Engineering Policy Ballot

Effective: January 1, 2025

Level 3

Level three revisions require the approval of the **Chief Engineer** and the **Federal Highway Administration** only. The Senior Management Team is encouraged to review the content and provide comment to the appropriate director. For all other parties, these revisions are posted for information only.

ENGINEERING POLICY BALLOT

Effective: January 1, 2025

Issue 1: Concrete Aggregate Quality

Approval: **Level 3 – Chief Engineer**

Sponsor: Brandi Baldwin – CM, Sarah Kleinschmit – CM, Jonathan Varner – CM

Summary: The revisions to the standard specifications and EPG, will help ensure concrete pavement and masonry are durable and will last the anticipated life span.

Fiscal Impact: The estimated fiscal impact is approximately $6 to $10 per ton aggregate increase.

Publications: Missouri Standard Specification: Sec. 1005
Engineering Policy Guide: 1001, 1005, 106.3.2.93-TM93
Job Special Provisions: Third-Party Test Waiver for Concrete Aggregate

SECTION 1005

AGGREGATE FOR CONCRETE

1005.1 Scope. This specification covers aggregate to be used for concrete construction.

1005.2 Coarse Aggregate.

1005.2.1 All coarse aggregate for concrete shall consist of sound, durable rock, free from objectionable coatings and frozen and cemented lumps. The percentage of deleterious substances shall not exceed the following values, and the sum of percentages of all deleterious substances, exclusive of the material passing No. 200 sieve (Gradations D and E), and thin or elongated materials, shall not exceed 6.0 percent. For crushed stone, the percentage of wear shall not exceed 50 when tested in accordance with AASHTO T 96.

Deleterious Material	Percent by Weight
Deleterious Rock	6.0
Shale	1.0
Chert in Limestone	4.0
Other Foreign Material	0.5
Material Passing No. 200 Sieve Gradations D & E	2.5[a]
Thin or Elongated	5.0

[a] Value may be raised to 3.0 percent, providing the material passing the #200 sieve in the fine aggregate is less than or equal to 1.0 percent.

1005.2.1.1 The above requirements shall~~will~~ apply to each size or fraction of aggregate produced.

1005.2.1.2 Crushed stone shall be obtained from rock of uniform quality. Rock tested for initial approval, source samples, and production samples shall meet the requirements below. ~~for Los Angeles abrasion, absorption, and soundness.~~ The absorption and soundness test results may be waived provided a durability factor of 90~~75~~ percent or higher is achieved~~absorption and s~~ Concrete pavement ~~Pavement~~aggregate approval will be based on maximum aggregate size produced that meets durability requirements.

Test Method[3]	Concrete Masonry Aggregate	~~PCCPConcrete Pavement Aggregate, First Source Approval Sample~~	Concrete Pavement~~PCCP~~ Aggregate, additional Source Approval Samples
Los Angeles Abrasion, AASHTO T 96, percent loss, max.[1]	50	~~50~~	50

Absorption, AASHTO T 85, percent, max.[1]	3.5	~~2.0~~	2.0
Soundness, MoDOT Test Method TM 14, percent loss, max.[1]	18.0	~~16.0~~	16.0
Durability Factor, AASHTO T 161 Procedure B, percent, min.	N/A	~~80~~	80
Micro Deval, AASHTO T327, percent loss, max.[1]	N/A	~~N/A~~	Value of the First Source Approval +5.0[2]
Reactivity, MoDOT Test Method TM 93	passes	~~passes~~	passes

[1] Evaluated every year
[2] When the Micro-Deval percent abrasion loss is 5.0 higher or more than the Micro-Deval abrasion loss of the first source approval, new T 161 B and TM-93 tests are required
[3]The engineer may require additional testing based on variable test results

~~Property~~	~~Value~~
~~Los Angeles Abrasion, AASHTO T 96, percent loss, max~~	~~50~~
~~Absorption, AASHTO T 85, percent, max.:~~ ~~(a) Portland Cement Concrete Pavement~~ ~~(b) Portland Cement Concrete Masonry~~	 ~~2.0~~ ~~3.5~~
~~Soundness, MoDOT Test Method TM 14, percent loss, max.:~~ ~~(a) Portland Cement Concrete Pavement~~ ~~(b) Portland Cement Concrete Masonry~~	 ~~16.0~~ ~~18.0~~
~~Durability Factor, AASHTO T 161 Procedure B, percent, min:~~ ~~(a) Portland Cement Concrete Pavement~~ ~~(b) Portland Cement Concrete Masonry~~	 ~~75[a]~~ ~~75[b]~~

~~[a] Approval will be based on maximum aggregate size produced that meets durability requirements.~~

~~[b] The maximum top size of the aggregate tested shall be 1 inch or greater.~~

1005.2.1.3 –All tests in 1005.2.1.2 shall be run for each source approval. The absorption, durability factor, and TM-93 test results may be waived for concrete pavement approval by the State Construction and Materials Engineer provided sufficient evidence of field performance is submitted. The aggregate producer or contractor, shall provide the following to the State Construction and Materials Engineer prior to any consideration of waiver of test requirements:

(a) The ledge combination aggregate has been previously used on a minimum of three different Missouri mainline pavement roadways,

(b) The minimum individual age of the three concrete pavements shall be 25 years,

(c) The minimum individual quantity of the three concrete pavements shall be 14,000 square yards mainline concrete pavement. Ramps shall not be used to meet this requirement.

The required documentation for a field performance waiver shall include the job number or contract ID, route, direction, specific location (e.g., log mile or station), and year(s) paved. Neither MoDOT nor the Commission is responsible for providing this required documentation.

1005.2.1.43 Gravel shall be washed and shall be in accordance with the criteria below for initial approval. Source approval and production samples shall also meet the following criteria:

Property	Value
Los Angeles Abrasion, AASHTO T 96, percent loss, max.	45
Absorption, AASHTO T 85, percent, max.	4.5
Soundness, MoDOT Test Method TM 14, percent loss, max.	18.0

1005.2.1.54 The engineer reserves the right to use additional test methods, such as ~~ASTM C 586, AASHTO T 161~~ ASTM C25, ASTM C1105, ASTM C1260, or other appropriate tests, to measure the soundness and durability of aggregate for use in concrete when deemed necessary.

1005.2.2 Coarse aggregate for concrete pavement or base course shall be crushed stone or porphyry.

1005.2.3 Grade F Aggregate. Coarse aggregate for Portland cement concrete pavement, base and approach slabs for bridges that is not produced from the Burlington, Keokuk, Cedar Valley (formerly Callaway) or Warsaw limestone formations, which is obtained from sources in the following areas shall have a maximum top size of ¾ inch:

(a) State of Kansas, Iowa and Nebraska.

(b) Counties of Missouri – Adair, Andrew, Atchison, Bates, Benton, Buchanan, Caldwell, Carroll, Cass, Cedar, Chariton, Clay, Clinton, Daviess, DeKalb, Gentry, Grundy, Harrison, Henry, Holt, Jackson, Johnson, Lafayette, Linn, Livingston, Mercer, Macon, Nodaway, Pettis, Platte, Putnam, Randolph, Ray, St. Clair, Saline, Schuyler, Sullivan, Vernon and Worth.

1005.2.4 Grade F shall be obtained from rock of uniform quality. Rock tested for initial approval, source samples, and production samples, shall meet the requirements below ~~for Los Angeles abrasion, absorption, soundness, and bulk specific gravity shall be in accordance with the criteria below~~. The absorption, soundness, and bulk specific gravity test results may be waived provided a durability factor of ~~75~~ 9080 percent or higher is achieved.

Property	Value
Los Angeles Abrasion, AASHTO T 96, percent loss, max.	50
Absorption, AASHTO T 85, percent, max.	1.5
Soundness, MoDOT TM 14, percent loss, max.	10.0
Bulk Specific Gravity, AASHTO T 85, min.	2.58
Durability Factor, AASHTO T 161 Procedure B, percent, min:	80~~75~~[a]

[a] Approval will be based on maximum aggregate size produced that meets durability requirements.

1005.2.5 Coarse aggregate for concrete for structures, except as specified in Sec 1005.2.6, may be gravel or crushed stone. Coarse aggregate for Class B, B-1, B-2, MB-2 or Seal concrete shall

be in accordance with either Gradation D or E. Coarse aggregate for Class A-1 concrete shall be in accordance with Gradation E.

