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PROFESSIONAL PAPER

Application of New Materials Technology With the Aim of Satisfying the Regulations

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Abstract: The reconstruction of the passenger car body is approached for several reasons: development of a new model, installation of a new unit, compliance with new regulations, weight reduction, introduction of new materials and technologies, etc. It can be realized through: constructive changes, introduction of new materials or combined. The paper analyses the effects of implemented changes in order to meet regulations as well as the need to change existing technologies on the example of a car body. The introduction of new materials can significantly improve the existing structure with minimal changes.

Keywords: car body, materials, modifications.

INTRODUCTION

Reconstruction of the car body is approached for several reasons: development of a new or restyling of the existing model, installation of new units, compliance with regulations, weight reduction, introduction of new materials / 1/2 / and technologies, etc. It can be realized through: constructive changes, introduction of new materials or combined / 3 /. The development and introduction of new materials for the production of car body parts is in line with general social requirements, available resources and the need to preserve them, preserve the environment, increase traffic safety, etc. With all this in mind, the following materials are increasingly used for the production of car body parts: high-strength steel sheets (HSS), Al-alloy sheets, titanium and its alloys, plastics materials, composites, etc. Figure 1.

Figure 1. Example of application of different materials in the construction of a car structure [4]

However, the introduction of new materials also requires a series of technological harmonizations in existing production processes or the introduction of completely new technologies. In addition to technologies by deformation, casting and sintering, there are more and more frequent requirements for new technologies by joining, especially materials with different characteristics / 4 /. In / 5 /, presents the introduction of new generation plastics in order to improve the rigidity of the bodywork. Having all the above in mind, as well as the need to install a new power units and meet the Regulations of ECE 12, 94 and 95, the reconstruction of the bodywork of the vehicle Koral was started.

REINFORCEMENT OF THE FIRST BODYWORK

When defining the reconstruction of the FIRST reinforced car body, the results of all realized tests were taken into account. The following changes have been made to the car body:

- constructive
- application of new materials.

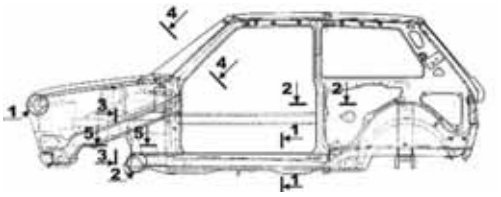

Figure 2. Supporting construction

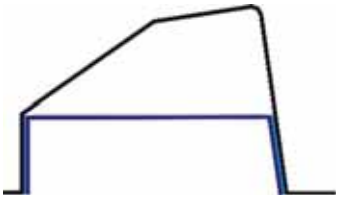

Figure 3. Detail

a. Constructive changes

At the beginning of the project, the goal was set to change the existing solutions of the existing body parts, as little as possible with the proposed reconstructions. This was a very significant limitation, especially considering the years of designing the car body of the base model as well as the regulations, which were in force at the time. The idea was as follows:

- **All open cross-sections** on the load-bearing structure, especially in critical zones, needs to be closed which significantly improves the structure. In fig. 2 shows the supporting structure of the bodywork of the Koral vehicle. The front upper cross member is defined by detail 1, see fig. 2 and 3. The introduction of a new girder resulted in a girder of a closed construction of a closed cross-section, which connects longitudinal girders much better in this zone, which is very important from the point of view of ECE 94. The introduction of this girder was aimed at reducing asymmetry of deformation the existing body parts have not been changed. A similar reconstruction was realized on several girders on the supporting structure.
- **Reconstruct critical places** on the supporting structure. For the type of supporting structure, as with the considered body, the front longitudinal supports are important elements of the supporting structure of the front skeleton. When designing them, it is necessary to take into account: their position, that is the direction of transmission of longitudinal deformations to other elements of the supporting structure, cross section, method of connection with other body elements, number and arrangement of weld points, etc. Based on the results of static tests and the developed quasi-static test / 6 /, two sensitive zones can be distinguished on the supporting structure of the frontal skeleton: A (joint zone of the front longitudinal girder, front inner lining and partition wall) and B (front inner lining joint zone, partition wall and car floor), as shown in Fig. 4. A new carrier was introduced by the constructive reconstruction of this joint, see fig. 5, in order to strengthen this zone as well as the place of support of the drive unit. Similar reconstructions were realized on other supporting zones in other sensitive zones.

