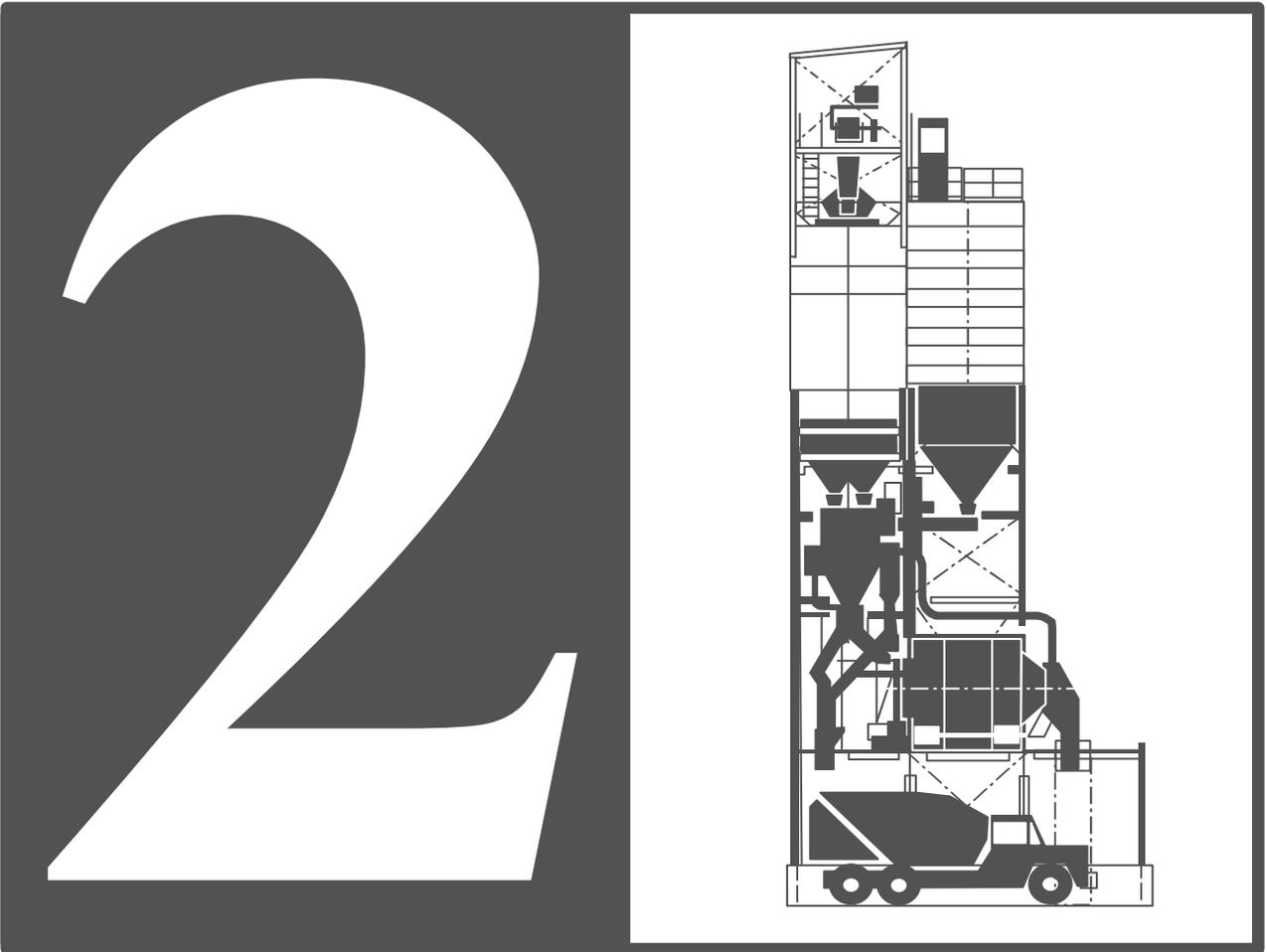


TN

TDOT

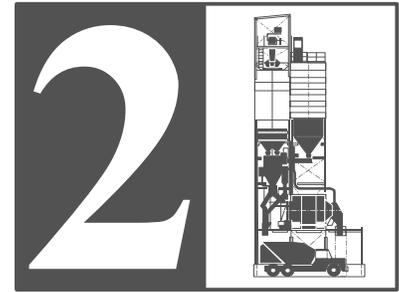
Department of
Transportation



**Concrete Plant Quality Control Technician
Course**

Tennessee Department of Transportation

Volume 3.1



Concrete Plant Quality Control Technician Course

Instructors: **Jamie Waller, P.E. – jamie.waller@tn.gov**

(615) 350-4151

Amanda Neighbors – amanda.neighbors@tn.gov

(615) 350-3314

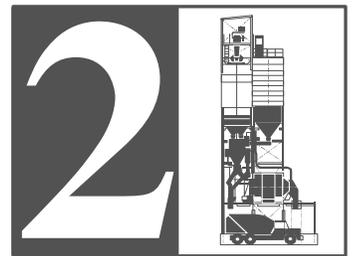
Jason Mellons – michael.j.mellons@tn.gov

(615) 350-4152

Training Coordinator: Kim Whitby – kimberly.whitby@tn.gov

(615) 350-4158

**Tennessee Department of Transportation
Division of Materials and Tests • Field Operations
6601 Centennial Blvd. • Nashville • Tennessee • 37243-0360
Phone 615.350.4100 • Fax 615.350.4128**



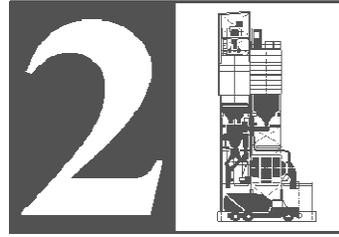
Concrete Plant Quality Control Technician Course

Tennessee Department of Transportation

Volume 3.1

Table of Contents

Sampling of Aggregates.....	1
Reducing Samples of Aggregate to Testing Size (T-248).....	13
Total Evaporable Moisture Content of Aggregate by Drying (T-255).....	23
Moisture Correction for Aggregates	31
Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing (T11).....	37
Sieve Analysis of Fine and Coarse Aggregates (T-27).....	47
<i>Sample Problems 1 including Fineness Modulus</i>	
<i>Sample Problems 2 including Fineness Modulus</i>	
Quality Assurance/ Quality Control.....	68
Appendix.....	77



Concrete Plant Quality Control Technician Course

Tennessee Department of Transportation

Volume 3.1

Class Schedule

1. Registration
2. Introduction
3. Construction and Maintenance of Aggregate Stockpiles
4. Sampling of Aggregates (T-2)
5. Reducing Samples of Aggregate to Testing Size (T-248)
6. Total Evaporable Moisture Content of Aggregate by Drying (T-255)
7. Break
8. Moisture Correction for Aggregates
9. Materials Finer than 75- μm (No. 200) Sieve in Mineral Aggregates by Washing (T-11)
10. Sieve Analysis of Fine and Coarse Aggregates (T-27)
11. Lunch
12. Quality Assurance/ Quality Control
13. Written Exam

1

Sampling of Aggregates

AASHTO T 2

ASTM D 75

TDOT Standard Method of Test for Sampling of Aggregates

References



TDOT Standard Specifications
AASHTO T 2
ASTM D 75



Apparatus

- **Shovel**
- **Scoops**
- **Brushes**
- **Sampling tubes**
- **Sample containers**
- **Tags**

Purpose

- **Preliminary investigation of the potential source of supply**
 - Sample at source
 - Complete quality testing (dependent upon application)
- **Control of the product at the source**
- **Control of the operations at the site of use**
 - Project site
 - Concrete plant
- **Acceptance or rejection of the materials**
 - TDOT Standard Specifications

Concrete Plant Quality Control Technician Course, Grade 2

Size of Aggregate

- **Nominal maximum size of aggregate is the first sieve upon which any material is retained**
- **Maximum size of aggregate is the sieve size above the nominal maximum size**

Concrete Plant Quality Control Technician Course, Grade 2

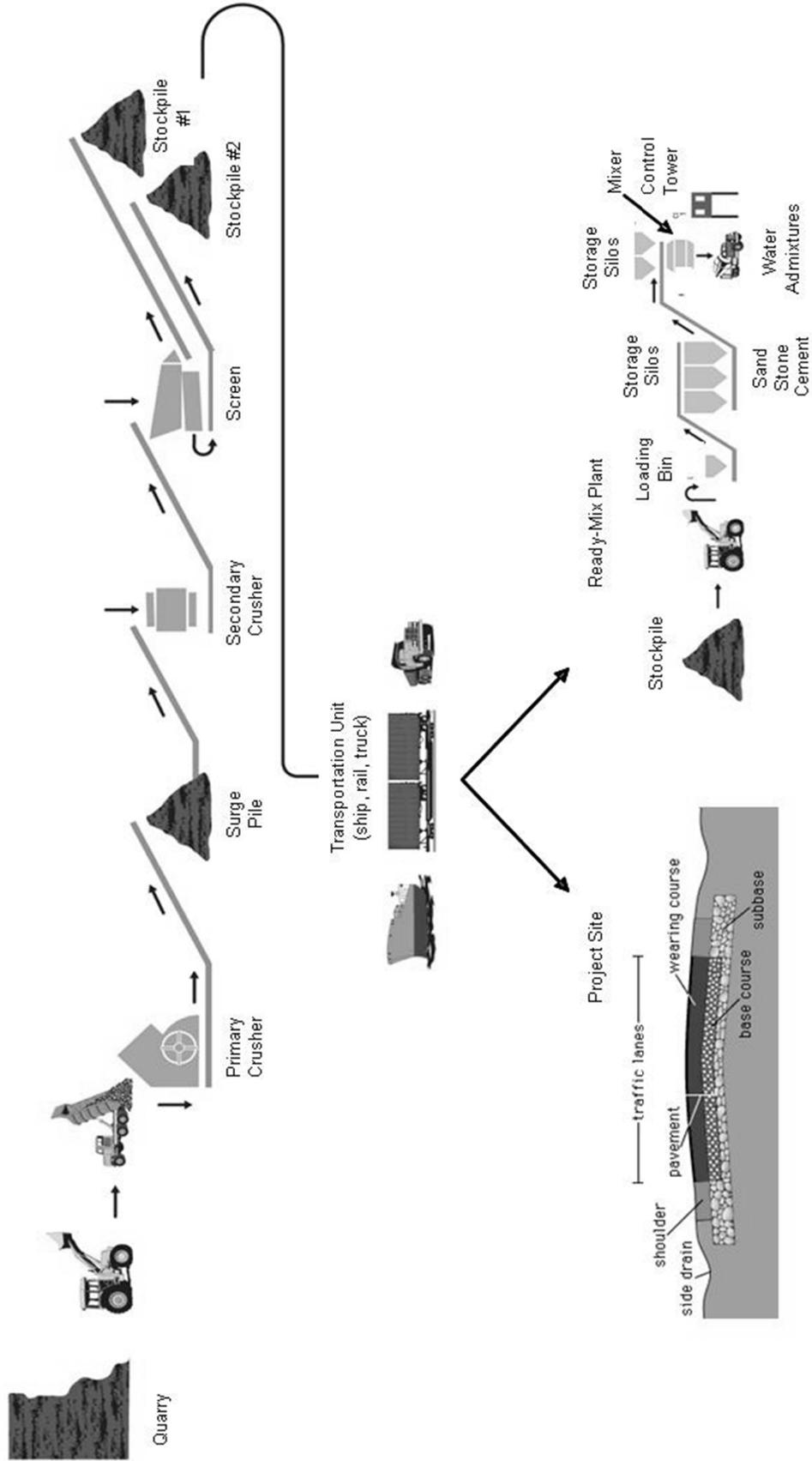
Field Sample Size



TABLE 1 Minimum Size of Field Samples

Aggregate Size ^A	Field Sample Mass, min, kg ^B [lb]	Field Sample Volume, min, L [gal]
Fine Aggregate		
2.36 mm [No. 8]	10 [22]	8 [2]
4.75 mm [No. 4]	10 [22]	8 [2]
Coarse Aggregate		
9.5 mm [$\frac{3}{8}$ in.]	10 [22]	8 [2]
12.5 mm [$\frac{1}{2}$ in.]	15 [35]	12 [3]
19.0 mm [$\frac{3}{4}$ in.]	25 [55]	20 [5]
25.0 mm [1 in.]	50 [110]	40 [10]
37.5 mm [$1\frac{1}{2}$ in.]	75 [165]	60 [15]
50 mm [2 in.]	100 [220]	80 [21]
63 mm [$2\frac{1}{2}$ in.]	125 [275]	100 [26]
75 mm [3 in.]	150 [330]	120 [32]
90 mm [$3\frac{1}{2}$ in.]	175 [385]	140 [37]

Aggregate Production and Use



Methods of Sampling

- **Flowing aggregate stream**
- **Conveyor belt**
- **Stockpiles**
 - **with power equipment**
 - **without power equipment**
- **Roadways**
- **Transportation units**

Concrete Plant Quality Control Technician Course, Grade 2

Flowing Aggregate Stream

- **From bins, for example**
- **Three increments**
- **Each increment obtained using a suitable sampling device**
- **Device must be capable of interrupting the entire flow of material as it passes off the belt**

Concrete Plant Quality Control Technician Course, Grade 2

Conveyor Belts

- **Three increments**
- **Production suspended while sampling**
- **Designated sampling area**
- **Templates useful for defining sampling area**
- **All material within sampling area is removed including fines (with a brush)**



Concrete Plant Quality Control Technician Course, Grade 2

Stockpiles

- **Stockpile must be checked for segregation and noted in log**
- **Segregation is the separation of varying sizes of aggregate**
- **Power equipment is recommended**
- **Portions collected at various locations around the main stockpile**

Concrete Plant Quality Control Technician Course, Grade 2

With Power Equipment

- Loader bucket digs straight into pile level to ground
- Loader bucket is raised (perpendicular to the ground) through the entire height of the pile



Concrete Plant Quality Control Technician Course, Grade 2

With Power Equipment

- Portion is dropped onto a clear spot away from the main pile
- The loader is then used to blend and backblade the smaller stockpile



Concrete Plant Quality Control Technician Course, Grade 2

With Power Equipment



- The new stockpile can now be sampled at even intervals
- Material is obtained from each location with a shovel by digging into the pile
- The three increments are then combined to comprise the final field sample

Concrete Plant Quality Control Technician Course, Grade 2

Without Power Equipment

If power equipment is not available:

- The stockpile is checked for segregation (and noted in log)
- The pile is visually divided into three even sections
- Portions are obtained from each section at least 12" below the surface by removing the outer layer of material
- The three increments are then combined to comprise the final field sample



Concrete Plant Quality Control Technician Course, Grade 2

Without Power Equipment

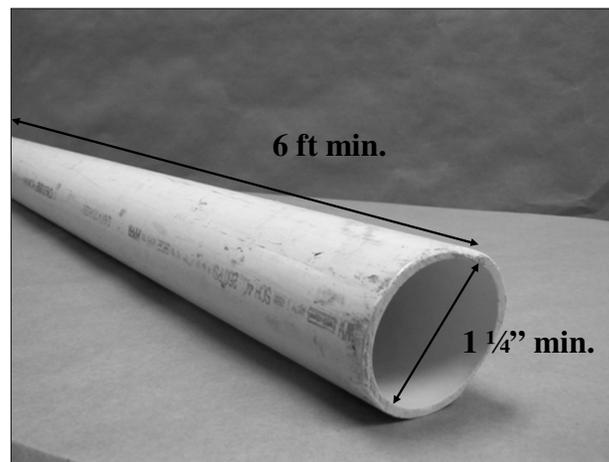
In lieu of shoveling:

- The stockpile is checked for segregation (and noted in log)
- Sampling tubes may be used
- Sampling tubes may not be used on stockpiles containing coarse aggregate
- A minimum of five increments must be collected
- The five increments are then combined to comprise the final field sample



Concrete Plant Quality Control Technician Course, Grade 2

Without Power Equipment (Sampling Tube)



Concrete Plant Quality Control Technician Course, Grade 2

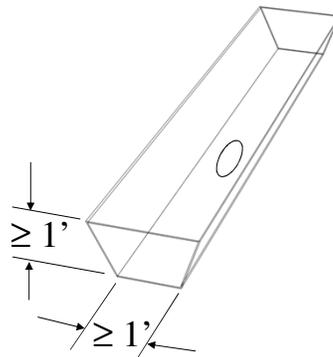
Roadways

- **Three increments**
- **Sample obtained from uncompacted or loosely-compacted base or sub base material**
- **Predetermined random locations**
- **Full depth of layer must be sampled**
- **Avoid contamination from underlying material**

Concrete Plant Quality Control Technician Course, Grade 2

Transportation Units

- **Railroad cars, barges, trucks**
- **Power equipment is recommended**
- **Various levels and random locations**
- **Three or more trenches**



Concrete Plant Quality Control Technician Course, Grade 2

Sample Containers

- **Durable**
- **Strong**
- **Able to be carried**
[≤ 50 lbs. (23 kg)]
- **Portion the sample, if necessary**
- **Appropriate container for test to be performed**



Concrete Plant Quality Control Technician Course, Grade 2

Tagging the Sample

Project Number: 55001-3231-18

Date Sampled: 11 Mar 02 Submitted: 12 Mar 02

Sampled by: F. Flintstone

Submitted by: F. Flintstone

Producer: Stone Materials, Inc.