Gradation D	Percent by Weight
Passing 1-inch sieve	100
Passing 3/4-inch sieve	85-100
Passing 3/8-inch sieve	15-55
Passing No. 4 sieve	0-10

Gradation E	Percent by Weight
Passing 3/4-inch sieve	100
Passing 1/2-inch sieve	70-100
Passing 3/8-inch sieve	30-70
Passing No. 4 sieve	0-20
Passing No. 8 sieve	0-6

1005.2.6 Coarse aggregate for ornamental concrete shall be crushed stone in accordance with Sec 1005.2.5, Gradation E. However, the use of coarse aggregate containing more than 2 percent chert will not be permitted.

1005.3 Fine Aggregate.

1005.3.1 Fine aggregate for concrete shall be a fine granular material naturally produced by the disintegration of rock of a siliceous nature, or shall be manufactured from an approved limestone or dolomite source as defined in Sec 1005.2. By specific approval from the engineer, chat sand produced from flint chat in the Joplin area or fines manufactured from igneous rock or chert gravel may be used. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating of injurious material. The percentage of deleterious substances shall not exceed the following values:

Deleterious Material	Percent by Weight
Clay Lumps and Shale	0.25
Coal and Lignite	0.50
Total Lightweight Particles, Including Coal and Lignite	0.50
Material Passing No. 200 Sieve (a) Natural Sand (b) Manufactured Sand	 2.0 4.0
Other Deleterious Substances	0.10

1005.3.2 The total lightweight particle requirement will not apply to angular chert sand or manufactured sand.

1005.3.3 Fine aggregate shall produce a mortar having a seven-day compressive strength of at least 90 percent of a control mortar developed at the same proportions, using standard Ottawa sand. Tests shall be performed in accordance with AASHTO T 106. Cement used in the tests shall be Type I, in accordance with Sec 1019. AASHTO T 106 may be waived provided the fine aggregate produces a glass color standard lighter than Organic Platte No. 3, in accordance with AASHTO T 21.

1005.3.4 Fine aggregate for ornamental concrete shall be free from coal and lignite material when tested in accordance with AASHTO T 113.

1005.3.5 All fine aggregate for PCCM shall meet the following gradation requirements:

Sieve	Percent by Weight
Passing 3/8-inch sieve	100
Passing No. 4 sieve	95-100
Passing No. 8 sieve	70-100
Passing No. 16 sieve	45-90
Passing No. 30 sieve	15-65
Passing No. 50 sieve	5-30
Passing No. 100 sieve	0-10

1005.4 Lightweight Aggregates.

1005.4.1 Lightweight aggregates shall be prepared by expanding, calcining, or sintering argillaceous material such as clay, shales, and slates.

1005.4.2 Grading. The grading shall be uniform and conform to the requirements given in Table I.

1005.4.3 Unit Weight. The unit weight of lightweight aggregates shall not exceed the following:

Dry, Loose Weight, Max. lb/cu ft	
Fine Aggregate	70
Coarse Aggregate	55

1005.4.3.1 Uniformity of Weight. If the unit weight of any shipment of lightweight aggregate when tested in accordance with AASHTO T 19 is found to vary by more than 10 percent from that of the sample submitted for source approval, the aggregate shipment may be rejected.

1005.4.4 Soundness. When tested in accordance with AASHTO T 104, the loss of lightweight fine or coarse aggregate in 5 cycles of the accelerated soundness test shall not exceed 8 percent if sodium sulfate is used or 10 percent if magnesium sulfate is used.

1005.4.5 Drying Shrinkage. The drying shrinkage of concrete specimens prepared and tested in accordance with AASHTO M 195, shall not exceed 0.07 percent.

1005.4.6 Sampling. Samples of fine and coarse aggregate shall be furnished by the contractor for source approval. Other samples shall be taken from shipments at intervals specified by the engineer.

Table I
Grading Requirements for Lightweight Aggregate

		Percent Passing Sieve Sizes									
Grade	**Size**	**1 1/2"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**No. 4**	**No. 8**	**No. 16**	**No. 50**	**No. 100**
Fine Aggregate											
	No. 4 to 0	---	---	---	---	100	85-100	---	40-80	10-35	5-20
Coarse Aggregate											
1	1" to 1/2"	100	90-100	20-55	0-10	0-5	---	---	---	---	---
2	1" to No. 4	100	95-100	---	25-60	---	0-10	0-5	---	---	---
3	3/4" to No. 4	---	100	90-100	---	20-55	0-10	0-5	---	---	---
4	1/2" to No. 4	---	---	100	90-100	40-70	0-15	0-5	---	---	---
5	3/8" to No. 8	---	---	---	100	85-100	10-30	0-10	0-5	---	---

Category:1001 general requirements for material

This article establishes procedures for material acceptance that includes necessary sample types and frequencies, required test methods, sampling procedures and reporting. This article also establishes requirements for acceptance of dust suppressant additives.

Sample weights (masses) are to be considered as minimum weights (masses).

1001.1 Duties

The duty of an ~~aggregate~~material inspector (or technician) is to ensure that only materials with initial evaluation and source approval are incorporated into the final product. The inspector will verify that materials are produced from the ledges or source as stated on the mix design. ~~Aggregate i~~Inspectors must be familiar with all ledge configurations in the district and be able to differentiate ledges in the quarry. Quarry visits should be made as necessary to visually verify that production is from the ledges as stated on the mix design. The ~~aggregate~~ inspector shall ensure that required sampling frequencies and testing procedures comply with the specifications.

1001.1.1 Initial Evaluation

1001.1.2 Diary

The inspector will maintain a bound diary describing the daily activities in accordance with EPG 106.20.11 Internal Material Records.

Figures

Fig 1001.10.1 Form T-630R, page 1

Fig 1001.10.1 Form T-630R, page 2

Fig 1001.10.2 Form T-630R Example 1, page 1

Fig 1001.10.2 Form T-630R, Example 1, page 2

Fig 1001.10.3 Form T-630R, Example 2

Fig 1001.10.4 Liquid Limit and Plastic Limit Tests

Fig 1001.10.5

Fig 1001.10.6 Example of Calibration Procedure, page 1

Fig 1001.10.6 Example of Calibration Procedure, page 2

Qualified List of Brand Names and Manufacturers

Qualified Dust Suppressant Additives

MGS Information

Current General Services Specifications (MGS) By Subject

1001.2 Producer Quality Management

When producer quality management is specified, the material producer is responsible for the following system prescribed with this specification. The goal of producer quality management is to have the producer take necessary actions to control and document the quality of their products to ensure they are specification compliant.

Each producer must provide Quality Control (QC) during production as a first line of inspection and testing. Producers must also provide an Independent Quality Assurance (QA) of the testing and inspection performed by QC. This independent QA may not be performed by QC or any other entity internal of the producer. Independent QA may either be qualified testing personnel or an industry recognized auditing organization. MoDOT will audit producers at its discretion, including QC reviews, QA reviews, product testing, record reviews, etc.

1001.2.1 Producer Quality Management Plan (QMP)

Each producer will submit a QMP to MoDOT detailing the basis of their QC/QA program. MoDOT will generally review the QMP and accept it based on compliance with specifications. Care should be taken when accepting the producer's QMP to anticipate problems and work them out before production begins. Central Office Construction and Materials will review the QMP for consistency with standard practices and compliance with the specification.

Testing and Inspection

The QMP should list all of the testing and inspection practices routinely performed to ensure compliance with the specification and production of a quality product. Some MoDOT specifications list specific testing frequencies and the QMP should not undermine those frequencies without proper justification. Producer QA should follow the testing requirements as stated in the specifications and should only vary with justification. For producers that select third party QA testing the producer shall i~~n~~dentify a third party testing lab that is AMRL certified to perform tests.

Record Keeping

Each producer should have a system for recording, compiling and storing testing and inspection related information. The exact method is not important, but must be thorough enough to allow specific test and inspection results to be retrieved when needed for individual products or lots. Since MoDOT's auditing will be largely based off of these records, attention should be given to ensure record keeping will serve that purpose and be easy to use. MoDOT can request the producers records at any time with the intent of records being used for auditing, research, or specification compliance.

Deficient Work, Non-Conforming Work and Disputes

The QMP should outline the procedure for product that does not comply with the specification and how to handle any disputes that arise. Similar to contractor performance management, QC should catch deficient work, document, and correct it when possible. The QMP should contain details covering all common deficient work and corrective actions. Work that cannot be corrected by QC or is found after QC approves the product is considered non-conforming work and should trigger a Non-Conformance Report (NCR). The QMP should detail how NCRs are distributed and resolved. A third party dispute resolution testing firm should be listed in the QMP for use when the MoDOT's audit results do no verify the QC/QA process.

