THE ANALYSIS OF SUBFRAME INFLUENCE ON CAR BODY BEHAVIOUR

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INTRODUCTION

The level of success of the construction is the reflection of the design period, as shown in Figure 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.

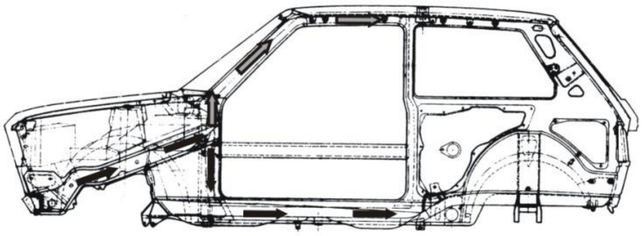

Figure 1 Vehicle Yugo - car body

Car body of vehicle Zastava10 is a car body of modern concept, with car body shown in Figure 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 subframe 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.

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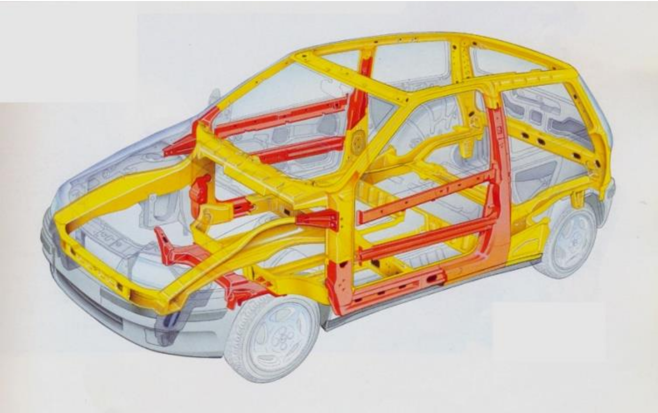

Figure 2 Vehicle Zastava10 (Punto FIAT) - car body

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 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.

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 Figure 2.

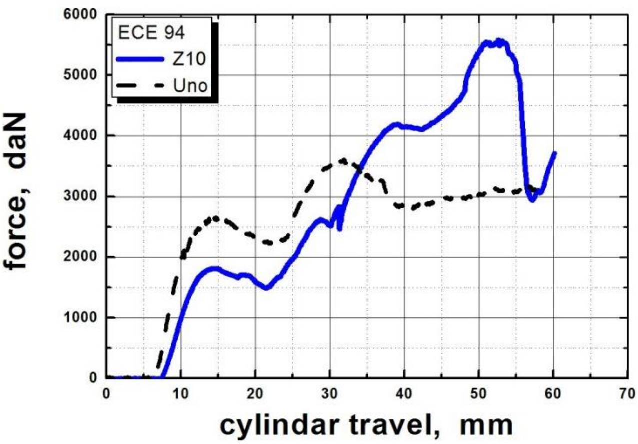

Figure 3 Comparative display of dependence force - travel for vehicle Zastava10 and model Uno

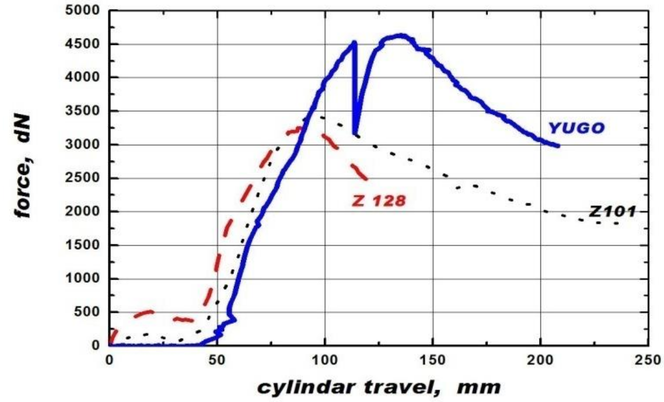

Figure 4 Comparative display of effect of car body improvement

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 Figure 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 Figure 3.

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.). FIgure 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.

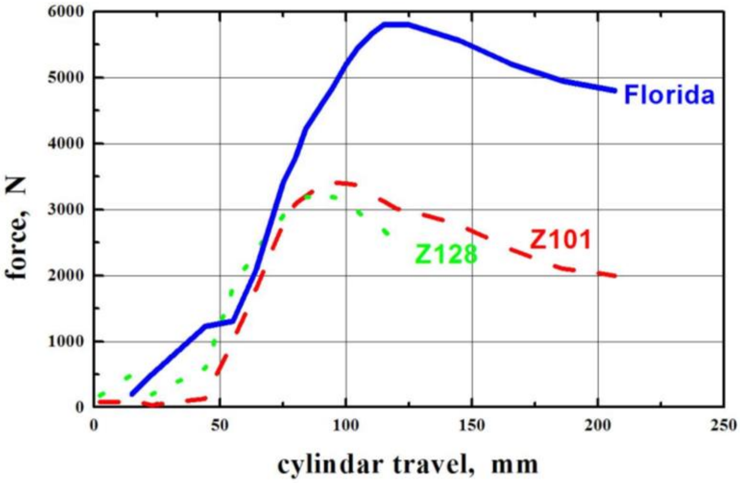

Figure 5 Improvement on vehicle Florida car body

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. Figure 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.

