TEMPERATURE DEVELOPMENT DURING SLIDING ON DIFFERENT TYPES OF ARTIFICIAL TURF FOR HOCKEY

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ABSTRACT (10 pt)

In the past, hockey players used to get burning and scraping injuries from making a sliding on artificial turf. In order to assess and compare this risk for different surfaces, a sliding tester has been developed, measuring temperature rise during a sliding. 3 surfaces have been tested: a sand-filled, a full synthetic hockey field and a third generation soccer field with sand and rubber infill. In dry conditions, the full synthetic field gave the highest temperature rise and the sand field the highest abrasion. In wet conditions, the temperature rise for all surfaces was much smaller.

Key Words: artificial turf, hockey, sliding

1. INTRODUCTION

A sliding is a crucial element in the game of hockey. It is performed by a player when he tries to reach a ball that is moving too far from him/her or too fast to touch it in a standing position. Therefore, the player dives to the ground with the stick and slides for a certain period of time over the field.

In the past, a lot of problems have occurred during these types of movements: players obtained burning and scraping injuries due to the heat development during the sliding and the abrasiveness of the field. This was very much the case on sand filled hockey fields, as well as on dry full synthetic fields.

There are several types of surfaces on which hockey is played: mainly artificial turf fields with or without infill. Unfilled surfaces are denser and are normally watered before the game. Filled pitches have longer, less dense piles and have sand infill in between the piles. At low level, artificial surfaces meant for soccer (so-called “third generation” artificial turf consisting of a long-piled surface with sand and rubber infill) are sometimes also used to play hockey on, although the longer piles and the rubber infill are not really adequate for the small hockey ball.

Most hockey players at high level prefer to play on the watered unfilled pitches, because their impression is that the risk of burns and scrapes after a sliding is smaller, and because the ball roll and bounce on such a field is faster than on a filled one. However, there is a lot of criticism on the abundant use of water for hockey games, especially in the regions with (increasing) water shortage [1].

Therefore, there is a need to investigate whether the subjective impression of the players that the risk of burning injuries on wet fields is smaller than on unwatered pitches can be confirmed by objective measurements, and how big the differences are one those fields.

2. EXPERIMENTAL SETUP

2.1 Test surfaces

In order to compare the sliding behaviour, measurements have been done on 3 types of surfaces: a second generation hockey field with sand infill (Desso Crown Hockey with 22mm sand infill, so free pile height 3mm), a full synthetic water field for hockey (Desso Sportilux) and a third generation football field with sand and rubber infill (Desso Challenge Pro2 40mm with 2cm SBR infill, so free pile height 2cm) as a reference. Test rigs of 9m long were installed in the laboratory, as illustrated in
Figure 1. All fields were manufactured by Desso Sports Systems. The fields were tested in dry condition as well as after watering (1l per m²).
Three different boxes of 9m length were constructed, so that each carpet could be laid down according to the regulations and the measurements could be done in a correct and consistent way. The artificial turf rigs were installed level in order to avoid slope influences.

