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Impact of Thick CFRP Panels: Near Edge Impact

CompTest 2004, Bristol

Presentation Structure

- Background to the research
- Experimental tests
- Numerical study
- Conclusions

Research sponsored by Airbus UK and the Needham Cooper Trust

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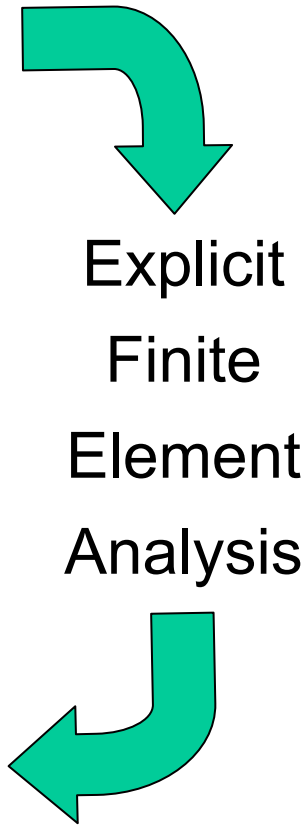
Background to the Research

- Desire to use composites more in structural and semi-structural components
- Composite panels are vulnerable to impact damage
- Damage is not necessarily visible
- Free edges inevitable on wing structure
- Most research has centred on thin laminates
- No detailed study found in the literature

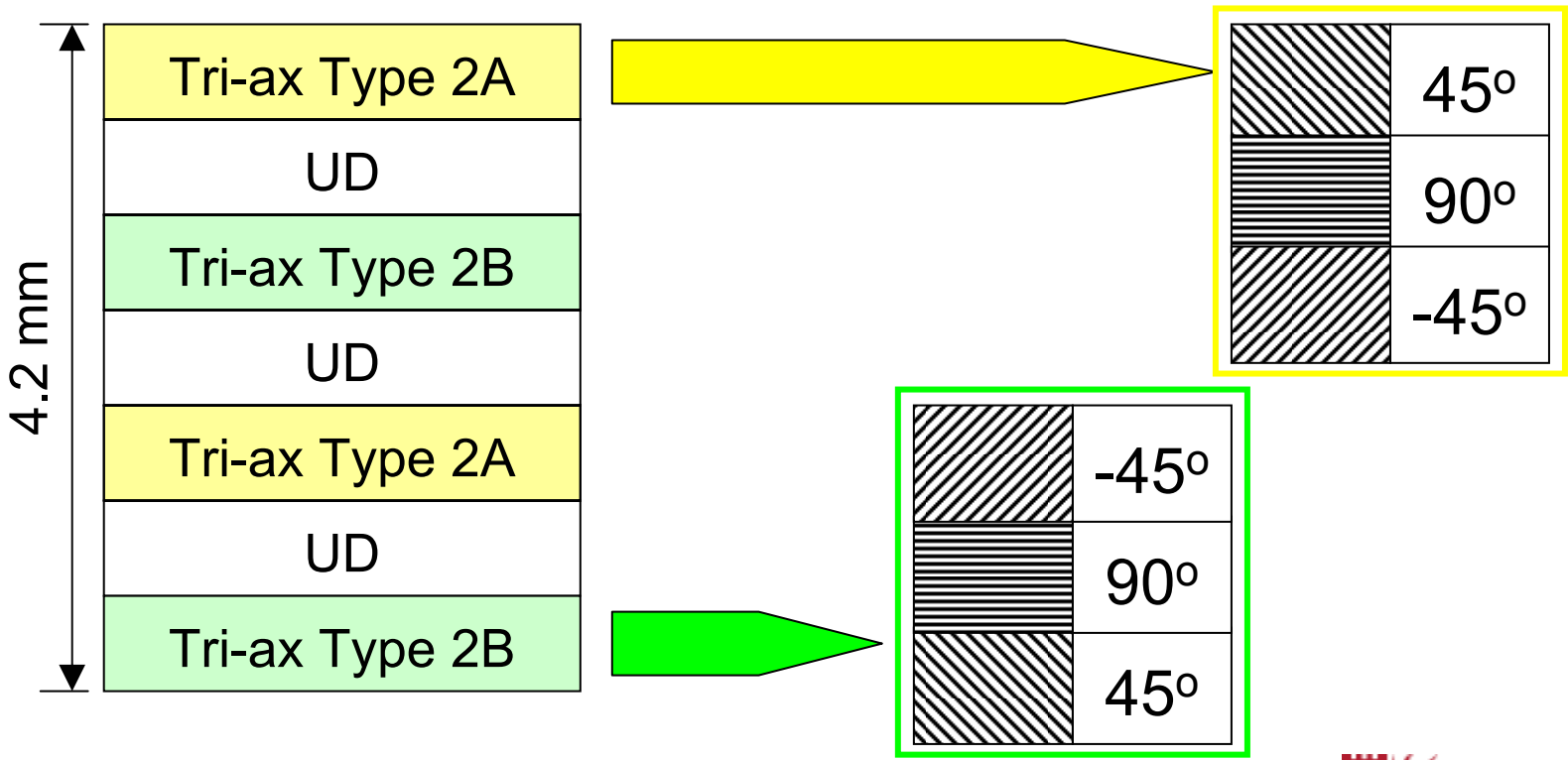
Background to the Research

- PhD studying impact of thick composites
- Central and edge transverse impact
- Three different thicknesses: 4, 8, 12 mm
- Drop weight impact machine
  - Three impact energies: 100, 200, 375 J
  - Two impact velocities: 5.5, 9.3 m/s, and static
- Ultrasonic C-scan, post impact strength
- THIS PAPER:
  - 8 mm thick only results at 3 energy levels



