

THE SPINDLE SPEED OPTIMAL CONTROL IN MODERN MILLING OPERATIONS

Krzysztof J. Kalinski
Technical University of Gdansk
Narutowicza 11/12, 80-952 Gdansk, POLAND
phone: +48 58 3471496
fax: +48 58 3472151
e-mail: kkalinsk@sunrise.pg.gda.pl

Abstract

The paper is devoted to new approach towards vibration surveillance of rotating elements in modern milling machines. It depends upon application of the optimal control of unsteady systems at energy performance index. Discrete model is obtained by the finite element method. In order to reduce vibration level, external control command is introduced. Thus, dynamics of controlled structure is described.

The approach relates to the machine tool closed-loop systems, in case of which the problem of self-excited *chatter* vibration is of a great importance. Therefore dynamic equation of the system is transformed such that relevant open-loop representation is obtained. As result, instantaneous change in the spindle speed appears as control command.

Here a face milling process by a slender end mill is a subject of consideration. Vertical milling centre VMC FADAL 4020HT has been chosen as an object of the performance. The cutting using slender tools is observed in modern machining centres frequently. A technological reason lies in making of difficulty accessible hobbings (e.g. die pockets). It is usually treated as finishing work, so that the depths of milling can reach significant values. Big depths of cut can also be met during manufacturing of the first groove.

There are explained a lot of sets of computer simulation results. They refer to various programs of the spindle speed change. All these cases evidenced practical meaning of the method proposed, because the changing spindle speed programme is really possible to be performed, and *chatter* vibration has been successfully reduced.