***Figure 6** Display of installed drive units*

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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 vehicle suspension system with subframe, as shown in Figure 6, with upgraded car body. 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.

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.

Figure 7 The initial position of car body with drive units

Figure 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 occurred on front part of front longitudinal support, in front of front wheel axis, see Figure 8.

Figure 8 The first inter- phase

Figure 9 shows the following inter- phase. The increased deformations of side door opening caused the windshields glass to start falling out. The deformation on front left longitudinal support was still increasing. The final position of the deformed car body is shown in Figure 10. In the given case, the extreme deformations occurred in the front part and at side door opening.

Figure 9 The second inter- phase

Figure 10 The final position

Major deformations also occurred on car body with installed drive units, with subframe, on front part of front longitudinal supports, figure 11, which was the consequence of the influence of subframe which had stiffened the front frame in the partition wall zone. Intensive deformation occurred at side door opening and windshield glass opening. Character of front frame deformation was considerably changed.

Figure 11 Appearance of front frame

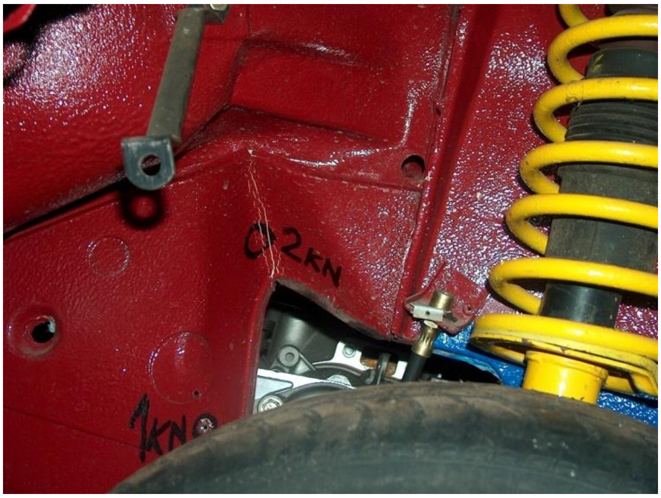

Figure 12 Front inner mudguard after the test

Figure 13 Partition wall after the test

Figure 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. Redistribution of load and increased deformations of front left longitudinal support occurred in front part. The installed drive units caused the significant changes of character of critical zones deformations. In case of this test, as well, critical zones, similar to those in investigations of car body without drive units, were located.

