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Measurements of car body deformation in ED paint tank and oven by water- and heat-resistant displacement meter and comparison with CAE

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In the automobile painting process, roof and door outer panels could deform due to the expansion/contraction caused by water pressure during immersion in paint tank and heat during oven baking/drying. This problem has become more pronounced recently because of employing thin steel plates and dissimilar materials demanded by light-weight automobiles.

Predicting deformation via CAE and proposing respective countermeasures have been progressed in the recent years. But in order to verify the prediction accuracy, it is necessary to measure the actual deformation during the process. However, it has been difficult to measure the deformation during the process due to the presence of high water pressure and heat.

Thus, we have developed and manufactured a water- and heat-resistant displacement sensor, whose electronic equipment is protected by a water- and heat-resistant case and can withstand water pressure and high temperature. This device can be attached to the automobile body during the painting process to measure the displacement continuously from the pretreatment/electrodeposition coating shop till the oven drying shop (Fig.1).

Fig.1 Appearance of Equipment

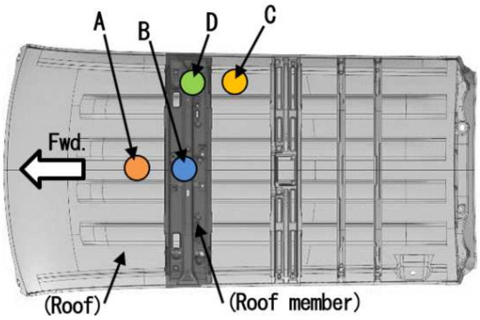

Fig.2 Measurement Points

The sensors were installed on an actual automobile body at the positions shown in Fig. 2, and the vertical displacement was measured. It was found from the results that the roof panel had displaced up and down in the order of several millimeters due to the water flow in the tank and the heat in the oven drying. Especially, the displacement was larger during immersion (Fig.3). It was also found that the roof panel and member had a larger amount of upward expansion, and the clearance between them became wider during the oven drying (Fig.4).

In addition to the measurements, the temperature distribution and thermal deformation were simulated during the oven drying, and validated them by comparing with the results obtained from measurements. This showed that the results of the thermal deformation CAE are in well agreement with the actual measurement as shown in Fig.5.

The developed device enabled validation of CAE accuracy, which could be employed to improve the efficiency and quality of the production process.

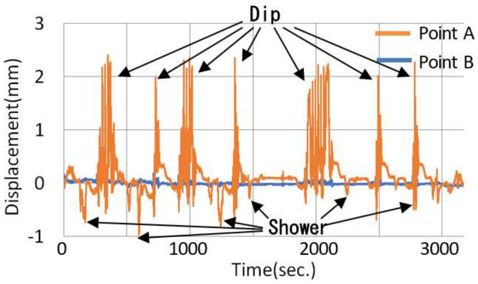

Fig.3 Displacement of roof panel and member during pretreatment & ED pool (at A & B)

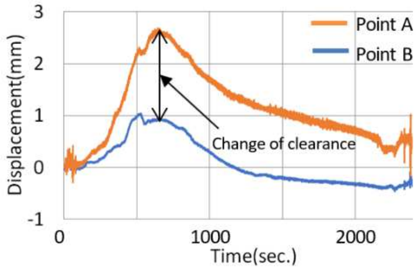

Fig.4 Displacement of roof panel and member during ED oven (at A & B)

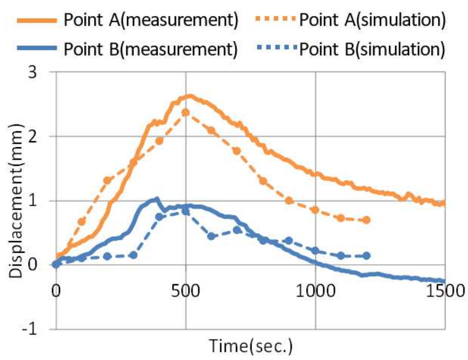

Fig.5 Results of displacement from CAE and measurements during ED oven (at A & B)