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**INFLUENCE CONTROLLED COOLING IN THE MOULD IN  
THE RESIDUAL STRESSES IN THE CAST IRON  
ROLLING**

*Abstract. In the mould, the effect of slow cooling of the cast-iron bleached rolling roll in a given period of time on its internal residual stresses was investigated. The internal stresses in the rolls were determined with the help of the magnetic structurocoper SA51-Hc-001.*

*Keywords: casting, rolling roll, controlled cooling, cast iron, residual stress, heat treatment*

**Introduction.** In the crystallization and cooling of alloyed and modified rolls in stationary combined chill mould sand moulds (Figure 1), internal residual molding stresses [1-4]. Their excess above a certain level [5] may lead to formation of hot and cold cracks in castings. After casting all the rolling rolls and their thermally treating of them tested in order to reduce the level of residual stress or naturally their aging for 3...6 months.

Temperature-time modes of thermal treatment (tempering) for some types of rolls allow to reduce internal residual stresses and exclude the stage of natural aging, which according to the current technical conditions lasts for 3...6 months.

Economically expedient is the production of cast rolls with reduced internal residual stresses due to the regulation of the cooling mode in the mould [6]. Elimination of the technological stage of the controlled heating and cooling rate of the rolling roll in a thermal furnace will significantly reduce the cost of production.

The analysis of the patent-licensed literature showed that there is no research in this direction, so the problem posed is topical, and its solution is of great practical importance.

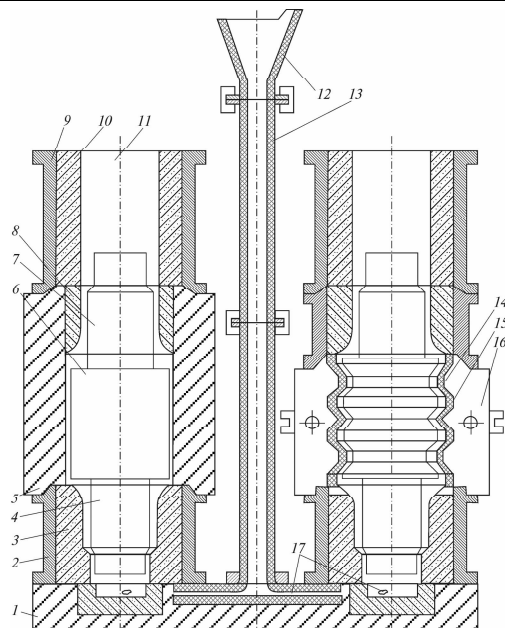


Figure 1 – Diagram of moulds for casting rolls with a smooth barrel and alloy gages (thin lines indicate the size of the finishing roll):

1-double tray; 2-form of the lower neck; 3-molding mixture; 4-lower neck of the rolling roll; 5-chill mould; 6-barrel rolling roll; 7-upper neck of the rolling roll; 8- "sealing" - molding mixture in the mould; 9-form of profit; 10-molding mixture arrived; 11-profit; 12-funnel; 13-riser; 14-ledge of the caliber of the chill mould; 15-hollow of the caliber of the chill mould; 16-chill mould with casted calibers and vertical connector; 17-tangential feeder

**Purpose.** Analysis of the effect of heat treatment in the casting form of the barrel of the roll-roll during crystallization and slow cooling of the casting on the change in residual casting stresses in the casting.

**Material and methods.** In the conditions of the rolling shop of PJSC "Dnepropetrovsk Rolling Mill Plant", two rolls of bleached cast iron were manufactured with СПХН-60 with barrel dimensions of III390x785 mm. On a double pallet, casting moulds of the experimental and serial rolls were installed. Melting of cast iron was carried out in an induction furnace ИЧТ-6 in accordance with the technological instructions of the plant. The casting of the melt at  $1320 \pm 5$  °C was performed through one common riser (see 13 in Figure 1). The cooling of the test roll was slowed down by the thermal insulation of the mould during a predetermined period of time.

