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Investigation and assessment of the edge grip of snowboards with laser vibrometry – a proposal of a standardised method

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Abstract

The edge grip of a snowboard defines its ability of holding the arc of a carving turn without intending to break out. In order to assess the vibrational movements of the edge under simulated loading conditions, two boards were put on the edge on a soft foam surface and loaded with 400 N such that the boards bent under the added load and the edge was in full contact with the surface. The shovels of the boards were excited with a swept sine signal from 5-200 Hz and the displacements measured with a laser vibrometer. The last edge point in contact with the surface proved to have the largest movement range. Maximal displacement was caused by the first torsional mode at 115-125 Hz, followed by combined bending/torsional modes at lower frequencies (23-30Hz, 80-90 Hz). One board exhibited a larger movement range in the first torsional mode compared to the other board, and the frequency peak of this mode was wider. The mobility index of this board, introduced in this study as the normalized area under the displacement curve of the last edge point, was 1.5 times higher than the index of the other board. The method used in this study offers an accurate quantification of the movement of the edge under standardized load conditions.

Keywords: snowboard, edge grip, vibrations, edge displacement, frequency reponse function, laser vibrometer

1. Main text

According to Foss and Glenne 2007, *'The dynamic property most responsible for adverse ski behavior at high speeds on hard snow is a highly active torsion mode. Higher torsional vibration of a ski forebody directly affects*

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edge control and stability, particularly during turns'. According to Buffinton et al. 2003 '*Natural frequencies and damping ratios are two of the key parameters characterizing snowboard ride, feel, and performance. In particular, damping ratios as well as the relative values of bending and torsional natural frequencies directly relate to snowboard controllability and handling'*. The edge grip of a snowboard is defined as the 'level of grip exhibited during turns', according to Subic et al. 2008. In essence, edge grip refers to the ability of the snowboard to hold the arc of a carving turn, i.e. the ability of maintaining carve integrity. Poor edge grip causes the board to break out of the carve.

As there is currently no objective method available for measuring the vibrational movement of the edge of a loaded, tilted and bent board, the aim of this paper is to develop a method for this purpose. The movement of the edge has to be measured against a soft surface, considering that maintaining the properties of snow over the entire edge length, as well as its temperature over time, is difficult under experimental conditions. According to Foss and Glenne 2007, the frequency response functions of skis on hard and soft snow are similar, with '*responses on hard snow … about one order of magnitude higher than those from soft snow*'.

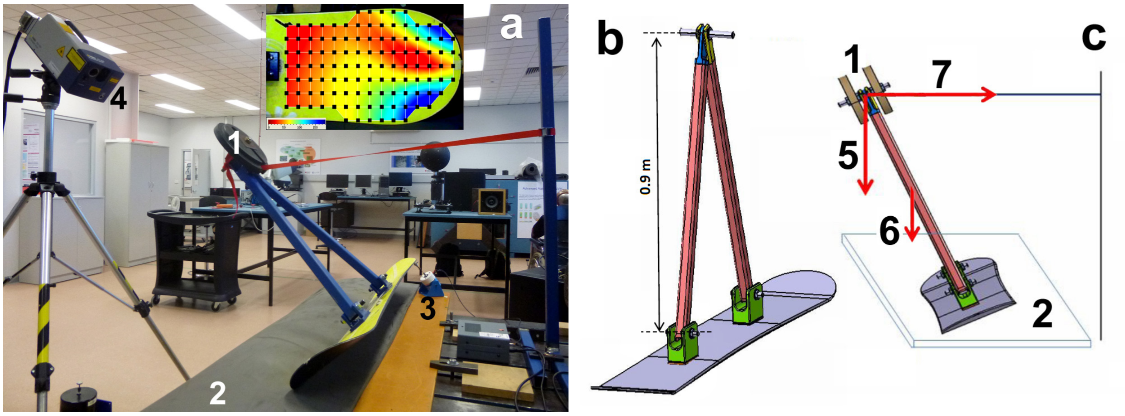

Fig. 1. (a) experimental set-up, 1: load, 2: foam mat, 3: shaker, 4: laser vibrometer, top insert: scanning grid projected on the shovel; (b) frame mounted on board; (c) experimental set-up, 5: weight of load, 6: weight of frame, 7: belt force.

2. Experimental Procedure

Two snowboard decks used in a previous study by Fuss et al. 2010 were analysed. The boards had similar bending stiffness; board A had a higher torsional stiffness than board B analysed by Fuss et al. 2010. In contrast to previous experiments by Fuss et al. 2010 carried out in free-free conditions, the goal of the current study was to analyse the displacement of the edge of a loaded board in contact with a softer surface. The boards were placed on a closed cell polyurethane foam mat (20 mm thick; density: 34 kg/m^3; 0.12 MPa stress at 0.5 strain) at an angle of 41 degrees (Figure 1). The boards were loaded with 20 kg through a 0.9 m high triangular frame (11 kg) connected to the holes for the binding screws, such that the boards bent under the added load and the edges were in full contact with the foam surface. The frame-board system had four instant centres, three revolute joints, and the instant centre of the bending board between the binding sites. The frame was connected by a belt to a post behind the board. This method kept the board in a stable position and the belt force simulated the centrifugal force when making a turn. The overall load perpendicular to the board was therefore approximately 400 N, i.e. the resultant of gravitational and belt forces (Figure 1c). In contrast to skis, where the binding is in the centre of the ski, thereby deflecting the ski fully by the bodyweight when carving, snowboards are loaded by both legs and the bindings are located off centre. Therefore, the mid section of the board is not deflected fully by the bodyweight when carving and consequently not in entirely in contact with the supporting surface. When loading the boards with the frame described above, the distance between mid-edge and surface was minimal between 40 and 45 degrees.