WINTER 2024
Volume 38, No. 3

TENNESSEE CONCRETE MAGAZINE

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TENNESSEE CONCRETE magazine is published for the Tennessee Concrete Association—

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Antioch, TN 37013
Phone: 615.360.7393
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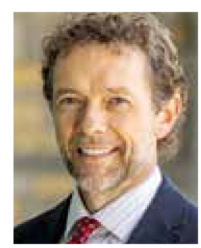

THE END OF 2024 RAPIDLY APPROACHING

Charlie Lay
2024 TCA President

Submit your design award entry!

Let's showcase the "Best of the Best"

TCA Annual Convention February 7-8, 2024

MEMBERS SUPPORTING MEMBERS

As the year draws to a close, TCA can look back on significant accomplishments in 2024, especially with regard to our future workforce Initiatives.

Be sure to check out the new interactive map on the TCA website that shows the over 50 high schools and middle schools that have signed up to participate in the Skate4Concrete program. As you look at the map, please take note of the blue map pins. These are schools that still need a local sponsor to help them learn more about concrete and the job opportunities in our industry. If you are not yet sponsoring a school please find one close to you and help TCA continue to tell the story about our concrete industry. If you are willing to help, please reach out directly to Joseph at jmcdaniel@tnconcrete.org.

Thanks to everyone who came out to support TCA's scholarship foundation at our recent golf outing. This event helps fund our scholarship program at the MTSU CIM program where TCA has provided more than 50 scholarships over the past 20 years. The dividends to our industry for this investment are impressive so thanks for your continuing support of this most important initiative.

Finally, please accept my personal invitation to attend TCA's 2025 Annual Convention on February 5 and 6, 2025 at the Cool Springs Marriott in Franklin, Tenn. The hotel block and registration are now open—please join me for this great event!

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IT'S WORTH REPEATING!

Alan Sparkman
Executive Director

Pick your best projects of the year and submit to the 2024 Concrete Design Awards

With 2024 rapidly drawing to a close, this is a good time to look back at what has happened in the Tennessee concrete industry during the past year.

After setting four consecutive concrete production records through the end of 2023 we saw a definite slowdown in concrete production during 2024. As of this writing numbers are only available through the end of July but they show that concrete production is down about 14 percent through mid year 2024. In spite of this year's decline, it appears that concrete production in Tennessee will still top 8,000,000 yard^3 in 2024. That would rank 2024 in the top six production years ever for Tennessee.

The numbers also show that the utilization of type one L cement continues to grow. We ended 2023 with type one L utilization at 90 percent of all cement consumed in Tennessee. That number has continued to creep upward throughout the year and as of the July numbers, the percentage is now 94 percent.

Also worth noting that residential construction across Tennessee is actually up (in terms of permit activity) over 2023. In fact, through the end of August the five major markets in Tennessee (Nashville, Knoxville, Chattanooga, Memphis and Clarksville - ranked in order of total permits so far in 2024) are up versus 2023 by 11.6 percent, with Clarksville and Chattanooga seeing increases of more than 30 percent vs 2023 on a year-to-date basis.

The outlook for 2025 should be positive as interest rate reductions will likely free up some commercial projects that have been sitting on the sidelines, and Tennessee's housing market should continue to perform well. Public work (think TDOT) should continue at its current level thanks to continuing federal funding, and Tennessee's own fuel tax collections continue to be at or slightly above budget projections.

All of this means that ready mix producers (and all other businesses) have to continue to focus on talent. I think the focus should first be on retaining and up-skilling your current employees and that means investing in training to keep your people both engaged and improving. Another reason to focus on retention is the demographic fact that the number of people entering the workforce is shrinking. New people will continue to be hard to find and new people will also require an ongoing investment in training to get them ready to work and to be effective in your organization. Today's workforce entrants pay attention to an organization's commitment to training and development, so every industry has to be ready to compete on their willingness to invest in employee development.

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by Landon Davis, L. K. Crouch, Daniel VandenBerge, Joel Wallace, John Pearson, and Alan Sparkman

THE EFFECT OF HIGH INITIAL CURING TEMPERATURES on Compressive Strength of Some Common Tennessee Concrete Mixtures

INTRODUCTION

Adequately curing concrete is perhaps the most important action required to produce a quality product. Curing is the "maintenance of a satisfactory moisture content and temperature in concrete for a sufficient period of time… so that the desired properties may develop" (1). Good curing practices increase strength, reduce shrinkage, lower permeability (and therefore increase durability) and improve abrasion resistance (1). The importance of curing and its positive effects are well documented and understood.

