

Study of Deformation's Indexes of Rolls of Different Designs

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Abstract. The elastic deformation of rolls influences the final thickness, thickness variations of strip and distribution of contact stresses. Prospective direction to address the problem of ArcelorMittal Temirtau JSC is the use of new roll materials. Calculating of elastic deformation of four-roll unit of continuous wide-strip hot rolling mill 1700 at ArcelorMittal Temirtau JSC for the actual profile of rolls of the "old", "modern" and "up-to-date" designs. Calculations have showed that during the use of rolls of "up-to-date" design AS1180HH in stands 6-8 bend deflection is reduced by 35-36.8%, and the design of rolls HVS80 in stands 9-12 – by 54.5-56.1% that will allow the minimization of strip defect “non-flatness” at rolling of both narrow and wide strips.

Meshing of product mix, strict requirements to the rolled product, increasing of rolling mills capacity are forcing rolling engineers on the necessity of reserves search in modern conditions. Using of new rolls material is the prospective direction for solution of this problem for ArcelorMittal Temirtau JSC also.

So, before 2001 in finishing stands of continuous wide-strip hot rolling mill 1700 at ArcelorMittal Temirtau JSC double-layer light-alloyed cast iron rolls with whitened working layer, transitive layer made of mottle and core made of grey cast iron with whitened layer thickness from 10mm to 30-32mm were used. At that time there were so-called old-type rolls LPHNd-62, LPHNd-63 used at finishing stands 6-8, rolls LPHNd-70, LPHNd-71, LPHNd-72, LPHNd-74, LPHNd-76 used in finishing stands 9-12. During recent 8-10 years modern type rolls are used at finishing stands of continuous wide-strip hot rolling mill 1700: HiCr (high chromium, chromium content >16%) in stands 6-8 and ICDP in stands 9-12.

At the same time there were steel rolls getting the popularity in Germany, designed by “Hontermann-Paipers” company instead of cast iron ones: so, in first finishing stands there are up-to-date rolls used made of steel AS1180XX – double-layer high chromium rolls, axial part and necks are cast from iron with globular graphite. Rolls made of this steel are characterized by high reliability in operation and stable rolling mode characteristics till the full permitted diameter reduction. Operational results showed that rolls made of this steel have lifetime 1.5-2 more than cast iron. In stands 9-12 there are rolls of grade HVS80 successfully used, where body is made of quick-cutting steel HSS, and axial part and neck made of high-strength cast iron with globular graphite. Rolls of this steel have high temperature strength, wear resistance and rigidity against burn cracks. Owing to this qualities the length of rolls campaign is elongated, number of their re-grinding is reduced, rolled product quality is improved and their tolerances are reduced.

Due to the fact that elastic strain of rolls and working stand influences the final thickness, thickness variation of rolled product and distribution of contact stress there was task given to calculate bend deflection Y_{WORK} of work rolls, used before, now and planned for future for finishing stands of continuous wide-strip hot rolling mill 1700 of ArcelorMittal Temirtau JSC with consideration of initial profile, heat crown and wear.

Initial data for calculation of elastic strain were: rolling force, strip width, length and diameters of work rolls and back-up rolls of finishing stand 12 of hot rolling mill 1700 of ArcelorMittal Temirtau JSC. Sampling selection was received by means of experimental measurements. There were 165 rolls of “old” and “modern” generation measured. There were 164158.4t of metal rolled from 1134 heats, including 11178 strips of different profile dimensions made of steel 3sp, 08kp, 08kpG, Ust-12, U1006, Rst-02z, etc. Statistical sampling of measurement results was also considering data from technology parameters measurement for each steel grade and profile dimension.

Using the Autodesk Inventor program Y_{WORK} was calculated for rolling of strips with different profile dimensions and steel grades for actual profile of work rolls in finishing stands of continuous wide-strip hot rolling mill 1700 of “old”, “modern” and “up-to-date” design.

