Mix Design Formulation

Paste and Void Content

Paste Content

Paving Method	Target	Property
Slip Formed	≤ 25.0	Shrinkage Resistance
Fixed Formed	≤ 28.0	

28.0%

Paste and Void Content

Design Parameter	Target	Property
Paste Content (with Air) to Void Content of the Mix Design (PC_{AIR}/VC_{MIX}) Ratio	< 1.25	Decreased Workability
	1.25 – 1.75	Enhanced Workability
	> 1.75	Increased Segregation

2.01

[1] Verification test results allowed for this value to be exceeded. However, it is best practice to design for the 1.25 – 1.75 target. Next time! Target should be on the higher end of that range for fixed formed...lower end for slip formed.

Verification Testing

Aggregate and Fresh Concrete

Test Method	Quality Characteristic	Min. Limit	Max. Limit
AASHTO T 19	Composite Aggregate Void Content	Informational	
AASHTO T 27	Sieve Analysis of Fine and Coarse Aggregates	Tarantula Curve	
AASHTO T 121	Unit Weight (lb / ft^3)	Target -3.0	Target +3.0
AASHTO T 119	Slump (in.)	Target -1.5	Target +1.5
AASHTO T 119	Segregation Resistance[1]	Visual	
AASHTO T 152	Air Content (%)	Target -1.5	Target +1.5
AASHTO T 309	Concrete Temperature (°F)	50	90
AASHTO T 395	System Air Metric (SAM) Number (psi)	–	0.20

[1] Testing for segregation resistance is performed while the concrete is being discharged and during AASHTO T 119 Standard Method of Test for Slump of Hydraulic Cement Concrete.

Verification Testing

Hardened Concrete

Test Method	Quality Characteristic		Min. Limit	Max. Limit
AASHTO T 22	Compressive Strength (psi)		5000	–
AASHTO T 97	Flexural Strength (psi)		650	–
AASHTO T 402	Chloride Ion Penetration Resistance (kΩ-cm)		10.4	–
AASHTO T 380	ASR Resistance Expansion (%)	100% Cement	–	0.030
		SCM Mitigation	–	0.019
AASHTO T 336	Coefficient of Thermal Expansion (με/°F)		Target -0.5	Target +0.5
AASHTO T 160	Unrestrained Volume Change (με)		–	420
AASHTO T 161	Deterioration Cracking Resistance	Durability Factor	90	–
		Mass Loss (%)	–	6.0
AASHTO T 365	De-icing Resistance: Calcium Oxychloride Content (g CA_{OXY} / g Paste)		–	0.14
AASHTO R 101	Degree of Saturation for 30 Year Life Cycle		–	0.85