Materials Used

- M36 Epoxy resin film
- High strength carbon fibre NCF, Tri-ax and UD



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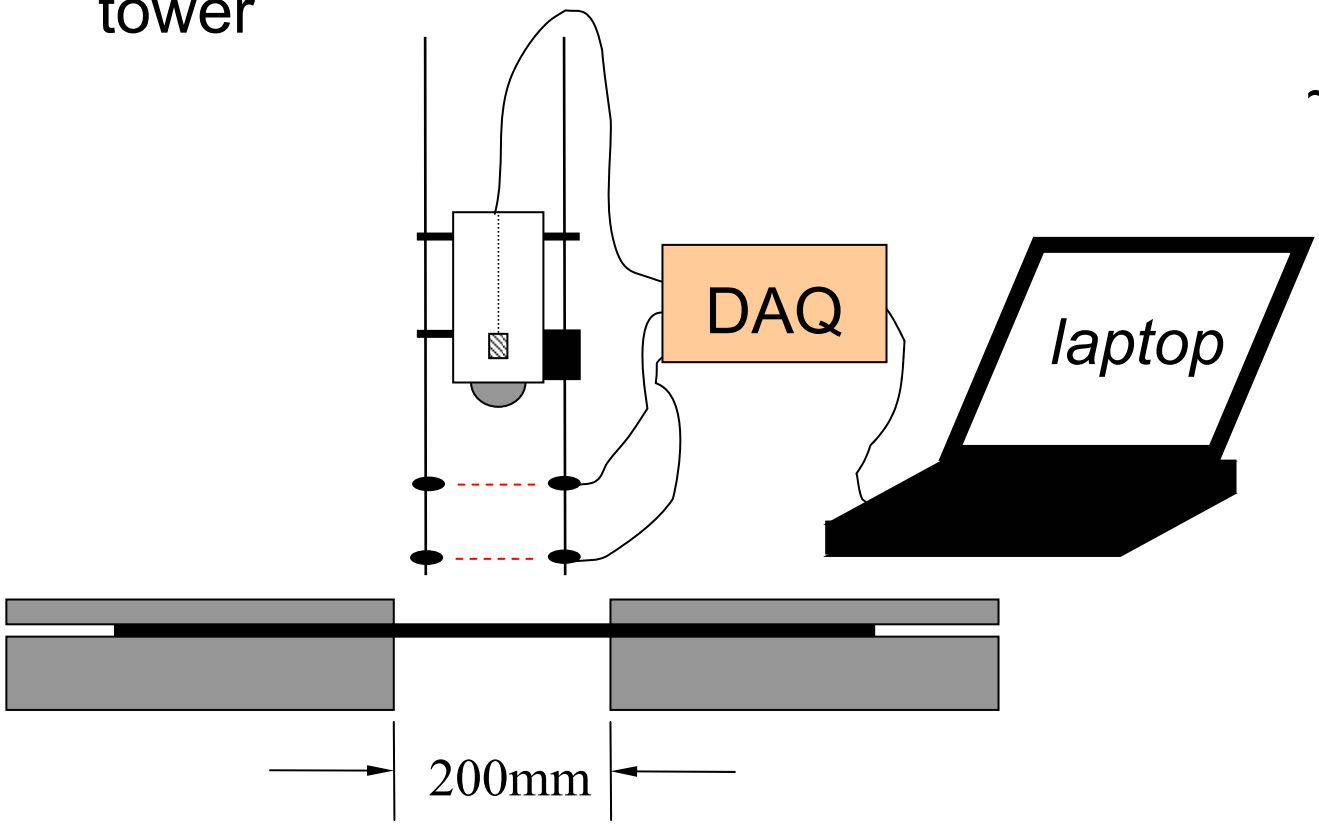
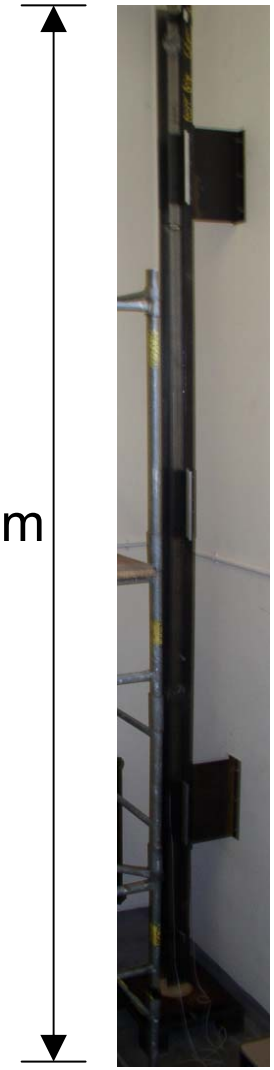
Experimental Tests – Impact

