Effects of Age and Limestone Fillers on Post-Tensioning Grout Performance

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Outline

- Background
- Inclined Tube Test (EN445)
 - Developed Modified Inclined Tube Test (MITT)
 - Inclined Tube + Modifications for Field Conditions
- Low Reactivity Fillers
- Shelf life
- Various Inclinations
- Conclusions



PT Background





Internal and external tendons











Ineffective grout











Unhydrated (filler?) material with putty consistency











Modified Inclined Tube Test (MITT)

- Shortened strand bundle (ease grout sampling)
- Dissection of duct
- Moisture content measurements
- Transparent duct?



FLORIDA 7/41



2 - in. diameter opaque schedule 40 PVC fitting male adapter (typ.)

Discharge

point

Sampling (24 Hours)





Water dosage for prepackaged grout

- Water dosage had significant effect on results
- Initially used maximum water dosage (MWD) recommended by manufacturer
- Subsequent testing used 15% excess water or 1.15·MWD
- In a few cases : 1.5 · MWD





Field Test Conditions

- Duct filled with strand
- Pressurize injection (55 psi [2.6kPa])
- Strand at top of duct
- Pressurize set (60 psi [2.9kPa])
- High temp injection
- 2 gal water in hose
- ◆ 1.15·MWD
- Constricted duct





Grout Production

Colloidal plant with 3-5 bag mixes









Bleed





















Findings: Prepackaged Grout

- Consistently produced soft grout in PT4 with 1.15·MWD
- Single instance of constricted duct produced soft grout in PT4
- PT1, PT2, and PT3 did not produce soft grout under any condition tested
- Soft grout typically present when moisture content in range 30-50% (or above)



Plain Grout

35% and 45% filler pulverized limestone
+ HRWR







Summary-Plain Grout with Filler

- Plain grout with <u>no fillers</u> will produce soft grout
- Segregation/soft grout increased with fillers
- HRWR increased segregation
- Pressure bleed test slightly more effective than inclined



Shelf Life Study

Shelf Life (months)	Storage requirements
6	"Store materials in a dry place"
6	"Store in unopened bags in clean, dry conditions"
6	"Store in unopened bags in clean, dry conditions"
9	"Store dry at 40-95°F"
12	"Keep container dry"
12	"Normal cement storage and handling practices should be observed. Store material in an interior, cool, dry place."



Laboratory: 65°F, 50-75% RH





Extreme: 95°F, 95% RH



Field: under cover outdoor in Gainesville, FL (June through November)

Laboratory and Field Conditions

- 1 test at mid of life (expiration ratio < 1)
- 1 test after expiration (expiration ratio > 1)





Particle Size Analysis

Standard Deviation of Particle Sizes





Increased particle size:

- -Pre-hydration?
- -Other Mechanisms?
- -Could be use to predict the formation of soft grout?





Findings-Shelf Life

- Prolonged storage increased soft grout at all storage conditions
- High temperature and relative humidity increased soft grout.
- Mean particle size and particle size distribution increases over time (95 °F, 95% RH)





Improved Grout Performance

- Implement MITT
 - ✓ No bleed permitted
 - No soft grout permitted
 - ✓ 24 hour moisture content < 35%
- MITT test with excess mixing water to ensure robust grout. Research used 15%.
- Test expired grout stored at extreme end of conditions allowed
- Develop standard method specified for the determination of PT grout shelf life
- Specified and enforce storage requirements for PT grouts



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