

700 MATERIAL DETAILS

Materials shall conform to the stated requirements and/or the requirements of the referenced specifications including modifications as noted.

Copies of all Supplemental Specifications referenced in this section are on file with the City of Columbus Transportation Division.

703 - AGGREGATE

703.01 General.

- A. **Soundness.** When the major portion of the unsound material in a coarse aggregate acquires a mud-like condition when tested for soundness, ensure that the maximum loss for all uses is 5 percent.
- B. **Stockpiles.** Use stockpiling and loading methods that permit ready identification of the aggregates and to minimize segregation. Clean the sites for stockpiles before storing materials. Do not remove aggregates from stockpiles within 1 foot (0.3 m) of the ground until final cleanup of the work. Do not use material that has become mixed with foreign matter or other sizes or grades of aggregates.

Handle aggregates in such a manner that the moisture content is reasonably uniform for each day's run.

- C. **Size.** Provide aggregate conforming to the size specified in the material specification, the construction item, or as shown in AASHTO M 43.
- D. **Method of Test.** Provide aggregate tested by the following methods:

Amount finer than No. 200 (75 µm) sieve	S1004*
Clay lumps	S1017*
Coal and lignite	AASHTO T113
Crushed pieces	S1021*
Deleterious materials	S1029*
Effect of organic impurities on strength of mortar	AASHTO T71
Liquid limit	AASHTO T89
Percent of wear, Los Angeles abrasion test	AASHTO T96
Plasticity index.....	AASHTO T90
Sieve analysis	S1004*, S1005*
Sieve analysis of mineral filler.....	AASHTO T37
Sodium sulfate soundness test, 5 cycle	AASHTO T104
Specific gravity and percent absorption for fine and coarse aggregate	S1031*
Unit weight.....	AASHTO T19
<i>Light weight chert in aggregates</i>	<i>AASHTO T113</i>

Sand equivalent.....AASHTO T176
Uncompacted void content.....AASHTO T304
Flat and elongated.....ASTM D 4791
Rapid freezing and thawingASTM C 666 Procedure B
Insoluble residue of carbonate aggregates.....ASTM D 3402
Compaction testingS1015*
In place gradation samplingS1090*
Sulphur leachate test.....S1027*
Soundness of aggregate by freezing and thawing..... ASTM T 103*

***Supplement on file in the ODOT Office of the Director.**

Size No.	Nominal size square openings ⁽¹⁾	Amounts finer than each laboratory sieve (square openings), percent by weight														
		4	3 1/2	3	2 1/2	2	1 1/2	1	3/4	1/2	3/8	No. 4	No. 8	No. 16	No. 50	No. 100
1	3 1/2 to 1 1/2	100	90 to 100		25 to 60		0 to 15		0 to 5							
2	2 1/2 to 1 1/2			100	90 to 100	35 to 70	0 to 15		0 to 5							
24	3 1/2 to 3/4			100	90 to 100		25 to 60		0 to 10	0 to 5						
3	2 to 1				100	90 to 100	35 to 70	0 to 15		0 to 5						
357	2 to No. 4				100	95 to 100		35 to 70		10 to 30		0 to 5				
4	1 1/2 to 3/4					100	90 to 100	20 to 55	0 to 15		0 to 5					
467	1 1/2 to No. 4					100	95 to 100		35 to 70		10 to 30	0 to 5				
5	1 to 1/2						100	90 to 100	20 to 55	0 to 10	0 to 5					
56	1 to 3/8						100	90 to 100	40 to 75	15 to 35	0 to 15	0 to 5				
57	1 to No. 4						100	95 to 100		25 to 60		0 to 10	0 to 5			
6	3/4 to 3/8							100	90 to 100	20 to 55	0 to 15	0 to 5				
67	3/4 to No. 4							100	90 to 100		20 to 55	0 to 10	0 to 5			
68	3/4 to No. 8							100	90 to 100		30 to 65	5 to 25	0 to 10	0 to 5		
7	1/2 to No. 4								100	90 to 100	40 to 70	0 to 15	0 to 5			
78	1/2 to No. 8								100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5		
8	3/8 to No. 8									100	85 to 100	10 to 30	0 to 10	0 to 5		
89	3/8 to No. 16									100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5	
9	No. 4 to No. 16										100	85 to 100	10 to 40	0 to 10	0 to 5	
10	No. 4 to 0 ⁽²⁾										100	85 to 100				10 to 30

(1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.