- 4.3m instrumented drop weight impact tower

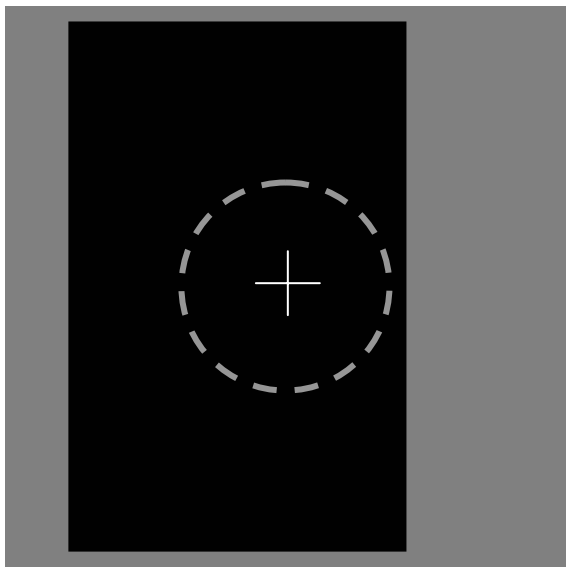


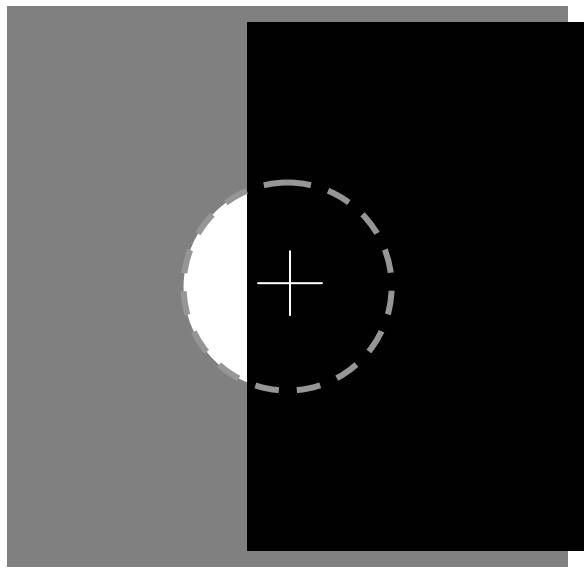


Experimental Tests - Impact

- Central

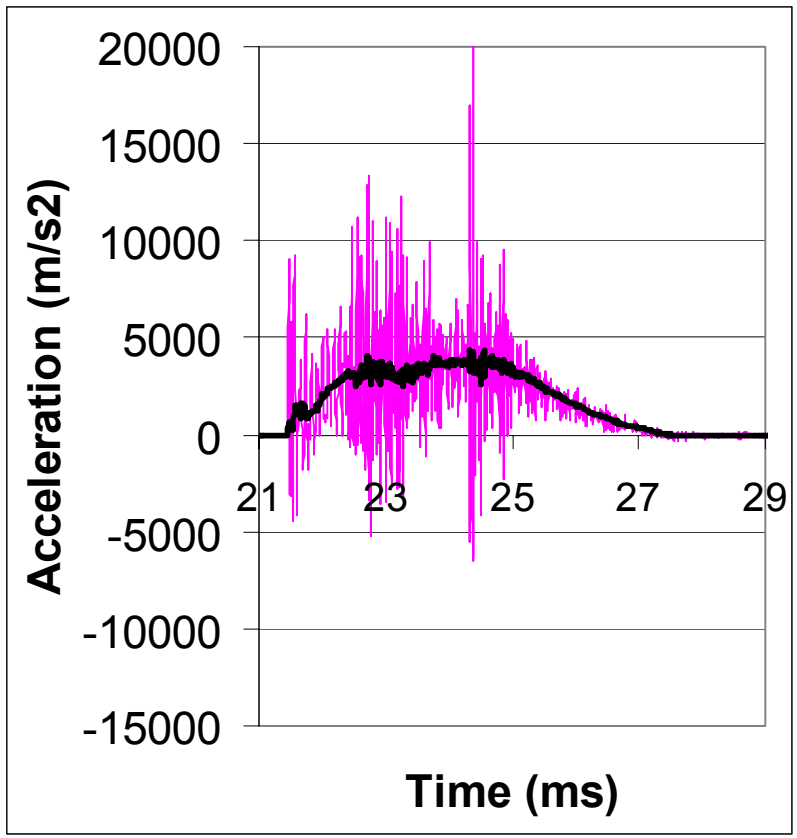
Edge



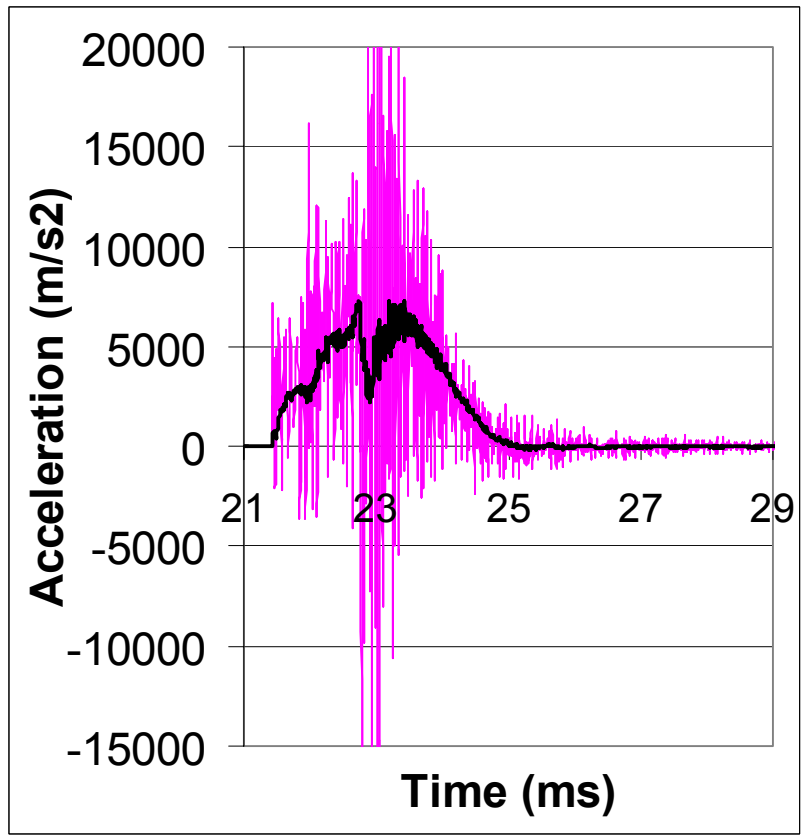


Experimental Results – Impact data

- Typical Accelerometer results, edge vs central impact



