DRYING OF HORIZONTAL TIMBER ROOF ELEMENTS AFTER WATER DAMAGE

Javad Darvishi[1], Samee Ullah[1], Kristine Nore[2], Mari Sand Austigard[3]

ABSTRACT: In the past few years the use of Cross Laminated Timber (CLT) has increased in Norway and rest of Europe. Norway has long experience with wood constructions, this material is only recently being used in major constructions. As CLT is a new material, there is not much knowledge available about the material's behaviour in various situations. The aim of the study "TrebyggTørk" has been to investigate if compact roofs with laminated timber elements have an advantage when it comes to drying, in comparison with ordinary ventilated timber framed roofs. Based on the results the CLT element with vapour retarder shows the most constant and rapid decrease of moisture content and seems to be the best option among the tested elements. If the vapor retarder is completely intact, it protects the CLT from water leakages.

KEYWORDS: Cross - Laminated Timber (CLT), Screw - Laminated Timber (SLT), Timber-framed roof system, Vapor retarder, Vapor barrier, Weather barrier, drying process

1 INTRODUCTION

Numerous building damages in Norway are reported to insurance companies every year. Around 75% of the reported damages are directly or indirectly caused by water. Water damages occur in all type of buildings and constructions. TEK17, guidance on technical requirements for construction work, places strict requirements on how water/moisture damage should be prevented during the construction process, and also after completion of constructions: "Groundwater, surface water, rainfall, domestic water and air humidity should not penetrate and cause moisture damage, mould formation or other hygienic problems." [1]

For roof structures, compact roofs have a higher damage rate compared to insulated sloping roofs with timber framework. Despite of this compact roofs are still being built in Norway. [2]

The statistic VASK from Finance Norway shows registered water damages in buildings during 2018. Water damage due to errors on part of the builder constitute only 6,3%, while wear and tear (22,9%) and external impact (55,4%) are the most common causes. External impact is typically moisture/water damages related to for example rainfall, condensation problems or construction violations. [3]

[1] Javad Darvishi, Norwegian Institute of Wood Technology, Oslo, Norway jda@treteknisk.no +47 909 96 270
Samee Ullah, Norwegian Institute of Wood Technology, Oslo, Norway sul@treteknisk.no +47 464 15 303
[2] Kristine Nore, Splitkon AS, Åmot, Norway kristine.nore@splitkon.no +47 909 49 484
[3] Mari Sand Austigard, Mycoteam, Oslo, Norway msa@mycoteam.no +47 905 32 965

In collaboration with producers, suppliers and leading contractors in CLT and other laminated timber elements in Norway, a simulated water damage on compact roof elements of laminated timber were investigated. The purpose has been to study the water/moisture damage robustness of the elements in a roof system compared to a traditional timber framed roof system.

2 MATERIAL AND METHODS

A drying test comparing three compact roof elements with laminated wood and one typical timber framed roof with ventilated cladding has been conducted during the period 05.07.2017 – 06.08.2018. The roof systems investigated were two CLT – elements with and without vapor retarder, one screw-laminated timber element (SLT) and one timber frame element with vapor barrier placed under insulation, and weather barrier on the top of the insulation. The horizontal dimensions of the elements were 1x1 metre, and the height varied between systems as shown in fig. 1.

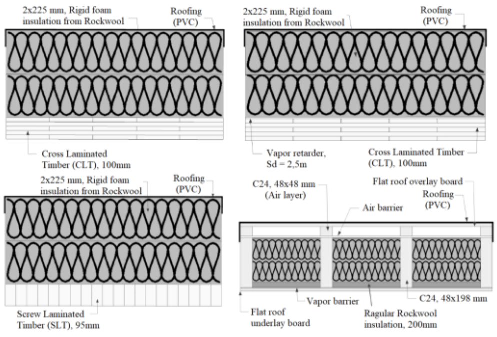

Figure 1*: Structure of the test elements*

Before the test elements were completed, the moisture content of the CLT- elements and beams was measured by use of hammer electrodes. The measurements were made in the centre of the top surface, as well as towards the edge. All elements and beams had a moisture content of about 10% before the experiment.

The roof structures were wetted by adding free water, and the moisture flow was monitored by moisture/temperature sensors and weighing cells.

