

# **CHAPTER 4**

## **ACCEPTANCE OF MATERIALS**

### **Acceptance**

Sampling and testing for determination of gradation, liquid limit and plasticity index, and cement content of material, if stabilized, will be performed at the plant and normally no further sampling or testing will be performed for these properties. However, should visual examination reveal that the material in any load is obviously contaminated or segregated, that load will be rejected without additional sampling or testing of the lot. In the event it is necessary to determine the gradation or Atterberg Limits or cement content of the material in an individual load, one sample (taken from the load) will be tested and the results compared to the requirements of Section 208.03 Table II-10, Table II-11 (for one test) and Sec. 307.05(b)(2). The results obtained in the testing of a specific individual load will apply only to the load in question.

Most of the material in a pavement is aggregate. The aggregate contributes strength and stability to the completed pavement. All of the particles needed in the aggregate that will meet specifications and do the job usually cannot be found in a single material; therefore, it becomes necessary to blend different sizes and materials in the proper quantities to produce the desired gradation.

### **Cement Stabilized Aggregate**

Hydraulic Cement can be added to Aggregate Base, Subbase or Select Material to give added strength to the pavement. The cement used must be Type I, I-P or II. The water used in mixing the cement stabilized material must have a pH between 4.5 and 8.5. (Section 307.02 a & b)

The material cannot be shipped to the project until the temperature is 40°F in the shade and rising. (Section 307.04)

Once production has started the contractor has 1 hour from the time of mixing at the plant to have material on the subgrade and start compaction. All compaction must be completed within 4 hours after the water was added at the plant. (VDOT Road. & Bridge Spec. Section 307.05)

## Road & Bridge Specifications Section 208.01

**TABLE II-9  
Design Range for Dense Graded Aggregates**

Amounts Finer Than Each Laboratory Sieve (Square Openings <sup>1</sup> ) (% by Weight)						
Size No.	50 mm 2 in.	25.0 mm 1 in.	9.5 mm 3/8 in.	2.00 mm No. 10	425 µm No. 40	75 µm No. 200
21A	100	94-100	63-72	32-41	14-24	6-12
21B	100	85-95	50-69	20-36	9-19	4-7
22	---	100	62-78	39-56	23-32	8-12

<sup>1</sup> In inches

## Road & Bridge Specifications Section 208.03

**TABLE II-10  
Process Tolerances for Each Laboratory Sieve (%)**

No. Tests	Top Size	25.0 mm 1 in.	19.0 mm 3/4 in.	9.5 mm 3/8 in.	2.00 mm No. 10	425 µm No. 40	75 µm No. 200
1	0.0	±10.0	±14.0	±19.0	±14.0	±8.0	±4.0
2	0.0	±7.1	±10.0	±13.6	±10.0	±5.7	±2.9
3	0.0	±5.6	±7.8	±10.6	±7.8	±4.4	±2.2
4	0.0	±5.0	±7.0	±9.5	±7.0	±4.0	±2.0
8	0.0	±3.6	±5.0	±6.8	±5.0	±2.9	±1.4

## Road & Bridge Specifications Section 208.03

**TABLE II-11  
Atterberg Limits**

No. Tests	Max. Liquid Limit	Max. Plasticity Index	
	Subbase and Aggregate Base Type I and II	Subbase Sizes No. 21A, and 22 and Aggregate Base Type II	Aggregate Base Type I and Subbase Size No. 19
1	25.0	6.0	3.0
2	23.9	5.4	2.4
3	23.2	5.1	2.1
4	23.0	5.0	2.0
8	22.4	4.7	1.7

(b) Atterberg Limits: Atterberg limits shall conform to the requirements of Table II-11 when tested in accordance with the requirements of VTM-7.

### Process Tolerance Cement Stabilized Aggregates

No. Tests averaged	Percent Below Design Allowed
1	1.6
2	1.1
3	0.9
4	0.8

### Acceptance Calculations for Gradation, Liquid Limit, Plasticity Index, and Cement Content

As previously stated, acceptance, for gradation, liquid limit, plasticity index and cement content will be based upon a mean (average) of the results of tests performed on samples taken in a stratified random manner from each lot. The procedure for calculating the acceptance or failure for gradation, liquid limit, plasticity index, and cement content is as follows:

Step 1. Obtain job-mix formula. The job-mix formula should be that formula as found on Form TL-127 as submitted by the Contractor/Technician for the type mixture being produced.

Example: Stabilized Aggregate Base Type I, No. 21A.

Job-Mix Sieves	Total % Passing
2 in. (50 mm)	100.0
1 in. (25 mm)	95.0
3/8 in. (9.5 mm)	67.0
No. 10 (2.00 mm)	38.0
No. 40 (425 µm)	21.0
No. 200 (75 µm)	10.0
L.L.	Max. 23
P.I.	Max. 2
Cement	4.00%

One week may be required by the Department to evaluate a new job-mix formula.

Step 2. Determine number of tests performed on quantity of material for acceptance. Usually the quantity of material tested for acceptance is a lot (2000 or 4000 Tons), which requires 4 tests (one for every 500 or 1000 Tons).

