Shear strain distribution of bonding interface in ductile PF bonded 2-ply bamboo sheet by the method of ESPI (electronic laser speckle interferometry)

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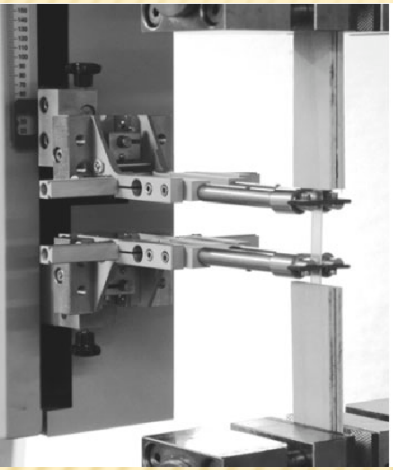
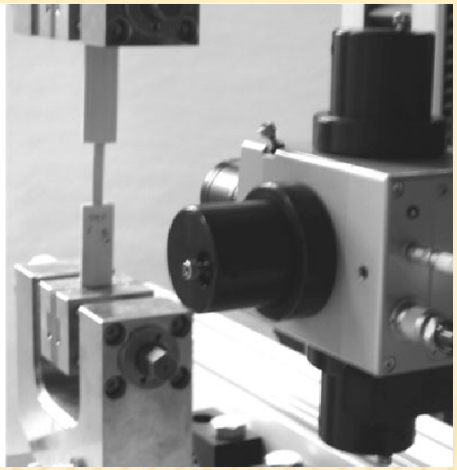


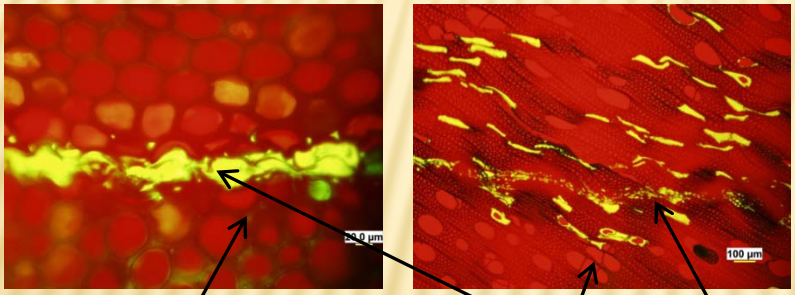


Introduction

ESPI → Capable of measuring shear strain distribution

PF → Mostly used in wood-based panels

Bamboo → Scarce studies on bamboo bonding interface



Bamboo bonding interface

Phenol-formaldehyde resin

Poplar bonding interface

Motivation

A kind of adhesive suitable for bamboo bonding.

Shear strain distribution of bamboo bonding interface.

Outline

1. Materials and methods
2. Results and discussion
3. Conclusions
4. Acknowledgement

Materials and methods

Homemade adhesives

Phenol-formaldehyde resin and modified PF with different content of PVA (polyving akohol) (5%, 10%, 20%) according to formula

