TECHNOLOGY OVERVIEW OF **UNDERFLOOR AIR DISTRIBUTION** SYSTEMS

INTRODUCTION

Underfloor Air Distribution (UFAD) is an innovative HVAC technology which uses an underfloor plenum (located between the slab and a raised access floor system) to serve as the conduit for supply air. Conditioned air is vented at low pressure through strategically-placed floor-level outlets on a raised access floor above the plenum. Typically a low-pressurized plenum is used with a central air handler, but some UFAD systems employ non-pressurized plenums which rely on fan-driven supply outlets in combination with a central air handler.

HOW DO UFAD SYSTEMS COMPARE TO CONVENTIONAL HVAC SYSTEMS?

The traditional approach to HVAC design in commercial/institutional buildings involves an indoor fan unit supplying conditioned air through a network of ducts connected to a series of evenly-spaced diffusers in the ceiling. The air ducts may be fully exposed, but are commonly hidden in the interstitial space above a dropped ceiling. The reliance on ducting means that ceiling service plenums are typically spacious to accommodate commercial size air ducts which are integral to this method of air heating and cooling.

Conventional HVAC systems rely on even mixing of supply air within the entire indoor conditioned space to achieve thermal comfort. The conditioned air must be forced out of the diffusers at relatively high volume to thoroughly mix with the entire volume of indoor air. While the air volume is constantly recycled through a return vent in the ceiling, both fresh air and stale air are exhausted together due to thorough mixing. (The return air system may be configured as an un-ducted ceiling plenum or as a ducted return.) Since conventional HVAC systems are designed to ensure complete mixing of indoor air volume, the entire air volume within the occupied zone (from floor to ceiling) must be maintained at a "setpoint" temperature to provide adequate fresh air and thermal comfort to occupants.

UFAD systems differ most dramatically from baseline in the way conditioned air is distributed; conditioned air is not mixed, but is gently vented at floor level. This gradual air movement from the floor register produces an effect known as controlled indoor air stratification.

Cool conditioned air remains in the lower indoor zone of occupancy (usually 4' to 6' above the floor level) and warmer air (no longer fresh) slowly rises to the ceiling as it is gradually displaced by cooler air. Indoor air stratification results in better energy efficiency during the cooling season because only a portion of the total air volume needs to be conditioned.

UFAD systems also promote both improved ventilation efficiency and better indoor air quality. The fresh air supply is delivered close to the occupant's work space without mixing with stale and contaminated indoor air. The stratification effect creates an even floor to ceiling air movement which efficiently separates and removes contaminated and stale air from the lower occupied zone and captured at return air vent located at ceiling height. As with a conventional HVAC system, the air handler sends the return air back to the HVAC system where is mixed with fresh air before repeating the cycle.

The raised access floor used in UFAD systems consists of a rigid structural grid that supports lay-in floor panels. This system allows for strategic placement of supply outlets and for easy re-configuration. Floor level supply outlets are not dependent on the ducting network (unlike baseline) and can be placed almost anywhere on the structural grid above the supply plenum. (Carpet tile is often selected to cover the lay-in panels to facilitate this adaptability.) Thermal comfort and occupant satisfaction are greatly improved because individual occupants have accessible and adjustable supply outlets at their work stations.

UFAD systems can reduce floor-to-floor height during construction because un-ducted systems do not require the same service plenum heights as conventional HVAC. This can significantly reduce construction cost for multi-story buildings because less building materials are required for the interstitial spaces. UFAD systems also eliminate the need for ductwork and drop ceilings, but the offset is that they require construction of a raised floor.

FAVORABLE APPLICATIONS FOR UFAD SYSTEMS

The best applications for UFAD systems are new construction projects which are located in cooling-dominant climates. New construction is favored because UFAD systems installed in new buildings are typically more cost-effective than retrofits. (Retrofit projects involving UFAD installation are less common, but these often involve projects which have issues with accommodating space for air ducts and other components due to restrictions in vertical heights.) Cooling-dominant climate is favored for applicability because UFAD systems have air distribution characteristics which provide maximum benefit when there is a long cooling season to optimize thermal comfort and energy efficiency. Generally buildings with high ceilings benefit the most from UFAD installations because there is more indoor air volume above the zone of occupancy which does not require conditioning.

UFAD systems often work well for office/administration projects which anticipate high churn rates (e.g., office re-configurations). This is because the raised floor feature provides easy access for all major power, telephone, cabling services which can reduce future costs for reconfiguring building services.

SCHOOL AND COLLEGE APPLICATIONS FOR UFAD SYSTEMS

School administrative buildings, classrooms, and school libraries are all excellent potential applications for UFAD systems. It is well established that the major advantages of the technology, including superior ventilation, thermal comfort and acoustical characteristics all benefit the learning environment.

However not all school projects are a "good fit" for UFADs. High school and college chemistry laboratories are not good applications because of high room pressurization requirements. School cafeterias, bathrooms and kitchens are problematical because they have high risk of spillage into the plenum.

THE PROS AND CONS OF UFAD SYSTEMS OVER BASELINE

The Pros

- Improved thermal comfort and occupant satisfaction
- Improved ventilation and indoor air quality
- More energy-efficient
- Reduction in supply fan power horsepower
- Floor plenum can create thermal storage effect
- Reduced life-cycle costs
- Better flexibility for reconfigurations
- Less HVAC noise from elimination of ducting

The Cons

- May have slightly higher capital costs
- Limited applicability for building retrofits
- Condensation problems in humid climates
- Spillage and dirt can enter the underfloor plenum
- Possibility of underfloor plenum pressure leaks

SUMMARY

UFAD systems offer many performance advantages over conventional HVAC systems, but the technology has not yet received widespread adoption in the U.S. One barrier is that the advantages for UFAD systems are fairly application dependent and climate-specific. For example, the advantages of the indoor stratification effect favor cooling dominant climates.

A major barrier to UFADs has been the perception that they are too costly even for new construction. This barrier will likely disappear in time as realistic initial and life cycle costs are better understood.

DSA
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REFERENCES & RESOURCES

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