Ministry of the Environment announces a Guide on Renovation and Repair of Buildings with Moisture and Microbial Damage - From theory to practice

Ministry of the Environment announces a Guide on Renovation and Repair of Buildings with Moisture and Microbial Damage – from theory to practice

Inari Weijo[1], Timo Turunen[1], Jukka Lahdensivu[1], Esko Sistonen[2] and Petri Annila[3]

[1]Ramboll Finland Oy
[2]Aalto University
[3]Tampere University

Abstract. In 2015, the Ministry of the Environment in Finland renewed the legislation and the National Building Code of Finland. It released completely new legislation concerning repair design. This was due to widely known issues relating to the indoor air quality of private and public buildings. In the autumn of 2019, the Ministry of the Environment in Finland published a guide concerning the repairs of moisture and microbial damage. It is available in Finnish and Swedish. This guide is a follow-up of the Environmental Guide "Building Moisture and Indoor Air Quality Assessment", published 2016. It completes the series of guides for the execution of a project repairing indoor air quality issues, from a condition assessment to the completion of repairs and the implementation of the building. These guides lead through common practices and how these issues shall be dealt with in Finland.

1 Introduction

In the Nordic Countries and in North America, indoor air problems are often related to moisture and mould induced damage in structures and buildings /1, 2, 3, 4/. Municipal service buildings in particular suffer from indoor air problems related to moisture damage. Buildings are usually multi-problematic: on average 2.92 structural parts per building were found to be moisture and mould damaged. Base floors and walls with direct contact to soil are the most problematic structures /5/.

In 2013, it was assessed that an immediate need for repairs was evident in approximately 15% of schools and 25% of hospitals /6/. The so-called repair debt is worth 30 to 50 billion euros, or roughly one tenth of the total value of buildings in Finland. The situation is similar in Sweden. According to a recent research made by Swedish Boverket (National Board of Housing, Building and Planning), the total real estate costs for internal and external measures, and costs related to ineffective use of resources, are estimated to be 5.5 - 6.8 billion euros per annum /7/.

The first National Building Code of Finland was published in 1976 and the part dealing with moisture performance of buildings has been updated approximately every 20 years. The regulation has previously concentrated on the construction of new buildings. First national guides to assess and design repair work on moisture damage were published in the late 1990's. In order to improve the quality and results of repair and renovation projects, new national legislation came into effect in Finland in 2015. A total of four difficulty classes and a new special design task, i.e. the design of repair work of moisture damaged structures, were introduced in the Government Decree on the determination of difficulty classes of building design tasks /8/. A building design task can be minor, conventional, difficult, or exceptionally difficult.

The repair work of moisture damage should always begin with an appropriate condition inspection of the building. The condition assessment reports are the basis for repair design. The report shall indicate, e.g. the moisture performance of the building, the health-related conditions of the building, as well as information on previous repair and alteration works /9/. The designer of the repair work shall determine the construction method and the moisture performance of the existing building /10/.

Furthermore, the design of the repair work of moisture damage shall include: 1) the measures taken to eliminate the detrimental impact or effect of the moisture damage on indoor climate and users of the building, and 2) the functionality of the repaired structure during its target service life /9/.

The Guide on Renovation and Repair of Buildings with Moisture and Microbial Damage is based on the legislation mentioned above. It is an independent follow-up of the Environment Guide on Building Moisture and Indoor Air Quality Assessment published by the Finnish Ministry of the Environment in 2016 /11/.

* Corresponding author: inari.weijo@ramboll.fi

In Sweden, for example, corresponding methods and procedures to ensure the quality of repair work exist, too. The Swedish industry standard, ByggaF, is a method that guarantees, documents and communicates moisture safety throughout the construction process, from planning to management. According to it, projects shall always deploy a systematic method to prevent moisture-related problems from originating already at the design phase /12/. The ByggaF method also includes a checklist for the evaluation of moisture performance of an existing building /13/.

