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Research Article/Araştırma Makalesi

Investigation of the Effect of Surface Roughness on Friction Performance of Brake Pad

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Abstract
Vehicle brake pads are produced by combining more than one material. Having different properties of the material forming the brake pad composition is affect to the friction performance of the vehicle. During braking, high temperatures occur in the vehicle brake pads. Depending on the temperature change, the friction coefficient and wear resistance of the brake pad are desired to be high. In this study, the effect of brake pad surface roughness on friction performance was investigated. The friction coefficient and wear tests of the brake pads with different surface roughness values were examined and their effect on the friction performance was determined.

1. Introduction

Brake pads are important elements in the brake systems of vehicles. It allows the vehicle with a certain speed to be stopped or slowed down. When the brake pedal is pressed, the pads are pushed against the disc connected to the rotating wheel and friction occurs. Due to friction, heat is generated at the interface of the disc and the pad, and this heat affects the materials that make up the pad. Brake pads are not manufactured from a single material. They are produced by molding many materials with various properties together. The materials used and the production conditions directly affect the friction, that is, the brake performance. At the same time, the physical properties of the pad such as density, hardness, surface roughness also affect the brake characteristics. There are some studies in the literature examining the correlation between the physical properties of the pad and its frictional properties. While some of the studies showed a significant correlation between physical properties and friction, in some of them no significant correlation was found (Vijay et al., 2020: 1, Vijay et al., 2019: 1, Jeganmohan et al., 2018: 12, Krishnan et al., 2019: 7, Akıncıoğlu et al., 2020: 56, Mahale and Bijwe, 2020: 144, Kalel et. al, 2021: 464, Jeganmohan et al., 2020 :101,

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Jeganmohan and Sugözü, 2020: 27, Raj et al., 2020: 23). Most likely, this is related to the materials added to the content.

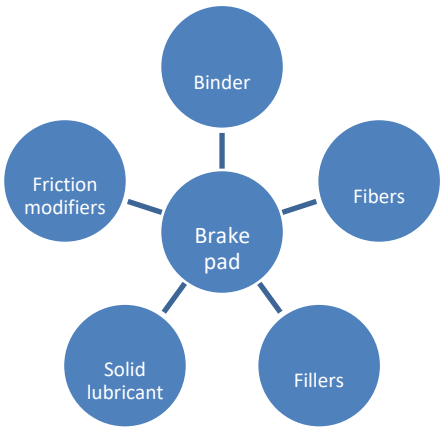
In this study, the relationship between brake pads with different surface roughness and brake performance was investigated experimentally.

2. Materials, Characterization, Sample Preparation and Experimentation

The most important factor when determining the brake pad content is that the materials do not harm the environment and human health. Since the contents of commercial linings are not shared for reasons such as patents, the materials are determined by scanning the literature, XRD analysis of the current product or by making preliminary studies.

The basic material groups of a pad are shown schematically in Figure 1. In this study, phenolic resin as binder, steel wool as fiber, graphite as solid lubricant, copper shavings brass shavings cashew dust alumina as friction modifiers and barite as filler were used.

