T016: Cross Rolling Simulations

Introduction

This document provides guidelines on how to set up simulations of various cross rolling processes.

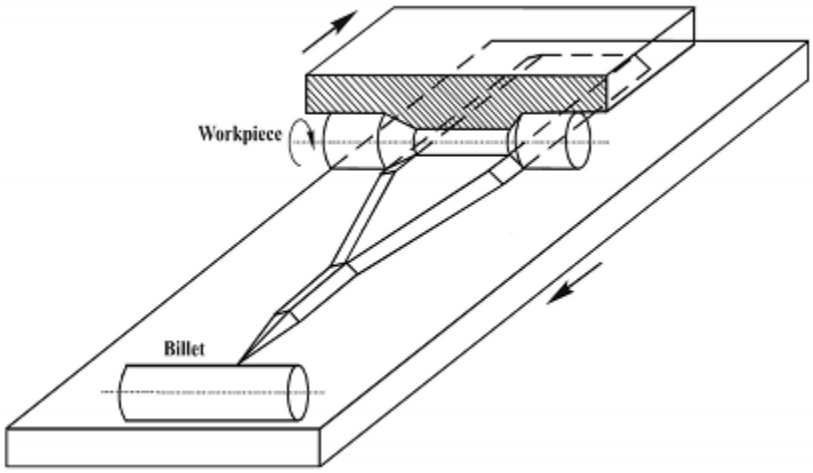
Problem Description

Cross rolling simulation is considered an advanced application due to the complex nature of part and tool movement that occurs during the process. Specific setup steps are required in order to accurately and efficiently model cross roll processes.

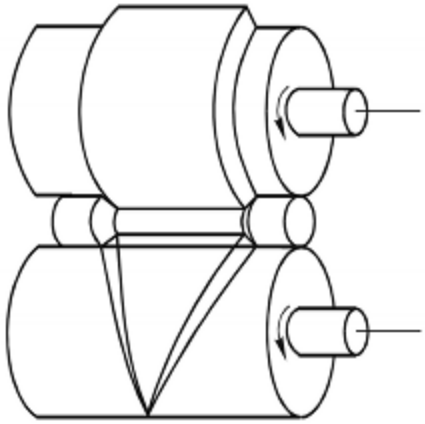
Background Information

Cross rolling, also known as transverse rolling or cross-wedge rolling, is a process often used to produce rolled preforms from round billet. A billet is inserted, transversely, between two or three dies. The dies then "cross" in opposite directions, rolling the billet around its axis. There are two main types of cross rolling machines:

- Straight, wedge die configuration



- Cylindrical, 2-3 roll configurations



Solution

The two cross roll processes described above require different approaches when setting up a simulation. These approaches are described below.

Straight, wedge die configuration

Straight die configurations are commonly used for preform, form and thread rolling.

This setup consists of two straight, wedge dies and a free workpiece. The dies are be set to translate linearly, in opposite directions, at the same speed in order to roll the part. Workpiece rotation is not constrained to a specific axis. A shear friction equal to 1 should be specified between the dies and the workpiece.

A text file called DEF_RSE.DAT must be present in the working directory. This file applies application specific settings for the Rigid Super-Element (RSE) scheme. The attached DEF_RSE.DAT file is provided as reference. It can often be used as-is. Each line in DEF_RSE.DAT has the following definitions:

10 (Flag to keep RSE active)
0 (Density)
0 0 0 -1 (Gravity magnitude and direction)
1 (Strain rate threshold; lower strain rate = rigid)
0 (Number of fixed rigid regions)
10 (RSE activation limit)

Cylindrical, 2-3 roll configurations

Cylindrical roll configurations are commonly used for rolled preforms that are used in downstream forming processes.

The setup consists of 2-3 rolls and a workpiece. The dies are set to rotate, in opposite directions, at the same speed in order to roll the part. Workpiece rotation is constrained to a specific axis. A shear friction equal to 0.7 to 1 should be specified between the rolls and the workpiece. Also, many small time steps should be used. One approach is to set the step size so that the workpiece rotates 1 degree every 5-15 steps. The "Fine internal mesh" meshing option should be selected if the user is interested in center-line defects. Finally, FEM volume compensation should be enabled.

A text file called AXIS.DAT must be present in the working directory. This file activates advanced DEFORM capabilities for handling rotating workpieces. The attached AXIS.DAT file is provided as reference. The user must ensure that the axis direction and origin are set for the rotating workpiece in their particular application. Each line in AXIS.DAT has the following definitions:

1 *(Object number)*
3 *(AXIS.DAT method)*
0 1 0 *(Rotation axis direction [X Y Z])*
0 0 0 *(Rotation axis origin [X Y Z])*
0.1 0 *(Radius of constraint, enforced rotational velocity)*

The working directory must also contain a DEF_RSE.DAT text file that only contains a 0 followed by a carriage return. The easiest way to create this file is to use a simple text editor. Do not use the attached DEF_RSE.DAT file for cylindrical roll configurations.

Related Information

The attached DAT files are described above and provided for use in the appropriate cross rolling applications.