

Method of Test for Flat & Elongated Particles

1. Scope:

This test is for determining the percentage by weight of coarse aggregate that have a maximum to minimum dimension greater than the specified ratio of 5:1(5 to 1) or 3:1(3 to 1).

2. Apparatus:

- 2.1 Proportional caliper device that is equipped with a 5:1 ratio setting and/or 3:1 ratio setting consisting of a base plate with two fixed vertical posts and a swinging arm mounted between them so that the opening between the arms and the posts maintain a constant ratio. The apparatus must be calibrated as stated in the procedure.
- 2.2 Balance having the capacity to weigh any sample which may be tested utilizing this procedure, accurate and readable to the nearest 0.1 gram.

3. Procedure:

- 3.1 Verification of Ratio: Ratio settings on the proportional caliper device shall be verified by the use of a calibrated machined block, micrometer, or other appropriate device.
- A. The caliper device must close and bars touch on both sides of the caliper. Set the caliper to a 5:1 or 3:1 ratio as required by the specification. Open the larger end of the caliper to 5 inches or 3 inches and verify that the other opening is 1 inch. If needed, adjust the bars with the set screws under the caliper device to meet calibration.
- 3.2 Use + #4 material from the SD 202 sieve test. Record the weight of the sieve samples being tested as indicated below. Weigh and record the total amount of material retained on each sieve to the nearest 0.1 gram in column (A) "Total Sample Weight on Sieve" Record "Total Sample Weight" (F). Split out approximately 100 particles of material retained on each sieve group that is in the sample.

Passing the 2" sieve and retained on the 1½" sieve
 Passing the 1½" sieve and retained on the 1" sieve
 Passing the 1" sieve and retained on the ¾" sieve
 Passing the ¾" sieve and retained on the ½" sieve
 Passing the ½" sieve and retained on the ⅜" sieve
 Passing the ⅜" sieve and retained on the #4 sieve

NOTE: If a 1 ¼" sieve is used in the sieving, the material retained on that sieve shall be combined with the material retained on the 1" sieve. If a 5/8" sieve is used in the sieving, the material retained on that sieve shall be combined with the material retained on the ½" sieve. If a ¼" sieve is used in the sieving, the material retained on that sieve shall be combined with the material retained on the #4 sieve. If there are not 100 pieces retained on any required sieve size for testing, test the entire amount retained on the sieve.

- 3.3 After counting out the first sample splits of approximately 100 particles per sieve size, obtain a weight to be able to use to split out the sample without counting particles in the

future. Weigh the amount of particles split out to test for each sieve size to the nearest 0.1 gram and record in column (B) "Weight of tested portion".

- 3.4 Set the longest length of the particle to be tested end to end in the larger end of the caliper device.
- 3.5 With the caliper device fixed in that position, tighten the pivot screw. Observe if the particle will pass through the smaller end of the caliper device at its minimum width or thickness. If it does, the particle should be counted as flat and elongated (F&E).
- 3.6 Repeat 3.4 and 3.5 for each particle to be tested.
- 3.7 Weigh the Flat and Elongated particles for each sieve sample to the nearest 0.1 gram and record in column (C) "Weight of Flat/Elongated Particles".
- 3.8 Calculate the "Percent of Flat/Elongated Individual Sieve" and the "Percent Flat/Elongated Weighted Average" to the nearest 0.1 percent by using the following equations.

$$\text{Percent of Flat/Elongated Individual Sieve (D)} = (C/B)100$$

$$\text{Percent Flat/ Elongated Weighted Average (E)} = (A/F)D$$

The Total Percent Flat and Elongated Particles (G) Is the sum of the Percent Flat/Elongated Weighted Average Column (E).

	(A)	(B)	(C)	(D)	(E)
Sieve Size	Total Sample Weight on Sieve	Weight of Tested Portion (100 pieces)	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
2" to 1 1/2"	0.0				
1 1/2" to 1"	0.0				
1" to 3/4"	1431.6	1431.6	0.9	0.1	0.0
3/4" to 1/2"	4818.7	809.3	6.7	0.8	0.4
1/2" to 3/8"	2095.4	228.5	4.6	2.0	0.4
3/8" to #4	1798.4	96.7	0.9	0.9	0.2
Total Sample Weight	10144.1	(F)			

Total Percent Flat and Elongated Particles	1.0	(G)
(Rounded)	1	

Figure 1

- 3.9 Record all test results on the appropriate form; for concrete use the form DOT-3 Coarse or DOT-68 and for asphalt use form DOT-69.

4. Report:

- 4.1 Report the percent flat and elongated particles in the total sample (Weighted average) to the nearest 0.1 percent or whole number as required by the specification.

5. References

ASTM D4791
SD 202
DOT-3 Coarse
DOT-68
DOT-69

Sample ID 2224661

Sieve Analysis and P.I. Worksheet

DOT - 3 (Coarse)

File No.

