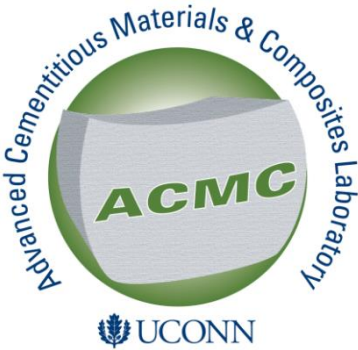


Development of a Risk Assessment Framework for Crumbling Concrete Foundations



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Professor and Department Head
Department of Civil & Environmental Engineering

Co-PI: Jim Mahoney

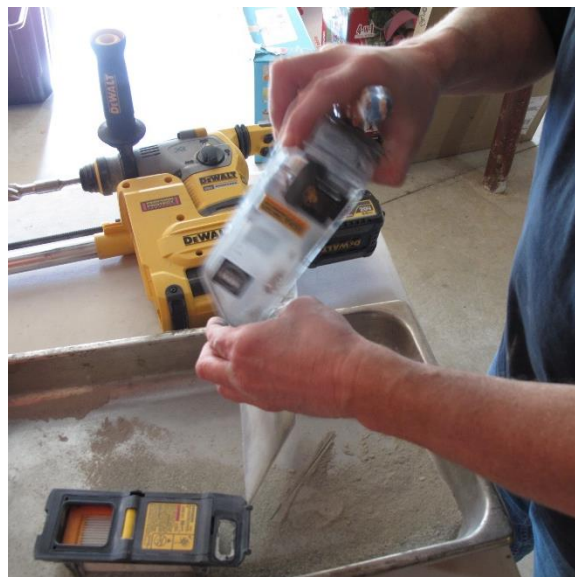
Director, Connecticut Advanced Pavement Laboratory
Assoc. Director, Connecticut Transportation Institute



- ❑ **Approximately 5 holes are drilled into the concrete from the inside**
- ❑ **Each hole is 1 inch in diameter and about 5 inches deep**
 - ❖ (Leaves 3+ inches of undisturbed concrete)
- ❑ **We don't damage any waterproofing on the outside of the foundation**
- ❑ **Collect the drillings from each hole and those are our samples for that house**
- ❑ **Clean out the hole and patch it using concrete patch material**
- ❑ **Entire process take 60 minutes or less**
 - ❖ Map the locations of the drill holes
- ❑ **No water is used in the drilling**
- ❑ **Looking for chunks of concrete from foundation replacements**
 - ❖ We will come and pick it up
 - ❖ james.mahoney@uconn.edu or 860.486.9299



Drilling method



Sample report table

Sample ID	Total Sulfur (S_T) average % by weight	Sulfate (S^{6+}) average % by weight	Sulfide (S^{2-}) average % by weight	Pyrrhotite (Fe_7S_8) average % by weight
W1 (wall)	0.31 ± 0.00	0.20	0.14	0.38
W2 (wall)	0.37 ± 0.01	0.23	0.17	0.46
W3 (wall)	0.43 ± 0.01	0.23	0.22	0.59
W4 (wall)	0.29 ± 0.02	0.21	0.11	0.31
W5 (wall)	0.45 ± 0.01	0.22	0.28	0.73

How to sign up for testing?

<https://crumblingconcrete.engr.uconn.edu/>

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Crumbing Concrete Research and Testing

HomeOur TeamOur MethodNewsRequest Form

Search this site...

Request Form

Name *

First

Last

Address

Street Address

Address Line 2

City

State / Province / Region

ZIP / Postal Code

Country

Email *

Phone

Year of Construction

Concrete supplier (if known)

