

Research on Biodeterioration of Cultural Heritage in Norway

Johan Mattsson and Truls Oftedal

Mycoteam AS, P.O. Box 5 Blindern, N-0313 Oslo, Norway

1. Introduction

1.1 Special aspects regarding Norwegian Geography and Climate

There is a great variation in humidity and temperature during the year and along north-south and west-east axis. The coastal area, with oceanic climate, has a long-term exposure to high relative humidity and small variations of temperature during the year (low summer temperature and high winter temperature). This gives favourable condition for the common furniture beetle, mildew fungi and to some extension wood-decaying fungi – especially in the outer part of walls.

Contrary, the special requirement for the house longhorn beetle regarding high summer temperatures and a not too cold winter temperature restricts the distribution to small areas in southern Norway. We find a clear difference in the distribution of the two main species of carpenter ants – where *Camponotus herculeanus* have a ubiquity distribution, while *C. ligniperdus* have a clearly southern occurrence.

At higher altitude (eg. mountain areas) the favourable period for growth and activity is considerably shortened. This results in reduced biodeterioration in wooden materials, and the service life of materials is prolonged.

The effect of cold climate is shown out into the extreme in the far north of Norway – especially on Svalbard (Spitsbergen). Although the air and soil humidity are generally high, very low temperatures and permafrost lead to unfavourable conditions for wood-decaying organisms.

1.2 Wood

The most used wood species in traditional Norwegian buildings are pine and spruce. Only exceptionally, other species such as oak and aspen are used.

Due to long-term exposure for humidity, sooner or later the decay has reached a critical limit for the service life of the materials. The critical limit is usually connected to technical properties, but other factors, such as antiquarian, cosmetic or economical aspects, might be taken into consideration.

The decay of wood due to natural exposure is more or less predictable. The service life are in many cases for Norwegian buildings and single building materials regarded to be pretty long – despite the relatively poor service life for pine- and spruce wood compared to hardwood. One explanation is the traditionally use of pine logs with an extensive amount of heartwood, which ensure a clear limitation regarding to growth of wood-decaying fungi and wood-boring insects.

Another reason for long service life of wood is the “favourable” climate (a combination of generally low precipitation and low temperature) and constructions based on long-term experience. Inserting protection layers, such as cladding outside the log construction has a traditional development through the 18th and 19th century. At the same time, expanding use of surface treatment by tar products, oil paint, linseed-oil paint and stains gave further protection from humidity and prolonged the service life.

“Unpredicted” or extensive decay is often due to relatively clear events/change in exposure (figure 1). Changed use (no more heating, lack of maintenance) or construction of the buildings (new materials, thermal insulation) may be the factors that provoke an

accelerated rate of decay. Even small changes, such as applying a modern paint system, can be sufficient for a major change in rate of decay.

Service life for building materials

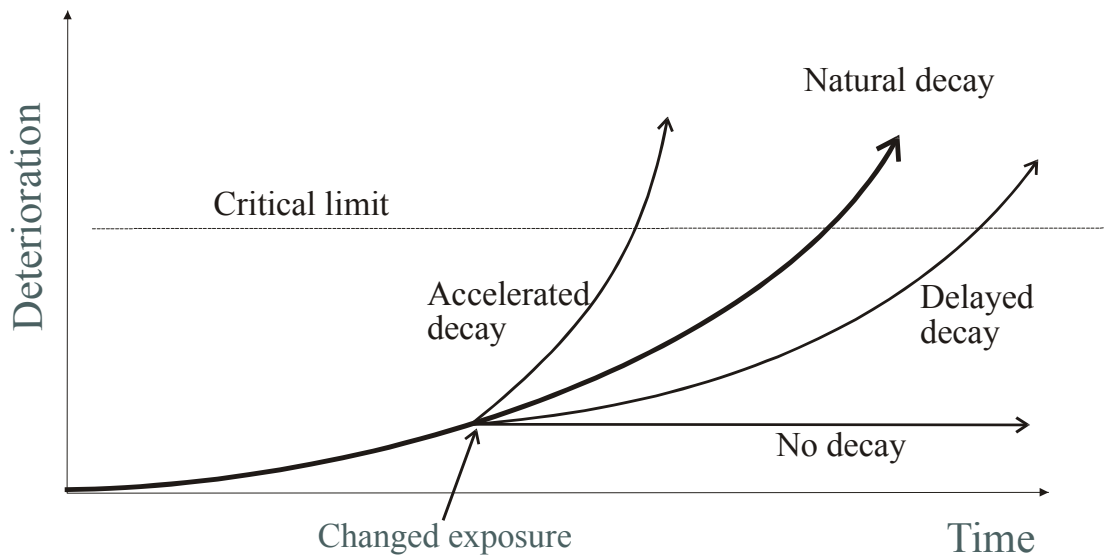


Figure 1. Service life, depending on change of exposure.

