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論 文 内 容 の 要 旨
Abstract of Dissertation

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In this research, the author subjected to investigate and reveal the effects of temperature and strain rate of difficult-to-cut plate on its deformation behavior under cutting by wedge and square punch. Apart from this laminated sheet, the cutting characteristics of a fragile acrylic resin sheet were studied. A thermal cutting method was proposed to overcome the unstable separation and quality of the sheared profile of the worksheet. The attention in this research is focused on both the experimental and the numerical analysis. The work materials of wedged indentation processes are based on the plate material which is nylon- polyethylene film (PA6/PE) of 0.16mm thickness and an acrylic sheet of 0.5mm thickness. Meanwhile, 1mm thickness of acrylic and two types of sintered silicon nitride plates are used for the shearing process. The main objectives of the research work are as follows:

First, concerning the wedge cutting of the nylon-polyethylene film (PA6/PE), the fundamental cutting characteristics of wedge indentation is reviewed. A general cutting mechanism of PA6/PE film and the factors affecting the cutting performance of wedged cutting process are presented. From the experiments, it is found that underlay stiffness and blade tip thickness are important factors that affected to the bent-up angle and cutting load response of the nylon film.

Second, in the previous study, it was also shown that the bad cutting profile occurrence in case of using a trapezoidal cutting blade with $w/t > 0.07$. In order to develop new countermeasures, temperature elevation effect is considered. Namely, changing the temperature of work body is seems to be effective to change the material properties and improve the edge profile. It was found that the appropriate range of the temperature of a blade body, a case of $T = 318$K against a room temperature 296K is suitable for cutting the 0.16mm PA6/PE film off during a wedge indentation. A finite element method (FEM) model was conducted to reveal the effect of temperature on the deformation of the PA6/PE film.

Third, to reveal deformation behavior and cracking patterns of an acrylic worksheet subjected to a punch shearing or a wedge indentation was investigated under varying mechanical conditions such as the cutting velocity, and the temperature of blade. As the results, a suitable cutting tool conditions for making a smart sheared wedging of the worksheet was proposed.

Furthermore, the cracking problems of fragile materials (ceramics and acrylic) were numerically studied by a finite element code MSC.MARC. In this model, a virtual crack close technique (VCCT) was developed. The adaptive auto-remeshing technique has also been conducted. The adopted constitutive models are the isotropic Von Mises model incorporated in MSC.MARC and the work material is considered to be an isotropic deformation. In this study, a VCCT model is applied to simulate a shearing process for investigating breaking behavior of ceramics and AC workpiece subjected to a shearing-tool indentation. This proposed model can be developed and apply to simulate the AC cutting in wedge indentation process.