TRANSVERSE IMPACT BEHAVIOR OF SCARF REPAIRED COMPOSITE BEAMS

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OBJECTIVES

To create a multiple testing Impact chamber for direct impact using the SHPB

Characterize the strength and toughness of repaired and non-repaired composite beams subjected to low-velocity impact

Methodology

Using SHPB for transverse impact tests on scarf repaired composite beams with a three-point bend fixture

ACKNOWLEDGEMENTS

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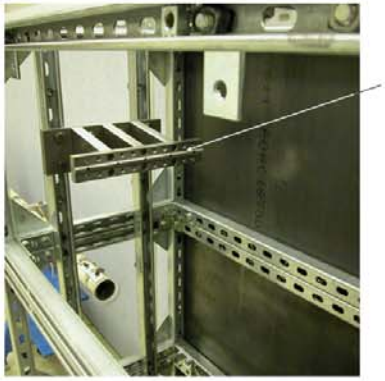
THE GAS GUN AND THE IMPACT CHAMBER

Length of Barrel = 7 ft. (2.13 m)

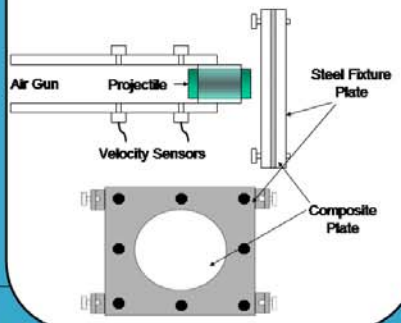
Mass of Projectile = 1.65 lb (750 g)

Max Velocity of Projectile ≈ 100 mph (44.7 m/s)

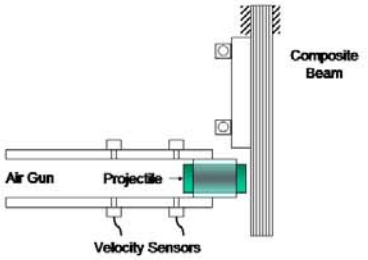
INSIDE THE IMPACT CHAMBER



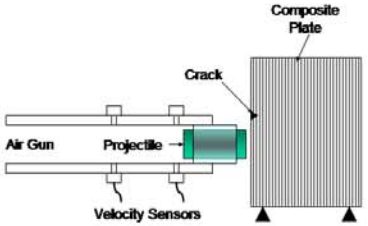
IMPACT ON PLATE



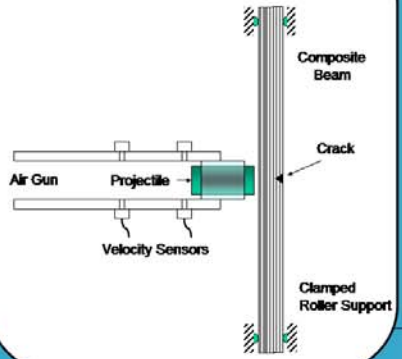
DYNAMIC FRACTURE 1



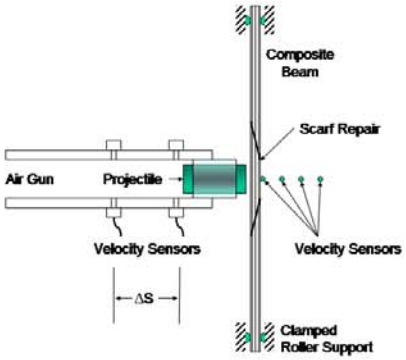
DYNAMIC FRACTURE 2



DYNAMIC FRACTURE 3



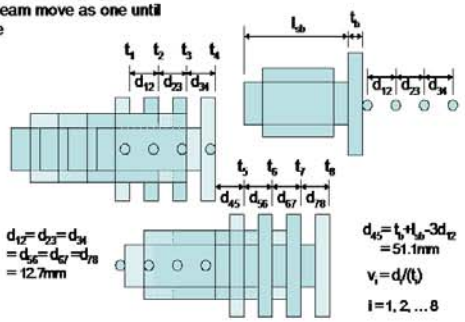
REPAIR BEAMS



$$V_{IB} = \frac{\Delta S}{\Delta T}$$

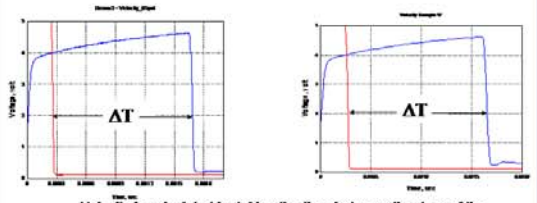
METHOD USED FOR INTERPRETATION OF VELOCITY SENSOR DATA

When testing beams it can be assumed the projectile and beam move as one until failure

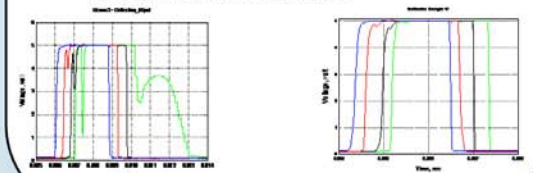


NON-REPAIRED COMPOSITE BEAM

REPAIRED COMPOSITE BEAM



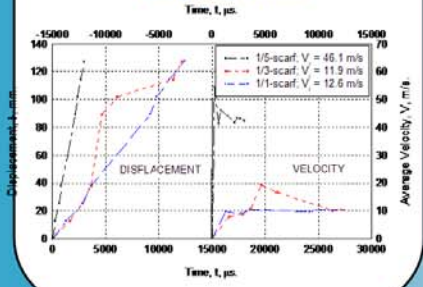
Velocity is calculated by taking the time between the drop of the two IR signals at a known distance apart.



Displacement calculated by the rise and drop of the IR sensors placed at a known distance S apart.

DISPLACEMENT AND VELOCITY HISTORY DATA

for Hysol EA9359.3 scarf repaired composite beams



CONCLUSIONS - REPAIRED

Only one repaired beam at each scarf angle was tested. The results showed that the absorbed energy (difference between impact energy and residual energy) for the 1/1 scarf was 19J, 14J for 1/3-scarf, and 106J for 1/5 scarf joints. No definite conclusions can be drawn. However, the results show a potential for testing absorbed energy of scarf repair joints.

Complete failure of repaired composite beam

Loci of failure between adhesive and metal mesh

Loci of failure between adhesive and composite beam

CONCLUSIONS - NON-REPAIRED

For the non-repaired beams, it was seen that by increasing the velocity of the projectile, the beams experienced different levels of damage. At lower velocities (13.5 m/s) the damage was minimal. At 25.7 and 28.5 m/s, beams experienced shearing damage and some delimitation. Beams tested at 39.6 m/s and higher failed. The absorbed energies of the beams were found to be 123 J for 13.5 m/s, 195 J for 28.5 m/s, 263 J for 39.6 m/s, and 509 J for 44.5 m/s.

Complete failure of a non-repaired beam

Shearing

Delimitation

DIFFICULTIES WHEN TESTING

Non-Repaired composite beams pose a difficulty when testing. If the impact velocity is not high enough to break the beams, the IR sensors measuring the displacement will have a time when a partial blockage of the sensors will occur, followed by the recoil of the projectile.

Improvements Needed for Analysis

- High Speed Camera
- Enhanced Laser Velocity System (ELVS)

Future Work

- Non-repaired beams with different widths
- Repaired beams at different scarf angles
- Composite beams with metal or rubber fixed on the impact area
- Dynamic Fracture
- Impact on Plate