Double Beam Shear (DBS), BS ISO Standard 19927-2018, a New Test Method for Determining Interlaminar Shear Properties of Composite Laminates

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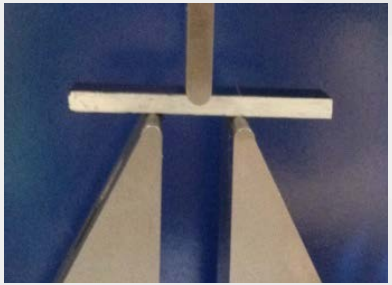
Why another interlaminar shear (ILS) test method?

- ILS properties are very important to
  - ❑ Evaluation of resin systems either in composite structural product development or for cure state validation in composite component manufacturing
  - ❑ Evaluation for the effectiveness of stitching/weaving techniques in resisting delaminations
  - ❑ Evaluation for the effectiveness of incorporating CNTs in nano-laminates for ILS resistance enhancement
  - ❑ Composite structural design, stress analysis, mechanical testing and FE modelling
- ILS strength values are overestimated in Short Beam Strength (SBS) method and are underestimated in V-notched Beam (VNB) method
- A competitive alternative ILS test method is desirable to fail fibre-reinforced laminates consistently in ILS-driven delamination

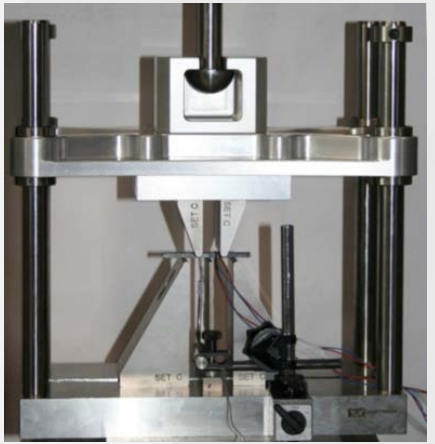
Established ILS Test Standards

Short Beam Strength (SBS)



Notched Shear (NS)

Double Beam Shear (DBS)

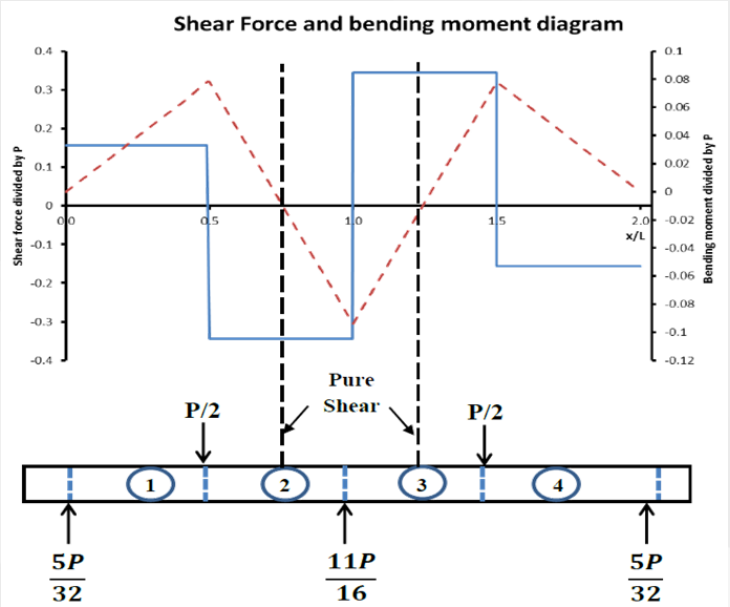


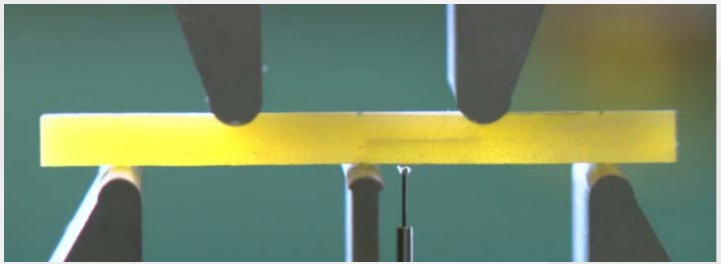
V-Notch Beam (VNB)

