

TENNESSEE CONCRETE MAGAZINE

AWARDS 2020
Volume 34, No. 2



HWY. 27 AND COAL HILL ROAD RETAINING WALLS PRECAST-TRANSPORTATION STRUCTURE

NOW OPEN
ENTRY SEASON FOR
2021 DESIGN AWARDS

See page 7

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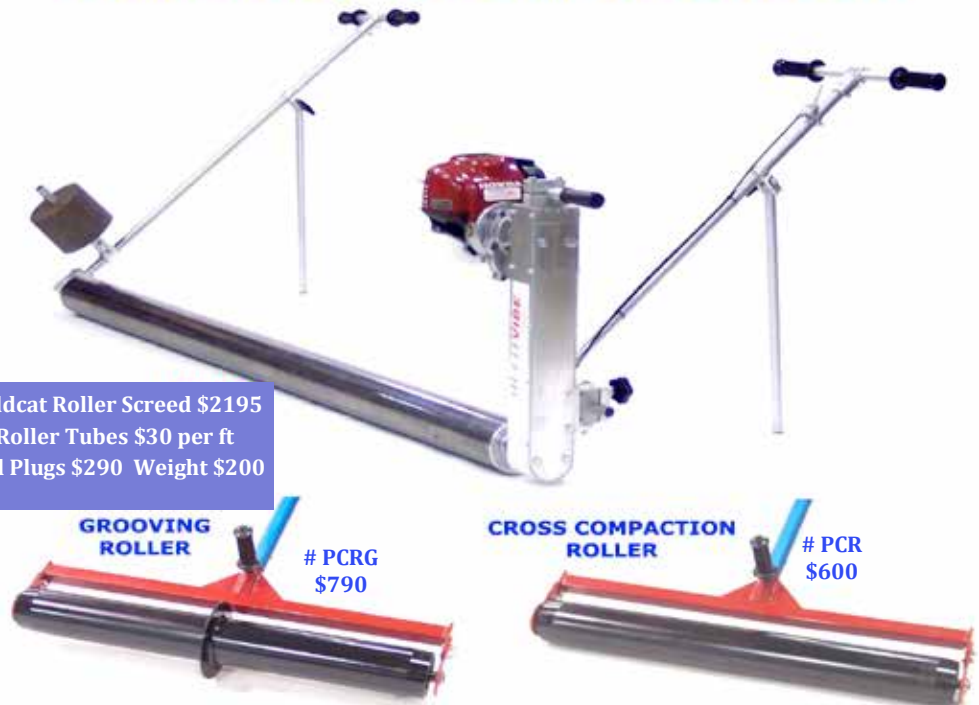


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699 President Place, Suite 400
Smyrna, TN 37167
Phone: 615-360-7393
Fax: 615-360-6670
Website: www.tnconcrete.org

Publisher

The KaHoy Group, LLC

Editor

Alan Sparkman

Assistant Editor

Donna Thompson

Advertising Director

Morris Woods

Design Director

Donna Heninger

For advertising rates and information, contact Morris at 888.401.6367 x704.

Subscriptions in US, free upon request. Outside US, \$12 per year. To subscribe, contact TCA at the above address.

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TCA President

DETERMINE TO BE REPRESENTED

... the entire industry wins when we recognize great projects that feature concrete.
.....
There are many deserving projects ... that go unrecognized
.....
Get your entries in right away!

I came away from TCA's 2019 Annual Convention determined for my organization to be better represented in the 2020 Concrete Design Awards. My determination paid off last year so now I want to issue a challenge to all my fellow TCA members for the 2021 Concrete Design Awards—enter some projects!

Perhaps this lessens my chances of winning again in 2021, but the entire industry wins when we recognize great projects that feature concrete. There are many deserving projects from all across the state that go unrecognized because no one took the time to enter them—the entry process is all online and the time commitment is small so don't let that become an excuse this year.

Whether or not your projects win their category, you win automatically because you have taken the time to recognize the great work of your customers. So don't miss this opportunity to improve your relationship with your customers while improving TCA's 2021 Concrete Design Awards—get your entries in right away!

—Wes Blalock



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NOW OPEN—ENTRY SEASON FOR 2021 DESIGN AWARDS



Alan Sparkman
Executive Director

Send in your best
projects of 2020
today!

.....
Complete your
entries online!

.....
Don't forget to
send in those great
projects!

Welcome to something a bit different for our 2020 Awards issue. This issue contains the winners of our *2020 Concrete Design Awards* that were presented back in March at the TCA Annual Convention. In the past we have released the Awards issue of our magazine after our convention (so Spring), but this year we decided to make the Awards issue our fall publication so everyone could see the great projects and turn right around and send in their entry forms for the 2021 competition! You can complete your entries entirely online and the time commitment is small, so send in your best projects of 2020 today.

The construction industry has fared better than many other parts of our economy in 2020 and for that I am grateful. It will be interesting to see how each of us views 2020 with the perspective of history but it seems pretty clear that 2020 will be remembered as a seminal point in our collective history. What we are living through right now is outside of the experience of any of us and it is challenging all of us to reconsider and perhaps redefine our own personal values.

I admire and respect the many individuals in the construction industry who have continued to move forward in the face of fear and uncertainty. I believe it is this spirit of courage and resolve that will more than anything else bring us through the great turmoil that 2020 has brought. Stay safe, healthy and keep moving us all forward—and don't forget to send in those great projects!

—Alan Sparkman

33RD ANNUAL CONCRETE EXCELLENCE DESIGN AWARDS & LIFETIME HALL OF FAME NOMINATIONS

DEADLINE: DECEMBER 1, 2020

NOTE: Deadline is early this year

(Deadline change will allow for earlier notification of winners and their guests to the annual convention.)

WHY ENTER?

- Receive social media posts
- Feature on special website
- Feature in *TNConcrete* magazine
- Recognition of *your* great work!

CATEGORIES

LIFETIME HALL OF FAME NOMINATION

AMBASSADOR AWARD

- Expanded to include Mixer Operators, Plant Managers, Production, and Sales/Marketing

ARCHITECT/ENGINEER AWARD

- Architect/Engineer - Commercial Buildings
- Architect/Engineer - Non-Building Structures (Bridges, Dams, Stadiums)
- 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



Qualifying category winners entered—compliments of the Mid-America ACI Chapter, International 2021 ACI Excellence in Concrete Construction Awards.

