Thermoplastic Multilayer Slide-Foil

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ABSTRACT The training of movement procedures to increase the skills of athletes is a fundamental part of competitive sports. A realistic training, supported by technical equipment provides athletes a better success of training and is requested by trainers and training centers all over the world. Especially in winter sports, like luge or bob, a realistic training simulation is not always possible and demands adaptations of specific training procedures. As a part of this article, a new multilayer slide-foil will be presented, which allows athletes an even more realistic training. For this purpose the structure and production process of the foil composite will be shown, as well as results of the tribological behaviour of the foil.

KEYWORDS slide foil, multi-layered system, thermoplastics

KURZFASSUNG *Thermoplastische Multilayer-Gleitfolie:* Das Training von Bewegungsabläufen, zur Steigerung von Fähigkeiten, ist ein fundamentaler Bestandteil im Leistungssport. Ein realistisches Training, unterstützt durch technische Systeme, ermöglicht es Athleten optimale Trainingserfolge zu erzielen und wird dementsprechend von Trainern und Leistungszentren überall auf der Welt gewünscht. Insbesondere in Wintersportarten, wie z. B. Rennrodeln oder Bobfahren, kann dies allerdings nur bedingt realisiert werden und erfordert oftmals Abstriche bei der Trainingsgestaltung. Im Rahmen dieses Beitrags wird daher eine mehrschichtige Verbundfolie vorgestellt, welche den Athleten ein realistischeres Training ermöglichen soll. Hierzu werden zum einen der Aufbau und die Herstellung des Folienverbundes erläutert sowie tribologische Untersuchungsergebnisse präsentiert.

SCHLAGWÖRTER Gleitfolie, Mehrschichtsystem, thermoplastischer Kunststoff

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Multilayer Slide-Foil for Luge Training

Fig. 1: Start area of the luge track in Altenberg

Fig. 2: Tests under realistic conditions at the olympic training center in Oberwiesenthal

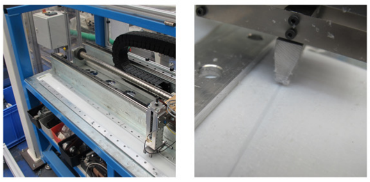

Fig. 3: Foil test on a test bench at the CUT

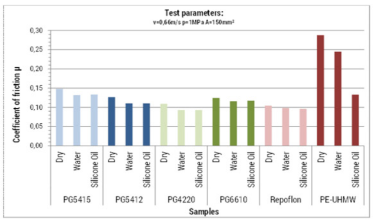

Fig. 4: CoF comparison of different slide-materials with no lubrication (dry), water and silicon oil

Motivation

The success of athletes at the Olympic Games, in World Cups or national competitions, is primarily the result of a scientific based training program. German athletes rank among the best in the world especially in luge, bob and skeleton (Fig. 1) and won a lot of trophies in the last years. The reason for this success is the large know-how of the BSD and the different training centers specialized in athlete training with the support of technical equipment. To increase these competencies, the PerlaTech GmbH, the CUT and the RBSV decided to cooperate to develop a new multilayer slide-foil, which gives the athletes the possibility to train on a "synthetic ice plate" with their sleds during the warm months (Fig. 2).

Structure and Fabrication

The foil consists at least of two different layers, which are firmly attached together through vulcanization, tubular rivets or snap connections.

The upper layer, also referred to as slide layer, imitates the sliding abilities and even the haptic of a real ice surface. It is produced by peeling ram-extruded cylinders made of modified UHMWPE. This material provides good sliding capabilities in combination with a good shock resistance. (Fig.5).

The lower layer, also referred to as guidance layer, is primarily used for the adjustment of the sled guidance, which can be done by the selection of different rubber materials or layer thicknesses. This layer also protects the slide layer against rough ground surfaces and prevents the foil composite from getting shifted by external forces.

Fig. 5: Producing of the slide-foil and layer structure (Source: PerLaTecH)

Advantages Compared to Conventional Synthetic Ice

- Wrinkle- and bump-free installation along curved tracks
- Easy producible multilayer slide surfaces with more than 30 m
- Lower CoF compared to currently used materials (Fig.3 & Fig.4)
- Easy adaptability for other technical applications and surfaces as a result of the flexible production method

Research Partners

- PerLaTech GmbH
- Saxonian Luge and Bob association (RBSV)
- Professorship of Materials Handling and Conveying Engineering

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1. Introduction

The success of athletes at the Olympic Games, in World Cups or national competitions is primarily the result of a scientifically based training program. German athletes are ranked among the best in the world, especially in luge, bob and skeleton. They won a lot of trophies in the last years. The success is also based on the different specialized training centers supported by technical equipment.

In the case of luge and bob, the start procedure has the biggest influence on the run. A wrong or even inconsistent acceleration at the beginning might be the reason for an uncatchable time loss, which can't be compensated by the driving skills of the athlete.

