THE ANALYSIS OF THE INFLUENCE OF NEW MATERIALS APPLICATION ON CAR BODY CONSTRUCTION

АНАЛИЗ ВЛИАНИЯ ПРИМЕНЕНИЙ НОВЫХ МАТЕРИЯЛОВ НА КОНСТРУКЦИЮ КУЗОВ

Dr. Eng. Milovanović M.[1], Mr. Eng Vitošević N.[1]
R&D Institute[1], Car factory Zastava Kragujevac, SERBIA

Abstract: *The need for constant improvement of new or restylized car models imposes the creation of new possibilities, such as introduction of new materials. Possibilities and needs differ in dependence on valid regulations and particular markets demands. The improvement of construction can be realized through: constructive changes, introduction of new materials or by combined method.*
In this paper, by using one car body model, the effects of realized changes were analysed with the aim of satisfying both the regulations and the need for change of existing technologies.
KEYWORDS: CAR BODY, MATERIALS, CHANGES.

1. Introduction

Reconstruction of passenger car body can be performed for many reasons: development of new model, restylizing of the existing model, installing of new aggregates, satisfaction of regulations, weight reduction, introduction of new materials and technologies etc. It can be realised through: constructive changes, by introduction of new materials or by combined method. Development and introduction of new materials for manufacture of car body parts were adjusted to general community demands, available resources and need to preserve them, ecology preservation, increase of safety in traffic etc. Bearing all that in mind, the following materials are more and more used for manufacture of car body parts: sheet metals made of high strength steels (SHS), sheet metals made of Al-alloys, plastic masses etc. However, the introduction of new materials requires a sequence of technological adjustments to the existing production processes or introduction of completely new technologies. [1] presents the introduction of plastic masses of new generation with the aim of improving car body stiffness. Taking all aforementioned facts into account, including the need for installing the new drive unit and satisfying By-law ECE 12, 94 and 95, the reconstruction of vehicle Koral car body, from production programme of car factory Zastava was initiated.

2. Strengthening of the first car body

When defining the reconstruction of the FIRST strengthened car body, the results of all realised tests were taken into consideration. The following changes were performed on car body:

- constructive changes
- application of new materials.

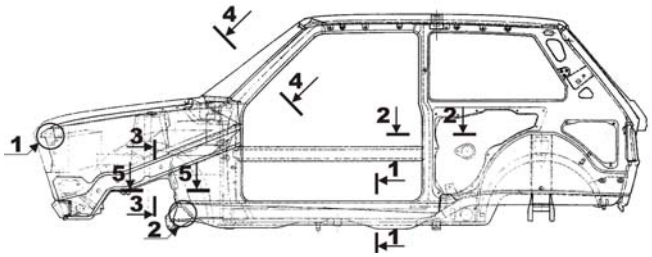


Fig. 1 *Carrying construction*

2.1 Constructive changes

At the beginning of the project the aim was set - to apply the proposed reconstructions with minimal changes of existing solutions, i.e. existing car body parts. That was a significant limitation, especially regarding the year when the basic model car body was designed and regulations valid at that time. The following changes were undertaken:

● **All open support sections** on carrying construction, especially in critical zones, must be closed, which would significantly improve the carrying construction. Fig. 1 shows the carrying construction of vehicle Koral car body. Front upper cross support was defined by detail 1, see fig. 1 and 2. By introduction of the new support, a closed section support of carrying construction was obtained, which connects longitudinal supports in this zone much better, which is very important from the aspect of By-law ECE 94. The introduction of this support was focused on reduction of asymmetry of deformations of left and right side of front frame without changing the existing car body parts. The similar reconstruction was realised on many supports on the carrying construction.

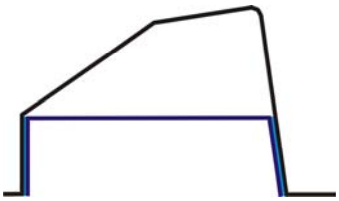


Fig. 2 *Detail 1*

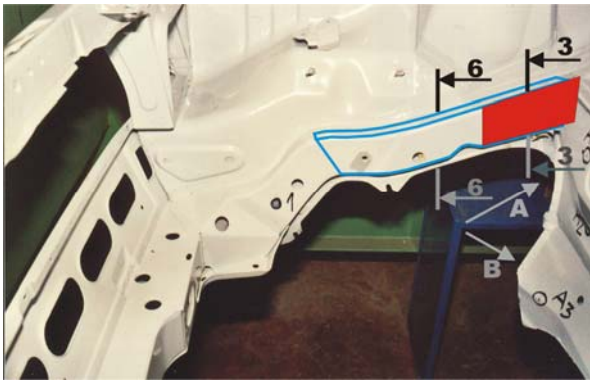


Fig. 3 *Sensitive zones on front frame*

● **To reconstruct critical points** on carrying construction. For the type of carrying construction such as the one of considered car body, front longitudinal supports are important elements of front frame carrying construction. When designing them, it is necessary to pay attention to: their position, i.e. direction of conveyance of longitudinal deformations onto the other elements of the carrying construction, cross section, method of connecting them to other car body elements, number and position of welding points etc. On the basis of static investigation results and developed quasi-static test [1,2] two sensitive zones can be identified on the carrying construction of the front frame: **A** (zone of connection of front longitudinal support, front inside coating and partition wall) and **B** (zone of connection of front inside coating, partition wall and car

floor), as shown in fig. 3. By constructive reconstruction of this joint, a new support was introduced, see fig. 4, in order to strengthen this zone, as well as drive unit support point. The similar reconstructions were realised in other sensitive zones on carrying construction.

