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Abstract

The present study deals with the prediction of machining forces under minimum quantity lubrication (MQL) environment by considering the contact length and chip thickness. The proposed methodology is an extension of Oxley's predictive machining theory (OPMT) to MQL machining. A novel approach to modify OPMT model has been used to incorporate the effects of lubrication at the chip-tool interface. Dual contact zone theory (sticking-sliding) has been used to model the frictional force in MQL machining. A mechanistic model for the local coefficient of friction (COF) has been developed as a function of cutting conditions and MQL parameters. The proposed model predicts cutting forces, contact length and chip thickness under MQL environment with reasonable accuracy and the same has been validated by experimental work.

Keywords Sliding coefficient of friction, Force model, Sticking-sliding contact zone, MQL

Nomenclature

A	Plastic equivalent strain (J-C equation)
A_s	Area of PSZ
B	Strain related constant (J-C equation)
b	Width of the workpiece
C	Strain rate constant (J-C equation)
C_p	Specific heat of work material
c	Shear zone length to shear zone thickness ratio for PSZ
F	Chip tool friction force
F_C	Cutting force (along the direction of cutting speed)
F_N	Normal force on AB (normal to the cutting speed direction)
F_n	Normal force obtained from tribotest
F_s	Shear force
F_T	Thrust force
F_t	Tangential force obtained from tribotest
$\bar{F}$	Chip-tool contact shear force
f_{MQL}	Flow rate of cutting fluid
H	Total contact length
k_{AB}, k_{chip}	Shear flow stress on *AB* and on chip-tool contact