



Techniques to Fingerprint Construction Materials--R06B XRF and FTIR Spectroscopy

Committee on Materials and Pavements
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U.S. Department of Transportation
Federal Highway Administration



MaineDOT



TDOT
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AASHTO

Techniques to Fingerprint Construction Materials (R06B)

Challenge

- Verify materials without sampling delays

Solution

- Technologies to verify specific construction materials in real time
- Technologies that can be used at the project site to determine specification compliance



Potential Benefits

- Rapid testing on site or in the lab
- Reduce testing time and cost
- Minimize noncompliance risk



R06B Technologies

➤ X-Ray Fluorescence Spectroscopy (XRF)

- Rapid elemental analysis of materials
- Specific application developed in R06B—testing traffic paints for Ti content



XRF Advantages and Limitations

Advantages

- Pre-calibrated for wide range of elements
- Automatic reading—no analysis
- 1-3-minute testing time
- Little or no sample prep required
- No maintenance required
- Numerous applications

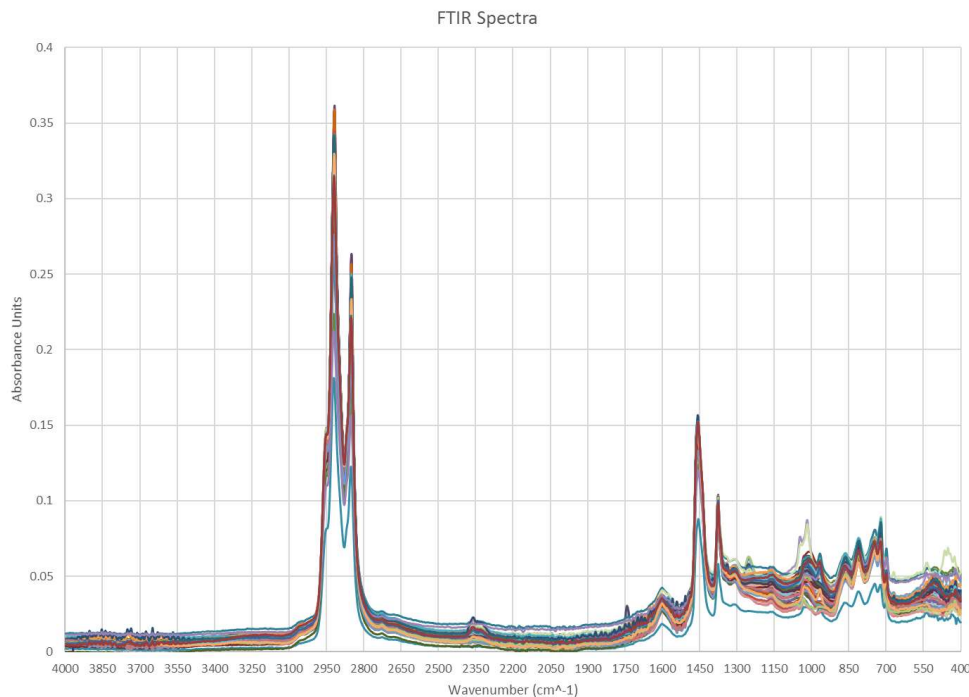
Limitations

- Requires user certification
- Upper and lower limits—different calibrations needed for trace metals vs. ores



Fourier Transform Infrared (FTIR)

- Identifies compounds
- Simple testing process
- Analysis more difficult than XRF

