

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

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## 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. It contains tools and routines for all actors in the building process; building developers' requirements, moisture safety design routines, risk evaluation, moisture plans, routines for moisture rounds at the building site, routines for commissioning and moisture safety documentation. On request from the Swedish construction sector, ByggaF has been transformed into an industry standard. ByggaF was used in the first pilot projects more than ten years ago and since then it has been frequently used by the building sector in a number of Swedish construction projects. One reason for the broad implementation of ByggaF is that it is referred to in the Swedish building regulations, another is that the Swedish environmental assessment tool "Miljöbyggnad" demand for using ByggaF in order to reach "silver level" or "gold level". To this date 144 moisture experts have been trained to use ByggaF and apply the standardized way of working to assure a moisture safe building process. It is difficult to quantify the effect of using ByggaF in terms of time and cost savings since moisture damages are never accounted for when planning a project, but based on our experience, many risk constructions and shortcomings during the construction have been avoided when using ByggaF. There has also been interest in using ByggaF expressed from other countries, both by Swedish contractors working with projects abroad but also from researchers in other countries. The industry standard has been translated into English, but in order to be applied in other countries, it needs to be adjusted to country specific conditions, such as regulation and building practices. In Finland, the Swedish version of ByggaF has been adapted to Finnish regulations and used for including moisture safety in real construction projects. ByggaF has also been adapted to specific applications such as construction of prefabricated single-family houses and renovation of multifamily houses.

## KEYWORDS

Moisture safety, moisture management, building process, industry standard,

## 1 INTRODUCTION

Working with moisture is even more important than ever. Many buildings, both new and old, suffer from moisture-related problems, with negative consequences on health, comfort and wellbeing, costs for refurbishment and lost confidence in the building sector. A recently published report from the Swedish Board of housing building and planning (Boverket 2018) points out moisture damage as the single dominant factor to the major building faults and costs. At the same time there is an increased interest in building in wood or wood-based materials, for example cross laminated timber, for environmental reasons. Wood must be handled with extra care to avoid damage caused by moisture. Building moisture-proof is also more sustainable because moisture damage is a major environmental impact, as moisture-damaged material must be demolished, discarded and replaced with new material which causes an environmental impact. In case extra drying out is needed as a result of leakage if

weather protection has not been used, this causes an environmental impact, extended time and cost in the construction project. These problems could have been avoided if moisture issues had been focused on and dealt with throughout the building process. In Sweden the authorities' requirements increases concerning moisture safety in the building process. Today all new constructions need special planning regarding moisture safety, according to the Building regulations (Boverket 2019). To fulfil the requirements regarding a moisture safe building process, it is recommended to use the ByggaF method for including moisture safety in the entire building process. For this reason, ByggaF has been widely used in construction industry. Another 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" (Swedish Green Building Council 2019). There has also been interest in using ByggaF expressed from other countries, both by Swedish contractors working with projects abroad but also from researchers in other countries. In Finland, the Swedish version of ByggaF has been adapted to Finnish regulations and used for including moisture safety in real construction projects.

## 2 DESCRIPTION OF THE BYGGAF METOD

A method for including moisture safety in the building process has been developed. In Sweden, the method is called ByggaF which is short for "Build moisture safe". The purpose of the method is to support all actors involved to work with moisture safety activities and to document them in a structured way. The method includes several tools and aids for building developers to specify requirements for moisture safety early on in the project, and to follow up and document the measures employed by different participants.

