From the Ground Up

Understanding the Benefits of Underfloor HVAC

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Introduction

As the architectural landscape evolves to prioritise sustainability and adaptability, traditional heating, ventilation, and air conditioning (HVAC) systems are increasingly being scrutinised for their limitations. These systems have long been effective in regulating indoor climates, but they often struggle to achieve an optimal balance between energy efficiency, thermal comfort, and design flexibility. These challenges are further magnified in modern buildings, where open-plan layouts and stringent sustainability goals demand innovative climate control solutions.

Underfloor HVAC systems have emerged as a forward-thinking alternative, offering a host of advantages over their conventional counterparts. By delivering conditioned air through a raised floor system, these systems enhance airflow efficiency and reduce energy consumption while maintaining superior occupant comfort. Their discreet design also provides architects with greater freedom to optimise interior layouts, supporting modern trends in adaptable, open-plan environments.

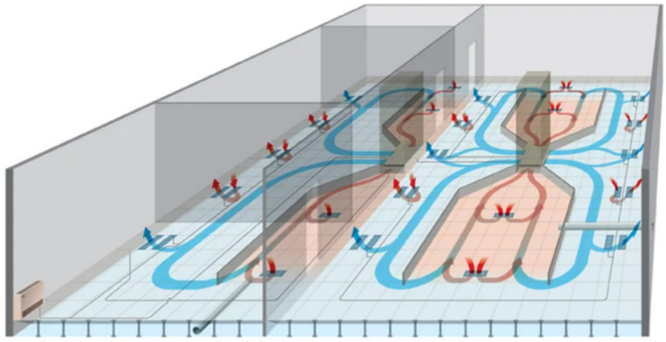
This paper delves into the advantages of underfloor HVAC systems, including their contributions to energy efficiency, indoor air quality, and thermal comfort. It also considers the importance of specifying a purpose-built floor to ensure the underfloor HVAC delivers optimal performance and longevity.

What is underfloor HVAC?

Underfloor HVAC systems, through which conditioned air is delivered through a raised floor plenum, represents a modern approach to heating, ventilation, and air conditioning. Initially developed in the 1950s to address high heat loads in specialised spaces like computer rooms and control centers,[1] underfloor systems are now gaining traction in commercial office buildings due to their efficiency, adaptability and ease of reconfiguration.

Unlike traditional overhead HVAC systems, which deliver conditioned air at ceiling level and rely on high-velocity mixing to regulate space temperatures, underfloor systems introduce air at floor or desk level through a network of supply outlets.[2] This approach enables an efficient airflow pattern where conditioned air rises naturally due to buoyancy, carrying heat and contaminants away from occupants. The result is a more targeted and efficient method of maintaining thermal comfort and air quality.

By leveraging natural airflow dynamics, underfloor HVAC systems minimise the energy required to achieve desired temperature and air quality levels.[3] Their design also supports modern building trends, such as open-plan layouts and flexible workspaces, by enabling efficient and cost-effective reconfiguration of supply outlets to match changing interior layouts.



Source: https://www.ny-engineers.com

Benefits of underfloor HVAC systems

Improved comfort and air quality

Underfloor HVAC systems are designed to deliver fresh air directly into the occupants' breathing zone, providing superior ventilation compared to traditional overhead systems. As conditioned air is supplied at floor level, heat, pollutants, and stale air naturally rise to the ceiling, where they can be effectively exhausted. This stratified airflow significantly enhances ventilation effectiveness and air quality, creating a healthier and more comfortable indoor environment.

A study published in Building & Environment comparing underfloor air distribution systems with overhead systems in an office environment demonstrated that underfloor systems give better performance than overhead systems in air contaminant removal.[4] In the same study, it was also shown that underfloor systems deliver significant energy savings while maintaining the same thermal comfort condition.[5]

Energy efficiency

Underfloor HVAC systems are designed to improve both ventilation efficiency and indoor air quality by delivering fresh supply air directly at floor level or near occupants. This approach enhances air distribution within the occupied zone, ensuring that fresh air is supplied where it is needed most while stale, heat-laden air is removed through stratified airflow. By avoiding the need for complete air mixing, these systems significantly reduce the energy required to achieve optimal air quality and thermal comfort.

Underfloor HVAC systems offer substantial energy savings compared to conventional overhead air distribution systems. Studies show that underfloor HVAC systems can reduce overall energy consumption by approximately 30% compared to ceiling-based systems, particularly in high-ceiling buildings, while still delivering satisfactory comfort for occupants.[6]

Adaptability and design flexibility

With raised floor systems, tenants can adjust layouts and reposition air diffusers without major demolition or construction. This adaptability allows organisations to modify their spaces quickly and cost-effectively, supporting evolving workplace needs while reducing the environmental impacts typically associated with traditional construction activities. The ability to reconfigure without disruption also makes underfloor systems particularly appealing for multi-tenant buildings and dynamic environments.