(2) Screenings.

Where standard size of coarse aggregate designated by two or three digit numbers are specified, obtain the specified gradation by combining the appropriate single digit standard size aggregates by a suitable proportioning device which has a separate compartment for each coarse aggregate combined. Perform the blending as directed by the Laboratory.

Size No.	Nominal Size square openings ⁽¹⁾	Amounts finer than each laboratory sieve (square openings), percent by weight														
		100	90	75	63	50	37.5	25	19	12.5	9.5	4.75	2.36	1.18	300 μm	150 μm
1	90 to 37.5	100	90 to 100		25 to 60		0 to 15		0 to 5							
2	63 to 37.5			100	90 to 100	35 to 70	0 to 15		0 to 5							
24	63 to 19.0			100	90 to 100		25 to 60		0 to 10	0 to 5						
3	50 to 25.0				100	90 to 100	35 to 70	0 to 15		0 to 5						
357	50 to 4.75				100	95 to 100		35 to 70		10 to 30		0 to 5				
4	37.5 to 19.0					100	90 to 100	20 to 55	0 to 15		0 to 5					
467	37.5 to 4.75					100	95 to 100		35 to 70		10 to 30	0 to 5				
5	25.0 to 12.5						100	90 to 100	20 to 55	0 to 10	0 to 5					
56	25.0 to 9.5						100	90 to 100	40 to 75	15 to 35	0 to 15	0 to 5				
57	25.0 to 4.75						100	95 to 100		25 to 60		0 to 10	0 to 5			
6	19.0 to 9.5							100	90 to 100	20 to 55	0 to 15	0 to 5				
67	19.0 to 4.75							100	90 to 100		20 to 55	0 to 10	0 to 5			
68	19.0 to 2.36							100	90 to 100		30 to 65	5 to 25	0 to 10	0 to 5		
7	12.5 to 2.36								100	90 to 100	40 to 70	0 to 15	0 to 5			
78	9.5 to 2.36								100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5		
8	9.5 to 1.18									100	85 to 100	10 to 30	0 to 10	0 to 5		
89	4.75 to 1.18									100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5	
9	4.75 to 1.18										100	85 to 100	10 to 40	0 to 10	0 to 5	
10	4.75 to 0 ⁽²⁾											100	85 to 100			10 to 30

(1) In millimeters, except where otherwise indicated.

(2) Screenings.

Where standard size of coarse aggregate designated by two or three digit numbers are specified, obtain the specified gradation by combining the appropriate single digit standard size aggregates by a suitable proportioning device which has a separate compartment for each coarse aggregate combined. Perform the blending as directed by the Laboratory.

E. **General.** Provide open hearth (OH), basic oxygen (BOF,) and electric arc (EAF) steel slag aggregate (known as steel slag) conforming to the following requirements when 703.04 aggregate for Asphalt Concrete Base or when any 703.05 aggregate is called for.

Supply all steel slag from sources according to ODOT Supplement 1071, Quality Control Requirements for Steel Slag Aggregate. Furnish steel slag to a size meeting the specified grading requirements. Provide steel slag aggregate that meets the specified coarse or fine aggregate quality requirements. Ensure that measurement of soft pieces includes soft lime, lime oxide, or magnesia agglomerations or any foreign materials prone to rapid disintegration under construction processing and weathering conditions. Ensure that additional testing beyond those listed are performed or required any time poor quality steel slag is suspected due to visual inspection, testing, or field performance problems.

For every shipment of steel slag aggregate to the Contractor, provide a letter of certification covering the steel slag in the shipment to the Engineer from the processor and copies of quality control records from the processor (according to ODOT Supplement 1071). Ensure that the letter of certification documents that steel slag production and processing or slag by product stockpile retrieval and processing was according to ODOT Supplement 1071. Failure to follow the processor QC plan or continued problems with performance recognized by the Laboratory attributable to steel slag is cause for limiting steel slag use from that processor.

Open hearth, basic oxygen, or electric furnace slag (steel slag) is not permitted for coarse or fine aggregate (virgin or recycled) used in any surface course mix or any mix used as a surface course according to 703.05.