Materials and methods

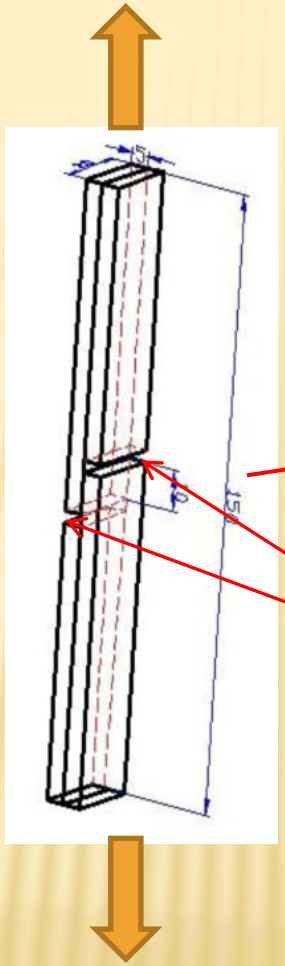
Hot pressing

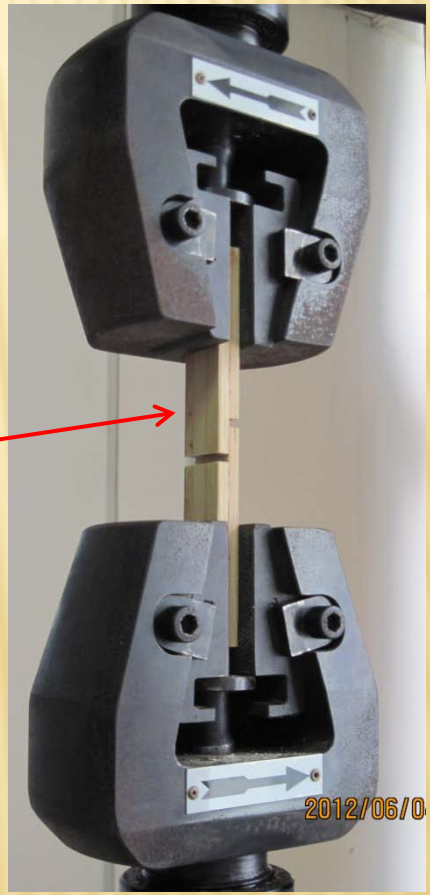
Specimens were all cured in a press 2MPa and at ambient temperature 140℃ for 15minutes. After curing, specimens were maintained in a condition room at 65% RH and 20℃ for 1 week until constant weight was attained.