Have you had a visual inspection performed by a licensed engineer? *

Yes

If yes, upload the report here (optional): field to upload PDF or Word file

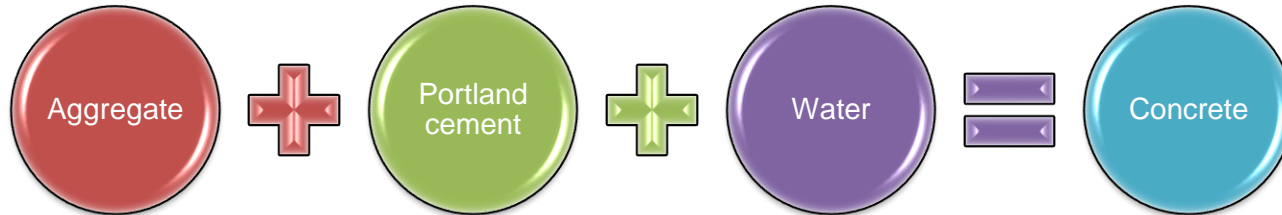
Choose File

No file chosen

Accepted file types: pdf, doc, docx, Max. file size: 10 MB.

- Other information available on the website:
- Research team
 - Test Methods
 - News

Sulfur sources and reactions in concrete



Normally no S

May contain sulfides in
pyrrhotite or pyrite
Some aggregates may contain
gypsum (not in CT)

0.6 – 1.8% total S as
sulfate

Gypsum added during
manufacturing

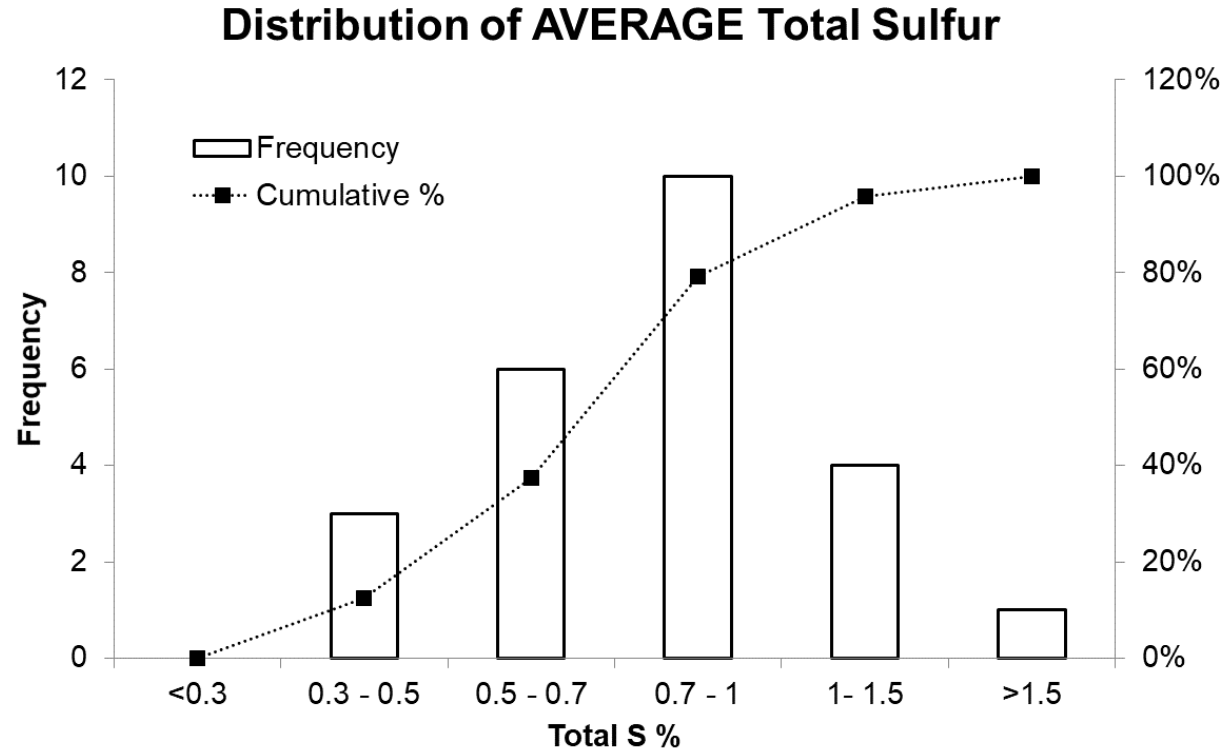
Initial mixing water
contains no S BUT
Concrete may be
exposed to water
containing **sulfate**
after placement

