Приложение 4

Пример оформления информационного блока

Decomposition method for solving systems of differential equations for the problems of modelling corrosion deformation processes

Zelentsov D.G., Liashenko O.A.
Ukrainian State University of Chemical Technology, Dnipro, Ukraine

The article offers and justifies a method for solving systems of differential equations (SDE) that simulate time changes of stress and strain state due to the influence of corrosive environment (the process of corrosion deformation). The task of modelling is the determination of the construction durability that is the time of its flawless operation. The finite element model of the object under study determines dimension of SDE modelling the process of corrosion deformation. The right-hand sides of the differential equations contain functions of mechanical stresses. The finite element method is used for calculating stresses. The proposed decomposition method is based on the transformation of the initial differential equations by introducing in them functions describing the influence of the remaining equations and the subsequent solution of one of these equations. Based on the analysis of the factors influencing the stress change in the area of the given finite element, we propose to introduce into the corresponding differential equation a function approximating the change of internal forces over time. In this case, the discrepancy between the results of the initial SDE solution and an individual equation is determined only by the error in approximating the dependence of the internal force on time. The article shows that this allows a multi-rate reduction of computational costs. In addition, for a numerical solution of SDE, we propose to use a modified algorithm of the Euler method with a variable integration step by argument. The result of the solution is determination of corrosive construction durability, i.e. operating time before exhaustion of bearing capacity. To illustrate the proposed method, we solved the problem of calculating the durability of a flat-plate subjected to corrosive wear. The article provides the results of numerical experiments confirming the accuracy of the proposed numerical solution with minimal computational costs. The decomposition method for solving SDE modelling the process of corrosion deformation of plane-stressed plates can be generalized to other classes of constructions.

Keywords: decomposition method, corrosive environment, process of corrosion deformation, system of differential equations, plane-stress corroding plates.

References

1. Petrov V.V., Ovchinnikov I.G., Shikhov Yu.M. *Raschet elementov konstruktsiy, vzaimodeystvuyushchikh s agressivnoy sredoy* [Calculation of structural elements interacting with aggressive environment]. Saratov, Sarat. un-t Publ., 1987. 288 p. (in Russian).

2. Karpunin V.G., KleschYov S.I., Kornishin M.S. *K raschetu plastin i obolochek s uchetom obshchey korrozii* [The calculation of plates and shells taking general corrosion into account]. *Trudy X Vsesoyuznoy konferentsii po teorii obolochek i plastin* [Proceedings of the 10th All-Union Conference on the theory of obokolok and plates], Tbilisi: Metsniereba publ., 1975, vol. 1, pp.166-174. (in Russian).

3. Zelentsov D.G., Liashenko O.A., Naumenko N.Yu. *Informatsionnoe obespechenie raschetov korrodiruyushchikh ob'ektov. Matematicheskie modeli i kontseptsiya proektirovaniya system* [Information provision for calculations of corrosive objects. Mathematical models and concept of systems design]. Dnepropetrovsk: Ukrainian State University of Chemical Technology Publ., 2012, 264 p. (in Russian).

4. Korotchenko A.T. *O primenenii metoda dinamicheskogo programmirovaniya k optimal'nomu integrirovaniyu sistemy differentsial'nykh uravneniy* [On the application of dynamic programming to the optimal integration of differential equations system]. *Prikladnye problemy prochnosti i plastichnosti* [Applied problems of strength and plasticity]. Vsesoyuzn. mezhvuz. sb., Gorkiy: GGU publ., 1976, no. 4., pp. 95-97. (in Russian).

5. Korotkaya L.I. *Ispolzovanie neyronnykh setey pri chislennom reshenii nekotorykh sistem differentsialnykh uravneniy* [The use of neural networks in the numerical solution of some systems of differential equations]. *Vostochno-evropeyskiy zhurnal peredovykh tekhnologiy* [Eastern European Journal of Advanced Technology], 2011, no. 3/4 (51). pp.24-27. (in Russian).
6. Denisyuk O.R. *Opredelenie ratsionalnyih parametrov chislennogo resheniya sistem differentsialnyih uravneniy* [Determination of rational numerical solution parameters for some classes of systems of differential equations]. *Vestnik Hersonskogo natsionalnogo tehnicheskogo universiteta* [Bulletin of the Kherson National Technical University], 2016, no. 3 (58). pp.208-212. (in Russian).
7. Alapati M. Discrete Optimization of Truss Structure Using Genetic Algorithm. International Journal of Recent Development in Engineering and Technology, 2014, vol. 3, issue 1, pp.105-111.
8. Ashlock D. Evolutionary Computation for Modeling and Optimization. New York: Springer publ., 2006. 572 p.