Operational and capital cost savings

Underfloor HVAC systems deliver significant operational cost savings by reducing installation complexity through simpler layouts and fewer ductwork materials. They lower power requirements and optimise HVAC controls, cutting energy costs while streamlining maintenance processes for long-term savings. Additionally, these systems reduce construction costs by enabling shorter building heights without compromising interior dimensions, improving worker safety during installation, and enhancing overall system efficiency.

System design and components

Underfloor HVAC systems consist of several key components that work together to deliver efficient and flexible climate control while seamlessly integrating with building infrastructure. The key components are as follows:

- **Raised floor system:** The foundation of an underfloor HVAC system is the raised floor, comprising panels supported on vertical pedestals above the structural slab floor. This creates a space beneath the floor that provides space for air distribution and infrastructure management.
- **Underfloor plenum:** The underfloor plenum is the space beneath the raised floor panels, which acts as a distribution zone for conditioned air. Beyond its role in air supply, the plenum also accommodates other infrastructure elements such as electrical power lines, data cables, and ductwork.
- **Air diffuser:** High-induction, floor-mounted air diffusers are strategically placed throughout the system to deliver conditioned air into occupied spaces. These diffusers ensure effective airflow distribution while allowing for localised control and reconfiguration.
- **Infrastructure integration:** The underfloor HVAC system is designed to integrate multiple building systems within the plenum, including electrical, telephone, and data cables. This integration not only streamlines installation but also allows for easier access and adaptability when modifications or upgrades are required.
- **Floor panel materials:** The raised floor panels are made from a variety of materials to suit different functional and aesthetic needs. Options include carpet tiles, linoleum, concrete, wood composite, and finished metal, providing flexibility for both design and durability requirements.
- **Plug-in fixtures:** To support adaptability, underfloor HVAC systems include plug-in fixtures such as flush-mounted electrical boxes, power/data outlets, and adjustable air diffusers. These fixtures enable easy reconfiguration to meet changing spatial or operational demands.

Importance of a purpose-built access floor

A purpose-built access floor is essential for the success of an underfloor HVAC system, as it ensures an **airtight assembly** that minimises air leakage, a common challenge in these systems. Air leakage from the plenum adversely affects system operation. Proper sealing of penetrations, joints, and partitions is critical to maintaining system efficiency, uniform air distribution, and occupant comfort.

Ease of access is critical in underfloor access floors for HVAC systems, enabling efficient maintenance, upgrades, and troubleshooting without disrupting building operations.

Design flexibility ensures the system can accommodate future changes or expansions, supporting evolving spatial and operational needs while maintaining optimal airflow and energy efficiency.

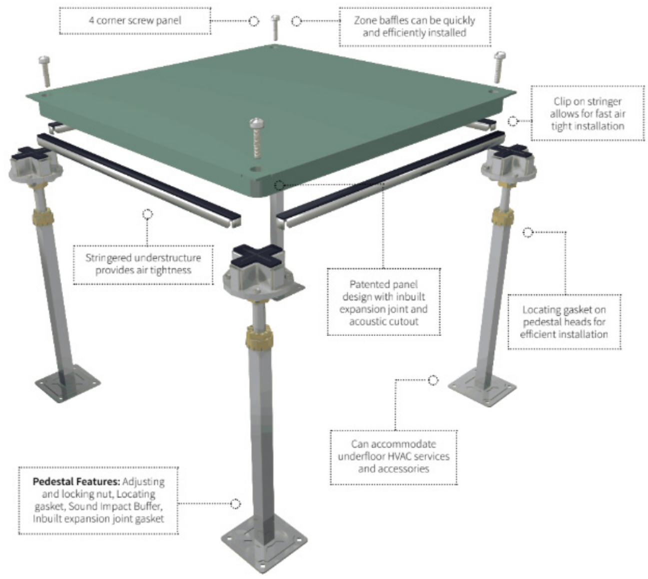
ASP Access Floors has established itself as a leader in innovative access floor systems, delivering cutting-edge solutions tailored to modern building requirements. At the forefront of ASP's innovations is the Icon Air floor system, a specialised solution engineered to optimise underfloor HVAC systems

Icon Air by ASP Access Floors

The **Icon Air** system by ASP Access Floors is a purpose-built solution designed specifically to enhance the efficiency and performance of underfloor HVAC systems. Engineered with a focus on airtightness, the Icon Air system transforms the underfloor cavity into an effective air plenum by incorporating a patented clip-on airtight stringer. This design significantly reduces air leakage, ensuring precise air distribution while minimising energy loss. The system's unique features, such as inbuilt expansion joints and acoustic cutouts, further improve the system by preventing panel-to-panel contact noise and enhancing occupant comfort in the space above.

Icon Air is certified to achieve exceptional air leakage performance, meeting or exceeding the stringent standards outlined in the BSRIA guide. ASP ensures that the system achieves the required air leakage rate lower in project site environments, with independent testing conducted as part of their quality assurance process to guarantee compliance and optimal efficiency.