AVERAGE 0.17% total S as
sulfate from Portland
cement

PLUS S as sulfide from
unoxidized pyrrhotite

PLUS S as sulfate from
already oxidized pyrrhotite

Results from 25 houses (130 samples, 390 analyses) with replaced foundations

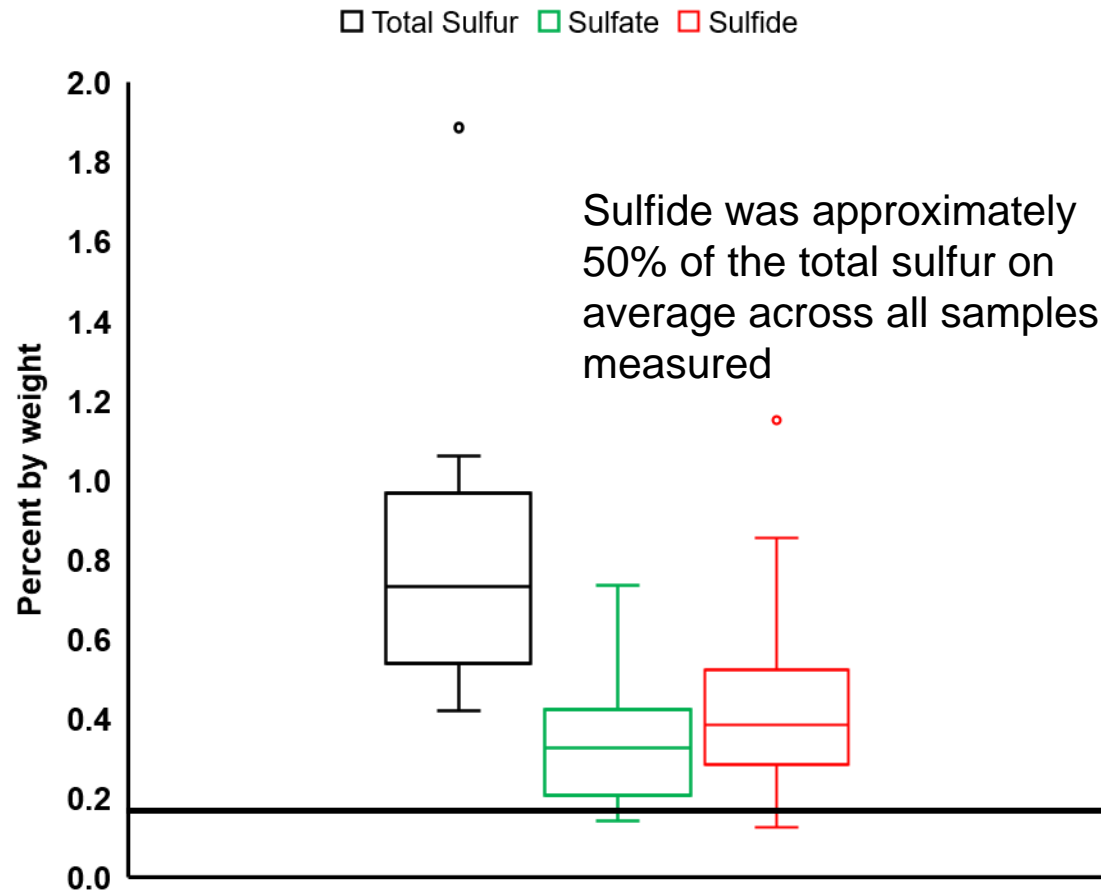


Very few homes (20% of all) have total S exceeding 1%

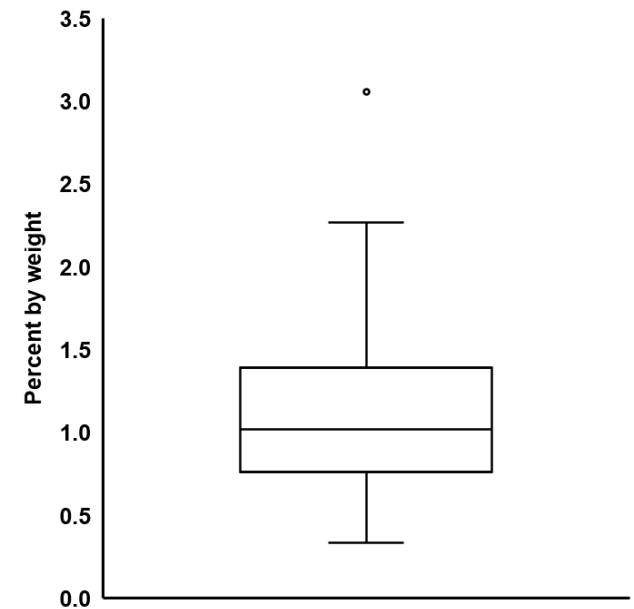
Most homes are in the range 0.5 to 1% total S, however there were three homes that had even lower total S concentrations