Materials and methods

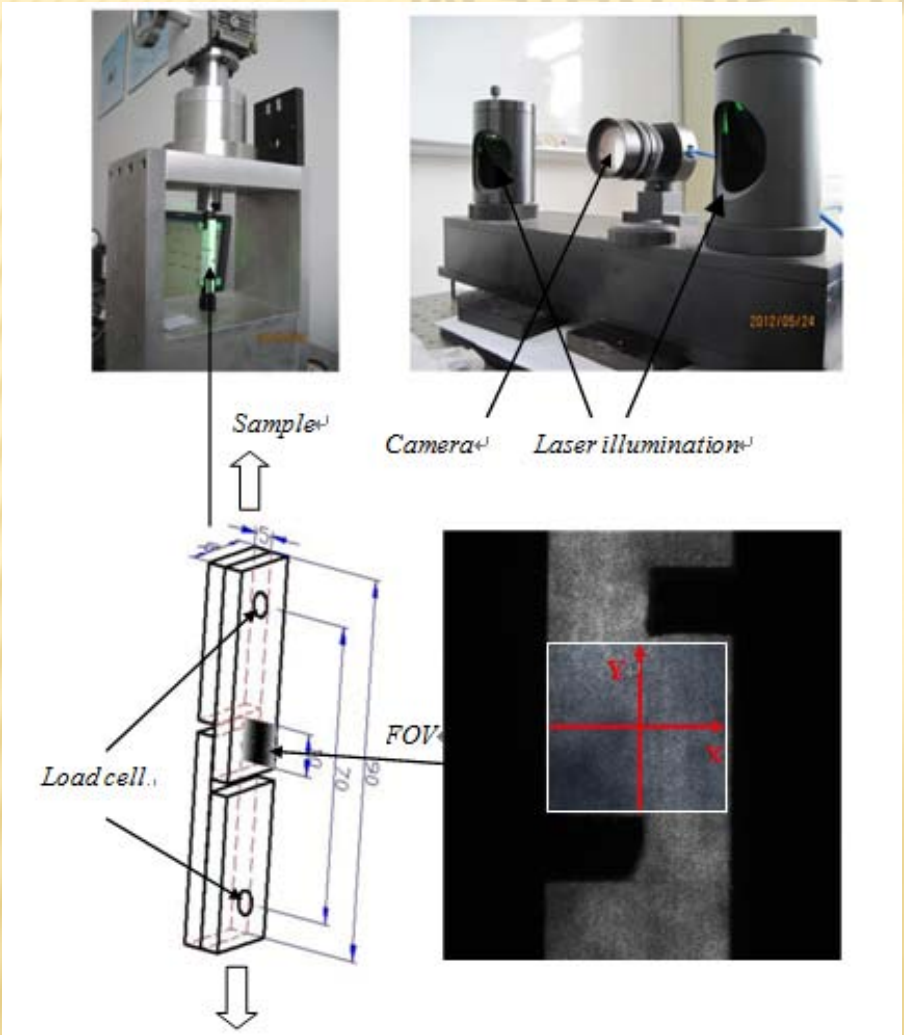
Shear testing

Shear specimens in accordance with DIN EN 302-1-2004 with a total length of 150mm, a width of 20mm and a thickness of 2×5mm, were manufactured from a 5mm thick planed, bleaching moso bamboo.





