

# ByggaF - A Method to Include Moisture Safety in the Construction Process

Prof. Kristina Mjörnell, SP-Technical Research Institute of Sweden & LU-Lund University,  
Building Physics.

CIB WBC16: Special Session on Moisture and Mould Issues.

## Abstract

ByggaF is a methodology for including moisture safety in the construction process that was developed and presented in 2007. ByggaF comprises methods to secure, document and communicate moisture safety throughout the construction process, from planning to management. The methods involve a standardized way of working designed to meet the demands of society and the client's requirements for moisture safety. On request from the Swedish construction sector, ByggaF has been transformed into an industry standard. Since then, ByggaF has been used in a number of Swedish construction projects. One reason for the broad implementation of ByggaF is that the Swedish environmental assessment tool Miljöbyggnad demand for using ByggaF in order to reach "silver level" or "gold level". Another reason is that more than 100 moisture experts have been trained to use ByggaF to assure a moisture safe building process. There has also been interest in using ByggaF expressed from other countries. The industry standard has been translated to English but it needs to be adjusted to country specific conditions, such as regulation and building practices in order to be applied in other countries. In Finland, the Swedish version of ByggaF has been adapted to Finnish regulations and used for including moisture safety in construction of a school at Bergö. There have also been attempts to adjust ByggaF to suit specific applications such as construction of prefabricated single family houses and renovation of multifamily houses.

**Keywords:** Moisture safety, moisture experts, industry standard, construction process

# 1. Introduction

Moisture damage affecting our buildings is a major problem and involves major costs for repair. Despite today's modern construction methods, the trend is not declining for this type of damage. Moisture damage may cause bad indoor environment, which in turn can have an adverse effect on human health. For home-owners, moisture problems often cause major unexpected expenses. The reasons for moisture damage arising in buildings are due to a number of different factors. This could be an unclear allocation of responsibilities, ambiguous requirements, scanty follow-up and monitoring, unrealistic time schedules, lack of communication between the stages, inadequate skills and insufficient procedures for assuring moisture safety. It could just as well be due to introduction of new types of structures, materials and components without a proper verification of moisture resistant properties. This may lead to degradation in the presence of moisture, with emissions, microbial growth and stability problems as a result. It is therefore extremely important to design moisture-proof structures composed of materials that can withstand the moisture loads that the structure is expected to be exposed to during its service life, and to ensure a suitable environment for the building both during the construction stage and the operational stage. Requirements for moisture safety may often conflict with other requirements such as accessibility, architectural and design requirements as well as energy requirements. These conflicts need to be addressed and resolved throughout the entire construction process.

In order to put more focus on the moisture issues and to work with a structured approach in the construction process, ByggaF – A methodology for including moisture safety in the construction process was developed and presented in 2007, ByggaF (2007) and Mjörnell et al (2012). The methodology was then introduced to the Swedish construction sector and is today widely used by building owners (here referred to as clients), designers and contractors. In 2013 ByggaF was made into an industry standard.

The purpose of ByggaF is to highlight moisture issues at an early stage in new construction, renovation and refurbishment projects and to document the activities and actions that are required and performed in a structured way to ensure a moisture-proof building. By early formulating and setting moisture requirements and requirements for the activities, these can be incorporated into the program documents, system documents, construction documents and control plans, etc. This means that the important choices of systems and designs as well as of materials and production methods that will impact the moisture safety of the building can be made from the beginning. There have though been doubts about what parts of the ByggaF methodology are compulsory and what parts are optional. Therefore, the methodology was developed into a Swedish industry standard for the construction sector in 2013, Mjörnell (2013). The aim with this paper is to disseminate awareness and knowledge about the Swedish industry standard ByggaF to make it available for other countries to apply in their quality management work. The aim is also to give a picture how ByggaF is used today in Sweden and partially in Finland as well where it was used for construction of Bergö school, and how ByggaF has been further developed and adapted to other uses such as prefabricated single-family houses and renovation, (Johansson and Bengtsson, 2015) and (Olsson and Tjäder, 2016).

## 2. The Method ByggaF

Industry standard ByggaF includes a method that secure, documents and communicates moisture safety throughout the construction process, from planning to operation of the building. The method involves a way of working designed to meet the demands of society and the client's requirements for moisture safety. The full industry standard written in Swedish is available at the website of Swedish moisture centre, [www.fuktcentrum.se](http://www.fuktcentrum.se), where there is also a direct translation of the standard into English. This paper only describes the outlines of the ByggaF method. For a detailed description we refer to the industry standard.