Example: Lot = 2000 or 4000 Tons = 4 Tests  
 Step 3. Calculate Acceptance Range. To calculate the acceptance range, the process tolerance for the number of tests performed is applied to the job-mix.  
 Acceptance Range = Job-Mix ± Process Tolerance

Example: (4 Tests)

<b>Job-Mix Sieves</b>	<b>Total % passing</b>	<b>Tolerance</b>	<b>Acceptance Range</b>
<b>2 in. (50 mm)</b>	<b>100.0</b>	<b>0.0</b>	<b>100.0</b>
<b>1 in. (25 mm)</b>	<b>95.0</b>	<b>± 5.0</b>	<b>90.0-100.0</b>
<b>3/8 in. (9.5 mm)</b>	<b>67.0</b>	<b>± 9.5</b>	<b>57.5-76.5</b>
<b>No. 10 (2.00 mm)</b>	<b>38.0</b>	<b>± 7.0</b>	<b>31.0-45.0</b>
<b>No. 40 (425 µm)</b>	<b>21.0</b>	<b>± 4.0</b>	<b>17.0-25.0</b>
<b>No. 200 (75 µm)</b>	<b>10.0</b>	<b>± 2.0</b>	<b>8.0-12.0</b>
<b>L.L.</b>			<b>Max. 23</b>
<b>P.I.</b>			<b>Max. 2</b>
<b>Cement</b>	<b>4.00</b>	<b>-0.80%</b>	<b>Min. 3.20%</b>

Step 4. Calculate mean (average) of Test results. This is done for each job-mix sieve, Liquid Limit, Plasticity index, and cement content.

$$\text{Mean (average)} = \frac{\text{Sum of Test Results}}{\text{Number of Tests}}$$

Example:

<b>Sample No.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Aver.</b>	<b>Acc. Lower</b>	<b>Range Upper</b>	<b>Job-Mix</b>
<b>SIEVE SIZE</b>								
<b>2 in. (50 mm)</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>
<b>1 in. (25 mm)</b>	<b>93.6</b>	<b>94.6</b>	<b>94.1</b>	<b>89.4</b>	<b>92.9</b>	<b>90.0</b>	<b>100.0</b>	<b>95.0</b>
<b>3/8 in. (9.5 mm)</b>	<b>69.0</b>	<b>70.7</b>	<b>63.9</b>	<b>63.6</b>	<b>67.0</b>	<b>57.5</b>	<b>76.5</b>	<b>67.0</b>
<b>No. 10 (2.00 mm)</b>	<b>42.0</b>	<b>41.6</b>	<b>36.3</b>	<b>36.8</b>	<b>39.2</b>	<b>31.0</b>	<b>45.0</b>	<b>38.0</b>
<b>No. 40 (425 µm)</b>	<b>24.4</b>	<b>23.9</b>	<b>20.0</b>	<b>21.1</b>	<b>22.4</b>	<b>17.0</b>	<b>25.0</b>	<b>21.0</b>
<b>No. 20 (75 µm)</b>	<b>9.4</b>	<b>8.8</b>	<b>7.0</b>	<b>7.7</b>	<b>8.2</b>	<b>8.0</b>	<b>12.0</b>	<b>10.0</b>
<b>L.L.</b>	<b>20.1</b>	<b>15.7</b>	<b>26.6</b>	<b>17.3</b>	<b>19.9</b>		<b>23.0</b>	<b>23.0</b>
<b>P.I.</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>		<b>2.0</b>	<b>2.0</b>
<b>Cement</b>	<b>3.9</b>	<b>4.2</b>	<b>3.8</b>	<b>4.1</b>	<b>4.0</b>	<b>3.2</b>		<b>4.0</b>

Step 5. Compare mean (average) of test results to acceptance range.

Example: The averages of the lot are within the acceptance range.  
This lot passes.

**Adjustment System - for Aggregate Base and Subbase**

**Adjustments for Gradation, Atterberg Limits and Cement Content**

In the event a lot of material does not conform to the acceptance requirements, adjustment points will be determined as follows:

<b>Sieve No.</b>	<b>Adjustment Points For Each 1% That The Gradation Is Outside The Process Tolerance</b>
<b>2 in. (50 mm)</b>	<b>1</b>
<b>1 in. (25 mm)</b>	<b>1</b>
<b>3/4 in (19 mm)</b>	<b>1</b>
<b>3/8 in (9.5 mm)</b>	<b>1</b>
<b>No. 10 (2.00 mm)</b>	<b>1</b>
<b>No. 40 (425 µm)</b>	<b>3</b>
<b>No. 200 (75 µm)</b>	<b>5</b>

<b>Atterberg Limits</b>	<b>Adjustment Points For Each 1% That The Atterberg Limits Exceed The Maximum Permitted In Table II-11</b>
<b>Liquid Limit</b>	<b>3</b>
<b>Plasticity Index</b>	<b>7</b>
<b>Cement Content</b>	<b>10</b>

In the event the total adjustment is 8.0 percent or less for cement content material, and the Contractor does not elect to remove and replace the material, the unit bid price paid for the material will be reduced at the rate stated herein. The adjustment will be applied to the tonnage represented by the samples: however should any one sample fail by more than 1.6 percent below the design cement content that portion of the lot must be removed from the road. (Section 307.05)

In the event the total adjustment for a lot is greater than twenty-five (25) points, the failing material shall be removed from the road. In the event the total adjustment is twenty-five (25) points or less and the Contractor does not remove and replace the material, the unit price paid for the material will be reduced 1% of the unit price bid for each adjustment point. The adjustment will be applied to the tonnage represented by the sample or samples.

Assume: Type Mix - Stabilized Aggregate Base Type I, Size 21A

Sample No.	1	2	3	4	Aver.	Lower	Upper	Job-Mix	P/F
Sieve Size									
2 in. (50 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
1 in. (25 mm)	99.0	99.0	100.0	100.0	99.5	90.0	100.0	95.0	
3/8 in. (9.5 mm)	77.0	88.0	74.1	78.2	79.3	57.5	76.5	67.0	F
No. 10 (2.00 mm)	43.0	40.8	42.2	42.6	42.2	31.0	45.0	38.0	
No. 40 (425 µm)	24.0	23.8	23.6	24.4	24.0	17.0	25.0	21.0	
No. 200 (75 µm)	13.8	13.9	13.8	13.6	13.8	8.0	12.0	10.0	F
L.L.	20.3	21.0	20.6	19.5	20.4		23.0	23.0	
P.I.	0.0	0.0	0.0	0.0	0.0		2.0	2.0	
Cement	3.3	2.7	3.1	2.9	3.0	3.2		4.0	F

Sample Calculations for Adjustments:

Step 1. Compute adjustment on 3/8 in. (9.5 mm) Sieve. Refer to the adjustment point table for gradation and note that, for the 3/8 in. (9.5 mm) sieve, a one point adjustment for each 1% that the gradation is outside the acceptance range is applied.