TO SUBMIT ENTRY VISIT:

<https://TNConcreteAssoc.WixSite.com/website-1>

FOR QUESTIONS EMAIL:

donna@tnconcrete.org



2020 CONCRETE AWARD WINNERS



GRAND CHAMPION
BLALOCK READY MIX
HWY. 27

Charles Blalock and Sons, Inc.
Neel-Schaffer, Inc., TDOT



2020 CONCRETE AWARD WINNERS



GRAND CHAMPION— PRECAST-TRANSPORTATION STRUCTURE

NOMINEE: Blalock Ready Mix

PROJECT: Hwy 27 and Coal Hill Road Retaining Walls

CONCRETE CONTRACTOR: Charles Blalock and Sons, Inc.

ENGINEER: TDOT/Neel-Schaffer, Inc.

PROJECT OWNER: TDOT

PRECAST COMPANY: Blalock Ready Mix



The Coal Hill Road retaining wall project is a part of TDOT's multi-phase widening and reconstruction of Highway 27 through Morgan County. This \$90 million project included grading and paving, construction of multiple bridges, and construction of a three-tiered retaining wall along the intersection of Coal Hill Road. Charles Blalock and Sons was the general contractor on the project and constructed the wall using precast concrete wall panels made by Blalock Ready Mix at their Kodak, TN plant. The height of the wall required a tiered design, dividing it into three stacked sections with drainage systems between each section. Over 12,000 cubic yards of concrete were used in the wall panels for this project.

Congratulations



2020 CONCRETE AWARD WINNERS

BEST ARCHITECT/ENGINEER-NON-BUILDING STRUCTURE (BRIDGES, DAMS, STADIUMS, ETC.)

NOMINEE: Jones Brothers, Inc.

PROJECT: CNQ 213 (Maury County)

READY MIXED PRODUCER: IMI

CONCRETE CONTRACTOR: Jones Brothers, Inc.

PROJECT OWNER: TDOT



In 2018, Jones Brothers was awarded the CNQ213 Project. This project was for the on and off ramps on HWY 43 in Mt. Pleasant, Tenn. 38401. On November 8, 2018, IMI began supplying concrete on this project to Jones Brothers. Over the course of 8 months IMI supplied 8,295 yards of 9439TN (TDOT Class CP 3000 Anti-Skid). IMI maintained to deliver concrete on a 2 to 3" slump. In doing so it allowed Jones Brothers to be able to slip the on- and off-ramps maintaining 8" of concrete without forms. During the course of placing 8,295 yards of concrete, IMI, along with Jones Brothers, made 49 pours ranging from 2.5 yards to 657 yards per pour. Jones Brother and IMI made this project a great success completing this project on June 3. The project was not scheduled to be completed until November 2019.

BEST ARCHITECT/ENGINEER-COMMERCIAL BUILDINGS

NOMINEE: Lithko Contracting, Inc.

PROJECT: Virgin Hotel Nashville

READY MIXED PRODUCER: Irving Materials, Inc.

ARCHITECT: Hasting Architecture Associates LLC

CONCRETE CONTRACTOR: Lithko Contracting, Inc.

ENGINEER: EMC Structural Engineers

PROJECT OWNER: Virgin Hotel Group



This project began pouring concrete on 2/3/2018 and topped out on 3/21/19. The Virgin Hotel Nashville will feature 240 guest rooms, multiple concept suites, food and beverage outlets, including the brand's flagship space, Commons Club, and meeting and event spaces. "Nashville's time is now, and we want to be part of that excitement," said Sir Richard Branson about the project.

2020 CONCRETE AWARD WINNERS



BEST ARCHITECT/ENGINEER-RESIDENTIAL

NOMINEE: Knoxville Overlook LLC

PROJECT: Knoxville Overlook

READY MIXED PRODUCER: Harrison Construction

ARCHITECT: Joshua Wright DBA Architects Wright

CONCRETE CONTRACTOR: Trowel Trades

ENGINEER: Haines Structural Group

PROJECT OWNER: Joshua Wright



This project is a 10 unit, 6 story residential building with parking structure underneath. Parking structure was done post tension with 20 parking spaces.

BEST FINISHING-ARTISAN

NOMINEE: Dusty & Josh Cornwall

PROJECT: Faux Wood

READY MIXED PRODUCER: Irving Material Inc.

CONCRETE CONTRACTOR: Dusty and Sons Concrete, LLC



This project featured a stamped wood pattern using rubber stamps. Different color methods were used. The base color was followed by antiquing and accented with the second and third colors. The stamp is a weathered wood stamp with cream beige color hardener, and pecan Tan release. The border and steps were stamped in a slight texture, and then were acid stained with a dark walnut color.



2020 CONCRETE AWARD WINNERS

PRECAST-SPECIALTY

NOMINEE: Blalock Ready Mix
 PROJECT: Dollywood Wildwood Grove
 READY MIXED PRODUCER: Blalock Ready Mix
 CONCRETE CONTRACTOR: Charles Blalock and Sons, Inc.
 PROJECT OWNER: The Dollywood Company
 PRECAST COMPANY: Blalock Ready Mix



As part of the Wildwood Grove addition to Dollywood, Charles Blalock and Sons, Inc. were tasked with constructing an entrance into the new area of the park. This entrance had to not only create an aesthetic gateway into the enchanted forest theming of Wildwood Grove but also provide a functional transition from the grading elevations of the original park into the new area. To accomplish this, Blalock Ready Mix provided custom-colored Redi-Rock LedgeStone retaining wall block to Charles Blalock and Sons for installation on the project. The resulting retain wall

structure allows the Wildwood Grove entrance to flow under the existing Mystery Mine rollercoaster without reconfiguring any foundations or track. At the other end of the wall, the stacked stone look compliments a pair of shotcrete tunnels leading into Wildwood Grove. These tunnels provide a break in the concrete designs, moving from the slate look at the Mystery Mine to the cracked earth design in Wildwood Grove. The Redi-Rock walls provide the structural support on both sides of the tunnels, blending in with the artisan finishes on the shotcrete.

PRECAST-TRANSPORTATION STRUCTURE

NOMINEE: Blalock Ready Mix
 PROJECT: Hwy 27 and Coal Hill Road Retaining Walls
 CONCRETE CONTRACTOR: Charles Blalock and Sons, Inc.
 ENGINEER: TDOT/Neel-Schaffer, Inc.
 PROJECT OWNER: TDOT
 PRECAST COMPANY: Blalock Ready Mix



The Coal Hill Road retaining wall project is a part of TDOT's multi-phase widening and reconstruction of Highway 27 through Morgan County. This \$90 million project included grading and paving, construction of multiple bridges, and construction of a three-tiered retaining wall

2020 CONCRETE AWARD WINNERS



along the intersection of Coal Hill Road. Charles Blalock and Sons was the general contractor on the project and constructed the wall using precast concrete wall panels made by Blalock Ready Mix at their Kodak, TN plant. The height of the wall required a tiered design, dividing it into three stacked sections with drainage systems between each section. Over 12,000 cubic yards of concrete were used in the wall panels for this project.

