Wind tunnel data for knitted windbreak prototypes

SND-ID: 2022-175-1. **Version**: 1. **DOI**: https://doi.org/10.5878/7v2p-gr22

Download data

SharedDataWindtunnelTestsKnittedStructures_2022-11-07.xlsx *(54.78 KB)*

Associated documentation

Article_Buildings_ArchitecturalKnittedWindBreaks_preprint_20221019.pdf *(6.86 MB)*

ReadMeWindTunnelTestsKnittedStructures.txt *(6.07 KB)*

Download all files

2022-175-1-1.zip *(~6.92 MB)*

Citation

Hörteborn, E. (2022) Wind tunnel data for knitted windbreak prototypes (Version 1) [Data set]. Chalmers University of Technology. Available at: https://doi.org/10.5878/7v2p-gr22

Creator/Principal investigator(s)

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Description

This data was gathered for a study that focused on knitted textiles since they have several properties that offer potentials for wider applications within the built environment. Particularly, two features of the knitted structure are key in this study. Firstly, the loop-structure of the knit that enables the creation of three-dimensionality both on a surface level as well as on an architectural scale without cutting and sewing. Secondly, the ability to easily incorporate a varying porosity in the design of the knitted textile.
Knitted textiles, employed as windbreaks in the urban space could contribute to the creation of high-quality outdoor environments, where design informed by the local wind conditions can add both character and satisfactory wind comfort to a space. In this study, results from wind tunnel tests at an early design stage are presented, with the focus on determining the effectiveness of drop-stitch knits with diverse porosities in terms of reducing wind speed. The overarching purpose is to show the potential of this type of structure and indicate, through a comparative study of knitted prototypes, important design aspects and knit patterns best suited for improving wind comfort.

The measurements were performed in a wind tunnel at Chalmers University of Technology. It is a closed-loop low-turbulence wind tunnel with a cross-sectional dimension of the test section of 1.8 m x 1.25 m. The wind tunnel has good flow uniformity (better than 1 %) and high flow stability. The incoming flow velocity was measured by a high-accuracy digital micromanometer with 0.5% accuracy. The micromanometer was connected to a Prandtl tube located in the wind tunnel inlet, approximately at a two-meter distance from the model. The air density was evaluated from the flow temperature and absolute pressure with 0.5% accuracy. The aerodynamic forces acting on the models were measured by a six-component balance with 1% accuracy. Only the drag force component was

analysed in this study. The flow velocity behind the model was measured by a hot film anemometer from Dantec Dynamics with an accuracy of over 2 %. The anemometer was measuring the streamwise wind velocity without distinguishing the direction.
All the models were mounted on a steel frame, with all members having a circular cross-section of 10 mm. The frame was mounted on a six-component balance located under the floor outside of the wind tunnel test section. The top and bottom of the textiles were held in place by a smaller steel rod (diameter: 3 mm and 2 mm). The total weight of the frame was 966 g.
The upstream velocities were approximately 3.5, 6, 8, 12.5 and 15 m/s (the slight variation between the test, was due to the blockage). These velocities correlate to the Beaufort scales of 3, 4, 5, 6 and 7, corresponding to a range from a gentle breeze to near gale. These values were measured for each test, resulting in minor differences each time. The models were tested at 4 different angles relative to the wind direction: 90°, 70°, 45°, and 20°.
The wind speed downstream was measured with a hot-film anemometer at a position that would correlate to 5/8 H, where H is the screen's height.

The porosity for the knitted models was calculated through analysing digital photographs of the knits, mounted on the frames to get the initial stretch, and then using a script to analyse the images in a Java-based programming environment Processing. The porosity is calculated as the number of sufficiently light pixels divided by the number of all pixels in the photograph.

Data are provided in an excel-file SharedDataWindtunnelTestsKnittedStructures_2022-11-07.xlsx, with the variables explained in the documentation file ReadMeWindTunnelTestsKnittedStructures.txt

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All tests were filmed to catch the movement of the prototypes and the wind. Video files are available upon request.

Data contains personal data

No

Language

English

Data format / data structure

Numeric

Text

Still image

Data collection 1

- Mode of collection: Physical measurements and tests
- Description of the mode of collection: wind tunnel measurements

Responsible department/unit

Department of Architecture and Civil Engineering

Contributor(s)

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Research area

Architectural engineering (Standard för svensk indelning av forskningsämnen 2011)

Fluid mechanics and acoustics (Standard för svensk indelning av forskningsämnen 2011)

Keywords

Textiles, Wind tunnel tests

Publications

Erica Hörteborn, Malgorzata A. Zboinska, Valery Chernoray and Mats Ander, Architectural knitted windbreaks for improved wind comfort in the city: A wind tunnel study of custom-designed porous textile screens. Buildings 2022, 12, accepted.

Accessibility level

Access to data through SND
Data are freely accessible

Use of data

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Versions

Version 1. 2022-12-23

Download metadata

DataCite

DDI 2.5

DDI 3.3

DCAT-AP-SE 2.0

JSON-LD

PDF

Citation (CSL)

File overview (CSV)

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