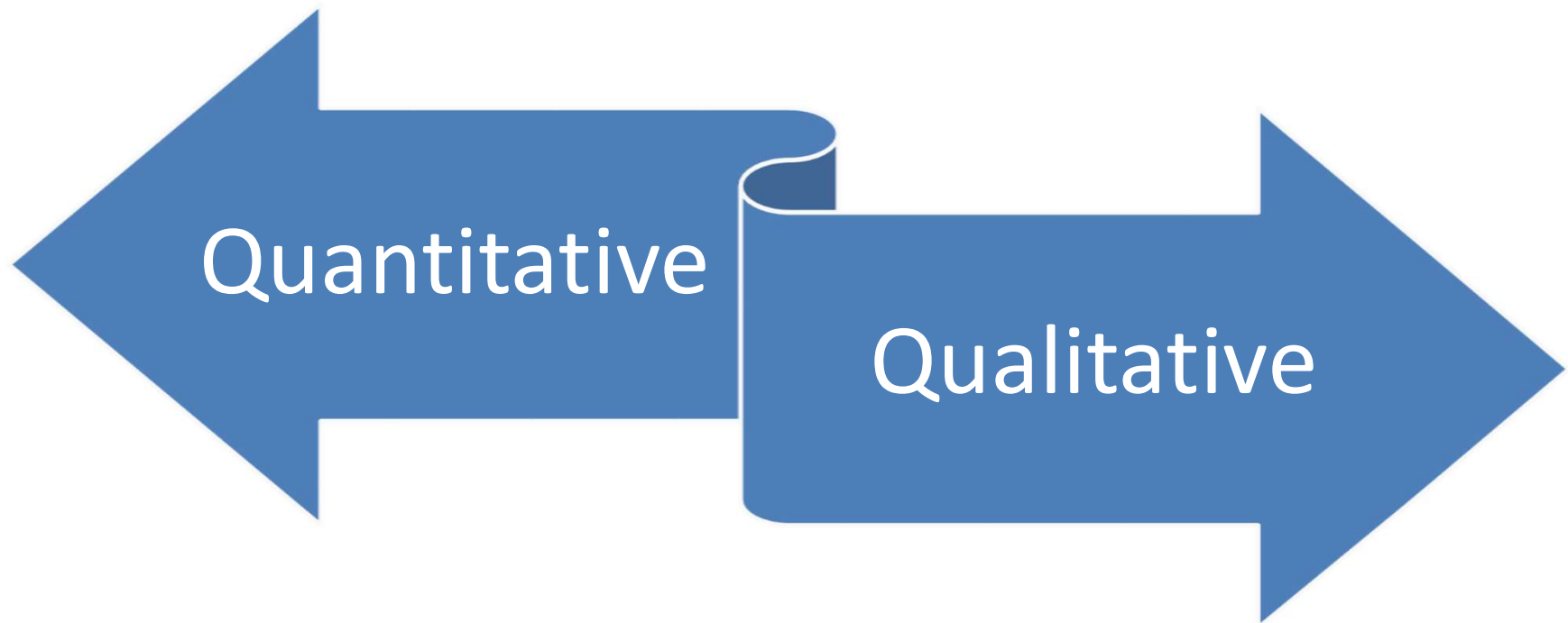


R06B—Maine

- XRF
 - Chlorides in bridge deck cores
 - Titanium in traffic paint
 - REOB in PG Binder
 - SS Rebar
 - Galvanized coating thickness
 - Glass Beads – lead, arsenic
 - Presence of RAS in HMA?
- FTIR
 - Polymer in PG Binder
 - Library of all Binders
 - Lime in HMA



R06B—Maine



Chloride Content – Bridge Deck Cores

- Current method: AASHTO T 260 (Gran Plot Method)
 - Requires nitric acid and silver nitrate
 - Numerous steps
 - 10 tests/day
- XRF method
 - No chemicals
 - 25+ tests/day
 - Less training required



