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NEED OF INTRODUCTION OF NEW MATERIALS TO THE PASSANGER CAR BODY IN ORDER TO COMPLY WITH REGULATIONS

Потребность введения новых материалов в кузов лёгковых автомобилей из-за приведения в соответствие к законным условиям

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Abstract: *Current regulations require automobile industry to continually improve the passenger automobile chassis, especially when it comes to the issue of stiffness of the complete supporting structure, as well as certain mounts, joints and subassemblies. These requirements are even more emphasized in the case of the models that are already in production, especially those older ones.*

This paper discusses the application possibilities for the new generation of plastic masses in order to increase the stiffness of the sensitive chassis joints. The advantages of their application are the following: there is no change in the shape of the tin parts, as well as keeping the existing technologies. High strength steels enable the increased hardness and lessened weight carbody, with compliance with standard efficiency tests (energy accumulation, oscilatting comfortability etc.).

In order to determinate the influence of new materials and constructive solutions appliance in comparasion to the existing solutions, the specific car bodyassemblies (side door, frontal frame) were tested. In order to show the concrete impact on the structure, the supporting structure of the front frame was tested in the laboratory conditions. Based on the analysis results, places for possible application have been recommended. Based on the analysis results, places for possible application of new plastic materials and high strength steel sheet metals have been recommended.

1. INTRODUCTION

The development of the passenger car body structure, in the sense of design, is at the optimal level, especially for the models that are coming out to the market for the first time. In order to enable compliance to ever-stricter safety regulations, reduction in vehicle weight, etc., the application of new materials, that is new technologies, is required. The development and usage of the new materials for automobile car body is in accordance with the general requirements of a society (saving of the economical resources, preservation of the energy sources and environment, passenger safety improvement etc.). Therefore, the materials used for car body manufacturing have been significantly of less weight in the recent years, such as: high strength steel sheet metal, aluminium sheet metal, titan and its alloys, sandwich materials and the like. Reduction in weight, together with compliance to the car body stiffness requirements, causes the fuel consumption reduction and creates the room for additional installment of the elements for active and passive safety improvement. However, a simple replacement and introduction of new materials require a number of the new technological solutions in the existing production process, that is the creation of the completely new processing systems. Summary survey of the car production development in the function of social changes and development of technology in Japan in the last four decades, is illustrated in fig. 1 /1/.

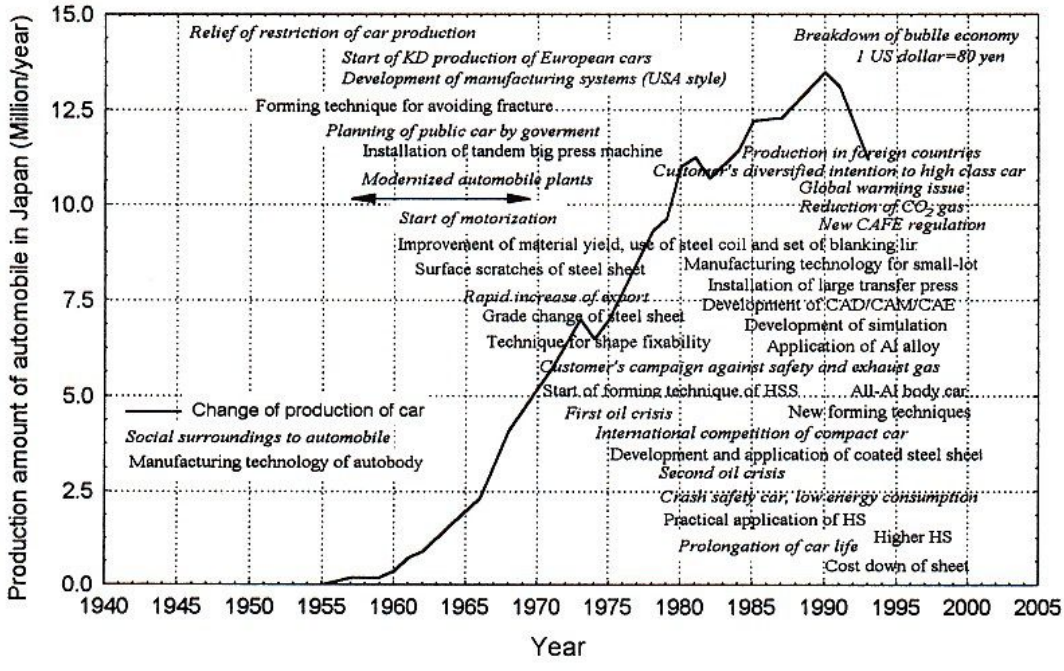

Fig.1 Car production in Japan , social surroundings related to automobile and manufacturing technology of autobody parts /1/