Materials and methods

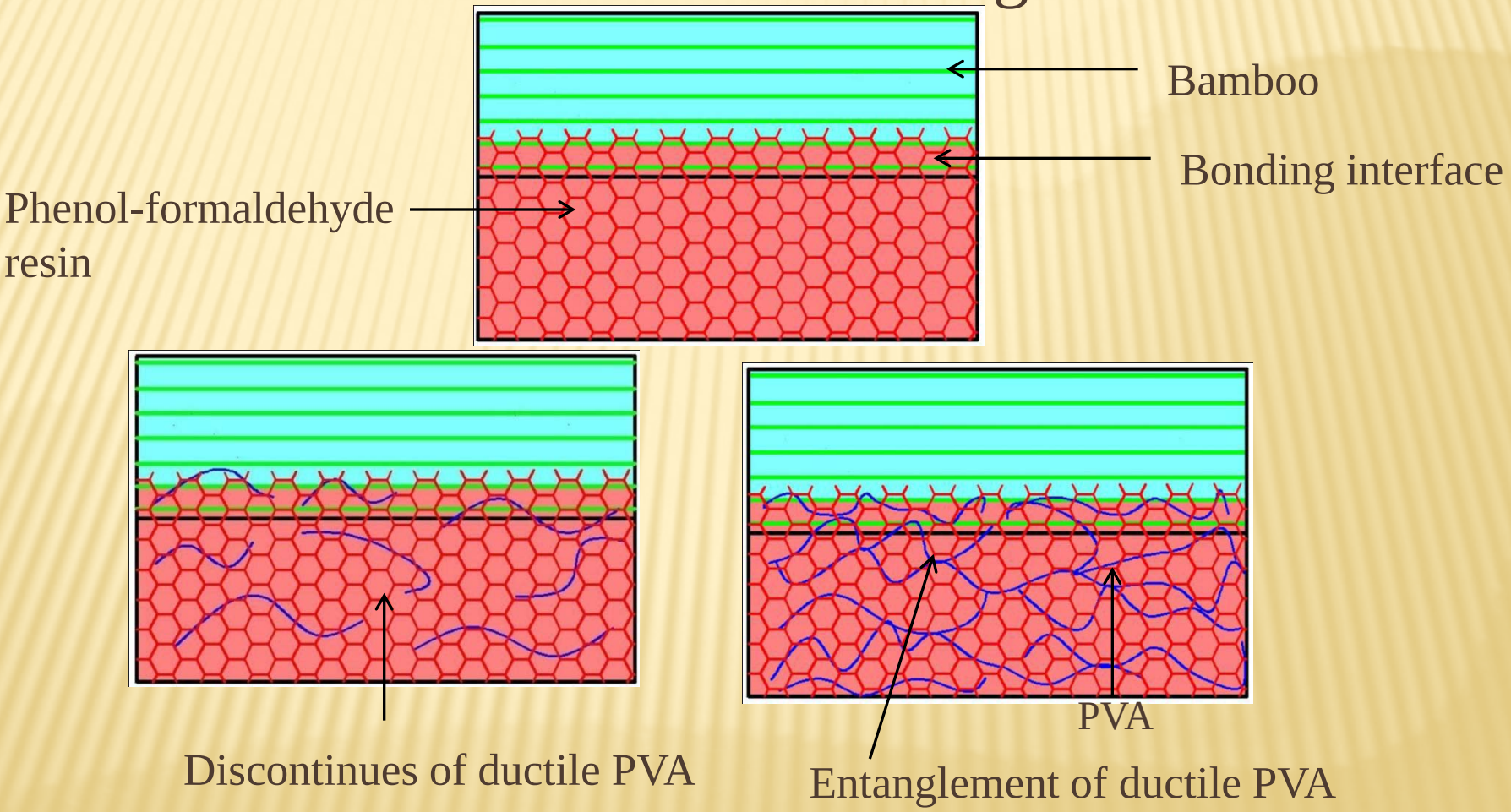


ESPI measurement

Specimens were pre-loaded to 50N and then strained in 14 steps of 5N. We conducted the shear testing twice in two directions X and Y. At each displacement step, a interference fringe image of the observed field of view was taken. The displacement maps were computed by summing up information from all 14 displacement steps.

