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A new wind tunnel facility dedicated to sports technology research and development

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Abstract

It is desirable to test sportswear and sports equipment at exactly the same conditions experienced during use. Although outdoor tests are in many cases the most adequate, they are at the same time quite complex, demand special measurement technology and wearable equipment. Results of such tests are often hard to interpret due to large variations because of rapidly varying ambient conditions and individual specifics of human objects, among other factors, which are hard or impossible to control. One common alternative is provided through indoor tests made in a stable, controlled environment.

Controlling such parameters as temperature, wind speed and direction, air humidity with indoor facilities intended to replicate ambient conditions, and designed to house large objects, is a complex undertaking. Furthermore, replicating seasonal conditions complicates matters even more. A significant amount of research and development related to the operation of sports and other related equipment at high speeds and windy conditions has been carried out in wind tunnels with different degrees of climatic realism. However, the majority of such facilities are designed and constructed for the automotive industry, the aerospace industry and for marine research. A new wind tunnel facility, opened in March 2015 at the Sports Tech Research Centre at Mid Sweden University, is currently among the very few facilities in the world designed under the direct control of sports technology specialists and dedicated primarily to research and development within sports, outdoor clothing and footwear as well as equipment development and testing.

The main goal when constructing this dedicated facility has been to successfully replicate ambient conditions for training and equipment testing in environments with controlled wind speed, temperature (+4 to +35 ^{o}C) and precipitation (from fine mist to heavy downfall). The wind tunnel facility houses the largest moving belt in Sweden (5 m long and 2.7 m wide) which can be adjusted for leveled, uphill and downhill motion. The moving belt is placed in a 10 m^2 test section in which the wind speed can be adjusted to match belt speed or independently up to 55km/h (without narrowing the test section). A fog and rain system, mounted in the test section, can generate rainy conditions varying from fine mist to heavy monsoon. It is also possible to open the facility in order to allow experiments to be performed in wide range of outdoor, ambient conditions.

This paper presents the basic parameters of the new wind tunnel facility. As this facility is open for wider international cooperation, we also report the general directions of current research and the future work planned to be carried out at this facility.

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*Keywords:*wind tunnel; climate control; moving belt; product development; indoor testing

1. Introduction

Realistic testing of new garments, footwear and equipment for sports and outdoor activities is a challenge designers, researchers and industry are constantly facing. Outdoor tests are considered to be the most realistic but are at the same time quite complex to perform, depending on multiple or hard to control factors. Gathering field data demands special protocols and special, often lightweight and wearable, measurement equipment not affected by vibrations and varying ambient conditions such as temperature or humidity. One common alternative is provided through indoor tests made in a stable, controlled environment.

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However, even with indoor facilities intended to replicate the ambient conditions needed for testing, controlling such parameters as temperature, wind or humidity is a complex undertaking even with small to medium-sized climatic chambers or wind tunnels designed for testing small-scale objects [1, 2]. As it is often very difficult, or even impossible, to adequately represent the whole test object as a sum of separate, smaller parts - especially when it is tested separately from the humans that will be using it. Therefore, it is desirable to have a laboratory facility mimicking, as closely as possible, a desired set of ambient conditions, while at the same time being large enough to simultaneously accommodate the test objects and the necessary measurement equipment.

A significant amount of research and development related to the behavior of different test objects and equipment at close to ambient conditions is carried out in “climatic” wind tunnels. Most current facilities are designed and constructed for automotive, aerospace and marine sector research and are developed with their specific demands in mind. Some years ago the decision was taken at Mid Sweden University to construct a test facility designed under the direct control of sports technology specialists and dedicated primarily to research and development within sports and related technologies. It was decided that this facility should primarily help boosting research and development within existing programs at the Sports Tech Research Centre but should also support the local and national industries oriented towards the sports and outdoor clothing, and footwear and equipment markets.

Sports technology research and development at the Sports Tech Research Centre is traditionally dedicated to winter activities and bicycle sports, but also involves equipment for the disabled and systems for field measurements. Therefore, from the very beginning, it has been clear that this new wind tunnel facility should have unique layout and parameters, and house a relatively large, flexibly-controlled moving belt. Being of interest to both winter and summer activities, it was presumed that the facility would require replicating a reasonably wide range of ambient conditions, including both low (winter) and high (summer) temperatures along with controlled levels of wind and precipitation.