79.3 Average 3/8 in. (9.5 mm) sieve                    1.0 Adjustment for each 1%  
~~-76.5~~ Upper Acceptance Range                    x 2.8% Outside Acceptance Range  
 2.8% Outside Acceptance Range                    2.8 Adjustment Points 3/8 in. (9.5 mm) sieve

Step 2. Compute Adjustment on No. 200 (75 µm) sieve. Refer to the adjustment point table for gradation and note for the No. 200 (75 µm) sieve, a 5 point adjustment for each 1% that the gradation is outside the acceptance range is applied.

13.8 Average No. 200 (75 µm) sieve                    5.0 Adjustment for each 1%  
~~-12.0~~ Upper Acceptance Range                    x 1.8% Outside Acceptance Range  
 1.8% Outside Acceptance Range                    9.0 Adjustment Points No. 200 (75 µm) sieve

Step 3. Compute Adjustment on Cement Content. Refer to Specifications and note that one adjustment point will be applied for each 0.1% that the material is out of the process tolerance. This statement means that 10 adjustment points will be applied for each 1% that the material is out; however, the maximum allowable adjustment is 8.

3.2	Lower Acceptance Range	10	Adjustment for each 1%
-	<u>3.0</u>	Average Cement Content	x <u>0.2</u> % Outside Process Tolerance
	0.2 % Outside Process Tolerance	2.0	Adjustment Points Cement Content

Step 4. Compute Total Adjustment. The total adjustment is the sum of the adjustments for gradation, L.L., P.I. and Cement Content. In our example, we had no adjustments applied for L.L. and P.I.

2.8	Adjustment 3/8 in. (9.5 mm) Sieve
9.0	Adjustment No. 200 (75 μm) Sieve
<u>+ 2.0</u>	Adjustment Cement Content
13.8	Total Adjustment points for Gradation and Cement Content

Section 207.01

**TABLE II-6**  
**Design Range: Select Material, Type I**

<b>% by Mass of Material Passing</b>				
<b>3 in. (75 mm) Sieve</b>	<b>2 in. (50 mm) Sieve</b>	<b>No. 10 (2.00 mm) Sieve</b>	<b>No. 40 (425 μm) Sieve</b>	<b>No. 200 (75 μm) Sieve</b>
100	95-100	25-55	16-30	4-14

Section 207.02

**TABLE II-7**  
**Process (P) and Range (R) Tolerance: Select Material, Type I**

<b>Tolerance on Each Laboratory Sieve (%)</b>										
<b>No. Test</b>	<b>3 in. (75 mm)</b>		<b>2 in. (50mm)</b>		<b>No. 10 (2.00mm)</b>		<b>No. 40 (425μm)</b>		<b>No. 200 ( 75μm)</b>	
	<b>P</b>	<b>R</b>	<b>P</b>	<b>R</b>	<b>P</b>	<b>R</b>	<b>P</b>	<b>R</b>	<b>P</b>	<b>R</b>
1	0.0		±4.0		±15.0		±10.0		±6.0	
2	0.0	0.0	±3.0	5.0	±10.5	18.5	±7.0	13.0	±4.0	8.5
3	0.0	0.0	±2.5	5.5	±8.5	22.0	±5.5	15.0	±3.5	10.0
4	0.0	0.0	±2.0	6.0	±7.5	23.5	±5.0	16.5	±3.0	10.5
8	0.0	0.0	±1.5	7.0	±5.5	26.5	±3.0	18.5	±2.0	12.0

**Adjustment System - Select Material, Type I**

In the event a lot of material does not conform to the acceptance requirements, adjustment will be determined as follows:

Sieve No.	Adjustment Points For Each 1% That The Gradation Is Outside The Process/Range Tolerance	
	Process	Range
3 in. (75 mm)	1	1
2 in. (50 mm)	1	1
No. 10 (2.00 mm)	1	1
No. 40 (425 µm)	3	3
No. 200 (75 µm)	5	5

Atterberg Limits	Adjustment Points
Liquid Limits	3
Plasticity Index	7

In the event the total adjustment, (EXCLUDING range adjustment) for the lot is greater than 25 points, the failing material shall be removed from the road. In the event the total adjustment, (EXCLUDING range adjustment) is 25 points of less and the Contractor does not elect to remove and replace the material, the unit price for the material will be reduced 1% for each adjustment point. The adjustment will be applied to the tonnage represented by the sample or samples.

**Adjustment Calculations on Select Material:**

Sample No.	1	2	3	4	Avg.	Range	Lower	Upper	Job-Mix	P/F
Sieve Size										
3 in.(75 mm)	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	
2 in. (50 mm)	100.0	90.4	95.1	100.0	96.4	9.6	96.0	100.0	98.0	F
No.10 (2.00 mm)	50.0	35.4	40.2	42.3	42.0	14.6	32.5	47.5	40.0	
No. 40 (425 µm)	35.0	22.1	25.2	30.4	28.2	12.9	17.0	27.0	22.0	F
No. 200 (75 µm)	17.0	11.0	13.1	15.4	14.1	6.0	7.0	13.0	10.0	F
L.L.	22.3	20.6	21.5	21.8	21.6			23.0	23.0	
P.I.	3.5	0.0	0.0	3.1	1.7			5.0	5.0	

Adjustments are computed as follows:

