Study of Ice Adhesion Behavior of SK One Component Polyurethane

H. Xue[1], H. Khawaja[1], M. Moatamedi[1], Z. Sun[2]

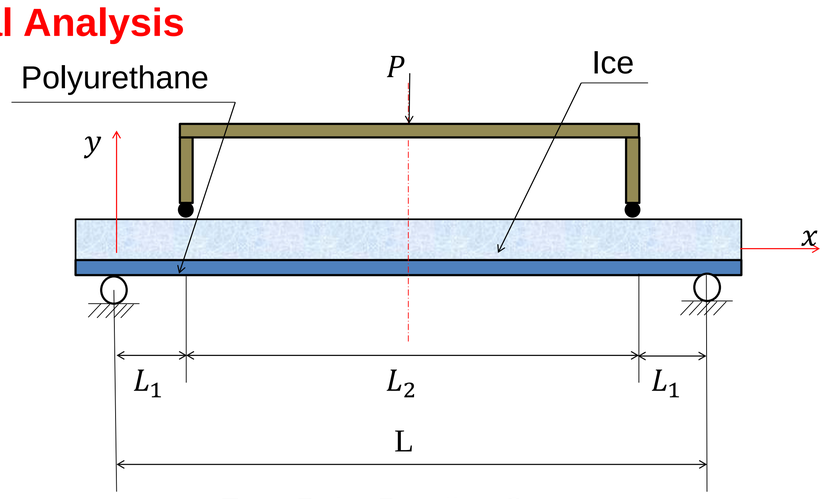
1. UiT-The Arctic University of Norway, Tromsø, Norway
2. China Institute of Water Resources and Hydropower Research, Beijing, China

Abstract

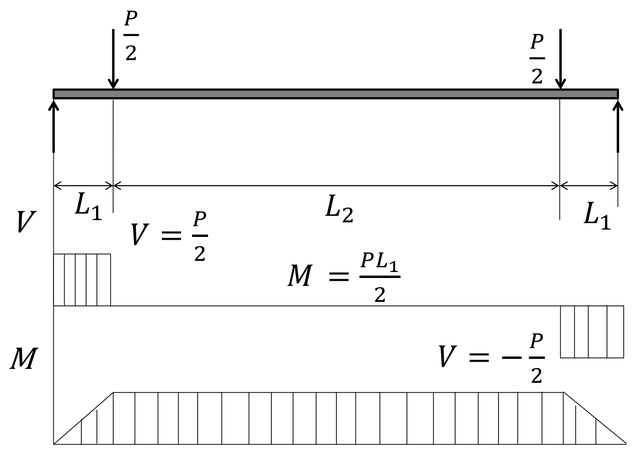
Ice adhesion causes many serious problems such as aircraft accidents, navigational issues on ships, and power loss on wind turbines. These challenges are mainly associated with the acute behavior of ice adhesion. The ice adheres when water seeps into the microscopic pores of the material substrate and freezes, thereby, forming an interlocking mechanism. Therefore, surface roughness has a significant effect on ice adhesion. In this study, an effort is being made to look at the ice adhesion over a non-toxic material SK One Component Polyurethane (SOCP) developed by China Institute of Water Resources & Hydropower Research (IWHR) in Beijing. The experimental analysis of ice adhesion will be carried out using four-point bending test set up in a cold room. The model will be analyzed theoretically using Euler–Bernoulli beam theory and the rule of mixtures. The experimental results will contain strain data gathered through data acquisition system using LabVIEW® software. In addition, numerical simulations will be performed using ANSYS® Workbench simulation software.

The study will provide reliable data on the ice adhesion and build the basis for the application of SK One Component Polyurethane (SOCP) in the cold climate conditions.