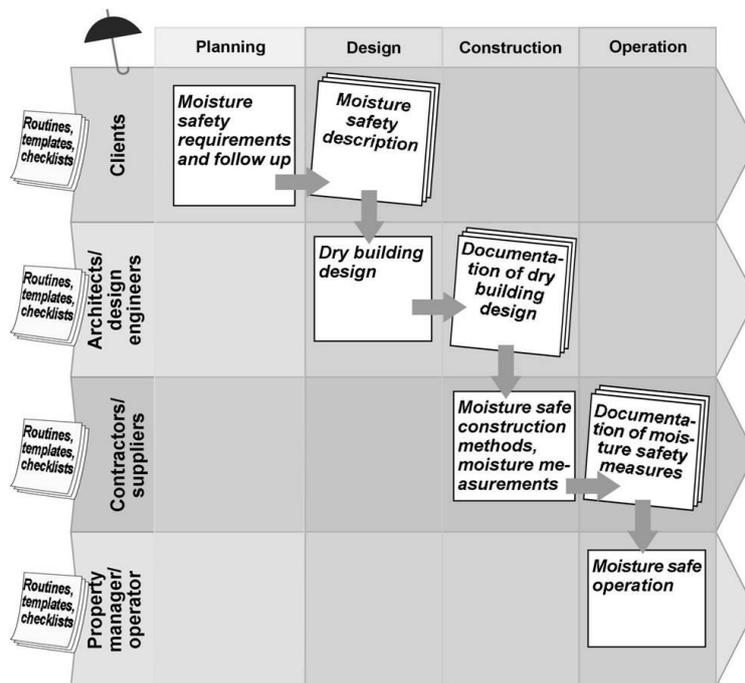


Figure 1 Overall picture of the ByggaF method.

The industry standard is designed to follow the stages in the construction process and covers the activities to be carried out at each stage. In line with how the Swedish building regulations are written, the industry standard has both “must-have requirements” that must be met and in addition, there is a guidance text that can clarify, explain or give examples of what the “must-have requirement” means. The guidance may also contain advice.

### 2.1 Who is responsible for what?

According to The Planning and Building Act, PBL, the client is the one who performs or fails to perform the planning, construction, alteration, renovation, demolition or excavation work. In order for the building to be planned and designed correctly, the client should engage the appropriate skills for the different work tasks. In many cases, the client hires a project manager as an extended arm in the construction process. However, the client is still responsible for compliance with the laws and regulations such as PBL and BBR. The client does not always

possess enough knowledge or time to pursue and monitor the moisture safety work in the project. It can be very helpful for the client to hire a person who is an expert in moisture safety, a moisture expert. The moisture expert can help the client to set requirements for moisture safety and to monitor compliance of the requirements. However, the practical moisture safety work is performed by all participants, planners, designers, contractors, suppliers and operators. The allocation of responsibility for different moisture safety activities at different stages may vary with different forms of construction contracts. Depending on the contract form, the responsibility boundaries are moved between systems planning, detailed planning and production. In the forms of contracts where the contractor also has the role of designer, the contractor must also take responsibility for what in this document are called designers' activities and responsibilities. In design and construct contracts, the responsibility for continually monitoring the moisture safety work lies with a coordinating moisture safety manager (MSM) for the production stage.