BEST FINISHING-COMMERCIAL DECORATIVE

NOMINEE: Charles Blalock and Sons, Inc.
PROJECT: Dollywood Wildwood Grove
READY MIXED PRODUCER: Blalock Ready Mix
CONCRETE CONTRACTOR: Charles Blalock and Sons, Inc.
PROJECT OWNER: The Dollywood Company



Wildwood Grove is the newest to the Dollywood theme park, located in Pigeon Forge, TN. The \$37 million project is the largest single expansion of Dollywood to date, adding multiple rides, restaurants, and other family attractions in a completely new area of the park. The theme of the area is an enchanted forest, complete with colored

and stamped concrete pathways throughout the grove and leading to an interactive water feature and lighted tree display. Charles Blalock and Sons completed all of the site work for this project, including the stamped and colored concrete flatwork. This work included a cracked earth pattern for main walkways to mimic a forest trail, complete with animal tracks imprinted in the concrete. Other areas were stamped with wood plant patterns to mimic wooden bridges and flooring, and aggregate seeding was used along the Wildwood Creek water feature to create a mountain stream running through the park. In order to meet the strict deadlines for opening the park to guests, Blalock Ready Mix added an additional batch lane and granular color system to their Pigeon Forge plant, operating seven days a week to complete the project. Wildwood Grove opened to the public in May 2019.

BEST FINISHING-COMMERCIAL

NOMINEE: Fred Hall
PROJECT: Winchester Fire Station #1
READY MIXED PRODUCER: Irving Materials, Inc.
CONCRETE CONTRACTOR: Hall's Backhoe & Dozer



This project is located in Winchester, TN. This project had just over 1000 cubic yards of concrete. The City of Winchester elected to repurpose Don Hall Ford's old dealership building for its new location. They chose to gut everything and only used the actual steel structure as a base for their beloved new fire station. Everything from the footers to the curb and gutter were poured with a 4000 pound mix. The interior slabs in the front entrance way were coated with a special epoxy coating using red and white



2020 CONCRETE AWARD WINNERS

granules to offset color. In the bay area a high gloss tinted epoxy was used also using granules for better durability and safety measures. To see this building now, you would never know this location ever housed a Ford Dealership. The City of Winchester couldn't be happier with the outcome of this long anticipated project.



BEST FINISHING-RESIDENTIAL DECORATIVE EXTERIOR

NOMINEE: Baltz & Sons Concrete
PROJECT: Morrissey Residence
READY MIXED PRODUCER: West Tennessee Concrete
ARCHITECT: Kevin Baltz
CONCRETE CONTRACTOR: Baltz & Sons Concrete
PROJECT OWNER: Morrissey



This phenomenal property was a great opportunity for Baltz & Sons to demonstrate a wide range of concrete finishes and applications. Baltz installed a driveway of washed limestone and stamped cobblestone, acid-stained and scored outer porches and sun-room, and a special sur-

faced deactivated micro-wash pool deck area. They later added concrete countertops for an outdoor kitchen and bar. The countertops feature a fractured stone edge form and lightly stamped texture surface.



SPECIALTY (FLOWABLE FILL, ICF, TILT-UP, ETC.)

NOMINEE: Charles Blalock and Sons, Inc.
PROJECT: Pirates Voyage
READY MIXED PRODUCER: Blalock Ready Mix
CONCRETE CONTRACTOR: Charles Blalock and Sons, Inc.
PROJECT OWNER: World Choice Investments, LLC



Pirates Voyage is a pirate-themed dinner show located in Pigeon Forge, TN. The attraction's stage area features life-size pirate ships and 15-foot deep, 300,000 gallon lagoon. The entire attraction was constructed inside an existing theater, creating unique challenges for the concrete construction. Charles Blalock and Sons, Inc. excavated the lagoon and constructed a temporary bridge to move equipment and materials to the bottom of the pit. After pouring a

2020 CONCRETE AWARD WINNERS



reinforced slab for the lagoon bottom, crews used multiple layers of shotcrete to construct the walls of the pool. Line pump mixes were then used to construct a foundation for the center pirate ship, which acts as the main stage and features decorative stamped concrete to mimic wooden planks. The entire construction was aided by a crane that was set up inside the theater building to assist with material and form moving.



BEST CONCRETE PARKING LOT

NOMINEE: Swanson Construction

PROJECT: McCormick Trucking

READY MIXED PRODUCER: IMI Concrete

CONCRETE CONTRACTOR: Olvera Bros. Concrete

PROJECT OWNER: McCormick Trucking

This project boasts a 4500-yard Fiber Reinforced Parking Lot.



NOW OPEN ENTRY SEASON FOR 2021 DESIGN AWARDS

GOING BEYOND ACI 332: Commercial/Residential Enhanced Durability Concrete

ENDING PHASE ONE

INTRODUCTION

The use of commercially-available deicing salts containing magnesium chloride (MgCl) on residential and commercial concrete such as sidewalks, driveways, etc. can lead to premature deterioration of the concrete. The Tennessee Concrete Association (TCA) approached Tennessee Technological University (TTU) researchers for additional ideas, beyond those in American Concrete Institute Residential Code Requirements for Structural Concrete (ACI 332-14) and Commentary. (1) According to Riding, Thomas, Hooton, Obla, & Weiss, “One of the best and most cost-effective means of extending the service life of reinforced concrete exposed to chlorides is to use concrete with a low permeability” (2). TTU researchers postulated that the rate and amount of damage to commercial and residential concrete would be controlled by the chloride permeability and absorption of the concrete. TTU researchers also hypothesized that the current requirements outlined in ACI 332-14 were adequate for obtaining strength but lacking in requirements to achieve a durable concrete (1). TTU researchers began a pilot study to determine if lower chloride permeability and absorption mixtures could be developed that met (or nearly met) Code Requirements for Residential Concrete (ACI 332-08) requirements (3). The final results obtained and the conclusions drawn from phase one are detailed below.

TTU PILOT STUDY

TTU researchers discussed the MgCl problem with TCA Executive Director in 2018 and attempted to develop commercial and residential enhanced durability (CRED) mixtures with the properties shown in Table 1. The CRED mixtures were intended to meet ACI 332-08 Type 3 Severe requirements for minimum compressive strength (3). However, the CRED mixtures were to be focused on limiting chloride permeability and absorption after boiling in an attempt to reduce both the rate and amount of MgCl entering the concrete. Concrete with Rapid Chloride Permeability values less than 1500-coulombs will provide adequate protection against harmful chlorides (2). 1500-coulombs is the midpoint of the low permeability category. The Surface Resistivity (AASHTO T358-17) category of very low V Low (SR ≥ 37 k Ω -cm) meets (actually is more stringent) the criteria of less than 1500 (4).