2 in. (50 mm) sieve:	actual range	9.6
	maximum range allowed	- <u>6.0</u>
	outside acceptance range	3.6
	adjustment for each %	1.0
	total adjustment	1.0 x 3.6 = <b>3.6</b>
No. 4 (425 μm) sieve:	average % passing	28.2
	upper acceptance range	- <u>27.0</u>
	outside acceptance range	1.2
	adjustment for each %	3.0
	total adjustment	3.0 x 1.2 = <b>3.6</b>
No. 200 (75 μm) sieve:	average % passing	14.1
	upper acceptance range	- <u>13.0</u>
	outside acceptance range	1.1
	adjustment for each %	5.0
	total adjustment	5.0 x 1.1 = <b>5.5</b>
<b>Total Lot Adjustment:</b>		<b>3.6 + 3.6 + 5.5 = 12.7</b>

To: \_\_\_\_\_ Date: \_\_\_\_\_  
 From: \_\_\_\_\_ Project: \_\_\_\_\_  
 Subject: Price Adjustment for Non-Compliance Route : \_\_\_\_\_ County \_\_\_\_\_  
 FHWA# \_\_\_\_\_  
 Producer: \_\_\_\_\_  
 Type of Material: \_\_\_\_\_  
 Tons Represented: \_\_\_\_\_  
 Date Shipped: \_\_\_\_\_

The above material does not conform to our requirements by the results below:

Control Test Report Number	Sieve Size	Test Results	Acceptance Range	Fails By	Adjustment Points
	3 in. (75 mm)				
	2 in. (50 mm)				
	1 in. (25 mm)				
	3/4 in. (19 mm)				
	3/8in. (9.5 mm)				
	No. 10 (2 mm)				
	No. 40 (425 μm)				
	No. 200 (75 μm)				
	L.L.				
	P.I.				
	Total Adjustment Points:				

District Materials Engineer

CY: State Materials Engineer  
 Resident Engineer  
 District Contract Administrator  
 Project Inspector  
 Contractor  
 File

**Adjustments for Variability (Standard Deviation)**

The Contractor shall control the variability of his product in order to furnish a uniform mix. When the quantity of any one type material furnished a project exceeds 1000 Tons, the variability of the total quantity furnished will be determined on the basis of the standard deviation for each sieve size. In the event the standard deviation is within the limits shown in the Standard Deviation Table, Table II-12, the unit bid price for the material will be adjusted as indicated hereinafter. Standard deviation computations will not be made separately on more than two job-mixes for the same type material unless a change is requested by the Department.

The unit bid price will be reduced by 0.5% for each adjustment point applied for standard deviation.

The disposition of material having standard deviations larger than those shown in Table II-12 will be determined by the Engineer. Adjustment Calculations on Material

**Computing Standard Deviation**

As previously pointed out, the standard deviation is a measure of variability. It is usually designated by the Greek symbol sigma ( $\sigma$ ), and in mathematical equation form is equal to:

Where:  $\Sigma$  = sum of

$$\sigma = \sqrt{\frac{\Sigma (X - \bar{X})^2}{n - 1}}$$

x = is the individual test result

$\bar{X}$  = is the average of all the test results and n is the number of test results.

While the formula may look complicated, the actual computing of the standard deviation is simple. The following example shows the procedure which should be used. Example: Given the following four test results for the 9.5 mm sieve, No. 21A Material. Test #1=56.6%, Test #2=64.2%, Test #3=77.5%, Test #4= 70.1%.

A table should be set up as follows:

n	x	$\bar{X}$	$x - \bar{X}$	$(x - \bar{X})^2$
---	---	-----------	---------------	-------------------

1. In the column headed n, list 1, 2, 3, 4 since there were four tests.

n
1
2
3
4

2. In the column headed  $x$ , list the individual test results in the problem.

n	x
1	56.6
2	64.2
3	77.5
4	<u>70.1</u>
	268.4

3. Add the results in the  $x$  column. This gives 268.4. Divide this total by the number of tests, which in this case is 4. This gives an average % passing the 3/8 in. (9.5 mm) sieve of 67.10. Show this value in the column headed  $\bar{X}$ . The average should always be shown to the nearest one-hundredth of a percent (two decimal places).

n	x	$\bar{X}$
1	56.6	67.10
2	64.2	67.10
3	77.5	67.10
4	<u>70.1</u>	67.10
	268.4	

4. Subtract the values in the  $\bar{X}$  column from the values in the  $x$  column. ( $56.6 - 67.10 = -10.50$ ), ( $64.2 - 67.10 = -2.90$ ), ( $77.5 - 67.10 = +10.40$ ), ( $70.1 - 67.10 = +3.00$ ). Record these values in the  $x - \bar{X}$  column. As a check, the values in this column can be added algebraically and should equal zero, except in cases where the average is not exact and has been rounded off to two decimal places

n	x	$\bar{X}$	$x - \bar{X}$
1	56.6	67.10	-10.50
2	64.2	67.10	-2.90
3	77.5	67.10	+10.40
4	<u>70.1</u>	67.10	<u>+3.00</u>
	268.4		0.00

5. Square the values in the  $x - \bar{X}$  column and record in the  $(x - \bar{X})^2$  column. ( $10.50 \times 10.50 = 110.25$ ), ( $2.90 \times 2.90 = 8.41$ ), ( $10.40 \times 10.40 = 108.16$ ), ( $3.00 \times 3.00 = 9.00$ ).

n	x	$\bar{X}$	$x - \bar{X}$	$(x - \bar{X})^2$
1	56.6	67.10	-10.50	110.2500
2	64.2	67.10	-2.90	8.4100
3	77.5	67.10	+10.40	108.1600
4	<u>70.1</u>	67.10	<u>+3.00</u>	<u>9.0000</u>
	268.4		0.00	235.8200

6. Add the  $(x - \bar{X})^2$  column. This gives a value of 235.8200.
7. Divide this value by the number of samples minus 1. In this case there are four samples ( $4 - 1 = 3$ ). Dividing 235.8200 by 3 we get 78.6067.

