

Best Practices in Building Systems (BPiBS)

BPiBS is a collaborative and interdisciplinary research project focused on improving how housing and building systems function.

Whole-System Thinking in Sustainable Building Design

by Rakesh Kumar

When we think of sustainable buildings, the conversation often begins and ends with energy efficiency and the integration of renewable energy systems, such as solar panels on the roof or high-performance insulation in the walls. A building is more than just the sum of its individual components, thinking in isolation.

True sustainability can be achieved by designing buildings as unified systems. Energy, water, structure, exterior, and health don't exist in isolation. A key focus should be on how energy, water, structure, and health systems integrate to create sustainable, resilient, and people-centred design. Usually, these individual building components interact in ways that are often unexpected. A truly sustainable building conserves resources while ensuring a healthy condition for its occupants. More holistic thinking is needed in the design and operation of buildings, moving away from isolated component-based design toward viewing them as a single unit.

A unified building design encompasses five thematic areas and their interdependencies, which will be discussed in more detail below.

Energy and Thermal Systems: Going Beyond Trends: The first step to sustainable building design isn't adding more technology, it's being less intrusive on the environment in the first place. Passive strategies, such as shading, orientation, and natural ventilation, can dramatically reduce energy demand before we ever plug in a system. Once the foundation is set by natural design, renewable energy sources and smart controls step in. Solar panels, geothermal heating, and advanced heat pumps create clean energy supply. In addition, occupancy-based system control adjusts building system operation schedules and setpoints based on observed occupant presence and behavior. All these strategies and technologies play a crucial role in advancing sustainable building by reducing environmental impacts, conserving resource, and improving energy efficiency.

Water and Waste Systems: Closing the Loop: Water and waste systems form the backbone of sustainable buildings, extending far beyond basic service providers to involve an integrated framework of resource efficiency, recovery, and resilience. These systems influence every stage of the water and waste cycle, from the sourcing and supply of potable water to the consumption, treatment, and reuse of wastewater, and from the

generation and transport of household and construction waste to its eventual recycling, recovery, or disposal. By managing interconnected flows, sustainable buildings can reduce their ecological footprint and improve community well-being. This approach turns water and waste systems into vital enablers of sustainability and resilience.

Building Exteriors and Grounds: Working with Nature: The integration of a thoughtful design process in exterior and surrounding landscaping is essential for enhancing the performance and resilience of sustainable building design. Features such as green roofs/walls not only improve indoor air quality and thermal comfort but also effectively manage rainwater harvesting and minimize the impact of the heat dome. How a building interacts with its environment divulges how much it appreciates nature. Instead of viewing the outside walls and surrounding areas as mere boundaries, modern design ideas consider them essential contributors to sustainability. Green roofs, solar panels built into envelopes, living walls, special pavements, and the use of local plants all improve buildings and their surroundings. By designing buildings to work with nature, we create stronger, more comfortable spaces. This approach fosters a connection with the environment instead of overpowering it.

Building Forms and Structure: Built to Last and Change: The design and construction practices of buildings are evolving to meet new priorities, such as sustainability, resilience, and occupant well-being. Eco-friendly construction techniques help reduce greenhouse gas emissions by using sustainable materials and lowering energy consumption. Circular principles extend the life of materials and components through adaptability, disassembly, and reuse, which helps minimize waste generated from construction and demolition. Modular and prefabricated methods increase efficiency while promoting sustainability. By implementing strategies such as passive heating and cooling, maximizing daylight and natural airflow, creating flexible layouts, and respecting cultural contexts, buildings can reduce their environmental impact while improving comfort, accessibility, and social well-being. These adaptable layouts ensure that structures remain relevant over time, accommodating changes in family size and housing patterns. By integrating innovative methods with responsible material choices, buildings can become not only sustainable and efficient today but also resilient and adaptable to future challenges.

Health and Lifestyle Systems: People at the Center: The primary goal of better building design goes beyond energy efficiency; it focuses on human health and well-being. A holistic design approach harmonizes sustainability with the overall human experience. This emphasis is on designing environments that promote occupant health. Achieving high indoor air quality, maximizing natural light, and forging strong connections to the outdoors are essential for enhancing occupant health, comfort, and productivity. It is imperative to employ key strategies for reducing pollutant levels, optimizing ventilation, and integrating biophilic design principles. To effectively tackle the stress caused by intrusive noise, the design prioritizes acoustic comfort with the use of sound-absorbing materials and strategic layouts. Furthermore, biophilic design commands attention by incorporating greenery, utilizing natural materials such as mass timber, and implementing culturally inspired patterns to reinforce our connection to nature. Ultimately, the success of such designs is determined by the health and well-being of the residents.

Building Systems in Harmony: A building can be conceptualized as a musical symphony, where each element plays a role in creating overall harmony. The components of energy, water, waste, structure, exteriors, and

health function identical to instruments, each contributing to balance based on principles of sustainability, resilience, and human well-being. When these elements are aligned effectively, the outcome is a cohesive and efficient building. For example, a façade overhang can lower cooling demand and save energy, while green roofs and walls help manage stormwater and improve insulation. Greywater reuse eases pressure on freshwater supplies and sustains surrounding landscapes, and well-designed interiors foster occupant health, productivity, and reduced social costs. Together, these strategies highlight the importance of integrating systems, materials, and design choices into a unified approach to better building performance.

A contribution by Rakesh Kumar

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