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Lightweighting and Improvement of Truck Bumper Designed According to Regulation R58.03

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ABSTRACT

In this study, it is aimed to use a rear bumper used as rear protection equipment in N category motor vehicles and trailers by passing several structural analyzes by means of Ansys program within the scope of the regulation. Forces of 10 kN and 18 kN were applied to the bumper equipment intended to be used in accordance with the relevant regulation. The design work was completed because of the analysis results and the relevant buffer was commissioned.

Keywords: Rear Bumper, ECE R58.03, Ansys, N Category vehicle

1. INTRODUCTION

In order to provide transportation, which is one of the most basic needs, there is a significant increase in the number of vehicles day by day. In addition to these increases, accident rates have also increased significantly with the increase in the number of vehicles traveling in traffic [1,2,3].The development of safety technologies in the automotive industry has the potential to significantly reduce fatalities. One of these measures is the robust rear bumper systems found especially on trucks. In the event of a rear-end collision between a car and a truck, these bumpers help to prevent serious injuries and fatalities by preventing people from getting under the truck [4,5,6]. Figure 1 shows the crash situation of a car hitting a truck without a rear bumper [7].

Figure 1. Accident News (Trt Haber, 2020)

Truck rear bumpers, which have been in production for a long time, are seen as the most important solution to prevent fatalities in rear-end collisions [8, 9]. Figure 2 shows the existing rear bumper designed for a truck with a Koluman brand concrete pump superstructure [10]. The image shown in Figure 3 will be the new bumper used within the scope of the study.

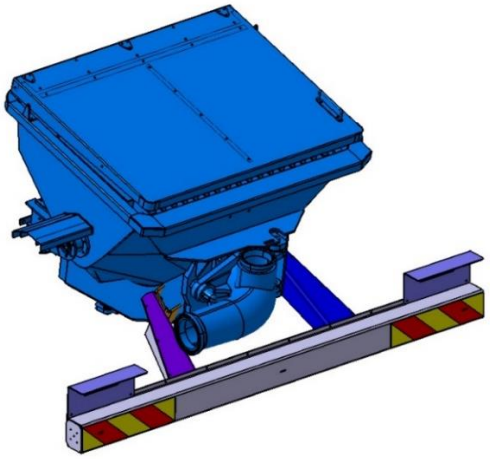

Figure 2. Available Rear Bumper [10]

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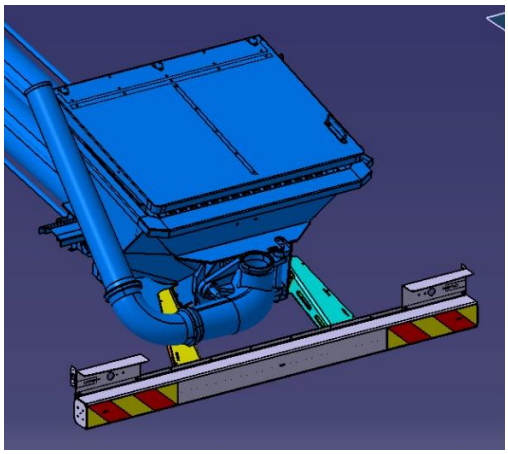

Figure 3 Newly Designed Rear Buffer Image

With the new design, the raw material quality used in s500 8 mm thickness has been changed to s900 7 mm quality. In addition, lightweighting is aimed by adding various discharges. In addition, the parts that are converted into socket fittings fit together quickly without taking measurements and do not require extra measurement work. Figures 4 and 4-1 show the existing brackets and Figures 5 and 5.1 show the newly designed brackets.

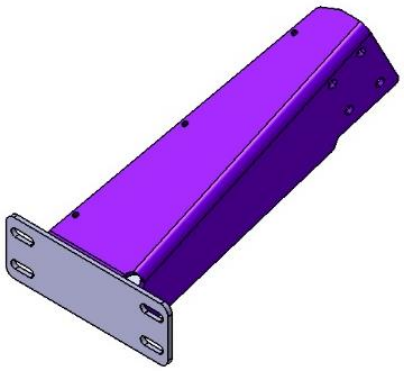

Figure 4. Available Bumper Bracket (Front)(s500 8mm)

