

# GDT 54

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## A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to estimate the effects of storage silos at bituminous central mix plants upon mix uniformity.

## B. Apparatus

This apparatus consists of the following:

1. Sampling devices as required by GSP 15.
2. Use [data sheets](#) that you prepare.

## C. Sample Size and Preparation

Approximately 1200 tons (1200 Mg) of mix will be produced during the sampling period. Of this quantity, 50% will come from the sampled trucks.

1. Take at least 18 truck samples from each of two locations: directly from the mixer and from the silo.
2. Use a random procedure to select the trucks to be sampled and where the trucks are loaded.
3. Test the samples for the following:
  - a. GDT 37 or GDT 83: Bitumen Content
  - b. GDT 38: Mechanical Analysis of Extracted Aggregate
4. You will compare the variances of extraction and gradation tests for samples representing the silo with the variance of samples representing the mixer according to a preselected statistical test for significance.
5. Prepare a [Sample Location Data Sheet](#). This sheet separates the production period to be sampled into lots of six successive truck loads per lot. From each lot, select three trucks for sampling as follows:
  - a. Place three dice of identical size and weight into a cup.
  - b. Shake vigorously and cast the dice onto a smooth, hard surface.
  - c. The digit on the upward face of each die designates a truck number.
    - 1) For example, if the three digits are 1, 3, and 5, sample the first, third, and fifth trucks of that lot.
    - 2) If a digit occurs more than once, such as 1, 3 and 3, discard that cast and continue casting until you get three different digits.
  - d. After selecting three trucks from a lot, designate each truck as either loaded directly from the plant mixer or directly from the silo as follows:

<b>NOTE: Designate the point of loading for each truck before selecting the trucks to be sampled in successive lots.</b>
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- 1) Begin with the first truck to be sampled. Place one die in the cup, shake vigorously, and cast on a smooth hard surface.
  - 2) If the digit on the upward face is even, designate the truck to be loaded from the silo. If the digit is odd, designate the truck to be loaded directly from the mixer.
  - 3) If this procedure designates that all three trucks be loaded at the same point, discard the three casts and repeat the procedure until both points of loading are represented by each lot.
  - 4) Continue selecting and designating trucks until you choose at least 18 trucks for loading at each of the two loading points, mixer and silo.
  - 5) Load the trucks not selected for sampling from the silo.
  - 6) This procedure provides for continuous operation of the silo and loading from the silo except for those trucks selected to be loaded directly from the mixer.
6. During sampling, take these precautions:

- a. Do not tell the producer which trucks have been selected for sampling.
  - b. Tell the plant manager that loading is to be from the silo unless otherwise directed.
  - c. Do not begin loading and delivery until the silo is at least 3/4 full.
  - d. While using the silo, keep the level of material above the tapered bottom section of the silo.
  - e. Mark off each truck batched on the sample location data sheet, whether sampled or not.
  - f. For trucks designated to be loaded from the mixer, divert them from beneath the plant at the last moment. Do not give advance notice about which trucks are to be sampled.
7. While a truck is being sampled, the plant can charge the silo. However, direct the plant foreman not to load any trucks until you have completed each sampling.
    - a. If you must interrupt the production before sampling is complete, you may continue the sampling at the point of interruption unless the delay is overnight.
    - b. If delayed overnight and material remains in the silo, make sure you empty and refill the silo to the 3/4 full point before resuming the sample plan.
    - c. Do not use the sample location data sheet to indicate which trucks were used to empty the silo.
    - d. Indicate and explain each point of interruption in production on the sample location data sheet.
  8. When a truck to be sampled is completely loaded, sample the truck before it leaves the yard.
  9. Take the sample according to GSP 15, "Sampling Procedure for Asphaltic Concrete Mixtures."
  10. Try to make all samples approximately equal in weight.

**NOTE: Use the same sampling procedure for all trucks, regardless of where they were loaded.**

**D. Procedures**

Test all samples at the same Laboratory. Use identical Laboratory techniques for sample preparation.

