Development of Impact Test for Automobile Windshield Glass

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Abstract.

A windshield glass protects passengers from foreign objects such as stones, gravel and wind. Due to this role of the glass, there are lots of damages caused by foreign objects while driving. In order to prevent such breakage, various studies have been conducted to improve the impact strength of the glass. However, most safety standards for verifying this phenomenon use circular impact bodies, so they cannot reproduce the concentration of stresses encountered in the actual driving environment.

In this study, a new strength test method using impact bodies with sharp edges and compressed air was developed to simulate fracture due to concentrated stress, and this test was compared with the existing free fall test method. As a result, the test method was confirmed to ensure high repeatability as well as similar results when compared to the conventional free fall method. In addition, as a result of verifying the influence according to the thickness of the windshield glass using this test method, it was confirmed that the thickness reduction for the weight reduction of the vehicle could be secured at a certain level.

1. Introduction

Recently, the automobile industry has major issues in terms of weight reduction due to emission gas and fuel efficiency regulations. Through the design optimization and downsizing, it have led to the development of lighter weight and improved fuel economy. But it is not easy to review the automobile safety. Especially, in case of windshield glass which directly affects the passengers, it is difficult to applying the actual vehicle because the security is not guaranteed.

The windshield glasses for most cars have a structure in which a polyvinyl butyral (PVB) film having a thickness of 0.8mm is bonded between glass plates having a thickness of 2.1mm, so the thinner the windshield glass thickness, the greater the risk to passenger safety from external objects. The glass breakage phenomena include stress fracture, thermal wire failure and so on. Among the many problems related to reliability of windshield glass, the crack caused by concentrated stress is a customer's chronic claim item. It mainly account for 50% of failure.

In order to prevent breakage phenomena, the test methods have been established such as impact resistance, penetration resistance. However, automobile safety standards for verifying this are limited to grasp whether glass is damaged or penetrated by circular impactor. For this reason, the existing standards are limited in reproducing the breakage phenomenon caused by the concentrated stress which is generated in the actual operation of the vehicle.

In this paper, we developed a new strength test method using the sharp tip and compressed air to reproduce the concentrated stress fracture phenomenon. Also, we analyzed the impact strength in comparison with the existing free impact test method. Through the verification of consistency between the two strength tests, it is possible to secure the preliminary reliability for windshield glass which is getting thinner in line with the recent trend of lightening automobiles.

2. The impact test method

2.1 Free fall impact test

In order to confirm the characteristics of cracks which have the greatest influence on the windshield glass fracture, we carried out free fall impact test. We set up the glass impact tester as shown in Fig. 1.

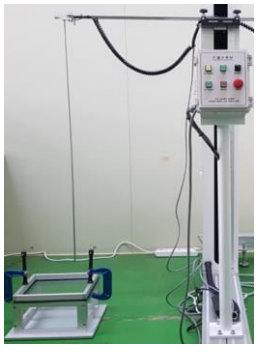

Fig.1 Free fall impact tester

The glass specimen follows the ISO 3537 and tube-base drop path was designed for vertical drop. The minimum drop height is 50cm and the maximum drop height is 180cm. The failure criterion is that when a crack of 2mm or more is detected with the eyes, and the concentrated stress fracture mechanism is reproduced for the single product.

2.2 Pressure impact test

We developed a new pressure impact test for finished product and glass of actual vehicle with sharp edge. Because the existing free fall test is only possible to applicate for single products. As shown in the Fig. 2, the principle of pressure impact test is explained. After setting the air gun in the area of interest, the impact tip was fired by regulating the pressure. The repetitive test was performed by increasing the pressure 0.1MPa when there was no crack and decreasing the pressure 0.1MPa when there was crack.

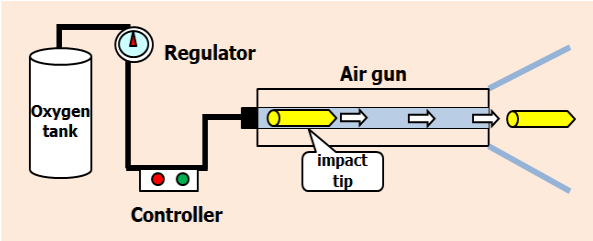

Fig.2 The principle of pressure impact test method

To compare with the existing free fall test method, the impact strength was analyzed by Weibull distribution after the test at least 6 times under the same condition. As a result, it was confirmed that the shape parameter of the free fall test method is 15.01, and the pressure impact test is 32.50, which is twice that of the existing test method. This means that the newly developed pressure impact test method has a smaller deviation and guarantees a high repeatability.

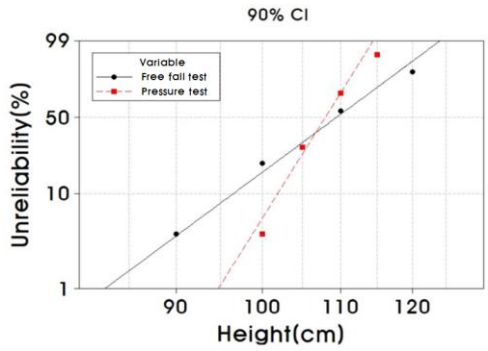

Fig.3 The comparison of impact strength with free fall test

3. Conclusions

We developed the new strength test of windshield glass to overcome the limitations of the existing free fall test method. The new strength measurement test make possible to applicate single products as well as finished products. Also, we reproduced the concentrated stress failure mechanism, the test deviation was reduced.

In the future, we will retain the windshield glass reliability by studying the influence of variables such as glass thickness, color, film type and temperature.

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