

903

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## SECTION 903-AGGREGATES

**903.01-Fine Aggregate for Concrete.** Fine aggregate for portland cement concrete shall conform to the requirements of AASHTO M 6, with the following exceptions and added stipulations.

- (a) The option regarding alternate freeze-thaw tests for soundness will not be exercised.
- (b) The fine aggregate shall be washed in the processing operations.
- (c) Fine aggregate manufactured from limestone or dolomite shall be processed from material which has been scalped to remove quarry fines. The material from which the fine aggregate is processed shall have a percentage of wear, AASHTO T 96, of not more than forty.
- (d) The amount of deleterious substances shall not exceed the following limits:

	Maximum Permissible Limits Per Cent by Weight
1. Clay Lumps	0.5
2. Coal and Lignite	0.5
3. Material Passing the 75 $\mu$ m (No. 200) Sieve	3.0
4. Other deleterious substances (such as shale, alkali, mica, coated/grains, soft and flaky particles)	3.0

If the fine aggregate is manufactured from limestone or dolomite and if the material finer than the 75  $\mu$ m (No. 200) sieve consists of the dust of fracture, essentially free from clay or shale, this limit may be increased to five per cent.

- (e) Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves, shall conform to the following requirements:

Sieve Size	Total Per Cent Passing by Weight
9.5 mm (3/8 inch)	100
4.75 mm (No. 4)	95-100
1.18 mm (No. 16)	50-90
300 $\mu$ m (No. 50)	10-30
150 $\mu$ m (No. 100)	0-10
75 $\mu$ m (No. 200)	0-3

The limits for fine aggregate passing the 300  $\mu$ m (No. 50) sieve may be changed to 5-30% when used in air-entrained

concrete mixes containing more than 235 kilograms (400 pounds) of cement per cubic meter (cubic yard) and for non air-entrained concrete mixes containing more than 295 kilograms per cubic meter (500 pounds per cubic yard). Air-entrained concrete is here considered to be concrete containing an air-entraining agent and having an air content of more than three percent.

- (f) Fine aggregate used in flowable mortar shall meet all the above requirements except the gradation shall be as follows:

Sieve Size		Total Per Cent Passing by Weight
19 mm	(3/4 inch)	100
75 µm	(No. 200)	0-10

**903.02-Fine Aggregate for Mortar.** Mortar sand shall conform to the requirements of AASHTO M 45. Sand for mortar shall be uniformly graded from coarse to fine within the following limits:

Sieve Size		Total Per Cent Passing, by Weight
2.36 mm	(No.8)	100
300 µm	(No.50)	15-40
150 µm	(No.100)	0-10
75 µm	(No.200)	0-5

**903.03-Coarse Aggregate for Concrete.** Coarse aggregate for any type or class of portland cement concrete shall consist of crushed stone, crushed slag, or crushed or uncrushed gravel unless otherwise specified.

Coarse aggregate for portland cement concrete base and pavement shall be furnished in two sizes: Size No. 4 and Size No. 67, as shown in Subsection 903.22. The two sizes shall be manufactured, within the specified limits, so as to produce Size No. 467, Subsection 903.22, when combined in the proper proportions at the batching plant.

Unless otherwise specified on the Plans, coarse aggregate for structural concrete shall be Size No. 57, Subsection 903.22.

Coarse aggregate for prestressed and precast concrete shall be Size No. 57 or Size No. 67, Subsection 903.22, as may be specified or directed.

Coarse aggregate for concrete curbing placed by machine-extrusion methods shall be Size No. 7, 57, 67 or 78, Subsection 903.22.

The coarse aggregates shall otherwise conform to the requirements of AASHTO M 80, with the following exceptions and stipulations:

## (a) Deleterious Substances.

The amount of deleterious substances shall not exceed the following limits:

	Maximum Per Cent, by Weight
1. Soft or non-durable fragments (fragments which are structurally weak such as shale, soft sandstone, limonite concretions, gypsum, weathered schist or cemented gravel)	3.00
2. Coal and lignite	1.00
3. Clay lumps	0.25
4. Material passing the 75 $\mu\text{m}$ (No. 200) Sieve	1.00
5. Thin or elongated pieces (length greater than 5 times average thickness)	10.00
6. Other local deleterious substances	1.00

In the case of crushed aggregate, if all the material finer than the 75  $\mu\text{m}$  (200 mesh) sieve (AASHTO T 11) consists of the dust of fracture essentially free of clay or shale, Item 4, Maximum Per Cent by Weight, may be increased to 1.5. The sum of the percentages of Items No. 1, 2, 3, 4, and 6 shall not exceed 5.0.

## (b) When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test (AASHTO T 104), the weighted percentage of loss shall be not more than nine. Coarse aggregate failing to meet the requirement for soundness may be accepted, provided it can be shown by evidence satisfactory to the Engineer that concrete of comparable proportions made from the same source has been exposed to weathering under conditions similar to those occurring at the site of the structure for a period of at least ten years without appreciable disintegration.

The option regarding alternate freeze-thaw tests for soundness will not be exercised.

The percentage of wear as determined by AASHTO T 96 shall not exceed 40.

