WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
MATERIALS PROCEDURE

SOUNDNESS OF AGGREGATES USING SODIUM SULFATE

1. PURPOSE

1.1 To establish a procedure testing aggregates for soundness following guidelines set forth by AASHTO T-104.

2. SCOPE

2.1 This procedure is designed to determine resistance to disintegration by saturated solution of sodium sulfate in both coarse and fine aggregates.

3. APPLICABLE DOCUMENTS

3.1 Reference to standard specifications and other standard procedures shall be the applicable current edition of the published document(s).

3.1.1 West Virginia Department of Transportation, Division of Highways Standard Specifications Road and Bridges.

3.1.2 Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate, American Association of State Highway Transportation Officials (AASHTO), Designation: T 104-99 (2016).

3.1.3 Standard Test Method for Evaluation of Durability of Rock for Erosion Control Using Sodium Sulfate or Magnesium Sulfate, ASTM International (ASTM), Designation D5240/D5240M – 12.

4. APPARATUS

4.1 Sieves, containers for samples, apparatus for immersing samples in solution, suitable means of regulating temperature of the samples in the sodium sulfate solution, thermometer, temperature recorder, balance, drying oven, hydrometer, and other equipment as specified in AASHTO T-104, Sections 3.1 thru 3.9.

4.1.1 Before starting a test, all equipment, especially sieves, shall be inspected, adjusted and cleaned as necessary.

5. SPECIAL SOLUTION REQUIRED

5.1 Prepare the sodium sulfate solution for immersion of test samples in accordance with AASHTO T-104, Section 4.1 and 4.1.1 (Notes 2 and 3).

5.2 Prepare the barium chloride solution for rinse verification of a tested sample in accordance with AASHTO T-104, Section 4.2.

NOTE: After the new sulfate solution has been maintained at the designated temperature for at least 48 hours and prior to use, it is recommended that crushed limestone be introduced into the new sulfate solution for an additional 48-hour period. This is to prevent any harmful chemical reaction which may occur between the carbonates and the freshly prepared sulfate solution.

6. SAMPLES

6.1 Fine Aggregate

6.1.1 A representative portion shall be split from the field sample by means of a sample splitter or quartering. The test portion shall be of such size that it will yield not less than 120 grams. of each of the following sieve fractions which are present in amounts of 5 percent or more in accordance with the mid-band grading of standard aggregate sizes for fine aggregates.

6.1.2 The test portion shall consist of material which passed through a 3/8" (9.5 mm) sieve.

6.1.3 The sample shall be of such a size that it will yield the following amounts of the different sizes that are available in amounts of 5 percent or more:

Table 6.1.3 – FINE AGGREGATE TEST PORTION

PASSING SIEVE		RETAINING SIEVE	
English	Metric	English	Metric
3/8"	(9.5 mm)	No. 4	(4.75 mm)
No. 4	(4.75 mm)	No. 8	(2.36 mm)
No. 8	(2.36 mm)	No. 16	(1.18 mm)
No. 16	(1.18 mm)	No. 30	(600 µm)
No. 30	(600 µm)	No. 50	(300 µm)

6.1.4 When setting up test portions in accordance with Section 6.2.3, such as combining 1 inch (25 mm) and ¾ inch (19 mm) material, should there be insufficient material of one of these sizes or should there be no material at all of one of these sizes; then, reduce the test portion by the applicable mass specified in Section 6.2.3 for the size not available.

6.1.5 When test portion sizes are not available in sufficient quantities to make up the desired test portion, or are less than 5 % of the aggregate being tested then those sizes shall not be tested.

6.2 Coarse Aggregate

6.2.1 A representative portion shall be split from a field sample by means of a sample splitter or quartering.

6.2.2 The test portion shall consist of material from which the sizes finer than the No. 4 (4.75 mm) sieve have been removed.

6.2.3 The sample shall be of such a size that it will yield the following amounts of the different sizes that are available in amounts of 5 percent or more:

Table 6.2.3 – COARSE AGGERGATE TEST PORTION

SIEVE TEST PORTIONS		MASS (g)
2 1/2 inches to 1 1/2 inches (63 mm to 37.5 mm)		5000 ± 300
Consisting of:		
	2 1/2 inches to 2 inches (63 mm to 50 mm) material	3000 ± 300
	2 inches to 1 1/2 inches (50 mm to 37.5 mm) material	2000 ± 200
1 1/2 inches to 3/4 inches (37.5 mm to 19 mm)		1500 ± 50
Consisting of:		
	1 1/2 inches to 1-inch (37.5 mm to 25 mm) material	1000 ± 50
	1 inch to 3/4-inch (25 mm to 19 mm) material	500 ± 30
3/4 inch to 3/8-inch (19 mm to 19 mm) material		1000 ± 10
Consisting of:		
	3/4 inch to 1/2 inch (19 mm to 12.5 mm material)	670 ± 10
	1/2 inch to 3/8-inch (12.5 mm to 9.5 mm) material	330 ± 5
3/8 inch (9.5 mm) to No. 4 (9.5 mm to 4.75 mm)		300 ± 5

6.2.4 When setting up test portions in accordance with Section 6.2.3, such as combining 1 inch (25 mm) and ¾ inch (19 mm) material, should there be insufficient material of one of these sizes or should there be no material at all of one of these sizes; then, reduce the test portion by the applicable mass specified in Section 6.2.3 for the size not available.

6.2.5 When test portion sizes are not available in sufficient quantities to make up the desired test portion, or are less than 5% of the aggregate being tested then those sizes shall not be tested.

6.3 For purposes of evaluating the entire sample, test portion sizes that are not tested will be calculated in accordance with Section 11.8.

6.4 When an aggregate sample contains both fine and coarse material, the fine and coarse fractions shall be tested separately. Each fraction shall be prepared and tested in accordance with the procedures for fine aggregate and coarse aggregate, respectively (6.1 and 6.2).

6.4.1 Calculate and report test results by combining the final results of both the coarse and fine aggregate test fractions. Calculations are based on the mid-bands (weighted average) of standard aggregate sizes as found in Table 6.4.1.

SIZE	REC/PROP	1½ in	3/4 in	3/8 in	# 4	# 8	# 16	# 30	# 50
AASHTO #3	% PASS MID	48	48	2					
AASHTO #3	MID-BAND	48	50	1					
AASHTO #4	MID-BAND	5	88	5					
AASHTO #56	MID-BAND		38	55	5				
AASHTO #57	MID-BAND		28	42	25	3			
AASHTO #68	MID-BAND		5	45	35	10	3		
AASHTO #7	MID-BAND			45	48	5			
AASHTO #78	MID-BAND			42	42	10	2		
AASHTO #8	MID-BAND			5	58	20	13		3
AASHTO #89	MID-BAND			5	58	20	13	3	
AASHTO #9	MID-BAND			0	8	68	20		3
MORTAR SAND	MID-BAND					5	36	25	12
FINE AGGREGATE	MID-BAND			0	3	22	17	17	22
WV 704.6.2A CLASS 1	MID-BAND		30	22	13	10	9	5	4
WV 704.6.2A CLASS 2	MID-BAND		10	20	15	14	11	7	7
WV 704.6.2A CLASS 8	MID-BAND		10	24	11	21	2	4	12
WV 704.6.2A CLASS 9	MID-BAND		10	20	15	12	9	8	4
WV 704.6.2A CLASS 10	MID-BAND		15	19	14	12	9	6	4

7. PREPARATION OF TEST SAMPLES

7.1 Fine Aggregate

7.1.1 The fine aggregate shall be washed over a No. 50 (300 µm) sieve. Washing shall be continued until the wash water becomes clear, the material retained on the No. 50 (300 µm) sieve shall be dried to a constant weight at 230 ± 9°F (110 ± 5°C)..