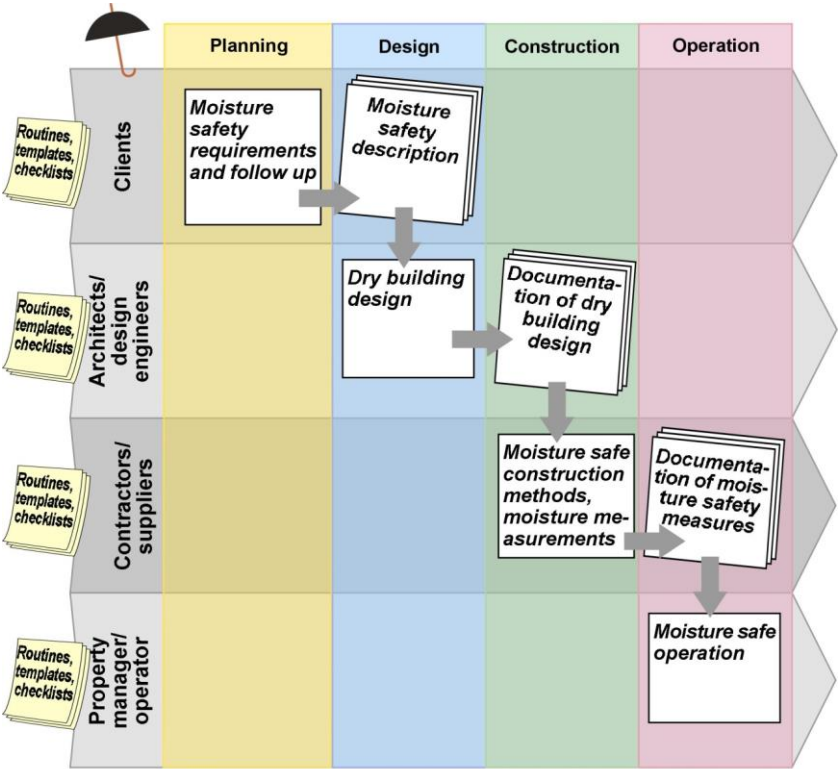


Figure 1 A schematic figure of the ByggaF method.

There are also tools for architects and design engineers, such as lists of references to literature, check lists and design examples to use for dry building design. For contractors, routines have been developed for setting up a moisture plan and moisture control during

construction. The method has been used by the building sector and applied in several construction projects both for residential, public and commercial buildings. Based on experience from these projects, the method and the tools have been evaluated and revised, (Mjörnell and Arfvidsson 2008, Mjörnell et al 2012, Mjörnell 2016, Fuktcentrum 2013).

**2.1 Industry standard ByggaF**

When the ByggaF method had been used for a couple of years, it was requested from the building sector to transfer it into an Industry standard. The reason was to clarify what activities and controls that should be included to ensure that ByggaF was applied, to define the responsibility when of moisture experts and to specify requirements in tender documents for procurements. The Industry standard ByggaF includes a methodology to ensure, document and communicate moisture safety in the entire building process, from planning to operation and management. The method involves an approach to meet the demands of society and the property developer's requirements for moisture control. The Industry standard is formulated as a technical standard starting with a section with terms and definitions, a section describing the method, legislation and regulations, responsibilities and organization for the moisture safety work, followed by sections for activities to be carried out in each stage of the building process; planning stage, detailed planning and design, production stage, end of production stage and management stage. Each activity is described with a specific heading and the text is divided into "the requirements" that must be met and "guidance text" to clarify, explain or give examples of what the requirement means. The guidance also contains advice. The division of responsibility for moisture safety issues within a building project is organized as in figure 2. The moisture expert has regular meetings with the design- and production managers to follow up the moisture safety work and regular meetings with the property developer to communicate the results and support decisions how to proceed with the moisture safety work.