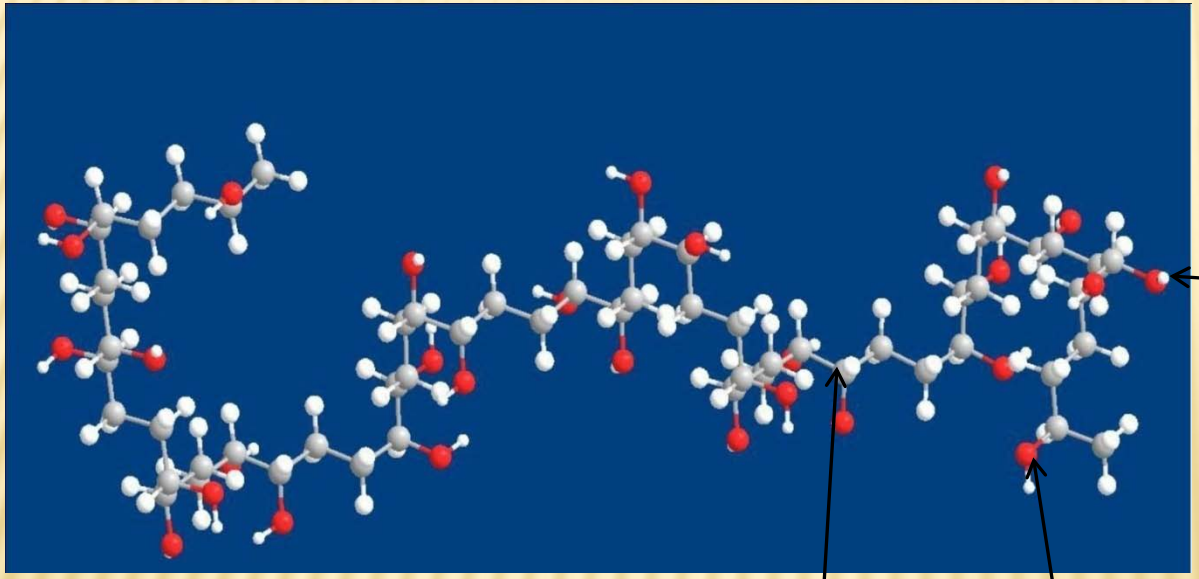
Results and discussion

Models of bamboo bonding interface



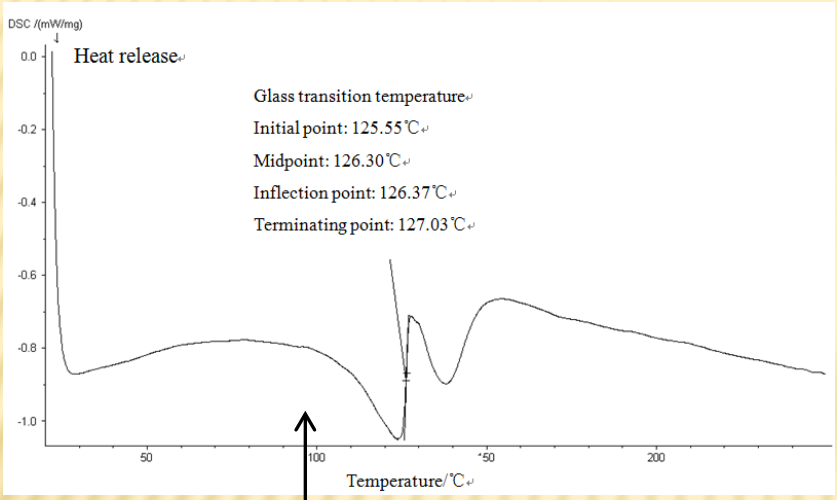
Results and discussion

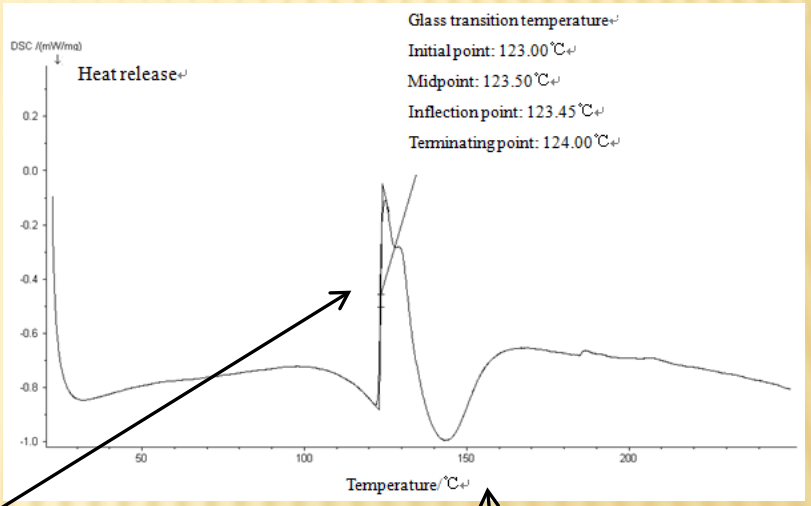
Models of bamboo bonding interface



Results and discussion

DSC (Differential Scanning Calorimetry)





