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Research and Elimination of the Causes of Self-Destruction Automotive Rear Windows Glasses

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ABSTRACT: This work is devoted to a practical study of the causes of self-destruction that occur spontaneously and chaotically with the rear windows glass of cars. To study the reasons, we used glass samples prone to self-destruction and modern measuring instruments for measuring internal residual stresses in the edge of the glass. The analysis of permissible indicators of residual and surface stresses is carried out, and the efficiency of the used heat-resistant materials is considered.

KEYWORDS: Automotive SafetyGlass, Tempered Glass, Glass Self-Destruction, Measurement of Residual Stress in Glass, Heat-Insulating Fabric.

I. INTRODUCTION

As everyone knows, the destruction of the integrity of automotive safety glass, as well as simple glass, occurs from ordinary mechanical shocks. However, unfortunately, when the car is parked in a closed garage, and the rear window glass collapses spontaneously (Fig. 1.).

Fig. 1. Self-destruction of the automotive rear window glass.

One way or another, there is always a reason, just like that the glass cannot break. From the moment of production and installation on the assembly line, chaotic self-destruction can occur at any time. The main reason for this phenomenon is the incorrect distribution of residual stresses on the glass after tempering. Possible factors of self-destruction of tempered glasses are presented in detail and quite clearly in the works [1, 2].

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II. ANALYSIS

A. Automotive Safety Glasses

Modern automotive safety glasses, depending on the type and purpose, can be divided into two types: laminated (multilayer, triplex) and tempered.

Laminated glass: Glass composed of two or more layers interconnected by one or more interlayers.

Tempered glass: Single-layer glass that has undergone a special heat treatment in order to increase its mechanical strength and ensure normalized crushing upon impact.

Laminated glass is used for the windshield, while tempered glass is used for the side and rear windows glasses of cars.

B. Tempered Glass

The main advantage by which tempered glass is used is its strength and safety (it does not shatter into cutting fragments).

Glass tempering technology is a way to increase the mechanical strength and heat resistance of the material (Fig. 2.). On average, it becomes 5-7 times stronger than usual, and is able to withstand temperature fluctuations in the range from 60 to 300 ° C.

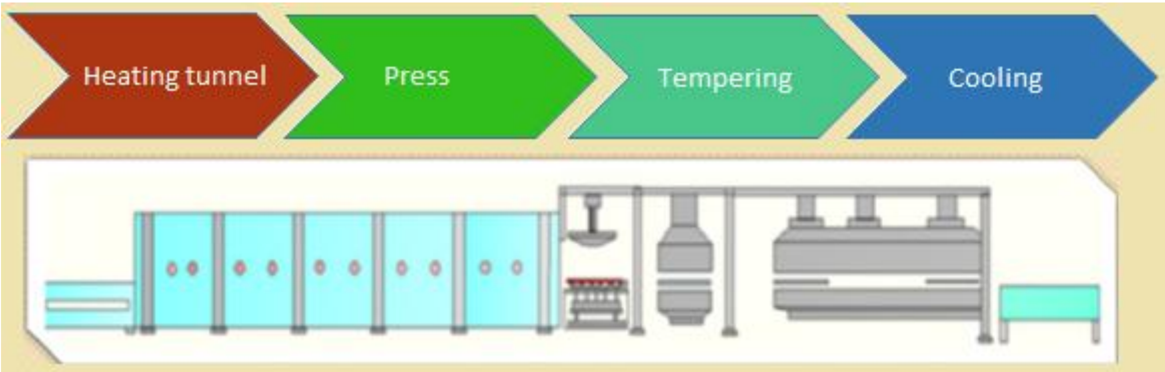

Fig.2. Production Process of Tempering.

The main method is thermal, which involves heating up to 650–680 ° C, after which the sheet is evenly and quickly cooled by air from both sides at once. This procedure creates residual mechanical stresses in the surface layers (Fig. 3.).

Technological equipment for tempering automotive glass - special continuous furnaces with a number of design features:

• reliable thermal insulation of the furnace;
• high-strength filaments without adhesions, with a long service life and protection against overheating;
• the support system of the transport ceramic roller allows achieving a perfectly flat surface of the product;
• the production process is controlled using a special interface.

The most modern are horizontal continuous cycle tempering furnaces equipped with forced convectors and glass protection against thermal shock (closed heating elements).

