

1116 – AGGREGATES FOR ON GRADE CONCRETE

SECTION 1116

AGGREGATES FOR ON GRADE CONCRETE

1116.1 DESCRIPTION

This specification is for coarse aggregates, intermediate aggregates, fine aggregates, mixed aggregates (coarse, intermediate and fine material) and miscellaneous aggregates for use in construction of concrete placed on grade.

For Intermediate Aggregates and Mixed Aggregates, consider any aggregate with 30% or more retained on the No. 8 sieve to be Coarse Aggregate.

1116.2 REQUIREMENTS

a. Quality of Individual Aggregates.

(1) Provide aggregate for concrete that complies with the following requirements. Crushed aggregates with less than 20% material retained on the 3/8" sieve from a source complying with these requirements prior to crushing. Fine Aggregates for Concrete have additional Quality Requirements stated in **subsection 1116.2e.(2)**.

Soundness by Freeze/Thaw (min.) (KTMR-21)*	0.90
Wear Grading B (max.)(AASHTO T 96)**	50%
Additional Requirements:***	
Modified Soundness by Freeze/Thaw (min.) (KTMR-21)	0.90
Relative Dynamic Modulus of Elasticity, minimum (KTMR-22 @ 660 F/T cycles) ...	95
Expansion, maximum (KTMR-22 @ 660 F/T cycles)	0.025%
* Soundness (KTMR-21) requirements do not apply to aggregates having less than 10% material retained on the No. 4 sieve.	
** Wear (AASHTO T 96) requirements do not apply to aggregates having less than 10% retained on the No. 8 sieve.	
***The additional requirements do not apply for uncrushed sand-gravel aggregates having less than 5% material retained on the 1/2" sieve.	

(2) All predominately siliceous aggregate must comply with the Wetting & Drying Test requirements, or be used with a Coarse Aggregate Sweetener, or will require Supplemental Cementitious Materials (SCM) to prevent Alkali Silica Reactions (ASR). When an SCM is utilized, provide the results of mortar expansion tests of ASTM C 1567 using the project's mix design concrete materials at their designated percentages. Provide a mix with a maximum expansion of 0.10% at 16 days after casting. Provide the results to the Engineer at least 15 days before placement of concrete on the project.

Wetting & Drying Test of Siliceous Aggregate for Concrete (KTMR-23)	
Concrete Modulus of Rupture:	
• At 60 days, minimum	550 psi
• At 365 days, minimum	550 psi
Expansion:	
• At 180 days, maximum	0.050%
• At 365 days, maximum	0.070%

Aggregates produced from the following general areas are exempt from the Wetting and Drying Test:

- Blue River Drainage Area.
- The Arkansas River from Sterling, west to the Colorado state line.
- The Neosho River from Emporia to the Oklahoma state line.

(3) Coarse Aggregate Sweetener. Types and proportions of aggregate sweeteners to be used with Mixed Aggregates are listed in **TABLE 1116-1**.

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TABLE 1116-1: COARSE AGGREGATE SWEETENER	
Type of Coarse Aggregate Sweetener	Proportion Required by Percent Weight
Crushed Sandstone*	40 (minimum)
Crushed Limestone or Dolomite*	40 (minimum)
Siliceous Aggregates meeting subsection 1116.2a.(2)	40 (minimum)
Siliceous Aggregates not meeting subsection 1116.2a.(2) **	30 (maximum)

*Waive the minimum portion of Coarse Aggregate Sweetener for all intermediate and fine aggregates that comply with the wetting and drying requirements for Siliceous Aggregates. In this case, combine the intermediate, fine and coarse aggregate sweetener in proportions required to comply with **subsection 1116.2a.(2)**

**To be used only with intermediate and fine aggregates that comply with the wetting and drying requirements of Siliceous Aggregates unless a Supplemental Cementitious Material is utilized.

b. Mixed Aggregates

(1) Composition. Provide coarse, intermediate, and fine aggregates in a combination necessary to meet **subsection 1116.2b.(2)**. Use a proven optimization method such as ACI 302.1 or other method approved by the Engineer. Aggregates may be from a single source or combination of sources.

(2) Product Control.