## (c) Coarse aggregate for cement treated permeable base shall be Size No. 57 meeting the quality requirements above.

**903.04-Aggregate for Lean Concrete Base.** Aggregate for Lean Concrete Base shall consist of crushed limestone, crushed slag, crushed or uncrushed gravel meeting the requirements of Subsection 903.05, for Class B, Grading D. The aggregate may be a "crusher or pit run" or may be sized into two or more sizes. If the material is "crusher or pit run", care shall be taken to prevent segregation during stockpiling and handling.

**903.05-Aggregate for Mineral Aggregate Base and Surface Courses.**

Aggregates for Mineral Aggregate Base and Surface Courses shall be crushed stone, crushed slag, crushed or uncrushed gravel, or crushed or uncrushed chert, together with such material as manufactured sand or other fine materials naturally contained, or added thereto as needed to conform with these Specifications.

The aggregate shall be of two classes: Class A and Class B.

- (a) Class A aggregate for mineral aggregate base and surface courses shall consist of hard durable particles or fragments of stone, slag, gravel, or chert, and other finely divided mineral matter. Individual materials shall meet the requirements specified below:
  - 1. Crushed stone shall be free of silt and clay. The coarse aggregate portion (retained on the 4.75 mm (No. 4) sieve) of the stone shall have a percentage of wear of not more than 50, and when subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall not exceed 15.
  - 2. Crushed slag shall be free of silt and clay and shall meet the quality requirements of crushed stone. It shall be reasonably uniform in density and shall have a dry-rodded weight of at least 112 kilograms per one tenth cubic meter (seventy pounds per cubic foot).
  - 3. Gravel and chert shall be screened and all oversize material may be crushed and fed uniformly back over the screen. The coarse aggregate portion shall have a percentage of wear of not more than 50, and when subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall not exceed 15. The portion of the material passing the 425  $\mu$ m (No. 40) sieve shall be non-plastic, or shall have a liquid limit of not more than thirty and a plasticity index of not more than eight.

If fine aggregate, coarse aggregate or binder, in addition to that present in the base material, is necessary in order to meet the gradation or density requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the mixing plant by a mechanical feeder to maintain a uniform flow on the belt to the mixer. Blending of materials on the stockpiles or in the pits by bulldozer, clamshell, dragline or similar equipment will not be permitted.

The composite gradation of Class A aggregate shall be the grading specified.

- (b) Class B aggregate for mineral aggregate base shall consist of crushed or uncrushed gravel, crushed or uncrushed chert, crushed stone or crushed slag, and other finely divided particles. The quality of Class B aggregate shall be the same as the quality requirements for Class A aggregate with the following exceptions:

The Sodium Sulfate Soundness shall not exceed 20. Class B aggregate shall be screened and the oversize materials may be wasted or crushed and returned over the screen and uniformly blended with the other material.

Material having a clay content greater than twelve per cent, as determined by hydrometer analysis (AASHTO T 88), will not be permitted. Material having a clay content not exceeding twelve per cent will be acceptable provided a plasticity index-fines product does not exceed 3 when calculated by the following formula:

$$\frac{\% \text{ Passing } 425 \mu\text{m (No. 40)} \times \text{P.I. of } -425 \mu\text{m (40) Material}}{100}$$

If an excess of binder occurs, crushed stone, crushed slag, gravel, chert, sand, or other approved granular materials shall be uniformly incorporated in such proportions, not to exceed twenty per cent of the total mix, as the Engineer directs.

If the quantity of binder is insufficient to bond the base or surface course properly, additional binder of approved quality, in an amount not to exceed fifteen per cent of the total mix, shall be uniformly incorporated as directed by the Engineer.

The use of material requiring the addition of coarse aggregate or binder in excess of the above limits will not be permitted, unless otherwise specified on the Plans or in the Contract.

Blending of additional material, if required, may be performed either at the screening or mixing plant or on the road. If blending is done at the plant, mechanical feeders which will maintain a uniform flow of the materials on the conveyor belt to the mixer or screening plant shall be employed. If blending is done on the road, the two or more materials shall be spread in uniform layers and blended by means of a mechanical mixer. Blending of materials on the stockpile or in the pit by means of a bulldozer, clamshell, or similar equipment will not be permitted.

When combinations of materials for Class B aggregate for mineral aggregate base and surface courses such as creek gravel and chert, bank gravel and chert, crushed stone and chert, crushed slag and chert, are permitted, they will be designated on the Plans or in the Contract, and the pertinent requirements of this Specification for quality, blending of materials, and gradings shall apply.

The composite gradation of Class B aggregate shall be the grading specified on the Plans or in the Contract.

Grading Table for Class A and Class B Aggregate for Mineral Aggregate  
Base and Surface Courses

Total Per Cent by Weight, Passing Sieves

Sieve Size	Grading A	Grading B	Grading C	Grading D	Grading E
63 mm (2-1/2")	100				
50 mm (2")	95-100	100			
37.5 mm (1-1/2")		95-100	100	100	
25 mm (1")			90-100	85-100	100
19 mm (3/4")		65-95		60-95	90-100
9.5 mm (3/8)	35-65		45-74	50-80	65-100
4.75 mm (No. 4)		35-55	30-55	40-65	
1.18 mm (No. 16)		15-45		20-40	
150 µm (No. 100)	0-10	4-15	4-15	9-18	5-15

**903.06-Aggregate for Plant Mix Base and Leveling Courses (Hot Mix).**

Aggregate for plant mix base and leveling courses shall consist of coarse aggregate, fine aggregate, and mineral filler when required.

