



New Technologies used in Maryland I-97 Patching Project Using Rapid Set Cements & Volumetric Mixers

All views expressed in this presentation are those of the authors and do not necessarily reflect the views or policies of Maryland DOT State Highway Administration (MDOT SHA)

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Acknowledgement

MDSHA

Office of Materials Technology (OMT)
Pavement and Geotechnical Division(PAGD)
Concrete Technology

District 5
Project Development
Construction

DOTs Helped us and shared their experiences (Iowa, NC, NY, Utah)

CTS Cement

Concrete Patching

MDSHA has exposed Concrete on about 1% of its entire roadway network
MDSHA uses PCC patch (Spot Repair) as part of the treatment options

Partial depth repairs

Removal of small, shallow (less than 1/3 of the thickness of the concrete pavement) areas of deteriorated PCC that are then replaced with a suitable material.

Full-Depth Repairs

Cast-in-place PCC repairs that extend through the full thickness of the existing PCC slab.

Repairs are either Type I, 6 ft to less than 15 ft in length;
or Type II, 15 ft and greater in length.

HMA material shall not be used to patch concrete pavements

- Section 522 – Portland Cement Concrete Pavement Repairs
- Section 525 – Portland Cement Concrete Spall Repairs



*Maryland Department of Transportation
State Highway Administration*

**STANDARD SPECIFICATIONS
for
CONSTRUCTION
and
MATERIALS**

Project : I-97 Concrete Patching

- IS 97 between Benfield Blvd to MD 174, Urban Interstate Road
- It was built in 1990, 12” of CRCP
- Three to four lanes in each direction, 10’ to 14’ Inside & Outside Shoulder
- Asphalt patching was performed in recent years but did not last long
- Limited Budget, 3 sub projects



Project Description

- IRI was about 140
- Following Distresses:
 - Corner Break
 - Joint Seal Damage
 - Patching
 - Spalling
 - Punch out
- Safety issue

Route	I-97
Functional Classification	Urban Interstate (11)
Lanes	Three to four lanes (11' to 12' width) in each direction
Shoulders	10' to 14' inside & outside shoulder in each direction.
Median Type	Positive Barrier and Grass
Section Type	Predominantly open
Other Features	Rumble Strips, Bridges, Terminal Joints, Guardrail, Noise Wall

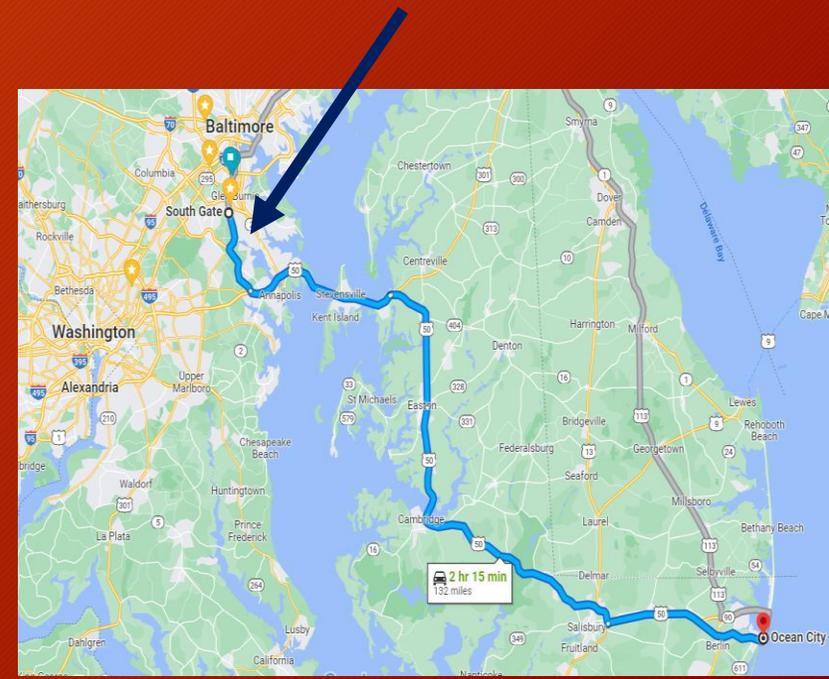
I-97	Dir	From	To	Pavement Structure	Last Major Rehab
Mainline ⁽²⁾	SB	9.67	12.1	12" of Continuous Reinforced Cement Concrete (CRCP) over 6" of Cement Stabilized Aggregate Based Course over 12" of Borrow Material	1990 ⁽¹⁾
Mainline ⁽²⁾	NB	12.1	13.29	12" of Continuous Reinforced Cement Concrete (CRCP) over 4" of Cement Stabilized Aggregate Based Course over 4" of Crushed Stone over 10" of Borrow Material	1996 ⁽¹⁾
Bridge Approaches	NB/SB	Several Locations		14" of Asphalt over 6" of GAB over 12" of Borrow Materials	1990/1996

Note (1) Concrete Patching was performed in 2012 and 2014.

Note (2) For Accel/ Decel Lanes and for Mainline between terminal joints and bridge joints, 12" of Jointed Plain Cement Concrete Pavement (JPCP) is used. Also, for shoulders, 12" of Jointed Plain Cement Concrete Shoulder is used.

