RESEARCHES CONCERNING THE CORRELATION OF THE SEMIPLANETARY ROLLING PROCESS FACTORS

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ABSTRACT

An available solution of the elimination of the superficial cracks network at the continuous cast slabs is the semiplanetary rolling. The application of a semiplanetary rolling mill at the exit of slab from the curve zone of the continuous casting machine leads at the slab unbending. For real constructive conditions of the geometry of casting machine, the establishing of the factors of semiplanetary rolling process, is necessary. The researches showed in this paper, worked at a lab semiplanetary mill, demonstrate that the bending of the linear body or the unbending of the curve body is possible. At the same time is establishing a correlation between the geometrical factors of body and the semiplanetary rolling factor – the relative reduction of thickness.

KEYWORDS: continuous casting, semiplanetary rolling, unbending process

1. Introduction

Semi-planetary rolling is an interesting deformation process. The rolling process is performed in a rolling stand mill consisting by a planetary cylinder and a massive cylinder what determines a non-uniform strain repartition into the thickness of rolled body [1].

The penetration of the satellite cylinder is much greater then the penetration of the massive cylinder [2].

The non-uniformity of the strain induces a compression stress field with the intensity of the stress greater in the proximity of the planetary cylinder and smaller in the proximity of the massive cylinder because the diameter of the satellite cylinder is much smaller then the diameter of the massive cylinder.

Consequently, into the deformation zone is developed a bending moment as result of the variation of the stress intensity.

This bending moment induces the curving of the deformed body or the unbending of the curved body.

An example of the semi-planetary rolling application may be the unbending of the continuous cast slab in the on-line regime.

Also, through the semi-planetary rolling may be worked curved pieces. The obtaining of the adequate quality of the rolled product the correct leading of the rolling process is necessary.

The factors of the semi-planetary rolling process (figure 1) are the reduction of the thickness, geometrical ratio *b/h* of the body, the radius *R* of the rolled product or the ratio *R/h* (we denote *b* the width *h* the thickness).

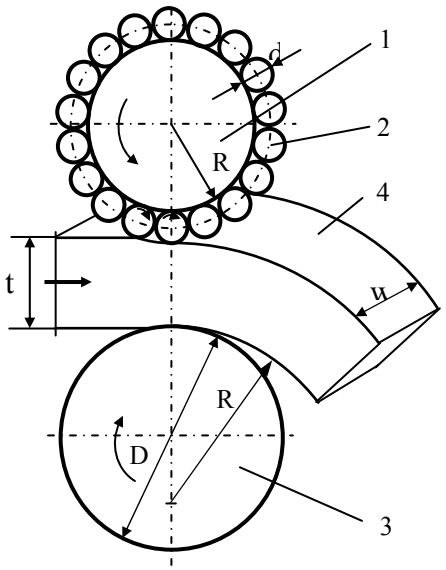

Fig. 1. *Scheme of semi-planetary rolling: 1-planetary cylinder, 2-satellyte cylinder, 3-massive cylinder, 4-semi-product.*

The paper objective is the establishing of the link among the relative thickness reduction and curvature radius for different values of the geometrical ratios of body. The establishing of this correlation is necessary to evaluate the practical possibilities of application of this procedure at the unbending process of continuous cast slabs.

2. Experimental conditions

The experimental researches have been effectuated at a semi-planetary rolling stand mill (fig.2) composed by a massive cylinder (diameter of 80mm) and a planetary ensemble, composed by 18 satellite cylinders (diameter of 12mm) and a support cylinder (diameter of 56mm). The length of the active surface of rolling cylinders is of 50mm.

In the aim of the simulation of semi-planetary rolling process the samples have been worked of lead. The dimensions of the samples are rendered in table 1. They were programmed for various values of the initial thickness and width, i.e. various values of the geometrical ratio *b/h*.

The experimental process consists in the measuring of the sample dimensions, programming the value of the thickness reduction, semi-planetary rolling and measuring of the effective value of thickness and radius of the rolled samples.

