

State Building Code: Pyrrhotite in Concrete Aggregate

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Issue

Does Connecticut's State Building Code (SBC) establish limits on the amount of pyrrhotite in concrete aggregate?

Summary

The SBC does not establish permissible levels of pyrrhotite in concrete or concrete aggregate. Under Chapter 19 of the SBC, concrete must comply with [American Concrete Institute \(ACI\) 318](#), a national standard that incorporates [ASTM C33](#), which is an industry standard for concrete aggregate. Neither ACI 318 nor ASTM C33 reference pyrrhotite. However, according to the Office of the State Building Inspector, ASTM C33's provisions on deleterious substances can be interpreted as prohibiting the use of concrete aggregate containing enough pyrrhotite to impact the integrity of concrete made with such aggregate. The SBC applies to most buildings or structures, whether residential, commercial, or public. However, it does not apply to state Department of Transportation (DOT) non-building projects.

DOT adopted standards for pyrrhotite in concrete aggregate used for its non-building projects (e.g., roads and bridges). The standard prohibits the use of aggregate that is more than 3% pyrrhotite, by mass. Additionally, no more than 5% of the aggregate, by mass, may be made up of deleterious material (organic or inorganic calcite, hematite, pyrrhotite, shale, clay, coal-lignite, shells, loam, mica, clinkers, or other organic matter). According to DOT, determining whether aggregate meets that standard is done through a visual inspection. If more than 3% of the aggregate looks rusty, DOT would reject it until further laboratory testing is completed. Since the standard was put in place

in January 2017, DOT has not had to request that any aggregate undergo laboratory testing for pyrrhotite. DOT's standard is contained in Appendix A.

As explained in OLR Report [2019-R-0220](#), it is currently illegal to knowingly use recycled material containing pyrrhotite to produce concrete for residential or commercial construction ([CGS § 29-265g](#)).

JSB:kl

**DIVISION III
MATERIALS SECTION
SECTION M.01
AGGREGATES**

- M.01.01—General**
- M.01.02—Coarse Aggregates**
- M.01.03—Fine Aggregates**
- M.01.04—Portland Cement Concrete (PCC) Aggregates**
- M.01.05—Bituminous Concrete Aggregates**

M.01.01—General

Each source of aggregate must be qualified for use by the Engineer as indicated in 1.06.01. Material from a qualified source is still subject to Project-level testing and may be subject to rejection as indicated in 1.06.04.

Aggregates must not have expansive or reactive properties. Aggregates reclaimed from pavements or structures may only be used where specifically allowed in the specifications.

Aggregate stockpiles must be located on smooth, hard, sloped/well-drained areas. Each source and gradation of aggregate must have an individual stockpile or bin. Stockpiles must be managed to minimize segregation and contamination with foreign materials.

M.01.02—Coarse Aggregates

Coarse aggregate must be uniform in consistency and only contain clean, hard, tough, durable fragments meeting the criteria in Table M.01.02-1.

TABLE M.01.02-1: Coarse Aggregate Criteria by Pit/Quarry Source

Item	Title	AASHTO Test Methods	Criteria
1	Material Passing No. 200 Sieve	T 11	1% maximum.
2	Loss on Abrasion	T 96	40% maximum
3	Soundness by Magnesium Sulfate	T 104	10% maximum @ 5 cycles

Standard sizes of coarse aggregate for applications other than bituminous concrete must meet the gradation requirements listed in Table M.01.02-2 as determined by AASHTO T 27.

Table M.01.02-2: Gradation of Standard Sizes of Coarse Aggregate

Square Mesh Sieves	Percent Passing by Weight					
	No. 3	No. 4	No. 6	No. 67	No. 8	No. 9
2 1/2 inches	100					
2 inches	90-100	100				
1 1/2 inches	35-70	90-100				
1 inch	0-15	20-55	100	100		
3/4 inch		0-15	90-100	90-100		
1/2 inch	0-5		20-55		100	
3/8 inch		0-5	0-15	20-55	85-100	100
No. 4			0-5	0-10	10-30	85-100
No. 8				0-5	0-10	10-40
No. 16					0-5	0-10
No. 50						0-5

M.01.03—Fine Aggregates

Fine aggregate must consist of clean, hard, durable, tough, uncoated particles free from lumps, meeting the requirements listed in Table M.01.03-1.

