This paper was written at the request of the Canadian Government regarding a study they are conducting on concrete. It is very interesting and informative.

Thank you for this forum to give voice to the many human benefits to be gained from the proper utilization of building materials.

Concrete being the second most consumed item in the world behind only water, 19 Billion Tons were placed last year, deserves more than a cursory examination of its health concerns and the many positive benefits it can bring to a home, school, commercial building, the occupants and the community in which we live.

We work, go to school and receive our healthcare inside of buildings constructed primarily of concrete. Our average home is made up of 25% concrete.

In order to make concrete workable it has an abundance of water in excess of what is required for its chemical reaction to take place. This excess water is called free water or water of convenience. As some of this free water is expelled early in the hydration process it forms bleed channels (streams) in the concrete.

Cement and concrete production are virtually unchanged since 300 BC, there are however some modern technologies that can improve concretes sustainability and its impact on society.

There are three flaws in conventional concrete that are correctable with the proper use of a well established technology.

- Free water entering occupied space

    - Moisture creates the opportunity for the growth of mould & bacteria
- Bleed channels provide a perfect path for water and damaging chemicals to enter concrete
- Bleed channels provide a perfect path for external water intrusion into an occupied space

Portland cement is the most important and primary ingredient in concrete. The production of Portland cement requires intense heat, 6 million Btu's per ton, which means a full concrete truck has Portland cement in it that was created using 18 Million Btu's of energy. A 50,000 sf building would require 2.9 Billion Btu's.

For this and a myriad of reasons it makes sense to enhance concrete and increase its longevity to make it as sustainable as possible.

The bleed channels formed in conventional concrete are the route of moisture migration and the route of external intrusion. Properly enhanced concrete does not have these bleed channels, denying external intrusion which is where salts and other materials, including water in the freeze thaw cycle, enter into the slab and destroy it.

Porosity is the enemy of concrete; this is particularly true of concrete exposed to the elements. Time, energy and money are constantly being expended to repair roads and bridges that could be better directed if the concrete was enhanced by a closed capillary system.

Bituminous roads require ongoing repair and replacement programs; the US is spending $27 Billion on wasteful road programs. As this material is petroleum based with a very limited life-cycle it seems a

questionable decision to continue on this path. Increasing pressure on budgets is encouraging local authorities to go for short-term fixes.

It is time to think long-term and avoid false economies. Enhanced concrete roads cost approximately twice as much as bituminous, however the life cycle is estimated to be 20 times longer/less expensive, clearly a quality choice that should be made.

A 50,000 square foot 2 story building with concrete exterior walls has 27,500 gallons of water trapped in the concrete at the start of its functional life. Over 70% of this water will leave the slab in the form of moisture vapor emission in the first 6 months and enter the occupied space setting up the potential for the growth of Mould & Bacteria. The balance of the moisture will emit slowly over many years.

“Indoor Environmental Quality,” (IEQ) as the name implies, simply refers to the quality of the air in a building environment. Occupants are often concerned that they have symptoms or health conditions from exposure to contaminants in the building. Research shows respiratory symptoms and illnesses are associated with damp buildings. The relationship between dampness, the various spores and its effect on IEQ are not completely understood at this time. It is however a well accepted fact that the elimination of moisture from this equation vastly improves the IEQ and has been shown to eliminate respiratory symptoms and active illnesses such as asthma attacks.

Ample data and studies are available from the CDC, Oxford, Yale and a host of reputable organizations as to work place VOC exposure from building materials, their alteration of indoor chemicals and their effect on human beings.

- Of the new-onset asthma cases in adults, 15-23% are work related asthma [American Thoracic Society 2004]
- Approximately 50% of the 89 million indoor environment workers (US only) have building-related symptoms of eye, nose and throat or headache and fatigue
- 14.1 million school days were lost in 2001 due to Asthma/Allergic symptoms
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The points above very briefly highlight some of the issues related to indoor environmental quality. It has been estimated that indoor environmental quality-related health issues cost businesses in the range of $20–70 billion annually due to lost productivity, decreased performance, and sick absences. Some of these health effects include respiratory issues that could fall under the classification of work-related asthma. Work-related asthma is a subset of occupational lung disease which can be further subdivided into occupational asthma, which can be caused by exposure to a sensitizer or irritant at work, and work-exacerbated asthma, which is when pre-existing asthma becomes worse due to exposures at work. Sensitizers and irritants effects are exacerbated by moisture and a damp environment.

Investigators, searching for specific causes of these increasing complaints, have ascribed the effects to both biological (for example, fungi or endotoxin) and chemical (volatile organic compounds [VOCs]) exposures (Brightman and Moss, 2000).

Commercial and institutional buildings are built primarily from concrete and additional cementitious materials.