Chloride Content – XRF method

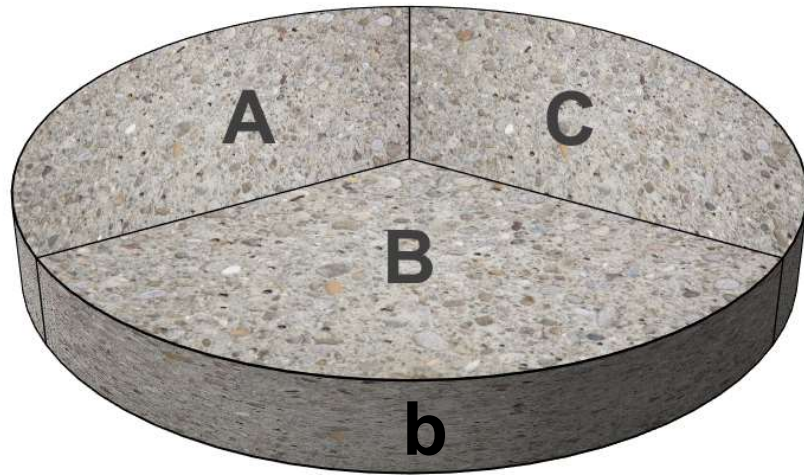


Chloride Content – Bridge Deck Cores

- Split-sample comparison
 - Evaluated numerous binding agents for pelletized samples, XRF settings, direct measurement of concrete
 - Selected the settings that provided the best correlation on a limited amount of measurements vs. titration values
 - Expanded population of comparisons
 - In-progress statistical validation

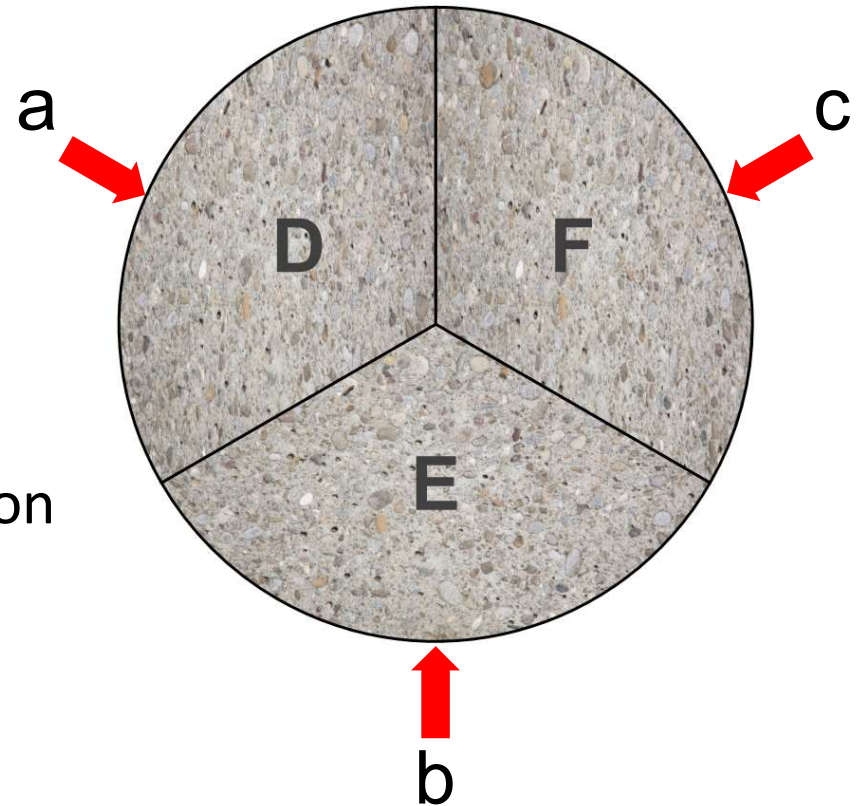
Item	Levels	Details
Analysis Mode	3	AllGeo and Two Mining Modes
Time Breakdown	2	5/5/5/45 & 15/15/15/15
Binding Agent	6	None and 5 recommended agents
Binding %	2	5% & 10%
Replicates	3	Three measurements on each pellet