1001.2.2 Producer QA

Each producer covered by this specification must comply with one of two methods of providing an independent QA verification of their QC program. The minimum frequency of QA testing is found in the specification.

a) Independent QA Testing Firm. The producer at their expense will employ an independent firm to periodically perform QA verification of QC test results. The independent testing firm should be an AMRL accredited laboratory. To be considered independent, the testing firm should have no direct business ownership tie to the producers.

b) Industry Recognized Audit Program. Since producers may participate in an organization or process that is recognized by MoDOT to represent industry quality standards. If the organization provides an auditing/testing function it may count as independent QA under these specifications.

1001.2.3 Control of Deficient Work

Deficient work is defined as work not compliant with the specification found by QC. Deficient work may be corrected by QC as outlined in the QMP with MoDOT's approval. QC will document all deficient work and corrective actions taken. An individual product's common deficient work may be

listed in an EPG article along with typical MoDOT approved repair methods that the producer may use.

When deficient work cannot be corrected as outlined in the QMP it becomes non-conforming work.

1001.2.4 Control of Non-Conforming Work

Non-conforming work is defined as work not compliant with the specification found by QC that cannot be corrected as routine practice outlined in the QMP or work not compliant with the specification found after QC accepts the products.

It is the producer's responsibility to initiate an Non-Conformance Report (NCR) and suggest a corrective action. "Use As Is" may be an acceptable corrective action, but impacts to MoDOT should be considered in accessing a possible reduction in cost. Each QMP should designate a MoDOT contact for all NCR's and that contact will coordinate the official MoDOT response ensuring that all necessary divisions and offices are involved.

Usually both the Engineer and contractor should be involved and give approval for an NCR's resolution to ensure no conflicts arise with design, costs, or constructability.

When a producer shows a pattern of NCRs reoccurring for an issue, MoDOT should address the issue with the producer as outline in the specification. This should be initiated by written letter outlining our concern and the history of the issue. If the producer's attempts to address the issue are unacceptable, the issue should be escalated to Construction and Materials Division. Failure to address the issue may result in rejection of the producers QMP which would make all products by the producer non-compliant and unacceptable.

1001.2.5 Hold Points

Hold points are defined by the QMP as any item that requires verification before work can continue. The QMP will list QC hold points and may have MoDOT hold points also. Usually each hold point will have a physical sign off and inspection sheet that is kept as part of the producers quality records.

A list of MoDOT hold points required is found in the specification and may be altered by the engineer when the QMP is approved to cover special circumstances. MoDOT may waive individual hold points at the discretion of the engineer. MoDOT should notify the producer as soon as possible when we intend to waive/miss a hold point to ensure we do not delay the producer.

The producer is responsible for notifying MoDOT sufficiently in advance of a MoDOT hold point to ensure inspectors are available and will not delay the producers operation.

1001.2.6 MoDOT Quality Assurance and Audits

The frequency of MoDOT Quality Assurance Testing and Audits will be determined by the specification and EPG guidance for individual products. MoDOT Quality Assurance Testing of products should occur on a quarterly basis as long as the producer is manufacturing products for MoDOT use, otherwise MoDOT Quality Assurance Testing is not necessary. The most common audit will be a once a year audit of documentation in AASHTOWARE Project (AWP), including any test results. A good auditing practice is to choose an incorporated product from the producer and verify the records for that individual product. An audit may occur at any time when producer QC and Independent QA of MoDOT Quality Assurance testing does no compare or other continual non-compliance discrepancies occur.

When a producer's PQM involves a ~~third party~~third-party testing service, the accreditation should be checked as well as the test results.

When a producer's PQM involves industry QA, MoDOT should either witness the industry QA audit or review the results as part of our audit process.

Issues discovered during an audit may result in NCRs for individual products or be addressed through modification of the PQM or other corrective action.

1001.3 Sampling Procedures

Sampling procedures shall be in accordance with AASHTO R90. Portions shall be combined and reduced in accordance with AASHTO R76.

When sampling a stockpile, it is recommended that separate samples be taken from different parts of the pile, care being taken to avoid any segregated areas and bearing in mind that the material near the base of the pile is likely to be segregated and coarser than the average of the material in the stockpile.

Table 1001.3 Size of Original Field Samples

Maximum Size of Particle[1]	Minimum Weight (Mass) of Sample, lb. (kg)[2]
2” (50 mm)	80 (36)
1-1/2" (37.5 mm)	54 (25)
1" (25.0 mm)	36 (16)
3/4" (19.0 mm)	22 (10)
1/2" (12.5 mm)	14 (6)
3/8" (9.5 mm)	10 (5)
[1] Maximum size of particle is defined as the smallest sieve through which 100 percent of the material will pass.	
[2] The samples prepared for testing shall be obtained from the field sample in accordance with AASHTO T248	

1001.4 Types of Samples

1001.4.1 Initial Evaluation

Sampling for initial evaluation shall be done by, or under the supervision of the District Geologist.

1001.4.1.1 Mines and Quarries

Producers should be reminded that all quarries will be sampled initially on a "ledge" basis regardless of intended use. The initial sample will be obtained for Central Laboratory testing from each ledge of stone that varies from the adjacent material. Sampling shall be in compliance with all federal, state and local safety requirements. It is suggested that the sample be obtained from the pile after each ledge has been excavated.

1001.4.1.2 New Formations or Special Investigations for Portland Cement Concrete Pavement Aggregates

The district is to consult with Construction and Materials prior to sampling.

A new formation is defined as one the department has not previously tested and approved for PCCP. It shall also apply to a new source of a previously tested formation if an examination of the new source indicates that the material may have different properties.

Special investigations are instances such as testing a previously rejected ledge in combination with approved ledges or other situations the department chooses to investigate. Initial evaluation for new formations or special investigations for use in PCCP shall start with a review of the service performance of concrete pavement utilizing aggregate from that formation and source (or nearby source). The paving could be city, county, commercial, etc. As much documentation as possible on age, mix design, etc. should be collected and a field review of the installations performed. If service performance is poor, the review may stop at this point and no testing performed. If service performance is satisfactory, sampling and testing may proceed. Approval of formations for use in production of aggregate for PCCP will meet the requirements of Sec 1005. ~~require completion of~~ The completion of AASHTO T161 Resistance of Concrete to Rapid Freezing and Thawing may be required if the designated physical properties do not comply with the standard specifications.

1001.4.1.3 Gravel and Sand Sources

A representative sample shall be obtained from the deposit. However, initial evaluation samples from the deposit will not be required provided plant produced material can be obtained meeting specification requirements, in which case the material may be submitted to the Central Laboratory for Source Approval (see Source Approval).

Samples should not be obtained from each of several plants located on the following sources: the Kansas, Missouri, Mississippi and Arkansas Rivers. Two samples per year, per stream, per district will be satisfactory for these sources.

1001.4.1.4 Lightweight (Low Mass Density) Aggregates

Manufactured lightweight (low mass density) aggregates prepared by expanding, calcining or sintering argillaceous materials such as clay, shales and slates shall be sampled. Care shall be exercised to obtain a representative sample. However, Initial Evaluation samples will not be required provided plant produced material meeting specification requirements can be obtained, in which case the material shall be submitted to the Central Laboratory for Source Approval Samples.

1001.4.1.5 Other Mineral Aggregates

Other mineral aggregates such as previously produced material, chat, slag, or other manufacturing by-products shall be treated as special cases. The district shall obtain instructions from Construction and Materials, prior to sampling these materials.

1001.4.1.6 Sampling

The mine or quarry site should be examined thoroughly, with care taken to obtain samples that represent each of the various ledges exposed in the mine or quarry face being sampled. A ledge stone sample shall include only those materials that indicate the inherent quality of the stone. Any materials, which are identifiable as being deleterious, shall not be included in the sample of the stone, since the Specifications will control the amount of such material that can be tolerated in the finished product. The Assistant State Construction and Materials Engineer must approve any deviation from the above procedure.

1001.4.1.7 Size of Sample

New formation or special investigation samples for use in PCCP or PCCM, when required, shall consist of approximately 2000 pounds (1000 kg) of material for each single ledge of stone. All other samples for the Initial Evaluation sample, representing a single ledge of stone, shall consist of 150 pounds (70 kg) of material.

1001.4.1.8 Producer Identification

It is important for historical tracking reasons to keep good records of changes in operators and locations. A facility number (producer/supplier code) is associated with a particular location and shall remain the same through changes in ownership. The exact name and location along with the facility number is to be used when referencing a particular source. If the name changes, subsequent reports, samples and correspondence should use the new name with a footnote * (* previously named) until sufficient permanent file records establish a record. A new facility number will only be issued for a new location.

1001.4.1.9 Identification of Sample

An AWP record, for Initial Evaluation samples, is to be filled out in accordance with AWP MA Sample Record, General. Ledge numbering instructions are in Automation Section 3900. The record shall indicate that the sample type is Gen Appr Initial. Instructions for entering ledge descriptions into AWP are also located in Automation Section 3900.