Key features	SBS	NS	VNB	DBS
Pure through-thickness ILS region	✗	✗	✓	✓
Specimen failure in pure ILS region	✗	✗	✗	✓
Simple specimen geometry	✓	✗	✗	✓
Trusted value of ILSS	✗	✗	✗	✓
Produces both ILSS and ILSM	✗	✗	✓	✓

Double beam shear method – BS ISO Standard 19927-2018

- DBS offers:
  - ❖ More accurate & reliable ILS properties
  - ❖ Greater ILS strength values
  - ❖ Cheaper than VNB or Iosipescu
  - ❖ Same jig for performing SBS
  - ❖ Delamination failure where SBS is unable to
  - ❖ Independent of width-to-thickness ratio





DBS Interlaminar shear strength (mechanics of materials approach) is calculated by

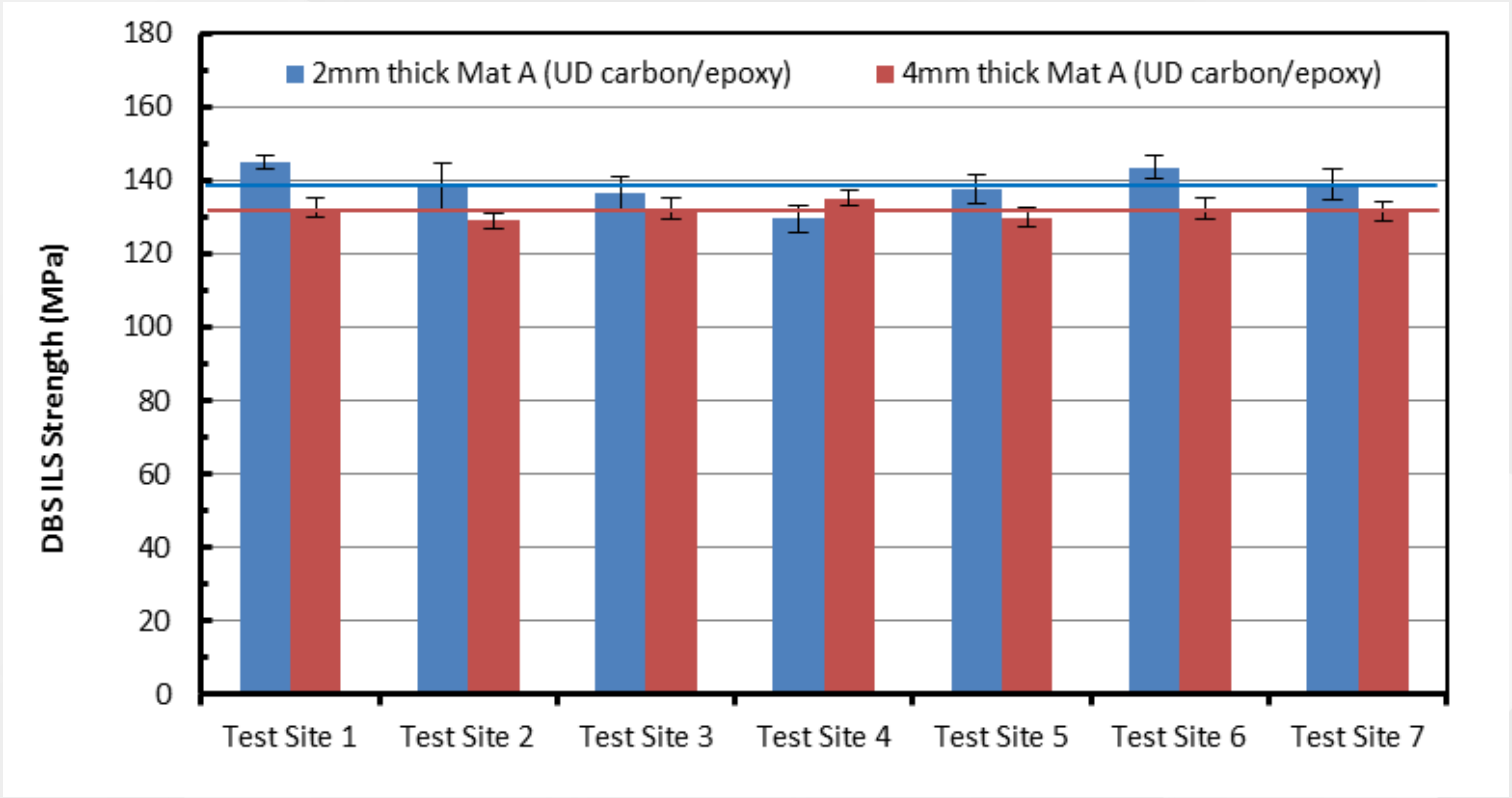
$$\tau = \frac{33P_{critical}}{64bt}$$

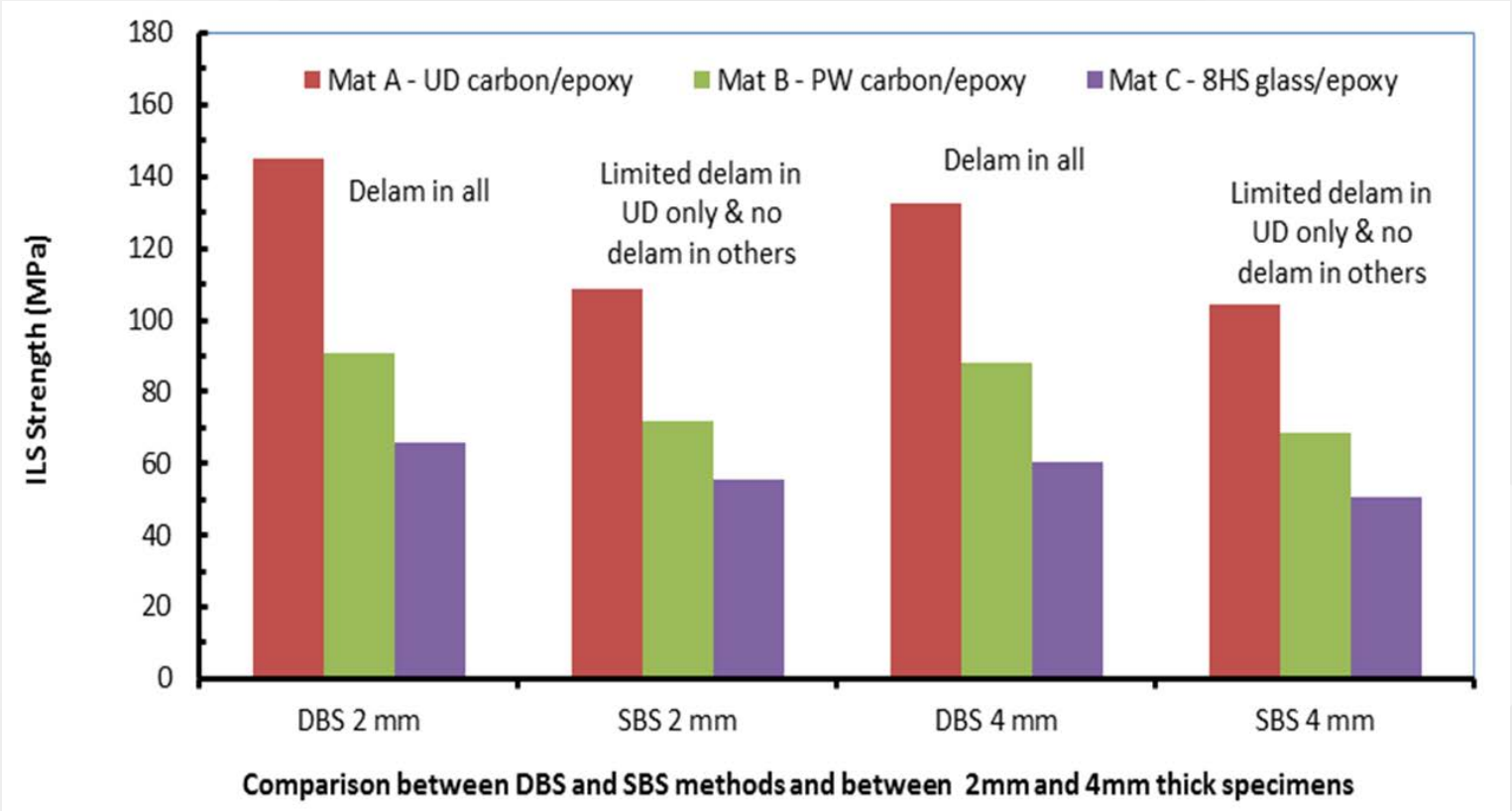
DBS ILS modulus:

