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Development of Criteria Specifying the Conditions of Interaction between the Scale with the Rolls of Continuous Cast Machine and Continuous Cast Billets

N.N. Ogarkov*, S.I. Platov, D.V. Sufyanov

Nosov Magnitogorsk State Technical University, 38, Lenin Street, Magnitogorsk 455000, The Russian Federation

Abstract

The study of surface condition of the rolls of continuous casting machine (CC-machine) of the secondary cooling zone is undertaken. It was stated that their working surfaces include the segments with stuck and peeled-off scale. The surface profilograms of the rolls with pickup scale are obtained. The domelike, tapered and trapezoidal form of fragments of the scale with a height 3-4 mm and tilt angles between the side faces of 43-88 are the most typical forms.

Based on the elements of the plasticity theory, the problem of determination of stress-strain behavior of continuous casting steel billets is solved in the process of indentation of the scale fragments into it. The mathematical relation between geometrical parameters of scale fragments and the thickness of crystallized jacket is found that allows determining a stress strain state criteria in accordance with that the scale pickup on the roll surface is carried out or its indentation into internal layers of CC steel billets with its following holding. It was stated that the indentation of good-size scale fragments in relatively thin crystallized skin creates comfortable facilities for pick-up of scale on the rolls, and the indentation of small-sized scale fragments in the thick crystallized jacket especially with large tilt angles between the side surfaces of fragments makes possible for their hold-up at the surface of concast steel billets in the imbedded condition. It was determined the criteria which contains two necessary conditions whereby the scale sticking on the rolls of CC machine is carried out or the indentation in continuous-casting machine followed by holding in it.

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Keywords: Continuous casting machine; continuous cast steel billets; scale; rolled-in scale; support roll; rolls wear.

* Corresponding author. Tel.: +7-904-941-1515.
E-mail address: ogarkovnikolai@mail.ru

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1. Introduction

The output of competitive engineering products requires for making design and engineering solutions based on the adequate amount of data on the development of quality factors with a formal description of all processes constructing such factors [1]. In the context of production of continuous cast steel billets the formation of qualitative characteristics is inextricably connected with the processes occurring at the surface of a contact between the support roll and continuous cast steel billets and especially at the secondary cooling zone [2-6]. In the process of continuous casting at the contact surfaces the scale is generally presented whose characteristics differ in many respects from roll material properties and work material [7-12].

The scale presented at the contact surfaces can stick on the rolls surfaces or be indented in the surface of continuous steel billets [13,14,17]. The study of the worked-out rolls of CC machine at the secondary cooling zone have shown that their work surfaces include the sectors with tightly hold-up and peeled off scale fragments. The scale fragments peeled off from rolls and indented into continuous steel billets at the further processing stages are the cause of defect formation "rolled-in scale" [4,8,15-17]. In addition to the effect of sticking and peeling-off of the scale from the rolls surface there is an uneven wear of rolls surface that, in turn, have impact on intensity of scale pickup and peel off.

At the present time there are detailed researches on formation of scale phase composition and its mechanical-and-physical properties but there is no data concerning the criteria depending on which the scale demonstrates its tendency for picking-up on the roll surface or its embedding into work material followed by hold-up of scale in it. [21].

For the purpose of determination of this criterion the investigational study and theoretical analysis were accomplished for liaison of scale fragments with roll surfaces and continuous cast steel billets.

2. Investigational study

The study of the profile of worn-out surface contour of the rolls of CC machine, the seizes and the form of the stuck scale was carried out based on the profilograms became available using the profilometer Mahr PSI with a cutoff 0,25 mm at the segments in length 10 mm (fig.1). The scale stuck to the rolls can be divided in a small one, in square from 10 мм2 to 300 mm2, and larger one that covers up to 1/5 the generatrix of the roll. The stuck scale overhangs the level of roll bed 3…4 mm thereby increasing the cyclic load on them. The most typical forms of small pick-up scale are dome-shaped (figure 1a), wedge-shaped (fig.1b) or trapeziform (fig.1c). The tilt angles between the side surfaces of pick-up scale are changed in the range of 43°…88°.

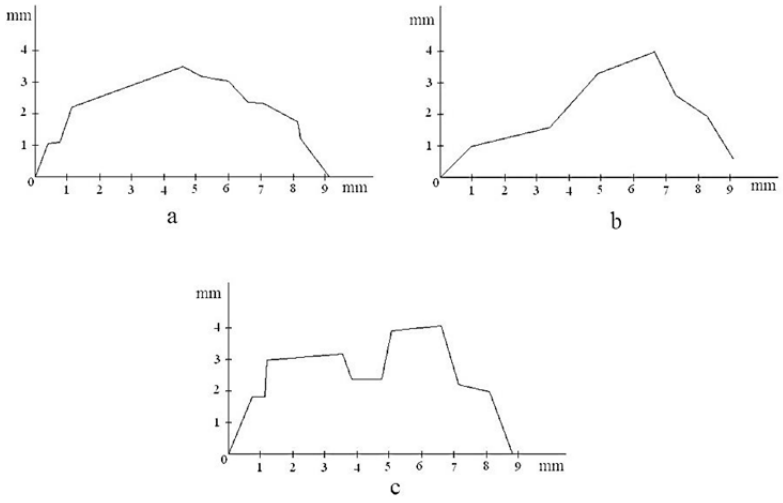

Fig. 1. Typical profilograms of fragments of the scale stick to the rolls.

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