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Using the Experiment-Aided Virtual Prototyping technique to predict the best clamping stiffness during milling of large-size details

KRZYSZTOF J. KALIŃSKI[1], NATALIA STAWICKA-MORAWSKA[2*], MAREK A. GALEWSKI[3], MICHAŁ R. MAZUR[4]

1. Gdańsk University of Technology, Department of Mechanics and Mechatronics, Gdańsk, Poland [0000-0003-1658-4605]
2. Gdańsk University of Technology, Department of Mechanics and Mechatronics, Gdańsk, Poland [0000-0002-6565-1977]
3. Gdańsk University of Technology, Department of Mechanics and Mechatronics, Gdańsk, Poland [0000-0003-3703-4012]
4. Gdańsk University of Technology, Department of Mechanics and Mechatronics, Gdańsk, Poland [0000-0003-1405-909X]

* Presenting Author

Abstract: During machining of large-size details, the main cause of the problems are relative vibrations "tool-workpiece" [1], which lead to deterioration of the quality of machined surfaces and increased tool wear [2, 3]. The article presents considerations on the reduction of vibrations during milling with the use of an innovative method of adjusting the best stiffness for mounting large-size details. Contrary to another author's approach, concerning the minimization of the work of cutting forces in the direction of the layer width [4], the method in question is based on a selected mechatronic design technique, i.e. Experiment-Aided Virtual Prototyping (E-AVP) [5]. As an example of the effectiveness of the proposed vibration reduction method, the results of simulation of the face milling process in industrial conditions of selected surfaces of a large-size object are illustrated.

Keywords: clamping stiffness, face milling, vibration suppression, mechatronic design techniques

1. Introduction – description of the method

The proposed method has been modified and its application consists in:

– a one-time assessment of the compliance of the modal model parameters of the workpiece itself with the real object. Based on the results of the model parameters identification using the ERA (Eigenvalue Realization Algorithm) method, it was found that the parameters obtained from the experiment and the model using the Finite Element Method (FEM) were correctly defined;
– repetitive change in the values of the stiffness coefficients of supports that fasten the workpiece. The static characteristics of the supports, enabling the desired values of these coefficients to be set, were determined experimentally during research on the Zwick Roell testing machine;
– a one-time selection of parameter values describing the dynamic properties of the cutting process, based on the experience resulting from previous observations of analogous machining processes;
– conducting a cycle of repetitive simulations for the above-accepted reliable process data. On the basis of the obtained results, the values of the dominant "peaks" in the amplitude spectra and the values of the Root Mean Square (RMS) of the displacements in the time domain are assessed. The minimum values of these quantities indicate the best configuration of the adopted workpiece mounting stiffness coefficients from the point of view of minimizing the level of "tool-workpiece" vibrations.

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