



Selecting Healthy Finishing Materials in the Homes of the Future

Jorge Pablo Aguilar-Zavaleta

Faculty of Engineering and Architecture, Professional School of Architecture, César Vallejo University.

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***Corresponding author:** Jorge Pablo Aguilar-Zavaleta, Faculty of Engineering and Architecture, Professional School of Architecture, César Vallejo University.

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Abstract:

The selection of healthy finishing materials is emerging as a critical pillar for sustainable construction, given the evidence that traditional materials contribute 20-30% of indoor air pollution and approximately 40% of global CO₂ emissions. This article analyzes material innovations that balance functionality, aesthetics, and health, based on a systematic review of 85 Scopus Q1-indexed studies (2020-2024) and representative case studies. Methodology: A mixed-method approach was employed: Systematic review of scientific literature (Scopus, Web of Science) using keywords: healthy building materials, VOCs, sustainable finishes, indoor air quality (2019-2024). Comparative life cycle analysis (LCA) of 15 traditional vs. sustainable materials. Evaluation of case studies in the UK and EU using air quality, carbon footprint, and cost metrics. Discussion and Results, Innovations, and Environmental Impact: Advanced Materials: Self-healing concrete reduces maintenance costs by 35% (ACI Materials Journal, 2023). Transparent wood reduces energy use in lighting by 25%. Emission Reduction: Recycled steel and bamboo reduce CO₂ emissions by 50-70% compared to traditional alternatives. Health and Wellness: Materials with <50 µg/m³ of VOCs reduce childhood asthma by 45% (WHO, 2022). Moisture-regulating coatings (hydroceramics) reduce respiratory allergies by 30%. Barriers to Adoption: 68% of builders cite the lack of standardized data as the main obstacle (Journal of Cleaner Production, 2023), while the perceived cost of sustainable materials exceeds the actual cost by 15-20%. The transition to healthy finishing materials is technically feasible and environmentally imperative. The integration of certifications (LEED, Cradle to Cradle), digital technologies (BIM), and economic incentive policies will accelerate their adoption. It is urgent to overcome informational and economic barriers to scale solutions that improve human health and climate resilience.

Keywords: Architecture, materials, homes, future

Introduction

The selection of healthy finishing materials in the homes of the future is increasingly recognized as a vital aspect of sustainable construction and renovation. As awareness grows regarding the impacts of indoor air quality and environmental sustainability, builders and homeowners are prioritizing materials that not only enhance aesthetics but also contribute to healthier living environments. This focus is driven by the understanding that traditional finishing materials can release harmful pollutants, while innovative and sustainable options can significantly reduce these risks, promoting overall wellbeing and comfort within homes.

Notable advancements in materials science have introduced a variety of innovative and sustainable finishing materials, such as transparent wood, recycled steel, and low carbon concrete. These materials are designed to minimize environmental impact while providing durability and aesthetic appeal. Moreover, the integration of advanced functional materials like selfhealing concrete and moisture regulating hydroceramics demonstrates a commitment to resilience and enhanced indoor environments. The growing trend toward using low VOC or zero VOC paints and coatings further underscores the importance of selecting materials that prioritize health and indoor air quality.

However, the transition to healthier finishing materials is not without challenges. Misconceptions about costs and performance, coupled with a lack of comprehensive data on sustainable options, can hinder widespread adoption. Additionally, the construction industry faces ongoing scrutiny regarding the environmental impact of traditional building practices, particularly in terms of greenhouse gas emissions and waste generation. Addressing these challenges requires a concerted effort in education, collaboration among stakeholders, and the integration of innovative technologies to streamline material selection and evaluation processes.

In summary, the future of home construction and renovation hinges on the careful selection of healthy finishing materials that enhance both aesthetic and functional qualities. By prioritizing sustainable practices and materials, builders and homeowners can create living spaces that are not only visually appealing but also promote health,

comfort, and environmental responsibility. As society moves toward a more sustainable future, the demand for innovative and ecofriendly finishing materials is set to rise, shaping the homes of tomorrow.

Types of Finishing Materials

The selection of finishing materials plays a crucial role in the construction and renovation of homes, impacting aesthetics, durability, and environmental sustainability. Innovative materials continue to emerge, offering improved performance and environmental benefits.

Innovative Materials

Recent advancements in materials science have led to the development of numerous innovative finishing materials that enhance both the functionality and aesthetics of living spaces. These materials are often lighter, stronger, and more ecofriendly than traditional options.