Strength testing of cylinders is often used for acceptance testing of a mix, determining form stripping time, estimating strength of the in-place concrete, and various other purposes. ASTM C31 specifies that a "standard curing" procedure is required when the cylinders are to be used for acceptance testing for strength, testing mixes for strength, and maintaining quality control (2). ASTM C31 states that standard initial curing shall maintain temperatures of 60-80ºF for cylinders from a mix with a specified strength less than 6000 psi (2). The cylinders are kept in this environment for up to 48 hours before being placed in a final curing environment (2). Practically, these conditions can prove difficult to provide, especially in summer weather (3). In reality, the initial curing environment is often provided on or close to the jobsite by the contractor. The hot temperatures of summer, when a large portion of concreting is accomplished, often lead to higher temperatures for initial curing than specified by ASTM.

This reality, combined with the fact that proper temperature is required for curing, implies that sufficient initial curing is often not provided for cylinders made in the field. Some compressive strength may be lost due to improper initial curing. This article provides data regarding how much strength may be lost by elevated initial curing temperatures for some common Tennessee concrete mixtures.

TABLE 1. MIX PROPORTIONS AND QUALITIES

MIXTURE	COMMERCIAL 3500	TDOT A	TDOT D	TDOT X
Total Cementing Materials (lbs/CY)	480	564	620	714
Type IL PC (lbs/CY)	375	423	465	714
TDOT Approved Class C Fly Ash (lbs/CY)	105	0	0	0
TN Class F Fly Ash (lbs/CY)	0	141	155	0
No. 57 Stone (lbs/CY)	1808	1752	1855	1702
River Sand (lbs/CY)	1283	1275	1115	1157
Volume Fine/Total Agg.	0.420	0.426	0.380	0.410
Water (lbs/CY)	250	242.5	229.5	271
w/c ratio	0.521	0.430	0.370	0.380
Design Air (%)	6	6	7	6
Air Entrainer (oz/cwt)	1¼	1	½	1
Mid-Range Water Reducer (oz/cwt)	1/8	5	15	7
High-Range Water Reducer (oz/cwt)	0	0	2 ¼	0

MATERIALS

The research team developed four mixtures with varying w/c ratios, cementing materials content, and supplementary cementitious materials (SCM) substitution rates. One mixture is commonly used by a Tennessee concrete producer. The other three are based on Tennessee Department of Transportation (TDOT) requirements. The mixes were chosen based on their total cementing materials content.

Each mixture was developed through trial batching. Mixtures were tested for temperature, slump, air content (pressure method), and unit weight according to ASTM C1064 (4), C143 (5), C231 (6), and C138 (7), respectively. The mixes were adjusted (by chemical admixtures) to meet the requirements specified by the producer or TDOT. Each material used was obtained from a TDOT approved supplier.

The mix proportions and some important quantities can be found in Table 1.

After final admixture dosage adjustments were made, the mixtures had the plastic properties shown in Table 2:

TABLE 2. MIX PLASTIC PROPERTIES

VALUE	COMMERCIAL 3500	TDOT A	TDOT D	TDOT X
Slump (in)	6 ½	3 ¾	7 ½	3
Air Content by Pressure (%)	5.0	6.2	7.0	5.0
Unite Weight (pdf)	141.3	142.2	141.7	142.5
Temperature	69	73	71	67

All mixes were adjusted to meet the appropriate specifications, including obtaining an air content very near to the design air content. The mixes are compared to their specifications in Tables 3-6. As shown, only the Commercial 3500 mix did not completely meet specifications. The small difference was considered inconsequential and acceptable for workability purposes. TDOT specifications were obtained from the TDOT specification book (8).

TABLE 3. COMMERCIAL 3500 COMPARISON TO SPECIFICATIONS

PROPERTY	MANUFACTURER REQUIREMENT	COMMERCIAL 3500 VALUES
Total Cementing Materials (lbs/CY)	480	480
w/c ratio	0.521	0.521
Volume Fine/Total Aggregate	0.420	0.420
Fly Ash Substitution (%)	21.875	21.875
Slump (in)	3 to 6	6 ½
Air Content by Pressure (%)	4.5 to 7.5	5.0

Note: Values that do not comply with producer specification are highlighted in red

TABLE 4. TDOT A COMPARISON TO SPECIFICATIONS

PROPERTY	TDOT 604 REQUIREMENT	TDOT A VALUES
Total Cementing Materials (lbs/CY)	564 minimum	564
w/c ratio	0.45 maximum	0.430
Volume Fine/Total Aggregate	0.44 maximum	0.426
Fly Ash Substitution (%)	25 maximum	25
Slump (in)	2 to 4	3 ¾
Air Content by Pressure (%)	4 to 8	6.2
Temperature (°F)	50 to 90	73

TABLE 5. TDOT D COMPARISON TO SPECIFICATIONS

PROPERTY	TDOT 604 REQUIREMENT	TDOT A VALUES
Total Cementing Materials (lbs/CY)	620 minimum	620
w/c ratio	0.40 maximum	0.370
Volume Fine/Total Aggregate	0.44 maximum	0.380
Fly Ash Substitution (%)	25 maximum	25
Slump (in)	8 maximum	7 ½
Air Content by Pressure (%)	4.5 to 7.5	7.0
Temperature (°F)	50 to 90	73

