Results from Two Full-Scale Hawker 4000 Fuselage Drop Tests

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Test Objectives

1. Generate data on composite aircraft structures
2. Generate data for the use in validation of computer modelling efforts
   – Reverse Engineered vs. detailed model
3. Evaluate various structural health monitoring instrumentation



General Configuration

- Section fuselage into thirds
  - Forward – Dynamic Drop Test
  - Aft – Dynamic Drop test
  - Middle – Materials Testing
- No inside components other than what was on when we obtained the sections
- Ballast Added to allow for inertial loading
- Drop height of 14 ft, which gives a nominal impact velocity of 30 ft/s
- Want significant pitch to initiate deformation and failures on a specific portion of the test article
- Main form of data collected is through accelerometers and digital image correlation

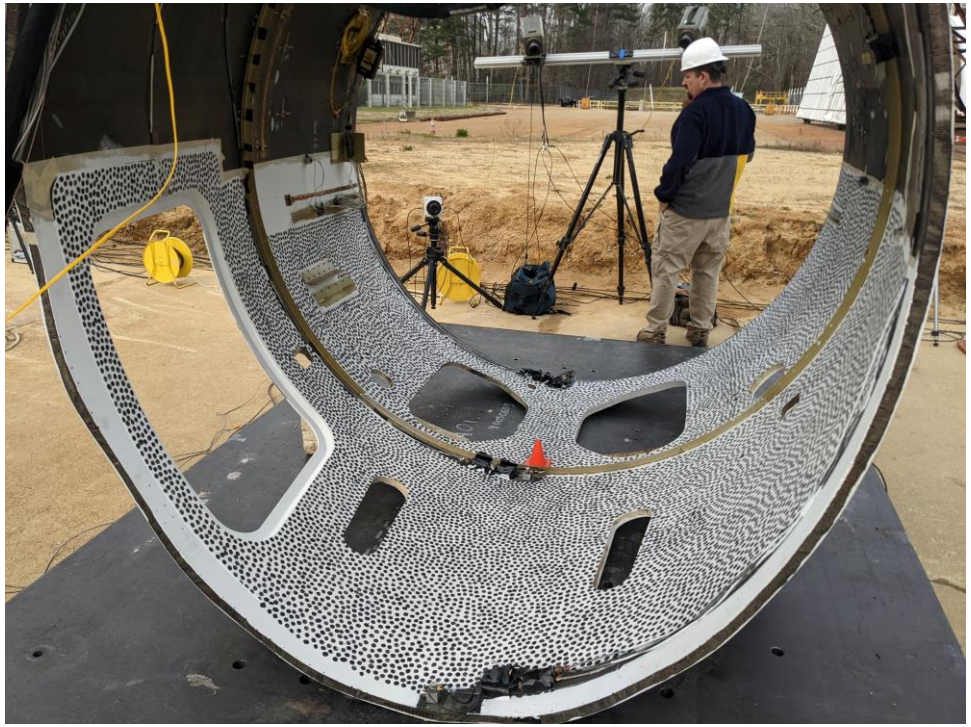


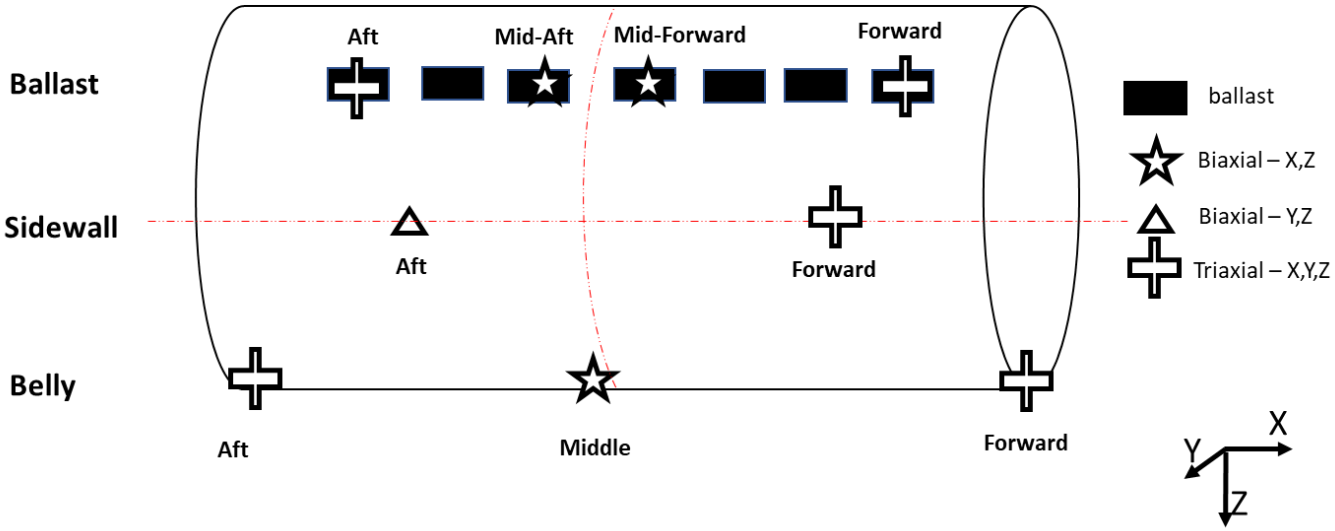


Forward Section Test Article

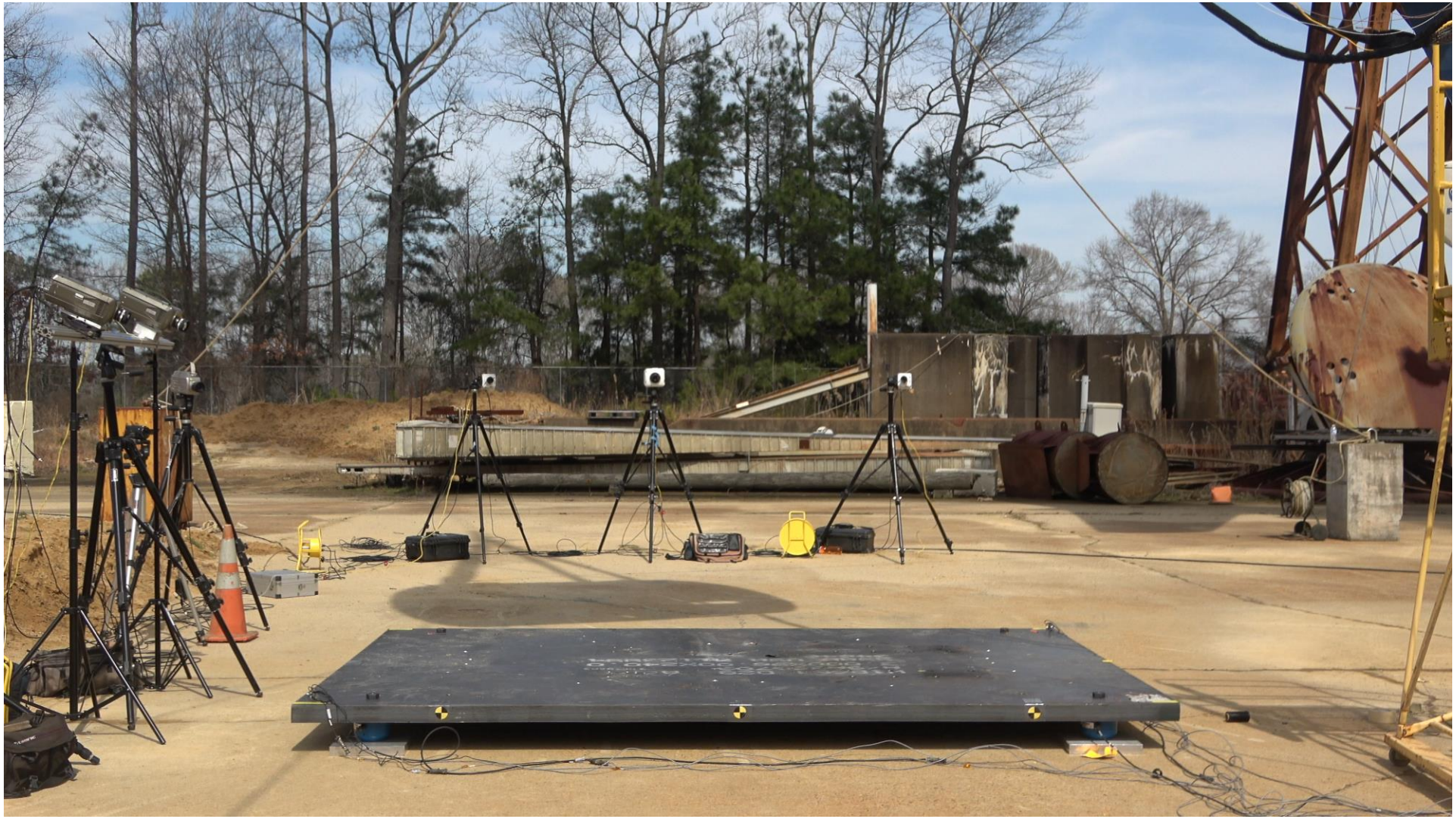
- Seven 25 lb ballast blocks each side, weighted toward the forward end
- Accelerometers on ballast, sidewall and belly measuring x, y, and z directions
- Outside and inside speckle coated
- Total weight 760 lb.







