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WEAR OF TIRE TREAD

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ABSTRACT
Wear of tire treads at roads surfaces is measured as abrasion resistance. Off – road behavior of tire treads on surfaces with sharp stones is not well characterized by abrasion resistance as the mechanism of rubber damage is here rather different. The sharp edges of stones can cut a rubber tread surfaces and gradually tear off bigger pieces of rubber (chip – chunk).The aim of this article is evaluation of chip – chunk behavior of different rubber compounds and evaluation process of tire treads wear. The process of the damage of tire tread is described in this article.
Keywords: rubber, rubber mixture, wear, Chip – Chunk test

1. INTRODUCTION
In rubber practice we often meet the problem of wear of the rubber product. Some types of wear, especially the wear of tire treads designed for off-road cars (working in very hard terrain conditions), are very similar to cutting. The tire is a very important part of the vehicle which is in direct contact with the road surface and responsible for the driving force transfer. In terms of design the tire is a very complicated component consisting of polymeric matrix and reinforcement. It is composed of various layers (Figure 1). In terms of wear the overlayer called tread equipped with design (pattern) is the most important part. The wear of tire treads on road surfaces is measured as abrasion resistance [1, 2]. The off-road behavior of tire treads on surfaces with sharp stones is not well characterized by abrasion resistance as the mechanism of rubber damage is rather different here. [3]. The sharp edges of stones can cut rubber tread surfaces and tear off gradually bigger pieces of rubber [4]. This type of wear is called chip and chunk effect in the tire processing industry, and it is just comparable to machining [5, 6].

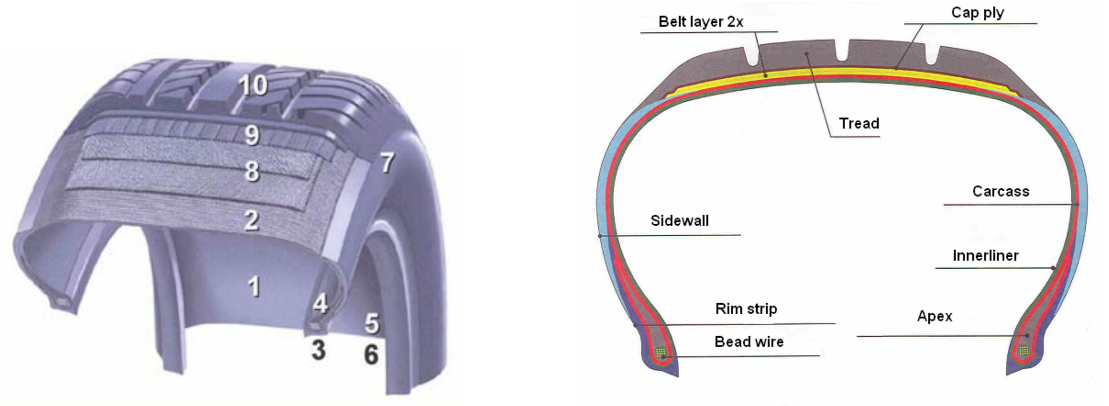


Figure 1. Tire visualization
1 – Inner-Liner, 2 - Carcass material, 3 – Bead wire (Core), 4 – Apex, 5 – Tire strip, 6 – Rim (Bead) strip, 7 – Sidewall, 8 – Breaker strip, 9 – PA Breaker strip, 10 - Tread

2. MATERIALS AND METHODS

The cutting and chipping test of rubber compounds which correlates with service behavior and provides test results at a reasonable speed and with accuracy was described by J. R. Beatty and B. J. Miksch in RCHT, vol. 55, p. 1531. In accordance with their description we constructed a rather modified apparatus [7, 8].

This enhanced laboratory apparatus provides test conditions which can be widely changed. It enables to measure different characteristics of chip and chunk processes [7].

Thirteen various types of tire tread mixtures designed for off-road tires production have been chosen for the experiments (motocross, mine and building vehicles). The tests were carried out on cylindrical samples of the Lüpke test with diameter 55 mm and thickness 13 mm (Figure 2.). The rotating vulcanized rubber cylinders (6) were abraded by a sharp ceramic edge tool (5), mounted on beam (3), lifted and dropped on the rubber sample perimeter by a pneumatic cylinder (4).The control of the impact frequency of the tool and of the revolutions of the electric motor (2) is provided by the control unit (7) – (Figure 3). The samples were weighed before and after the test. The evaluation of the wear progress during the testing period was tested as well [4, 5].

