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# WEAR OF RUBBER PARTS

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## ABSTRACT

*Rubber (rubber mixture) is an indispensable material as an element for automobile because of its original characteristics such as big elongation (transformation) and ability of restoration which is unattainable by other materials. Rubber is the main raw material for production of automotive components such as tires, bushes, insulators and seals. All these products have to be safe and wear resistant. Good wear resistance is very important for tires. The article describes the testing possibilities of tires used in very hard traffic conditions (off-road tires).*
**Keywords:** rubber, rubber mixture, wear

## 1. INTRODUCTION

Wear of tire treads at road surfaces is measured as abrasion resistance. Off-road behaviour of tyre treads on surfaces with sharp stones is not well characterised 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 (chips or chunks).

## 2. EXPERIMENTAL

The test for cutting and chipping of rubber compounds which correlates with service behaviour and gives test results with reasonable speed and accuracy was described by J. R. Beatty and B. J. Miksch in RCHT, vol. 55, p. 1531. In accordance with their description we constructed rather modified apparatus. The enhanced laboratory apparatus where conditions of testing can be widely changed makes possible to measure different characteristics of chip-chunk processes.


*Figure 1. Sample for chip-chunk test: a) before the test, b) after the test*

Tests were carried out on cylindrical samples for Lüpke test with diameter 55 mm and thickness 13 mm. The rotating vulcanised rubber cylinders were abraded by sharp edge mounted on beam lifted and dropped on the rubber sample perimeter by pneumatic cylinder. The samples were weighed before and after test. The samples were made from compounds designated for production of motocross, motoenduro fork lifter tires and off-road tires. The evaluation of wear progress during the testing period was tested as well.