Test Video - Realtime



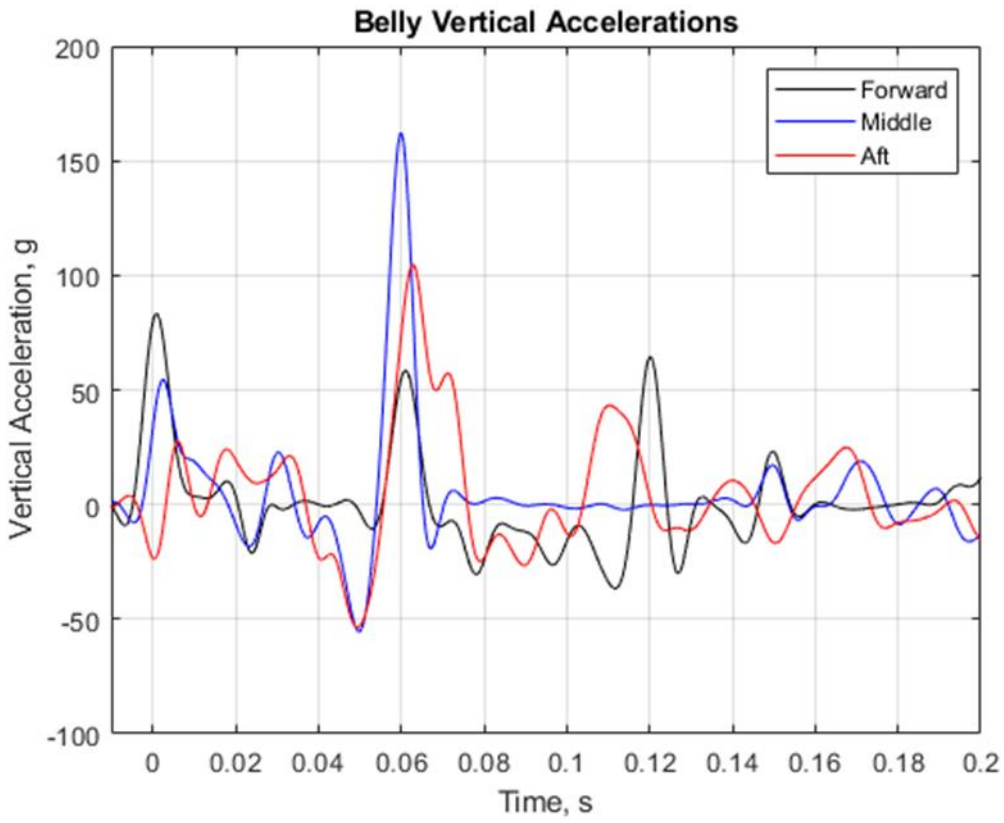
- Impact of 30 ft/s vertical velocity, 19.7 degrees pitch down