Project Challenges

- High Volume and Speed made it difficult to locate required patching
 - AADT >130,000
 - Speed Limit 65 mph
 - Crash truck was used to protect engineers walking on the shoulders
- Maintenance of Traffic
 - It is an important road both for workdays and weekend commutes
 - Road closure during the day was not an option
 - Only two lines were permitted to be closed 9:00 PM to 5:00 AM
 - Not enough time to saw cut, remove the damaged area, put bars, pour concrete, and CURING
- Only feasible solutions was reducing the curing time
 - Minimum compressive strength of 2000 psi to be pened to traffic



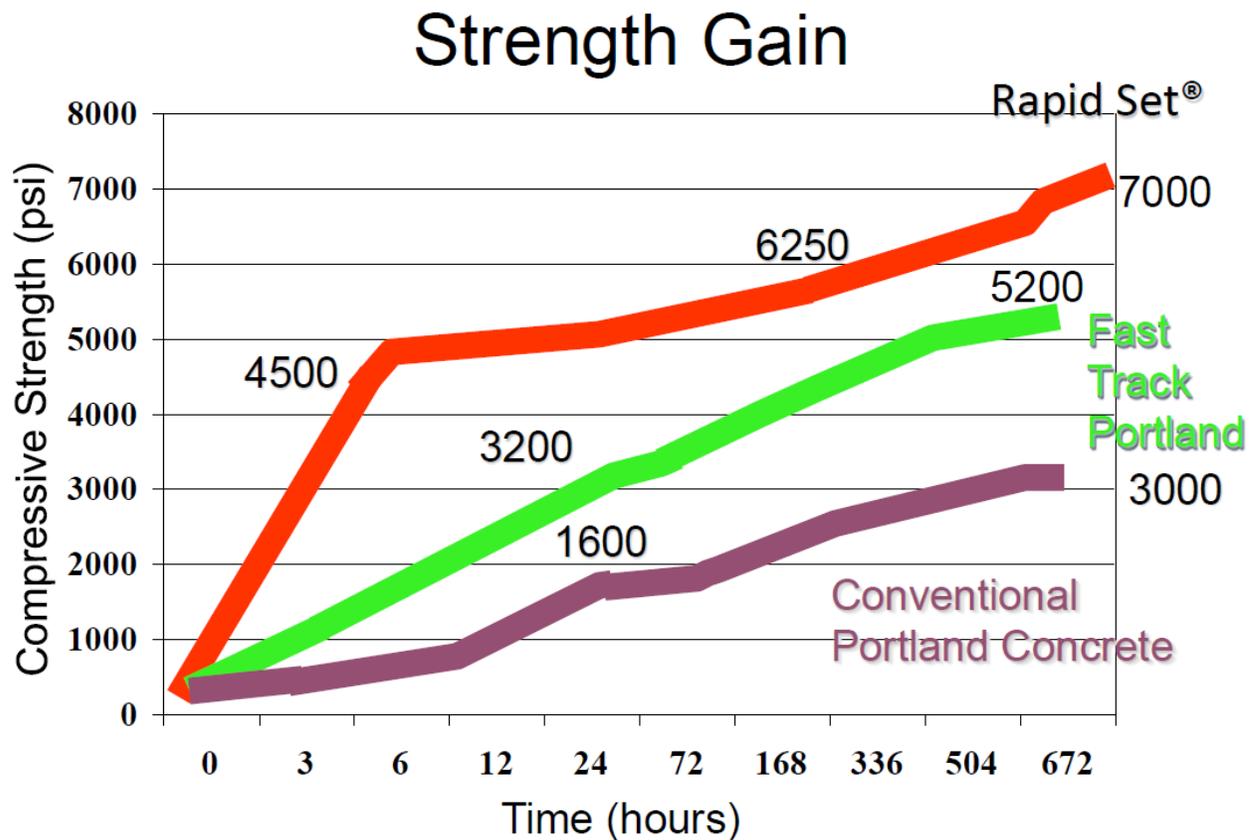
Fast Setting Hydraulic Cement

- Perform research and literature review
- Discussed with several DOTs and checked their specifications (e.g. NC, Iowa, NY, Missouri)
- Discussed with experts at TRB
- Discussed with some manufacturers
- Rapid Set Cement (RSC)
 - Fast Setting Hydraulic Cement
 - It has the predetermined requirements
 - Good Results in other States
 - High early Strength
 - Minimal shrinkage
 - Resistant to chemical attacks

Table 1- Concrete Mix Requirements

Property	Test method	Requirements
Air Entrainment	AASHTO M154 including Section 5	5.0%- 8%
Compressive strength (min) at 4 hours	AASHTO T22	2000 psi
Compressive strength (min) at 24 hours	AASHTO T22	3000 psi
Drying shrinkage (max) at 4 hours	ASTM C157	0.04
Water/Cement Ratio		0.38 - 0.46