Pit Number: 185 Sampled from: Stockpile

County: Davidson Region: 3

Concrete Plant Quality Control Technician Course, Grade 2



2

Reducing Samples of Aggregate to Testing Size

AASHTO T 248

ASTM C 702

TDOT Standard Method of Test for **Reducing Samples of Aggregate to Testing Size**

References



TDOT Standard Specification
AASHTO T 248
ASTM C 702



Methods of Reduction

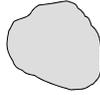
- **Method A - Mechanical Splitter**
- **Method B - Cone and Quarter**
- **Method C - Miniature Stockpile**



To Determine Method

- **Moisture condition of the aggregate**

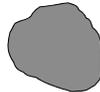
- **Dry**



- **Moist**



- **SSD/Absorption**



- **Wet/Free Moisture**



Concrete Plant Quality Control Technician Course, Grade 2

To Determine Method

- **Size of aggregate**

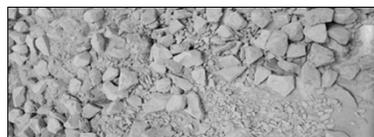
- **Coarse**



- **Fine**



- **Combined**



Concrete Plant Quality Control Technician Course, Grade 2

Determine Method

Aggregate Size	Coarse	Combined	Fine
Drier than saturated-surface-dry	 A, B	 A, B	 A
Free moisture on surface	 A, B	 A, B	 B, C

} Splitting Method

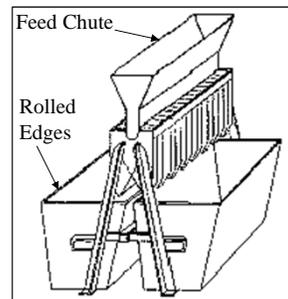
- Method A - Mechanical Splitter
- Method B - Cone and Quarter
- Method C - Miniature Stockpile

Concrete Plant Quality Control Technician Course, Grade 2

Mechanical Splitter / Method A

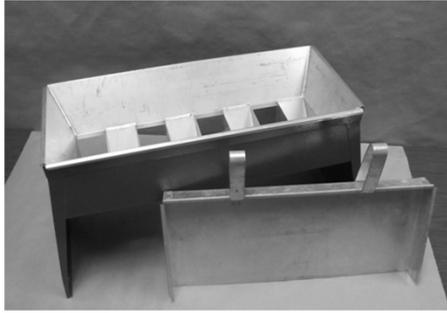
For Coarse and Mixed Aggregate

- Even number of chutes
- Chutes of equal width
- At least 8 chutes
- Individual chutes about 50% larger than largest particles

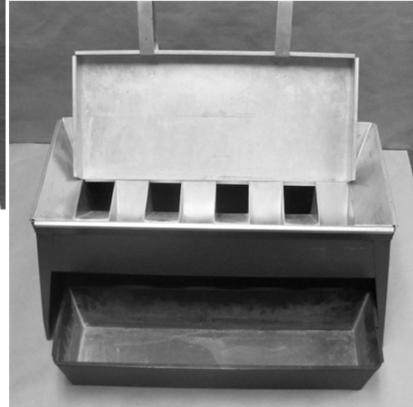


Concrete Plant Quality Control Technician Course, Grade 2

Mechanical Splitter / Method A



**COARSE or COMBINED
AGGREGATE**

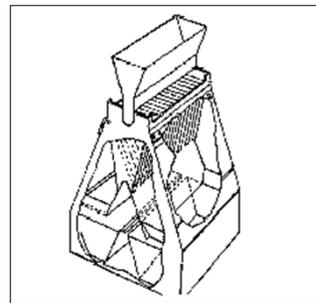


Concrete Plant Quality Control Technician Course, Grade 2

Mechanical Splitter / Method A

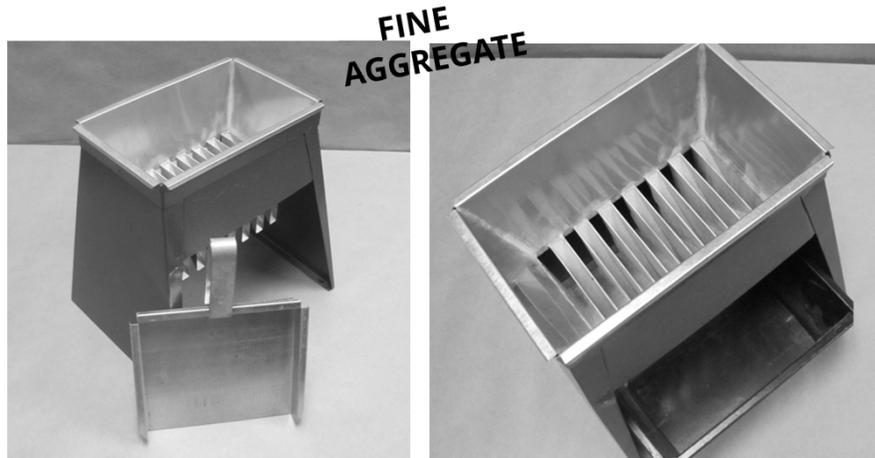
For Fine Aggregate

- Even number of chutes
- Chutes of equal width
- At least 12 chutes
- Individual chutes about 50% larger than largest particles (3/4" max.)



Concrete Plant Quality Control Technician Course, Grade 2

Mechanical Splitter / Method A



Concrete Plant Quality Control Technician Course, Grade 2

Cone and Quarter / Method B



Cone the sample on a hard, clean, level surface.

Mix. Form a new cone.



Flatten the cone to a uniform thickness.

Diameter = 4 x thickness to 8 x thickness

Concrete Plant Quality Control Technician Course, Grade 2

Cone and Quarter / Method B



Divide the flattened cone.

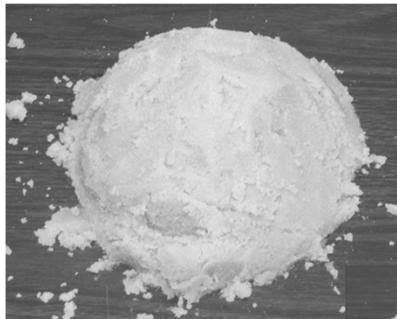


After dividing, remove two diagonal quarters (including fines).

Mix and quarter the remaining material until sample is adequately reduced.

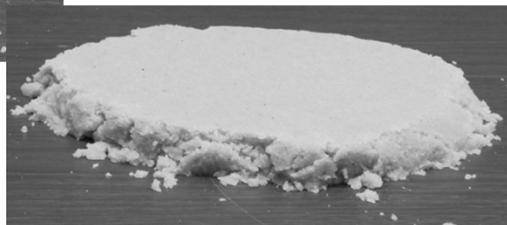
Concrete Plant Quality Control Technician Course, Grade 2

Cone and Quarter / Method B



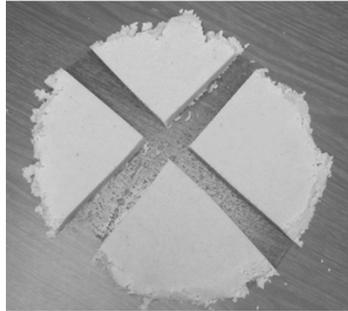
Flatten to uniform thickness $D=4t$ to $8t$

Turn material over 3 times and place into a cone



Concrete Plant Quality Control Technician Course, Grade 2

Cone and Quarter / Method B



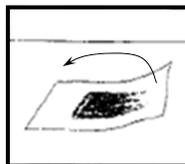
Use scoop to separate into four quarters



Collect diagonal quadrants as the sample

Concrete Plant Quality Control Technician Course, Grade 2

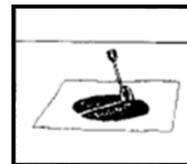
Quartering Alternative / Method B



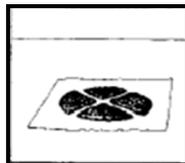
Mix with a shovel or with the canvas blanket



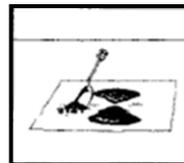
Form the material into a cone



After flattening the cone, use a shovel to divide



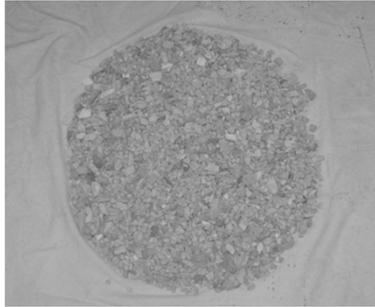
Quarter the material



Remove diagonal quarters (including fines)

Concrete Plant Quality Control Technician Course, Grade 2

Quartering Alternative/Method B



Mix on canvas cloth by rolling aggregate on cloth.



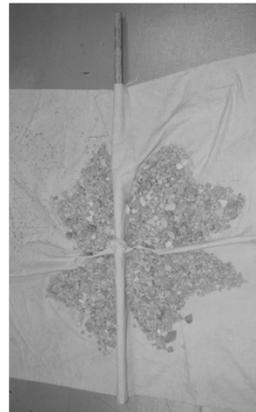
Flatten aggregate pile to constant thickness with shovel.

Concrete Plant Quality Control Technician Course, Grade 2

Quartering Alternative/Method B

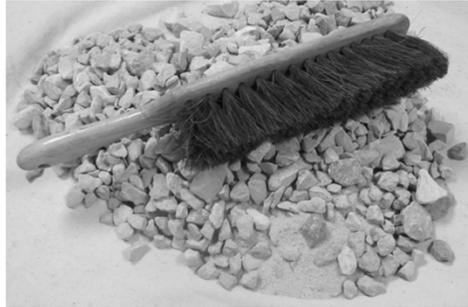


Using a stick, divide the aggregate into four separate quarters

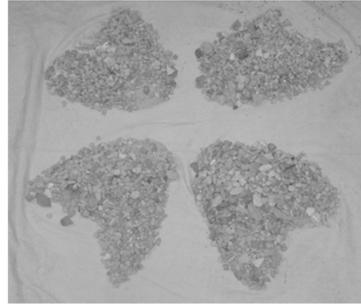


Concrete Plant Quality Control Technician Course, Grade 2

Quartering Alternative/Method B



Collect fines using brush to include with the sample.



Remove diagonal quarters to use including the fines.

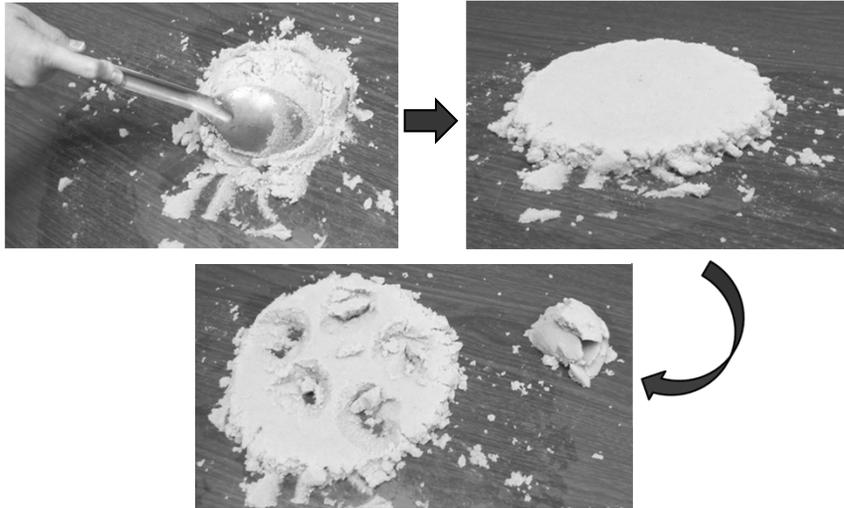
Concrete Plant Quality Control Technician Course, Grade 2

Miniature Stockpile / Method C

- **Place sample on hard, clean, level surface**
- **Mix thoroughly by turning over three times**
- **Form a cone with the last turning**
- **Flatten, if desired, to a uniform thickness**
- **Select at least five increments at random locations using a shovel, scoop, or spoon**

Concrete Plant Quality Control Technician Course, Grade 2

Miniature Stockpile / Method C



Concrete Plant Quality Control Technician Course, Grade 2



3

**Total Evaporable Moisture Content of
Aggregate by Drying
AASHTO T 255
ASTM C 566**

TDOT Standard Method of Test for
**Total Evaporable Moisture Content of
Aggregate by Drying**

References



TDOT Standard Specifications
AASHTO T 255
ASTM C566



Apparatus

- **Balance**
- **Heat Source**
- **Sample Container**
- **Stirring Spoon**

Sample Size

TABLE 1 Sample Size for Aggregate

Nominal Maximum Size of Aggregate, mm (in.) ^A	Mass of Normal Weight Aggregate Sample, min, kg ^B
4.75 (0.187) (No. 4)	0.5
9.5 (3/8)	1.5
12.5 (1/2)	2
19.0 (3/4)	3
25.0 (1)	4
37.5 (1 1/2)	6
50 (2)	8
63 (2 1/2)	10
75 (3)	13
90 (3 1/2)	16
100 (4)	25
150 (6)	50

^A Based on sieves meeting Specification E11.

^B Determine the minimum sample mass for lightweight aggregate by multiplying the value listed by the dry-loose unit mass of the aggregate in kg/m³ (determined using Test Method C29/C29M) and dividing by 1600.