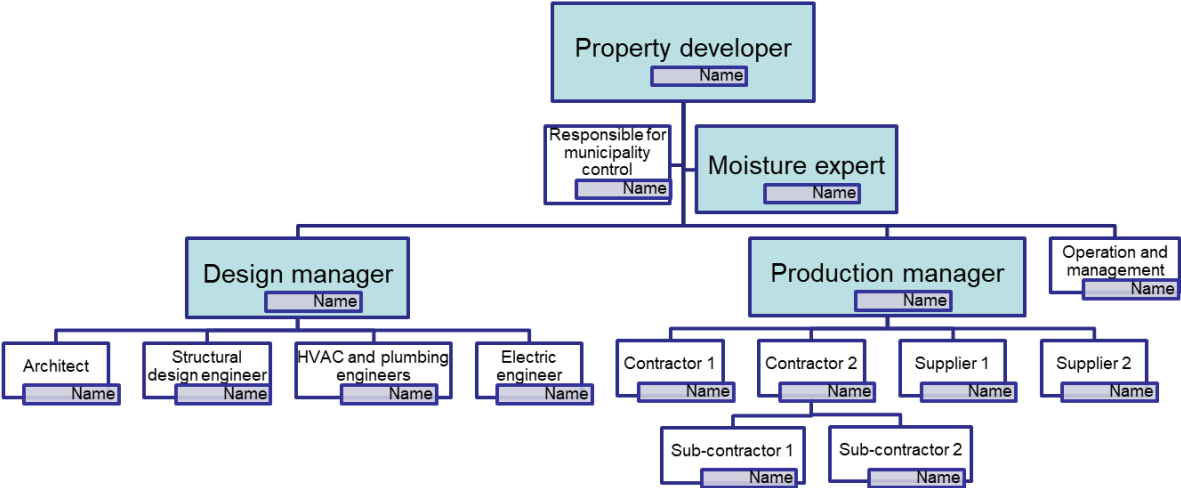


Figure 2 Organisation of responsibility of moisture safety issues in a building project.

The main required activities included in the Building Industry standard are listed in Table 1.

Table 1: Activities included in the Industry Standard ByggaF.

Stage	Activities included in the Industry standard
Moisture safety in the programme stage	<ul style="list-style-type: none"> <li>• Appoint a moisture expert</li> <li>• Early moisture risk analysis</li> <li>• Decide on the developer's moisture safety requirements</li> <li>• Decide on measures in cases of non-conformance</li> <li>• Decide on procedures for monitoring</li> <li>• Formulate moisture requirements and requirements for activities in the contract documents</li> </ul>
Moisture safety in the planning stage	<ul style="list-style-type: none"> <li>• System planning               <ul style="list-style-type: none"> <li>○ Information to planners about the developer's moisture safety requirements and methods for monitoring</li> <li>○ Appoint moisture safety officer for planning</li> <li>○ Present a procedure for moisture safety planning</li> <li>○ Moisture safety planning</li> <li>○ Moisture risk analysis</li> <li>○ Inspection and documentation of system selections for moisture safety</li> <li>○ Decision on specific moisture safety requirements in the production stage</li> </ul> </li> <li>• Moisture safety specification</li> <li>• Detailed planning               <ul style="list-style-type: none"> <li>○ Information to planners about the developer's moisture safety requirements and methods for monitoring</li> <li>○ Appoint moisture safety officer for planner</li> <li>○ Procedure for moisture safety planning</li> <li>○ Monitoring meetings with planners</li> <li>○ Review of moisture safety planning</li> <li>○ Collect supporting data for moisture safety documentation</li> </ul> </li> </ul>
Moisture safety in the production stage	<ul style="list-style-type: none"> <li>• The results of moisture safety planning are communicated to production</li> <li>• Information to contractors and suppliers about the developer's moisture safety requirements and methods for monitoring</li> <li>• Appoint a moisture safety officer for production</li> <li>• Identify moisture-sensitive elements, structures and installations</li> <li>• Prepare a moisture safety plan</li> <li>• Developers' monitoring meetings with contractors and suppliers</li> <li>• Moisture inspection rounds</li> <li>• Measurement and inspections</li> <li>• Document non-conformance in relation to the moisture safety plan</li> <li>• End of production stage               <ul style="list-style-type: none"> <li>○ Collect and establish supporting data for operation and maintenance instructions for moisture safety</li> <li>○ Collect supporting data for moisture safety documentation</li> </ul> </li> <li>• Moisture safety documentation</li> </ul>
Moisture safety in the management stage	<ul style="list-style-type: none"> <li>• Review of property organisation</li> <li>• Moisture inspection rounds in the management stage</li> </ul>

A number of guiding documents and templates have been developed to support the actors in their activities and documentation of the moisture safety work. These includes:

1. ByggaF industry standard
2. Risk identification and evaluation at early stage
3. Moisture Inventory of existing building
4. The developer's moisture safety requirements and activities
5. Job description for moisture expert

6. Moisture Safety Description (template)
7. Moisture Safety Planning and Risk Management (template)
8. Moisture Plan (template)
9. Moisture Round Protocol (template)
10. Deviation Report (template)
11. Content for moisture safety documentation (template)

All material can be downloaded from: [www.fuktcentrum.se](http://www.fuktcentrum.se)

