*hamowanie, długość drogi hamowania test hamulców, klocki hamulcowe, współczynnik tarcia, kompozytowych klocków*

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# TESTING OF COMPOSITE BREAK BLOCKS OF THE TYPE LL

*The aim of this paper is to compare the composite brake block LL with traditional cast iron type P10 used largely for freight wagons. Properties of friction materials of aforesaid block types have a significant impact on the braking of railway vehicles. The result is the evaluation and comparison of friction characteristics on the basis of braking distances for various speeds and weight of the wagon.*

# TESTOWANIA KOMPOZYTOWYCH KLOCKÓW TYP LL

*Celem niniejszej pracy jest porównanie kompozytowych klocków hamulcowych typu LL z tradycyjnymi klockami z żeliwa typu P10 stosowanych głównie do wagonów towarowych. Właściwości materiałów ciernych klocków mają istotny wpływ na hamowanie pojazdów szynowych. Resultatem jest ocena i porównanie cech tarcia na podstawie drogi hamowania dla różnych prędkości i mas wagonu.*

## 1. INTRODUCTION

The claims on the overall operational reliability of railway vehicles rise with the increase in the number of kilometres newly reconstructed tracks and with the increasing of operating speeds at the new and upgraded vehicles. The basic condition for safe operation of these vehicles is reliable and effective braking system. Brake blocks are the most important part of the braking system, which aim is to create a braking effect by friction.

Cast iron is the most common friction material of the block brakes used for freight wagons. It performs with its properties the requirements to operate vehicles only to a certain speed. Declining value of the blocks friction coefficient advert to an application inadvisability of the cast iron at higher speeds, since they induce an undesirable prolongation of the stopping distance and the increase of the brake blocks wear. This unwelcome fact as well as high level of noise during the braking evoked an interest in the development and manufacture of new friction materials. Smoother surface of the wheel tread, better operating properties in braking and lower values of noise emissions can be

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achieved by replacing of existing cast iron blocks for the composite braking blocks. Consequently the demands on practice of the tests on brake test benches or directly driving tests on the track rise.

The paper present analyze of test results from the measurement of the cast iron blocks and composite brake blocks in real rail operations.

## 2. DESCRIPTION OF TESTED BLOCKS

Compared block CoFren C952 / 1 is metal-ceramic composite block LL categorie based on iron with addition of friction modifiers. Properties of this material are: good stability of the friction coefficient, low thermal sensitivity and high resistance against wear of the material. Braking noise reduction, which cast iron blocks create by the increase of friction values at the end of braking, is also a benefit of this material. Four to fifth times higher lifetime of composite blocks compared to blocks of cast iron is another advantage of composite blocks. The course of the friction coefficient of CoFren C952 / 1 block during braking is evident from Fig. 1. The disadvantage of this material is lower thermal conductivity resulting in greater thermal stress of the railway wheel tread [5]. This helps to the formation of inclusions on the block friction area and subsequent to the damage of wheel tread. This disadvantage is suppressed by a higher content of metallic powders in metal-ceramic composite blocks.

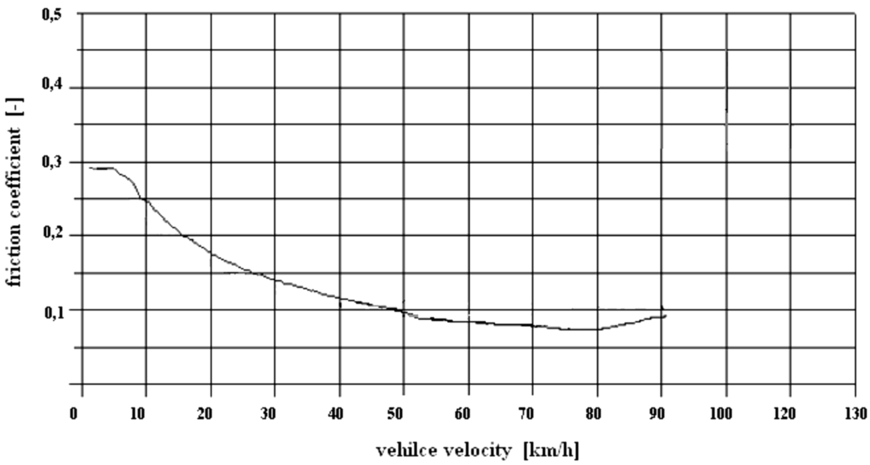


*Fig. 1. Friction coefficient course of the brake block CoFren C952 / 1 depending on the speed after 4 seconds from the braking start, contact force 60 kN [3]*

Block GG (P10) is made from cast iron containing 1.0% of phosphorus. This type of block is cheap and available. It ensures uniform heat dissipation during braking. Its disadvantage is the higher noise level, creating of sparks during braking and higher brake blocks wear. This is linked with a higher burden of environment by noise emissions and solid particles [4]. When braking from higher speeds there is an undesirable extension of the stopping distance, due to declining course of the friction coefficient, as seen in Fig. 2.