As a result, most of the training centers have an indoor starting track, which gives their athletes the possibility to train the starting procedure. Some training centers, like Berchtesgaden or Oberhof, use an expensive cooling system to reproduce a real ice channel. The advantage of this method is a realistic training simulation, which is not financeable for the smaller training centers. The lower priced alternative is a thick rubber-foil, so athletes can train with modified sleds. A major disadvantage of this low budget solution is the overly high guidance of the sled by sinking into the foil as well as the use of the roller sleds (see figure 1). To support the smaller training center and also to offer an alternative to the expensive cooling systems, a new multi-layer slide-foil has been developed by the PerLaTech GmbH, the Saxonian Luge and Bob association (RBSV) together with the professorship of Materials Handling and Conveying Engineering.

Figure 1: Indoor starting track with ice (left) [1] and a track with a rubber-foil (right)

2. Structure of the Slide-Foil

The main goal of the foil development was the simulation of a surface, which offer a coefficient of friction (CoF) and shock resistance similar to a real ice surface. The foil should also provide a good wear resistance against the sled runners and claw-gloves, used by the athletes (see figure 2). Furthermore, a wrinkle and bump-free installation of the foil on any kind of surface was also requested by trainers and athletes.

On the base of these requirements, the foil should consist of at least two different layers, which are attached together through vulcanization, tubular rivets or snap connections. The upper layer, also referred to as slide layer, imitates the sliding abilities and even the haptic of a real ice surface. It is produced by peeling ram-extruded cylinders made of modified UHMWPE. This material provides good sliding capabilities in combination with a good shock resistance.

The lower layer, also referred to as guidance layer, is primarily used for the adjustment of the sled guidance, which can be done by the selection of different rubber materials or layer thicknesses. This layer also protects the slide layer against rough ground surfaces and prevents the foil composite from getting shifted by external forces.

The dimension of the layers composite arises from the chosen thickness of the foils and can be adjusted as required. This flexibility makes foil lengths more than 30 m possible, so only one foil composite is needed to coat a starting track. Therefore, a bump free installation of the foil is achievable, which also reduces the cleaning and maintenance effort (see figure 3).

Figure 2: Claw-gloves and runner of a sled

Figure 3: Mounted slide foil on a starting track at the Olympic training center in Oberwiesenthal

3. Tribological Tests of the Foil—Runner Pairing

To gain information about the efficiency of the foil, tribological tests have been done. They were carried out in an iterative process between laboratory analyzations and test drives under real operating conditions (see figure 4) in direct cooperation with the trainers and athletes of the Olympic training center in Oberwiesenthal. The focus lied on the analysis of the runner geometry, relating to the coefficient of friction between sled runner and slide layer, the sled guidance during the run, as well as the resistance of the layer composite against the hits by the claw-gloves.

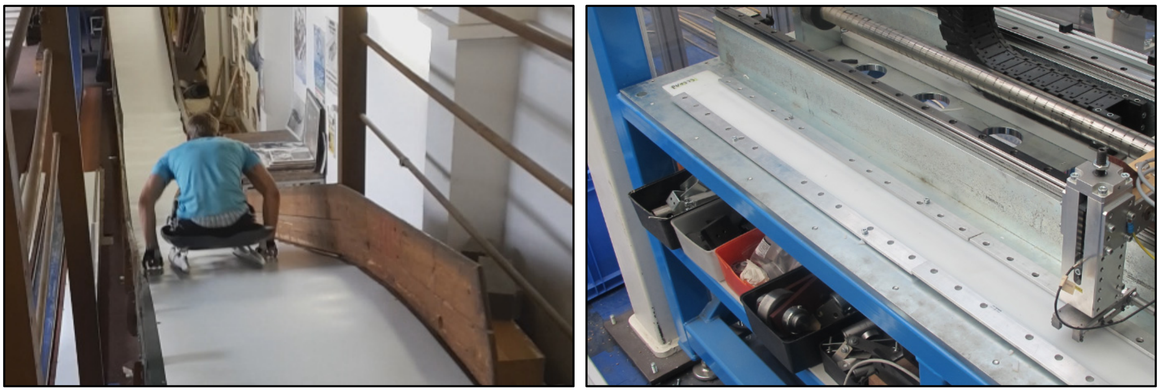

Figure 4: Tests of the slide-foil under real-life conditions (left) and in laboratory (right)

The changes between the laboratory and athletes tests were necessary, because of the limited transferability of the test result. Especially the tests of claw-resistance and sled guidance show large differences between the recommended capabilities of the foil, based on laboratory results and athlete feedback. To the athlete feeling the tests of the coefficient of friction be-tween sled runner and slide-foil were nearly identical and allowed a good visualization of the geometry influence of the sled runner on the slide layer.

The tests with four samples of different curvature radiuses were made, based on the freeform geometry of the sled runner. Four different contact pressures from 1 MPa to 21 MPa were simulated on each sample. In figure 5 the influence of different contact ratios is shown during the run with several test velocities.