Samples



Concrete Plant Quality Control Technician Course, Grade 2

Determine Sample Mass

- Weigh the sample to the nearest 0.1 of a unit of the original sample mass



6285.6 g

Concrete Plant Quality Control Technician Course, Grade 2

Dry the Sample

- Dry the aggregate to a constant mass in an oven at $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$)
- Allow the material to cool



Concrete Plant Quality Control Technician Course, Grade 2

Reweigh the Sample

- Weigh the sample to the nearest 0.1 of a unit of the original sample mass



6163.8 g

Concrete Plant Quality Control Technician Course, Grade 2

Calculations

$$P_{Moisture, Total} = \frac{M_{Original} - M_{Dry}}{M_{Dry}} \times 100$$

$$P = \frac{W - D}{D} \times 100$$

$$P = \frac{6285.6 - 6163.8}{6163.8} \times 100 = 1.98\% \approx \underline{2.0\%}$$

Concrete Plant Quality Control Technician Course, Grade 2

Problem

Given:

- Weight of the original sample (W) = 1092.4 g
- Weight of sample after drying (D) = 1080.5 g

Determine:

Total percent (P) moisture content of the aggregate.

Concrete Plant Quality Control Technician Course, Grade 2

Solution

$$P = \frac{W - D}{D} \times 100$$

$$P = \frac{1092.4 - 1080.5}{1080.5} \times 100 = 1.101 \approx \underline{1.1\%}$$

Concrete Plant Quality Control Technician Course, Grade 2

Practice

Sample Number	Original Weight	Dry Weight	Moisture Content
1	588.3	570.9	
2	1556.8	1540.9	
3	1225	1220.1	
4	1665.2	1650.5	

Concrete Plant Quality Control Technician Course, Grade 2

Solutions

Sample Number	Original Weight	Dry Weight	Moisture Content
1	588.3	570.9	3.04782
2	1556.8	1540.9	1.03186
3	1225	1220.1	0.40161
4	1665.2	1650.5	0.89064

$$p_1 = \frac{588.3 - 570.9}{570.9} \times 100 = 3.048 \sim 3.0\%$$

$$p_2 = \frac{1556.8 - 1540.9}{1540.9} \times 100 = 1.032 \sim 1.0\%$$

$$p_3 = \frac{1225.0 - 1220.1}{1220.1} \times 100 = 0.402 \sim 0.4\%$$

$$p_4 = \frac{1665.2 - 1650.5}{1650.5} \times 100 = 0.891 \sim 0.9\%$$

Concrete Plant Quality Control Technician Course, Grade 2

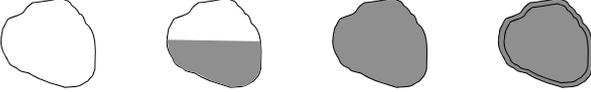


Determine the percent moisture content in the wet condition:

Determine the percent moisture of the aggregate at SSD (Absorption):

Concrete Plant Quality Control Technician Course, Grade 2

DRY 900g	MOIST 930g	SSD 955g	WET 975g
---------------------------	-----------------------------	---------------------------	---------------------------



Determine the percent of free moisture on the sample:

Determine the amount of water the aggregate has in the wet condition:

Concrete Plant Quality Control Technician Course, Grade 2



4

Aggregate Moisture Corrections For Concrete Batching

Aggregate Moisture Corrections for Concrete Batching

References

TDOT Standard Specifications

Purpose

- Control the amount of mixing water that actually ends up in mix.
- Biggest source of water to be accounted for:
 - Coarse Aggregate
 - Fine Aggregate
- Aggregates contain both absorbed and free water.
- Reference: TDOT Standard Specification 501.03

Concrete Plant Quality Control Technician Course, Grade 2

Aggregate Moisture Content

- **Dry Weight**
 - Weight of sample no longer changes after being heated
- **Absorbed Water**
 - Not included in the mixing water
 - Determine Percent Absorption of Aggregate
- **SSD Condition (Saturated Surface Dry)**
 - Pores and Cavities are filled with absorbed water , but the surface is dry
- **Wet Condition**
 - Contains both free and absorbed water
 - Free water must be included in the design as mixing water

Concrete Plant Quality Control Technician Course, Grade 2

Aggregate Moisture Content Formulas

1. **Determine Percent Free Moisture in Aggregates:**

$$\% \text{ Free Moisture} = \% \text{ Moisture} - \text{Absorption}$$
2. **Determine SSD Batch Weights**
3. **Calculate Aggregate Moisture Corrections:**

$$\text{Moisture Correction} = \text{SSD Weight} \times \% \text{ Free Moisture}$$
4. **Amount of Water to Subtract from Mixing Water based off moisture corrections:**

$$\text{Mixing Water Correction} = [\text{CA Moisture Correction (lbs)} + \text{FA Moisture Correction (lbs)}] / 8.34 \text{ lbs/gal}$$

Concrete Plant Quality Control Technician Course, Grade 2

Aggregate Moisture Content Formulas (Continued)

5. Determine Actual CA & FA Batch Weights:

Actual Aggregate Batch Weights = SSD Batch Weight + Moisture Correction

6. Determine Actual Water to be Batched:

Actual Water Batched = Designed Water - Mixing Water Correction

Concrete Plant Quality Control Technician Course, Grade 2



CONTRACTOR'S DAILY REPORT OF CONCRETE INSPECTION

Completed by Contractor's Concrete Plant Inspector

Date _____

Contract No. _____

Proj. Ref. No. _____ County (Leave blank) Region _____ Project _____

Contractor _____ Sub-Contractor _____

Ready Mix Co. _____ Location _____

Type of Plant Mixer _____ Date Scales Checked: No Yes

Transit Mixer Checked for Presence of Water Before Batching: Yes No

Plant and Trucks Checked (Form T-232): Yes No Date _____

Approved Process Control Plan: Yes No Date _____

Daily Stockpile Check Results: Satisfactory Unsatisfactory Aggr. Card No. C.A. _____

W.R.A. / Retarder oz. _____ A.E.A. oz. _____ F.A. _____

W.R.A. / Retarder oz. _____ A.E.A. oz. _____ Total C.Y. Batched _____

Batch Size _____ yd ³ (m ³)	Water		Cement lbs. (kg)	Fly Ash lbs. (kg)	GGBFS lbs. (kg)	Coarse Aggregate lbs. (kg)	Fine Aggregate lbs. (kg)
	gal (L)	lbs. (kg)					
Agg. Size / Other Material							
Percent Free Moisture						0.5%	4%
SSD Batch Wts.	30		479	106		1912	1138
Moisture Corrections	6.6					9.56	45.52
Actual Batch Wts.	23.4					1922	1184

Remarks _____

SCREEN ANALYSIS TOTAL PERCENT PASSING SIEVE

Size No.	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#200
Size No.	3/8"	#4	#8	#16	#30	#50	#100	#200	F.M.

Date Tested: C.A. _____ F.A. _____ Plant Technician _____ Cert. No. _____

Example

Batch Size _____ m ³ (yd ³)	Water		Cement lbs. (kg)	Fly Ash lbs. (kg)	GGBFS lbs. (kg)	Coarse Aggregate lbs. (kg)	Fine Aggregate lbs. (kg)
	gal (L)	lbs. (kg)					
Agg. Size / Other Material							
Percent Free Moisture							
SSD Batch Wts.	25		425	140		1.1%	2.5%
Moisture Corrections						1810	1229
Actual Batch Wts.							

Determine the Moisture Corrections and Actual Batch Weights for the following example:

Example Results

Batch Size _____ m ³ (yd ³)	Water		Cement lbs. (kg)	Fly Ash lbs. (kg)	GGBFS lbs. (kg)	Coarse Aggregate lbs. (kg)	Fine Aggregate lbs. (kg)
	gal (L)	lbs. (kg)					
Agg. Size / Other Material							
Percent Free Moisture						1.1%	2.5%
SSD Batch Wts.	25		425	140		1810	1229
Moisture Corrections	6.1					19.91	30.73
Actual Batch Wts.	18.9					1830	1260

Coarse Aggregate

1810 x 1.1% = 19.91 lbs.

1810+ 19.91 = 1830 lbs.

Fine Aggregate

1229 x 2.5% = 30.73 lbs.

1229+ 30.73 = 1260 lbs.

Water

(19.91+30.73) / 8.34 lbs = 6.1 gals

25 - 6.1 = 18.9 gals

5

Materials Finer Than 75- μm (No.200) Sieve

In Mineral Aggregates by Washing

AASHTO T 11

ASTM C 117

TDOT Standard Method of Test for
**Materials Finer Than 75- μ m (No. 200) Sieve in Mineral
Aggregates by Washing**

References



TDOT Standard Specifications
AASHTO T 11
ASTM C 117



Apparatus

- Balance
- Sieves
- Container
- Oven
- Wetting Agent

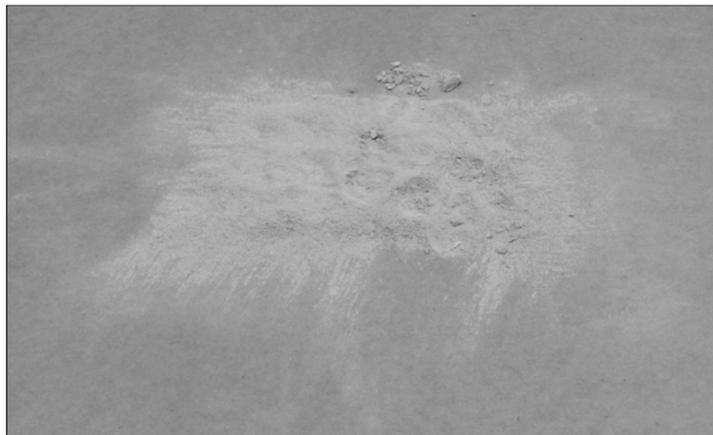
Sample Size

Nominal Maximum Size ^A	Minimum Mass, g
4.75 mm (No. 4) or smaller	300
Greater than 4.75 mm (No. 4) to 9.5 mm (3/8 in.)	1000
Greater than 9.5 mm (3/8 in.) to 19.0 mm (3/4 in.)	2500
Greater than 19.0 mm (3/4 in.)	5000

^A Based on sieve sizes meeting Specification E11.

Concrete Plant Quality Control Technician Course, Grade 2

Minus 200 Material



Concrete Plant Quality Control Technician Course, Grade 2

Dry the Material

- Dry the aggregate to a constant mass in an oven at $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$)
- Allow the material to cool



Concrete Plant Quality Control Technician Course, Grade 2

Determine the Sample Mass

- Weigh the sample to the nearest 0.1 of a unit of the original sample mass



Concrete Plant Quality Control Technician Course, Grade 2

Two Procedures

Procedure A - Washing with plain water

- Dust of Fracture



Procedure B - Washing using a wetting agent

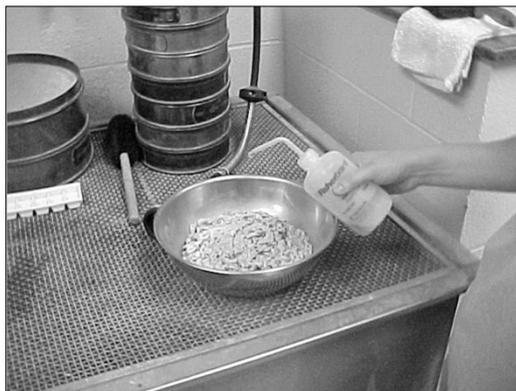
- Clay Particles



Concrete Plant Quality Control Technician Course, Grade 2

Procedure

- Place the sample in the container
- Add water to cover the sample
- Add wetting agent if performing Procedure B



Concrete Plant Quality Control Technician Course, Grade 2

Procedure

- Agitate the sample
- Use a spoon to stir, if desired
- Ensure complete separation of particles



Concrete Plant Quality Control Technician Course, Grade 2

Procedure

- Pour the wash water with suspended solids over the nested sieves



Concrete Plant Quality Control Technician Course, Grade 2

Procedure

- Repeat the washing with plain water
- Repeat until wash water is clear
- Use wetting agent first wash only



Concrete Plant Quality Control Technician Course, Grade 2

Dry the Material

- Dry the aggregate to a constant mass in an oven at $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$)
- Allow the material to cool



Concrete Plant Quality Control Technician Course, Grade 2

Determine the Sample Mass

- Weigh the sample to the nearest 0.1 of a unit of the original sample mass



Concrete Plant Quality Control Technician Course, Grade 2

Calculations

$$P_{\leq 75 \mu m} = \frac{M_{Dry, Before} - M_{Dry, After}}{M_{Dry, Before}} \times 100$$

$$A = \frac{B - C}{B} \times 100$$

Concrete Plant Quality Control Technician Course, Grade 2

Results

- If the amount of material finer than 75- μm is less than 10% then report the results to the nearest 0.1.
- If the amount of material finer than 75- μm is greater than 10% then report the results to the nearest whole number.

Concrete Plant Quality Control Technician Course, Grade 2

Problem

Given:

- Original mass of the sample = 595.6 g
- Mass of the sample after washing = 579.3 g

Determine:

- The percent (P) of material finer than the No. 200 sieve in the sample.

Concrete Plant Quality Control Technician Course, Grade 2

Solution

$$P_{\leq 75 \mu m} = \frac{595.6 - 579.3}{595.6} \times 100 = 2.737 \approx \underline{2.7\%}$$

Concrete Plant Quality Control Technician Course, Grade 2

Practice

Given:

- Original mass of the sample = 6895.5 g
- Mass of the sample after washing = 6045.0 g

Determine:

- The percent (P) of material finer than the No. 200 sieve in the sample

Concrete Plant Quality Control Technician Course, Grade 2

Solution

$$P_{\leq 75 \mu m} = \frac{6895.5 - 6045.0}{6895.5} \times 100 = 12.33 \approx \underline{12\%}$$

Concrete Plant Quality Control Technician Course, Grade 2



6

Sieve Analysis of Fine and Coarse Aggregates

AASHTO T 27

ASTM C 136

TDOT Standard Method of Test for
Sieve Analysis of Fine and Coarse Aggregates

References



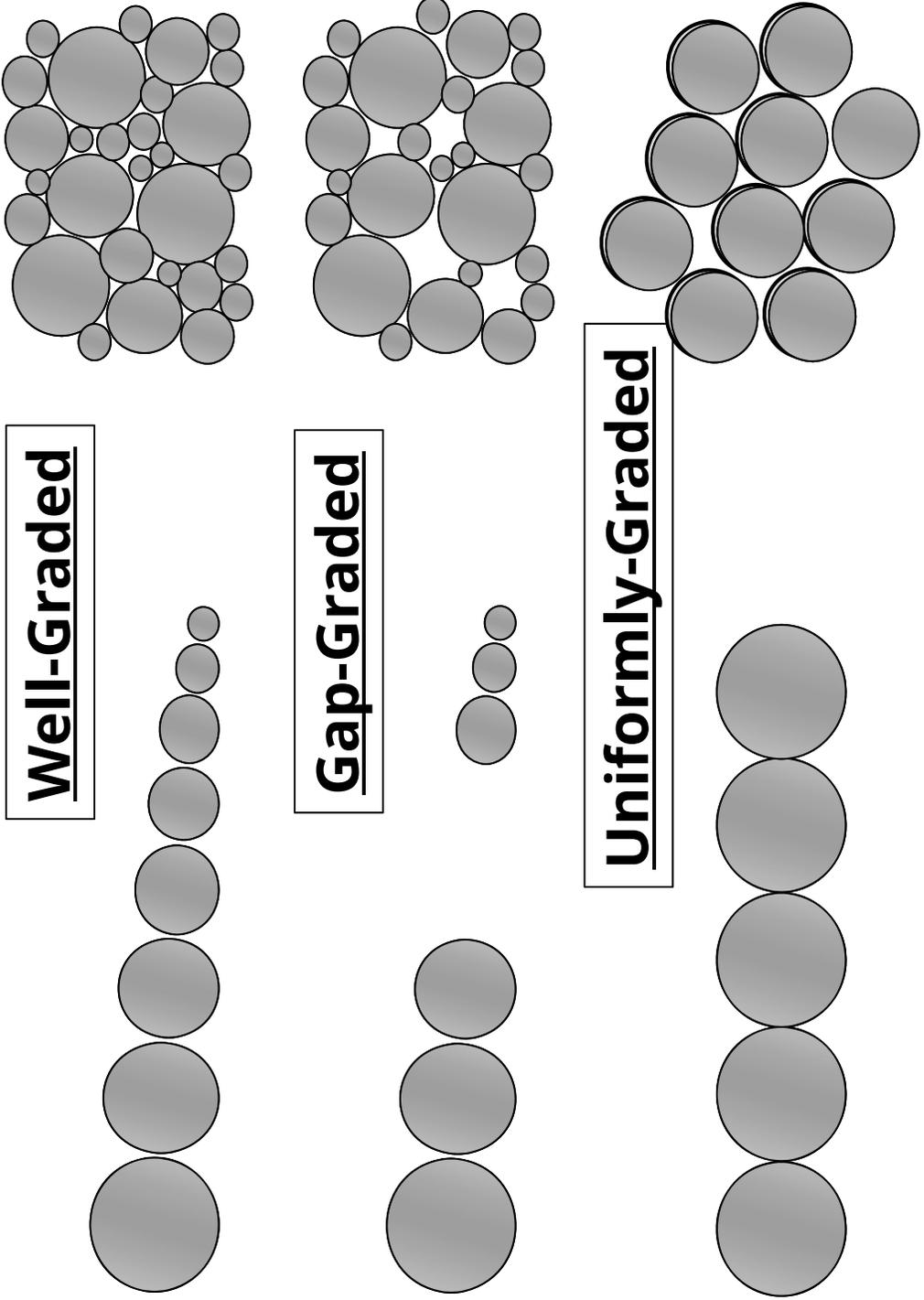
TDOT Standard Specifications
AASHTO T 27
ASTM C 136