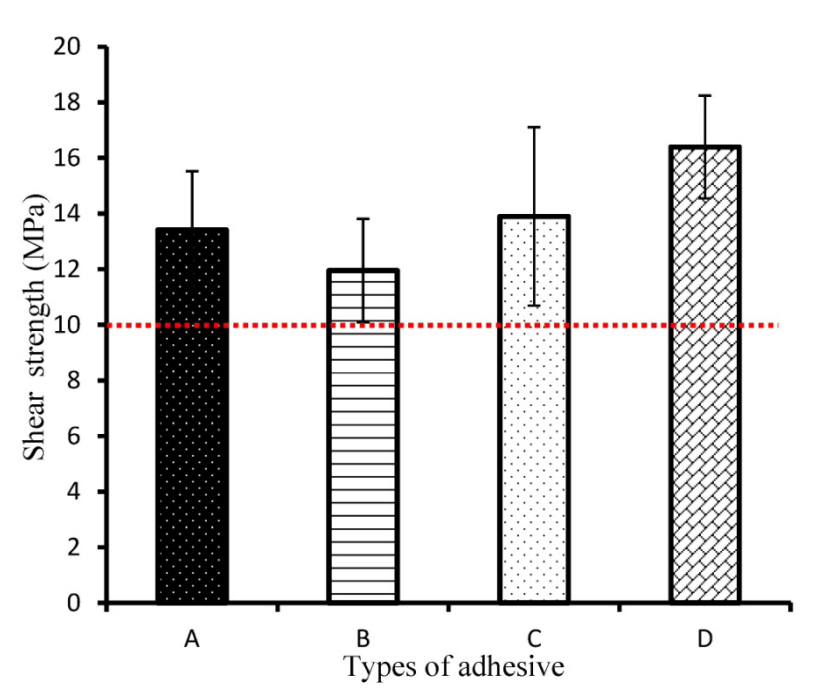
PF

The increase of endothermic peak proves chemical reaction while curing

PF with 20% PVA

Results and discussion

Shear testing

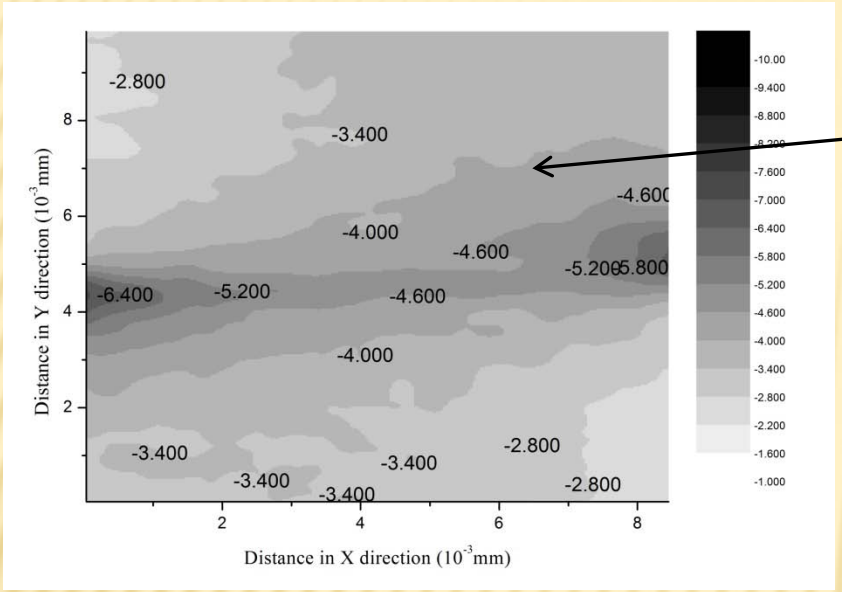


Sample A to sample D with PVA: 0%, 5%, 10%, 20%

As depicted in Figure, we can see that, with the percentage of PVA increasing, the shear strength start to descend at first, but rebound higher than before later. The maximum strength is 16.39MPa with the percentage of PVA 20%, while the minimum one is 11.95MPa with the percentage of PVA 5%.