703.02 Aggregate for Portland Cement Concrete.

A. Fine Aggregate.

1. Provide fine aggregate consisting of natural sand or sand manufactured from stone. Natural sand is required in 255, 451, 452, 526, and 511 deck slabs.
2. **Sieve Analysis.**

Sieve Size	Total Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	70 to 100
No. 16 (1.18 mm)	38 to 80
No. 30 (600 μm)	18 to 60
No. 50 (300 μm)	5 to 30
No. 100 (150 μm)	1 to 10
No. 200 (75 μm)	0 to 5

Should the fineness modulus of a job control sample of sand from any source vary by more than 0.20 from that of the representative sample from that source, the sand may be rejected.

3. **Soundness, Sulfur, etc.**

Loss, sodium sulfate soundness test	Maximum Percent
Item 305, 306	12
Items 255, 451, 452, 511, 515, 519, 526, 602, 603, 604, 608, 609, 610, 612, 622, and 625	10

When tested for the effect of organic impurities on strength of mortar, ensure that the compressive strength at 3 and 7 days of mortar made with untreated sand is not less than 95 percent of the compressive strength of mortar made with treated sand.

Provide aggregations of soil, silt etc., with a maximum percent by weight of 0.5.

Provide fine aggregate for 255, 451 and 452 that contain not less than 25 percent of siliceous particles as determined by the insoluble residue test on file at the Laboratory.

B. Coarse Aggregate.

1. Provide coarse aggregate consisting of clean washed, gravel crushed carbonate stone, or crushed air-cooled blast furnace slag.
2. **Physical Properties.**

Percent of wear, Los Angeles test, maximum (stone or gravel)	40
Unit weight, compacted, minimum lbs/ft ³ (kg/m ³) (slag)	70 (1121)
Loss, sodium sulfate soundness test, %, maximum	
305, 306	15
255, 451, 452, 511, 12 519, 526, 602, 603 604, 609, 610, 622, 625	12
515	10

Deleterious substances shall not exceed the following:

Material Type	Percent By Weight	
	Superstructure	All Other Concrete
Soft pieces	2.0	3.0
Coal and lignite	0.25	0.25
Clay lumps	0.25	0.25
Pieces having a length greater than 5 times the average thickness	15	15
Shale and shaly material, limonitic concretions alkali, metallic particles and chert, which disintegrates in 5 cycles of the soundness test	0.5	1.0

3. Amount passing the No. 200 (75 μ m) sieve. Ensure that the percent by weight of material passing the No. 200 (75 μ m) sieve in the aggregate portion of the concrete mix does not exceed the following:

Material Type	Percent by Weight	
	Super-Structure	All Other Concrete
<i>Crushed carbonate stone and crushed air cooled blast furnace slag</i>	3.4	3.8
<i>Washed gravel</i>	2.0	2.2

703.03 Fine Aggregate for Mortar or Grout.

- A. Provide fine aggregate consisting of natural sand or sand manufactured from stone or air cooled blast furnace slag.
- B. **Sieve Analysis.**

Sieve Size	Total Percent Passing	
	Natural Sand	Manufactured Sand
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 to 100	95 to 100
No. 50 (300 μ m)	10 to 40	20 to 40
No. 100 (150 μ m)	0 to 15	10 to 25
No. 200 (75 μ m)	0 to 5	0 to 10

- C. **Soundness, Sulfur, etc.**

Loss, sodium sulfate..... 10
 soundness test, %, maximum:

When tested for the effect of organic impurities on strength of mortar, ensure that the compressive strength of mortar made with untreated sand is not less than 95 percent of the compressive strength of mortar made with treated sand.

Aggregations of soil, silt, etc., maximum percent by weight 0.5.

703.04 Aggregate for:

- (1) *Asphalt concrete* base, 301
- (2) Aggregate base, 304
- (3) Slope and channel protection, 601

1. The coarse aggregate for *asphalt concrete* base used in combination with rigid and flexible pavements shall be of crushed carbonate stone, crushed gravel, or crushed air-cooled blast-furnace slag. The fine aggregate for *asphalt concrete* base shall be natural sand or sand manufactured from stone, gravel, or air-cooled slag.