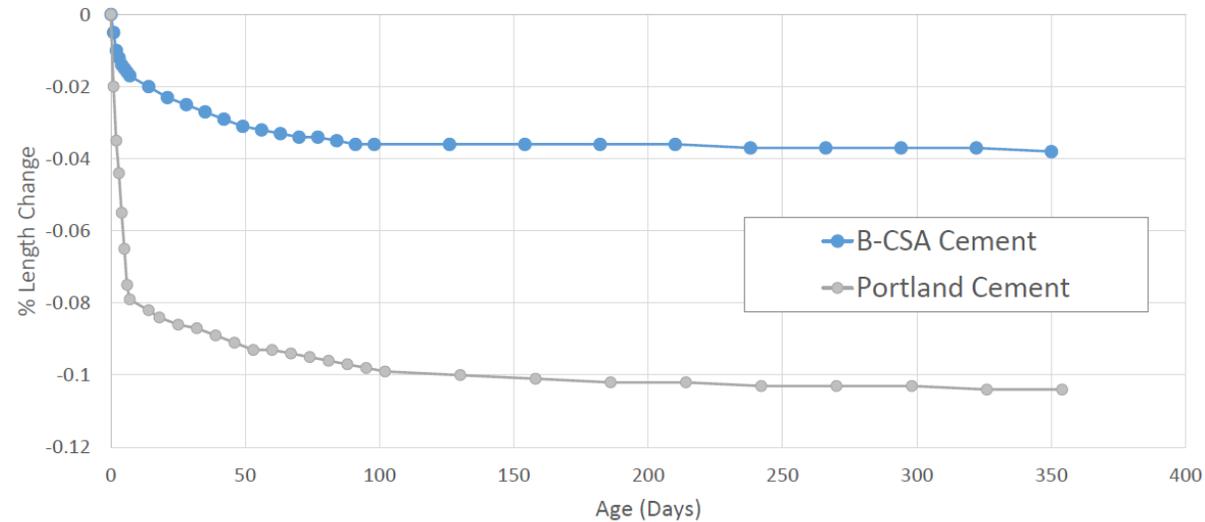
RSC : Fast Setting Hydraulic Cement



RSC : Fast Setting Hydraulic Cement

Very Low Shrinkage: Increased durability

Drying Shrinkage – ASTM C596



From CTS presentation

Volumetric Mixer Truck

Lesson learned from other DOTs project :
Use Volumetric Mixer Truck

When precise design mix and quantity needed.

Mix designs are approved by OMT's Concrete
Technology Division, based on results of trial batches.

Include the same format and units used by volumetric
mixer printout

Provide daily production data at the end of each
production shift



Batch, measure, mix and dispense all from one unit.

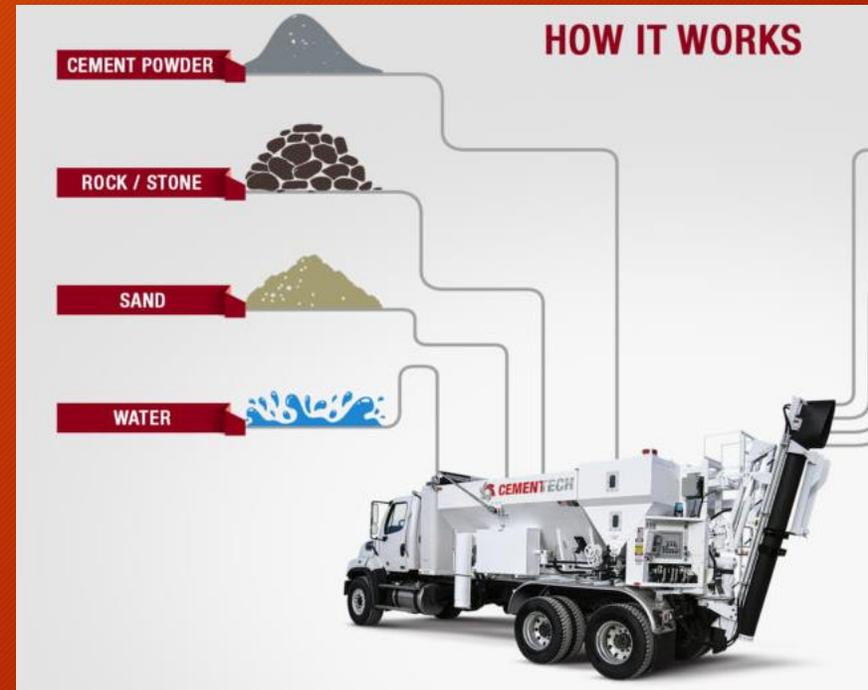
Volumetric Mixer Truck

All equipment calibrates by weight with the material delivered to the mix auger by volume.

With volumetric technology, all materials from sand and stone to cement powder and water continually blend on demand.

This means the mixer can be started and stopped as needed

High quality concrete with no waste



<https://www.youtube.com/watch?v=2dXMyuli3KE>

<https://www.youtube.com/watch?v=OoAEVU0EFTQ>

Volumetric Mixer Truck

SPECIAL PROVISIONS

500 — RAPID SETTING CEMENTITIOUS CONCRETE

CONTRACT No. AA8885177

7 of 7

Trial Batches. Perform 1 hour, 1.5 hour, 2 hour, 2.5 hour, 3 hour, 3.5 hour, 4 hour, 6 hour, and 24 hour compressive strength tests. Use the same components in the trial batches to be used in production. Trial batches must be approved by OMT's Concrete Technology Division. If a volumetric mixer truck is used in production, the trial batch is to be performed with the volumetric mixer truck.

