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Validation of Material Parameters of Plastic Materials for CAE Analysis of Thermal Deformation Behavior Using Digital Image Correlation Method

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In order to predict the thermal deformation behavior of a plastic part by computer aided engineering (CAE), temperature- and time-dependent material parameters are required. The material parameters obtained from the test-piece level tests were validated by measuring the time-lapse thermal deformation of plastic parts in a thermostatic chamber that has an observation window as shown in Fig. 1 by the digital image correlation method (DIC).

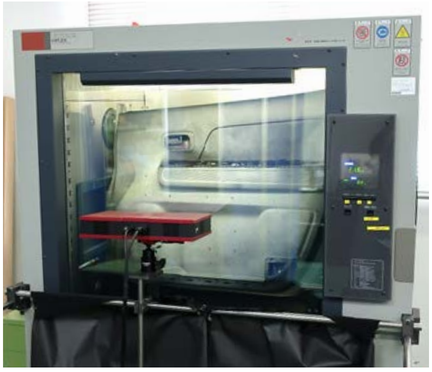

Fig.1 Thermostatic chamber with an observation window

The experiments using flat plates were performed to verify the parameters obtained in test-piece level tests. It was confirmed that the parameter of heat shrinkage was appropriate from the results of thermal strain measurement of flat paltes. On the other hand, CAE results predicted larger creep deformation and it was considered to be the effect of conducting the heat deformation test of flat plates with both ends abutting on the jig, whereas the parameters used were based on the flexural creep test where the plates ends are not abutted.

The thermal deformation behavior of the parts (door trim) was measured using a thermal cycle test. And, CAE using the parameters obtained from test-piece level experiments, could accurately predict the position of the maximum displacement in the area marked in Fig.2 (Fig.3 and Fig.4). However, the amount of the displacement predicted by CAE differed with the measured values (Fig.5) and it was considered to be the effect of using the parameters obtained using flexural creep tests.

Fig.2 DIC measurement area in the door trim

In conclusion, CAE using parameters obtained from test-piece level tests can qualitatively predict the amount of deformation of a part. Therefore, this method of CAE can be employed in the early stages of component design to prevent problems caused by thermal deformation.

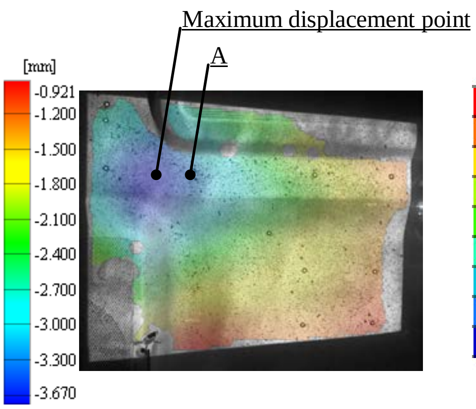

Fig.3 Displacement after the heat cycle test of the door trim (experiment)

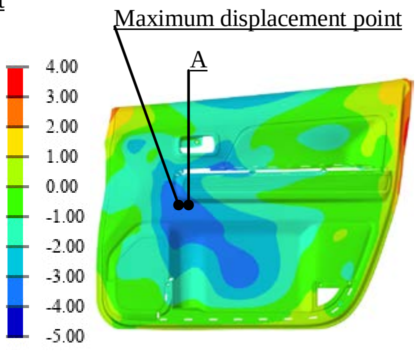

Fig.4 Displacement after the heat cycle test of the door trim (CAE)

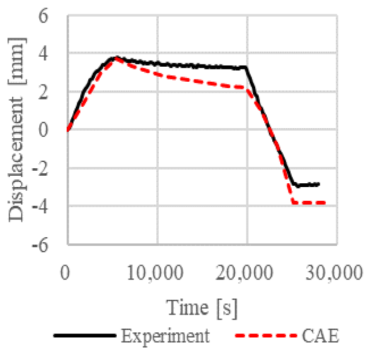

Fig.5 Displacement at point A