THE ANALYSIS OF THE INFLUENCE OF DRIVE UNIT ON CAR BODY BEHAVIOUR

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Abstract: *This paper has presented several carrying constructions of vehicles, i.e. the development of the carrying construction of one producer. In addition to the analysis of carrying construction behaviour, it is necessary to take into account the influence of additionally installed drive units onto the carrying construction behaviour. In this paper, the influence of drive unit on carrying construction behaviour has been demonstrated. With the aim of presenting the results, behaviour of carrying construction in conditions of quasi-static test has been shown, as well as in conditions of simulation of front impact test.*

Keywords: CAR BODY, BEHAVIOUR, INFLUENCE.

1. Introduction

The level of success of the construction is the reflection of the design period, as shown in fig. 1, where the carrying construction of vehicle Zastava Yugo**,** designed in the 70-ties of the last century, is presented. The carrying construction was similar to the carrying construction of other FIAT models, with the frontal frame construction considerably influenced by the construction of the front vehicle suspension system. The functions of the front suspension system of the vehicle did not include the stiffening of the frontal frame. The designed directions of car body deformation are specific due to the characteristic position of front longitudinal supports, which direct deformation considerably towards longitudinal roof supports, and less towards car floor. There was no connection with the car floor elements on the frontal part, which was unfavourable from the aspect of carrying construction loading.

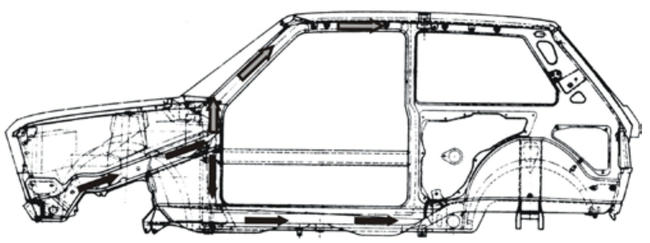

Fig. 1 *Vehicle Yugo-car body.*

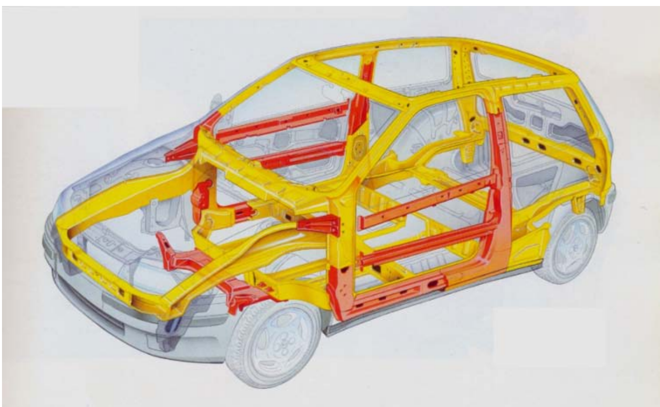

Fig. 2 *Vehicle Zastava10- car body*

In serial car production, the car bodies are mainly made out of thin-walled sheet metals, which are connected by suitable procedures (welding, soldering, gluing etc.). Car body[2] is influenced by several factors: adopted vehicle style, vehicle concept, vehicle size, vehicle version, application of new materials, influence of safety regulations etc. Modern style influences the appearance of carrying construction greatly, especially bearing in mind ever stricter regulations related to vehicle impact.

Car body of vehicle Zastava10 is a car body of modern concept, with car body shown in Fig. 2. Frontal frame was strengthened considerably; together with front vehicle suspension system, it makes a set which is of great importance for car body behaviour at front impact. The installed chassis stiffens the frontal frame. Front longitudinal supports, which direct deformation towards car floor, are also important. With the purpose of satisfying side impact conditions, side shell frame, with prominent pillar B and lateral longitudinal supports of floor, was strengthened considerably. Side door frame was strengthened additionally. The carrying construction of this car body is also robust and adjusted to the by-law demands. With the aim of strengthening the construction, sheet metals of increased strength, which strengthen the construction with significant weight reduction, were also applied. When designing the carrying construction of one vehicle several cases may occur; they are:

- Carrying construction of the existing model is improved(minor reconstruction)
- Major reconstruction
- The designing of both the new generation of carrying construction and vehicle elements which influence its behaviour.