Results and discussion

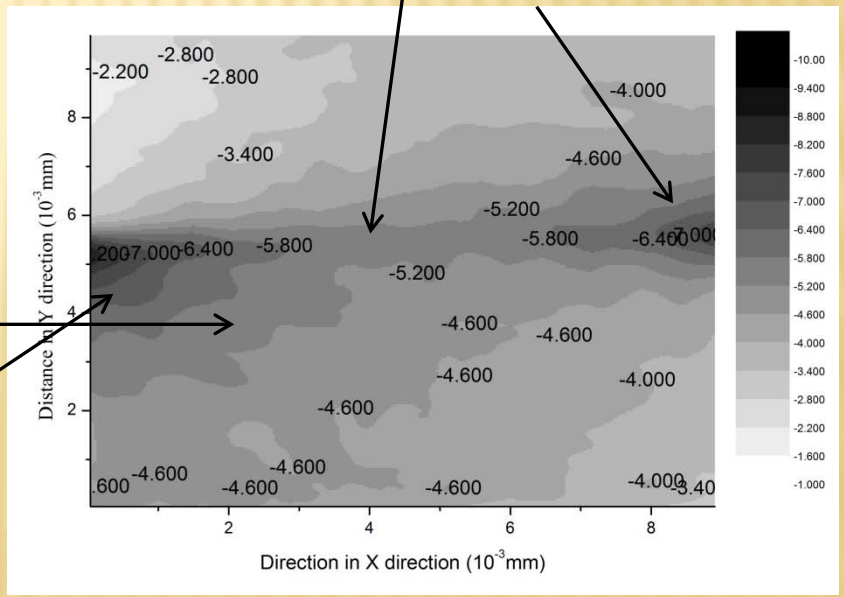
Shear strain distribution



Strain distribution of specimen with PF

High gradient of strain

Strain concentration



Strain distribution of specimen with PF modified by 20% PVA

Strain concentration

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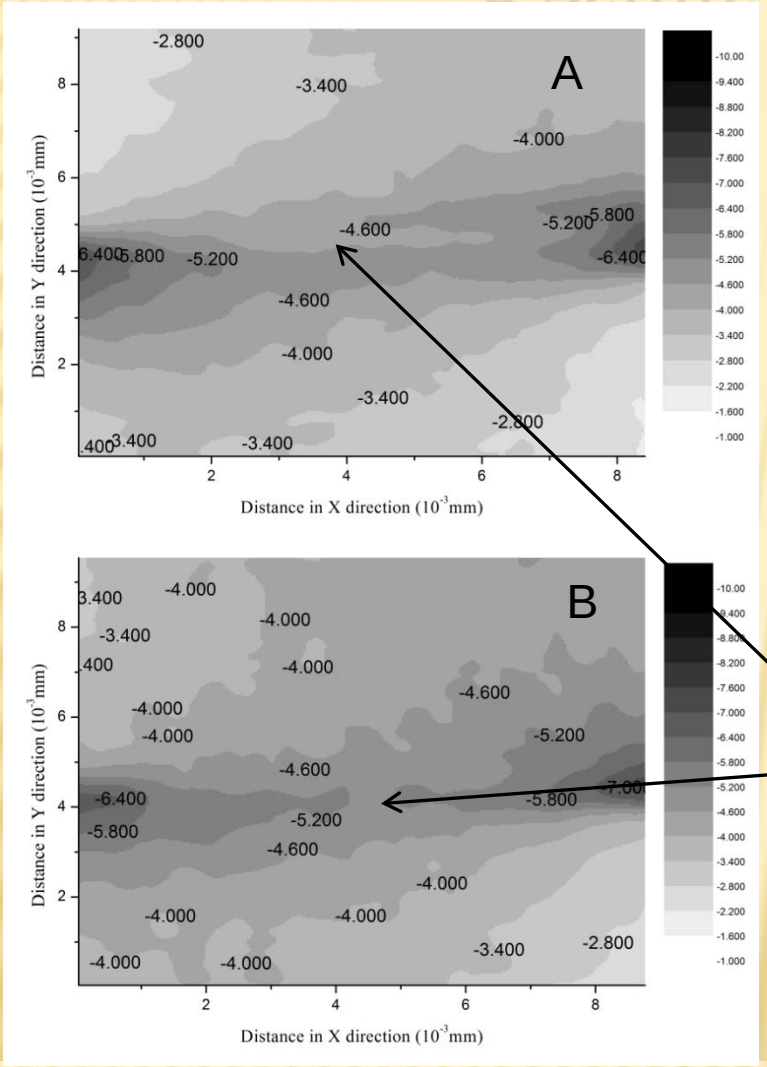
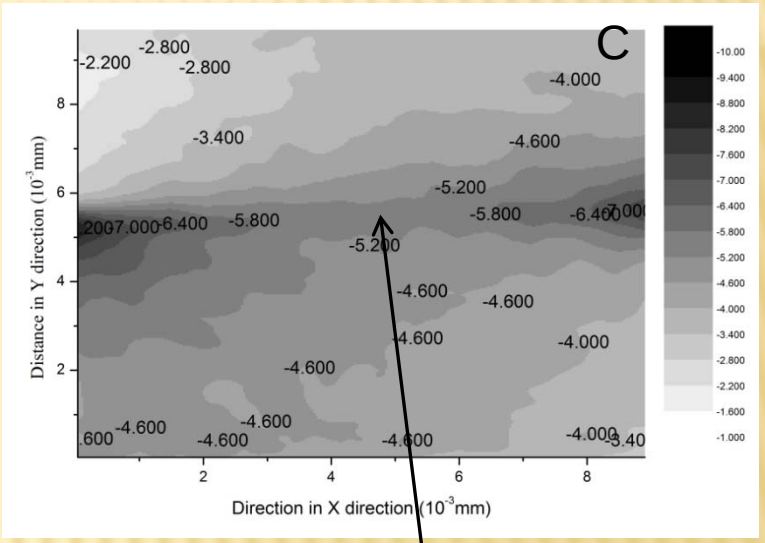
Results and discussion

