The Sparling Spreading PyRoll Plugin

Christoph Renzing

May 19, 2022

This plugin provides a spreading modelling approach with Sparling's formula for flat rolling, adapted on groove rolling by an equivalent rectangle approach.

1 Model approach

1.1 Sparling's spread equation

Sparling [1] proposed Equation 1 for estimation of spreading in flat rolling, h and b are height and width of the workpiece with the indices 0 and 1 denoting the incoming respectively the outgoing profile. a, b, f, g and j are correction coefficients for roll surface, bar surface, material, temperature and strain rate, respectively.

$$\beta = \frac{b_1}{b_0} = \frac{h_0}{h_1}^{wabfgj} \tag{1}$$

w is the spread exponent and given by Sparling [1] is given in Equation 2, where R is the roll radius.

$$w = 0.981 \exp\left[-0.6735 \left(\frac{2.395 b_0^{0.9}}{R^{0.55} h_0^{0.1} \Delta h^{0.25}}\right)\right] \tag{2}$$

2 Usage instructions

The plugin can be loaded under the name `pyroll_sparling_spreading`.

An implementation of the `spread` hook on `RollPass` is provided, calculating the spread using the equivalent rectangle approach and Sparling's model.

Several additional hooks on `RollPass` are defined, which are used in spread calculation, as listed in Table 1. Base implementations of them are provided, so it should work out of the box. For `sparling_exponent` the equations 2 is implemented. The others default to 1. Provide your own hook implementations or set attributes on the `RollPass` instances to alter the spreading behavior.

Table 1: Hooks specified by this plugin. Symbols as in Equation 1.

Hook name	Meaning
`sparling_roll_surface_coefficient`	roll surface correction coefficient a
`sparling_bar_surface_coefficient`	bar surface correction coefficient b
`sparling_velocity_coefficient`	material correction coefficient f
`sparling_material_coefficient`	temperature correction coefficient g
`sparling_friction_coefficient`	strain rate correction coefficient j
`sparling_exponent`	spread exponent w

References

[1] L. G. M. Sparling. "Formula for 'Spread' in Hot Flat Rolling". en. In: *Proceedings of the Institution of Mechanical Engineers* 175.1 (June 1961), pp. 604–640. ISSN: 0020-3483, 2058-1203. DOI: 10.1243/PIME_PROC_1961_175_043_02.