8. The only step left is to take the square root of 78.6067, which is 8.866 or 8.9. This is the standard deviation of the four test results.

$$\Sigma (X - \bar{X})^2 = 235.8200$$

$$\sigma = \sqrt{\frac{\Sigma (X - \bar{X})^2}{n-1}} = \sqrt{\frac{235.8200}{3}} = \sqrt{78.6067} = 8.866$$

Therefore: = 8.866 or 8.9

The standard deviation can be computed at any time and for any number of samples except one, since one number has no variability. However, each time a sample is run, the average will probably change, making it necessary to recompute each column. From this it can be seen that after very many samples have been taken, it will be quite a long process to determine the standard deviation. For this reason we are not requiring that the Department furnish the Contractor or Producer with standard deviations until the end of the project.

The Plant Quality Control Technician should; however, be familiar with the standard deviation and should know how to compute it, since it is our intention to assist the Producer with computing it until he is able to do so himself.

**TABLE II-12  
Standard Deviation**

<b>No. of Payment Adjustment Points for Each Sieve Size</b>			
<b>Sieve Size</b>	<b>1 Adjustment Point for Each Sieve Size</b>	<b>2 Adjustment Points for Each Sieve Size</b>	<b>3 Adjustment Points for Each Sieve Size</b>
2 in. (50.0 mm )	0.6-1.5	1.6-2.5	2.6-3.5
1 in. (25.0 mm)	4.6-5.5	5.6-6.5	6.6-7.5
3/4 in.(19.0 mm)	5.6-6.5	6.6-7.5	7.6-8.5
3/8 in. (9.5 mm)	7.1-8.0	8.1-9.0	9.1-10.0
No. 10 (2.00 mm)	5.6-6.5	6.6-7.5	7.5-8.5
No. 40 (425 μm)	3.6-4.5	4.6-5.5	5.6-6.5
No. 200(75 μm)	3.1-4.0	4.1-5.0	5.1-6.0

To: \_\_\_\_\_ Date: \_\_\_\_\_  
 From: \_\_\_\_\_ Project: \_\_\_\_\_  
 Subject: Price Adjustment for Non-Compliance Route : \_\_\_\_\_ County \_\_\_\_\_  
 FHWA# \_\_\_\_\_  
 Producer: \_\_\_\_\_  
 Type of Material: \_\_\_\_\_  
 Tons Represented: \_\_\_\_\_  
 Date Shipped: \_\_\_\_\_

The above material does not conform to our requirements by the results below:

Control Test Report Number	Sieve Size	Standard Deviation or test results	Allowable Deviation or Range	Fails By	Adjustment Points
	3 in. (75 mm)				
	2 in. (50 mm)				
	1 in.(25 mm)				
	3/4in. (19 mm)				
	3/8 in.(9.5 mm)				
	No. 10 (2 mm)				
	No. 40 (425 μm)				
	No. 200(75 μm)				
	L.L.				
	P.I.				
	Total Adjustment Points:				

District Materials Engineer

## **Control Charts**

A control chart is a graphical record of data taken from a repetitive process. The process is in statistical control when repeated measurements from the process behave as random samples dispersed about a target value.

The control chart used for central mix aggregate is based on the bell shaped (normal) curve; the control guides are obtained from standard deviations for the particular sieves. By using these guides and plotting the individual test results, the Contractor can predict when the process is getting out of control by using the warning signals that are shown on the chart. When one test results exceeds the number one warning signal, which is 2 standard deviations from the job-mix, the Contractor should investigate his process. The reason is that approximately 95% of the material should fall within this range.

When 3 consecutive test results exceed the number 2 warning signal, which is one standard deviation from the job-mix, the Contractor should also investigate his process. The reason is that approximately 68% of the material should fall within this range.

When 11 consecutive test results fall on the same side of the job-mix, the Contractor should also investigate his process. Eleven (11) is the statistical number that could indicate the job-mix was set on the wrong side and the Contractor is not getting full benefit of the process tolerances.

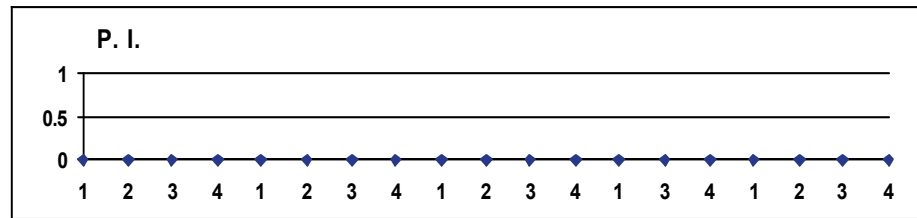
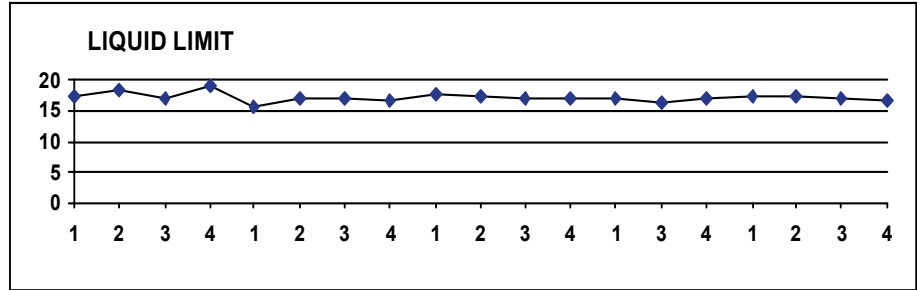
## **Plotting Control Charts**

It is our policy now to require the Producer to plot his own Control Charts. If he so desires, we will furnish and set-up the charts, and help him get started in the plotting. The Plant Quality Control Technician will be required to plot the Control Charts.

1. Fill out heading as indicated.
2. Fill in proper job-mix values for appropriate sieves from job-mix formula.
3. Control guides for all sieve sizes are listed at the bottom of sheet. Draw in Control Guides on appropriate Control Sieves in different colors. Example: Red lines for one-point controls and blue lines for three-point controls.
4. As soon as test values have been obtained on an individual sample, plot these values on their proper Control Sieve Chart.
5. After all four samples of a lot have been run, average the test results and plot these over the fourth test number of the lot. Test averages must be plotted in a different color than individual test results.