TABLE M.01.03-1: Fine Aggregate Requirements

Item	Property	AASHTO Test	Criteria
1	Grading		
	Portland Cement Concrete	T 11 T 27	3% maximum passing No. 200 sieve Table M.01.04-1
	Bituminous Concrete	T 27	100% Passing 3/8 inch, 95% Passing the No. 4 min.
2	Absorption	T 84	3% maximum
3	Plasticity limits	T 90	0 or not detectable
4	L.A. Abrasion	T 96	50% maximum (fine agg. particle size ≥ No. 8
5	Soundness by Magnesium Sulfate	T 104	15% maximum@ 5 cycles for PC Concrete 20% maximum@ 5 cycles for Bituminous Concrete
6	Clay Lumps and Friable Particles	T 112	3% maximum
7	Deleterious Material - organic or inorganic calcite, hematite, pyrrhotite, shale, clay, coal-lignite, shells, loam, mica, clinkers, or other organic matter (wood, etc.).	As determined by the Engineer	Must not contain more than 3% by mass of any individual listed constituent and not more than 5% by mass in total of all listed constituents.

Screenings and Dust must meet the requirements of Table M.01.03-2 as determined by AASHTO T 27.

TABLE M.01.03-2: Screenings and Dust Gradation

Square Mesh Sieves	Percent Passing by weight	
	Screenings	Dust
3/8 inch	100	
No. 4		100
No. 8	60-100	40-100

M.01.04—Portland Cement Concrete (PCC) Aggregates

In addition to the requirements in M.01.01 through M.01.03, the aggregates used in Portland Cement Concrete must meet the following:

All Aggregates: Coarse and Fine aggregates must originate from the aggregate producers and locations included on the Department’s Qualified Materials List (QML). The list is available on the Department’s web site www.ct.gov/dot. The criteria for inclusion in the QML are stated within the list.

Coarse Aggregate: Coarse aggregate of a size retained on a 1-inch (25 mm) square opening sieve must not contain more than 8% of flat and elongated pieces when tested in accordance to ASTM D4791 at a 1:5 ratio.

Reclaimed concrete aggregates must consist of clean, durable fragments of uniform quality. Materials must be from crushing or otherwise processing of concrete structures or portions thereof. Prior to demolition or removal, concrete structures must not exhibit signs of material degradation and be inspected by the Engineer. Reclaimed aggregate must be tested separately to confirm compliance with all requirements prior to blending with virgin aggregate.

Reclaimed coarse aggregate must not contain chlorides in excess of 0.5 pounds/cubic yard. Chloride content must be determined in accordance with AASHTO T 260, Procedure A. Regardless of chloride content, reclaimed aggregates must not be used in concrete for pre-stressed concrete members.

Fine Aggregate: Manufactured sand must be produced from washed stone screenings; stone screenings or gravel; or combinations thereof, after mechanical screening or with a process approved by the Engineer.

The fineness modulus of fine aggregate from a source must not vary more than 0.20 from the base fineness modulus of that source.

The fine aggregate must not produce a color darker than Gardner Color Standard No. 11 in accordance with AASHTO T 21.

Fine aggregates that fail to meet soundness requirements as specified in Table M.01.03-1, but meet all other requirements, may be used with the approval of the Engineer on a case-by-case basis. Typically concrete composing any surface subject to polishing or abrasion (i.e., wheel traffic or running water) will not be allowed to contain such material.

Gradation of each size aggregate must be within the ranges listed in Table M.01.04-1 as determined by AASHTO T 27.

Table M.01.04-1: Fine Aggregate Gradations

Sieve Size	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100
% passing	100	95-100	80-100	50-85	25-60	10-30	2-10

M.01.05—Bituminous Concrete Aggregates

In addition to the requirements in M.01.01 through M.01.03, the source of aggregates used in Bituminous Concrete must have a Quality Control Plan for Fine Aggregates (QCPFA) on file with the Engineer. The QCPFA must describe the locations and manufacturing processing methods used at the source. The QCPFA must describe how conformance to Items 1 through 7 in Table M.01.03-1 is monitored and what actions will be taken if nonconformance is observed. The QCPFA must be revised and resubmitted to the Engineer whenever the process, location, or manner of how the fine aggregate is produced or monitored changes. A source of fine aggregate may be suspended by the Engineer due to demonstrated noncompliance with the QCPFA or the consistent production of material that does not meet Project specifications as determined by the Engineer.