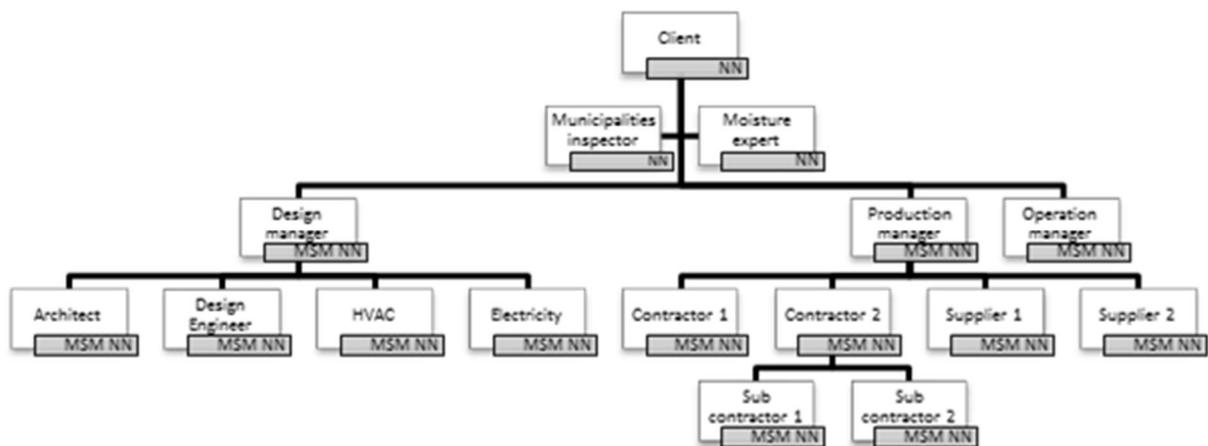


Figure 2 Responsibilities for the moisture safety work in the project organisation.

## 2.2 Moisture safety in the planning stage

The first thing the client should do is to appoint a moisture expert. Our experience is that involving a moisture expert following up the moisture safety work in the project is of crucial importance for the result. To start with the moisture expert will support the client making the early moisture risk analysis which he or she is responsible for. By making an early risk analyses before the mayor decisions about the buildings location, foundation practices, principles for handling rainwater, drainage systems, supporting framework, construction methods etc. are made, moisture critical constructions and designs could be avoided, which will save time and money in the long run. The moisture expert may also help the client to decide on the moisture safety requirements to be set in the project. It must be possible to verify and monitor the moisture safety requirements. The requirements must include both technical requirements and requirements for activities and skills.

## 2.3 Moisture safety in the design stage

Already in the procurement and contracting of planners and designers it is important to inform them about the moisture safety requirements and the methods that will be used to monitor

compliance of the requirements. Each participant involved in the design stage, designing materials, building elements or installations that affect the moisture safety of the building must follow the procedure for moisture safety design. To start with, all structures and materials sensitive to moisture and moisture critical work operations must be identified. The next step is to estimate the moisture condition that the various building elements and materials as well as combination of materials will be exposed to and describe how they vary in time. Then the estimated moisture conditions are to be compared with the permitted moisture conditions in order to evaluate the probability of damage to occur.

## **2.4 Moisture safety in the production stage**

Ahead of production, the moisture expert supported by project planners and designers must notify the main contractor of the result of the moisture safety planning and motivate their choice of construction and designs and can also answer questions regarding the drawings and technical descriptions. This is also an opportunity for feedback on the planning and design process.

Firstly, moisture-sensitive elements, structures and installations that are important in production are identified. Secondly, a moisture safety plan is prepared that describes the moisture safety measures to be undertaken in order to protect the building and construction materials from damaging moisture during production and must also include the control points identified during the planning stage. The moisture safety manager for production must ensure the implementation of the activities in the moisture safety plan as well as implementation and documentation the measurement and inspections according to the moisture safety plan. Moisture inspection rounds at the construction site are performed by the moisture safety manager and the moisture expert throughout the construction process.

In the end of the construction process, the moisture safety manager collects data for operation and maintenance instructions for moisture safety from subcontractors and suppliers as well as data from the moisture safety work carried out by subcontractors and suppliers, and submits this to the moisture expert, who in turn compiles the moisture safety documentation from planning and production and submits it to the developer.

## **2.5 Moisture safety in the operation stage**

In the commissioning stage when the building is handed over to the building owner, the developer's moisture expert and the moisture safety manager for production go through the moisture critical structures of the building and the measures to be carried out to ensure that moisture safety is maintained, with the responsible administrator and operations manager. During subsequent management of the building, the operation manager, on behalf of the building owner, is responsible for carrying out recurrent operational inspection rounds, in which moisture safety is one of many aspects to be considered.

### 3. Experiences from using ByggaF

In order to get an idea on how frequently ByggaF is used in the construction industry today and to get feedback on the field of application, usefulness and suggestion for improvements, 25 deep interviews were conducted. The interviewees were selected partly from the lists of moisture experts holding a diploma from Swedish moisture centre, partly from moisture experts who have been involved in projects that have received “gold level” in the Swedish environmental assessment tool Miljöbyggnad, a certification system for buildings, based on Swedish construction rules and regulations such as BBR, which implies working according to ByggaF.

