FEM Simulation of the rolling of stator vanes

Harm Wisselink

University of Twente/ NIMR Cluster Modelling of Forming
Fac. Mechanical Engineering/ Applied Mechanics
P.O. Box 217,7500 AE, Enschede

Netherlands Institute *for* Metals Research

Introduction

ELDIM manufactures among others stator vanes for the compressor of an aero engine (figure 1). These vanes are produced from strips of sheet metal by a cold rolling process. The development of a rolling process for a new type of vane can take several cycles of trial and error, before all requirements are fulfilled.

Figure 1: Pratt&Whitney F119-PW-100 for the JointStrikeFighter.

Objectives

The objective of this research is to build a model that gives more insight in this rolling process, which should accelerate the development of the rolling process for new vane types.

The rolling process

The roll-die and die-plate contain respectively the convex and concave airfoil profile of the vane. Due to the applied horizontal force, the die-roll rolls over the die-plate, deforming a strip (clamped in the die-plate) into a vane.

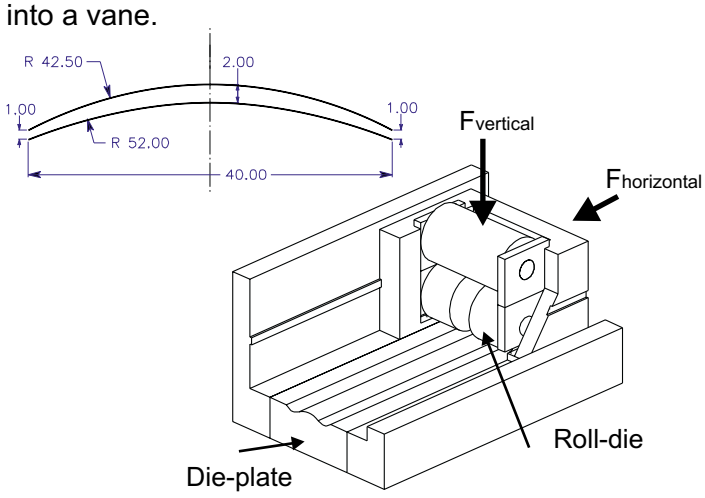

Figure 2: Tools and airfoil profile used for the rolling process.

The investigated vane [1], rolled from an 40x3mm aluminium strip, has a straight and symmetrical profile (figure 2).

FEM model

The rolling of straight vanes can be considered as a stationary process. The ALE formulation in the Finite Element Method code DiekA is suitable for such processes [2]. Starting from an estimated initial geometry the steady state geometry is calculated. The tools are modelled rigid.

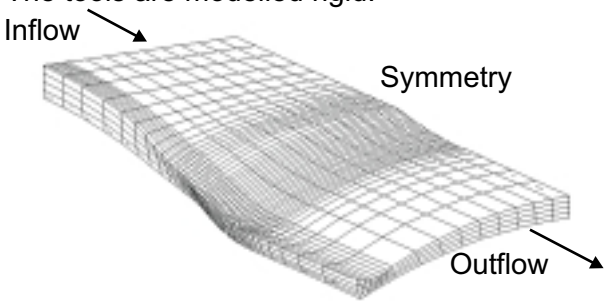

Figure 3: Steady state FEM mesh.

Results

The calculated deformation of the material agrees with the measured deformations (figure 4). A parameter study is performed with different friction coefficients and initial strip dimensions.

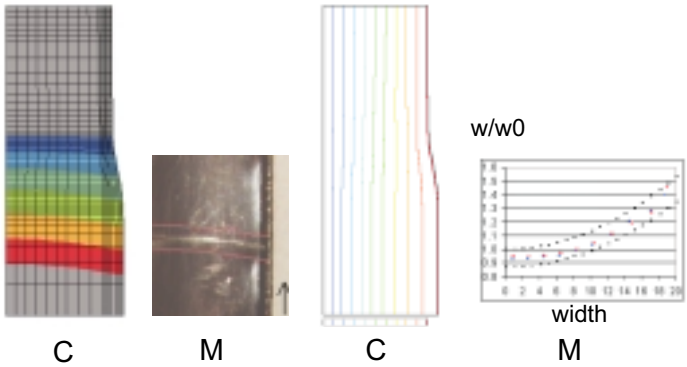

Figure 4: Calculated (C) and measured (M) deformations.

Future work

The model will be extended to be able to simulate real (non-symm.) vane profiles. Furthermore the elastic deformation of the tools has to be taken into account.

References

[1] A. Z. Abee, On the simulation of the shape rolling process of stator vanes using a FEM model, Master thesis, University of Twente, 2000
[2] H. H. Wisselink, Analysis of guillotining and slitting, Ph.D thesis, University of Twente, 2000

University of Twente
The Netherlands

Contact info:
Harm Wisselink h.h.wisselink@wb.utwente.nl
Han Huetink j.huetink@wb.utwente.nl
Martien van Dijk ID_eldim@eldim.nl
Andre van Leeuwen ID_eldim@eldim.nl