Table 2 shows a comparison of an ACI 332 concrete mixture that is commercially available in middle Tennessee and the three CRED mixtures developed in the TTU pilot study. The three CRED mixtures achieved their respective surface resistivity and absorption-after-boiling goals. Similarly, the three CRED mixtures easily met compressive strength goals. Additional compressive strength was not desired but the much higher strength

values attained were a consequence of enhanced durability. The superiority of the engineering properties of CRED mixtures is evident, but does it result in enhanced MgCl durability?

TCA STUDY

Concrete Mixtures

TCA and TTU researchers agreed to include four commercial and two CRED mixtures in the MgCl durability study. The rationale for including each mixture in the study is shown in Table 3. Designs for each mixture are shown in Table 4. Table 5 shows a comparison of three mixtures with ACI 332-14 RF3 requirements. ACI 332-14 Commentary indicates that the RF3 Exposure Class should be used for concrete elements such as driveways, curbs, stairs, steps, and porches exposed not only to freezing and thawing in a near saturated state but also exposed to deicing chemicals. CRED Level 1 did not meet ACI 332-14 requirements for substitution of supplementary cementing materials. CRED Level 2 did meet ACI 332-14 requirements for substitution of supplementary cementing materials. The 3500-psi and 4000-psi mixtures were included since they are commonly used in middle Tennessee and were not expected to meet ACI 332 requirements (1).

Conditioning and Testing Procedure

Only one batch of each mixture in the study was used due to limited space in the low temperature (125°F) drying oven. Each batch contained twelve 4-by-8-inch and nine 3-by-6-inch cylinders. Table 6 shows the conditioning protocol for the study. Table 7 shows testing protocol for the TCA study. Compressive strength was determined as per ASTM C 39-18 (5). Split tensile strength was determined as per ASTM C 496-17 (6). Static modulus of elasticity was determined in accordance with ASTM C 469-14 (7). Absorption after boiling was determined as per ASTM C 642-13 (8) at 28-days. For later absorption after boiling test, the MgCl salt had to be removed from the cylinders by alternating cycles of boiling and oven drying prior to determining absorption after boiling. Table 7 also shows the number and type of samples used for each testing procedure.

Results and Preliminary Analysis

Table 8a and Table 8b shows plastic property results for each mixture and applicable requirements. Table 9 and Figure 1 show mean 3-by-6-inch cylinder weight gain in percent using the mean cylinder weight after the first drying cycle as a control weight. Table 10 and Figure 2 show mean MgCl penetration depth into

TABLE 1. PROPOSED COMMERCIAL & RESIDENTIAL ENHANCED DURABILITY (CRED) CONCRETE

| | CRED LEVEL 1 | CRED LEVEL 2 | CRED LEVEL 3 |
|--------------------------------|-----------------|-----------------|-----------------|
| 14-day Mean SR (kΩ-cm) | | | V Low (SR ≥37) |
| 28-day Mean SR (kΩ-cm) | Low (SR ≥21) | V Low (SR ≥37) | |
| 28-day Mean Absorption (%) | HPC Level (≤5%) | HPC Level (≤5%) | HPC Level (≤5%) |
| 28-day Mean Strength (psi) | ≥ 4500-psi | ≥ 4500-psi | ≥ 4500-psi |
| w/cm | ≤ 0.45 | ≤ 0.45 | ≤ 0.45 |
| Total cementing material (pcy) | 520 | 520 | 520 |

TABLE 2. COMPARISON OF RESULTS IN THE PILOT STUDY

| MIXTURE | ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 | CRED LEVEL 3 |
|--|--------------------|--------------------|-------------------|-------------------|
| Total Cementing Material (pcy) | 564 | 520 | 520 | 520 |
| Percent Portland Cement | 80 | 60 | 50 | 50 |
| Percent and Type of Primary Supplementary Cementing Material | 20 Class C Fly Ash | 36 Class F Fly Ash | 50 Slag Grade 100 | 46 Slag Grade 100 |
| Percent and Type of Secondary Supplementary Cementing Material | 0 | 4 metakaolin | 0 | 4 metakaolin |
| w/cm | 0.443 | 0.39 | 0.39 | 0.39 |
| Mean SR Category 7-days | High | Moderate | Moderate | Moderate |
| Mean SR Category 14-days | High | Low | Low | Very Low |
| Mean SR Category 21-days | High | Low | Very Low | Very Low |
| Mean SR Category 28-days | Moderate | Low | Very Low | Very Low |
| Mean Strength (psi) 14-days | 5067 | 6457 | 7347 | 8300 |
| Mean Strength (psi) 28-days | 5597 | 7097 | 8767 | 9130 |
| Mean Percent Absorption 28-days | 4.96 | 4.48 | 3.15 | 2.75 |

TABLE 3. TCA STUDY DURABILITY EVALUATION MIXTURE RATIONALE

| MIXTURE | CEMENTING MATERIALS (PCY) | W/CM | RATIONALE FOR INCLUSION IN THE TCA STUDY |
|---|---------------------------|------|--|
| Commercial 3500-psi | 480 | 0.52 | Lower end of commercial spectrum |
| Commercial 3500-psi with Penetrating Sealer | 480 | 0.52 | Effect of penetrating sealer |
| Commercial 4000-psi | 500 | 0.49 | Middle of commercial spectrum |
| Commercial ACI 332 | 564 | 0.44 | Upper end of commercial spectrum |
| CRED Level 1 | 520 | 0.39 | Effect of Low Chloride Permeability |
| CRED Level 2 | 520 | 0.39 | Effect of Very Low Chloride Permeability |

GOING BEYOND ACI 332: Commercial/Residential Enhanced Durability Concrete

ENDING PHASE ONE

TABLE 4. TCA STUDY DURABILITY EVALUATION MIXTURES

| MATERIALS | COMMERCIAL 3500-PSI | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|------------------------------------|---------------------|---------------------|--------------------|--------------|--------------|
| Type I/II PC, (lbs/CY) | 375 | 398 | 451 | 312 | 260 |
| Grade 100 Slag, (lbs/CY) | 0 | 0 | 0 | 0 | 260 |
| Class F Fly Ash, (lbs/CY) | 0 | 0 | 0 | 187.2 | 0 |
| Class C Fly Ash, (lbs/CY) | 105 | 112 | 113 | 0 | 0 |
| Metakaolin, (lbs/CY) | 0 | 0 | 0 | 20.8 | 0 |
| No. 57 Stone, (SSD lbs/CY) | 1816 | 1860 | 1854 | 1911 | 1927 |
| River Sand, (SSD lbs/CY) | 1279 | 1210 | 1215 | 1250 | 1258 |
| Water (lbs/CY) | 250 | 250 | 250 | 203 | 203 |
| Design Percent Air | 6 | 6 | 5 | 6 | 6 |
| Air Entrainer, (oz/cwt) | 1.05 | 1 | 1.05 | 0.6 | 0.44 |
| Mid-Range Water Reducer (oz/cwt) | 4.18 | 5.37 | 7.42 | 8.75 | 7.32 |
| High-Range Water Reducer, (oz/cwt) | 0 | 0 | 0 | 7.25 | 6.22 |