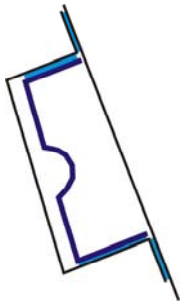


Fig. 4 *Section 6-6*

● **Introduction of new supports,** whereat it must be taken into consideration that only the minimal changes are made on the existing supports and in the procedure of car body assembling. New strengthening on the joint of front inside coating and partition wall was designed, on passenger's space side, with the intention to use this strengthening as a joint of front longitudinal support and floor frame (section 5-5, se fig. 5), as well as for strengthening the joint itself. Fig. 6 shows some newly-introduces strengthenings on carrying construction.

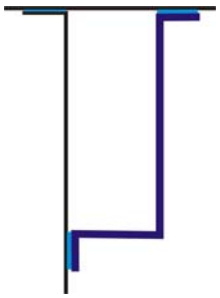


Fig. 5 *Section 5-5*

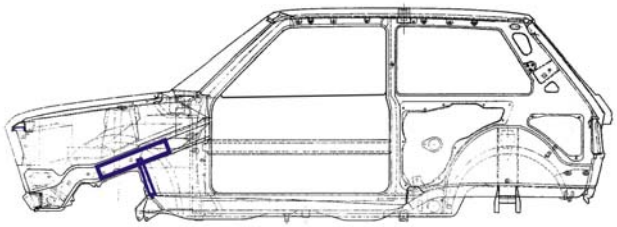


Fig. 6 *Schematic display of newly-introduced strengthenings*

Fig. 7 *Strengthening of side door*

● **Strengthening of side door.** Side door is important for car body behaviour according to ECE 94, and especially according to ECE 95. There were several serial solutions for strengthening the side doors on the vehicle, in dependence on the model. One strengthening solution within door band was selected, see fig. 7, to which new strengthening was added. In addition to that, two new pipe strengthenings were introduced. Side door frame was strengthened, as well as joints of frame with strengthening in band.

2.2 Application of new materials

● **Application of materials for strengthening car body joints.** From the aspect of By-law ECE 94 and 95, lateral side frame, in connection with side door frame, is important part of the carrying construction, especially on the vehicle without air bags. The analysis of the effect of one car body joint strengthening showed that the desired effects of car body joints strengthening were achieved. The total effect of strengthening of vehicle Florida car body as a whole gave good results [2]. Since the same procedure of car body joint strengthening was applied, the similar total effects of car body strengthening can be expected. In such a complex reconstruction, it is very important to identify, i.e. select car body joints which must be strengthened in order to obtain significantly strengthened car body as a whole. Fig. 8 gives a schematic display of strengthened car body joints on vehicle Koral car body by application of plastic masses of new generation.

For strengthening car body joint, materials of company Dow Automotive, named Betafoam 88100 and 88124, were used. In the special pump, the materials are mixed at room temperature and, afterwards, the obtained mixture is injected into the desired joint, after completed process of surface protection and car body painting. The material is formed and it gets its final shape at room temperature, after 20-30min, in dependence on size of strengthened joint, i.e. available space in carrying construction elements. Besides being applied for strengthening of car body joints into which they were injected, the new materials were used as a connection and support of pipe strengthening of lateral side frame. Without such a material, the desired effect of carrying construction strengthening would not have been achieved, especially in the zone of windshield glass.

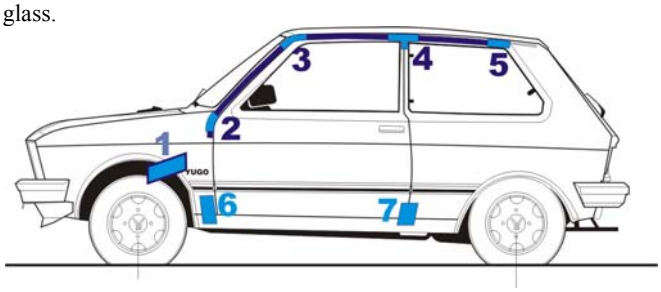
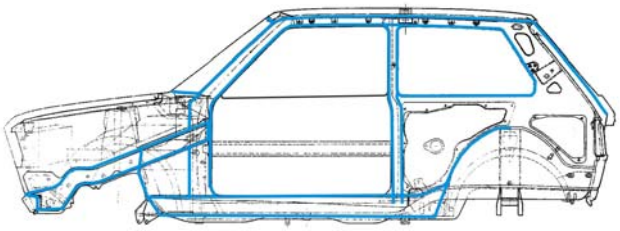