- Use developed PC-based software
- Software requires input from basic material properties (E_{11}, E_{22}, G_{12} & v_{12}, lay-up and ply thickness)
- Software requires input from test set-up such as loading arm, span length, etc.
- Software requires input of a load-mid-deflection test curve

Industrial round-robin exercise details on composite materials and testing set-up:

- Five composites used: Carbon/epoxy: UD 34-700/LTM45, UD IMS65/977-2, PW T300/970;
  E-glass/epoxy: PW PPG1062/LTM26 and 8HS G7781/919
- All panels autoclave cured
- Nominal thicknesses from 2 mm to 5.3 mm
- All cylindrical supports and loaders are 6 mm in diameter
- A single nominal support span-to-depth ratio of 5
- A miniature DVRT/LVDT positioned at one pure ILS location to measure beam deflection
- SBS tests also carried out follow both EN ISO and ASTM


2mm thick Mat A (UD carbon/epoxy)
4mm thick Mat A (UD carbon/epoxy)
DBS ILS Strength (MPa)
180
160
140
120
100
80
60
40
20
0
Test Site 1
Test Site 2
Test Site 3
Test Site 4
Test Site 5
Test Site 6
Test Site 7


ILS Strength (MPa)
180
160
140
120
100
80
60
40
20
0
Mat A - UD carbon/epoxy
Mat B - PW carbon/epoxy
Mat C - 8HS glass/epoxy
Delam in all
Limited delam in UD only & no delam in others
Delam in all
Limited delam in UD only & no delam in others
DBS 2 mm
SBS 2 mm
DBS 4 mm
SBS 4 mm
Comparison between DBS and SBS methods and between 2mm and 4mm thick specimens

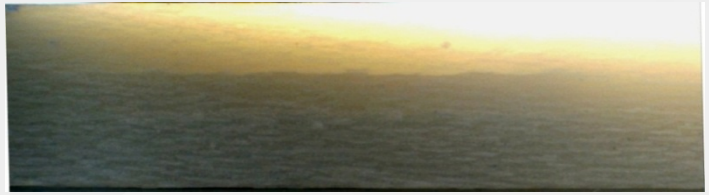
Failure Mechanisms in DBS and SBS Samples

DBS

SBS

34-700/LTM45 carbon/epoxy

PPG1062/LTM26 E-glass/epoxy



G7781/919 E-glass/epoxy

Conclusions

- DBS method produces consistent delamination at one of pure ILS sections in six composite material systems
- DBS produces delamination in composite systems, which SBS is unable to do so
- DBS generates higher ILS strengths for the composite systems tested
- DBS has been proven in terms of ILS data reproducibility and repeatability
- Different width-to-thickness ratios don't affect DBS ILS properties

Questions?

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