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Competition preparation from the point of view of ski technicians

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ABSTRACT

Competition preparation, which includes a detailed analysis of the external conditions, the preparation of the skis and subsequent testing, is a complex process that requires precision and is also a power-sapping operation. The technicians are required to have a sure instinct as well as knowledge of meteorology, physics and chemistry. Another difficulty is the time pressure to get a large number of skis finished to the point. Routine and teamwork are helpful, but also understanding the tribological processes involved.

1 Introduction

The women's biathlon competition starts today at 2.30 pm. It's only 7 am, but the first ski technicians from the waxing companies are already at work. After the weather and snow quality have been assessed, the waxing of the skis will begin. Around 9 am the skis are ready and the technicians change the smock and apron against the running suit. First, the skis are checked for gliding on a slope. A suitable glide path is marked out and the time of each run is measured. This shows which ski is the fastest today. Since speed is not everything, but also how the ski behaves on the foot, all test skis are now run in the stadium to evaluate the running feeling. Only then is there a grade, which is made up of glide time and skiing feel. This grade and the assessment of the snow and environmental conditions are reflected in the recommendation that the waxing companies provide to the ski teams.

Equipped with this information, the team technicians now begin to wax the competition skis. First the skis are cleaned to remove wax residues. Then the wax layers are built up, which begins with the application of the base wax and ends with the speed finish. The last step is always the brushing of the skis, so that the fine grinding structures, which are added with wax, are exposed again. After waxing and testing, it is now 12.30 pm. The time before the race is now used by the athletes to choose their top ski. This process must be completed 1 hour before the race, as the skis must now be stamped and waxed.

This article deals with the problems of ski testing, measuring friction and evaluating skis.

2 Results

2.1 Analysis of the external conditions

What does competition snow look like?
From a microscopic perspective, snow is a mixture of millions of individual ice crystals. Shortly after new

snow has fallen, the individual flakes clump together and form small ice grains after a few days. These grains are partly spherical and have diameters like the thickness of a hair. Most competitions are held on a mixture of natural and artificial snow. The snow cannons cannot produce snow flakes, but shoot small drops into the cold from which ice grains crystallize. Therefore artificial snow is very dense. The secret of sliding on snow and ice is a nanometer-thin film of water on the surface of the ice crystals. Figure 1 left shows competition snow at a temperature of -10°C. The grains have an average diameter of 100 μm. On the right you can see microscopy work in the ski tunnel, which had a basic character and did not serve the immediate preparation for the competition.

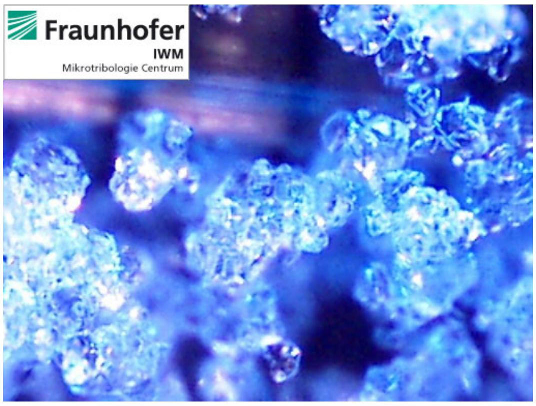


Fig. 1: Competition snow, Oberhof 2009, Kulle curve. Snow microscopy in the Oberhof ski tunnel.

Meteorology and track conditions

To evaluate the weather conditions, the technicians usually use sources available on the Internet, such as www.yr.no, a Norwegian site. As the weather can change quickly in competition venues, which are usually located in the mountains, these forecasts are sometimes very inaccurate. This influence was particularly noticeable during the preparation of the Paralympics in the Russian Krasnaya Polyana, or more precisely in the ski resort of Esto Sadok. In the Caucasus, close to the Black Sea, the weather changed so quickly and drastically that conventional forecasts were of little use. Therefore, Team Snowstorm decided to reduce the global weather model, which works with a mesh size of 25 km, to a mesh size of only 1 km with the help of high performance computers in order to determine the weather with a 72 hour forecast for the stadium area Laura. The Nordic Paraski Team Germany as well as the German Ski Association were supplied with the weather forecasts. The dress rehearsal took place for the Biathlon World Cup 2014 in Oberhof.