TABLE 6. TDOT X COMPARISON TO SPECIFICATIONS

PROPERTY	TDOT PLAN REQUIREMENT	TDOT X VALUES
Total Cementing Materials (lbs/CY)	714	714
w/c ratio	0.38	0.380
Volume Fine/Total Aggregate	0.44 maximum	0.410
Fly Ash Substitution (%)	25 maximum	0
Slump (in)	2 to 4	3
Air Content by Pressure (%)	4 to 8	6.0
Temperature (°F)	50 to 90	67

PROCEDURE

In order to test for the effects of out-of-spec temperatures for initial curing, special curing protocols were developed. The protocols are as follows:

1. Each batch contained three cylinders cured according to ASTM C31 specifications as a control group. The minimum and maximum temperatures during the initial cure phase for these cylinders were monitored to ensure compliance to specification.
2. Three cylinders from each batch were cured in an "immersed" environment. This variable was introduced to evaluate the effects of immersing cylinders (in mold) in water. ASTM C31 explicitly suggests this method (2). It should be noted that these cylinders were not capped and totally submerged in water. Rather, the research team opted to cover all cylinders in plastic bags to control moisture loss. To ensure that no water entered the cylinders prior to set, roughly an inch of freeboard was allowed between the water level and the lips of the immersed cylinders. The water was brought to laboratory temperature before curing.
3. Three cylinders were cured in an oven set to 95ºF, with temperature verified by thermometer.
4. Finally, three final cylinders were cured in an oven set to 125ºF, with temperature verified by thermometer.

Pearson found that elevated temperatures as described in conditions 3 and 4 were easily reached with an ambient temperature range of just 66-98°F (3). In fact, Pearson's work shows that cylinders with "no protection" can reach temperatures of up to 136°F in summer weather in a 48-hour period (3).

In total, 6 batches of each mix were produced, with 12 cylinders per batch. This resulted in a total of 288 cylinders cast. All cylinders were taken from their initial curing environments at 48 hours after casting and put into a curing tank monitored to meet ASTM C31 specification (73.5 +/- 3.5ºF) for final curing (2). The curing protocol is shown in Table 7.

TABLE 7. INITIAL CURING PROTOCOL

CURING TEMPERATURE (°F)	DESCRIPTION
Specification (60 to 80)	In molds in laboratory air
Specification (60 to 80)	In molds immersed in water in laboratory air
Elevated (95)	In molds in 95° oven
High (125)	In molds in 125° oven

Note: at the conclusion of their assigned curing temp for the first 48-hours, cylinders would be removed from their molds and immersion cured in a water tank at approximately 73.5±3.5ºF until 28-day testing.

Note: at the conclusion of their assigned curing temp for the first 48-hours, cylinders would be removed from their molds and immersion cured in a water tank at approximately 73.5±3.5ºF until 28-day testing.

At 28 days, each cylinder was removed from the final curing environment, and surface resistivity testing was performed according to AASHTO T358 (9). Following the non-destructive surface resistivity test, the cylinders were tested for compressive strength according to ASTM C39 (10). The testing protocol is shown in Table 8.

TABLE 8. TESTING PROTOCOL

TEST METHOD	FREQUENCY	SPECIMEN TYPE
Surface Resistivity, AASHTO T358	3 per batch per curing condition @ 28 days	4 x 8 cylinders
Compressive Strength, ASTM C33	0.3 per batch per curing condition @ 28 days	04 x 8 cylinders (after SR testing)

RESULTS

The results from hardened property testing are shown in Tables 9-18. The tables show the results (batch means) per curing condition acquired from testing. The results are then averaged together to find an average value for each mix per curing condition. For both surface resistivity and strength testing, the range of the results is calculated and compared to an acceptable range.

The acceptable ranges were found by first obtaining the appropriate limiting coefficient of variation (COV) for each test. The research team determined that multi-laboratory parameters were most appropriate for precision analysis because two users completed the testing. For surface resistivity testing, AASHTO T358 limits the multi-laboratory COV to 12.5% (9). ASTM C39 does not provide a multi-laboratory COV for 4x8 cylinders (10). Given the lack of an appropriate COV, the research team opted to analyze the batches tested by both users separately, using the single-user COV limit of 3.2% for 4x8 cylinders made in the lab by ASTM C39 (10).

To calculate an acceptable range of results, the limiting COVs selected were then multiplied by a multiplier of standard deviation or coefficient of variation found in ASTM C670 (11). Because a total of 6 batches were made for each mix, a multiplier of 4.0 was selected from Table 1 of ASTM C670 (11). Each user made three batches of each mix, so a multiplier of 3.3 was selected from Table 1 of ASTM C670 (11).

