FINITE ELEMENT ANALYSIS OF COMPOSITE SANDWICH PANELS UNDER IMPACT LOADING

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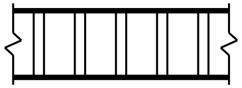
Previous Work and Panel Fabrication

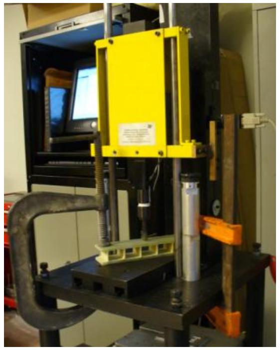
- Previous work idealized panel as a beam on an elastic foundation to determine most efficient design.
  - Straight design (pictured) had highest strength to weight ratio.



- Straight design chosen for further analysis
  - Computational model desired to eliminate costly work of experimental testing
  - Experimental testing performed to validate computational model
    - Panels with a height of 1.5” were fabricated using the VARTM process
    - “Beam” segments 9” long x 2” wide were cut from panels
    - Facesheet thickness = 0.25”
    - Stiffener thickness = 0.05”

Experimental Setup

- Panels tested with Dynatup 9200 drop tower.
  - ½” diameter spherical head
- Each panel had 6 stiffener spaced 1.5” on center.
  - Loading at midspan between middle two stiffeners
- Panels clamped to impact table
- High speed camera recorded impacts



- Two loading conditions
  - 94 J – Preliminary tests of 94 J impact showed significant damage
  - 151J – Meant to collapse the entire panel’s core

Finite Element Modeling

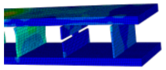
- FEA ran in Abaqus using explicit analysis
  - Geometry built in AutoCAD
  - Meshing, material properties, loading, and boundary conditions applied in FeMap
- IMPERFECTION function used to apply out of plane imperfection in the stiffeners.
- JOIN connector elements used to simulate facesheet-stiffener interaction .
  - Gives behavior representative of experimental results
- BRITTLE FAILURE function applied to stiffeners
  - Only applied at mid height of stiffeners
  - Requires isotropic material properties in this region
- Loading applied using AMPLITUDE, DEFINITION=TABULAR function
  - Loading conditions based off load time history from experimental tests.

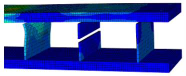
Experimental Results

- Maximum Deflections
  - 94 J : 0.70”
  - 151 J : 0.95”
- Brittle failure characteristics
  - Failure seen 1 ms into all runs
- Delamination between facesheet and stiffener observed

Model Results

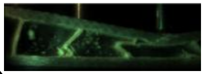
- Maximum Deflections
  - 94 J : 0.28”`
  - 151 J: 0.473”
- Timing of interior 4 stiffeners
  - 94 J = failure occurs at 7.8 ms
  - 151 J = failure occurs at 5.6 ms
- Tensile failures seen in outer stiffeners
  - Unable to differentiate between compressive and tensile failure using brittle failure definition

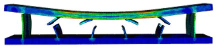




Comparison of Experiment and Model

- Maximum deflections seen at mid span between the middle two stiffeners for experimental tests and model runs
- Model deflections roughly ½ of deflections recoded during experiment
- Model and experiment experience brittle failure of interior 4 stiffeners
- Good correlation in deflected shapes of model and experiment





Conclusions and Future Work

- Accuracy of model in capturing global response appears promising.
- Use the model to apply loads more representative of blast simulation
- Parametric study of the straight design to optimize the panel for blast application
  - Vary stiffener spacing, height, and thickness

Acknowledgements

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