1001.4.1.10 Columnar Sections

A columnar section, produced from SM, shall accompany all ledge stone samples. Instructions for developing columnar sections and the correct templates to use in AWP are in Automation Section 3900.

1001.4.1.11 Time Required for Central Laboratory Tests

Individual times required to complete the tests may be longer than listed below, depending on the number of samples undergoing tests in the Central Laboratory.

Coarse aggregate from a previously approved source or formation intended for use in Portland cement concrete requires a minimum of 16 working days after receipt of the sample in the Central Laboratory.

Coarse aggregate from new formations intended for use in Portland cement concrete requires a minimum of 5 months after receipt of the sample in the Central Laboratory. As an option the producer may hire an independent laboratory to perform the tests. MoDOT must approve the independent laboratory and the test results submitted to MoDOT for interpretation and verification.

Coarse aggregates intended for other uses require a minimum of four working days.

1001.4.1.12 Initial Evaluation of Material

Free Form and Initial Evaluation templates on AWP test reports for Initial Evaluation samples will indicate the uses for which the material may be suitable, subject to the results obtained on the Source Approval Samples. The following

Durability Factor, Paving Concrete

Report 2009

See also: Research Publications

codes, listed in order of hierarchy, will be used for Initial Evaluation:

1005CACP, Initial Evaluation Suitable for all uses
1005CACM, Initial Evaluation Suitable for all uses except PCCP
1002CAAC, Initial Evaluation Suitable for all uses except PCCP, PCCM and 1003 Grade A
1004CABS, Initial Evaluation Suitable for only Bit Surface and Agg Base
1006CAAS, Initial Evaluation Suitable for only Agg Surface and Agg Base
1007CAAB, Initial Evaluation Suitable for only Agg Base.

Material produced for Sec 502 Portland Cement Concrete Base and Pavement per Sec 1005 may be produced from any combination of ledges so long as each ledge has had an Initial Evaluation and the specific combination of ledges has had a prior Source Approval of PCCP quality or the combined ledges has had AASHTO T161 testing performed and has met the minimum durability requirements of Sec 1005. Material, excluding Section 1005 for PCCP may be produced from any combination of ledges that have an initial evaluation. Source Approval for the final product must be for a specific ledge combination and must meet the specification for which it is produced.

1001.4.1.13 Producer Notification

The producer is to be notified in writing of the aggregate uses for which each ledge is suitable. The letter is to explain that tests for Initial Evaluation are performed on each ledge in order to determine the inherent quality of the stone. The notification is to state that samples of crushed aggregates produced to comply with Sec 1005, Sec 1004 or Sec 1002 will have to be submitted to the Central Laboratory for Source Approval. The producer is also to be reminded that any produced aggregate must meet all other requirements of the specifications for the intended use. A copy of the letter shall be forwarded to Construction and Materials, Physical Laboratory.

All correspondence to aggregate producers concerning Initial Evaluation is to be addressed using information from the materials producers file as shown in AWP as follows:

Contact Person
Facility Full Name or short Name (either)
P. O. Box or Street Address (Address part 2)
City, State, Zip Code

The producer supplier name and producer supplier number is to be shown at the bottom of the page as a filing reference in the manner indicated in the external correspondence standards, e.g.:

City Wide #1, Sugar Cr. Quarry

1. 3003000114

1001.4.2 Source Approval Samples

Source Approval based on Central Laboratory test results will be required on aggregates produced for use to meet the quality requirements of Sec 1002, Sec 1003 Grade A, Sec 1004 and Sec 1005. Source Approval is not required for Sec 1006, Sec 1007 or Sec 1009 unless the ledges have not previously been sampled. No produced material of this type is to be accepted for use until a Source Approval sample has been tested and approved by the Central Laboratory unless the material is from an operating quarry, which previously had Source Approval. Note that Sec 1009 specifications require a minimum of Sec 1002 quality.

1001.4.2.1 Sampling

Samples are to represent the final product that has been produced to meet a definite specification and intended specific use. Source Approval samples will be required each year and should be obtained at the site of production. Source Approvals intended for PCCP, that have not previously been approved or tested for PCCP, may require the completion of AASHTO T161 Resistance of

Concrete to Rapid Freezing and Thawing, if the designated physical properties do not comply with the standard specifications ~~will require completion of AASHTO T161 Resistance of Concrete to Rapid Freezing and Thawing.~~ AASHTO T161 testing will not be required on a yearly basis, however, if physical properties of aggregate for a specific combination of ledges vary significantly from previous Source Approval samples, T161 testing may be requested by the Central Laboratory. Source samples, submitted to the Central Laboratory for testing, shall not be used for combination purposes such as trial mix or any purpose other than Source Approval. Source Approvals are required for each unique combination of ledges represented by the mix design. Only one Source Approval is required when fractions of varying gradations are produced from the same ledges. These samples will be obtained from production of the aggregate with district personnel verifying the ledge(s) for the product. If ledge configuration changes during production, a new mix design will be required, and a new Source Approval taken to represent the material produced. Sampling for Source Approval may be more frequent than yearly if changes in the material are observed.

When multiple ledges are incorporated into the product, consideration to method of sampling should be given so the sample represents all ledges being combined. A representative sample shall be secured by obtaining three or more approximately equal increments, selected at random from a stockpile. When sampling during production, the increments shall be gathered over a period time sufficient to ensure the sample represents all ledges being combined. The increments shall be combined to form a field sample whose mass equals or exceeds the minimum recommended.

1001.4.2.2 Size of Sample

Source Approval samples of coarse aggregate submitted to the Central Laboratory shall consist of 150 pounds (70 kg) of any fraction of material produced with the maximum size no smaller than 1/2 in. (12.5 mm) nor larger than 1-1/2 in. (37.5 mm). Source Approval of fine aggregate from natural deposits (i.e.; natural sand) shall consist of 50 pounds. Source Approval samples intended for PCCP that require T161 testing shall consist of 650 pounds (300 kg).

1001.4.2.3 Identification of Sample

An AWP sample record, for Source Approval samples, is to be filled out in accordance with AWP MA Sample Record, General. The record shall indicate that the sample type is "Gen Appr Source (All General Items)." Before selecting a material code for aggregate submitted for coarse aggregate for concrete, the inspector should refer to the QLIS Source report located in the Materials – Aggregate folder of Cognos 8. This report lists Source Approval samples submitted to the Lab by quarry and is grouped by ledge or ledge combination. If a ledge or ledge combination has never had prior PCCP approval or AASHTO T161 testing performed, the material cannot be considered for PCCP until a sample has had AASTHO T161 testing performed. Material codes containing PCCP apply only to material representing specific ledges or ledge combinations that meet at least one of the following:

- prior PCCP approval
- completed AASHTO T161 testing compliant with Specification 1005 minimum durability factor and or other tests required to evaluate the material
- a sample that is being submitted for T161 testing to either the Lab or an approved outside lab.

Material that does not meet the requirements for PCCP should be submitted with a PCCM Only material code. The Plant ID field is to be filled out with the appropriate ledge or ledge combination prior to submitting the sample to the Lab. The Sample ID number(s) under which the ledge(s) or deposit was tested, and given Initial Evaluation, shall be shown under the Other Tab with the type set to “Initial Evaluation Sample ID #”. Use successive rows with multiple Initial Evaluations and enter ID # in corresponding column.

1001.4.2.4 Time Required for Central Laboratory Tests

The actual tests conducted in the Central Laboratory on Source Approval samples will depend on the uses for which the produced aggregate is intended.

Previously approved formation and member sources for coarse aggregate for Portland cement concrete requires a minimum of 16 working days from the date received in the Central Laboratory.

Source Approval samples of fine aggregate for Portland cement concrete require a minimum period of ten working days for complete tests.

Coarse and fine aggregate for uses other than Portland cement concrete will require a minimum of four working days for the completion of tests.

1001.4.2.5 Approval of Material

Remarks on test reports for Source Approval samples will state that the sample does or does not comply with specifications for the particular use intended. When compliance is indicated, this constitutes approval of the produced aggregate represented by the sample for the uses shown.

When ledges are being re-sampled in accordance with Re-sampling of Approved Ledges, production may continue to be accepted providing preliminary test results indicate specification compliance for the material. However, Source Approval samples should be submitted as soon as possible for the evaluation of future production.

If a producer elects to produce material before Source Approval is granted, the district shall notify the producer by letter that the producer is producing without approval and at risk of rejection. A copy of the letter shall be forwarded to the State Construction and Materials Engineer.