Table 1- Concrete Mix Requirements

Property	Test method	Requirements
Air Entrainment	AASHTO M154 including Section 5	5.0%- 8%
Compressive strength (min) at 4 hours	AASHTO T22	2000 psi
Compressive strength (min) at 24 hours	AASHTO T22	3000 psi
Drying shrinkage (max) at 4 hours	ASTM C157	0.04
Water/Cement Ratio		0.38 - 0.46

Volumetric Mixer Truck

Calculated Mix Design for 1 yd ³						
FOR:	LC Concrete - MDDOT HE / # 7 Stone					
MIX:	MDDOT HE					
						DATE: 17-Aug-20
	MATERIALS					
	SOURCE	SP.G.	SSD WT.	VOLUME	BATCH WT.	
CEMENT	CTS Rapid Set	2.95	611	3.32	611	Pounds
FLY ASH	None	2.71	0	0.00	0	0%
SAND*	Vulcan Concrete Sand	2.63	1330	8.10	1385	Pounds
STONE #1	Vulcan Washed #7	2.79	1650	9.48	1658	Pounds
STONE #2	None	2.74	0	0.00	0	Pounds
WATER	Approved Mix Water	1.00	33.5	4.48	26.123	Gallons
AIR %	Air Mix 200	Oz. per 100 wt: 0 - 2	6.0%	1.62	6	Percent
FIBER	ANY Fiber	Lbs. per Yard: 0.00	0.0	---	0.0	Pounds
WR OZ/100	Eucon WR	Oz. per 100 wt: 0 - 10	0.0	---	0	Ounces
ACCELL. OZ/100	ANY Accelerator	Oz. per 100 wt: 0.00	0.0	---	0	Ounces
TOTAL WT			3870	27.0	3872	Pounds
* Sand is automatically adjusted.						
Target Volume:	27.00					
Free Moisture:	SAND	4.0%				
	STONE	0.5%				
W/C RATIO:	0.46	pounds/pounds				
Theo. Unit Weight:	143.34	pounds/ft ³				
Coarse Aggregate:	35	% of Total Volume				
Coarse Aggregate:	43	% of Total Weight				
Coarse Aggregate:	53.90	% of Coarse Aggregate Volume to Total Aggregate Volume				
THIS THEORETICAL DESIGN MUST BE VERIFIED BY TRIAL BATCH!						
Comments:	Keep slump at 4 - 5 inches when making concrete. ① dosage from product sheet 0.5 - 1.0 oz. per 100 wt ② dosage from product sheet 2 - 10.0 oz per 100 wt.					

Volumetric Mixer Truck

Recommendation: Approval: <i>[Signature]</i> 12-17-12 Assistant Division Chief Date	Maryland Department of Transportation State Highway Administration Office of Materials Technology MARYLAND STANDARD METHOD OF TESTS	
<i>[Signature]</i> 12/17/12 Division Chief Date	CALIBRATING CONCRETE MOBILE MIXERS	MSMT 558
Approved: <i>[Signature]</i> 01/17/13 Director Date		

SCOPE:

This procedure is used to calibrate concrete mobile mixers so that the designed mixes will remain uniform throughout the project. It is recommended that this procedure be repeated several times a year since the consistency and quality of cement is subject to change.

MATERIALS AND EQUIPMENT:

1. Scale - capacity of at least 200 lb.
2. Metal container with handles, of 30 gal capacity (a trash can may be suitable for this use).
3. Yield Box (specially constructed yield test boxes, one quarter cubic yard capacity, are provided with each new Concrete-Mobile unit).
4. Stopwatch accurate to one second.
5. Graduated container, with a 2 qt capacity, accurate to 1 ounce.

TEST PROCEDURE:

CEMENT FEED COUNT CALIBRATION

1. Place a deflector in the bottom of the mixer to deflect all cement discharged into the container when the mixer is in the upright position. Make sure aggregate bins are empty and clean.
2. Set the mobile mixer to run at the proper operating speed according to the operating speed meter (OSM) for the machine being calibrated. Set cement feeder at 100 percent.
3. Prime the entire length of the conveyor belt by running about two bags of cement into a container. The cement discharged from the machine during this priming run should be discarded and not counted as part of the calibration.
4. Record the weight of a cleaned 30 gal container on Worksheet I.
5. Reset the cement meter register to zero and place the 30 gallon container at the end of the conveyor belt. Run out a convenient amount of cement 100 - 150 lb then record the count on Worksheet I.

Volumetric Mixer Truck

STATE HIGHWAY ADMINISTRATION
OFFICE OF MATERIALS AND TECHNOLOGY
FIELD CALIBRATION SHEET FOR MOBILE MIXERS

MSMT 558

RECORD ALL WEIGHTS OBTAINED, ACTUAL METER COUNT AND TOTAL SECONDS TO NEAREST TENTH FOR THE SIX TEST RUNS IN THE SPACES BELOW. THEN TOTAL THE RESULTS FOR THE SIX RUNS.
CAUTION: USE WEIGHT OF CEMENT ONLY - DO NOT INCLUDE WEIGHT OF CONTAINER.

