AGENDA
232 - Fly Ash in Concrete
October 21, 2019, 1:00 – 4:00
Duke Energy Convention Center C-232
Cincinnati, Ohio, USA

Mini-Session - New Approaches to Measuring Pozzolanic Activity

A New Approach to Measuring Pozzolanic Activity
Maria Juenger
University of Texas at Austin

SCM Pozzolanic Reactivity: A Key Parameter to Predict Performance
W Jason Weiss
Oregon State University

Reactivity Testing for Supplementary Cementitious Materials: Classification and Relationships with Paste Properties
Prannoy Suraneni
University of Miami

Predicting Fly Ash Reactivity by using Particle Analysis
Tyler Ley
Oklahoma State University

Meeting Agenda

1. Call to Committee 232 Meeting to Order (L. Sutter)
2. Introductions by attendees
3. Approval of the Agenda
4. Approval of the Minutes of the October 15, 2018 meeting (Approved by letter ballot – 17-3-0-4-5)
    a. Editorial corrections by J. Dongell, J. Hearne, F. Rajabipour
5. Membership Update: Officers (3), Voting (26), Associate (46), Consulting (5), Liaison (2)
    a. Changes: Associate to Voting – L. Burris, I. Diaz-Loya, K. Freeman, J. Thomas
    Voting to Consulting – J. Hicks, S. Ratchye, P. Tikalsky, T. Van Dam
    New Associate – J. Clendenen, J. Whidden
    Dropped (Voluntarily) – H. Haynes
    b. Quorum Check (40% - 11 voting members)
6. Chair's Comments
    a. TAC Breakfast Report
7. CRC Proposal Approval (See Attachment A) - Two (2) requests, One (1) Presentation by Shaurav Alam, Louisiana Tech
8. Liaison Reports
    a. TAC – M. Brown
    b. ACAA – T. Adams
    c. ASTM – L. Sutter
    d. NRMCA – K. Obla
    e. CIA
    f. FHWA
    g. EPRI
    h. Others?
9. Rewrite of 232.2R – Progress Reports
    a. Notations and Definitions
    b. Sources of Fly Ash *Lead Author: Ivan Diaz*
    c. Fly Ash Composition *Lead Author: J. Fox*
    d. Effects of Fly Ash on Concrete *Lead Authors: Mike Thomas & Bud Werner*
    e. Fly Ash Specifications *Lead Author: C. Constantino*
    f. Fly Ash Test Methods *Lead Author: B. Clark*
    g. Fly Ash in Concrete Construction *Lead Author: J. Blankenship*
    h. Fly Ash in Concrete Products *Lead Author: H. Keiper*
    i. Other Uses of Fly Ash *Lead Author: H. Keiper*
    j. Fly Ash and Sustainability *Lead Author: J. Buffenbarger*
    k. Appendix A - Rapid Quality Control Tests *Lead Author: F. Rajabipour*

10. New Documents
    a. Tech Note on Maximum FA Limits – Ballot on Responses to TAC Comments (K. Obla)
        i. Item passed: 22-2-0-2-3
        ii. Discuss comments
    b. Tech Note on Harvested Ash – First Ballot (H. Keiper)
        i. Item passed: 9-10-1-3-6
        ii. One (1) negative
        iii. Discuss comments
11. Sessions this Meeting
    a. Sunday: New Experience with Testing and Application of Concrete Pozzolans
12. Future Sessions
    a.
13. Old Business
    a. Bottom ash – Incorporate into 232: Next Steps
    b. Use of recovered ash - Discussion & Updates (F. Rajabipour)
14. New Business
15. Adjournment

Attachment A

RESPONSE OF POLYETHYLENE TEREPHTHALATE (PET) AND CONSTRUCTION RENOVATION AND DEMOLITION (CRD) BLOCKS PANEL UNDER COMPRESSION

SADAQAT ULLAH KHAN [1] AND SAJJAD ALI[2]