1001.4.2.6 Producer Notification

The producer is also to be notified in writing of the results of tests on Source Approval samples of material produced to meet the requirements of Sec 1002, Sec 1003 Grade A, Sec 1004 and Sec 1005. The letter is to list the ledges represented by each source sample and reiterate that crushed aggregate must meet all other requirements of the specifications for which it is specifically being produced. A copy of the letter shall be forwarded to the State Construction and Materials Engineer.

All correspondence to aggregate producers concerning Source Approval is to be addressed using information from the materials producers file as shown in AWP as follows:

Contact Person
Facility Full Name or Short Name (either)
P. O. Box or Street Address (Address part 2)
City, State, Zip Code

The producer supplier name and producer supplier number is to be shown at the bottom of the page as a filing reference in the manner indicated in the external correspondence standards, e.g.:

City Wide #1, Sugar Cr. Quarry

1. 3003000114

Category:1005 Aggregate for Concrete

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This guidance establishes procedures for the inspection, testing and acceptance of coarse and fine aggregate for use in concrete.

MGS Information

Current General Services Specifications (MGS) By Subject

Contents

1005.1 Procedure

Inspection, testing, and sampling will be governed by the instructions contained in EPG 1001 General Requirements for Material.

Samples required for Laboratory tests are as follows:

(a) Initial Evaluation for coarse aggregate.
(b) Source Approval.
(c) Source Approval for lightweight aggregate.
(d) QC/QA samples for concrete Masonry.

Aggregate, Gradation Optimization

Report 2005

Durability Factor, Paving Concrete

Report 2009

See also: Research Publications

1005.2 Acceptance

Source Approval is based on the results of Laboratory tests. Acceptance is based on routine tests in the field to ensure compliance with Sec 1005.

1005.3 Records and Reports

All plant records shown in EPG 1001.6 General Requirements for Material - Records and Reports shall be maintained. The aggregates shall be reported through AASHTOWARE Project (AWP) in accordance with AWP MA Sample Record, General.

1005.4 Laboratory Procedures for Sec 1005

1005.4.1 Types of Samples Tested

1005.4.1.1 Initial Approval Sample

Tests consist of specific gravity, absorption, Los Angeles abrasion, micro deval, and soundness (water-alcohol and sodium sulfate).

~~When deemed necessary coarse aggregate intended for use in portland cement concrete may also be subjected to additional tests including: magnesium sulfate soundness, potential alkali reactivity of carbonate rocks, rapid freeze-thaw and alkali-silica reaction in concrete.~~

The minimum time required for completion of initial approval sample tests is 24 working days from the date received.

Test results and calculations shall be recorded through AWP.

1005.4.1.2 Source Approval Sample

Coarse aggregate tests consist of sieve analysis, specific gravity, absorption, rodded unit weight, Los Angeles abrasion, deleterious content, micro deval, and soundness (water-alcohol and sodium sulfate). The minimum time required for completion of tests is 16 working days from the date received unless T161 testing is required, then a minimum of ~~5~~4 months should be allowed. ~~Test results and calculations shall be recorded through AWP.~~

Conditional approval for use of PCCP and PCCM may be granted based off the results of the above listed tests, however, care must be taken when allowing conditional approval under these conditions as the results of durability factor and reactivity may result in the conditional approval being revoked and the material not being accepted for PCCP or PCCM use.

Both PCCP and PCCM will be evaluated for reactivity under MoDOT Test Method TM-93. If AASHTO T161 Resistance of Concrete to Rapid Freezing and Thawing is required, testing may take up to 4 months to complete from date received. If ASTM C 1105 Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction is required, testing may take up to 15 months to complete from the date received. ~~unless T161 testing is required, then a minimum of 5 months should be allowed.~~

Test results and calculations shall be recorded through AWP.

Fine aggregate tests consist of sieve analysis; specific gravity; absorption, rodded unit weight; other deleterious substances, clay lumps and shale, and lightweight particle content when specified; and

mortar strength test. The minimum time required for completion of tests is 16 working days from the date received. Test results and calculations shall be recorded through AWP.

1005.4.1.3 Source Approval Sample for Lightweight Aggregate

Source approval samples are obtained for lightweight aggregate. Tests consist of sieve analysis, specific gravity, absorption, loose unit weight, and soundness by sodium sulfate. Tests for soundness need not be run providing recent satisfactory results were obtained on a previous sample of similar characteristics and from the same source. Test results and calculations shall be recorded through AWP.

~~1005.4.1.4 Absorption as Received Sample~~

~~Absorption as Received Samples are not required by the District, but can be submitted if the quality or characteristics of the material has changed. Tests consist of specific gravity and absorption and shall be performed on the sample in the "as received condition". The minimum time required for completion of tests is three working days from the date received. Test results and calculations shall be recorded through AWP.~~

~~1005.4.1.5 Rodded Unit Weight Sample~~

~~Rodded Unit Weight Samples are not required by the District, but can be submitted if the quality or characteristics of the material has changed. The minimum time required for a unit weight test is two working days from the date received. Test results and calculations shall be recorded through AWP.~~

1005.4.2 Procedure

1005.4.2.1 Sieve Analysis

Fine and coarse aggregates shall be tested in accordance with AASHTO T 27.

Lightweight aggregate shall be tested according to AASHTO T 27 except the minimum weight (mass) of the test sample should be approximately one-half the amount shown.

1005.4.2.2 Specific Gravity and Absorption

Coarse aggregate shall be tested in accordance with AASHTO T 85 for Bulk Specific Gravity.

Fine aggregate shall be tested in accordance with AASHTO T 84.

1005.4.2.3 Specific Gravity of Lightweight Aggregate

Apparatus

(a) Vacuum System. A system capable of maintaining a vacuum of 16 mm or more of mercury in a chamber of sufficient size to accommodate the aggregate sample. The system must have airtight valves so there is no loss of vacuum when the system is closed and to allow inundation of the aggregate with water.
(b) Balance. A balance or scale having a capacity of 1 kg or more and sensitive to 0.1 g or less.
(c) Oven. The oven shall be capable of maintaining a uniform temperature of 110 ± 5 °C (230 ± 9 °F).
(d) Heater. An electric heater equipped with fan for drying aggregate to surface dry condition.
(e) Pycnometer. A calibrated 500 ml volumetric flask.
(f) Water Bath. A water tank capable of maintaining a temperature of 23 ± 1.7 °C [73.4 ± 3 °F].
(g) Trowel. A small masonry trowel for stirring aggregate.
(h) Containers. A metal pail approximately 150 mm (6 in.) in diameter and 200 mm (8 in.) high and pans of suitable size to allow uniform drying of aggregate.

Sample Preparation

(a) Obtain approximately 2200 g of aggregate from the sample by use of a sample splitter.
(b) Dry the sample to constant weight in an oven at a temperature of 110 ± 5 °C [230 ± 9 °F].
(c) Remove the sample from the oven and allow to cool in air at room temperature.

Test Method

(a) Introduce the sample in the pail and place in the vacuum chamber. A piece of fine wire mesh fitted inside the pail will prevent particles from floating. Evacuate at 16 mm of mercury or more for 20 minutes.
(b) Inundate the aggregate with water.
(c) Remove the pail containing aggregate and water from the vacuum chamber and let soak for four hours.
(d) Drain the water from the sample and place in a pan of sufficient size to permit the sample to be spread in a thin layer. Expose the sample to a gentle moving current of warm air, with the use of an electric heater, and stir frequently with a trowel to ensure uniform drying. When the sample approaches the surface dry condition, transfer the sample to a smaller pan to slow down the drying process. This aids in the detection of the surface dry condition. At this point, it is necessary to stir continuously to ensure uniform drying of the sample. The trowel is used to check the surface dry condition of the aggregate by running it horizontally through the aggregate several times and checking immediately for moisture. The surface dry condition is reached when moisture is visible on the tip of the trowel covering approximately 40 mm (1 1/2 in.) from the tip end.
(e) Immediately introduce approximately 300 g of the saturated surface-dry material into a pycnometer of known weight (mass) and record the weight of the pycnometer and sample. Record this and all other weights (masses) to the nearest 0.1 g.
(f) Fill the pycnometer with water to approximately 90 percent of its calibrated capacity. Roll and agitate the pycnometer eliminate all air bubbles.
(g) Immerse the pycnometer in a water bath. Adjust the water level in the pycnometer to the calibrated line with water at the same temperature as the bath. Record the total weight of pycnometer, sample and water.
(h) Remove the aggregate from the pycnometer, dry to constant weight at a temperature of 110 ± 5 °C [230 ± 9 °F]. Cool in air at room temperature and weigh.
(i) Determine the weight of the water required to fill the pycnometer of its calibration capacity at 23 ± 1.7 °C [73.4 ± 3 °F].

