AWARDS 2021
Volume 35, No. 3

TENNESSEE CONCRETE MAGAZINE

GRAND CHAMPION

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TENNESSEE CONCRETE MAGAZINE

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CELEBRATE OUR ANNUAL **DESIGN AWARDS**

Duane King
TCA President

… great projects that feature our favorite building material — ready mixed concrete.

… continuing to see progress on the new office project for our association.

… our new headquarters will provide a strong foundation for TCA's future.

Get your 2022 entries in right away!

This issue of our *TNConcrete* magazine celebrates our Annual Concrete Design Awards competition. It features the winners from the 2020 contest, and I invite you to take a look at all of these great projects that feature our favorite building material — ready mixed concrete. I also encourage each of my fellow ready mix producers to enter your best, your most unique, concrete projects from the past year. It's a great way to recognize your customers for the work they do with our product, and you might just see your project(s) featured in these pages next year!

We are continuing to see progress on the new office project for our association. We have a great location for our new home that is convenient and has a beautiful setting, it is literally surrounded by The Mill Ridge Park. Construction for the first amenities for the new park has begun across the road from our site, and there will be a new turn lane and road widening that should make access to our site better, as well as exposing our new headquarters to all those visiting the park. We are working on several tracks as we prepare our new home and will be asking for some input and assistance from our members as we move into the actual construction phase.

What is really exciting about our new headquarters is that it will provide a strong foundation for TCA's future. Your board is working to update our TCA Strategic Plan for 2022 and beyond so that TCA can continue to be a first-class resource to support the business of concrete in Tennessee. Concrete production in Middle Tennessee is reaching record levels and our industry has been blessed to actually grow through the pandemic. We are thankful for that growth but as each of you know, growth brings its own challenges. As we look toward TCA's future, we are looking to the best ways for TCA to help our members' companies meet those challenges.

If you have thoughts about how TCA can support our industry, I would love to hear from you.

— Duane King

THE NEW CONVERSATION — SUSTAINABLE CONSTRUCTION

Alan Sparkman
Executive Director

Get those projects entered right away!

One of our best and most prolific research partners continues to be Dr. L. K. Crouch and Tennessee Technological University.

The good news … concrete is one of the best choices to reduce environmental impacts ….

Welcome to our annual Awards issue of Tennessee Concrete magazine. This is a strong reminder that it is time to get your best projects entered for next year's Concrete Design Awards competition — so don't delay. The entry can be completed 100 percent online and you can't win if you don't enter. Whether or not your project(s) win in their category, you will be a winner for taking time to recognize the great work of your customers — get those projects entered right away!

As usual, this magazine also features results from TCA's ongoing concrete research. One of our best and most prolific research partners continues to be Dr. L.K. Crouch and Tennessee Technological University. Our joint efforts with Tennessee Tech have produced a wealth of practical, useful and impactful research findings, and nearly all of that information has been published in this magazine. Check out our past issues for this important resources and be sure to click on the new Research tab on the *tnconcrete.org* home page (one of the red tab buttons at the top). We have organized our research both chronologically and by topic under the Research tab to make it easy for you to access this information made possible by the support of our TCA member companies.

I recently attended the PCA Promoters Forum that was held in Nashville earlier this year. Nearly 100 professional promoters from across the U.S. attended to hear about the latest resources from national associations, as well updates on federal legislation that could have a major impact on the construction industry (some good, some not-so-good). We also heard of promotional successes from across the country, and we heard a lot about what concrete customers and influencers are talking about as we head toward the end of 2021.

Much of this conversation is focused on sustainable construction and how the construction industry can reduce the impacts of new construction. The top of mind topic here is embodied carbon, but there are many other issues involved. All of them are introducing a new dimension of competition to material selection for construction projects AND to the process of selecting material providers (like ready mix producers) for those projects. The good news about this is that concrete is not only the most utilized construction product on the planet, concrete is also one of the best choices to reduce environmental impacts like embodied carbon — but all the other competitive products (i.e., wood, steel, etc.) are actively promoting their products as better solutions than concrete.

Ultimately, this means that we have to up our game in terms of understanding these new dimensions of competition, and we have to learn how we can compete at both an industry and individual company level. TCA has been working, and will continue to work, on behalf of our members to prepare you for this brave new world. One specific example of how we are doing this is TCA's Environmental Product Declaration (EPD) program. If you find yourself in need of an EPD for an upcoming project, TCA can help — quickly and economically. Questions? Please reach out to me directly at asparkman@tnconcrete.org.

Don't forget to submit your Awards entries right away! Also, please mark your calendar for TCAs 2022 Annual Convention scheduled February 9 and 10, 2022. Be there in-person to accept your award!

— Alan Sparkman

2021 TCA CONCRETE EXCELLENCE AWARDS SEASON IS OPEN!

TIME TO SUBMIT APPLICATION FOR THE 34TH ANNUAL CONCRETE EXCELLENCE AWARDS PROGRAM NOMINATIONS!

ENTRY DEADLINE: DECEMBER 20, 2021

The purpose of the awards is to honor outstanding concrete projects, and those who designed and built them across the state of Tennessee. Award winners are honored at Tennessee Concrete Association's Annual Convention Award Luncheon where they receive an award plaque and go on to receive statewide recognition in *TNConcrete* magazine's annual annual awards issue. One category winner will be announced as the Grand Prize Winner for the most outstanding project among all the winning projects.

The awards luncheon will take place at Franklin Marriott Cool Springs on Thursday, February 10, 2022.

CATEGORIES

TCA EMERALD AWARD FOR ENVIRONMENTAL EXCELLENCE

The TCA Emerald Award For Environmental Excellence is presented annually to the TCA producer member plant that has best demonstrated environmental excellence and innovative management. TCA strives to recognize the overall stewardship and environmental efforts of our member companies through this annual award. We proudly recognize TCA Producer Members who:

- Make outstanding contributions to preserving and protecting the environment.
- Exhibit environmental leadership for the ready mixed concrete industry.
- Maintain sound environmental management practices in their operations.
- Install state-of-the-art environmental equipment and/or implement environmentally friendly plant procedure.