9-14

PROJECT PH 0066(00)15

COUNTY Aurora, Ziebach

PCN B015

Charge to (If not above project)

Field No. 09

Date Sampled 04/01/2016

10:00 am

Date Tested 04/01/2016

11:00 am

Sampled By Tester, One

Tested By Tester, One

Checked By Tester, Two

Material Type COARSE AGGREGATE

Source Hills Materials, Rapid City Quarry

Paving

Lot No.

Sublot No.

Weight Ticket Number or Station

Lift of

% moist. = (wet wt. - dry wt.) / dry wt. x 100 =

Original Dry Sample Wt. (0.1g) 10312.3

Sieve Size mm in	F.M. *	Retained (.1g)	% total ret.(0.1%)	% pass. (0.1%)	% pass. (rounded)	Spec Req.
100 4						
75 3						
62.5 2 1/2						
50 2						
37.5 1 1/2		0.0	0.0	100.0	100	100-100
31.5 1 1/4						
25 1		0.0	0.0	100.0	100	95-100
19 3/4		1431.6	13.9	86.1	86	
16 5/8		2964.8	28.8	57.3	57	
12.5 1/2		1853.9	18.0	39.3	39	25-60
9.5 3/8	*	2095.4	20.3	19.0	19	
6.25 1/4						
4.75 #4	*	1798.4	17.4	1.6	2	0-10
Pan						
Total						

Sieve Size mm in	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
50.0 2					
37.5 1 1/2					
25.0 1					
19.0 3/4	1431.6	1431.6	0.9	0.1	0.0
12.5 1/2	4818.7	809.3	6.7	0.8	0.4
9.5 3/8	2095.4	228.5	4.6	2.0	0.4
4.75 #4	1798.4	96.7	0.9	0.9	0.2

Total sample wt. 10144.1

Percent flat and elongated particles
in the total sample (weighted average)

rounded 1.0
1

+ #4 Gradation Check:
within 0.3% of original dry wt.

D wt. before washing(0.1g)
u s wt. after washing (0.1g)
t C loss from washing
h k, % - #200

Sieve Size mm #	retained (0.1g)	% total ret.(0.1%)	% total X % pa.#4(0.1%)	% pass. (0.1%)	% pass. (rounded)	Spec Req.
3.35 6						
2.36 8	60.7	0.6		1.0	1	0-5
2.00 10						
1.70 12						
1.18 16						
0.850 20						
0.600 30						
0.425 40						
0.300 50						
0.180 80						
0.150 100						
0.075 200						
PAN dry	98.4	98.4				3771.0
PAN wash	0.0		1.0			3728.2
TOTAL	10303.20					42.8

+ #4 % Particles less than 1.95 SP. GR.	
Specific gravity of solution (1.95 ± 0.01)	1.96
wt. of lightweight particles (0.1 g)	0.1
weight of + #4 material (0.1 g)	1857.0
% lightweight particles	0.0
SPECIFICATION	0.0-1.0

Crushed Particles Test	
weight of crushed particles	
weight of total + #4 sample	
percent of crushed particles	
SPECIFICATION	or more FF, min.

Coarse	1.13%	x % Retain/Design	=:	- #4 Gradation check:	0.1
Chip		x % Retain/Design	=:	within 0.3% of the	
Fine		x % Pass/Design	=:	wt. before washing	
Total/Combined - #200					

Figure 2

Sample Id 2203625 Sieve Analysis DOT - 68
Mineral Aggregate Stationary Plant Mix 9-14

Mix Batch Ticket	lbs./cu. yd.	Total Agg. %
1" rock	1374.00	0.776
Chip	396.00	0.224
		0
		0
Total	1770.0	1.0

Test # 04 File Number _____
 PCN/Project B015 PH 0066(00)15 County Aurora, Ziebach
 Charge to (if not above project) _____
 Sample Represents 1155.0 Cu.Yd. Class and Type COARSE AGGREGATE
 Date Sampled 03/13/2015 10:00 am Sampled By Tester, One
 Date Tested 03/13/2015 11:00 am Tested By Tester, One
 Checked By Tester, Two

1" rock

Sample Wt. (0.1g)	10312.3	Retained (0.1g)	% total ret.(0.1%)	% pass. (0.1%)
2				
1 1/2				
1 1/4				
1				
3/4				
5/8				
1/2				
3/8				
1/4				
#4				
#8				
Pan Dry				
Pan Wash				
TOTAL	10303.20			

Gradation Check==> **0.09**
 wt. before wash 3771.0
 wt. after wash 3728.2
 loss from wash 42.8
 % - #200==> 1.14
 Bin adj. - 200==> 0.881