Figure 4 Sensitive zones on the frontal skeleton

Figure 5. Section 6-6

- **Introduction of new supports**, taking care to change the existing supports as little as possible, as well as the car body assembly procedure. A new reinforcement was designed at the junction of the front inner lining and the partition wall, on the passenger side, with the aim of connecting this reinforcement to the front longitudinal girder with the floor skeleton (section 5-5, see Fig. 6) as well as the reinforced joint itself. In fig. 7 shows some of the newly introduced reinforcements on the supporting structure.

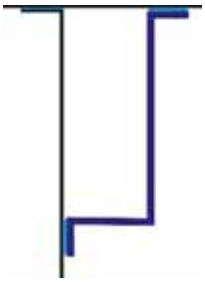

Figure 6. Section 5-5

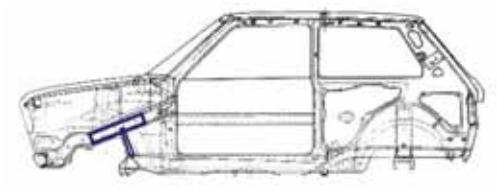

Figure 7. Display of newly introduced reinforcements

- **Reinforcement of side doors.** The side doors are important for the body's behavior according to ECE 94 and especially according to ECE 95. There were several standard side door reinforcement solutions on the vehicle, depending on the model. One reinforcement solution in the door belt was selected, see fig. 8, to which a new reinforcement has been added. In addition, two new pipe reinforcements were introduced. The skeleton of the door is reinforced laterally as well as the connections of the skeleton with the reinforcement in the belt.

Figure 8. Section 7-7

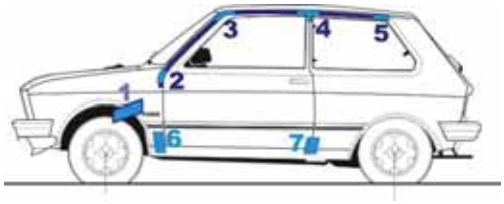

Figure 9. Schematic representation of reinforced body joints

b. Application of new materials

- **Application of materials for strengthening body joints.** From the point of view of ECE Regulations 94 and 95, the side frame, in conjunction with the side door frame, is an essential part of the supporting structure, especially on a vehicle without airbags. Analysis of the reinforcement effects of one body joint showed that the desired body joint reinforcement effects were achieved. The overall effects of strengthening the body of the Florida vehicle as a whole gave good results / 6 /. Since the same body reinforcement procedure is applied, similar overall body reinforcement effects can be expected. In such a complex reconstruction, it is very important to determine or select the body joints, which need to be strengthened, in order to obtain a significantly strengthened body as a whole. In fig. 9 is a schematic representation of reinforced body joints on the body of a Koral vehicle using new generation plastics.
- To strengthen the body joints, Dow Automotive form materials called Betafoam 88100 and 88124 used.
- The materials are mixed in a special pump at room temperature, and then the resulting mixture is injected into the desired joint, after the surface protection and body painting process is completed. The material is formed and gets its final shape at room temperature, after 20-30 minutes, depending on the size of the reinforced joint or the available space in the elements of the supporting structure. The new material, in addition to reinforcing the body joints into which they were injected, was used as a connection and support for the pipe reinforcement of the side frame. Without this material, the desired effect of strengthening the supporting structure would not be achieved, especially in the area of the windshield.
- **Application of structural adhesives.** One of the ways to strengthen body joints or body parts is the use of structural adhesives, which can significantly reduce the number of weld points. For additional bonding of body joints, especially in critical areas where access for spot welding is difficult, Betamate 1493 adhesive from Dow Automotive was used, as schematically shown in Fig. 10. Having in mind the goal of applying these adhesives for joining the elements of the supporting structure, the structural adhesive was first used in the front longitudinal girder, in order to strengthen its connection with other parts of the body as well as the connection with transverse supports. The next place of greater application is the skeleton of the side, at the

joints of the longitudinal girders as well as the places of connection with other parts or elements of the supporting structure. In general, this improves the joints of the longitudinal girders, with each other, as well as their connections with the transverse girders.

