Contribution to composite ‘T’ beam design in industrial environment by using the grid technique

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Introduction

- T-shape beam for aeronautic structures
  - Design level => various technical solutions for joining
  - Key selection: 1st macroscopic crack on the structure

Validation of the test
Qualification of the « 1st crack » level

Sources: Hexcel Reinforcements
Proposed study

- Validation of testing conditions
- Comparison of different technical solutions
- Failure analysis
  - Based on displacement fields
  - Needs a global sight on the experiment

- Strain analysis
  - Needs a numerical derivation
  - Local sight on the experiment

Measuring system optimized for the three 1st points
### Choice of an OFFT

#### Introduction

- Choice of an OFFT

#### Displacement analysis

- Random signal
  - Periodic signal
    - Frequency processing
      - Correlation
        - Grid Method

#### Strain analysis

- Synthetic speckle
- Gridless method

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Choice of an OFFT

Presentation of Grid Method

- Fast
- Robust
- Full field

- Covered field: 55×44 mm²
- Spatial resolution: 0.51 mm
- Resolution: $\sigma = 2.1 \, \mu m$

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Displacement analysis

Strain analysis

Conclusions
Choice of an OFFT

\[ \phi_x = \arctan \left( \frac{1}{2\pi} \sum_{k=1}^{n_x p_x} \cos \left( k \cdot \frac{2\pi}{p_x} \right) I_x \left( r - \frac{n_x p_x}{2} + k, s \right) \right) \]

\[ \Delta \phi_x = \frac{2\pi (\delta_2 - \delta_1)}{p_x} \Rightarrow \delta_x = p_x \left( \frac{\Delta \phi_x}{2\pi} \right) \]
Displacement analysis

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Test validation

Boundary conditions
Loading conditions
Displacement analysis

Comparison of different technical solutions

- Comparison with or without using Z-pinning technology
- Sub-surface reinforcements effect clearly visible

Local reinforcement effects
Displacement analysis

- 1\textsuperscript{st} damage = key parameter for end-user selection
- Defined as the 1\textsuperscript{st} negative slope in the load vs displacement graph
Displacement analysis

Choice of an OFFT

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Failure mode


• Definitions

Metrological approach

Spatial Resolution

Resolution

Spatial Resolution

Mesurande

Spatial Resolution
Theoretical analysis on strain uncertainty

\[ \varepsilon \leq 10\% \text{ si } \lambda_{\text{méca}} \geq 5 \times RS \]

\[ N_{\text{dériv}} \approx 1.4 \times N_{\text{lissage}} \]
Strain analysis

Results

- Shows the critical zones before damage
- Useful for a 1st sight, but other experimental tools are more accurate (ESPSI, Moiré Interferometry...)

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Conclusions
Conclusions

- Boundary conditions study => 1st level in a quality approach
- Grid method is an efficient tool to compare technological solutions
- Quantative study on failure
- Good-looking strain maps ≠ accurate strain maps

Forecomings
- Strain measurements with a new portable ESPSI test-rig
Obrigado.

Têm perguntas?