Finally, the product of the selected COV's and their multiplier was multiplied by the mean value per mix. This results in the acceptable range of results per batch per curing condition. In all cases, surface resistivity testing results fell within the acceptable range. In most cases, strength testing results fell within the acceptable range.

TABLE 9. STRENGTH TESTING RESULTS FOR COMMERCIAL 3500 MIX (PSI)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN
Standard	3420	3540	3970	3790	3530	3750	3670
Immersed in Lab Air	3430	3580	3800	3830	3480	3860	3660
Oven at 95 °F	3220	3440	3490	3490	3200	3335	3360
Oven at 125 °F	2420	2450	2260	2800	2540	2560	2510

TABLE 10. STRENGTH TESTING RESULTS FOR TDOT A MIX (PSI)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN
Standard	3530	3080	3490	3180	3790	3250	3390
Immersed in Lab Air	3640	3180	3730	3170	3885	3254	3480
Oven at 95 °F	3240	2820	3360	3090	3320	3120	3160
Oven at 125 °F	3010	2720	2490	2570	3380	2610	2800

by Landon Davis, L. K. Crouch, Daniel VandenBerge, Joel Wallace, John Pearson, and Alan Sparkman

THE EFFECT OF HIGH INITIAL CURING TEMPERATURES on Compressive Strength of Some Common Tennessee Concrete Mixtures

TABLE 11. STRENGTH TESTING RESULTS FOR TDOT D MIX (PSI)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN
Standard	5225	5030	5210	5200	5300	5550	5250
Immersed in Lab Air	5240	5180	5280	5180	5020	5450	5230
Oven at 95 °F	4700	4600	5160	4790	4750	4710	4790
Oven at 125 °F	4510	3890	4060	2690	3970	3840	3830

TABLE 12. STRENGTH TESTING RESULTS FOR TDOT X MIX (PSI)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN
Standard	5840	6840	6515	7230	6780	6910	6690
Immersed in Lab Air	6100	7060	7140	7910	7200	7420	7140
Oven at 95 °F	5560	6590	6410	7170	6280	6380	6400
Oven at 125 °F	4700	5770	5900	5970	5710	5530	5600

ANALYSIS

The data in Tables 9-12 reveal that elevated initial curing temperatures seem to damage the curing process in the first 48 hours after casting. The research team sought to quantify the strength potential sacrificed by not curing in standard temperatures. Tables 13 and 14 demonstrate that elevated initial curing temperatures may also increase variability in strength results, as most cases of testing result ranges being out of their allowable range are linked to high curing temperatures.

Table 19 shows the mean 28-day strength for each mix per curing condition compared to the strength specified by TDOT/the producer. In the case of the Commercial 3500 mix, an elevated initial curing temperature of 95ºF led to the cylinders failing to meet specified 28-day strength. For all mixes except for TDOT X, a high initial curing temperature of 125ºF led to the cylinders failing to meet specified 28-day strength. This seems to be strong evidence that improper initial curing can lead to low breaks, causing problems for facility owners, contractors, and producers.

Table 20 shows the change in means of 28-day strength for immersed, elevated, and high curing conditions. For TDOT A and TDOT X, immersed curing provided modest strength gains compared to standard curing, while producing small losses for the other mixes. However, in all cases, higher-than-spec initial curing temperatures proved detrimental to 28-day strength, with the 125ºF initial curing state providing an average strength loss of 23% across all mixes. This is strong evidence that deviation from ASTM specifications for initial curing of field made cylinders prohibits the samples from reaching their full-strength potential at 28 days.

A statistical analysis of the data gathered was performed using a paired t-score test. The paired t-score test allows for analysis of dependent samples (12). The cylinders exposed to standard curing were taken as the control group for this analysis. Statistical significance was defined as a t-score above the two-tailed critical t-value at a 5% significance level for the corresponding degree of freedom. The results are presented in Table 19. In all cases of initial curing temperatures being higher than allowed by the specification, the cylinders had a significantly lower average compressive strength than their companion cylinders that were

TABLE 13. PRECISION RESULTS FOR USER 1 (PSI)

MIX AND CURING CONDITION	MEASURED RANGE	ACCEPTABLE RANGE
Commercial Standard	260	390
Commercial Immersed	280	397
Commercial in 95°F	150	362
Commercial in 125°F	350	275
TDOT A Standard	300	381
TDOT A Immersed	260	547
TDOT A in 95°F	460	514
TDOT A in 125°F	540	441
TDOT D Standard	90	554
TDOT D Immersed	260	547
TDOT D in 95°F	460	514
TDOT D in 125°F	540	441
TDOT X Standard	390	738
TDOT X Immersed	850	788
TDOT X in 95°F	790	709
TDOT X in 125°F	440	608

TABLE 14. PRECISION RESULTS FOR USER 2 (PSI)