Verification Testing

Degree of Saturation

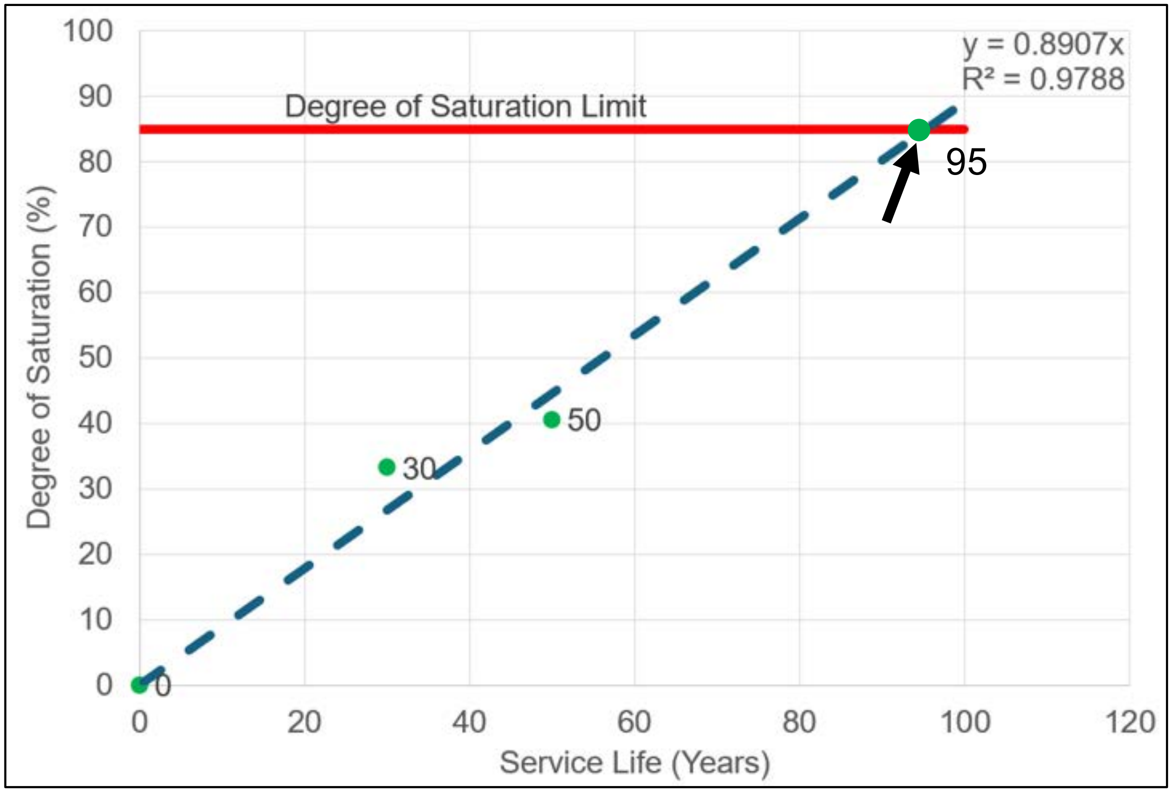
AMERICAN ENGINEERING TESTING

Sample ID	DOS-1	DOS-2	Average	**Specification**
SSD Mass (g)	937.53	948.13		
OD Mass (g)	890.78	904.7		
Vacuumed Mass (g)	952.83	963.11		
Immersed Mass (g)	556.3	575.2		
ρ (Ω.m)	207.5	208.5	208.0	
F_{app}			1,638	
S_{nick} (%)			0.081	
S_2 (%)			0.035	
S (%) 30 years			33.28	≤ 85%
S (%) 50 years			40.60	≤ 85%

Notes:
1. All test specimens were fabricated at AET on July 31, 2023.
2. The test results represent the specimens tested and the methods specified.
3. ϕ was considered 1.3, for deicing exposure.
4. 30 and 50 years of service life were considered.