Location:  
 From \_\_\_\_\_  
 To \_\_\_\_\_  
 District \_\_\_\_\_

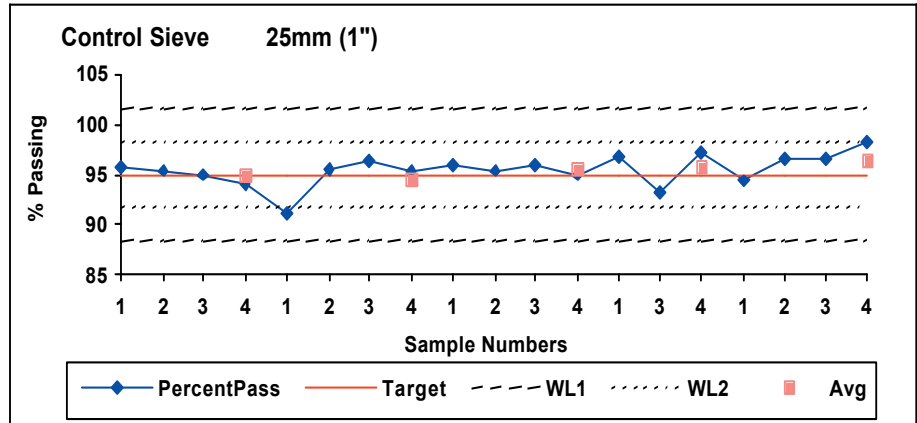
Project or Maintenance No. \_\_\_\_\_  
 Contractor \_\_\_\_\_  
 Aggregate Size \_\_\_\_\_



**CONTROL GUIDES**

**WARNING SIGNALS**

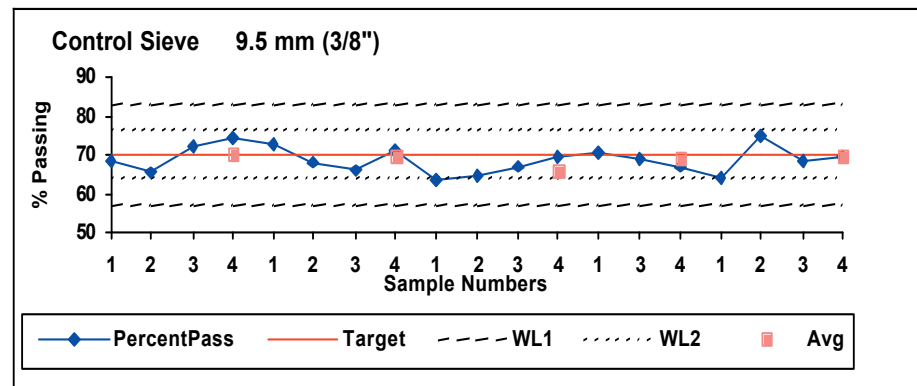
- (1) 1 PT. BEYOND  $\pm 6.7\%$
- (2) 3 CONSECUTIVE PTS. BEYOND  $\pm 3.3\%$
- (3) 11 CONSECUTIVE PTS. ON SAME SIDE OF JOB MIX.



**CONTROL GUIDES**

**WARNING SIGNALS**

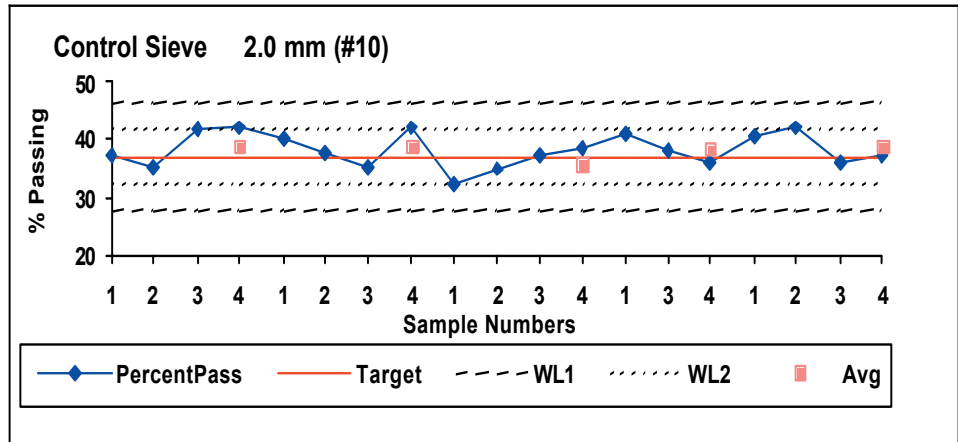
- (1) 1 PT. BEYOND  $\pm 12.7\%$
- (2) 3 CONSECUTIVE PTS. BEYOND  $\pm 6.3\%$
- (3) 11 CONSECUTIVE PTS. ON SAME SIDE OF JOB MIX.



**CONTROL GUIDES**

**WARNING SIGNALS**

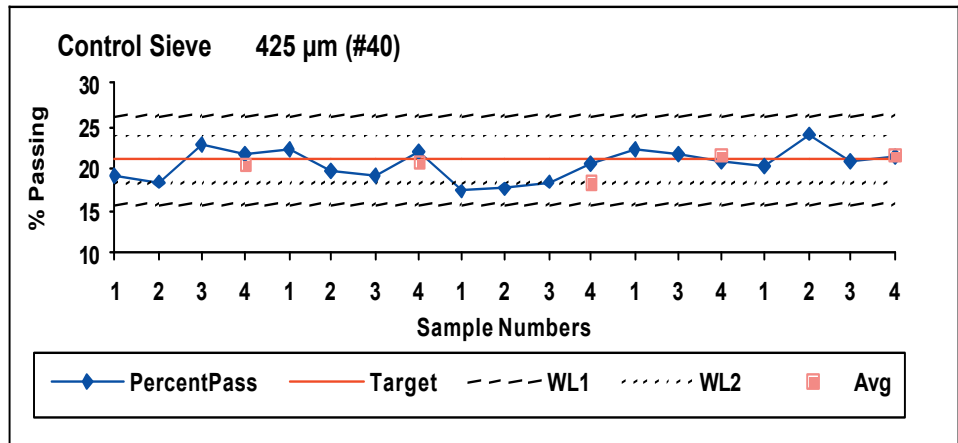
- (1) 1 PT. BEYOND  $\pm 9.3\%$
- (2) 3 CONSECUTIVE PTS. BEYOND  $\pm 4.7\%$
- (3) 11 CONSECUTIVE PTS. ON SAME SIDE OF JOB MIX.