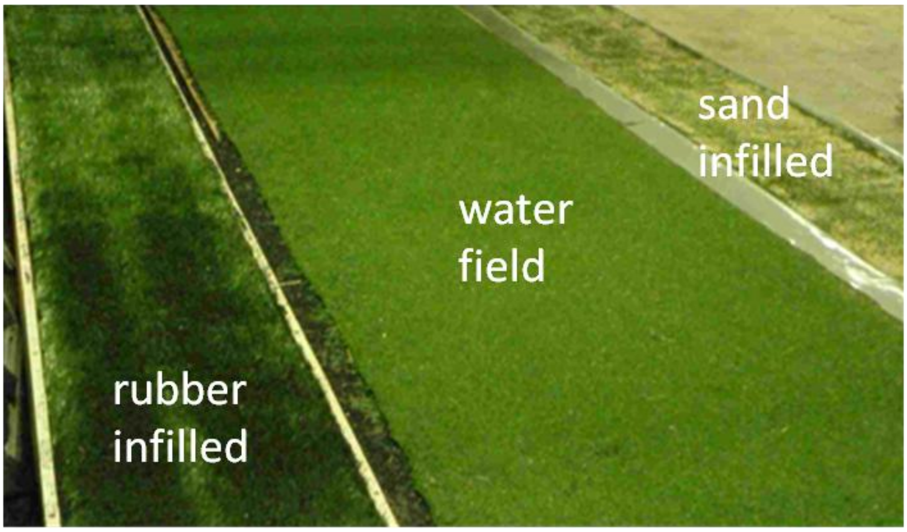

Figure 1. Test surfaces

2.2 Existing method to test sliding behaviour

The only available test for sliding behaviour nowadays is the “Determination of skin/surface friction” by FIFA for soccer turf fields [2] using the so-called Securisport Sports Surface Tester. It consists of a rotating test foot on which a silicon skin is mounted. This test foot moves across the test specimen in a circular motion and the coefficient of friction between the silicon skin and the test specimen is calculated. This test has a number of disadvantages: the measurement

- is done at a constant speed (instead of a decreasing speed in a real-life sliding tackle)
- follows a circular movement (instead of a linear movement for a real sliding, moreover the test foot will move every time over the same piece of turf, causing changes in the frictional characteristics of the test specimen)
- uses a vertical load of 100N which is not representative of real conditions
- does not measure the temperature during the sliding, even though this is a crucial parameter in the study of burning injuries

Therefore, there is a need for an improved test method.

2.3 Novel approach: the sliding tester

In order to achieve a realistic approach of the sliding, a test setup with a ramp, a sledge and samples of turf of 1.25 by 2.5m, is developed (see
Figure 2). The sledge is launched down the ramp to give it a certain horizontal speed to enter the field. Then the wheels of the sledge release the rails of the ramp and the sledge slides on the field with its bottom surface, on which an 'artificial skin' is attached. This artificial skin consists of a specifically selected polymer with frictional and thermal properties similar to human skin. The ramp is made of aluminium and is easy to disassemble and assemble, allowing transport to soccer fields. A 24-V battery is used to supply the magnetic release mechanism for the sledge. The mass of the sledge can be varied between 15 and 30kg by means of extra weights. Combined with a contact surface of about $100cm^2$, this leads to a very realistic contact pressure. The speed at which the sledge enters the field is variable up to 22km/h, depending on the release height. This is again a very realistic value, considering that the maximum speed of a football player during sprinting is just above 30km/h and that a real sliding will never be done at maximum speed.

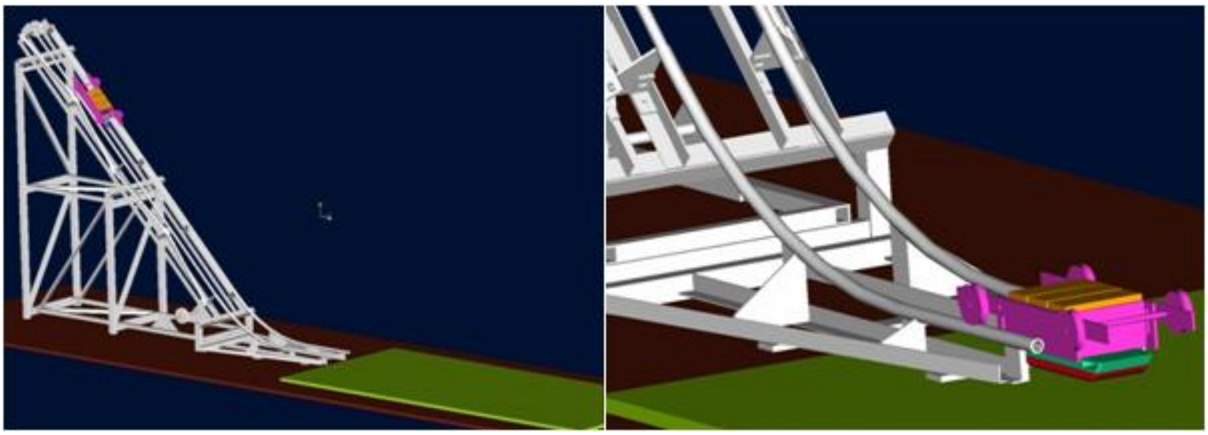

Figure 2. The sliding tester

After each test, the sliding distance is measured, and the coefficient of friction between the artificial skin and the field is calculated from it. A further parameter that is measured during the sliding is the contact temperature between the artificial skin and the field, using a National Instruments A/D-converter and 4 thermocouples (type K) attached between the artificial skin and an isolating layer on the sledge. The evolution of the temperature at 4 discrete points on the skin along the sliding direction is thus measured at 1000Hz.