MIX AND CURING CONDITION	MEASURED RANGE	ACCEPTABLE RANGE
Commercial Standard	550	384
Commercial Immersed	370	377
Commercial in 95°F	290	349
Commercial in 125°F	280	254
TDOT A Standard	170	335
TDOT A Immersed	80	338
TDOT A in 95°F	300	318
TDOT A in 125°F	150	278
TDOT D Standard	520	555
TDOT D Immersed	270	557
TDOT D in 95°F	190	496
TDOT D in 125°F	1200	367
TDOT X Standard	940	674
TDOT X Immersed	1100	719
TDOT X in 95°F	850	642
TDOT X in 125°F	1200	574

Note: In Tables 13 and 14, measurement ranges found to not comply with the calculated permissible range of results are highlighted in red.

TABLE 15. SURFACE RESISTIVITY TESTING RESULTS FOR COMMERCIAL 3500 MIX (KΩ-CM)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
Standard	12.7	9.3	10.6	9.7	9.5	9.0	10.1	3.7	5.1
Immersed in Lab Air	10.3	9.2	10.0	9.1	9.2	8.7	9.4	1.6	4.7
Oven at 95 °F	10.3	9.7	10.6	9.2	8.7	8.9	9.6	1.9	4.8
Oven at 125 °F	9.2	9.1	9.6	8.6	9.0	8.8	9.0	1.0	4.5

TABLE 16. SURFACE RESISTIVITY TESTING RESULTS FOR TDOT A MIX (KΩ-CM)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
Standard	9.3	10.3	10.1	9.7	9.1	9.1	9.6	1.2	4.8
Immersed in Lab Air	8.9	8.8	9.3	9.4	9.2	9.8	9.2	1.0	4.6
Oven at 95 °F	10.2	11.1	10.8	10.3	9.1	9.6	10.2	2.0	5.1
Oven at 125 °F	12.3	12.9	11.9	16.7	15.7	15.3	14.1	4.8	7.1

TABLE 17. SURFACE RESISTIVITY TESTING RESULTS FOR TDOT D MIX (KΩ-CM)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
Standard	11.3	11.8	12.0	11.8	11.0	10.6	11.4	1.4	5.7
Immersed in Lab Air	11.4	11.7	11.7	11.2	11.2	11.2	11.4	0.5	5.7
Oven at 95 °F	12.0	12.7	11.5	11.6	11.5	11.8	11.9	1.2	5.9
Oven at 125 °F	17.4	16.3	17.9	20.6	20.9	18.9	18.7	4.6	9.3

TABLE 18. SURFACE RESISTIVITY TESTING RESULTS FOR TDOT X MIX (KΩ-CM)

INITIAL CURING CONDITION	BATCH 1	BATCH 2	BATCH 3	BATCH 4	BATCH 5	BATCH 6	MEAN	RANGE	ALLOWABLE RANGE
Standard	9.4	9.7	10.4	8.7	8.6	8.8	9.3	1.8	4.6
Immersed in Lab Air	9.0	9.1	9.5	9.3	8.3	9.1	9.1	1.2	4.5
Oven at 95 °F	9.0	8.8	9.1	8.2	8.2	8.1	8.6	1.0	4.3
Oven at 125 °F	7.0	7.2	8.0	6.4	6.9	7.0	7.1	1.6	3.5

cured according to spec. In the case of the TDOX X mix, immersed curing proved statistically beneficial over the standard procedure. Cases with no statistical difference in average strength are denoted as "NSD."

Tables 19, 20, and 21 all give strong evidence that ensuring initial curing temperatures for field-made cylinders is critical for meeting strength specifications and ensuring that a cylinder adequately demonstrates the strength potential of a mix.

Surface resistivity results did not give analogous results to strength testing. As strength decreases, one can generally expect surface resistivity to decrease with it. However, Tables 15-18 show that that expectation was not always met, specifically with TDOT A and TDOT D mixes. These mixes yielded higher surface resistivity results at higher initial curing temperatures. The authors theorize that this is a result of the ovens drying the specimens during initial curing. These cylinders then did not totally re-saturate during final curing. Because AASHTO T358 requires cylinders to be saturated for testing, these results are likely not accurate (9). The unsaturated voids within the cylinders would cause "artificially" high resistance to electrical current. The research team *does not* conclude that improper curing contributes to greater surface resistivity at 28 days.

CONCLUSIONS

Summer weather can provide difficulties in maintaining proper curing conditions for concrete cylinders. However, the effort required to do so is necessary for contractors, producers, and owners to know that field-made cylinders are providing a fair assessment of in-place concrete on a job site. Without proper procedures, time and money may be spent replacing or further inspecting concrete that did not meet specified strength.

