

The Dangers of Pyrrhotite Mineral in Concrete

Concrete is the most widely used construction material in the world. In the most basic form, its composition includes cement or lime, aggregate, which is gravel or crushed stone, sand and water. When properly mixed, water causes concrete to harden through a process called hydration. Additives may be mixed into the composition to achieve a desired effect, such as increased tensile strength or water resistance.

The lifespan of concrete varies based on climate, composition and cure time. Ancient Roman structures made of a volcanic form of concrete still stand today. Modern versions of the material have also stood the test of the time, such as Court Street in Bellefontaine, Ohio, which was poured in 1891. Despite its strength and durability, issues with this material do arise when the composition quality is compromised.

A compromising agent

A mineral known as Pyrrhotite [Pir-uh-tahyt] is linked to crumbling concrete foundations in Quebec, Canada and Eastern Connecticut. The issue, which may take decades to surface, occurred when local quarries included the mineral in their concrete mixtures. Over time, the iron sulfide the mineral contains can react with oxygen and water, leading to swelling and cracking.

The extent of this issue should not be taken lightly. In Canada, an estimated 1,700 residential homes are suspected of having Pyrrhotite problems. In Connecticut, there are several hundred cases and thousands are suspected of having foundations with material sourced from a quarry with this mineral.

Once a home is identified as having this issue, construction experts state that homeowners cannot repair the foundations—they must replace them. The estimated cost to replace a foundation ranges from \$150,000 to \$200,000 or more per home. Further adding to the gravity of this issue, homeowners insurance often doesn't cover the replacement cost.

How to mitigate this risk

Quality control is an important risk mitigation step in avoiding substandard materials, and concrete is no exception. A state's department of transportation often inspects the quarries that supply aggregate for roadways, but this may not be the case with those supplying aggregate strictly for residential construction.

When speaking with concrete contractors and quarry operators, ask the following questions:

- Does your organization follow Total Quality Management practices? Are you ISO 9001 certified?
- Is there a formal quality control program in place?
- Are quality control personnel trained and certified?
- Are testing facilities certified by the American Association of State Highway and Transportation Officials, ASTM International, or a similar qualifying organization?
- Are formal records maintained?
- Is the mined material tested for the presence of Pyrrhotite?

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Are the mined materials tested for:

- Safety – Friction testing
- Angularity – Fractured-face testing
- Hardness – LA abrasion test
- Durability – Soundness
- Absorption – Specific gravity

Finally, you should ensure that the following material tests are performed*Cement*

- Initial and final setting time
- Compressive strength test (three-, seven- and 28-days strength using mortar cubes)
- Percentage passing through a 75 micron sieve

Fine aggregate

- Particle size distribution (sieve analysis)
- Specific gravity
- Water absorption
- Moisture content determination

Coarse aggregate

- Sieve analysis
- Specific gravity
- Water absorption
- Moisture content determination
- Flakiness index
- Elongation index
- Aggregate impact value

- Aggregate crushing value
- LA abrasion test
- Ensure that a petrographic examination of rock is performed to ascertain the quality of the quarry material

Concrete

- Workability tests (slump test, compaction factor test)
- Compressive strength test (cube or cylinder)
- Ask if a determination of total chloride and sulfate content was made
- Ask if there is temperature monitoring of concrete using infrared digital thermometer or other device
- Ask if there are trial mixes prepared per design calculations in the initial stage of designing a mix in order to ascertain items such as desired workability and strength

Summary

As the unfortunate homeowners in Quebec and Eastern Connecticut will attest, you cannot understate the quality control program of an organization and product. Concrete in its myriad of applications must adhere to the quality control standards set forth by organizations ranging from ASTM International to the National Ready Mix Concrete Association. Quarries should test for the presence of Pyrrhotite and qualified contractors should ascertain that these and other tests were in fact made.

Sources: NRMCA - Preparation Guidelines for Quality Manual For Ready Mixed Concrete Companies; CivilConstructionResourcez.Wordpress.com - Some Important Quality Control Tests Commonly Conducted at Construction Sites, November 22, 2012.

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