No home had total S below 0.3%

Distribution of sulfur species

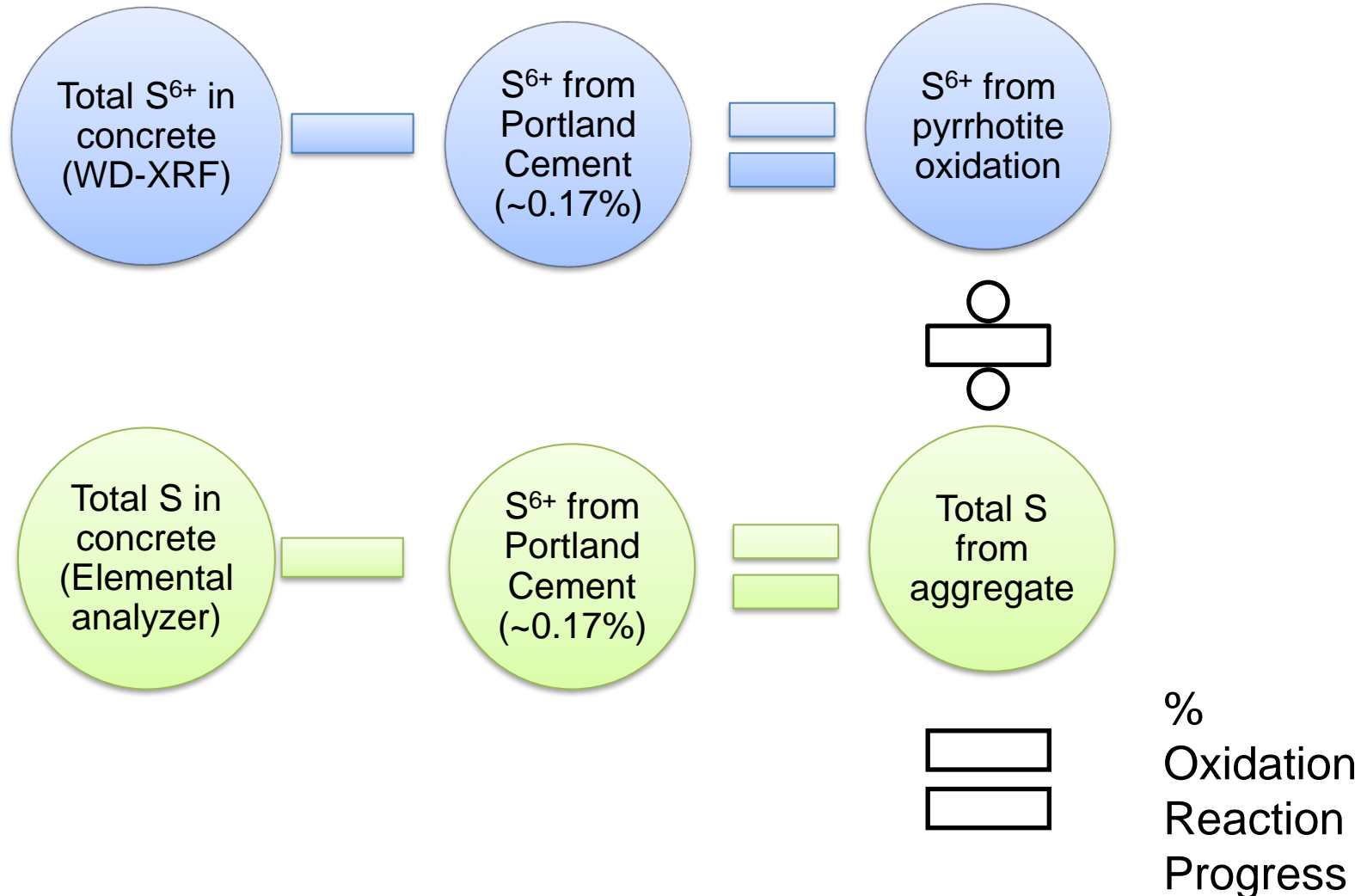


PYRRHOTITE IN REPLACED FOUNDATIONS



