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Numerical Modelling of Metal Cutting Processes by use of the Stabilized Optimal Transportation Meshfree Method

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In metal cutting processes, the material is removed continuously from the work-piece by the cutting tool under highly dynamic loading conditions. Due to the complex mechanism of chip formation as well as the tool-chip interaction, it is still an important challenge to give an accurate prediction of cutting force, chip morphology and temperature by numerical modelling approach. In terms of numerical modelling, a proper contact model and computational framework have to be applied in the calculation to capture the tool-chip interaction and the fracture induced topology change.

In this work, the chip formation process is simulated by use of the stabilized Optimal Transportation Meshfree (OTM) method [1]. The frictional tool-chip contact constraint is enforced directly by applying the penalty regularization, based on the surface generation at the contact interface. The Johnson-Cook model combined with finite plasticity is applied to account for the strain hardening, the strain rate hardening and the thermal softening [2]. The plastic dissipation-induced temperature rise is evaluated by considering that a certain amount of the plastic work rate is converted into heat.

Combined with the above contact algorithm and the improved constitutive model, the stabilized OTM method has shown a good convergence for simulation of chip formation in metal cutting process. The cutting force and the temperature at different cutting speeds and cutting depths have been calculated and compared with experimental results in the literature.

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