Apparatus

- **Balance**
- **Oven**
- **Sieves**
- **Mechanical Shaker**

Aggregate Gradation



Field Sample Size



TABLE 1 Minimum Size of Field Samples

Aggregate Size ^A	Field Sample Mass, min, kg ^B [lb]	Field Sample Volume, min, L [gal]
	Fine Aggregate	
2.36 mm [No. 8]	10 [22]	8 [2]
4.75 mm [No. 4]	10 [22]	8 [2]
	Coarse Aggregate	
9.5 mm [$\frac{3}{8}$ in.]	10 [22]	8 [2]
12.5 mm [$\frac{1}{2}$ in.]	15 [35]	12 [3]
19.0 mm [$\frac{3}{4}$ in.]	25 [55]	20 [5]
25.0 mm [1 in.]	50 [110]	40 [10]
37.5 mm [$1\frac{1}{2}$ in.]	75 [165]	60 [15]
50 mm [2 in.]	100 [220]	80 [21]
63 mm [$2\frac{1}{2}$ in.]	125 [275]	100 [26]
75 mm [3 in.]	150 [330]	120 [32]
90 mm [$3\frac{1}{2}$ in.]	175 [385]	140 [37]

Test Sample Size

7.4 *Coarse Aggregate*—The size of the test sample of coarse aggregate shall conform with the following:

Nominal Maximum Size, Square Openings, mm (in.)	Test Sample Size, min, kg (lb)
9.5 (3/8)	1 (2)
12.5 (1/2)	2 (4)
19.0 (3/4)	5 (11)
25.0 (1)	10 (22)
37.5 (1 1/2)	15 (33)
50 (2)	20 (44)
63 (2 1/2)	35 (77)
75 (3)	60 (130)
90 (3 1/2)	100 (220)

Dry the Material

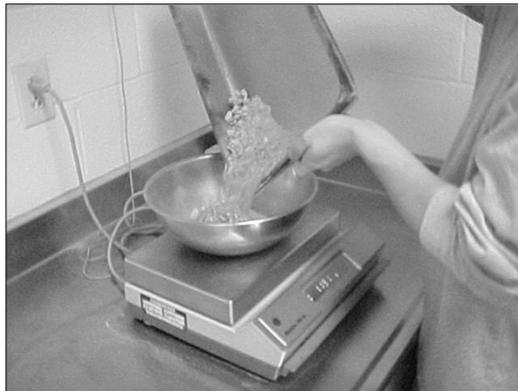
- Dry the aggregate to a constant mass in an oven at $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$)
- Allow the material to cool



Concrete Plant Quality Control Technician Course, Grade 2

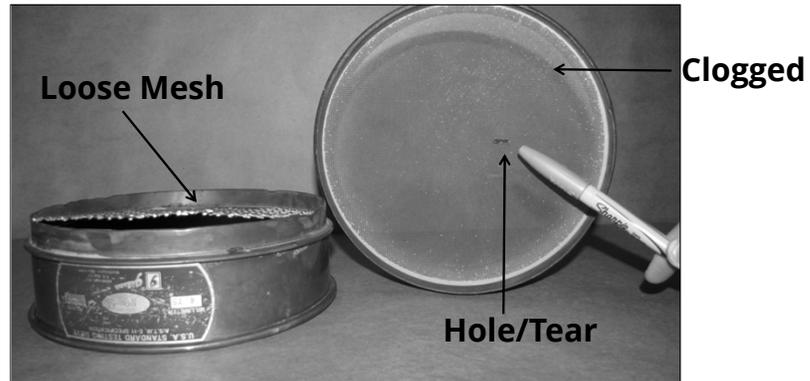
Determine the Sample Mass

- Weigh the sample to the nearest 0.1 of a unit of the original sample mass



Concrete Plant Quality Control Technician Course, Grade 2

Sieves



Concrete Plant Quality Control Technician Course, Grade 2

Mechanical Shaker

- Use a mechanical shaker to agitate the sieves



Concrete Plant Quality Control Technician Course, Grade 2

Weighing

- Weigh the sample to the nearest 0.1 of a unit of the original sample mass



Concrete Plant Quality Control Technician Course, Grade 2

Overloaded Sieve



Options for Overloading

- Use larger sieve
- Portion the sample
- Place another sieve in the nest

Concrete Plant Quality Control Technician Course, Grade 2

Maximum Loading of Sieves

TABLE 1 Maximum Allowable Quantity of Material Retained on a Sieve, kg

Sieve Opening Size, mm	Nominal Dimensions of Sieve ^A					
	203.2-mm dia ^B	254-mm dia ^B	304.8-mm dia ^B	350 by 350 mm	372 by 580 mm	
	0.0285	0.0457	0.0670	0.1225	0.2158	
	Sieving Area, m ²					
125	C	C	C	C	C	67.4
100	C	C	C	C	C	53.9
90	C	C	15.1	27.6	C	48.5
75	C	8.6	12.6	23.0	C	40.5
63	C	7.2	10.6	19.3	C	34.0
50	3.6	5.7	8.4	15.3	C	27.0
37.5	2.7	4.3	6.3	11.5	C	20.2
25.0	1.8	2.9	4.2	7.7	C	13.5
19.0	1.4	2.2	3.2	5.8	C	10.2
12.5	0.89	1.4	2.1	3.8	C	6.7
9.5	0.67	1.1	1.6	2.9	C	5.1
4.75	0.33	0.54	0.80	1.5	C	2.6

^A Sieve frame dimensions in inch units: 8.0-in. diameter; 10.0-in. diameter, 12.0-in. diameter; 13.8 by 13.8 in. (14 by 14 in. nominal); 14.6 by 22.8 in. (16 by 24 in. nominal).

^B The sieve area for round sieve frames is based on an effective diameter 12.7 mm (½ in.) less than the nominal frame diameter, because Specification E11 permits the sealer between the sieve cloth and the frame to extend 6.35 mm (¼ in.) over the sieve cloth. Thus the effective sieving diameter for a 203.2-mm (8.0-in.) diameter sieve frame is 190.5 mm (7.5 in.). Sieves produced by some manufacturers do not infringe on the sieve cloth by the full 6.35 mm (¼ in.).

^C Sieves indicated have less than five full openings and should not be used for sieve testing except as provided in 8.6.

Sample Problem #1

Original Sample Mass (g)	507.8	
Sieve Size or Designation	Individual Weight Retained (g)	
4.75 mm No. 4	0.0	
2.36 mm No. 8	51.0	
1.18 mm No. 16	98.0	
600 um No. 30	106.0	
300 um No. 50	117.0	
150 um No. 100	95.0	
75 um No. 200	29.0	
< 75 um	11.0	
Total		

Sample Problem #1

Original Sample Mass (g)	507.8
Sieve Size or Designation	Individual Weight Retained (g)
4.75 mm No. 4	0.0
2.36 mm No. 8	51.0
1.18 mm No. 16	98.0
600 um No. 30	106.0
300 um No. 50	117.0
150 um No. 100	95.0
75 um No. 200	29.0
< 75 um	11.0
Total	507.0

$$\text{AASHTO Loss} = \frac{\text{Original Sample Mass} - \text{Sum of Individual Wt.}}{\text{Original Sample Mass}} \times 100$$

$$\text{AASHTO Loss} = \frac{507.8 - 507.0}{507.8} \times 100$$

✓ AASHTO Loss = 0.16% ≤ 0.3%

Sample Problem # 1

Original Sample	507.8
-----------------	-------

Sieve Size or Designation	Individual Weight Retained (g)	Individual Percent Retained	Cumulative Percent Retained	Cumulative Percent Passing
4.75 mm	0.0	0.0	0.0	100.0
2.36 mm	51.0			
1.18 mm	98.0			
600 um	106.0			
300 um	117.0			
150 um	95.0			
75 um	29.0			
< 75 um	11.0			

Sample Problem # 1

Original Sample	507.8
-----------------	-------

Sieve Size or Designation	Individual Weight Retained (g)	Individual Percent Retained	Cumulative Percent Retained	Cumulative Percent Passing
4.75 mm	0.0	0.0	0.0	100.0
2.36 mm	51.0	10.0	10.0	90.0
1.18 mm	98.0	19.3	29.3	70.7
600 um	106.0	20.9	50.2	49.8
300 um	117.0	23.0	73.3	26.7
150 um	95.0	18.7	92.0	8.0
75 um	29.0	5.7	97.7	2.3
< 75 um	11.0	2.2	99.8	0.2

Fineness Modulus

Sieve	Cumulative Percent Retained
3 in	
1 1/2 in	
3/4 in	
3/8 in	
No. 4	
No. 8	
No. 16	
No. 30	
No. 50	
No. 100	
Total	
FM	

Fineness Modulus

Sieve	Cumulative Percent Retained
3 in	0.0
1 1/2 in	0.0
3/4 in	0.0
3/8 in	0.0
No. 4	0.0
No. 8	10.0
No. 16	29.3
No. 30	50.2
No. 50	73.3
No. 100	92.0
Total	254.82
FM	2.55

Sample Problem #2

Original Sample Mass (g)	91.2	
Sieve Size or Designation	Individual Weight Retained (g)	
75 mm	3 in	0.0
50 mm	2 in	0.0
37.5 mm	1 1/2 in	6.0
25 mm	1 in	20.0
19 mm	3/4 in	16.0
12.5 mm	1/2 in	13.0
9.5 mm	3/8 in	28.0
4.75 mm	No. 4	8.0
< 4.75 mm	< No. 4	0.0
Total		

Sample Problem #2

Original Sample Mass (g)	91.2	
Sieve Size or Designation	Individual Weight Retained (g)	
75 mm	3 in	0.0
50 mm	2 in	0.0
37.5 mm	1 1/2 in	6.0
25 mm	1 in	20.0
19 mm	3/4 in	16.0
12.5 mm	1/2 in	13.0
9.5 mm	3/8 in	28.0
4.75 mm	No. 4	8.0
< 4.75 mm	< No. 4	0.0
Total		91.0

$$\text{AASHTO Loss} = \frac{\text{Original Sample Mass} - \text{Sum of Individual Weights}}{\text{Original Sample Mass}} \times 100$$

$$\text{AASHTO Loss} = \frac{91.2 - 91.0}{91.2} \times 100$$

✓ **AASHTO Loss = 0.22% ≤ 0.3%**

Sample Problem # 2

Original Sample	91.2
-----------------	------

Sieve Size or Designation	Individual Weight Retained	Individual Percent Retained	Cumulative Percent Retained	Cumulative Percent Passing
75 mm	0.0	0.0	0.0	100.0
50 mm	0.0	0.0	0.0	100.0
37.5 mm	6.0			
25 mm	20.0			
19 mm	16.0			
12.5 mm	13.0			
9.5 mm	28.0			
4.75 mm	8.0			
< 4.75 mm	0.0			

Sample Problem # 2

Original Sample	91.2
-----------------	------

Sieve Size or Designation	Individual Weight Retained	Individual Percent Retained	Cumulative Percent Retained	Cumulative Percent Passing
75 mm	0.0	0.0	0.0	100.0
50 mm	0.0	0.0	0.0	100.0
37.5 mm	6.0	6.6	6.6	93.4
25 mm	20.0	21.9	28.5	71.5
19 mm	16.0	17.5	46.0	54.0
12.5 mm	13.0	14.3	60.3	39.7
9.5 mm	28.0	30.7	91.0	9.0
4.75 mm	8.0	8.8	99.8	0.2
< 4.75 mm	0.0	0.0	99.8	0.2

Fineness Modulus

Sieve	Cumulative Percent Retained
3 in	
1 1/2 in	
3/4 in	
3/8 in	
No. 4	
No. 8	
No. 16	
No. 30	
No. 50	
No. 100	
Total	
FM	

Fineness Modulus

Sieve	Cumulative Percent Retained
3 in	0.0
1 1/2 in	6.6
3/4 in	46.0
3/8 in	91.0
No. 4	99.8
No. 8	99.8
No. 16	99.8
No. 30	99.8
No. 50	99.8
No. 100	99.8
Total	742.34
FM	7.42



7

Quality Assurance / Quality Control

TDOT Standard Method of Test for
Quality Assurance / Quality Control

References

TDOT Standard Specifications
Standard Operating Procedures (SOP)
FHWA Publication Np. HIF-07-004

QA / QC

- **Quality Assurance (QA)**
A set of activities conducted by the owner to insure that the product delivered complies with the specifications
- **Quality Control (QC)**
A set of activities conducted by the contractor to monitor the process to insure that the concrete will meet or exceed the QA test requirements



Quality Assurance

- Associated with Acceptance
- Performed by TDOT or TDOT representative
- Example : Air Content, Slump, & Compressive Strength



Concrete Plant Quality Control Technician Course, Grade 2

Quality Control

AASHTO states:

“The sum total of activities performed by the seller to make sure that a product meets contract specifications”.



