

A Brief History of Connecticut's Crumbling Foundations

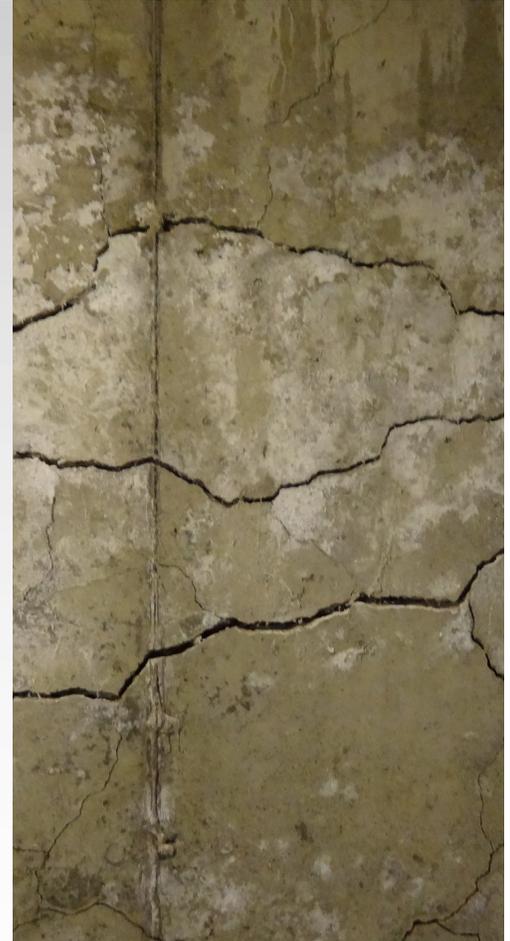
By Kevin E Miller

Starting at the Beginning...

The following is a brief introduction to the history of the crumbling concrete crisis...the source of the damage; in short, the extent of what we know. Media coverage, publications, and municipal records provide a wide range of information and results when portraying the number of Connecticut homes that could have pyrrhotite present in their concrete foundations.

Tolland, Connecticut—Ground Zero

Old Kent Road in this town was the location of the first reported crumbling foundation. In February of 1985 this Tolland home was constructed by a builder with a long-term business relationship with J.J. Mottes Company, the concrete supplier. In April of 1993, the owners noticed some cracking on the north and east side of the basement. The builder's response was to request that they simply keep an eye on it. Fast forward to 1995...and now a tremendous amount of cracking was in evidence, along with discoloration of the foundation. The changes taking place triggered additional testing, requiring cores for strength results, and in March of 1996 Materials Testing performed a petrographic examination (under a microscope) to determine the cause of the problem.
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Tolland, Connecticut—Ground Zero

(continued from page 1) The results indicated a water/cement ratio of more than 0.70. Concrete in that ratio range can easily be porous enough to absorb surrounding water or moisture. Industry experts were brought in to provide theories as to what could have been the source of these concrete defects. The extent of the foundation's discoloration as well as the general deterioration and extensive cracking left everyone wondering what was taking place. The first question they asked was "Was it the water used to make the concrete?" Additional questions came to mind, such as "Was the sand contaminated?" "Was there a problem during the production of the cement?"

No one could have anticipated at the time that it would be years before substantial evidence proved that it was in fact the mineral pyrrhotite that was the culprit.



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Pyrrhotite, The Slow Motion Disaster

When we mention the word “disaster” we are often referring to earthquakes, hurricanes, tornadoes, and other naturally occurring events. When the crumbling foundations disaster began to unfold, no one could have anticipated that a mineral found on every continent in the world and in most of our 50 states...in other words, a commonly occurring substance...would be the source and cause of so much economic loss. What was becoming apparent was that the pyrrhotite disaster was a naturally-occurring phenomenon,

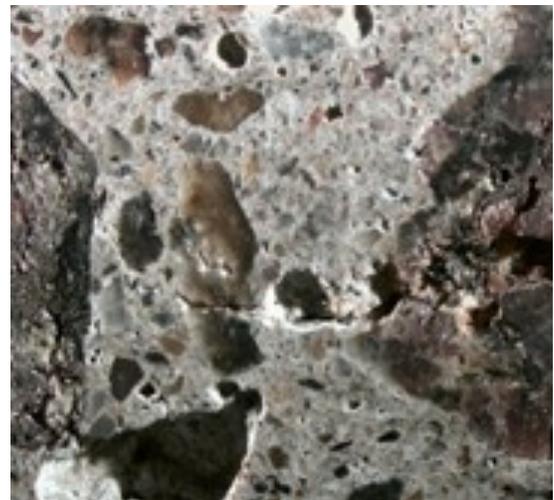
and a direct result of the reaction of moisture and oxygen coming in contact with pyrrhotite contained within the concrete itself. It was in fact the reaction which caused noticeable severe “map” cracking and material expansion, resulting in reduced strength of the concrete structure itself. Evidence began to emerge, and continues to emerge, that the timeline of concrete failure can vary considerably, beginning in as few as five years or more after placement.