3. RESULTS AND DISCUSSION

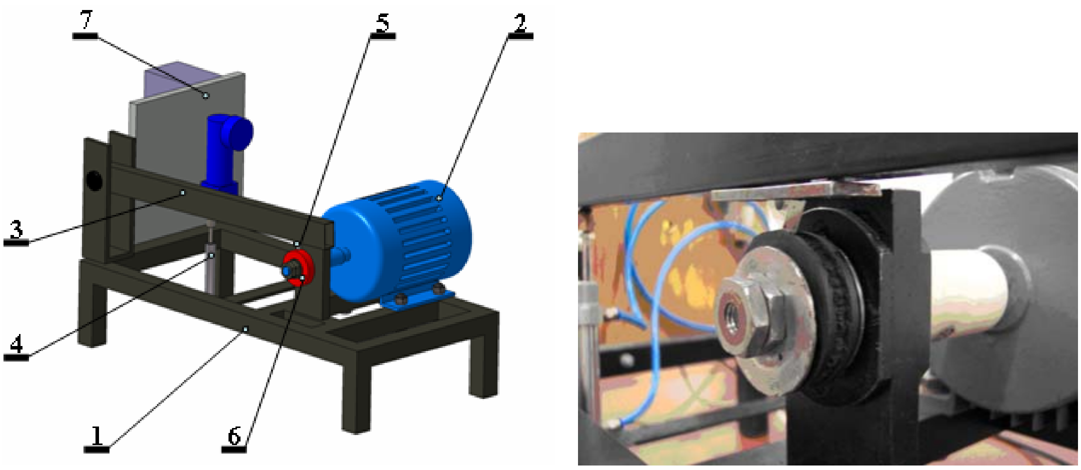
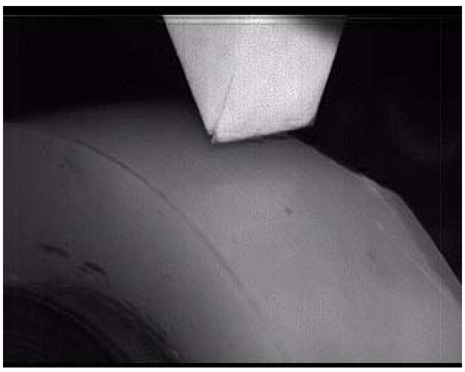


Figure 3. Design of cutting and chipping tester and detail of ceramic tool
1 – frame, 2 –electric motor, 3 – beam, 4 – pneumatic cylinder , 5 – ceramic tool, 6 – rotating sample, 7 – control panel

The influence of drop of the ceramic tool on the surface of the testing sample is crucial. If the sample were rigid, the evaluation of the impact of dropping force would be quite easy. The elastic properties of the testing sample however cause a series of other effects of smaller intensity (jumping on the surface Fig. 7.) apart from the main effect (the first drop of the ceramic tool on the testing sample). The main effects of the ceramic tool have only partial influence on the total wear. It turned out that evaluating total work needed for wear (i.e. creating a groove on the testing sample) only by the energy of the drop would be biased. After the first testing of the experiment equipment, it was clear that the results in a given series of measurements would be comparable if the experiments ran under the same conditions. The construction of the main body with a key fitting the groove on the shaft and clamping basement with teeth prevent skidding of the testing sample while running and the control system of the testing machine will secure constant conditions for testing.

Most of the samples showed a gradual increase in wear in the first interval of the experiment. A marked increase of the wear starts after the creation of the first rip, which means that before the first rips happen, the surface wear is negligible (Figure 5, 6, 7). The wear process has been studied by the help of stroboscopic camera.

Figure 4. Sample wearing during the test period



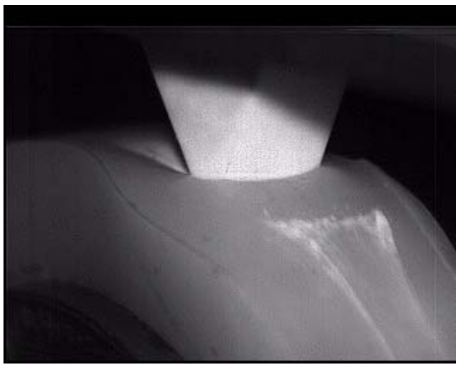
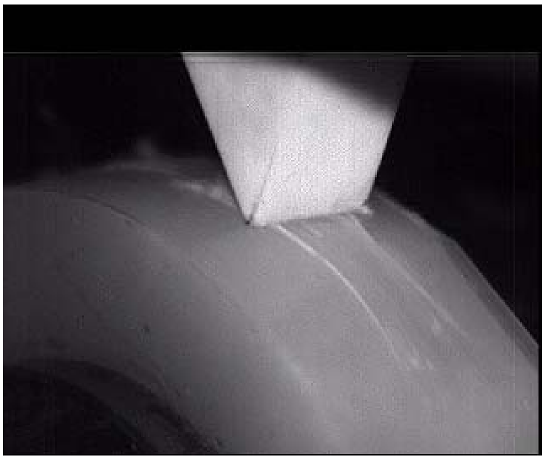


Figure 5. Initial phases of wear *Figure 6. Jumping on the surface*



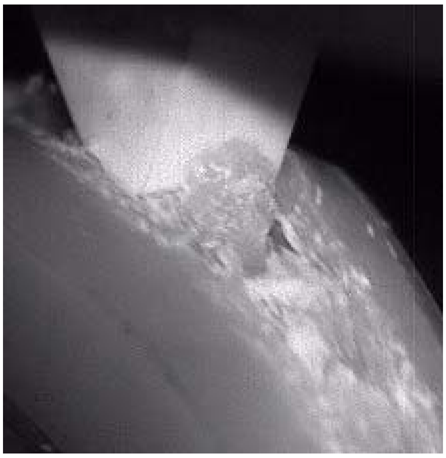


Figure 7. Creation of first rips *Figure 8. Start the “avalanche effect”*

4. CONCLUSION

The sets of measured values were processed and the results shown in graphs. A wear test under different running conditions, characterised by different rotary frequencies of the testing sample was carried out. The expected increasing tendency of wear with increasing the rotations was proved.

The wear behaviour was observed during the test. Special attention was paid to the initial phase of the experiment. The experiments proved that the increase of wear during the test is relatively uniform, apart from the initial phase (Figure 5). The initial phase of the experiment is characterised by a very gradual increase. A fast increase is triggered by the first rip of the testing sample (Fig. 8).

5. ACKNOWLEDGEMENT

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6. REFERENCES

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