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Quality control of cast brake discs

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Abstract

The largest industrial application so far have the gray cast irons which are characterized by low tensile and bending strength, while at the same time they have good ultimate comprehensive strength. Additionally, the fatigue strength of gray cast irons is comparatively low and they are only to some extend sensitive for the surface waters effects. Cast iron is the material, which is comparatively easy to be processed, and for this reason – it is not expensive. Brake discs are exploited in particularly hard conditions. They must be resistant both against the thermal fatigue and abrasion wearing (at dry friction) as well as against seizing, corrosion and mechanical load [1-3]. The gray cast iron, better than other materials, fulfills all the requirements necessary for making the material for the casts resistant against such tough conditions. This work reflects the researches aiming to define the quality of cast brake discs (ventilated and non-ventilated ones) upon a period of their exploitation in real conditions. The following researches were performed: evaluations of the disc surface condition, measurement of disc thickness, examination of run – out flank and metallographic analysis. In order to more detailed recognition of mechanisms and reasons of brake discs wearing in real conditions, one should conduct additional examinations: computer analysis of the microstructure, chemical composition analysis, etc., as well as study of the technology of their production in foundries, where they are manufactured [4]. By obtaining the full set of the mentioned above data one can draw final conclusions and remove causes of possible defects.

Keywords: Brake discs, Cast iron, Quality control

1. Introduction

Permanent and high quality products are essential for modern automotive industry. Investigations for improvement quality of vehicles elements are right materials selection and analysis of abrasive wear. Therefore, we can increase wear resistance materials and eliminate factors accelerating wear resistance. Brake disc operates in especially hard condition work. They must be resistant both against the thermal fatigue and abrasion wearing (at dry friction) as well as against seizing, corrosion and mechanical load [1].

The gray cast iron, better than other materials, fulfills all the requirements necessary for making the material for the casts resistant against such tough conditions. Cast iron has: high thermal conductivity, high scuffing resistance, high factor friction and strength of materials, constant size in high temperature and small modulus of elasticity [1].

In case of destruction of working part in abrasive wear with surface oxidation, good results obtains employ grey cast iron with pearlitic matrix.

Graphite has especially influence for dry friction. Excretion of graphite counteracted seizing process of working parts, because graphite has antiseizure properties. [1].

Grey cast iron used on automotive industry in production: brake discs, cylinder liners, machine frames, engine blocks, piston rings, crankshaft, exhaust manifold and distribution shaft cam [5].

Traditional production in automotive industry are brake discs made of grey cast iron. Modern automotive industry used the new materials and technology in production brake discs with aluminium metal -matrix composite. Service life for new modern brake discs with metal - matrix composite reached many kilometres [5].

2. Aim and range of investigation

Main aim of the work was quality control for cast brake - discs (ventilated and not ventilated discs) after period their exploitation in real conditions. Range of investigations contained: measurement thickness of disc, qualification value of run – out flank and metallography analysis.

Quality controls of cast brake discs were for two brake discs made of cast iron (ventilated and not ventilated discs). Course for disc ventilated carried out 85 000km, and for disc not ventilated 70 000km.

3. Results and analysis

3.1. Measurement of thickness of working part

Investigation of measurement thickness for working part brake - discs effected at help of slide calliper with exactitude 0, 1 mm. Producers nominal data thickness for examined working part brake - discs represent as follows: for not ventilated disc value in range 10,8-11,1 mm and for ventilated brake disc value in standard 24 mm.

After investigation of measurement thickness for real work part brake disc value represent as follows: for not ventilated disc average result in range 9,8 mm and for ventilated brake disc average result were 23,5mm. Minimum thickness admits value of data producer for ventilated brake disc 9,55 mm and for not ventilated brake disc 23 mm.

Values of thickness for examined disks still were situated in minimum value for description producer.

3.2. Run – out flank

Examination realised with employed turning lathe and position sensor. Accuracy of measurement was for position sensor with exactitude 0,01 mm. Figure 1 show the idea of control run – out flank for brake disc.

Results of investigations were following:

- run – out flank 2,4 mm for not ventilated brake disc,
- run – out flank 0,6 mm for ventilated brake disc.

Unacceptable level of run- out flank was for ventilated brake disc (for working data carmaker). Unacceptable level of run- out flank was for not ventilated brake disc (for working data carmaker), too.

