博　士　論　文　の　要　旨

専攻名 Science and Advanced Technology
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博士論文題名 Determination of the Values of Critical Ductile Fracture Criteria and Prediction of Fracture Initiation in Shear Punching Processes（臨界延性破壊基準値の決定とせん断打ち抜き加工における破壊開始点の予測）

要旨（２，０００字程度にまとめること。）

Punching processes are widely used for the production of automobile parts, mechanical components, and other parts. To produce highly accurate parts, it is important to estimate the ratio of the sheared surface to cut surface. Many researchers applied the Finite Element Method (FEM) to analyze the ratio of the sheared surface to the fracture surface on the cut surfaces by using fracture criterion which is considered to be material constant. However, it is difficult to determine the fracture criteria on the cut surface by tensile tests or bending tests because the punching process involves many complicated steps.

In this research, FEM was applied to the punching processes to determine the values of critical fracture criteria (C) by using the ductile fracture criteria proposed by Cockcroft and Latham, Oyane and Ayada. The ductile fracture criteria were compared with the boundary between the sheared surface and fracture surfaces using experiments performed with a simple punching system. The values of ductile fracture criteria for the fracture initiation of the formed cut surface were predicted under the various clearances between the punch and the die with various punch diameters. The influence of stress triaxiality and the effect of punch diameter on the sheared surface length were also studied.

The results proved that the critical fracture criterion (C) is not material unique constant and it depends on the clearance between the punch and the die. The accurate clearance-dependent critical fracture criteria of SPCC steel which can be used in the prediction of fracture initiation in the punching and fine blanking processes with the maximum punch diameter of 25 mm can be obtained from this research.

The results described that the critical fracture criterion is affected by stress triaxiality. The decrease in the clearance causes a decrease in the range of stress triaxiality in the clearance zone and larger sheared surface was obtained. The results also indicated that the effect of punch diameter also should be taken into account in the prediction of fracture initiation in the conventional punching and fine blanking processes.

The new idea of using clearance-dependent ductile fracture criteria to reduce costs and time for the experiments to obtain critical fracture criterion was also introduced in the analysis of influence of process parameters on the sheared surface length in fine blanking processes. The numerically verified optimized process parameters such as initial compression, punch corner radius, die corner radius and V-ring height for the production of fine sheared surface of SPCC steel in fine blanking processes were also described.