P30: Experimental and Theoretical Evaluation of Aluminium Deflection due to Lightning Strikes

N. S. Jamoshid, D. Mitchard, C. Stone, A. Haddad
Morgan-Botti Lightning Laboratory, Cardiff School of Engineering, Cardiff University
Cardiff, Wales, UK
jamoshidn@cardiff.ac.uk

Introduction: This research focuses on the displacement of aluminum plates subjected to the forces generated by a lightning current in order to compare modelling and experimental results directly. The electromechanical forces produced during lightning strikes can cause catastrophic damage such as deflection, matrix crack and delamination. There is a need to understand the performance of existing and new materials under such extreme conditions in order to improve the ability to withstand these forces and minimise damage.

Results

Experimental Results

- The numerical model only considered the electromagnetic force in a static condition.
- A number of additional factors were observed in the dynamic experimental results such as damped oscillation, constructive and destructive interference, elastic/plastic deformation and an air pressure effect.
- The maximum deflection occurred before the plate swings into a light damping mode.
- The results showed very good agreement and were mostly within the measurement and calculation error margins of the experiment.

Future Work

- Progress onto the study of more complex materials, such as aerospace grade carbon composites.

Mechanical Properties of Aluminium

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<th>Property</th>
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<td>Young's Modulus, E</td>
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<td>Poisson's Ratio, ν</td>
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<td>Dimensions</td>
<td>50 x 50 x 0.20 cm</td>
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Numerical Model (COMSOL Multiphysics)

Magnetic Fields
- Electromagnetic force/Lorentz force - Magnetic flux density (B) and Electric current distribution
- $F_z = \int \int dv x \vec{B}$

Solid Mechanics
- Electromagnetic force, $F_z$
- Displacement/Deflection

Experimental Setup

Comparison of static model and dynamic experimental measurements of maximum displacement

Comparison of dynamic deflection up to the first 3ms following a lightning strike, indicating the maximum deflection and duration of the lightning strike

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