Test Video – High Speed



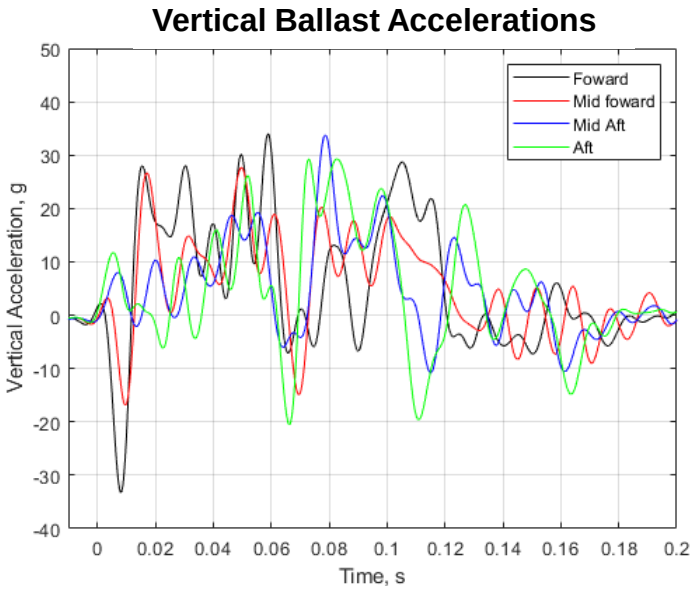
Belly Acceleration Results

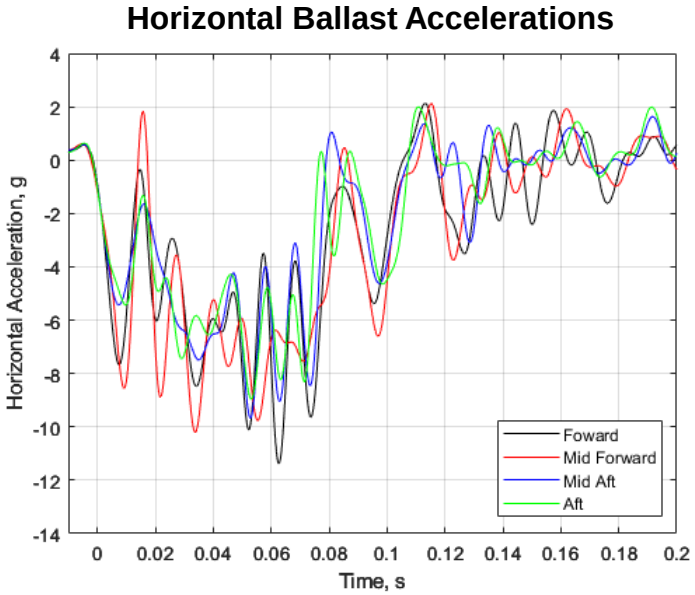
- In belly region, two distinct events
- Initial impact occurs at t=0 seconds. Most pronounced at impact location (forward)
- Second event occurs ~ 0.06 seconds after impact, which is middle contact. Most pronounced in middle due to stiffening ring present
- Both events are shock-type events with little sustained accelerations



