Multiphysics investigation of Ice Adhesion over PVC surface

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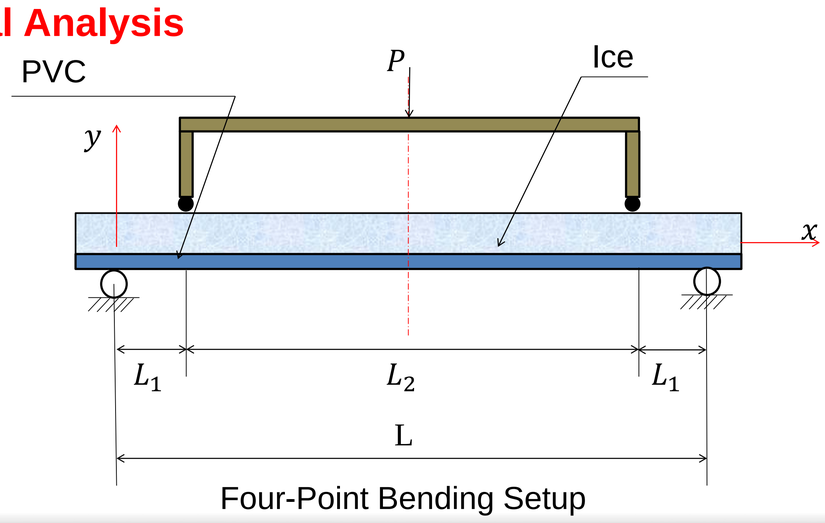
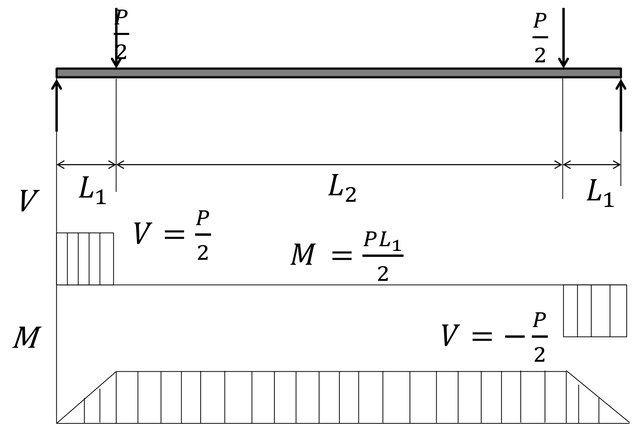
Abstract

This work investigates the ice over a PVC (polyvinyl chloride also known as 'PVC') surface as a two-layer laminate model. In this study, ice was frozen over a PVC surface and allowed to adhere. The built samples were tested experimentally in a four-point loading setup. The experimental results contain strain data gathered through data acquisition system using LabView® software. The data was collected at the rate of 1 KHz per load step. This model is analysed theoretically using Euler–Bernoulli beam theory and the rule of mixtures. The correlations from Euler–Bernoulli beam theory and the rule of mixtures were coded in MATLAB® script for theoretical analysis. In addition, numerical simulations were performed using ANSYS® Multiphysics. The FEM model of ice and PVC sample was built using solid elements. The mesh was tested for its sensitivity. Finally theoretical results, experimental results and numerical simulation results were compared. A good agreement between the results was observed.

