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DETERMINATION OF THE PROPERTIES OF WHEEL TYRE METAL OF RAILWAY ROLLING STOCK IN CROSS-SECTIONAL VIEW

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Summary. The article presents the results of experimental investigations directed at study of tyre metal properties with destructive methods. Hardness and microstructure have been differenced in cross-sectional view by hardness and grain size.

Key words: wheel pair, tyre, hardness, microstructure, chemical composition.

INTRODUCTION

Rail transport is one of the most important branches of economics activity of which is directed at support of internal and external transport relations [Myamlin 2006]. Safety of train operation depends much on reliable functioning of the assemblies and transport means. It is ensured by stable and optimal level of metal mechanical properties, as well as soundness of metal. Required level of mechanical properties of assemblies and components is provided by chemical composition of steel and structure after thermal treatment.

Locomotive wheel pairs take and transfer weight of body and bogies with all equipment on rails, as well as dead weight. While moving wheel pair interacts with rail gauge, takes up shocks caused by track irregularities and guiding forces. Wheel pair, in its turn, rigidly reacts on track. In addition, traction motor torque is transmitted to it, tractive and braking forces are realized in place of contact of wheels with rails. Magnitude and nature of effect of static and dynamic forces depend on conditions of operation and rail track state, design and parameters of locomotive underframe.

Thus wheel pair is one of critical assemblies of underframe on state of which train operation safety depends. Therefore special demands are made to the material choice, manufacturing of separate elements and formation of wheel pair [Filonov 1996].

Taking into account complicated working conditions and high requirements to the operational dependability, wheel tread surface should possess high strength, impact toughness and wear resistance, whereas metal of wheel disk and hub is to have required toughness. Compound wheels meet these requirements, where tyre can be made of high-strength and dead-hard steel, whereas wheel center – of more ductile and cheap steel.

Upon reaching limiting wear or appearing of another operational damage a tyre can be replaced without change of a wheel [Lukin 2000].

Tyres directly interact with rails. Main characteristics of tyres defining their quality and service durability are strength and hardness of tyre body and flange. The higher strength and hardness are, the higher wear resistance is. Therefore tyre material should possess high strength to resist wear and crumpling, and should be tough enough to resist impact loads [Filonov 1996].

During locomotive operation tyre wear occurs over wheel rolling circle. So the metal earlier contained inside the tyre will appear on the surface of the used tyre, and this metal will work in conditions of contact with rails and brake shoes. That’s why metal in sectional view must meet technical requirements of normative documents.

At present tyres are produced for railway rolling stock in accordance with standards. Tyres are manufactured of 2 grade steel for passenger, freight and shunting locomotives, driving motor cars, diesel-powered trains and transit vehicles. Chemical composition is specified in table 1.

Table 1. **Chemical composition of tyres made of 2 grade steel**

Content of elements, % by weight					
C	Si	Mn	V	P	S
				not more than	
0.57-0.65	0.22-0.45	0.60-0.90	up to 0.15	0.035	0.040

Total content of sulfur and phosphorus must not exceed 0.065%. Permissible content of molybdenum is not more than 0.08%, nickel – not more than 0.25%, chromium – not more than 0.20%, copper – not more than 0.30%.

One of the evaluation parameters for metal properties is Brinell hardness. Hardness is measured by a sphere 10mm at a load 29430N on a transverse template on the basis of mean value of three measurements at a depth 20mm and three measurements at a depth 40mm from a tread surface. Hardness measurement is fulfilled on the flange in one point.

While manufacturing high speed railway rolling stock and for the purpose of providing safe operation on the railways there appeared a task to improve ultrasonic nondestructive test of wheel pair elements.

Metal inhomogeneity (inhomogeneity of chemical composition, structure) exerts influence on the quality of ultrasonic control. It influences stability of acoustic properties, first of all of acoustic vibration speed, damping coefficient, it results in an uneven sensitivity, and errors of defect coordinate measuring.

RESEARCH OBJECT

The objective of the present work is to determine tyre metal properties of railway rolling stock in cross-sectional view.

The following tasks were set to achieve the stated objective:

- to manufacture the templates from a suitable tyre;
- to carry out investigation of tyre’s chemical composition, hardness and microstructure in cross-sectional view;
- to perform an analysis of metal homogeneity by the results of investigation of chemical composition, hardness and determination of microstructure.

The object of investigation. Tyre of a locomotive wheel pair.

The subject of investigation. Metal of locomotive wheelset tyre.

Methods of investigation. For the purpose of solution of the assigned tasks there were conducted experimental investigations of metal homogeneity by methods of chemical analysis, Brinell hardness test and microanalysis using the samples made of reproduced heat-treated tyres before their service.

RESULTS OF EXPEREMENTAL RESEARCH

Metal hardness was measured by a sphere 10mm at a load 29430N on the transverse templates according to a scheme (fig. 1). Fig. 1 also contains the results of determined hardness for one of the test specimens.