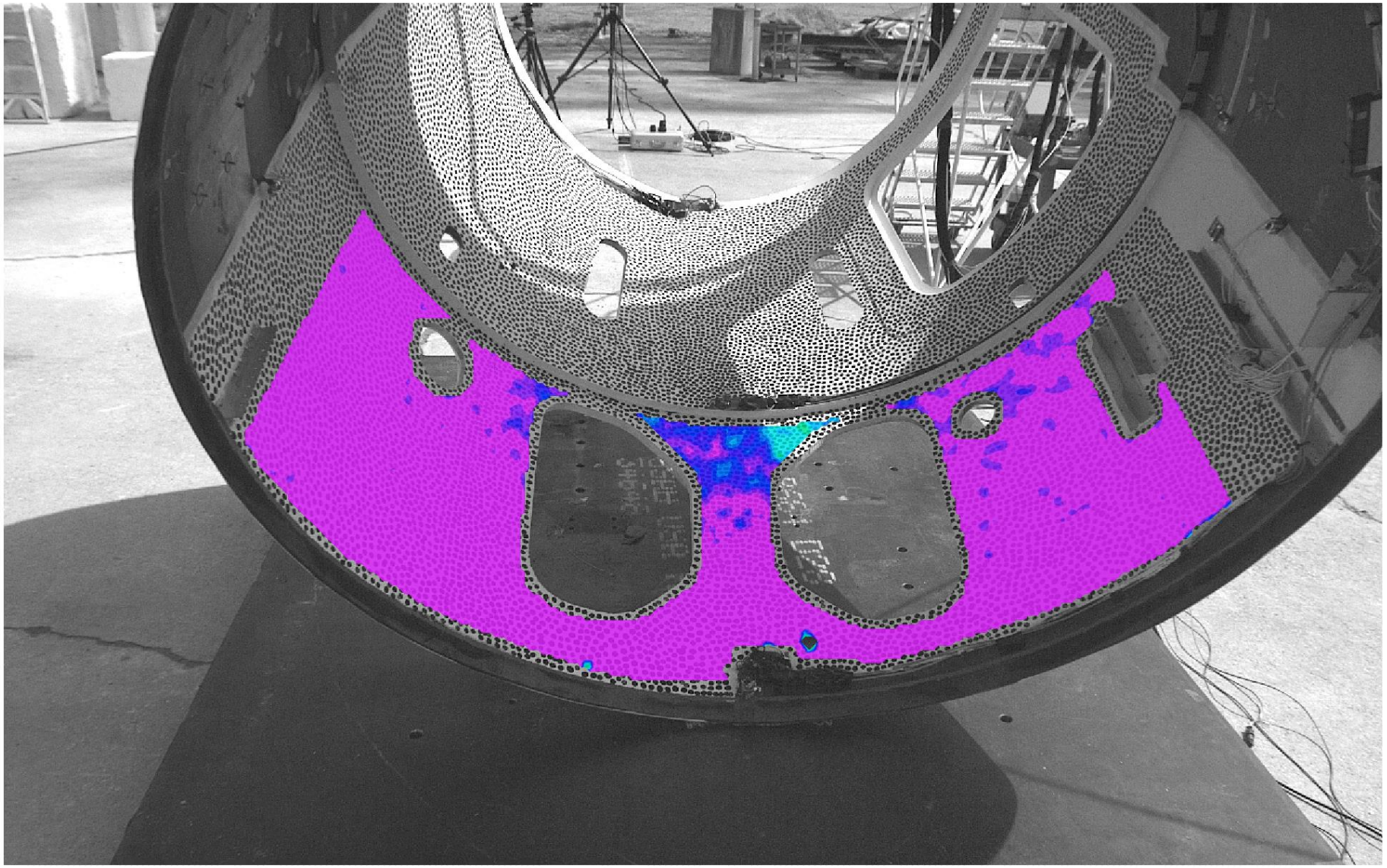
Ballast Acceleration Results

- Port side shown
- Sustained pulse at ballast locations
- High oscillations of approximately 40 Hz
- Trapezoidal to triangular in nature, lasting approximately 0.12 to 0.14 seconds in duration
- Peak magnitudes of 33 g in the vertical direction and 11.3 g in the horizontal direction
- Starboard side similar results

