



VDOT's Experience with Performance Specifications

Michael Sprinkel, P.E., Associate Director

Celik Ozyildirim, P.E. PhD, Principal Scientist

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Outline

- ERS (end result specification)
- Route 58 example
- VDOT Specifications



End Result Specifications Goals

- Provide long lasting concrete structures
- Allow contractor innovation
- Ensure consistent uniform concrete
- Pay based on the quality of concrete
- Pay based on Percent Within Limits (PWL): percentage of concrete between upper and lower specification limits



End Result Specifications

- Contractor: Entirely responsible for supplying a product
- Agency: Responsible for accepting, rejecting, or applying a price adjustment

TRB Circular E-C074, Glossary of Highway Quality Assurance Terms.



Differences in Specifications

<i>Item</i>	<i>Current</i>	<i>ERS</i>
Mix Design	Prescriptive	Based on properties
Testing	VDOT	Contractor and VDOT
Basis of Pay	Minimum	PWL

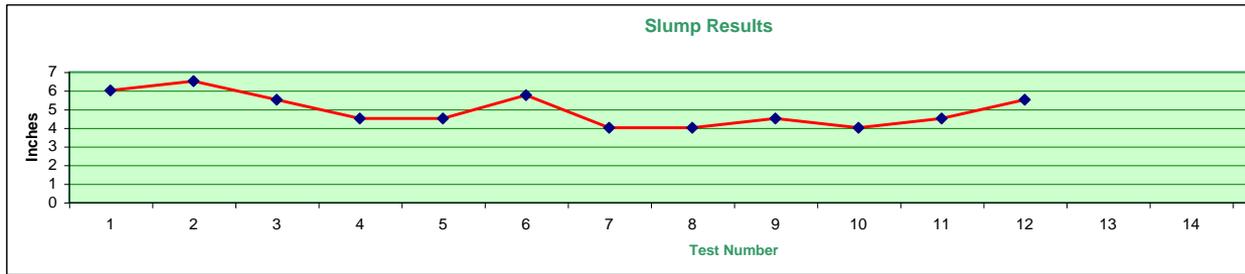


ERS

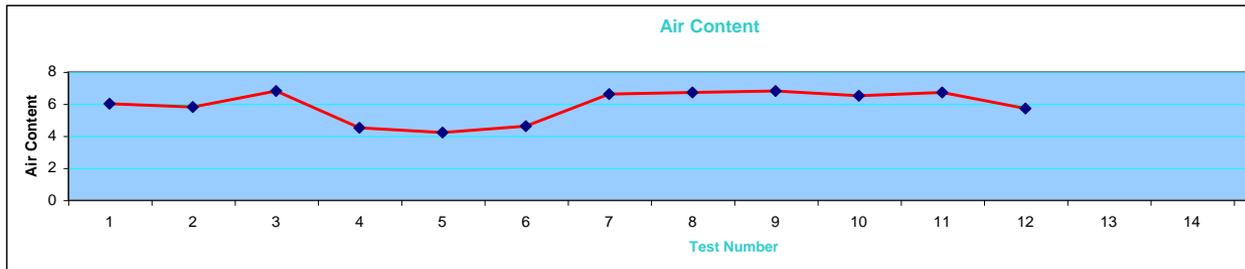
- Prequalification: Mix development and QC plan by the contractor; includes charts for process control
- Mix design approval by the agency
- Acceptance by the agency