The Emerald Award will be granted for each of the following plant production categories:

Small: 25,000 YD3 or less
Mid: 25,001 – 75,000 YD3
Large: 75,001 YD3 or more

FOR QUESTIONS EMAIL:
donna@tnconcrete.org

LIFETIME ACHIEVEMENT CATEGORIES

LIFETIME HALL OF FAME NOMINATION

Intended to recognize individuals who have made significant contributions to the concrete industry in Tennessee over a period of many years. More than one person may be inducted in any given year, or no one may be selected. Persons nominated do not have to be retired, but service to the industry over a number of years is a primary consideration for this award.

AMBASSADOR AWARD
(Expanded to include Mixer Operators, Plant Managers, Production, and Sales/Marketing.)

To recognize concrete professionals who represent the front line of every ready mixed concrete company. The number of Ambassadors selected each year will depend upon the number and quality of submissions. Ambassadors and their stories may be featured on the TCA website. Anyone – employer, customer, owner, supplier — can nominate a concrete **professional** for this honor.

DESIGN CATEGORIES

ARCHITECT/ENGINEER AWARD
- Architect/Engineer - Commercial Buildings
- Architect/Engineer - Non-Building Structures (Bridges, Dams, Stadiums, etc.)
- Architect/Engineer - Residential

CONTRACTOR AWARD
- Best Finishing - Residential Decorative Exterior
- Best Finishing - Residential Decorative Interior
- Best Finishing - Commercial
- Best Finishing - Commercial Decorative
- Best Finishing - Artisan
- Best Roller Compacted Concrete
- Best Pervious Concrete
- Specialty (Flowable Fill, ICF, Tilt Up, etc.)

PRECAST AWARD
- Precast - Building Structure
- Precast - Transportation Structure
- Precast - Specialty

READY MIXED CONCRETE AWARD
- Best Concrete Home
- Best Concrete Parking Lot
- Best Pervious Concrete Parking Lot

2021 CONCRETE AWARD WINNERS

GRAND CHAMPION
DOBYNS-BENNETT SCIENCE & TECHNOLOGY CENTER
Ready Mix USA, Perkins & Will, Burwil Construction, Haun Concrete Construction, and Kingsport City Schools

GRAND CHAMPION
ARCHITECT ENGINEER COMMERCIAL BUILDINGS
DOBYNS-BENNETT SCIENCE AND TECHNOLOGY CENTER

READY MIXED PRODUCER: Ready Mix USA
ARCHITECT: Perkins & Will
CONCRETE CONTRACTOR: Burwil Construction
CONCRETE FINISHER: Haun Concrete Construction
PROJECT OWNER: Kingsport City Schools

Dobyns-Bennett Science & Technology Center is the new face and main entrance for the D-B campus. The 70,000 square-foot, 400-seat building fulfills the mission to create a culture that inspires innovation through science and technology. The new three-story building includes: 18 science/technology labs, two teacher work spaces, six student work spaces, one TEAL (Technology Enhanced Active Learning) lab, one large research lab, and four small research labs allowing for cross-curricular collaborations. A student cafe and administrative offices are also located among the three floors. With this addition, Dobyns-Bennett student capacity has been raised to support 2,500 students at 85 percent utilization.

2021 CONCRETE AWARD WINNERS

BEST ARCHITECT/ENGINEER NON-BUILDING STRUCTURES (BRIDGES, DAMS, STADIUMS, ETC.)
INTERSTATE 440 RECONSTRUCTION PROJECT
READY MIXED PRODUCER: Irving Materials, Inc.
ARCHITECT: WSP
CONCRETE CONTRACTOR: Kiewit Infrastructure
ENGINEER: WSP
OWNER: TDOT

This was TDOT's largest project to date at 154.8 million dollars. Constructed in the 1980s, I-440's pavement had begun to fail and also needed to be widened from four lanes to six lanes to accommodate an average of 100,000 vehicles per day. Kiewit Infrastructure partnered with WSP, a construction management group, and won the project through the Design Build Project Delivery Method. Kiewit started work in August of 2018 and completed a month ahead of schedule in July of 2020. Two hundred and fifteen thousand (215,000) tons of concrete pavement was crushed and recycled as base, 38,000 cubic yards of Concrete Ready-mix was poured, and CarbonCure was approved for the first time on a TDOT project for a small portion of ditch pavement. Overall, this project was a huge success for Nashville and TDOT.

2021 CONCRETE AWARD WINNERS

BEST CONCRETE HOME
ROBERT'S RESIDENCE
READY MIXED PRODUCER: Irving Materials, Inc.
CONCRETE CONTRACTOR: Nickell Company
PROJECT ARCHITECT: Tippett Sease Baker
OWNER: Robert's Residence

Robert's residence was a 10,000 square foot private home built with an incredible view overlooking a spectacular countryside in Williamson County. Nickell Company poured more than 800 cubic yards of concrete that included footings, slabs, 4800 square foot of basement and garage walls, and a decorative circular retaining wall as part of the landscape. Our contract totaled $480,000 and the work was completed in July of 2020, just four months after we started. Nickell Company, LLC worked 5,496 manhours without a lost-time accident.

Our biggest challenge during construction was the logistics of navigating a mile and one-half long narrow driveway to the building site. We had to plan deliveries and stage each portion of the work not to interfere with vehicles coming and going. The concrete trucks had to be scheduled precisely as there was not a good place to turn around, and they certainly could not pass each other on the driveway.

This project deserves an award because it represents the quality work and expertise Nickell Company, LLC, uses on complex residential projects. We managed the details of this project that resulted in a unique concrete project completed on time and under budget.