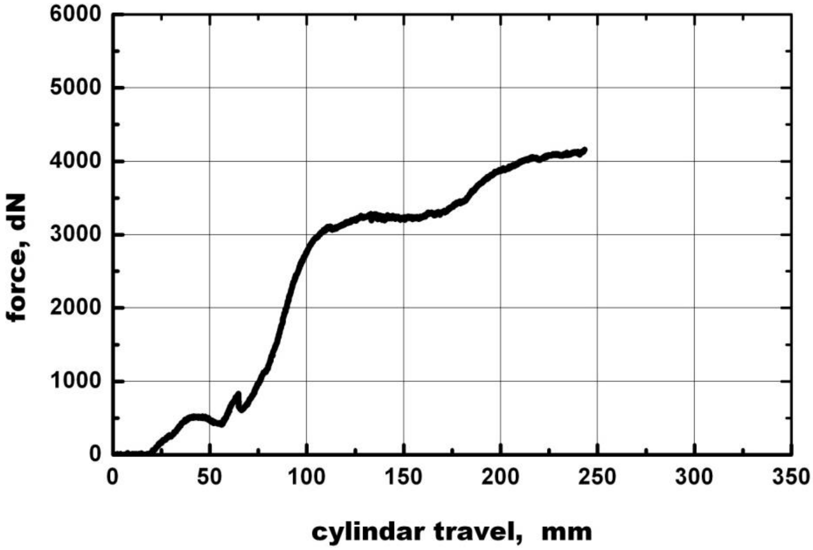

Figure 14 Force - travel dependence of cylinder on "bare" car body

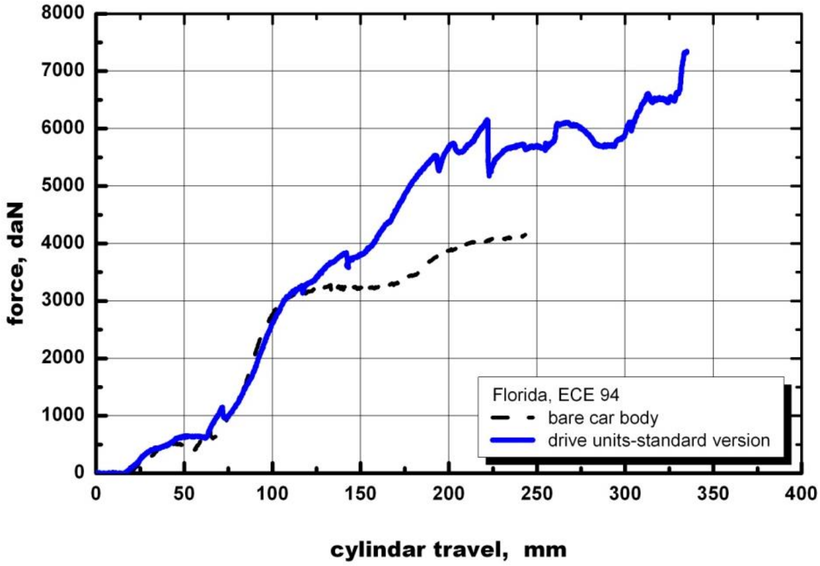

Figure 15 Influence of installed drive units - standard vehicle version

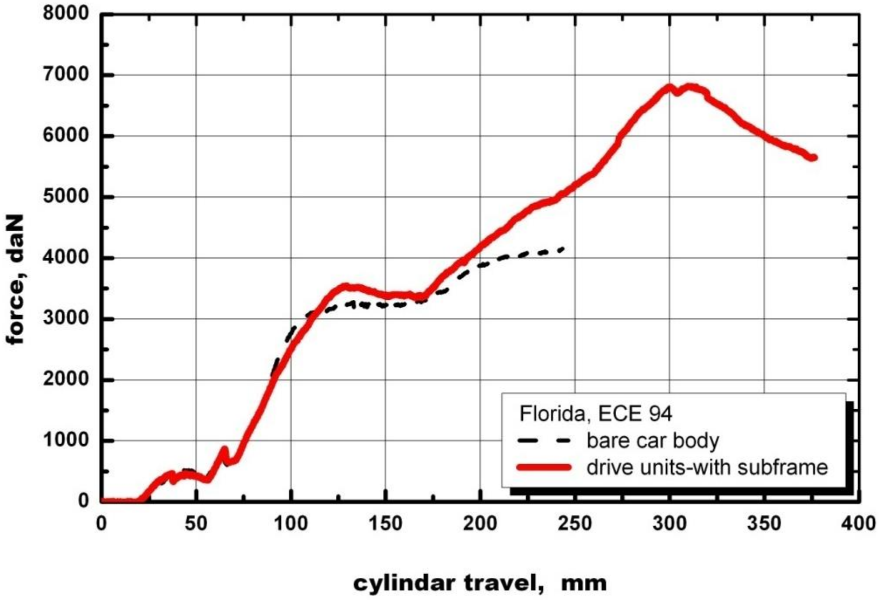

Figure 16 Influence of installed drive units – with subframe

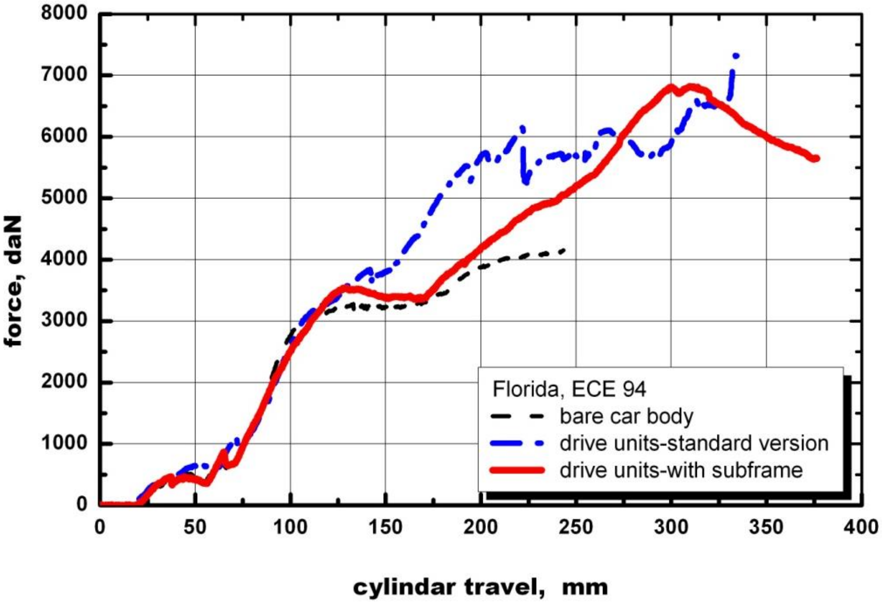

Figure 17 Comparative display of the influence of installed drive units

As expected, the installed serial drive units influenced the behaviour of car body, which was manifested by increased force at construction fracture. The first critical zone was less prominent, which was probably the consequence of contact between the wheel and car body.

As expected, the installed drive units with subframe influenced the behaviour of car body, which was manifested by increased force at construction fracture. The first critical zone was more prominent, which was probably the consequence of the lack of contact between the wheel and car body**.**

On serially installed drive units, deformation of front part towards partition wall occurs; its character, however, becomes significantly improved after the contact of wheel and gearbox with the car body. In the case of subframe, after the deformation of front longitudinal supports, the influence of subframe, visible at the end of the test, occurs. Car body deformation character has been considerably changed.

CONCLUSIONS

The development and introduction of new solutions in car industry is a necessity. The presented results indicate the influence of installed drive units which must be taken into account when making calculations and in the initial project phase.

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