From the formability standpoint, there are numerous problems in manufacturing body parts using light materials. In general, formability of light materials is lower compared to low-carbon steels. In this case, in addition to material destruction, there are also problems in the form of wrinkles, surface deflections and springback. The dominant characteristics related to outer pressed parts are stiffness, shape fixability and surface quality, while the important features of the inner components are the stiffness of certain pressed parts and the complete structure, as well as the fatigue strength /2/.

2. APPLICATION OF THE NEW PLASTICS MASSES

The application of the plastics in the automobile production is constantly growing, for the exterior vehicle parts as well as for the interior vehicle parts. Ever present intention of the raw material manufacturers is to apply the plastics on the very car body, for production of the external covering, even for the supporting structure. There are numerous examples of the external coverings made of plastic (front external covering-fenders, hood, trunk door, etc.), parts that are not too loaded, and the need for quick and frequent replacements of these parts is also present. In order to lower the weight of the vehicle by application of the plastics, the detailed research has been started, especially at the manufacturers of material. In the beginning of the research, the application included only the external coverings. This paper discusses the application of the material made by the company Gurit Essex, since these are the new materials in this area. Why are we discussing the application of these materials? There are several reasons for that /3/:

- The structures of new car body are mostly optimized and leave little possibilities for designers
- The need for compliance with ever-stricter regulations
- Minimal changes on the structure, that is keeping the existing structure elements.

Materials of the company Gurit Essex can be applied for the following purposes /3/:

To make greater tin surfaces stiff
As soundproof and vibration-proof materials
To increase the stiffness of the structure.

Using them for the above mentioned purposes, the following manufacturers install these materials into their vehicles: **Daimler**-Chrysler, **FIAT** /Alpha-Romeo/ Lancia/ Ferrari/ Iveco, **Volkswagen**/Skoda/ Audi/ Seat, **GM**/ Opel/Saab, **Nissan**, **Renault**, **PSA**, **Ford**/Volvo/Jaguar, **Porsche**, **BMW**/Rover, **Daewoo**, **Lada**, **Hyundai** /3/.

This paper will only consider the aspect of the plastic masses application in order to increase the stiffness of the structure, while not changing the existing car body structure. Betacore 5207 can be used for these purposes.

Based on the results of the static testing of the body, under the conditions of the maximal longitudinal forces, two sensitive zones can be singled out for the types of the body used in the vehicles such as "Florida"", and they are: 1-the zone of the joint of the front longitudinal support, front internal covering and separating wall and 2-the zone of the joint of the front internal covering, separating wall and automobile floor. The front longitudinal support is one of more important elements of the front frame.

In the sensitive zone, transversal section of the front longitudinal support is significantly changed in all directions. In order to get the shape of the support, which supported or shaped the plastic mass, it was necessary to make a model of master-resin by taking the prints from the support. This model shows the complexity of the front longitudinal support in this zone, then, from the lower side, connection with the support along the joint of the front internal fender and separating wall. The shape of tin support is carved in the master-resin model. Betacor is carrying this tin support and giving it shapes. Betacor is shaping itself according to the tin support, by cutting and shaping on the temperature of about 35°C /4/.

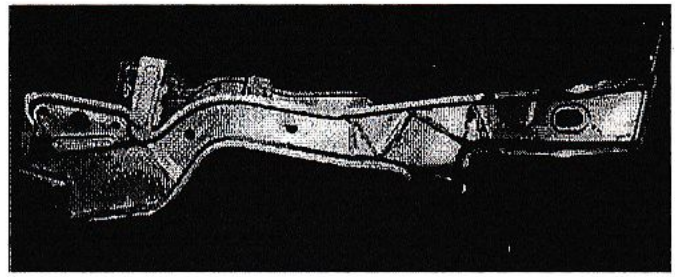

Fig. 2 Installation of the reinforcement

Figure 2 shows the location of this assembly installed on the sensitive place of the front longitudinal support, which needed to be strengthened. It is noticed that tin supports reduced the plastic mass that should be applied in order to fulfil the whole section. On the two manufactured prototypes, thus prepared samples, were fixed on the front longitudinal support, with precisely defined spots for Betacor expanding, and spots for leaning as well.