2.	Physical Properties:	<u>301</u>	<u>304</u>	<u>601</u>
	Percentage of wear, Los Angeles test, maximum (stone or gravel)	50	50	50
	Unit weight, compacted, lbs/cu. ft (kg/m ³) minimum (slag).....	65		65
		(1041)	-	(1041)
	Loss, sodium sulfate soundness test, percent maximum.....	15	15	15
	Percentage of fractured pieces minimum.....	40	90	90

Deleterious substances shall not exceed the following:

	Percent by Weight	
	<u>301</u>	<u>304</u>
Soft pieces.....	3.0	-
Coal and lignite.....	1.0	-
Clay lumps.....	0.25	-
Pieces having a length greater than	5	-

times the average thickness.....	15	-
Shale, shaley material, and chert which disintegrates in 5 cycles of the soundness test.....	2.5	5

Gravel used under 304 shall be crushed from material retained on the 1/2 inch (12.5 mm) sieve.

Under 304, the portion of aggregate passing the No. 40 sieve (425 μm) shall have a maximum liquid limit of 25 percent and a maximum plasticity index of 6.

703.05 Aggregate for.

1. Asphalt concrete, 402, 404, 412, 415 and 416
2. Bituminous cold mix, 405
3. Prime coat, 408
4. Seal coat, 409

Fine Aggregate.

1. The fine aggregate shall be natural sand or sand manufactured from stone, gravel or air-cooled slag.

2. Sieve Analysis.

<u>Sieve Size</u>	<u>Total Percent Passing</u>
3/8 inch (9.5 mm).....	100
No. 4 (4.75 mm).....	90-100
No. 8 (2.36 mm).....	65-100
No. 16 (1.18 mm).....	40-85
No. 30 (600 μm).....	20-60
No. 50 (300 μm).....	7-40
No. 100 (150 μm).....	0-20
No. 200 (75 μm).....	0-10

3. Soundness, etc.

Loss, sodium sulfate soundness test, percent, maximum	15
Aggregations of soil, silt, etc. maximum percent by weight	0.5

Coarse Aggregate.

1. The coarse aggregate shall be *clean washed*, crushed carbonate stone, crushed air-cooled slag or crushed gravel.

2. **Physical Properties.**

Percentage of wear, Los Angeles test maximum
(stone or gravel)40

Unit weight, compacted, minimum pounds per cubic foot (kg/m³) (slag)
402, 403, 404, 405, 407, 408, 409, 412, 415 and 416..... 70 (1121)

Loss, sodium sulfate soundness test, percent, maximum:
402, 403, 404, 412, 415 and 416.....12
405 and 40915

Percent by weight of fractured pieces, minimum40

Deleterious substances shall not exceed the following:

	Percent by Weight
Soft pieces.....	3.0
Coal and lignite	1.0
Clay lumps	0.25
Amount finer than No. 200 sieve (75 μm).....	3.0
Pieces having a length greater than 5 times the average thickness.....	15
Shale, shaley material and other deleterious substances, such as limonitic concretions, alkali, and chert which disintegrates in 5 cycles of the soundness test	2.5

General Requirements for Coarse and Fine Aggregate.

1. *Calculate each individual sieve fraction soundness loss and ensure that the fractional size does not exceed the following:*
 - A. *13.0 percent for all surface courses and any asphalt concrete course directly below an open graded friction course.*
 - B. *13.0 percent for No. 8 aggregate fractions used in intermediate courses to traffic over the winter months.*

- C. 15.0 percent for all other coarse aggregate used in intermediate courses that will be exposed to traffic over the winter months.

Statistical evaluation of data will be per Group List procedures.

703.06 Sand Cover, 407, 408.

1. The sand shall be natural sand or sand manufactured from stone or air-cooled slag.
2. **Sieve Analysis.**

<u>Sieve Size</u>	<u>Total Percent Passing</u>
No. 4 (4.75 mm)	90-100
No. 50 (300 μm)	7-40
No. 200 (75 μm)	0-10

703.07 Mineral Filler.

1. The mineral filler shall be limestone dust, portland cement, or other inert mineral matter. It shall be thoroughly dry and free from lumps.
2. **Sieve Analysis.**

<u>Sieve Size</u>	<u>Total Percent Passing</u>
No. 30 (600 μm).....	100
No. 50 (300 μm).....	95-100
No. 200 (75 μm).....	65-100

703.08 Granulated Slag.

1. The granulated slag shall be the glassy, granular materials formed when molten blast furnace slag or electric furnace slag is rapidly chilled, as by immersion in water. Material containing mill waste, cinders, large pieces of ungranulated slag or other matter foreign to the production of slag in the normal operation of the blast furnace or electric furnace may be rejected.