Shear strain distribution





Discontinuity of stress transmission

Continuity of stress transmission

Sample A to sample C with PVA: 5%, 10%,20%

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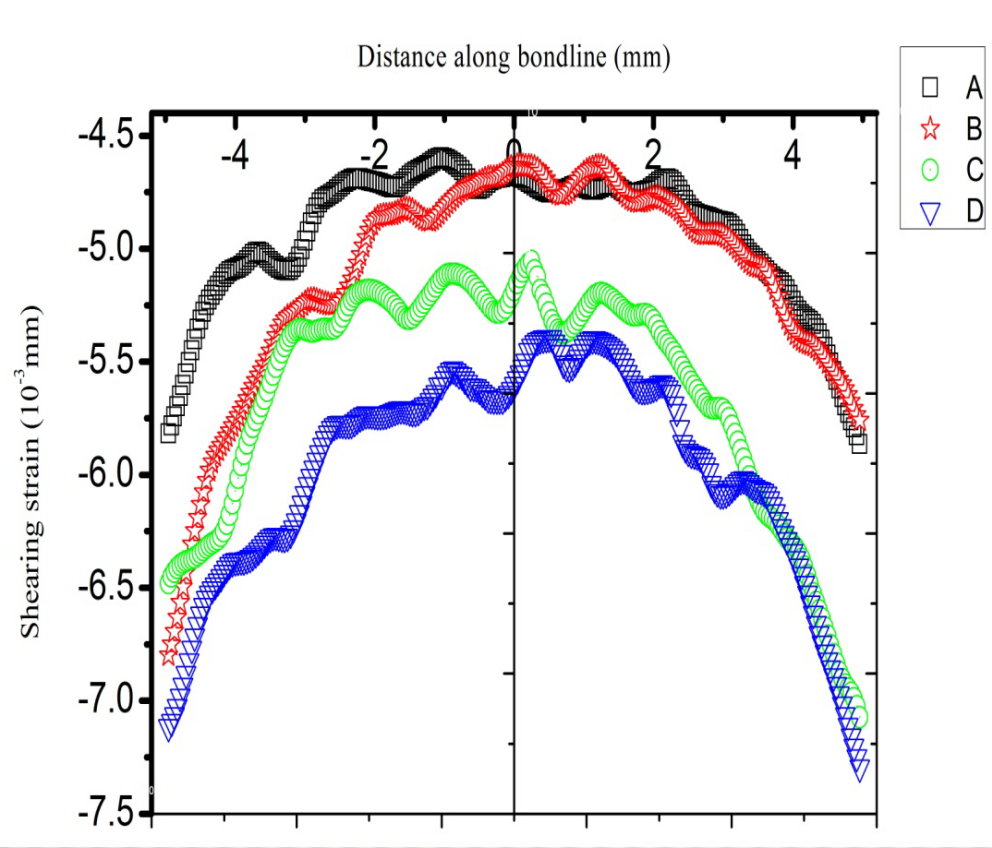
Results and discussion



Sample A to sample D with PVA:
0%, 5%, 10%,20%.

Shear strain distribution

Line plots of shear strains along the glue line are shown in Figure , indicating that the values and the range values of strain are higher with ductile PF. With the percentage of PVA increasing, values of shear strain also increase.

Conclusions

In terms of shear testing and strain distribution by ESPI along the bond line, it displays marked difference among shear strength and strain distribution glued with PF modified by different content of PVA.

The results obtained here have shown that ductile PF could diminish stress distribution in adhesive assemblies and lead to bonding interface slipping, which could effectively reduce destructive energy in their overall strength. The amount of pre-polymerized adhesive-PVA could have a positive influence on the stress transmission and strain distribution in the vicinity of bonding interface, which may contribute to compatibility with ductile bamboo.

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Thank you

Cheng Yong and Mingjie Guan