ANALYSIS OF A GAME PROBLEM OF BRAKING A DISK IN THE CASE OF CONSTANT CONTROLS

A. E. Lamotkin, S. I. Osipov

The process of braking a disk in the form of a differential game is studied. The dynamic system is based on the Coulomb friction model. The existence of a game value in the case of constant controls of the players is analyzed for different values of initial velocities and parameters of the disk. The aim is to minimize the braking distance. For each case, the guarantees of the first and second players are examined, and a statement about the existence or nonexistence of a game value is formulated. For example, it is shown that in the case of slip-free braking, there exists a game value, and it is attained when the first player applies the greatest possible control allowing him not to slip and the second player minimizes the friction. In the conclusion of the paper, we prove a final theorem stating that the slip-free mode is the best braking mode for the first player under constant controls.

Keywords: optimal braking, antagonistic braking, differential game.

REFERENCES

1. Canudas de Wit C., Tsiotras P. On the optimal braking of wheeled vehicles. *Proc. American Control Conf.*, 2000, pp. 569–573. doi: 10.1109/ACC.2000.878964 .

2. Lamotkin A.E., Pronchatov D.A. Analysis of the possibility of improving some brake systems. *Mechanics. Researches and Innovations*, A. O. Shimanovskii (ed.), Gomel': BelGUT Publ., 2017, vol. 10, pp. 111–115 (in Russian).

3. Krasovskii N.N., Subbotin A.I. *Game-theoretical control problems.* N Y, Springer, 1988, 517 p. ISBN: 978-1-4612-8318-8 . Original Russian text published in Krasovskii N.N., Subbotin A.I. *Pozitsionnye differentsial'nye igry*, Moscow, Nauka Publ., 1974, 456 p.

4. Ushakov V.N., Lebedev P.D., Matviychuk A.R., Malev A.G. Differential games with fixed terminal time and estimation of the instability degree of sets in these games. *Proc. Steklov Inst. Math.*, 2012, vol. 277, pp. 275–287. doi: 10.1134/S0081543812040190 .

5. Lamotkin A.E., Osipov S.I., Pronchatov D.A. On the possibility of considering the braking of a disk in the form of an antagonistic differential game. *CEUR Workshop Proc.*, 2017, vol. 1894, pp. 57–63 (in Russian).

6. Rill G. Wheel dynamics. *Conf. Proc. XII Internat. Symposium on Dynamic Problems of Mechanics (DINAME)*, P.S. Varoto and M.A. Trindad eds., ABCM, Ilhabela, SP, Brazil, February 26 – March 2, 2007, pp. 1–8.

Aleksey Evgen'evich Lamotkin, doctoral student, Ural Federal University, Yekaterinburg, 620002 Russia, e-mail: alexeylamotkin@yandex.ru .

Sergei Ivanovich Osipov, Cand. Sci. (Phys.-Math.), Ural Federal University, Yekaterinburg, 620002 Russia, e-mail: sergei.osipov@urfu.ru .