Modeling of roller leveling process

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Abstract: *Roller leveling is a technological process of metal forming, used to minimize the flatness of sheet blanks and reduce the level of residual stresses. When leveling, the workpiece is subjected to cyclic alternating bending with decreasing amplitude. The report presents an experimental testing set-up designed and used to model the leveling process. The equipment is described and the first results are presented.*
Keywords*: LEVELLING PROCESS, LEVELLING FORCE, MODELING*

1. Introduction

Sheet blanks are widely used in industrial production. For their cutting, laser and plasma cutting is often used. After that, sheet blanks often have insufficient geometric accuracy (flatness). To improve the geometric accuracy of sheet blanks various methods can be used, including roller levelling.

Roller levelling is a technological process of metal forming, used to minimize the flatness of sheet blanks and reduce the level of residual stresses. When levelling, the workpiece is subjected to cyclic alternating bending with decreasing amplitude. In this case, the penetration depth of deformation should be at least 0.7 of the thickness of the workpiece [1].

When levelling due to the presence of cyclic loading, there are conditions in the process that both hinder the levelling process (hardening) and facilitate it (the Bauschinger effect). All this can give rather large differences in the results of calculations performed by different methods. To obtain reliable results it is necessary to know the dependance of stress on the degree of deformation for a given material.

The existing experience of the world's leading manufacturers of process equipment (ARKU, KOHLER, etc.) shows the feasibility of using multi-roll levelers both for straightening piece sheet parts and for integrating levelers into existing and planned automated lines for the production of piece sheet blanks of a wide range for machine-building, petrochemical, aerospace and other branches of industrial production.

Multi-roll levelers are used for cold straightening of steel sheet blanks and blanks of non-ferrous alloys up to 50 mm thick and up to 5000 mm wide. Hot straightening of steel sheet blanks is carried out at temperatures of 500-700 °C, mainly immediately after leaving the working stand of the rolling mill. Sheets with a thickness of over 40 - 50 mm are usually straightened in a cold state under presses.

2. Experimental set-up

The experimental set-up is designed for modeling the leveling process of a sheet blank. Technological tests are designed to identify the ability of a metal to undergo deformations similar to those that the metal undergoes during its processing (leveling).

Physical modeling of the leveling process is carried out using up to 13 leveling rolls on samples with dimensions (L×W×T) 200÷1500×50÷100×0÷10 mm. The technical parameters of the set-up are given in Table 1, the general view is shown in Fig. 1.

Modeling of leveling is carried out as follows. The workpiece is fed into the gap between the rolls from the input side of the mill 1, where it is captured by rotating rolls. The workpiece moves to the output side of the mill; during the movement, the workpiece is subjected to successive alternating bends with decreasing amplitude (leveling). When leveling, force is recorded using strain gauges installed in the mill, and torque is recorded using strain gauges installed in the gearbox 2.