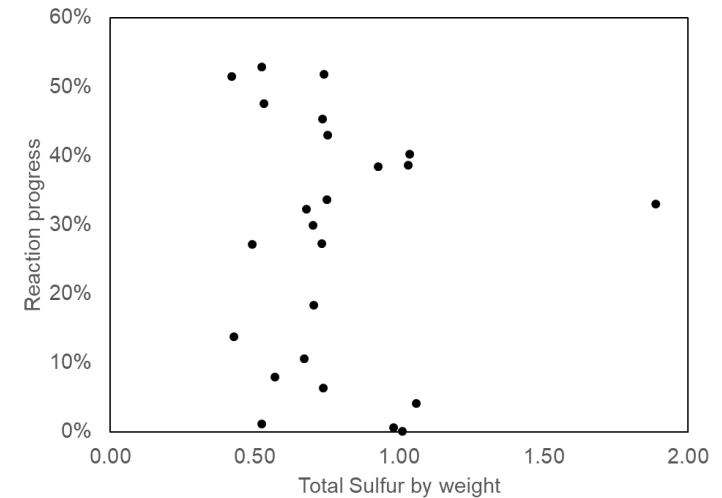
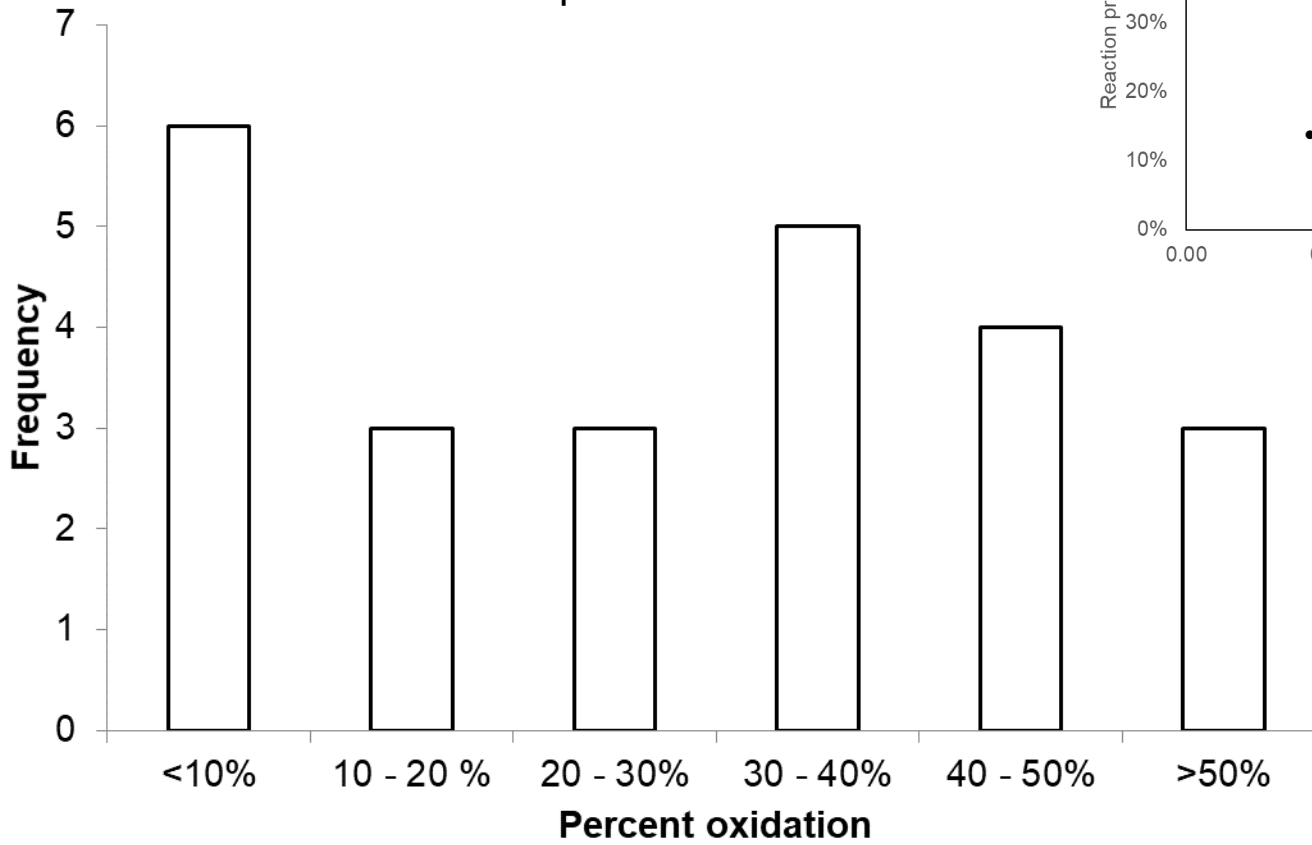
Sulfate from
Portland Cement

