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Moisture supply in Danish single-family houses – the influence of occupant behavior and type of room

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Abstract

According to ISO 13788, the internal moisture supply in dwellings can be described by humidity classes defined by outdoor temperature, occupancy and ventilation. Hygrothermal measurements in indoor air in 500 Danish single-family houses were made to investigate if this corresponds with reality. The study focuses on the dependency of number and age of occupants, occupants' time spent in the house, square meters living space, ventilation habits and type of room. Moisture supply depends on the type of room; bathroom, basement and living room have the highest values. None of the other parameters seems to have a significant effect.

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Keywords: Dwellings, humidity class, moisture supply, occupancy, type of room, social status, ventilation

1. Introduction

Internal humidity load in buildings located in maritime climate (e.g. Western Europe) can be described by humidity classes according to [1]. These are based on interrelated values of *internal moisture excess* (named *moisture supply* in this paper) and outdoor temperature, depending on the use of buildings including occupancy and ventilation, not considering building style and use of materials. Most Danish single-family houses would be considered to belong to humidity class 2. The question is whether occupant behavior is more important for the moisture supply in a house than the building style.

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It has been discussed to let an inspection documented in a Home Condition Report (HCR), requested by the owner at sale and made by an building expert, include a snapshot of the moisture conditions to indicate whether a specific house has an increased level of moisture compared to what is "acceptable" [2]. The HCR should lay out the condition of the house compared to what can be expected from a house of similar type and age with a typical/normal level of maintenance. The building inspection is visual with the option of using simple hand-held instruments, if relevant, but with no destructive measures allowed.

If occupant behavior is the most decisive, measuring moisture as a part of building inspection when a house is going to be sold is not very informative; it would only reveal the past not the future. This paper focuses on the effect of occupant behavior on moisture supply. The effect of building style is discussed in another paper presented at the conference [3]. Further details of the study are described in [4].

2. Research method

As no recent systematic measurements of moisture in Danish houses exist, it is not known how much the moisture supply varies houses in-between or how much it changes within a house. Neither is it known whether there are geographical differences or differences between different types of houses. It was estimated that a sample of 500 houses would be sufficient to represent Danish single-family houses. Based on changes in building style and use of building materials seven types of houses were selected, as described in [3].

To evaluate whether geography had any influence, houses were selected from 21 municipalities, representing about 20 % of the Danish population. In total they showed to have a representative amount of occupants' owned houses and a socio-economic index as for Denmark as a whole. However most of the houses visited were owner occupied. The Danish Building and Housing Register (BHR) was used to divide the houses in building types, from these lists 15-25 houses were randomly selected in each municipality. Each house was visited once for on-site inspection and for placing sensors for logging of temperature and relative humidity for a 14-day period. To ensure that the time of year would not disturb the result, different municipalities were visited at different time of year.

Each visit started with interviewing the occupants on their experience of indoor moisture conditions, and about their cooking, washing and ventilation habits. Also the number and age of occupants, occupants' time spent in the house (weekdays and weekends), square meter living space and their social status (education and type of work) was part of the interview. Data on construction types, building materials, ventilation system etc. was registered, although it was supposed to be available in the BHR, which unfortunately often not is updated. Data on living conditions, number of occupants, etc. will not be part of a normal house inspection at sale, as the future occupants' number and habits are not known. However, it has been included in this study to evaluate the effect of occupant behavior on moisture conditions, in case there are differences that cannot be explained by building style.

3. Results

The average indoor temperature for all rooms not including basements was 22.6 °C, highest in kitchens and bathrooms and lowest in bedrooms, as seen in Table 1.

Table 1. Indoor temperature and relative humidity for different types of room. Measurements are primarily made in bathrooms, kitchens and bedrooms. 'Room, various' covers children's room, home office etc. *: Except basement

Indoor temperature (No. of rooms)	All rooms *	Bathroom (426)	Kitchen (365)	Scullery (73)	Living room (241)	Room, various (79)	Bedroom (453)	Basement (32)
Average	22.6	23.0	23.0	22.3	22.8	22.5	21.8	20.6
Std deviation	2.5	2.3	2.1	3.7	2.4	1.9	2.7	3.1
Relative humidity								
Average	53.0	54.0	51.5	52.6	51.7	53.0	54.0	63.9
Std deviation	8.1	8.5	7.4	10.0	8.9	7.9	6.9	12.4