The material shall be of such nature that it will compact to the satisfaction of the Engineer.

2. **Sieve Analysis.**

<u>Sieve Size</u>	<u>Total Percent Passing</u>
2 inch (50 mm)	100
1 inch (25 mm)	85-100

No. 100 (150 μm)0-15

703.10 Screenings.

1. The screenings shall be No. 10 size gravel, stone, or air-cooled slag. Where crushed material is specified, it shall be crushed from material larger than the 1/2 inch (12.5 mm) sieve.
2. Loss, sodium sulfate soundness, percent, maximum15

703.11 Suitable Materials for Embankment Construction. Soil, granular materials, shale, rock, random materials, asphalt concrete, Portland cement concrete or recycled materials, (when allowed) and further defined below are suitable for use in embankment construction. The Engineer will submit samples of soils not identified from the plan subsurface investigation, from borrow sources or materials appearing questionable in the field.

Use open hearth, and basic oxygen steel slag that complies with 703.15.

Use air cooled blast furnace slag that conforms to ODOT Supplement 1027.

Use open hearth steel slag, basic oxygen steel slag, RPCC, and RACP that are completely blended with other soil or granular material. Make at least 30 percent of this blend of other soil or granular materials. Pieces of RACP shall not exceed 4 inches (100 mm) in the largest dimension.

Use coal completely blended with other soil or granular materials. Make at least 90 percent of this blend of other soil or granular materials.

When allowed or specified all recycled embankment materials must comply with ODOT Supplemental Specification 871.

- (a) **Soils.** Soils classified by AASHTO Classifications A-4-a, A-4-b, A-6-a, A-6-b, and A-7-6 as further defined below: Maximum laboratory dry weight is at least 90 pounds per cubic foot (1450 kg/m³), and more than 35 percent by weight of the grains or particles will pass a No. 200 (75 mm) sieve.

Do not use soils having a liquid limit in excess of 65 or soils identified by AASHTO classifications A-2-5, A-5, or A-7-5 in the work.

- (b) **Granular Materials.** Granular materials classified AASHTO Classifications A-1-a, A-1-b, A-3, A-3a, A-2-4, A-2-6, and A-2-7, which can be readily incorporated in an 8 inch (200 mm) layer, and in which more than 65 percent by weight of the grains or particles are retained on the No. 200 sieve (75 mm).

- (c) **Shale.** *Shale as defined in 203.02 and further defined below. Shale will be tested for durability to determine whether the shale is hard or soft shale.*

The Engineer will test the shale in accordance with ASTM D 4644 Slake Durability of Shale and Similar Weak Rocks as modified below:

The Engineer will obtain a typical 6 inch (152 mm) diameter piece of shale. If a 6 inch (152 mm) diameter sample cannot be obtained because the material is too weak, weathered or deteriorated, then the shale is soft shale.

The shale will be placed in a bucket of water. The Engineer will examine the deterioration or slaking after 48 hours.

After 48 hours if the material is not deteriorated, then the shale will be broken down by hand pressure. If less than 25 percent of the material is retained on the 3/4 inch (19 mm) sieve, then shale materials will be considered soft shale.

If more than 75 percent of the shale is retained on the 3/4 inch (19 mm) sieve or when the material does not deteriorate, then the shale will be field tested for hardness. The field test for hardness will consist of the following:

If more than 40 percent of the shale breaks down, by visual inspection, with 6 complete passes with a steel drum roller, then the shale is classified as soft shale. When smooth drum rollers are used, provide a minimum compression of 500 pound per linear inch (3.45 KN/mm) of roller drum width. When drum rollers with tamping feet are used, provide a minimum compression of 500 pounds per square inch (KN/mm²) of tamping foot contact. The Contractor shall provide documentation to verify the above.

If less than 40 percent of the shale breaks down, by visual inspection, then material will be considered hard shale.