Process Modelling, Simulation and Experimental Validation for Prediction of Chip Morphology during High Speed Machining of Al 2024-T3

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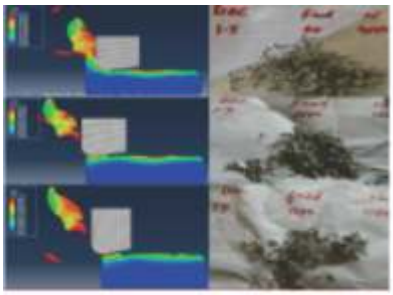
Abstract:

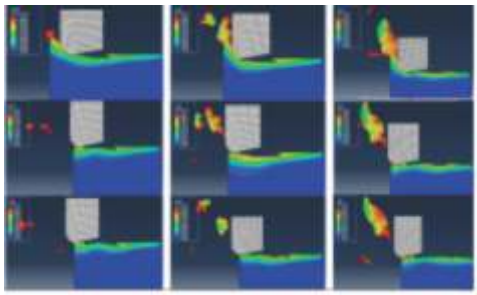
Metal cutting is one of the most widely used manufacturing techniques in the industry and there are lots of studies to investigate this complex process in both academic and industrial world. Predictions of important process variables such as cutting speed, cutting feed and stress distributions play significant role on validating chip morphology. Researchers find these variables by using experimental techniques which makes the investigation very time consuming and expensive. At this point, finite element modelling and simulation becomes main tool. These important cutting variables can be predicted without doing any experiment with finite element method.

The aim of this project is to create a numerical model to examine the chip morphology convinced by orthogonal machining in the finished work piece and the chip is validated by numerical simulation comparing with experimental result. The Finite Element Method (FEM) is used to simulate and compare chip morphology with experimental result which is simulated by an orthogonal metal cutting process. Therefore, Arbitrary Langrangian-Eulerian (ALE) adaptive meshing FEM is employed to simulate the model. The Johnson-Cook material model is used to describe the work material behavior and fully coupled thermal-stress analysis are combined to realistically simulate high speed machining with an orthogonal cutting.

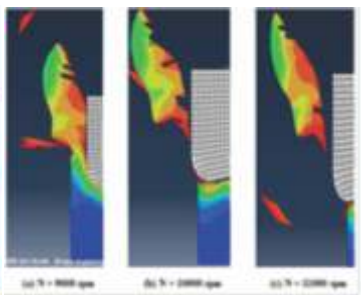
Therefore, orthogonal cutting simulations of Al2024-T3 are performed and simulated result along with experimental is validated. In first step, effects of work piece flow stress and friction models on cutting variables such as chip geometry is investigated by comparing simulation results with experimental results available in the literature. Chip morphology study is understood by validating the chip width and chip thickness based on numerical validation with experimental result and also agreed that numerical simulation is important tool to predict chip morphology, chip formation without carrying lots of trial and error activity on machine shop which is really necessary for today's competitive market.



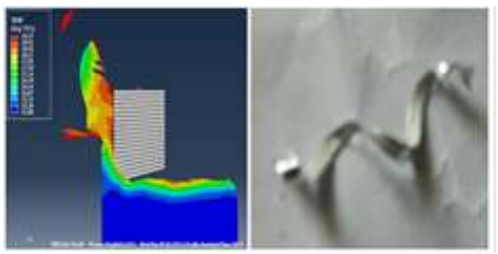
Chip morphology comparison between simulated result vs experimental result



Different parameter simulations cases for chip formation in Al2024-T3 machining



Serrated chip figures at different spindle speeds



Comparison of chip geometries from machining tests and FE prediction