If at any time the sources of materials are changed, a new mix design will be required in accordance with Subsection 407.03.

(a) Coarse Aggregate.

Coarse aggregate (aggregate retained on the 4.75 mm (No. 4) sieve) shall be crushed stone, crushed granite, crushed gravel, crushed slag or combination of these materials. This material shall conform to the quality requirements of ASTM D 692 except that the sodium sulfate soundness loss on limestone shall not exceed nine percent, and the aggregate shall contain no more than five percent soft or nondurable particles.

Crushed gravel shall consist of siliceous particles processed from washed material. At least seventy percent by count of the gravel retained on the 4.75 mm (No. 4) sieve shall have a minimum of two fractured faces, one of which must be fractured for the approximate average diameter or thickness of the particle. The addition of pea gravel or uncrushed particles shall not be permitted.

Virgin coarse aggregate for Grading A, A-CRL and A-S mixes shall be crushed stone, crushed slag, or a combination thereof.

The absorption of crushed gravel passing the 19.0 millimeter (3/4 inch) sieve and retained on the 4.75 millimeter (No. 4) sieve shall not exceed five percent when tested in accordance with AASHTO T 85 when used in Grading CW mixes.

After drying in the plant, the aggregate retained on the 4.75 millimeter (No. 4) sieve shall have a loss of not more than 1.00 percent by weight when washed over a 2.36 millimeter (No. 8) sieve in accordance with the coating test in Subsection 407.03.

(b) Fine Aggregate.

Fine aggregate (aggregate passing the 4.75 millimeter (No. 4) sieve) shall consist of limestone fines, natural sand, sand manufactured from stone, gravel, or slag, or combinations thereof. It shall consist of hard, tough grains free from injurious amounts of deleterious substances, and when subjected to five cycles of the sodium sulfate soundness test, it shall have a weighted loss of not more than 12 percent.

In natural sand and manufactured sand, the percentage of material finer than 75  $\mu\text{m}$  (No. 200) mesh shall not exceed five percent.

Virgin fine aggregate used in Grading A and AS mixes shall consist of crushed stone or crushed slag only and shall be stored separately from the coarse aggregate.

The amount of deleterious substances in natural sand shall not exceed the following limits:

	Maximum Permissible Limits Percent by Weight
1. Clay Lumps	0.5
2. Coal & Lignite	0.5
3. Other deleterious substances (such as shale, alkali, mica, coated grains, soft & flaky particles)	3.0

(c) The Combined Grading.

The combined gradings may be achieved by the appropriate combination of coarse aggregate with the appropriate fine aggregate. A minimum of three sizes of aggregate shall be required for all mix designs except for C, C-S and CW mixes which shall be designed from a minimum of two sizes of aggregate.

The Contractor shall establish a gradation for each aggregate used in the mix. The aggregate stockpile gradation tolerance on each sieve is listed below.



9.5 mm (3/8") sieve and larger	± 10%
4.75 mm (No. 4) sieve	± 7%
2.36 mm (No. 8) sieve	± 5%
600 µm (No. 30) sieve	± 4%
75 µm (No. 200) sieve (coarse aggregate)	± 2%
75 µm (No. 200) sieve (fine aggregate)	± 4%

When the coarse aggregate portion of Grading CW mix is crushed limestone, not less than 20 percent nor more than 50 percent by weight shall be natural sand, or sand manufactured from slag or other approved non-skid aggregate. When the coarse aggregate portion is crushed gravel or crushed slag, not less than 15 nor more than 40 percent by weight of the mineral aggregate shall be agricultural limestone or Size No. 10 limestone screenings.

The gradations of the coarse and fine fractions of aggregate shall be such that when combined in proper proportions the resultant mixture will meet one of the following gradings, as specified:

**HOT PLANT MIX BASE COURSE  
MIXTURE DESIGN RANGE OF GRADATIONS**

Total Per Cent Passing, by Weight

Sieve Size	Grading A	Grading A-S	Grading A-CRL	Grading B
50 mm (2")	100	100	100	100
37.5 mm (1-1/2")	81-100	75-100	80-93	95-100
19 mm (3/4")	50-71	55-80	60-75	70-85
9.5 mm (3/8")	35-50	-	-	49-72
4.75 mm (No. 4)	24-36	7-11	12-16	34-51
2.36 mm (No. 8)	13-27	-	-	23-42
600 µm (No. 30)	7-17	-	-	11-22
300 µm (No. 50)	-	-	-	9-14
150 µm (No. 100)	0-10	0-6	0-4	4-10
75 µm (No. 200)	0-4.5	0-4.5	0-3.5	2.5-6.5

**HOT PLANT MIX LEVELING COURSE  
MIXTURE DESIGN RANGE OF GRADATIONS**

Total Per Cent Passing, by Weight

Sieve Size	Grading B-M	Grading C	Grading C-W	Grading C-S
25 mm (1")	100	-	-	-
19 mm (3/4")	85-100	100	100	-
9.5 mm (3/8")	59-79	70-90	75-100	100
4.75 mm (No. 4)	42-61	39-66	-	89-94
2.36 mm (No. 8)	29-47	23-47	43-67	53-77
600 µm (No. 30)	13-27	10-27	23-47	23-42
300 µm (No. 50)	7-20	8-15	-	-
150 µm (No. 100)	4-10	4-8	4-10	9-18
75 µm (No. 200)	0-6.5	2.5-6.5	2.5-6.5	6-13.5

Asphalt treated permeable base gradation shall be as follows:

Sieve Size	Total percent passing by weight
50 mm (2")	100
37.5 mm (1-1/2")	70-100
19 mm (3/4")	55-80
4.75 mm (No. 4)	0-11
150 µm (No. 100)	0-4
75 µm (No. 200)	0-3

**903.07-Aggregate for Bituminous Coated Aggregate Base (Plant Mix).**

The mix aggregate for Bituminous Coated Aggregate Base shall be crushed stone or crushed slag meeting the quality requirements of ASTM D 692, except that the sodium sulfate soundness loss shall not exceed nine percent. Crushed slag aggregate retained on the 4.75 millimeter (No. 4) mesh sieve shall not contain more than 20 percent by weight of glassy particles.