Chip

Sample Wt. (0.1g)	3098.8	Retained (0.1g)	% total ret.(0.1%)	% pass. (0.1%)
2				
1 1/2				
1 1/4				
1				
3/4				
5/8				
1/2				
3/8				
1/4				
#4				
#8				
Pan Dry				
Pan Wash				
TOTAL	3094.30			

Gradation Check==> **0.15**
 wt. before wash 2752.8
 wt. after wash 2707.1
 loss from wash 45.7
 % - #200==> 1.66
 Bin adj. - 200==> 0.370

Sample Wt. (0.1g)	Retained (0.1g)	% total ret.(0.1%)	% pass. (0.1%)
2			
1 1/2			
1 1/4			
1			
3/4			
5/8			
1/2			
3/8			
1/4			
#4			
#8			
Pan Dry			
Pan Wash			
TOTAL	0.0		

Gradation Check==> **0.00**
 wt. before wash _____
 wt. after wash _____
 loss from wash _____
 % - #200==> _____
 Bin adj. - 200==> _____

Sample Wt. (0.1g)	Retained (0.1g)	% total ret.(0.1%)	% pass. (0.1%)
2			
1 1/2			
1 1/4			
1			
3/4			
5/8			
1/2			
3/8			
1/4			
#4			
#8			
Pan Dry			
Pan Wash			
TOTAL	0.0		

Gradation Check==> **0.00**
 wt. before wash _____
 wt. after wash _____
 loss from wash _____
 % - #200==> _____
 Bin adj. - 200==> _____

Composite Coarse Aggregate

Sieve Size	1" rock	Chip	Retained Total	Cumulative % Passing	Spec. Gradation	Job Mix Formula
2			0.0	100.0	100	
1 1/2			0.0	100.0	100	100-100
1 1/4			0.0	100.0	100	
1	0.0		0.0	100.0	100	95-100
3/4	10.8		10.8	89.2	89	
5/8	22.4	0.0	22.4	66.9	67	
1/2	14.0	0.0	14.0	52.9	53	25-60
3/8	15.8	0.8	16.5	36.4	36	
1/4		9.7	9.7	26.6	27	
# 4	13.5	6.8	20.3	6.4	6	0-10
# 8	0.5	4.5	4.9	1.4	1	0-5
Pan	0.7	0.7	1.4	0.1	0	
Total	77.6	22.4	0.0	0.0	99.9	

Total Combined - 200 ==> 1.25

+ #4 % Particles less than 1.95 Specific Gravity

Specific gravity of solution (1.95 ± 0.01)
 wt. of lightweight particles (0.1 g)
 weight of + #4 material (0.1 g)
 % lightweight particles

Bin Adj. % lightweight particles
 Composite % lightweight particles
 SPECIFICATION maximum

0.0-1.0

Coarse	1.25%	x	% Retain/Design	58.00	=	0.73
Chip		x	% Retain/Design		=	
Fine	1.45%	x	% Pass/Design	42.00	=	0.61
04 Referenced			Total/Combined - #200			1.3

Figure 3a

Flat and Elongated Particles

Sieve Size mm	inches	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
Rock Size	50.0	2				
1"	37.5	1 1/2				
% of Rock	25.0	1				
	19.0	3/4	1431.6	0.9	0.1	0.0
	12.5	1/2	4818.7	6.7	0.8	0.4
	9.5	3/8	2095.4	4.6	2.0	0.4
	4.75	#4	1798.4	96.7	0.9	0.2
Total sample wt.		10144.1				
Percent flat and elongated particles in: 1"						1.0
Percent flat and elongated particles in Total Rock:						0.8

Rock Size	50.0	2				
Chip	37.5	1 1/2				
% of Rock	25.0	1				
	19.0	3/4				
	12.5	1/2	0.0	0.0		
	9.5	3/8	104.8	75.0	0.0	0.0
	4.75	#4	2282.8	40.8	1.1	2.7
Total sample wt.		2387.6				
Percent flat and elongated particles in: Chip						2.6
Percent flat and elongated particles in Total Rock:						0.6

Rock Size	50.0	2				
	37.5	1 1/2				
% of Rock	25.0	1				
	19.0	3/4				
	12.5	1/2				
	9.5	3/8				
	4.75	#4				
Total sample wt.		0.0				
Percent flat and elongated particles in:						0.0
Percent flat and elongated particles in Total Rock:						

Combined Percent Flat and Elongated Particles for Total Rock:

Rounded:	1.4
Spec Max:	10

Figure 3b

Sample ID 2203604
File No.