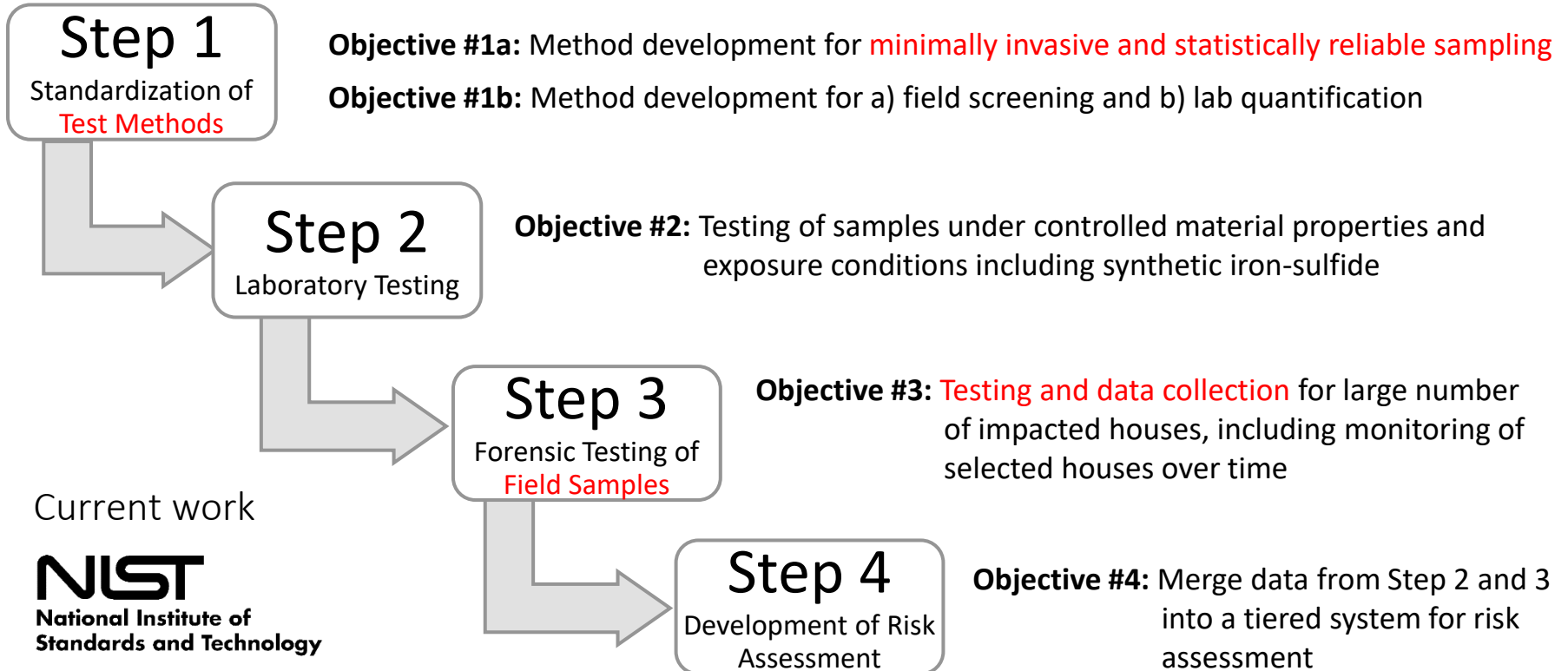
Evaluation of reaction progress



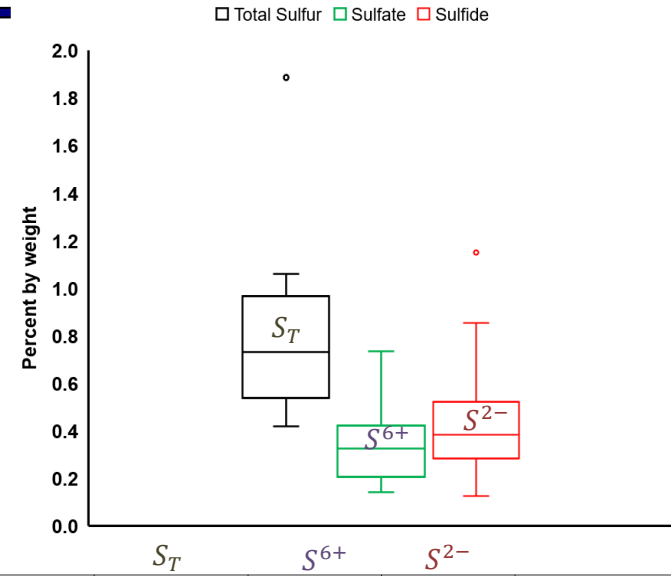
