

# CMH-17 Content Development Addressing HEWABI

Prepared for

**Joint CMH-17-EASA-FAA Workshop on  
Damage Tolerance**

**EASA Headquarters, Cologne, Germany**

**July 15-17, 2019**

Prepared by

** NSE COMPOSITES**

NSE Composites  
1101 North Northlake Way, Suite 4  
Seattle, WA 98103  
(206) 545-4888  
[www.nsecomposites.com](http://www.nsecomposites.com)

**D.M. Hoyt  
Patrick Enjuto**

1. General Information
2. Introduction to Composite Structure Development
3. Aircraft Structure Certification and Compliance
4. Building Block Approach For Composite Structures
5. Materials and Processes
6. Quality Control of Production Materials and Processes
7. Design of Composites
8. Analysis of Laminates
9. Structural Stability Analyses
10. Design and Analysis of Bonded Joints
11. Design and Analysis of Bolted Joints
12. Damage Resistance, Durability, and Damage Tolerance
13. Defects, Damage, and Inspection
14. Supportability, Maintenance, and Repair
15. Thick-section Composites
16. Crashworthiness and Energy Management
17. Structural Safety Management
18. Environmental Management

# Ch 12: Damage Resistance, Durability, and Damage Tolerance

12.1 Introduction

12.2 Rules, Requirements and Compliance for Aircraft

12.3 Design Development and Substantiation

12.4 Inspection for Defects and Damage

12.5 Damage Resistance

12.6 Durability and Damage Growth Under Cyclic Loading

12.7 Residual Strength

12.8 Application/Examples

12.9 Supporting Discussions

# Ch 12: Damage Resistance, Durability, and Damage Tolerance

## 12.1 Introduction

## 12.2 Rules, Requirements and Compliance for Aircraft

### 12.2.1 Civil aviation regulations and guidance

### 12.2.2 Categories of damage

### 12.2.3 Load and damage relationships

### 12.2.4 Compliance Approaches

## 12.3 Design Development and Substantiation

## 12.4 Inspection for Defects and Damage

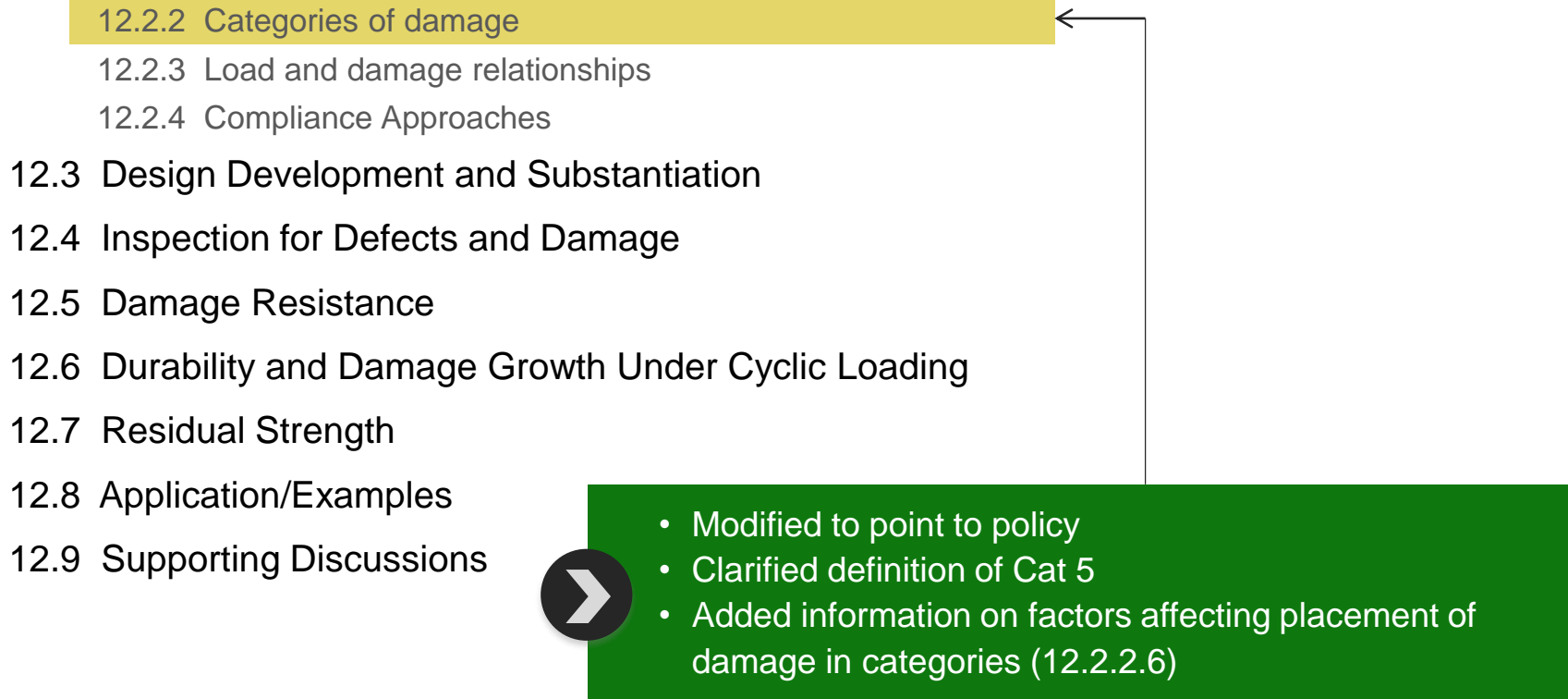
## 12.5 Damage Resistance

## 12.6 Durability and Damage Growth Under Cyclic Loading

## 12.7 Residual Strength

## 12.8 Application/Examples

## 12.9 Supporting Discussions

- 
- Modified to point to policy
  - Clarified definition of Cat 5
  - Added information on factors affecting placement of damage in categories (12.2.2.6)

