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Effect of Repairing and Grinding Scratched Alpine Skis on Their Friction on Snow

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Abstract

Ski base service includes filling of scratches, grinding and waxing. The aim of this study was to investigate the effect of scratched and then repaired ski bases on their kinetic friction on snow. Kinetic friction of three different types of skis (junior, women and racing skis) in four preparation steps (factory-new, standard grinded, scratched, repaired) were measured at two different velocities (4 and 8 ms^{-1}). Testing took place on a linear tribometer with defined conditions at -8°C snow temperature. The normal force was set to typical values for the particular ski type. The coefficient of friction of the scratched skis almost doubled compared to the unscratched ones. This may be caused by asperity interlocking between the snow grains and the scratches. The coefficient of friction of the repaired bases was re-established since only about 1% of the before scratched area was covered with the filling material.

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Keywords: Alpine skiing, snow friction, ski preparation, ski base;

1. Introduction

For many winter sports, and alpine skiing in particular, the equipment and its preparation are of great importance to enjoy the sport to the fullest. Preparation of ski bases includes filling of scratches, grinding and waxing the ski base. A ski base is usually made of PE, which has, beside good processing properties, superior frictional behavior on snow. The structure of the ski base plays an important role in order to minimise the CoF between ski and snow or ice [1, 2, 3, 4]. During usage friction causes wear resulting in scratches which affect the structure of the ski base. Ski service aims to restore the structure by filling scratches and regrinding the ski base. The aim of this study was to investigate the effect of scratched and then repaired ski bases on their kinetic friction on snow.

Nomenclature

CoF	coefficient of friction
HDPE	high-density polyethylene
LDPE	low-density polyethylene
PE	polyethylene
UHMWPE	ultra-high molecular weight polyethylene

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2. Method

2.1. Ski samples and preparation

Different types of skis manufactured by HEAD (Kennelbach, Austria) were used. To cover a wide range of ski types, a junior, a women and a racing ski was chosen. Names, target users, dimensions and base materials are presented in Table 1. For each ski type, four skis were prepared to one of the following preparation steps: factory-new, standard grinded, scratched, repaired. The preparations steps were executed one after another, e.g. scratched skis were factory-new skis that were standard grinded and subsequently scratched.

Standard grinding was done on a Discovery machine (Wintersteiger, Austria) with standard grinding parameters for alpine skis. The scratched preparation step, to simulate heavy usage, was established by manually scratching an area of about 30% of the ski base in longitudinal direction using a slotted screwdriver. The scratches where distributed over the whole base with the majority being located directly underneath the binding. Fig. 1 shows a 5.2 x 7.5 mm sized image of a representative scratched ski base area underneath the binding and the corresponding surface profile. The images were taken with a focus variation microscope (Infinite Focus G4, Alicona, Austria). Fig. 1 (b) shows three scratches with widths between 0.5 and 1.0 mm and depths of 80 to 160 µm.

Repairing consisted of coating the whole ski base with LDPE (Basejet, Wintersteiger, Austria) followed by standard grinding. In the Basejets sliding shoe, an extruder continuously liquefies and heats LDPE to about 300°C. Valves then distribute the molten LDPE on the base while the sliding shoe is moved over the ski. The process also heats the ski base itself leading to a bonding of the ski base material and the LDPE.

Factory-new ski were inherently waxed, all other skis were waxed after preparation with Discovery Universal wax (Waxjet, Wintersteiger, Austria).

Table 1. Ski specifications.

Brand	Name	Target User	Tip / Waist / Tail Width (mm)	Length (cm)	Base Material
	Lemon Lime	Junior	103 / 67 / 90	125	extruded HDPE
HEAD, Austria	Beauty	Women	129 / 92 / 117	159	extruded HDPE
	GS	Racers	102 / 68 / 87	178	sintered UHMWPE

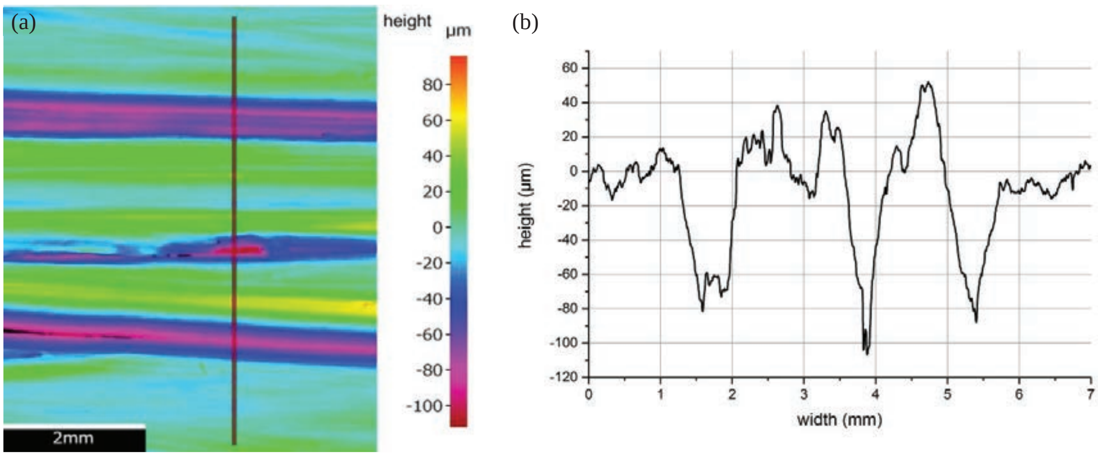

Fig. 1. Quasi 3D microscopic image of a scratched area. The red line indicates the position of the surface profile (a). Surface profile (b).

2.2. Friction measurements

The friction measurements took place on the large-scale linear tribometer of the Centre of Technology of Ski- and Alpine Sports in Innsbruck, Austria. Detailed information concerning the test facility can be found in [3]. The CoF was calculated by F_r/F_n, whereof the friction force F_r was measured and the normal force F_n was set to typical values for the particular ski type: 160 N for junior skis, 190 N for women skis and 300 N for racing skis. A series of 15 consecutive runs was conducted for each