2021 CONCRETE AWARD WINNERS

BEST FINISHING-ARTISAN
VALLETT RESIDENCE
READY MIXED PRODUCER: Irving Materials, Inc.
CONCRETE CONTRACTOR: Creative Concrete Solutions
ENGINEER: Garner Engineering (Robb Garner)
OWNER: Vallett

Approximately six days to form and prepare the spiral staircase at the residence. The spiral case is 4 feet wide and 13 feet tall and consists of 21 steps. The steps were pumped using 2 1/2 inch line pump. Travis Quillin, with Creative Concrete Solutions, lead the charge of constructing and placing the concrete for this project.

2021 CONCRETE AWARD WINNERS

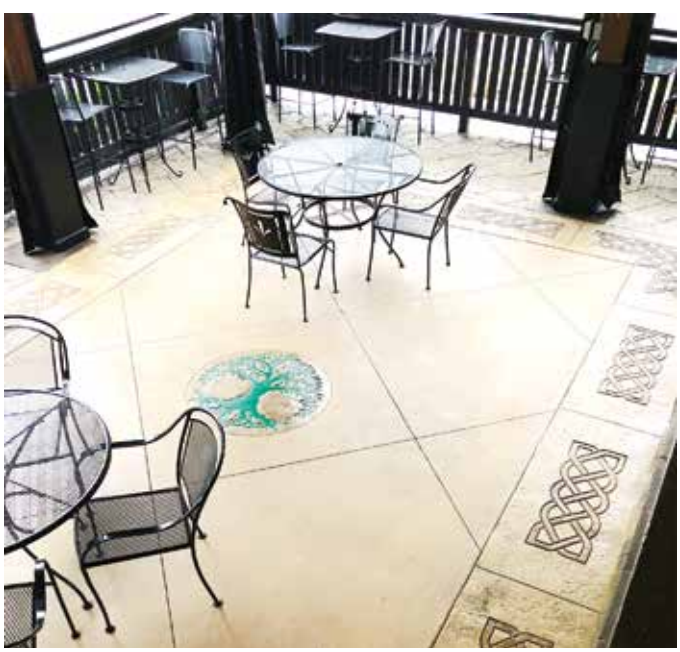
BEST FINISHING-COMMERCIAL
DOWNTOWN SEVIERVILLE STREETSCAPES
READY MIXED PRODUCER: Blalock Ready Mix
CONCRETE CONTRACTOR: Charles Blalock & Sons, Inc.
ENGINEER: Vaughn & Melton Consulting Engineers
OWNER: City of Seviervill

The downtown Sevierville streetscapes project began in 2019 as a $6.7 million revitalization and modernization of the Court Avenue and Bruce Street corridors around the historic court house. This project included undergrounding all utilities, reconfiguring street parking with expanded sidewalks and streetscapes, and replacing all asphalt paving with concrete. Charles Blalock and Sons, Inc., was the general contractor and concrete contractor for the project, self-performing all concrete paving, sidewalks, and ADA improvements. In order to create the correct street crown and profile while working around the new parking and streetscape features, Blalock crews used a Bidwell bridge deck screed to pave and profile the two streets. Key highlights of the concrete work included decorative crosswalks, granite masonry inlays along sidewalks and new landscaping sections, and stainless steel inlays along Bruce Street replicating the historic rail lines that once ran through Sevierville.

2021 CONCRETE AWARD WINNERS

BEST FINISHING COMMERCIAL DECORATIVE
CELTIC CROSSING IRISH PUB PATIO RENOVATION
READY MIXED PRODUCER: Delta Industries
ARCHITECT: Kevin Baltz
CONCRETE CONTRACTOR: Baltz & Sons Concrete
ENGINEER: Kevin Baltz
OWNER: DJ Naylor

This spectacular patio renovation of an iconic landmark restaurant and pub in Midtown Memphis showcases a variety of decorative concrete techniques and methods. Having worked together in the past, the restaurant and property owners tapped Kevin Baltz of Baltz & Sons Concrete to design the renovation and helm its installation. Central to the project was the implementation of a new stenciling system from BRICKFORM, in which rigid stencil templates are integrated into the finishing process, allowing the finishers to quickly and easily achieve intricate patterns and icon in the surface of the concrete. Baltz used a full range of decorative finishing methods to showcase the versatility and range of concrete—pigmented and exposed aggregate, micro-washed sand nishes, stenciled patterns, seamless and pattern-stamped concrete patios; grind and polished concrete countertops; CNC controlled engraving of pigmented surfaces; acid staining; acrithane, acrylic, and epoxy sealers, and custom template stamps all contribute to a cohesive and thematic design that captures and enhances the character of the Irish Pub restaurant. The result is a functional and practical showcase of the decorative applications of concrete. Concrete was supplied by Delta Industries--#4000 psi Limestone mixes with Solomon UF-500; Contractor source supplied pattern and seamless stamps; BRICKFORM Stencils System; Pigments and sealers supplied by WILLIAMS EQUIPMENT, BRICKFORM, CLEMMONS.



BEST FINISHING RESIDENTIAL DECORATIVE - EXTERIOR

KENEARUM HOUSE
READY MIXED PRODUCER: Harrison Construction
CONCRETE CONTRACTOR: East TN Concrete
OWNER: Charles Bryant

Driveway and sideway was poured with 150 CY of acorn light-colored concrete. The borders of driveway, porches, and sideways were stamped using a texture touch up with an artisan walnut colored stain. Stain: boarders stain with Artisan Walnut.

2021 CONCRETE AWARD WINNERS

BEST FINISHING RESIDENTIAL DECORATIVE - INTERIOR

KENEARUM HOUSE
READY MIXED PRODUCER: Harrison Construction
CONCRETE CONTRACTOR: East TN Concrete
OWNER: Charles Bryant

Interior basement slab was done with 45 CY of peagravel concrete with mocha deep color added. Slab was then ground, exposed and polished.