No Greater than 4%	RUN # 1	RUN # 2	RUN # 3	RUN # 4	RUN # 5	RUN # 6	TOTAL
CEMENT WEIGHT	92.6	93.8	96.8	97.0	95.8		476.0
METER COUNT	29.7	30.0	31.2	31.2	30.8		152.9
SECONDS	11.50	11.63	12.04	11.95	11.91		59.03

TOTAL METER COUNT	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW CEMENT METER COUNT	
A	B	= C	X D =	E	
152.9	476.0	0.321	95.88	30.80	NEW CEMENT METER COUNT 30.80

TOTAL SECONDS	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW TIME	
A	B	= C	X D =	E	
59.03	476.0	0.124	95.88	11.89	NEW TIME 11.89

MATERIAL	TOTAL DESIGN WT	BAGS OF CEMENT	TOTAL WT. NEW TIME	% OF MOISTURE (C X D) ÷ C	ACTUAL WEIGHT
	A	B	= C		F
SAND	1330.0	6.5	204.6	5%	214.8
STONE	1850.0	6.5	253.8	1%	255.1

MATERIAL	ACTUAL WEIGHT	NEW TIME	WEIGHT PER. SECOND	CALIB. AT 7 SEC.	CALIBRATION WEIGHT	ACTUAL METER OR GATE SET
	A	B	= C	X D	= E	
SAND	214.8	11.89	18.07	6	108.4	4.0
STONE	255.1	11.89	21.46	5	107.3	6.5

YIELD	NEW METER COUNT	BAGS OF CEMENT	ACTUAL METER READING	TRUCK NUMBER	CONCRETE MOBILE MIXER SERIAL #
	A X	B	=		
1	30.80	6.5	200	006	ZM4-409H-2192-019
0.25	30.80	6.5	50	RPM	1061
				LICENSE PLATE	314ED97

Signature Inspector	David M. Welsh / Michael Strong	**Realibration: (Yield Test) if Mobile is Required
Date:		August 18, 2020
Signature Contractor	Christopher "Crit" Grochmal: of LC Concrete	Date: August 18, 2020
Contract #	AA888-5177	Location: Patching along I-97: SB MD 3C / NB MD 3 BU

Note: When calibrating the Sand and Stone weights, a minimum of three (3) test runs will be required.

±2% CALIBRATED WEIGHT			SAND ±2% CALIBRATED WEIGHT			STONE ±2% CALIBRATED WEIGHT		
0.00	0.00	0.00	106.2	106.4	110.6	105.1	107.3	109.4
GATE	WEIGHT	TIME	GATE	WEIGHT	TIME	GATE	WEIGHT	TIME
			4.0	106.2	7.0	6.5	106.2	6.9
			4.0	108.8	7.2	6.5	105.3	6.8
			4.0	110.4	7.4	6.5	107.6	6.9

SAND
STONE

Volumetric Mixer Truck

STATE HIGHWAY ADMINISTRATION
OFFICE OF MATERIALS AND TECHNOLOGY

FIELD CALIBRATION SHEET FOR MOBILE MIXERS

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No Greater than 4%	RUN #1	RUN #2	RUN #3	RUN #4	RUN #5	RUN #6	TOTAL
CEMENT WEIGHT	93.6	94.4	93.8	93.2	94.0		469.0
METER COUNT	30.5	31.0	31.0	31.8	32.0		156.3
SECONDS	10.21	10.45	10.42	10.70	10.78		62.56

TOTAL METER COUNT	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW CEMENT METER COUNT	NEW CEMENT METER COUNT
A /	B	= C	X D =	E	
156.3	469.0	0.333	95.88	31.95	31.95
TOTAL SECONDS	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW TIME	NEW TIME
A /	B	= C	X D =	E	
62.56	469.0	0.112	95.88	10.75	10.75

MATERIAL	TOTAL DESIGN WT. A	BAGS OF CEMENT B	TOTAL WT. NEW TIME C	% OF MOISTURE (C X D)FC	ACTUAL WEIGHT F
SAND	1330.0	6.5	204.6	5%	214.8
STONE	1850.0	6.5	253.8	1%	255.1

MATERIAL	ACTUAL WEIGHT A	NEW TIME B	WEIGHT PER SECOND C	CALIBR. AT 7 SEC. X D	CALIBRATION WEIGHT E	ACTUAL METER OR GATE SET
SAND	214.8	10.75	19.99	6	120.0	5.5
STONE	255.1	10.75	23.74	5	118.7	6.3
YIELD	NEW METER COUNT A X	BAGS OF CEMENT B	ACTUAL METER READING =	TRUCK NUMBER	CONCRETE MOBILE MIXER SERIAL #	
1	31.95	6.5	208	003	ZM4-409H-1951-014	
0.25	31.95	6.5	52	RPM	1074	
				LICENSE PLATE	284ED51	

Signature Inspector: David M. Welsh / Michael Strong
 Signature Contractor: Christopher "Crit" Grochmal: of LC Concrete
 Contract #: AA888-5177
 Location: Patching along I-97: SB MD 3C / NB MD 3 BU
 Date: August 18, 2020

Note: When calibrating the Sand and Stone weighing bins, use the same bin for both materials.

