Interaction of inter- and intralaminar damage in scaled quasi-static indentation tests: Part 1-Experimental Results

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Appendix

This set of X-ray images provides additional information for the full damage extent of four scaled laminated composite plates which are Reference (Ref), In-plane Scaling (Is), Ply-block Scaling (Ps) and Sublaminate Scaling (Ss) that are studied in this paper. Two damage states of each case are presented here. The damage states A and B represent the damage before and after the first significant load drop, respectively. A 1mm or 0.5mm hole was drilled through each plate centre in order to provide clear path for the dye to penetrate into all damaged regions. A Nikon XTH225ST CT scanner was used. It has a 1 micron focal spot size and 225 kV, 225W microfocus X-ray source. The data repository service is provided by ‘data.bris’, University of Bristol.

(A-b): Typical load-displacement curve of static indentation test with indication of two damage states, before and after first load drop, A and B.

(A-c): Set of schematics of four scaled laminates. (Unit: mm)
Comparison of the most damage before the first load drop

Ref

Ps

Ss

Is

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of tensile crack before the first load drop

[45°/0°/90°/-45°/45°/0°/90°/-45°...S.../-45°/90°/0°/45°/-45°/90°/0°/45°]
Comparison of the damage state 'B' between each case at the same interface - 1

[45n/0n/90n/-45n/45n/0n/90n/-45n...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 2

[45°/0°/90°/-45°/45°/0°/90°/-45°...S...-45°/90°/0°/45°/-45°/90°/0°/45°/0°/45°/0°/45°/0°/45°/0°/45°/0°/45°]
Comparison of the damage state 'B' between each case at the same interface - 3

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 4

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 5

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 6

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 7

[45°/0°/90°/-45°/45°/0°/90°/-45°...S...-45°/90°/0°/45°/-45°/90°/0°/45°/]
Comparison of the damage state 'B' between each case at the same interface - 8
Comparison of the damage state 'B' between each case at the same interface - 9

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 10

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 11

[45°/0°/90°/-45°/45°/0°/90°/-45°...S...-45°/90°/0°/45°/-45°/90°/0°/45°]
Comparison of the damage state 'B' between each case at the same interface - 12

[45n/0n/90n/-45n/45n/0n/90n/-45n...S...-45n/90n/0n/45n/-45n/90n/0n/45n]
Comparison of the damage state 'B' between each case at the same interface - 13

[45°/0°/90°/-45°/45°/0°/90°/-45°...S...-45°/90°/0°/45°/-45°/90°/0°/45°]
Comparison of the damage state 'B' between each case at the same interface - 14

Ref

Ps

Is

Ss

[45°/0°/90°/-45°/45°/0°/90°/-45°...S...-45°/90°/0°/45°/-45°/90°/0°/45°]
Comparison of the distance from top surface to the top first damage across four cases before first load drop.

Ref_A 1.03 mm [45/0/90/-45/45/0/90/-45/90/0/45/-45/90/0/45]

Is_A 0.82 mm [45/0/90/-45/45/0/90/-45/90/0/45/-45/90/0/45]

Ps_A 3.1 mm [45/0/90/-45/45/0/90/-45/90/0/45/-45/90/0/45]

Ss_A 3.02 mm [45/0/90/-45/45/0/90/-45/90/0/45/-45/90/0/45]
Comparison of the distance from top surface to the largest delamination across four cases after the first load drop.

Ref_B

[45/0/90/45/45/0/90/-45S/45/90/0/45/-45/90/0/45]

1.48 mm

Is_B

[45/0/90/45/45/0/90/-45S/45/90/0/45/-45/90/0/45]

1.78 mm

Ps_B

[45/0/90/45/45/0/90/-45S/45/90/0/45/-45/90/0/45]

3.30 mm

Ss_B

[45/0/90/45/45/0/90/-45S/45/90/0/45/-45/90/0/45]

3.16 mm