Figure 1. Material groups that combine brake pad materials



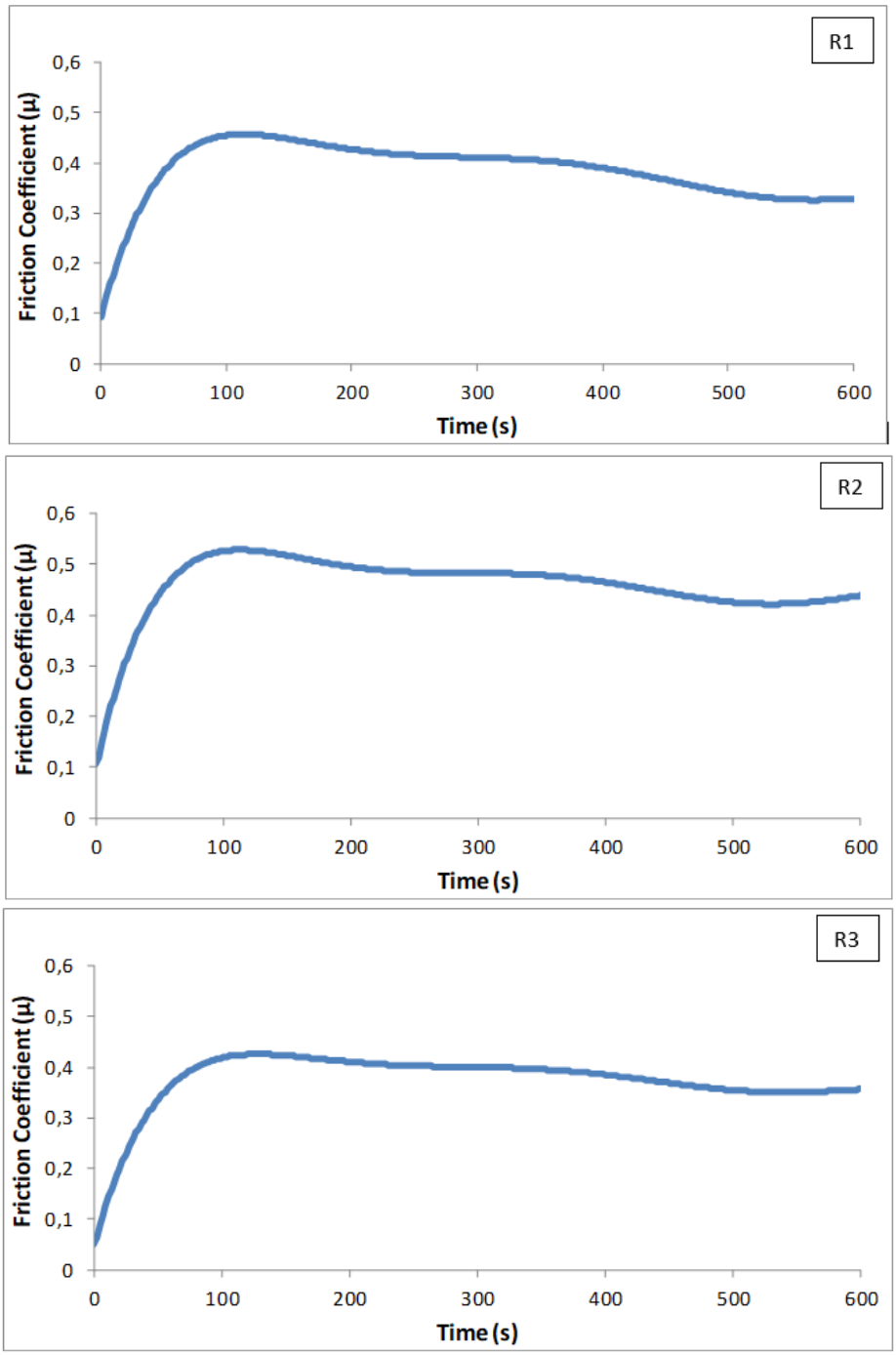
The production of the samples was carried out according to the appropriate standards. The surfaces of the samples obtained have been adapted to different surface roughness values with different sanding processes. Density and hardness of the samples were determined according to appropriate standards. The samples were named R1, R2, and R3.

A computer-controlled special design brake tester was used for the brake tests of the samples, and detailed information about the device is available in the previous studies of the authors (Sugözü, 2015: 57, Sugözü, 2018: 70). The masses of the samples before and after the brake test were determined with the help of precision scales and the wear amounts were calculated.

3. Results and Discussion

Friction coefficient data was taken from the brake test every second and shown graphically in Figure 2, Figure 3 and Figure 4. The most important parameter when evaluating the performance of brake pads is the coefficient of friction. The disc and brake compatibility of the pads with a high friction coefficient is more preferable. The high friction coefficient shortens the braking distance by increasing the friction force.

Figure 2. The variation of the friction coefficient of the samples in seconds



The hardness and density properties of the samples are given in Figure 3. The properties of the materials that make up the content affect both hardness and density. For example, the rate of addition of light materials such as barite affects the density, while the presence of metallic chips and reinforcements such as steel wool affects the hardness.