7.1.2 The washed portion shall be separated into different sizes by sieving as follows: Make a rough grading of the sample by means of a set of nested sieves as specified in 6.1.2 by mechanically sieving for 5 minutes. From the fractions obtained in this

manner, select samples from each sieve of sufficient size to yield not less than 100 grams, (Generally, a 120 gram sample will be sufficient). Renest the sieves with intermediate retainer pans to prevent intermingling and mechanically shake for 10 minutes, then check for thoroughness of sieving as defined in AASHTO T-27, Paragraph 7.4. If necessary, continue sieving until the requirements of Paragraph 7.4 are met.

7.1.3 Weigh out test portions of 100 ±0.5 grams from each of the separated sieve fractions. Record initial weights to nearest 0.1 gram.

7.1.4 Fine aggregate sticking in the meshes of the sieves shall not be used in preparing the test portion. Carefully clean the sieves after each use by removing and discarding any particles sticking in the meshes of the sieves.

7.1.5 Place the individual test portions into separate containers for testing. Containers for all fractions finer than the No. 4 (4.75 mm) sieve shall be the standard 3 inch (76 mm) diameter testing sieves, with two sieves nested to completely enclose the sample. Screen sizes to be used with each fraction are as follows:

Table 7.1.4 – CONTAINER SIEVE SIZES

TEST PORTION SIEVE SIZE		CONTAINER SIEVE SIZE	
English	**Metric**	**English**	**Metric**
3/8" - No. 4	(9.5 mm) - (4.75 mm)	No.10	(2 mm)
No. 4 - No. 8	(4.75 mm) - (2.36 mm)	No.10	(2 mm)
No. 8 - No. 16	(2.36 mm) - (1.18 mm)	No. 20	(850 µm)
No. 16 - No. 30	(1.18 mm) - (600 µm)	No. 40	(425 µm)
No. 30 - No. 50	(600 µm) - (300 µm)	No. 60	(250 µm)

7.2 Coarse Aggregate

7.2.1 The coarse aggregate sample shall be mechanically sieved for 10 minutes or hand sieved to refusal until none of the particles being sieved are passed in one minutes time, so as to yield sufficient quantities of the different sizes within the tolerances of Paragraph 6.3.1.

NOTE: Finger manipulation of the particles may be used to determine refusal.

7.2.2 Thoroughly wash the individual fractions over a No.4 (4.75 mm) screen and dry to constant weight at a temperature of 230 ± 9°F (110 ± 5° C).

7.2.3 Weigh out the amounts required for test portions as specified in Paragraph 6.3.1. Record the initial weights to the nearest gram.

7.2.4 Place the test portions into separate containers for testing.

NOTE: Containers for the 3/8 inches (9.5 mm) to No. 4 (4.75 mm) fraction shall be constructed of 1/8 inches (3.2 mm) galvanized hardware cloth with dimensions approximately 3 inches (76 mm) x 3 inches (76 mm) x 2 inches (51 mm) deep. Containers for ¾ inches (19 mm) to 3/8 inches (9.5 mm) fractions shall be constructed of ¼ inches (6.4 mm) galvanized hardware cloth with dimensions approximately 4 ½ inches (114 mm) x 4 ½ inches (140 mm) x 1 ½ inches (38 mm) deep. Containers for the plus ¾ inches (19 mm) fractions shall be constructed of ¼ inches (6.4 mm) galvanized hardware cloth with dimensions approximately 4 ½ inches (114 mm) x 6 ½ inches (165 mm) x 3 inches (76 mm) deep. Place the test portions into separate containers for testing.

7.3 Ledge rock submitted for testing before final commercial preparation shall be crushed. Testing shall be performed in accordance to Section 7.2.

7.4 Stone for riprap, special rock fill, rock gutter, etc. shall be tested in accordance with their intended use. Representative test portions shall be selected from the sample and tested as follows: The sample shall be thoroughly washed and dried to a constant weight at a temperature of 230 ± 9°F (110 ± 5°C).. Allow the sample to cool to room temperature. Place the test portion into suitable containers for testing.

8. PROCEDURE

8.1 The samples shall be immersed in the prepared solution of sodium sulfate for not less than 16 hours nor more than 18 hours in such a manner that the solution covers them to a depth of at least 12.7 mm.

NOTE: Suitably weighted wire grids placed over the sample containers will prevent lightweight aggregates from floating out of the container.

8.2 The solution should be covered to reduce evaporation and prevent the accidental addition of extraneous materials into the test portions.

8.3 The samples shall remain immersed in the solution at a temperature of 70 ± 2°F (21 ± 1°C) for the immersion period.

8.4 Remove the test portions from the solution and allow to drain for 15 ± 5 minutes, and then place in the drying oven. The temperature of the oven shall have been brought previously to 230 ± 9°F (110 ± 5°C). Dry samples at the specific temperature until constant weight has been achieved.

NOTE: Time required to establish a condition of constant weight can be attained as follows: With the oven containing the maximum sample load expected, check the weight losses of test samples by removing and weighing them, without cooling, at intervals of 2 to 4 hours, make enough checks to establish required drying time for the least favorable oven location (See AASHTO T-104) and sample condition. A condition of constant weight will be considered to have been achieved when weight loss is less than 0.1 percent of sample weight in 4 hours of drying. When such a determination has been made, samples may be considered to have attained a constant weight when they have been dried at the specified temperature for an equal or longer period of time than that which has previously been found to be adequate for producing the desired constant weight condition under equal or heavier loading conditions of the oven.

8.5 After removal of the test portions from the solution, the specific gravity and temperature of the solution shall be determined and recorded. Any necessary adjustments to the specific gravity and temperature can be made upon removal of the test portions from the solution.

8.6 After drying, allow samples to cool to room temperature, when they shall again be immersed in the prepared solution as described in 8.1.

NOTE: If the test must be continued over a weekend, leave the samples in an oven-dried condition (constant weight) at room temperature and resume the cycles on the next work day.

8.7 Repeat the steps outlined in Paragraphs 8.1 through 8.6 until five immersions and drying cycles have been completed.

NOTE: A record shall be kept of the number of cycles that each test portion undergoes to prevent over or under cycling.

9. QUANTITATIVE EXAMINATION

9.1 After the final drying cycle, cool the test portions to room temperature. Wash the test portions free of the sodium sulfate solution by soaking the test portions in a

circulatory bath of water at 110 ± 10°F (43 ± 6°C) for one hour or more as determined by the reaction of the rinse water with barium chloride ($BaCL_2$). If reaction occurs, as evidenced by a milky, white precipitate, continue washing and rinsing. Washing may be considered complete when no reaction occurs. In the washing operation, the samples shall not be subjected to impact or abrasion that may tend to break up particles.

NOTE: The washing procedure may be accomplished more effectively if the test portions were placed in the bottom of a tank where hot water may be introduced near the bottom and allowed to overflow. After the sodium sulfate solution has been removed, each fraction of the sample shall be dried to a constant weight at 230 ± 9°F (110 ± 5°C).. When the test portions have dried, allow them to cool to room temperature.

9.2 Mechanically sieve the fine aggregate fraction for 10 minutes over the same sieves with intermediate retainer pans as specified in Paragraph 6.1.2. Weigh the residue retained after sieving, including all material cleaned from the meshes of the screen to the nearest 0.1 gram and record.

