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Do we Need Hygrothermal Simulations to Evaluate the Design for Durability?

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1 Introduction

During the past decades, the Danish building regulations have amended from prescriptive building regulations towards performance-based regulations. The performance-based regulations describe the functional attributes that *e.g.* building components must fulfill. These requirements can be achieved with several designs; *i.e.* the regulations do not any more describe how to build but rather what performance the finished buildings shall have. In Denmark there is no common approach for documenting the durability of building envelope structures.

Therefore, this paper presents a number of methods that might be applicable to document the services life as required in the Danish Building regulations related to moisture problems. Furthermore, the paper will discuss if hygrothermal simulations are needed for evaluating the durability of the design of structures. Using an exterior wooden-stud wall as example, the paper discusses how the risk of moisture problems can be assessed applying different methodologies. Furthermore, calculations/simulations are compared to measurements conducted in the stud wall, to illustrate how the documentation of the expected performance can be conducted. Finally, two examples are presented on failure mechanisms, where unsuited materials or design is used for a given outdoor climate.

2 Methods for Assessing Moisture Problems

Designers of structures can use a variety of methods to support or document that the structure is durable regarding moisture exposure under in use conditions, see Figure 1.

The authors understand that these methods are those most commonly used in Denmark. The approaches are ranked from simple to complex, and can be used to evaluate the risk of moisture problems, where mould growth is considered the first indication of a mediocre structure design, which can contribute to health problems indoors.

3 Example of Problems Despite Good Results of Moisture Assessment

MgO boards were introduced in Denmark for use as wind barriers in facades etc. around 2009-2010. There were several different suppliers who all described the material as well suited for the use. The boards had many good properties including permeability, strength, weight, fire

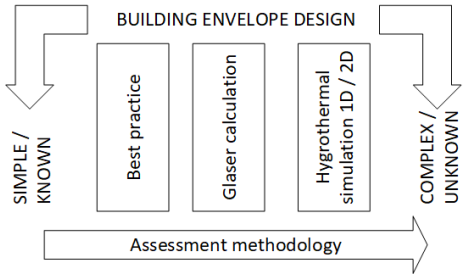

Figure 1. Example of an approach on how to document the moisture durability depending on complexity or (un)known materials.

properties, workability and price. Due to the price and workability, the boards quickly became popular and gained a good market share even though there was not sufficient impartial documentation. After about five years problems started to occur. The use of boards as wind barrier meant that the boards were exposed to high relative humidity in longer periods of the year. This caused problems as the boards contains salt, which absorbs moisture until the boards start to "cry", *i.e.* salty water was running from the boards. This caused problems with increased moisture levels in the neighboring materials, corrosion of fastener, screws etc. and mould growth.

The main problem here were that the degradation mechanisms for the material were not identified before the products was used. In this case an assessment or simulation of the moisture content on the wind barrier could have been used to identify the moisture level the product would be exposed to (and which it should be able to resist).

4 Discussion and Conclusion

Designing for durability requires that designers consider several aspects where some information is difficult to predict *e.g.*, climate changes and some are unknown *e.g.*, material properties of new products. Using common best practice documents for design is based on many years of experience. However, the conditions under which the building elements perform is retrospective and the used materials and components are well known. In Glaser calculations and hygrothermal simulations the future climate can be taken into account, and especially moisture as an agent that might reduce the durability – is perhaps the most important factor to consider.

The authors do not believe that hygrothermal simulations always is the way of documenting building envelope design for its durability. However, the simulations are a strong tool to support the documentation and investigation of new structures that consist of known materials and components. In cases with new materials, the authors do not believe that environmental actions such as agents causing corrosion or decay always are identified as this depends on the designer knowledge. Furthermore, action effects are not necessary made visible through the simulations as new materials are not teste and available in hygrothermal simulation programs. In such cases, the simulations can be used to determine the microclimate that the new product is placed in and its required properties to secure a long service life.

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