The aggregate for the bituminous mixtures shall be produced in two fractions.

Aggregate for Mix No. 1 shall be separated on the 31.5 millimeter (1-1/4 inch), 37.5 millimeter (1-1/2 inch) or 45 millimeter (1-3/4 inch) screen.

Aggregate for Mix No. 2 shall be separated on the 25 millimeter (1 inch) or 31.5 millimeter (1-1/4 inch) screen.

The aggregate sizes shall be such that when combined in the proper proportions the resultant mixture will meet one of the following gradings, as specified.

**AGGREGATE FOR BITUMINOUS COATED AGGREGATE  
BASE (PLANT MIX)  
MASTER RANGE OF GRADATIONS**

Sieve	Total Percent Passing, by Weight	
	Mix No. 1	Mix No. 2
75 mm (3")	100	-
63 mm (2-1/2")	95-100	-
50 mm (2")	-	100
37.5 mm (1-1/2")	30-70	60-95
19 mm (3/4")	0-15	0-20
9.5 mm (3/8")	0-3	0-5
4.75 mm (No. 4)	-	0-2

Choker aggregate for Mix No. 1 or Mix No. 2 shall be crushed stone, crushed slag or crushed gravel meeting the quality requirements of Subsection 903.13 and the gradation requirements of Size No. 68, Subsection 903.22.

**903.08-Aggregate for Bituminous Road Mix Surface Course.** Aggregate for Bituminous Road Mix Surface Course shall consist of crushed stone, crushed slag or crushed gravel. It shall conform to the quality requirements of ASTM D 692 except that when tested for stripping, the aggregate shall have a bituminous film retention by count in excess of 95 per cent; and at least 50 per cent by count of the gravel retained on the 4.75 millimeter (No. 4) sieve shall have at least 1 fractured face fractured for the approximate average diameter of the aggregate.

Aggregates which do not meet the film retention requirement may be used provided a satisfactory chemical additive is used that will result in a water resistant film.

Crushed slag aggregate retained on the 4.75 millimeter (No. 4) sieve shall not contain more than 20 per cent, by weight, of glassy particles.

The amount of material finer than 75  $\mu$ m (No. 200) mesh shall not exceed 1.0 per cent. If all material finer than the 75  $\mu$ m (No. 200) mesh sieve consists of dust of fracture, essentially free from clay or shale, the percentage may be increased to 1.5.

The gradation of the aggregate shall meet the requirements for the following sizes shown in Subsection 903.22.

Mix Aggregate	Size No. 68
Choker Aggregate	Size No. 8

**903.09-Aggregate for Bituminous Sand-Gravel Binder and Surface Coarse (Hot Mix).** Aggregate for Bituminous Sand-Gravel Binder and

Surface Course (Hot Mix) shall consist of local bank or pit-run sand and gravel. The portion retained on the 4.75 millimeter (No. 4) sieve shall consist of sound, durable siliceous particles, free of shale and clay. It shall have a percentage of wear not greater than 50. The fine aggregate portion (passing the 4.75 millimeter (No. 4) sieve) shall consist of natural or manufactured sand, and the percentage of clay, as determined by hydrometer analysis (AASHTO T 88), shall not exceed five.

The bank or pit-run sand and gravel shall be screened and all oversize material may be crushed and fed uniformly back over the screen. After screening the bank or pit-run material shall be stockpiled before it is fed to the drier.

The combined aggregate shall meet the following gradation requirements:

**AGGREGATE FOR BITUMINOUS SAND-GRAVEL  
BINDER AND SURFACE COURSE  
MASTER RANGE OF GRADATIONS**

		Total Per Cent Passing, by Weight	
Sieve Size		Binder	Surface
25 mm	(1")	100	-
19 mm	(3/4")	80-100	100
12.5 mm	(1/2")	-	95-100
4.75 mm	(No. 4)	40-70	65-90
75 µm	(No. 40)	15-40	20-45
150 µm	(No. 100)	1-10	5-15

**903.10-Aggregate for Bituminous Plant Mix Surface Course (Cold Mix).** The mix aggregate for cold bituminous plant mix shall consist of crushed stone or crushed slag meeting the quality requirements of ASTM D 692. Crushed slag aggregate retained on the 4.75 millimeter (No. 4) sieve shall contain not more than 20 per cent, by weight, of glassy particles.

The amount of material finer than 75 µm (No. 200) mesh (AASHTO T 11) shall not exceed 1.0 per cent. If all material finer than the 75 µm (No. 200) mesh sieve consists of the dust of fracture, essentially free from clay or shale, the percentage may be increased to 1.5.

