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Lucas Wazney, Shawn P. Clark, Jarrod Malenchak



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## Laboratory investigation of the consolidation resistance of a rubble river ice cover with a thermally grown solid crust

Lucas Wazney<sup>1a</sup>, Shawn P. Clark<sup>1b</sup>, Jarrod Malenchak<sup>2c</sup>

<sup>1</sup>University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

<sup>2</sup>Manitoba Hydro, Winnipeg, Manitoba, Canada, R3C 0G8

<sup>a</sup>umwaznel@myumanitoba.ca

<sup>b</sup>Shawn.Clark@umanitoba.ca

<sup>c</sup>JMalenchak@hydro.mb.ca

Corresponding author: Lucas Wazney

### **ABSTRACT**

River ice behaviour during freeze-up depends on a complex relationship between dynamic and thermal processes. This study investigates the effects of cold ambient air temperatures on the ability of a rubble ice cover to resist consolidation (mechanical thickening) under externally applied forces. An experimental apparatus was constructed in a refrigerated room at the University of Manitoba. The apparatus consists of a translating plate that was used to deform a floating rubble ice cover in a waterproof tank. Prior to resistance testing, the ice cover was exposed to an ambient air temperature of  $-10.5^{\circ}\text{C}$  for a specified duration. During this time, the interstitial water between the rubble pieces at the surface froze, creating a solid crust that solidified a portion of the rubble surface. Instruments were used to measure the displacement of the plate and resisting force generated by the ice cover during the resistance testing phase. Results indicate that even short durations of freezing (less than two hours) have a considerable impact on the peak resistance of an ice cover. The force required to consolidate a 155 mm thick rubble ice cover exposed to an ambient air temperature of  $-10.5^{\circ}\text{C}$  for two hours was over 30 times that of an equivalent unfrozen accumulation of rubble ice. The peak resistance of a cover comprising rubble ice with a solid crust was found to be much greater than the sum of the individual contributions of the rubble and solid ice layers considered separately. Results from this study highlight

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