Resources

- Reverberation Calculations through TechLine℠ at 1-877-ARMSTRONG
- Brinjac Engineering Research Study, “Energy and Environmental Effects of High Light Reflectance Ceilings in Offices,” 2006 at armstrong.com/performance
- CEU Courses at armstrong.com/ceu:
  - “Creating Sustainable Commercial Interiors”
  - “Acoustical Basics for Ceiling and Wall Systems”
  - “Speech Privacy in Office Design”
  - Additional CEU Courses available from your Armstrong rep.
- Armstrong Web site:
  - Product Selector Tool at armstrong.com/ceilings
  - Acoustic Design information at armstrong.com/acoustics
- “Office Acoustics: Attaining Speech Privacy In Open And Closed Plan Environments” (CS-3712)
- Your Armstrong Ceiling Systems representative at 1-877-ARMSTRONG

1-877-ARMSTRONG armstrong.com/ceilings

CS-3833-507 Printed in the United States of America

Armstrong®

CEILING | SYSTEMS
[Between us, ideas become reality.]®

The impact of acoustical ceilings on workplace environment, energy savings, fire safety and construction costs

Armstrong®

For years, suspended ceilings were known primarily for their functional value. They were a way to cover up pipes and cables, while providing convenient access for maintenance. Today, those same suspended ceilings offer much more.

In order to substantiate the performance of suspended ceilings in such areas as acoustic environment, energy savings, fire safety, and construction costs, a number of studies have recently been conducted. Their findings are summarized below.

ACOUSTIC ENVIRONMENT

Over the years, study after study has measured employees' satisfaction with their workplace environment and the results have continued to point to noise as a major cause of reduced effectiveness, higher stress and declining job satisfaction.

Exposed structure designs, meaning those that use no ceiling and reveal building service elements such as the ductwork and piping, can cause acoustic problems because sound reflecting off the deck above results in excessive reverberation.

Any large space of this type will usually need some sound absorption to control overall noise levels. In addition, if the exposed deck is less than 15 feet high, reflections between open plan cubicles can cause distractions for the occupants.

Many noise issues related to exposed structure designs can be addressed through the use of acoustical canopies and clouds, two types of "free-floating" ceilings.

Figure 1 documents the difference in reverberation time and the overall level of sound that the installation of acoustical clouds can make in an exposed structure space. (Reverberation time is a measure of the time required for loud reflected sounds such as a handclap to become inaudible.) The results for a continuous or "wall-to-wall" ceiling are also included for comparative purposes.

Figure 1: Reverberation Time

	Reverb time	Reverb reduction	Sound reduction
Exposed structure (No ceiling)	3.4 seconds	Baseline	Baseline
Acoustical clouds (50% ceiling)	1.1 seconds	67%	2.0 decibels
Continuous ceiling (10' height)	0.5 seconds	85%	5.0 decibels

50' x 100' exposed structure, 15' to deck, windows two sides, commercial carpet

ENERGY SAVINGS

In general, increasing the reflectance of a ceiling has a very positive impact on the lighting and HVAC energy use of a building, especially when used in conjunction with an indirect lighting system.

To investigate the effects of increasing the ceiling reflectance, Brinjac Engineering, a multi-discipline consulting engineering firm based in Harrisburg, PA conducted two studies.

Finding: Compared to a 75% reflective ceiling, a 90% reflective ceiling achieved an average reduction of nearly 24% in lighting energy costs when used with indirect lighting. (See Figure 2.)

Figure 2: Energy Cost Savings

Ceiling light reflectance	Work Plane illuminance (footcandles)	Reduction in lighting energy costs
75%	52.0	Baseline
80%	56.1	7.9%
85%	60.2	15.8%
90%	64.4	23.8%

60'x60'x10' open office, 12' luminaire spacing

In addition, a 90% reflective ceiling allowed spacing between indirect luminaires to be increased, thus reducing the total number of luminaires needed to achieve light levels similar to the 75% ceiling.

Finding: Reducing the number of lighting fixtures lowers the heat load on the HVAC cooling system. Compared to a 75% reflective ceiling, a 90% reflective ceiling reduced annual HVAC energy costs up to 9.1% for an indirect lighting system and 7.4% for a 2'x 2' recessed parabolic troffer system, depending on geographic location.

