LABORATORY INVESTIGATIONS OF REINFORCED CAR BODY BEHAVIOUR IN CONDITIONS OF BY-LAW ECE 95

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Abstract: *International regulations have the uniform definitions for criteria for homologation of vehicle and vehicle elements. Every by-law deals with one strictly defined programme and trial related to it. Trial procedures are defined within the regulations. In homologation investigations of collision, car body behaviour as a part of whole vehicle behaviour is analysed. Bering in mind the need for obtaining data on foreseeing the car body behaviour in collision trial, laboratory method for investigating car body behaviour in quasi-static conditions has been developed. The paper presents the results of investigating behaviour of vehicle Yugo reinforcedcar body in conditions ECE 95.*

Keywords: *VEHICLE, CAR BODY, REINFORCED, INVESTIGATIONS.*

1. Introduction

Investigations of passenger car body, which are performed in course of designing process, can basically be divided into: laboratory and exploitation investigations. According to valid international regulations, trial procedures and conditions which must be fulfilled are defined within regulations. The vehicle producer is obliged to bring his product into line with adopted by-laws, to put his vehicle through tests and to obtain corresponding homologations. For estimating the quality of carrying construction, within vehicle behaviour, By-laws ECE12, ECE94 and ECE95 are of extreme importance. The main aim of these by-laws is to define the impact investigation procedures, which would simulate the deformations that arise at collision of vehicles in exploitation. Standardized procedures allow correct estimation of constructive loading of vehicle and loading of passengers, static and dynamic deflections, photographic observations, as well as post-collision observations of those surfaces or events which are used for determining the construction criteria.

By-law ECE 95 (lateral impact). By-laws ECE12 and ECE94 are applied for testing the behaviour of vehicle and passengers in case of frontal impact. For this kind of by-laws, it is typical that investigation conditions are constantly becoming stricter with the aim of increasing the safety level. By-law ECE 5, lateral impact, is the addition to By-laws ECE 12 and ECE94, related to the testing of vehicle and passengers. Fig. 1, 2 and 3 present the conditions for investigating the vehicle according to ECE95.

Fig. 1 *Position of motionless barrier.*

In trial ECE 95, the following is typical:

- Vehicle is motionless in the course of trial. Moving platform, of specific mass and at specific speed, hits the vehicle
- Impact occurs on the driver's side
- Behaviour of carrying construction is tested
- The level of loading of driver's vital parts is tested.

Fig. 2 *Testing zone*

Fig.3 *Zone of test on driver*

From the aspect of carrying construction, the zone of barrier impact into vehicle is particularly interesting, see fig. 1 and 2. In that area, the investigation conditions are constantly being changed and adjusted to exploitation cases.

2. Laboratory investigations car body in conditions of ECE 95

Bearing in mind the need for obtaining the data on foreseeing the car body behaviour at lateral impact trial, the laboratory method for investigation of car body in quasi-static conditions was developed. The concept of monitoring the behaviour of car body only was selected, without the influence of car body elements which

are additionally installed and the influence of other aggregates on vehicle. The paper shows the results of trial simulation in conditions of by-law ECE 95, se Fig. 4 and 5. Car body is connected to the device on point for connection of front and rear suspension. When defining the investigation conditions, the experiences obtained by developed quasi-static trial in conditions of By-law ECE 94 / 1, 2 / were used. Due to that, in this trial the suitable profiled barrier was immediately defined.

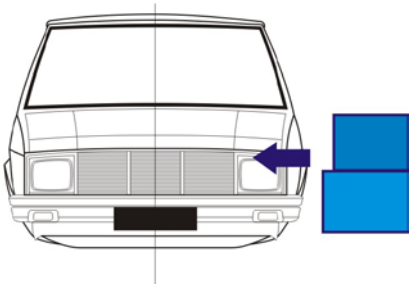

Fig. 4 *Conditions of developed laboratory trial*

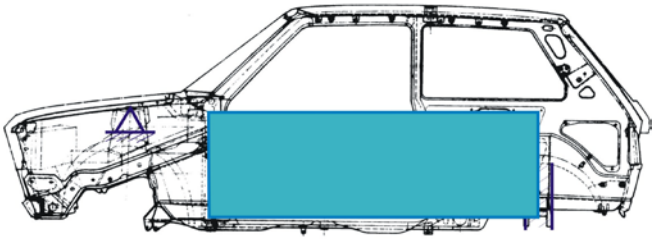

Fig. 5 *Car body connecting method*

Fig. 6 and 7 present the developed device for investigating car body in conditions of by-law ECE 95. Reconstructions were mainly performed on impact panel, in order to partially simulate the conditions of barrier in ECE 95.