**CONTROL GUIDES**

**WARNING SIGNALS**

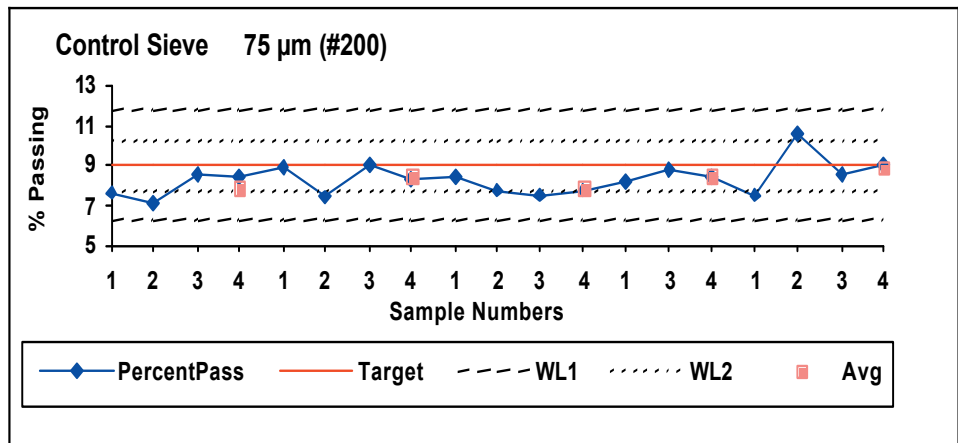
- (1) 1 PT. BEYOND  $\pm 5.3\%$
- (2) 3 CONSECUTIVE PTS. BEYOND  $\pm 2.7\%$
- (3) 11 CONSECUTIVE PTS. ON SAME SIDE OF JOB MIX.



**CONTROL GUIDES**

**WARNING SIGNALS**

- (1) 1 PT. BEYOND  $\pm 2.7\%$
- (2) 3 CONSECUTIVE PTS. BEYOND  $\pm 1.3\%$
- (3) 11 CONSECUTIVE PTS. ON SAME SIDE OF JOB MIX.



## **Referee System**

- (a) In the event the test results obtained from one of the four samples taken to evaluate a particular lot appear to be questionable, the Contractor may request that the results of the questionable sample be disregarded, where upon he shall perform tests on five additional samples taken from randomly selected locations in the roadway where the lot was placed. In the event the Engineer determines that one of the four test results appear to be questionable, the Department will perform tests on five additional samples taken from randomly selected locations in the roadway where the lot was placed. The test results of the three original (unquestioned) samples will be averaged with the tests results of the five road samples and the mean of the test values obtained for the eight samples will be compared to the requirements for the mean of eight tests as shown in Table II-10 and Table II-11.
  
- (b) In the event the Contractor questions the mean of the four original test results obtained for a particular lot, the Contractor may request approval to perform additional testing of that lot. In the event the Engineer determines that the mean of the four original test results are questionable, the Department will perform additional testing of that lot. The test results of the original four samples will be averaged with the test results of four additional samples taken from randomly selected locations in the roadway where the lot was placed and the mean of test values obtained for the eight samples will be compared to the requirements for the mean result of eight tests as shown in Table II-10 and Table II-11. If the Contractor requests further tests, the Contractor shall sample and test the material in accordance with Department approved procedures.

In the event the mean of the test values obtained for the eight samples conforms to the requirements for the mean results of eight tests, the material will be considered acceptable. In the event the mean of the test values obtained for the eight samples does not conform to the requirements for the mean result of eight tests, the lot will be adjusted in accordance with adjustment rate specified in Section 208.08. The provisions of this Section will not be applicable to mixes containing cement or other admixtures that alter the characteristics of the material. For Select Material the final mean results will be compared to the requirements for the mean of 8 tests as shown in the Select Material, Type I, Process and Range Tolerance and Allowable Limits.

**Chapter 4**  
**Acceptance of Material**  
**Questions**

1. What types of Portland Cement are allowed in stabilized Central-Mix aggregates?
  - A. Type I and Type II
  - B. Types I, I-P and III
  - C. Types I, I-P and II
  - D. Types I-P, II and III
  
2. What are the specification requirements for water used in cement treated aggregates?
  
3. In the production of cement stabilized aggregate, no one sample shall have a cement content below design by more than \_\_\_\_ percent.
  - A. 1.1%
  - B. 1.3%
  - C. 1.6%
  - D. 1.8%
  
4. If the total adjustment (excluding range adjustment) for the lot is greater than 25 points the failing material has to be removed from the road.
  - A. True
  - B. False
  
5. The maximum time interval between manufacture of cement treated aggregate and final shaping and compaction is \_\_\_\_\_.
  
