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WEAR TEST OF BRAKE CLOGS MATERIALS

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Abstract: The work presents the results obtained with regard to the tribological behavior of materials intended for the manufacture of brake blocks for motor and towed rolling stock. A composite material was developed for making clogs. On the resulting samples, determinations of wear parameters were made using the wear test installation on steel plate. In order to compare the results obtained, the tribological research was also carried out on samples of phosphorous cast iron type P10, the classic material of the brake clogs.
Keywords: composite, organic materials, cast iron, resistance to wear, brake clogs

1. INTRODUCTION

In order to reduce noise pollution generated by rail traffic, passive measures at the site of disturbance and active measures at the noise source may be applied. The most important source of noise is rolling noise, which affects all types of train. Source-oriented measures reduce noise throughout the rail system. The problem of noisy rail freight wagons can be reduced by replacing cast iron brake blocks with composite brake blocks. The industry has developed several types of composite brake blocks in order to replace conventional cast iron brake blocks, which are the main source of rail and wheel roughness and rolling noise [1-3]. The fitting of existing railway freight wagons with K or LL brake blocks is the most cost-effective measure for vehicles [4]. The installation of the K clogs on the existing wagons requires modifications to the braking system, these being recommended to be used in new vehicles and the installation of LL clogs on the existing wagons does not require major modifications to the braking system, these being recommended to be used in old vehicles in operation. Retro-equipment leads to investment costs between 200-700 million euros (LL clogs) or 1.0–1.8 billion euros (clogs K) and additional maintenance costs of 200-400 million euros (cumulated until 2025, for both technologies) at European level [5-7]. The European Commission recommends obtaining composite materials for high-quality brake blocks in order to significantly reduce costs and noise. Classic brake blocks are made of cast iron. The technical quality conditions and the main dimensions of the P10 phosphorous cast iron brake clogs, intended for the rolling stock engine and towed by the railway with the normal track gauge, are specified in the Tender Book No.1/SFMR/SDT/2000/Brake blocks for motor and towed rolling stock, endorsed by the Railway Authority Romanian [8]. The European Commission and experts [5, 9-10] recommend obtaining composite materials for high-quality brake blocks in order to significantly reduce costs and noise.

2. EXPERIMENTAL PART

Taking into account the advantages of composite materials for the manufacture of brake blocks [1, 9,10], their behavior in operation compared to those produced from phosphorous cast iron, laboratory-phase experiments were carried out on obtaining composite materials for the brake blocks of the rolling stock. In order to test the composite materials, cylindrically shaped test tubes were produced, their dimensions being chosen according to the characteristics of the experimental testing facilities. In Figure 1 are presented the components of the press used to form the test tubes of composite material.

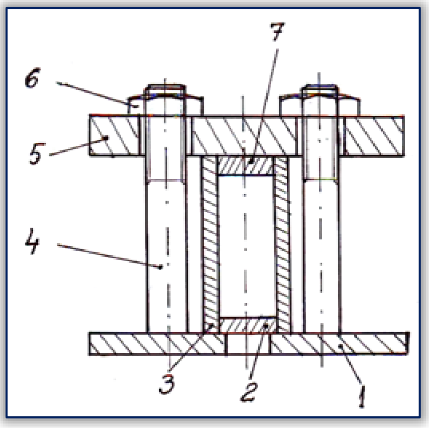

Figure 1. Press for the formation of test tubes of composite material: 1 - the motherboard; 2 - pill for extracting the sample; 3 - cylindrical body; 4 – stud for pressing; 5-top plate; 6 - nut; 7 - pill for pressing

When elaborating the technology of obtaining the composite material test tubes, it was taken into account the establishment of the technological parameters of the process, the order and the way of adding the components in the experimental recipes. Samples of composite materials were produced using the following components: brass powder, aluminium powder, graphite, carbon fibre, hexamethylenetetramine and novolac. The composition of the recipes of the samples from the composite material is shown in Figure 2. Experimental samples obtained from composite materials are shown in Figure 3.

