



information

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What's Your IAQ I.Q.?

There's a lot of talk these days about indoor air quality (IAQ).

More and more, commercial, industrial, and residential designers and builders are paying attention to the condition of the air in the buildings for which they're responsible.

Architects, engineers, and builders are becoming more proactive in assuring IAQ, as highly publicized "sick" buildings have resulted in costly remedial work and litigation.

Worries about the growing incidence of asthma in some populations, and the potential concentration of airborne allergens in energy-

efficient closed-system buildings, has brought new attention to construction materials.

And architects, engineers and builders are finding that their clients increasingly demand "green" structures—those designed to minimize their impacts on the environment in many aspects.

Concrete always has been the best choice for "green" building, but concrete also is the best building material for forestalling sick building syndrome. Concrete reduces out-gassing of indoor air pollutants. And because concrete structures are more energy efficient, they lower emissions from furnaces.



Unlike many materials, concrete reduces out-gassing of harmful indoor air pollutants.

Pollutants Moving Inside

The issue of indoor air quality is a serious one. Indoor air can be a complex chemical cocktail of pollutants that "outgas" from building materials, paints, carpet, adhesives, office equipment, and consumer products.

Levels of indoor pollutants are linked to the presence and potency of pollutant sources, the volume and mixing rate of air in enclosed spaces, moisture vapor and temperature, air exchange rates, pollutant interaction and reactivity rates, and outdoor air quality levels.

Ironically, even as outdoor ambient air has become cleaner, indoor air has deteriorated. Recent research indicates that pollutant levels in the air inside our homes and offices may be two to five times higher than the air outside. Since people spend 75 to 90 percent of their time indoors, the quality of the indoor air is of concern.

"Indoor air quality should be maintained at levels expected to protect occupants from





adverse health effects and discomfort,” said the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

“Indoor air quality in buildings often does not meet the levels desired by the occupants. . . . Buildings have been made tighter, ventilation rates have been reduced, and many new contaminants have been detected or introduced into the indoor environment,” ASHRAE said in a position paper. “These factors tend to increase the concentration of air-borne contaminants indoors.”

But there are other factors at work as well. “New construction techniques and new materials, machines, and consumer products have been introduced ... some of which out-gas more pollutants,” ASHRAE said.

Construction and remodeling is rife with products that produce VOCs and other pollutants in quantities that overtax existing HVAC systems, said the Environmental Protection Agency in its March 1998 publication, *Building Air Quality: A Guide for Building Owners and Facility Managers*.

These can include installation of new particle board, partitions, carpet or furnishings; painting; reroofing; and demolition. “Reduce source[s] by careful materials selection and installation,” EPA urges owners, who should “select materials to minimize emissions of contaminants while maintaining adequate safety and efficacy.”

Concrete Fits the Need

If the right construction materials are important to preserving IAQ, then concrete should be the architect's or specifier's first choice. New research (1998) by the University of Western Ontario shows that concrete—even when produced with performance-enhancing admixtures—best serves indoor air quality.

The research paper—*Concrete's Role in the Indoor Air Environment*—shows that concrete made with a water-based form-release agent, a water-reducing admixture, a superplasticizing admixture, an air-entraining agent, and a waste fuel-derived cement, all emitted VOCs at rates well below those of other building materials (See table on next page for a sampling of results.).

Those made with a chemical-based form-release agent and a cure-and-seal agent emitted VOCs similar to other building materials, but these rapidly dropped off with time, and do not appear to pose a potential health risk.

In addition, the VOCs emitted from the concrete samples are not suspected carcinogens, while VOCs from other materials are more toxic.

To maintain IAQ, a paper from the Centre for Building Studies, Concordia University, Montreal, recommends that inert building materials such as ceramic tiles or concrete be used instead of synthetic floor coverings like carpeting.

