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Case Study of a Cold Attic in a Pitched Roof with Minimal Ventilation

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Abstract

Wood counts as a national resource of Sweden and the Swedish government aims to increase the use of wood material in the building industry. This, together with the fact that wood building materials are described as sustainable and renewable, makes the usage of wood materials more favorable in the industry. Trees absorb carbon dioxide as they grow and when trees are made into building materials, that carbon dioxide remains sequestered in the finished product. The disadvantage of using wood products is often related to moisture and moisture damages.

The ongoing climate change with longer periods of humid outdoor climate makes the design of cold attics difficult. In this paper, results from real time measurements of three cold attics with pitched roof constructions made of wood is presented. The tree attics are designed to cope not only with the Swedish moisture criteria set by the National Board of Housing and Planning in Sweden (Boverket) but also to withstand the suggested ongoing climate change. The aim of this study is to present the results and discuss this type of construction and how the attics of the three buildings are preforming.

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Keywords: Attic ; Ventilation ; Moisture ; Performance

1. Introduction

Cold attics keep puzzling builders in Sweden. The construction is well known and widely used in mainly small houses. The construction often consists of a pitched roof structure with an attic space were the insulating layer is placed on the attic floor. Historically, small houses had no major issues with this type of construction because the buildings were equipped with warm chimneys that warmed up the attic space and kept the moisture levels down. In modern buildings, the chimney is long gone or not used as frequently as before; this of course leads to a colder attic. Due to this, small houses in Sweden have gotten moisture related problems in this type of construction [1][2][3]. At one stage, the building owners started to increase the insulation layer on the attic floor to enhance energy performance in their houses. This led to even more damages and after many investigations, it was stated that the cause of the damages was the warm and moist indoor air that passed through the attic floor and condenses in the colder parts of the attic, often

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on the tongue and groove boards on the roofing. To come to terms with this problem it was suggested that the attic space should be ventilated with outside air to get rid of this moist indoor air. In some conditions, this might work, but it can also aggravate the problem. During clear nights, parts of the roofing can get cold and therefore also outside air can generate condensation in the cold areas of the attic. To prevent this from happening, the builders started to put insulation directly on the roof to keep the inside of the tongue and groove warm.

To further complicate matters it is suggested in the Swedish Building Code that material that is not well investigated should not exceed a material *critical moisture level* (75% RH) [4]. This, coupled with the fact that the Swedish government aims to increase the use of wood material in the building industry, makes use of wood material in some parts of a building (e.g. a cold attic) somewhat intricate. This paper will present early results from a project that was initiated by a construction firm in Borås to highlight and investigate how to construct a modern cold attic with minimal ventilation. The construction company consultants is mainly interested to find out whether an attic construction of this type is robust enough considering the Swedish Building Code. There has been investigations made on attic spaces with minimal ventilation before, [5],[6], but these have been on flat roof constructions.

2. The objects

The studied object consist of three buildings that are located in Borås, some 70 km east of Gothenburg, and serves as an Assisted Living Facility (ALF). Two of the three buildings are identical and have three apartments each, Building 1 and Building 3. The third building looks different, it is built like a T-shape, Buildings 2.1, 2.2 and 2.3. This building includes six apartments in the wings, a lunch room for the tenants, examination rooms and rooms for the staff. Figure 1 illustrates the layout of the buildings. This kind of living is a type of assisted living, termed "SoL-boende" in Sweden, and houses people with care needs due to, e.g. physical or alcohol/drug related disabilities.

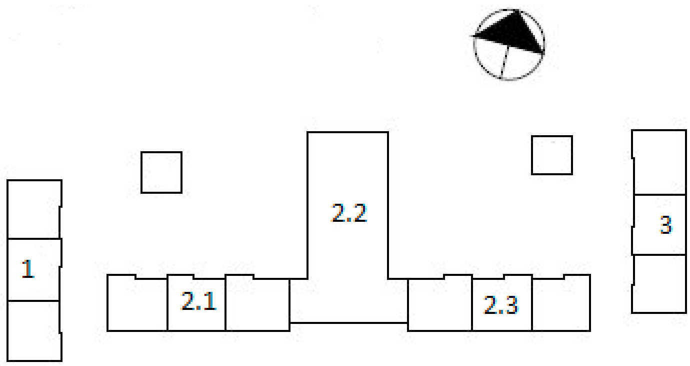

Fig. 1. Layout of the buildings in the study. The arrow marks north direction.

The buildings were finished in 2015 and are owned by the Borås municipality. Due to this the buildings are also quality insured by SP Swedish Research Institute, with their P-label. This means that SP has been involved in the whole building process to quality insure the indoor climate according to SPCR 14 [7]. This in turn means that SP has made visits at the building site and conducted measurements of the buildings' sound quality and airtightness. The building envelope airtightness is very important when minimal ventilation of the attic space is used. The energy consumption of the buildings are projected to 50 kWh /m^{2}year. The entire facility is heated by district heating. The ventilation of the apartments in the buildings 1, 2.1, 2.3 and building 3 is made by a heat exchanger. Fresh outside air is taken in through grilles, and exhaust exit through roof hoods. House 2.2 with the common areas are vented with a system of rotating heat exchanger.