Fig. 8 *Schematic display of strengthened car body joints*



Sl. 9 *Application points of structural adhesives on vehicle Koral car body*

● **Application of structural adhesives.** One of the methods for strengthening car body points, i.e. car body parts, is application of structural adhesives, which can reduce the number of welding points considerably. For additional gluing of car body joints, especially in critical zones where the access for spot welding is difficult, adhesive Betamate 1493 of company Dow Automotive was applied, as schematically shown in fig. 9. Bearing in mind the aim of application of these adhesives for connecting the elements of carrying construction, structural adhesive was first applied on front

longitudinal support, in order to strengthen its connection with other car body parts and connection with cross supports. The following point of lager application is lateral side frame, on points of longitudinal supports connecting and points of connection with other parts, i.e. carrying construction elements. This method is mainly used for improving longitudinal supports joints, as well as their connections to cross supports.

Fig. 10 *Device for quasi-static tests*

Fig. 11 *Car body appearance after quasi-static test*

Fig. 12 *Impact test conditions according to ECE 94 in longitudinal direction*

3. *Analysis of the effects of vehicle Koral car body strengthening*

The investigation of the effects of strengthening of the FIRST strengthened car body of vehicle Koral was performed in test simulation conditions according to ECE 94, according to methodology defined in [1,2]. Fig. 10 shows the device for quasi-static tests in conditions of by-law ECE 94. During the test, the following is realised:

- Measuring of total deformation displacements on all measuring points
- Measuring of deformation displacements on selected measuring points
- Recording of car body behaviour.

Fig. 13 *Test conditions according to ECE 94 in cross section*

Fig. 14 *vehicle appearance after the test according to ECE 94*

Fig. 15 *Appearance of car body front after the test*

Fig. 11, 15, 16 and 17 show the results of quasi-static investigations of the first strengthened car body of vehicle Koral. One of the main parameters when analysing the car body behaviour is the analysis of total car body deformation, see fig. 11 and 15. Car body deformation is considerably larger on driver's side, which is conditioned by the test itself, adjusted to the demands of by-law ECE 94. Large deformation zones are the same as those on the vehicle after impact test according to ECE 94, see fig. 14. Performed test gave the expected results regarding estimation of car body behavior in front impact test.

Application of new materials and technological procedures, as well as reconstructions carried out on the carrying construction, influenced a significant increase of longitudinal stiffness of car body, see fig. 17, compared to basic model [1].

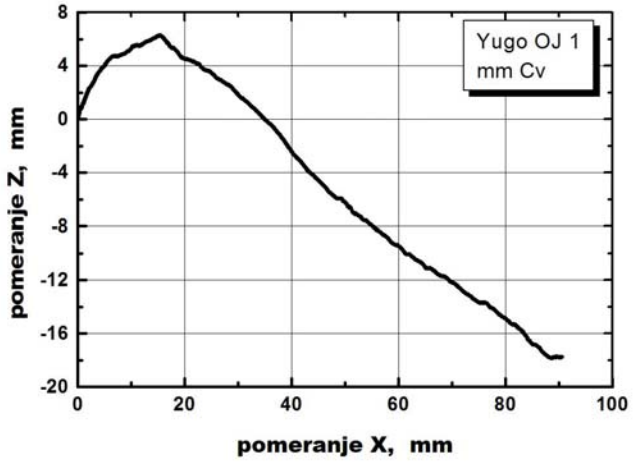


Fig. 16 *Displacement of steering wheel connection point* strengthened 1

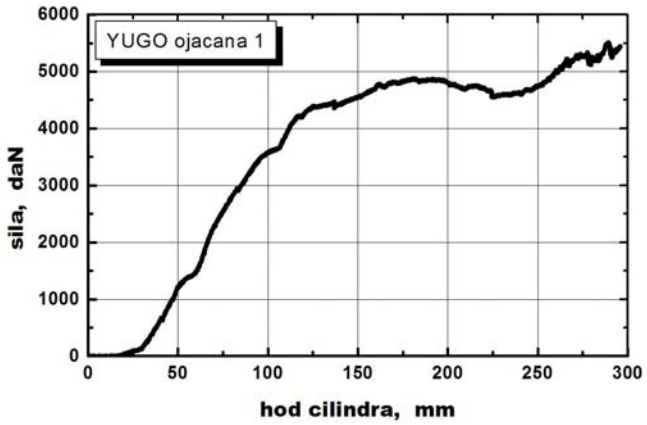


Fig. 17 *Realised dependence force-travel*

Based on results of car body behaviour investigation, car body behaviour expected in front impact test can be estimated. Strengthening gave good results, which was confirmed in vehicle test according to ECE 94.

In addition to the need for construction improvement, in the case of reconstructed car body particular procedures can also be applied with the aim of increasing the car body quality, since sensitive points on car body can be eliminated.

4. Conclusion

Development and introduction of new materials in car industry is a necessity, especially regarding increasingly stricter demands. However, introduction of new materials requires a sequence of technological adjustments or introduction of completely new technological processes. One of the reasons for possible delay is the price of such a process.

In addition to that, it is necessary to improve methods for estimation of performed interventions constantly. Shown results indicate necessity for new materials introduction, especially for previously designed models.

Literature

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