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Low-Carbon Future: The Effect of Earthen Architecture on Indoor Environmental Quality (IEQ)

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Abstract

Earthen architecture is critical to decarbonizing the building sector and improving indoor environmental quality (IEQ). These materials exhibit very low carbon emissions due to their local sourcing and minimal processing requirements, and are considered a vital sustainable alternative to high-carbon materials like concrete in the sector.
Traditional earth structures offer excellent thermal comfort, natural moisture regulation, and a healthy indoor atmosphere thanks to their high thermal mass and hygroscopic nature. Sources confirm that the passive climate control capabilities of these materials minimize energy consumption and carbon footprint. Also, these materials require 62-71% less energy to produce than traditional systems and can reduce embodied emissions by up to 91%. The fundamental IEQ advantage offered by earth structures stems from the material's high thermal mass and porous-hygroscopic nature. These properties dampen temperature fluctuations throughout the day, stabilizing indoor temperature and minimizing the need for mechanical air conditioning.
Unbaked earth acts as a moisture flywheel, maintaining relative humidity between 20-75%, thus protecting respiratory health and preventing mold growth indoors. In terms of air quality, earth performs a passive cleaning process by sorbing volatile organic compounds (VOCs) in the indoor air. Modern mixtures such as lightweight straw clay (LSC) offer superior performance by combining thermal resistance with moisture buffering capacity, creating passive survival zones when supported by passive strategies. However, there are very few studies in the literature that address the low carbon emission properties and IEQ performance of earth-based materials.
This study will investigate the effects of earth-based components in terms of low-carbon emission on IEQ. The aim is to highlight the contribution of earth-based materials to both carbon targets and healthy indoor environment requirements, and to provide guidance for the selection of sustainable building materials.

Keywords: Earthen Architecture, Adobe, Indoor Environmental Quality, Low Carbon Emission, Healthy Interiors