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Investigation of Chip Formation Mechanism in Orthogonal Metal Cutting

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Abstract: *Since it has immediate consequences on tool performance, surface integrity, machining efficiency, and general process sustainability, the chip formation mechanism in metal cutting is a significant area of inquiry in manufacturing science. An uncomplicated but practical two-dimensional analytical basis for the complex dynamics of chip development is provided by orthogonal cutting. In this paper, chip formation while machining mild steel orthogonally with uncoated carbide tools under varied feeds and velocities is extensively analyzed.*

For analyzing chip shape, cutting forces, and temperature distribution, experimental tests were conducted using a CNC lathe with orthogonal cutting configuration in combination with force dynamometers, high-speed cameras, and infrared temperature sensors.Along with analytical models derived from Merchant's theory of shear plane, finite element simulations were performed with DEFORM-2D software to analyze the chip formation process further.

The results indicated a strong correlation between chip form and cutting speed. High speeds generated continuous or segmented chips due to thermal softening and localized shear strain, while low speeds generated discontinuous chips due to brittle fracture. High temperature and stress concentrations in the primary and secondary shear zones were established by finite element modeling, as supported by experimental data, and tool-chip interaction and material flow details were given.

Physical mechanisms governing chip generation in orthogonal metal cutting are more clear through this work.

In order to maximize tool design and machining conditions in industry, it stresses the influence of cutting parameters on chip properties, cutting forces, and heat conditions. In metal cutting operations, findings are particularly relevant to improve machining efficiency, extend tool life, and achieve higher surface finishes.

Keywords: DEFORM-2D