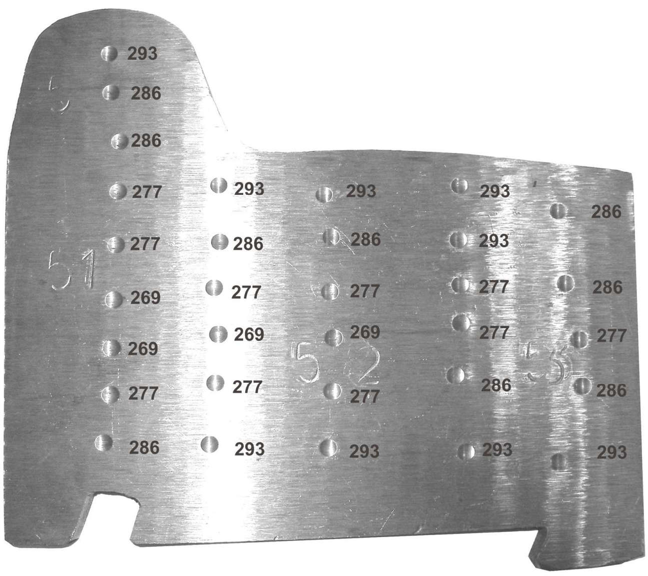


Fig. 1. Location of hardness measurement sites and the results of determined hardness (HB) in a cross-section of tyre

Hardness determination by a cross-section of tyre samples has shown that flange and layer beneath the tread surface have maximum value of hardness. Maximum difference between the hardness values reaches 24 HB in one cross-sectional view on the separate samples. Maximum value of flange hardness doesn’t exceed 302 HB in the samples under investigation, difference in the flange hardness values – 16 HB, difference in the hardness values of a layer beneath the tread surface – 16 HB. All hardness values of the tyres under investigation comply with technical demands standards.

Determination of chemical composition of tyre metal was carried out in the cross-sectional view with the help of a vacuum spectrometer according to ten chemical elements specified in the scheme standard (fig. 2).

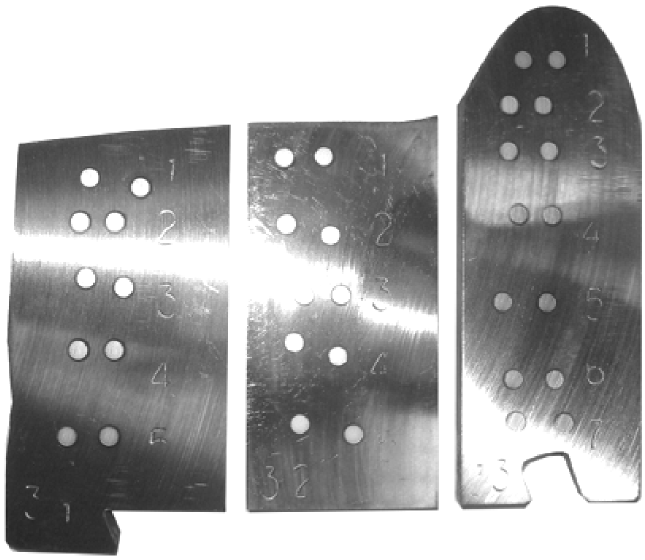


Fig. 2. Positions of tyre's determined chemical composition

Determination of chemical composition of tyre steel under investigation in the specified places has shown that absolute discrepancy of the parallel determination results at a confidence probability P = 0.95, for the determined chemical elements does not exceed a value of permissible discrepancies for the appropriate interval of mass fraction. Chemical composition of the tyres under investigation conforms to 2 grade steel. Changes of chemical composition in a tyre cross-sectional view comply with technical demands of standard. Characteristic dependence of chemical composition distribution is not found in a cross-sectional view.

Determination of inhomogeneity of tyre metal grain size in a cross-sectional view was carried out on the sections made of the layer beneath the tread surface, central zone of a tyre and lower layer at a surface of mating with wheel center.

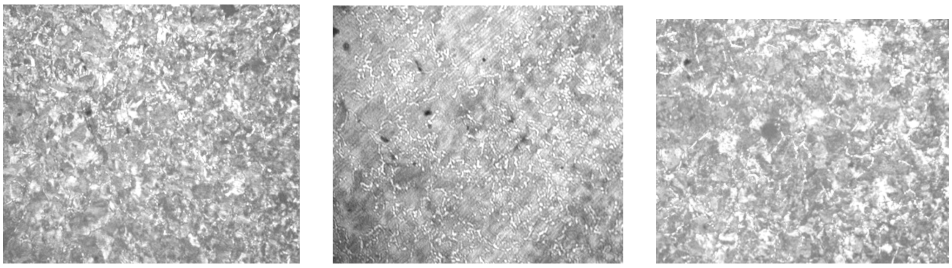
Manufactured microsections of specimens were reviewed after the etching in a 4% percent alcoholic solution HNO_3 on the microscope at increase ×100.

Fig. 3 presents microstructure of tyre metal in a cross-sectional view:

a) layer beneath the tread surface – sorbit with small ferrite streaks, small-grained and medium-grained (fig. 3 a);

b) central zone of tyre – sorbit with small ferrite streaks, inhomogeneous: along with medium grains there are coarse grains (fig. 3 b);

c) layer at a mating surface of tyre and wheel center – sorbit with small ferrite streaks, inhomogeneous: along with small and medium grains there are coarse grains also (fig. 3 c).



a b c

Fig. 3. Microstructure of a layer beneath the wheel tread (a), central zone of tyre (b), layer at a surface of mating with wheel center (c)

SUMMARY

1 Change of metal hardness is found in a cross-sectional view of tyre. Hardness value is within standard norms.

2. There is differenced microstructure of layer beneath the tread surface, central zone and layer at a surface of mating with wheel center.

3. Characteristic dependence of chemical composition distribution is not found in a cross-sectional view.

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ОПРЕДЕЛЕНИЕ СВОЙСТВ МЕТАЛЛА БАНДАЖЕЙ КОЛЕСНЫХ ПАР ПОДВИЖНОГО СОСТАВА ЖЕЛЕЗНЫХ ДОРОГ В ПОПЕРЕЧНОМ СЕЧЕНИИ

Басов Г.Г., Киреев А.Н., Лысак Д.В.

Аннотация. В статье представлены результаты экспериментальных исследований свойств металла бандажей разрушающими методами. Установлено различие твердости и микроструктуры в поперечном сечении по твердости и величине зерна.

Ключевые слова: колесная пара, бандаж, твердость, микроструктура, химический состав.