Thermal treatment to reduce residual stresses in series rollers was carried out in a chamber furnace with a sliding hearth in a mode of

heating to a temperature of 600 °C, then holding for 10 hours and cooling with an oven.

The internal stresses were estimated with the help of the magnetic structuroscope SA51-Нс-001 as shown in Figure 2.

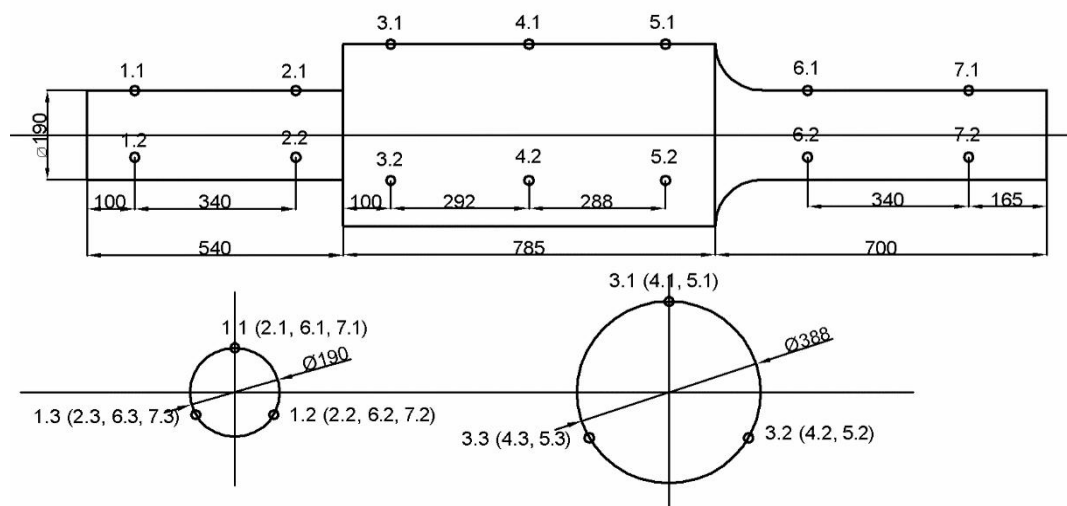


Figure 2 – Scheme for measuring stresses in rolling rolls with a diameter of 390 mm

Results of the research. Residual stresses in the rolling rolls of the SPHN-60 version of the following chemical composition of masses were studied. %: C 3.23 ... 3.59, Si 0.52 ... 0.61, Mn 0.52 ... 0.54, up to 0.3 P, up to 0.12 S, Cr 0, 64 ... 0.78, Ni 1.65 ... 1.82, iron is the rest.

A comparative analysis of the results of measuring the residual casting stresses of rolling rolls from bleached cast iron obtained by different methods is given in Table. 1.

Table 1

Results of measuring residual stresses in rolling rolls from bleached cast iron obtained in different ways

Batch of rolls	Roll number	Coercive force, A / cm				Average
		in point groups				
		3	4	5		
serial	8038	6.9	6.7	6.8	6.80	
experienced	9097	6.5	6.3	6.3	6.36	
adjustable heating and cooling in the oven	91412	6.1	6.0	6.2	6.10	

Comparison of the obtained results shows that the thermal insulation of the mould during a given period of time during the crystallization and cooling of the casting contributes to a reduction of residual casting stresses by 6.4% compared to the standard production technology of rolling rolls.

After the roll is cooled and removed from the mould, its further controlled heating and cooling in the heat treatment furnace ensures a reduction of the residual casting stress by 10.2%.

**Conclusions.** The effect of delayed cooling of a cast-iron bleached rolling roll in a given period of time on its internal residual stresses is studied. A 6.4% decrease in internal residual stresses in the test roll due to controlled cooling compared to the production roll was established. Thermal treatment of a series roll in an oven with a controlled heating rate of up to 600 ° C, then holding for 10 hours and cooling with the furnace ensures a 10.2% reduction in internal residual stresses compared to a standard roll without heat treatment. A promising area for further research is the development of thermo-current regimes for controlled cooling of other roll sizes for the purpose of eliminating heat treatment after casting of rolls.

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