

## Seam weld characterization by FEM analysis in aluminium extrusion

L. Donati, L. Tomesani

### Summary

In recent years aluminum extruded hollow profiles are increasingly used in near-net shape manufacturing processes such as bending and hydroforming; in fact, by applying these secondary processes, it is possible to obtain very high complex parts, especially for the transport industry. It is known that hollow profiles obtained by direct hot extrusion necessarily have some longitudinal welding lines (so called seam welds) produced inside the die and it is common experience, during secondary forming processes, the appearance of early cracking in proximity of those lines [1,2]. At the same time, the direct hot extrusion is the only process able to produce hollow extruded profiles at low cost. The early cracking of the profiles during secondary deformation is not a consistent effect [3]: sometimes it happens at low strains, sometimes at high ones, thus suggesting a dependency of the phenomena on extrusion parameters and in particular on die design [4]. As a consequence, today the hollow profiles produced by direct extrusion are designed for very low-strain forming processes or directly used in the shape determined by the extrusion step. This greatly reduces the industrial applicability of the products, especially regarding the possibility to adopt high-strength light-alloys for reduced-weight vehicle parts. The problem of assessing the formation of seam welds in aluminium extrusion processes is here presented. The paper reviews and discusses the application of the principal criteria proposed in literature for seam welds characterization [5,6,7], one of them being proposed by the authors, by implementing them into the complete thermo-mechanical 3D finite element simulation of a specific welding experiment [8]. The experiment consisted in the extrusion of an I-shaped profile with a seam welds in the middle of its length; the die assembly was modified throughout the experiments in order to determine different local welding conditions and, as a result, different welding qualities on the extruded profiles, ranging from perfect welds to completely unwelded profiles. The possibility for each adopted criterion to clearly separate the good welds from the bad ones is investigated and the failures, when found, were discussed. The relationship between the output of the welding criteria and the local welding parameters, such as contact pressure, temperature, time of contact, strain and strain rate is also analyzed, in order to evidence the sensitivity of the method.

**keywords:** Extrusion, seam welds, FEM simulations, welding criteria, AA6082.

### References

1. Loukus A., Subhash G., Imaninejad M., Mechanical properties and microstructural characterization of extrusion welds in AA6082-T4, *Journal of Materials Science* 39 (2004), 6561-6569;
2. E. Chu, Yu Xu, Hydroforming of aluminum extrusion tubes for automotive applications. Part II: process window diagram, *International Journal of Mechanical Sciences* 46 (2004) pp.285-297;
3. Akeret R., Properties of pressure welds in extruded aluminium alloy section, *Journal of the Institute of Metals* 100 (7) (1972) pp.202-207
4. Akeret R., Extrusion welds-Quality Aspects are now center stage, *Proceedings of the fifth International Aluminum Extrusion Technology Seminar (ET 92)*, Vol. I, (1992), pp.319-336;
5. Donati L., Tomesani L., "The prediction of seam welds quality in aluminum extrusion", *Journal of Material Processing Technology*, 153—154 (2004) pp.366-373.
6. Plata M., Piwnik J., "Theoretical And Experimental Analysis Of Seam Weld Formation In Hot Extrusion Of Aluminum Alloys", *Proceedings of the Seventh International Aluminum Extrusion Technology Seminar (ET 2000)*, Vol. I, (2000) pp.205-211;
7. Bourqui B, A. Huber, C Moulin, A. Bunetti, Improved weld seam quality using 3D FEM simulations in correlation with practice, *Proceedings of first EAA (European Aluminum Association-extruders division-) Montichiari - BS-*,(2002);
8. Donati L., Tomesani L., The effect of die design on the production and seam weld quality of extruded aluminium profiles, *J. of Material Processing Technology*, 164-165 (2005) 1025-1031.