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Experimental tests of ice pressuring

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ABSTRACT

The mechanical properties of ice such as resistance for pressuring are essentially important for ice drilling technology as well as for assurance of stability of constructions of the north marine ports, platforms, vessels and other infrastructure like lighthouses, etc. In order to investigate the resistance of ice for pressuring, the experimental tests of ice pressuring were performed in the cold room of geographical faculty of Lomonosov Moscow State University on the equipment of Geotek Company (Russia). The prepared fresh water ice samples were of about of 8 cm height and 7 cm in width. It was prepared in the cold room by the single directional freezing. During the experimental tests the pressuring deformation rate was set the value from 0.01 to 0.06 min-1 for ductile and brittle compressive failure. The ductile compressive failure of ice sample was going on during the experimental test under the maximal pressure of about 2500 kPa. The total final deformation of the ice sample was about 33% from the initial size achieved. The brittle compressive failure of ice sample was going on during the experimental test under the maximal pressure of about 1100 and 300 kPa applied along vertical c-axes and basal lines correspondingly. Also the variation of long-term equivalent cohesion of fresh and brine ice (Ceq) was measured with ball stamp test. The crystalline structure of prepared samples from fresh water ice and brine ice was studied in the polarized light.

KEY WORDS Ice tests; Ice mechanical properties; Ductile compressive failure; Brittle compressive failure; Ball stamp test

INTRODUCTION

As it stated in the book "Actions from Ice on Arctic Offshore and coastal Structures" from Loset et al., (2006) the mechanical properties of ice such as resistance for pressuring are essentially important for ice drilling technology as well as for assurance of stability of constructions of the north marine ports, platforms, vessels and other infrastructure like lighthouses, etc. and the ice loads should be calculated with respect to these studied ice properties.

In order to investigate the resistance of ice for pressuring, the experimental tests of ice pressuring were performed in the cold room of geographical faculty of Lomonosov Moscow State University on the equipment of Geotek Company (Russia) (illustrated in Figure 1).

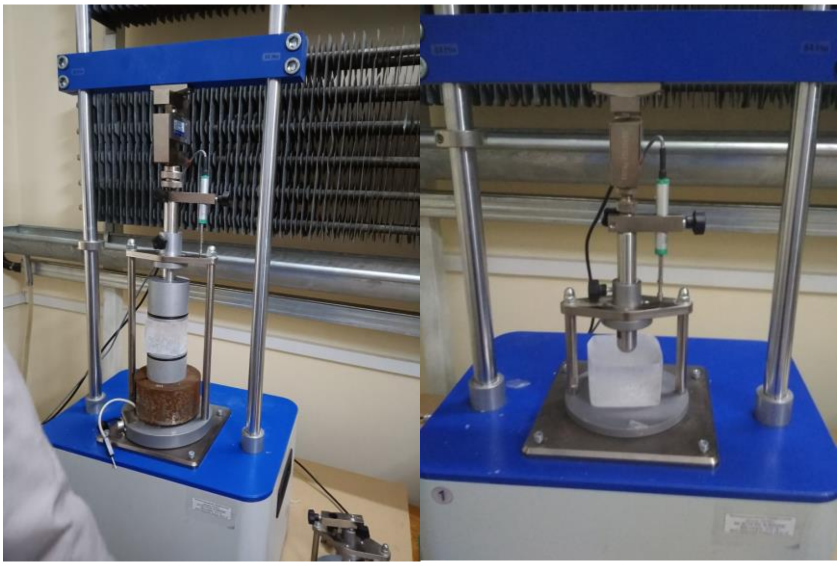

Figure 1. Experimental set up in the cold room for ice pressuring and ball stamp test.

The tests of mechanical properties of ice were performed for ductile and brittle compressive failure according to Schulson (1990) and (1997), who suggest the following schematic sketch illustrating the ductile-to-brittle transition (illustrated in Figure 2).