TABLE 5. COMPARISON OF TCA STUDY DURABILITY EVALUATION MIXTURES WITH REQUIREMENTS

| PROPERTY | ACI 332 EXPOSURE CLASS RF3 REQUIREMENT | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|--|--|--------------------|--------------|--------------|
| Cement content (lbs/CY) | None | 564 | 520 | 520 |
| Water-cement ratio | None | 0.44 | 0.39 | 0.39 |
| Percent Class F Fly Ash Substitution (by weight) for PC | 25 maximum | 0 | 36 | 0 |
| Percent Class C Fly Ash Substitution (by weight) for PC | 25 maximum | 20 | 0 | 0 |
| Percent Grade 100 Slag Substitution (by weight) for PC | 50 maximum | 0 | 0 | 50 |
| Total of Fly ash, Silica Fume, Slag and Other Pozzolans Substitution (by weight) for PC* | 35 maximum | 0 | 40 | 0 |

*No More than 25% fly ash and no more than 10% silica fume

TABLE 6. TCA DURABILITY CONDITIONING FOR TCA STUDY MIXTURES

| PROCEDURE | FIRST 28-DAYS | ODD WEEKS 5-35 | EVEN WEEKS 6-36 |
|---|---------------|-------------------|------------------------------------|
| Limewater curing | X | | |
| Drying at 125°F | | X | |
| Weight Determination | | X (end of drying) | |
| Digital Image | | X (end of drying) | |
| Soak in 15% (by weight) solution of commercial deicer containing MgCl | | | X (change solution every 4 cycles) |

TABLE 7. TESTING PROTOCOL FOR TCA STUDY MIXTURES

| TEST OR PROCEDURE | 28-DAYS (curing only, no conditioning) | 224-DAYS (after 28 days of curing and 12 cycles of conditioning) | 280 DAYS (after 28 days of curing and 17 cycles of conditioning) |
|------------------------------|---|--|--|
| Compressive strength | (2) 4x8 cylinders | (2) 4x8 cylinders | (2) 4x8 cylinders |
| Split tensile strength | (2) 4x8 cylinders | (2) 4x8 cylinders | (2) 4x8 cylinders |
| Static Modulus of Elasticity | (1) 4x8 cylinder | (1) 4x8 cylinder | (1) 4x8 cylinder |
| Absorption after boiling | (3) 3x6 cylinders | (3) 3x6 cylinders | (3) 3x6 cylinders |

TABLE 8A. PLASTIC PROPERTIES AND REQUIREMENTS FOR TCA STUDY MIXTURES

(A) ACI 332 AND CRED MIXTURES

| PROPERTY | ACI 332 EXPOSURE CLASS RF3 | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|-----------------------------------|---|-----------------------|--------------------|--------------------|
| Slump (inches) | 4±1 without mid or high range water reducer 9 maximum with mid or high range water reducer | 3.50 | 5.75 (has HRWR) | 5.50 (has HRWR) |
| Air content by pressure meter (%) | 6 ± 1.5 | 5.4 | 6.2 | 6.0 |

TABLE 8B. PLASTIC PROPERTIES AND REQUIREMENTS FOR TCA STUDY MIXTURES

(B) COMMERCIAL MIXTURES

| PROPERTY | COMMERCIAL REQUIREMENTS | COMMERCIAL 3500 PSI | COMMERCIAL 4000 PSI |
|-----------------------------------|----------------------------|------------------------|---------------------|
| Slump (inches) | 3 to 6 | 5.00 | 5.50 |
| Air content by pressure meter (%) | 4.5 to 7.5 | 6.3 | 5.5 |

TABLE 9. MEAN 3-BY-6-INCH CYLINDER WEIGHT GAIN (%) FROM MAGNESIUM CHLORIDE SOAKING

| CYCLE | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|-------|------------------------|-------------------------------------|------------------------|-----------------------|--------------|--------------|
| 1 | 0.1 | 0 | 0.3 | 0 | 0.1 | 0 |
| 2 | 1.3 | 0 | 1.0 | 1.2 | 0.5 | 0.3 |
| 3 | 1.9 | 0 | 1.8 | 1.5 | 0.6 | 0.3 |
| 4 | 2.2 | 0 | 2.0 | 1.7 | 0.7 | 0.4 |
| 5 | 2.4 | 0 | 2.2 | 1.8 | 0.9 | 0.5 |
| 6 | 2.5 | 0 | 2.2 | 1.7 | 1.0 | 0.6 |
| 7 | 2.6 | 0 | 2.4 | 2.1 | 1.1 | 0.6 |
| 8 | 2.9 | 0 | 2.6 | 2.2 | 1.1 | 0.6 |
| 9 | 2.9 | 0 | 2.7 | 2.5 | 1.4 | 0.9 |
| 10 | 3.0 | 0 | 2.9 | 2.4 | 1.2 | 0.7 |
| 11 | 3.0 | 0 | 2.9 | 2.5 | 1.1 | 0.6 |
| 12 | 3.1 | 0 | 3.0 | 2.4 | 1.3 | 0.6 |
| 13 | 3.1 | 0 | 3.0 | 2.5 | 1.3 | 0.6 |
| 14 | 3.1 | 0 | 3.0 | 2.5 | 1.3 | 0.5 |
| 15 | 3.1 | 0 | 2.9 | 2.4 | 1.3 | 0.5 |
| 16 | 2.8 | 0 | 2.6 | 2.3 | 1.4 | 0.6 |
| 17 | 2.9 | 0 | 2.8 | 2.4 | 1.3 | 0.5 |

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TABLE 10. MEAN MAGNESIUM CHLORIDE SALT SOLUTION PENETRATION DEPTH IN 4-BY-8-INCH CYLINDERS (INCHES) AND 28-DAY CHLORIDE PERMEABILITY CATEGORY

| | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|---|---------------------|-------------------------------|---------------------|--------------------|--------------|--------------|
| 224-days | 1.27 | 0 | 1.21 | 1.21 | 0.31 | 0.40 |
| 28-day surface resistivity chloride permeability category | Moderate | Very Low* | Moderate | Moderate | Low | Very Low |

*Due to drying and sealer application the test was conducted on day 32

4-by-8-inch cylinders from the post-failure cylinders used in 224-day split tension test. These penetration depths were not measured at the 280-day period as the depths were not definitive and accurate results could not be obtained for all specimens. Penetration depth seems to qualitatively correlate well with chloride permeability. SR was conducted only on 28-day 4-by-8-inch samples since it was not clear to the TTU researchers what effect the MgCl salt residue would have on later chloride permeability results (4). Tables 11, 12, and 13 show compressive strength, split tensile strength, and static modulus of elasticity results for 4-by-8-inch cylinders, respectively. Table 14 shows absorption after boiling results for 3-by-6-inch cylinders.