9.3 Hand sieve the coarse aggregate fraction over the sieve shown below for the appropriate size of particle:

Table 9.3 –SIEVE SIZE

SIZE OF AGGREGATE		**SIEVE USED TO DETERMINE LOSS**	
English	**Metric**	**English**	**Metric**
2 1/2 inches to 1 1/2 inches	(63 mm) to (37.5 mm)	1 1/4 inch	(31.5 mm)
1 1/2 inches to 3/4 inches	(37.5 mm) to (19 mm)	5/8 inch	(16.0 mm)
3/4 inch to 3/8 inch	(19 mm) to (9.5mm)	5/16 inch	(8.0 mm)
3/8 inch to No. 4	(9.5 mm) to (4.75 mm)	No. 5	(4.0mm)

9.4 Hand sieving shall be conducted with agitation sufficient only to assure that all undersize material passes the designated sieve. No extra manipulation shall be employed to break up particles or cause them to pass the sieves. Weigh the residue retained after sieving, including all material cleaned from the meshes of the screen to the nearest gram and record. Ledge rock examination shall be conducted in the same

manner as for any coarse aggregate using the appropriately designated sieve shown above for the appropriate sized particles. Weigh to the nearest gram and record.

9.5 In the case of stone for riprap, special rock fill, rock gutters, etc., weigh the sample to the nearest gram and record.

NOTE: The difference between each of these amounts and the initial weight of the fraction of the sample tested is the loss in the test and is to be expressed as a percentage of the initial weight.

10. MID-BAND GRADATION REQUIREMENTS

10.1 Mid-bands are the percent retained at stated testing sieve sizes defined in AASHTO T-104 and in Section 10 and Table 6.4.1 of this MP and are computed from the mean of the most and least permitted passing from largest to smallest sieve based on aggregate sizes as defined in West Virginia Department of Transportation, Division of Highways, Standards Specifications, Roads and Bridges, Sections 702, 703, and 704, or the average percent retained based on sieve analysis of representative samples of the source.

10.2 Fine Aggregate

10.2.1 The gradation used to calculate the weighted percentage loss shall normally be a mid-band grading of standard sized fine aggregate as shown in Table 6.4.1.

10.3 Mortar Sand

10.3.1 The gradation used to calculate the weighted percentage loss for mortar sand shall normally be a mid-band grading of a standard mortar sand as shown in Table 6.4.1.

10.4 Coarse Aggregate

10.4.1 Hand sieve the coarse aggregate fraction over the sieve shown below for the appropriate size of particle:

10.4.2 The gradation used to calculate the weighted percentage loss for aggregate consisting of a combination of coarse and fine fractions shall be the mid-band grading of the sizes of aggregate being tested. Table 6.4.1 lists mid-band weightings for Concrete Aggregates, Base Course Aggregates, Classes 1, 2, 7, 8, and 9. The

percentage loss for stone and riprap, rock gutter, special rock fill, etc., shall be the total percentage loss of the test portion. No weighting will be necessary.

10.5 The percentage loss for stone and rip rap, rock gutter, special rock fill, etc., shall be the total percentage loss of the test portion. No mid-bands are necessary.

10.6 The gradation used to calculate the weighted percentage loss when the standard size is unknown shall be governed by the largest size particle present in the test portion, as listed in Table 10.6.

TABLE 10.6 MID-BAND GRADATIONS WHEN THE SPECIFIC AGGREGATE SIZE IS UNKNOWN

SOUNDNESS OF AGGREGATES BY SODIUM SULFATE							
TOP SIZE OF AGGREGATE		**1½ in**	**3/4 in**	**3/8 in**	**No. 4**	**No. 8**	**No. 16**
SIEVE SIZE		**2 in**	**1½ in**	**1 in**	**3/4 in**	**1/2 in**	**3/8 in**
2 1/2" - 1 1/12"		47	5				
1 1/2" - 3/4"		47	87	36	5		
3/4" - 3/8"		6	8	47	57	37	5
3/8" -#4				15	33	48	60

11. CALCULATIONS

11.1 The report shall include the following data and shall be recorded on Form HS-9. Refer to Form HS-9 on the WVDOH, MCS&T Webpage Tool Box[1]. A sample of this form is also attached for reference.

11.2 Weighted average calculated from each fraction, based on the grading of the sample as received for examination determined by using T27 or, preferably, on the average grading of the material from that portion of the supply of which the sample is representative; that being the mid-band grading (A) of standard sized aggregates as listed in Table 6.4.1.

11.3 The weight of each sieve fraction before testing is expressed as an initial weight (B).

11.4 The weight of each sieve fraction of each sample retained after sieving is expressed as a final weight (C).

11.5 The weight loss (D) of each fraction of each sample is the difference between the initial sieve fraction weight (B) and the final sieve fraction weight (C).

$$D = (B - C)$$

[1] http://transportation.wv.gov/highways/mcst/Pages/tbox.aspx

11.6 The percentage of loss (E) is calculated for each sieve fraction, as a quotient of the weight loss (D) and the initial weight (B) of each sieve fraction.

$$E = D/B \times 100$$

11.7 The weighted percentage loss (F) is calculated for each sieve fraction, as a product of the percentage of loss (E) and the mid-band grading (A) of the portion of the sample testeddivided by the sum of all mid-band gradings of the sample as tested.

$$F = E \times A$$

NOTE: Material finer than a No. 50 sieve is assumed to be sound. Therefore, the percent loss for material finer than a No. 50 sieve is 0. The difference between the sum of the mid-bands listed in the tables for each aggregate size and 100 is the mid-band for the portion of material finer than a No. 50 sieve for that aggregte size. Therefore,the divisor for the sum of weighted percent loss shall be 100.

11.8 The weighted percentage loss shall be calculated to the nearest 0.1 percent.

11.9 Sizes finer than the Number 50 (300 µm) sieve shall be assumed to have 0 percent loss.

11.10 The total weighted percentage loss is calculated as the sum of each weighted percentage loss (F) of each sieve fraction divided by the sum of mid-bands for the aggregate sample tested.

$$\text{Total weighted percentage loss} = \sum F/100$$

11.11 For aggregates containing appreciable amounts of both fine and coarse material calculate their weighted percentage losses collectively for both the minus No.4 (4.75 mm) and plus No. 4 (4.75 mm) fractions based on their mid-band gradings, considering both the fine and coarse fractions combined as 100 percent. Report the results jointly giving the percentage of the minus 4.75 mm and plus 4.75 mm material as one sample.

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Director
Materials Control, Soils & Testing Division

RLS: MBs
Attachment

WEST VIRGINIA DIVISION OF HIGHWAYS, DEPARTMENT OF TRANSPORTATION

MATERIALS CONTROL, SOILS, AND TESTING DIVISION

WEST VIRGINIA DIVISION OF HIGHWAYS, DEPARTMENT OF TRANSPORTATION

F.S. No.: _____ Lab No.: _____ Pass/Fail/NPF: _____

Specification: _____ Total Weighted Percent Lo _____

Type of Gradation: _____ Specification Requirement _____

Date Prepared _____ Materials Code: _____ Nominal Max Size: _____

Date Started: _____ Type Material: _____ Mid-Band Type: _____

Date Completed: _____ Source: _____ (AASHTO AGG. NUMBER) _____

SIEVE SIZE		(A)	(B)	(C)	(D)	(E)	(F)	
PASSING	RETAINED	% OF TOTAL SAMPLE (A/B) (MID-BAND)	INITIAL MASS, 0.1 gram	FINAL MASS, 0.1 gram	MASS LOSS (B-C)	PERCENTAGE OF LOSS (D/B x 100)	WEIGHTED % LOSS, (A X E)	COMMENTS
2-1/2" (63 mm)	1-1/2"(37.5 mm)	20.0	100.0	90.0	10.0	10.00	200.00	
1-1/2"(37.5 mm)	3/4" (19 mm)	20.0	100.0	90.0	10.0	10.00	200.00	
3/4" (19 mm)	3/8" (9.5 mm)	0.0	100.0	90.0	10.0	10.00	0.00	
3/8" (9.5 mm)	#4 (4.75 mm)		100.0	90.0	10.0	10.00	0.00	
#4 (4.75 mm)	#8 (2.36 mm)		100.0	90.0	10.0	10.00	0.00	
#8 (2.36 mm)	#16 (1.18 mm)		100.0	90.0	10.0	10.00	0.00	
#16 (1.18 mm)	#30 (600 µm)		100.0	90.0	10.0	10.00	0.00	
#30 (600 µm)	#50 (300 µm)		100.0	90.0	10.0	10.00	0.00	