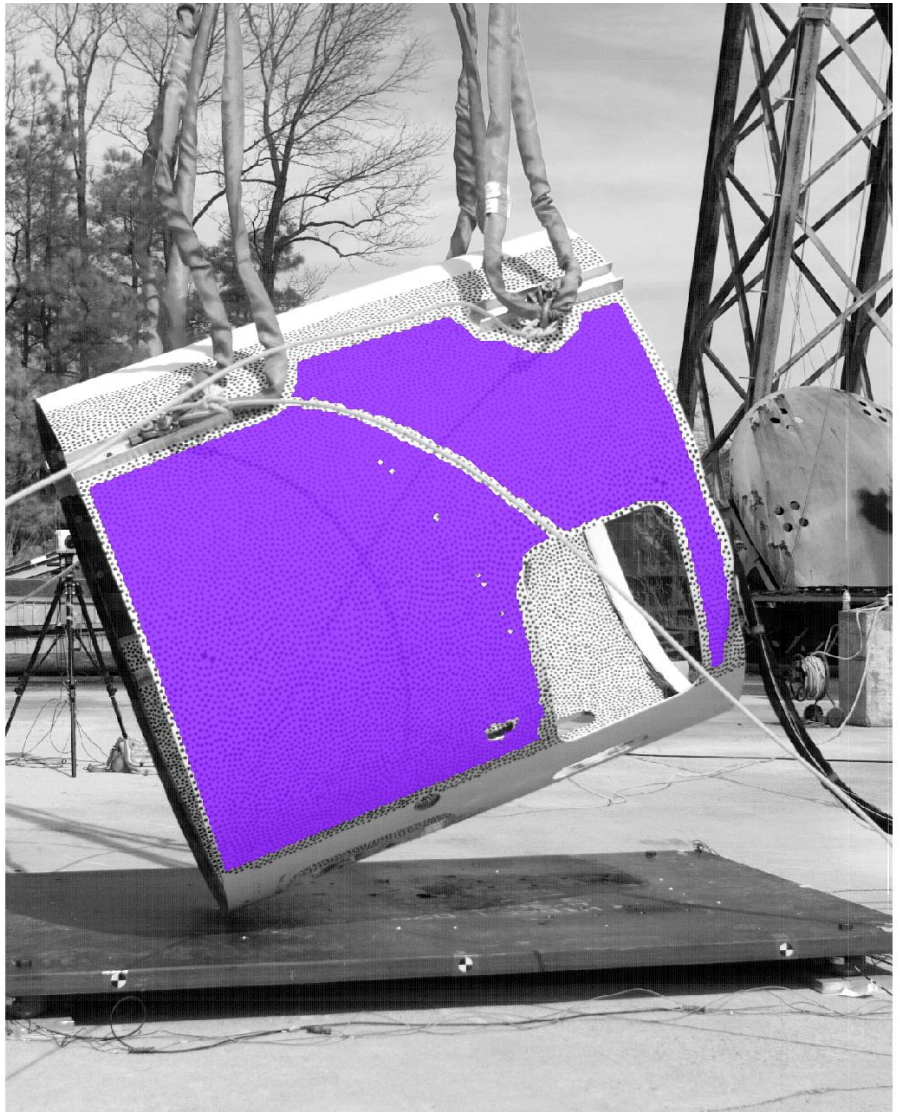


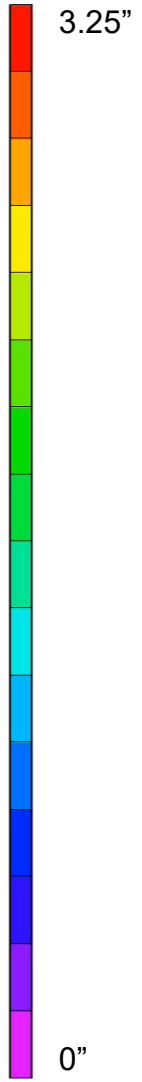


Digital Image Correlation Results – Interior - Sigma



Digital Image Correlation Results – Exterior – Out of Plane Deflection





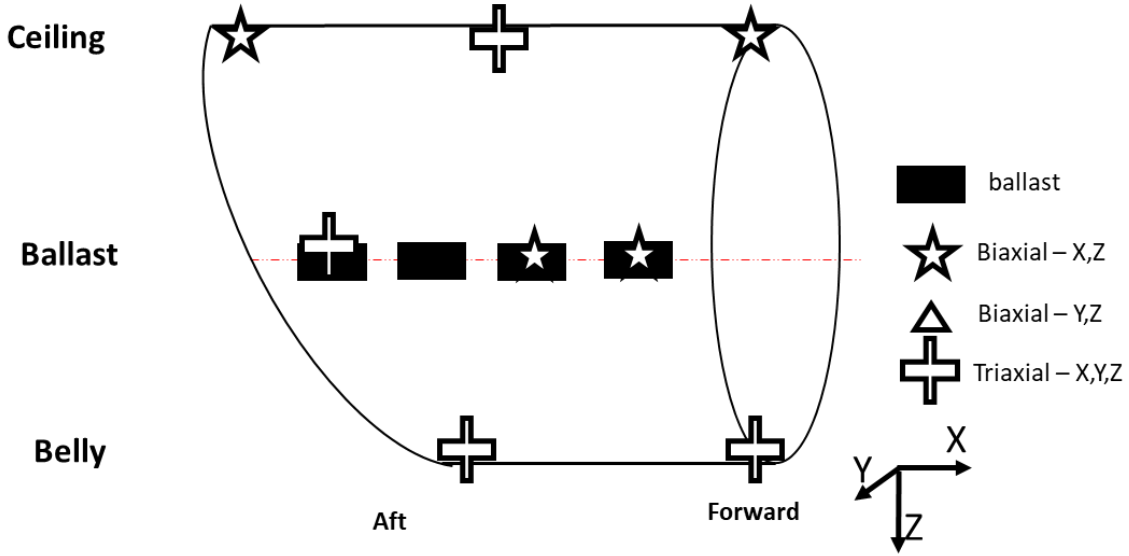
Post-Test Condition





Aft Section Test Article

- Four 25 lb ballast blocks each side, weighted toward the forward end
- Accelerometers on ballast, ceiling and belly measuring x, y, and z directions
- Outside speckle coated
- Total weight 490 lb.





Test Video - Realtime



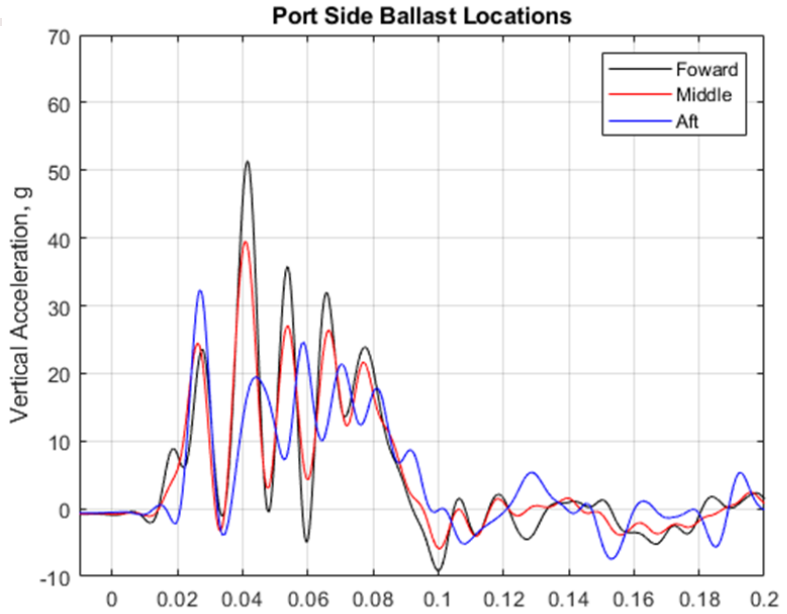
- Impact of 26.7 ft/s vertical velocity, 17.9 degrees pitch down

