

Fundamental FEM Analysis on Tensile Deformation of the Sheet Metal Embossed on Both Sides of the Plane

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ABSTRACT

The effort for lightning transportation equipment has been addressed for the purpose of the global environment conservation and the low carbon society. In order to reduce the weight of sheet metal, use of a thinner sheet metal of high strength is effective. However, when using the thinner sheet metal, decrease of the bending rigidity becomes a critical problem. One of the solution is use of embossed sheet, because it has higher second moment of area than a plane sheet. The deflection behavior mechanism of an embossed sheet has been investigated using the numerical simulation[1]. However, in relation to the tensile deformation behavior, only experimental studies have been conducted[2],[3]. These studies showed that the apparent mechanical characteristics of a sheet metal like n-value and r-value were changed by conducting embossing process to the plane sheet. This means that, in addition to the bending rigidity, other practical properties of sheet metal would be also changed by embossing of plane sheet.

In this study, the finite-element method (FEM) analysis on tensile deformation of sheet metals embossed on both side of the plane was carried out. Fundamental tensile deformation behavior of the embossed sheets was investigated and the relationships between deformation mechanism and apparent mechanical properties are considered. Assuming the isotropic material, the analysis about the typical direction of emboss is conducted

From the simulation results, deformation was found to be different between the outer region and the inner region of the boss part of an embossed sheet. Tensile deformation occurs mainly between bosses and some networks of deformation region were formed. At that time, material at boss part mainly rotated together with a little elongation. Because actual tensile deformation regions decrease, tensile load necessary for deformation of the sheet metal decreased, and so the apparent yield stress would decrease. When the tensile deformation increased, the deformation region and the apparent yield stress increased together, and so the apparent work hardening exponent would become high. This means that uniform elongation would become larger by embossing a sheet metal. On the other hand, because the apparent strength coefficient for work hardening only shows a little change, the apparent tensile strength decreased. when boss height increase, the apparent r-value decreased. Because these results agreed basically well with past experimental results, it is thought that a fundamental mechanism of tensile deformation of embossed sheets could be clarified.

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