Optimization of sledge properties in ice sledge hockey

P. Kjærnli¹, A. Seim¹, N.P. Vedvik¹, D. Blankenburg¹, K.A. Aasland¹, Ø. Sandbakk²
1: Department of Engineering Design and Materials and 2: Center for Elite Sports Research - NTNU, Trondheim, Norway;

Introduction
Ice sledge hockey is a modified version of regular ice hockey targeting athletes with a physical disability in the lower body. An aluminum sledge is used as an adaptive device and two carbon sticks for puck handling and player movement. In order to optimize the complex movements in this sport, the mass of the sledge should be reduced, and more importantly, the contact between the player and the ice should be optimized. The aim of this project was to optimize the sledge properties in ice sledge hockey, with a particular focus on the transfer of forces between the player and ice. Specifically, this involves the seat and the connection between the seat and the blades.

Methods
Initially, a test rig was designed to accurately measure the stiffness of different parts of the sledge. Corresponding tests were simulated employing NX Nastran 7.5. The results from these tests were used as design inputs for the further development of different test sledges. Thereafter, these sledges were tested on ice by the Norwegian national team and compared with today's available high performance sledges. The subjects provided subjective feedback and performed specific sprint and technique tests on ice.

Results
The rig tests revealed that the forces were primarily transferred in the rear part of the seat, whereas only minor forces were transferred in the front part. When comparing the different seat designs during ice testing, the players felt better contact between the body and ice and used shorter times both in a 30-m sprint test and a technique test with circular movements using flat bottom shaped seat made from a high stiffness material. However, most players experienced discomfort in these seats. Additionally, the knees slipped over each other when the players with two legs leaned during a turn. Here, additional bracket to strap the knees improved maneuverability and showed better performances in the technique test.

Discussion
The current study highlight the importance of supporting the rear part of the sledge with a rigid structure, where flat bottom seats made from a high stiffness material seems to provide better control. However, these seats gave a significant discomfort that needs to be improved by customization. Due to the minor forces transferred in the front part of the seat, weight savings through a less rigid design can be employed. In order to further optimize the sledge, testing of different designs and materials are required to reveal a better specification. The problem with slipping movements of the knees was eliminated by adding a bracket to strap the legs to the sledge at the knees.