Sustainable Self-Consolidating Grout Research

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Dr. Craig Baltimore, SE

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.
Description

This presentation is a summary/overview of the work completed at the California Polytechnic State University in San Luis Obispo on Sustainable Self Consolidating Grout.

The limited time of the presentation impacts the amount of content detail. The presentation includes the following:

• A description of the grout process and the benefit of sustainable self-consolidating grout.
• A brief research summary that lists conclusions only.
• A description of the next round of testing to investigate use of the grout under commercial industry conditions – similar to a proof of concept test.

Learning Objectives

- What is SUSTAINABLE SELF CONSOLIDATING GROUT
- SUMMARY of PAST RESEARCH
- PROPOSED NEXT ROUND OF TESTING
GROUTING PROCESS

BOND REBAR
(Homogeneous Behavior)

THE METHOD
PLACE GROUT

THE METHOD
MECHANICAL VIBRATE

SELF CONSOLIDATING GROUT

MORE FLUIDITY
A Self-Consolidating Grout FLOWS around the Reinforcement and Congestion

Measured in a bullseye not a Slump

Flows around reinforcement and fills voids without VIBRATION

Requires no consolidation or reconsolidation, resulting in significant labor savings
SELF CONSOLIDATING GROUT

Currently available self-consolidating grouts that create the flowability with CHEMICAL ADMIXTURES

WHAT IS BEING RESEARCHED and PRESENTED

• Self Consolidating Grout
• No Chemicals
• Uses Waste Products to create flowability
  ▪ Fly Ash : waste product from burning coal
  ▪ Blast Slag : waste product from making steel
• SUSTAINABLE !!

RESEARCH SUMMARY

• Fly Ash and Blast Slag have been used in CONCRETE as cement replacement for decades – much research and references available.

CONCRETE is not GROUT
what is good for one is not necessarily so for the other
thus a need for grout research in cement replacement

• Only recently has serious consideration been given to replacing the cement in GROUT.

• In 2009, The Concrete Masonry Association of California & Nevada (CMACN) began a large testing program
  ▪ Brigham Young University
  ▪ Cal Poly – San Luis Obispo

• The testing indicated the possibility of flowability.
RESEARCH SUMMARY
• 2014 Initial testing in Sustainable Self-Consolidating Grout
  • Compression test
  • Reinforcement bond (pull out tests)
  • 4 foot wide x 12 foot high wall – bucket filled
    • Verify consolidation
    • Prism Testing
  • Showed promising results

• 2014 Initial testing in Sustainable Self-Consolidating Grout
  • Compression test
    • Identified acceptable mix-designs (further research)
      • 56 day compression strength > 2,000 psi
      • Compression strengths while > 2,000 psi, were less than conventional grout mix.

  • Reinforcement bond (pull out tests) – Bond Stress > 400 psi

  • Verify consolidation
    • Based on shotcrete core consolidation grades
      (ACI 560.2-95 1995)
      Scale of 1 to 5
        • 1 = Best
        • ≤ 3.0 Acceptable
        • Acceptable Consolidation average grade of 2.5
2014 Initial testing in Sustainable Self-Consolidating Grout

Showed promising results
narrow down and modify mix design

2015

- Modified mix design
- Repeatability – all student construction
- 4 foot wide x 12 foot high wall – bucket filled
  - Prism Testing
  - Verify consolidation
- Compression test
RESEARCH SUMMARY

2015

- Modified mix design: good consistent results
- Prism Testing: 10% higher than current code values
- Verify consolidation: improved consolidation to 2.0 grade
- Compression test: All mix designs > 2000 psi at 28 day

**Improved results**

narrow down to single mix design

RESEARCH SUMMARY

2016

- Modified mix design
- Slump Flows: 28” with VSI of 0
- Compression test: > 2,400 psi 28 days

**Consistent Results**

Ready for Proof of Concept Testing
Under Commercial/Industry Conditions
PROOF of CONCEPT TESTING

Program Description

- BUILD CMU WALLS USING THE METHODS, PERSONNEL, AND COMPANIES FROM INDUSTRY.
  - General Contractor
  - Masons
  - Pumper

- CREATE REPRESENTATIVE CONDITIONS
  - Professor stays away!
  - Give a set a plans and specifications to G.C.

- THIRD PARTY CONFIRMATION
  - CERTIFIED TESTING LAB
  - INSPECTOR DOCUMENTING PROCESS

- CANNOT CREATE ALL CONDITIONS - START WITH COMMON
PROOF of CONCEPT TESTING

RETURN WALL
12 ft. LONG

PLAN

PROOF of CONCEPT TESTING

Third Party Testing
1. Grout compressive strength
   a. 6 samples for 28 day
   b. 6 samples for 56 day
2. Flow characteristics – tested at site for each batch – confirmed through actual pumping.
3. non-shrink properties
4. Prism test
   a. 3 prisms cut from bottom courses
   b. 3 prisms cut from mid-height
   c. 3 prisms cut from top courses
   d. 6 prism made at site
5. Cores at various wall height to verify proper consolidation and re-bar cover
6. Shear test to verify bond between grout and CMU shell
7. Re-bar bond test to verify development lengths.
PROOF of CONCEPT TESTING

GOAL

DOCUMENTATION TO GIVE CONFIDENCE TO INDUSTRY FOR ACTUAL USE

“If you don’t ask, you don’t get.”
Mahatma Gandhi

The next slide will end the presentation, but

“I ask”
Are there any questions?

END

Craig Baltimore, Ph.D., SE
Cal Poly, San Luis Obispo
Dept. of Architectural Engineering

E-mail: cvbaltimore@calpoly.edu
Phone: (805) 756 6384