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**Modeling of cutting force in MQL machining environment considering chip tool contact friction**

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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

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