Concrete Plant Quality Control Technician Course, Grade 2

Q/C Program

- **Training**
- **Preliminary material testing**
- **Equipment and process monitoring**
- **Testing of concrete and individual materials during trial batching and production**
- **Analysis of QC test results and process monitoring**
- **Minimum requirements are listed in Batch Plant Process Control Plan (Page 82)**

Concrete Plant Quality Control Technician Course, Grade 2

Testing

- **All personnel involved with QA and QC should receive proper training**
- **TDOT requires Concrete Field Testing Technician and Concrete Plant Quality Control Technician certification**
- **All certified technicians should be listed on the Concrete Certified Technicians Form (Page 111)**

Concrete Plant Quality Control Technician Course, Grade 2

Record Keeping

- **Concrete Plant Records Minimum Requirements (Page 81)**
- **Proper documentation is a key factor for interpreting data, making informed decisions, and troubleshooting problems that may arise**
- **Elements : Clear / Consistent labeling, accurate sample locations, and an organized filing system**
- **The batch plant must be continuously monitored and regularly calibrated**

Concrete Plant Quality Control Technician Course, Grade 2

Batching Tolerance

- **Standard Specifications 501.09**
- **Aggregate : 1.5% of the required weight**
- **Cementitious Materials : no less than 1% nor no more than 4% of the required weight**
- **Water : accuracy of measuring the water shall be within a range of error of not over 1%**



Concrete Plant Quality Control Technician Course, Grade 2

Temperature



- **High Temperature :**
 - Increased water demand to maintain workability
 - Decrease set time
 - Increase danger of plastic and early-age shrinkage cracking
 - Reduction in air void system effectiveness
 - Lower ultimate strength
- **Options for lowering temperature of concrete**
 - Cool aggregate by shading stockpile and sprinkling with water
 - Chill mixing water or use ice
- **Standard Specification 604.11: The temperature of the concrete at point of discharge shall not exceed 90°F**

Concrete Plant Quality Control Technician Course, Grade 2

Temperature

- **Low Temperature:**
 - Reduced early strength
 - Freezing of concrete before it sets
 - Reduced rate of hydration, thus shrinkage cracking and changing the saw-cutting window
- **Options:**
 - Heat aggregate
 - Heat mixing water
- **Standard Specifications 501.11**
 - Pour if temperature is 35° and rising
 - Do Not Pour if 40° and falling



Concrete Plant Quality Control Technician Course, Grade 2

Air Content

- Achieving the target air content and air void system is one of the most challenging aspects of controlling concrete mixtures
- Factors
 - Ingredients
 - Temperature
 - Mixing time
 - Batching sequence
 - Slump
 - Admixture Interaction
 - Haul Time
 - Vibrations



Concrete Plant Quality Control Technician Course, Grade 2

Additional TDOT Forms

- Process Control Inspection (Page 78)
- Placement Site Process Control Plan (Page 84)
- Concrete Delivery Ticket- (Page 90)
 - TDOT Standard Specification 501.03 B. & 604.03 B.
- Concrete Truck Check List (Page 103)
- Materials List (Page 112)

Concrete Plant Quality Control Technician Course, Grade 2

Process Control – Truck Counter



Concrete Plant Quality Control Technician Course, Grade 2

Process Control – Water Meter



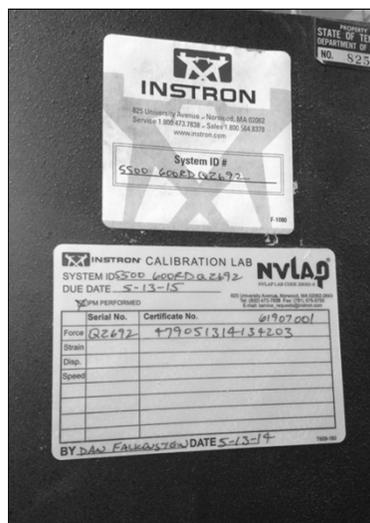
Concrete Plant Quality Control Technician Course, Grade 2

Process Control – Aggregate Separation

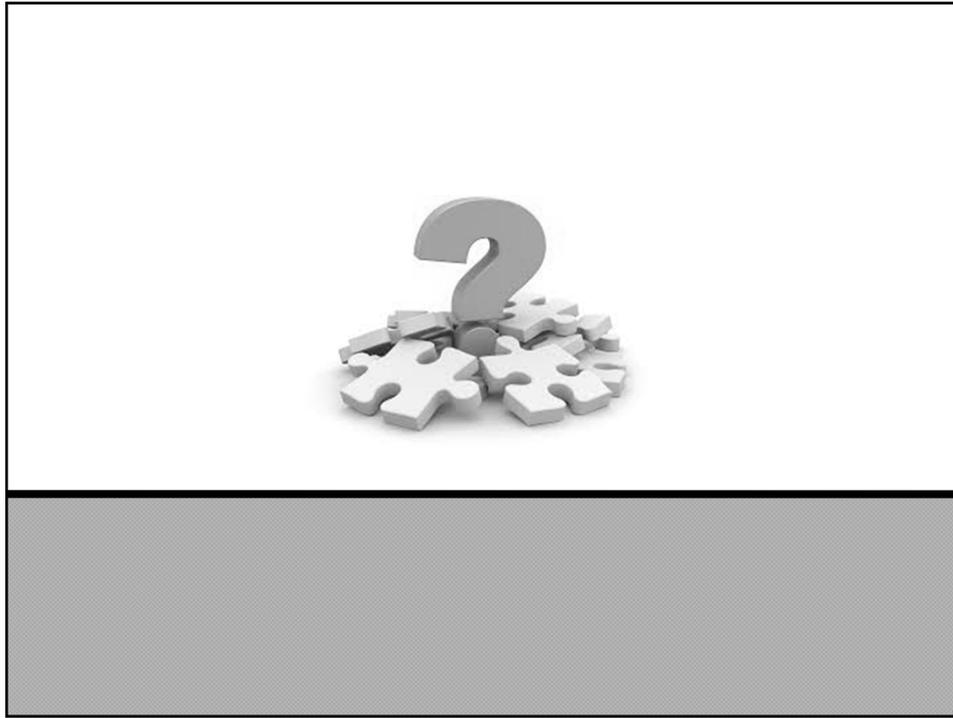


Concrete Plant Quality Control Technician Course, Grade 2

Process Control – Scale Calibrations



Concrete Plant Quality Control Technician Course, Grade 2



Appendix

Concrete Plant Quality Control Technician Course

Tennessee Department of Transportation

Volume 3.1

Table of Contents

Appendix

- Inspection of Process Control Concrete Plant or Bridge Deck.....78
- Concrete Plant Records.....81
- Annual Batch Plant Concrete Process Control Plan Part 1 of 2.....82
- Placement Site Concrete Process Control Plan Part 2 of 2.....84
- Contractor’s Daily Report of Concrete Inspection (Form DT-0311).....86
- Portland Cement Concrete Bridge Deck Pour (Form DT-0311 Attachment A).....87
- Daily Report of Cement Concrete Paving (Form DT-0292).....88
- Concrete Cylinder/Core Test Report.....89
- Concrete Delivery Ticket (Form DT-1756).....90
- Ready-Mix Concrete Producer Comment Form.....91
- Truck Weight Limits Circular Letter.....92
- Example of Truck Weight Limits Calculation.....102
- Concrete Truck Inspection Checklist.....103
- Bridge Deck Construction Checklist Circular Letter.....104
- Certified Technicians.....111
- Concrete Constituent Materials.....112
- Contractor Material Certification and/or Sampling & Testing Record (Form DT-0044).....113

**INSPECTION OF PROCESS CONTROL
CONCRETE PLANT OR BRIDGE DECK POUR**

Date:	
Producer:	
Plant:	
Region:	
HQ M&T Inspector:	
Regional M&T Representative:	
Plant Representative:	
For Deck Pours:	
Contract:	
Contractor:	
Project Manager:	
Engineer:	
Regional Inspector:	
Additional Remarks (<i>major deficiencies, scheduled follow-up visits, etc.</i>):	

CONCRETE PLANT QUALITY CONTROL INSPECTION CHECKLIST

INSPECTION ITEM	YES	NO	COMMENTS
Is the process control plan posted in plain view at the plant?			
Does the Process Control include all TDOT or ACI qualified Concrete Class 2 or higher technicians employed by the concrete supplier that may be responsible for any concrete testing, plant operations or any changes involving concrete mixing?			
Is a copy of the Concrete Class 2 or Class 3 certification for these personnel posted on the wall or available upon request?			
Does the concrete producer have an approved concrete design for the type of concrete being produced?			
Are gradations on fine and coarse aggregate being run according to the recommended (weekly or minimum 500 C.Y. for bridge decks & other) (1,500 C.Y. for roadway paving), including fineness modulus tests and recorded in the files at the concrete plant location?			
Are weight checks of aggregate, cement, fly-ash, water, and admixtures being recorded and placed in the files?			
Are moisture checks and calculations being made on stockpiles before any batching of concrete? These checks can be made by the use of moisture probes or other. At least, one (1) check shall be made in the AM and one (1) in the PM. Are the checks being made and is this information being recorded?			
Have scale checks been made on the aggregate and cement scales with a TDOT representative present? Have the scale checks been recorded and posted at the plant?			
Are the aggregate stockpiles being kept cool on hot days and warm on cold days by some approved method?			
Is there a qualified technician at the plant to do QC testing as concrete is being batched?			
Are calculated corrections recorded for adjustments made when water is withheld or added on the delivery ticket? (ice should also be shown in adjustments)			
Do all the batch tickets reflect the adjustments to the concrete mixture at the plant such as added water, ice, admixtures and etc?			
Is the initial slump, air, and temperature tests being performed from the first concrete delivery truck for a particular pour and is this information being recorded?			
Is the plant keeping records of any and all adjustments made to the concrete at the plant such as adding ice?			
Is a list posted at the plant of approved concrete trucks? (The list shall be in a conspicuous location and kept up-dated for accuracy). (A copy of this list shall be sent to Regional M & T every 6 months).			
Has TDOT M & T checked the concrete lab this year and is the completed plant check posted in a conspicuous place that indicates the plant meets the specifications meets all lab requirements and is an approved concrete supplier?			
Does the concrete supplier keep a record of all tests and inspections performed at the plant by QC personnel?			

Are the records kept in order, current, and readily available at the concrete plant for review at any time by TDOT personnel and/or FHWA representatives?			
Is the wash water being dumped from all trucks before batching operations begin?			
Are the aggregate stockpiles separated in an approved fashion and uncontaminated?			
You are being asked to observe a concrete truck being loaded to send to a TDOT project. Does the concrete truck have a working revolution counter? Does the concrete truck have a manufacturers' identification plate? Does the concrete truck have a working water meter?			
Are records of delivery tickets of all materials such as coarse and fine aggregates, cement, fly-ash and all other admixtures and additives used for state projects kept in the plant files until the project is complete?			
Is it raining too hard to continue batching concrete?			
Is it too hot or cold to be batching concrete?			
Are the admixtures being introduced into the concrete trucks at the correct time and in the correct dosage?			
Is the slump of the concrete within specifications and being checked before any High Range Water Reducer (or super-plasticizer) is being added?			
Do the concrete trucks have the tare, maximum interstate, and maximum non-interstate weight limits marked on the driver's side of the truck and visible at a distance of 50 feet (a minimum of 2-inch lettering is recommended)?			
Is there any "Completed Projects" documentation left in the Concrete Supplier's files that has not been picked up by the Project Supervisor or his representative for incorporation into the project final records for those "Completed Projects"?			

CONCRETE PLANT RECORDS

MINIMUM REQUIREMENTS

1. The contractor/material supplier shall keep a **record of all tests and inspections performed** at the plant by QC personnel. The records shall be kept current and shall be readily available at the concrete plant for review at any time by TDOT personnel and/or FHWA representatives. It is required that a file cabinet or other suitable filing system be maintained at the concrete plant with this information and documentation.
2. **A process control plan shall be posted** in plain view at the plant location. This process control shall include all TDOT or ACI qualified Concrete Class 2 or higher technicians employed by the concrete supplier that may be responsible for any concrete testing, plant operations or any changes involving concrete mixing. A copy of the Concrete Class 2 or 3 certification for these personnel should be available upon request at the plant.
3. **Gradations on fine and coarse aggregate (including fineness modulus tests)** shall be maintained in a file at the concrete plant location. According to the minimum requirements of the specifications a gradation must be run weekly or every 1500 C.Y. for 501 Items and every 500 C.Y. for 604 Items.
4. **Checks on accurate weightings** of aggregates, cement, fly-ash, water and admixtures shall be maintained in the records at the plant site. Scales shall be inspected and checked as often as the Engineer may deem necessary to assure their continued accuracy. The scale checks must be recorded and documentation of this shall be retained in the project files at the plant.
5. **Moisture checks and calculations** shall be made on stockpiles before any batching of materials. These checks can be made by the use of moisture probes or other means but this information must be recorded and the documentation retained in the project files at the plant. At least, one (1) check shall be made in the A.M. and one (1) check in the P.M.
6. **Calculated corrections or adjustments made for water withheld or added** shall be recorded. If ice is used, the calculations shall reflect this adjustment in the batching information. All batch tickets must reflect these adjustments also. Retain documentation of these adjustments in the plant files.
7. **An initial slump, air and temperature of the concrete** shall be made from the first truck to be loaded out for delivery to the job-site. If a deck pour is involved, the first three (3) loads should be checked to ensure each load complies or it may be rejected at the job-site for failure to meet specifications (refer to SOP 4-1). Also, the slump before the addition of the HRWRA or MRWRA shall be 3 inches maximum. Any check for slump shall be more than a visual check. An actual slump tests shall be performed. Random checks on the slump, air and temperature shall continue throughout all concrete pours and be documented. Documentation of this information shall be retained at the plant.
8. Keep **records of delivery tickets** of all materials such as coarse and fine aggregates, cement, fly-ash and all other admixtures and additives used for state projects at the plant site.
9. **Record any and all adjustments made to the concrete at the plant.** These records will be maintained at the plant site and given to the Project Supervisor at the conclusion of the project along with a letter stating the concrete incorporated into the work meets the requirements of the specifications as outlined in Section 501 or 604, whichever is applicable. It shall be the responsibility of the project supervisor to collect this documentation and records at the conclusion of the project.
10. **Truck checks** are to be made on a periodic basis, checking for the blade wear, working revolutions counters, identification plates and water meters. A copy of these checks must be sent to the Regional Materials & Tests office at least every six (6) months or whenever trucks are added or taken away from the fleet. Trucks not shown on the updated list are not to be used on a state project. Post a copy of the active list of approved trucks in a conspicuous place at the concrete plant. Retain historical records of these periodic truck checks in the files at the plant.
11. **A completed plant check by TDOT Materials & Tests** shall be posted in a conspicuous place that indicates the plant meets the specification requirements and is an approved material supplier for concrete.

ANNUAL BATCH PLANT CONCRETE PROCESS CONTROL PLAN PART 1 OF 2

DATE: _____

READY MIX CONCRETE COMPANY: _____

READY MIX COMPANY LOCATION: _____

<i>All qualified TDOT Level 2 or higher qualified Concrete Technicians shall be listed in this section or on attached sheets. Include every technician that will be working on this project and update as needed.</i>	NAME:	CERT.#
	NAME:	CERT.#
	NAME:	CERT.#
	NAME:	CERT.#

We hereby propose to utilize the below listed process controls to insure that the concrete delivered to the above referenced project meets Tennessee Department of Transportation Specifications. If approved, this plan will be posted at the concrete plant along with approved mix designs for each particular project.

The following Sampling, Testing, and Inspections will be performed by T.D.O.T. Certified Plant Technicians.

- 1.) Tests to determine aggregate gradations (AASHTO T-27 with T-11 when required) will be performed prior to any batching and then a minimum of once per week or every 500 C.Y. for each source of aggregate utilized for this project. *Perform fineness modulus test on fine aggregate per AASHTO M-6 with each gradation.*
- 2.) Stockpiles will be checked daily to insure that they are being maintained in an uncontaminated and unsegregated manner. Current aggregate quality reports shall be kept on file at the plant.
- 3.) Calibration of weighing systems for aggregates, cement, fly ash, water meters, and admixture dispensing systems will be performed at the beginning of the project, then every month or as conditions warrant. Scale checks may be performed by a Certified Scale Company at a minimum interval of six (6) months.
- 4.) Assurance of accurate weighing, proper metering, and mixing of all materials and the quality of water will be verified daily.
- 5.) Mixing trucks and/or equipment, counters, concrete build - up in drums, blade wear, water gauges, etc. will be checked at the beginning of each project and randomly thereafter. Transport trucks shall be checked and approved by Tennessee Department of Transportation before use. The Producer shall update the concrete truck checklist every six (6) months and distribute to Regional Materials and Tests.