BEST CONCRETE PARKING LOT

COLUMNS ON MAIN
READY MIXED PRODUCER: Irving Materials, Inc.
ARCHITECT: Rule Joy Tramell Bubio
CONCRETE CONTRACTOR: Nickell Company
OWNER: ECI Construction

Columns on Main was a new multi-family apartment complex built on 22 acres that included 310 units and 600 parking spaces. Nickell Company poured 20,384 SF of integral colored concrete pavement with a saw cut finish, and another 1921 SF of concrete entrance ramps. Our contract, which also included other site work, totaled $673,315 and represented 1,700 yards of concrete poured. The job started in January 2020 and was completed nine months later. Nickell Company, LLC, worked 1,347 man-hours without a lost-time accident.

Two problems were encountered during construction that made this project challenging. First, the existing grade made it difficult to meet the ADA requirements. We were able to use our CAD files and expert technology to lay out the parking lot and sidewalks correctly before making any pours.

The other problem dealt with scheduling. Tenants were "moving in" as soon as we completed a building. We met with the owner and the city of Spring Hill on a weekly basis to endure we met the "move-in" dates of the residents and helped maximize the owner's revenue.

This project deserves an award because it represents the quality and the unique way concrete can add diversity to a parking lot. The colored and cut concrete creates a welcoming focal point to the property. Not only were the layout and scheduling problems solved, but the parking lot represents excellent workmanship by Nickell Company, LLC.

2021 CONCRETE AWARD WINNERS

BEST PERVIOUS CONCRETE PARKING LOT
SH DATA CENTER PARKING LOT
READY MIXED PRODUCER: Harrison Construction
ENGINEER: Michael Brady Inc. (MBI) - Chris Fox
CONCRETE CONTRACTOR: Hatfield Construction
OWNER: Butch Smith
ARCHITECT: Joey Staats- Johnson Architecture

The entire SH Data Center project involved over 8500 CY of concrete, however, it involved exactly 110 CY of the pervious concrete to help with their parking lot issues. The site is located on top of a hill in downtown Knoxville. With limited real estate, pervious was a great option for them to build a larger parking area while controlling runoff water.

2021 CONCRETE AWARD WINNERS

BEST CONTRACTOR SPECIALTY FLOWABLE FILL ICF TILT UP

SEVEN ISLANDS STATE BIRDING PARK
READY MIXED PRODUCER: Ready Mix USA
ARCHITECT: TDOT
CONCRETE CONTRACTOR: Kay & Kay Contracting
ENGINEER: Derek Moore
OWNER: Knoxville

Seven Islands State Birding Park is a 416-acre wildlife refuge with natural trails, views of the Smoky Mountains and the French Broad River. The park is also a research and educational facility for schools and other groups, and a demonstration area for land use and habitat management techniques.

This $6MM project was completed to improve accessibility within the park. The project included an ADA walking path and parking area, the pedestrian bridge and a primitive island trail. The bridge provides access over the French Broad River to a new loop trail.

The contractor's primary challenges were to complete the project with minimal disturbance to the river and wildlife, and to pour custom formed abutments cast with bird images. A temporary bridge was erected as a working platform. Mixers backed onto the temporary bridge where the concrete was crane and bucketed. To prevent leakage of fresh concrete, a special double-pier form was designed and used. However, the form design impeded concrete flow so a Self-Consolidating Concrete (SCC) mix was requested. The SCC mix was also used for the custom abutments. The special forms and SCC mix performed well, with no leakage into the river and attractive abutment castings.

2021 CONCRETE AWARD WINNERS

TCA EMERALD ENVIRONMENTAL AWARD SMALL 25,000 YD3 OR LESS

Plant Operator Paul Phillips, Boones Creek Plant, Gray, Tennessee, Ready Mix USA

TCA EMERALD ENVIRONMENTAL AWARD FOR MID 25,001 - 75,000 YD3 OR LESS

Plant Operator Joel Baxley, Ready Mix USA, Morristown Plant, Morristown, Tennessee

Storm Water Drainage Channel

Sediment Basin

CN Environment Students

CN Book Donation

by L. K. Crouch, Alex Kelley, Samuel Mathews, Daniel Badoe and Alan Sparkman

IS THERMALLY BENEFICIATED CLASS F Fly Ash as Good as Current Tennessee Class F Fly Ash?

INTRODUCTION

Use of fly ash in concrete mixes enhances the concrete's strength, durability, and sustainability, and reduces its cost of production. The demand for fly ash remains high while its supply is decreasing or at least is uncertain in the future. Unfortunately, many sources of fly ash do not meet American Society for Testing and Materials (ASTM) or American Association of State Highway and Transportation Officials (AASHTO) requirements for fly ash used in concrete. Typically, loss-on-ignition (LOI), a measure of unburned carbon, is too high in fly ashes which fail to meet these standards.

Thermal beneficiation of fly ash is a proprietary process and so a detailed discussion would be unwise if not illegal. However, thermal beneficiation of fly ash typically begins with a fly ash not meeting ASTM or AASHTO standards for LOI and results in a fly ash meeting ASTM and/or AASHTO Class F fly ash requirements for use in concrete.