Despite exact predictions, there are still local sources of error, which are caused by the nature of the terrain, the competition time or local temperatures and humidity. Figure 2 underlines this using the example of the Oberhof ski stadium. Here, snow samples were taken at several points along the race track, temperatures and humidity were measured and the measuring points were fitted into a track model using GPS. Due to the late start time (15.30 hrs), only some parts of the track were exposed to direct sunlight, which can be clearly seen from the values for snow temperature and snow moisture. With a race duration of about 2 hours it was clear that the conditions would change rapidly. Differences in the snow temperature of 5°C are a big challenge in the choice of wax. The differences in snow moisture require a reaction regarding the grinding structure. The decision regarding the preparation strategy should therefore always be made only after a thorough assessment of the local conditions.

2.2 Glide tests

Glide tests are carried out in the immediate vicinity of the running track or on the track. To evaluate the skis, a test runner descends a marked out course several times without introducing measuring errors by changing his posture. At each run, the skiing time is measured and documented. During these tests, the order of the skis is varied to avoid routine effects. Ideally, a glide test should not be performed by the technician who waxed the skis. The shorter the gliding distance, the smoother - in terms of posture - the tester will ski. However, the time differences are also very small for short distances, which makes the evaluation more difficult. The opposite is true for long gliding distances.

In order to further test the gliding behavior, the ski technicians go out on the course as a pair. The parallel gliding, which is shown in Fig. 3b), allows the detection of nuances. Very often the technicians

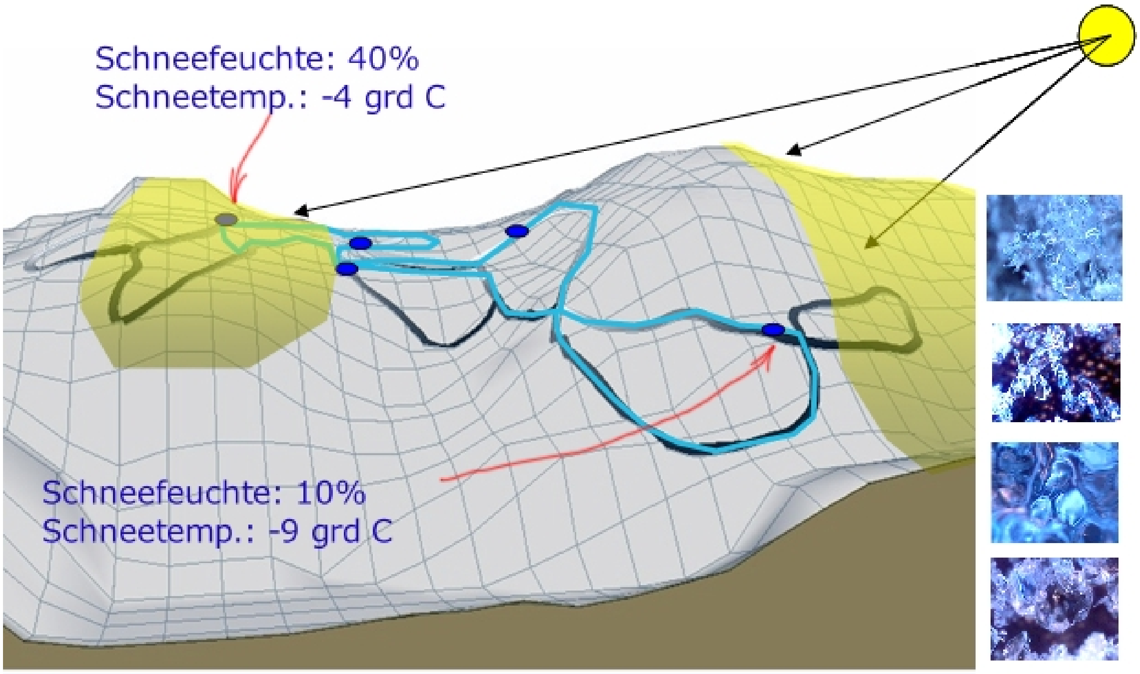


Fig. 2: Route, solar radiation, snow temperature, snow moisture and snow structure at selected points of the Oberhof ski stadium.