- 6.) Adjustment of mix proportions due to the moisture content of both fine and course aggregates will be performed prior to initial daily mixing and again in the afternoon if operations are continuous through AM and PM hours of the day. Moisture determination will be in accordance with AASHTO-T255. Moisture Probes may be utilized but must be correlated and verified with a dry moisture check weekly.
- 7.) Slump (AASHTO T119), air entrainment (AASHTO T-152 - AASHTO T-196 for concrete containing light weight aggregates) and ambient air and mix temperatures shall be checked for specifications compliance on the initial load and randomly thereafter for each day's run. Air loss during transport shall be determined on initial loads and randomly verified thereafter.
- 8.) If Class "D" Concrete is included in the plans, SOP 4-1 is applicable. The Producer/Contractor shall check slump and air at the plant initially and randomly throughout pour to assure that the requirements are met.
- 9.) An approved report will be furnished daily to the project supervisor showing all pertinent information. Records of tests and inspections that are project specific and not included on the daily reports are to be maintained and submitted to the project supervisor upon project completion. Documents that are plant and lab specific shall be maintained at the plant systematically.
- 10.) *An approved delivery ticket will accompany each load sent to the project. All information including actual batch weights of each component identified as well as other information in the Standard Specification shall be identified on the delivery ticket.*

The above scheduled frequencies of testing are a minimum. Should problems become evident, they will be increased as the conditions require.

Sign Name: _____
Representative Concrete Supplier

Print Name: _____
Representative Concrete Supplier

PLACEMENT SITE CONCRETE PROCESS CONTROL PLAN PART 2 OF 2

DATE: _____

CONTRACT NO: _____

PROJECT NO: _____

REFERENCE NO: _____

COUNTY: _____

CONTRACTOR: _____

READY MIX COMPANY AND LOCATION: _____

PRIME CONTRACTOR: _____

<i>All qualified Field Technician or higher qualified Concrete Technicians shall be listed in this section or on attached sheets. Include every technician that will be working on this project and update as needed.</i>	NAME:	CERT.#
	NAME:	CERT.#
	NAME:	CERT.#
	NAME:	CERT.#

We hereby propose to utilize the below listed process controls to insure that the concrete incorporated in the work on the above referenced project meets Tennessee Department of Transportation's specifications. If approved, this plan will be posted on the project at a place accessible to all quality control personnel.

Initial concrete loads at the beginning of pours will be checked for specification compliance prior to use. Loads that test out of specification will be rejected. All sampling, testing, and inspections will be performed by ACI or TDOT Certified Personnel.

- 1.) Tests for slump (AASHTO T-119), air and mix temperatures, and air content (AASHTO T-152 / T-196) will **be performed prior to placement** of the first load and for each sample from which early and/or 28 day test cylinders are obtained. For bridge decks, slump, temperatures, and air content tests shall be performed on the first three loads. Thereafter, they shall be conducted at least once every fifty cubic yards (50cy). No concrete shall be placed when the rate of moisture evaporation from the freshly placed concrete exceeds 0.2 lb/ft²/hr as determined by Figure 2.1.5, American Concrete Institute Publication "ACI 305R-89." If data collected during the 24 hours prior to the pour or predictions from the National Weather Service indicate the moisture evaporation rate of 0.2 lb/ft²/hr or more, the pour should be rescheduled or the Contractor shall demonstrate to the satisfaction of the Engineer prior to the pour, that protection can be provided.

- 2.) Early test specimens for Tennessee Department of Transportation compression testing will be cast in accordance with AASHTO T-23. The Contractor shall supply the necessary curing equipment, molds, and wheelbarrow as identified in Standard Specification Subsection 604.03(b) and a temporary storage facility in accordance with Standard Specification Subsection 722.09. The frequency of casting early break cylinders will be as follows:

For Bridge Decks:

Not less than one pair to represent every fifty cubic yards (50cy). See SOP 1-1 and 4-1

For Major Structures:

Contractor shall perform all tests on the first load. At least one pair of cylinders will be made per unit per structure to represent up to 100cy for that unit of pour. See SOP 1-1

For Minor Structures:

Contractor shall perform all tests on the first load. At least one pair of cylinders will be made to represent up to 100cy for that unit of pour. See SOP 1-1

For Small Quantities:

As specified in the Standard Specifications Subsection 604.03 and SOP 1-1.

For Concrete Pavement:

One pair for each 300m³ (400 cy) minimum of 1 pair AM and 1 pair PM. If Class A is used, the frequency shall be as for major structures as listed above.

- 3.) Yield tests will be performed in accordance with AASHTO T-121 initially per mix design, at 240m³ (300cy) intervals and/or during pours exceeding 80m³ (100 cy), and/or one for each bridge deck pour.
- 4.) A Tennessee Department of Transportation approved report will be furnished daily showing all pertinent information (Date, Contract, Item Number(s), Batch Weights, Moisture Corrections, Admixtures, Slump, Air Content, Temperatures, etc.) A delivery ticket shall accompany each load. Information to be included shall be in accordance with Section 604 of the Standard Specifications. Records of tests and inspections performed at both the batch and placement sites will be submitted to the project supervisor upon completion of the project. This submission will also include certification that the concrete incorporated into the work meets Tennessee Department of Transportation specifications.

The above scheduled frequencies of testing are a minimum, should problems become evident, they will be increased as the conditions require.

Sign Name: _____ Print Name: _____
Representative Prime Contractor Representative Prime Contractor

Sign Name: _____ Print Name: _____
Sub-Contractor Sub-Contractor

Item No(s) 501.02
 Report No. 345
 Design No. 02-999

STATE OF TENNESSEE
 DEPARTMENT OF TRANSPORTATION
 DIVISION OF MATERIALS AND TESTS
 6601 CENTENNIAL BLVD.
 NASHVILLE, TENNESSEE 37243-0360



CONTRACTOR'S DAILY REPORT OF CONCRETE INSPECTION
 TO BE DELIVERED TO THE PROJECT WITH THE INITIAL LOAD

SAMPLE

Date 12-Jan-03 Completed by Contractor's Concrete Plant Inspector
 Contract No. 5678
 Proj. Ref. No. SP County Montgomery Region 4 Project 12345-6789-10
 Contractor Wrong Bros. Sub-Contractor Billy Bob
 Ready Mix Co. City Ready Mix Co. Location Clarksville, TN
 Type of Plant Mixer _____ Date Scales Checked: 08-Aug-01
 Transit Mixer Checked for Presence of Water Before Batching: Yes No
 Plant and Trucks Checked (Form T-232): Yes No Date 01-Aug-01
 Approved Process Control Plan: Yes No Date 01-Jul-01
 Daily Stockpile Check Results: Satisfactory Unsatisfactory Aggr. Card No. C.A. 2559
 W.R.A. / Retarder oz. 15 A.E.A. oz. 5.25 F.A. 5669
 W.R.A. / Retarder oz. _____ A.E.A. oz. _____ Total C.Y. Batched 300

Batch Size m ³ (yd ³)	Water gal (L) lbs. (kg)	Cement lbs. (kg)	Fly Ash lbs. (kg)	GGBFS lbs. (kg)	Coarse Aggregate lbs. (kg)	Fine Aggregate lbs. (kg)
Agg. Size / Other Material						
Percent Moisture						
Dry Batch Wts.	<u>30</u>	<u>479</u>	<u>106</u>		<u>1912</u>	<u>1138</u>
Moisture Corrections	<u>6.6</u>				<u>9.56</u>	<u>45.52</u>
Actual Batch Wts.	<u>23.4</u>				<u>1922</u>	<u>1184</u>

Remarks _____

SCREEN ANALYSIS TOTAL PERCENT PASSING SIEVE

Size No.	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#200
CA	<u>100</u>	<u>100</u>	<u>100</u>	<u>89.2</u>	<u>36.1</u>	<u>18.1</u>	<u>3.6</u>	<u>2.8</u>	
Size No.	3/8"	#4	#8	#16	#30	#50	#100	#200	F.M.
FA	<u>100</u>	<u>96.3</u>	<u>88.8</u>	<u>81.8</u>	<u>63.4</u>	<u>9.3</u>	<u>0.5</u>	<u>0.2</u>	<u>2.6</u>

Date Tested: C.A. _____ F.A. _____ Plant Technician _____ Cert. No. _____

DAILY INSPECTION REPORT OF ROADWAY CONCRETE

Completed By Contractor's Q.C. Placement Site Technician from T-2A Information

Locations Used on Project Paved Ditch

Air Temp: High 90 Low 85 Brand or Type of Curing water
 Method of Curing Cyl. _____ Technician Responsible for Cyl. James Williams
 Average Time in Truck 30 min.

Cylinder No.	Station Made	Slump	% Air	Mix Temp.	Age of Test	Cylinder Made By
<u>297, 297A</u>	<u>90+00</u>	<u>3.25</u>	<u>5.1</u>	<u>80</u>	<u>28 days</u>	<u>Jones Bros.</u>

Ticket Numbers _____

Additional Water Required: Roadway (Gals). _____ Requested by: _____

Remarks: _____
 Contractor Technician James Williams Cert. No. 1234

Original to:



**STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360**

SAMPLE

DAILY REPORT OF CEMENT CONCRETE PAVING

This Section To Be Completed By Producer

Section No. 501-01.02 Date 01-Aug-02
Pay Item Contract No. 18-May-03

Report No. 13 County Dickson Region 3

Project Reference No. SP Route No. I-40

Project No. 12345-6789-10

Source of Cement Lonestar Location Cape Girardeau, Missouri

Source of Fly Ash M.R.S. Location Joppa, Illinois

Source of F.A. Ingram Materials Location Clarksville, Tennessee

Source of C.A. Vulcan Materials Location Dickson, Tennessee

	WATER		CEMENT	FLY ASH	F.A.	C.A. SIZE 4	C.A. SIZE 67	C.A. SIZE
	GALS.	LBS.	(LBS.)	(LBS.)	(LBS.)	LBS.	LBS.	LBS.
Specific Gravity	1		3.15	2.67	2.61	2.63	2.63	
Solid Volume Proportions	13.97		7.44	2.91	28.48	21.09	21.11	
Ave. Daily Free Moisture								
Dry Batch Amounts	28	235	395	131	1253	935	935	
Moisture Correction					1344	0.9	0.9	
Actual Batch Amounts	17.08				730	918	918	

Concrete Laid - Sta. 384+73 to Sta. 387+40 Surface Pavement Length 267'

Cross Section _____ Width Variable Right or Left of C/L _____

Bridge - Sta. _____ to Sta. _____ Equation - Sta. _____ =Sta. _____

Extra Width - Sq. Yds. Concrete _____ Cu. Yds. Concrete _____

No. Batches _____ Total Sq. Yds. Concrete 217.1 Total Cu. Yds. Concrete 29-Feb-00

Air Temp.: A.M. 75 P.M. 94

Concrete Temp.: A.M. 90 P.M. _____ Brand A.E.A. Mas. Bld. Cure Type or Brand _____

To Be Completed By Contractor's Q.C. Placement Site Technician from T-2A Information

Ins. Slump	% Air	Spec. No.	Test No.	STATION NO. OF SPECIMENS		CEMENT USED			
				Cylinders		Station to Station		Tons	Truck or Car No.
3	5.2	1175	1	384+73 to 387+40		384+73	387+40		
2.5	5.3	1176	2	384+73 to 387+40		384+73	387+40		
WATER CHANGES				CALCULATED					
				ACTUAL					

Size of Batch in Cu. Yds. 10 % Size No. 4 30 % Size No. 67 30

Design No. 02-1234

Remarks: Inspection Card Nos.: C.A. 3456; F.A. 3457
Contractor: Wright Bros.; Subcontractor: H.M.C; Concrete supplied by IMI.

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor

Signature _____
Title Project Inspector



**STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION**

SAMPLE

**DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360**

CONCRETE CYLINDER/CORE TEST REPORT

Information to be completed by TDOT personnel for cylinders/cores tested for acceptance

Reference No. <u>STP-M-1234(5)</u>	County <u>Davidson</u>	Region <u>3</u>
Project No. <u>01234-5678-90</u>	Contract No. <u>1234</u>	Date <u>12-Jan-03</u>
Contractor Placing Concrete <u>Bob Jones</u>	Volume Poured this Date (m ³ , yd ³) <u>600 cu. yds.</u>	
Daily Report No. <u>5678</u>	Date of Pour <u>30-Jan-03</u>	Requested Age of Test <u>28 days</u>
Concrete Producer <u>Nashville Ready Mix</u>	Location <u>Nashville</u>	
Cyl./Core Numbers <u>45, 45A, 45B</u>	Volume Represented by Cyls/Cores (m ³ , yd ³) <u>402 cu. yds.</u>	
Design Number <u>02 1234</u>	Design Strength <u>3000 psi</u>	Concrete Class <u>A - PCCP</u>
TDOT Supervisor <u>Bill Smith</u>	Date Placed in Wet Curing Environment <u>08-Feb-03</u>	

Item Number	<u>501.01</u>	<u>501.01</u>	<u>604.03.01</u>		
Pay Quantity	<u>150 sq. yds.</u>	<u>150 sq. yds.</u>	<u>368 cu. yds.</u>		
Quantity Delivered	<u>16.67 cu. yds.</u>	<u>16.67 cu. yds.</u>	<u>368 cu. yds.</u>		
Sta. of Cyl./Core	<u>012+3.67</u>	<u>123+4.67</u>	<u>123+4.67</u>		

Description of Pour(s):

Remarks: Partly cloudy, 80 degrees F, 60% RH, winds from NW at 4 mph.

Laboratory Test Data (ASTM C-39, C-511, and C1231)				Field Test Data	
Cylinder No. / Core No.	<u>45</u>	<u>45A</u>	<u>45B</u>	Slump, in. (ASTM C-143)	
Serial No.	<u>12345</u>	<u>67890</u>	<u>98765</u>	Air Temp., °F	
Date Received	<u>31-Jan-03</u>	<u>31-Jan-03</u>	<u>31-Jan-03</u>	Concrete Temp., °F (ASTM C-1064)	
Date Tested	<u>14-Feb-03</u>	<u>14-Feb-03</u>	<u>14-Feb-03</u>	% Air (ASTM C-173, C-231, or C-138)	
Date Reported	<u>15-Feb-03</u>	<u>15-Feb-03</u>	<u>15-Feb-03</u>	Unit Weight (lbs/ft ³) (ASTM C-138)	
Diameter (in)	<u>6</u>	<u>6</u>	<u>6</u>	Performed by/ Cert. No. Contractor Observer/Cert. No.	
Cross-sectional Area (in ²)	<u>28.26</u>	<u>28.26</u>	<u>28.26</u>		
Maximum Load (lbf)	<u>97497</u>	<u>100323</u>	<u>10032</u>		
Compressive Strength (psi)	<u>3450</u>	<u>3550</u>	<u>3550</u>		
Ave. Compressive Strength (psi)	<u>3517</u>				
Type of Fracture	<u>Cone</u>	<u>Cone-Split</u>	<u>Shear</u>		
					
	Cone	Cone and Split	Cone and Shear	Shear	Columnar
Performed by	<u>RPG</u>	<u>RPG</u>	<u>RPG</u>		
Technician Certification No.	<u>2345</u>	<u>2345</u>	<u>2345</u>		

Comments:

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor
Copy to Contractor to accompany shipment of cylinders

Approved by _____
Director of Materials and Tests

Date _____

Contractor: Received by _____ Date _____



CONCRETE DELIVERY TICKET

Date: _____ Ticket # _____
 Contract # _____ County _____ Region _____ Load # _____
 Project # _____ Proj. Ref. # _____
 Conc. Design # _____ Concrete Class: _____ No. Cubic Yards: _____ Actual W/C : _____

		ACTUAL	TARGET ³	TOLERANCE
CEMENT	lbs.			
FLYASH	F <input type="checkbox"/> C <input type="checkbox"/> lbs.			
SLAG	lbs.			
ROCK	lbs.			
SAND	lbs.			
WATER	gal.			