The Chemical Cocktail: Construction-Related Indoor Air Pollutants

While there are many indoor air pollutants, only a few are related to building materials. However, they are among the most significant compounds contributing to indoor air quality problems. Use of concrete as a building material can preclude introduction of these pollutants into the indoor environment. These pollutants include:

Volatile Organic Compounds (VOCs). These are organic vapors which degrade indoor air. Over 300 VOCs have been identified in indoor air at concentrations exceeding 1 part per billion (ppb). Some of the most common VOCs are *ethylbenzene*, *benzene*, *xylenes*, *styrene*, and chlorinated solvents such as *carbon tetrachloride*, *methylene chloride*, and *chloroform*.

Consistently, VOCs are found in elevated concentrations indoors compared to outdoors. Their sources include building materials, but also consumer products, cleaning solvents, paints, adhesives, and indoor combustion sources.

Formaldehyde. Formaldehyde is an irritating gas found in much greater amounts inside as opposed to outside. It's so potent that in liquid form it's used as a preservative for biological specimens. Strengths in excess of 100 ppb are measured in many indoor environments. Major sources of formaldehyde indoors are insulation and processed, pressed wood products, but also furnishings, textiles and consumer products.

Asbestos. These are calcium magnesium silicates in fibrous form, previously used as a functional fireproofing and insulating material. Asbestos release into indoor air depends upon the integrity of the matrix containing it. Removal of potential indoor asbestos sources may not be appropriate because removal itself may introduce asbestos into the air.

IAQ Worse in New Homes

The energy crisis of the 1970s precipitated a fall-off in the amount of air moved in buildings. Current concerns over energy efficiency as well have often reduced ventilation to the point of causing indoor air quality complaints. Newly constructed homes can be the worst offenders, having significantly elevated VOCs and poorer IAQ, EPA-funded research has shown.

In 1993, the Lawrence Berkeley National Laboratory (LBL)—with additional funding by the Department of Energy’s Office of Building Technologies—began investigating indoor air quality in five new houses in the eastern United States.

LBL’s Indoor Environment Program found that for these energy-efficient homes, ventilation rates ranged from 0.07 to 0.4 h⁻¹ (air changes per hour) with a median value close to 0.2 h⁻¹, indicating that these houses have tighter “envelopes” than older housing and that new building techniques have improved building tightness.

Concentrations of airborne organic contaminants were measured in the houses. The median concentration of total VOCs in the houses was 2.4 mg/m³, well above the median concentration of 0.7 mg/m³ typical of a population of about 600,000 homes as determined in an EPA study.

“One possibility is that structural components consisting of natural lumber, laminated lumber, plywood, and oriented strand-board are the dominant sources,” LBL reported. “These wood products are the most logical sources of terpene hydrocarbons, aldehydes, and acetic acid. Because they are present in a house in large amounts, they may form a sizable chemical reservoir that could be a source of contaminant emissions over extended periods.”

These problems of persistently elevated VOC concentrations and odors may be common in new houses built with current construction materials and techniques, the report said. Ways to reduce emissions might include modifying new housing materials.

The problem of improving IAQ is not limited to residences. “Sick buildings” have been the bane of some architects and building engineers. A “sick building” is one in which more than 20 percent of occupants report illness perceived as being building-related. These complaints routinely include eye, nose and throat irritation, dryness of

Building Material	VOC Concentration (mg/m ³)	VOC Emission Rate (mg/m ² h)
Felt carpet	1.95	0.080
Linoleum	5.19	0.22
Sheet vinyl flooring	54.8	2.3
Particle board	N/A	2.0
Gypsum board	N/A	0.025
Plywood paneling	N/A	1.0
Acryl latex paint	2.00	0.43
Epoxy, clear floor varnish	5.45	1.3
Silicone caulk	N/A	<2.0
Plastic silicone sealer	77.9	25.0
Putty strips	1.38	0.34
Water-based EVA wall and floor glue	1,410.0	271.0
PVA glue cement	57.8	10.2
Concrete with water-based form-release agent	0.018	0.003

Concentrations and emission rates of VOCs for common materials.

mucous membranes and skin, nose bleeds, skin rash, mental fatigue, headache, cough, hoarseness, wheezing, nausea, and dizziness.

Sick Building Syndrome is associated with new types of building materials, lowered volumes of ventilation, and enhanced air-tightness of a structure.