Fig. 3: Ski technician with prepared skis in the stadium area. b) Pair tests to determine differences in the glide behaviour of the individual skis. c) Change of the skis. d) Glide test on a defined course.

hold hands during the parallel glide to feel the smallest differences in speed. To make sure that the advantage was not only subjective, the skis are crossed over, see Fig. 3c).

2.3 Model tests

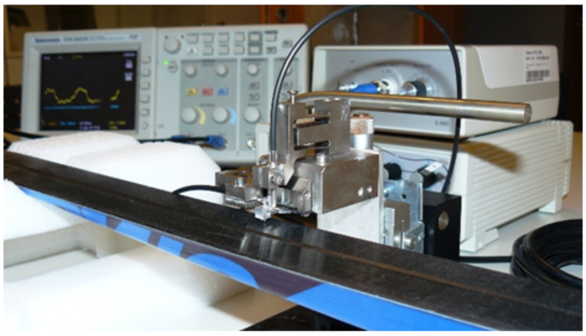
Since ski tests involve considerable effort, there are approaches to save time with model tests. One of these approaches uses a 30 cm long sliding body. The gliding body is made of metal and is covered on its 4 sides with ski base material. Each of the sides is treated with ski wax and is available for a glide test, which is carried out by 2 ski technicians, see Fig. 4. On a slope, the upper technician lets the glide body run and the lower technician takes the time. After 4 runs all waxes are checked.

2.4 Microtribometry

A microtribometer is a measuring instrument with which the smallest frictional forces can be measured. Instead of the snow grain, a small silicon ball is used. On the surface of the silicon ball there is a layer of water of similar thickness as on a snow grain at -10°C [1]. The ball is pressed with a certain force onto the waxed ski. This force must be chosen so that the resulting pressure corresponds to the pressure of an entire ski on a snow surface. The ball can be moved over the ski base by means of a drive. The ball itself is connected to a force sensor that detects the resistance when sliding over the ski base. The greater the resistance, the greater the friction must be. With this approach, two properties of the ski base can be tested. First, the ball with its layer of water "feels" the degree of hydrophobicity of the ski wax. If the

Fig. 4: Sliding test with test specimen.

water repellency is high, the water layer forms only a weak capillary neck with the ski base, resulting in low friction. Furthermore, the ball ploughs through the near-surface area of the ski base and is thus able to characterize the wax polymer layer [2].



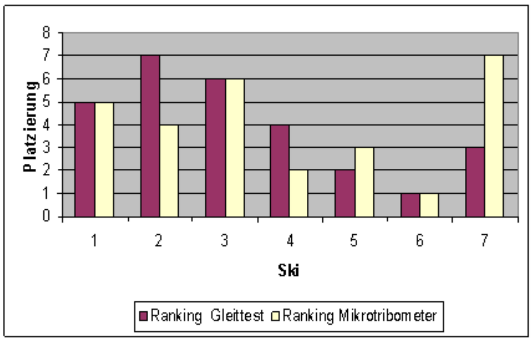


Fig. 5: Left: Measurement with a microtribometer. Right: Comparison of the results of microtribometer measurement and sliding test.

Using the described procedure, 7 pairs of differently prepared skis were tested. For each measurement, the frictional force was measured so that the skis could be placed, see Figure 5 on the right. Then the skis were subjected to the glide test and the travel times were determined, which also led to a placement. With the exception of skis number 2 and 7, it was possible to show the tendencies in the skis' gliding properties with the microtribometer. The deviations in placement indicate that the friction effect can also be influenced by other factors, such as ski tension.

3 Summary

Ski tests are a necessary condition for success in racing. The tests should be preceded by intensive analyses of the external conditions such as temperature, humidity, terrain profile and, above all, the properties of the snow. The analyses should be carried out at as many points on the track as possible to detect local differences. Supporting the field tests with laboratory tests is recommended, as this allows a large number of variants to be tested under constant conditions, thus allowing a pre-selection which can reduce the number and duration of the field tests.

4 References

[1] Scherge, M., Gorb, S.N., Biological Micro- and Nanotribology, Springer Verlag, 2001.
[2] Scherge, M. Wax or no wax - That is the question here, *Gliding* 1(2016) 1-3.

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