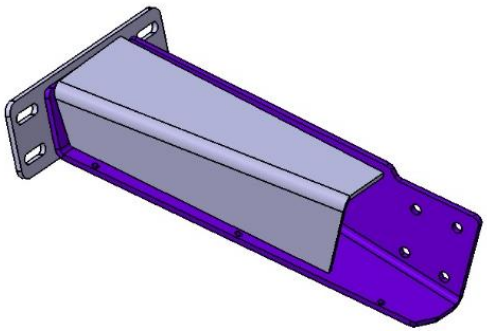

Figure 4.1 Available Bumper Bracket (Rear)(s500 8mm)

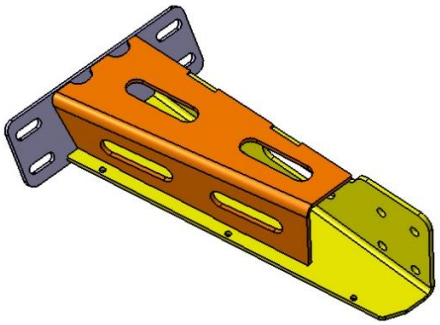

Figure 5. New Design Bumper Bracket (Front)(s900 7mm)

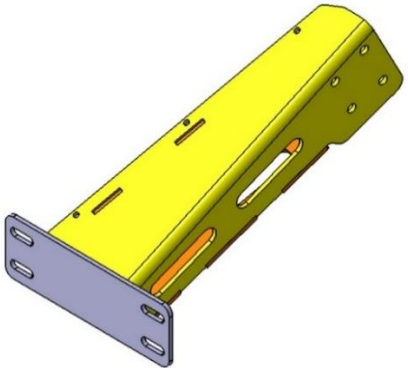

Figure 5.1 New Design Bumper Bracket (Rear)(s900 7mm)

2. RESULTS and DISCUSSION

Protective equipment that must be fitted to the rear of trucks is subject to regulations set out by the Economic Commission for Europe (ECE) (Regulation, 2017) [2] . According to these regulations, the durability of the material is tested by applying forces to specific areas on the bumper. The European Economic Commission (ECE) has issued a regulation coded R58.03 to ensure the required

strength of these bi-rims, and the values specified in this regulation are shown in Figure 6 on the bumper.

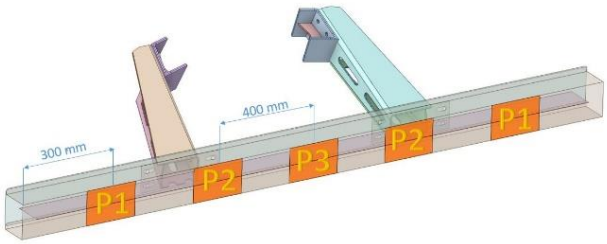

Figure 6 New Designed Buffer

The material of the designed rear bumper was prepared for static analysis in the Ansys program and made as shown in Figure 7**.**

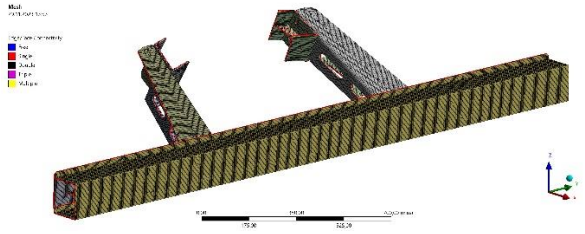

Figure 7 New Designed Buffer (mesh)

A P1 load of 10 kN was applied to this designed rear bumper, and the stress results on the material as a result of the application are shown in Figure 8 for the available bumper and Figure 9 for the newly designed bumper.

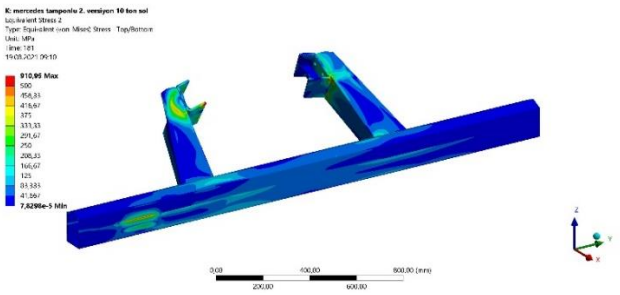

Figure 8. P1 Force Application (Available)