As per data of calculations there were trends built for dependence of bend deflection on width of rolled strips for steel grade 3sp (killed) (Fig. 1 & 2), where it is visible that after the decreasing of strip width down to 1268mm work roll bend deflection is reducing (as the intra-roll pressure along the rolls contact is reducing) and the compression deformation of contacting rolls is decreasing. During the rolling of wide strips with application of counter-bending force the ratio of rolls bending is decreasing and the gap is closing due to uneven wear of rolls is closing on account of pressing of edge sections of roll body.

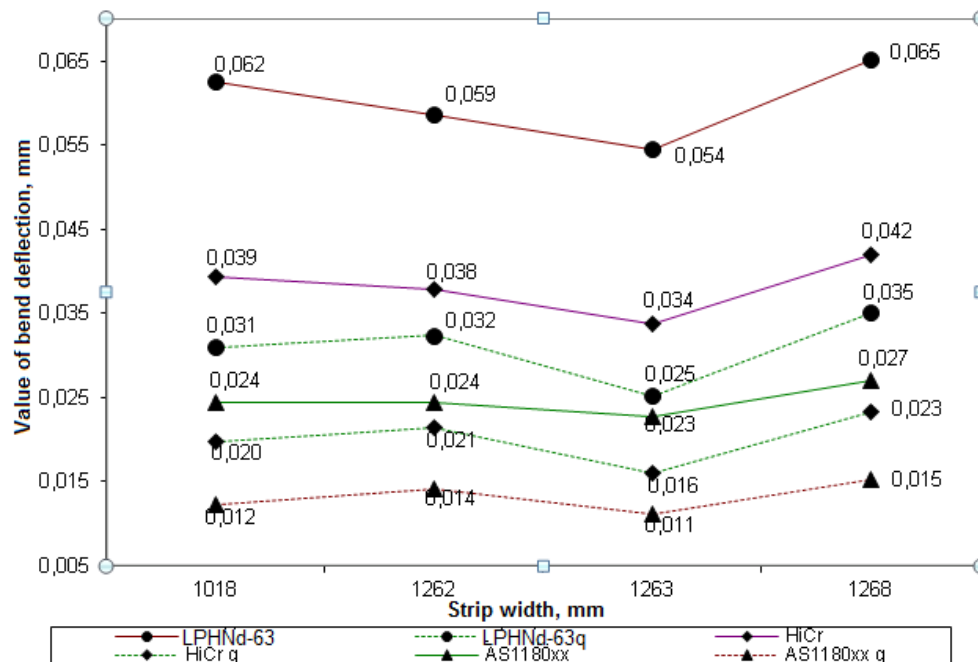


Fig. 1. Dependence of bend deflection for rolls of design LPHND-63, HiCr, AS1180xx at the rolling of different widths of strips with applied forces of counter-bending and without them (q – with application of counter-bending force)