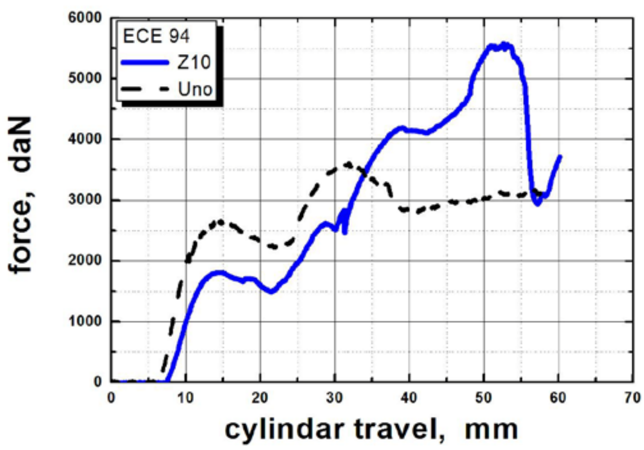

Fig. 3 *Comparative display of dependence force-travel of vehicle Zastava10 and previous model (Uno)*

The third case occurred when designing vehicle Zastava10 car body, where a completely new carrying construction was designed with the aim of satisfying market demands in the following ten-year period. The development of the carrying construction was accompanied by a significant improvement of both the solution for front vehicle suspension system and interconnections of all other drive units in frontal part with car body. The results of such a procedure are shown in Fig. 2.

Improvement of one model of any producer inevitably leads to improvement of vehicle construction. For the behaviour of the older vehicle car body (car body of vehicle Uno), it is typical that large deformations first appear on the connection of front longitudinal supports and partition wall, then the deformations occur on side shell frame, and finally the construction collapse occurs /3/. In this way, with directed collapse point, the desired objective is accomplished. In new vehicle model car body, considerably higher level of force is achieved, and the behaviour of car body is significantly improved. Deformations of the carrying construction in the front part are insignificant and also directed regarding point and direction. Side shell frame is slightly deformed, i.e. passenger space deformation is minimal, see fig. 6 and 7. Regardless of stricter investigation conditions, increase of force achieved for car body of vehicle Z10 compared with car body of vehicle Uno is significant, which indicates that great efforts were invested in order to accomplish such a result, see Fig.3.

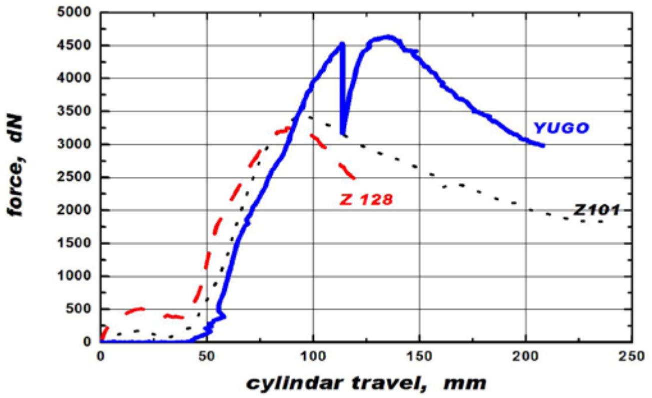

Fig.4 *Comparative display of effect of car body improvement*

The following model which was developed in Zastava was vehicle Yugo, which maintained many elements of vehicle Z101/128 (carrying constriction type, front vehicle suspension system, drive unit suspension etc.). FIg. 4 shows the comparative display of obtained improvement of vehicle Yugo behaviour. Critical point in car body behaviour can be observed, which can also be the consequence of the welding quality. In vehicles Z101 and Z128, since the front part is the same, almost identical accomplished force was obtained. Model Yugo exceeded the previous model significantly, which was expected as it was the new model. However, the realized difference was limited by the similar front vehicle suspension system, i.e. realized carrying construction, which was adjusted to this system.