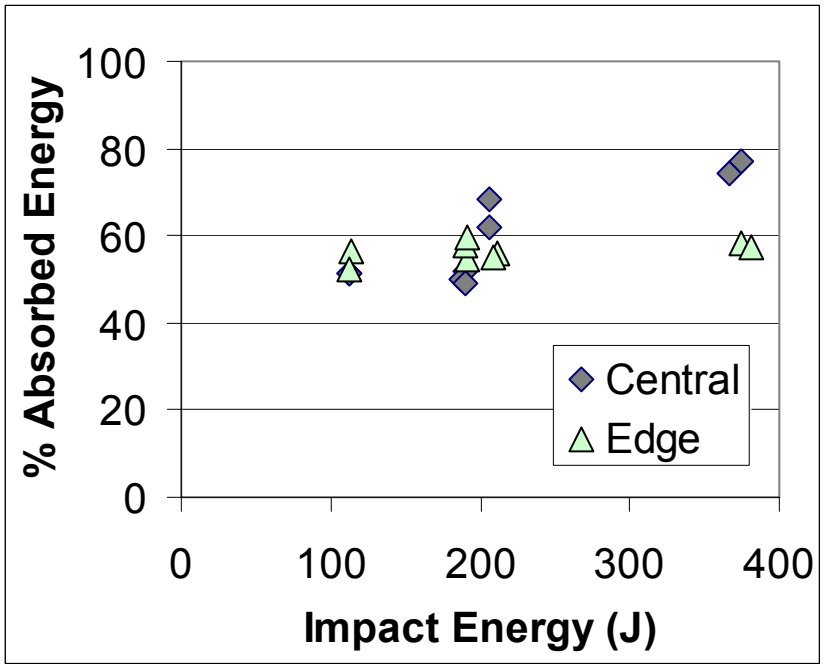
Edge

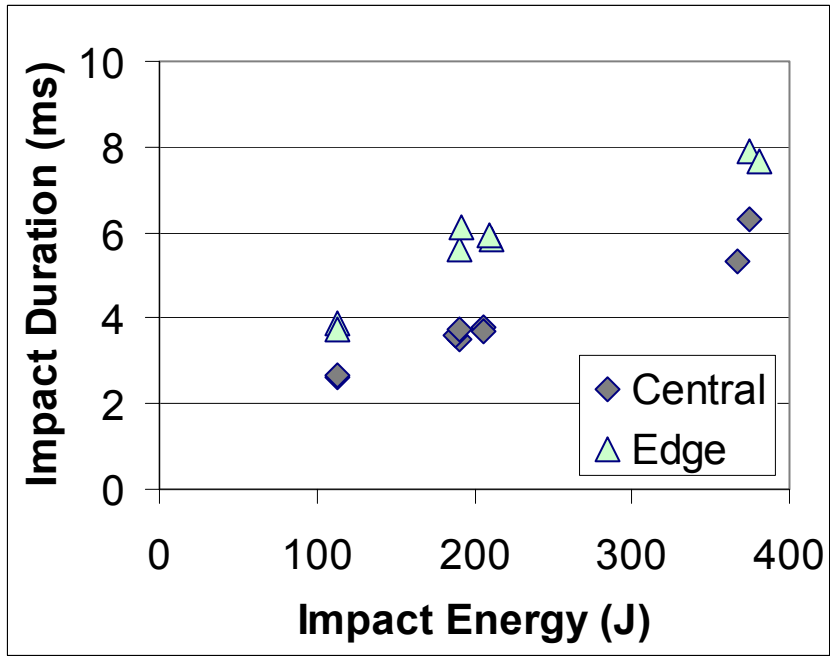


Central

Experimental Results – Impact Data Summary

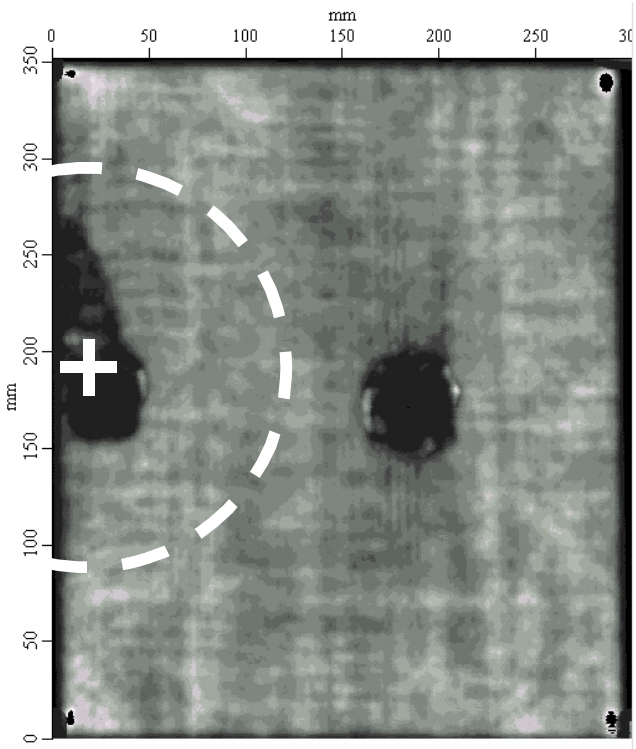
- Impact event duration and absorbed energy ratio



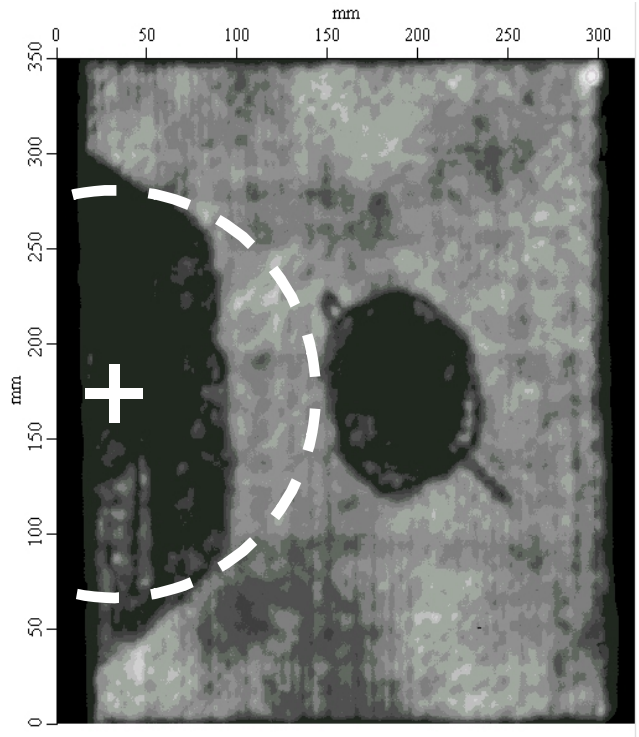


Experimental Results - NDT

- C-scan results