±2% CALIBRATED WEIGHT			SAND ±2% CALIBRATED WEIGHT			STONE ±2% CALIBRATED WEIGHT		
0.00	0.00	0.00	117.6	120.2	122.4	116.3	118.7	121.1
GATE	WEIGHT	TIME	GATE	WEIGHT	TIME	GATE	WEIGHT	TIME
			5.5	120.2	5.8	6.3	119.0	6.1
			5.5	122.2	5.9	6.3	120.9	6.3
			5.5	118.6	5.6	6.3	116.5	6.1

STATE HIGHWAY ADMINISTRATION
OFFICE OF MATERIALS AND TECHNOLOGY

FIELD CALIBRATION SHEET FOR MOBILE MIXERS

MSMT 558

RECORD ALL WEIGHTS OBTAINED, ACTUAL METER COUNT AND TOTAL SECONDS TO NEAREST TENTH FOR THE SIX TEST RUNS IN THE SPACES BELOW. THEN TOTAL THE RESULTS FOR THE SIX RUNS. CAUTION: USE WEIGHT OF CEMENT ONLY - DO NOT INCLUDE WEIGHT OF CONTAINER.

No Greater than 4%	RUN #1	RUN #2	RUN #3	RUN #4	RUN #5	RUN #6	TOTAL
CEMENT WEIGHT	92.6	93.8	96.8	97.0	95.8		476.0
METER COUNT	29.7	30.0	31.2	31.2	30.8		152.9
SECONDS	11.50	11.63	12.04	11.95	11.91		59.03

TOTAL METER COUNT	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW CEMENT METER COUNT	NEW CEMENT METER COUNT
A /	B	= C	X D =	E	
152.9	476.0	0.321	95.88	30.80	30.80
TOTAL SECONDS	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW TIME	NEW TIME
A /	B	= C	X D =	E	
59.03	476.0	0.124	95.88	11.89	11.89

MATERIAL	TOTAL DESIGN WT. A	BAGS OF CEMENT B	TOTAL WT. NEW TIME C	% OF MOISTURE (C X D)FC	ACTUAL WEIGHT F
SAND	1330.0	6.5	204.6	5%	214.8
STONE	1850.0	6.5	253.8	1%	255.1

MATERIAL	ACTUAL WEIGHT A	NEW TIME B	WEIGHT PER SECOND C	CALIBR. AT 7 SEC. X D	CALIBRATION WEIGHT E	ACTUAL METER OR GATE SET
SAND	214.8	11.89	18.07	6	108.4	4.0
STONE	255.1	11.89	21.46	5	107.3	6.5
YIELD	NEW METER COUNT A X	BAGS OF CEMENT B	ACTUAL METER READING =	TRUCK NUMBER	CONCRETE MOBILE MIXER SERIAL #	
1	30.80	6.5	200	006	ZM4-409H-2192-019	
0.25	30.80	6.5	50	RPM	1061	
				LICENSE PLATE	314ED97	

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±2% CALIBRATED WEIGHT			SAND ±2% CALIBRATED WEIGHT			STONE ±2% CALIBRATED WEIGHT		
0.00	0.00	0.00	106.2	108.4	110.6	105.1	107.3	109.4
GATE	WEIGHT	TIME	GATE	WEIGHT	TIME	GATE	WEIGHT	TIME
			4.0	106.2	7.0	6.5	106.2	6.9
			4.0	108.8	7.2	6.5	105.3	6.8
			4.0	110.4	7.4	6.5	107.6	6.9

STATE HIGHWAY ADMINISTRATION
OFFICE OF MATERIALS AND TECHNOLOGY

FIELD CALIBRATION SHEET FOR MOBILE MIXERS

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No Greater than 4%	RUN #1	RUN #2	RUN #3	RUN #4	RUN #5	RUN #6	TOTAL
CEMENT WEIGHT	92.8	93.2	92.0	92.1	92.0		462.1
METER COUNT	31.0	32.0	32.0	32.0	32.0		159.0
SECONDS	12.70	13.10	13.20	13.60	13.60		66.20

TOTAL METER COUNT	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW CEMENT METER COUNT	NEW CEMENT METER COUNT
A /	B	= C	X D =	E	
159.0	462.1	0.344	95.88	32.99	32.99
TOTAL SECONDS	TOTAL WEIGHT CEMENT	FACTOR TO 4 DECIMALS	WT. / BAG OF CEMENT+2%	NEW TIME	NEW TIME
A /	B	= C	X D =	E	
66.20	462.1	0.143	95.88	13.74	13.74

MATERIAL	TOTAL DESIGN WT. A	BAGS OF CEMENT B	TOTAL WT. NEW TIME C	% OF MOISTURE (C X D)FC	ACTUAL WEIGHT F
SAND	1330.0	6.5	204.6	5%	214.8
STONE	1850.0	6.5	253.8	1%	255.1

MATERIAL	ACTUAL WEIGHT A	NEW TIME B	WEIGHT PER SECOND C	CALIBR. AT 7 SEC. X D	CALIBRATION WEIGHT E	ACTUAL METER OR GATE SET
SAND	214.8	13.74	15.64	7	109.5	8.5
STONE	255.1	13.74	18.57	6	111.4	6.0
YIELD	NEW METER COUNT A X	BAGS OF CEMENT B	ACTUAL METER READING =	TRUCK NUMBER	CONCRETE MOBILE MIXER SERIAL #	
1	32.99	6.5	214	004	ZM4-408H-7965-014	
0.25	32.99	6.5	54	RPM	1067	
				LICENSE PLATE	234ED58	