The typical form of the temperature curves obtained from the thermocouples is illustrated in the next figure. As soon as the sledge makes contact with the field, the contact temperature rises quickly until the sledge comes to a standstill, after which the temperature gradually goes down again. Different surfaces result in different temperature curves [3, 4].

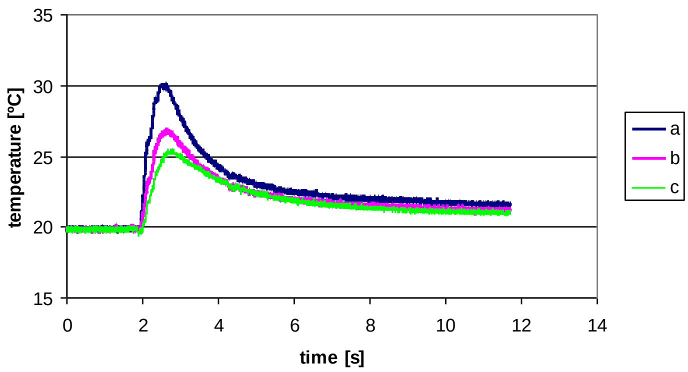

Figure 3. Typical temperature curves

3. RESULTS AND DISCUSSION

Figure 4 shows the measured temperature rise during the sliding tests. The average rise in temperature on the full synthetic field in dry conditions was 12.2±0.8°C. On the sand-rubber infilled soccer field, again in dry conditions, it was clearly smaller: 7.9±0.3°C. Initially, similar values were obtained on the dry sand-infilled field: 8.9±1.7°C. However, it was noticed that on the sand, the artificial skin of the sledge is wearing extremely quickly: already after 2 attempts the skin was worn completely, leading to a temperature rise of 29°C at the third attempt. As the artificial skin was worn away during this attempt, it was not included in the average of 8.9°C.

The tests were repeated in wet conditions, after watering of 1l per m^2, which gave a moderately wet feel. In the case of the full synthetic surface as well as the sand-rubber field, the temperature dropped drastically to become less than 2°C (1.9±0.0°C resp. 1.7±0.2°C). On the sand field, the temperature rise also decreased, but less drastically, to 5.8±1.5°C. The reason why the temperature drop was smaller in this case could be that the sand absorbed some of the water, so that there was no real water film on the surface as on the full synthetic and sand-rubber field. It was noticed however that the abrasion of the wet sand field was much smaller than in dry conditions as the artificial skin showed much less traces of wear.