  - 100J impact

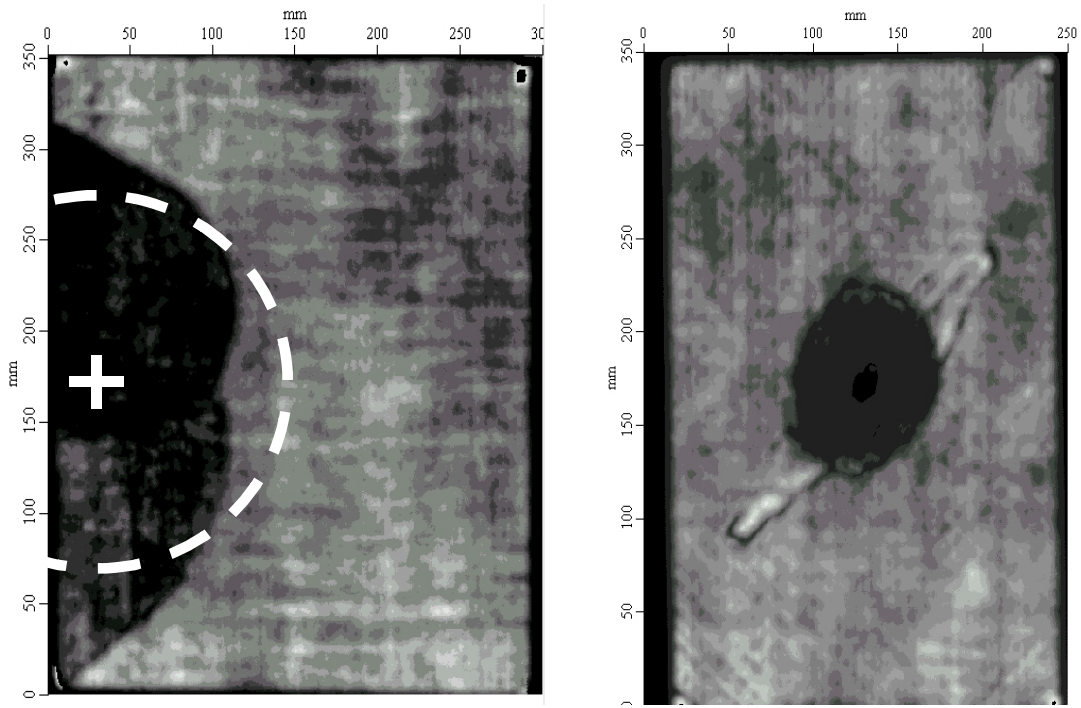


200J impact



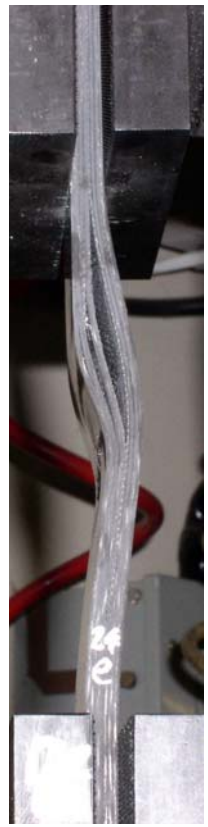
Experimental Results - NDT

- C-scan results
  - 375J impact



Experimental Results – Residual Strength

- 500kN hydraulic test machine with hydraulic grips
  - 50 mm wide coupons
  - Compression/stability test
  - Tensile strength