Surface Testing of Core Slices

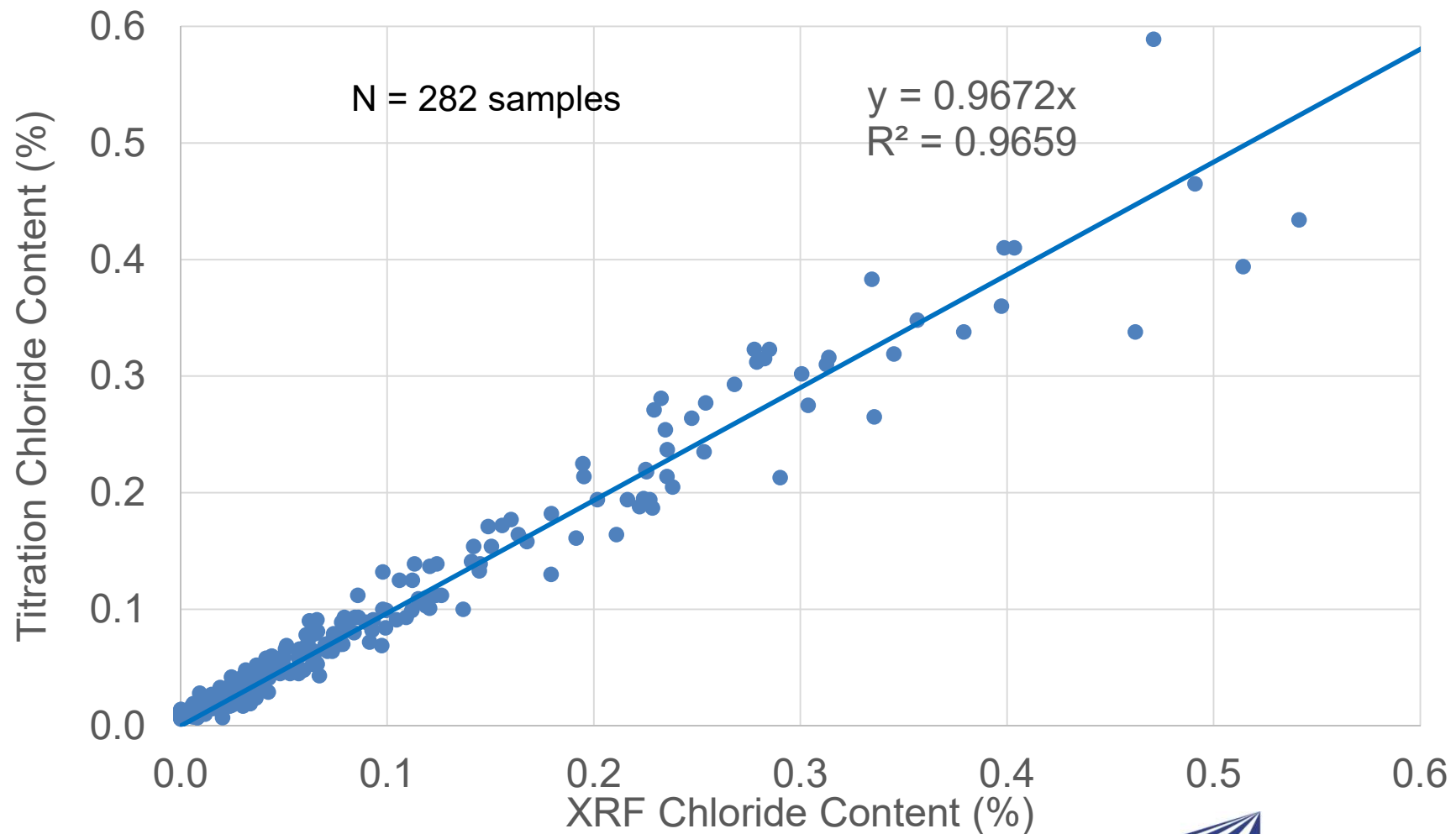


Top, bottom, edge of slice
Average of all readings v. Titration
 $R^2 \approx 0.91$

- Exposed aggregate a problem
- Higher variability



Pulverized specimens



Chloride Content – Bridge Deck Cores

- Conclusions from study
 - Pellets of pulverized material superior to surface readings of slices
 - No binding agent required
 - In process of:
 - testing lab-prepared reference samples
 - validating correlation with independent split-sample comparisons

Stainless steel rebar



El	%	+/- 2σ
V	0.110	0.010
Cr	23.490	0.073
Mn	1.818	0.045
Fe	70.056	0.093
Co	0.123	0.045
Ni	3.758	0.044
Cu	0.347	0.014
Zr	0.004	0.001
Nb	0.018	0.001
Mo	0.253	0.004
W	0.017	0.005
Pb	0.007	0.002

R06B—Tennessee

- XRF
 - Silica and Calcium Carbonate in Limestone
 - Titanium in Thermoplastic
 - Glass Beads – lead, arsenic
 - REOB in Binder?
 - Galvanized coating thickness?