Calculate the bulk specific gravity as follows:

$$Bulk\ Specific\ Gravity = \frac{A}{B - W - C}$$

Where:
A = weight of oven-dry sample in air, g
B = weight of pycnometer and saturated surface dry material, g
W = weight of water required to fill pycnometer to calibration mark at 23 ± 1.7 °C (73.4 ± °3 F)
C = weight of pycnometer with sample and water to calibration mark, g.

1005.4.2.4 Absorption of Lightweight Aggregate

Apparatus

(a) Balance. A balance or scale having a capacity of 5 kg or more and sensitive to 0.5 g or less.
(b) Oven. The oven shall be capable of maintaining a uniform temperature of 110 ± 5 °C (230 ± 9 °F).
(c) Heater. An electric heater equipped with fan for drying aggregate to surface dry condition.
(d) Trowel. A small masonry trowel for stirring aggregate.
(e) Containers. Pans of suitable size to allow uniform drying of aggregate.

Sample Preparation

(a) Obtain approximately 2200 g of aggregate from the sample by use of a sample splitter.
(b) Dry the sample to constant weight (mass) in an oven at a temperature of 110 ± 5 °C (230 ± 9 °F).
(c) Remove the sample from the oven and allow to cool in air at room temperature.

Test Method

(a) Immerse the sample in water at room temperature for approximately 24 hours.
(b) Drain the water from the sample and place in a pan of sufficient size to permit the sample to be spread in a thin layer. Expose the sample to a gentle moving current of warm air, with the use of an electric heater, and stir frequently with a trowel to ensure drying. When the sample approaches the surface dry condition, transfer the sample to a smaller pan to slow down the drying process. This aids in the detection of the surface dry condition. At this point, it is necessary to stir continuously to ensure uniform drying of the sample. The trowel is used to check the surface dry condition of the aggregate by running it horizontally through the aggregate several times and checking immediately for moisture. The surface dry condition is reached when moisture is visible on the tip of the trowel covering approximately 40 mm (1 1/2 in.) from the tip end.
(c) Weigh the saturated surface dry sample and record the weight. Record this and all subsequent weights to the nearest gram.
(d) Dry in the oven to constant weight at a temperature of 110 ± 5 °C [230 ± 9 °F], cool in air at room temperature and weigh.Calculate the absorption as follows:

$$Absorption, percent = \frac{100(B - A)}{A}$$

Where:
A = weight (mass) of oven-dry sample in air, g, and
B = weight (mass) of saturated-surface-dry sample in air, g

1005.4.2.5 Unit Weight

Aggregate shall be tested in accordance with AASHTO T 19.

1005.4.2.6 Los Angeles Abrasion

Coarse aggregate shall be tested in accordance with AASHTO T 96.

1005.4.2.7 Deleterious Content

The percentage of deleterious substances for coarse aggregate is to be determined according to TM-71, Deleterious Content of Aggregate. Where field determinations show a total deleterious content of 2.0 percent or less, including not more than 0.5 percent shale, the deleterious content shall be inspected visually. The sample is to be tested if visual inspection indicates more than 2.0 percent total deleterious material present in the sample. Source approval samples shall always be tested regardless of the content of deleterious material.

The percentage of lightweight particles in fine aggregate shall be determined according to AASHTO T 113, except the heavy liquid shall be a solution of zinc chloride and water of having a specific gravity of 2.00 ± 0.01.

The other deleterious substances, clay lumps, and shale in fine aggregate shall be visually determined and separated into the constituents required by the applicable Specification when an examination of the sample prepared for sieve analysis indicates a need for exact determination of deleterious content. Percentages shall be calculated as follows:

$$P = \frac{C \times 100}{W}$$

Where:

P = Percentage of deleterious material
W = Weight (mass) of test sample
C = Actual weight (mass) of deleterious material.

1005.4.2.8 Mortar Strength

Fine aggregate subjected to the mortar strength test shall produce a mortar having a tensile strength at the age of seven days of at least 90 percent of that developed at the same age by mortar of the same proportions, consistency, made of the same cement, and Standard Ottawa sand. Tests shall be AASHTO T 106. Cement used in the tests shall be Type I meeting the requirements of Specification Sec 1019.

1005.4.2.9 Soundness by Use of Alcohol Freeze

Coarse aggregate shall be tested in accordance with MoDOT Test Method T 14.

1005.4.2.10 Soundness by Use of Sodium or Magnesium Sulfate

Lightweight aggregate and coarse aggregate shall be tested in accordance with AASHTO T 104.

1005.4.2.11 Rapid Freeze-Thaw

Coarse aggregate for PCCP shall be tested in accordance with AASHTO T161 (Method B).

1005.4.2.12 Alkali-Silica Reaction in Concrete

Coarse aggregate for PCCP shall be tested in accordance with ASTM C 1260.

1005.4.2.13 Colormetric Test

Fine aggregate shall be tested in accordance with AASHTO T21.

1005.4.2.14 Alkali-Carbonate Reaction in Concrete ~~**Screening Protocol for Alkali Carbonate Reactivity**~~

The State of Missouri has aggregate formations that are prone to alkali carbonate reactivity (ACR). This reaction is caused when the alkali contained in the Portland cement reacts with the aggregate,

chemically changing the aggregate to an expansive material. Concrete that uses aggregate prone to ACR will experience significant map cracking caused by the aggregate expanding inside the concrete. Currently, there is no way to mitigate this reaction. The only way to prevent this reaction from occurring in concrete (masonry or pavement) is to avoid using aggregates prone to ACR. MoDOT has two ACR screening protocols for evaluating coarse aggregate. One protocol is for handling new quarries or new ledge combinations coming online. The second protocol is for handling existing quarries that have previously been sampled and tested for Source Approval. See EPG 106.3 for MoDOT Test Method TM-93 – Alkali Carbonate Reactivity Screening Protocol.

1005.4.3 Sample Record

The sample record shall be completed in AASHTOWARE Project (AWP) in accordance with AWP MA Sample Record, General and shall indicate acceptance, qualified acceptance, or rejection. Appropriate remarks, as described in EPG 106.20 Reporting, are to be included in the remarks to clarify conditions of acceptance or rejection. Test results shall be reported on the appropriate templates under the Tests tab.

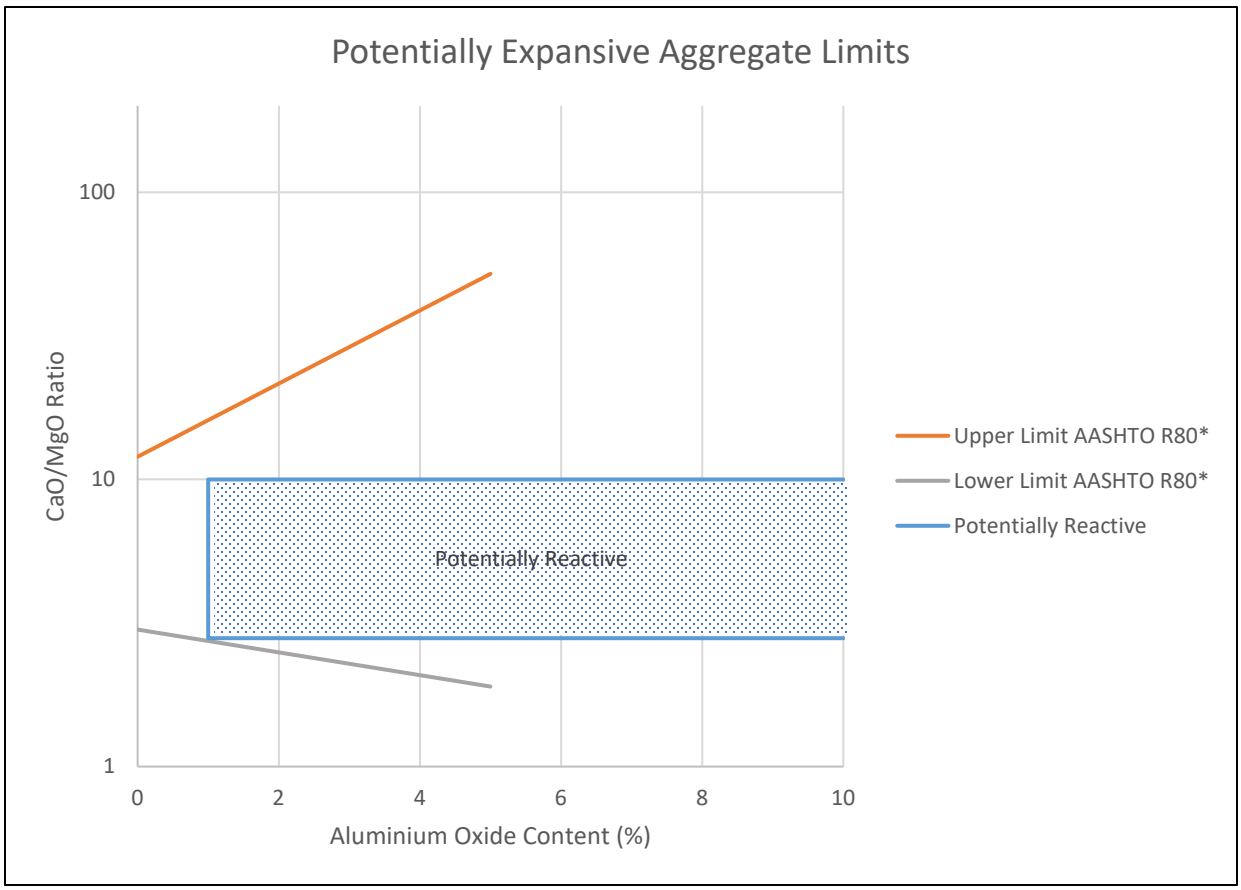
106.3.2.93 TM-93, Alkali Carbonate Reactivity Screening

