METHOD AND INSTALLATION FOR WEARING TESTING OF SINTERED BASALT

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Abstract: The paper presents a comparative study of the wearing testing of sintered basalt pellets doped with TiO_2 and without doping. Also it presents the method and installation for wearing testing the pellets. For wear testing the brake disk with sintered basalt pellets, it was considered that this is a device used as an arresting gear. For the other break disk, 3 cases were taken into account: the case in which the brake disk with sintered basalt pellets engages a brake disk on which 2 brake pads were fixed; the case in which the brake disk with sintered basalt pellets engages a brake disk on which 4 brake pads were fixed and the case in which the brake disk with sintered basalt pellets engages directly a brake disk. The test were performed on a milling machine, the brake disk with sintered basalt pellets being fixed on the machine compound table and the simple disk brake, the ones with 2 and 4 brake pads respectively, being fixed into the milling head.

1. INTRODUCTION

Sintering is a processing technique used to produce density-controlled materials from metal powders and/or ceramic powders by applying thermal energy. Sintering is in fact one of the oldest human technologies, with origins in the prehistoric era, having in view pottery fabrication and the production of tools and weapons from sponge iron. One the most important utilization of sintering in modern era is fabricating sintered components from ceramic materials, inclusive basalt, with appreciable abrasive resistance and high resistance to chemical agents etc.

Sintering is categorized in the synthesis/processing element among the basic four elements of materials sciences and engineering. Unlike other processing technologies, the different stages of processing and corresponding variables, must be considered. For example in shaping stage, one may use a simple compacting die, isostatic pressing, casting, injection molding etc. Depending on shaping technique, the sintering conditions are modified and also the sintering properties may vary considerably. In sintering stage may be used different techniques and different process variables, which may induce variations in microstructure and properties of sintered material.

2. INSTALLATION FOR WEARING TESTING

It has been designed a device (figure 1) for supporting the sintered basalt pieces with a special adhesive which gives in at reasonably high temperatures so that the parts are not affected at detachment. With the help of a device using a diamond blade (figure 2), sintered basalt pellets of 4mm thickness were cut.

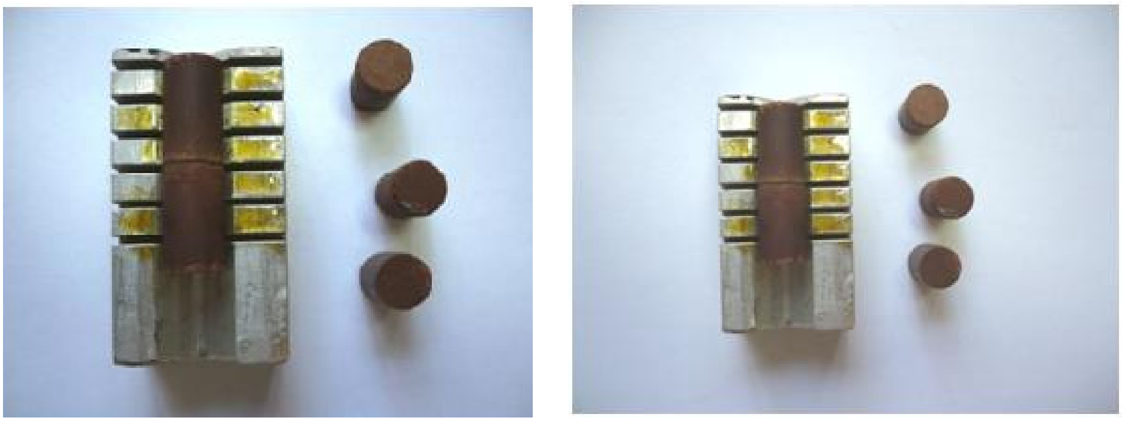

Fig.1 Device for supporting the sintered basalt pieces

Fig.2 Device for cutting the sintered basalt pieces

Two brake disks were grinded, as shown in figure 3.