SUM OF WEIGHTED LOSS (∑H/100)= **4.0** **=% OF LOST MATERIAL**

TESTED BY: CALCULATED BY:

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
MATERIALS PROCEDURE

ACCEPTANCE CRITERIA FOR STEEL WIRE REINFORCEMENT USED IN CONCRETE

1. PURPOSE

1.1 Establish a procedure to qualify approved and non-approved manufactures that produce drawn bright finish wire reinforcement for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of such information.

1.3 To establish a procedure for transmitting such information to the Districts and contractors of WVDOH projects.

2. SCOPE

2.1 This procedure shall apply to all producers who "manufacture" from a rough casted steel rod material to a drawn smooth bright finish wire product or produce a welded wire reinforcement product "WWR" from smooth bright finish wire.

2.2 This procedure will not apply to precast concrete fabricators such as concrete pipe manufactures that draw their own bright finish wire reinforcement by automated casting equipment. This WWR shall be approved for use by Q-cast certification requirements as per Table 1 of M.P. 603.02.10

~~2.2~~ 2.3 This procedure shall apply to all steel wire reinforcement for concrete furnished to WVDOH projects and purchase orders. ~~The WVDOH may elect to use other control procedures when special conditions dictate.~~

3. APPLICABLE DOCUMENTS

3.1 ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

3.2 NTPEP Certificate of conformance from manufacturer.

4. ACCEPTANCE PROCEDURE

4.1 With each shipment, the wire manufacture shall provide shipping documents which contain either the steel wire approved source number, or the approval number that was assigned to the material as per Section 6.1 of this document.

5. ACCEPTANCE PROCEDURE (APPROVED SOURCE LIST)

5.1 For a producer to be considered an approved source manufacturer of steel reinforcement wire, either welded or non-welded, the manufacturer must comply with the following ~~requirements:~~ requirement:

~~5.2 The manufacturer is to submit a statement to the WVDOH Materials Control, Soils and Testing (MCS&T) indicating intention to be included on the WVDOH approved source list (APL) as an approved source of steel wire reinforcement for concrete.~~

5.3 The prospective source shall produce a certificate indicating the prospective source is an active member in compliance with the National Transportation Product Evaluation Program "NTPEP." [1]

~~5.4 The prospective source shall additionally submit a certified statement that all material shipped to the MCS&T will conform to Specification ASTM A1064 or AASHTO M32. A representative of the manufacturer that has the authority to bind the company shall sign the certified statement.~~

~~5.5 An evaluation and sampling of the material at the manufacturing facility shall be conducted by MCS&T personnel or by their designee for conformance to ASTM A1064. This shall be to reinforce confidence in the ability of the facility to produce a quality product within WVDOH Specifications.~~

~~5.5.1 Five samples each, five foot in length, each of different sizes or lots are to be tested by MCS&T or their designee (as determined by the active date as discussed in Section 5.6) to confirm WVDOH specification compliance~~.

5.6 Once the above requirements ~~is~~ are met, a laboratory approval number will be assigned to the manufacturer to indicate WVDOH requirement conformance, this approval number shall be active for one year. Acceptance of manufacturers facility can be verified by accessing the MCS&T online approved source list.

5.7 Revocation of approved source status may result from non-conformance to NTPEP participation. ~~or tested material that does not comply with the specifications listed above.~~

5.8 "Approved Source" approval may be reinstated at the discretion of the MCS&T based on the findings of an investigation. The reinstatement process will commence upon the receipt of a letter of request from the manufacturer to the MCS&T. The letter of request should indicate reasons for reinstatement, and documentation to substantiate such reasons.

6. ACCEPTANCE PROCEDURES (NON-APPROVED SOURCE)

6.1 Steel wire used for concrete reinforcement will require testing and evaluation on a lot-by- lot basis by direct coverage, provided the material meets the following requirements:

6.2 The wire source shall produce a certificate indicating the manufacturing source of basic bright finish wire is an active member in compliance with the National Transportation Product Evaluation Program "NTPEP". Or the wire source obtains its WWR material as described in section 2.2 of this M.P.

~~6.3~~ ~~A five-foot length of basic bright finish steel reinforcement representative of the sizes and heats used in the concrete structure shall be obtained by MCS&T personnel or its designee to be tested in MCS&T laboratories or their designee's laboratories.~~

~~6.4~~ ~~The metallic components of the wire shall be tested to conform to the requirements of ASTM A1064 for yield, tensile, and reduction.~~

6.5 If ~~the results of~~ the evaluation ~~testing~~ reveal that the material is in compliance with the above Specification, ~~Specifications,~~ an approval number will be issued by the MCS&T that shall be affixed to the shipping documents of the basic bright finish steel reinforcement.

7. DOCUMENTATION REPORT

7.1 An updated list of steel wire reinforcement for concrete shall be conducted once a year, but no longer than two, and can be updated at any time with a new facility, or with a removal of a facility.

7.2 A current approved list of steel wire reinforcement is available to all contractors, fabricators, and suppliers by accessing the MCS&T APL Website[2]

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[2] https://transportation.wv.gov/highways/mcst/Pages/Listings_Sorted.aspx

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ORIGINAL ISSUANCE: XX XX, 20XX

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
MATERIALS PROCEDURE

ACCEPTANCE OF NON-STANDARD OR NON-CONFORMING MATERIALS IN CONSTRUCTION

1. PURPOSE

1.1 To provide guidelines of sampling, testing and resolution of all materials that may be addressed in in plans, but are not otherwise addressed by the current edition of the Standard Specifications and Supplementals (Standard Specifications) and/or Materials Control, Soils and Testing Division (MCS&T) testing.

1.2 Provide a method for accepting material that does not meet the requirements of the above-mentioned documents and is not otherwise addressed in those documents.

1.3 Provide guidelines and/or course of action/inaction when a material test has not been performed or has been performed incorrectly.

2. SCOPE

2.1 This procedure applies to all materials that do not have an already established acceptance, or non-conformance resolution already established in the Standard Specifications, or any other WVDOH documents.

2.2 This procedure applies to situations where the resolution of a non-conformance is not clearly defined or described by the Standard Specifications or other WVDOH documents, or the District wishes to diverge from these documents.

3. PROCEDURE

3.1 ST-1 - The special testing (ST-1) form shall be submitted to MCS&T with documentation and/or data sheets pertaining to the proposed material. ~~The ST-1 is to be submitted prior to use for all materials.~~ Pre-sampled material cannot be used until authorization is received from the MCS&T Division or the non-conformance has been resolved.