NEED FOR FURTHER RESEARCH

The research team set a secondary goal of establishing a numerical relationship between cementing materials content and percent loss due to high initial curing temperatures. No relationship was found. In order to do so, the authors suggest a study with mixes of constant w/c ratios and SCM type and substitution rate.

Furthermore, the research team did not fully immerse the "immersed" condition cylinders, in order to prevent water from entering the specimens before set. Because this was found beneficial in one case, the authors suggest a study where the cylinders are fully immersed for the initial curing period. This might be accomplished with tight fitting cylinder lids.

Elevated initial curing temperatures have been shown to negatively affect hardened concrete qualities. However, in some cases, initial curing temperatures may be lower than the 60°F minimum allowed by ASTM C39 (10). The authors suggest a study on the effects of low initial curing temperatures on common Tennessee concrete mixtures.

TABLE 19. STRENGTH RESULTS vs. SPECIFICATIONS (PSI)

MIX	COMMERCIAL 3500	TDOT A	TDOT D	TDOT X
Producer/TDOT Strength Spec	3500	3000	4000	3000
Average Strength for Standard Curing	3670	3390	5250	6690
Average Strength for Immersed Curing	3670	3480	5230	7140
Average Strength for Oven at 95°F	3360	3160	4780	6400
Average Strength for Oven at 125 °F	2510	2800	3830	5600

Note: Measured strengths that do not meet specification are highlighted in red.

TABLE 20. DIFFERENCE IN MEANS PER CURING STATE (COMPARED TO STANDARD CURING)

CONDITION	COMMERCIAL 3500	TDOT A	TDOT D	TDOT X
Immersed	0.3% LOSS	2.7% GAIN	0.4% LOSS	6.7% GAIN
Oven at 95°F	8.4% LOSS	6.8% LOSS	8.8% LOSS	4.3% LOSS
Oven at 125°F	31.6% LOSS	17.4% LOSS	27.0% LOSS	16.3% LOSS

TABLE 21. STATISTICAL ANALYSIS OF RESULTS

CURING STATE/ MIX	COMMERCIAL 3500	TDOT A	TDOT D	TDOT X
Standard (in spec)	Control	Control	Control	Control
Immersed	NSD	NSD	NSD	Superior
Oven at 95°F	Inferior	Inferior	Inferior	Inferior
Oven at 125°F	Inferior	Inferior	Inferior	Inferior

Note: Statistically inferior cases are highlighted in red and statistically superior cases are highlighted in yellow.

by Landon Davis, L. K. Crouch, Daniel VandenBerge, Joel Wallace, John Pearson, and Alan Sparkman

THE EFFECT OF HIGH INITIAL CURING TEMPERATURES on Compressive Strength of Some Common Tennessee Concrete Mixtures

DISCLAIMER

The opinions expressed in this article are those of the authors and not necessarily those of the Tennessee Concrete Association.

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ACKNOWLEDGEMENTS

The authors appreciate the support of the Tennessee Concrete Association. The authors would like to thank Mr. Carson Grantham of BASF for his donation of admixtures to the project.

The authors appreciate the administrative and financial support of the Tennessee Technological University Department of Civil and Environmental Engineering and the Center for Energy Systems Research, with particular thanks to Mrs. Donna Walls, Ms. Linda Thurman, Mr. Mark Davis, Dr. Satish Mahajan and Dr. Ben Mohr.

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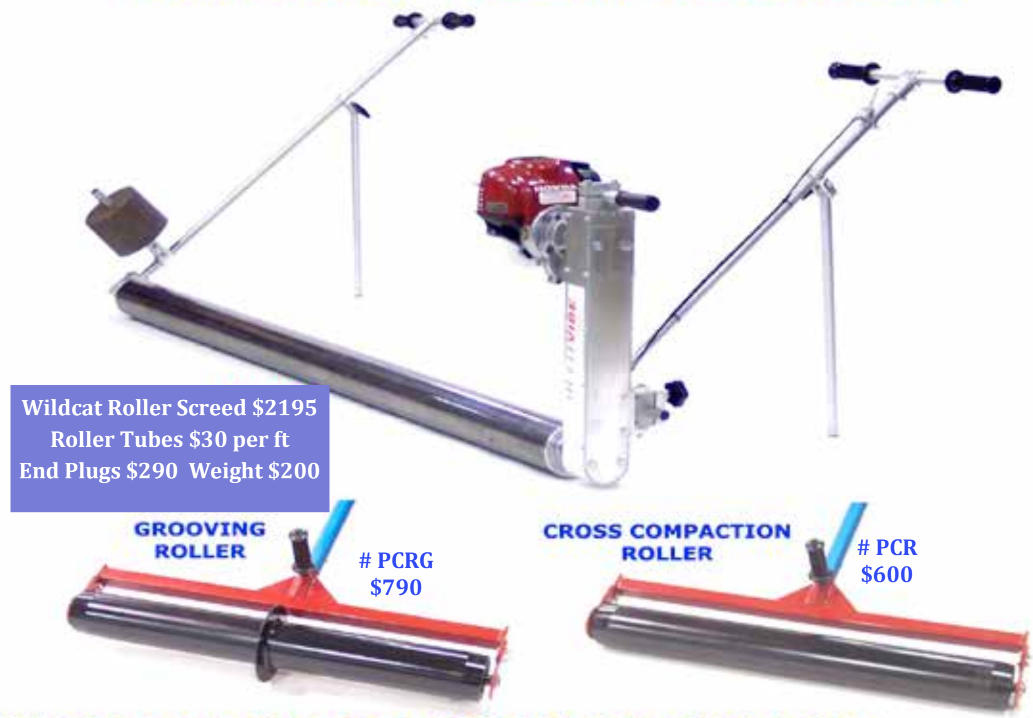