The Tennessee Concrete Association (TCA) strongly favors the use of thermally beneficiated fly ash as a supplementary cementing material (SCM) in concrete. Thermally beneficiated fly ash would help ensure that fly ash is always available for

TABLE 1: FLY ASH PROPERTIES AND REQUIREMENTS

PROPERTY	THERMALLY BENEFICIATED CLASS F FLY ASH (SAMPLES A & B)		TYPICAL POPULAR TN CLASS F FLY ASH	ASTM C618-17A	AASHTO M295-11
Silicon Dioxide (%)	53.9	52.8	42.9	–	–
Aluminum Oxide (%)	27.6	27.5	17.3	–	–
Iron Oxide (%)	9.69	10.08	20.34	–	–
$SiO_2 + Al_2O_3 + Fe_2O_3$ (%)	91.1	90.4	80.5	70 min.	70 min.
Calcium Oxide (%)	1.8	2.2	7.4	–	–
Magnesium Oxide (%)	1.0	1.0	1.7	–	–
Sodium Oxide (Na_2O)	0.31	0.31	0.60		
Potassium Oxide (K_2O)	2.33	2.33	2.07		
Sodium Oxide Equivalent ($Na_2O+0.658K_2O$)	1.85	1.85	1.96		
Sulfur Trioxide (%)	0.14	0.21	2.72	5 max.	5 max.
Loss on Ignition (%)	0.5	0.6	1.0	6 max.	5 max.
Moisture Content (%)	0.1	0.0	0.2	3 max.	3 max.
Alkalis as Na_2O (%)	1.03	1.03	0.82	–	1.5 max.
Fineness (Amount Retained on #325 Sieve)	21.6	21.7	19.0 (15.4 average)	34 max.	34 max.

TABLE 2: MIXTURES USED TO EVALUATE THERMALLY BENEFICIATED CLASS F FLY ASH

PROPERTY	CONTROL CLASS D	THERMALLY BENEFICIATED CLASS D	CONTROL CLASS A	THERMALLY BENEFICIATED CLASS A
Type I PC, (lbs/CY)	465	465	423	423
Popular TN Class F Fly Ash, (lbs/CY)	155	0	141	0
Beneficiated SC Class F Fly Ash, (lbs/CY)	0	155	0	141
No. 57 Stone, (SSD lbs/CY)	1849	1840	1747	1741
River Sand, (SSD lbs/CY)	1112	1106	1270	1263
Water, (lbs/CY)	229.5	229.5	242.5	242.5
Design Percent Air	7	7	6	6
Air Entrainer, (oz/cwt)	2.8	4.0	2.5	2.3
Mid-Range Water Reducer, (oz/cwt)	3.1	3.1	7.6	8.2
High-Range Water Reducer, (oz/cwt)	4.5	4.2	0	0

TABLE 3: COMPARISON OF FLY ASH EVALUATION MIXTURES WITH TDOT CLASS D PCC REQUIREMENTS

PROPERTY	DOT 604.03 CLASS D PCC REQUIREMENTS	CONTROL CLASS D	THERMALLY BENEFICIATED CLASS D
Cement content (lb/CY)	620 minimum	620	620
Water-cement ratio	0.40 maximum	0.37	0.37
Percent Fine Aggregate by Total Aggregate Volume	44 maximum	38	38
Percent Class F Fly Ash Substitution (by Weight) for PC	25 maximum	25	25

TABLE 4: COMPARISON OF FLY ASH EVALUATION MIXTURES WITH TDOT CLASS A PCC REQUIREMENTS

PROPERTY	TDOT 604.03 CLASS A	CONTROL CLASS A	THERMALLY BENEFICIATED CLASS A
Cement content (lb/CY)	564 minimum	564	564
Water-cement ratio	0.45 maximum	0.43	0.43
Percent Fine Aggregate by Total Aggregate Volume	44 maximum	42.5	42.5
Percent Class F Fly Ash Substitution (by Weight) for PC	25 maximum	25	25

by L. K. Crouch, Alex Kelley, Samuel Mathews, Daniel Badoe and Alan Sparkman

IS THERMALLY BENEFICIATED CLASS F FLY ASH

AS GOOD AS CURRENT TENNESSEE CLASS F FLY ASH?

Tennessee concrete producers. Unfortunately, Tennessee does not currently have thermally beneficiated fly ash available. In an effort to validate the use of thermally beneficiated fly ash, TCA obtained thermally beneficiated Class F fly ash from South Carolina and contracted with Tennessee Technological University (TTU) to conduct a comparison of its impacts on concrete properties with a Tennessee Class F fly ash known to perform well as a SCM. The two primary target audiences for the comparison are Tennessee concrete producers and the Tennessee Department of Transportation (TDOT).

MATERIALS AND PROCEDURE

Table 1 shows two samples of thermally beneficiated Class F fly ash compared to a typical Tennessee Class F fly ash known to perform well as an SCM in concrete, meeting ASTM C618-17a (1) and AASHTO M295-11 (2) requirements. All three samples met ASTM and AASHTO requirements for use in concrete.

TDOT-approved materials for concrete used in the study are shown in Table 2, column 1 with the exception of the thermally beneficiated Class F fly ash that was investigated. The proportions of the four mixtures used in the study (see Table 2) were determined through trial batching. After trialing, all four mixtures met the indicated TDOT 604.03 (3) concrete plastic and hardened property requirements. Tables 3 and 4 show TDOT 604.03 (3) requirements for minimum cementing materials, w/cm ratio, fine aggregate percentage by total aggregate volume, and allowable SCM replacement percentages for Class D and A concrete, respectively. Six 0.85-cubic-foot batches of each mixture were made and tested as per Table 5 protocol.

RESULTS AND DATA QUALITY

Tables 6 and 7 show compressive strength results, result ranges, and allowable result ranges for TDOT Class D and A, respectively. Tables 8 and 9 show static modulus of elasticity results, result ranges, and allowable result ranges for TDOT Class D and A, respectively. Tables 10 and 11 show surface resistivity results, result ranges, and allowable result ranges for TDOT Class D and A, respectively. Table 12 shows absorption after boiling results, result ranges, and coefficients of variation.