		ACTUAL	TARGET
A.E.A.	oz.		
W.R.A.	oz.		
WATER	oz.		
MISC.	oz.		

Will accept computer generated equivalent

Max. water allowed¹ (Actual) _____ Gallons

Total water² (Plant) _____ Gallons

Max. water allowed (Project) _____ Gallons

Water added (Project) _____ Gallons

No. Rev. @ Mixing Speed (Plant) _____

No. Rev. @ Mixing Speed (Project) _____

Time loaded: _____ Time discharged: _____

Truck No. _____ Loc. Sta. _____

 (Unit of Structure)

 Print Name (Plant Tech)

 Plant Tech Cert. No.

 Plant Tech. Signature

 Print Name (Inspector at delivery point)

 Field Tech Cert. No.
 (TDOT Rep.)

 Inspector Signature

¹ Based on actual cementitious material allowed by design

² Actual used at plant

³ May be adjusted to meet specification requirements.



Ready-Mix Concrete Producer Comment Form

Concrete Producer:

Producer Location:

Contract/Project #:

Contractor:

TDOT/CEI Inspector:

Please leave detailed comments concerning the sampling, handling, testing, or curing of concrete on TDOT projects below and e-mail to jamie.waller@tn.gov. All comments will be reviewed and addressed accordingly.

E-Signed:

Date:

Company:

E-mail address:

CIRCULAR LETTER

SECTION: 109.01 MEASUREMENT OF QUANTITIES
NUMBER: 109.01-02
SUBJECT: TRUCK WEIGHT LIMITS
DATE: JANUARY 1, 2010

The Department now will require that all weight tickets conform to the new limits outlined on these sheets as required by law.

Interstate weight limits shall apply when hauling on any of the following:

- a) Ramps entering or exiting the interstate system.
- b) Any portion of an existing interstate open or previously opened to traffic.
- c) The surface course of a new interstate facility (never opened to public traffic). However, Non-Interstate Highway limits will apply to hauling on the subgrade or base courses of newly constructed interstate widening projects if accessed by non-interstate routes.
- d) New and existing structures **on interstates**.

In consideration of the status of construction, relative to the present federal interstate system, it is considered that the above determinations provide adequate guidance as to the applicability of interstate truck weights.

SECTION I: Non-Interstate Highway

- 1) Two axle truck (one front, one rear)
20,000# each axle
Maximum gross weight = 40,000# *
- 2) Three axle straight (one front, tandem rear)
Front axle = 20,000#
Tandem axle = 34,000#
Maximum gross weight = 54,000# *

Exception: Class 9 tag or zone tag
Maximum gross weight = 66,000# *
- 3) Four axle straight (one front, three rear)
Front axle = 20,000#
Single axle rear = 20,000#
Tandem axle = 34,000#
Maximum gross weight = 74,000# *
- 4) Three axle truck tractor and trailer (one axle front of tractor, one rear of tractor, one rear of trailer)
Front axle = 20,000#
Rear axle Tractor = 20,000#
Rear axle Trailer = 20,000#
Maximum gross weight = 60,000# *
- 5) Four axle truck tractor and trailer (one front of tractor, one rear of tractor, tandem rear of trailer)
Front axle Tractor = 20,000#
Rear axle Tractor = 20,000#
Tandem axle Trailer = 34,000#
Maximum gross weight = 74,000# *
- 6) Four axle truck tractor and trailer (one front of tractor, tandem rear of tractor, one rear of trailer)
Front axle Tractor = 20,000#
Tandem rear Tractor = 34,000#
Single axle Trailer = 20,000#
Maximum gross weight = 74,000# *
- 7) Five axle tractor and trailer (one front of tractor, tandem rear of tractor, tandem rear of trailer)
Maximum gross weight = 80,000# *

* A tolerance of up to 500 pounds will be allowed over the maximum gross weight.

SECTION II: Interstate Highway (Contracts Let On or After October 31, 2008)

Per Section 107.02 of the Standard Specifications, all trucks delivering material (rock, asphalt, concrete, etc.) to construction projects shall display the allowable gross weight for the Interstate System on the side of the truck. The Bridge Formula shall be used to determine Interstate System gross weights as defined below and in the attached Bridge Formula Weights brochure:

Weight Distribution Formula (Bridge Formula)

$$W = 500 \left(\frac{L N}{N-1} + 12N + 36 \right)$$

W = overall gross weight

N = number of axles under consideration

L = distance in feet between extremes of axles under consideration

SECTION III: Interstate Highway (Contracts Let Prior to October 31, 2008)

A. Weight based on axle loadings

- 1) Two axle truck (one front, one rear)

18,000# each axle

Total = 36,000#

- 2) Three axle straight (one front, tandem rear)

Front axle = 18,000#

Tandem rear = 32,000#

Total = 50,000#

- 3) Four axle straight (one front, three rear)

Front axle = 18,000#

Single axle rear = 18,000#

Tandem axle rear = 32,000#

Total = 68,000#

- 4) Three axle truck tractor and trailer (one axle front of tractor, one rear of tractor, one rear of trailer)

Front axle = 18,000#

Rear axle Tractor = 18,000#

Rear axle Trailer = 18,000#

Total = 54,000#

- 5) Four axle truck and trailer (one front of tractor, one rear of tractor, tandem rear of trailer)

Front axle Tractor = 18,000#

Rear axle Tractor = 18,000#

Tandem axle Trailer = 32,000#

Total = 68,000#

6) Four axle truck tractor and trailer (one front of tractor, tandem rear of tractor, one rear of trailer)

Front axle Tractor = 18,000#

Tandem rear Tractor = 32,000#

Single axle Trailer = 18,000#

Total = 68,000#

7) Five axle tractor and trailer (one front of tractor, tandem rear of tractor, tandem rear of trailer)

Total = 73,280#

B. Weight Distribution Formula (Bridge Formula)

$$W = 500 \left(\frac{L N}{N-1} + 12N + 36 \right)$$

W = overall gross weight

N = number of axles under consideration

L = distance in feet between extremes of axles under consideration

The weights shown in Sub-Section A above can be increased if the Weight Distribution Formula is not violated. However, the weights shown in the section for Non-Interstate Highways may not be exceeded on Interstate Highways regardless of the Weight Distribution Formula.

Copy of Bridge Formula Weights brochure is attached.



Bridge Formula Weights

With a few exceptions noted in this pamphlet, the Bridge Formula establishes the maximum weight any set of axles on a motor vehicle may carry on the Interstate highway system. This pamphlet describes the Bridge Formula, why it was established, and how it is used.

What Is It?

Congress enacted the Bridge Formula in 1975 to limit the weight-to-length ratio of a vehicle crossing a bridge. This is accomplished either by spreading weight over additional axles or by increasing the distance between axles.

Compliance with Bridge Formula weight limits is determined by using the following formula:

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$

W = the overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds.

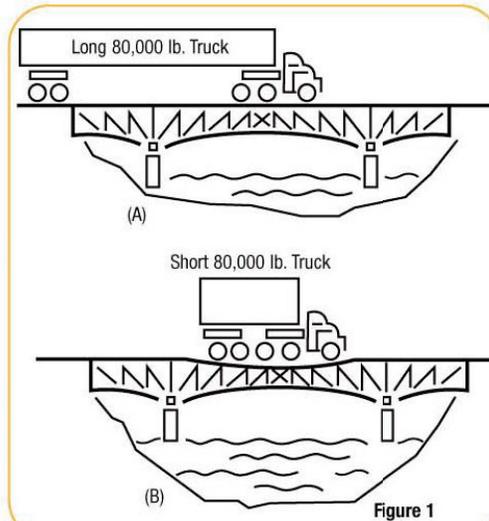
L = the distance in feet between the outer axles of any group of two or more consecutive axles.

N = the number of axles in the group under consideration.

In addition to Bridge Formula weight limits, Federal law states that single axles are limited to 20,000 pounds, and axles closer than 96 inches apart (tandem axles) are limited to 34,000 pounds. Gross vehicle weight is limited to 80,000 pounds (23 U.S.C. 127).

Is the Formula Necessary?

Bridges on the Interstate System highways are designed to support a wide variety of vehicles and their expected loads. As trucks grew heavier in the 1950s and 1960s, something had to



be done to protect bridges. The solution was to link allowable weights to the number and spacing of axles.

Axle spacing is as important as axle weight in designing bridges. In Figure 1A, the stress on bridge members as a longer truck rolls across is much less than that caused by a short vehicle as shown in Figure 1B, even though both trucks have the same total weight and individual axle weights. The weight of the longer vehicle is spread out, while the weight of the shorter vehicle is concentrated on a smaller area.

How Is the Formula Used?

The weight on various axle configurations must be checked to determine compliance with the Bridge Formula. Three definitions are needed to use the Bridge Formula correctly.

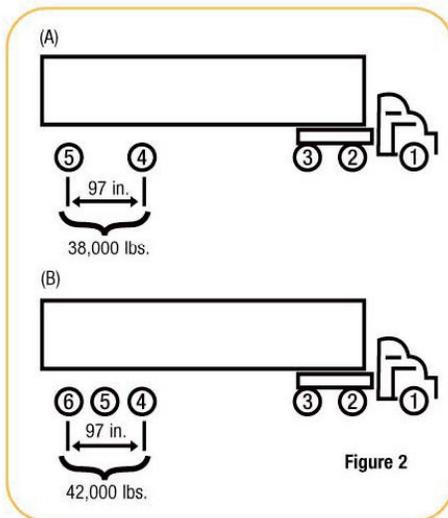
Gross Weight—the weight of a vehicle or vehicle combination and any load thereon. The Federal gross weight limit on the Interstate System is 80,000 pounds unless the Bridge Formula dictates a lower weight limit.

Single-Axle Weight—The total weight on one or more axles whose centers are spaced not more than 40 inches apart. The Federal single-axle weight limit on the Interstate System is 20,000 pounds.

Tandem-Axle Weight—The total weight on two or more consecutive axles whose centers are spaced more than 40 inches apart but not more than 96 inches apart. The Federal tandem-axle weight limit on the Interstate System is 34,000 pounds.

Interstate System weight limits in some States may be higher than the figures noted above due to "grandfather" rights. When the Interstate System axle and gross weight limits were first adopted in 1956, and amended in 1975, States were allowed to keep or "grandfather" weight limits that were higher.

Bridge Formula calculations yield a series of weights (Bridge Table, pages 5-6). It is important to note that the single-axle weight limit replaces the Bridge Formula weight limit on axles not more than 40 inches apart, and the tandem-axle weight limit replaces the Bridge Formula weight limit for axles over 40 but not more than 96 inches apart. At 97 inches apart, for example, two axles may carry 38,000 pounds (Figure 2A), and three axles may carry 42,000 pounds, as shown in Figure 2B.



3

Federal law states that any two or more consecutive axles may not exceed the weight computed by the Bridge Formula even though single axles, tandem axles, and gross weight are within legal limits. As a result, the axle group that includes the entire truck—sometimes called the "outer bridge" group—must comply with the Bridge Formula. However, interior combinations of axles, such as the "tractor bridge" (axles 1, 2, and 3) and "trailer bridge" (axles 2, 3, 4, and 5), must also comply with weights computed by the Bridge Formula (Figure 3).

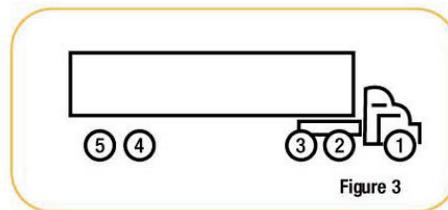
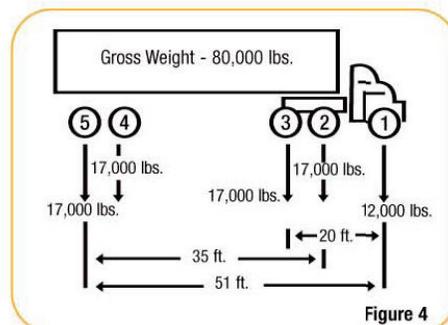


Figure 3 shows the most common vehicle checked for compliance with weight limit requirements. Although the Bridge Formula applies to each combination of two or more axles, experience shows that axle combinations 1 through 3, 1 through 5, and 2 through 5 are critical and must be checked. If these combinations are found to be satisfactory, then all of the others on this type of vehicle normally will be satisfactory.

The vehicle with weights and axle dimensions shown in Figure 4 is used to illustrate a Bridge Formula check.



4

Permissible Gross Loads for Vehicles in Regular Operation¹

Based on weight formula

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$

Distance in feet (L) between the extremes of any group of 2 or more consecutive axles

Maximum load in pounds carried on

any group of 2 or more consecutive axles²

L	N=	Maximum load in pounds carried on							
		2 AXLES	3 AXLES	4 AXLES	5 AXLES	6 AXLES	7 AXLES	8 AXLES	9 AXLES
Tandem Axle Weight (see pages 3 & 4)	4	34,000							
	5	34,000							
	6	34,000							
	7	34,000							
	8	34,000	34,000						
	More than 8/less than 9	38,000	42,000						
	9	39,000	42,500						
	10	40,000	43,500						
	11		44,000						
	12		45,000	50,000					
	13		45,500	50,500					
	14		46,500	51,500					
	15		47,000	52,000					
	16		48,000*	52,500	58,000				
	17		48,500	53,500	58,500				
	18		49,500	54,000	59,000				
	19	Example (see page 7)	50,000	54,500	60,000				
	20		51,000	55,500	60,500	66,000			
	21		51,500	56,000	61,000	66,500			
	22		52,500	56,500	61,500	67,000			
	23		53,000	57,500	62,500	68,000			
	24		54,000	58,000	63,000	68,500	74,000		
	25		54,500	58,500	63,500	69,000	74,500		
	26		55,500	59,500	64,000	69,500	75,000		
	27		56,000	60,000	65,000	70,000	75,500		
	28		57,000	60,500	65,500	71,000	76,500	82,000	
	29		57,500	61,500	66,000	71,500	77,000	82,500	
	30		58,500	62,000	66,500	72,000	77,500	83,000	
	31		59,000	62,500	67,500	72,500	78,000	83,500	
	32		60,000	63,500	68,000	73,000	78,500	84,500	90,000
	33			64,000	68,500	74,000	79,000	85,000	90,500
	34			64,500	69,000	74,500	80,000	85,500	91,000
	35			65,500	70,000	75,000	80,500	86,000	91,500
	36		Exception (see page 9)	66,000	70,500	75,500	81,000	86,500	92,000
	37			66,500	71,000	76,000	81,500	87,000	93,000
	38			67,500	71,500	77,000	82,000	87,500	93,500
	39			68,000	72,000	77,500	82,500	88,500	94,000
	40			68,500	73,000	78,000	83,500	89,000	94,500
	41			69,500	73,500	78,500	84,000	89,500	95,000
	42			70,000	74,000	79,000	84,500	90,000	95,500
	43			70,500	75,000	80,000	85,000	90,500	96,000
	44			71,500	75,500	80,500	85,500	91,000	96,500
	45			72,000	76,000	81,000	86,000	91,500	97,500
	46			72,500	76,500	81,500	87,000	92,500	98,000
	47			73,500	77,500	82,000	87,500	93,000	98,500
	48			74,000	78,000	83,000	88,000	93,500	99,000
	49			74,500	78,500	83,500	88,500	94,000	99,500
	50			75,500	79,000	84,000	89,000	94,500	100,000
	51			76,000	80,000	84,500	89,500	95,000	100,500
	52			76,500	80,500	85,000	90,500	95,500	101,000
	53			77,500	81,000	86,000	91,000	96,500	101,500
	54			78,000	81,500	86,500	91,500	97,000	102,000
	55			78,500	82,500	87,000	92,000	97,500	102,500
	56		Interstate Gross Weight Limit (see page 2)	79,500	83,000	87,500	92,500	98,000	103,000
	57			80,000	83,500	88,000	93,000	98,500	104,000
	58				84,000	89,000	94,000	99,000	104,500
	59				85,000	89,500	94,500	99,500	105,000
	60				85,500	90,000	95,000	100,500	105,500

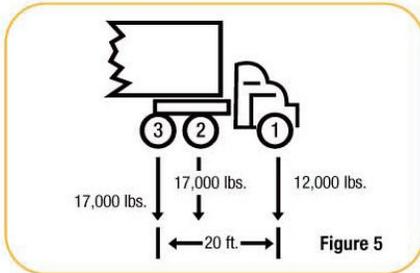
¹The values in this table reflect FHWA's policy of rounding down when calculated weights fall exactly halfway between 500-pound increments. Because the Bridge Formula is designed to protect highway infrastructure, FHWA determined that this conservative policy is consistent with the statutory mandate.