Fig. 6 *Quasi-static trial according to ECE 95*

2.1 Evaluation of car body behaviour

It is performed on the basis of the following indicators:

- Total deformation displacements on selected measuring points
- Measuring of deformation displacements on selected measuring points in course of entire trial
- Deformations of typical car body joints and car body as a whole
- Recording of car body behaviour.

Deformation displacement on selected measuring points in course of entire trial. Selection of measuring points is adjusted to trial conditions and carrying construction of investigated car body, see Fig. 8. Measuring points are mainly located on lateral side frame (1, 2, 3, 36 and 37, driver's side) and door reinforcement (35, driver's side).

Fig. 7 *Reconstructed barrier according to ECE 95*

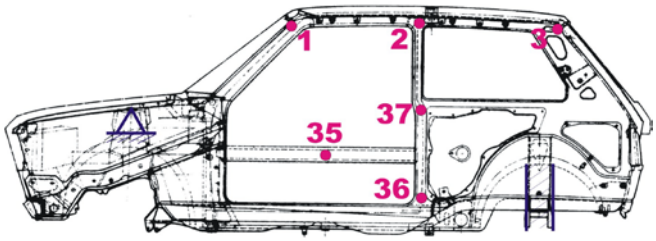

Fig. 8 *Deformation displacement- measuring points*

Fig.9 *Total deformation displacement- measuring points*

Total deformation displacement on selected measuring points. Fig. 9 shows the measuring points on which total deformation displacement is measured, symmetrically on the left and the right side. The zone of barrier impact, which is important for the analysis of car body behaviour, is analyzed.

Fig. 10.1 *Initial position*

3. Analysis of car body behaviour

In one such trial, it is possible to perform the visual monitoring of car body behaviour in the course of the experiment, and to take appropriate actions if necessary. Fig. 10.1-10.3 show some trial phases.

Fig. 10.2 *During the experiment*

Fig. 10.3 *Total car body deformation*

In the initial position, Fig. 10.1, the form of non-deformed car body can be seen. In the following phases, lateral side frame becomes deformed, in the zone of door post B. In the final position, Fig. 10.3, total deformation of lateral side frame can be observed. As expected, the largest deformation occurred on post B and front left side door. Still, there were no larger deformations of longitudinal supporter of car floor, especially on driver's side. As expected, increased deformation of front left door opening was obtained. On the right side, minimal deformations occurred on car body.

Fig. 11 *The zone of connection of post B with floor*

Analysis of deformations of typical car body joints. From the aspect of this trial, the behaviour of left car body side is important, (driver's side), where sensitive car body parts can be noticed as well. The lateral side frame has received loadings, and conveyed them further onto the carrying construction elements. Fig. 11, 12 and 13 show the sensitive points.

Fig. 12 *Connection of post A*

Fig. 13 *Total deformation of left side door*

Fig. 14 *Deformation of car body*

Opening of side door is a sensitive point from the aspect of this trial; therefore, the sensitive zones which are located exactly on opening frame and door frame were selected for the analysis. In Fig.11 the function of post B can be noticed, its connections to the floor as well as connections of longitudinal support of car floor. Since the door is directly exposed to impact, its deformation is increased, see Fig.12 and 13. When analyzing the reinforcement, attention must be paid that the obtained construction is not too stiff;

this also isn't a good solution because of need to realise proper decelerations.