Table 1. *Dimensions of the samples, [mm]*

Length	Width	Thickness
100	10	6, 9, 13, 16
	20	6, 9, 13, 16
	30	6, 9, 13, 16

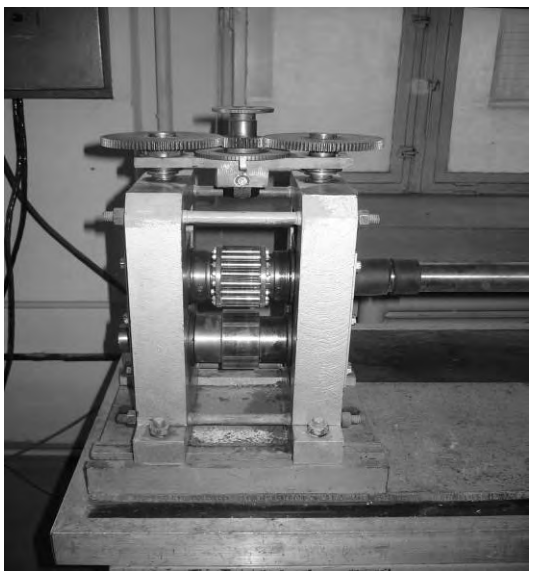

Fig. 2. *Semi-planetary rolling stand mill (experimental model).*

3. Results and interpretation

In figure 3 are showed some examples of semi-planetary rolled samples.

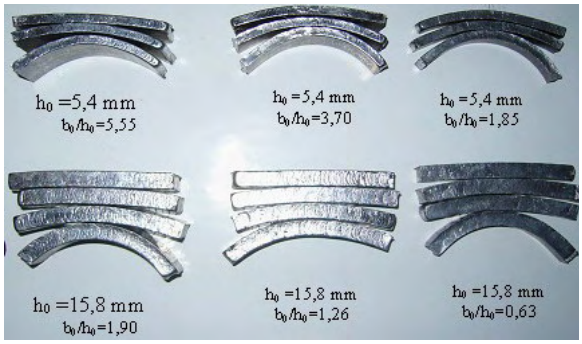

Fig. 3. *Semiplanetary rolled samples.*

The results of the experimental researches are systematized in graphic form in the figures 4, 5.

In figure 4 is showed the variation of the curvature radius of semi-planetary rolled samples, in absolute values, in the all cases of their geometrical factors, in function of the relative reduction of thickness.

In figure 5 is showed the variation of the ratio - curvature radius/initial thickness of semi-planetary rolled samples, in the all cases of their geometrical factors, in function of the relative reduction of thickness.

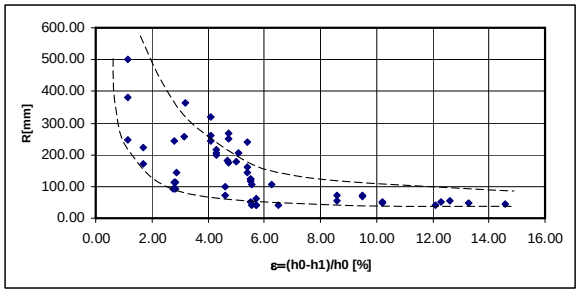

Fig. 4. *Variation of curvature radius with relative thickness reduction.*

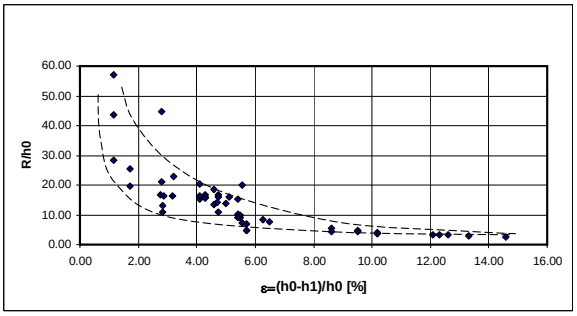

Fig. 5. *Variation of R/h_0 ratio with relative thickness reduction.*

It observes a smaller dispersion of experimental data in the second case, in case of small deformations as effect of the measuring precision of the curvature radius.

Consequently, the ratio *R/h* allows a better evaluation of the deformation degree (relative reduction of the thickness) what is necessary at the unbending of a continuous cast slab with a date curvature radius and date thickness.

4. Correlation of the results

The influence of the reduction of thickness on the curvature radius is certitude.

The increasing of the thickness reduction determines the adequate increasing of the curvature radius. For establishing a truthful correlation we made the refining of experimental data using a specializing soft (DATAFIT).

As result the regress equation has been established.

$$\frac{R}{h_0} = 41{,}89 \cdot \varepsilon^{-0{,}846} \cdot 1{,}05^{\frac{b_0}{h_0}} \quad (1)$$

The comparative representation of the experimental results and regression surface, conform the equation (1) as showed in figure 6.