**E. Calculations**

1. Evaluate the test values for variances attributable to using the silo. Evaluate the following values for the mixture type:

Type of Mix	Qualities to be Evaluated for Variance
4.75 mm	% AC, % Passing No. 4 (4.75 mm), % Passing No. 8 (2.36 mm)
4.75 mm	% AC, % Passing No. 4 (4.75 mm), % Passing No. 8 (2.36 mm)
9.5 mm	% AC, % Passing 3/8" (9.5 mm), % Passing No. 8 (2.36 mm)
9.5 mm	% AC, % Passing 3/8" (9.5 mm), % Passing No. 8 (2.36 mm)
12.5 mm	% AC, % Passing 1/2" (13 mm), % Passing No. 8 (2.36 mm)
12.5 mm	% AC, % Passing 1/2" (13 mm), % Passing No. 8 (2.36 mm)

2. For each test quantity to be evaluated, complete the data evaluation sheet and calculate the following parameters:

- Xp = Arithmetic mean of all pugmill samples
- Xs = Arithmetic mean of all silo samples
- Vp = Between sample variance for pugmill samples
- Vs = Between sample variance for silo samples
- Sp = Standard deviation for pugmill samples
- Ss = Standard deviation for silo samples
- Np = Number of pugmill samples
- Ns = Number of silo samples

3. After calculating the parameters, use them to test for significance between pugmill and silo means and between sample variance (V) according to the following:

a. Significance of Difference Between Pugmill and Silo Means:

1) Calculate the quantity “t” as follows:

$$t = \frac{X_p - X_s}{s \left[ \frac{1}{N_p} + \frac{1}{N_s} \right]^{1/2}}$$

where:

$$s = \left[ \frac{(N_p - 1)V_p + (N_s - 1)V_s}{(N_p - 1) + (N_s - 1)} \right]^{1/2}$$

Significance of Ratio of Silo Variance (Vs) to Pugmill Variance (Vp)

Calculate the ratio:

$$\frac{V_s}{V_p}$$

4. Evaluate the calculated quantities “t” and  $(V_s \div V_p)$  to determine significance of silo effects on mix uniformity.
5. A significant effect upon any one average or mean value for asphalt content or gradation is enough to reject the silo.
  - a. Modify the evaluation if you see that existing influences caused biased results. In this case, repeat the test and eliminate the suspected source of bias.
  - b. Just because the silo passes this second test does not absolutely prove acceptability for the silo or the producer. Continue to monitor and investigate the trends of significant silo effects.
  - c. If you notice trends that show the silo has significant effects on the bituminous mix, contact the Office of Materials and Research. Do not approve the loads coming from the silos.

## F. Report

1. Report the results of all the tests on the [Sample Location Data Sheet](#).
2. Submit the completed form the Area Engineer and the Office of Materials and Research in Forest Park.
3. Inform your department head and the Area Engineer of any material that fails inspection.

DATA EVALUATION SHEET

Sample Type \_\_\_\_\_ Test \_\_\_\_\_

LOT NUMBER TRUCK NUMBER	COLUMN A TEST VALUE	COLUMN B SQUARE OF COLUMN A

Sum A = Sum of Column A

Sum B = Sum of Column B

Formulas:

Arithmetic Mean 
$$X = \frac{\text{Sum A}}{N}$$

Between Sample Variance 
$$= \frac{N(\text{Sum B}) - (\text{Sum A})^2}{N(N - 1)}$$

Standard Deviation = (Between Sample Variance)<sup>½</sup>

SAMPLE LOCATION DATA SHEET

LOT NO.	TRUCK NO.	SAMPLE IDENTIFICATION		TRUCK TALLEY	REMARKS
		Trucks to be sampled	Load Point		
1	a	x	S	x	Began 7:45 a.m. 3-25-70
	b	x	S	x	
	c			x	
	d			x	
	e			x	
	f	x	P	x	
2	a			x	Breakdown 10:30 a.m. 3-25-70 Resumed 2:30 p.m. 3-25-70
	b	x	P	x	
	c			x	
	d	x	S	x	
	e	x	P	x	
	f			x	
3	a	x	S	x	Stopped-Overnight break
	b			x	
	c			x	
	d	x	P	x	
	e	x	S	x	
	f			x	
4	a			x	
	b	x	P	x	
	c			x	
	d	x	P	x	
	e	x	S	x	
	f			x	