The acceptable range of the hardened property results was determined by obtaining the standard deviation or coefficient of variation from the appropriate test method and multiplying by an ASTM C 670 factor for the number of test results (8). The multi-laboratory precision was used for the 4×8-inch cylinder results, since AASHTO T 22 states that the preparation of cylinders by different operators would probably increase the variation above multi-laboratory precision criteria (4). All hardened property test results met the acceptable precision criteria except the TDOT Class A control compressive strengths at 7, 14, and 28-days (indicated in red in Table 7). Batch 6 of TDOT Class A control (typical Class F fly ash) mixture seemed to be unusually strong compared to batches 1 through 5 at 7, 14, and 28-days. The reason for the higher strength of batch 6 is not known but is not considered a serious problem. Unfortunately, no precision criteria are available

TABLE 5: TESTING PROTOCOL FOR FLY ASH COMPARISON MIXTURES

TEST METHOD	FREQUENCY	SPECIMENS
Compressive Strength, AASHTO T22 (4)	3 @ 7, 14, 28 and 56 days	4 x 8 cylinders
Static Modulus of Elasticity ASTM C 469 (5)	1 of 3 @ 28 and 56 days	4 x 8 cylinders
Surface Resistivity, AASHTO T 95-11 (6)	3 @ 7, 14, 28, and 56 days	56-day compressive strength 4 x 8 cylinders
Hardened Concrete Absorption, ASTM C642 (7)	3 @ 56 days	3 x 6 cylinders

TABLE 6. TDOT CLASS D COMPRESSIVE STRENGTH RESULTS AND DATA QUALITY (PSI)

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
7-days									
Class D Control	5500	5280	5780	5530	5730	5890	5618	610	719
Class D Beneficiated	5470	5660	5760	5740	5730	5350	5618	410	719
14-days									
Class D Control	6190	6190	6500	6090	6210	6470	6275	410	803
Class D Beneficiated	6490	6420	6190	6320	6200	6160	6297	330	806
28-days									
Class D Control	6780	6750	7110	6750	7230	7240	7977	490	893
Class D Beneficiated	6870	6830	6810	6910	7260	6990	6945	450	889
56-days									
Class D Control	7800	7610	7890	7630	7650	8200	7797	590	998
Class D Beneficiated	7670	7480	7930	7600	8220	7790	7782	740	996

TABLE 7. TDOT CLASS A COMPRESSIVE STRENGTH RESULTS AND DATA QUALITY (PSI)

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
7-days									
Class A Control	3990	4250	4180	4260	4110	4720	4252	730	544
Class A Beneficiated	4360	4510	4480	4280	4410	4330	4395	230	563
14-days									
Class A Control	4650	4780	4490	4700	4460	5250	4722	790	604
Class A Beneficiated	4830	5180	4970	4970	4970	4870	4965	340	636
28-days									
Class A Control	5080	5080	5080	5120	5190	6030	5263	950	674
Class A Beneficiated	5610	5710	5580	5600	5900	5400	5633	500	721
56-days									
Class A Control	5880	5980	5910	5990	5970	6520	6042	640	773
Class A Beneficiated	6190	6430	6420	6760	6550	6170	6420	590	822

by L. K. Crouch, Alex Kelley, Samuel Mathews, Daniel Badoe and Alan Sparkman

IS THERMALLY BENEFICIATED CLASS F FLY ASH AS GOOD AS CURRENT TENNESSEE CLASS F FLY ASH?

for hardened concrete absorptions after boiling.

The hardened property results obtained seemed to be of sufficient quality on which to base reasonable conclusions.

ANALYSIS OF RESULTS

Statistical Comparison of Results

The tests of the hypotheses of equality of corresponding mean values of concrete properties across mixes are represented in Table 13 for the various mixtures at a given curing time and for the same mixture over various curing times, respectively. A statistical t-test with the assumption of unequal variances was performed. The estimated t-value was observed to be less than the critical t-value at the corresponding degree of freedom with a 5 percent significance level. The compared mixes that were deemed to have statistically equal values were denoted as NSD (no significant difference) in Table 13. When the estimated t-value exceeded the critical t-value at the corresponding degree of freedom with 5 percent significance level, the compared mixes were deemed to have significantly different values. The green shaded cells in Tables 13 indicate thermally beneficiated Class F fly ash results are statistically significantly different and superior to typical Class F fly ash results. The red shaded cells in Tables 13 indicate thermally beneficiated Class F fly ash results are statistically significantly different and inferior to typical Class F fly ash results. Numbers shown in Table 13 are the percent difference in mean results. Positive numbers indicate the percentage by which the mean value of a property of a thermally beneficiated Class F fly ash exceeds that of a typical Class F fly ash.

Table 13 shows that in 20 of 22 cases, or 90.9% of the time, thermally beneficiated Class F fly ash was superior or equal to the typical Tennessee Class F fly ash, which is known to perform well as a SCM. This would seem to be strong (if not overwhelming) evidence that the thermally beneficiated Class F fly ash is at least as good as typical Class F fly ash.

TDOT Specification Compliance

All compressive strength results that are shown in Table 6 exceed the TDOT Class D concrete specification 28-day requirement of 4000-psi at all ages. Similarly, all compressive strength results that are shown in Table 7 exceed the TDOT Class A concrete specification 28-day requirement of 3000-psi at all ages. TDOT does not have SR, static modulus of elasticity, or absorption specifications for Class A or D concrete mixtures.

Material Cost

It is currently not possible to accurately estimate the cost of thermally beneficiated Class F fly ash in Tennessee. However, if the cost of thermally beneficiated Class F fly ash were double the cost of the typical Tennessee Class F fly ash known to perform well as an SCM, it would still be about 50% the cost of Type I Portland cement or about 67% of the cost of Grade 100 Ground Granulated Blast Furnace Slag.