1.3 Stored materials and products

The problem with deterioration of paper materials is mainly connected to storage in damp buildings, or at least buildings with poor ventilation and without heating. Under such conditions, there can be long periods when the relative humidity is high enough for mould growth and attack of various insects.

Similar damages as for paper are also a problem for other stored materials (e.g. textiles, leather) in open-air museums and other unheated buildings.

1.4 Stone materials

It has been done little about the biodeterioration of stone material. However, during the latest years, the interest for protection of rock carvings (from the bronze age, 3.-5.000 years BC) has increased the focus on this topic. Decay of different kind of stone materials by microorganisms are proven, with a special emphasis on crustaceous lichens – even if also bacteria and fungi are playing an important role. The decay occurs normally slowly, but can under certain circumstances happen relatively fast – especially in combination of physical factors (e.g. fluctuation of temperature – where the freezing of water is essential) and influence of chemicals and mechanical exposure.

2. Research activities

Even if the Directorate of Cultural Heritage has a research department, it is not any general research activities regarding biodeterioration of cultural heritage in Norway.

However, sporadically single projects concerning various themes are occasionally carried out. Norwegian Institute for Cultural Heritage Research, Norwegian University of Science and Technology, Norwegian Institute of Building Research and Norwegian Institute of Wood Science are institutions that from time to time carry out projects concerning

deterioration problems, but it is as far as we know only Mycoteam that works with the aspect of biodeterioration. In order to describe the variation of activities, we can show the relevant projects we (Mycoteam) have carried out during the last years:

- **Damages in flooded houses.** This implied investigations of differences in biodeterioration (mould and decay fungi) in traditional and modern buildings with water damages caused by flood. Ongoing project with possibility for extensive moisture measurements and studies of development of mould growth, attack of wood-decaying organisms and insects.
- **Damages due to change of constructions** (thermal insulation and establishing of damp-proof layers). It is shown that some insulation materials can act as a “fertilizer” for *Serpula lacrymans*. Another problem with inserting thermal insulation is the change of temperature and humidity, which can initiate growth of mould and decay fungi. We have also shown the critical effects of inserting damp-proof layers in existing constructions.
- **Moisture balance in brick walls with different surface coatings.** Due to humidity measurements through a year, it is shown that it is relatively small differences in humidity in the inner part of brick constructions (where end of floor beams and other wooden material are inserted). This implies that it is not critical for the construction, whether it is used traditional or modern surface treatment or plaster – even if it can be of major concern regarding antiquarian aspects...
- **Decay in log buildings due to surface treatment.** Extensive humidity measurements have shown that the moisture content in logs (both new and old) is varying, depending on exposure and paint system. In some cases the moisture content can reach critical limits for growth of wood-decaying fungi.
- **Protection of rock carvings against lichens/micro fungi.** Rock carvings are overgrown by microorganisms. This biological activity leads to some decay of the stone and it is therefore often desirable to remove the organisms. Traditionally, this removal has implied unacceptable use of chemicals (formaldehyde) and mechanical methods that has lead to further damage of the carvings. Our experiments showed that specific covering of the surface in few months completely can remove crustaceous lichens and stain fungi – both on the surface and 3-4 mm down into the stone.
- **Protection against wood-decaying fungi and other microorganisms in wood with soil contact.** Our experiences from Bryggen in Bergen (the Wharf) indicates that deteriorated wood are protected against further damage development by keeping the wood wet and in contact with high salt concentrations. It is also shown that salt has a preservative effect on new wood samples.
- **Environmental friendly protection against house longhorn beetles.** House longhorn beetles attacks are often wrong evaluated because of lack of knowledge. This often leads to unnecessarily large restorations. Systematic registrations of house longhorn beetle attacks and registrations of eventual further development of the attacks would therefore be useful.
- **MM Wood.** EU-project, cooperation between Norway, Sweden, Germany and Italy. The main goal is to develop a database system for registration of buildings with biological decay problems, in order to easier carry out proper restorations and protection of the cultural heritage.
- **Single building surveys.** Restorations of protected buildings, e.g. the Royal Palace (Slottet), Bygdø kongsgård, medieval buildings, stave churches and other churches. Use of heat treatment in order to repair dry rot damages.

3. Discussion

It is awareness of the importance for protection of the cultural heritage, but the knowledge of where the critical factors for carry out optimal actions are limited. Limited economical resources restrict the possibility for active research work in order to find fundamental understanding of physical factors and biological organisms – especially about the situation in old buildings combined with modern materials and use.

We see a need for cooperation in further research in these topics, both in a multi-disciplinary aspect and in an international context. Many of the problems have an universal aspect, even if the single material or climatic situation is unique. Use of the experience from other researches is by that reason of great importance – both in order to inspire and inform. Our believe is therefore that increased personal international contact leads to both exchange of experience and combined effort in further research activities. It is obvious that this is considerable more important and rewarding than only reading publications and surfing on the web.