The mix aggregate for leveling and surface course mixtures shall be Size No. 68, Subsection 903.22. Key or choker aggregate shall be crushed stone, crushed slag, or crushed gravel meeting the same quality requirements as the mix aggregate and shall meet the gradation requirements of Size No. 8, Subsection 903.22.

**903.11-Aggregate for Asphaltic Concrete Surface Courses (Hot Mix).** Aggregate for asphaltic concrete surface courses shall consist of a combination of coarse and fine aggregate, and mineral filler when required or specified. A minimum of three sizes of aggregates shall be required for all mix designs.

The Contractor shall submit a mix design at least 14 working days prior to the scheduled start of production of any asphalt paving mixture in complete accordance with Subsection 407.03(C).

If at any time the sources of materials are changed, a new mix design will be required in accordance with 407.03(C)2, Revision of Job Mix Formula.

(a) Coarse Aggregate.

The coarse aggregate (aggregate retained on the 4.75 millimeter (No. 4) sieve) shall consist of crushed stone, crushed slag, crushed gravel, crushed granite, crushed quartzite, crushed gneiss, other approved non-skid aggregates or combinations thereof. The coarse aggregate shall meet the quality requirements of ASTM D 692 with the following exceptions and additions:

- (1) Crushed limestone shall have a sodium sulfate soundness loss not exceeding nine per cent.
- (2) Material retained on the 4.75 millimeter (No. 4) sieve shall contain a maximum of 20 per cent elongated pieces (length greater than five times the average thickness).
- (3) Crushed gravel shall consist of siliceous particles processed from washed material, of which at least seventy per cent by count, of the material retained on the 4.75 millimeter (No. 4) sieve shall have a minimum of two fractured faces, one of which must be fractured for the approximate average diameter or thickness of the particle. The addition of pea gravel or uncrushed particles will not be permitted. The absorption of the crushed gravel retained on the 4.75 millimeter (No. 4) sieve shall not exceed five per cent when tested in accordance with AASHTO T 85.
- (4) Crushed slag coarse aggregate shall contain no more than 20 per cent, by weight, of glassy particles; except that where used in Grading G mix, the percent of glassy particles, by weight, shall not exceed 10.
- (5) After drying in the plant, the aggregate retained on the 4.75 millimeter (No. 4) sieve shall have a loss of not more than 1.00 percent by weight when washed over a 2.36 millimeter (No. 8) sieve in accordance with the coating test in 407.03.

(b) Fine Aggregate.

The fine aggregate (passing the 4.75 millimeter (No. 4) sieve) shall consist of natural sand, fines prepared from stone, slag, gravel, granite, quartzite, gneiss, other approved non-skid aggregates, or combinations thereof. It shall consist of hard tough grains free from injurious amounts of clay, loam or other deleterious substances. The fine aggregate when subjected to five cycles of Sodium Sulfate Soundness test shall have a weighted loss of not more than 12 per cent. Manufactured sand shall have no more than five percent passing the 75  $\mu\text{m}$  (No. 200) sieve when tested in accordance with AASHTO T 11.

- (1) Natural sand shall be washed. The natural sand shall be so graded that not more than five per cent will be retained on the 4.75 millimeter (No. 4) sieve.
- (2) Fine aggregate consisting of natural sand will be tested in accordance with AASHTO T 11 and the amount of material finer than a 75  $\mu\text{m}$  (No. 200) mesh sieve shall not exceed four per cent by weight.

The amount of deleterious substances in natural sand shall not exceed the following limits:

Maximum Permissible Limits  
Percent by Weight

1. Clay Lumps	0.5
2. Coal & Lignite	0.5
3. Other deleterious substances (such as shale, alkali, mica, coated grains, soft & flaky particles)	3.0

- (3) Agricultural limestone, when used as a portion of the fine aggregate, shall be manufactured from sound, durable stone and shall be crushed so that at least 85 per cent will pass the 2.36 millimeter (No. 8) mesh sieve and at least 50 per cent will pass the 600  $\mu\text{m}$  (No. 30) mesh sieve.

(c) The Combined Grading.

The several aggregate fractions shall be sized, graded, and combined in such proportions that the resulting composite blend will meet one of the following grading requirements, as specified, together with the stipulations pertaining to the constituents of the blend hereinafter specified.

The Contractor shall establish a single value for each sieve size required in the mix for each aggregate stockpile with an allowable stockpile tolerance on each sieve as specified in Subsection 903.06(c).

When Gradings D, E, or F are used for the surfacing of shoulders or for other non traffic lane construction, the design may be modified as approved by the Engineer.

ASPHALT CONCRETE SURFACE COURSE  
MIXTURE DESIGNATION  
DESIGN RANGE OF GRADATIONS

Total Percent Passing, by Weight

Sieve Size	Grading D	Grading E	Grading F
19 mm (3/4")	-	-	-
16 mm (5/8")	100	100	-
12.5 mm (1/2")	95-100	95-100	-
9.5 mm (3/8")	80-93	80-93	100
4.75 mm (No. 4)	54-76	54-76	89-100
2.36 mm (No. 8)	35-57	35-57	78-92
600 µm (No. 30)	17-29	17-29	38-67
300 µm (No. 50)	10-18	10-18	23-47
150 µm (No. 100)	3-10	3-11	7-18
75 µm (No. 200)	0-6.5	0-8	5-13

When crushed gravel is used in Grading G mix, the percent passing the 150 µm (No. 100) sieve shall be 2-7.