Fig.3 Grinded brake disks

There were drilled 16 closed holes (at 30 °) of 2 mm deep, as shown in figure 4.
Sintered basalt pellets were introduced in the previous drilled holes into disk brakes ,their attachment being done both by shape and by gluing with adhesive, as shown in figure 5.

Fig.4 Closed holes drilled into the brake disks

Fig.5 Attaching basalt sintered pellets into brake disk closed holes

By fixing the pellets, their remaining thickness above the brake disk is 2 mm, being the maximum wear on which the brake disk can be used for.

For wear testing the brake disk with sintered basalt pellets, it was considered that this is a device used as an arresting gear. For the other break disk, 3 cases were taken into account: the case in which the brake disk with sintered basalt pellets engages a brake disk on which 2 brake pads were fixed (figure 6), the case in which the brake disk with sintered basalt pellets engages a brake disk on which 4 brake pads were fixed (figure 6) and the case in which the brake disk with sintered basalt pellets engages directly a brake disk.

Fig.6 Brake disks with 2 and 4 attached brake pads

The tests were performed on a milling machine, the brake disk with sintered basalt pellets being fixed on the machine compound table and the simple disk brake, the ones with 2 and 4 brake pads respectively, being fixed into the milling head (these are the ones which perform the rotational motion), as shown in figure 7.

Fig.7 Montage with simple disk brake and with 2 attached brake pads

2. METHOD FOR WEARING TESTING

The milling machine ensures the 3 revs on which the tests were performed: 630 rpm, 800 rpm and 1000 rpm. Taking in account relation (1), which gives the vehicle wheel peripheral speed and that the vehicle wheel radius is r_{wheel} = 0.300 m, we obtain practically vehicle moving speeds, corresponding to the revs the tests were made and which are given in relations (2) (3) and (4).

$$v_p = \frac{2\pi \cdot r \cdot n}{60} \quad (1)$$

$$v_{p1000} = \frac{2\pi \cdot r \cdot n}{60} = 113\ km/h \quad (2)$$

$$v_{p800} = \frac{2\pi \cdot r \cdot n}{60} = 90{,}4\ km/h \quad (3)$$

$$v_{p630} = \frac{2\pi \cdot r \cdot n}{60} = 71{,}2\ km/h \quad (4)$$

All the tests were performed on a period of time of 1 h, measuring the mean wear at pellets and at the corresponding brake disks. As operating hours was taken in account the time until the pellets wear is the maximum one, that is 2 mm. Another variable taken in account was the working pressure. In order to determine this pressure, it has been started from real data for the case of a braking device from a Dacia-type vehicle. Thus, in figure 8 is presented the features that appear in a Dacia-type vehicle wheel and characteristic elements of the braking system.

Wheel characteristic features*:* Dacia-type vehicle weight, G_a = 960 kg; Wheel radius, r_{wheel} = 0.300 m; Weight (force) at wheel, $F_R = G_R = (0{,}75 \times G_a)/2 \approx 360$ daN; Braking torque at wheel (at braking disk), $M_{fR} = M_{fd} = F_R \times r_{wheel} \approx 108$ daN; Braking surface at wheel, S_f = 106,75 cm^2

Brake disk characteristic features: Outer diameter, d_e = 0,235 m; Inner diameter, d_i = 0,140 m; Medium diameter, d_{md} = 0,235 m; Pressure, $p_{sl} = M_{fd}/(S_f \times r_{md}) \approx 10{,}76$ daN/cm^2.

