On the potential of HAMSTER's bi-climatic chamber for testing building component airtightness durability

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SUMMARY

Durability of airtightness – and more generally of thermal performances – is an important question at both building and component levels. Its assessment is complicated in practice mainly due to the logistical aspects of those long duration studies and experiments. One can conduct laboratory tests with artificial ageing or deduce information from repeated in-situ tests or data analysis of existing components. In this paper, we describe two projects relevant in this context. On one hand, HAMSTER is a new bi-climatic chamber installed in 2022 in Brussels. It has great potential to assess the airtightness of building components in various conditions including, but not limited to, its durability. Two main applications are identified: (1) measuring airtightness performances in specific climatic conditions and (2) assessing the durability of building components through accelerated ageing. On the other hand, PERCHE is a research project where airtightness of exiting old wood windows with heritage value is assessed through in-situ measurements using the direct technique. Additionally, the potential of improvement of different interventions is also quantified in that research.

KEYWORDS

Bi-climatic chamber; HAMSTER; airtightness durability of building components; old wood windows; PERCHE

1 LABORATORY TESTING

1.1 HAMSTER testing facility

HAMSTER is a new hot box – cold box testing facility installed in 2022 in Brussels, Belgium. This equipment is used to conduct HAM-test of 3 m x 3 m walls, or flat or inclined roofs. The equipment is made of two climatic chambers: a cold box to reproduce exterior climate and a hot box to simulate interior conditions. It also includes numerous features to reproduce rain, pressure difference or infrared radiations. The accessible ranges of temperatures and relative humidities in both chambers are shown in Figure 1. Using this bi-climatic chamber in the context of building component airtightness is interesting in two specific contexts: (1) testing a component performance in specific climatic conditions; and (3) testing a component after an accelerated ageing process.

Although the assessment of airtightness performance is generally conducted in standardized and reproducible conditions, the elements responsible for airtightness are not performing equally under any conditions. For example, (Fleury and Thomas, 1972) and (Konstantinov and Verkhovsky, 2020) studied the air permeability of windows under different temperature conditions, and (Kysela et al., 2023) use a bi-climatic chamber to investigate the impact of seasonal variation changes on the airtightness performance of joint in timber-frame structures. Note that contrary to the traditional climatic chambers, bi-climatic chambers allow to control the climatic conditions on both sides of the tested element. This can be useful for testing elements of the building envelope, subjected to difference of temperature and relative humidity rather than homogeneous climatic conditions.

In real conditions, building components are subjected to different climate exposures during their lifetime, which creates some deterioration and affects their characteristics, including airtightness. However, studying these characteristics in real conditions (i.e., natural ageing) is often too long. Artificial ageing is then used to reproduce the impact of natural ageing in laboratory conditions in shorter duration. In the literature, different methods are used for artificial ageing, the most common being (NORDTEST, 2000). However, the method should always be designed to meet the specific objective of the study, which explain why many different methods exists. As far as possible, the component should not be exposed to climatic stresses to which it is not exposed during natural ageing, in order to avoid any unrealistic chemical or physical reactions. However, extreme conditions allow to increase the acceleration factor, i.e., the ratio between durations of natural ageing and artificial ageing. Table 1 provides a series of studies assessing the durability of components' airtightness through accelerated ageing, the type of cycles done and the potential of reproducibility with HAMSTER.

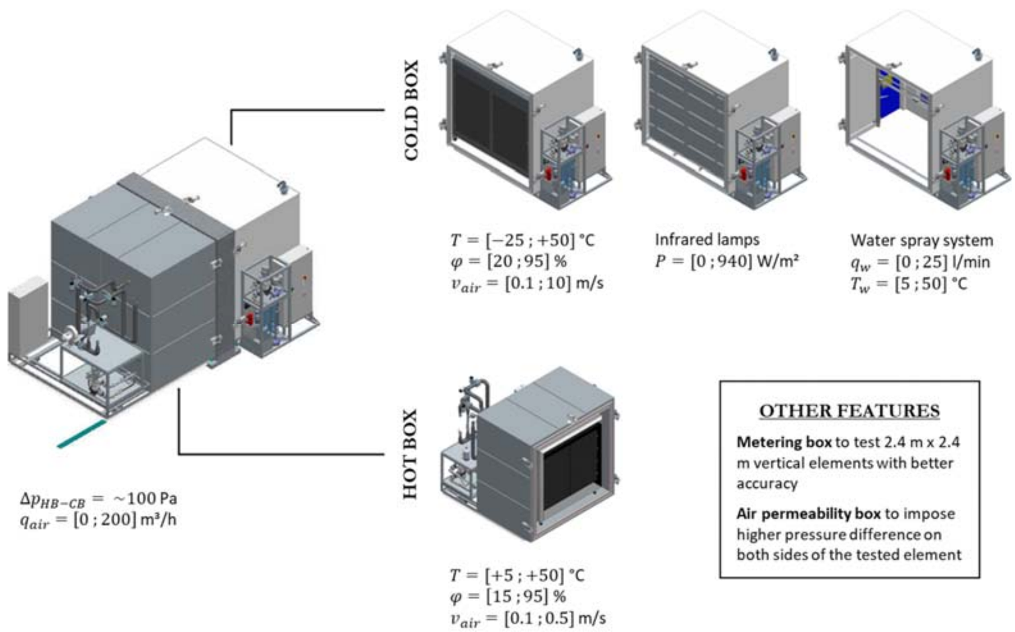

Figure 1. Features for HAMSTER equipment.

Table 1: studies assessing the durability of components' airtightness through accelerated ageing

Reference	Tested components	Type of cycles	Reproducible with HAMSTER?
(Van Linden and Van Den Bossche, 2020)	Different sealing materials for building joints	Wetting and drying; Mechanical ageing; Mechanical deformation;	Yes Yes Yes
(Gullbrekken et al., 2019)	Clamped joints in the vapour barrier	Wetting and drying	No (70°C)
(Langmans et al., 2015)	Taped joints for exterior air barrier	Thermal loads; hygrothermal loads; UV and vapour loads	No (70°C) No (70°C) No (UV and 60°C)
(Litvak et al., 2019)	Window-wall interface	Thermal creep; Weathering; Wind exposure; Break test	No (60°C) Yes Yes No (180°C)
(Michaux et al., 2014)	Walls where airtightness is ensured by coatings, wood panels, membrane, and industrialized systems	Wind and storm; Moisture; temperature	Yes Yes No (70°C)

2 IN-SITU MEASUREMENTS

Another way of looking at the durability of building components' airtightness is by empirical observations of in-situ testing conducted on existing elements. In this context, the project PERCHE aims to measure airtightness of existing wood windows having a heritage value, and to quantify the impact of typical solutions implemented to improve their airtightness without replacing them. Measurements are done using the direct method as described in (Prignon, 2020) on different relevant typologies for Brussels' Region.

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