GRINDING ROLL BEARING STEEL 100CR6 OF BAINITE STRUCTURE

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ABSTRACT
This paper deals with machinability roll bearing steel 100Cr6 of the bainite structure in the grinding operations. The paper present comparison of grinding process of roll bearing structure of bainite structure and martensite structure of different hardness on the base tool wear, surface quality a grinding forces.
Keywords: bainite, heat treatment, grinding, wear

1. INTRODUCTION
Heat treatment is included in the technology process in production of roll bearing parts. Microstructure of these parts after heat treatment consists of martensite and residual austenite. This heat treatment enables to reach the required properties of roll bearing rings, first of all from the point of view of noisiness, life time, etc. On the other hand, martensite structure is hard but with low toughness, there is relatively strong deformation of shape and dimension first of all of the light bearing rings. The next, residual stresses induced by formation the martensite structure are tensile stresses. Some materials have to be cemented because of low contents of carbon. These materials enable to produce roll bearing rings of hard surface and tough core. The disadvantage of this solution is long term and expensive process.
Nowadays, there is the next progressive solution of the higher mentioned technology from the point of the heat treatment. It is production of roll bearing rings made of 100Cr6 with bainite structure [1]. Hardness of this structure is about 3 to 4 HRC lower that hardness of martensite structure. On the other hand, its toughness is twice higher in comparison with the martensite structure [1]. Generally bainite materials are very progressive [2]. And so, this paper deals with grinding of roll bearing steel 100Cr6 of bainite structure and its comparison with martensite structure through the measurement G – ratio, grinding forces and surface roughness.

2. EXPERIMENTS
Roll bearing material 100Cr6 of dimensions 100x10x50 mm was used in experiments. Heat treatment and mechanical properties of martensite and bainite structure of 100Cr6 is described in [1]. Conventional hardening enables to produce martensite structure of hardness 62 HRC and toughness 23 $J.cm^{-2}$. Hardness of bainite structure is 59 HRC and toughness 55 $J.cm^{-2}$ (cooling in the technical salt 3 hours at temperature 240 ^{o}C). Measurements were carried out on surface grinder BPH 20 with grinding wheel A99 54 J 9 V 250x76x20 – surface infeed grinding with application cutting fluid Emulzin H (2% concentration). Cutting conditions: $v_c = 30$ $m.s^{-1}$, $v_f = 8$ $m.min^{-1}$, $a_p = 0{,}01 \div 0{,}04$ mm.

