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A review on Latvian historical building stock with heavy walls

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Abstract

The conservation of historic buildings' cultural values and the improvement of their energy performance can be perceived as rather contradictory. A thermal insulation cannot always be applied on the exterior surface of external walls. In that case, interior insulation measures should be investigated and currently represent the most difficult retrofit measure in historic buildings. The main objective of this study is to carry out literature review and to examine most commonly found historic building heavy wall types in Latvia, determine their physical properties, classify them by different types, observe and describe main historic building envelope deterioration symptoms and their possible causes. The study shows that historical buildings consume one third of total final heating energy consumed by both residential and non-residential building sector. The study also reveals that historical building external wall hygrothermal properties have not been widely studied in Latvia. This study will serve as basis for development of effective, comprehensive decision guidelines to improve the energy performance of historic buildings by investigating interior insulation measures.

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Keywords: Historical buildings; Energy efficiency; Internal insulation; Hygrothermal properties

1. Introduction

CO₂ emissions are rising globally and energy consumption in buildings is among the greatest contributors to global warming. Buildings account for 40 % of energy consumption and 36 % of CO₂ emissions in the EU [1]. Recent review carried out by De Boeck et al. [2] on energy performance of residential buildings concluded that the greatest challenge is to perform cost-efficient building retrofit projects as it is multi-objective problem with large number of measures

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and constraints that often are competing. Energy efficiency projects in historic buildings are facing two contradicting goals – cultural values and the improvement of their energy performance. A thermal insulation cannot always be applied on the exterior walls due to the preservation of the facade [3]. In that case, interior insulation measures should be considered. Internal insulation currently represents the most difficult retrofit measure in historic buildings due to hygrothermal processes in external walls.

The main objective of this review is to determine the size, share and the energy consumption of historic building stock in Latvia, as well as examine most commonly found historic building external wall types in Latvia, determine their physical properties, classify them by different types, observe and describe main historic building envelope deterioration symptoms and study their possible causes. This will serve as basis for further investigations of application of internal insulation in historic buildings. Historic buildings represent all types of protected and non-protected buildings built before 1945. The survey of structural elements is limited to buildings with heavy walls (stone, brick, timber framing), thus excluding wooden buildings.

2. Methodology

This review has been carried out based on a literature study. Relevant articles were searched in the databases of Scopus, Web of Sciences, Riga Technical University, web page of the State Inspection for Heritage Protection, web pages of Ministry of Economics and the Central Bureau of Statistics, and in the National Library of Latvia. In the search procedure the key words used were: historical building, internal insulation, historical building materials, energy efficiency in historical buildings.

3. Survey of historic building stock

The building sector in Latvia consumes almost 40 % of total national energy consumption [4]. Therefore building sector has significant energy efficiency potential. Most of the existing buildings have high energy consumption and they have significantly lower thermal properties than can be achieved by currently available technologies. Table 1 illustrates total number of residential and non-residential buildings and respective built area constructed before and after 1945, including wooden buildings. While one family buildings are dominating (83 %) in number of buildings, they take only 49 % from built area. It can be explained by the nature of historic buildings – building stock constructed before 1945, is largely made up of one or two floor buildings.

Table 1. Total number of residential and non-residential buildings and respective built area constructed before and after 1945 [4, 5].

Building type	Area, mio. m ²	Number of buildings	Area, mio. m ²	Number of buildings	Area, mio. m ²	Number of buildings
	Built before 1945		Built after 1945		Total	
Multi family buildings	8.5	16586	38.0	20029	46.5	36615
One family buildings	12.2	109376	21.3	186866	33.5	296242
Non-residential buildings	4.2	5135	11.2	15077	15.4	20212
Total	24.9	131037	62.7	221972	95.4	353069

Latvian State Inspection for Heritage Protection has listed 3441 architectural monuments: 1291 of these monuments are of national significance, while 2150 monuments are of local significance [6].

Based on number of assumptions from [4–6] annual heating energy consumption in historical building stock in Latvia is estimated 5.8 TWh or approximately 31 % from total final heating energy consumed by both residential and non-residential building sector in 2011 [8].

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