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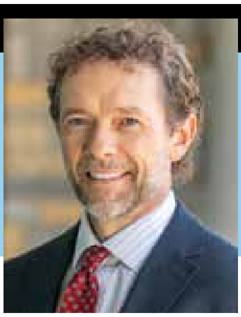


TECHNICAL DIRECTOR'S MESSAGE—JOHN B. PEARSON, P.E.

GOING WITH THE FLOW:

Recent Changes to TDOT's Training Concerning Self-Consolidating Concrete

Self-consolidating concrete (SCC) is used on many construction projects for its unique ability to flow within formwork and around reinforcing steel and other obstructions without the need for vibration. Until recently the Tennessee Department of Transportation (TDOT) was including SCC training as part of their Concrete Certified Field-Testing Technician program. On May 1, 2024, TDOT issued a memorandum to concrete producers, consultants and contractors to inform them that as of the Fall of 2023 the TDOT Materials and Tests division no longer includes SCC in their training curriculum. The full memo can be accessed on the tn.gov website. Please be aware that per the memo the requirements for contractors, consultants, producers and others to have SCC certified personnel to design batch, place and inspect SCC have not changed. Prior to the change this transition was conveyed to the industry at TDOT/industry meetings and concrete training classes in the Fall 2023/Spring 2024, a reminder that participating in these TDOT/industry meetings is a great opportunity to remain informed of upcoming changes that may impact your operations.

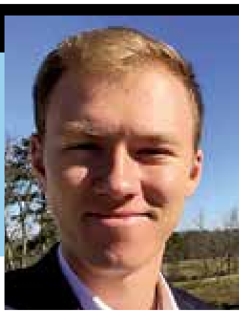
According to the memo certifications that were issued by TDOT through the Spring 2023 for Concrete Certified Field-Testing Technician (which included SCC) remain valid through their current expiration date. Moving forward external personnel that are required to be certified to perform applicable SCC tasks will need to instead obtain the **ACI Self-Consolidating Concrete Testing Technician Certification**. The Tennessee Concrete Association is authorized by ACI to offer this certification exam in Tennessee. Persons registering for the exam need to be aware that the ACI certification includes additional ASTM test methods that were not included in the previous TDOT training and certification, so personnel need to prepare to be tested over all the included methods. The ACI certification includes the following ASTM test methods on the written and performance exam:

- C1610 - Static Segregation of Self-Consolidating Concrete Using Column Technique
- C1611 - Slump Flow of Self-Consolidating Concrete
- C1621 - Passing Ability of Self-Consolidating Concrete by J-Ring
- C1712 - Rapid Assessment of Static Segregation Resistance of Self-Consolidating Concrete Using Penetration Test
- C1758- Fabricating Test Specimens with Self-Consolidating Concrete

Exam dates, locations and registration forms will be posted on TCAs website as they become available. It may take a little bit of learning curve to determine the level of demand for this exam so If you cannot find an open test date for you or your personnel please reach out to TCA's Director of Technical Services, John Pearson, to see if additional exam dates can be placed on the calendar. Feel free to reach out any time with questions or exam needs for this or any other ACI program.■

Have you ever considered using your industry experience and expertise by assisting with the administration of ACI certification exams? Supplemental Examiners assist with the administration of performance exams and Proctors assist with the administration of the written exam. TCA offers certification exams for over 20 ACI programs. If you have an interest in serving as a Supplemental Examiner or Proctor for one or more of these programs in East, Middle, or West Tennessee please email John Pearson, TCA Director of Technical Services at jpearson@tnconcrete.org.

WORKFORCE COORDINATOR'S MESSAGE—JOSEPH MCDANIEL



WORKING TO GROW THE WORKFORCE OF THE TENNESSEE CONCRETE INDUSTRY

I am Joseph McDaniel, workforce coordinator for the Tennessee Concrete Association. My goal has been to reach students from across the state and to stir their interest in pursuing a career in the concrete industry. We have had encouraging success over the last several months with our latest initiatives, as follows.

