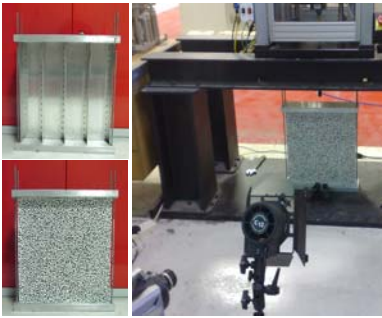


Aims

- Investigate the use of ultra-high speed imaging for Digital Image Correlation (DIC) to allow monitoring of very rapid dynamic events
- Use high speed DIC to investigate the effects of dynamic behaviour of a stiffened panel subject to in-plane impact loads
- The relationship between dynamic and static buckling loads has been observed to vary dramatically

Cameras

- 2 x Shimadzu HPV-2 Ultra-high speed cameras
 - Fixed resolution of 320 x 260 pixel
 - Single CCD chip
 - Synchronised
- Up to 1,000,000 fps
- Limited to 100 frames
- Synchronised

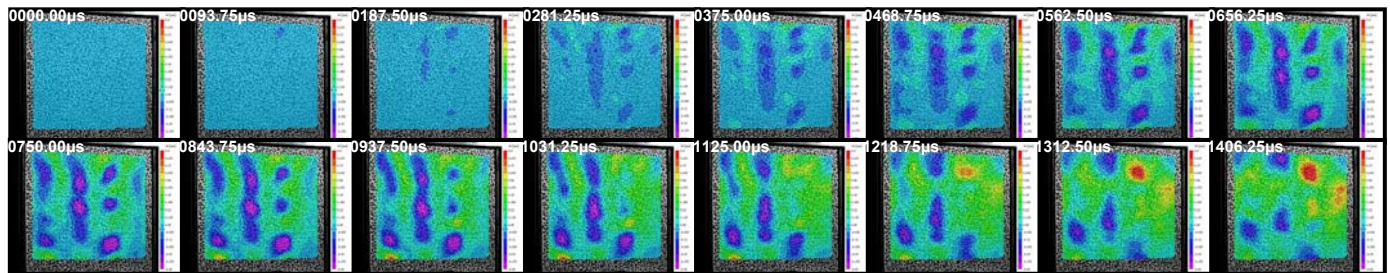


Specimen and Set-up

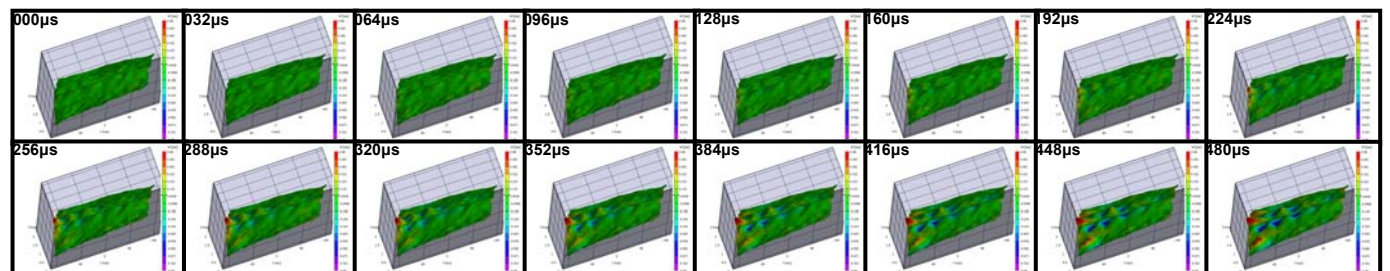
- The panel was manufactured from aircraft grade duraluminium (BS1470 6082 – T6), it is 400mm square and has 5 vertical stiffeners
- The top and bottom edges are built-in and the vertical edges are free, the top support is allowed to move vertically on guide rods using phosphor bronze bushes
- The panel was subject to in-plane impact loads at the centre of the top support using a 5.72kg drop weight, from drop heights of 80 and 150mm, in an Instron Dynatup 9250HV drop-weight test machine
- The cameras were triggered using a foil contact at the point of impact and images were recorded at 32k and 125k fps for the two drop heights
- The specimen was illuminated using 3 x 1250W high power halogen lamps

Results

The images below present out-of-plane panel displacements during an impact event from a drop height of 80mm and using a capture rate of 32k fps, only every 3rd image is presented giving a duration of 93.75 μ s between images. The duration of the impact event was approximately 1ms, high speed DIC results show the development of numerous small buckles between the stiffeners and their increase in amplitude up to ~1ms. After 1ms, out-of-plane vibration modes can be observed in the panel.



A 3D representation of the out-of-plane displacements resulting from an impact event with a drop height of 150mm are presented below, where the panel is impacted from the left. The images were captured at 125k fps, but only every 4th image is presented giving a duration of 32 μ s between images. Initial out-of-plane imperfections can be seen in the panel before a clear development of the buckling pattern is observed. The high level of time resolution can be extremely beneficial for the assessment of the dynamic buckling load.



Conclusions

- Ultra-high speed photography and DIC were successfully combined to provide full-field displacement measurements of dynamic buckling events and allows for detailed analysis of the buckling behaviour.
- This approach could also be utilised in the investigation of other rapid dynamic events
- Further work aims to validate and improve dynamic FE models using the findings

Acknowledgements

- Brian Speyer (Speyer Photonics) for supplying the Shimadzu cameras
- Hubert Schreier (Correlated Solutions Ltd.) for technical assistance with testing and data processing