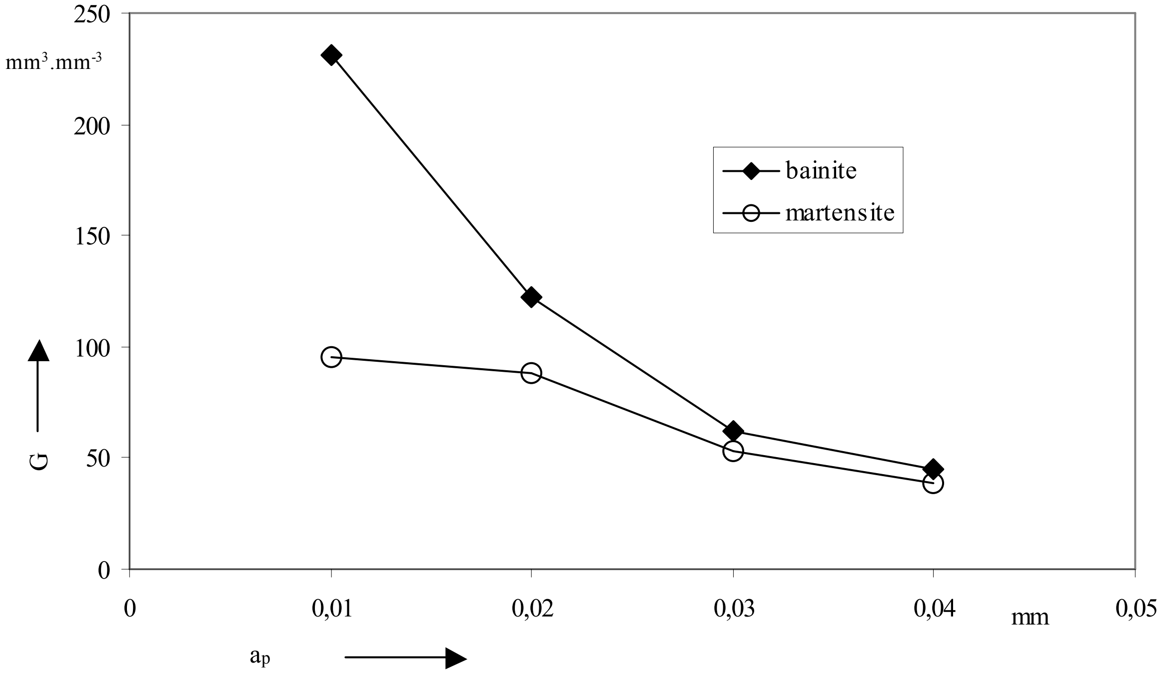

Figure 1. Influence of a_p on G - ratio

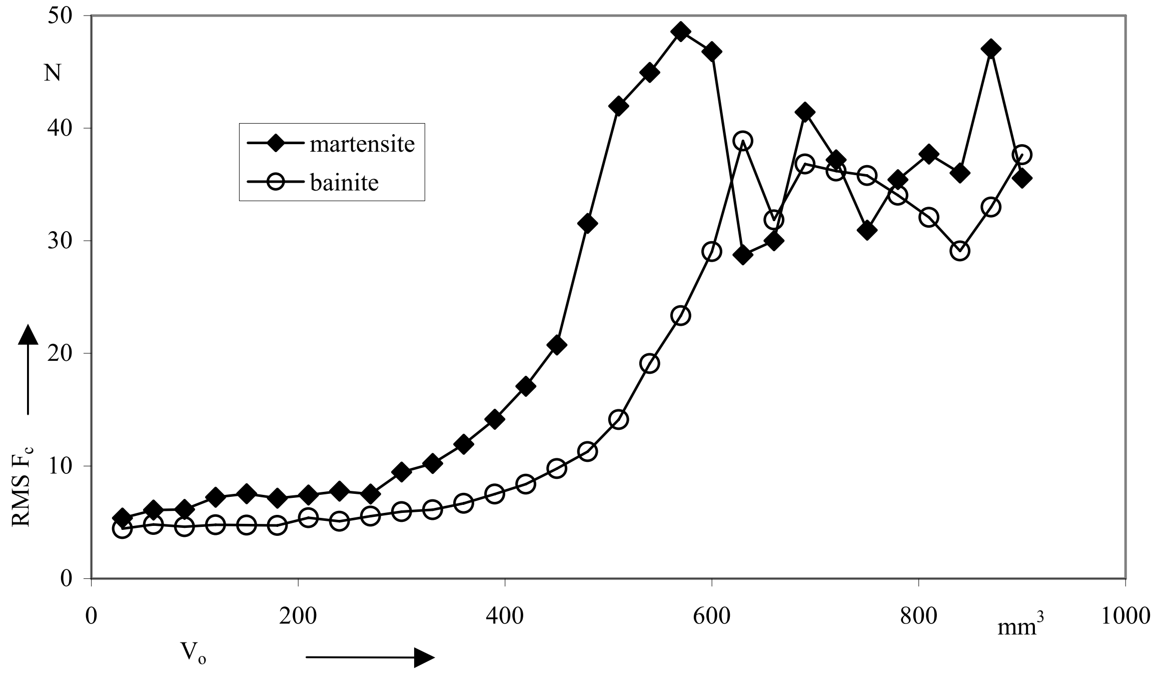

Figure 2. Influence of grinding wheel wear on RMS value of F_c, a_p = 0,01 mm

Figure 1 illustrates that there is a different intensity of grinding wheel wear when grinding martensite in comparison with bainite first of all under the low cutting depth a_p = 0,01 mm (G – ratio is 3 times higher for bainite). This difference is not such significant with application higher cutting depth especially under a_p = 0,03 and 0,04 mm. There is more intensive abrasive effect of the structure of higher hardness in comparison with the bainite structure. Rising of cutting depth leads to rising of temperature in the contact of wheel and workpiece and abrasive effect takes less significant role in comparison with low cutting depths.

Measurement of grinding forces verifies the higher mentioned information. Grinding forces were measured in the certain interval during the grinding wheel wear related to the material removal V_o (material removal per 1 mm of grinding wheel width). Grinding force was analyzed from the point of the static value (frequency up to 10 Hz) and RMS value of the dynamic component F_c (from 10 Hz). Analyze of the dynamic component enable to monitor the grinding wheel wear. RMS value of dynamic component does not change too much after dressing and there is its steep rise in the area of the worn grinding grain [3]. This enables to state dressing interval as value of V_o above which the grinding wheel should be redressed.