Figure 2: Magnesium Chloride Salt Solution Penetration Depth in 4-by-8-inch Cylinders (a) 3500-psi (b) CRED Level 1

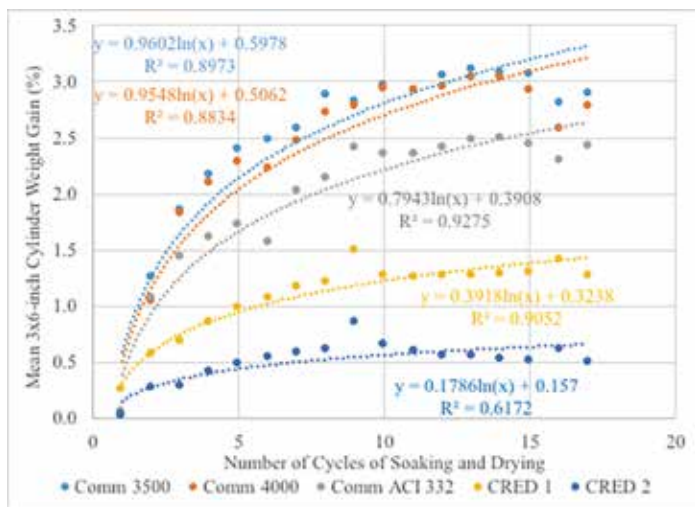


Figure 1: Mean 3-by-6-inch Cylinder Weight Gain vs. Number of Cycles

The percent losses calculated in Tables 11 through 13, shown below, were determined by subtracting the 224-day or 280-day result from the 28-day result and dividing the difference by the 28-day result. The answer was expressed as a percent loss. The percent loss was reported to the nearest positive number (increases in engineering properties were ignored). Percent gains in Table 14, shown below, were calculated in a similar manner.

Figure 3: Shows the percent loss in compressive strength, split tensile strength, and static modulus of elasticity at 280-days. The differences in percent loss of engineering properties at 280-days between current mixtures and improved (sealed or low permeability) mixtures is very evident especially for compressive

TABLE 11: MEAN COMPRESSIVE STRENGTH OF 4-BY-8-INCH CYLINDERS (PSI)

| | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|----------------|------------------------|-------------------------------------|------------------------|-----------------------|--------------|--------------|
| 28-days | 5200 | 5360 | 6070 | 6610 | 8770 | 10330 |
| 224-days | 3160 | 5070 | 4060 | 5590 | 10200 | 11430 |
| 280-days | 1960 | 5410 | 2660 | 3490 | 10660 | 11000 |
| 224-day % Loss | 39.2 | 5.4 | 33.1 | 15.4 | 0 | 0 |
| 280-day % Loss | 62.3 | 0 | 56.2 | 47.3 | 0 | 0 |

TABLE 12: MEAN SPLIT TENSILE STRENGTH OF 4-BY-8-INCH CYLINDERS (PSI)

| | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|----------------|------------------------|-------------------------------------|------------------------|-----------------------|--------------|--------------|
| 28-days | 440 | 445 | 520 | 530 | 565 | 770 |
| 224-days | 280 | 320 | 290 | 325 | 615 | 575 |
| 280-days | 225 | 405 | 250 | 305 | 510 | 550 |
| 224-day % Loss | 36.4 | 28.1 | 44.2 | 38.7 | 0 | 25.3 |
| 280-day % Loss | 49.2 | 9.5 | 52.6 | 42.5 | 9.9 | 28.4 |

TABLE 13: MEAN STATIC MODULUS OF ELASTICITY OF 4-BY-8-INCH CYLINDERS (PSI)

| | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|----------------|------------------------|-------------------------------------|------------------------|-----------------------|--------------|--------------|
| 28-days | 3950000 | 4050000 | 4150000 | 4300000 | 4650000 | 5550000 |
| 224-days | 2650000 | 3350000 | 2650000 | 2500000 | 4900000 | 5300000 |
| 280-days | 950000 | 3350000 | 850000 | 1350000 | 4850000 | 5050000 |
| 224-day % Loss | 32.9 | 17.3 | 36.1 | 41.9 | 0 | 4.5 |
| 280-day % Loss | 75.9 | 12.4 | 79.5 | 68.6 | 0 | 9.0 |

TABLE 14: ABSORPTION AFTER BOILING OF 3-BY-6-INCH CYLINDERS (%)

| | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|----------------|------------------------|-------------------------------------|------------------------|-----------------------|--------------|--------------|
| 28-days | 5.28 | 2.27 | 5.25 | 4.96 | 4.28 | 3.80 |
| 224-days | 6.65 | 6.03* | 6.65 | 6.20 | 4.71 | 4.32 |
| 280-days | 7.01 | * | 6.78 | 6.41 | 4.51 | 4.14 |
| 224-day % Gain | 25.9 | * | 26.7 | 25.0 | 10.0 | 13.7 |
| 280-day % Gain | 32.9 | * | 29.2 | 29.3 | 5.5 | 8.9 |

*The iterative process of boiling / drying for removing MgCl salt proved inappropriate for penetrating sealers (sealer melted). Penetrating sealers were not designed for such high temperatures. Therefore, the authors ignored the 224-day and 280-day absorption after boiling results of the 3500-psi sealed mixture.

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strength and modulus of elasticity. In the opinion of the authors, the graph makes a strong argument for lowering concrete permeability to reduce/minimize deicing salt damage.

