

Influence of the slitting passes system on the slitting pass wear during the bars rolling process

Wpływ układu wykrojów rozcinających na ich zużycie podczas walcowania prętów

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An analysis of the roll wear in the multi-strand rolling of ribbed bars has been made in the study. For the computer simulations were used two slitting pass system. For determining the wear of the passes, the results of numerical computation of unit friction force work done using the Forge2011® computer program.

KEYWORDS: groove-rolling, ribbed bars, wear, numerical modeling, FEM

Continuous rolls of long products can be counted among the most efficient processes to obtain a finished product with high mechanical and strength properties and good surface quality in a narrow range of dimensional tolerances [1]. The dimensional accuracy of the product depends on the shapes of passes the co-operating sequentially. During operation, these passes are worn out, which affects the dimensional accuracy of the finished product and the rolling process [2, 3, 4, 5].

The most common type of wear in plastic working processes is abrasive wear due to the friction between the working surface of the roll and the rolled material. The Archard model is often used to describe this type of wear [6].

The process of ribbed bar rolling with longitudinal band separation is characterized by intensive wear of the rolls with slitting passes. The aim of the study was to determine the influence of the slitting passes system applied to their wear in the three-strand rolling of ribbed bars with a diameter of 16 mm.

Theoretical studies included both the classic slitting passes with two grooves and the new layout using three slitting grooves. Numerical modeling of the rolling process was carried out using the MES-based Forge2011® computer software. The quantitative wear of slitting passes was determined on the basis of the method developed in [7, 8].

Assumptions accepted for modification of the slitting passes system

The slitting passes system currently used in one of the national continuous bar mill has been modified by inserting an additional third slitting pass in place of the

"smooth barrel" blank that was used in the stand 13. Then the traditional edging pass in stand 14 was replaced by a groove used in the rolling process of flat bars with rounded corners. In contrast, the stand 15 was changed from a pre-slitting pass to a slitting pass, which has larger indentations of the knife parts. The slitting pass (stand 16) in both systems is the same. Corrections of the slitting pass system are shown in fig. 1.

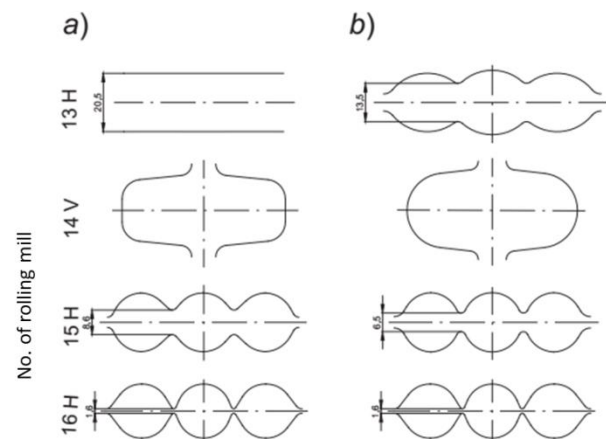


Fig. 1. The slitting pass system used for the production of ribbed bars with a diameter of 16 mm rolled in three-strand technology: a) slitting pass system used presently, b) new slitting pass system. Where H - horizontal roll stand, V - vertical roll stand

Changing the height of the knife parts in the passes has resulted in a decrease in the band deformation in the band areas of the groove, thereby reducing the wear of the grooves. In the traditional rolling process with longitudinal band separation, a large deformation is used in areas of the band in contact with the cutter parts of the slitting passes (stands 15 and 16) – fig. 1a. The significant deformation caused by cut parts of the groove is used to design bridges in a multi-strand band with a height that will allow for proper band separation in the non-driven separating rollers [2, 8, 9].

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Numerical modeling of the rolling process in slitting passes

The results of numerical calculations of the unit friction force work of rolls determined using an MES-based computer program were used to determine the wear of pre-slitting pass (stand 15) and slitting pass (stand 16). The wear model used in the Forge2011® computer software does not allow quantitative, but only a qualitative (comparative) assessment of the roll wear and only for qualitative (comparative) analysis. In order to use the simulation results using the simplified Archard model to quantify the wear of rolls, it is necessary to consider the wear coefficient, which was determined from the experimental studies presented in [8] $k_{zuz} = 1.4 \cdot 10^{-6} \text{ mm}^3 \cdot \text{mm}^{-1} \cdot \text{mm}^{-2}$.