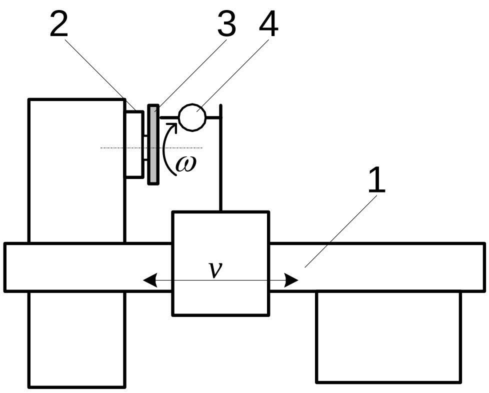

Fig. 1. Idea of control runs – out flank for brake disc: 1-turning lathe, 2 – lathe chuck, 3 – brake disk, 4 – position sensor

3.3. Metallography analysis

Figure 2 shows scheme of specimens from brake discs (with marks). The metallographic specimen etched in NITAL. The picture showed below (fig. 3 – 8) microstructure for not ventilated and ventilated brake discs. Metallographic microscope Nikon OPTIPHOT for metallographic analysis was used. After metallography analysis describes shape and graphite distribution in accordance with [6]. For ventilated brake disc graphite morphology was: 60% I A + 40% II A. For not ventilated brake disc graphite morphology was: 75% I C + 25% II C. MultiScanBase13.01® computer programme for measurement length flake graphite and interlamellar spacing λ [7] was used. Mean length of flake graphite was 131,916 μm for not ventilated brake disc. For ventilated brake disc mean length of flake graphite was 77,099μm. Average interlamellar spacing λ for not ventilated disc was 39,953μm, for ventilated brake disc mean interlamellar spacing λ was 27,383μm. Analysis of microstructure showed much inhomogeneity of microstructure. The matrix consisted with pearlite for ventilated brake disc. For not ventilated brake disc observed pearlite with ferrite.

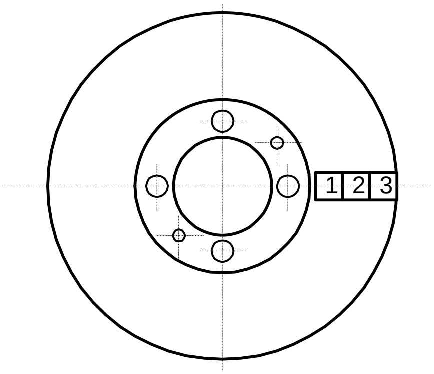

Fig. 2. Scheme of specimens from brake discs (with marks)

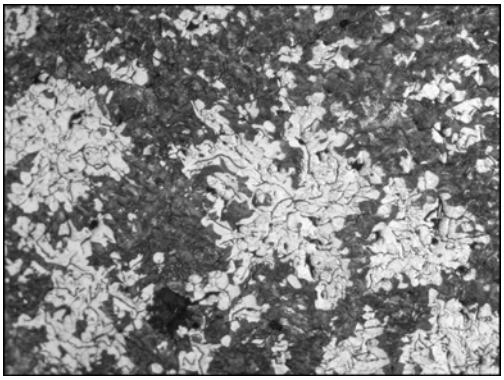

Fig. 3. Microsection of specimen number 1, etched in Nital, magnification 100x, (for not ventilated brake disc)

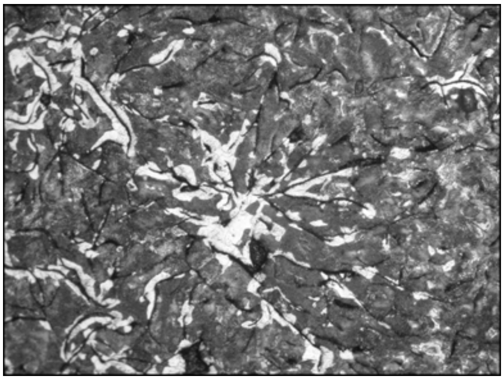

Fig. 4. Microsection of specimen number 2, etched in Nital, magnification 100x, (for not ventilated brake disc)

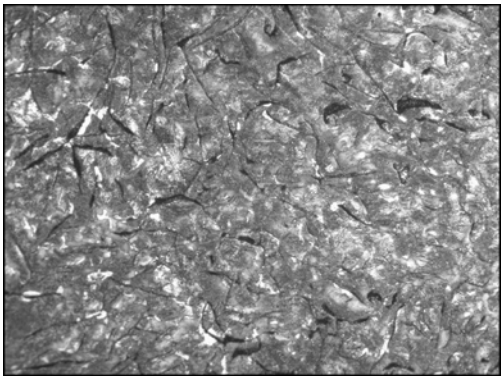

Fig. 5. Microsection of specimen number 3, etched in Nital, magnification 100x, (for not ventilated brake disc)