In 2015, a similar systematic approach, called Kuivaketju10, was launched in Finland. The purpose of this approach is to avoid moisture problems during the entire lifecycle of a building /14/. The person nominated as the responsible person for moisture control in a construction project plays a very important role during the whole process. This method has been taken into use quite widely, especially in the construction of new buildings.

In Norway, a mandatory third-party inspection was introduced in 2013, because there had been major problems in the control of design and execution of construction projects /7/. The inspection also includes issues relating to building physics, and the contents of the inspection depend on the difficulty class of the project /15/.

2 Phases of repair project

There is an established practice in Finland how to proceed when repairing and improving indoor air quality. The process begins with a thorough condition investigation, covering all the essential issues concerning the building or structural component to be repaired. In the case of a moisture damage, the structural failures and sources of moisture need to be clarified, but also its effect on indoor air quality and other structures shall be assessed. The building or the space shall to be assessed in its entirety. After all the necessary assessments have been performed, the project team will evaluate the initial data. Do they cover all the information required to consider appropriate actions in the building? If so, then it is possible to evaluate suitable repair methods and only then proper project planning may begin.

In project planning phase, all the remaining possible repair methods are examined carefully from different points of view. When a suitable solution is established, the actual detail design work can begin. Detail design is a gradually proceeding phase, where the project team must evaluate the effect the decisions made will have on the final solution.

When the actual building work begins, all the quality requirements and expectations shall be carefully supervised to ensure that in the end, result will meet the demands and expectations set. A party undertaking a building project must have adequate capabilities to implement the project, considering how demanding it is.

Though the process of the repair project in Figure 1 is quite widely known and established, often this process is somehow deficient, and some phases are disregarded. This is often the reason why a repair project fails.

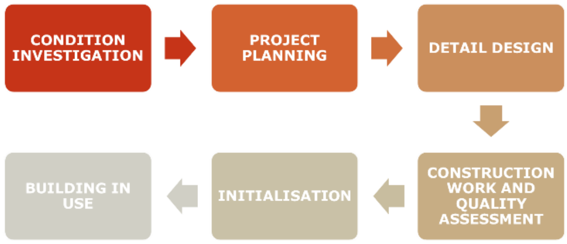


Fig. 1. The phases of a repair project.

2.1. Demands for repair designer

Repair design engineering differs substantially from traditional structural design. When the designer creates solutions for a new building, focus is often on the load-carrying capacity. The building's physical properties can be determined as desired and the solutions optimized. When dealing with an old building, there are always limitations to the actions that can be applied, technical as well as functional. Each building differs from another and the problems are complex. Because of the individuality, the designer needs to define the demand for repair work more accurately. For example, the repair designer establishes the requirements for quality and how it can be verified, so that the repair work will meet the requirements set. The repair designer also specifies the actions for monitoring the building when it is in use. The defined tests and inspections need to be available at the management stage to ensure the designed functions of structures and technical systems.

A significant share of moisture and microbial damage require large-scale repairs to be performed in the building. For this reason, changes and improvements are often also required in the mechanical engineering systems, such as the ventilation system, HVAC-system, and air conditioning. Thus, the repair designer cannot be an expert on all fields but must have a reliable team of experts to support the design process. The National Building Code of Finland sets new requirements for the repair designer, depending on how demanding the repair work is. For example, the design of repair work on moisture damaged structures is exceptionally difficult, if there is extensive internal moisture or mould damage in the building, regardless of previous design work. The qualification requirement for designers, based on education and experience, is also presented in the current legislation. In addition to a traditional construction-related degree, the studies of a designer of repair work must include courses in indoor climate and condition inspection methods. Similarly, other actors, such as the constructor, involved in the building project need to have adequate expertise and professional skills.

3 Selection of repair method

The repair designer's priorities are, quite obviously, technical functionality and building physics, but one must also take into consideration the expectations of the building's owner and the possible operator or tenant of the building. Regarding the actual repair work, the owner or developer is also interested in the service life before and after the repairs and in the economical profitability of the repair actions. It is in their interest to ensure that the actions taken are economically viable and will lead to a better quality and increased value of the building property.