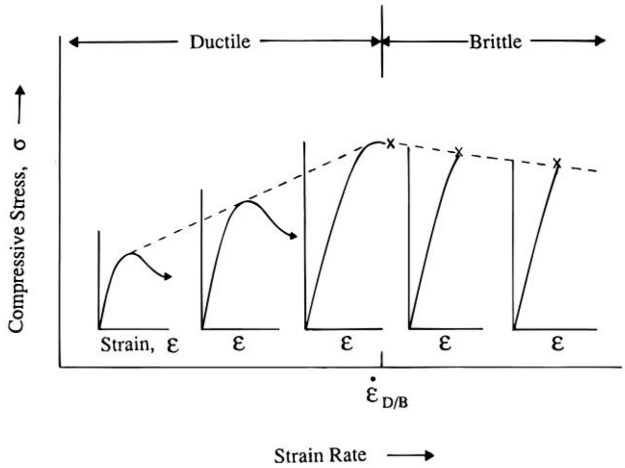

Figure 2. Schematic sketch for illustration of the ductile-to-brittle compressive failure transition. The curves show hypothetical compressive stress-strain curves at progressively increasing strain rates reprinted from Schulson (1990) and (1997).

MATERIAL AND METHODS

The fresh water ice samples were prepared of about of 8 cm height and 7 cm in width. It was prepared in the cold room by the single directional freezing.

During the experimental tests the pressuring deformation rate was set the value from 0.01 to 0.06 min-1 for ductile and brittle compressive failure.

The ductile compressive failure of ice sample was going on during the experimental test under the maximal pressure of about 2500 kPa.

The total final deformation of the ice sample was about 33% from the initial size achieved.

The strength during the ductile pressuring test experiment firstly arose up to 2500 kPa, then drop and went under the pressure of about 1200 kPa.

The brittle compressive failure of ice sample was going on during the experimental test under the maximal pressure of about 1100 and 300 kPa applied along vertical c-axes and basal lines correspondingly (illustrated in Figure 3).

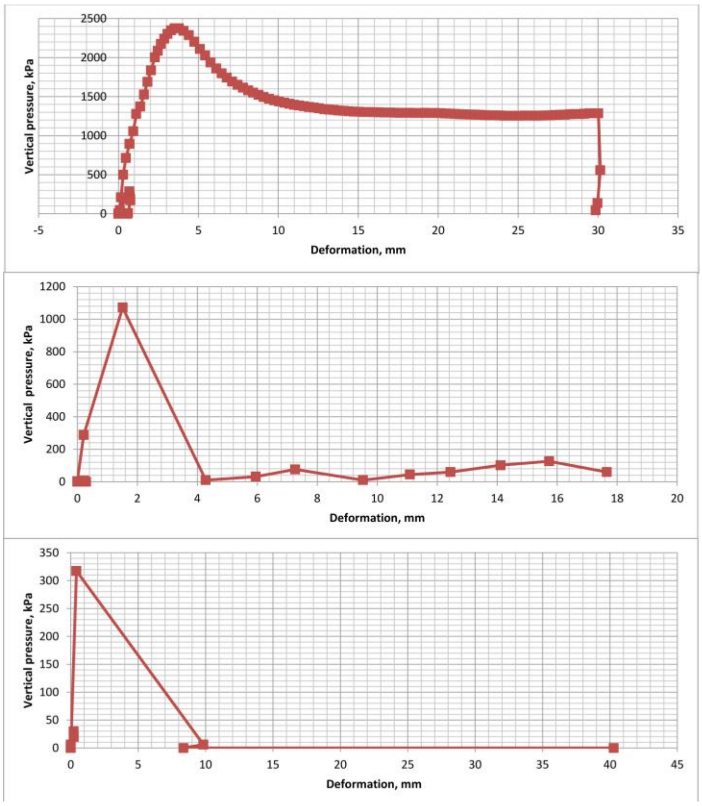

Figure 3. Vertical pressure vs. deformation charts of the ductile and brittle compressive failure experiments

Also the variation of long-term equivalent cohesion of fresh and brine ice (Ceq) was measured with ball stamp test (illustrated in Figure 4).