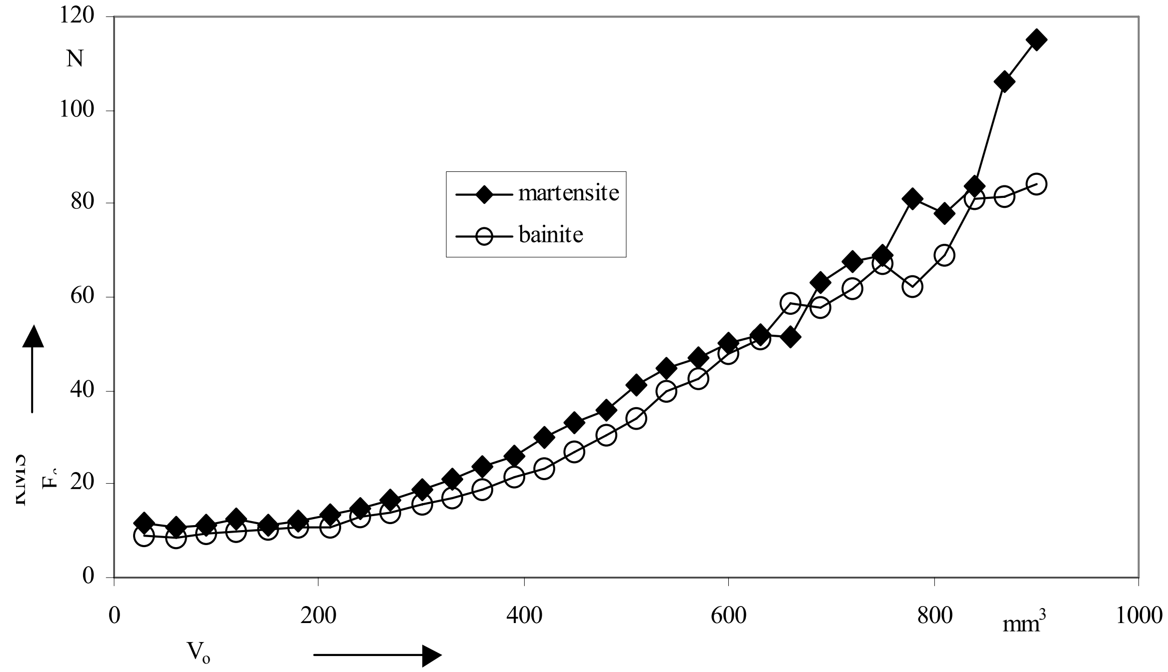

Figure 3. Influence of grinding wheel wear on RMS value of F_c, a_p = 0,03 mm

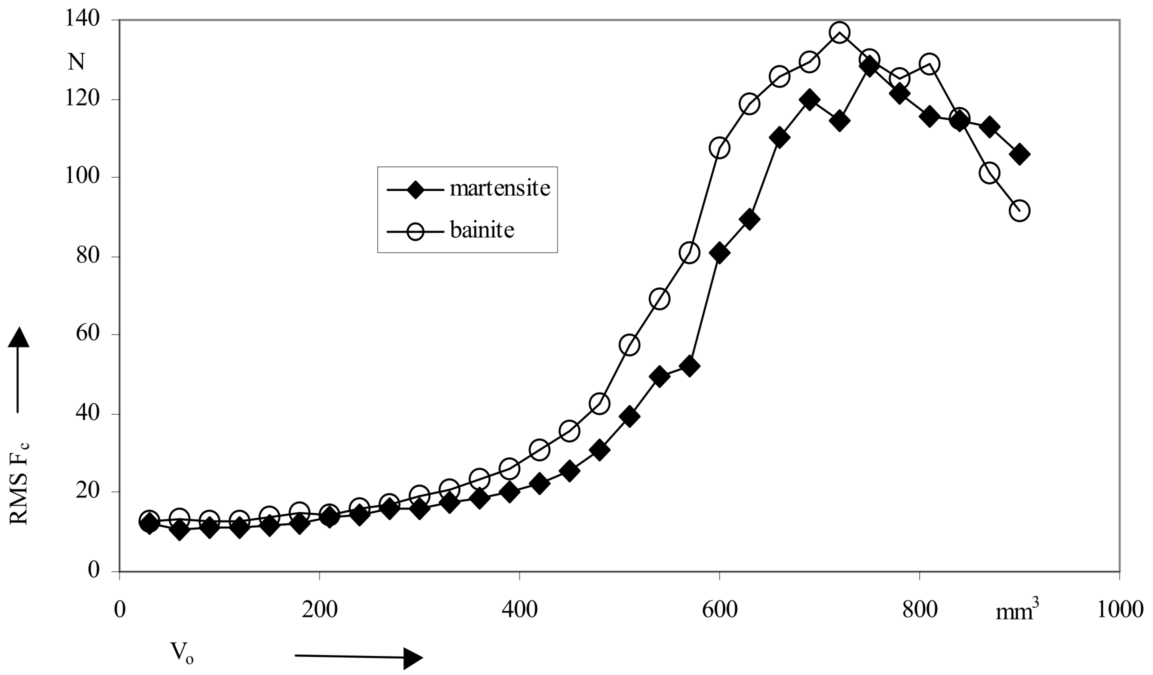

Figure 4. Influence of grinding wheel wear on RMS value of F_c, a_p = 0,04 mm

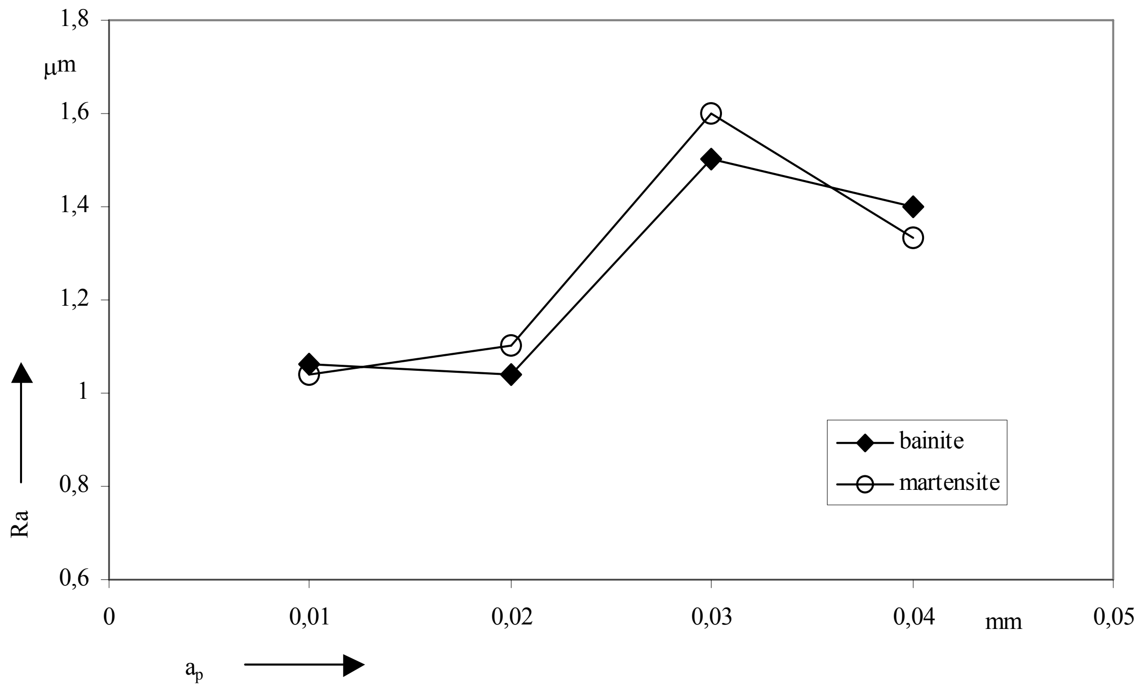

Figure 5. Influence of a_p on surface roughness Ra

3. DISCUSSION OF RESULTS AND CONCLUSION

Figure 2 compare change of RMS value for a_p = 0,01 mm. Dressing interval for bainite structure is longer than that for martensite because of the higher intensity of wheel wear. On the other hand, under the higher cutting depth is process of wheel wear very similiar for both materials (Figure 3, a_p = 0,03 mm and Figure 4, a_p = 0,04 mm). This corelates with measured values of G – ratios.

There are no significant differences between martesite and bainite structure considering surface roughness (Figure 5). Surface roughness rises with rising the cutting depth. On the other hand, diffrent structure can affect required precision of the produced parts and technology process. It is connected with higher thermal deformation of roll bearing rings made after martensite heat treatment. These deformation could affect the allowances for grinding operations or precision after grinding. Allowances for grinding operations should enables to remove deformation caused by heat treatment. There were carried out the measurement of the ovality of the real roll bearing rings (diameter 30 mm) before and after heat treatment. Average ovality after bainite heat treatment is about 0,028mm. On the other hand, average ovality after martensite heat treatment is about 0,11 mm. This experiments enable to mention that there could be smaller allowances for machining operations after bainite heat transfer in comparison with the martensite structure.

4. REFERENCES

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