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One of the biggest environmental concerns is solid waste management. The limited landfill sites further augment the problem and raise the need for alternate utilisation of solid waste. The major portions of solid waste are plastic drinking bottles made of Polyethylene Terephthalate (PET) and construction renovation and demolition (CRD) waste. The use of PET bottles has been augmented globally because of these characteristics, while the recycling rate of PET bottles is much smaller [1]. According to the Environmental Protection Agency study released in 2008 in the USA, 80% of PET bottles are transferred to landfill, 8% is incinerated and just 7% are reused annually [2]. This difference in production and recycling of PET bottle results in a huge burden on limited landfill sites. On the other hand, the demolition waste is not utilized and is often illegally dumped on vacant sites and cause contamination on soil and ground water and creates adverse impacts on environment. Therefore, the recycling of plastic and construction renovation and demolition (CRD) waste for the production of new materials appears as one of the best solution.

Recently, authors worked on reclaimed plastic and CRD waste to construct blocks. In one of the project, PET bottles was utilised making blocks. PET was mixed with sand, fly ash and/or marble powder in fixed proportions after melting. PET was used as binder. Those mixes were then used to cast the blocks of 10×8×6 inches. Compressive strength, heat resistance, and water absorption tests were performed on those blocks and results were analysed and compared with those of conventional concrete (CC) block. Based on the results, it was found that the "PET Block" has more compressive strength, less water absorption and is more resistant to heat than CC Block.

In another project, recycled aggregates that were derived by crushing concrete were used in different desired proportions in place of natural aggregate for the production of blocks. These blocks were tested against heating, residual compressive strength, weight loss and specific gravity. Results were compared with those of the blocks made up of CC Block in order to examine the differences in strength and physical attributes. The results were promising and blocks made of CRD aggregates were competitive with the CC blocks.

In this proposal, authors are intended to check the properties of blocks made of CRD with the PET and fly ash as binder without any cement. Authors will further investigate these blocks as masonry panel under compression and elevated temperature. This project is significant as these blocks will be made of waste materials such as PET, Fly ash and CRD. There will be lesser carbon foot print in the production of these blocks and sustainable use of natural resources will be targeted through this endeavor. Thus, this abstract is submitted for the review of the technical committee and for their endorsement on the attached form for the application of grant of the ACI Foundation's Concrete Research Council. The resume of the Principle Investigator and Co-Principle Investigator is also attached with this email for the reference.

Regards,

PI: Dr. Sadaqat Ullah Khan
Associate Professor
Department of Urban and Infrastructure Engineering
NED University of Engineering and Technology, Karachi.

Co- PI: Engr. Sajjad Ali
Assistant Professor
Department of Civil Engineering
NED University of Engineering and Technology, Karachi

References

[1] D. Foti, "Use of recycled waste pet bottles fibers for the reinforcement of concrete," *Composite Structures,* vol. 96, pp. 396-404, 2013.

[2] R. Siddique, J. Khatib, and I. Kaur, "Use of recycled plastic in concrete: A review," *Waste Management,* vol. 28, pp. 1835-1852, 2008/01/01/ 2008.

Rapid Curing of Geopolymer Concrete using Frontal Polymerization Technique

A. Problem Statement

Recent studies of heat-cured fly ash based geopolymer concrete (GPC) have shown its suitability for the fabrication of new precast structural members and enhance structural health of existing concrete made infrastructure components by spot repair method. However, hours of moderate heating (50°C to 70°C) essential for curing of a substantial size structural component can quickly turn into an energy guzzler, which potentially eliminates the earned green credentials. The proposed research will focus on finding avenues to achieve rapid curing of ultra-high-strength GPC at ambient condition after short-term localized heating.

Initial work has shown frontally polymerized geopolymer concrete (FPGPC) is a possibility. The process includes blending of monomer, initiator, cross-linkers, and GPC slurry, which upon application of heat, polymerizes and the reaction front moves forward to cure the GPC resulting in a durable finished product compatible with traditional Ordinary Portland Cement (OPC) mortar samples. Therefore, FPGPC has the potential to save significant time and energy required in the curing of GPC product and can create a new horizon in fly ash utilization.