## **2.2 Moisture safety design and risk assessment**

Each participant who selects, designs, draws and constructs materials, building elements or installations that affect the moisture safety of the building must comply with the procedures for moisture safety planning and design. The planning and design engineers' group must jointly conduct and document a moisture risk analysis. In case the design conditions are changed a new moisture-risk analysis should be performed. The planning- and design manager is responsible for the coordination of the moisture risk analysis. A template is developed to support the designers to perform moisture safety design and risk evaluation. The document is however perceived as difficult for designers to use. One of the problems is that designers cannot judge the probability and consequence in a risk evaluation. One reason is that there are lack of routines, tradition and system for experience feedback in the construction sector, which in turn make it difficult for designers to information about what is high and low risk constructions. ByggaF suggests that qualified assessments should be used for the risk analysis, but the guidance does not explain how to carry out the assessment. Instead, there is a description in how a proper risk analysis is done, which does not help the designer to evaluate the risks at this stage. There is a need for a better description of how a qualified assessment should be carried out. This has been identified as one of the areas of improvements.

## **2.3 Management and administration of ByggaF**

Swedish Moisture Centre (SMRC) is responsible for management and administration of ByggaF. This involved updating documents as regulation changes and to develop and improve the method to better suit the users and the building process. SMRC has, since about ten years ago, arranged training courses for Moisture Experts. More than 150 persons from industry and academia have been participating and until today 144 persons have received a diploma for passing the exams. Every year SMRC arrange a day to share experience aimed for the Moisture Experts Alumni and in 2017 they took the initiative to form a network of Moisture Experts in Sweden and in 2018 an interest association was established. The association is an important collaboration partner in managing and further development of ByggaF since the members represent the everyday users of the method and tools. SMRC is still responsible for development and management of ByggaF.

## **2.4 Adaption to the renovation process**

Even though ByggaF is a general method that could be applied on all buildings and both new and renovation of existing buildings, the sector sometimes asks for more specific tools. Therefore, two initiatives to adapt ByggaF for specific use, one is renovation of buildings and the other is single family houses were initiated. The adaptation to renovation process was done based on eighteen interviews with moisture experts and four building owners in the sector. In addition to existing documents and template they suggested a more profound inventory of the existing building. To ensure than a more profound inventory is carried out,

there must be a forcing requirement in the Industry standard ByggaF. The document should state the requirements to do an inventory in the program stage as well as a guidance of possible procedure to carry out an inventory. Another aspect of implementing the inventory in the industry standard is to ensure proper communication of the results to the designers and contractors. The result of the inventory should give indications about necessary investigations, which can be important for the designers. This is something that should be described in future versions of ByggaF. (Olsson and Tjäder 2017)

## **2.5 Adaption to prefabricated production of single-family housing**

The generality of the ByggaF method constitutes a disadvantage when applied to prefabricated manufacturing of single-family homes due to differences from general construction in the building process and building techniques. The purpose of the second initiative was to adapt ByggaF into a modified method ByggaF-PST applicable to prefabricated manufacturing of single-family homes with timber frame. 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: Factory production. Another difference with this building technique is that the client in most cases chooses a house from a catalogue. This means that the house already is more or less planned when the client gets involved in the project. For this reason, there is an essential difference between the prefabricated and the general building process. This affects the activities, stages, and parties in the presented method ByggaF-PST. The adjustments in ByggaF that were made regarded constructions, parties and stages that are relevant to prefabricated manufacturing of single-family homes. In addition to these adjustments some parts have been added to the documents and the method. Among these changes a more detailed checklist for risk assessment was made. Other changes regard supplemented moisture safety requirements and activities in the factory concerning moisture safety. (Johansson and Bengtsson 2015)

## **3 APPLICATION IN CONSTRUCTION PROJECTS**

Our impression and experience from meeting moisture experts in training courses and in the alumni network, that ByggaF is used in all ongoing projects. There is no statistics solely on which projects have been using ByggaF, but there is statistics on the number of buildings certified according to the environmental assessment system Miljöbyggnad, this is a reasonably good estimation since there is a requirement to follow ByggaF to reach gold or silver level. Since 2012 to today, there are 1375 buildings certified according to Miljöbyggnad, of which 975 at silver and 165 at gold level.