3.1.1 Payment for this material shall be withheld upon non-concurrence of this sample, pending a DMIR.

3.2 DMIR – A District Materials Inspection Report (DMIR) shall be submitted to MCS&T for consideration ~~authorization / approval~~ for the following situations:

3.2.1 The Material did not meet the Standard Specifications or other Division Testing Requirements.

3.2.2 The Material is not addressed in the Standard Specifications or other Division Documents and has been placed before testing (ST-1 or acceptance methods were not utilized.)

Commented [D1]: Give MCST ability to Reject a ST-1? – In the case of "improper use of ST-1"

Commented [LDL2]: Very often the district issues an ST-1 long after using the material.. if they issued an ST-1 prior to using the material, then they should get it approved by DC coverage. DB DC is for like Lagging etc, they need to do a DMIR

Commented [LDL3]: Shouldn't this say consideration? DB –Yes fixed thanks.

Commented [LDL4]: Should this say "approval or non-approval" we may not agree with the DMIR and respond otherwise, DB – Yes Fixed Thanks!

3.2.3 Sampling and/or testing was not done correctly, samples or documentation was lost, or testing otherwise cannot be used to represent or accept the material.

3.2.4 The resolution of the material has not been addressed in a change order or other contractual resolutions.

4. ST-1 DOCUMENTATION AND SUBMISSION TO MCS&T

4.1 The ST-1 Form is available as a pdf file on the Division Webpage[1]. This form shall be filled out with all the listed information pertaining to the material that the contractor proposes to use, or has used. All required fields must be completed before submitting the ST-1 to MCS&T.

4.1.1 The District must electronically send the fillable PDF form. This cannot be hand-written and scanned (the Sample ID must be able to be selected for Copy and Paste).

4.2 The ST-1 ~~s~~sample ~~s~~hall be submitted by District Construction to the District Materials Supervisor. The District shall then generate the sample and associate all line items before submitting the ST-1 sample to MCS&T for review and concurrence/non-concurrence. A workflow guideline for this is available in the MCS&T ProjectWise folder (location provided by request.)

4.3 The ST-1 shall be sent to the ST-1/DMIR mailbox (St1dmir@wv.gov). The sample shall be logged and sent to the applicable MCS&T section to review. If the subject material(s) meets the project requirements, MCS&T will concur with the sample. The reviewer will then authorize the sample.

4.3.1 An email will be generated to the District Materials Supervisor notifying them that the ST-1 has been concurred and authorized. The District will place the ST-1 and MCS&T email into ProjectWise under the Contract ID and associated line item number.

4.4 If the material fails to meet the minimum requirements, the reviewer will mark the sample as non-concur, then authorize the ~~sample~~ST-1. ~~The reviewer~~MCS&T will send the ST-1 to the District Materials Supervisor stating why the ST-1 was not concurred. The District will place the ST-1 and MCS&T email into ProjectWise under the Contract ID and associated line item number.

5. DMIR DOCUMENTATION AND SUBMISSION TO MCS&T

5.1 The DMIR shall also include all the pertinent project information that is provided on the WVDOH DMIR form. A sample DMIR form is attached. The live DMIR form is available on the WVDOH MCS&T Webpage.

5.1.1 The DMIR shall be sent to the ST-1/DMIR mailbox (St1dmir@wv.gov).

[1] https://transportation.wv.gov/highways/mcst/Pages/tbox.aspx

Commented [LDL5]: I thought a ST-1 was to be used after the contractor used the material but did not get prior approval for the material as per section 106.3 this requirement sounds like what would be used on a 440 form.

DB – Updated to reflect both cases

Commented [LDL6]: I assume the "sample" means material in question, and not a lab test? Does the word sample even needs to be there? DB – Removed word for confusion.

Commented [D7]: Give/add ability to reject ST-1 in this section.

Commented [LDL8]: Should this be "process" authorized sounds too much like approving or agreeing - DB – We authorize samples in SM, even if they fail.

Commented [LDL9]: Would the word ST-1 be better than sample. Yes thanks

Commented [LDL10]: I was told we don't directly communicate with the district, all in and out going correspondence goes thru St1dmir ? so St1dmir can track it. DB – Yes, fixed.

Commented [SRL11]: No Sample Form is attached.

DB Answer – I will have this ready when we send it through

5.2 The DMIR shall include the following sections: General Information, Materials Requirement, Materials Inspection, Investigation, Recommendation, and Attachments.

5.3 The Materials Inspection Section shall clearly state the purpose and scope, giving the problem statement of the situation that initiated the DMIR.

5.3.1 A description of the material, known quantities, technical issues, or any requirement from the applicable Specifications, Contract Proposal, Project Plans, Material Procedures (MPs), Standard Details, Special Provisions, AASHTO, ASTM, or any Non-Specification issues should be provided.

5.4 The Investigation Section shall clearly state all relevant details of the situations during the occurrence.

5.4.1 A justification and any supporting and/or relevant detail shall be provided.

5.5 The Recommendation Section shall clearly state and justify the final price assessment resolution (which may be $0.00), including all applicable fees and penalties.

5.5.1 The assessment fees should be listed individually and with a final total price assessment. A justification of the price assessment shall be provided.

5.5.2 A resolution and a justification of the recommendation shall be provided.

5.6 The Attachment Section shall provide the necessary documentation and evidence for the materials inspection.

5.6.1 All attachments shall provide the Laboratory.

5.6.2 Project Data, Source Data, Sample Data, Lab Data, Daily Reports, Invoices, and/or any other document necessary to provide evidence should be provided.

5.7 A DMIR will originate in the District and be sent to the District Construction Engineer, then to MCS&T who will either concur or non-concur. It is then sent to Contract Administration, then to Regional Construction Engineer, then back to the District Construction Engineer.

Commented [D12]: RLS comment - Who submits, what happens if they don't act upon 30 days? These types of time frames are better suited as requirements in the specifications. DB – Corrected, may need more tweaking though.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils & Testing Division

Commented [D13]: RLS Comment - Either on the memo or DMIR form we need to establish a signature block and note that the District CE needs to be aware. DB answer – we will include this on the form.

RLS:PBc

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE TO APPROVE GALVANIZED STEEL U-CHANNEL SIGN ~~POST~~SUPPORTS AND U-CHANNEL BREAKAWAY SPLICE DEVICE PRODUCTS

1. PURPOSE

1.1 To establish a procedure to approve steel u-channel sign ~~post~~supports and associated breakaway splice device products (hence force referred to as "sign support unit") for use on West Virginia Division of Highways (WVDOH) projects~~,~~.

~~1.1~~1.2 ~~and t~~To insure the ongoing manufactured quality of ~~such products~~the above-mentioned products.

2. SCOPE

2.1 This procedure shall apply to all steel ~~u-channel sign postsupports and breakaway hardware~~sign support units described herein, ~~-~~used for WVDOH projects~~. . unless the project plans state otherwise.~~

3. REFERENCED DOCUMENTS

3.1 ASTM A1075 Standard Specification for Flanged Steel U-Channel ~~post~~supports.

3.2 WVDOH Standard Specifications for Roads and Bridges, Sections 657.2.11 and 709.56.

3.3 ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

~~3.3 [INSERT APPLICABLE SPEC FOR ZINC ALLOY MAGNESIUM (ZAM) COATING]~~

3.4 Manual for Assessing Safety Hardware (MASH), Second Edition.

~~3.4~~3.5 Any other current, applicable coating standards, or manufacturer's standards, including proprietary coating products.