Coring a Foundation Wall to Test for the Presence of Pyrrhotite in the Concrete

The Mystery Solved

A turning point in the history of this crisis occurred in 2008 when a petrographer in Ohio, Nick Scaglione, tested concrete samples from a Tolland residence and found pyrrhotite. The confirmed discovery of the mineral pyrrhotite and its known effects of sulfidic aggregates was firmly determined to be the cause of the delayed cracking, expansion, and crumbling concrete. Since the discovery of the source of the crumbling concrete, many laboratories, petrographers, concrete experts, engineers, and scholars have been involved in researching new test methods, repair procedures, and future prevention through quarry inspections. It became clear that the source of the problem was concrete supplied specifically by a company known as J.J. Mottes, located in Stafford Springs. It was also determined that the source of the aggregate used to produce the concrete was quarried in West Willington at Becker's Quarry. The Becker's Quarry aggregates were used as late as 2014, before an agreement was reached to stop its use in concrete. Although some commercial and transportation structures have shown minor signs of damage, most of the severe deterioration has been in residential homes located in almost 50 Connecticut towns. It's important to point out that the damage from this slow-moving disaster has seeped across the border into communities in Massachusetts.



Pyrite versus Pyrrhotite

Pyrite and Pyrrhotite are closely related sulfidic minerals that oxidize in the presence of moisture and oxygen. Pyrite and Pyrrhotite are the largest source of sulphide minerals in the Earth's surface layers and contained in rocks of all classes. Pyrite, also referred to as "fool's gold" is generally slower to react than Pyrrhotite yet both can be equally as damaging when used in construction materials. These minerals usually appear as concentrated bands within the host rock and become exposed to the atmosphere during quarry operations, crushing and finally, as an aggregate for use in concrete.



Pyrrhotite



Pyrite

Difficult to Predict a Timeline

The attack of sulfate on concrete is a very complex phenomenon and has been under investigation since as early as the 1920's. There are two distinct forms of sulfate attack categorized as internal or external. With external sulfate attack, the effect can include exposure to seawater, sewer effluents, harsh chemicals, and direct contact with soils or rocks containing sulfides.

With an internal attack...the type of attack most commonly associated with this crisis...the expansion, efflorescence, and cracking common with Connecticut's crumbling foundations is caused by an internal source of sulfate attack when the mineral pyr-

rhotite is exposed to moisture and oxygen.

The damaging effects on concrete move through different phases: the first being the oxidation of the iron sulfides, and secondly the sulfuric acid, as a by-product of the oxidation leading to the decaying of the concrete.

Simply stated, the transformation of the mineral pyrrhotite when exposed to oxygen and moisture causes a harmful attack on the cement used to produce the concrete foundation. The rate of deterioration is impossible to predict because of the great number variables in play.

In Conclusion

We've addressed, briefly, the past 27 years of this history of this crisis...since the first discovery of questionable concrete, the source of the problem, and the type of reaction associated with pyrrhotite. Currently many scientists, engineers, and construction experts are working hard to develop new testing methods and repair procedures to provide us with the answers we need going forward. Future articles will cover concrete basics, how to examine your concrete foundation, repair and replacement methods, and the various predictable stages of pyrrhotite damage.

A Note from CFSIC

Background and Qualifications of Kevin Miller

Kevin Miller has been employed in the concrete industry for the past 30 years. Kevin, well-versed and educated in concrete technology, troubleshooting concrete defects, and designing concrete mixtures for commercial and residential applications, is an industry veteran. Additionally, during his seven-year term as President of the Connecticut Ready Mix Concrete Association, he witnessed and was instrumental in supporting legislative changes and the incorporation of stricter quarry inspections to assure the long-term durability of concrete used in roads, bridges, and highways as well as in other commercial and residential uses.

Kevin continues to remain active in the industry as a consultant on Government projects and as a troubleshooter on residential and commercial concrete issues. CFSIC has engaged with Kevin to create the only comprehensive concrete failure training course available in the state of Connecticut. He continues to serve as consultant and advisor to CFSIC.

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