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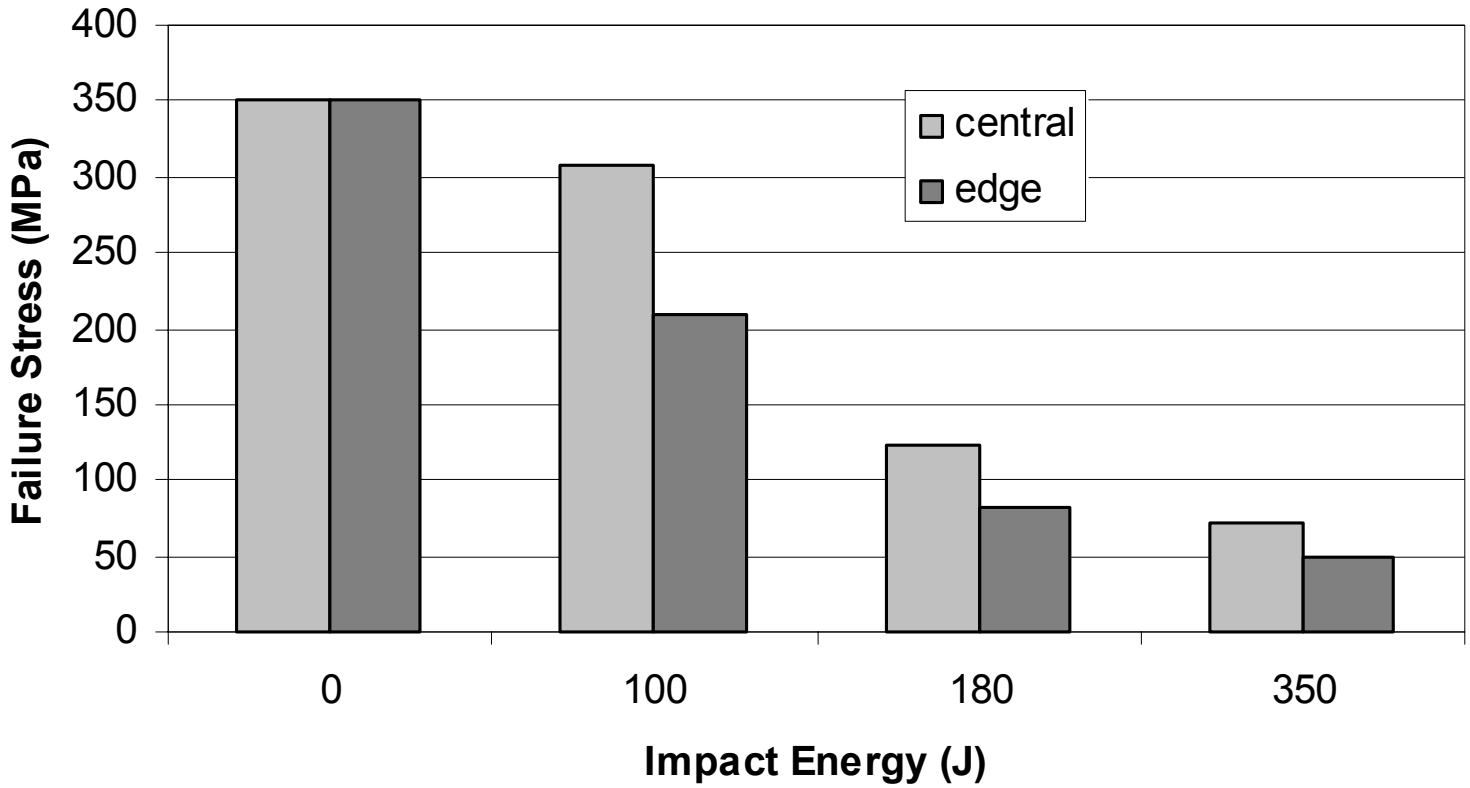
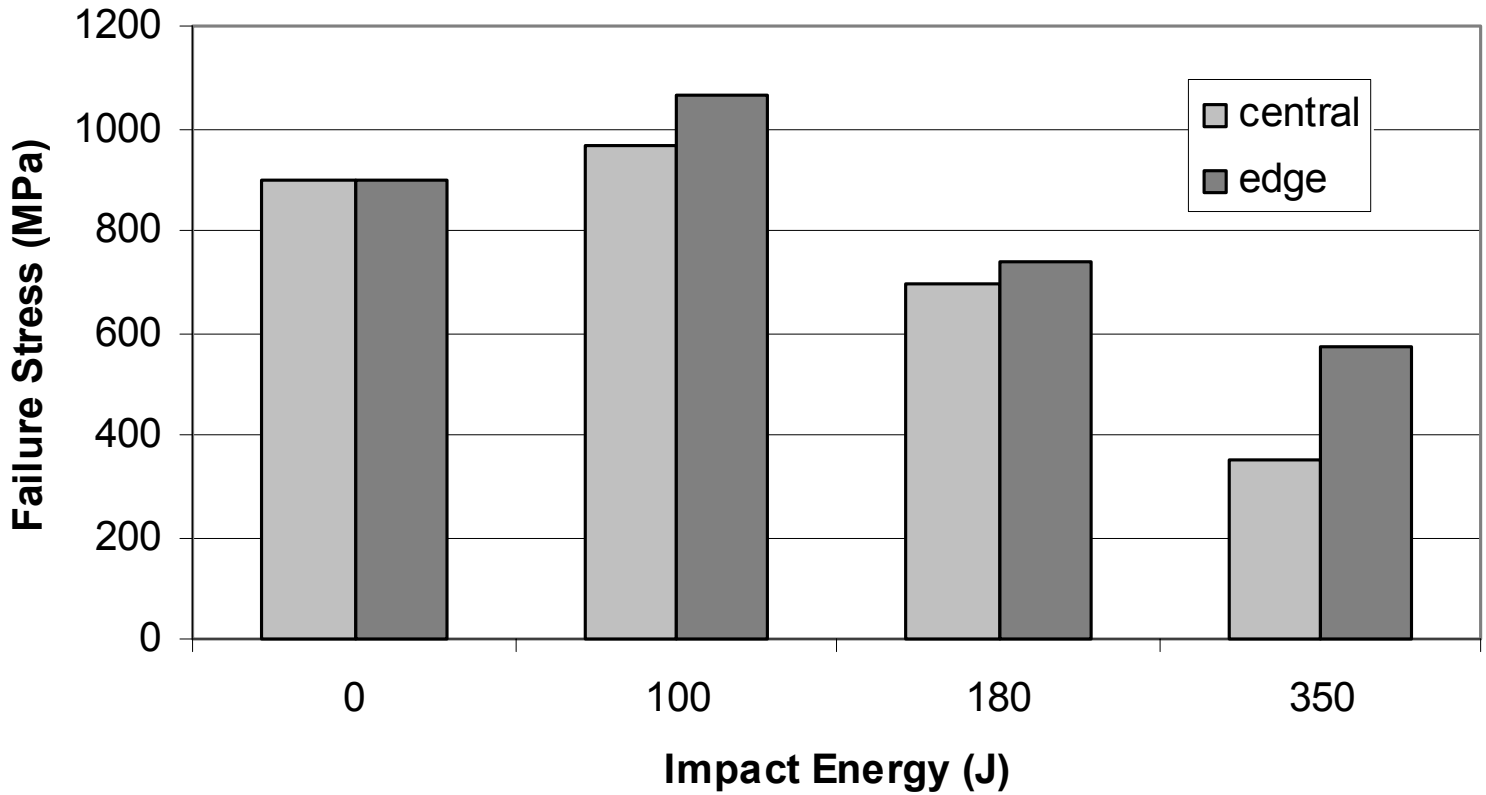
Experimental Results – Residual Strength

