5223.
13. *Agapov V. P.* Finite-Element Method for Statics, Dynamics and Stability of Constructions *(in Russian) / V. P. Agapov.* – Moscow: Publishing House of Association of Construction Engineering Institutes, 2004. – 248 p.
14. *Klovanich S. V.* Finite-Element Method for Concrete Reinforced Mechanics *(in Russian) / S. F. Klovanich, I. N. Mironenko.* – Odessa : Publishing House of the National Odessa Nautical University, 2007. – 111 p.
15. Simulation of concrete straining based on modified version of the flow theory *(in Russian)* / *V. S. Hudramovich, V. M. Levin, Ye. V. Samarskaya, S. V. Shabelnik* // Problemy Prochnosti. – 2014. – Vol. 46, Is. 5. – P. 595 – 600.
16. *Ilyushin A. A.* Transactions in 4 volumes. Vol. 2. Plasticity : 1946 – 1966 *(in Russian) A. A. Ilyushin.* – Moscow: Fizmatlit, 2004. – 479 p.

17. *Birger M. A.* General algorithms for solution of problems in theory of elasticity, plasticity and creep *(in Russian)* // Progress in the Mechanics of Deformable Media / *M. A. Birger.* – Moscow : Nauka, 1975. – P. 51 – 73.
18. *Hudramovich V. S.* Stability of Elastic-Plastic Shells *(in Russian)* / *V. S. Hudramovich.* – Kiev : Naukova Dumka, 1987. – 216 p.
19. Approximation Solution of Operator Equations *(in Russian)* / *M. A. Krasnoselsky, G. M. Vaynikko, P. P. Zabreyko et al.* – Moscow : Nauka, 1969. – 455 p.
20. *Samarsky A. A.* Methods of Solution of Grid Equations *(in Russian)* / *A. A. Samarsky, Ye. S. Nikolaev.* – Moscow : Nauka, 1978. – 592 p.
21. *Marchuk G. I.* Introduction to Projection-Grid Methods *(in Russian)* / *G. I. Marchuk, V. I. Agoshkov.* – Moscow : Nauka, 1981. – 416 p.
22. *Hart E. L.* Projection-iterative version of the pointwise relaxation method / *E. L. Hart* // J. Math. Sci. – 2010. – V. 167, No. 1. – P. 76 – 88.
23. *Hudramovich V. S.* Projection-iterative versions of FEM in damage problems for elastoplastic straining plates with holes *(in Russian)* / *V. S. Hudramovich, E. L. Hart* // Proceedings of International Symposium dedicated to 100th Anniversary of A. A. Ilyushin. – 2011, Moscow: Publishing House of Lomonosov MGU, 2011. – P. 144 – 147.
24. *Hart E. L.* Applications of the projective-iterative versions of FEM in damage problems for engineering structures / *E. L. Hart, V. S. Hudramovich* // Maintenance-2012 : 2 Int. Conference, 2012, Zenica, Bosnia and Herzegovina : Proceedings. – Zenica : Univ. of Zenica, 2012. – P. 157 – 164.
25. *Hudramovich V. S.* Elastoplastic deformation of nonhomogeneous plates / *V. S. Hudramovich, E. L. Hart, S. A. Ryabokon* // J. Eng. Math. – 2013. – V. 78, No. 1. – P. 181 – 197.
26. *Hart E. L.* Projection-iterative schemes for realization of the finite element method in problems of deformation of plates with holes and inclusions / *E. L. Hart, V. S. Hudramovich* // J. Math. Sci. – 2014. – V. 203, No. 1. – P. 55 – 69.
27. *Hudramovich V. S.* Simulation of stressed-strained state of shell structures for rocket technology and power engineering *(in Russian)* / *V. S. Hudramovich* // Tekhnicheskaya Mekhanika. – 2013. - No 4. – P. 97 – 104.