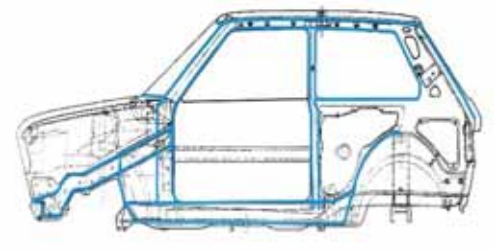

Figure 10. Places of application of structural adhesives on the body of a Koral vehicle

Figure 11. Car body testing device

ANALYSIS OF THE EFFECTS OF CORAL VEHICLE BODY REINFORCEMENT

Testing of the reinforcement effects of the FIRST reinforced body of the Koral vehicle was performed in the conditions of the ECE 94 test simulation, according to the methodology defined in / 5 /. In fig. 11 shows a device for quasi-static tests. During the test, the following measurements are performed:

- Total deformation displacement at all measuring points
- Deformation displacement at selected measuring points
- Recording car body behavior.

Figure 12. car body after test

Figure 13. Vehicle after ECE test 94

In fig. 14 and 15 show the results of a quasi-static test of the first reinforced body of a Coral vehicle. The behavior of vehicles with a reinforced body after the ECE 94 test is shown in Fig. 13. One of the basic parameters of body behavior is the analysis of deformed body, see Fig. 12. Significantly greater deformation on the driver's side. The zones of large deformations are the same as on the vehicle, after the impact test. The developed test gave the expected results. The application of new materials and technological procedures has significantly increased the longitudinal stiffness of the body, see fig. 15, in relation to the base model / 5 /.

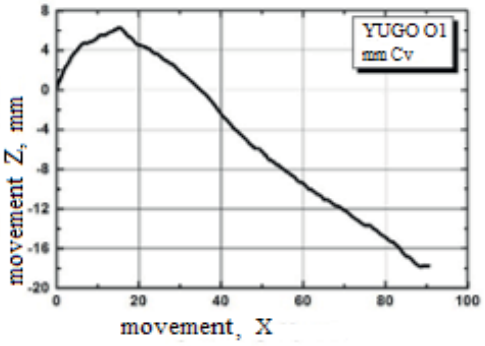

Figure 14. Moving the steering wheel connection

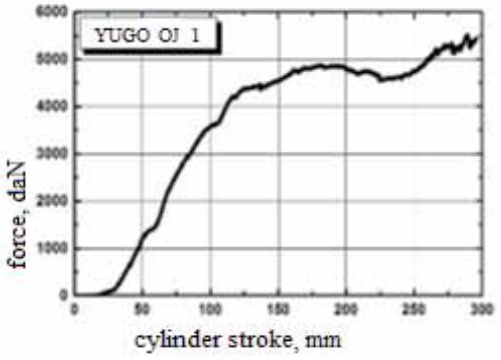

Figure 15. Realized force-stroke dependence

CONCLUSION

The development and introduction of new materials in the automotive industry is inevitable, especially given the increasingly stringent requirements. The requirements for reducing harmful gases and fuel consumption are directly related to reducing the weight of the car. Reducing car weight can be achieved in several ways: using high-strength steels, aluminium alloys, polymeric or composite materials. The application of these materials often limits the application of classical technologies, ie. requires new procedures and often completely new technologies. One of the reasons for the possible delay is the cost of such a process. The presented results indicate the justification of the introduction of new materials, especially for models that were previously designed, ie. in models where reconstruction is justified. In this way, the reconstruction of previous models creates new models with new shape and characteristics.

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