The results from the interviews indicate that many of the users are concerned with the paper work originating from the requirement of documentation of requirements, moisture safety design and moisture safety activities during production. They ask for shorter documents summarizing the most important issues to be communicated. The documents aimed for the building owner are less frequently used and moisture experts are engaged at a later stage in the process. The interviewees are also concerned about insufficient knowledge and engagement on the part of the building owners. Another concern is the building owners unwillingness to spend money on moisture safety expertise in the beginning of the project when it would be easier to form the basis of a moisture safe design and construction, rather than to be involved later in the process to manage moisture safety issues when conditions for assuring moisture safe building are bad or even when things already have gone wrong. Critical decisions influencing the moisture safety of the building are taken early in the construction process. Another concern is that too much time is spent on meetings, rather than on constructive work.

Yet another concern is that architects and design engineers’ levels of ability vary when it comes to moisture safety design. There is also a lack of practice to document the moisture safety design and an uncertainty how to perform risk analyses. Today, risk analyses are done based on earlier experience from damages which is not sufficiently enough. In some cases the risk analyses has been disregarded. The competence among the contractors is also low and there is insufficient information and communication between employee and workers.

The moisture inspection round is an appreciated and frequently used activity and the template for documentation is widely used. However, some companies have slightly adapted the template in order to make it easier to include pictures taken during the rounds. There are also attempts to make a digital tool for the moisture inspection round. The application is however not yet launched on the market.

Many ask for a less comprehensive version of ByggaF and some companies have adjusted the documents, such as the moisture safety description, moisture design and risk evaluation, moisture safety plan and moisture round protocol, to make them easier and more suitable for their own work processes.

Among the things the interviewee asked for is a certificate affirming that the ByggaF has been used in the building process and an adjustment of ByggaF to small projects. They also stress on

the importance to bring up moisture issues and moisture risks early in the building process before the procurement documents are sent out.

## **4. Adjustment of ByggaF to other uses**

As a result of the relatively wide use of ByggaF, there have been inquiries to adjust ByggaF to specific construction processes such as construction of single family houses as well as renovation. Such attempts have been made by students in the form of two diploma works. The aim with the first study was to adapt ByggaF into a modified method ByggaF- PST applicable to the industrialized manufacturing process of single family houses with timber frame, in order to assure that it fulfills the moisture requirements specified in the buildings regulations. This work was done in collaboration with the housing industry.

The prefabricated manufacturing building process requires adjustments in ByggaF because the building process involves construction of modules and elements in a factory. For this reason ByggaF-PST includes a new stage; manufacturing of modules in factory. Another difference is that the client in most cases chooses a house from a catalogue. This means that the house already is more or less planned and designed when the client gets involved in the project. The house consists of prefabricated modules manufactured inside a factory, delivered to the building site where they are put together. For this reason there is an essential difference between the prefabricated and an ordinary building process. This affects the activities, stages, and parties involved in the presented method ByggaF-PST.

Since the client comes in late in the process, after the design is decided, and generally would not have the knowledge or the competence of setting requirements or following up moisture issues, the role as the moisture expert is delegated to the house supplier. The checklists for design as well as the risk evaluation are adapted to the most common design of prefabricated single family house modules. Another difference is that the production stage is divided into two; production of modules in factory and erection at the building site. (Johansson and Bengtsson 2015)

The aim of the second study was to adjust ByggaF to the renovation process. As a first stage interviews were conducted asking the users how ByggaF needs to be adjusted to better suit the renovation process. There was a concordance among the interviews that the most important document to further develop is the routine and checklist for inventory and investigation prior to renovation. There is also a need to adjust the procedure and template for moisture risk evaluation to suit constructions most critical in the process of renovation. The work is ongoing and not yet published. (Olsson and Tjäder, 2016)

## **5. Administration and training in ByggaF**

The industry standard ByggaF is administrated by the Swedish moisture centre. Every year Lund University together with SP Technical Research Institute of Sweden arrange training for moisture experts. It is a 10 days of lectures (compulsory), a number of assignments to work with at home between the training occasions and a written examination in the end. When all training

requirements are fulfilled the attendees get a diploma. Until now, approximately 220 persons have attended the training and 100 persons have got the diploma.

