

Modelling of multiple surface roughness parameters during hard turning: A comparative study between the kinematical-geometrical copying approach and the design of experiments method (DOE)

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ABSTRACT

This paper proposes and applies two different methodologies for modelling the roughness parameters in hard turning. The first method is based on the kinematical-geometrical copying of the cutting tool geometry onto the machined surface including a feedback loop through the parameter of statistic equality of sampling lengths in surface roughness measurements (SE). The other method employs the Design of Experiments (DOE) principles expressing the roughness parameters as first order nonlinear function of the input variables: cutting speed v , feed f , depth of cut a_p , and tool nose radius r_e . The research includes the R_a and R_z roughness parameters which are commonly modelled throughout the research works, and additionally develops models for the R_p , R_v and $R_{mr(c)}$ roughness parameters which are more challenging to model compared to R_a and R_z as they depend more on the shape of the roughness profile and position of its mean line. Both methodologies for all roughness parameters were verified using a CNC lathe and special rings made of steel EN C55 with hardness of 53 ± 1 HRC. Considering that the roughness profile is just a part of the total geometric deviations of the processed surfaces, and it is obtained from the total profile using software filtration, the research also considers the W_a parameter (waviness profile), as well as the deviations from the circularity (out-of-roundness) of the processed rings as indicators for the stability of the machining process.

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