# Ch 12: Damage Resistance, Durability, and Damage Tolerance

12.1 Introduction

12.2 Rules, Requirements and Compliance for Aircraft

12.3 Design Development and Substantiation

12.3.1 Damage Threat Assessment

12.3.2 Damage design criteria

12.3.3 Substantiation

12.3.4 Addressing Category 5 damage

12.3.5 Additional design development guidance

12.4 Inspection for Defects and Damage

12.5 Damage Resistance

12.6 Durability and Damage Growth Under Cyclic Loading

12.7 Residual Strength

12.8 Application/Examples

12.9 Supporting Discussions

Section under development,  
draft is in-work



- HEWABI (and other cat 5 damage?) included in damage threat assessment

# Ch 12: Damage Resistance, Durability, and Damage Tolerance

12.1 Introduction

12.2 Rules, Requirements and Compliance for Aircraft

Section under development,  
draft is in-work

12.3 Design Development and Substantiation

12.3.1 Damage Threat Assessment ←

12.3.2 Damage design criteria ←

12.3.3 Substantiation

12.3.4 Addressing Category 5 damage

12.3.5 Additional design development guidance

12.4 Inspection for Defects and Damage

12.5 Damage Resistance

12.6 Durability and Damage Growth Under Cyclic Loading

12.7 Residual Strength

12.8 Application/Examples

12.9 Supporting Discussions



- Add content on “Categorizing Damage” and how to do so
- Coord w/ 12.2.2.6

# Ch 12: Damage Resistance, Durability, and Damage Tolerance

12.1 Introduction

12.2 Rules, Requirements and Compliance for Aircraft

12.3 Design Development and Substantiation

12.3.1 Damage Threat Assessment

12.3.2 Damage design criteria

12.3.3 Substantiation

12.3.4 Addressing Category 5 damage

12.3.5 Additional design development guidance

12.4 Inspection for Defects and Damage

12.5 Damage Resistance

12.6 Durability and Damage Growth Under Cyclic Loading

12.7 Residual Strength

12.8 Application/Examples

12.9 Supporting Discussions

No Rev. G related to Cat 5 or HEWABI



- Added content on Cat 5 detailing that damage resistance criteria may be used

# Ch 12: Damage Resistance, Durability, and Damage Tolerance

## 12.1 Introduction

## 12.2 Rules, Requirements and Compliance for Aircraft

## 12.3 Design Development and Substantiation

### 12.3.1 Damage Threat Assessment

### 12.3.2 Damage design criteria

### 12.3.3 Substantiation

### 12.3.4 Addressing Category 5 damage

### 12.3.5 Additional design development guidance

## 12.4 Inspection for Defects and Damage

## 12.5 Damage Resistance

## 12.6 Durability and Damage Growth Under Cyclic Loading

## 12.7 Residual Strength

## 12.8 Application/Examples

## 12.9 Supporting Discussions

### Updated per final policy statement

- Synchronized HEWABI definition (and w/ AC 20-107B)