4. APPROVAL PROCEDURE

4.1 For a ~~manufacturer's~~ steel ~~u-channel sign postsupports and associated breakaway hardware~~sign support unit ~~described herein~~ to be considered for inclusion on the Approved Products List (APL), the manufacturer must first submit the product information ~~described~~as outlined in this MP. The submission must also adhering to the guidelines outline in the ~~, and in the manner specified, in~~ Standard Specification

Commented [D1]: It just sounded "right" to have this pluralized. An English major or someone smarter than me may disagree, please do if you think so.

Commented [D2]: Do you guys have a street name for this?

Commented [D3]: We just assume that plans override these specifications.

Commented [D4]: I'm not sure if this works, for "ZAM" or other products that may pop up, since we aren't specifically referring it. But this cover us if other "ZAM" type products pop up.

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~~section~~ Section 709.56.1. Required certification statements described herein are in addition to the product information and documentation described in 709.56.1.

Commented [D5]: Do we capitalize Section?

4.2 The manufacturer shall submit a certification ~~statement which~~statement that identifies the following information:

1. ~~brand~~ Brand name of the manufacturer's steel u-channel sign ~~post~~supports ~~and the~~
2. ~~brand~~ Brand name of the manufacturer's recommended breakaway splice device~~ for use with the manufacturer's u-channel supports~~.

The statement shall clearly specify if one or both of the manufacturer's ~~two (~~2~~)~~ lb/ft and ~~three (~~3~~)~~ lb/ft ~~size u-channel supports, and associated breakaway splice device for each~~sign support units, are being submitted for evaluation. A manufacturer recommended breakaway splice device is required for each u-channel support size.

The statement shall clearly certify that each size u-channel support and breakaway splice device submitted for evaluation fully complies with all requirements specified ~~in~~ of Standard Specification ~~section~~ Section 709.56.1. The certified statement shall be signed by a representative of the manufacturer who has authority to bind the company.

~~4.2~~4.3 The manufacturer shall submit a certification statement stating that all supplied steel components ~~to be supplied shall be of~~are domestic~~ origin~~. The certified statement shall be signed by a representative of the manufacturer who has authority to bind the company.

~~4.3~~4.4 An evaluation and sampling of material at the manufacturer's facility or facilities will be conducted by ~~department~~ WVDOH personnel, or by its designee, for conformance to the appropriate ASTM specification. ~~to reinforce confidence in the ability of the manufacturer to produce a quality product within WVDOH specifications.~~ Five samples ~~of each size~~ of galvanized u-channel sign ~~post~~support~~-s~~ support of each size shall be obtained at each facility. Each sample can be of any~~ size and of any~~ length ~~beyond~~ greater than two feet. U-channel ~~Post~~support~~-s~~ supports must be drilled or punched and representative of the finished product.

Commented [D6]: Do we have a frequency on this or is it based on the Spec?

~~4.4~~4.5 The ~~material~~ u-channel supports will be tested to the mechanical and chemical requirements of ASTM A1075 Grade 60, and the galvanization requirements of ASTM A123 in WVDOH laboratories. Laboratory testing of breakaway splice devices is not required.

~~4.5~~4.6 The material will be inspected for proper hole alignment, spacing, and clearance. All u-channel sign ~~post~~supports shall have a hole spacing that is consistent~~ly spaced~~ at 1" -in center to center without misalignment relative to one another and relative to the centerline of the u-channel ~~post~~support web. All hole clearances after galvanizing shall be capable of inserting a 5/16-in galvanized bolt by hand, without interference of excessive galvanize buildup.

4.64.7 ~~An~~ Subsequent inspection of the manufacturing facilities ~~may~~ shall be conducted on a xx year frequency which may be adjusted at the discretion the Director of WVDOH or their designee. ~~to reinforce confidence in the ability of the facilities to produce a quality product.~~

4.74.8 Once the above requirements are met, laboratory approval numbers will be assigned to indicate WVDOH Specification conformance and approval of the product(s). Individual lab approval numbers will be issued for the manufacturer's ~~two (~~2~~)~~ lb/ft u-channel supports, ~~three (~~3~~)~~ lb/ft u-channel supports, and breakaway splice devices for each size u-channel support. Note, as specified in Standard Specification 709.53, verification and approval of conformance to crash testing performance requirements contained in MASH is required prior to final approval and the issuance of laboratory approval numbers. In addition, Traffic Engineering Division monitored field evaluation testing of the recommended breakaway splice devices for use with the u-channel supports is also ~~typically~~ required at the discretion of the Director of Traffic Engineering Division of their designee. ~~These approval numbers shall be active for two (2) years. Acceptance of a manufacturer's specific products can be verified by accessing the WVDOH online APL.~~

4.84.9 ~~Issuance~~ Affirmation of ~~new~~ the assigned laboratory approval numbers after the initial two (2) years, and every two (2) years thereafter shall typically be based on historical satisfactory performance and conformance to the Standard Specifications, additional sampling similar to that described in ~~sections~~ Sections 4.4 through 4.6, and/or follow up inspection of the manufacturer's facilities as described in section 4.7.

4.94.10 Revocation of approved source status may result from furnishing material that does not comply with Specifications.

4.104.11 "Approved Source" status may be reinstated at the discretion of the Materials Control, Soils and Testing Division (MCST) Director, or their designee based on the findings of an investigation. The reinstatement process will commence upon the receipt of a letter of request from the manufacturer. The letter of request should indicate reasons for reinstatement and documentation to substantiate such reasons.

5. SHIPPING DOCUMATION

5.1 The manufacturing mill shall furnish to the project or ~~Division~~ MCST (when purchase order material is shipped) a shipping document. This document will include the following information:

1. Date of shipment
2. Project or purchase order number
3. Description and quantity of materials shipped
4. Current laboratory approval numbers for all materials shipped

6. PROCEDURE AT DELIVERY SITE

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6.1 District personnel will visually inspect each shipment and review information on the shipping document in accordance with Section 5.1.

6.2 All shipments that are damaged, incomplete, or otherwise considered to be in noncompliance with the specifications shall be rejected. A list of approved ~~steel u-channel sign post~~supports ~~and breakaway splice devices~~sign support units is available to all contractors, fabricators, and suppliers by accessing the WVDOH ~~approved~~ Approved ~~source~~ Product ~~list~~ List website.[1]

Ron L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

RLS:Hlb

[1] https://transportation.wv.gov/highways/mcst/Pages/APL_By_Number.aspx

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR PERCENT CRUSHED PARTICLES

1. PURPOSE

1.1 To set forth a standard method of test for determining the percent of crushed particles in coarse aggregate.

2. SCOPE

2.1 This method of test is applicable to that portion of crushed aggregate which is retained on the 4.75 mm (No. 4) sieve when that material is being used for applications where the standard specifications places a requirement on the percent of crushed particles.

3. EQUIPMENT

3.1 *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231.

3.2 *Oven*—An oven capable of maintaining a temperature of 230°F ± 9°F (110°C ± 5°C).

3.3 *Sieve*—4.75 mm (No. 4), conforming to AASHTO M 92

3.4 *Pans*—Large flat pans for spreading the aggregate in a single layer, and suitable for containing the pieces of aggregate as they are separated.

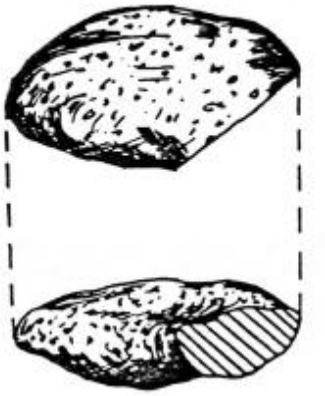
4. DEFINITIONS

4.1 Crushed Particle - A particle of aggregate which has at least one face fracture as defined in Section 4.1.1.

4.1.1 Face Fracture - A face fracture is defined as a break that has resulted from the production process (crushing operation) which constitutes an area of at least 25 % of the largest two-dimensional area of the particle.