B. Research Objective

The proposal will follow a methodical research approach that will combine material characterization and standard ASTM tests. The research approach has two main objectives:

Objective 1: Investigation of the Effect of Constituents on the FPGPC

- ***Literature Review and Material Characterization:*** GPC constituents of fly ash (FA) and alkaline solution. FP requires monomer, initiator, and cross-linkers. The literature review will focus the chemical bonding possibility of different ingredients in fly ash, alkaline solution, monomer, initiator, and cross-linkers followed by characterization at the microscopic level and later standardization.
- The principal outcome at this phase will be the identification of an appropriate ratio of GPC slurry and chemicals required for FPGPC without compromising the mechanical strength.

Objective 2: Assessment of the Developed FPGPC

- This phase will include the making of test samples and evaluation of their post-curing mechanical properties, and selection of batches producing the best results, and their potential reproducibility. Testing of the specimens will be conducted by following the ASTM standards for Compression Strength (C39), Flexure Strength (C78), Poisson's Ratio (C469), and Water Absorption, Density, and Void (C642).

C. Work Plan

<u>Phase I –Analysis of Fly Ash Chemical and Physical Properties (3-months)</u>:

- Fly ash, in particular, has wide variation depending on types of coal source and the facility that produces it. Literature and work are available, showing the strength of GPC made from differently sourced fly ash differs. However, no work shows the effect of frontal polymerization and quick curing on the GPC. Therefore, fundamental analysis of the fly ash is essential to produce the best mix design for FPGPC based structures. Research works in this phase will meet the requirement of Objective 1.
- A comprehensive literature review will be undertaken to establish the current state-of-the-art in applications of FPGPC as a construction material for the rapid repair and construction of concrete made infrastructures. The literature review will include technical data and chemical

information related to the development of the FPGPC material and its potential for designing, casting, and curing of a full-scale reinforced panel. The collected information will help in developing the mix design suitable for casting the full-scale transportation structures.

<u>Phase II - Establishment of mix design for FPGPC materials (9-months)</u>:

- ***Standardization of Fly Ash:*** This phase of the work will be the final step for meeting criteria mentioned in Objective 1. Variation at elemental and molecular level reduces reliability and hinders reproducibility. So, understanding of necessary fundamental components and their levels of variations is necessary to develop standard protocols for reliable reproduction of the products or to develop protocols for adjustments of materials in the mix-design and during the construction of infrastructures. Therefore, the necessary materials needed to be chemically and physically analyzed to achieve this standardization protocol. Possible analytical tools that may be utilized for standardization of the byproducts to obtain chemical and physical data for this project are - Titration and solubility studies, Filtration and DLS for size analysis, SEM/TEM for shape determination, and Composition studies using XRF, Raman, FT-IR, UV-Visible spectroscopy, and column exchange chromatography.
- ***Making and Performance Evaluation of Test Specimens:*** In this last phase, the research team will make test specimens using the FPGPC material. The performance evaluation includes a comparison of the results obtained from the previous study and by making control OPC and GPC specimens.
- Performance of the developed FPGPC materials will be evaluated based on standard ASTM tests - C39, C78, C114, C469, and C642. This step of the investigation will meet the goals of Objective 2 in the proposed research.

D. Present State of Knowledge

The PI understands that the knowledge on the OPC concrete, GPC, and FP is necessary to produce any material that will match the OPC concrete or GPC properties while made by the FPGPC technique. However, the current proposal discusses the FPGPC briefly due to the limitation of the number of pages allowed, and the final report will include the discussion on the OPC concrete, GPC, and FP. Figure 1 shows the cured cylinders and cubes made of FPGPC material, and the strength comparison between the cylinder samples showed average strength of FPGPC samples were around 4000 psi, which was around 5 to 10% less than the OPC and GPC samples.

Figure 1: Curing FPGPC Samples, Cured Cylinder and Cubes and SEM Image Showing Unreacted Components

E. References

Allouche, E.N., Montes, C., Diaz, I. and Vaidya, S. 2007. A New Generation of Cementitious Materials for Mortal Lining of Buried Pipes. Pipeline 2007, ASCE, Boston, MA. July, 9 p.

Dhakal M., Al-Masud M., Alam S., Montes C., Allouche E., and Saber A. 2013. Design, Fabrication, and Testing of a Full Scale Geopolymer Concrete Median Barrier. World of Coal Ash Conference (WOCA), Lexington, Kentucky, April 22-25.