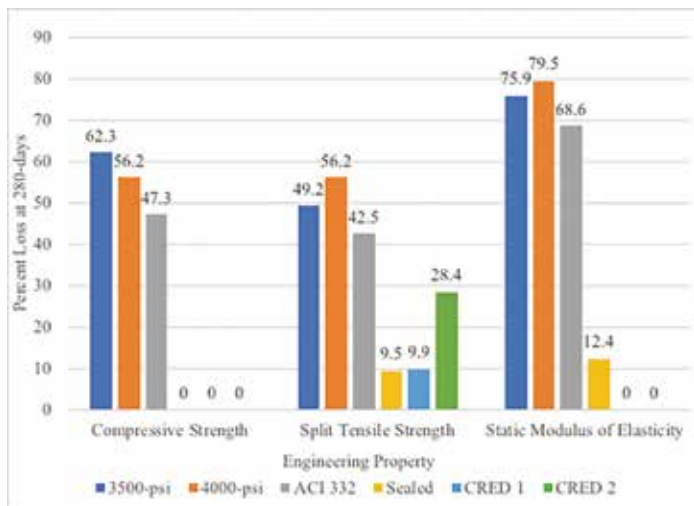


Figure 3: Comparison of Percent Loss of Engineering Properties at 280-days of Conditioning

Table 15, shown below, shows rankings (1 to 6, 1 best) for each evaluation used in the TCA study. The mean ranking is also included to provide a relative comparison of mixture performance.

PRELIMINARY CONCLUSIONS

Based on the limited data available (only one commercially-available magnesium chloride deicing salt and five different concrete mixtures) the following conclusions can be drawn:

1. Using a low permeability concrete mixture or a concrete mixture treated with a penetrating sealer greatly reduces both the rate and amount of magnesium chloride deicer salt intrusion into the concrete.
2. Using a low permeability concrete mixture or a concrete mixture treated with a penetrating sealer greatly reduces the concrete compressive strength loss due to magnesium chloride deicer salt intrusion.
3. Using a low permeability concrete mixture or a concrete mixture treated with a penetrating sealer reduces the concrete split tensile strength loss due to magnesium chloride deicer salt intrusion.
4. Using a low permeability concrete mixture greatly reduces the concrete static modulus of elasticity (stiffness) loss due to magnesium chloride deicer salt intrusion.
5. Using a low permeability concrete mixture greatly reduces the increase in hardened concrete absorption due to magnesium chloride deicer salt intrusion.
6. Using a low permeability concrete or a concrete mixture treated with a penetrating sealer should substantially increase

the service life (greatly delay deterioration) of commercial or residential concrete exposed to commercial deicing salts containing magnesium chloride.

7. The current requirements in ACI 332-14 are not strenuous enough in order to achieve a durable concrete.

WHAT'S NEXT FOR THE TCA MAGNESIUM CHLORIDE DURABILITY STUDY?

The study will be expanded upon and phase two will tentatively begin in June 2020. Phase one was conducted under ideal laboratory conditions which are near impossible to achieve in the field. Further testing is needed to explore the effects on the durability due to non-ideal conditions such as the addition of water, improper curing, or both. These non-ideal conditions could have great effects on the ability of the concrete to withstand the deleterious effects of de-icing chemicals and these results would further reinforce the conclusions drawn from phase one.

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 15: 280-DAY SUMMARY OF PRELIMINARY ANALYSIS BY PERFORMANCE RANKING TO DATA

| | COMMERCIAL 3500-PSI | COMMERCIAL 3500-PSI W/ SEALER | COMMERCIAL 4000-PSI | COMMERCIAL ACI 332 | CRED LEVEL 1 | CRED LEVEL 2 |
|---|------------------------|-------------------------------------|------------------------|-----------------------|--------------|--------------|
| Minimum Salt Intrusion Depth* | 6 | 1 | 4 Tie | 4 Tie | 2 | 3 |
| Minimum Weight Gain | 6 | 1 | 5 | 4 | 3 | 2 |
| Minimum Compressive Strength Loss | 6 | 3 | 5 | 4 | 1 | 2 |
| Minimum Split Tensile Strength Loss | 5 | 1 | 6 | 4 | 2 | 3 |
| Minimum Static Modulus of Elasticity Loss | 5 | 3 | 6 | 4 | 1 | 2 |
| Absorption after Boiling Gain | 5 | * | 3 | 4 | 1 | 2 |
| Mean Ranking | 5.5 | 1.8 | 4.8 | 4.0 | 1.7 | 2.3 |

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ACKNOWLEDGEMENTS

The authors appreciate the financial and technical support provided by the Tennessee Concrete Association.

The authors would like to thank Denny Lind of BASF for extensive donations of chemical admixtures to the project. Also, the authors would like to thank Martin Medley for donations of materials used in this project. In addition, the authors would like to thank Mark Davis and Perry Melton for their patience and skill in fabrication, maintenance, and repair of the equipment.

Further, we appreciate the financial support of the TTU Department of Civil and Environmental Engineering.

Finally, the authors appreciate the administrative, financial and information technology support provided by the TTU Center for Energy Systems Research, particularly Dr. Satish Mahajan, Robert Craven, Etter Staggs, and Anya Milum.

AUTHOR INFORMATION

Samuel Mathews, E.I. is a civil engineering master’s student at Tennessee Technological University.

L. K. Crouch, Ph.D., P.E. is a professor of Civil Engineering at Tennessee Technological University.

Tyler Hughes, E.I. is a future civil engineering master’s student and current civil engineering student at Tennessee Technological University.

Daniel Badoe, Ph.D. is a professor of Civil Engineering at Tennessee Technological University.

Alan Sparkman, CAE, LEED AP, CCPf, is executive director of the Tennessee Concrete Association.

THE POWERS OF CONCRETE

by Makenzie Kelley



The theme this year at Giles County High School is superheroes. Superheroes possess powers that place them in a category of superiority, and it is because of their abilities and strengths that people around the globe from young to old admire and celebrate them. In this respect, concrete can be compared to superheroes. Just like each hero, concrete has a wide variety of “superpowers.” Concrete is incredibly strong, water and fire resistant, and resource efficient. With all of these “powers,” concrete has shown that it is more than capable of providing the support we need. With natural disasters, like hurricane Michael, Florida and other Southern states suffer insurmountable damages that cost everyone millions of dollars, but concrete has shown that it can withstand the horrific onslaught of a hurricane. Concrete could help bypass some of the damage cost if it was used to build homes/commercial buildings and streets and highways.

Ever since Thomas Edison built the first concrete home in 1908, people have continued to build them. Reinforced concrete is the only building material that is highly resistant to both fire and water, meaning that it can even be used for underwater structures. The homes and buildings that are made with concrete absorb and retain heat, making them more

energy efficient. Many of the homes have a reported 5-8% annual energy saving over softwood lumber. It is also used in high-end countertops, sinks, fireplaces, and floors. Another “power” of concrete is that its strength increases over time. The typical compressive strength is 3000 to 7000 psi, but strengths of 20000 psi is possible. All of these numbers mean that the concrete homes are better for the environment and are able to withstand the crushing blows of natural disasters.