Tax Deductions

High light reflectance ceilings also have an impact on the Energy Policy Act of 2005 (EPAct 2005), which establishes a tax deduction for expenses incurred for energy-efficient commercial buildings.

Lighting systems are one of the focuses of the act because of their ease and availability of upgrading, and the known achievements in energy efficiency that will be gained. The tax deduction for lighting systems can be as high as 60¢ per square foot. In the case of publicly owned buildings, it is the architect who can claim the deduction.

LEED® Credits

In addition to energy savings and tax deductions, high light reflectance ceilings can also contribute to LEED points in the Energy and Atmosphere category under EA Credit 1.0. In the Brinjac study, for example, energy points were achieved by simply increasing the light reflectance of the ceiling.

Ceilings can also be a factor in the Indoor Environment Category under EQ Credits 8.1, 8.2 because high light reflectance ceilings can "extend" daylight into a space.

Ceiling systems can also contribute in the Materials and Resources category in Construction Waste Management, Recycled Content, Local/Regional Materials, and Rapidly Renewable Materials.

FIRE SAFETY

The ceiling represents a significant percentage of a room's surfaces, and is critical to controlling the growth of a fire within a room or space.

However, the elimination of suspended ceilings in building design continues to grow. While building codes and insurance interests do not prohibit these exposed structure or "no ceiling" concepts, going beyond the code by installing a suspended ceiling can provide an extra margin of fire safety.

Ceiling Provides Separation

When a suspended ceiling is eliminated from a building, there is no longer a physical separation between the elements of the building services and the occupied room or space below.

In contrast to an exposed structure design, an Underwriters' Laboratories (UL) fire resistant rated ceiling system not only provides that separation but also a known, specified fire resistance period.

However, even a conventional acoustical ceiling can provide a limited degree of fire resistance. That's because most fires start small, and may be controlled early by the sprinkler system. A conventional ceiling may thus remain intact and provide resistance to the movement of smoke, fire gases, and spread of flame into the space above.

Smoke Detector/Sprinkler Activation

A recent study on smoke detector and sprinkler activation time by Hughes Associates of Baltimore, MD demonstrates the difference ceiling height makes. (See Figure 3.)

Finding: In building spaces where a ceiling is not in place, the height of the space is normally greater and the size of the fire will be larger at the time of smoke detector or sprinkler system activation.

When a suspended ceiling is used at a typical ceiling height, smoke detection and sprinkler systems will activate faster, providing earlier warning for escape and allowing the sprinklers to react to a much smaller fire.

Figure 3: Activation Times*

	Boutique Retail	School/ Restaurant	Big Box Retail
Increase in ceiling height	From 15' to 25'	From 9' to 20'	From 15' to 25'
Fire growth rate	Medium/ Fast	Slow/ Medium	Medium/ Fast
Average time for smoke detector activation	60-70% longer	80-100% longer	83% longer
Average time for sprinkler activation	21% longer	29% longer	30% longer
Average fire size	48% larger	55-68% larger	73% larger

*Compared to a space with a suspended ceiling at a typical ceiling height.

In addition, sprinklers are generally designed with the assumption they will be located under a continuous ceiling without obstructions like those created by the ductwork, beams, trusses, pipes, etc. in exposed structure areas. Sprinklers installed in a continuous ceiling thus improve the chances of reliable performance during a fire, thereby reducing the potential threat to the occupants.

CONSTRUCTION COSTS

From a cost perspective, it would appear that first time construction costs for an exposed structure design would be lower than those for a suspended ceiling. However, that is not necessarily the case.

Research by Project Time & Cost, Inc., a cost consulting firm based in Atlanta, GA found that while it is possible to design an exposed structure that has cost savings over a suspended ceiling, those savings are often negated, to varying degrees, by changes to the building service elements for aesthetic and functional reasons.

While the cost of installing suspended ceilings is well known and budgeted, the added cost of no ceiling is usually buried in larger contracts for painting, mechanical, electrical, plumbing, and fire safety, and not as visible.

Moreover, contractors are not always aware of the need to bid exposed structure jobs differently than those with a suspended ceiling. Then, they are surprised by requirements that their work meet a greater level of aesthetic "finish."