Signature Inspector: David M. Welsh / Michael Strong
 Signature Contractor: Christopher "Crit" Grochmal: of LC Concrete
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±2% CALIBRATED WEIGHT			SAND ±2% CALIBRATED WEIGHT			STONE ±2% CALIBRATED WEIGHT		
0.00	0.00	0.00	107.3	109.5	111.7	109.2	111.4	113.7
GATE	WEIGHT	TIME	GATE	WEIGHT	TIME	GATE	WEIGHT	TIME
			8.5	110.6	5.8	6.0	109.8	7.8
			8.5	111.0	5.9	6.0	112.6	7.8
			8.5	110.6	5.6	6.0	109.6	7.8

Volumetric Mixer Truck

N #	2	DATE	2020-Aug-18			
#	CONTRACT NUMBER	CYL #	AREA	BRK TYPE	TOTAL LOAD	P.S.I.
↗	AA8885177	EB-1	13.2	3	16.3	1240
↗	"	EB-2	13.4	3	18.9	1410
↗	"	EB-3	13.3	3	20.0	1500
↗	"	EB-4	13.3	3	20.6	1540
↗	"	EB-5	13.3	1	26.4	1980
↗	"	EB-6	13.4	1	21.9	1630
↗	"	EB-7	13.2	2	20.5	1550
E	"	EB-8	13.4	1	22.6	2140
A	"	EB-9	13.3	2	17.8	1340
R	"	EB-10	13.4	2	26.0	1940
L	"	EB-11	13.4	6	28.8	2150
Y	"	EB-12	13.4	1	30.9	2310
B	"	EB-13	13.4	3	19.9	1490
R	"	EB-14	13.2	1	18.3	1370
E	"	EB-15	13.2	1	23.4	1770
A	High Strength (Trial Batches)	EB-16	13.3	1	28.1	2100
K						
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SPECIAL PROVISIONS CONTRACT No. AA8885177
 500 — RAPID SETTING CEMENTITIOUS CONCRETE 7 of 7

Trial Batches. Perform 1 hour, 1.5 hour, 2 hour, 2.5 hour, 3 hour, 3.5 hour, 4 hour, 6 hour, and 24 hour compressive strength tests. Use the same components in the trial batches to be used in production. Trial batches must be approved by OMT's Concrete Technology Division. If a volumetric mixer truck is used in production, the trial batch is to be performed with the volumetric mixer truck.

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Compressive strength (min) at 4 hours	AASHTO T22	2000 psi
Compressive strength (min) at 24 hours	AASHTO T22	3000 psi
Drying shrinkage (max) at 4 hours	ASTM C157	0.04
Water/Cement Ratio		0.38 - 0.46

Volumetric Mixer Truck



Volumetric Mixer Truck



Volumetric Mixer Truck



Volumetric Mixer Truck



Volumetric Mixer Truck



I-97 Concrete Patching - Construction

- SHA Contract No. AA8885177
- Start Patching: September 13, 2020 (Completed Patching: December 14, 2020)
- In average 6 patch per night.
- All work was performed at night.



I-97 Concrete Patching - Construction

Test performed every 50 cy of concrete mix,
 Air Test, Temperature, Slump and Cast 4x8 concrete cylinders sent to SHA Lab after 1
 hour

Acceptance is based on 24 hours break period as specified in the SP.

The Administration will reject the patches of the day production represented
 by a strength test if it is more than 500 psi below
 the 24 hours Minimum Compressive Strength $f'c$ (psi)

OMT085 2/2011

Design
 Early Break
 Acceptance
 Other

MARYLAND STATE HIGHWAY ADMINISTRATION
 PORTLAND CEMENT CONCRETE TEST RESULTS

CONTRACT NO: AAS885177 FAP NO: AC-NHPP-097-1(65)E DATE PLACED: 8/18/2020

MIX DESIGN NO: PRODUCER / LOCATION: LC CONCRETE

USE / LOCATION: CONC PVMT REPAIR ITEM NO: 5001 Quantity Registered 71 Total Qty Registered 71 CY (e.g. 6, 36 or 50+)

FIELD TEST RESULTS - PLASTIC CONCRETE

LOAD TICKET NO:	<u>7438</u>	STANDARD CURED ACCEPTANCE CYLINDERS (28 DAY)
WATER CEMENT RATIO	<u>N/A</u>	<input type="checkbox"/> AFTER MOLDING: SPECIMENS IMMEDIATELY MOVED TO STORAGE AND UNDISTURBED FOR INITIAL CURING
SLUMP (Inches) (AASHTO T-119)	Test 1: <u>41</u> Test 2: <u> </u>	<input type="checkbox"/> INITIAL CURING: SPECIMENS WERE STORED AT 60 TO 80 °F IN MOIST CONDITION FOR 19 TO 48 HRS
AIR CONTENT (%) (AASHTO T-152 or T-156)	Test 1: <u>8.0</u> Test 2: <u> </u>	<input type="checkbox"/> FINAL CURING: AFTER COMPLETION OF INITIAL CURING AND WITHIN 90 MIN AFTER REMOVING MOLDS, SPECIMENS WERE SUBMERGED IN SATURATED LIMB WATER TANKS AT 73 ± 3 °F OR DELIVERED TO LABORATORY
AIR TEMPERATURE	<u>78 F</u>	NOTE: SPECIMENS NOT FOR ACCEPTANCE (Early Break): STORE BY OR ON THE STRUCTURE AND PROVIDE THE SAME TEMPERATURE AND HUMIDITY ENVIRONMENT AS THE STRUCTURE DELIVER TO LAB WITHIN 14 HRS OF REQUESTED TEST AGE
CONCRETE TEMPERATURE (ASTM C-1064)	<u>84 F</u>	RESULTS OF FIELD TESTS
CYLINDER NUMBERS	<u>1 thru 18</u>	<input type="checkbox"/> MEETS SPECIFICATIONS
DATE STRIPPED	<u> </u>	<input type="checkbox"/> DOES NOT MEET SPECIFICATIONS
CURING METHOD (AASHTO T-23)	<u> </u>	SIGNED: <u> </u> (Printed Engineer / Rep)
MOLDED BY	<u>Team of Joe</u>	FIELD REMARKS / RESOLUTIONS: Breaks period: 1 hr, 1-1/2 hrs, 2 hrs, 2-1/2 hrs, 3 hrs, 3-1/2 hrs, 4 hrs, 6 hrs and 24 hrs (TRIAL BATCH)