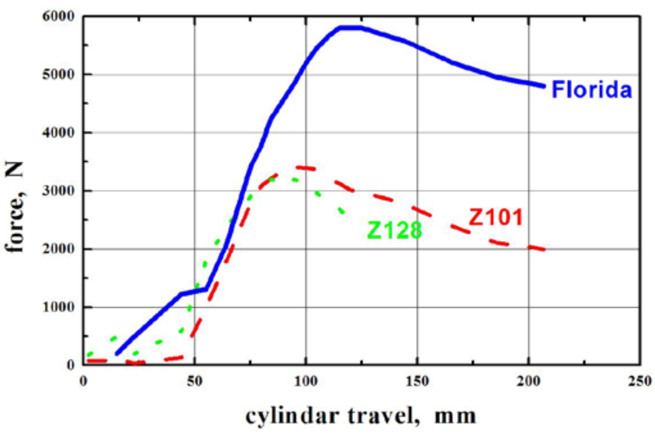

Fig. 5 *Improvement on vehicle Florida car body*

When developing vehicle Zastava Florida (90-ties of the last century), the opportunity was not taken to change the construction of front system for vehicle suspension, the consequence of which would be the change of carrying construction in the front part. Fig.5 shows the accomplished improved level of car body behaviour, which was not sufficient to satisfy by-law ECE 94. I Maintenance of the same construction of front vehicle suspension system also had a lot of influence on vehicle Florida car body.

2. The analysis of the influence of drive unit on car body behaviour

The developed method was focussed on obtaining data on car body behaviour at impact test. The concept of monitoring the behaviour of car body itself, regardless of the influence of additionally installed car body parts, i.e. influence of drive units installed on the vehicle, was selected. The initial assumption was that each installed drive unit would have a positive influence on car body behaviour and that such influence should be taken into account in later stages of the analyses, but not in the initial designing phase.

With the aim of getting closer to impact tests, the experiment was carried out in order to determine the influence of vehicle drive units which are installed on the car body. The following elements were installed on the investigated car body: propulsion group, part of steering mechanism and front suspension system, as shown in Fig. 6, as serial solutions on the vehicle. The installed drive units were mainly the ones which could influence the behaviour of frontal frame. The installing conditions were identical to those on the vehicle.

Fig.6 *Display of installed drive units*

Concerning the initial test conditions, nothing was changed regarding: device, investigation conditions, measuring points and car body estimation method. The initial analysis of car body behaviour was performed via visual monitoring of car body.

Fig.7 *The initial position of car body with drive units*

Fig. 7 shows the initial position of the investigated car body with installed drive units, where the initial position of the wheel in relation to car body can be seen clearly. In the initial test phase, the first car body deformations appeared on the front outer coating (mudguard). The initial deformation also occurred in the zone of partition wall junction, front inner coating and front longitudinal support, which resulted in the initial contact of wheel and floor.

Fig.8 *The first inter-phase*

Fig.9 *The second inter-phase*

Fig.10 *The final position*

Fig. 8 presents the first inter-phase. The initial crack on windshield glass can be noticed. The deformation on the floor, as the consequence of wheel contact, can also be observed, as well as deformation of the front side door opening, as the result of deformation conveyance over front longitudinal supports. Fig. 9 shows the following inter-phase. The increased deformations of side door opening caused the windshields glass to start falling out. Deformations in the zone of partition wall junction, where the separation of the partition wall from front inner coating occurred, are also visible. The final position of the deformed car body is shown in Fig. 10.

On car body with installed drive units no major deformations occurred on front end of front longitudinal supports, Fig. 11, while the deformations were increased on car body behind front wheels. The increased deformation was obtained in the zone of partition wall junction, left front side door opening and windshield glass opening.