This test method establishes the procedures for identifying potential alkali carbonate reactivity (expansion) and acceptance of aggregate used in concrete pavements and masonry. This test method applies to new quarries, new ledges (and combinations of ledges), existing quarries and ledges.

106.3.2.93.1 Means of Evaluating Aggregate Alkali Carbonate Reactivity

1. Chemical Analysis

The chemical analysis of aggregate reactivity is an objective, quantifiable and repeatable test. MoDOT will perform the chemical analysis per the process identified in ASTM C 25 for determining the aggregate composition. The analysis determines the calcium oxide (CaO), magnesium oxide (MgO), and aluminum oxide (Al_2O_3) content of the aggregate. The chemical compositions are then plotted on a chart with the CaO/MgO ratio on the y-axis and Al_2O_3 percentage on the x-axis per Fig. 2 in AASHTO R 80. Aggregates are considered potentially reactive if the Al_2O_3 content is greater than or equal to 1.0% and the CaO/MgO ratio is either greater than or equal to 3.0 or less than or equal to 10.0 (see chart below). See flow charts in 106.3.2.93.2 for approval hierarchy.



*MoDOT's upper and lower limits of potentially reactive (shaded area) aggregates.

2. Petrographic Examination

A petrographic examination is another means of determining alkali carbonate reactivity. The sample aggregate for petrographic analysis will be obtained at the same time as the source sample. MoDOT personnel shall be present at the time of sample. The petrographic sample shall be placed in an approved tamper-evident container (provided by the quarry) for shipment to petrographer. Per ASTM C 295, a petrographic examination is to be performed by a petrographer with at least 5 years of experience in petrographic examinations of concrete aggregate including, but not limited to, identification of minerals in aggregate, classification of rock types, and categorizing physical and chemical properties of rocks and minerals. The petrographer will have completed college level course work in mineralogy, petrography, or optical mineralogy. MoDOT does not accept on-the-job training by a non-degreed petrographer as qualified to perform petrographical examinations. MoDOT may request petrographer's qualifications in addition to the petrographic report. The procedures in C 295 shall be used to perform the petrographic examination. The petrographic examination report to MoDOT shall include at a minimum:

- Quarry name and ledge name; all ledges if used in combination
- MoDOT District quarry resides

- Date sample was obtained; date petrographic analysis was completed
- Name of petrographer and company/organization affiliated
- Lithographic descriptions with photographs of the sample(s) examined
- Microphotographs of aggregate indicating carbonate particles and/or other reactive materials
- Results of the examination
- All conclusions related to the examination

See flow charts in 106.3.2.93.2 for the approval hierarchy. See section 106.3.2.93.3 for petrographic examination submittals. No direct payment will be made by the Commission for shipping the petrographic analysis sample to petrographer, or for the petrographic analysis performed by the petrographer.

3. Concrete Prism/Beam Test

ASTM C 1105 is yet another means for determining the potential expansion of alkali carbonate reactivity in concrete aggregate. MoDOT will perform this test per C 1105 at its Central Laboratory. Concrete specimen expansion will be measured at 3, 6, 9, and 12 months. The test specimens will be considered alkali carbonate reactive (expansive) if the specimens expand greater than 0.015% at 3 months, 0.025% at 6 months, or 0.030% at 12 months. See flow chart in 106.3.2.93.2 for the approval hierarchy.

106.3.2.93.2 Approval Process for Potential Alkali Carbonate Reactive Aggregate

1. Process for New Ledges and New Quarries

The flowchart shown in Figure 1 shows the process for determining alkali carbonate reactivity (expansiveness) in new ledges and quarries. It is important to note TM-93 is only for determining whether or not aggregate is potentially expansive. All other requirements of Sec. 1005 shall be met for the ledge(s) to be approved for use in pavement or masonry concrete.

Should ASTM C 1105 test method need to be performed on the aggregate, the quarry will be notified by District personnel that this test method requires 12 months to complete, and during those 12 months, the aggregate cannot be approved for use in pavement or masonry concrete. The aggregate however, can be considered for other uses based on meeting required specifications.

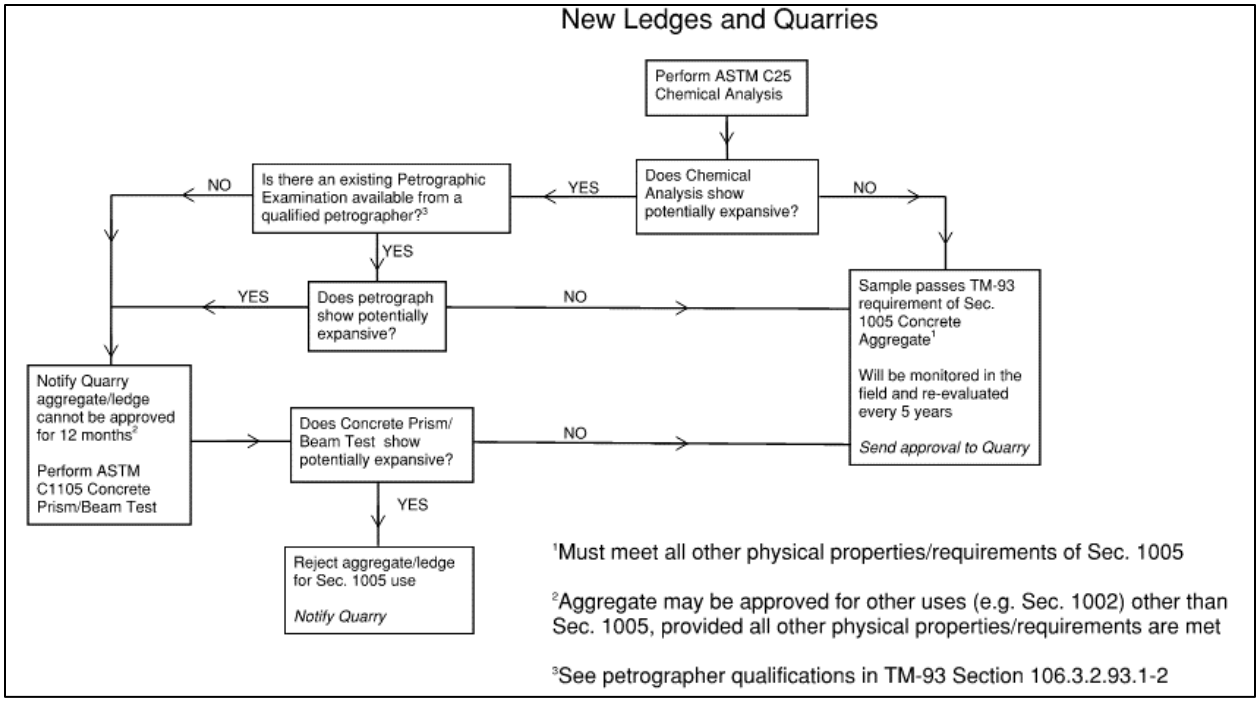


Figure 1. Process for determining alkali carbonate reactivity for new ledges and quarries.

2. Process for Existing Ledges and Existing Quarries

The flowchart shown in Figure 2 shows the process for determining alkali carbonate reactivity (expansiveness) in existing ledges and quarries. It is important to note TM-93 is only for determining whether or not aggregate is potentially expansive. All other requirements of Sec. 1005 shall be met before the ledge(s) are approved for use in pavement or masonry concrete.