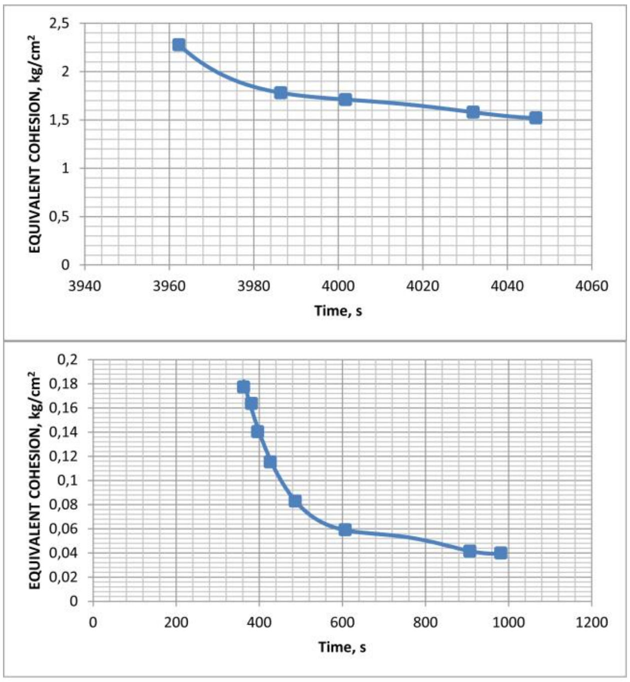

Figure 4. The variation of long-term equivalent cohesion of fresh and brine ice (Ceq)

Crystalline structure of prepared samples from fresh water ice and brine ice was studied in the polarized light (illustrated in Figure 5).

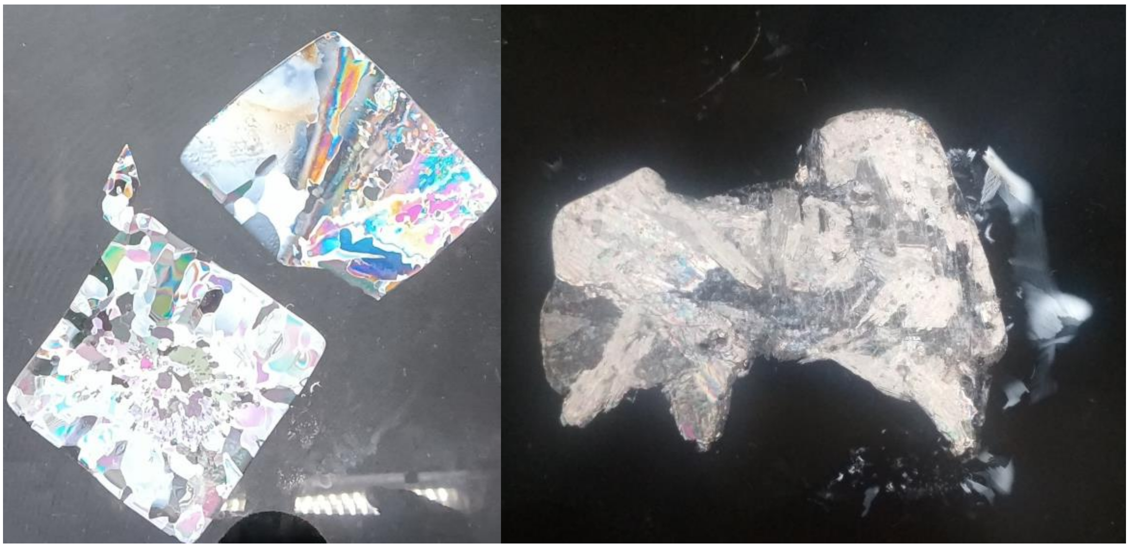

Figure 5. Crystalline structure of prepared samples from fresh water ice and brine ice

CONCLUSIONS

Demonstrated on the figure 2 and 3 results may prove, that the ductile failure pressure is higher than the brittle one. And the brittle failure pressure of ice sample applied along vertical c-axes is higher than the applied along basal lines. And the equivalent cohesion of fresh ice is higher than for the brine ice due to the difference in the structure. The obtained results coincide with the obtained earlier results and development of Loset et al., (2006) Schulson (1990) and (1997) and also of Lemenkov and Lemenkova (2021).

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