BE PRO BE PROUD

BeProBeProudTN.org

The BeProBeProud truck is keeping the roads hot here in Tennessee. They are traveling to schools across the state teaching students about opportunities in the trades by allowing them hands-on experience on state of the art construction simulators. The drivers/operators of the BPBP truck are Jason and Allison Lewis who are doing an amazing job promoting the industry. They are also promoting our third initiative, called Concrete Quest.

Concrete Quest is another partnership with RocketStart to "gamify" learning about concrete. Students who play work through four levels, each covering important concrete content. We launched Concrete Quest about three months ago, and since then over 70 students have signed up from 30 plus schools across the state—that number is growing every day! The full impact of this initiative is yet to be realized.

Skate4Concrete is a free Concrete 101 Curriculum designed to teach students concrete basics through studying a concrete skatepark. After completion, students are awarded a certificate and can choose to make their own Mini Concrete Skateparks and enter them in our Mini Concrete Skatepark Competition. We have seen a staggering increase in participation with this initiative as well, with over 50 middle and high schools participating this year. That is a 400 percent increase from last year! We have visited several schools across the state sharing about the curriculum, the latest being at Munford High School. Please let me know of any schools near you who may be interested in participating, and check out our 2024 TN S4C Map to sponsor a school near you.

Finally, Driver Dash is TCA's partnership with RocketStart to help our ready mix producer members retain the workforce you already have—your Concrete Delivery Professionals. Drivers are awarded badges and points based on their performance on the job and top drivers receive gift cards and other rewards from TCA. There are three TCA Members who are in the Dash: Harrison Construction, Ready Mix USA, and Screaming Eagle Ready Mix. Their drivers are crushing it! Any TCA Ready Mix producer can put up to five of their drivers in the Dash, at no cost to you. Get your best drivers in the Dash!

TCA appreciates all your support and participation in these initiatives. Please be on the lookout for emails about opportunities to sign-up your drivers for Driver Dash, to sponsor a S4C kit, to bring a concrete truck to a BPBP event, and more. Never stop telling your concrete story!

CIM UPDATE

by Jon Huddleston, CIM Director

This has been another amazing start to an academic year for Middle Tennessee State University's Concrete Industry Management (CIM) program. This fall saw the largest entering class in over a decade with a total of seventy-two first-year and transfer students bringing the program enrollment to 196 students. This growth is a 19.5 percent increase from the Fall of 2023 with 78 CIM students receiving more than $154,000 in concrete industry specific scholarships.

There are several moving parts that have created the growth we have seen in the past few years like the recruiting efforts of our CIM Coordinator Sally Victory, the fundraising support of our local CIM Patrons group and CIM National Steering Committee, and the multitude of associations and employers who promote our degree program. Growing CIM quickly to meet industry demand is often on my mind. However, occupying just as much of my time and effort is sustaining this growth and the retention of current students. For this we have relied heavily on the American Concrete Institute (ACI) Student Club, and they are the true stars of this program update. We have had great club leadership in the past, but circumstances like the economic downturn affecting enrollment in practical degrees like CIM to pandemic shutdowns have both heavily restricted club growth and participation. This is no longer the case, and the club is thriving!

MTSU CIM's ACI club membership has traditionally hovered between ten and twenty active members, but in the past year the officers have brought renewed energetic leadership and ideas that have increased the club to more than fifty active members. We have even seen four students change their major in the past year because they saw how active the ACI club was compared to student organizations in other majors on campus.

This club energy also comes with a competitive spirit as the club recently took part in the highly competitive ACI Pervious Concrete Cylinder Competition, displaying not only their skills but also the dedication and innovation of our student members. With each ACI competition in this modern club era they continue to improve. From placing eighteenth in the bowling ball competition last year and then twelfth in the beam competition last semester to taking seventh in this semester's pervious competition, they continue to hone their knowledge, skills, and abilities. These students have gained practical experience in concrete mix design, testing procedures, and the performance analysis of pervious concrete, preparing them for future careers in construction, environmental engineering, and materials science.

These experiences, the guest speaker events hosted by the club and their K-12th grade community service concrete pours has not only elevated the profile of the ACI Student Club on campus but has also set the stage for even greater involvement in future competitions, community outreach projects, and professional development opportunities. The students are excited to continue growing the club, the CIM program and the concrete industry and will continue to be a vital factor in our overall success!

MTSU ACI students watch the split tensile test of the pervious cylinder at the competition

MTSU ACI students watch the infiltration test of their pervious cylinder at the competition

ACI Pervious Team members Ashlyne Roeger, Hailey Mondelli, Kole Butz, Tristen Yang, Brian Eayrs, Claire Mullins, Carlie Mullins

Info Link

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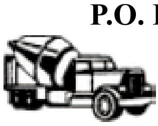

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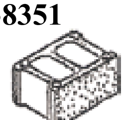

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