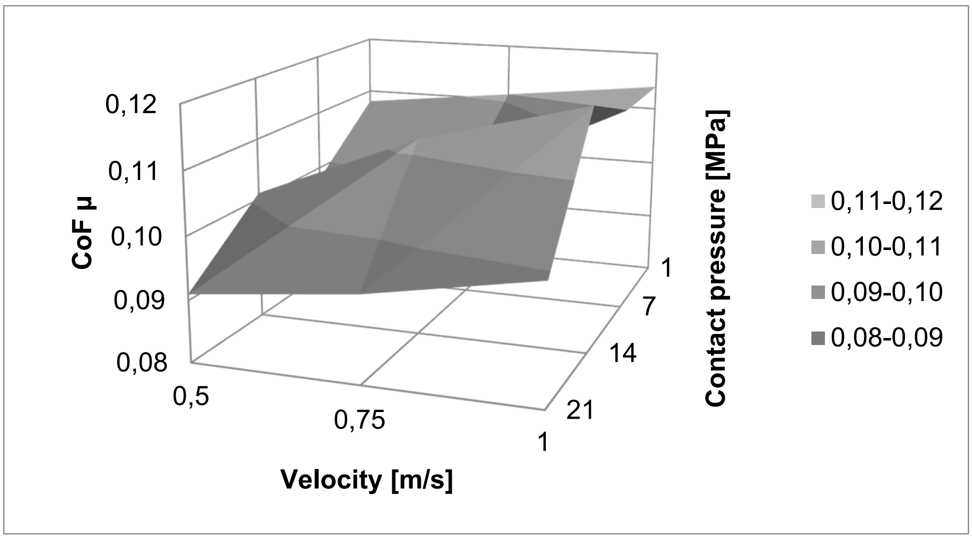

Figure 5: CoF test result for a slide-foil sample

The results of these tests show interdependency between velocity, contact pressure and coefficient of friction. The increased coefficient of friction with increasing velocity is contrary to the goal of a low friction slide-foil. To reduce this behavior, different lubricants were tested by the development team. The test results in figure 6 shows, that the lubricants are only effective on slide-foils with a high coefficient of friction. Slide-foils with general low friction have only a low benefit of additional lubrication. So the reduction of friction is only solvable by a material modification of the foil and requires tribological tests with different load scenarios.

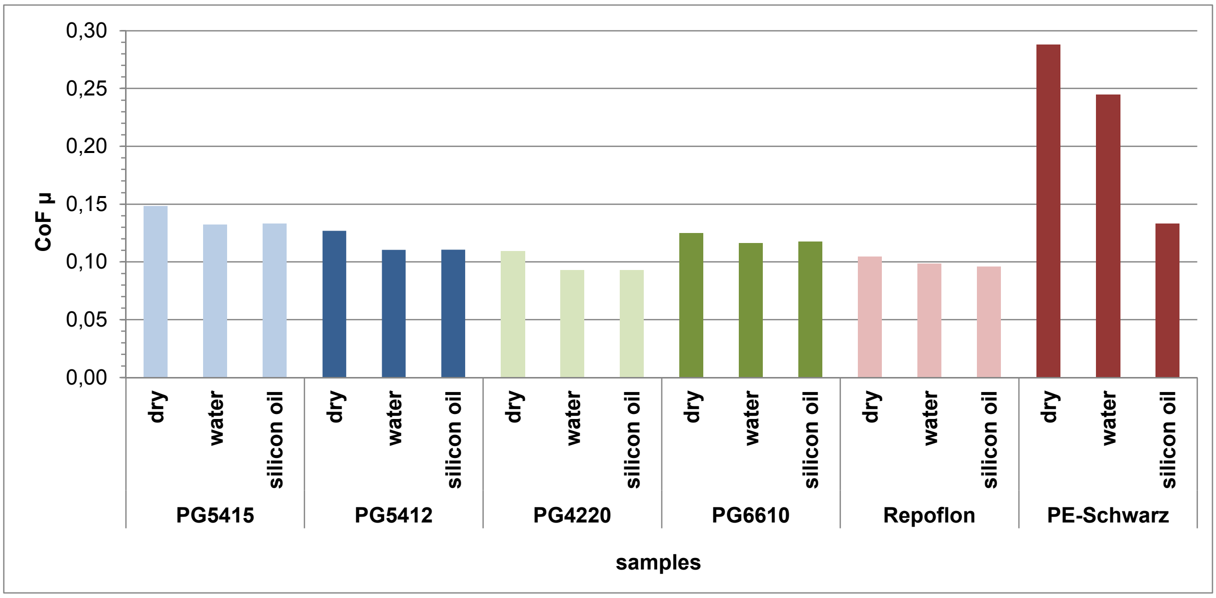

Figure 6: Coefficient of friction with different lubricants with p = 1 MPa and v = 0.75 m/s

4. Conclusion and Outlook

The main objective of the research project was the development of a slide-foil for luge and bob training, which should be reached by use of different tribological tests. These tests were made in a laboratory environment and also on a real starting track. They allowed the development of a functional slide-foil prototype, which is currently used for long-term studies at the Olympic training center in Oberwiesenthal. Furthermore, the layer composite of the new slide-foil provides a lot of advantages compared to commercial synthetic ice plates. Especially, the easy installation and low maintenance requirements offers a serious alternative to conventional training tracks for luge and bob.

In addition to the ongoing slide-foil development, the test results are also adaptable for the development of other technical applications, which need flexible, large-scale slide surfaces.

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