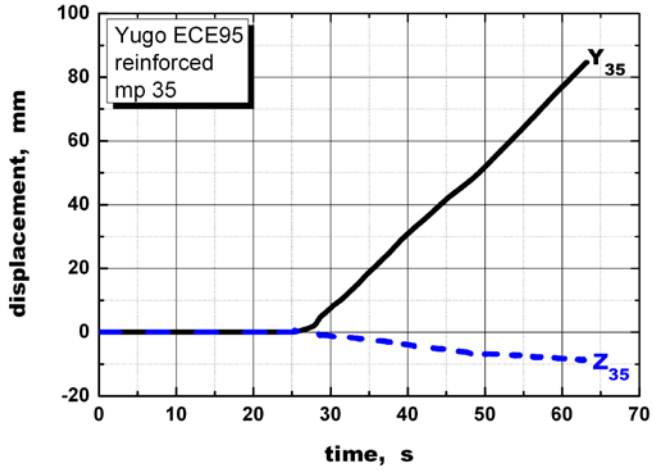

Fig. 15 *Displacement in Y and Z direction*

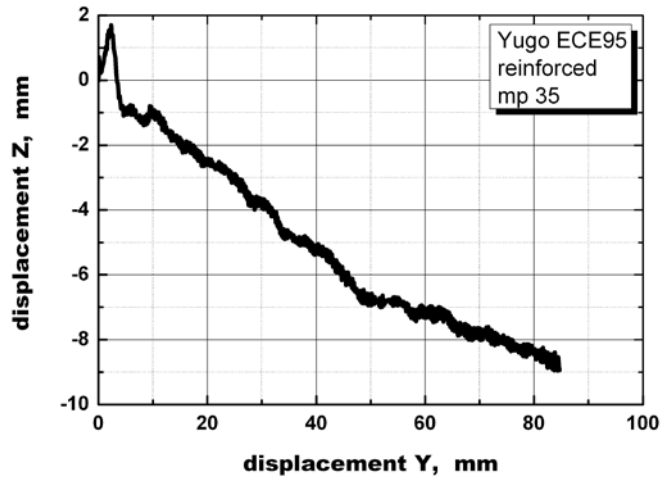

Fig. 16 *Displacement in Y-Z plane*

Analysis of car body deformation. The zone of barrier impact according to ECE 95, i.e. impact panel in the case of trial, has a considerable influence on car body behaviour. Therefore, new car body constructions are adjusted to trial conditions in order of complying with the trial requirements. Fig. 14 shows the behaviour of one reinforced car body of vehicle Koral in the case of laboratory trial according to ECE 95. Large deformations of car body on driver's side are exactly in the zone of impact panel contact. On the opposite side, deformations are minimal.

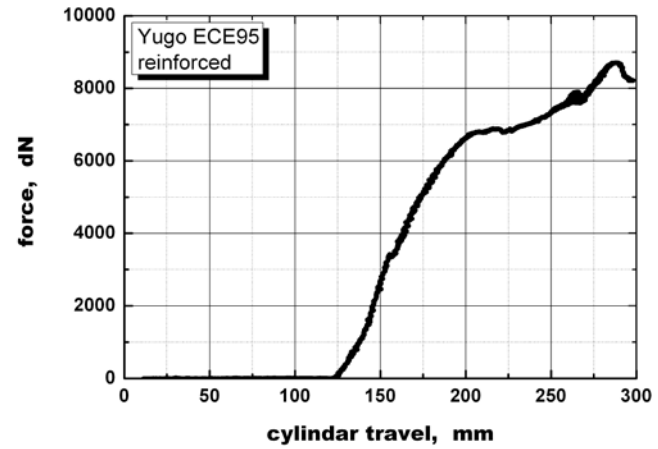

Fig. 17 *Dependence force-travel*

Deformation displacement on selected measuring points. When investigating the behaviour of car body in conditions of trial according to ECE 95, displacement on measuring points was measured: 1, 2, 3 , 35, 36 and 37, see Fig. 8, as well as on point which are sensitive from the aspect of this trial. Fig. 15 and 16 show the results of measuring deformation displacement on measuring point 35. In this trial as well, with the aim of obtaining data necessary for final estimation of car body behaviour in conditions ECE 95, realized force and cylinder travel were measured, see Fig. 17.

4. Conclusion

Alongside with the development of the designing process, it is necessary to constantly improve the method for verification, i.e. in presented case of developed laboratory trial, the method for foreseeing the evaluation of car body behaviour at lateral impact trial. The complete mastering of the trial takes the same amount of time as designing of the trial itself. The presented results indicate the points where it is necessary to perform the reconstruction with the purpose of improving the construction. The investigation results could also be used for calibration of developed mathematical model.

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