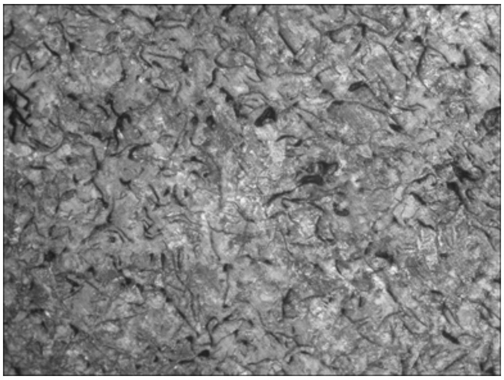

Fig. 6. Microsection of specimen number 1, etched in Nital, magnification 100x, (for ventilated brake disc)

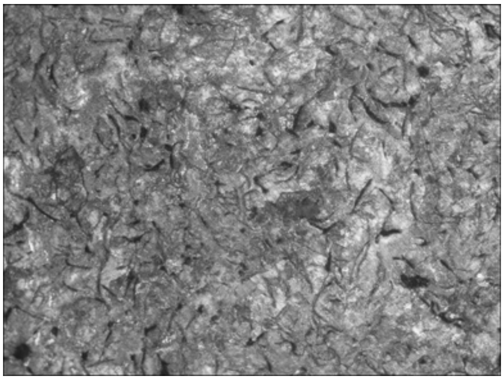

Fig. 7. Microsection of specimen number 2, etched in Nital, magnification 100x, (for ventilated brake disc)

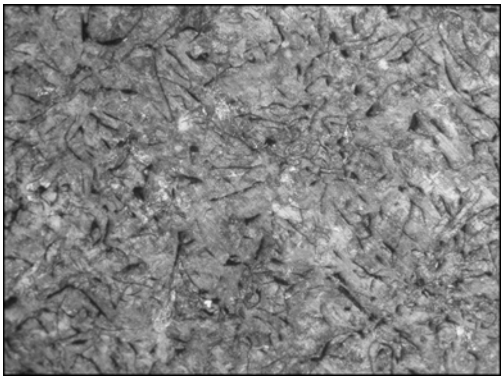

Fig. 8. Microsection of specimen number 3, etched in Nital, magnification 100x, (for ventilated brake disc)

Figure 9 shows scheme of metallography analysis for perpendicular samples to working surfaces of brake disc.

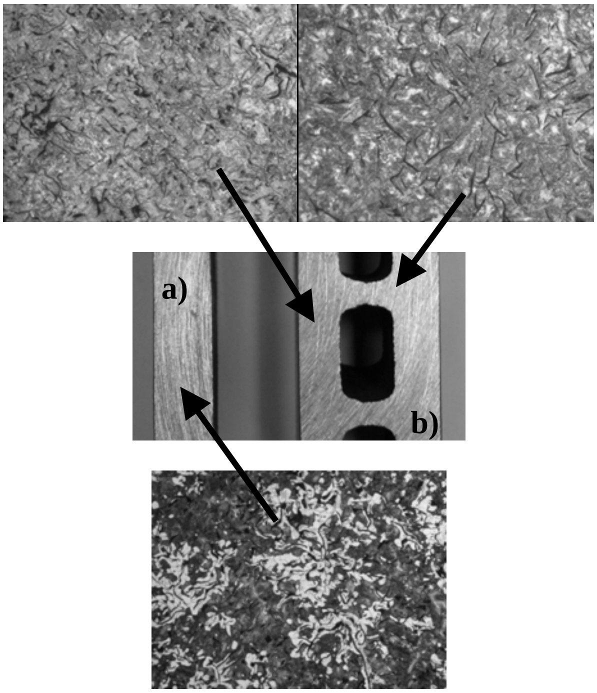

Fig. 9. Cross sections to working surface of brake disc for not ventilated brake disc a) and ventilated brake disc b), etched in Nital

4. Conclusions

Analysis of microstructure showed much inhomogeneity of microstructure. Average length of flake graphite was 131,916 µm for not ventilated brake disc. These results are disadvantageous [8]. For ventilated brake disc mean length of flake graphite was 77,099µm. The result is better than for not ventilated brake disc.

The matrix consisted pearlite for ventilated brake disc. For not ventilated brake disc was observed pearlite with ferrite.

Influence on rapid wear for not ventilated brake - disk has inhomogeneity of matrix microstructure.

Brake disc after worked was non-uniform wear. Non – uniform wear caused deformation of stability of dimension for brake disc. Further using for standard of security was prohibited.

In order to more detailed recognition of mechanisms and reasons of brake disks wearing in real conditions, one should conduct additional examinations (chemical composition analysis, etc.), as well as study the technology of their production in foundries, where they are manufactured. By obtaining the full set of the mentioned above data one can draw to final conclusions and remove causes of possible defects. Conditions for production of iron casting and influence for abrasive wear was presented in work [8].

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