(c) Gradations such as those shown in **TABLE 1116-2** have proven satisfactory in reducing water demand while providing good workability. Adjust mixture proportions whenever individual aggregate grading varies during the course of the work. Use the gradations shown in **TABLE 1116-2**, or other gradation approved by the Engineer.

Optimization is not required for concrete for patching pavements more than 10 years old, or Commercial Grade Concrete. The Engineer may waive the optimization requirements if the concrete meets all the requirements of **DIVISION 400** and/or **DIVISION 500**.

Follow these guidelines:

1. Do not permit the percent retained on two adjacent sieve sizes to fall below 4%;
2. Do not allow the percent retained on three adjacent sieve sizes to fall below 8%; and
3. When the percent retained on each of two adjacent sieve sizes is less than 8%, the total percent retained on either of these sieves and the adjacent outside sieve should be at least 13%.
(for example, if both the No. 4 and No. 8 sieves have 6% retained on each, then:
 - 1) the total retained on the 3/8 in. and No. 4 sieves should be at least 13%, and
 - 2) the total retained on the No. 8 and No. 16 sieves should be at least 13%.)

TABLE 1116-2: ALLOWABLE GRADING FOR MIXED AGGREGATES FOR CONCRETE													
Type	Usage	Percent Retained - Square Mesh Sieves											
		1 ½"	1"	¾"	½"	⅜"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
MA-3	Optimized All Concrete		0	2-12	Note ¹	Note ¹	Note ¹	Note ¹	Note ²	Note ²	Note ²	95-100	98-100
MA-4	Optimized All Concrete ³	0	2-12	Note ¹	Note ¹	Note ¹	Note ¹	Note ¹	Note ²	Note ²	Note ²	95-100	98-100
MA-5	Optimized All Concrete		0	2-12	8 min	22-34		55-65		75 min		95-100	98-100
MA-7	Contractor Design KDOT Approved	Proposed Grading that does not correspond to other limits in this table but meet the requirements for concrete in DIVISION 400 and/or DIVISION 500 .											98-100

¹ Retain a maximum of 22% and a minimum of 6% of the material on each individual sieve.

² Retain a maximum of 15% and a minimum of 6% of the material on each individual sieve.

³ Maximum top size of Limestone is ¾".

(d) Optimization Requirements for all Gradations.

- Actual Workability must be within ± 5 of Target Workability.

Where: W_A = Actual Workability

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W_T = Target Workability

CF = Coarseness Factor

1. Determine the Grading according to KT-2
2. Calculate the Coarseness Factor (CF) to the nearest whole number.

$$CF = \frac{+3/8'' \text{ Material \% Retained}}{+ \#8 \text{ Material \% Retained}} \times 100$$

3. Calculate the Actual Workability (W_A) to the nearest whole number as the percent material passing the #8 sieve.

$$W_A = 100 - \% \text{ retained on \#8 sieve}$$

4. Calculate the Target Workability (W_T) to the nearest whole number where
For 517 lbs cement per cubic yard of concrete

$$W_T = 46.14 - (CF/6)$$

For each additional 1 lb of cement per cubic yard, subtract 2.5/94 lbs from the Target Workability.

- (c) Deleterious Substances. Maximum allowed deleterious substances by weight are:

- Clay lumps and friable particles (KT-7) 1.0%
- Coal (AASHTO T 113)..... 0.5%
- Shale or Shale-like material (KT-8)..... 0.5%
- Sticks (wet) (KT-35)..... 0.1%
- Sum of all deleterious 1.5%

- (d) Uniformity of Supply. Designate or determine the fineness modulus (grading factor) for each aggregate according to the procedure listed in Section 5.10.5-Fineness Modulus of Aggregates (Gradation Factor) of Part V before delivery, or from the first 10 samples tested and accepted. Provide aggregate that is within ± 0.20 of the average fineness modulus.

Provide a single point grading for the combined aggregates along with a plus/minus tolerance for each sieve. Use plus/minus tolerances to perform quality control checks and by the Engineer to perform aggregate grading verification testing. The tests may be performed on the combined materials or on individual aggregates, and then theoretically combined to determine compliance.

Maintain an Actual Workability within ± 5 of the Target Workability for combined aggregates.

- (3) Handling of All Aggregates.