TABLE 8: TDOT CLASS D STATIC MODULUS OF ELASTICITY RESULTS AND DATA QUALITY (10^6-PSI)

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
28-days									
Class D Control	3.95	4.05	4.20	3.95	4.00	4.05	4.03	0.25	0.68
Class D Beneficiated	4.45	4.20	4.10	4.35	4.00	4.20	4.22	0.45	0.71
56-days									
Class D Control	4.25	4.10	4.15	4.20	4.30	4.55	4.26	0.45	0.72
Class D Beneficiated	4.30	4.20	4.50	4.30	4.30	4.20	4.30	0.30	0.73

— Continued on page 22

TABLE 9: TDOT CLASS A STATIC MODULUS OF ELASTICITY RESULTS AND DATA QUALITY (10^6-PSI)

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
28-days									
Class D Control	3.60	3.75	3.55	3.55	3.60	3.90	3.66	0.35	0.62
Class D Beneficiated	3.85	4.15	3.95	3.90	3.90	3.80	3.93	0.35	0.66
56-days									
Class D Control	4.30	3.85	4.10	3.90	3.95	4.15	4.04	0.40	0.68
Class D Beneficiated	3.80	3.95	3.95	4.05	4.10	3.95	3.97	0.30	0.67

TABLE 10: TDOT CLASS D SURFACE RESISTIVITY RESULTS AND DATA QUALITY (KILOHM-CM)

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
7-days									
Class D Control	9.7	9.2	9.3	9.6	9.8	9.5	9.5	0.6	4.8
Class D Beneficiated	9.6	9.7	9.4	10.1	9.3	9.3	9.6	0.7	4.8
14-days									
Class D Control	10.9	10.4	10.6	11.2	11.0	10.8	10.8	0.8	5.4
Class D Beneficiated	11.4	11.2	11.0	11.9	10.9	11.0	11.2	1.0	5.6
28-days									
Class D Control	13.8	13.3	13.7	14.5	14.3	14.1	14.0	1.2	7.0
Class D Beneficiated	15.2	14.9	14.9	15.2	14.6	14.8	14.9	0.6	7.5
56-days									
Class D Control	20.8	20.4	20.3	21.2	20.7	21.3	20.8	1.0	10.4
Class D Beneficiated	24.4	24.3	22.6	24.8	24.6	24.4	24.2	2.0	12.1

NEED FOR FURTHER RESEARCH

The current project only compared one thermally beneficiated Class F fly ash to a typical Tennessee Class F fly ash known to perform well as an SCM. It seems prudent to make further comparisons with other thermally beneficiated Class F fly ash samples. However, if thermally beneficiated Class F fly ash samples are required to meet the same ASTM, AASHTO, and TDOT requirements as typical Class F fly ash, it seems reasonable to expect similar performance as a concrete SCM.

CONCLUSION

Based on the testing and statistical analysis done in this project, it appears that the South Carolina thermally beneficiated Class F fly ash evaluated is similar in performance as a concrete SCM to the Class F fly ash typically used in Tennessee.

DISCLAIMER

The opinions expressed herein are those of the authors and not necessarily the opinions of the Tennessee Concrete Association (TCA).

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TABLE 11: TDOT CLASS A SURFACE RESISTIVITY RESULTS AND DATA QUALITY (KILOHM-CM)

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
7-days									
Class A Control	8.6	8.3	8.5	8.5	7.7	8.2	8.3	0.9	4.2
Class A Beneficiated	7.4	7.4	7.0	7.4	7.6	7.8	7.4	0.8	3.7
14-days									
Class A Control	9.5	9.1	9.2	9.3	8.7	9.2	9.2	0.8	4.6
Class A Beneficiated	8.6	8.6	8.2	8.7	9.4	9.0	8.8	0.8	4.4
28-days									
Class A Control	12.1	11.7	11.6	11.9	11.5	11.9	11.8	0.6	5.9
Class A Beneficiated	12.0	12.5	12.1	12.3	12.1	12.0	12.2	0.5	6.1
56-days									
Class A Control	19.3	19.0	18.6	18.8	18.4	20.0	19.0	1.6	9.5
Class A Beneficiated	21.3	22.0	20.5	20.9	21.1	21.6	21.2	1.5	10.6

TABLE 12: 56-DAY ABSORPTION AFTER BOILING RESULTS, RANGES AND COEFFICIENTS OF VARIATION

MIXTURE	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	COV%
Class D Control	4.09	4.21	4.32	4.37	4.58	4.45	4.34	0.49	4.0
Class D Beneficiated	4.51	4.89	4.60	4.77	4.39	4.49	4.61	0.50	4.1
Class A Control	4.78	4.91	4.78	4.82	4.73	4.41	4.74	0.50	3.6
Class A Beneficiated	4.82	4.86	5.05	4.78	4.98	4.86	4.89	0.27	2.1

TABLE 13: STATISTICAL ANALYSIS COMPARING BENEFICIATED ASH VS. TYPICAL ASH

PROPERTY	THERMALLY BENEFICIATED FLY ASH CLASS D CONCRETE VS. TYPICAL FLY ASH CLASS D CONCRETE		THERMALLY BENEFICIATED FLY ASH CLASS A CONCRETE VS. TYPICAL FLY ASH CLASS A CONCRETE	
Surface Resistivity @ 7 days	NSD		Inferior	-10.8%
Surface Resistivity @ 14 days	NSD		NSD	
Surface Resistivity @ 28 days	Superior	6.4%	Superior	3.4%
Surface Resistivity @ 56 days	Superior	16.3%	Superior	11.6%
Compressive Strength @ 7 days	NSD		NSD	
Compressive Strength @ 14 days	NSD		NSD	
Compressive Strength @ 28 days	NSD		NSD	
Compressive Strength @ 56 days	NSD		Superior	6.3%
Static Modulus of Elasticity @ 28 days	Superior	4.5%	Superior	7.3%
Static Modulus of Elasticity @ 56 days	NSD		NSD	
Absorption after Boiling	Inferior	-6.2%	NSD	

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CONTINUOUS TEMPERATURE LOGGERS FOR ACCEPTANCE CYLINDERS

Earlier this year I used this column to share information on a curing study that the TCA performed to evaluate various practical methods of initial curing of concrete cylinders. Although not all methods proved successful at maintaining the required curing conditions, the study showed that with proper planning and a little effort the required initial curing environment (60F to 80F for concrete with < 6000 psi specified strength) could be achieved using practical methods. In this issue I want discuss a related topic — measuring and reporting initial curing temperatures. According to ASTM C31, maximum and minimum initial curing temperatures are required to be recorded and reported for each set of cylinders. Since early age curing temperatures can greatly impact the later age cylinder strength, this data can be critical information for the engineer and/or the building official, especially when a low strength test result is reported. They must use judgement along with the reported results to determine whether additional steps (such as coring) must be taken to ensure that structural adequacy is not compromised. Unnecessary coring of the structure costs the project time and money.

