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RESISTANCE TEST OF AUTOMOBILE RIMS ON A FRONTAL IMPACT

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Abstract The paper presents a pilot study whose aim was to determine how passenger car rims are resistant to impacts when encountering a hole in the road, a curb and the like. For this purpose, a special apparatus was designed and used for testing. Test covered the total of six rims, made of different materials, aluminum and steel. The main resistance parameters were deformation and fracture of the rim. The testing took into account whether the rim is original or replacement. In general, aluminum rims showed higher frontal impact resistance. It is recommended that future standards and recommendations include this type of assessment, given that this factor can have an impact on traffic safety.

Keywords: passenger car rim; impact resistance; deformation; fracture.

1. INTRODUCTION

During the normal use of the vehicle, the wheels are exposed to loads that are relatively small and constant. However, when encountering potholes, climbing curbs and in similar situations, the wheel is exposed to increased and concentrated loads. How much the rims are able to withstand such a load is not determined by regulations or recommendations. As far as the standard is concerned, the closest to this issue is ISO 7141 [1], which tests the resistance of the rim to a predominantly side impact. The test provided by this standard simulates the impact to which the wheel is exposed when a vehicle skids sideways causing the wheel to hit the curb sideways. In such a case, the direction of force action is different than when hitting a pothole in the road or when hitting a curb head-on.

Since there are no standards or much data on the resistance of rims to frontal impact, a pilot study was conducted to determine how much the rims differ in this respect and what could be the further direction of research and possibly the adoption of standards or recommendations.

2. METHOD

The research included six rims. In order to determine the difference between the materials most often used to make rims, two rims were made of steel and four of aluminum alloy. One steel and two aluminum rims were OEM (original equipement manufacturer), and the remaining three were aftermarket, in order to determine how much the origin possibly has an effect on strength.

The aim of the test was to simulate the impact that the rim takes when the car hits a pothole or curb. For this, an apparatus is used where the rim stands upright on a stand that holds it firmly, and a weight is released onto the rim in free fall. Changing the intensity of the impact is achieved by changing the height from which the weight is released. The mass of the weight was 125 kg, and on its lower part there was a kicker that came in contact with the rim. Testing aparatus is shown on Figure 1.

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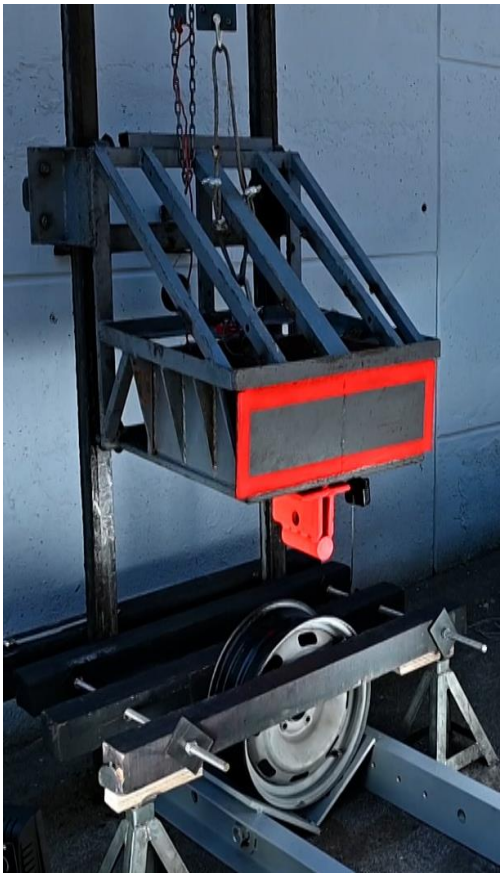

Figure 1. Testing device.

The rims were tested without tires to avoid their possibly unequal influence on damage. To compensate the fact that the tire actually partially dissipates the impact, the kicker was not as sharp as a curb or the edge of a pothole in the road, but instead had the form of a 50 mm diameter cylinder. The kicker stood so that the axis of the roller was normal to the plane of the rim edge of the rim, and it hit one edge. The base had two slanted plates as the main support so that the rim rested on a flat surface in four places. Thus, the load on the supports was significantly less than at the point of impact, in order to prevent the occurrence of deformations at the points of support.

The consequences of the impact were determined by measuring how much the edge of the rim moved from its original position, i.e. by measuring the depth to which the kicker penetrated, as well as by assessing the condition (breakage) of the rims. Due to the different reaction of the rims to the impact, the heights from which the weight was dropped also differed. Thus, the test with an initial weight height of 15 cm was performed only on one aluminum rim, because it showed that the damage was negligibly small. For this reason, in the case of aluminum rims, in the continuation of the test, the height from which the weight with the kicker was allowed to fall freely was increased. On the other hand, for steel rims, it was not necessary to exceed 15 cm, because already at that height the damage was noticeable, i.e. such that the rim would not be usable.

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3. RESULTS

The test results are shown in Table 1.

Table 1. Test results.

Rim	Starting height of the kicker above the rim	Deformation/damage
Steel OEM	15 cm	11 mm
Steel aftermarket	15 cm	14 mm
Aluminum OEM 1	15 cm	1 mm
	50 cm	5 mm
	100 cm	11 mm
Aluminum OEM 2	100 cm	6 mm
	150 cm	broken
Aluminum aftermarket 1	50 cm	broken
Aluminum aftermarket 2	50 cm	14 mm
	100 cm - impact at the point of the spoke	10 mm and smaller edge crack
	100 cm - impact between the spokes	broken

On the tested rims, it unexpectedly turned out that the aluminum ones are significantly stronger than the steel ones. With a weight height of 15 centimeters, the damage was barely noticeable on the aluminum ones, and the steel ones had a noticeable deformation, over 10 mm. Aluminum rims, depending on the model, usually had such a deformation when the weight was dropped from a height of 50 to 100 cm.

Significant differences were also shown between the aluminum rims. With the strongest rim, from the initial position of the weight of 100 cm, a deformation of 6 mm occurred on the edge of the rim, and at 150 cm, the edge of the rim broke. The weakest aluminum rim broke from a height of 50 cm.

In the case of one aluminum rim, the spans between the spokes on the rim are unusually large, because the spokes are narrow, there are relatively few of them - five, and the diameter of the rim is relatively large - 18 inches. On it, as expected, it was shown that the place of impact has a great

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influence. From a height of 100 cm, a impact between the spokes broke the rim, and a blow at the point of the spoke from the same height damaged only the rim edge, albeit noticeably. Figure 1 is showing the damage on one of the rims.

Figure 1. Damage on one of the rims.

4. CONCLUSION

A pilot test showed that there are large differences in strength between different rim models, which indicates the possibility and need to investigate this topic in more detail. The obtained results show that the rims made of aluminum alloys are significantly more resistant to impact than the steel rims, as well as that aluminum rims under higher loads, in addition to deformation, may crack. The importance of such tests is that the behavior of the rim during an impact has a great impact on safety, since in case of significant damage, air is lost from the tire, which affects the stability of movement and the ability to drive the vehicle. Because of that, it can be recommended that the resistance of the rims to frontal impact be one of items covered by recommendations and standards.

Acknowledgements

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References

[1] ISO 7141, 2005, Road vehicles - Light alloy wheels - Impact test, International Organization for Standardization, Geneva.