

Final transverse movement of an elastic rod with mass at the end when the vibrations are damped at the moment of stopping

© S.V. Russkikh^{1,2}, F.N. Shklyurchuk^{1,2}

¹Moscow Aviation Institute (National Research University), Moscow, 125993, Russia

²Institute of Applied Mechanics of Russian Academy of Sciences, Moscow, 125040, Russia

The article considers nonstationary transverse vibrations of an elastic cantilever rod with a mass at the right end under controlled displacement of the left end along a vertical guide. The flexural vibrations of the rod are sought in the form of eigenmode vibration expansion. The following problem is posed: to find the law of controlled movement of the left end of the rod, governing its movement to the required distance in a given time, while simultaneously several lower eigenforms of the elastic vibrations are damped at the moment of stopping. The acceleration of the left end of the rod is considered to be an unknown function. The acceleration is supposed to be proportional to some finite function. This function, in turn, is written in the form of a series of sines or cosines with unknown coefficients at a given time of controlled motion. Examples of calculation with damping of elastic vibrations in the first three eigenforms are given.

Keywords: elastic cantilever rod, normal coordinates, damping of elastic vibrations, finite function, finite displacements

REFERENCES

- [1] Chernousko F.L., Bolotnik N.N., Gradetsky V.G. *Manipulyatsionnye raboty: dinamika, upravlenie, optimizatsiya* [Manipulation robots: dynamics, management, and optimization]. Moscow, Nauka Publ., 1989, 363 p.
- [2] Berbuk V.B. *Dinamika i optimizatsiya robototekhnicheskikh system* [Dynamics and optimization of robotic systems]. Kiev, Naukova dumka Publ., 1989, 187 p.
- [3] Chernousko F.L., Akulenko L.D., Sokolov B.N. *Upravlenie kolebaniyami* [Control of vibrations]. Moscow, Nauka Publ., 1976, 383 p.
- [4] Chernousko F.L., Ananyevsky I.M., Reshmin S.A. *Metody upravleniya nelineynymi mekhanicheskimi sistemai* [Methods of nonlinear mechanical system control]. Moscow, Fizmatlit Publ., 2006, 326 p.
- [5] Grishanina T.V. *Vestnik Moskovskogo aviatsionnogo instituta (Scientific journal of Moscow Aviation Institute)*, 2004, vol. 11, no. 1, pp. 64–68.
- [6] Grishanina T.V. *Vestnik Moskovskogo aviatsionnogo instituta (Scientific journal of Moscow Aviation Institute)*, 2004, vol. 11, no. 2, pp. 68–75.
- [7] Grishanina T.V. *Izvestiya RAN. Mekhanika tverdogo tela — Proceedings of the Russian Academy of Sciences. Mechanics of Solids*, 2004, no. 6, pp. 171–186.
- [8] Grishanina T.V., Shklyurchuk F.N. *Dinamika uprugikh upravlyaemykh konstruksiy* [Dynamics of elastic controllable structures]. Moscow, MAI Publ., 2007, 328 p.
- [9] Russkikh S.V. *Izvestiya vysshikh uchebnykh zavedeniy. Mashinostroenie — Proceedings of Higher Educational Institutions. Machine Building*, 2016, no. 12, pp. 97–105.
- [10] Grishanina T.V., Russkikh S.V., Shklyurchuk F.N. *Uchenye Zapiski Kazanskogo Universiteta. Seriya Fiziko-Matematicheskie Nauki — Proceeding of Kazan University. Physics and Mathematics Series*, 2017, vol. 159, book 4, pp. 429–443.

Russkikh S.V., Cand. Sc. (Phys. & Math.), Assoc. Professor, Department of Design and Strength of Aeronautical Missile and Space Products, Moscow Aviation Institute (National Research University), Senior Research Fellow, Institute of Applied Mechanics of Russian Academy of Sciences. Author of 35 research publications. Research interests: mechanics and dynamics of a deformable rigid body, dynamics of elastic controllable structures, dynamics of space systems. e-mail: sergey.russkih@rambler.ru

Shklyarchuk F.N., Dr. Sc. (Eng.), Professor, Honored Scientist of the Russian Federation, Chief Research and Development Officer, Institute of Applied Mechanics of Russian Academy of Sciences, Professor of the Department of Design and Strength of Aeronautical Missile and Space Products, Moscow Aviation Institute (National Research University). Author of 215 research publications. Research interests: mechanics and dynamics of a deformable rigid body, dynamics of elastic controllable structures, dynamics of space systems. e-mail: shklyarchuk@list.ru