- Compression



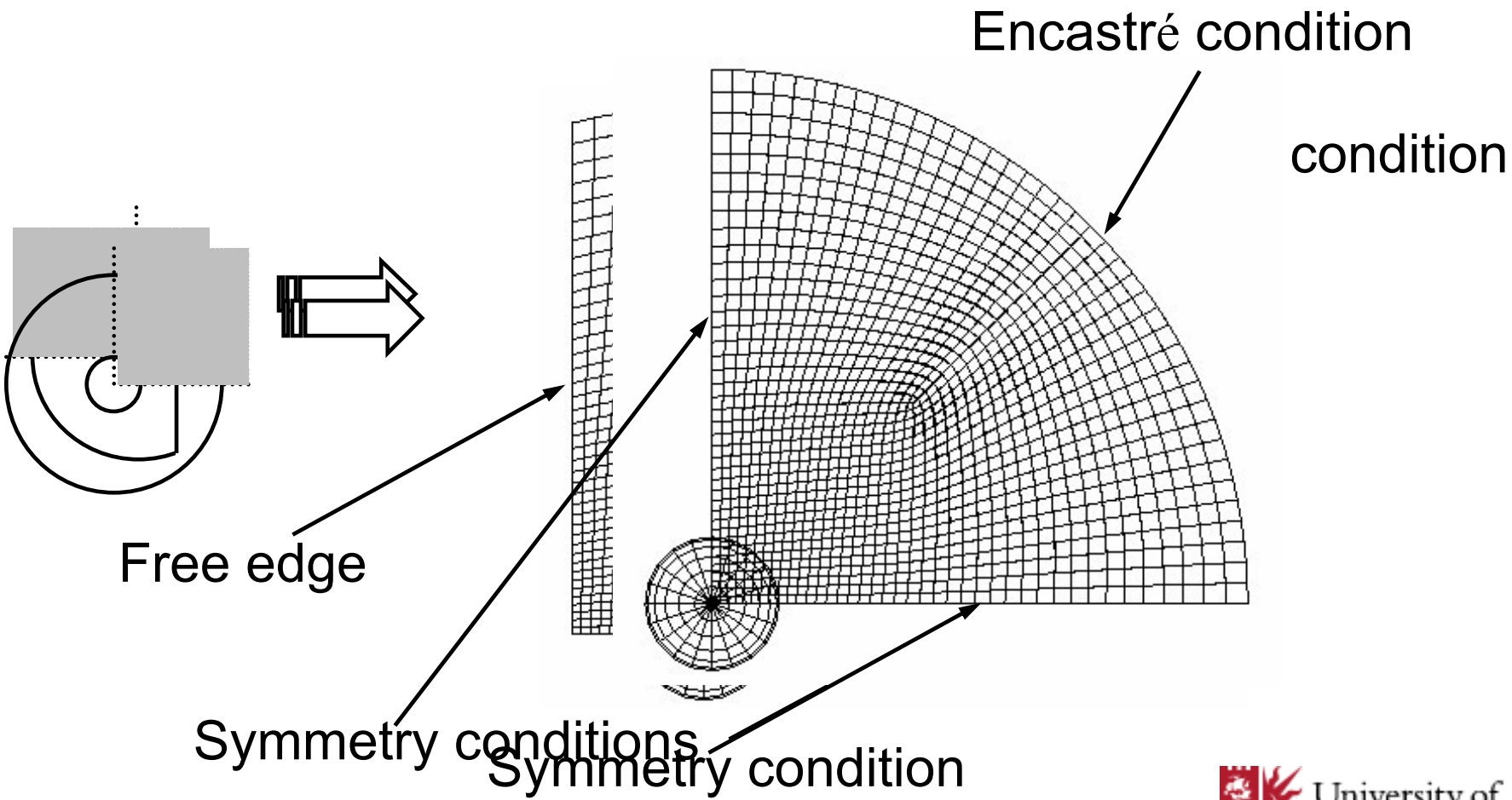
Experimental Results – Residual Strength

