EXPERIMENTAL STUDY ON ERROR OF SHAPE WHEN FINISHING THE INTERIOR CYLINDRICAL SURFACE

V. Chirila,
Technical University "Gh.Asachi," Iasi

1. THEORETICAL APPRECIATIONS

Taking into consideration the technical progresses registered so far, the process of finishing the interior cylindrical surfaces might be done through the following methods:

- finishing through micro-chip removal (abrasives or diamonds)
- finishing through plastic distortion (rolling of balls and rollers);
- finishing through unconventional methods.

The process of finishing through micro chip removal can be done through honing, vibratory-honing and lapping; it can be frequently used in profile factories from the whole world. The process of finishing through plastic distortion (rolling of balls and rollers) can be applied neither to metals and hard or extra-hard alloys, nor to hyper quenching materials or to gray iron (forces and very high couples of forces). The process of finishing through unconventional methods needs expensive machines and is studied more in laboratories, as a technical possibility.

Taking into consideration all the previous affirmations, one can tell that honing through abrasives or diamonds can be applied to all metallic materials: hard alloys, all kinds of steel treated through heat, alloyed steel metals and non-ferrous alloys, special gray iron, hyper quenching gray iron. This process can be observed as final processing for all kinds of motors with internal combustion, built in the whole world, as well as linear hydraulic motors.

The main purpose of honing is the improvement of the irregularity of the surface and the lessening of errors of shape (circularity and cylindrical shape).

Therefore, honing can belittle the error of shape, caused by the previous processing (finish boring, grinding etc.), without eliminating them completely. The most frequent deviations from the correct (exact) geometrical shape are the ones from circularity, AF_c and the ones from cylindrical shape, AF_l.

The deviation from circularity (AF_c) is equal to the double of the maximum distance between the adjacent circle (the circle with minimum radius and interiorly tangent to the real shape) and the real shape, the evaluation being observed only in transversal section. The deviation from cylindrical shape (AF_l) is equal to the double of the maximum distance between the adjacent cylinder (the cylinder with minimum radius and interiorly tangent to the real shape) and the real shape, obtained after processing, the evaluation being observed in longitudinal section (Figure1).

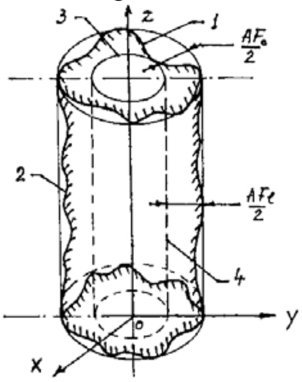

Figure 1 – Deviations from circularity and cylindrical shape
1. Real shape (transversal section)
2. Real shape (longitudinal section)
3. Adjacent circle
4. Adjacent cylindre

For a cylindrical part, the deviation from circularity might have different values, if measurements are achieved in a number ,*n*, of transversal sections of the part. The Deviation from cylindrical shape has <u>a unique value</u>, because

$R^* = \max R_{(n\ sections)}$ and $r^* = \min r_{(n\ sections)}$,

R^* and r^* being part of different transversal sections (Figures 2 and 3).

2. THE DEVELOPMENT OF THE EXPERIMENT

For the study of deviations from circularity, AF_c, in the process of honing on horizontal machines (MH-800, planed and designed by the author of this paper) a cylinder of gray iron, F_c 200 was used under the following conditions:

- internal diameter $Ø\ int$ = 95 mm;
- external diameter, $Ø\ ext$ = 115 mm;
- length ....L = 270 mm;

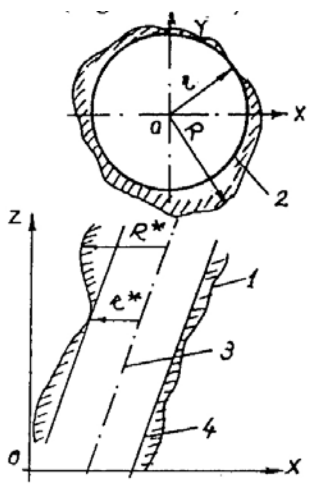

Figure 2 – The evaluation of the deviations from circularity and cylindrical shape

