AN LCA CASE STUDY OF VERNACULAR ARCHITECTURE RETROFITTING IN NORTHERN ITALY WITH NATURAL AND BIO-BASED MATERIALS

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Abstract

It is almost universally acknowledged that the building sector has multiple relevant impacts on the environment. Indeed, it is a major consumer of raw materials, but also of intermediate products and related services, such as transports; moreover, energy performance of buildings strongly influences the use of fossil fuels resources. Therefore, it is not surprising that production, transport and use of construction materials have a significant impact in terms of global climate change, non-renewable resources depletion and damages to human health and ecosystems. For these reasons, choosing the right construction products has a relevant role in reducing environmental impacts. Hemp is a raw material that has found wide acceptance in the building industry in recent years, thanks to its fast growth and the limited amount of fertilizers, water and energy necessary in the cultivation stage of the crop. In this work, we report the results of the environmental assessment of the retrofitting of a countryside dwelling relying widely on the use of hemp-based materials. The building is a typical example of the rural vernacular architecture of northern Italy, and its retrofitting was made using only natural and bio-based materials. In Figure 137 some details of the outcome of the retrofitting activity are presented. In particular, the final façade of the building and the earthen and hemp-lime plasters can be noticed, respectively, in Figure 137a, b and c. The environmental profile of this intervention was compared with a hypothetical scenario of retrofitting with synthetic materials, adopting the Life Cycle Assessment (LCA) methodological framework as standardized by ISO 14040:2006 and ISO 14044:2006+A1:2018. The "cradle-to-gate" scenario was adopted, corresponding to stages A1-A5 of the European standard EN 15804:2012+A1:2013.

Figure 137. Details of the retrofitted vernacular building: a) external façade; b) earthen plaster and c) hempcrete plaster.

The overall impacts of the retrofitting process were divided by the net internal floor area and the results were expressed in terms of environmental impact potential per square meter. Global warming potential of the two scenarios are presented in terms of greenhouse gas (GHG) emissions, removals and balance in Figure 138. The real scenario, which comprised the use of natural and bio-based materials such as hempcrete in different forms (i.e. sprayed, cast between shuttering and blocks), insulating panels made from wood, hemp and kenaf fibers, cork-based filling material, and finishing plasters made with earth or hemp-lime mixtures performed much better than the hypothetical synthetic counterpart. For the alternative scenario, the use of traditional insulating and plastering materials were considered such as mineral wool and expanded polystyrene (EPS), expanded perlite, and cement-lime plasters.

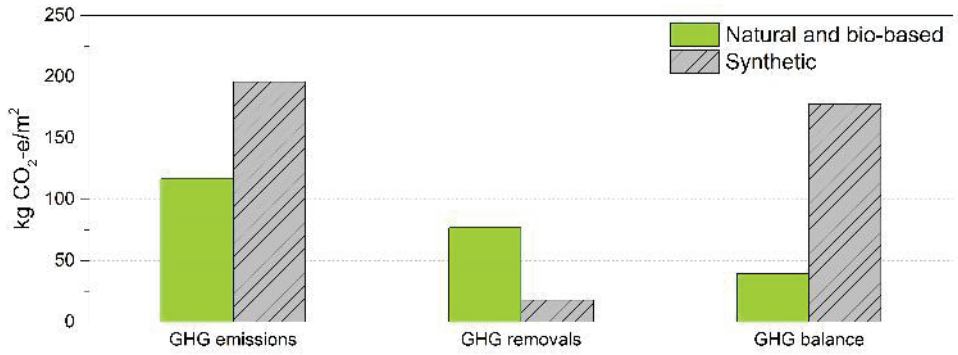

Figure 138. Greenhouse gas (GHG) emissions, removals and balance for the two retrofitting scenarios: i.e. using natural and bio-based or synthetic materials.

Keywords: hempcrete, carbonation, lime, LCA, vernacular architecture, retrofitting