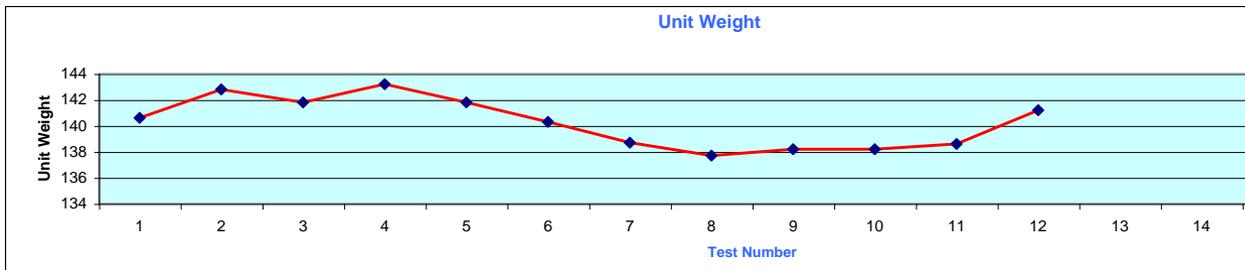
Control Charts: Fresh Concrete



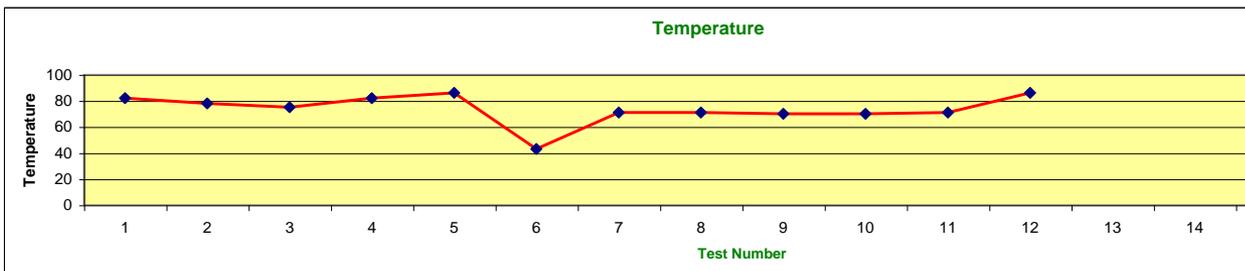
Slump



Air content



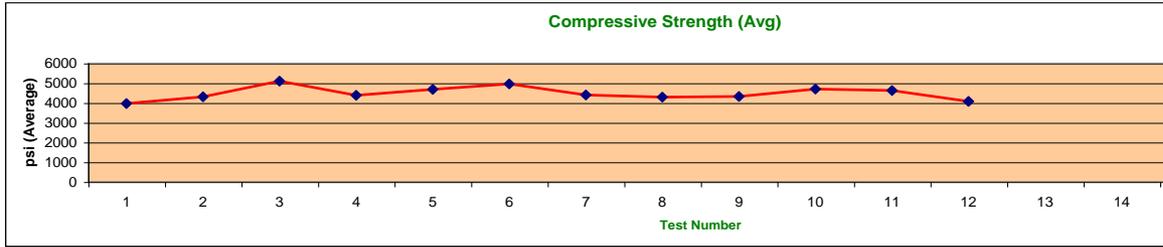
Density



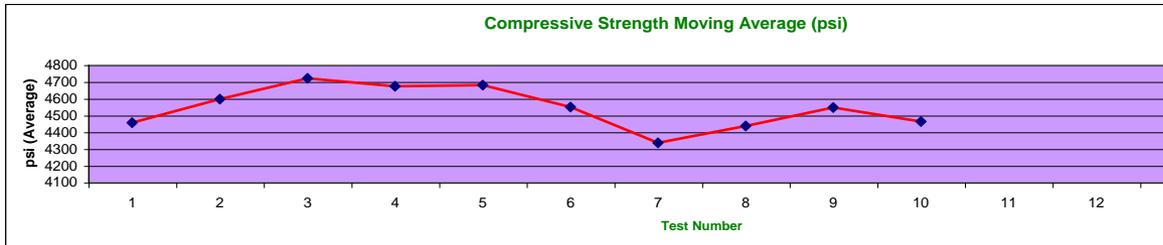
Temperature



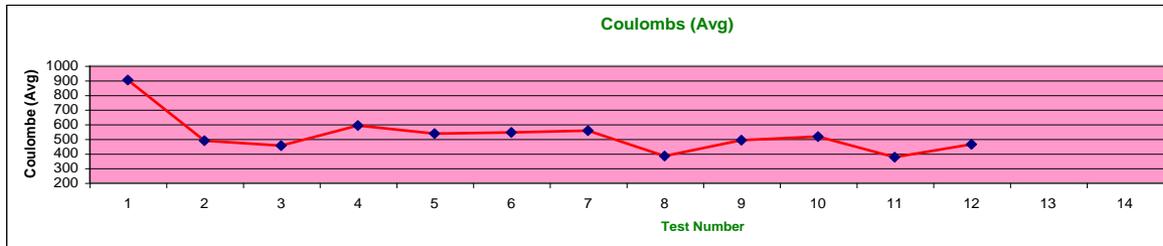
Control Charts: Hardened Concrete



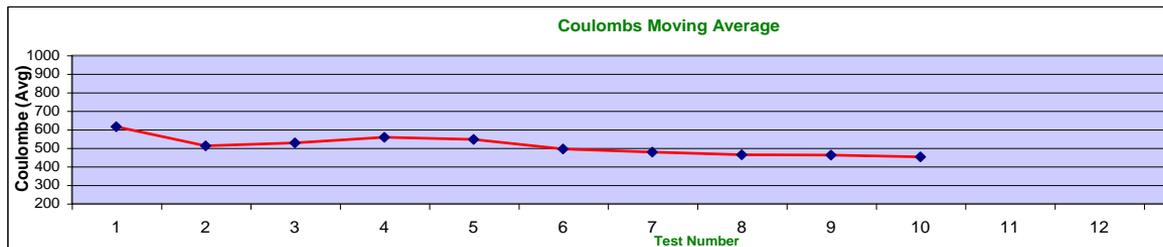
Compressive strength



Str. moving average of 3



Permeability



Perm. moving average of 3



ERS

- Used in pilot bridge and pavement structures
- Mix design portion has been incorporated into VDOT specifications as an option
- Pay factor portion is still under discussion



Pay Factor

- Pay factor based on PWL
 - Compressive strength
 - Permeability
- Pay factor in current pavement specification
 - Rideability
 - Thickness



Estimating PWL

- Compressive strength

$$Q_L = (\text{Average} - \text{LSL})/s$$

- Permeability

$$Q_U = (\text{USL} - \text{Average})/s$$

Q: Quality Index, used to determine PWL from Tables

LSL: lower specification limit

USL: upper specification limit

s: sample standard deviation



Pay Factor (PF)

PWL for strength and permeability:

- $PF = 82 + 0.2 (PWL)$

PF IS NOT ENFORCED IN PILOT PROJECTS

- 100% pay for $PWL = 90\%$



ERS Sampling

Lots and sublots: structural concrete

- Lot is limited to 500 yd³ and consists of sublots.
- Sublot has maximum of 100 yd³ and at least one sublot for each day's placement.



ERS Sampling

Lots and sublots: pavements

- Lot: 1 lane mile or a day's production
- Sublot: 0.2 mile
- One sample from each sublot randomly selected



ERS Tests

Screening tests at the fresh state
(contractor):

- Air content
- Slump
- Density