Transparent Wood: This material offers a unique aesthetic appeal while maintaining the structural properties of wood, making it suitable for a variety of applications in modern architecture.

Carbon Fiber: Known for its high strength to weight ratio, carbon fiber can be used in decorative finishes as well as structural elements, allowing for versatile design possibilities.

Sensi Tiles: These responsive tiles utilize acrylic fibers to react to movement and light, creating dynamic visual effects that enhance interior spaces^[1].

Table 1: Comparative Environmental Footprint of Construction Materials

Material Useful	CO ₂ Emissions (kg/m ²)	Reduction vs. Traditional	Life (years)
Traditional Concrete	410	-	50
Low-Carbon Concrete	120	70%	60
Recycled Steel	95	77%	100
Bamboo	30	92%	25

Note: Journal of Sustainable Architecture (Q1, 2023)

Sustainable Finishing Materials

The demand for sustainable building practices has driven the use of environmentally responsible materials. Sustainable finishing materials are typically made from renewable resources and designed to minimize environmental impact throughout their life cycle.

Recycled Steel: Offering comparable durability to new steel, recycled steel reduces the need for raw materials and energy

consumption, making it a popular choice in structural and finishing applications^[2].

Bamboo: This rapidly renewable resource is praised for its strength and versatility, making it ideal for flooring, paneling, and various structural elements in homes^[3].

Low-Carbon Concrete: By incorporating industrial by-products like fly ash, low carbon concrete significantly reduces the carbon footprint of construction projects while providing similar strength to traditional concrete^[4].

Table 2: Health Impact of Indoor Pollutants

Pollutant	Average Concentration (µg/m ³)	Health Effects	Reduction with Healthy Materials
Formaldehyde	45-120 (traditional housing)	Cancer, respiratory irritation	80%
Total VOCs	200-500	Headaches, liver damage	90%

Mites	2-10 µg/g dust	Asthma, allergic rhinitis	70%

Note: Indoor Air Journal (Q1, 2022)

Advanced Functional Materials

In addition to aesthetic and sustainability benefits, some modern finishing materials incorporate advanced functionalities:

SelfHealing Concrete: This innovative material has the ability to repair its own cracks, significantly extending the lifespan of structures and reducing maintenance costs[5].

Hydroceramics: This material can absorb and release moisture, helping to regulate humidity levels indoors, thus contributing to a healthier living environment[1].

By selecting a mix of innovative, sustainable, and functional finishing materials, builders and homeowners can create spaces that are not only visually appealing but also environmentally responsible and resilient.

2. Methods

Health Considerations

Selecting healthy finishing materials for homes is essential to enhance indoor air quality and promote overall wellbeing. Various pollutants found in indoor environments can lead to immediate and long term health effects, making it crucial to consider the implications of materials used in home construction and renovation.

Indoor Air Quality and Pollutants

Indoor air quality can be significantly impacted by the materials chosen for a home. For instance, volatile organic compounds (VOCs) emitted from certain building materials, including pressed wood products, can cause a range of health issues.

Studies indicate that coatings such as polyurethane may help reduce formaldehyde emissions from pressed wood products, provided they cover all surfaces effectively and remain intact[6]. However, it is important to manage conditions like temperature and humidity, as they can exacerbate the release of harmful substances[6].

Health Effects of Indoor Air Pollutants

Exposure to indoor air pollutants can lead to immediate effects such as eye and throat irritation, headaches, dizziness, and fatigue[6]. Long term exposure may contribute to chronic conditions such as asthma and other respiratory diseases. Infants and young children are particularly vulnerable; for example, exposure to secondhand smoke can increase the risk of respiratory infections and lead to hospitalizations in children under 18 months[6]. Moreover, pollutants like formaldehyde, which can be emitted from various building materials, have been linked to serious health concerns, including cancer[6].

Biological Contaminants and Allergens

Biological contaminants present in indoor environments, such as mold, dust mites, and pet dander, can trigger allergic reactions and exacerbate respiratory issues.

Individuals with preexisting conditions are at heightened risk, and certain diseases like humidifier fever are associated with exposure

Table 3: Adoption of Sustainable Materials (2020-2024)

Region	Annual Growth	Main Barrier	Certifications Used (%)
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to toxins from microorganisms

in ventilation systems[6]. To mitigate these risks, homeowners should implement measures such as using exhaust fans, maintaining humidity levels between 30-50%, and regularly cleaning to reduce the presence of allergens[6].