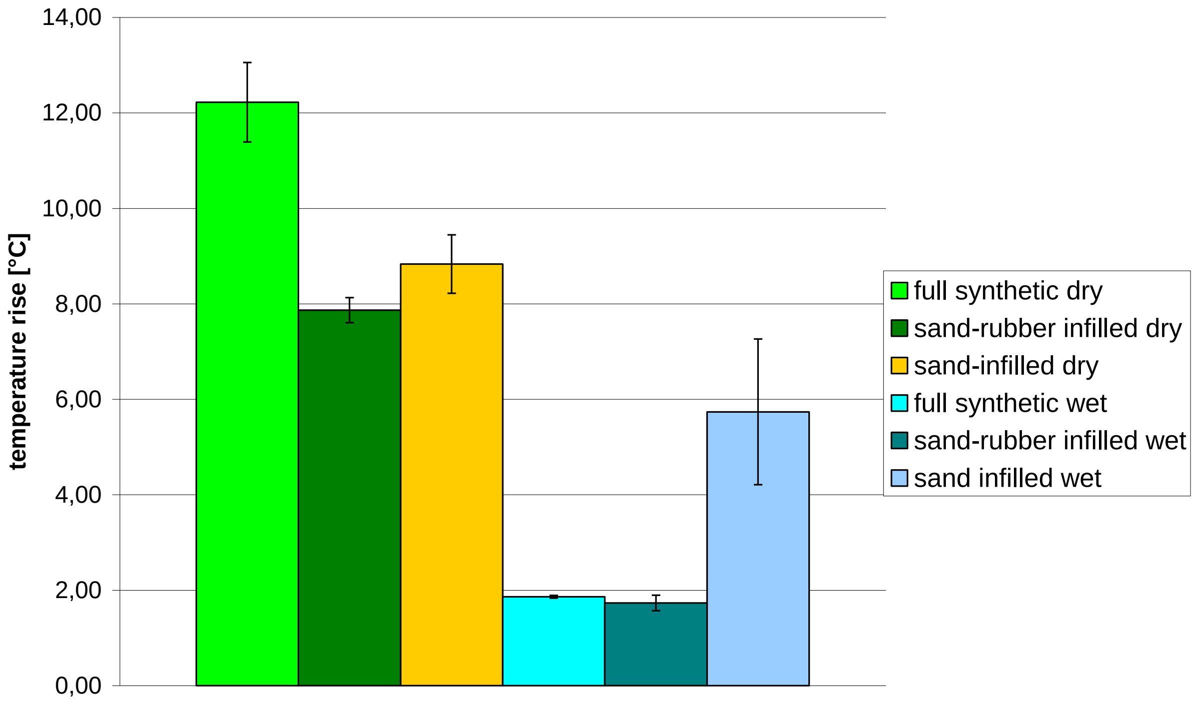

Figure 4. Temperature rise on studied surfaces

In dry conditions, the highest temperature rise is measured on the full synthetic surface. On the sand-rubber soccer field it is clearly smaller. On the sand-infilled field the temperature rise is also smaller, but the abrasion is much higher, wearing the artificial skin extremely quickly. It is likely therefore that sliding injuries on the sand field are even more likely to occur as the abrasion is so high.
In wet conditions, the temperature rise is clearly much smaller for each of the surfaces. For the watered full synthetic and the sand-rubber field, a rise in temperature is hardly noticeable. On the wet sand field, the temperature rise is almost half of the one in dry conditions. Moreover, the abrasion is much smaller in this case. This means that burning and abrasion wounds are less likely to occur on wet fields.

It should be noted that all experiments were done at an ambient temperature of 20.2±0.2°C. It can be expected that the results could differ a lot when done at higher temperatures. Williams and Pulley [5] measured that the temperature on an artificial turf field can go up to 93°C on a day when air temperatures were 37°C. Especially in the case of rubber, a high temperature increase of the field when exposed to sunny conditions can be expected. This means that the sand-rubber field might not give the best results in warmer conditions, because e.g. a sand field is less likely to warm up that much.

It should be noted as well that all experiments in wet conditions were done immediately after watering. In real game situations the watering of the field is done before the start of the game, which means that due to e.g. sunny conditions the water can evaporate quickly and the effect of the watering is not constant throughout the duration of the game. Brakeman [6] reported that immediately after irrigation, the artificial turf field temperature dropped from 79°C to 29°C, but after 5 minutes it had already rebounded to 49°C and after only 20 minutes it had rebuilt to 73°C. This means that the capability of the surface to store the water will have a huge influence on the heating of the surface.

4. CONCLUSION

In this study, the sliding behaviour on different hockey surfaces in both dry and wet condition has been studied. This sliding behaviour was assessed by means of a sliding tester, measuring the temperature rise during the sliding of a standardised sledge. The higher the temperature rise, the higher the risk is of burning injuries. The sliding behaviour has been compared on 3 surfaces: a second generation hockey field with sand infill, a full synthetic water field for hockey and a third generation football field with sand and rubber infill. These surfaces have been tested in dry and wet (watered) conditions.

In dry conditions, the smallest temperature rise was measured on the sand-rubber field. The temperature rise was higher on the full synthetic surface, and on the sand field the abrasion was much higher.

In wet conditions, the temperature rise was clearly much smaller for each of the surfaces. Burning and abrasion wounds are less likely to occur on wet fields.

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