Importance of the Contact Interface Definition in the Numerical Simulation of Tool Wear in Metal Cutting

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Abstract. Tool wear remains of high interest for industry, as it influences process costs and part's surface integrity. Although experimental and analytical investigations have been the main ways to investigate wear, the growing development of computational power enables predicting tool wear based on chip formation simulations [1]. Tool wear can be predicted following an iterative procedure and computed based on the simulated thermomechanical loadings applied onto the tool [2,3]. In most of the studies, the early wear models developed in [4,5], depending on the sliding velocity, interface temperature and contact pressure are employed. Their parameters are often determined using an inverse approach based on cutting tool wear tests and metal cutting simulations [6]. The major drawback with these approaches is that they are directly dependent on the implementation of the whole numerical model including the contact interface definition, i.e. friction and heat partition. It becomes obvious that any lack of knowledge on these fundamental data may lead to misleading results and affect the relevancy of the tool wear simulation. The present work proposes to emphasize their effect both from the mechanical and thermal points of views on the tool wear simulation. A multi-step procedure is first developed to predict cutting tool wear by combining a pure thermal model to an Arbitrary-Lagrangian-Eulerian (ALE) thermomechanical sub-model in order to properly predict the thermomechanical loadings applied onto the tool. Their changes are then assessed under different friction and heat partition conditions (constant and variable coefficients) and the resulting worn tool geometries are computed based on two wear models from the literature [2,3]. It is shown that the implemented friction model plays a major role and that the predicted interface temperature can be drastically modified which is found to be especially critical as soon as a temperature dependent wear model is used.

REFERENCES

1. Arrazola PJ, Ozel T, Umbrello D, Davies M, Jawahir IS (2013), Recent advances in modelling of metal machining processes, CIRP Annals - Manufacturing Technology 62(1):695-718.
2. Xie LJ, Schmidt J, Schmidt C, Biesinger F (2005) 2D FEM estimate tool wear in turning operation, Wear 258:1479-1490.
3. Attanasio A, Ceretti E, Rizzuti S, Umbrello D, Micari F (2008) 3D finite element analysis of tool wear in machining, CIRP Annals – Manufacturing Technology 57(1):61-64
4. Usui E, Shirakashi T, Kitagawa T (1984) Analytical prediction of cutting tool, Wear 100(1-3):129-151
5. Takeyama H, Murata T (1963) Basic investigation on tool wear, Journal of engineering for industry – Transaction of the the ASME 33-38.
6. Binder M, Klocke F, Doebbeler B (2017) An advanced numerical approach on tool wear simulation for tool and process design in metal cutting, Simulation Modelling Practice and Theory 70:65-82