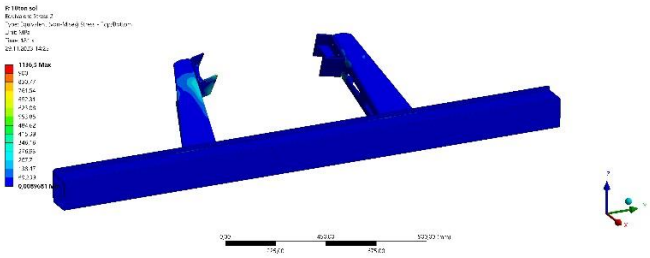

Figure 9. P1 Force Application (New)

In the same way, a P2 load of 18 kN was applied to the designed rear bumper, and the stress results on the material after the application are shown in Figure 10 for the available bumper and Figure 11 for the newly designed bumper.

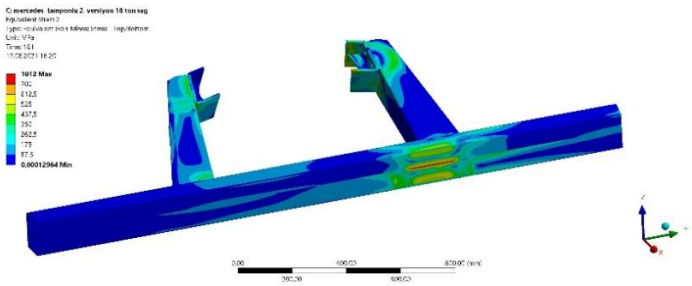

Figure 10. P2 Force Application (Available)

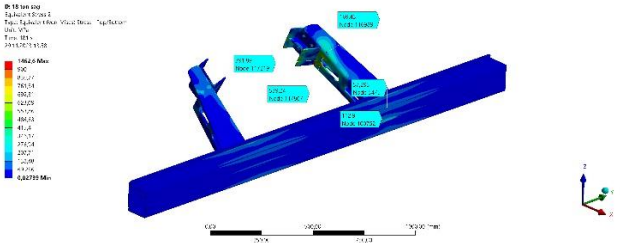

Figure 11. P2 Force Application (New)

Finally, a P3 load of 10 kN was applied to the designed rear bumper, and the stress results on the material after

the application are shown in **Figure 12** for the existing bumper and **Figure 13** for the newly designed bumper.

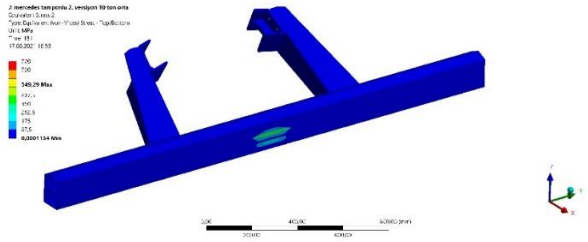

Figure 12. P3 Force Application (Available)

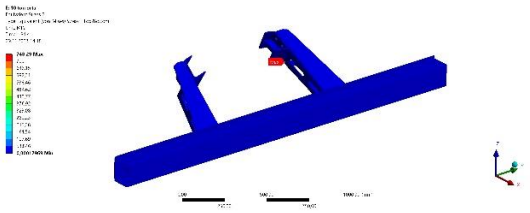

Figure 13. P3 Force Application (New)

3. CONCLUSION

In this study, it is aimed to lighten a structure designed to increase safety against accidents at the rear of vehicles by changing the raw material and design. This design was tested under forces of 10 kN and 18 kN in accordance with the regulation. As a result of the study, the minimum strength values required for the material to be used in the design of the bumper were reached. The analyses performed with the newly defined materials are more resistant than the existing bumper. Compared to the old analysis, the analysis has given a much better result in both total deformation and axial deformations. When we compare the equivalent stresses, although the new analysis seems to be higher in value, it exhibited almost the same behavior over yield as the old analysis. For example, in the existing buffer, the material quality was s500 and the legs were read at max 600 MPa. In the new analysis, the material S900mc read 1100 MPa values in similar areas. In addition, as a result of the study, the weight of the existing bumper was reduced from 22.25 kg to 17.90 kg with the new design, resulting in an average weight reduction of 5 kg.

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