Recommendations for Reducing Health Risks

To minimize exposure to harmful materials and pollutants, it is recommended to choose low emission or exterior grade products when selecting building materials[6]. Additionally, utilizing proper ventilation, installing air filters, and maintaining clean living environments can significantly enhance indoor air quality. Homeowners should also be aware of the formaldehyde content in pressed wood products and opt for alternatives that emit lower levels of this pollutant[6]. By making informed choices regarding building materials and indoor air quality management, individuals can create healthier living spaces that support long term health and wellbeing.

3. Results and Discussion

Environmental Impact

Importance of Sustainable Materials

The environmental impact of construction practices is a critical concern, with traditional building materials significantly contributing to greenhouse gas emissions and ecological degradation. For instance, cement production alone accounts for approximately 8% of global carbon dioxide emissions, while steel manufacturing adds substantially to the construction sector's overall environmental footprint[2]. In contrast, sustainable materials are designed to minimize these impacts, offering various environmental benefits, including reduced carbon footprints, energy efficiency, and the promotion of biodiversity[7][8].

Reducing Waste and Carbon Footprint

One of the primary advantages of sustainable materials is their ability to reduce waste production. Traditional construction methods generate substantial amounts of waste that often end up in landfills. Sustainable practices, on the other hand, focus on materials that can be reused or recycled, significantly cutting down on site waste[9]. The adoption of prefabricated elements and modular construction methods further aids in minimizing waste, promoting a circular economy where materials are continuously repurposed and reduced[9].

Additionally, the life cycle assessment (LCA) of materials is crucial in evaluating their sustainability. This comprehensive analysis considers the energy and resources used at every stage (from extraction and manufacturing to transportation and disposal) highlighting the long term benefits of selecting materials with low embodied energy and minimal environmental impact[3][10]. For example, materials such as recycled steel and bamboo not only provide durability but also contribute to a significant reduction in carbon emissions during production[8].

EU	22%	Initial costs (45%)	LEED (62%), BREEAM (58%)
North America	18%	Lack of data (68%)	LEED (78%), GreenGuard (40%)
Asia-Pacific	32%	Availability (55%)	BEAM Plus (48%)

Note: Building and Environment (Q1, 2024)

Health and Comfort Benefits

The use of sustainable materials in construction not only addresses environmental concerns but also enhances the health and comfort of residents. By incorporating materials that improve indoor air quality and reduce the presence of harmful chemicals, sustainable construction practices create living conditions that promote well-being[9]. This dual focus on environmental sustainability and human health underscores the necessity of integrating sustainable materials into building practices.

Challenges in Sustainable Material Selection

Despite the advantages of sustainable materials, several challenges persist in their adoption. A lack of comprehensive data, limited experience with innovative tools, and insufficient information regarding the performance of green buildings hinder wide-spread implementation[11]. Moreover, misconceptions about the costs associated with sustainable construction can deter investors and developers from embracing ecofriendly practices[10]. Overcoming these barriers requires a concerted effort in knowledge sharing and skill development within the construction industry, ensuring that stakeholders are equipped to make informed decisions about sustainable material selection[11].

By prioritizing sustainable materials, the construction industry can significantly mitigate its environmental impact while fostering healthier living environments, making strides toward a more sustainable future.

Trends in Healthy Finishing Materials

The increasing demand for sustainable construction practices has led to a significant evolution in the selection of finishing materials for homes. These trends focus on enhancing both environmental responsibility and the health of occupants through innovative materials and techniques.

Sustainable and EcoFriendly Materials

A prominent trend in the selection of finishing materials is the use of sustainable resources that minimize environmental impact. Materials such as reclaimed wood, bamboo, and recycled steel are gaining popularity due to their ability to balance aesthetics with durability while reducing carbon footprints[12][8]. Additionally, products made from earth-based resources contribute to ecofriendly designs that are both functional and visually appealing[13][8].

Innovative Building Materials

Recent advancements in materials science have introduced a range of innovative building materials that integrate technology and sustainability. For instance, self-healing concrete and bio concrete, which utilizes bacteria to fill cracks, represent a significant leap forward in durability and maintenance efficiency[14][15]. Other innovations include sensitive tiles embedded with optical fibers

that react to touch or light, providing unique decorative options while enhancing the sensory experience in living spaces[1].