(a) Segregation. Before acceptance testing, remix all aggregate segregated by transit or stockpiling.

(b) Stockpiling.

- Maintain separation between aggregates from different sources, with different gradings or with a significantly different specific gravity.
- Transport aggregate in a manner that promotes uniform grading.
- Do not use aggregates that have become mixed with earth or foreign material.
- Stockpile or bin all washed aggregate produced or handled by hydraulic methods for 12 hours (minimum) before batching. Rail shipment exceeding 12 hours is acceptable for binning provided the car bodies permit free drainage.
- Provide additional stockpiling or binning in cases of high or non-uniform moisture.

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c. Coarse Aggregates for Concrete.

(1) Composition. Provide coarse aggregate that is crushed gravel or crushed stone meeting the quality requirements of **subsection 1116.2a**. Consider limestone, calcite cemented sandstone, rhyolite, quartzite, basalt and granite as crushed stone.

Mixtures utilizing siliceous aggregate not meeting **subsection 1116.2a.(2)** will require supplemental cementitious materials to prevent Alkali Silica Reactions. Provide the results of mortar expansion tests of ASTM C 1567 using the project’s mix design concrete materials at their designated percentages. Provide a mix with a maximum expansion of 0.10% at 16 days after casting. Provide the results to the Engineer at least 15 days before placement of concrete on the project.

(2) Product Control. Use gradations such as those in **TABLE 1116-3** which have been shown to work in Optimized Mixed Aggregates, or some other gradation approved by the Engineer that will provide a combined aggregate gradation meeting **subsection 1116.2b**.

TABLE 1116-3: GRADING REQUIREMENTS FOR COARSE AGGREGATES									
Type	Composition	Percent Retained - Square Mesh Sieves							
		1 ½"	1"	¾"	½"	3/8"	No. 4	No. 8	No. 30
CPA-1	Crushed Gravel or Crushed Stone	0	0-10	14-35	-	50-75	-	95-100	-
CPA-3	Crushed Gravel or Crushed Stone	-	-	0	0-35	30-70	75-100	95-100	-
CPA-4	Crushed Gravel or Crushed Stone	-	0	0-20	-	-	-	95-100	-

d. Intermediate Aggregate for Concrete.

(1) Composition. Provide intermediate aggregate for mixed aggregates (IMA) that is crushed stone, natural occurring sand, or manufactured sand meeting the quality requirements of **subsection 1116.2a**.

(2) Product Control. Provide IMA grading when necessary to provide a combined aggregate gradation meeting **subsection 1116.2b**.

e. Fine Aggregates for Concrete.

(1) Composition.

(a) Type FA-A. Provide either singly or in combination natural occurring sand resulting from the disintegration of siliceous or calcareous rock, or manufactured sand produced by crushing predominately siliceous materials meeting the quality requirements of **subsection 1116.2a**. and **subsection 1116.2e.(2)**.

(2) Additional Quality Requirements.

(a) Mortar strength and Organic Impurities. If the DME determines it is necessary, because of unknown characteristics of new sources or changes in existing sources, provide fine aggregates that comply with the following:

- Mortar Strength (KTMR-26). Compressive strength when combined with Type III (high early strength) cement:
 - At age 24 hours, minimum 100%*
 - At age 72 hours, minimum 100%*
- *Compared to strengths of specimens of the same proportions, consistency, cement and standard 20-30 Ottawa sand.
- Organic Impurities (AASHTO T 21). The color of the supernatant liquid is equal to or lighter than the reference standard solution.

(3) Product Control.

(a) Size Requirements. Provide FA-A that comply with **TABLE 1116-5** or some other gradation approved by the Engineer that will provide a combined aggregate gradation meeting **subsection 1116.2b**.

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TABLE 1116-4: GRADING REQUIREMENTS FOR FINE AGGREGATES FOR CONCRETE								
Type	Percent Retained-Square Mesh Sieves							
	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
FA-A	0	0-10	0-27	15-55	40-77	70-93	90-100	98-100

(b) Deleterious Substances.

- Type FA-A: Maximum allowed deleterious substances by weight are:
 - Coal (AASHTO T113).....0.5%
 - Sticks (wet) (KT-35).....0.1%
 - Sum of all deleterious0.5%

f. Miscellaneous Aggregates for Concrete.