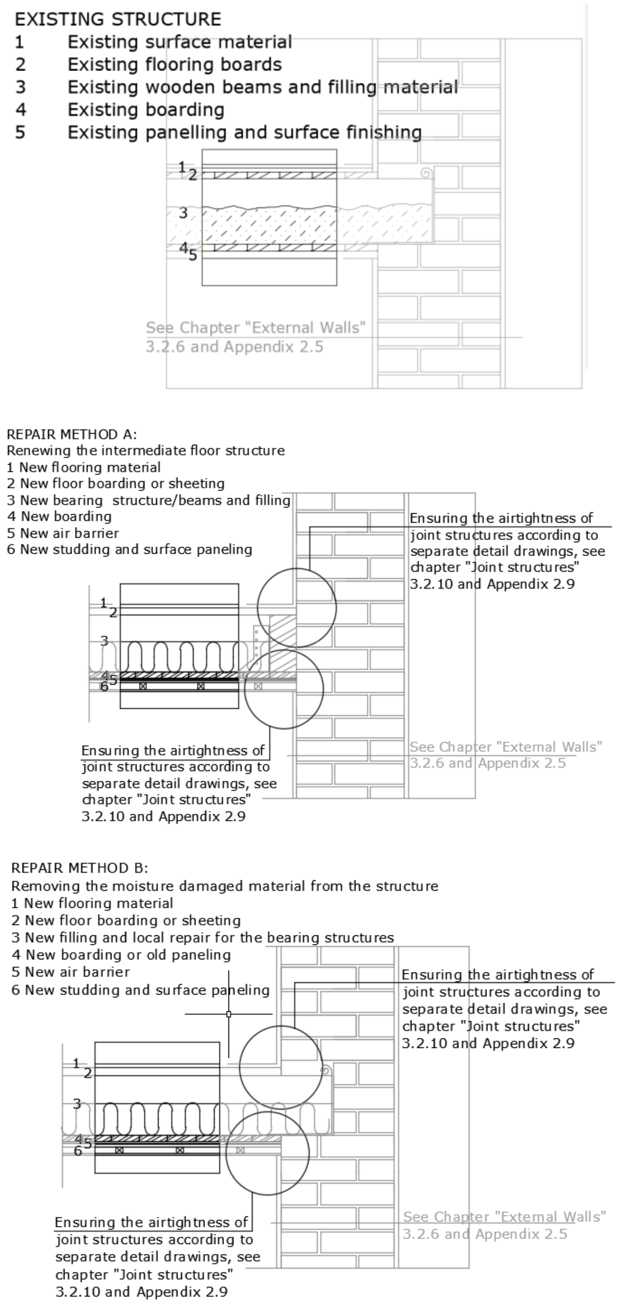
At the same time, the operator or the tenant will prioritise the functionality of the premises before, during and after the repair project, as well as, the safety and health of the premise in their use. Typically, requirements on quality are less technical and more operational in nature. The operator and the tenant are seldom interested in the building's structure, but keener on the influence of all construction work relating to their own activity in the premises. In project planning, the designers' challenge is to settle the various expectations in cooperation with other parties and present a solution that does not sacrifice the technical functionality, but also accommodates the need for other parties.

3.1. Service life of repair

In every repair work, it is important to define the targeted service life. It often receives too little consideration when suitable repair methods are decided upon, although each party to the project must have a presumption of it, at least subconsciously. However, when expectations concerning the target service life are voiced openly, the project team can define and outline several alternatives and bring together an understanding of possible repair solutions. The service life needs to be defined on two principle bases: for each building part separately and for the property as an entity. When examining a separate component, the point of view can be more technical and concentrate on fixing the damage and its impact on indoor air quality. Eventually, it is crucial to pull all the separate repair methods in the building together and calculate the service life for the entire building. The repair designer must be able to consider, whether the repair work performed in separate spaces and building components, e.g. in Figure 3, support one another and execute the expectations for the entire building. The repaired building component with the shortest residual service life often defines the service life of the entire repair project. It needs to be carefully considered whether that is suitable and can be accepted.