In the past, I have experienced several issues concerning measurement and documentation of max-min initial curing temperatures. From my observations, many of the thermometers marketed for this purpose appear to be cheaply made, do not have a high degree of accuracy, and have not proven very durable when subjected to the conditions of use. In addition, user error can be a common occurrence. If the thermometers are not reset at the proper time, erroneous temperatures can be reported and may not be evident since there is no time stamp on the data. Lastly, I have always been troubled by only having a maximum and a minimum value when evaluating low strength test results. If the temperatures are within tolerance, this may not prove problematic; but, in the event of a low strength test result, I would expect better decisions could be made if continuous temperature readings were available throughout the initial curing period. This is where continuous temperature loggers can come to the rescue. Many reasonably priced temperature loggers are available today that can be used to document max-min temperature. Many of these loggers have desirable features that make them superior to a traditional max-min thermometer. The loggers that I used in the TCA curing study earlier this year can be submerged in water, are Bluetooth enabled, and have a downloadable app that can be used to activate and read the loggers from a smartphone. From the app, you can view graphs as well as export and email the data. I have been using the loggers for well over a year with no equipment failures or need to replace the standard size battery. To say that I am pleased with the loggers is an understatement.

The ability to document max-min temperatures for initial curing has never been easier. As a bare minimum, these temperatures need to be recorded and reported as required by ASTM C31 for every set of cylinders cast for compression testing. However, I think that our industry would be much better served if we would consider using continuous loggers to obtain this data. Max-min data could still be reported, as required; but, if low breaks were to occur, the temperature history of the curing environment would be available and could be used to make better informed project decisions that may save the project (and project team) time and money.

TENNESSEE CONCRETE ASSOCIATION

High School Essay Contest 2022

The Tennessee Concrete Association (TCA) is once again sponsoring the annual High School Essay Contest for Tennessee. Your students are invited to participate.

All entries into the Tennessee Concrete Association Essay Contest will be judged by a panel of industry experts. TCA will award cash prizes to first, second and third place essays.

First place ($750)
Second place ($500)
Third place ($250)

TCA contest winners will have their essays published in the spring issue of *TNConcrete* magazine, in addition to the cash prizes.

ESSAY CONTEST RULES —

- Open to all high school students ages 16 to 18 at the beginning of the school term.
- Essay must be typed, double-spaced and not exceed 600 words.
- Complete online form to submit essay at www.tnconcrete.org or mail it to TCA.
- Essay will be judged on content and writing ability (grammar, style, clarity, etc.).
- Essay should demonstrate a student's awareness of concrete's role as a building material in homes, commercial buildings, streets and highways. (Consider what was left standing after hurricane Michael.)
- Winning essay authors will submit a headshot photo to accompany their essay for the *TNConcrete* magazine.

Tennessee Concrete Association reserves the right to publish the winning entries in whole or in part. All entries become the property of Tennessee Concrete Association.

Submit Entries by Friday, January 7, 2022 to www.tnconcrete.org

2021

"The Remarkable Legacy of Concrete" by Claire Sanborn

2020

"The Powers of Concrete" by Makenzie Kelley

2018

"Concrete Memories" by Karina Rovey

2017

"America and Her Need for Concrete" by Brooks Tryon

2016

"It All Began with the Concrete" by Angele Latham

TCA UPDATE FALL 2021

by Jon Huddleston, Associate Professor & CIM Director

CONGRATULATIONS CIM GRADUATES

Recent CIM graduates at award luncheon.

WORLD OF CONCRETE LAS VEGAS (JUNE 7 – 10)

Six MTSU CIM students, Sally Victory and Jon Huddleston attended this year's rescheduled World of Concrete in Las Vegas. This was the convention center's first major conference since Covid-19 caused the Las Vegas entertainment industry to come to a screeching halt due to Covid-19 restrictions.

MUSIC CITY GRAND PRIX (AUGUST 6 – 8)

Indy car driver Max Chilton (#59) rounds the corner in front of the School of Concrete and Construction Management logo during a practice lap for the Big Machine Music City Grand Prix on Friday, August 6.

MTSU School of Concrete and Construction Management had over 300 students, faculty and staff attend the three-day event, thanks to the generous support of the Music Grand Prix organizers and our concrete industry partners. A special thanks goes to Somero Enterprises for sharing their hospitality trailer with us.

The 2,142 concrete barriers lining the track, produced by Jarrett Concrete Products, utilized a mix design developed by students in the Concrete Industry Management program. MTSU students also helped design the pit road portion of the track in the Nissan Stadium parking lot.

FIBER REINFORCED CONCRETE ASSOCIATION

The Fiber Reinforced Concrete Association (FRCA) met at MTSU on August 6 for its annual meeting and took a pause from busy meetings to enjoy a tour of the jobsite at the new School of Concrete and Construction Management building. FRCA members represent major manufacturers, suppliers and marketers of the world's most popular fiber reinforcement products in the concrete industry.

SCHOOL OF CONCRETE AND CONSTRUCTION MANAGEMENT BUILDING UPDATE

The new School of Concrete and Construction Management building is making fast progress. The second story hollow core planking was installed at

the beginning of August and the topping slabs were completed two weeks after that. The second story walls are currently being constructed and topping out is just around the corner. ■

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