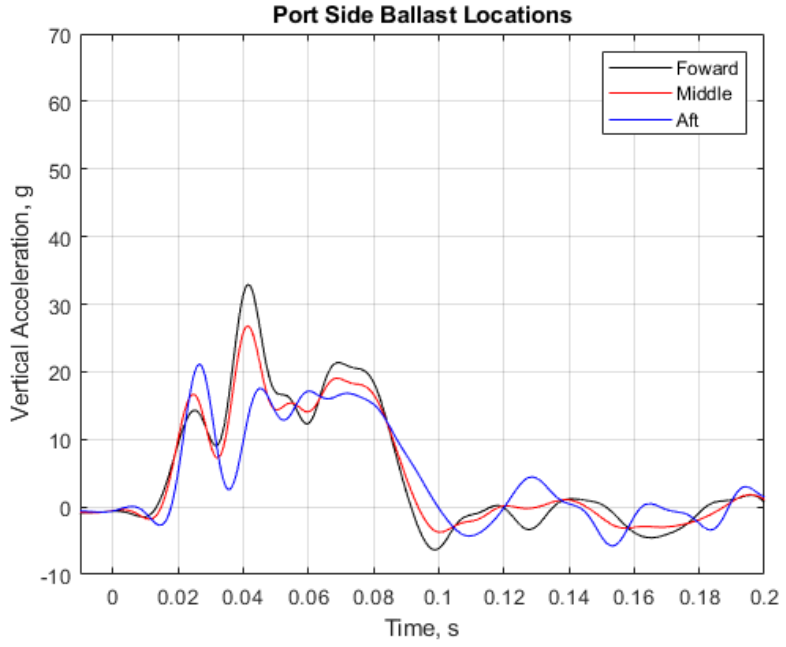
Test Video – High Speed



Acceleration Results

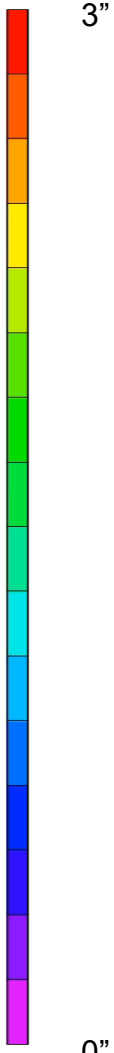
- Belly accelerations unusable due to instrumentation detachment
- Starboard and Port side ballast similar results
  - Port side shown
- Sustained pulse at ballast locations
- High oscillations of approximately 75 Hz
- Trapezoidal to triangular in nature, lasting approximately 0.1 seconds in duration
- Lower 60 Hz lowpass filtering used to identify underlying pulse shape
- Peak values of 32.9 g