1. Real shape
2. Adjacent circle
3. Axle of cylinder
4. Adjacent cylinder

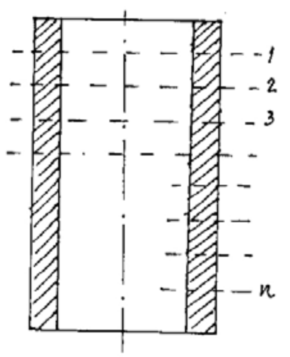

Figure 3 – Measurement sections
1,2,3,...,n – positions of sections

- previous processing – finish boring on finish boring machine, under the ideal coordinates ***2D*** – 450;
- the parametres of the finish boring process:
    - n=30 rot/min – V_{rot}=8,95m/min;
    - s_l=2,5mm/min – V_l=2,5mm/min
    - t=0,2mm ;
    - the irregularity obtained after the finish boring, R_a≈1,25 μm.
- the parametres of the honing process:
    - n=165rot/min – V_{rot}=50m/min;
    - s_l=2m/min – V_l=2m/min ;
    - honing time, θ = 5 min ;
    - diamond wheels ASM 14-10;
    - the irregularity obtained after the honing process, R_a=0,11μm.

In order to perform the measurements, the apparatus TALYROND 73, license TAYLOR-HOBSON (England) was used. This apparatus is able to measure the deviations from circularity, to visualize the results of measurements on its own monitor, but also to copy the results of measurements, on paper, with the help of its own printer (Figure 4).

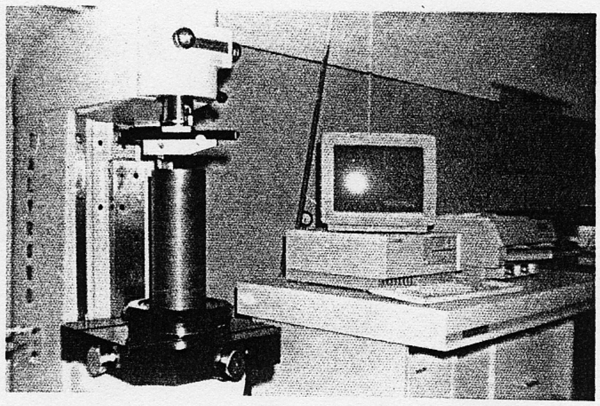

Figure 4 – The apparatus TALYROND 73

3. THE INTERPRETATION OF RESULTS

As one can observe out of Figures 5,6,7 and 8, obtained with the help of the apparatus's printer TALYROND 73, the deviation from circularity, AF_c, has different values in those specific, n, measuring sections; these values can be read on the respective figures (the division = 1 μm).

The most important conclusion, that justifies the present paper, is that that due to these measurements of deviations of circularity, the value of the deviation of cylindrical shape (AF_l) can be highlighted, <u>without any other measurements</u>.

In conformity to the statements from the chapter **Theoretical Considerations**, the deviation from cylindrical shape $AF_l=2(R^*-r^*)$; $R^*$is the highest value of the radius, obtained at circularity measurements (Figure 6) and r* is the lowest value of the radius (Figure 8), these values being obtained in different sections.

