DUCTILITY CALCULATIONS IN THE ELECTROMAGNETIC FORMING OF FREELY EXPANDING ALUMINUM SHEET – A FORMING LIMIT DIAGRAM APPROACH

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The electromagnetic forming process is a high velocity manufacturing technique, which uses electromagnetic (Lorentz) body forces to shape sheet metal parts. One of the several advantages of this technique is the considerable ductility increase observed in several metals, with aluminum featuring prominently among them.

Motivated by the quasi-static case, the present work extends the concept of Forming Limit Diagrams (FLD's) to model the ductility of electromagnetically formed sheets. This general theory, which accounts for high strain rates, ohmic heating, thermal and viscoplastic constitutive effects, is subsequently applied to study the ductility of freely expanding electromagnetically loaded aluminum tubes. Necking strains are measured in tubes of various geometries, which are loaded by different coils and currents. The experimental results – obtained by M. Seth and G. Daehn at Ohio State University – are plotted in principal strain space and show reasonable agreement with the corresponding theoretical FLD predictions, which indicate a two to three fold increase in the forming limits with respect to the quasi-static case.