- Concrete temperature



ERS Tests

- Acceptance tests at the hardened state (VDOT)
 - Strength
 - Permeability
- Also testing for drying shrinkage for
MEPDG



Route 58 Project Description

- US 58 WB, Southampton County near Courtland, VA
- 4-in bonded: 2.6 miles
- 7-in unbonded: 2.2 miles
- 11-in JPCP: 0.30 miles
- Existing pavement: 8-in CRCP



Surface Preparation (Unbonded)



1 inch Asphalt Porous Friction Course (PFC)

Unbonded Overlay



Unbonded Surface After Construction



Bonded Overlay



Bonded Surface After Construction

Average bond strength = 335 psi (ASTM C1583)



Mixture

- 596 lb/yd³ cementitious material
- 25% Class F fly ash
- w/cm: 0.43 to 0.45
- #57 coarse aggregate
- Natural sand



Route 58 ERS Sampling

- Total concrete produced: 8,088 yd³
- Lot: One lane mile
- Sublot: 0.2 miles
- One sample from each sublot was selected randomly.



FHWA Mobile Lab



Route 58 Project

Averages of lots (14 lots)

Test	Value	Standard Deviation	Pay factor
Compressive strength (psi)	4870	340	101.31
Permeability (Coulomb)	600	120	102.00
Average			101.66



Conclusions

- Route 58 construction was successfully executed on time
- Concrete was of high quality
 - Acceptable strength, low permeability
- Route 58 project would qualify for bonus



2016 VDOT Road & Bridge Specifications

Three mix design options:

1. Prescriptive method
2. Contractor/producer designed mix with trial batch data showing compliance*
3. Contractor/producer designed mix with field data confirming compliance*

*no minimum cementitious material content





VTRC

Virginia Transportation
Research Council



Thank you.
Questions?

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