Hitchcook roll flattening PyRoll Plugin

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This plugin provides the analytical roll flattening model developed by Hitchcook and Trinks [1] and adapted by Bohm and Flaxa [2] and Flaxa, Hinkfoth, and Bohm [3].

1 Model approach

The models are derived from the general theory of elasticity. According to Hitchcock, roll flattening due too high forces and large contact lengths has to be considered as it enhances calculation of roll force and torque. Hitchcook and Trinks [1] assumed the pressure distribution for rolling to be elliptical, therefore the roll shape stays cylindrical and a replacement radius larger than the can be calculated. Bohm and Flaxa Bohm and Flaxa [2] and Flaxa, Hinkfoth, and Bohm [3] extended the usage of the method to greater initial (R_0) to flattened roll radii (R_1) For the calculation the roll force and the elastic constants of the roll material are required. Furthermore the calculation has to be done in an iterative way. To implement the method for groove rolling, the calculations are done using a equivalent rectangle. Equivalent variables are denoted *eq*.

To calculate the flattened radius following equation is used:

$$\frac{R_1}{R_0} = 1 + \frac{16}{\pi} \frac{-\nu_\mathrm{W}^2}{E_\mathrm{W}} \frac{F_\mathrm{Roll}}{h_\mathrm{eq,0} - s}, \frac{R_1}{R_0} < 5.235 \tag{1a}$$

$$\frac{R_1}{R_0} = \left(\frac{16}{\pi} \frac{1 - \nu_\mathrm{W}^2}{E_\mathrm{W}} \frac{F_\mathrm{Roll}}{h_\mathrm{eq,0} - s} \right)^{\frac{2}{3}}, \frac{R_1}{R_0} > 5.235 \tag{1b}$$

2 Usage instructions

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

An implementation of the hooks `flattened_radius` and `flattening_ratio` for calculation the values for R_1 and $\frac{R_1}{R_0}$ are provided on the `Roll`. Several additional hooks on `Roll` are defined, which are used for calculation, as listed in Table 1.

Table 1: Hooks specified by this plugin.

Hook name	Meaning
`poissons_ratio`	Poissons's ratio of roll material ν_W
`youngs_modulus`	Youngs's modulus of roll material E_W
`flattening_ratio`	Ratio between flattened and initial radius $\frac{R_1}{R_0}$
`flattened_radius`	Flattened roll radius R_1
`max_roll_radius`	Max. roll radius
`min_roll_radius`	Min. roll radius
`working_roll_radius`	Working roll radius

References

[1] J. H. Hitchcook and W. Trinks. *Roll neck bearings*. en. New York, 1935, p. 51.

[2] J. Bohm and V. Flaxa. "Vereinfachte Methode zur Berechnung der Walzkraft unter Beachtung der Walzenabplattung". In: *Wissenschaftliche Zeitschrift der Technischen Hochschule Otto von Guericke* 25.3 (1981), pp. 121–124.

[3] V. Flaxa, R. Hinkfoth, and J. Bohm. "Berücksichtigung der Walzenabplattung beim Kaltwalzen von dünnen Bändern". In: *Neue Hütte* 24.9 (1979), pp. 328–331.