Digital Image Correlation Results – Exterior – Out of Plane Deflection

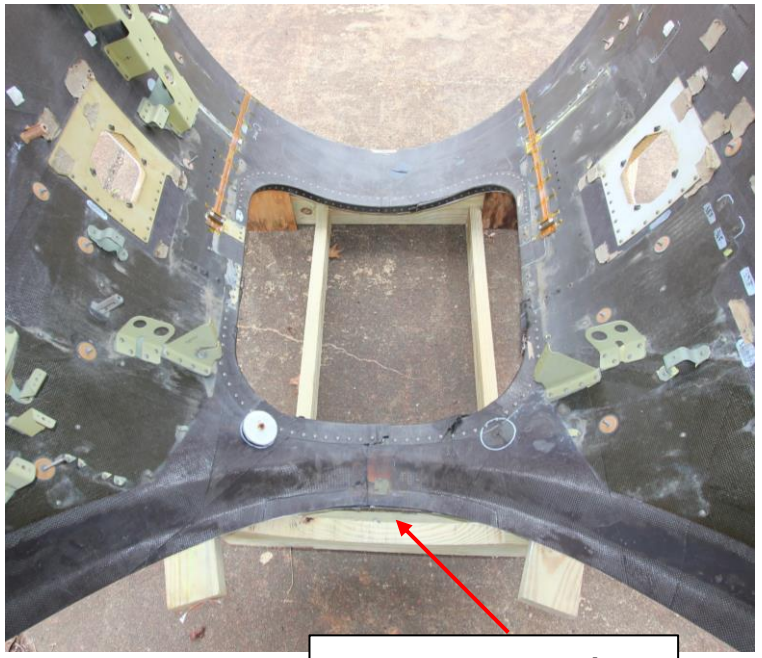




Post-Test Deformation

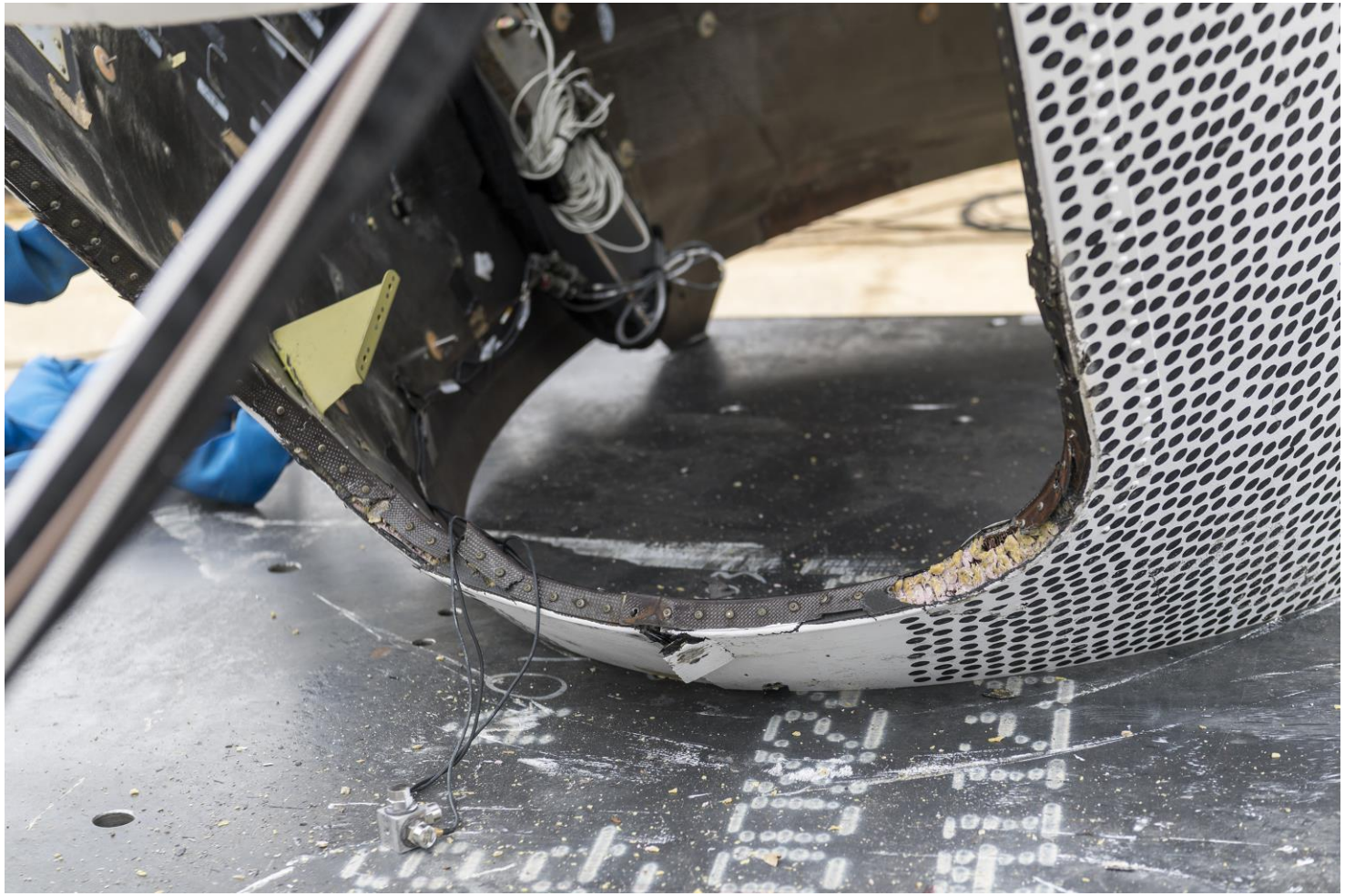
- The impact location suffered the majority of the visible damage
- Main damage modes were composite fracture and delamination/debonding





Post-test Deformation (Cont)

- Debonding seen in areas not in the immediate impact area
- Primarily focused on the belly area of the test article
- Areas not around belly area were undamaged



Summary

- Tests were conducted as a part of a larger test/analysis campaign utilizing a quasi-building block approach
- Two successful dynamic drop tests conducted using Hawker 4000 fuselage hardware completed
  - Satisfy all test objectives
  - Failure was initiated in specified areas and was able to be measured
  - Acceleration and digital image correlation primary data collected
    - Some data dropout in accelerometer data
- Data will be used to calibrate finite element models for ultimate evaluation of various modelling techniques
- Full-scale testing, when available, provides a robust way of providing necessary test data for model calibrations and validations