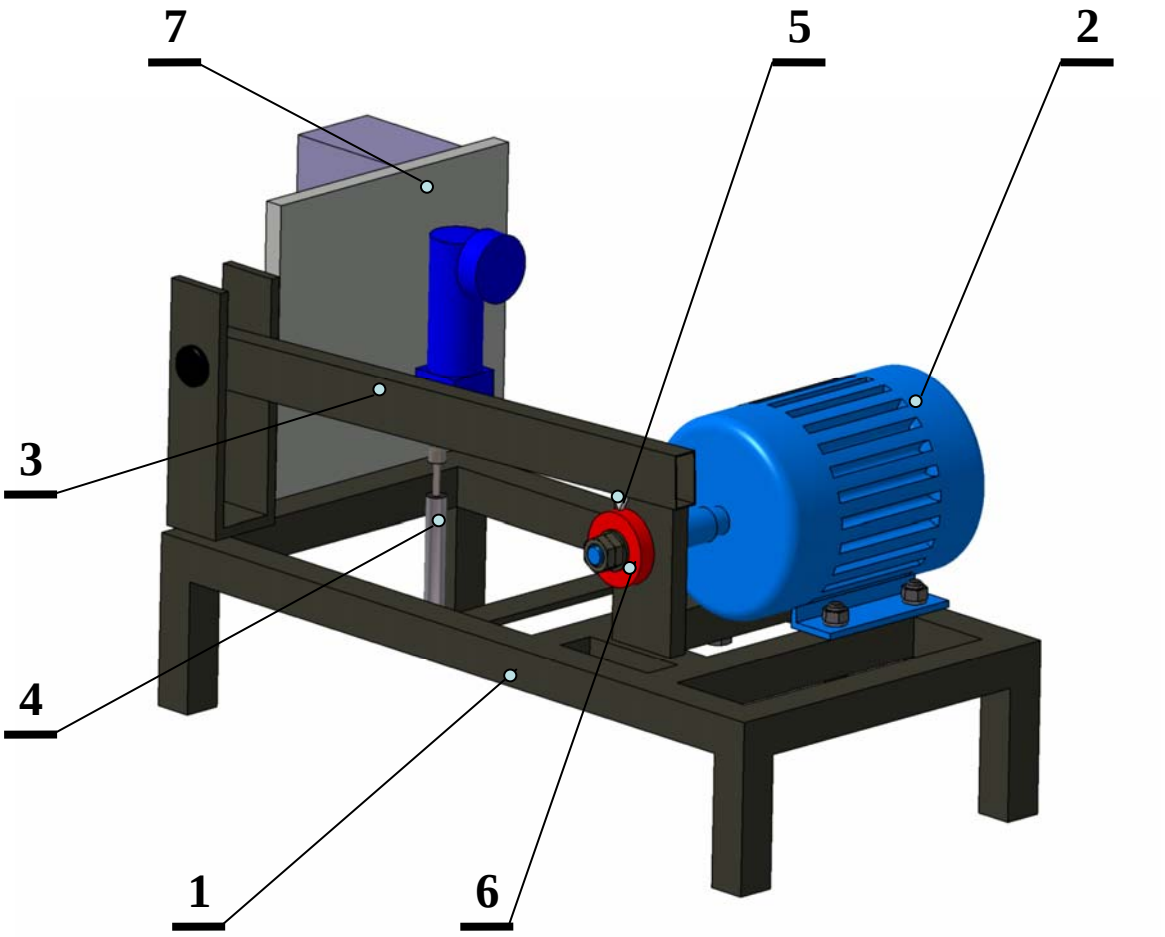


*Figure 2. Design of cutting and chipping tester*
*1 – frame, 2 –electric motor, 3 – beam, 4 – pneumatic cylinder , 5 – ceramic tool, 6 –rotating sample, 7 – control panel*


