

Going Beyond ACI 332 Type 3 Severe: Commercial & Residential Enhanced Durability Concrete

TTU researchers developed 3 mixture designs to achieve the properties shown in Table 1. The 3 mixture designs are shown in Table 2 along with a current ACI 332 Type 3 mixture design for comparison. It was hoped these enhanced durability mixtures would survive magnesium chloride exposure much longer (and with less damage) than current ACI 332 or commercial mixture designs.

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. Mixture Comparison Results

Mixture	ACI 332	CRED Level 1	CRED Level 2	CRED Level 3
Total Cementing Material (lbs/CY)	564	520	520	520
Percent Portland Cement	80	60	50	50
Percent SCM 1	20 Class C	36 Class F	50 Slag G100	46 Slag G100
Percent SCM 2	0	4 MK	0	4 MK
w/cm	0.443	0.39	0.39	0.39
Chloride Perm Category 7-days	High	Moderate	Moderate	Moderate
Chloride Perm Category 14-days	High	Low	Low	Very Low
Chloride Perm Category 21-days	High	Low	Very Low	Very Low
Chloride Perm 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

Preliminary magnesium chloride exposure evaluation was modelled after a method found in literature. Week long wetting and drying cycles were used as in literature, however, a commercially available deicing salt contain magnesium chloride was used instead of reagent grade magnesium chloride. The preliminary evaluation is currently in progress on a 100% PC TDOT Class D concrete mixture.

The TDOT Class D mixture (six 4x8 and three 3x6 cylinders) were cured for 28-days using limewater immersion. Each wetting and drying cycle includes drying for 125°F for a week and then soaking in 15% solution of commercially available deicing salt for a week. Weights were recorded for each cylinder at the end of each drying cycle (no attempt was made to remove adhering salt). Compressive strength tests are planned for December (after 6 months of wetting and drying cycles). Compressive strength tests will be compared to 28-day compressive strengths previously obtained for this mixture.

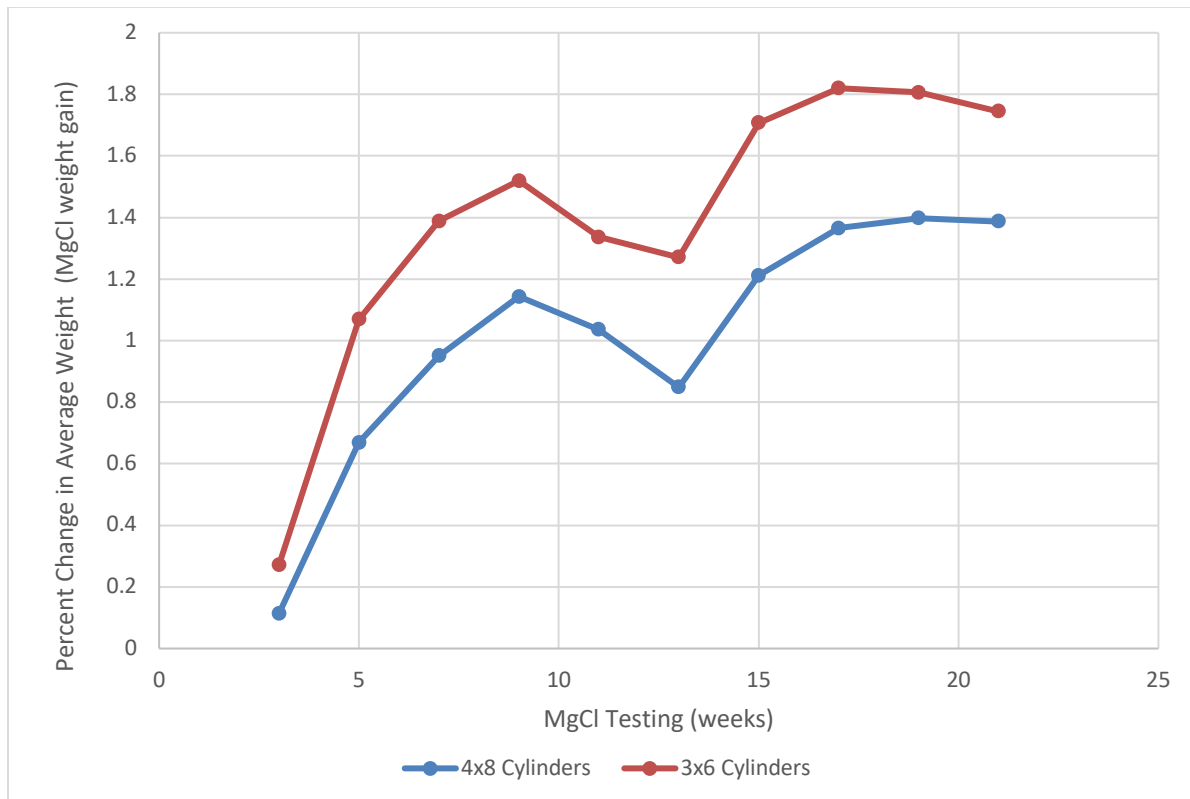


Figure 1. Percent Change in Weight over Time

Future Plans for CRED Concrete Research

TTU researchers plan to propose magnesium chloride exposure research to TCA in December or January. Current thinking is that TCA executive director Alan Sparkman would select six mixtures (probably including 2 TTU CRED and one ACI 332) to be evaluated. Mixtures would first be fabricated and cured for 28 days. 28-day tests (compressive and possibly split tensile, modulus, and absorption) would be used as controls. The remaining cylinders would be subjected to wetting and drying cycles for 6 to 9 months and then tested for the same properties. Weight gain/loss would also be monitored during W/D cycles. Further digital images would be taken prior to, during, and at the conclusion of W/D cycles. Details of the proposed research have not been finalized.