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### Title

## The effect of hot/wet environment on the structural weight of aircraft wing using thermoplastic CFRP

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### Abstract

Carbon fiber reinforced plastic (CFRP) is expected to reduce weight due to superior specific strength and stiffness. Currently, thermosetting CFRP is used for aircraft, but the use of thermoplastic CFRP has been desired in terms of recyclability. However, the application of thermoplastic CFRP to aircraft has hardly been investigated. Additionally, aircraft are exposed to high temperature and humidity condition, hot/wet environment, and may degrade. Moisture absorption and its effects on the properties of CFRP is a useful parameter to design. In this study, we mainly discussed the effect of material selection and environmental degradation on the structural weight of the aircraft wing. We focused on T800S/#3900-2B, which is a current material as thermosetting CFRP, and T700G/LM-PAEK, which has gained attention in recent years as thermoplastic CFRP. The structural design of the wing was carried out by the following processes: 1) tensile/compressive test under room temperature and hot/wet environment based on the standard for aircraft design to obtain the mechanical properties and 2) a two-way coupled aeroelastic analysis that determines the optimum thickness of the wing box by failure analysis based on that failure strain. As the result, we showed that the total weight of the thermoplastic CFRP wing was heavier 8.9% than that of the thermosetting CFRP wing, but the weight of upper skin of the thermoplastic wing was lighter. This was because thermoplastic CFRP has superior Compression After Impact (CAI) strength, possibly owing to higher ductility of its resin. Therefore, we considered multi-material design in which thermoplastic CFRP was applied to only the upper skin, and its weight reduced 3%. We also showed that the compression strength reduced significantly by 23% under hot/wet environment, so that the structural weight increased by 13 percent. Therefore, we revealed that degradation due to hot/wet environment was a matter that can't be ignored in composite aircraft design.

### References

[1] Date S, et al., "Effects of fiber properties on aerodynamic performance and structural sizing of composite aircraft wings", *Aerospace Science and Technology*, volume 124, May 2022