Each element was equipped with 4 HygroTrac sensors that monitored temperature, relative humidity (RH) and moisture content. For laminated timber elements, two of the sensors were placed on the top surface (one in the centre and one towards the edge), one sensor was drilled into the centre of the element (from the bottom), while the last sensor was placed on the bottom surface of the element. In the timber framed element sensors were placed on the top, centre, and bottom of the middle beam of the roof system, and underneath the plywood. The sensor locations are shown in Figure 2.

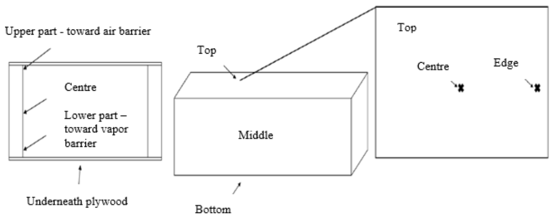

Figure 2: *Location of HygroTrac sensors, timber framed- (left side) and laminated timber elements (right side).*

The roof constructions were placed in a bicycle shed at Follum in Hønefoss. The roof elements were suspended from a roof beam. The north, south and west walls of the shed were covered in order to prevent excessive wind stress and cross ventilation. All the elements were protected from direct sunlight and rain during the entire investigation. A HygroTrac sensor logging air temperature and humidity was placed on a roof beam to monitor the ambient climate.

After compilation, each of the elements was suspended from a weighing cell. A total of 20 litres of water were added per sample, of which 10 litres were added on day 1, while 2x5 litres were added morning and evening on day 2. This was done to ensure that the elements were exposed to free water for about 48 hours. After 48 hours, the excess water was drained.

3 RESULTS

The drying test has been done in an outdoor environment, which generally lead to a slower drying process for the elements – especially in the winter period. As shown in figure 3, all roof constructions have a stable drying process except CLT without vapor retarder. Due to power failure the graphs show a gap from the middle of March 2018 to the middle of April 2018. After the power failure the graph for "CLT without vapor retarder" shows an increasement in moisture content (from 28% to 38%). Since no extra moisture has been added to the element, the best explanation seems to be that the sensor didn't work properly from approximately November 2018 until the power failure. Since the vapor retarder has protected the CLT with vapor retarder from the added water, this element dries out best among the laminated timber elements. It should be noted that "Timber framework" element dries faster than all laminated timber elements in the summer period (middle of April 2018 until August 2018). This illustrates the effect on drying from a smaller wood cross section. On the other hand, timber framework has been shown to have somewhat higher risk of mould growth than laminated timber elements when exposed to prolonged wetting. [4]

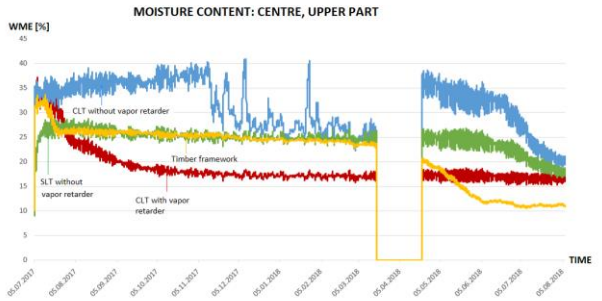

Figure 3: *Registered moisture content for centre, upper part until 06.08.2018*

4 CONCLUSIONS

Based on the overall results we can say that "CLT with vapor retarder" comes out as the best option. In a real water damage situation, the authors are doubtful that a vapor retarder can be installed completely without points of possible water intrusion, and even more doubtful that it will remain completely watertight throughout its lifetime. With water/moisture under this layer drying is very difficult, as several damage cases have shown. The test also shows the necessity of proper strategies for dehydration after water damage in laminated wood elements.

REFERENCES

[1] The Norwegian Building Acts and Regulations (Direktoratet For Byggkvalitet), *General requirements for moisture content, 2017 accessed 13 November 2019, in Norwegian,* <https://dibk.no/byggereglene/byggteknisk-forskrift-tek17/13/vi/13-9/>

[2] Building Management, Building Research Series (Byggforskserien) *No 700,110, Construction damage overview. SINTEF Building Research, Oslo, 2010. accessed 13 November 2019, in Norwegian,* <https://www.byggforsk.no/dokument/629/byggskader_oversikt>

[3] Finance Norway, *Water damage statistics, 2018 accessed 13 November 2019, in Norwegian* <https://www.finansnorge.no/statistikk/skadeforsikring/vask/>

[4] Åsbø, A. and Testad, E. S. (2018) *Drying and Risk of Mould Growth After Water Damage in Horizontal Timber Roof Elements* (in Norwegian). Master thesis, NMBU, Ås.