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a) b)

Fig. 3. Technological equipment - Continuous horizontal furnace
a) Heating section b) Press and tempering section

C. Tempered Glass Requirements

C.1. Tempered glasses must be mechanically strong and withstand the impact of a ball with a mass of (227 ± 2) g from a height of $2^{+0.005}$ m. The test results are considered positive if five out of six tested samples did not break.
C.2. Tempered glass must withstand the crushing test.
The test results are considered positive if:
- the number of fragments in any square with dimensions (5 x 5) cm is at least 40, while:
- the number of fragments in a strip 2 cm wide along the entire edge of the specimen and in an area with a radius of 7.5 cm around the point of impact is not determined;
- a shard divided by the side of the square is considered half of the shard. If the fragment goes outside the exclusion zone, then only the part of the fragment that goes outside this zone is evaluated;
- the presence of fragments with an area of more than 3 cm^2 is not allowed, with the exception of a strip 2 cm wide along the entire edge of the samples and a zone with a radius of 7.5 cm around the point of impact;
- the presence of fragments more than 100 mm in length is not allowed, with the exception of a strip 2 cm wide along the entire edge of the samples and an area with a radius of 7.5 cm around the point of impact, provided that
a) their ends are not pointed;
b) the fragments reach the edge of the glass and do not form an angle with it more than 45°.
The test results are considered positive if three of the four tests carried out at each point were positive.
C.3. The edges of hardened products must be strong and withstand the scratch test (Determination of resistance to spontaneous destruction of glass after applying mechanical defects (scratches) around its perimeter).
C.4. The value of the residual stresses in the edges of the glass is set in the normative and technical documents for products for a specific purpose [3].

D. Determination of Tensile Stress at Edges of Tempered Glass

D.1. Tensile stress measurement is carried out at 12 points along the perimeter of the glass (Fig. 4). The measurement is carried out along the entire contour of the product to determine the maximum value of the tensile stress. The number of points is set by the manufacturer depending on the configuration of the glass and the characteristics of the technological process.

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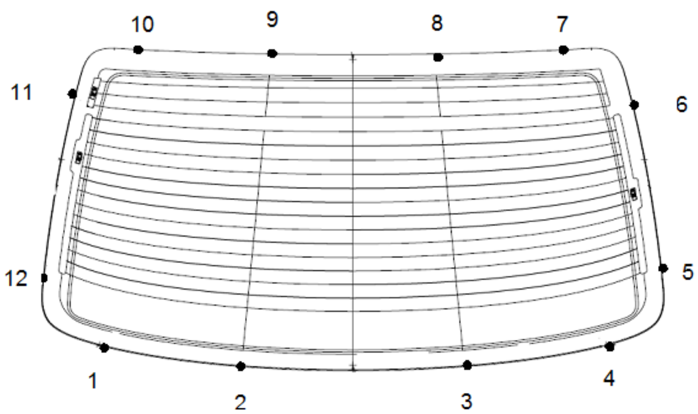

Fig. 4. Location of measurement points.

D.2. Turn the polariscope scale counterclockwise, observing the white field through the eyepiece of the device, catch a black stripe running parallel to the edge. The black stripe running parallel to the edge is taken as "0" (Fig. 5).

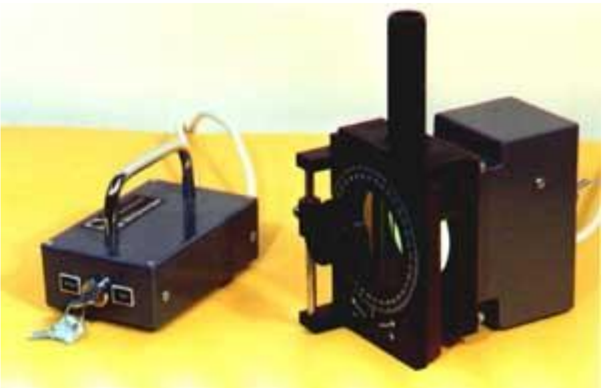
Fig. 5. Polariscope "Sharpless".

D.3. The rear and side windows tempered glasses can have more than one black stripe, so the zero stripe should be localized first (of all the others that move inside during tensile stress measurement and are farthest from the edge). A light zone (corresponding to the stretch zone) is localized above the zero strip. By rotating the analyzer of the polariscope to the left, the zero band is gradually brought closer to the "neutral zone" until full contact is made. In order to correctly measure the angle of reference, you should take readings only at the moment when the light zone between the two darkened ones completely disappears. The final measurement result is specified using a magnifying glass and a mercury filter. At the same time, a uniform, clear spot becomes clearly visible, in which there is no longer a light green color.

D.4. Shift the black bar to the edge of the glass by rotating the polariscope analyzer. As soon as the axis of the strip is on the edge of the glass, the reference angle is determined.