Every year, a regathering for all the attendees is arranged. The aim of this meeting is to exchange experience how ByggaF is used in the construction industry, feedback on specific drawbacks and suggestion for improvement and to inform each other of new types of moisture safety problems in general but also on new research and regulations concerning moisture issues to be better prepared for the commission as moisture experts.

Additionally, ByggaF is introduced to the students at Lund University as well as at Chalmers University.

## **6. Discussion**

The extensive use of ByggaF may partly be explained by an advice in the Swedish building regulation BBR but also due to the fact that ByggaF must be used in order to achieve gold or silver level in the Swedish environmental certification system Miljöbyggnad. However, we have very little knowledge to what extent the different parts of ByggaF is used since it is not required to report this in detail for achieving the certificate. The results from the interviews indicate that many of the users are concerned with the heavy paper work originating from the requirement of documentation of requirements, moisture safety design and moisture safety activities during production: It is however important to keep track of activities and decisions done and a comprehensive documentation is indispensable if a retrospect is needed. The ByggaF users ask for shorter documents summarizing the most important issues to be communicated. This is something that will be considered in the further development of ByggaF. Even though the results from the interview study point out a demand for higher competence levels among the actors, the situation is much better than a couple of years ago but of course the competence levels among all actors need to be increased. Training courses suited for different actors such as clients, moisture experts, contractors and design engineers have been developed and arranged by the Swedish moisture centre at least ones a year.

## **7. Conclusions**

The industry standard ByggaF includes a method that guarantees, documents and communicates moisture safety throughout the construction process, from planning to management. The industry standard involves a standardized way of working designed to meet the demands of society and the developer's requirements for moisture safety. The purpose of the industry standard ByggaF is to highlight moisture issues at an early stage in new construction, renovation and refurbishment projects and to document the activities and actions that are required and performed in a structured way to ensure a moisture-proof building. By formulating and setting moisture requirements and requirements for the activities, these can be incorporated into the program documents, system documents, construction documents and control plans, etc. This means that the important systems and material selection and production methods that will impact the moisture safety of the building can be made from the beginning. The aim is to make it clear and easy for the building owner to

work according to the methodology and support him or her in the formulation and following up of moisture requirements during the different phases in the construction process. The industry standard has been developed in collaboration between researchers, building owners, contractors, design engineers and authorities. It is an open access standard available to download at [www.fuktcentrum.se](http://www.fuktcentrum.se). The English version makes it possible to use the industry standard not only in Sweden but also in other countries and in international construction projects. The requirement part of the industry standard must however be adapted to national conditions and regulations.

An interview study was conducted to get knowledge about to what extent ByggaF is used by the Swedish construction industry today and what the users views and experience from using ByggaF as well as suggestions for further development and adjustment. The conclusion is that parts of ByggaF are widely used but the users express concerns about the low level of competence in moisture issues among both designers and contractors. There are also concerns about the heavy paperwork and a wish to make that less extensive.

Until now there have been two attempts to further develop and adjust ByggaF to suit specific needs such as the construction of prefabricated single family houses and renovation of multifamily houses have been conducted in the form of diploma works.

Swedish moisture centre is responsible for administration and training in ByggaF. Up to now, approximately 220 persons have attended training for moisture experts and a little more than 100 persons have received a diploma.

## References

ByggaF metod för fuktsäker byggprocess (2007). ByggaF method for moisture safe building process. FoU Väst Report 2007/02. In Swedish.

Mjörnell, K, Arfvidsson, J, Sikander, E, (2012), A Method for Including Moisture Safety in the Building Process, *Indoor and Built Environment*, 2012;21;4:583-594.

Branschstandard – ByggaF, Industry Standard ByggaF (2013). Version 2013-05-08. (available online [www.fuktcentrum.se](http://www.fuktcentrum.se) [addressed on 6/12/2013]), Swedish and English versions are available.

The Planning and Building Act, PBL, National board of housing, building and planning.

Swedish Building Regulations, BBR, National board of housing, building and planning.

Johansson, J. and Bengtsson, M., (2015), Adjustment of ByggaF to prefabricated manufacturing of single family homes with timber frame. LTH School of Engineering, Lund University. Campus Helsingborg.

Olsson, P. and Tjäder, E., (2016), Preliminary title: How ByggaF is used and suggestions on adjustments to suit renovation. Diploma work at Chalmers University of Technology, Gothenburg, Sweden, (in course of preparation).