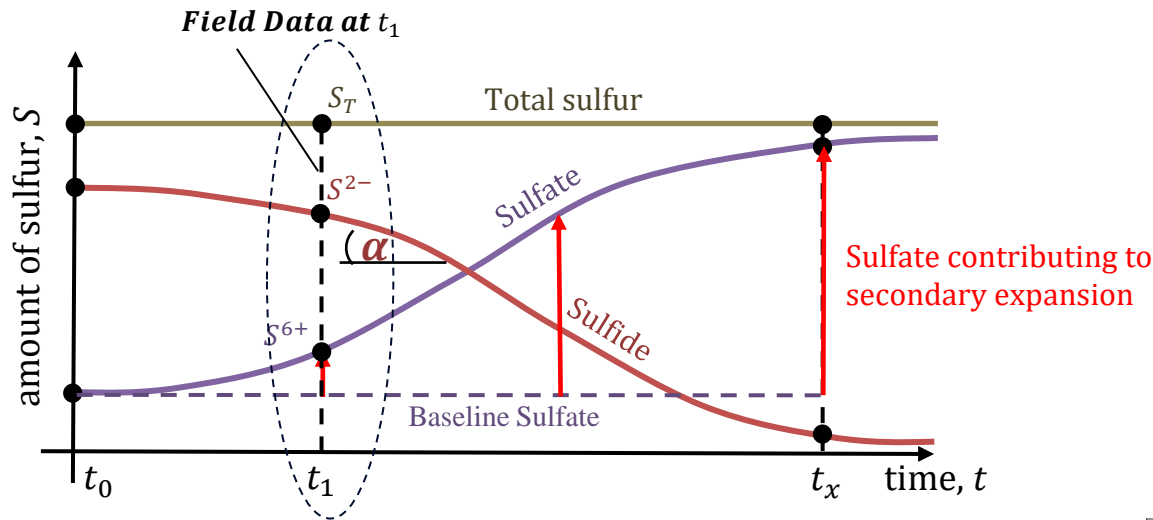
Reaction progress in replaced foundations