**Grading D.**

The coarse aggregate shall consist of crushed gravel, crushed granite, crushed slag, crushed quartzite or crushed gneiss. Other crushed aggregate may be used provided it has the following chemical, physical, and performance characteristics for Type I, Type II or Type III aggregate:

(1) Type I

Silica Dioxide content - minimum of 50%  
Calcium carbonate content - maximum of 32%

The coarse aggregate shall contain a minimum of 50% by weight of the original sample of acid insoluble residues that are coarser than the 150 µm (No. 100) mesh sieve when tested in accordance with ASTM D 3042.

The British Pendulum (Tester) number BPN shall not be less than 33 when tested in accordance with AASHTO T 278 after

nine hours of accelerated polishing of the aggregate using the British Wheel in accordance with AASHTO T 279.

(2) Type II

Silica Dioxide content - minimum of 30%

The coarse aggregate shall contain a minimum of 35% by weight of the original sample of acid insoluble residues that are coarser than the 150  $\mu\text{m}$  (No. 100) mesh sieve when tested in accordance with ASTM D 3042.

The British Pendulum (Tester) number BPN shall not be less than 30 when tested in accordance with AASHTO T 278 after nine hours of accelerated polishing of the aggregate using the British Wheel in accordance with AASHTO T 279.

In addition to the above requirements, the aggregate shall have met the preapproval process of the Division of Materials and Tests.

(3) Type III (for roads with current ADT of 12,000 or less excluding Interstate Highways).

Silica Dioxide content - minimum of 20%

The coarse aggregate shall contain a minimum of 25% by weight of the original sample of acid insoluble residues that are coarser than the 150  $\mu\text{m}$  (No. 100) mesh sieve when tested in accordance with ASTM D-3042.

The British Pendulum (Tester) number BPN shall not be less than 25 when tested in accordance with AASHTO T 278 after nine hours of accelerated polishing of the aggregate using the British Wheel in accordance with AASHTO T-279.

In addition to the above requirements, the aggregate shall have met the preapproval process of the Division of Materials and Tests.

The fine aggregate shall consist of natural sand or sand manufactured from gravel, slag or from crushed stone aggregate meeting the physical and chemical requirements listed above. The use of carbonate rocks such as limestone and dolomite or other aggregates tending to polish under traffic will not be permitted in the coarse aggregate and will be permitted only to the extent specified herein in the fine aggregate.

Grading E.

When Grading E is to be used as a surface for traffic lanes, the mineral aggregate shall be composed of not less than 50 percent, nor more than 80 percent crushed limestone, and not more than 50 percent or not less than 20 percent natural sand, slag sand, sand manufactured from gravel or other approved non-skid aggregates, or any combination of these materials, except as herein specified.



The sand percentage on the job mix formula shall be in the range of 20-50 percent. However, if needed to meet or improve the specified design criteria, the limestone and sand percentage may be altered by the numerical value of 5 percent from the percentage shown by the Contractor on the original job mix formula. If the aggregate percentages shown on the original job mix formula are altered, the Contractor shall submit a new job mix formula using the aggregate percentages shown on the Design.

When Grading "E" is used for surfacing of shoulders or other non-traffic lane construction, the mineral aggregate may be composed entirely of limestone including Size No. 10 (Screenings) and manufactured sand, but in no case shall the mineral aggregate for this construction consist of less than 50 percent limestone.

#### Grading F.

The mineral aggregate shall be composed of not less than 75 per cent nor more than 85 per cent of either natural sand, slag sand, sand manufactured from other approved non-skid aggregates, sand manufactured from siliceous materials or any combinations of these materials, and not less than 15 per cent nor more than 25 per cent of stone screenings meeting the gradation requirements of Size No. 10 Section 903.22. Agricultural limestone meeting the requirements of 903.11(b) may be substituted for all or part of the stone screenings.

#### 903.12-Aggregate for Slurry Seal and Micro-Surface.

- (a) **Aggregate for Slurry Seal.** The aggregate shall be crushed slag, crushed granite or crushed stone (crushed stone as specified for the types listed for Grading D in Subsection 903.11(c)) meeting the requirements of ASTM D 692, except the gradation shall be as specified below. The aggregate shall have a minimum sand equivalent (AASHTO T 176) of 45. The aggregate shall be proportioned to produce a uniform gradation meeting the following requirements:

#### GRADATION LIMITS FOR AGGREGATE BASED ON WASH GRADATION

Sieve	Design Master Range (Total Percent Passing)	Mixture Control Tolerances
9.5 mm (3/8 inch)	100	
4.75 mm (No. 4)	90-100	±6.0
2.36 mm (No. 8)	65-90	±5.0
1.18 mm (No. 16)	45-70	±5.0
600 µm (No. 30)	30-50	±4.0
300 µm (No. 50)	20-38	±4.0
150 µm (No. 100)	12-28	±3.0
75 µm (No. 200)	8-16	±3.0

- (b) **Aggregate for Micro-Surface.** The aggregate shall be crushed slag, crushed granite or crushed stone (crushed stone as specified for the types listed for Grading D in Subsection 903.11(c)) meeting the gradation limits below and the physical properties of ASTM D 692 except the percent of fractured pieces shall be 100. The aggregate shall have a minimum sand equivalent (AASHTO T 176) of 65. The aggregate shall be proportioned to produce a uniform gradation meeting the following requirements:

**GRADATION LIMITS FOR AGGREGATE  
BASED ON WASH GRADATION**

Sieve	Design Master Range (Total Percent Passing)	Mixture Control Tolerances
9.5 mm (3/8 inch)	100	
4.75 mm (No. 4)	70-98	±6.0
2.36 mm (No. 8)	45-70	±5.0
1.18 mm (No. 16)	30-55	±5.0
600 µm (No. 30)	20-35	±4.0
300 µm (No. 50)	12-25	±4.0
150 µm (No. 100)	7-18	±2.0
75 µm (No. 200)	4-12	±2.0

**903.13-Aggregate for Hot Bituminous Seal Coat.** Aggregate for Hot Bituminous Seal Coat shall consist of crushed stone, crushed slag or crushed gravel meeting the quality requirements of ASTM D 692, except that at least 50 per cent by count of crushed gravel aggregates shall have at least one fractured face. Crushed slag aggregate retained on the No. 4 sieve shall contain not more than 20 per cent, by weight of glassy particles.

The amount of material finer than 200 mesh shall not exceed 1.0 per cent. If all material finer than the 200 mesh sieve consists of the dust of fracture, essentially free from clay or shale, the percentage may be increased to 1.5.

At the option of the Engineer, the aggregate may be tested for bituminous film retention. When tested in accordance with AASHTO T 182, the aggregate shall have a bituminous film retention in excess of ninety-five per cent. Aggregates which are tested and do not meet the film retention requirement may be approved provided a satisfactory chemical additive is used.

Aggregate used in the mat shall be Size No. 7, Subsection 903.22.

**903.14-Aggregate for Double Bituminous Surface Treatment.** Aggregate for Double Bituminous Surface Treatment shall conform to the requirements of Subsection 903.13. Aggregate used in the mat shall be Size No. 7, Subsection 903.22. Aggregate used in the seal shall be Size No. 8, Subsection 903.22. At least 90 percent of the aggregate particles retained on the 4.75 millimeter (No. 4) sieve shall have one or more fractured faces, fractured for the approximate average diameter or thickness of the particle.

**903.15-Aggregate for Aggregate-Cement Base Course.** Aggregate for Aggregate-Cement Base Course shall consist of coarse aggregate composed of sound, tough, durable fragments of crushed stone, crushed slag, crushed or uncrushed gravel, or crushed or uncrushed chert; fine aggregate composed of natural or manufactured sand, and silt-clay or other finely divided mineral matter.

The aggregate shall be screened and of such gradation that all will pass a 37.5 millimeter (1-1/2 inch) sieve, not more than 75 per cent will pass the 4.75 millimeter (No. 4) sieve, and not less than five nor more than 15 per cent will pass the 75  $\mu$ m (No. 200) sieve. The fraction passing the 425  $\mu$ m (No. 40) sieve shall have liquid limit not greater than 35, and a plasticity index not greater than 10. If blending of materials is required, it shall be done at the screening plant or at the stationary mixing plant.

The combined total of shale, organic material, or other unwanted substances shall not exceed five per cent by weight.

**903.16-Mineral Filler.** Mineral Filler shall meet the requirement of AASHTO M 17, except that mineral filler shall be non-plastic.

**903.17-Aggregate for Underdrains.** Aggregate for Underdrains shall be crushed stone, crushed slag, or washed gravel meeting the quality requirements of ASTM D 692 and the grading requirements for Size 6, 7, 8, 57 or 78, Subsection 903.22.

**903.18-Aggregate for Sand-Asphalt Surface Course.** Aggregate for Sand-Asphalt Surface Course shall consist of natural sand and/or crushed siliceous material meeting the quality requirements of ASTM D 1073. In the natural sand the percentage of material finer than the 75  $\mu$ m (No. 200) mesh shall not exceed five. The natural sand or combination of these materials shall meet the following requirements for gradation:

Sieve Size	Total percent passing by weight
4.75 mm (No. 4)	100
2.36 mm (No. 8)	95-100
600 $\mu$ m (No. 30)	50-80
300 $\mu$ m (No. 50)	30-60
150 $\mu$ m (No. 100)	8-25
75 $\mu$ m (No. 200)	2-10

**903.19-Lightweight Aggregates for Structural Concrete.** Lightweight aggregate for structural concrete shall conform to the requirements of AASHTO M 195 with the following additional stipulations:

1. The lightweight aggregate shall be produced by fusing raw shale, slate or clay in a rotary kiln producing particles having a wear of not more than 40 percent when tested according to AASHTO T 96.

2. The lightweight coarse aggregate shall conform to the grading requirements for 19 millimeters (size 3/4 inch) to 4.75 millimeters (No. 4) as shown in Table 1 of AASHTO M 195.
3. The absorption of the coarse aggregate shall not exceed 10 percent when tested in accordance with AASHTO T 85.
4. When the coarse aggregate is subjected to five alterations of the sodium sulfate soundness test in accordance with AASHTO T 104, the weighted percentage of loss shall not be more than nine.

**903.20-Stockpiling Aggregates.** Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground shall be firm and smooth and well drained. A cover of at least 75 millimeters (three inches) of aggregate shall be maintained in order to avoid the inclusion of soil or foreign material. The stockpiles shall be built in layers not exceeding 1.2 meters (four feet) in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of aggregate composed essentially of material finer than the 4.75 millimeter (No. 4) sieve and base material.