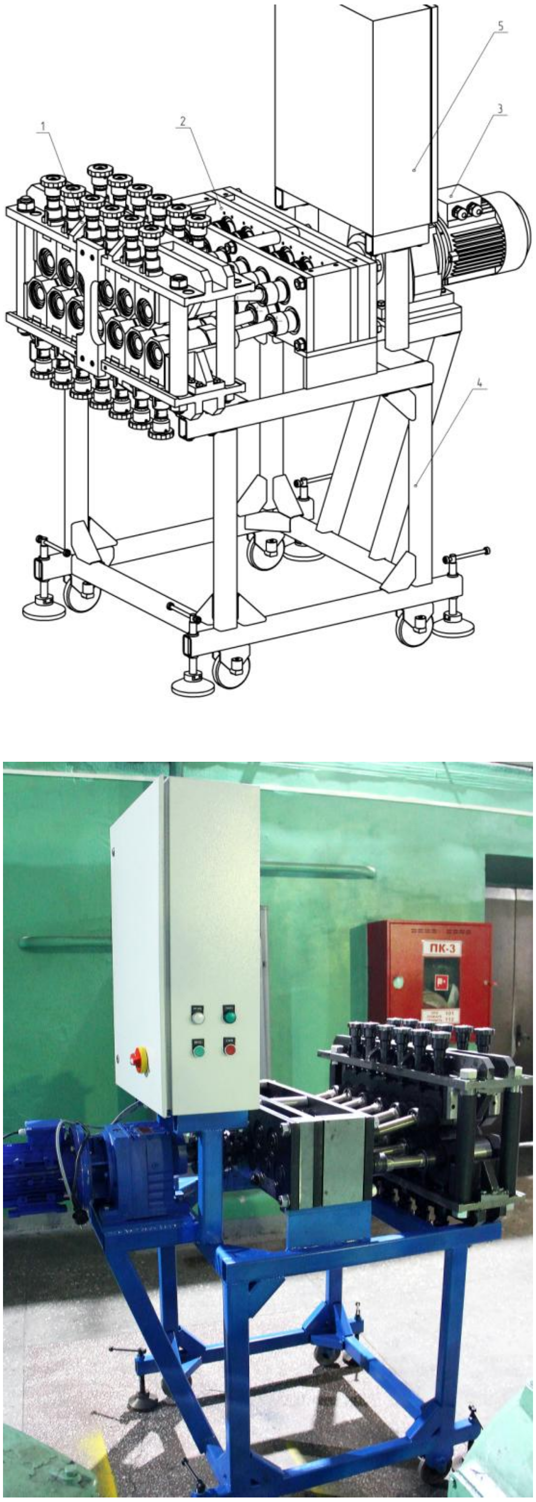

Fig. 1 *Experimental set-up used in the modeling.*

Table 1: *Experimental equipment technical parameters.*

Power supply	220 V, 50 Hz
Power of installed engines, kW	2,2
Maximum sample length, mm	1500
Minimum sample length, mm	200
Maximum sample width, mm	100
Minimum sample width, mm	50
Maximum sample thickness, mm	10
Minimum sample thickness, mm	1

Sketches of the leveling roll and gearbox shaft with strain gauges are shown in Fig. 2 and 3, respectively.

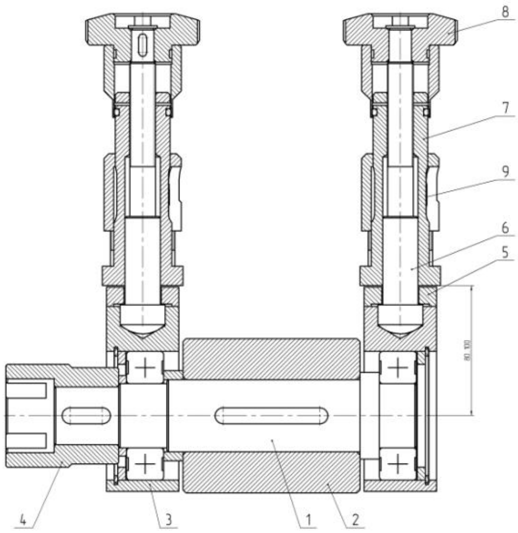

Fig. 2 *Sketch of the leveling roll.*

In the sketch shown, part 4 transmits torque to roll 2 mounted on shaft 1. Using screw 6, part 7 experiences tensile stresses in a specially prepared section where strain gauge 9 is installed.

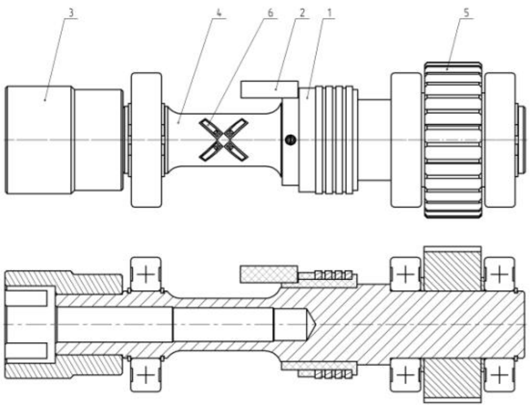

Fig. 3 *Sketch of the gearbox shaft.*

In the sketch shown, 1 – current collector; 2 –amplifier; 3 – part for connecting to the cardan shaft; 4 – shaft; 5 – gear; 6 – strain gauge.

Force measurements were carried out using a bridge circuit (Fig. 4).

Strain gauges BA350-100AA(11)-BX30 with a nominal resistance of 350 ± 0.2 Ohm and a gain of 2.11 ± 1% were used. Standard 360 Ohm and 3 kOhm resistors were used.

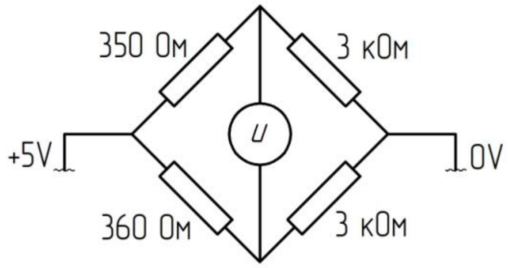

Fig. 4 *Bridge circuit.*

To convert electrical quantities into force values, a preliminary calibration of the bridge circuit was carried out at two points. For calibration, an HBM RTNC3/15T sensor with a HBM WE2108M meter was used. The accuracy of the HBM RTNC3/15T sensor is within 17.5 N.

3. Conclusion

The article presents the design of an experimental set-up for modeling of the leveling process. The energy-power parameters obtained during modeling can be used to adjust calculations and computer models during computer simulations.

4. References

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