Research on the aircraft structures and advanced composite materials

● Responsible Representative

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● Abstract

Application of the composite materials will contribute to improving the performance of aircraft and spacecraft components. JAXA conducts researches for overcoming weaknesses of current composite materials, clarifying unknown aspects such as fracture mechanisms, improving performance and enabling application to design technology.

http://www.aero.jaxa.jp/eng/research/basic/structure-composite/

● Reasons for using of JSS2

We performed damage simulation of CFRP under impact loading in order to assess the design safety of CFRP structure. For precise simulation, each CFRP lamina must be modeled separately, and huge number of DoFs are needed. Application of the supercomputer system makes such high-computational-cost calculation possible.

● Achievements of the Year

Low-velocity impact damage simulation was performed using ECDM (Enhanced Continuum Damage Mechanics) model, which was damage model developed in JAXA. Low-velocity impact tests were performed based on the ASTM D7136 standard, and damage was measured by non-destructive inspection (NDI). In FY29,   ECDM model was modified in order to improve the precision. Moereover, simulations were performed for various CFRP prepregs,   various stacking sequences and various boundary conditions.

Simulation was performed using ABAQUS/Explicit 2016 on JSS2 system. Each ply of the CFRP

laminate was modeled by one continuum shell element in the thickness direction. ECDM model was implemented using usersubroutine of ABAQUS.

Figure 1 shows model overview, and Figure 2 compares damage area predicted by simulation and measured damage area. Both results agree well, and the validity and precision of the model were demonstrated.
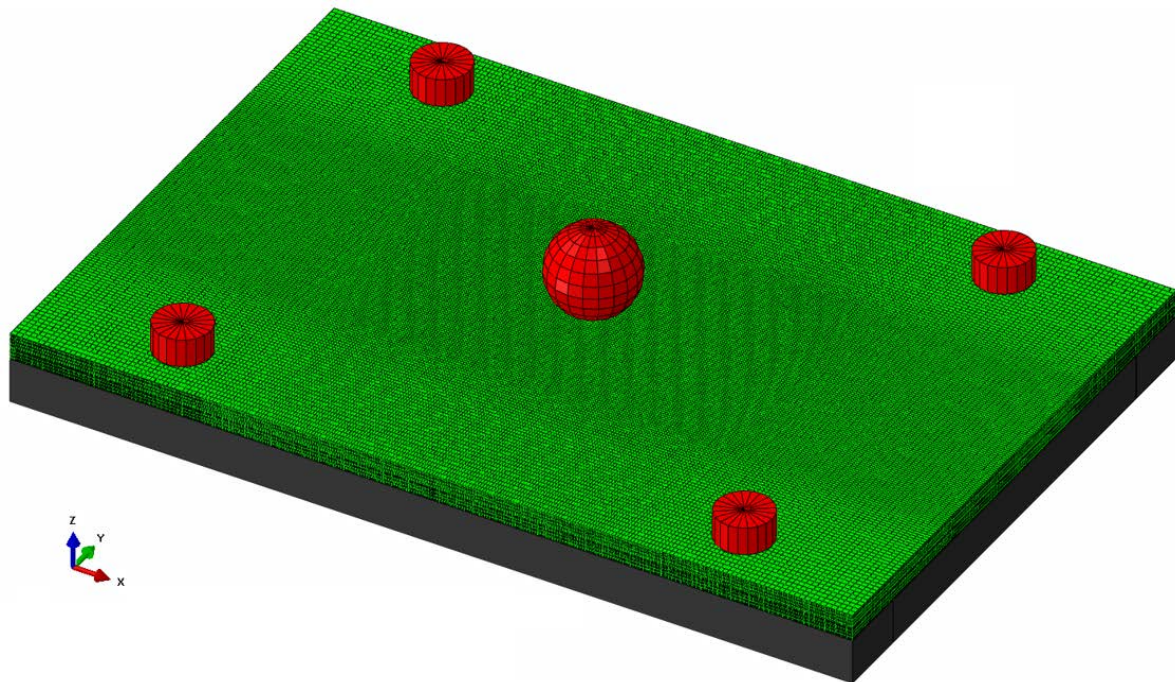

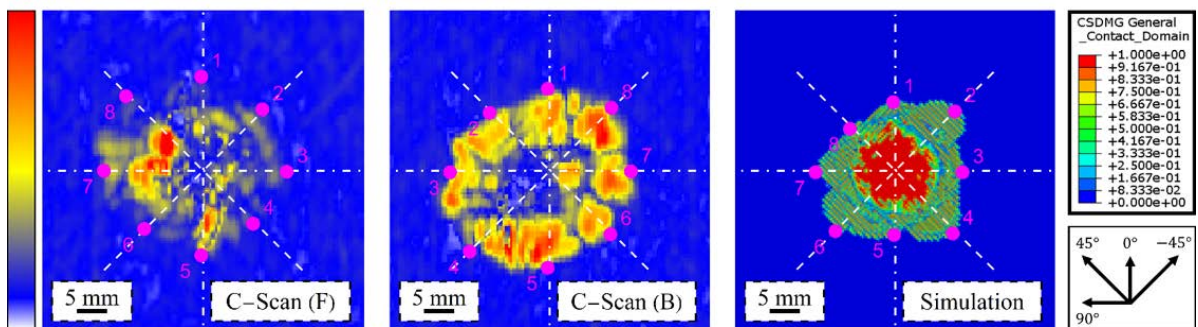Fig.1 Model overview of the low-velocity impact simulation

Fig.2 Comparison of the measured and predicted damage area

● Publications

● Presentations

1）Akinori Yoshimura, Masaya Ebina, Kenichi Sakaue, Anthony M. Waas, 'High Fidelity Simulation of Low Velocity Impact Behavior of CFRP Laminate', 32nd American Society for Composites Technical Conference, Oct. 2017, Purdue University, IN, USA

2) Masaya Ebina, Akinori Yoshimura, Kenichi Sakaue, Yuichiro Aoki, 'Low Velocity Impact Simulation of CFRP Laminates Considering Microscopic Damage Interaction', 33rd American Society for Composites Technical Conference, Sep. 2018, Seattle, WA, USA (scheduled)

● Usage of JSS2

● Computational Information

Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	12 - 120
Elapsed Time per Case	340.00 hours

● Resources Used

Fraction of Usage in Total Resources*1 (%): 0.03

Details

Computing Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	0.00	0.00
SORA-PP	35,294.26	0.44
SORA-LM	751.30	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage assigned(GiB)	Fraction of Usage*2 (%)
/home	036.56	0.03
/data	365.58	0.01
/ltmp	7,486.98	0.56

Archiver Resources		
Archiver System 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