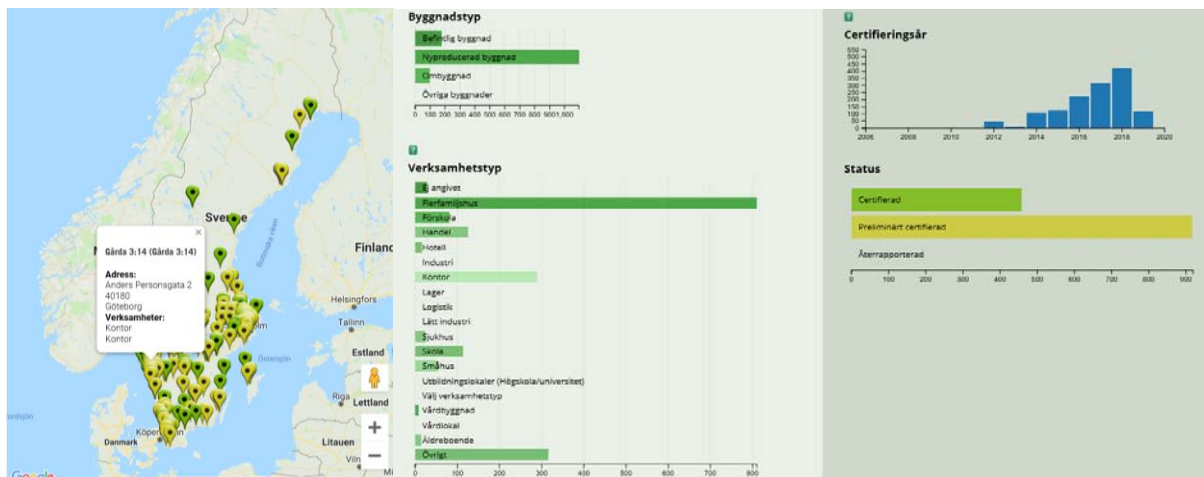


Figure 3 Today 1375 buildings are certified according to Miljöbyggand silver and gold level. Green dot is certified (457) and yellow is preliminary certified (918), Statistics from SGBC 2019.

Most of the certified buildings are multi-family housing followed by office buildings, commercial buildings, pre-schools and schools. The buildings are mainly new construction but also renovated and reconstruction. Information of the actual building can be found on the SGBC's website. In addition, there are building owners who use ByggaF but not Miljöbyggnad. For example, the city of Borås has followed the procedures of ByggaF for more than ten years and one school in Finland has used a version of ByggaF adjusted to Finnish conditions.

#### 4 CONCLUSIONS

A method for including moisture safety in the construction process has been developed and successfully adopted by the Swedish construction industry. One reason is that it is an advice in the building regulation to use ByggaF, but it is also required to follow ByggaF to reach silver and gold level in the Swedish environment assessment system Miljöbyggnad. The ByggaF method was transferred into an industry standard to enforce that necessary activities are carried out and routines have been followed and documented in a standardized way. It is possible to adapt ByggaF to other countries, if national conditions and regulations are considered and accounted for in the requirements and in the templates. Some routines and templates are however perceived as difficult for designers to use, such as the moisture risk assessment. This procedure must be explained in more detail and supplemented with practical examples to be useful. ByggaF is a general method that can be applied in construction of all types of buildings, both new and existing, but adjustments have been made to better suit specific applications. ByggaF has been adapted for renovation of buildings by supplemented by a more detailed template for inventory. ByggaF has also been adjusted to new construction prefabricated manufactured single-family homes with timber frame. Although several changes have been made in ByggaF to achieve this, ByggaF-PST requires further adjustments based on feedback from the industry. Based on the statistics from buildings certified according to Miljöbyggnad, 1375 buildings should have been used ByggaF in the construction, renovation or reconstruction of multifamily buildings, office buildings, commercial buildings, pre-schools and schools.

Quality assurance is difficult and heavy-duty work, but digitization opens up new opportunities for smart systems to capture the right control points, to ensure that people get the right information and documentation can be made more accessible and tracked. There are great development opportunities to digitize ByggaF.



## 5 ACKNOWLEDGEMENTS

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