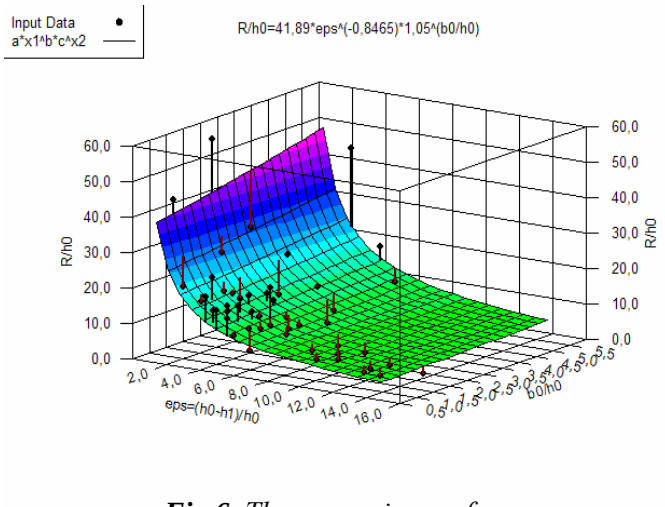

Fig.6. *The regression surface.*

The influence of the b/h ratio of the R/h ratio for different values of the relative thickness reduction is presented in figure 7.

Is evident the b/h ratio has grater influence for reduced values of deformation degree and at the greater values of R/h ratio (fig.7.)

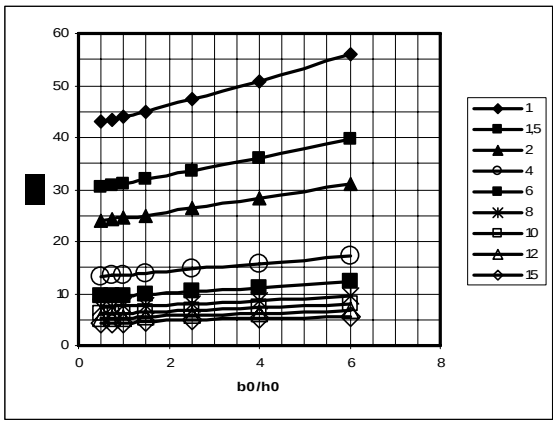

Fig.7*. The influence of the b/h ratio of the R/h ratio for different values of the relative thickness reduction.*

The variation of the R/h ratio with relative reduction of thickness (ε), is presented in figure 8. This graphic may be used at the evaluation of the deformation degree necessary for unbending of cast slabs.

Thus, for known R/h ratio and b/h ratio, in function of the geometry of continuous casting machine and geometry of crystallizer we can establish the value of the relative thickness reduction.

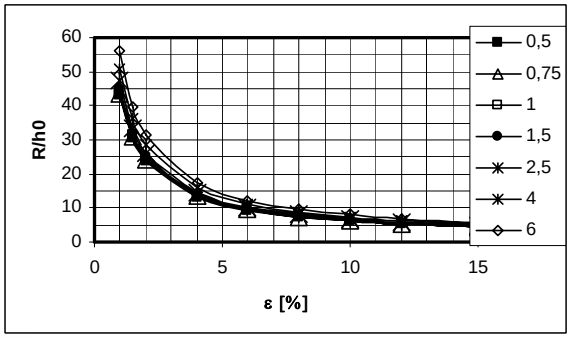

Fig. 8*. The variation of the R/h ratio with relative reduction of thickness (ε).*

5. Conclusions

The experimental researches demonstrated:

1. Semiplanetary rolling is a deformation method what induces a non uniform deformation in the thickness of rolled body. This phenomenon determines the curving or unbending of rolled body.
2. In case of semiproduct with certain value of geometric ratio b/h, in aim of obtaining a certain curvature radius by semiplanetary rolling the establishing an adequate value of relative reduction is necessary.

3. Unbending a continuous cast slab may be realized by semiplanetary rolling selecting the adequate value of relative reduction correlated with geometrical ratio b/h and R/h ratio (R being the radius of curve thread).

4. The researches demonstrated at the geometrical ratio b/h greater two in the body section is developed a plane deformation state. In this case the base factor for programming of semiplanetary rolling process is the thickness reduction.

Consequently the semiplanetary rolled may be applied at the exit of continuous cast slab of curve thread of casting machine in the aim of unbending with out tensile stresses.

This fact will have as effect the elimination of cracks on the superior surface of continuous cast slab.

Finally it will assure the quality of metallurgic products and decreasing of production costs.

References

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