The Byon Lee Wear Model PyRolL Plugin

Christoph Renzing

February 20, 2025

The *Byon Lee Wear Model* Plugin implements a wear model for the oval - round - oval groove series. The model was published by Byon et al. [1, 2, 3] a focuses solely on the mechanical and geometrical factors are considered. Metallurgical influences like corrosion or thermal fatigue are neglected. The main parameters that are considered are:

F_R Roll Force

L_d Contact Length

H_s Shore Hardness

N_b Number of rolled billets

The key difference between other models like the Wear model of e.g. Archard, is that the proposed model also allows to calculate the resulting wear contour. Byon et al. therefore assumes, that for round grooves, the wear contour takes a parablic form. The wear radius for oval grooves is calculated using the following Equation 1:

$$R_{w,g} = R_2 \cdot J_w + R_{p,0} \cdot (1 - J_w) \tag{1}$$

In this equation, Rw, g is the worn radius of the groove profile. R_2 is the second radius of the oval groove, J_w is a weight function introduced by Byon et al.. $R_{p,0}$ is the radius of the incoming round profile.

The weight function J_w for oval grooves is calculated as:

$$J_w = 1 - \kappa \cdot \left(\frac{F_R^2 \cdot L_d \cdot N_b}{H_s} \right) \tag{2}$$

The derivation of the equation can be found in the author's original publication [3]. Further, the authors provide a formula to calculate the offset of the wear profile from the initial groove contour. The implementation of this part was neglected due to usage of the *shapely* python package witch allows for direct fitting of the contour to the desired points. These points are the so-called detachment or separation points, witch mark the

point were the profile detaches from the original groove.
As for round grooves, the used equations are:

$$R_{w,g} = R_2 \cdot J_w + 0.75 \cdot R_b \cdot (1 - J_w) \tag{3}$$

In this equation R_b is the bulge radius of the incoming oval profile. This bulge radius can be calculated can be calculated according to the model of Schmidt [4], Byon, Kim, Kim, and Lee [5] or Lee and Goldhahn [6]. To calculate the weight Equation 2 is used. The correction coefficients κ were measured by the autor from various rolling trials. For round - oval passes the value is $\kappa = 19.6e-12$ and for oval - round passes $\kappa = 35.9e-12$. Further, for round - oval roll passes the value 0.75 is a empirical coefficient as stated by the original author.

1 Usage instructions

The plugin can be loaded under the name **??**. The functionality of the plugin should need the following values to operate: **??** for the shore hardness of the roll material and **??** a integer number of rolled billets.

References

[1] Sang-Min Byon and Youngseog Lee. "Experimental and Semi-analytical Study of Wear Contour of Roll Groove and Its Applications to Rod Mill". In: *ISIJ International* 47.7 (2007), pp. 1006–1015. ISSN: 0915-1559, 1347-5460. DOI: 10.2355/isijinternational.47.1006. (Visited on 11/08/2024).

[2] S M Byon and Y Lee. "A Study of Roll Gap Adjustment Due to Roll Wear in Groove Rolling: Experiment and Modelling". In: *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture* 222.7 (July 2008), pp. 875–885. ISSN: 0954-4054, 2041-2975. DOI: 10.1243/09544054JEM1065. (Visited on 04/20/2022).

[3] S. M. Byon, H. S. Park, and Y. Lee. "Experimental Study for Roll Gap Adjustment Due to Roll Wear in Single-Stand Rolling and Multi-Stand Rolling Test". In: *Journal of Mechanical Science and Technology* 22.5 (May 2008), pp. 937–945. ISSN: 1738-494X, 1976-3824. DOI: 10.1007/s12206-008-0121-6. (Visited on 11/22/2024).

[4] Birger Schmidt. "Entwicklung und Erprobung einer Softwarelösung für die mathematische Simulation des Walzens von Langprodukten". PhD thesis. Freiberg: TU Bergakademie Freiberg, 1997.

[5] Sang-Min Byon et al. "An Approximate Model to Predict the Surface Profile of Material Sections in a 3-Roll Rolling Process". In: *Journal of Mechanical Science and Technology* 31.7 (July 2017), pp. 3489–3497. ISSN: 1738-494X, 1976-3824. DOI: 10.1007/s12206-017-0638-7. (Visited on 12/07/2023).

[6] Youngseog Lee and Gert Goldhahn. "Prediction Model of the Exit Cross Scetional Shape in Round-Oval-Round Pass Rolling". In: *Korean Society for Precision Engineering* 2.1 (2001), pp. 87–93.