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A 3D ARBITRARY LAGRANGIAN EULERIAN FORMULATION FOR THE NUMERICAL SIMULATION OF COLD ROLL FORMING PROCESSES

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ABSTRACT

Being a multi-stage progressive process, in which small amounts of forming are applied at each pass of rolls, cold roll forming is nowadays more and more largely employed to bend a long strip of sheet blank into a desired cross-sectional profile via roller dies. As the sheet is continuously bent and plastically deformed along a linear axis in order to progressively shape to the desired contour, a complex three dimensional surface can be developed. The material at different positions is formed along different strain paths. In order to achieve defect-free products, the amount of change in each pass must be limited so that the required bends can be formed without the occurrence of plastic longitudinal elongations. This is essential to the strip edges, where the presence of larger deformation can be detected. As a result, one is here faced with a very complex problem.

Towards a better understanding of the mechanics of the deformation of the strip during the forming process, and due to its intrinsic complexity, 3D finite element analysis have been conducted thanks to our home made finite element code: METAFOR. This enables a prediction of the distribution of strains and of the geometry of formed profiles during and after the forming process (i.e. springback can be taken into account). In order to validate the reliability of the simulation, numerical simulation results of the distribution of longitudinal strains are compared with experimental results available in the literature and obtained through physical experimentations.

As a central point, to reach excellent comparison with physical experiments, some sophisticated numerical techniques had to be developed and implemented in the code. A first development concerned the use of EAS (Enhanced Assumed Strain) finite elements.

Another major feature of the presentation will be the use of the ALE (Arbitrary Eulerian Lagrangian formulation) that allows to obtain stationary processes (as an Eulerian code would – if available) by using a Lagrangian code and repositioning continuously the nodes of the blank to be formed.

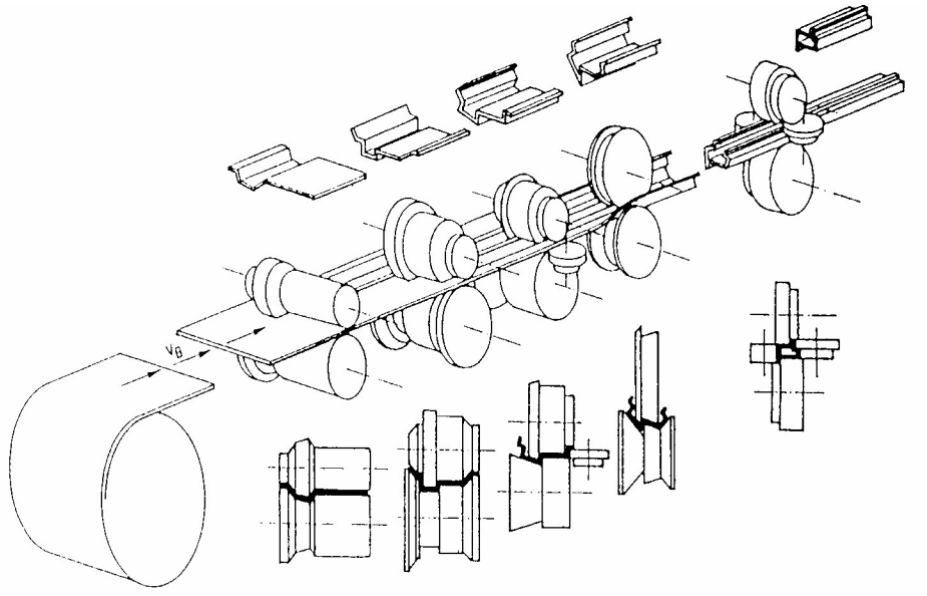

Figure: a typical cold roll forming operation