- FTIR
 - Polymer in PG Binder
 - Library of all Binders
 - PPA in Binder



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Heavy Metals in Glass Beads

- Current Practice:
 - Tennessee requires every lot to be tested with EPA tests 3052, 6010B, or 6010C.
- Future Method:
 - Perform XRF testing on every lot. Allow manufacturer to Certify lots to Federal Aid Standard.



Silica in Limestone

- Currently tested by standard-less program on WDXRF in Lab.
- Handheld can perform same testing but still requires a lot of sample prep to be accurate.



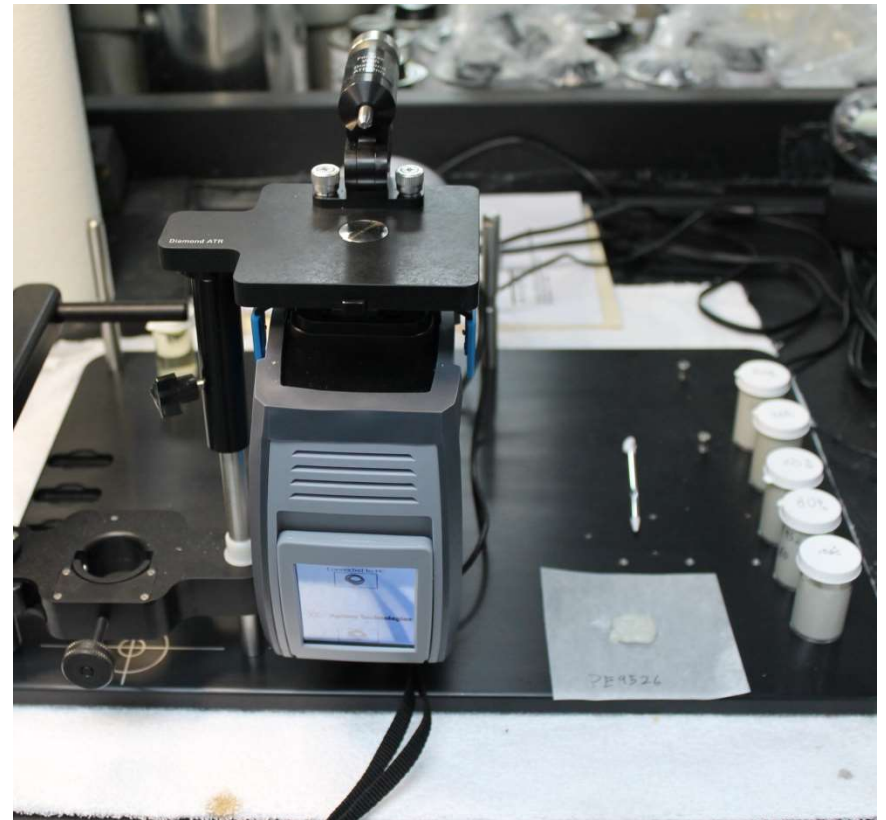
Titanium in Thermoplastic

- Current Practice:
 - Tennessee currently accepts thermoplastic on certification.
- Future Practice:
 - The handheld can perform verification testing in the field/lab on Thermoplastic.
 - There may be some issues with some fillers in the Thermoplastic.



Future for this Product in TN

- Looking into other materials
 - Following Maine and using XRF as a rapid test for Chloride Content of Bridge Decks.
 - Using the XRF and FTIR to detect REOB's and PPA's in our Binders.
 - Using the FTIR to verify Qualified Products List materials, such as Texture Coating and Additives for Asphalt and Concrete.



What's Next for R06B

The Future

- Webinar - August 22, 2018
 - <https://collaboration.fhwa.dot.gov/dot/fhwa/WC/Lists/Seminars/DispForm.aspx?ID=1706>
- Peer Exchange - September 26-27, 2018
 - <https://fs6.formsite.com/Mrussell/form204/index.html>
- Regional User Producer Group Meetings?
- Others?

For More Information on R06B

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Additional Resources:

GoSHRP2 fhwa.dot.gov/GoSHRP2
Website:

AASHTO SHRP2 <http://shrp2.transportation.org>
Website:

R06B Product **Coming soon**
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