- Tensile



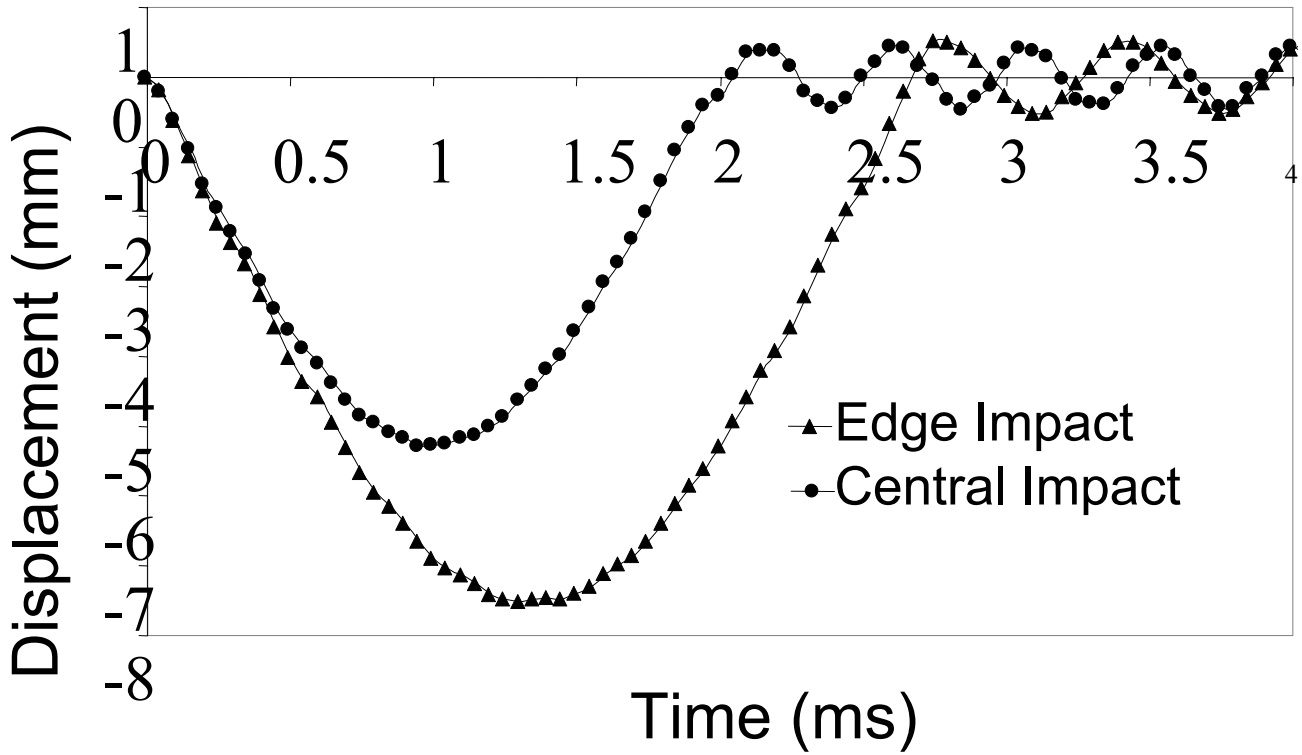
Finite Element Model: 3d

- Used to model edge impact



FEA Results: Edge Impact

- Displacement comparison with central impact



Conclusions

- Impact near a free edge has serious implications to the response and damage of thick laminates
- Near a free edge the impact lasts longer and has lower peak forces
- Near a free edge the impact induces more delamination than fibre breakage

Conclusions

- Due to the difference in the dominant damage mode in near free edge compared to central impacts the strengths are different
  - Central impact coupons have lower tensile strength, edge impact coupons have lower compressive strength
- Some FE modelling has been undertaken and shows qualitative agreement with the experimental results

Thank you for your attention

Any Questions ?

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