LAB TEST RESULTS - HARDENED CONCRETE

AASHTO T-22					DATE RECEIVED:
CYLINDER #	BIN #	DATE TESTED	AGE (DAYS)	STRENGTH (PSI)	
					LAB REMARKS: RESULTS OF LAB TESTS <input type="checkbox"/> MEETS SPECIFICATIONS <input type="checkbox"/> DOES NOT MEET SPECIFICATIONS

SIGNED: (CMTE/ TD Engineer / Rep)

DISTRIBUTION: PROJECT ENGINEER / PRODUCER / REGIONAL FILE (Original)

I-97 Concrete Patching – Construction

- Volumetric Mixer Truck Calibration with SHA Lab Representator
- Inspector on site checks the setting of mix on the truck every night

STATE HIGHWAY ADMINISTRATION
OFFICE OF MATERIALS AND TECHNOLOGY
FIELD CALIBRATION SHEET FOR MOBILE MIXERS

RECORD ALL WEIGHTS OBTAINED, ACTUAL METER COUNT AND TOTAL SECONDS TO NEAREST TENTH FOR THE SIX TEST RUNS IN THE SPACES BELOW. THEN TOTAL THE RESULTS FOR THE SIX RUNS. CAUTION: USE WEIGHT OF CEMENT ONLY - DO NOT INCLUDE WEIGHT OF CLEAN RANGE.

No Greater than 4%	RUN # 1	RUN # 2	RUN # 3	RUN # 4	RUN # 5	RUN # 6	TOTAL
CEMENT WEIGHT	92.6	93.8	96.8	97.0	95.8		476.0
METER COUNT	29.7	30.0	31.2	31.2	30.8		152.9
SECONDS	11.50	11.63	12.04	11.95	11.91		59.03
TOTAL METER COUNT	A	B	C	D	E		
152.9	476.0	0.321	95.88				NEW CEMENT METER COUNT 30.80
TOTAL SECONDS	A	B	C	D	E		
59.03	476.0	0.124	95.88				NEW TIME 11.89
MATERIAL	TOTAL DESIGN WT	TOTAL WT. OF CEMENT	TOTAL WT. OF CEMENT + 2%	% OF MOISTURE	ACTUAL WEIGHT		
SAND	1330.0	6.5	204.6	8%	214.8		
STONE	1650.0	6.5	253.8	1%	255.1		
MATERIAL	ACTUAL WEIGHT	NEW TIME	WEIGHT PER SECOND	CALIBR AT 7 SEC.	CALIBRATION WEIGHT	ACTUAL METER OR GATE SET	
SAND	214.8	11.89	18.07	6	108.4	4.0	
STONE	255.1	11.89	21.46	5	107.3	6.5	
YIELD	NEW METER COUNT	BAGS OF CEMENT	ACTUAL METER READING				
1	30.80	6.5	200.19				
0.25	30.80	6.5	50.05				
Signature	David M. Welch / Michael Strong		**Re-calibration / Yield Test if Mobile is Required		Date: August 18, 2020		
Inspector							
Signature							
Contractor	Christopher "Cris" Grochmal: of LC Concrete		Date: August 18, 2020				
Contract #	A4885-5177		Location: Patching along I-97 SB MD 3C / NB MD 3 BU				
NOTE: When entering the Sand and Stone weights a minimum of three (3) test runs will be required.							
CALIBRATED WEIGHT		CALIBRATED WEIGHT		CALIBRATED WEIGHT			
DATE	WEIGHT	TIME	DATE	WEIGHT	TIME	DATE	WEIGHT
	4.0	106.2	7.0	6.5	106.2	6.9	
	4.0	108.8	7.2	6.5	105.3	6.8	
	4.0	110.4	7.4	6.5	107.6	6.9	



Field Calibration Sheet

concrete mobile mixer – inspection and cleaning for calibration

I-97 Concrete Patching – Construction

Removing concrete slab by the lift out method



A method of pavement removal that caused damage to the existing concrete pavement



I-97 Concrete Patching – Final Inspection



Cement coating on stone came off



Cracks and spalling on repaired pavement

SUMMARY

- MDSHA had performed concrete patching on IS-97
- MOT restrictions required the road to be opened to the traffic ASAP and all day
- Rapid Set Cement was used to reduce the curing time for concrete patching
- New Special Provision (SP) were developed
- It was recommended to use Volumetric Mixer Truck
- The patching is complete and MDSHA monitors the road to evaluate their performance