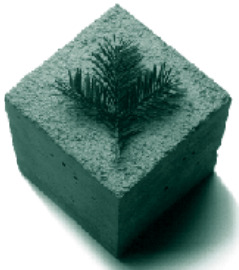
Concrete Meets IAQ Challenge

The Canada Mortgage and Housing Corporation (CMHC) has worked with a variety of vendors and associations to identify the elements of “Healthy Housing.” Its Healthy Housing fact sheets look room-by-room at features that make for healthier homes for buyers and the environment, and those elements include concrete and concrete products.

“More durable materials such as poured-in-place ready mixed concrete, concrete block and tilt-up concrete can save resources and costs, especially when the costs of reinstallation are considered,” CMHC said. “Use [of] locally produced materials reduces the load on the transportation system, conserving resources and reducing atmospheric emissions.”

Concrete floors can be a real benefit, CMHC said. “A low-emission water-based sealer will provide a low-maintenance finish to the concrete floor while eliminating concrete dust.” A high-performance, rigid-board waterproof insulation, placed under the concrete slab, will help raise the temperature of the floor slab and increase comfort.

In addition to reducing outgassing of VOCs and other indoor air pollutants, the walls of a



Consortium to Explore Building Materials, IAQ

Our understanding of building materials emissions and their relationship to IAQ will grow, thanks to the Consortium for Material Emissions and Indoor Air Quality Modeling, at the Institute for Research in Construction (IRC), National Research Council of Canada, Ottawa.

IRC has launched a five-year research project, whose goals include development of guidelines for selecting building materials and furnishings, and determination of ventilation strategies for buildings being designed or retrofitted to meet a specified indoor air quality level.

The IRC team will develop ways to measure the emission characteristics of building materials and furnishings under both laboratory and field conditions; develop models for predicting the concentration of contaminants generated by various building materials and furnishings; and develop a database of these measured emission characteristics.

State-of-the-art facilities for use at IRC—developed with broad industry support—include a full-scale test chamber for measuring the emissions from complete assemblies, furniture pieces, or a complete office workstation; and a new small-scale test chamber for measuring the emissions from material samples.

concrete building provide first class sound proofing, with a sound transmission class rating of about 48, according to the wall system used. Perhaps even better, concrete is virtually vermin-proof.

Because of their high thermal mass, concrete homes and buildings are more energy efficient than those made of other materials, needing less energy to heat and cool. This can reduce the amount of atmospheric emissions produced by fossil-fueled power plants. And thermal mass means that less VOC-emitting insulation need be used to keep buildings warm in winter.

Use of textured concrete block can provide an aesthetic indoor wall treatment that can preclude the use of VOC-emitting paints or wall treatments. Because concrete is inert, it requires no VOC-based preservatives like wood. It's naturally waterproof and fire-resistant, so it doesn't need special coatings or sealers, which release indoor pollutants.

For home and building construction, concrete can be utilized with insulating concrete forms, concrete masonry, aerated concrete, tilt-up concrete, and precast concrete products. They all share concrete's best virtues of workability, beauty, strength, durability, low

maintenance, energy efficiency, environmental friendliness, and peace and quiet.

Home Buyers Going Green

In the meantime—even as new homes pose greater IAQ problems—more than ever, new home buyers want “green” elements incorporated into their purchases, and that also favors concrete.

According to *Professional Builder* magazine, more than 60 percent of buyers want “healthy house” features in their new purchase, and 25 percent say that it is important to buy a home constructed with green methods (i.e., less wood and more recycled materials).

Of the top elements in a new home to make consumers consider moving, third is more energy efficiency, with 22 percent of home buyers, *Professional Builder* reported. Certainly, green building represents a value-added element for the homebuilder and designer.

Concrete always has been a great choice for green building, but concrete also is the best building material for maintaining optimum indoor air quality. Let extensive use of portland cement concrete and concrete products help you and your customers breathe easier.

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The Environmental Council of Concrete Organizations is a coalition dedicated to promoting the environmental benefits of concrete and its role in safe and sustainable construction.

ECCO members are companies, organizations, and individuals affiliated with the concrete industry. Together, they are committed to developing and disseminating information on the environmental benefits of concrete and concrete products.