Figure 3. The variation of the friction coefficient of the samples in seconds

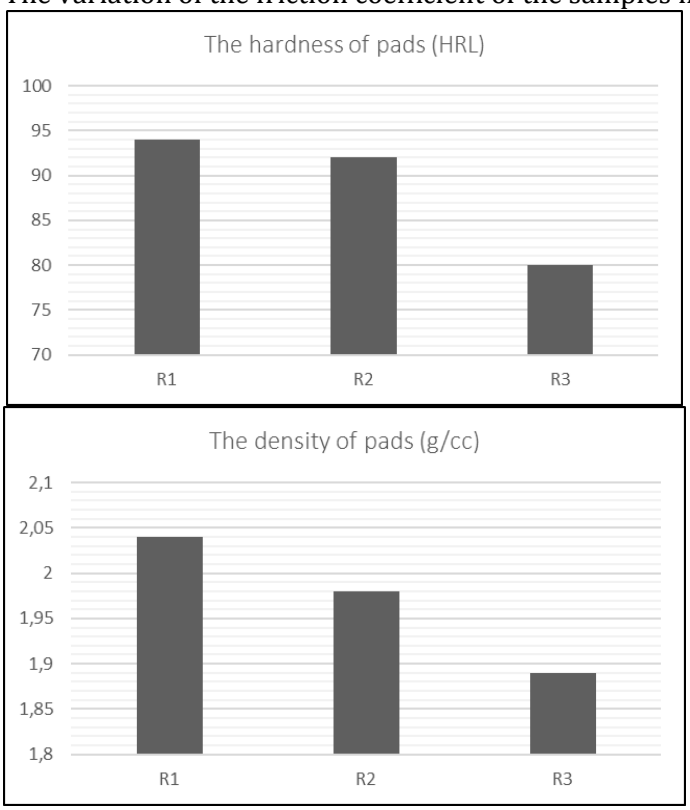
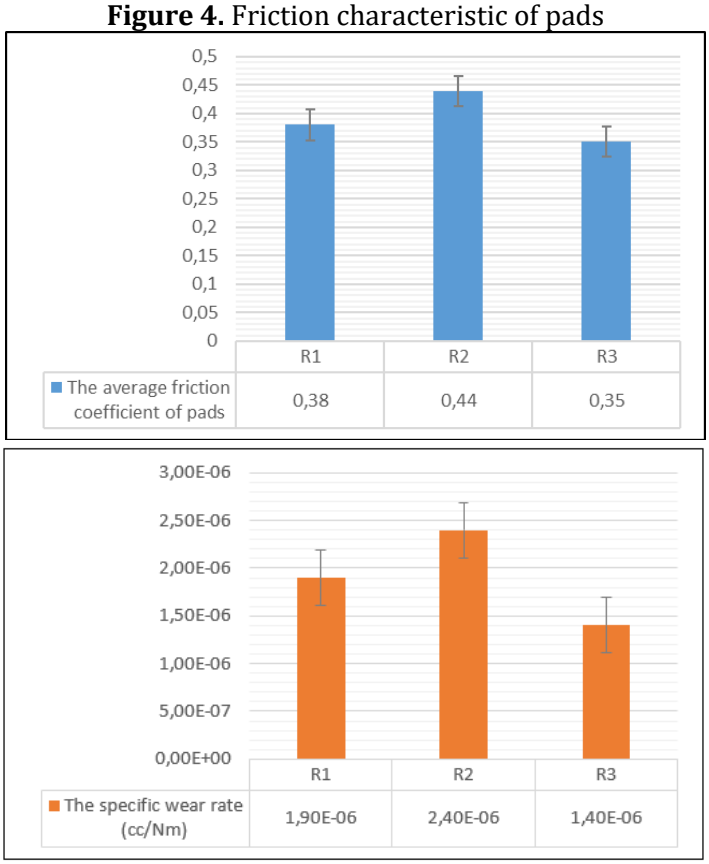


Figure 4. Friction characteristic of pads



The surface roughness of the samples named R1, R2 and R3 are 0.88, 1.02 and 0.82, respectively. In Figure 4, the average friction coefficient and specific wear rate values of the pads are given. Accordingly, surface roughness and friction properties were compared.

4. Conclusions

- As the hardness of the pad decreased, the surface roughness increased.
- It has been observed that the contact area of the pad with high surface roughness with the disc surface is larger.
- As the pad density increased, the surface roughness increased.
- As the surface roughness increased, the friction coefficient increased and the wear resistance decreased.

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