Verification Testing

Degree of Saturation



Construction Methods

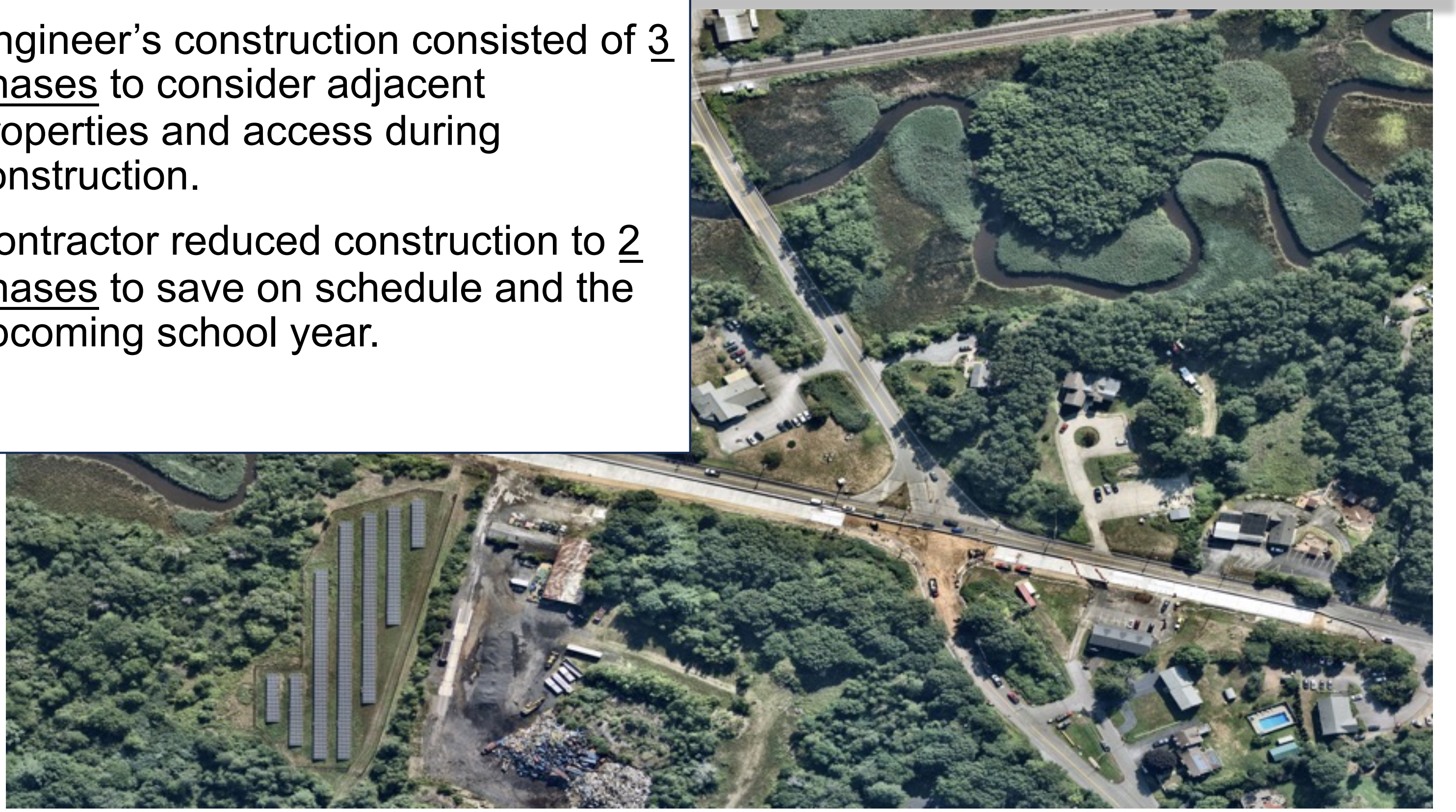
MassDOT Cement Concrete Pavement Project

massDOT Massachusetts Department of Transportation Highway Division

HNTB

Phasing

- Engineer's construction consisted of 3 phases to consider adjacent properties and access during construction.
- Contractor reduced construction to 2 phases to save on schedule and the upcoming school year.



Site Preparation

Free edge and joint reinforcement [Longitudinal and transverse]

Isolation joints for proposed CBCI setup for separate pour

Construction Methods

Tie/Dowel Bar Configuration

- Design to provide #6 dowel bar splicers 24” long, 36” o.c.
- To support phasing, construction joint changed to ¾”dia. X 24” epoxy deformed tie bar set at mid slab

Construction Methods

Protection From Adverse Conditions

- Hot, evaporative, high solar radiation conditions present throughout most of the placements
- Incorporate ice into the mix during batching at the plant
- Evaporation Rate > Bleed Water Rate: Apply liquid evaporation reducers to combat high evaporation rate during finishing
- Apply **white pigmented** liquid membrane-forming compound for curing and sealing (ASTM C1315) immediately after texturing
- Apply **white** polyethylene film for curing immediately after final set