6. Is it permissible to accept central-mix aggregate by visual inspection?
  
  
7. It is the Departments policy to require the producer to plot his own Control Charts.
  - A. True
  - B. False
  
8. If the job-mix formula on the 3/8 in. (9.5 mm) sieve is 68% passing, what is the acceptance range?

**Chapter 4**  
**Acceptance of Material**  
**Questions**

9. Can the acceptance range on a sieve fall outside of the Design Range for that particular sieve?
10. The contractor must accept the price adjustment.
- A. True
  - B. False
11. The pH requirement for water used in cement stabilized aggregate \_\_\_\_\_ to \_\_\_\_\_.
12. The ambient air temperature must be at least \_\_\_\_\_ before production can start for cement stabilized material.
- A. 50°F
  - B. 32°F
  - C. 40°F
  - D. 90°F
13. A lot is usually an average of:
- A. 2 samples
  - B. 6 samples
  - C. 8 samples
  - D. 4 samples
14. Standard Deviation and variability are the same thing.
- A. True
  - B. False
15. The Referee System can only be implemented by the contractor.
- A. True
  - B. False

**Chapter 4**  
**Acceptance of Material**

**Problem No. 1**

Complete the following test report and calculate the percent of unit price adjustment.

Type Mix - Stabilized Aggregate Base Type I, No. 21A

<b>Sample No.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Aver.</b>	<b>Lower</b>	<b>Upper</b>	<b>Job-Mix</b>	<b>P/F</b>
<b>Sieve Size</b>									
<b>2 in. (50 mm)</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>				<b>100.0</b>	
<b>1 in (25 mm)</b>	<b>96.0</b>	<b>100.0</b>	<b>98.5</b>	<b>100.0</b>				<b>97.0</b>	
<b>3/8 in. (9.5 mm)</b>	<b>70.9</b>	<b>67.3</b>	<b>74.9</b>	<b>62.8</b>				<b>67.0</b>	
<b>No. 10 (2.00 mm)</b>	<b>40.7</b>	<b>39.4</b>	<b>45.0</b>	<b>34.5</b>				<b>39.0</b>	
<b>No. 40 (425 μm)</b>	<b>22.5</b>	<b>21.5</b>	<b>25.4</b>	<b>19.7</b>				<b>24.0</b>	
<b>No. 200 (75 μm)</b>	<b>11.2</b>	<b>13.1</b>	<b>10.4</b>	<b>10.8</b>				<b>10.0</b>	
<b>L.L.</b>	<b>21.6</b>	<b>18.8</b>	<b>20.6</b>	<b>19.7</b>				<b>23.0</b>	
<b>P.I.</b>	<b>1.5</b>	<b>0.0</b>	<b>0.5</b>	<b>0.0</b>				<b>2.0</b>	
<b>Cement</b>	<b>3.9</b>	<b>3.2</b>	<b>2.5</b>	<b>2.7</b>				<b>4.0</b>	

**Chapter 4**  
**Acceptance of Material**

**Problem No. 2**

Complete the following test report and calculate the percent of unit price adjustment.

Type Mix - Stabilized Aggregate Base Type I, No. 21A

<b>Sample No.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Aver.</b>	<b>Lower</b>	<b>Upper</b>	<b>Job-Mix</b>	<b>P/F</b>
<b>Sieve Size</b>									
<b>2 in. (50 mm)</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>				<b>100.0</b>	
<b>1 in (25 mm)</b>	<b>100.0</b>	<b>98.0</b>	<b>96.0</b>	<b>97.4</b>				<b>95.0</b>	
<b>3/8 in. (9.5 mm)</b>	<b>70.8</b>	<b>67.1</b>	<b>62.8</b>	<b>66.7</b>				<b>67.0</b>	
<b>No. 10 (2.00 mm)</b>	<b>45.0</b>	<b>34.5</b>	<b>39.4</b>	<b>38.2</b>				<b>39.0</b>	
<b>No. 40 (425 μm)</b>	<b>21.3</b>	<b>25.4</b>	<b>20.8</b>	<b>24.1</b>				<b>24.0</b>	
<b>No. 200 (75 μm)</b>	<b>14.1</b>	<b>9.8</b>	<b>11.1</b>	<b>10.2</b>				<b>10.0</b>	
<b>L.L.</b>	<b>25.0</b>	<b>19.7</b>	<b>20.6</b>	<b>19.8</b>				<b>23.0</b>	
<b>P.I.</b>	<b>5.8</b>	<b>0.0</b>	<b>0.5</b>	<b>0.0</b>				<b>2.0</b>	
<b>Cement</b>	<b>3.3</b>	<b>2.5</b>	<b>2.9</b>	<b>2.9</b>				<b>4.0</b>	

**Chapter 4**  
**Acceptance of Material**  
**Problem No. 3**

Complete the following test report and calculate the percent of unit price adjustment.

Type Mix - Stabilized Aggregate Base Type I, No. 21A

<b>Sample No.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Aver.</b>	<b>Lower</b>	<b>Upper</b>	<b>Job-Mix</b>	<b>P/F</b>
<b>Sieve Size</b>									
<b>2 in. (50 mm)</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>				<b>100.0</b>	
<b>1 in (25 mm)</b>	<b>94.2</b>	<b>91.6</b>	<b>94.4</b>	<b>97.1</b>				<b>94.0</b>	
<b>3/8 in. (9.5 mm)</b>	<b>68.5</b>	<b>67.4</b>	<b>70.6</b>	<b>61.3</b>				<b>67.0</b>	
<b>No. 10 (2.00 mm)</b>	<b>34.2</b>	<b>32.4</b>	<b>34.8</b>	<b>40.9</b>				<b>34.0</b>	
<b>No. 40 (425 μm)</b>	<b>15.8</b>	<b>14.4</b>	<b>14.5</b>	<b>21.6</b>				<b>16.0</b>	
<b>No. 200 (75 μm)</b>	<b>8.8</b>	<b>8.7</b>	<b>8.0</b>	<b>9.9</b>				<b>11.0</b>	
<b>L.L.</b>	<b>20.5</b>	<b>19.1</b>	<b>20.0</b>	<b>28.6</b>					
<b>P.I.</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>4.2</b>					
<b>Cement</b>	<b>3.3</b>	<b>2.7</b>	<b>2.5</b>	<b>3.5</b>				<b>4.0</b>	