Mold is a serious health hazard in the home environment, as it produces allergens, irritants, and in some cases, potentially toxic substances. Further, mold can trigger respiratory problems such as

asthma in vulnerable and allergic populations. Therefore, preventing and eliminating mold problems is a crucial part of ensuing quality housing conditions.

Controlling mold problems in the home environment is largely dependent on controlling the level of moisture in the home, because mold cannot grow without moisture. Further, excessive moisture in the home is cause for concern as it can also cause or contribute to structural home damage and other housing hazards to human health such as cockroaches, dust mites, and peeling lead paint.

We have a methodology to remove the free water from concrete and improving IEQ by eliminating moisture vapor emission and allowing the real use of no VOC adhesives and coatings in the construction process. Our concrete admix stops all external intrusion of water, vapor and gaseous materials by making the concrete impermeable. We also enhance the life cycle of concrete by closing the capillary system and improving performance, salt & chemical intrusion, abrasion resistance, efflorescence, etc.

With an open capillary system concrete allows the intrusion of external moisture vapor emission (MVE) into the occupied space further eroding IEQ. This is a problem for all exposed concrete slabs but the problem is exacerbated on or below grade where ground water “pushes” into the occupied space through the open capillary system in the form of MVE which condenses into water in the occupied environment. This is also an issue where rain driven and improper water management allow leakage through exposed vertical building slabs.

There are a number of water and vapor barriers that can be employed to mitigate this particular problem; however they are rife with pitfalls and environmental concerns.

In 1999 the US, EPA, through the Architectural and Industrial Maintenance coating act (AIM) reduced the level of allowable VOC's inside the building envelope. This was designed to improve indoor air quality (IAQ) and it was partially successful in that regard. The elimination of VOC's from primary building materials forced many products, paint, flooring adhesives and coatings prominent among them, to become water based.

This new water based reality wreaked havoc in the construction world that is continuing to this day. The painting world got a relatively quick handle on the solution, allowing the free water to pass through the paint into the occupied space, the impermeability of flooring materials have proven to be an insolvable issue with a no VOC chemical adhesive system.

The painting worlds "fix" of allowing the free water to pass through it into the occupied space does nothing positive for IAQ/IEQ.

As the solution for moisture is under the category of a remediation material it does not have the same strict VOC requirements, in fact the most popular, and not surprisingly most successful moisture remediation materials, contain VOC's and a variety of gaseous materials that force the use of a respirator during the application process. The buckets these materials come in must be recycled due to groundwater intrusion.

This material is classified as a level 3 moderate toxin.

As our quest for a better world continues to progress it has now been determined that VOC's need to be removed from all building materials.

Nitrogen oxides (NOx) are emitted by car exhausts, burning of biomass or lightning. When NOx and VOC's bake together in the sunshine they form low level ozone which is extremely detrimental to respiratory systems and crop production.

That in part is why VOC's must be eliminated from all building materials. This will force many products, roofing membranes, air barriers, sealers; anything you adhere to concrete through non-mechanical means will have an adhesive similar to what is being used for flooring, water-based, which has proven to be a disaster of immense proportions and the topical fix contains VOC's.

The enhancement of concrete that closes the capillary system and eliminates the free water will positively impact health and the human condition. The benefits of this technology are well known in the concrete world but have not become a part of our everyday experience due to the upfront cost involved.

Social conscience, litigation or legislation will be required to enact this positive change, the VOC reduction in building materials is a start but further action is needed.

A closed capillary system will increase the longevity of concrete, eliminating the effects of moisture intrusion and MVE.

Outline Review:

- Concrete dispels massive amounts of free water into occupied spaces
    - This erodes IEQ
    - Creates opportunity for Mould & Bacteria development
- VOC reduction

    - Problems with construction process
        - Present fix contains VOC's
        - Quality is compromised
- Concrete in occupied buildings allows moisture intrusion
    - Erodes IEQ
- Exterior concrete is compromised by open capillary system
    - Concrete must be repaired or replaced
        - Huge energy & Financial expenditures
- Stops free water from entering occupied space
    - No moisture, no Mould
- Closed capillaries disallow external moisture intrusion
    - Improves IEQ
    - Increases concrete life-cycle
        - Salt & Chemical intrusion eliminated
        - Freeze/Thaw damage eliminated
        - Abrasion resistance dramatically increased
- Allows the use of no VOC building materials
    - Improves IEQ
        - No VOC Topical applications required
    - Moisture related construction disruptions are eliminated
        - Building costs are decreased

Thank you for your interest, we would be pleased to give to your group a presentation to further clarify and discuss these important issues.

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Additional Information non-attributed:

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3. American Academy of Allergy, Asthma and Immunology
4. American Lung Association
5. CDC Control and Prevention
6. Indoor Air Quality in Connecticut Schools