*Figure 3. Samples wearing during the test period*

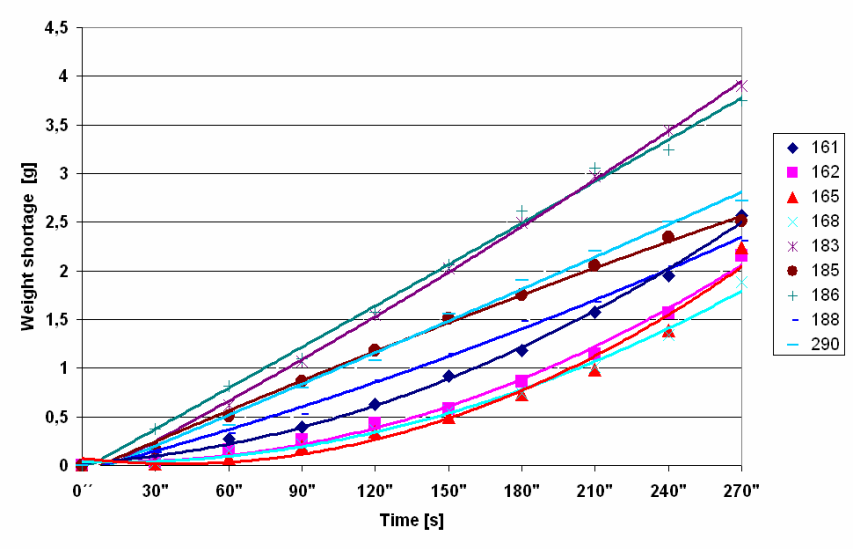


*Figure 4. Wear of samples during the test period*

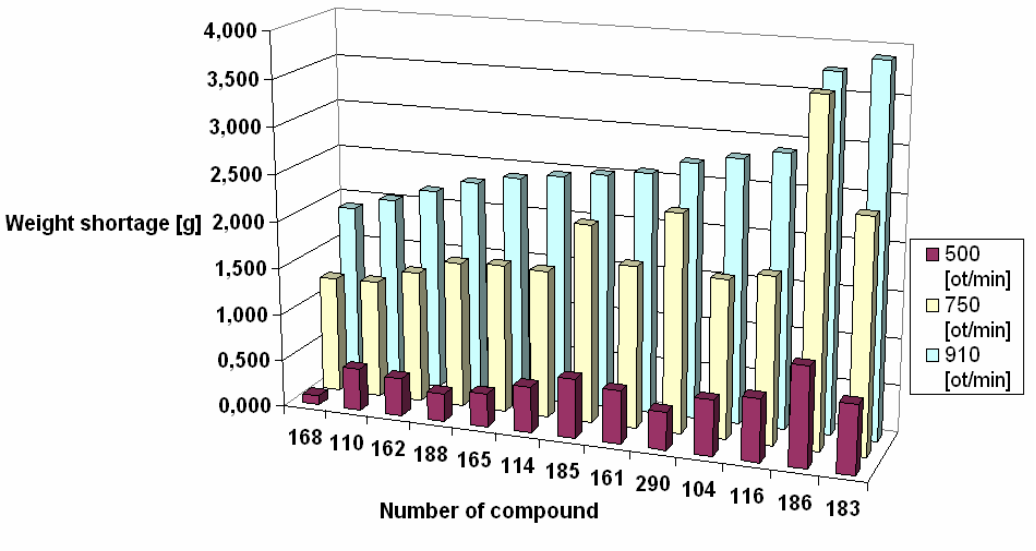


*Figure 5. Wear of samples by various conditions*

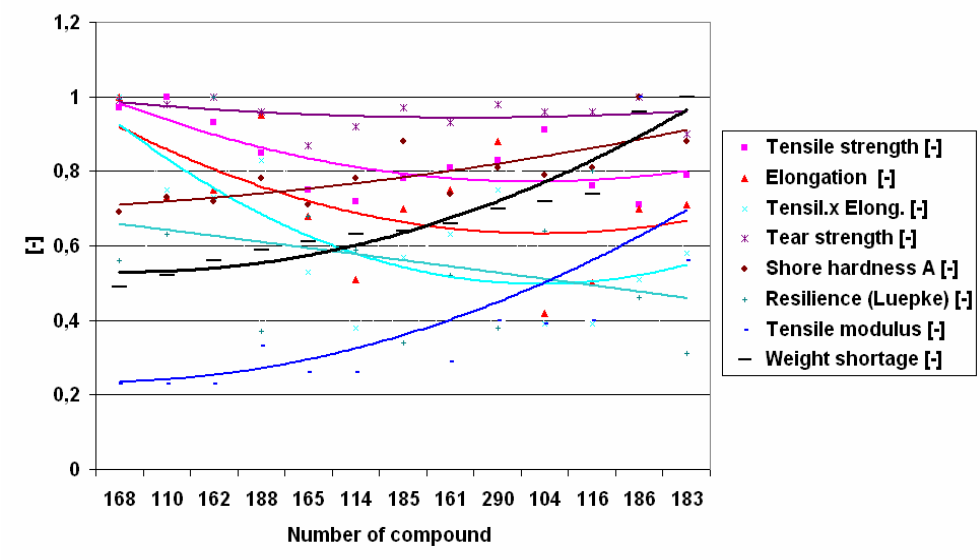


*Figure 6. Comparison of all measured properties*

The measured dates were statically calculated processed. For evaluation of measured dates the multiple linear regression was used. We used the linear statistical model of Chip – Chunk resistance in the form.

$$\mathbf{Y = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3\ X1\ X2 + \beta 4\ X3 + \beta 5\ X4 + \beta 6\ X5 + \beta 7\ X6 + \varepsilon}$$

where Y … Weight Shortage [g]
Xi … measured value of properties of rubber compounds, i.e.
βi … material constants
X1 … Tensile Strength [MPa]
X2 … Elongation [%]
X3 … Tear Strength [Númm]
X4 … Shore Hardness [ShA]
X5 … Resilience [%]
X6 … DMA (Tensile Modulus) [MPa]
βi … regression parameters
ε … error

By the least – square method we obtained the estimates of unknown parameters βi . The answered regression function takes the form:

**Y = 2,619273 + 0,034052 X1 – 0,001868 X2 + 0,000125 X1 X2 – 0,129815 X3 + 0,116571 X4 + 0,012328 X5 + 0,000121 X6**

(suitability of the model describes the determinacy index: R2 = 0,850893).

*Table 1. Correlation matrix*

| Correlation matrix | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | Y |
|---|---|---|---|---|---|---|---|
| $X_1$ | 1,000000 | 0,352717 | 0,489553 | -0,573941 | 0,355879 | -0,522965 | -0,595387 |
| $X_2$ | 0,352717 | 1,000000 | 0,273991 | -0,223167 | -0,274672 | -0,131786 | -0,320170 |
| $X_3$ | 0,489553 | 0,273991 | 1,000000 | 0,136835 | 0,121560 | 0,203524 | -0,207062 |
| $X_4$ | -0,573941 | -0,223167 | 0,136835 | 1,000000 | -0,622169 | 0,967055 | 0,832489 |
| $X_5$ | 0,355879 | -0,274672 | 0,121560 | -0,622169 | 1,000000 | -0,600251 | -0,486060 |
| $X_6$ | -0,522965 | -0,131786 | 0,203524 | 0,967055 | -0,600251 | 1,000000 | 0,782667 |
| Y | -0,595387 | -0,320170 | -0,207062 | 0,832489 | -0,486060 | 0,782667 | 1,000000 |

## 3. CONCLUSION

Presented testing method shows the possibility of evaluation of wear (chip – chunk) resistance of tire treads on the small samples. This method makes possible to compare various types of compound with a standard and follow the progress of wear during the test period. The wear of sample during the test period depends on the properties of rubber compounds and testing conditions. Significant correlation of chip-chunk resistance with usual rubber properties was found. According statistical calculation all measured data are statistical significant.

## 4. ACKNOWLEDGEMENT

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