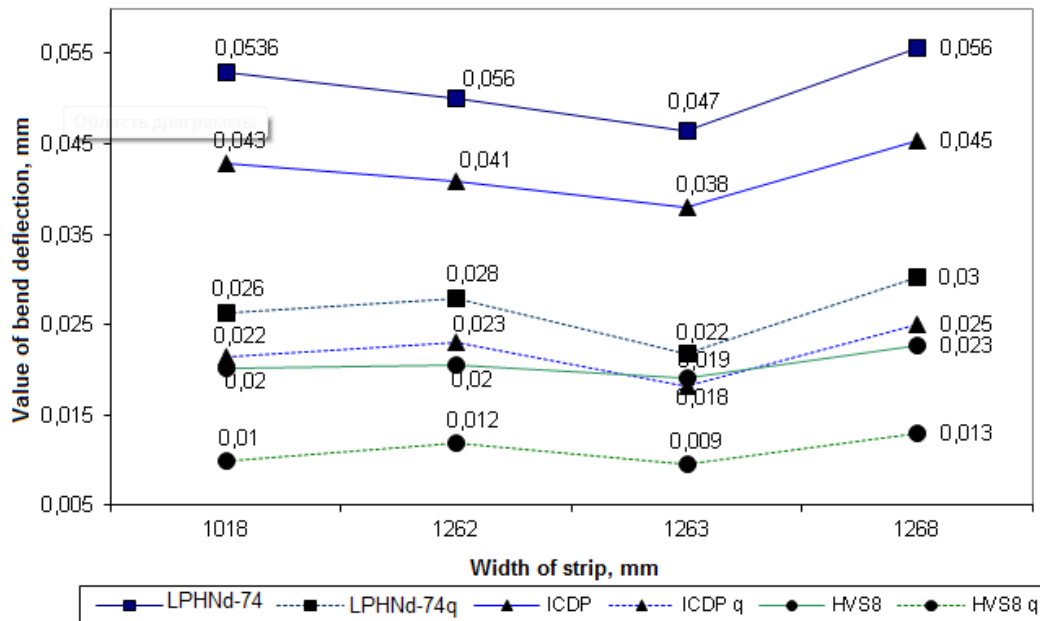


Fig. 2. Bend deflection for rolls of design LPHND-74, ICPD, HVS80 at the rolling of different widths of strips with applied forces of counter-bending and without them

From the trend (Fig.1) it is visible that for roll of design LPHNd-63 at the rolling of narrow strips with steel grade 3sp the bending value was 0.031mm, for roll of design HiCr – 0.02mm (reduction by 0.011mm – 35.5%), for roll of design AS1180XX– 0.013mm (reduction by 0.007mm – 35%). At the rolling of wide strips for roll of design LPHNd-63 the bending value was 0.03mm, for roll of design HiCr – 0.019mm (reduction by 0.011mm – 36.7%), for roll of design AS1180xx – 0.012mm (reduction by 0.007mm – 36.8%).

From the trend (Fig.2) it is visible that for roll of design LPHNd-74 at the rolling of narrow strips with steel grade 3sp the bending value was 0.026mm, for roll of design ICPD – 0.002mm (reduction by 0.004mm – 15.4%), for roll of design HVS80 – 0.01mm (reduction by 0.012mm – 54.5%). At the rolling of wide strips for roll of design LPHNd-74 the bending value was 0.025mm, for roll of design ICPD – 0.021mm (reduction by 0.004mm – 16%), for roll of design HVS80 – 0.009mm (reduction by 0.012mm – 56.1%).

Thus, at the rolling of both narrow and wide strips it is more feasible to use rolls of “up-to-date” design due to less value of bend deflection, which influences the final profile of strip and gives the opportunity of production of metal with higher quality than at rolls of “old” and “modern” designs. It is proven that roll bends more at rolling of narrow strips, therefore the strip defect “non-flatness” is more specific for narrow strips. This tendency is tracked for rolls of “old”, “modern” and “up-to-date” designs. Besides this rolls of “up-to-date” design AS1180XX, planned for usage in first finishing stands of continuous wide-strip hot rolling mill 1700 and rolls of design HVS80 for last finishing stands, have the smallest bend deflection of work rolls with similar rolling conditions, with application of counter-bending force and without it.

Conclusion.

Elastic deformation of rolls influences the final thickness, thickness variation of rolled product and distribution of contact stress. Using of new rolls material is the prospective direction for solution of this problem for ArcelorMittal Temirtau JSC. For that purpose the constituent of elastic deformation for four-roll unit of continuous wide-strip hot rolling mill 1700 was calculated for conditions of ArcelorMittal Temirtau JSC according to actual profile of rolls of “old”, “modern” and “up-to-date” designs. Calculations have showed that during the using of rolls of “up-to-date” design AS1180XX in stands 6-8 bend deflection is reduced by 35-36.8%, and for rolls of HVS80 design in stands 9-12 – by 54.5-56.1%, that will allow the minimization of strip defect “non-flatness” at rolling of both narrow and wide strips.