No clear trend, some homes have a lot of oxidation, some very little, with no clear relationship to total sulfur





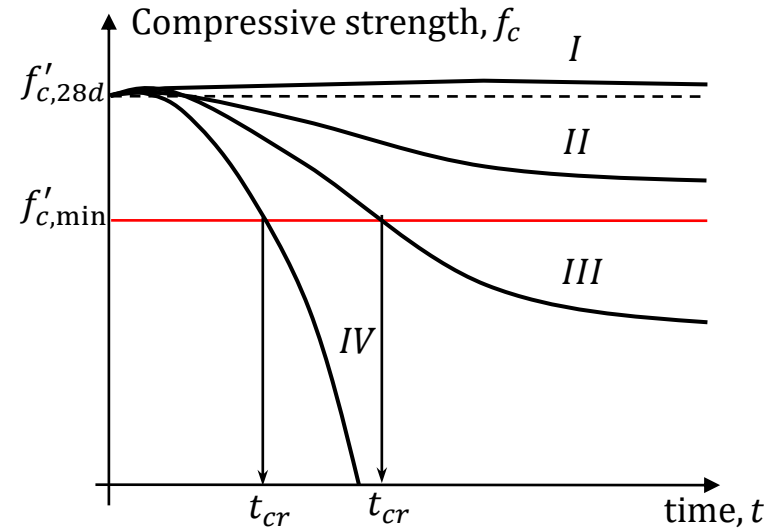
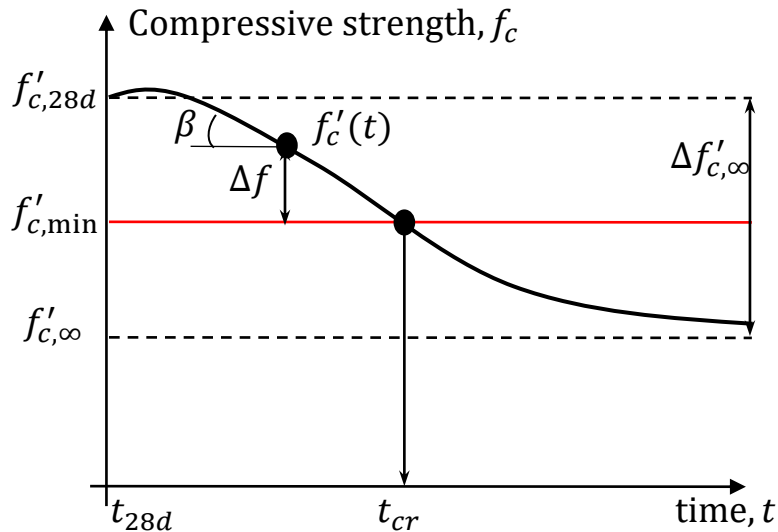
Research Goal – Reaction Rate



Sample ID	S_T Total Sulfur (S_T) average % by weight	S^{6+} Sulfate (S^{6+}) average % by weight	S^{2-} Sulfide (S^{2-}) average % by weight	Pyrrhotite (Fe_7S_8) average % by weight
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- Long-term process (10+ years) → challenging
- Distinction between Sulfate and Sulfide
- Collection of Field data over time
- Laboratory Testing (controlled parameter, accelerated reactions)
- Lab tests / research: synthesis of pure pyrrhotite, expansion and cracking rate of mortar and concrete specimens, oxidation rate of aggregates, strength tests ...

Research Goal – Risk Assessment



- Risk I* No risk, no action required
- Risk II* Low risk, recommendations need to be followed
- Risk III* Medium to high risk, action depends on Δf $f'_{c,\infty}$ β
- Risk IV* High risk, action depends on Δf β

**Thank you to all people supporting
this effort.**

What questions do you have ?