Abstract: The paper presents the carrying construction of one vehicle. Both car body and carrying construction have been analysed. The conditions of car body investigation in quasi-static conditions were adjusted to analysed car body. With the aim of presenting the analysis results, behaviour of carrying construction in conditions of quasi-static test was shown, as well as in conditions of simulation of front impact test.

KEYWORDS: CAR BODY, BEHAVIOUR, INFLUENCES

1. Introduction

On modern passenger vehicles, self-supporting car body construction is most frequently applied. Regarding serially manufactured cars, car bodies are usually made of thin-wall sheet metals, which are attached by appropriate procedures (welding, soldering, gluing etc). The carrying structure is influenced by many factors: adopted vehicle style, vehicle concept, vehicle size, vehicle version, application of new materials, safety regulations influence etc. In this paper, behaviour of one modern passenger car body was analysed. Vehicle style was adjusted to market demands. Modern style influences the appearance of carrying construction significantly, bearing in mind ever stricter regulations related to vehicle impact.

One of the example solutions for the modern car body is given for model Opel Corsa, which belongs to the same category of vehicles as the car body of vehicle which is being investigated. Opel Corsa is a model which belongs to the upper A class and due to relation wheel base – maximal length belongs to the group of modern-concept vehicles within its class with well-defined passenger space enabled by a large wheel base. Interior and exterior of vehicles from this class are no longer far behind upper class models. In models belonging to this class of vehicles the increased wheel base influences significantly the increase of vehicle length. The increase of wheel base, i.e. vehicle length, influences directly the increase of vehicle mass. Taking all that into consideration, it is necessary to define the carrying construction which has to satisfy the regulations of by-law for impact, which inevitably leads to vehicle mass increase. Figure 2 presents the car body of this vehicle. Frontal frame is well de vised, and is characterized by strong front longitudinal supports and bottom front longitudinal support which also serves as a bumper frame. Also, the support on the junction of front inner and outer coating is of increased section. In the point of junction with partition wall, front longitudinal support branches towards the floor, where it directs the deformation at frontal impact. Further on, on the floor, strong longitudinal supports are made. Back frame is also very compact. In this model, particular attention has been paid to the defining of side frame, where pillar B (i.e. side door strengthening) dominates. In addition to door strengthening in the belt area, additional strengthening was added in the bottom door part, in the shape of pipe. The carrying construction is robust with all the elements of modern carrying construction.

For the investigated car body, the carrying construction was designed with the similar goals. Frontal frame, which together with front suspension system makes an entity important for car body behaviour at frontal impact, was strengthened significantly. Also, front longitudinal supports, which direct deformation towards car floor, are more prominent. Regarding side impact demands, side frame, with prominent pillar B and side longitudinal floor supports, was strengthened considerably. Side door frame was additionally strengthened. The carrying construction of this car body is also robust and adjusted to the by-law demands.
2. **Behaviour of car body in quasi-static conditions**

For estimating the influence of particular parameters on car body, for different car body types, laboratory trial for investigating car body in quasi-static conditions was developed, whereat By-laws ECE 33 and 94 /1,2/, see figure 4, were simulated throughout the investigation method development. Car body is tied onto the measuring bench, as shown in fig. 5. On the front part, loading is conveyed by constant speed, up to the construction fracture. That is when the test is over. The shape of impact plate is adjusted to the valid by-law.

![Fig. 4 Simulation conditions according to ECE 94](image1)

The concept of monitoring behaviour of car body only was selected, regardless of the influence of additionally installed parts and all other vehicle drive units. The estimation of car body behaviour was performed on the basis of the following indicators:

- deformation displacement on selected measuring points (1, 82,Cv,99)
- recording of car body behaviour
- deformations of characteristic car body joints and car body as a whole.

3. **The analysis of the effects onto the behaviour of carrying construction of car body**

Fig. 7 presents the initial position; the investigated car body (ICB) is still non-loaded. It is necessary to observe the initial position of front longitudinal support in relation to the measuring bench, as well as the position of pillar A.

![Fig. 7 Initial position](image2)

Fig. 8 presents the midway position of loaded car body. Lifting of front car body part occurs. Deformation is conveyed over front longitudinal supports onto the pillar A, which is deformed in the upper part. Deformations on front inner mudguard are insignificant.

![Fig. 8 Midway position](image3)

Fig. 9 presents the final position of car body after completed test. The total deformation of front longitudinal supports is directed towards floor, which is the final aim of the construction.

![Fig. 9 Final position](image4)
In fig. 10 and 11 smaller deformation of front left longitudinal support can be noticed, in the zone of contact with impact plate. Deformation is conveyed, to a smaller extent, onto the front left inner mudguard and partly to the pillar A. Deformation of front left longitudinal support is directed towards the floor, which is good if we take into consideration the test of front impact on vehicle. Fig. 12 shows the car body of vehicle of the same producer belonging to the previous generation of vehicles (PCB). Considerably larger deformation of front left longitudinal support can be observed, which is conveyed onto the pillar A and door opening. The consequence of that is separation of front inner mudguard from the floor. Deformations on the investigated car body are considerably smaller on the left side, although the test conditions were somewhat stricter.

Both in quasi-static test, see fig. 13, and in front impact test, the right side remained almost non-deformed, see Fig. 14. Such behaviour is the consequence of test conditions and car body construction which was adjusted to the required conditions. Fig. 13 shows the difference in deformations of the left and right part of frontal frame. Deformation of frontal frame was absorbed up to the partition wall.

The behaviour of frontal frame elements, which are important for car body behaviour at front impact test, is monitored via dislocation of measuring point 1, on front left longitudinal support. On the older car body, this displacement is directed upwards, which is unfavourable from the front impact aspect. On the investigated car
body deformation is directed downwards, by which the movement of drive unit at front impact test is directed as well. The consequence of such a deformation of front longitudinal support, on the investigated car body, was that the linkage point of steering wheel was displaced upwards, see fig. 16. On the older car body, displacement typical for the observed form of carrying construction was obtained.

Fig. 16 Displacement of linkage point of steering wheel

Fig. 17 Comparative presentation of dependence force-travel

Fig. 18 Appearance of previous car body after quasi-static test

The improvement of one model of any producer inevitably leads to the improvement of vehicle construction, see fig.17, 18 and 19. For the older car body behaviour it is typical that large deformations occur first on junction of front longitudinal supports and partition wall, then on side frame, and in the end the construction breakdown occurs. In this way, with directed breakdown point, the desired aim has been achieved, see fig. 18. On the newer vehicle car body, significantly higher level of force was obtained, and the behaviour of car body was considerably improved. Deformations of carrying construction in front part are insignificant, and are also directed according to place and direction. Side frame is slightly deformed, that is passenger space deformation was minimal, see fig. 19.

4. Conclusion

Development and introduction of new solutions in car industry is inevitable, especially bearing in mind ever stricter market demands and valid regulations. The introduction of new constructive procedures requires a series of technological adjustments or introduction of completely new technological processes. In addition to that, it is necessary to improve methods for estimating the performed interventions constantly, as shown in the paper.

5. References