Both friction characteristics of blocks shown in Fig. 1 and Fig. 2 were obtained from tests on the brake test bench KKVMZ Žilina University, Department of Transport and handling equipment. Measurements were made in the frame of the solving of diploma thesis aimed to compare the results from brake test bench with tests on the track.

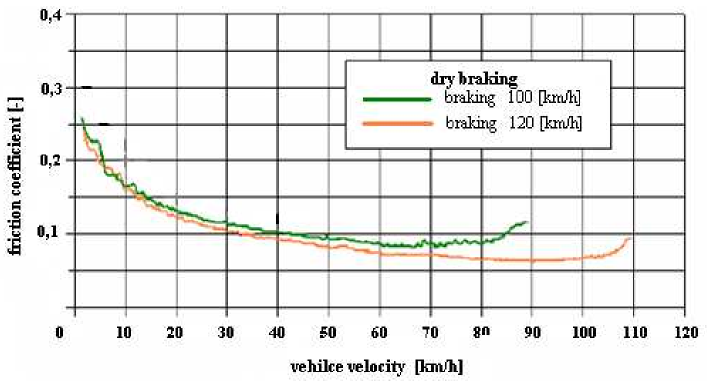


*Fig. 2. Friction coefficient course of the brake block P10 depending on the speed after 4 seconds from the braking start, contact force 60 kN [3]*

## 3. DESCRIPTION OF BRAKING TESTS ON TRACK

For the comparison of mentioned blocks on the real track were made braking tests on a straight line of ZSR with a slope of 0 ‰. The tests carried out by Railway Research and Development Institute. The evaluation of the stopping distances was done on the basis of data from these tests published in [1]. The aim of the tests carried out to compare the measured values for cast iron brake block GG (P10) and composite brake block LL (C952 / 1) at stopping distances in operation. The precise measurement of actual initial speed at the time of the beginning of a quick-acting braking and also accurately measurement of stopping distances are a prerequisite for the correct determination of braking effect [2]. Measuring set containing the measuring wagon and tested vehicle was used in the test. Measurements carried out on the freight wagon Eas shown in Fig. 3, which was disconnected from the assembly using electro pneumatic coupler. The release of this coupler is controlled remotely, whereas the measuring car and the locomotive are permanently coupled. Disconnecting and braking of the test vehicle must not affect the brake of the rest of the assembly. It is necessary to measure actual speed, speed at disconnection and after stopping also braking distance.


*Fig. 3. Goods wagon Eas with a measuring device.*

The actual test was preceded by preparation of the test vehicle and blocks. Test preparation included a running-in of individual brake blocks on the ground to achieve the best results of contact area. Each block was marked during the type exchange, to ensure that after the next exchange each of the blocks returned to the same place where they were run. Contact surfaces lubrication of the vehicle was another part of the preparation. The entire brake system was checked and adjusted. The test was performed on average worn wagon. The arrangement of the blocks on the brakes was 2xBg. The test consisted of two types of measurements for GG blocks (P10) and LL blocks (C952 / 1). The first series of the measurements was realized for each type of block from the speed of 120 km/h, for load 22.8 tons, which corresponded to the weight of the empty wagon. The second series of measurements was conducted for each type of block from the speed of 100 km/h with a load of 22.8 + 55.973 = 78.773 t. The concrete blocks with an average weight of approximately 1050 kg were used during the test as a load.

**3.1 Processing of measured data**

Test course was carried out with a wagon loaded to the prescribed weight. The wagon was disconnected from the measuring wagon after it achieved the required speed. The stopping distance to its full stop was monitored. Consequently, the traction unit with the measuring wagon returned for the disconnected car. In order to achieve the maximum down force on the brake block was considered a brake cylinder filling time of 4 seconds. The course of measured values in graphs and tables correspond to this fact.

**The first series of measurements**:
Wagon weight: 22,8 t
Wagon speed: 120 km/h

*Tab. 1. Measured values for the brake block LL (CoFren C952 / 1) – braking from speed of 120 km/h*

| LL (CoFren C 952/1) | | | | | | |
|---|---|---|---|---|---|---|
| Measurement number | | | 1 | 2 | 3 | 4 |
| Vehicle speed in disconnecting | v | [km/h] | 117,7 | 118,5 | 118,9 | 120,6 |
| Speed after 4 seconds | $V_2$ | [km/h] | 106,88 | 106,99 | 108,03 | 110,34 |
| Braking distances after 4 seconds | $L_2$ | [m] | 560,22 | 559,68 | 562,52 | 565,41 |
| Braking distances | L | [m] | 680 | 695 | 698 | 735 |
| Pressure in the brake cylinder | $p_c$ | [bar] | 1,3 | 1,3 | 1,3 | 1,3 |
| Thrust force | $F_{bm}$ | [kN] | 6,75 | 6,69 | 6,71 | 6,56 |
| Ambient temperature | T | [°C] | 18,5 | 18,7 | 19,1 | 14,6 |
| Average braking distances | L | [m] | 702 | | | |

