On the modelling of instability and flatness defects of sheets:
application to rolling process

H. Zahrouni¹, K. Kpogan¹, S. Abdelkhalak²,³, A. Limam⁴, H. Ben Dhia⁴, M. Potier-Ferry¹

¹Université de Lorraine, CNRS, Arts et Métiers ParisTech, LEM3, F-57000 Metz, France. E-mail: hamid.zahrouni@univ-lorraine.fr
²Applied Mechanics and Systems Research Laboratory, Tunisia Polytechnic School, University of Carthage, B.P. 743-2078 La Marsa, Tunisia.
³Military academy of Fondouk Jedid, 8012 Nabeul, Tunisia.
⁴INSA Lyon, Université de Lyon, 69621, Villeurbanne Cedex, France. E-mail: ali.limam@insa-lyon.fr
⁵MSSMat UMR CNRS 8579, Ecole CentraleSupélec, France. E-mail: hachmi.ben-dhia@centralesupelec.fr

ABSTRACT

Rolling of thin sheets generally induces flatness defects due to the small thickness of the sheet and to the thermo-elastic deformation of rolls, whose profile in the roll-bite does not generally match perfectly the strip thickness profile. This leads to heterogeneous plastic deformations throughout the strip width and then to out of mid-plane displacements that relax compressive residual stresses [1]. The most important flatness defects are “edge-waves” and “center-waves” buckles. During the rolling process, the buckling waves are usually suppressed by global traction. Thus, in some cases, the sheet may appear more or less flat, or even perfectly flat on the rolling line. Nevertheless we can still talk about flatness defects, insofar as there may be residual stresses in the sheet. This is why the post-bite stress profile is called “latent flatness defects”. Few works are available in the literature dealing with instability phenomena observed in rolling process. Among them we can cite [2-4].

In the present work, we develop a numerical technique to compute flatness defects of thin sheet during the rolling process. To this end, we propose a coupling technique based on Arlequin method [6] which allows us to couple a three dimensional finite element model with a shell element well adapted to large displacements, large rotations and to instability phenomena [5]. To solve the resulting non linear problem, asymptotic numerical method is used. It is a numerical tool based on high order predictor algorithm which allows to compute instability responses with high accuracy [7]. Results of this algorithm are compared successfully with experimental data.

REFERENCES