- Captured additional content on safety management and conditional inspections
- Updated to reflect required considerations in design
- Modified existing content as needed to summarize Relevant Past Practice and Appendices, and point to policy



# Ch 12: Damage Resistance, Durability, and Damage Tolerance

12.1 Introduction

12.2 Rules, Requirements and Compliance for Aircraft

12.3 Design Development and Substantiation

12.4 Inspection for Defects and Damage

12.5 Damage Resistance

12.5.1 Influencing Factors

12.5.2 Design Issues and Guidelines

12.5.3 Test Issues

12.5.4 Analysis Methods

12.6 Durability and Damage Growth Under Cyclic Loading

12.7 Residual Strength

12.8 Application/Examples

12.9 Supporting Discussions

Add Cat5/HEWABI-related content in each of these areas.

- *FAA/UCSD findings, spring/mass models, dynamic FE models, testing issues, etc*
- *OEM lessons learned*

# Some Technical References

## ▪ FAA/UCSD

- DeFrancisci, G. K., Chen, Z. M., and Kim, H., “Low-Velocity, High-Mass, Wide-Area Blunt Impact on Composite Panels,” Transportation Research Record: Journal of the Transportation Research Board, No. 2206, 2011, pp. 1-9.
- Kim, H., DeFrancisci, G. K., and Chen, Z. M., “Ground Vehicle Blunt Impact Damage Formation to Composite Aircraft Structures,” Advanced Composite Materials, Vol. 23, No. 1, 2014, 53–71.
- DeFrancisci, Gabriela K. “High Energy Wide Area Blunt Impact on Composite Aircraft Structures.” PhD Thesis, University of California San Diego, 2013.
- Kim, H., “High Energy Wide Area Blunt Impact Session - UCSD FAA Research.” Composite Damage Tolerance Workshop, Montreal, September 2015.

## ▪ OEMs

- Boeing – “Large Composite Aircraft - Unidentified Ground Damage: Mitigation – HEWABI.” CMH-17 D&DT Working Group, Wichita, October 2015.
- Airbus – “HEWABI-related efforts by Airbus.” Composite Industry/Regulatory Working Group Meeting, Charleston, March 2015.

## ▪ EASA/Bishop GmbH

- Mikulik, Z. and Haase, P., “CODAMEIN - Final Report.”, EASA.2010.C13, Hamburg, March 2012.
- Haack, C., “Composite Damage Metrics and Inspection - EASA CODAMEIN III Meeting.” Composite Industry/Regulatory Working Group Meeting, Charleston, March 2015.

## ▪ Airlines

- DAL & UAL – “High Energy Wide Area Blunt Impact – Airline Perspectives.” Composite Damage Tolerance Workshop, Montreal, September 2015.
- UAL – “Recent Incidents of HEWABI.” Composite Damage Tolerance Workshop, Montreal, September 2015.

# Key Messages

- Need to calibrate things that were found to be important in large-scale tests
- Strengths and weaknesses of analysis methods
- Can generate severe damage without exterior detectability
- See Presentations and TW Notes from Charleston, SC (3/31/15)
  - Simon, Hyonny, Chantal, Al Fawcett