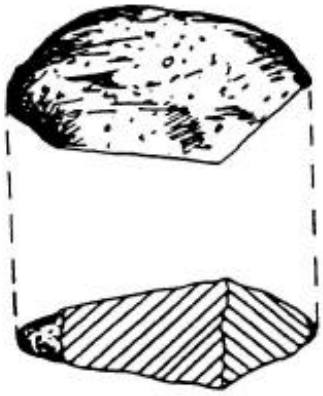
4.1.2 Single Face Fracture - A particle which has only one exposed break in a single plane meeting the requirements set forth in Section 4.1.1. An example of a single face fracture is shown in Figure 1.

FIGURE 1



4.1.3 Multi-Face or Two Face Fracture - A particle which has at least two exposed breaks in two or more planes meeting the requirements set forth in Section 4.1.1. An example of a multi-face fracture is shown in Figure 2.

FIGURE 2



5. TEST PORTION PREPARATION

5.1 Obtain enough aggregate from the field sample to yield a test portion of the appropriate size by use of a sample splitter. (*see NOTE*)

5.2 Sieve the aggregate over a 4.75 mm (No. 4) sieve and discard the minus 4.75 mm (No. 4) material.

5.3 Gently wash the aggregate retained on the 4.75 mm (No. 4) sieve to remove any dust or coatings.

5.4 Dry the clean, sieved aggregate to a constant mass in an oven maintained at 230°F ± 9°F (110°C ± 5°C).

NOTE: Approximate mass of the test portion of crushed aggregate after sieving.

NOMINAL MAXIMUM SIZE OF PARTICLES	MINIMUM MASS OF TEST PORTION
9.5 mm (3/8-in.)	500 g
19 mm (3/4-in.)	1500 g
37.5 mm (1-1/2-in.)	3000 g
Over 37.5 mm (1-1/2-in.+)	5000 g

6. TEST PROCEDURE

6.1 Weigh the test portion and record the mass on the WVDOH form T302 (see attached form). *See NOTE in Section 5. for the required test portion mass.*

6.2 Place the test portion in a large, flat pan or on another suitable workspace. Arrange and label three pans for separating the test portion into single-face, multi-face, and no-face fractures.

6.3 Pick up and inspect each particle to determine the number of face fractures and place them in the appropriate pan or container.

6.4 After the entire test portion has been separated, weigh each fraction and record the masses on the T302 form.

6.5 The entire test portion is to be re-combined and the test is to be conducted by a second technician. The second technician is to follow the steps described in Sections 6.1 through 6.4.

6.6 Use form T302 for comparison of the two Technician's results. When the results obtained by two technicians vary more than two percent, it is necessary for both technicians to review the test procedure and re-conduct the test, beginning at Section 6.1.

7. CALCULATIONS

7.1 Let M_2 = the mass of all particles which have two or more face fractures.

M_1 = the mass of all particles which have only one fractured face.

M_0 = the mass of all particles which have no fractured faces.

$M_3 = M_1 + M_2$ = Total mass of crushed particles (Single-Face or more)

M_4 = Total test portion mass

7.2 Total Percent Crushed Particles (Single-Face or more) =

$$(M_3 / M_4) \times 100$$

7.3 Percent Multi-face Fractures =

$$(M_2 / M_4) \times 100$$

7.4 When the final two results have been obtained, they shall be averaged, and the average reported is to be to the nearest 1.0%.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR FRIABLE PARTICLES IN AGGREGATES

1. PURPOSE

1.1 To provide a standard method for obtaining the approximate percent by weight of clay lumps and friable particles in aggregates. Although this test method is performed on a dry, prewashed sample, it is not intended to alter the intent of ASTM C 142.

2. SCOPE

2.1 This method of test is applicable to all coarse and fine aggregates when a test for friable particles is required.

3. EQUIPMENT

3.1 *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231.

3.2 *Oven*—An oven capable of maintaining a temperature of 230°F ± 9°F (110°C ± 5°C).

3.3 *Pans*—Large flat pans for spreading the aggregate in a single layer.

3.4 *Sieves*—The following sieve sizes conforming to AASHTO M-92; 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), and 850 µm (No. 20).

4. DEFINITIONS

4.1 Friable Particle - Any piece of aggregate that can be broken into smaller particles with the thumb and forefinger, excluding the use of the fingernails.

5. TEST PORTION PREPARATION

5.1 In order to provide a clean, workable test portion, it is necessary that the aggregate sample be washed, oven dried and sieved over the proper sieve described below in sections 5.1.1 and 5.1.2.

5.1.1 *COARSE AGGREGATE* - Sieve a sufficient quantity of the coarse aggregate over a 4.75 mm (No. 4) sieve so as to yield a test portion of no less than 5000 g retained on the 4.75 mm (No. 4) sieve.

5.1.1.1 Record the mass of the test portion.

Commented [SRL1]: I removed the requirement for a second, more sensitive balance due to the smallest amount of friable material measurable on this aforementioned balance is well below the specification threshold of 1% for fine material, being 0.1% of 200g = 0.2g, and the balance used is capable of measuring 0.1g (.05% of the 200g sample), which makes a second, more sensitive balance unessential.

Commented [SRL2]: The requirement of splitting the coarse sample into multiple fractions has been removed. This procedure had previously been simplified from the AASHTO method, taking out the weighted average based upon the gradation. The most likely reason the weighted average was originally removed (when the MP was written) is that gradations are not required for quality testing, so the author had no gradations on which to base the weighted average. It has been decided that separating the coarse test portion and re-combining it was unnecessary.

5.1.2 *FINE AGGREGATE* - Sieve a sufficient quantity of the fine aggregate sample over a 1.18 mm (No. 16) sieve so as to yield a test portion of approximately 200 g retained on the 1.18 mm (No. 16) sieve.

5.1.2.1 Record the mass of the test portion.

6. TEST PROCEDURE

6.1 Spread the sieved sample in a thin layer on the bottom of a large flat pan.

6.2 Examine the sample for possible friable particles and squeeze or roll the pieces between the thumb and forefinger attempting to break them into smaller particles.

6.3 After all discernible friable particles have been broken, remove the smaller particles from the remainder of the sample by use of the sieves listed in the following table.

Standard size of sieve upon which test portion is retained	Standard size of sieve through which friable particles are permitted to pass
COARSE AGGREGATES: 4.75 mm (No. 4)	2.36 mm (No. 8)
FINE AGGREGATES: 1.18 mm (No. 16)	850 µm (No. 20)

7. CALCULATIONS

7.1 Percentages of friable particles are determined by the following formula:

$$Fp = \frac{Mf}{M} \times 100$$

where:

Fp = Percentage of friable particles

Mf = Mass of the friable particles removed after second sieving.

M = Mass of the test sample retained on the first sieving.

7.2 Report results to the nearest 0.01%.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR PERCENT BY WEIGHT OF SHALE IN CRUSHED AGGREGATE

1. PURPOSE

1.1 To provide a standard method for determining the percent by weight of shale and aggregate pieces exhibiting shale characteristics contained in crushed aggregate.

1.2 In cases where more detailed examination is considered necessary, other methods described in ASTM C 295 should be followed.

2. SCOPE

2.1 This method is applicable to that portion of crushed aggregate which is retained on the 4.75 mm (No. 4) sieve when that material is being used for applications where the standard specifications places a requirement on the percent of shale in crushed aggregate.