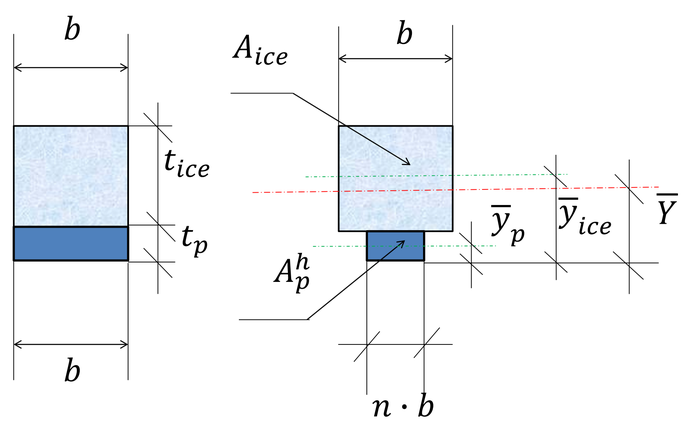
Theoretical Analysis



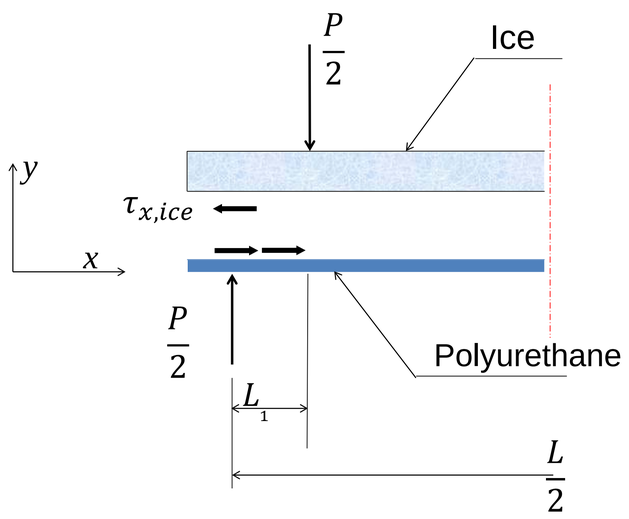
Four-Point Bending Setup



Shear Force and Bending Moment Diagram

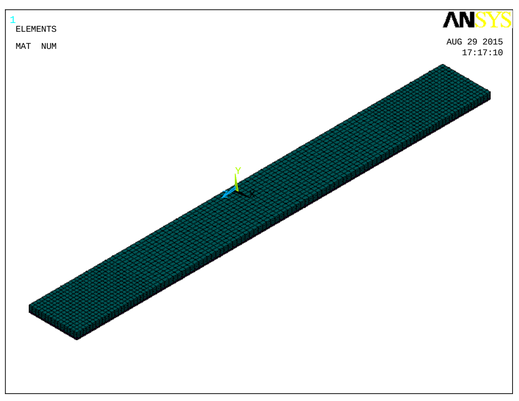


Rule of Mixture is applied: Left shows the original cross-sectional area of a beam with ice and Polyurethane. Right shows that the area of Polyurethane is reduced when expansion factor is multiplied. Green line shows the neutral axis of each material. Red line shows the new neutral axis of a beam after taking into account balance coefficient.

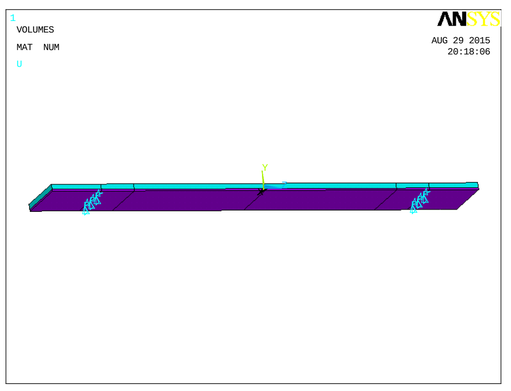


Shear stress experienced by ice and Polyurethane

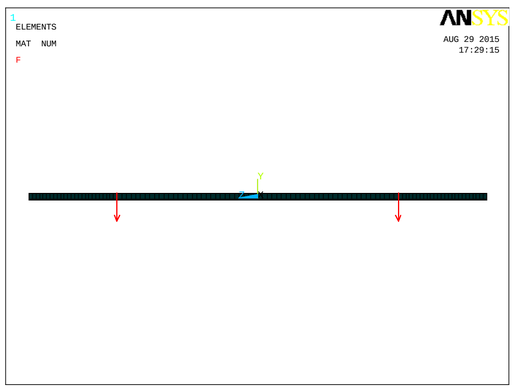
Multiphysics Numerical Simulation using ANSYS®



FEM Model of Four-Point Bending



Applied displacements constraints on FEM model



Applied forces on FEM model

Conclusions

- Euler-Bernoulli beam theory can be used to solve the four-point bending problem. The results will 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.

Contact

Hassan A. Khawaja

Assoc. Professor,
UiT-The Arctic University of Norway,
Norway

E-mail: hassan.a.khawaja@uit.no