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Analysis of End-of-Life Vehicle (ELV) Seatbelt Webbing For Closed-Loop Recycling.

-Second Report Quantification of Contamination and Degradation Reflecting Usage Environment-

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Plastics derived from end-of-life vehicles (ELVs) have long posed challenges as waste materials due to their diverse material compositions and the complexity of contamination, which make effective reuse difficult. Moreover, the strengthening of ELV-related regulations is currently under consideration in Europe, further increasing the necessity of enhancing the recyclability of ELV plastics.

In the first report, we focused on post-consumer recycled (PCR) materials derived from ELVs, particularly seatbelt webbings (hereafter, “webbings”), and presented research findings aimed at quantifying their manufacturing-year distribution, types of contaminants, and the actual conditions of aging degradation(1).

In the second report, we quantitatively evaluated the degradation level of a single driver-seat ELV webbing with a known usage history. The target specimen was a driver-seat webbing used for 150,000 km over 14 years. Based on the frequency of contact between the webbing and the human body, the measurement regions were classified into four categories. The measurement locations are shown in Figure 1.

These regions were defined as follows: (1) the region contacted by the upper body when seated, (2) the region contacted by the lower body when seated, (3) the intermediate region between the tongue stopper—which controls the position of the webbing—and the point where the label is attached, and (4) the region not contacted during seating.

Furthermore, taking into account influencing factors such as temperature and humidity conditions throughout the usage period, we measured the presence of organic substances, inorganic substances, water-soluble compounds, and insoluble compounds. The degree of contamination and degradation was quantified based on contact frequency with the human body, and comparative analyses were conducted.

To check whether any differences in molecular weight had developed among the measurement areas under actual user conditions, we measured the molecular weight of the ELV webbing samples. Gel permeation chromatography (GPC) was used for this analysis, as it is a standard method for evaluating polymer chain length and detecting possible signs of degradation. The results are shown in Figure 2.

The GPC curves showed no noticeable differences in molecular weight among the samples taken from different parts of the webbing. All regions exhibited similar molecular weight distributions, indicating that significant chain scission or polymer breakdown had not occurred. Because no decrease in molecular weight or broadening of the distribution was observed, we conclude that the resin in the webbing did not undergo meaningful degradation during long-term use.

Overall, these results suggest that, even after 14 years of use and exposure to everyday mechanical and environmental stresses, the polymer material maintained its essential structure. Therefore, degradation of the resin under actual usage conditions appears to be minimal.

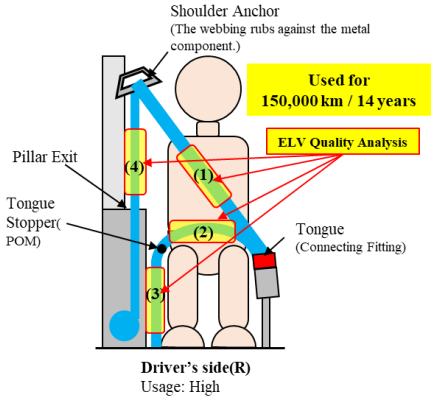

Fig.1 Sampling Locations of ELV Webbing

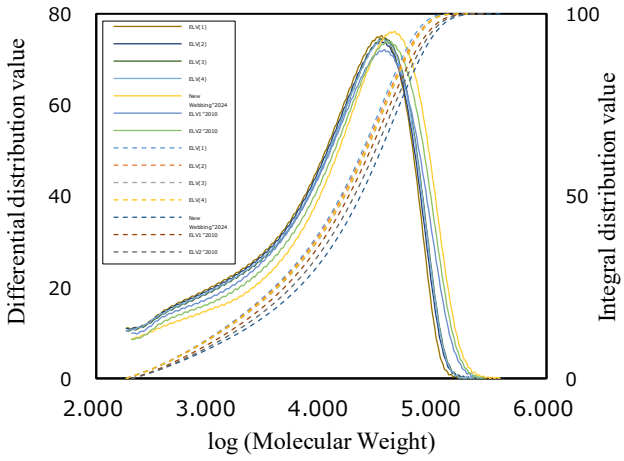

Fig.2 Molecular Weight Distribution Comparison Among Samples

References

(1) Takeru Fukuda, Masatoshi Kobayashi, Rumi Ogawa, and Yutaka Fujiwara: Analysis of Lifespan Distribution, Dirt and Deterioration State of Seatbelt Webbing Recoverd from End-of-life Vehicles for Closed-loop Reycling(First Report), 2025 JSAE Annual Congress (Spring), 20255065, 2025.