Gyratory Aggregate Worksheet

DOT - 69
9-14

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Field No. QC03 Date Sampled 03/12/2015 Date Tested 03/12/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type AGGREGATE COMPOSITE Source Jones Pit
Lot No. 1 Sublot No. 3
Weight Ticket Number or Station # 49627 Sta. 625+25 Lt Lift 1 of 1

% moist. = (wet wt. 8616.4 - dry wt.) / dry wt. x 100 = 3.9

Original Dry Sample Wt. (.1g) 8289.9

Sieve Size mm in	Retained (.1g)	% total ret.(0.1%)	% pass. (0.1%)	% pass. (rounded)	Spec Req.	Sand Equiv. Test Reading #1	Sand Rdg.	Clay Rdg.	S.E.
50 2						Reading #2	3.1	6.6	47
37.5 1 1/2							3.1	6.5	48
31.5 1 1/4						Sand Equivalent Tests Results			48
25 1	0.0	0.0	100.0	100		Fine Aggregate Angularity Test Results			41.8
19 3/4	0.0	0.0	100.0	100	100-100	Flat and Elongated Particles Test Results			1.1
16 5/8	7.3	0.1	99.9	100					
12.5 1/2	501.4	6.0	93.9	94	89-100				
9.5 3/8	890.3	10.7	83.2	83	79-93				
6.25 1/4	990.4	11.9	71.3	71					
4.75 #4	787.3	9.5	61.8	62					
Pan	5116.7	61.7				D wt. before washing(0.1g)			709.30
Total	8293.4					wt. after washing (0.1g)			707.10
+ #4 Gradation Check:						loss from washing			2.2
within 0.3% of original dry wt.						% - #200			0.31

Sieve Size mm #	retained (0.1g)	% total ret.(0.1%)	% total X % pa.#4(0.1%)	% pass. (0.1%)	% pass. (rounded)	Spec Req.
3.35 6						+ #4 % Particles less than 1.95 SP. GR.
2.36 8	187.7	29.8	18.4	43.4	43	
2.00 10						wt. of lightweight particles (0.1 g) 16.4
1.70 12						weight of + #4 material (0.1 g) 1516.9
1.18 16	137.2	21.8	13.5	29.9	30	% lightweight particles 1.1
0.850 20						SPECIFICATION 0.0-3.0
0.600 30	112.0	17.8	11.0	18.9	19	- #4 % Particles less than 1.95 SP. GR.
0.425 40	54.3	8.6	5.3	13.6	14	
0.300 50	42.7	6.8	4.2	9.4	9	wt. of lightweight particles (0.1 g) 3.1
0.180 80						weight of - #4 material (0.1 g) 342.9
0.150 100	35.0	5.6	3.5	5.9	6	% lightweight particles 0.9
0.075 200	10.5	1.7	1.1	4.8	4.8	SPECIFICATION 0.0-3.0
PAN dry	4.8	49.2	4.8			wt. before washing (0.1g) 629.8
PAN wash	44.4	7.8				wt. after washing (0.1g) 585.4
TOTAL	628.60					loss from washing (-#200) 44.4

Coarse	0.31%	x % Retain/Design	38.20	=	0.12	- #4 Gradation check:
Chip		x % Retain/Design		=		within 0.3% of the
Fine	7.81%	x % Pass/Design	61.80	=	4.83	wt. before washing
Total/Combined - #200						5.0
Na. Rock	31.00	Cr.Fines	28.00	Natural Fines	25.00	
Osch Nat Fines	16.00	Natural Sand	.00	Ma.Sand	.00	
Filler	.00	Cr.Rock	.00	Add Rock	.00	

Crushed Particles Test	
weight of crushed particles	651.7
weight of total + #4 sample	729.3
percent of crushed particles	89
SPECIFICATION	2 or more FF, min. 65-100

Comments: 12" sieves used

Weight of measure and glass plate		327.1
Weight of measure, glass plate & water		426.8
M = net mass of water		99.7
Water Temperature / Density	77F (25.0C)	997.03
V = volume of cylinder, mL		100.0

Dry - #4 bulk specific gravity (Gsb)	2.563	2.563	
Volume of cylinder, mL (V)	100.0	100.0	
Weight of cylinder, g (A)	183.0	183.0	
Wt. of cylinder + aggregate, g (B)	332.5	332.2	
Wt. aggregate, g (F=B-A)	149.5	149.2	Average
Uncompacted voids, (nearest 0.1%) $U = [(V - (F/Gsb)) / V] \times 100$	41.7	41.8	41.8

Sieve Size	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/Elongated Particles	Percent Flat/Elongated Individual Sieve	Percent Flat/Elongated Weighted Average
mm	in				
50.0	2				
37.5	1 1/2				
25.0	1				
19.0	3/4				
12.5	1/2	508.7	475.3	1.8	0.4
9.5	3/8	890.3	237.4	0.5	0.2
4.75	#4	1777.7	63.7	1.0	0.9

Total sample wt. 3176.7

Percent flat and elongated particles in the total sample (weighted average)

rounded 1.1
1