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ScienceDirect

Energy Procedia 132 (2017) 417–422

Energy Procedia

www.elsevier.com/locate/procedia

11th Nordic Symposium on Building Physics, NSB2017, 11-14 June 2017, Trondheim, Norway

Moisture-resilient upgrading to blue-green roofs

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Abstract

This study identifies building technical challenges when upgrading roofs and rebuilding them as blue-green roofs in Nordic climate. Identification of challenges were done through several steps – a literature study, interviews with architect, contractor, consultants, researchers and property developers, in addition to a case study of two existing roofs in Oslo and two at NTNU. This paper presents a process model for ensuring an early focus on building technical challenges and moisture-resilience when upgrading to blue-green roofs.

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Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics.

Keywords: Blue-green roofs; Upgrading; Building technical challenges; Climate adaptation; Moisture-resilience; Urbanism; Exisiting buildings

1. Introduction

Climate change in Nordic countries are likely to present themselves as an increase in rainfall, both in intensity and in amount [1]. Furthermore, we are likely to see an increase in urbanism as people relocate from districts to cities [2]. These changes in climate, and in where we live, cause challenges to how we manage an expected increase in storm water in our cities. One possible solution is presumed to be blue-green roofs. Blue-green roofs are defined as roofs with a living surface consisting fully or partly of plants, and are believed to contain and delay the runoff from rainfalls [3]. For Norway it is estimated that 80 % of the existing building mass will be standing in 2050 [4]. To maximize the presumed benefits, it might be necessary to rebuild existing roofs into blue-green roofs. To gain more knowledge on what impact this will have on existing roofs this study tries to identify possible building technical and building physical challenges when upgrading roofs into blue-green roofs.

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1876-6102 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics
10.1016/j.egypro.2017.09.649

2. Method

This research has been carried out by a quantitative approach. To increase the validity of evaluation of the research findings, triangulation was used as a strategy. Triangulation is a technique when different sources are used to investigate the same research question or theory. The triangulation was done in accordance with theory presented by Mathison [5]. In this study, the strategy consisted of a literature study, interviews and a case study.

The literature study investigated relevant topics such as green roof, roof rebuilding, green roof retention, roof upgrading. This was done to examine what literature and which studies that was available and done with the topic of upgrading existing roofs. In addition, 38 historical guidelines in Byggforskserien (SINTEF Building Research and Design Guides) [6] were reviewed. The goal by doing so was to:

1. Get an overview of existing literature and research conducted on the topic
2. Identify Norwegian building techniques used to build roofs from the foundation of the Byggforskserien in 1958 to today's date.

Eight semi-structured interviews were performed with actors who have worked with blue-green roofs, and/or have insight in building technical challenges related to designing and constructing/rehabilitating buildings. The interviewees were one architect, two consulting engineers (one specializing in construction engineering, the other in building physics), a contractor, three property developers and a scientist from a Norwegian research institute. By performing these interviews, the goal was to identify and compare the actors different opinions on challenges related to rebuilding old roofs to blue-green roofs.

A case study was executed with the intention of uncovering challenges in upgrading/rebuilding existing roofs to blue-green roofs. For Case 1, a cluster of buildings (objects) at campus NTNU (Norwegian University of Science and Technology) were inspected and evaluated. Information was also gathered by trying to locate technical documents as building plans and design documents. Finally, the interviewees were invited to think through an upgrading scenario for some of the objects in order to uncover problems related to the upgrading. The other case study (Case 2) used two roofs in Oslo that were going to be upgraded with extensive blue-green roofs systems. For Case 2, the goal was to see/learn how the property developers planned and executed the construction, and at the same time learn what they identified as challenges when establishing a blue-green roof on a previously traditionally compact roof with asphalt membrane.

3. Blue-green roofs

3.1. Vegetation and retention layer

Use of vegetation as an insulating and protective layer on roofs is not a new invention and has been used in Norway, as well as the rest of the world, for centuries [7]. The structure of green roofs consists of a vegetation layer, growing medium (or soil layer), a drainage layer and a membrane layer and a waterproofing layer [8]. See Fig. 1. Today it is common to divide the types of blue-green roofs in three categories – Extensive, semi-intensive and intensive. The names refer to the amount of maintenance per square meter each type requires[9]. The International Green Roof Association defines the three by certain criteria listed in Table 1.

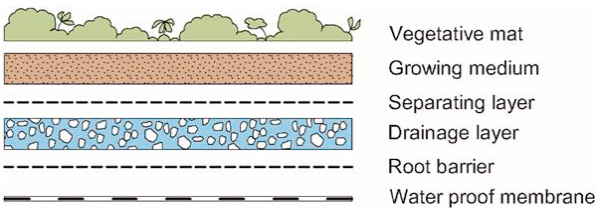

Fig. 1. Blue-green roof system [8].

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