4. CONCLUSIONS

Observing Figures 6 and 8, performing measurements, taking into consideration that the value of a division is 1 μm and making the calculus R^*-r^*=2.1 μm, one can easily observe that

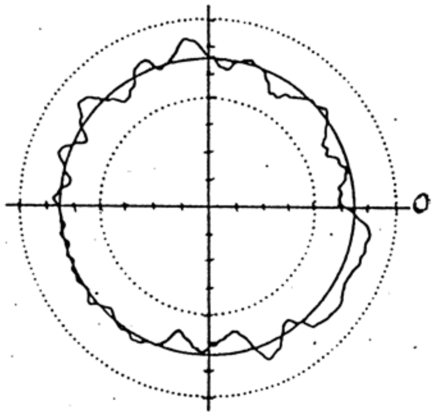

Figure 5 – The deviation from circularity, measured at 25% of the height

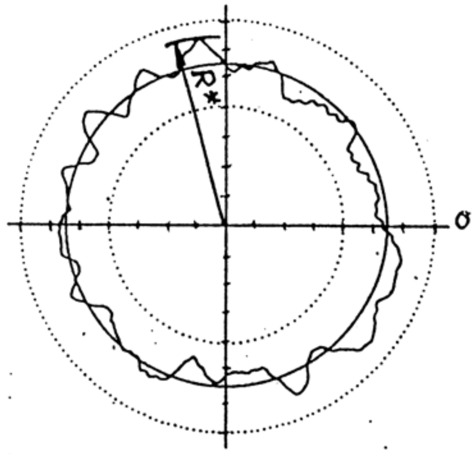

Figure 6 – The deviation from circularity, measured at 50% of the height (observe R*)

$$AF_l = 2(R^*-r^*) = 4,2,\ \mu m$$

The results obtained can be compared to those of researchers from other countries [2], in the respective paper it is shown that after a time of 540 seconds of processing, the deviation from circularity (AF_c) lessens below the value of 10 μm, as it is shown in figure 95, page 185.

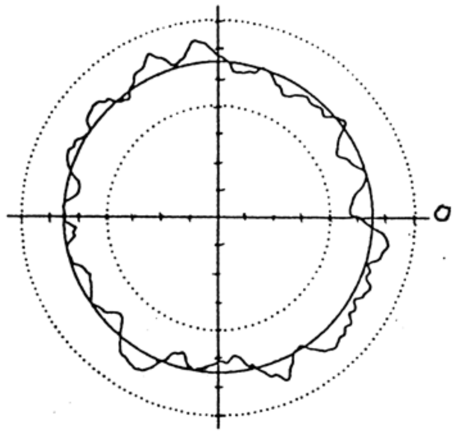

Figure 7 – The deviation from circularity, measured at 75% of the height

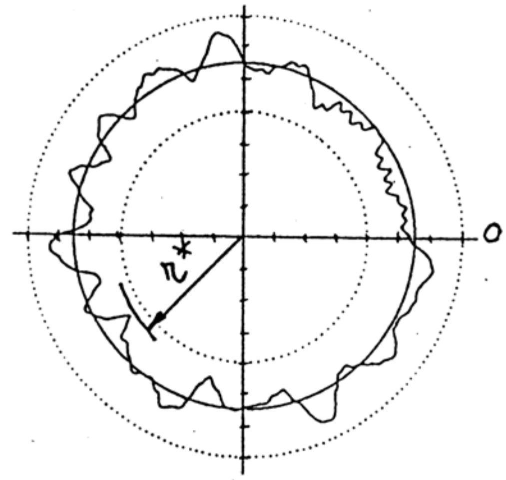

Figure 8 – the deviation from circularity, measured at 95% of the height (observe r*)

Bibliography

1. **Chirila, V.** – *Contributions to the Conceiving, the Design, the Manufacture and theExperimenting of Functional Parametres to a Honing Machine, Dissertation , Iasi 1992*
2. **Tönshoff, T.** – *Formgenauigkeit, Oberflächenrauheit und Werkstaffab- tragbeim Langhubhonen, Dizertation, Dortmund 1970 (Errors of Shape, the Quality of Surface and Output of Honing, Dissertation)*
3. **Chirila, V.** – *Modern Methods of Controlling in Machines Manu- facturing, II^nd part, ISBN 9975-63-069-3, TEHNICA INFO, Chisinau 2001*