Research on Structure and Composite Material Technologies for Digital Certification

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Abstract

The objective of this research is to develop a FEM model to predict the thermal deformation of CFRP laminates during their AFP (Automated Fiber Placement) manufacturing process and to optimize the manufacturing conditions of CFRP products.

Reasons and benefits of using JAXA Supercomputer System

High-performance parallel computing is necessary because a computationally expensive contact modeling is used and multiple simulations need to be performed.

Achievements of the Year

A FEM model was developed to predict the thermal deformation of CFRP laminates during their AFP (Automated Fiber Placement) manufacturing process. Two types of FEM models were considered, and the prediction accuracy and computational time were compared between the two models. The obtained results are as follows.

(1)FEM model 1predicts the thermal deformation of CFRP laminates by taking account of the temperature-time history within each prepreg layer from a thermal analysis and the laminating processes. FEM model 2 is a simplified model neglecting the temperature-history.

(2)The deformation states from FEM models 1 and 2 were similar and were in qualitative agreement with the experimental result (Fig. 1).

(3)The computational time of FEM model 2 was about 1/1000 that of FEM model 1 (Fig. 2).

(4)Based on the results of the prediction accuracy and computational time, it was found that FEM model 2 is

effective for predictig the thermal deformation of CFRP laminates.

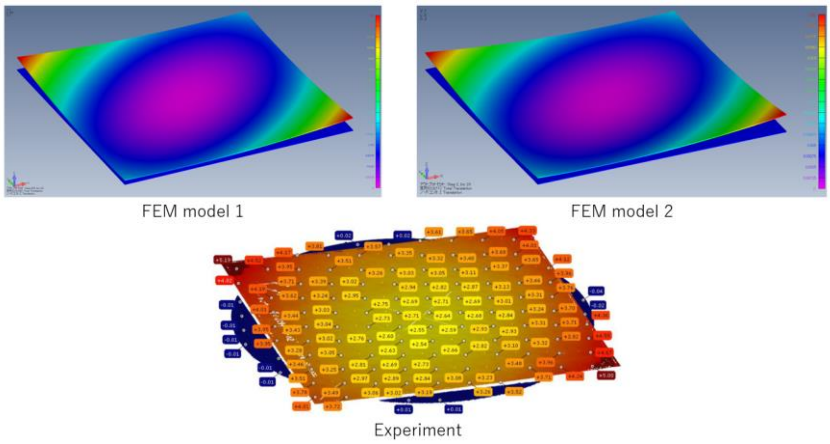

Fig. 1: Deformation states from FEM model 1, FEM model 2 and experiment

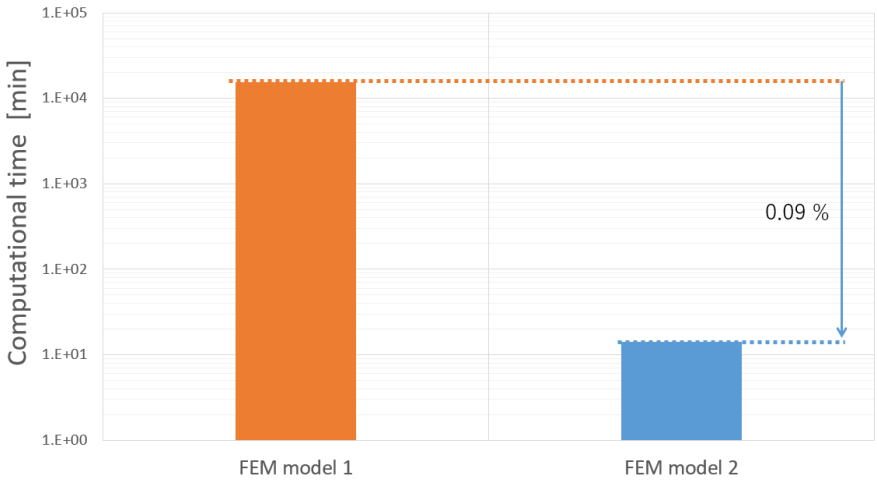

Fig. 2: Comparison of computational time

Publications

- Oral Presentations

Yasutomo Tateishi, Yoshiaki Yamaoka, Hikaru Hoshi, Yuichiro Aoki, Sunao Sugimoto, Toshiya Nakamura, Study of thermal stress FEM for CFRP thermoplastic composite laminates manufactured by in-situ consolidation with AFP, 65th JSASS/JSME/JAXA Structures Conference, Matsue, August 2022.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	2 - 256
Elapsed Time per Case	86400 Second(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.15

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-ST	23.88	0.00
TOKI-GP	0.00	0.00
TOKI-XM	71,283.78	39.04
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	248.71	0.21
/data and /data2	74,342.09	0.46
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	0.00	0.00

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[*2] (%)
ISV Software Licenses (Total)	0.00	0.00

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.