3.2. The categories for different repair measures

There is often discussion regarding the "right" repair measure for each case. The repair alternatives can be categorized by their thoroughness and effectiveness to the structures. In the published Guideline, these have been divided into three categories that are dealt with on a principal level in the Guide. The category "A" is the most thorough repair method that always includes removing contaminated materials from the structure. It may also include actions concerning load-bearing structures. This category is often perceived as the most expensive repair work, but also as a method with the longest service life. The category "C" is the lightest method, in which the repairs are performed with minor measures that may only affect the surface structures. These can include, e.g. improving the airtightness of a structure and enhancing the moisture behaviour of a . The middle category "B" is somewhere in between, partly demolishing the structure and removing the contaminated material, but saving all the load-bearing structures. An example of different repair principles is shown in Figure 2.



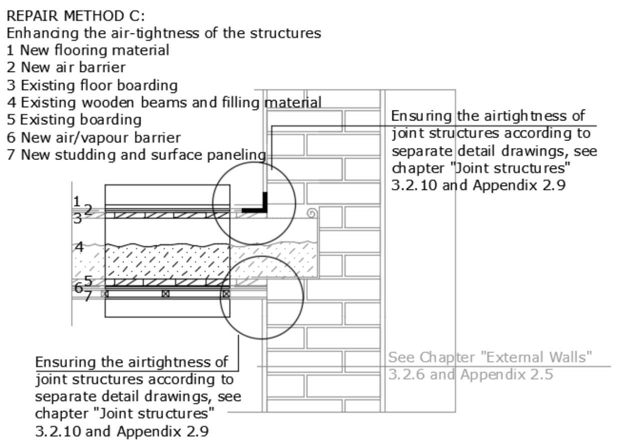


Fig. 2. Example of different repair methods of intermediate floor. /16/

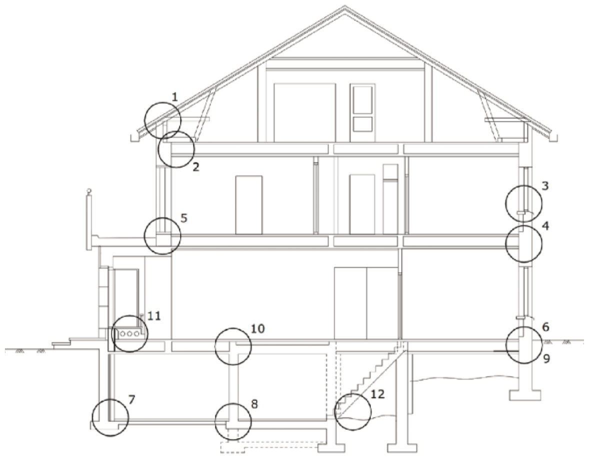


Fig. 3. Example of how to define important details in the building under repair design. /16/

The categories are represented at a principal level for all different building components, such as external wall structures or intermediate floor structures. Emphasis is put on the comparison of the technical differences, risks in the execution, the effect on service-life and the energy-efficiency of the repairs.

The Guideline compiles all typical structures used in public buildings in Finland after the Second World War. Despite this outline, these examples either cover most of the building types in Finland or can be easily applied to other building types.

4 Executing repair design

Repair design is a gradually focusing process. Firstly, the designer shall have all technically applicable alternatives to consider and compare in the specific project. The alternatives are defined roughly to be able to examine how the repair will affect the structure, other repairs and the building itself. The alternatives are also considered from other viewpoints, such as economical, service life, feasibility and functionality. After deciding upon a suitable solution that satisfies all parties in the project, the designer can start with detail design.

4.1. The importance of details

The Guideline emphasizes the importance of detail design and the design of structural connections. Repairs often culminate in the performance of the connection between different building components and how the detail performs with regard to structural physics. Practical examples are presented of connection structures and solutions, as well as, how to recognize and apply the most important details in the current project, see Figure 3 and Figure 4.