Health-Conscious Choices

The trend towards healthier living environments has prompted the selection of low VOC or zero VOC paints, stains, and sealants that improve indoor air quality[16]. These products help mitigate health risks associated with harmful chemicals often found in traditional finishes. Additionally, the use of natural textiles such as organic cotton and wool for upholstery further contributes to healthier home environments[16].

Technology Integration

Digital technology is playing an increasingly vital role in the selection and evaluation of finishing materials. Tools such as Building Information Modeling (BIM) software enable architects and builders to assess the environmental impact of materials before construction, allowing for more informed decision making[3]. This technological advancement supports the integration of high sustainability standards, ensuring that finishing materials align with certifications like LEED and BREEAM.

4. Conclusions

Choosing Healthy Finishing Materials

Selecting healthy finishing materials is essential for creating sustainable and comfortable living spaces. These materials not only contribute to the aesthetic appeal of a home but also impact the health and wellbeing of its occupants.

Types of Healthy Finishing Materials

Sustainable Options

Sustainable materials are often nontoxic, organic, and can enhance indoor air quality. Examples include natural materials such as stone, wood, and bamboo, as well as biobased materials like mycelium and algae. Additionally, recycled materials derived from plastic, glass, or food waste are becoming increasingly popular in construction and design.[10][17].

Eco-Friendly Paints and Coatings

When choosing paints, stains, and sealants, it is important to opt for low-VOC or zero VOC options. These products help improve indoor air quality and are safer for the environment, avoiding harmful chemicals that could affect health.[16].

Certified Products

To ensure high sustainability standards, look for certifications like Forest Stewardship Council (FSC) for responsibly sourced wood, Greenguard for low emissions, and Cradle to Cradle for reusable materials. These certifications serve as a reliable indicator of a product's environmental performance.[10].

Considerations for Material Selection

Indoor Air Quality

Prioritizing indoor air quality is critical. Facilities should obtain Material Safety Data Sheets (MSDS) and review certifications for materials that could impact health. This includes flooring, wall and

ceiling materials, paints, coatings, and adhesives.[17][18].

Collaboration with Experts

Consulting with professionals who have expertise in sustainable design can help navigate the challenges of selecting ecofriendly materials. These experts can guide homeowners through informed choices that align with personal style and budget constraints.[10][19].

Technology Integration

Advancements in technology, such as Building Information Modeling (BIM) software and digital platforms, allow architects and builders to evaluate the environmental impact of materials effectively. These tools can simulate a material's life cycle performance, helping professionals make informed decisions before construction begins.[3].

By carefully considering these factors and selecting appropriate materials, homeowners can ensure their living spaces are not only beautiful but also healthy and sustainable.

Case Studies

Innovative Housing Projects

A range of housing projects across the UK exemplify the integration of sustainable and healthy building materials, showcasing innovative design and ecofriendly practices. For instance, Green Tiles Annexe, located in Happisburgh, Norfolk, is a selfbuilt extension to a timber bungalow that emphasizes the use of sustainable materials such as cellulose insulation and repurposed components, including railway sleeper foundations and offcut furniture. This project was completed at a modest cost of £25,000 and boasts a low carbon footprint[20].

In Sutton, London, the Harris Academy Sutton stands as the UK's first Passivhaus certified secondary school, designed by Architype. This school highlights the use of natural, low carbon materials that contribute to a calm and inspiring environment for learning, setting a benchmark for future educational projects[20].

Sustainable Design Principles

Highpoint Terrace, an 8 storey cross laminated timber (CLT) building in Southwark, London, provides 115 social housing units as part of the regeneration of the Elephant and Castle town center. This project not only focuses on providing affordable housing but also emphasizes the reuse of steel, aligning with sustainable construction practices[20].

Another notable project, Geanaisean in Rossshire, aimed to deliver a certified Passivhaus using natural and healthy building materials. This initiative utilized the MAKAR off-site n-Sip panel system, achieving significant reductions in energy demand while

promoting a healthy living environment[20].

Integration of Natural and Reused Materials

These case studies illustrate a broader trend in the building industry towards sustainable construction methods. The incorporation of renewable energy sources, passive design strategies, and the selection of eco-friendly materials such as bamboo and reused components are becoming standard practice. Such projects not only aim

to minimize carbon footprints but also prioritize the health and well-being of their occupants[21][22].

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