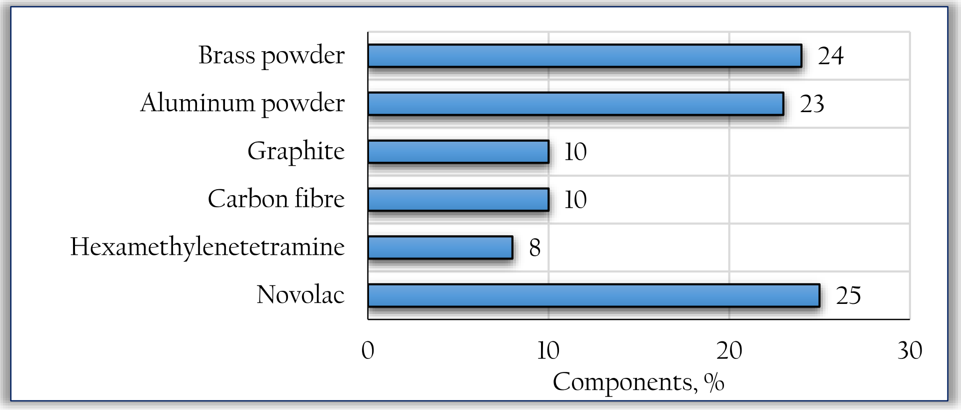

Figure 2. Composite sample recipe component

Figure 3. Experimental specimens made of composite material

For comparison with phosphorous cast iron, the classic material of brake clogs, cast iron test-iron test tubes of the P10 type were produced. Cast iron was developed in an induction furnace of 10 kg capacity (figure 4). The metal load was made up of cracks of cast iron clogs for the formation of slag, a mixture of lime and bauxite was used and the melting time of the load was 75 minutes. The temperature was measured with an optical pyrometer and a thermocouple. After measuring the temperature, cast iron was poured into molds to obtain the test tubes.

Before discharge from the furnace, a sample was taken to determine the chemical composition as shown in Table 1.

Table 1. The chemical composition of the cast iron

The chemical composition, %(wt)						
C	Si	Mn	P	S	Cr+Mo+Ti+W+V+Nb	1.72%S + 0.30% < %Mn < 1%
3.12	1.93	0.87	1.02	0.065	0.257	0.411% < 0.87% < 1%

Figure 4. Preparation and casting of cast iron samples

The samples (cast iron and composite material) were prepared to determine the wear resistance characteristics using: the test plant for abrasive wear on steel plate.
For the determinations of the wear parameters, the use test plant of the test-test of the experimental test tubes (cast iron and composite material) on the steel plate (S 355 JR) was used. Test parameters:
- the tangential sliding speed of the test tube has the average value Va = 0.209 m/s;
- the length of the spiral wear path results from the composition of the two movements (rotation and advance) and has the value of 70 m;
- fixing the test tube ensures a perpendicular position on the surface of the rotating disc, with a deviation below 2°;
- the test tube has a cylindrical shape with dimensions of ø 14 x 30 (mm);
- the pressure of pressing the test tube on the steel disc is 0.4 N/mm2;
- the length of the spiral path ensures a measurable mass wear at an analytical balance with an accuracy of 0.001 g.

The results of the measurements obtained on the end-of-life test facility (Figure 5) are given in Table 2.


Figure 5. Test of abrasive wear on the steel plate of the test-pieces

Table 2. Measurement results in the steel disc test of the test-pieces

Test tube	Initial mass of the test tube m_0, [g]	Final mass of the test m_f , [g]	Initial length of the test tube l_i, [mm]	Initial length of the test tube l_f , [mm]	Test time t, [min]	Mass wear $u = m_0 - m_f$, [g]	The course of wear Lu, [m]
Composite material	8.267	8.259	30.3	30.25	7.08	0.008	70
Phosphorous cast iron	31.205	31.204	30.25	30.24	7.08	0.001	70

Analysing the results it is observed that the mass wear is higher in composite material samples compared to phosphorous cast iron samples. In industry, in the exploitation of machines and equipment, in transports there has appeared the growing need to reduce or control wear, for several reasons, namely: extending the life of machines / products, manufacturing more efficient products, developing new advanced products, conserving limited material resources, saving energy and improving safety. These objectives were most often achieved only through dimensional changes, by selecting more advanced materials or by heat treatments. The quality of the surfaces of the elements of a friction coupling, made by various technological processes, is sometimes essentially different from the quality of the surfaces, after a few hours of operation during which the elements of the coupling are subjected to relative movement and contact pressures.

3. CONCLUSIONS

The knowledge of the functionally optimal microgeometry of the coefficient of friction, the temperature in the contact area and of the intensity of wear, gives the possibility of pertinent assessments regarding the durability in operation of the material intended for the manufacture of the brake shoe. Cast iron brake clogs provide a coefficient of friction almost independent of atmospheric conditions and the properties of the material are independent of the manufacturer.
The implementation of UIC rules for the reduction of noise on the track leads to action being taken regarding rolling noise. Newly built rolling stock shall comply with these standards. In the case of rolling stock in operation, cast iron brake clogs can be replaced with composite brake blocks, but a number of technical problems still need to be resolved. The composite material must provide a coefficient of friction capable of guaranteeing the specified stopping distance in all weather conditions. By replacing cast iron brake clogs with composite material clogs, a number of advantages are obtained: a constant and higher coefficient of friction than conventional ones, low expenses with the adjustment of the braking system, lower weight of the sabotage, similar values for wheel wear, wear resistance greater than about 5 times, it does not emit toxic brake powders and reduces noise by about 50%.

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