The detail design must define the construction work so thoroughly that the constructor is able to execute the repairs without any doubt. Typically, the repair designer needs to define structures that are more specific and more unusual than those designed by a structural designer for new construction. The number of detail drawings and written specifications will be far greater than what is required in the building of a new structure.

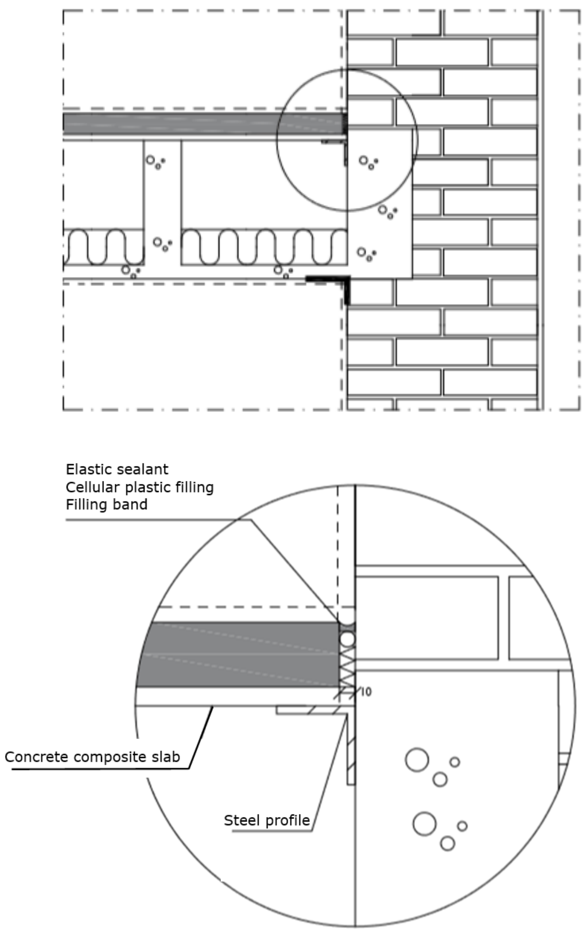


Fig. 4. Example of principle drawings in guideline; how to execute airtight joint structure in intermediate floor structure. /16/

4.2. Ensuring repair work on construction site

The designer also determines the quality assurance (QA) methods to be applied during renovation, to verify that the structure will perform as designed. The QA methods shall be defined both for construction work and the period after commissioning. Methods shall not only involve the structural but also technical systems in the building. It shall be compulsory for the constructor to educate the operator of the building how to use all technical systems in the building.

On the construction site, the most typical QA-method is performing hygrometer measurements, both on the surface and inside the structure. Traditionally, these are made to ensure that e.g. floors can be covered with flooring materials that will not let moisture permeate. However, moisture control is a much larger concept than mere separate measurements. The repair designer defines the methods and construction stages, in which QA methods need to be applied. The constructor must create separate moisture control specifications to describe how to execute weather protection or ensure the adequate drying time and coverability of the building. These documents shall be subjected to the construction supervisor and the building management for approval.

5 Conclusions

Repairing moisture and mould damaged buildings is now much more regulated than ever before in Finland. Both the requirements for repair design and construction work and the knowledge of damage and repair methods have grown extensively.

Furthermore, tenants and citizens are nowadays much more aware of issues concerning health-related conditions of the building and their effect on one's health. Legislation in Finland has therefore been updated, particularly concerning repair work especially in moisture and mould damaged buildings. In addition to this, the Ministry of the Environment has updated or rewritten the national guidelines relating to buildings and their damage.

The field of assessing and designing old buildings has become a significantly more complex process, where it is increasingly important to perform systematic work when proceeding with the process. However, no matter how many guidelines and systems we create, the combinations of various kinds of repair possibilities and strategies are countless.

The repair designer must always be the leading expert of their project. There will always be need for case-specific consideration and exceptions, where the consultant's expertise is crucial. Therefore, good principle guidelines will provide the designer and the building manager with support to remember all the aspects of their work, yet they cannot replace the need for design at every stage of the process.

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