In order to explore the impact of the new material, static testing of the front frame was done first, and it was on: standard front frame and front frame with installed reinforcement. The front frame was tied to the measurement table, in the back, in the zone of the connection of the transversal support and instrument panel. Figure 3 comparatively show the behaviour of the front frame with and without reinforcement. In all cases (torsion, bending, backward, forward there are significantly smaller movements in the renforced frame. The largest impact of the reinforcement is noticed in the case of symmetric longitudinal load forward (acceleration of the wehicle).

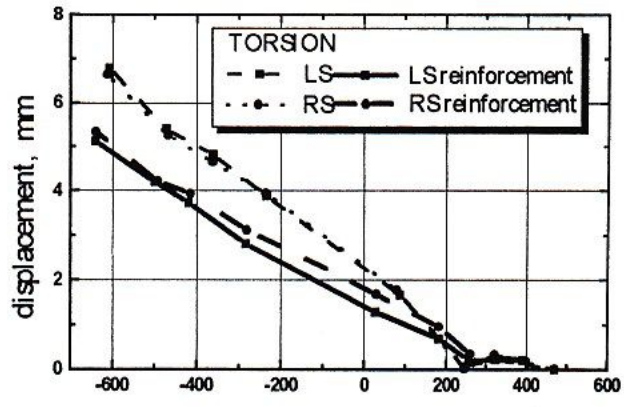

Fig.3 Torsion testing

3. HIGH STRENGTH STEEL SHEETS

High strength sheet metals are most frequently used in machine construction industry, because of their high stiffness and low weight (contributing to lower total weight of the specific design). HSS enable production of automobile bodies with higher stiffness and lower weight, showing satisfactory performances (energy accummulation upon accidents, oscillatory comfort etc.). The initial use of HSS began in the '70s, as a response to the energy crisis, and its application is continuously rising especially in the Japanese car factories. It is estimated that (according to / 1/) the present share of HSS, which is equal to around 20%, will be increased in the future to almost 43%. Simultaneously, the body weight will be reduced by 10-20%.

Compared to conventional low-carbon sheet metals for deep drawing, these sheet metals have unfavorable formability characteristics and higher price for the same weight. They are used for manufacturing body parts that do not require high degree of

deformations. Basic classification of these steels is as follows:

- conventional micro-alloyed ones (HSLA),
- rephosphorized, i.e. phosphor-alloyed steels,
- dual-phase steels.

Fig. 4 illustrates the development of high-strength, cold-rolled steels for auto-body applications /5/.

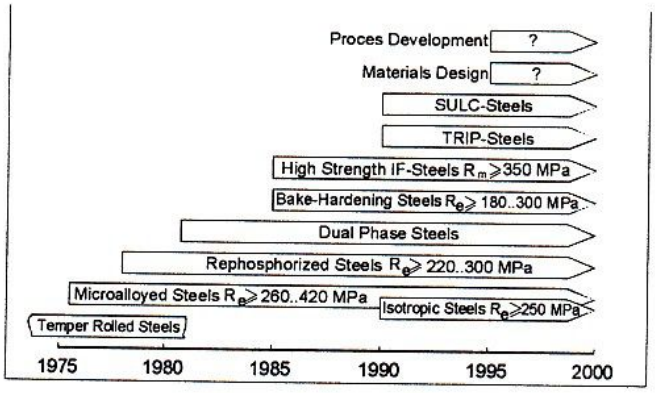

Fig.4 The development of high strength steels /5/

Upon considering the HSS application, two cases can be identified:

-possibility of using HSS within the existing technology and

-design of new technology, including the use of HSS bodies in new automobile models.

General limiting factors in using HSS can be systematically shown as the group of the following characteristics /6/:

-fracture resistance,

-shape fixability,

-fittability.

Successful forming until fracture covers wide area of forming limit, was exceptionally studied at the conventional low-carbon steel sheet metals. However, the last two requirements are characteristic of HSS and feature the deflection properties.