Theoretical Analysis

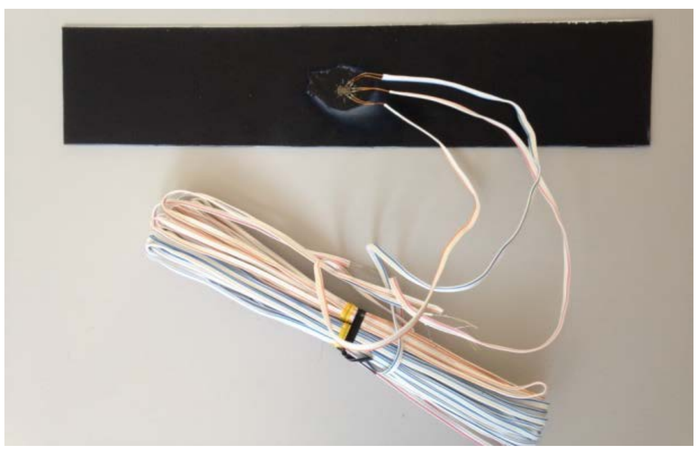


Four-Point Bending Setup



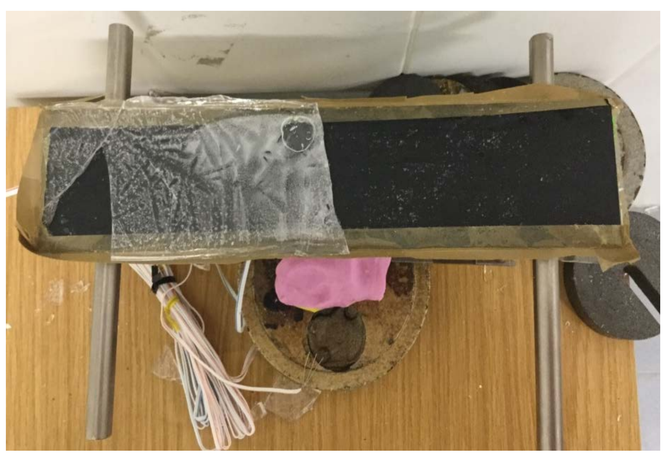
Shear Force and Bending Moment Diagram

Experimental Setup



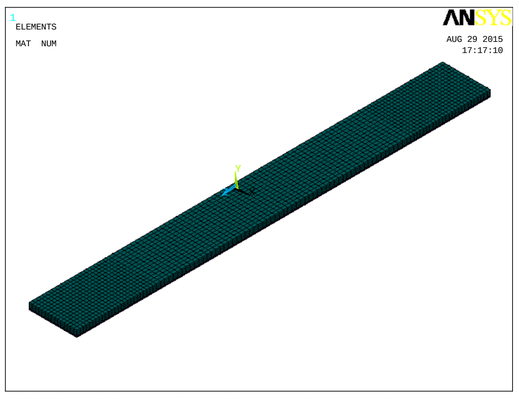
PVC Sample with Rosette Strain Gauge

PVC and Ice sample placed for four-point bending test

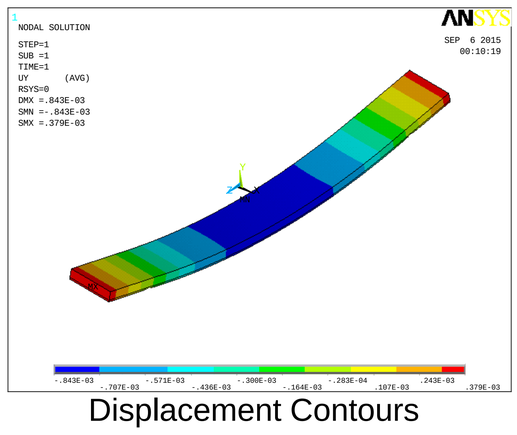


Delamination of Ice over PVC surface

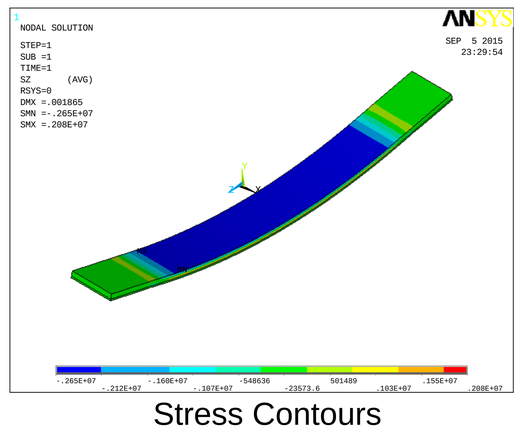
Multiphysics Numerical Simulation using ANSYS®



FEM Model of Four-Point Bending



Displacement Contours



Stress Contours

Conclusions

- Euler-Bernoulli beam theory can be used to solve the four-point bending problem. The results give the correlation of displacements with load, longitudinal stress and shear stress.
- Problem containing more than two materials requires Rule of Mixtures. This rule helps to derive common variables from two materials, such as Young's modulus, moment of inertia, and moment of area.
- A good agreement is found between all of three methodologies.

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