Due to the fact that cutter parts of the slitting pass are subject to the fastest wear as compared to the rest of the groove, the values obtained for those pass areas were only analyzed.

The study provided complete information to determine the theoretical shape of the nominal pre-slitting pass (fig. 2) and pre-slitting pass (fig. 3) after rolling 1000 Mg of bars using two slitting passes systems.

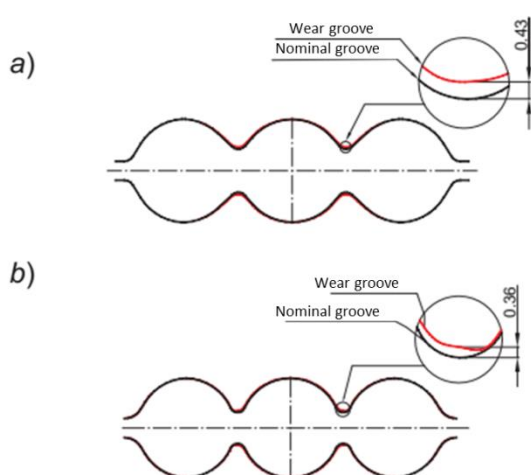


Fig. 2. Theoretical shape of the pre-slitting pass after rolling 1000 Mg of bars as compared to the nominal shape, stand 15: a) slitting pass system used presently, b) new slitting pass system

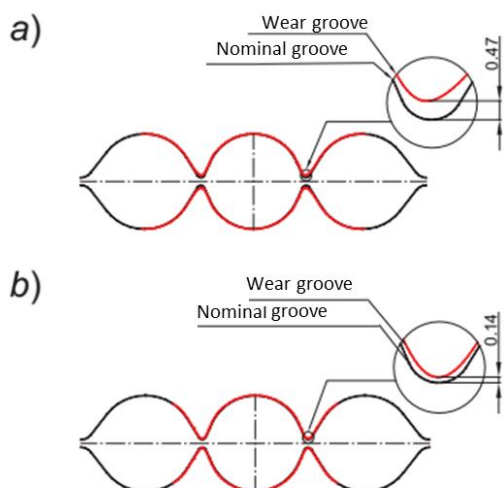


Fig. 3. Theoretical shape of the slitting pass after rolling 1000 Mg of bars as compared to the nominal shape, stand 16: a) slitting pass system used presently, b) new slitting pass system

In stand 15, less wear occurs in the newly developed pass as already in stand 13, there is a pre-forming of the bridges in the band, which results in the possibility of using smaller deformation in these band areas in stand 15. The wear in the groove currently used is 0.43 mm (fig. 2a), while in newly developed groove - 0.36 mm (fig. 2b).

In stand 16, there is also a noticeable wear decrease in a knife parts of the groove when comparing the previously used slitting pass system (two slitting passes) with the newly developed system (three slitting passes). The maximum wear of the knife parts in the slitting pass for the current system is 0.47 mm (fig. 2a), while the use of the new system results in a reduction in wear in the slitting pass to 0.14 mm (fig. 2b).

In the slitting pass system used so far, the slitting pass (stand 16) are worn the fastest, and at the same time it is mainly responsible for proper band separation, since this is where the final shaping of the bridges connecting the individual strands in the band is made. In contrast, in the newly developed system arrangement, the slitting pass (stand 16) was significantly weighted, as the total deformation in the band areas, in which the bridges connecting the individual strands were formed, was spread over three passes. This has greatly increased the durability of this groove.

Conclusions

Theoretical studies on wear of rolls in the process of rolling ribbed bars using multi-slit technology were carried out. Particular attention has been paid to pre-slitting and slitting passes as their wear is greatest and affects the stability of the rolling process. The research has allowed to anticipate the wear of passes and operation life, which can partially eliminate rolling mills breakdowns resulting from breakdowns caused by excessive wear of grooves.

Based on the results obtained, it has been found that the use of a new slitting pass system provides less band deformation at the bridging areas, resulting in less wear of pre-slitting and slitting knife parts.

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