Dumping, casting or pushing over sides of stockpiles will be prohibited, except in the case of aggregate for base material and fine aggregate materials.

Unless otherwise authorized, aggregates from different sources different gradings or differing in specific gravity by more than 0.03 shall not be stockpiled together. Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

When it is necessary to operate trucks or other equipment on a stockpile in the process of building the stockpiles, it shall be done in a manner approved by the Engineer. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated, and failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedure.

**903.21-Test Methods.** In stating requirements for most materials in Section 903, reference has been made to AASHTO and ASTM Standard Specifications for materials. The current AASHTO or ASTM Standard Specification effective at the time of letting for a particular Contract, shall be the governing specification. Those Specifications, in turn, include reference to the respective AASHTO and ASTM methods of sampling and testing. In a few instances, however, properties of materials in Section 903 have been specified without reference to corresponding AASHTO and ASTM Standard Specifications. In such instances, the following methods of sampling and testing will govern:

Test	Test Method
Unit Weight	AASHTO T 19
Percentage of Wear	AASHTO T 96
Soundness	AASHTO T 104
Liquid Limit	AASHTO T 89
Plastic Limit and Plasticity Index	AASHTO T 90
Sieve Analysis	AASHTO T 27
Hydrometer Analysis	AASHTO T 88
Material Passing 75 $\mu\text{m}$ (No. 200) Sieve in Aggregate	AASHTO T 11
Stripping Test of Bitumen- Aggregate Mixtures	AASHTO T 182
Resistance to Plastic Flow by: Marshall Method	AASHTO T 245 <sup>(1)</sup>

- (1) AASHTO T 245 except as modified by Tennessee Department of Transportation Research Reports, Numbers 16 and 18.

TABLE 1 Standard Sizes of Processed Aggregate

Size	Nominal Size, Square openings	Amounts Finer than Each Laboratory Sieve (Square Openings), weight percent														
		100 mm (4")	90 mm (3-1/2")	75 mm (3")	63 mm (2-1/2")	50 mm (2")	37.5 mm (1-1/2")	25.0 mm (1")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No.4)	2.36 mm (No.8)	1.18 mm (No.16)	300 μm (No.50)	150 μm (No.100)
1	90 - 37.5 mm (3-1/2" - 1-1/2")	100	90-100	--	25-60	--	0-15	--	0-5	--	--	--	--	--	--	--
2	63 - 37.5 mm (2-1/2" - 1-1/2")	--	--	100	90-100	35-70	0-15	--	0-5	--	--	--	--	--	--	--
24	63 - 19.0 mm (2-1/2" - 3/4")	--	--	100	90-100	--	25-60	--	0-10	0-5	--	--	--	--	--	--
3	50 - 25.0 mm (2"-1")	--	--	--	100	90-100	35-70	0-15	--	0-5	--	--	--	--	--	--
357	50 - 4.75 mm (2" - No. 4)	--	--	--	100	95-100	--	35-70	--	10-30	--	0-5	--	--	--	--
4	37.5 - 19.0 mm (1-1/2" - 3/4")	--	--	--	--	100	90-100	20-55	0-15	--	0-5	--	--	--	--	--
467	37.5 - 4.75 mm (1-1/2" - No. 4)	--	--	--	--	100	95-100	--	35-70	--	10-30	0-5	--	--	--	--
5	25.0 - 12.5 mm (1" - 1/2")	--	--	--	--	--	100	90-100	20-55	0-10	0-5	--	--	--	--	--
56	25.0 - 9.5 mm (1" - 3/8")	--	--	--	--	--	100	90-100	40-85	10-40	0-15	0-5	--	--	--	--
57	25.0 - 4.75 mm (1" - No. 4)	--	--	--	--	--	100	95-100	--	25-60	--	0-10	0-5	--	--	--
6	19.0 - 9.5 mm (3/4" - 3/8")	--	--	--	--	--	--	100	90-100	20-55	0-15	0-5	--	--	--	--
67	19.0 - 4.75 mm (3/4" - No. 4)	--	--	--	--	--	--	100	90-100	--	20-55	0-10	0-5	--	--	--
68	19.0 - 2.36 mm (3/4" - No. 8)	--	--	--	--	--	--	100	90-100	--	30-65	5-25	0-10	0-5	--	--
7	12.5 - 4.75 mm (1/2" - No. 4)	--	--	--	--	--	--	--	100	90-100	40-70	0-15	0-5	--	--	--
78	12.5 - 2.36 mm (1/2" - No. 8)	--	--	--	--	--	--	--	100	90-100	40-75	5-25	0-10	0-5	--	--
8	9.5 - 2.36 mm (3/8" - No. 8)	--	--	--	--	--	--	--	--	100	85-100	10-30	0-10	0-5	--	--
89	9.5 - 1.18 mm (3/8" - No. 16)	--	--	--	--	--	--	--	--	100	90-100	20-55	5-30	0-10	0-5	--
9	4.75 - 1.18 mm (No. 4 - No. 16)	--	--	--	--	--	--	--	--	--	100	85-100	10-40	0-10	0-5	--
10	4.75 mm (No. 4 - 0 <sup>a</sup> )	--	--	--	--	--	--	--	--	--	100	85-100	--	--	--	10-30

<sup>a</sup>Screenings