²The following loaded vehicles must not operate over H15-44 bridges; 3-S2 (5-axle tractor

semitrailer with a wheelbase of less than 38 feet), 2-S1-2 (5-axle semitrailer combination with a wheelbase of less than 45 feet), 3-3 (6-axle truck trailer combination with a wheelbase less than 45 feet), and any truck with 7 or more axles.

H15-44 bridges are designed for a specific vehicle load; H15 refers to a 15-ton 2-axle truck; 44 refers to the year AASHTO published the loading information. See AASHTO Standard Specifications for Highway Bridges.

Before checking for compliance with the Bridge Formula, a vehicle's single-axle, tandem-axle, and gross weight should be checked. Here the single axle (number 1) does not exceed 20,000 pounds, tandems 2-3 and 4-5 do not exceed 34,000 pounds each, and the gross weight does not exceed 80,000 pounds. Thus, these preliminary requirements are satisfied. The first Bridge Formula combination is checked as follows:



Check axles 1 through 3 (Figure 5)

Actual weight = 12,000 + 17,000 + 17,000 = 46,000 pounds.

N = 3 axles

L = 20 feet

$$W = 500 \left[\frac{LN}{N-1} + 12N + 36 \right]$$

$$W = 500 \left[\frac{(20 \times 3)}{(3 - 1)} + (12 \times 3) + 36 \right] = 51,000 \text{ lbs.}$$

Maximum weight (W) = 51,000 pounds, which is more than the actual weight of 46,000 pounds. Thus, the Bridge Formula requirement is satisfied.

Example From the Bridge Table (pages 5 & 6)

The same number (51,000 pounds) could have been obtained from the Bridge Table by reading down the left side to L = 20 and across to the right where N = 3.

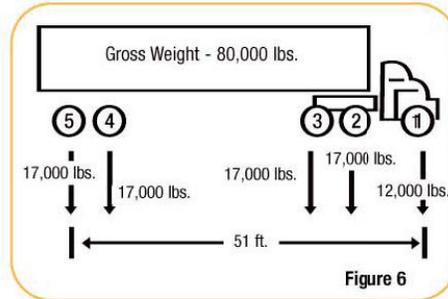


Figure 6

Now check axles 1 through 5 (Figure 6)

Actual weight = 12,000 + 17,000 + 17,000 + 17,000 + 17,000 = 80,000 pounds.

Maximum weight (W) = 80,000 pounds (Bridge Table for "L" of 51 feet and "N" of 5 axles).

Therefore, this axle spacing is satisfactory.

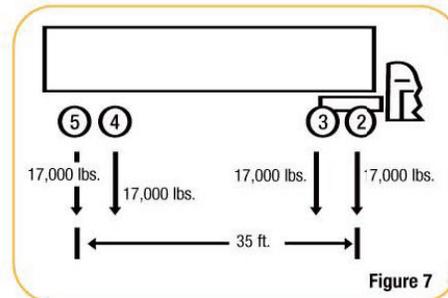


Figure 7

Now check axles 2 through 5 (Figure 7)

Actual weight = 17,000 + 17,000 + 17,000 + 17,000 = 68,000 pounds.

Maximum weight (W) = 65,500 pounds (Bridge Table for "L" of 35 feet and "N" of 4 axles).

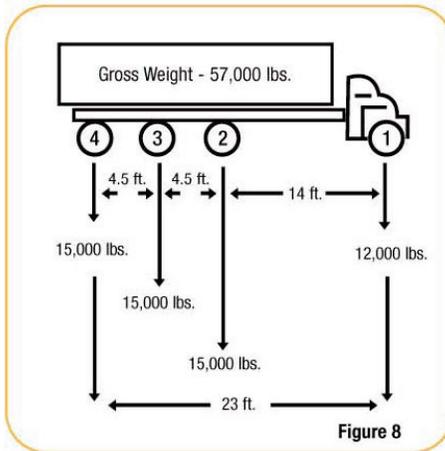
This is a violation because the actual weight exceeds the weight allowed by the Bridge Formula. To correct the situation, some load must be removed from the vehicle or the axle spacing (35 feet) must be increased.

Exception to Formula and Bridge Table

In addition to the grandfather rights noted on page 3, Federal law (23 U.S.C. 127) includes one other exception to the Bridge Formula and the Bridge Table—two consecutive sets of tandem axles may carry 34,000 pounds each if the overall distance between the first and last axles of these tandems is 36 feet or more. For example, a five-axle tractor-semitrailer combination may carry 34,000 pounds both on the tractor tandem (axles 2 and 3) and the trailer tandem (axles 4 and 5), provided axles 2 and 5 are spaced at least 36 feet apart. Without this exception, the Bridge Formula would allow an actual weight of only 66,000 to 67,500 pounds on tandems spaced 36 to 38 feet apart.

**Bridge Formula Application
to Single-Unit Trucks**

The procedure described above could be used to check any axle combinations, but several closely spaced axles usually produce the most critical situation.



The truck shown in Figure 8 satisfies the single-axle weight limit (12,000 pounds are less than 20,000 pounds), the tandem-axle limit (30,000 pounds are less than 34,000 pounds) and the gross-weight limit (57,000 pounds are less than 80,000 pounds). With these restrictions satisfied, a check is done for Bridge Formula requirements, axles 1 through 4.

Actual Weight = 12,000 + 15,000 + 15,000 + 15,000 = 57,000 pounds.

Maximum weight (W) = 57,500 pounds (Bridge Table for "L" of 23 feet and "N" of 4 axles).

Since axles 1 through 4 are satisfactory, check axles 2 through 4:

Actual weight = 15,000 + 15,000 + 15,000 = 45,000 pounds.

Maximum weight (W) = 42,500 pounds (Bridge Table for "L" of 9 feet and "N" of 3 axles).

This is a violation because the actual weight exceeds the weight allowed by the Bridge Formula. The load must either be reduced, axles added, or spacing increased to comply with the Bridge Formula.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

CIRCULAR LETTER

SECTION: 604.17 CONCRETE STRUCTURES
NUMBER: 604.17-01
SUBJECT: BRIDGE DECK CONSTRUCTION CHECKLIST
DATE: JANUARY 25, 2000

The following pages contain a checklist procedure to be followed before, during and after bridge deck pours and a list of factors that adversely affect deck construction.

PAGE 1
STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

CONTRACT _____ CONTRACTOR _____
PROJECT _____ BRIDGE NUMBER _____
REFERENCE _____ STATION NUMBER _____
COUNTY _____ LANE (IF APPL) _____

BRIDGE DECK CONSTRUCTION CHECK LIST
TO BE COMPLETED BEFORE, DURING AND AFTER BRIDGE DECK POURS

THIS REPORT IS TO COMPLETED BY THE
APPROPRIATE PROJECT PERSONNEL
AND COPIES SENT TO
THE CONTRACTOR
AND
MAINTAINED IN
THE PROJECT FILES FOR REVIEW

BRIDGE DECK CONSTRUCTION
PRE-POUR CHECKLIST

CONTRACT _____	CONTRACTOR _____
PROJECT _____	STRUCTURE _____
REFERENCE _____	STATION _____
COUNTY _____	LANE/SPAN _____

1. Check forms:
 - a. Clean, free of major defects. _____
 - b. Mortar tight. _____
 - c. Line and grade. _____
 - d. Structurally adequate to insure minimum settlement in deck or overhang. _____

2. Check rebar:
 - a. Clean. _____
 - b. Dimensionally correct. _____
 - c. Supported per specs and Standard Drawing STD-9-1. _____
 Note: Overhang may require different supports.
 - d. Document rebar quantities in field book. _____

3. Check screed rails and headers for line and grade. _____

4. Check screed for camber, insure is correct for template. _____

5. Make dry run with screed, check for correct slab thickness and rebar clearance.
 Document thickness and clearances in field book.
 Note: Check mechanical condition of screed. _____

6. Check access to site for concrete trucks, have equipment on hand for towing,
 grading, etc., if required. _____

7. Check concrete plant:
 - a. Up-to-date scales check. _____
 - b. Check concrete trucks to be sure on approved list, all revolution counters
 and water gauges working, and load does not exceed mixing capacity. _____
 - c. Insure enough approved trucks available to maintain required pouring rate. _____
 - d. Insure adequate supply of aggregates, cement, and additives are on hand for
 deck pour. _____

8. Check to be sure Contractor has scheduled enough personnel to handle pour,
 including equipment mechanics. _____

BRIDGE DECK CONSTRUCTION (Cont'd)
PRE-POUR CHECKLIST

- 9. Have Contractor verify the availability and operability of all necessary equipment, including finishing machines, continuous water source or portable tanks, water distribution equipment, two work bridges, vibrators, sprayers, 12 ft. straightedge and appropriate backup items. _____
- 10. Obtain material certifications for the curing compound and burlap, and for the polyethylene where applicable. Check to be sure an adequate supply of these curing materials is available. _____
- 11. Where placement by pumping requires more than one setup, obtain proposed plan from the Contractor showing the locations of the pumping equipment, the location(s) of the leading edge of the concrete pour while repositioning the pumping equipment and a realistic time for each work delay anticipated while repositioning pumping equipment. _____
- 12. Require the Contractor to designate which of the pumping configurations listed in Subsection 604.17(a) will be used at the end of the discharge line. No exceptions are to be made, other than alternative equipment proposed under Subsection 105.17 and approved in writing by the Division of Structures under the conditions of that Subsection. _____
- 13. Have the Contractor designate his/her authorized representative who will be present and have the authority to represent the Contractor during the bridge deck pour. _____
- 14. Hold Pre-Pour Conference to coordinate and confirm above items.
Note: Place copy of Pre-pour conference minutes in project files. _____

INSPECTOR _____

TITLE _____

DATE _____

BRIDGE DECK CONSTRUCTION
CHECKLIST DURING POUR

Answer "Yes" or "No" except as noted and elaborate on "No" answers.

- 1. Are all concrete trucks on the approved list? _____
- 2. Is plastic concrete checked several times behind screed for slab depth and rebar cover and documented? _____
- 3. Do pour, finishing operations and deck finish comply with specifications? _____
- 4. Do checks of the pour rate indicate it is satisfactory? (at least 20'/hr. along roadway) _____
- 5. Has the deck been straightedged and any deficiencies corrected? _____
- 6. Are required tests on concrete made and the data recorded in book and on tickets? _____
- 7. Is the amount of curing compound checked both before use and after deck pour to determine quantity used? Compute rate and show here in ft.²/gal. _____
- 8. Is the curing compound applied as soon as the water sheen disappears from the surface of the concrete? _____
- 9. From a work bridge, is damp burlap placed as soon as surface will support the burlap without undue marring of the concrete? _____
- 10. After placement, is the burlap immediately wet with a misty spray and kept wet thereafter with a continuously fed soaker hose? _____
- 11. Is the burlap properly anchored to provide full protection to the concrete? _____

INSPECTOR _____

TITLE _____

DATE _____

BRIDGE DECK CONSTRUCTION
POST POUR CHECKLIST

- 1. Check curing process every day to be sure deck is kept wet.
Note: Suggest checking early A.M., midday, and late P.M., at a minimum. _____
- 2. Check bridge deck for deficiencies using 12' straightedge and/or profilograph as required by specifications and have contractor make necessary corrections. _____
- 3. Review "Pre-Pour" and "During Pour" checklists and observations, give written instructions to Contractor concerning any unsatisfactory conditions of deficiencies to insure these are not repeated on next pour. _____
- 4. Place copy of all checklists, Pre-Pour Conference minutes, and instructions to Contractor in project file. _____

INSPECTOR _____

TITLE _____

DATE _____

FACTORS THAT ADVERSELY AFFECT DECK CONSTRUCTION

- I. Failure to Conduct Proper Pre-pour Inspections
 - a. Inadequate use of pre-pour conferences.
 - b. Insufficient checking of screed ordinates, header profiles, screed rail profiles, condition of equipment, forming, slab thickness and bar reinforcement cover.
 - c. Non-compliance with Section 511 of the Special Provisions and insufficient knowledge of current contract documents.
 - d. Inadequate dry run with screed to check slab thickness and bar reinforcement cover.
 - e. Failure to take strong positive corrective action.
 - f. Failure to observe and adhere to plan notes requiring that all elevations and dimensions on structures to be widened be verified in the field prior to ordering materials.

- II. Condition of Equipment
 - a. Poor Maintenance.
 - b. Inadequate backup system.
 - c. Inability to vary speed of screed strike-off mechanism and travel speed of screed independently.
 - d. Lack of adequate review of equipment condition.

- III. Improper Use of Screeds
 - a. Failure to keep concrete raked down in front of screed.
 - b. Failure to make more than one pass with a longitudinal screed.
 - c. A & B above adversely affects deck profile and deck finish.

- IV. Failure to Meet the Minimum Required Concrete Placement Rates
 - a. Concrete Supply Problems
 - i. Inadequate delivery
 - ii. Failure to receive a uniform or consistent concrete mix.
 - b. Concrete Placement Problems
 - i. Inability to strike-off concrete in a timely fashion in order to straightedge and achieve corrective work that may be necessary.
 - ii. Failure to achieve adequate final finish and curing.
 - iii. Failure to achieve a reasonable concrete placement rate contributes to shy deck thickness and bar reinforcement cover.

- V. Failure to Read and Have Current Knowledge of Contract Documents

- VI. Lack of Sufficiently Trained and Experienced Personnel on the Part of the Department of Transportation and the Contractor.

Concrete Certified Technicians

CONCRETE PRODUCER _____ LOCATION: _____

TECHNICIAN QUALIFICATIONS

Concrete Field Testing Technicians (TDOT Level 1 or equivalent)		
Name	Certification Number	Expiration Date

Concrete Plant Technicians (TDOT Level 2 or equivalent)		
Name	Certification Number	Expiration Date

Concrete Mix Design Technicians (TDOT Level 3 or equivalent)		
Name	Certification Number	Expiration Date