Construction Methods

Protection From Adverse Conditions

Construction Methods

Mixing and Delivery

Construction Methods

Handling and Placing

Finishing

Hand Operated Vibratory Screeding

Vibratory Bull Floating (Magnesium)

Construction Methods

Finishing

Texturing: Longitudinal Tining

Construction Methods

Finishing

Texturing: Longitudinal Tining

Construction Methods

Curing

ASTM C1315 Cure and Seal Compound

Construction Methods

Curing

White Polyethylene Film

Construction Methods

Hard Saw Cut Contraction Jointing

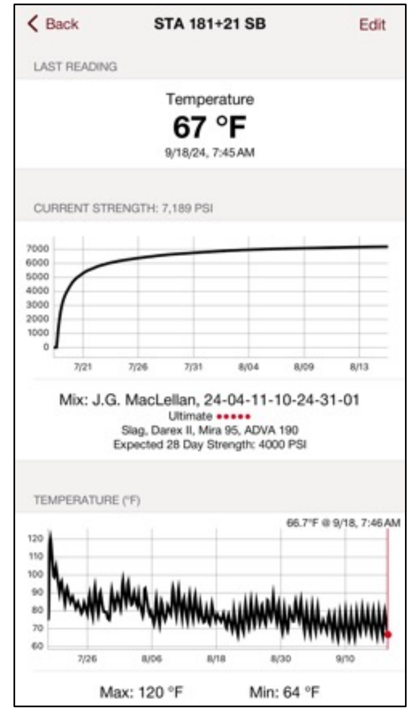
Construction Methods

Hard Saw Cut Contraction Jointing

Testing During Construction

Slump, Air, Temperature, Compression

ASTM C1074 Maturity Meter



Construction Methods

Final Walkthrough

Lessons Learned and Future Considerations

MassDOT Cement Concrete Pavement Project

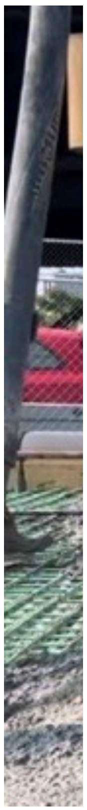
Lessons Learned and Future Considerations

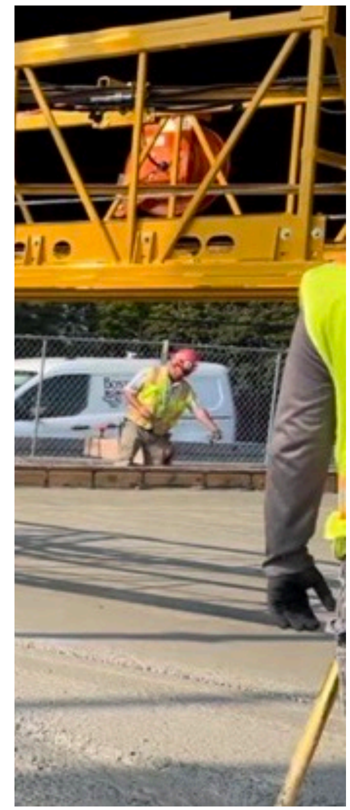
Moving Forward

- Next up: Holyoke, MA (District 2) U.S. Route 20 (Fall 2025)!
- Concrete pavement mix design can be further optimized
  - Increase aggregate content, decrease paste content
  - Polypropylene fibers to increase flexural strength and decrease slab depth
  - Alternative low carbon cementitious materials
    - Performance based pozzolanic cement, recycled ground glass pozzolan, natural pozzolans, and more
  - Innovative chemical admixtures
    - Colloidal silica admixtures to enhance cohesion, finishing, and curing
    - Permeability reducing admixtures (PRA)
  - Type I / II vs. Type IL Cement
    - Test results showed increased permeability during production with Type IL
- Specify 2000 psi for traffic opening instead of 70% of f'_C

Lessons Learned and Future Considerations

Moving Forward





Questions and Discussion