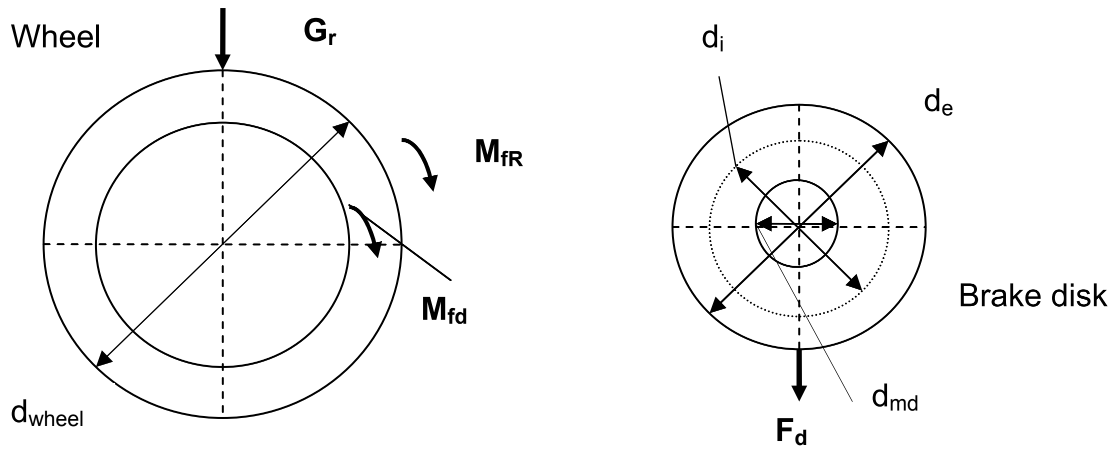

Fig.7 Wheel and brake disk characteristic features

In order to achieve the pressure at the break disk with sintered basalt pellets, a torque indicator handle wrench was used, placed on the milling machine head. The system to achieve the pressure and the corresponding characteristic elements, are shown in figure 8.

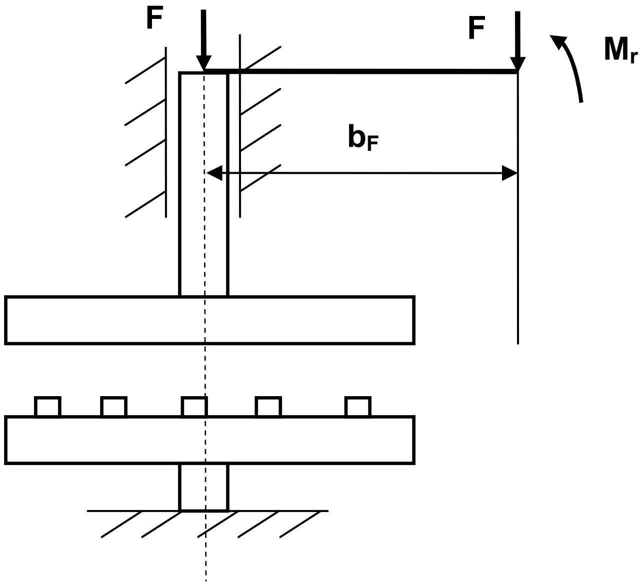

Fig.8 Pressure system characteristic features

Pressure system characteristic features: Torque indicator handle wrench beam, b_F = 0,710 m; Torque, $M_r = M_{fd} = F \times b_f = p_{sl} \times S_f \times r_{md}$.

Case I: p_{sl} = 1 daN/cm^2

a) Brake disk with 2 brake pads – Brake disk with 2 x 2 sintered basalt pellets,
S_f = 3,79 cm^2 (surface of 4 sintered basalt pellets with diameter reduced through sintering at 1,1 cm); F = 0,5 daN (at the end of torque indicator handle wrench beam).
In figure 9 is presented the montage for obtaining the necessary work pressure.

Fig.9 Montage for obtaining the necessary work pressure

b) Brake disk with 4 brake pads – Brake disk with 4 x 2 sintered basalt pellets,
S_f = 7,59 cm^2; F = 1,01 daN
c) Simple brake disk – Brake disk with 12 sintered basalt pellets,
S_f = 11,38 cm^2; F = 1,50 daN

Case II: p_{sl} = 10,76 daN/cm^2

a) Brake disk with 2 brake pads – Brake disk with 2 x 2 sintered basalt pellets,
S_f = 3,79 cm^2; F = 5,38 daN
b) Brake disk with 4 brake pads – Brake disk with 4 x 2 sintered basalt pellets,
S_f = 7,59 cm^2; F = 10,86 daN
c) Simple brake disk – Brake disk with 12 sintered basalt pellets,
S_f = 11,38 cm^2; F = 16,14 daN

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