Fig.11 *Appearance of front frame*

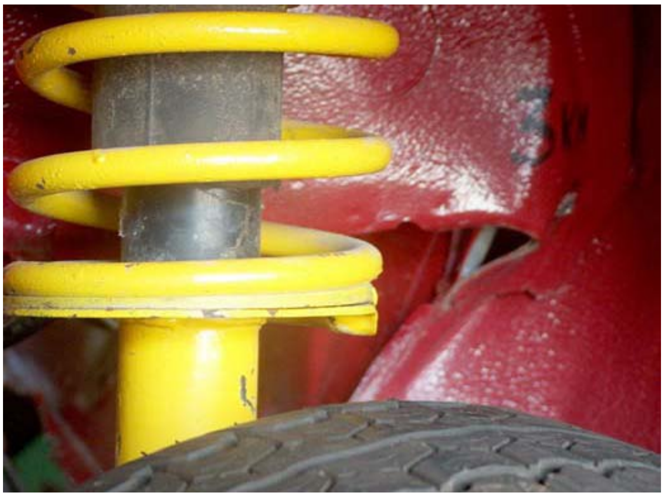

Fig.12 *Front inner mudguard after the test*

Fig.13 *Partition wall after the test*

Fig. 11, 12 and 13 show the front part of vehicle Florida car body, on which the drive units were installed, after the quasi-static test. Here, as well, major deformation of car body was obtained on the left side, but it was significantly smaller than on the ″bare″ car body. In this case, also, the front end of front longitudinal supports remained non-deformed. The installed drive units caused the significant changes of character of critical zones deformations. In this test, also, the located critical zones were the same as ones found in investigation of car body without drive unit.

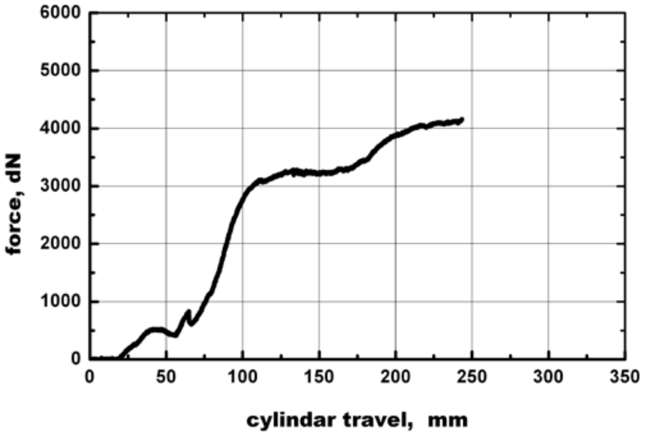

Fig.14 *Force-travel dependence of cylinder on "bare" car body*

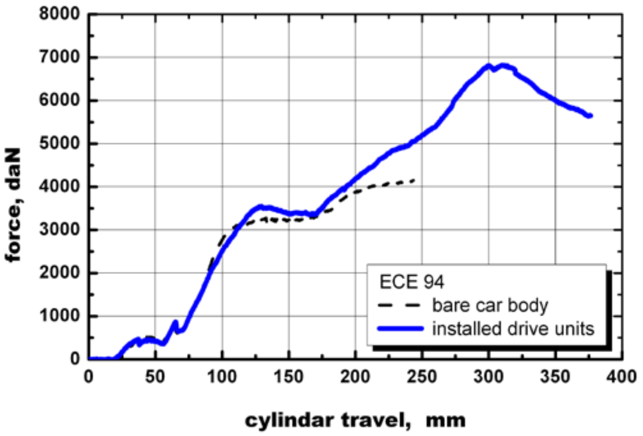

Fig.15 *The influence of installed drive units*

As expected, the installed drive units influenced the behaviour of car body, which was expressed by increased force at construction fracture. However, regardless of the altered behaviour of car body, the critical zones remained the same.

3. Conclusion

Development and application of new solutions in car industry is a necessity, especially considering ever stricter market demands and valid regulations. In addition to that, it is necessary to improve, constantly, the methods for evaluation of performed interventions. The presented results indicate the influence of installed drive units which must be taken into account when doing the calculations and in the initial phase of the project.

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