Aalto University
School of Engineering

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Title of the dissertation	Rate and size effects on the deformation and fracture of warm and floating columnar freshwater ice
Contents of the dissertation	Understanding how ice fractures is crucial for ensuring safe operations in ice-heavy regions. In fact, climate change is bringing warmer conditions and making the ice warmer. The properties and behavior of the ice may be fundamentally different when it is warm, very close in temperature to zero degrees, than cold. While cold ice has been typically studied in the literature, this dissertation targets warm ice and attempts to bring a better understanding of the mechanics of warm ice. Large scale fracture experiments, using edge-cracked rectangular plates loaded at the crack mouth, were conducted in the Ice Tank of Aalto University. The ice was very warm with a temperature of about -0.3 ℃ at the top surface. The plates covered a size range of 1:39, the largest for ice tested under laboratory conditions, with three plate sizes: 0.5m x 1m, 3m x 6m and 19.5m x 36m. The monotonic loading rates applied led to test durations from fewer than 2 seconds to more than 1000 seconds, with some experiments tested under creep/cyclic-recovery loading. The study generated novel findings for ice and strong evidence that warm ice may fracture differently than the kinds of ice typically studied in laboratories or nature. Size and rate effects were interrelated as rate dependent size effects and size dependent rate effects. Under the creep/cyclic-recovery conditions, the ice showed an elastic-viscoplastic response but, interestingly, no significant viscoelasticity was observed. The fact that the ice didn't show viscoelastic response doesn't fit our conventional understanding of how ice deforms and raises questions on how to model very warm ice.
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