In this case, deflection covers creation of surface geometrical defects at pressed parts in the form of: concavities, convexities, mild waves, as well as inaccuracies as a result of elastic recovery, etc.

Shape fixability properties refer to the material capability to keep the shape and dimensions it had upon processing after forming and removal from the tool. Fittability refers to the material capability to keep contact with the tool contact surfaces during processing.

Deflection properties are most frequently tested in the laboratory conditions on the models, which are used for simulating nonhomogenous stress-strain condition in certain segments of the part being pressed. Conventional testing in this area is so-called "Yoshida-test", which includes the tensile test of the square (diagonal) or triangle test piece (on the longest side). Height of the wrinkle formed in the direction of tensile testing illustrates the deflection trend.

Basic problems concerning HSS processing relate to:

-problems with machine adjustment, as a result of narrowing the working area of the blank holding force, due to the occurrence of wrinkles, i.e. fracture,

-so-called "galling" and difficult forming compared to low-carbon sheet metals,

-increased number of parts for rework and increased number of interventions in tool maintenance,

-insufficient power of individual machines.

Besides, the material and process costs were increased, weldability was decreased and shape fixability was decreased, as a result of reduced sheet metal thickness.

In order to manufacture the HSS parts successfully, the following actions are recommended:

-adjustment of gap between the punch and die,

-in order to reduce galling, it is recommended: make special selection of materials and surface treatment for tools and lubricants, change in the forming process (additional performing in the critical areas), application of draw beads, division to more operations, optimization of blank shape, etc.

Further on, some results of deflection investigation for four steel sheet metals categories are given. PHZ materials refer to sheet metals alloyed by phosphorus. The following materials have been used:

a) classic annealing, t=685 °C, lasting 20+22 h (material PHZ 260),

b) annealing above PSK line, t=722°C, lasting 20+22 h (material PHZ BH),

c) classic low-carbon steel sheet killed by aluminium C0148P5,

d) BH sheet metal of foreign producer marked CHR35B.

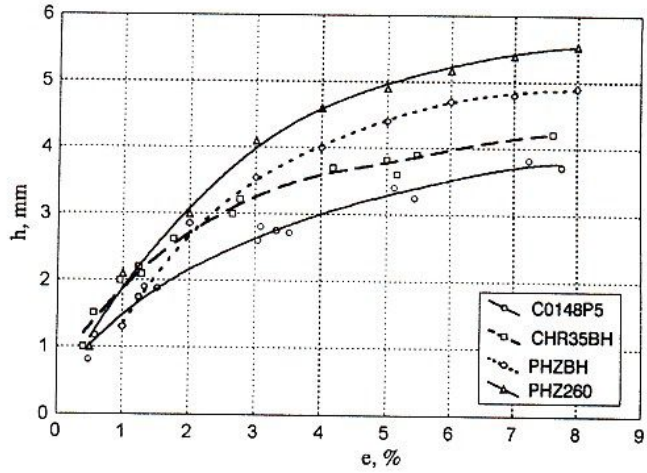

Fig.5. Wrinkle height dependence on the degree of strain /6/

The basic examination of tendency to deflection is so called YOSHIDA -test of single-axis tension of square specimen. Wrinkle height is the basic measuring value and indicator of tendency to deflection. Fig.5 show the results of deflection investigation for particular materials /6/.

The increase of the amount of deflection along with the increase of the yield strength is obvious. Such general evaluation is not sufficient, but has to be supplemented with results of deep drawing in real conditions. Work piece geometry, tool construction, tribological conditions, etc, are extremely important then.

4. CONCLUSION

Performed analysis has shown that application of the new materials on the passenger automobile chassis in order to improve its structure is justified. This is especially true for the plastic materials of new generation. Their great advantage for installment on the models which are already in production is that they neither require replacement of other elements of structure nor replacement of the existing technologies.

High strength steel sheet metals have exceptional application in car industry which is constantly growing, especially in developed industrial countries. Because of reduced formability qualities they are used for obtaining parts with low degree of drawing and simple geometry.

The basic advantages of using HSS are: reduction of autobody weight, increase of passive safety, improvement of

sagging resistance, etc. Its disadvantages are: the appearance of deflection, change of tribological conditions, insufficient holding force, etc.

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