*Tab. 2. Measured values for the brake block GG (P10) - braking from speed of 120 km/h*

| GG (P10) | | | | | | |
|---|---|---|---|---|---|---|
| Measurement number | | | 1 | 2 | 3 | 4 |
| Vehicle speed in disconnecting | v | [km/h] | 117 | 118,9 | 118,2 | 121,1 |
| Speed after 4 seconds | $V_2$ | [km/h] | 114,12 | 114,88 | 113,68 | 117,52 |
| Braking distances after 4 seconds | $L_2$ | [m] | 577,2 | 581,4 | 582,2 | 583,8 |
| Braking distances | L | [m] | 672,6 | 729 | 691 | 732 |
| Pressure in the brake cylinder | $p_c$ | [bar] | 1,2 | 1,2 | 1,2 | 1,2 |
| Thrust force | $F_{bm}$ | [kN] | 6,77 | 6,45 | 6,72 | 6,68 |
| Ambient temperature | T | [°C] | 26,4 | 26 | 26,6 | 15,2 |
| Average braking distances | L | [m] | 706,15 | | | |

**The second series of measurements**:
Wagon weight: 22,8 + 55,973 = 78,773 t
Wagon speed: 100 km/h

*Tab. 3. Measured values for the brake block LL (CoFren C952 / 1) – braking from speed of 100 km/h*

| LL (CoFren C 952/1) | | | | | | |
|---|---|---|---|---|---|---|
| Measurement number | | | 1 | 2 | 3 | 4 |
| Vehicle speed in disconnecting | v | [km/h] | 101,057 | 100,402 | 97,753 | 99,785 |
| Speed after 4 seconds | $V_2$ | [km/h] | 96,67 | 95,22 | 92,88 | 94,35 |
| Braking distances after 4 seconds | $L_2$ | [m] | 659,52 | 657,1 | 655,7 | 652 |
| Braking distances | L | [m] | 787,317 | 718,324 | 771,161 | 752,312 |
| Pressure in the brake cylinder | $p_c$ | [bar] | 3,8 | 3,8 | 3,8 | 3,8 |
| Thrust force | $F_{bm}$ | [kN] | 26,17 | 26,13 | 25,21 | 26,5 |
| Ambient temperature | T | [°C] | 26,7 | 26,7 | 27,1 | 27,3 |
| Average braking distances | L | [m] | 773,03 | | | |

*Tab. 4. Measured values for the brake block GG (P10) - braking from speed of 100 km/h*

| GG (P10) | | | | | | |
|---|---|---|---|---|---|---|
| Measurement number | | | 1 | 2 | 3 | 4 |
| Vehicle speed in disconnecting | v | [km/h] | 99,13 | 101,931 | 100,789 | 101,233 |
| Speed after 4 seconds | $V_2$ | [km/h] | 92,43 | 94,55 | 92,12 | 94,36 |
| Braking distance after 4 seconds | $L_2$ | [m] | 675,69 | 679,4 | 681,14 | 685,3 |
| Braking distance | L | [m] | 793,831 | 809,481 | 808,681 | 810,477 |
| Pressure in the brake cylinder | $p_c$ | [bar] | 3,8 | 3,8 | 3,8 | 3,8 |
| Thrust force | $F_{bm}$ | [kN] | 25,95 | 26,49 | 26,22 | 26,28 |
| Ambient temperature | T | [°C] | 27,7 | 29,1 | 28,2 | 28,8 |
| Average braking distances | L | [m] | 805,56 | | | |

## 4. EVALUTION OF THE TESTS

Brake tests showed the higher braking performance of the composite blocks LL (CoFren C952 / 1) as the cast iron blocks GG (P10) on track in an empty and a loaded wagon as shown in table 5 and table 6. Measured braking distances were reduced to a nominal initial velocity. Subsequently, the arithmetic mean was calculated for the braking distance

*Tab. 5. Evaluation of measurement for speed of 120 km/h*

| | Wagon weight [t] | Prescribed speed [km/h] | Braking distances [m] |
|---|---|---|---|
| LL (CoFren C952/1) | 22,8 | 120 | **702** |
| GG (P10) | 22,8 | 120 | **706,15** |

*Tab. 6. Evaluation of measurement for speed of 100 km/h*

| | Wagon weight [t] | Prescribed speed [km/h] | Braking distances [m] |
|---|---|---|---|
| LL (CoFren C952/1) | 78,772 | 100 | **773,03** |
| GG (P10) | 78,772 | 100 | **805,56** |

## 5. CONCLUSION

Based on measured values obtained from real measurements were compared the properties of cast iron brake blocks GG-type (P10) and composite brake blocks type LL (CoFren C 952 / 1). The characteristics of this both types of blocks, namely braking distance and driving tests were verified on the track with a slope of 0 ‰ according to UIC 544-1. The results showed that the value of stopping distance of the wagon with composite blocks was about 4.15 meters less. It makes about 0.6 % of the initial stopping distance for an empty wagon braked from a speed of 120 km/h. The stopping distance for loaded wagon braked from a speed of 100 km/h was about 32.53 meters shorter which represents 4 % of the initial stopping distance. This test has been found that the tested composite blocks meet the requirement to maintain the stopping distance. In order to successfully replacement of the cast iron blocks by composite it is necessary to make more long testing and inspections of many other parameters which were not observed in this trial.

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