ICON Air system diagram



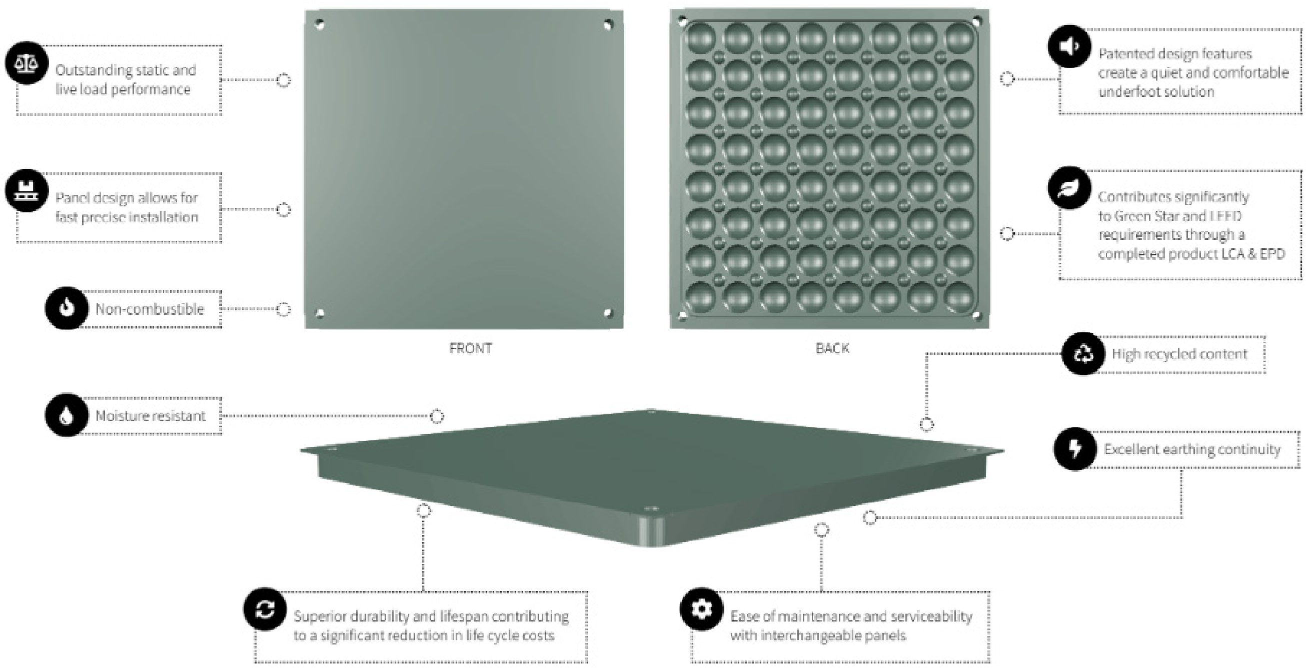
Source: www.aspfloors.com

Icon Air Panel

The **Icon Air Panel** is the principal component of the Icon Air system. With a high recycled content, non-combustible materials, and moisture resistance, it meets stringent Green Star and LEED certification requirements. Its design supports reduced lifecycle costs by offering superior durability, streamlined installation and maintenance, and reduced energy consumption.

Constructed with a hardened steel top and bottom plate, encapsulating a cementitious core, the Icon Air Panel is built for durability, supporting medium- to super-heavy industrial loads. This robust construction allows the system to accommodate a variety of applications, including commercial offices, educational institutions, libraries, and casinos.

Icon Air Panel features



Source: www.aspfloors.com

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Easy access for maintenance

The Icon Air system is specifically designed to provide easy access for maintenance and repairs, ensuring HVAC equipment and infrastructure remain readily accessible. Its modular panel design includes screw holes in each corner, allowing panels to be individually screw-fixed for greater rigidity while enabling faster and more efficient removal and reinstallation during maintenance tasks. This design eliminates structural blockages and ensures that maintenance can be performed with minimal disruption.

Design flexibility for dynamic spaces

The Icon Air’s modular design provides flexibility, enabling reconfiguration without compromising performance. Interchangeable panels, combined with precise tolerances and fast installation features, make the system adaptable to changing space needs, reducing downtime and operational disruption

REFERENCES

1 Luskay, Larry and David Sellers. "Why the "Simple Underfloor Air Distribution System" Isn't Quite as Simple as It Seems." American Council for an Energy-Efficient Economy. https://www.aceee.org/files/proceedings/2002/data/papers/SS02_Panel3_Paper18.pdf (accessed 28 January 2025).

2 Ibid.

3 Ibid.

4 Ho, Son, Luis Rosario and Muhammad M. Rahman. "Comparison of underfloor and overhead air distribution systems in an office environment." Building & Environment, Vol. 46, No. 7 (2011): 1415-1427.

5 Ibid.

6 Alajmi, Ali and Wid El-Amer. "Saving energy by using underfloor-air-distribution (UFAD) system in commercial buildings." Energy Conversion and Management, Vol. 51, No. 8 (2010): 1637-1642.

All information provided correct as of February 2024.

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