The Unseen Enemy of Fresh Concrete Floor Surfaces

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This fall and winter a number of properly designed and well placed concrete slabs will be adversely affected by an unseen enemy. An enemy that can, within the first 24 hours of placement, silently and invisibly destroy to varying degrees the surface integrity of a concrete slab. As a result of its presence, concrete slabs may dust severely causing excessive wear or floor covering adhesion problems.

The Enemy

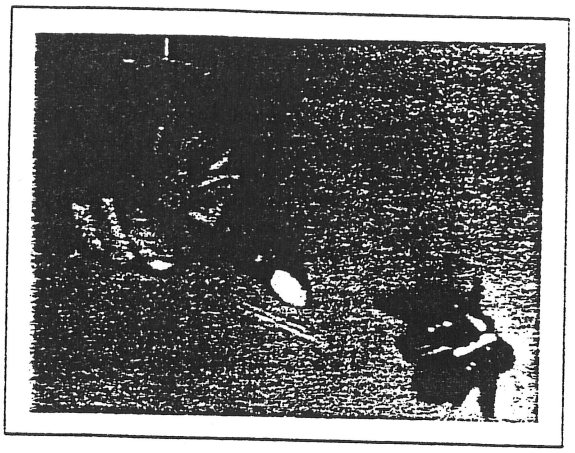
The unseen enemy is carbon dioxide (CO_2). CO_2 is created and may be present at levels detrimental to a freshly placed concrete slab through the use of many types of portable combustion heaters. Portable combustion heaters that burn wood, oil, gas, coal or coke are often used in cold weather concreting operations to elevate and maintain interior subgrade and ambient temperatures to levels above freezing. The types of units that are of concern exhaust measurable levels of CO_2 and do not provide for the continued exchange of air within the structure. In an enclosed area where the air is relatively still, the carbon dioxide exhausted can settle and concentrate near the slab surface. There it can react with the moisture present (H_2O) on the fresh concrete surface to form carbonic acid (H_2CO_3). The acid formed then combines with the hydrated lime (calcium hydroxide ($Ca(OH)_2$) created during the hydration of cement to form weak calcium carbonate ($CaCO_3$). The process is called carbonation and the soft surface layer created can reach depths of up to ¼". Even slight carbonation can cause serious and aggravating problems.

There is no reported threshold as to the amount of CO_2 that will damage fresh concrete. Kauer and Freeman[1] have reported tests at varying CO_2 concentrations. The results, even at the weakest test concentration (4.5%), showed carbonation occuring to depths ranging from 0.025 to 0.075 inch depending upon curing method. With exhaust gases from older propane fired heaters reported to contain between 5 and 8 percent CO_2, and oil burning salamanders between 12 and 15 percent, it is easy to see how CO_2 can reach potentially damaging levels.

Membrane curing compunds or sealers applied immediately following finishing operations have been shown to be effective in reducing but not totally eliminating carbonation. Specimens treated with a membrane curing compound and exposed to 4.5 percent CO_2 for 24 hours were carbonated to a depth of .025 inch, while moist burlap permitted carbonation to .057 inch.[1]

Prevention

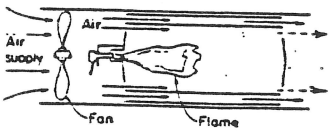
When transportable, temporary heat is required, the use of vented, indirect fired or modern direct fired natural gas or propane heating units capable of limiting CO_2 exhaust to 0.005% or below have proven most effective. These types of units are often placed outside the building with warmed fresh air entering through ductwork or by



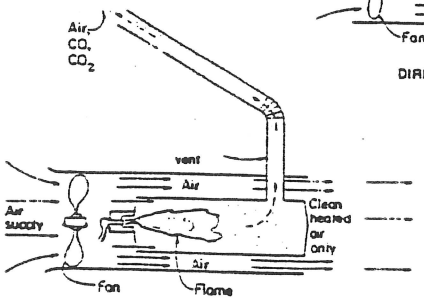
placing the nose of the unit through an exterior wall or opening. When placed inside a building either type of unit should be positioned so that the drawing end projects through to the outside or ductwork should be used to provide the incoming avenue for fresh outside air. In either case the continual introduction of fresh outside air, warmed through the unit, will increase interior air pressure to the point that continued air exchange is forced through small planned openings or through the many voids typically present during early stages of construction. When used inside the building indirect fired units must be carefully vented to the outside. Direct fired units that draw and recirculate inside air only or that exhaust high levels of CO_2 should not be considered. When found to be practical the building's own heating system or electrical units are also excellent in preventing carbonation.

Summary

The carbonation of fresh concrete slabs is a common, serious and often overlooked problem. The unpredictability of carbonation warrants careful consideration of temporary heating methods if good quality concrete floor surfaces are to be constructed during the late fall and winter.



DIRECT-FIRED HEATER



VENTED, INDIRECT-FIRED HEATER

Ref: [1] Kauer, J.A., and Freeman, R.L., "Effect of Carbon Dioxide on Fresh Concrete." Journal of the American Concrete Institute, Dec. 1955, pg. 447, Dec. 1956, Part II, pg. 1299.

Credits: Frank A. Randall, Jr., "Carbonation of Fresh Concrete Floor Surfaces," Concrete Construction, Nov. 1979.
Harold Coates