D.5. The magnitude of the tensile stress, MPa, is determined by the formula:

$$\sigma = \frac{n\,1.12}{b}$$

where *n* is the angle of reference, degree;
b - glass thickness, mm.

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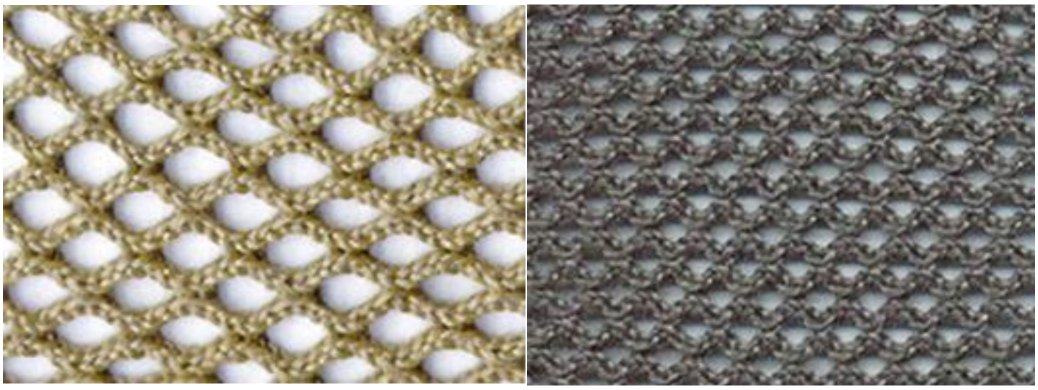
III. RESULTS

We are taken samples of tempered rear windows glasses prone to self-destruction in the amount of 5 pieces. and the edging (black paint, ceramic) was removed using sandpaper to measure the tensile stress at the edge of the glass. The obtained measurements showed the presence of stresses in the edge of the glass up to 140 degrees. with a target of 80 deg. (max. permissible indicator 100 degrees.).

When inspecting the technological equipment, it was found that the heat-insulating fabric BEKAERT Quench KNR 2 was used in two layers, which blocked the flow of air during tempering to the lower surface of the glass, and also access was limited from the upper and lower surfaces of the equipment (tool).



a) b)

Fig. 6. Thermal insulation fabric.
a) BEKAERTNovaquenchKNR 52 b) BEKAERTQuenchKNR 2

During the research, the following steps were taken to solve the problem of self-destruction on automotive rear windows glasses:

• Changes have been made to the design of the bending frame, taking into account the fastening of the heat-insulating fabric in such a way as to provide maximum air access to the bottom surface of the glass and uniform placement of the rear window glass on the bending frame (tool) (Fig. 7).

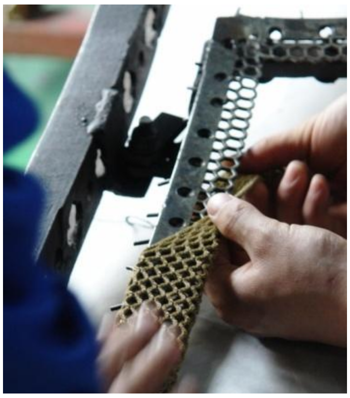


Fig. 7.Fastening the heat-insulating fabric.

• The thermal insulation fabric was replaced with BEKAERT Novaquench KNR 52 since the size of the square hole is larger than that of BEKAERT Quench KNR 2.

• The pressure at the bottom blast is increased from 1.8 to 2.1 (kgf/cm^2).

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IV. DISCUSSION

The broad significance of this study lies in the fact that the main causes of self-destruction on automotive rear windows glasses are taken to study. Deviation from the established methods and parameters leads to non-uniform heating both on the surface and in the thickness of the edge of the automotive glass. We have shown that insufficient air access to the bottom surface of the glass and uneven placement of the rear window glass on the bending frame leads to uneven and local tensile stresses.

Cases of self-destruction of car rear windows glasses on the body of vehicles are far from isolated, they occur spontaneously and chaotically and can cause serious harm to the health of passengers. It is undesirable to expose automotive glass to significant temperature changes in a short period of time (for example, remove ice from windows glasses with hot water), which can lead to their destruction. Using a wiper without washer on dirty glass leads to micro cracks and scratches, which can also provoke the consequences of destruction.

REFERENCES

1. Mick Ekhout, StepphanNiderehe. Spontaneous glass breakage in hot bent, heat-strengthened, laminated glass panels. GlassPerformancedays 2007, p. 679.
2. J.V. Colvin. The analysis of bent heat treated glass breakages. GlassPerformancedays 2007, p. 685.
3. GOST32565-2013. SafetyGlassforGroundVehicles. GeneralSpecification. 5.1.4. Tempered Glass Requirements.