3. EQUIPMENT

3.1 *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231.

3.2 *Oven*—An oven capable of maintaining a temperature of 230°F ± 9°F (110°C ± 5°C).

3.3 *Sieve*—4.75 mm (No. 4), conforming to AASHTO M 92

3.4 *Aggregate Sample Splitter*—compliant with AASHTO T 248.

3.5 *Pans*—Large flat pans for spreading the aggregate in a single layer.

3.6 *Beakers*—600 ml capacity suggested.

4. DEFINITIONS

4.1 Although shale is defined by many noted authors in numerous ways, Walter T. Huang, PhD (Petrology, 1962) defines shale in a manner best suited for Division of Highways quality determinations. Therefore, Huang's definition will act as a guideline and is defined as follows: "Shale is a laminated and thinly bedded fine grained clastic rock containing mainly silt and clay and including many particles

less than 1 or 2 microns in diameter." According to the same reference, most shale is made up of 1/3 quartz, 1/3 clay minerals, and 1/3 miscellaneous substances. "In addition, it may be said that shale usually has a relatively smooth or soapy texture, can be scratched with a copper penny and powder can be produced by scraping a piece of shale with a knife."

4.1.1 In addition to the above characteristics, shale, when in contact with a moist environment, softens considerably due primarily to the clay constituent and bedding properties and often exhibits the property of slaking. This is one of the primary characteristics which causes shale to be considered deleterious when contained in aggregate to be used in highway construction.

5. TEST PORTION PREPARATION

5.1 Obtain enough aggregate from the field sample to yield a test portion of the appropriate size by use of a sample splitter. (*see NOTE*)

5.2 Sieve the aggregate over a 4.75 mm (No. 4) sieve and discard the minus 4.75 mm (No. 4) material.

5.3 Gently wash the aggregate retained on the 4.75 mm (No. 4) sieve to remove any dust or coatings.

5.4 Dry the clean, sieved aggregate to a constant mass in an oven maintained at 230°F ± 9°F (110°C ± 5°C).

NOTE: Approximate mass of the test portion of crushed aggregate after sieving.

NOMINAL MAXIMUM SIZE OF PARTICLES	MINIMUM MASS OF TEST PORTION
19 mm (3/4 in.)	3000 grams
37.5 mm (1-1/2 in.)	5000 grams
75 mm (3 in.)	10000 grams

6. TEST PROCEDURE

6.1 Weigh the test portion and record the mass. *See NOTE in Section 5. for the required test portion mass.*

6.2 Spread the test portion in a thin layer on the bottom of a large flat pan.

6.3 Examine each particle for shale characteristics and separate the shale from the remainder of the crushed aggregate.

Commented [SRL1]: The process of separating the test portion over multiple sieves was removed. The procedure may have been based on another AASHTO procedure, where the percentages of shale were calculated using a weighted average based on the gradation of the original sample. Since gradations are not required for quality testing, a weighted average is not needed for this test.

6.3.1 In the case of pieces of aggregate resembling shale but not exhibiting all the properties of shale, weigh, and soak in water for 24 hours and re-examine.

6.3.1.1 If after 24 hours the suspect pieces of aggregate remain sound, they should be considered satisfactory and not be included with other deleterious material.

6.3.1.2 If after soaking in water for 24 hours the suspect pieces of aggregate show evidence of slaking or if slight hand pressure causes disintegration, these pieces should be recorded as being deleterious.

6.4 Weigh and record the mass of shale present in the test portion.

7. CALCULATIONS

7.1 Calculate the percentage of shale as follows:

$$S = \left(\frac{W_1}{W_2}\right) x\ 100$$

Where:

S = Total percent of shale or shale like pieces in the test portion.

M_1 = Total mass of shale or shale like pieces contained in the test portion.

M_2 = Total mass of coarse aggregate test portion retained on the 4.75 mm (No. 4) sieve

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD OF DETERMINATION OF PERCENT OF THIN OR ELONGATED PIECES IN COARSE AGGREGATE

1. PURPOSE

1.1 To provide a standard method for determining the percent of thin and elongated pieces in a coarse aggregate sample.

1.2 Excessive amounts of thin or elongated pieces of aggregate can create structural and workability problems in base course, portland cement concrete and bituminous concrete mixtures resulting in a loss in strength, skid resistance and wearing ability. Their presence may cause internal and/or external damages when utilized in the previously mentioned applications and consequently the quality of the finished product may be related to the presence of thin or elongated pieces.

2. SCOPE

2.1 This method of determination is applicable to all coarse aggregates (both natural and crushed) and is applied when a test for thin or elongated pieces is required.

3. EQUIPMENT

3.1 *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231.

3.2 *Pans*—Large flat pans for spreading the aggregate in a single layer.

3.3 *Calipers*—Precision built calipers that will maintain a constant 4:1 ratio.

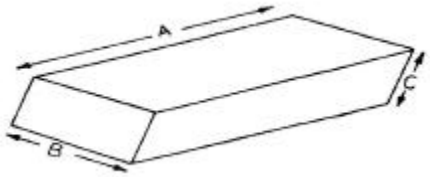
4. DEFINITIONS

4.1 Thin Aggregate - One in which the ratio of the width to the thickness is greater than 4:1.

4.2 Elongated Aggregate - One in which the length to the width is greater than 4:1.

4.3 For consistency in evaluating aggregate for possible thin or elongated pieces, the following diagram is provided so as not to confuse one measured dimension with another.

Where:



A = length
B = width
C = thickness

5. TEST PORTION PREPARATION

5.1 Obtain enough aggregate from the field sample to yield a 5000 g minimum test portion by use of a sample splitter.

5.2 Sieve the aggregate over a 4.75 mm (No. 4) sieve and discard the minus 4.75 mm (No. 4) material.

5.3 Gently wash the aggregate retained on the 4.75 mm (No. 4) sieve to remove any dust or coatings.

5.4 Dry the clean, sieved aggregate to a constant mass in an oven maintained at 230°F ± 9°F (110°C ± 5°C).

6. TEST PROCEDURE

6.1 Weigh the test portion and record the mass.

6.2 Spread the test portion in a thin layer in the bottom of a large flat pan.

6.3 Make a preliminary separation of all material which is obviously neither thin nor elongated.

6.4 Determine the maximum thickness (C) of the possible THIN pieces of aggregate by using the small opening of the calipers.

6.4.1 Remove the aggregate particle from the caliper without disturbing the setting of the opening and place the greatest width (B) of the particle in the large opening.

6.4.2 If the greatest width of the aggregate particle is larger than the large opening of the calipers, it shall be considered a THIN piece of aggregate and shall be placed aside for weighing.

6.5 Determine the maximum width (B) of the possible ELONGATED pieces of aggregate by using the small opening of the calipers.

6.5.1 Remove the aggregate particle from the caliper without disturbing the setting of the opening and place the greatest length (A) of the particle in the large opening.

6.5.2 If the greatest length (A) of the aggregate particle is larger than the large opening of the calipers, it shall be considered an ELONGATED piece of aggregate and shall be placed aside for future reference.

6.6 Combine all pieces of aggregate classified as either THIN or ELONGATED and record the total mass to the nearest gram.

7. CALCULATION

7.1 The percent of thin and/or elongated pieces is determine in the following manner:

$$T\&E = \frac{M_1 + M_2}{M_3} \times 100$$

Where:

T&E = percent of thin and/or elongated pieces

M_1 = oven dry mass of THIN pieces

M_2 = oven dry mass of ELONGATED pieces

M_3 = oven dry mass of test portion