(1) Aggregates for Mortar Sand, Type FA-M.

(a) Composition. Provide aggregates for mortar sand, Type FA-M that is natural occurring sand.

(b) Quality.

- Mortar strength and Organic Impurities. If the DME determines it is necessary, because of unknown characteristics of new sources or changes in existing sources, provide aggregates for mortar sand, Type FA-M that comply with the following:
 - Mortar Strength (KTMR-26). Compressive strength when combined with Type III (high early strength) cement:
 - At age 24 hours, minimum 100%*
 - At age 72 hours, minimum 100%*
 - * Compared to strengths of specimens of the same proportions, consistency, cement and standard 20-30 Ottawa sand.
 - Organic Impurities (AASHTO T 21). The color of the supernatant liquid is equal to or lighter than the reference standard solution.

(c) Product Control.

- Size Requirements. Provide aggregates for mortar sand, Type FA-M that comply with **TABLE 1116-5**.

TABLE 1116-5: GRADING REQUIREMENTS FOR MORTAR SAND								
Type	Percent Retained - Square Mesh Sieves							Gradation Factor
	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	
FA-M	0	0-2	0-30	20-50	50-75	90-100	98-100	1.70-2.50

- Deleterious Substances. Maximum allowed deleterious substances by weight are:
 - Clay lumps and friable material (KT-7)..... 1.0%
 - Coal (AASHTO T 113).....0.5%
 - Sticks (wet) (KT-35).....0.1%
 - Sum of all deleterious 1.5%

(2) Modified Lightweight Aggregates.

(a) Composition. Provide a modified lightweight aggregate produced from a uniform deposit of raw material combined with FA-A that meets **subsection 1102.2c**.

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(b) Quality.

- Soundness, minimum (KTMR-21)0.90
- Loss on Ignition5%

(c) Product Control.

- Size Requirements. Provide modified lightweight aggregates that comply with **TABLE 1116-6**.

TABLE 1116-6: GRADING REQUIREMENTS FOR MODIFIED LIGHTWEIGHT AGGREGATES						
Type	Percent Retained - Square Mesh Sieves					
	¾"	½"	⅜"	No. 4	No. 8	No. 16
Grade 1	0	0-10	30-60	85-100	95-100	
Grade 2		0-2	0-30	20-50	50-75	90-100

- Deleterious Substances.
 - Organic Impurities (AASHTO T 21). The color of the supernatant liquid is equal to or lighter than the reference standard solution.
- Unit Weight (dry, loose weight) (max.) 1890 lbs/cu yd

(d) Concrete Making Properties. Drying shrinkage of concrete specimens prepared with modified lightweight aggregate and FA-A proportioned as shown in the Contract Documents can not exceed 0.07%.

(e) Uniformity of Supply. Designate or determine the fineness modulus (grading factor) according to procedure listed in Part V, Section 5.10.5-Fineness Modulus of Aggregates (Gradation Factor) before delivery, or from the first 10 samples tested and accepted. Provide aggregate that is within ±0.20 of the average fineness modulus.

(f) Proportioning Materials. Submit mix designs for concrete using modified lightweight aggregate to Construction and Materials for approval prior to use.

(g) Stockpiling

- Stockpile accepted aggregates in layers 3 to 5 feet thick. Berm each layer so that aggregates do not "cone" down into lower layers.
- Keep aggregates from different sources, with different gradings or with a significantly different specific gravity separated.
- Transport aggregate in a manner that promotes uniform gradation.
- Do not use aggregates that have become mixed with earth or foreign material.
- Stockpile or bin all washed aggregate produced or handled by hydraulic methods for 12 hours (minimum) before batching. Rail shipment exceeding 12 hours is acceptable for binning, provided the car bodies permit free drainage.
- Provide additional stockpiling or binning in cases of high or non-uniform moisture.

1116.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTION 1115**.

1116.4 PREQUALIFICATION

Aggregates for concrete must be prequalified according to **subsection 1101.4**.

1116.5 BASIS OF ACCEPTANCE

The Engineer will accept aggregates for concrete based on the prequalification required by this specification and **subsection 1101.5**.