Concrete is also used to build over 30% of the interstate highways in the United States. It is able to retain stormwater and return it to the soil, which helps to replenish the natural water supplies. Concrete has the strength to withstand the wear and tear of repeated traffic. Oil and fuel spillages will not damage the condition of the road like it would on a typical asphalt road. Extreme heat will cause asphalt roads to crack and expand, causing hazardous conditions for drivers. This will not happen when the roads are made of concrete.

The incredible “superpowers” of concrete allow it to be one of the most useful building materials for constructing highways/streets and homes. Concrete can be made in exact quantities in order to reduce waste of materials. It is also made of limestone, which is one of the most abundant materials on earth, or waste materials from factories. So move over Superman, step aside Spiderman, and take a backseat Batman--concrete is the real-life superhero fighting for the everyday citizen!

CONCRETE: CONSTRUCTION YOU CAN COUNT ON

by Audrey Everson



The memories were the only things left of my family home. Neither the wooden swing my father and I made when I was six nor the wooden steps my sister and I carved our initials in were left. Our house was completely swept away and destroyed, leaving behind a few beams of distressed wood to remind us of what was once there.

I gazed upon the beach, looking left and right, attempting to see what this disastrous thing had also done to my neighbors on Mexico Beach. It was as if I had been scanning an open prairie made of sand. All of my neighbors’ homes resembled mine, well, resembled what was not there; some were more damaged than others, but it was obvious that hurricane Michael had made its mark. However, there was something bizarre. Two house down from mine, a large, white house was left standing, and it looked as if it had not even encountered Michaels’ wrath. How could that be? What was different between the rest of our houses and theirs?

A few moments later, an older man exited the resilient home. He began to observe his surroundings just as I had, but the difference was his home had survived. I was debating if I should approach him and get my several questions answered. After seconds of debating, I decided to approach the man. As I was walking, feeling the sand between my

toes and breathing in the still, post-storm air, the man said, “Well, hi there, little lady. Is your family okay? That was one heck of a storm.”

I responded, “Yes sir, everyone is safe. Though, as you can see, my home did not make it.” Then I paused and continued with curiosity, “Sire, if you don’t mind my asking, how come your house survived and the rest of ours didn’t.”

He affirmed, “Well, you see, my home was made out of concrete from the ground up. Yours, as well as the others, was constructed of wood.”

“What is so special about concrete?” I asked with confusion.

“Well, concrete has the strength, resistance, and durability to hold out against strong winds and debris from a hurricane. Concrete can do so by providing a dry, warm, damp-resistant, and energy-efficient foundation for a building to stand up to hurricanes and other natural disasters such as tornadoes, typhoons, and earthquakes. My concrete home is able to withstand up to 300- mph winds. My wife and I were able to make a hurricane-proof house by using concrete, and as a plus, it wasn’t much more expensive than if we made our house out of other materials.”

“So, you’re telling me that what saved your house was the fact that its building material was simply concrete?” I asked to ensure I was comprehending what I was being told.

“Yes, ma’am. That’s exactly what I am telling you. There are about twenty-three types of concrete, and they all have their own importance depending on its job.”

I could not believe what I was being told. What saved this man’s home was the fact that it was constructed of concrete, and what caused me to lose my home was the fact it was made of wood. People need construction they can count on: construction that can hold up against the

unpredictable. In this case, concrete is the only choice.

A CONCRETE SURPRISE

by Bricen Hicks



I like high school, but the best part of education is hands-on learning. My school allows its students to go on job shadow days.

I chose to go with my dad to one of his construction sites. He is a contractor, and I was excited to go to the house he had been working on the last few months to see the final project.

The latest house he built was almost completely made of concrete. Dad and I had been talking a lot about it. From his first descriptions, I thought the house would end up looking like a giant cinder block. Boy was my mental picture wrong!

His crew began the project by laying the foundation. They dug the footer and had the concrete company bring mix with extra fiber to pour the footing. Next, the crew spent hours framing the basement walls and getting the forms ready to pour. When they were ready for the concrete company to send out the concrete truck, Dad ordered the concrete, and had it colored a dark gray. The truck brought the concrete to the building site. The mix was just right. Dad and his crew poured the walls and waited for them to cure. Then, the construction team was ready to pour the basement floor. Dad had the floor concrete tinted a medium gray color. The color looked great with the dark gray walls. Next, the crew formed and poured the main floor the same color as the basement floor. The main floor walls

were formed and poured. Dad chose a light gray color for the walls. The colors all blended together nicely.

The construction crew did the interior walls and put in the doors and windows. They got the house in the dry with a durable metal roof. Dad chose black. The front porch was formed and poured with the dark gray concrete. They put black shutters on the windows to bring everything together. Then, it was time for the team to do the inside work.

The floors were polished to give them a brilliant shine. The main floor walls were washed to a light grey, almost white color. With beautiful gray concrete countertops, the kitchen was breath-taking. Elegant white stairs extended out of the wall and down into the basement. The steps created the illusion that they were floating. The downstairs walls were sealed and the floors were polished. The contrast was stunning!

Dad and the construction team also poured a driveway leading up to this amazing home. The concrete was the medium gray color to match the house and was stamped to look like marble. It was impressive!

Dad and I walked outside on the stamped concrete patio and sat down on the outside furniture, which was also made of concrete. After seeing everything inside the house and all the angles of the outside of it, I realized how my initial image of a giant brick was extremely off. This house gave off a futuristic vibe, and with everything so elegant, it looked like a mansion. I was inspired by the beauty and durability of the concrete. Dad and I even discussed the cost of the home. The most amazing part for me was not the splendor of the house, it was the value. After the tour and our talk, I have decided that I want to build a house for myself out of concrete. ✨

END OF AN ERA *for* MTSU's CIM Program



Dr. Heather J. Brown has officially handed her CIM Director role to Mr. Jon Huddleston who is a proud CIM alumni and faculty member. Dr. Brown has held this post since 2006 after arriving at MTSU in 2001. Since 2006, the MTSU CIM program has developed a concrete contracting concentration, an executive MBA with a focus on the industry, a road construction certificate and new courses such as Decorative, Masonry and Precast. Three different study abroad programs have helped our students appreciate concrete construction in other countries such as Dominican Republic, England and the UAE. Countless student

competitions and research projects have been a highlight of Dr. Brown's involvement with CIM. In 2016 the CIM department became the CCM department housing both CIM and Construction Management. With the help of the concrete industry and the State, a building was funded and approved in 2019 and will take this program to the next level. After 14 years of academic administration, Dr. Brown turned the department over to newcomer Dr. Kelly Strong. He has stepped in seamlessly to continue the bright future ahead of us. Dr. Brown will continue as a member of the faculty.

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