Should ASTM C 1105 test method need to be performed on the aggregate, the quarry will be notified by District personnel that this test method requires 12 months to complete, and during those 12 months, the aggregate cannot be approved for use in pavement or masonry concrete. The aggregate however, can be considered for other uses based on meeting required specifications.

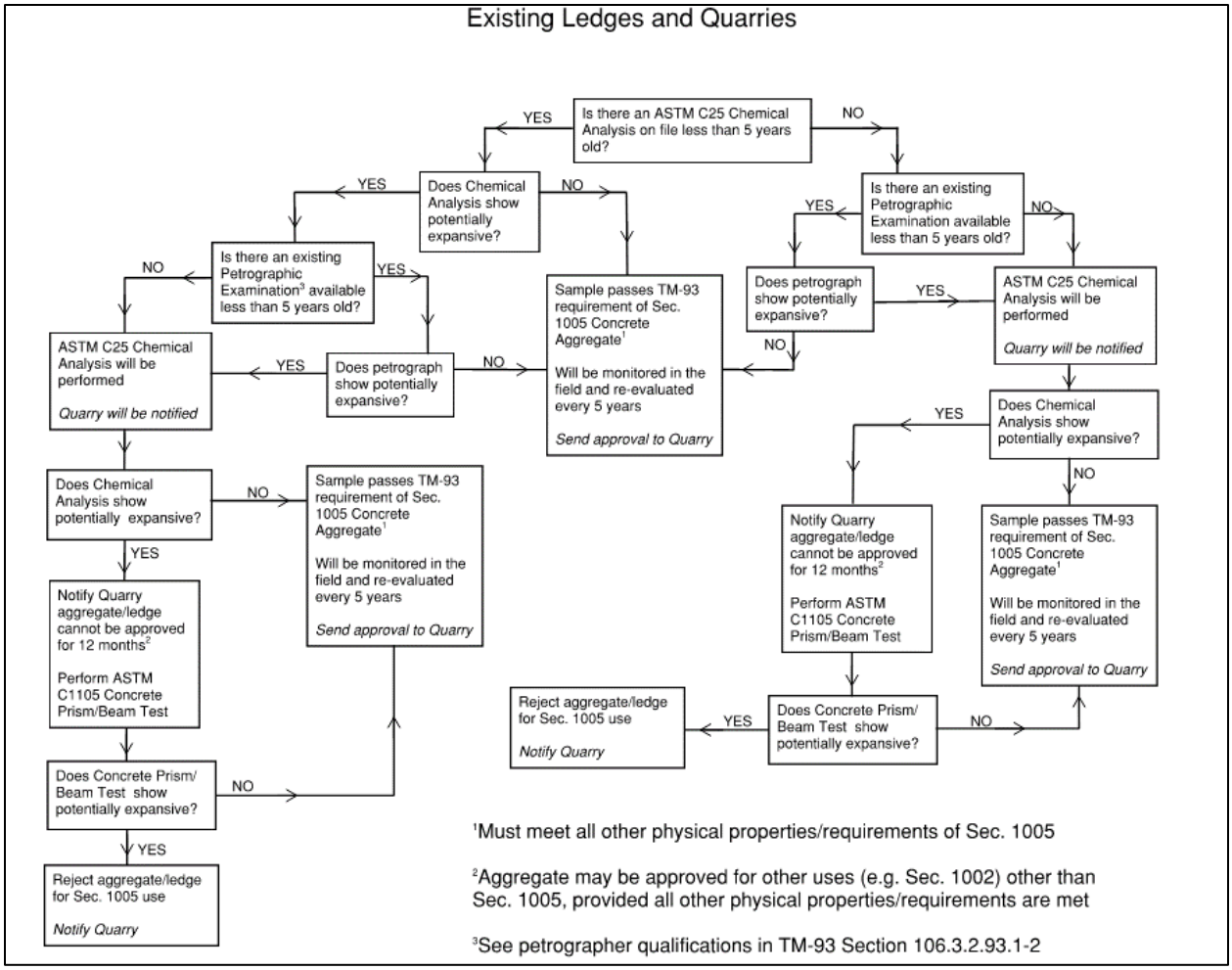


Figure 2. Process for determining alkali carbonate reactivity for existing ledges and quarries.

106.3.2.93.3 Submitting Petrographic Examinations Reports to MoDOT

1. Petrographic Examination Reports

Petrographic examination reports can be used in the process to determine the alkali carbonate reactivity (expansiveness) of aggregate. See petrographer requirements in Section 109.3.2.93.1. When a quarry obtains a petrographic examination report, the report shall be submitted to the District Construction and Materials Department of the district the quarry resides. The submittal can be made electronically or can be an original hard copy mailed/delivered to the district. Hard copy reports will be scanned/digitized for easier file storage. Regardless of whether or not the petrographic examination report shows the aggregate is potentially expansive, ~~the district will retain the report per MoDOT's document retention policy~~MoDOT will retain the report. The district will ~~ensure~~ forward the report to ~~the~~

Central Office Construction and Materials Division ~~is aware of the petrographic examination report findings~~for document retention. This will allow time to prepare for ASTM C 1105 testing if necessary.

All petrographic reports will be digitally stored by Central Office Construction and Materials Division.

Third-Party Test Waiver for Concrete Aggregate JSP-24-06

1.0 Description. Third party tests may be allowed for determining the durability factor for concrete pavement and concrete masonry aggregate.

2.0 Material. All aggregate for concrete shall be in accordance with Sec 1005.

2.1 MoDOT personnel shall be present at the time of sampling at the quarry. The aggregate sample shall be placed in an approved tamper-evident container (provided by the quarry) for shipment to the third-party testing facility.

2.2 AASHTO T 161 Method B Resistance of Concrete to Rapid Freezing and Thawing, shall be used to determine the aggregate durability factor. All concrete beams for testing shall be 3-inch wide by 4-inch deep by 16-inch long or 3.5-inch wide by 4.5-inch deep by 16-inch long. All beams for testing shall receive a 35-day wet cure fully immersed in saturated lime water prior to initiating the testing process.

2.3 Concrete test beams shall be made using a MoDOT approved concrete pavement mix design.

3.0 Testing Facility Requirements. All third-party test facilities shall meet the requirements outlined in this provision.

3.1 The testing facility shall be AASHTO accredited.

3.1.1 For tests ran after January 1, 2025, accreditation documentation shall be on file with the Construction and Materials Division prior to any tests being performed.

3.1.2 Construction and Materials Division may consider tests completed prior to January 1, 2025, to be acceptable if all sections of this provision are met, with the exception of 3.1.1. Accreditation documentation shall be provided with the test results for tests completed prior to January 1, 2025. No tests completed prior to September 1, 2024, will be accepted.

3.2 The testing facility shall provide their testing process, list of equipment, equipment calibration documentation, and testing certifications or qualifications of technicians performing the AASHTO T 161 Procedure B tests. The testing facility shall provide details on their freezing and thawing apparatus including the time and temperature profile of their freeze-thaw chamber. The profile shall include the temperature set points throughout the entirety of the freeze-thaw cycle. The profile shall show the cycle time at which the apparatus drains/fills with water and the cycle time at which the apparatus begins cooling the specimens.

3.3 Results, no more than five years old, from the third-party test facility shall compare within ±2.0 percent of an independent test from another AASHTO accredited test facility or with MoDOT test records, in order to be approved for use (e.g. test facility results in a durability factor of 79, MoDOT's recent durability test factor is 81; this compared within +2 percent). The independent testing facility shall be in accordance with this provision. The comparison test can be from a different sample of the same ledge combination.

3.4 When there is a dispute between the third party durability test results and MoDOT durability test results, the MoDOT durability test result shall govern.

3.5 Test results shall be submitted to MoDOT's Construction and Materials division electronically for final approval. Test results shall include raw data for all measurements of relative modulus of elasticity and percent length change for each individual concrete specimen. Raw data shall

include initial measurements made at 0 cycles and every subsequent measurement of concrete specimens. Raw data shall include the cycle count and date each measurement was taken. Test results shall also include properties of the concrete mixture as required by AASHTO T 161 This shall include the gradation of the coarse aggregate sample. If AASHTO T 152 is used to measure fresh air content, then the aggregate correction factor for the mix determined in accordance with AASHTO T 152 shall also be included.

4.0 Method of Measurement. There is no method of measurement for this provision. The testing requirements and number of specimens shall be in accordance with AASHTO T 161 Procedure B.

5.0 Basis of Payment. No direct payment will be made to the contractor or quarry to recover the cost of aggregate samples, sample shipments, testing equipment, labor to prepare samples or test samples, or developing the durability report.