2. Basic design of the wind tunnel facility

The wind tunnel laboratory at the Sports Tech Research Centre, designed with the help from our colleagues at Loughborough University, can be set to either a closed-circuit or atmospheric air inlet configuration (Fig. 1a).A dedicated brick building (10) houses the wind tunnel, together with the service units and laboratories, and is approximately 10m wide, 8m high and 23m long. The working part of the tunnel has double Lexan walls. The area (2) between the inner walls (3) and the outer corridor (1) is protected from the wind and provides space for equipment and service personnel (“calm corridor”). Air enters the test section that

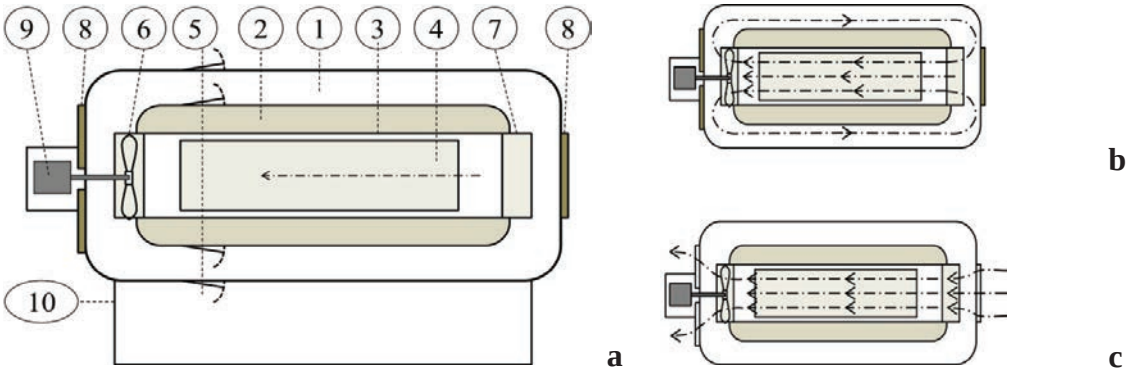

Fig. 1.Schematic diagram of(a) the Wind Tunnel Laboratory, air flow with (b) closed return and (c)atmospheric inletconfiguration of the wind tunnel.

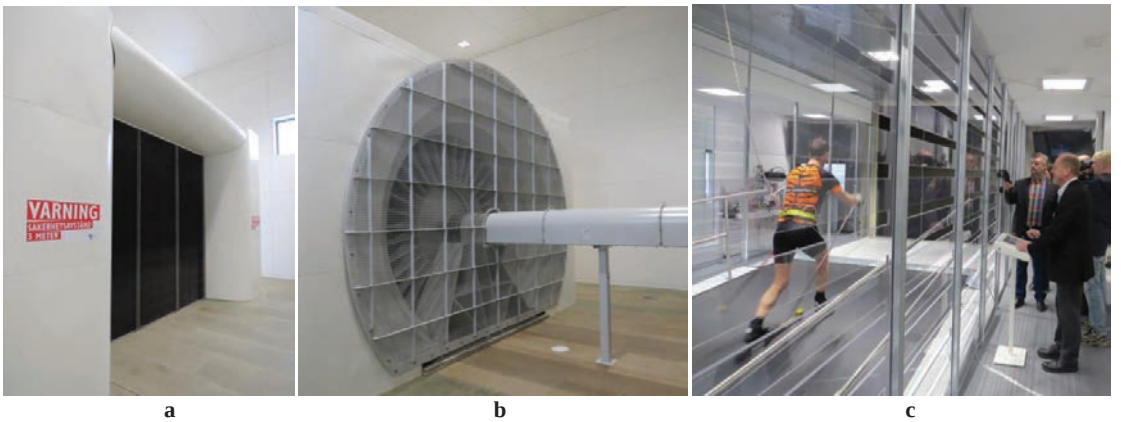

Fig. 2. Flow straightener (a) and fan (b) as seen from the air return channel; (c) view from the “calm corridor” through the inner Lexan wall