



MATERIAL SPECIFICATION FOR AGGREGATES - CONCRETE

TABLE OF CONTENTS

1002.01	SCOPE
1002.02	REFERENCES
1002.03	DEFINITIONS
1002.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
1002.05	MATERIALS
1002.06	EQUIPMENT - Not Used
1002.07	PRODUCTION
1002.08	QUALITY ASSURANCE
1002.09	OWNER PURCHASE OF MATERIAL - Not used

1002.01 SCOPE

This specification covers material requirements for aggregates for use in hydraulic cement concrete.

1002.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

- LS-412 Scaling Resistance of Concrete Surfaces Exposed to De-icing Chemicals
- LS-601 Material Finer than 75µm Sieve in Mineral Aggregates by Washing
- LS-602 Sieve Analysis of Aggregates
- LS-604 Relative Density and Absorption of Coarse Aggregate

- LS-606 Soundness of Aggregate by Use of Magnesium Sulphate
- LS-608 Percent Flat and Elongated Particles in Coarse Aggregate
- LS-609 Petrographic Analysis of Coarse Aggregate
- LS-610 Organic Impurities in Sands for Concrete
- LS-613 Determination of Insoluble Residue of Carbonate Aggregates
- LS-614 Freezing and Thawing of Coarse Aggregate
- LS-615 Determination of Potential Alkali-Carbonate Reactivity of Carbonate Rocks By Chemical Composition
- LS-618 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- LS-619 Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- LS-620 Accelerated Detection of Potentially Deleterious Alkali-Silica Reactive Aggregate by Expansion of Mortar Bars
- LS-625 Guidelines for Sampling of Granular Materials

MTO Aggregate Sources Lists (ASL):

- Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates
- Aggregate Sources List for Concrete Base/Pavement Coarse Aggregates

MTO Forms:

- PH-D-10 Aggregate Sample Data Sheet

CSA Standards

- A23.2-1A Sampling Aggregates for Use in Concrete *
- A23.2-12A Relative Density and Absorption of Coarse Aggregate *
- A23.2-14A Potential Expansivity of Aggregates; Procedure for Length Change Due to Alkali-Aggregate Reaction in Concrete Prisms *
- A23.2-23A Method of Test for the Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus *
- A23.2-24A Method of Test for Resistance of Unconfined Coarse Aggregate to Freezing and Thawing
- A23.2-25A Test Method for Detection of Alkali-Silica Reactive Aggregate by Accelerated Expansion of Mortar Bars *
- A23.2-26A Determination of Potential Alkali-Carbonate Reactivity of Quarried Carbonate Rocks by Chemical Composition *
- A23.2-27A Standard Practice to Identify Potential for Alkali-Reactivity of Aggregates and Measures to Avoid Deleterious Expansion in Concrete *
- A23.2-29A Method of Test for the Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus *

* [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

- C 87/C 87M-10 Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
- C 330/C 330M-14 Lightweight Aggregates for Structural Concrete
- C 666/C 666M-15 Resistance of Concrete to Rapid Freezing and Thawing

1002.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Alkali-Aggregate Reaction (AAR) means a chemical reaction that occurs in concrete between alkalis in the cement (e.g., sodium and potassium) and minerals in the aggregate. This reaction may cause deleterious expansion and cracking of the concrete. AAR includes alkali-carbonate and alkali-silica reactions.

Air-Cooled Blast Furnace Slag means the material resulting from solidification of molten blast furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.

Bench means a ledge parallel to stratigraphic bedding that, in quarries, forms a single level of operation above which rock is excavated from a contiguous face.

Duplicate QA Samples means two samples taken at the same time and location, one to be used for quality assurance testing and the other for referee testing.

Manufactured Sand means fine aggregate produced by crushing bedrock or containing crusher screenings.

Mineral Filler means a finely pulverized, inert, inorganic mineral or rock (e.g., limestone powder) having physical and mineralogical properties suitable for use in concrete.

Nominal Maximum Aggregate Size means the largest sieve listed in the applicable specification upon which any material is permitted to be retained.

Physical Property means an inherent attribute or feature of an aggregate material. Tests are carried out to determine a material's resistance to weathering or degradation or both. Physical properties are generally not affected by aggregate production processes.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

Self-Consolidating Concrete means a highly flowable, yet stable concrete that can spread readily into place, fill formwork, and encapsulate the reinforcement without any mechanical consolidation and without undergoing segregation or excessive bleeding.

Siliceous Aggregates means rock particles containing or composed of silica (SiO_2) or minerals with silica in the crystal structure as silicate (SiO_4).

1002.05 MATERIALS

1002.05.01 General

Aggregates shall be according to OPSS 1001. Aggregates shall be according to this specification when tested according to the MTO, CSA, and ASTM test methods identified herein.

Except as noted below or elsewhere in the Contract Documents, aggregates may be sands, gravel, quarried rock, or air-cooled blast furnace slag; provided the source is of such nature and extent to ensure acceptable processed aggregates of a consistent grading and quality. When any change in the character of the aggregate occurs or when the performance of aggregate meeting the requirements of this specification is found to be unsatisfactory, use of the aggregate shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Steel slag is prohibited for use as aggregate in hydraulic cement concrete. Air-cooled blast furnace slag is prohibited for use as aggregate in concrete pavements.

Irrespective of compliance with all of the physical property requirements stated in this specification, at the discretion of the Owner, aggregates may be accepted or rejected for use based on demonstrated past field performance in hydraulic cement concrete.

The field performance of a concrete structure or pavement using aggregates, accepted on the basis of demonstrated past field performance, shall be evaluated according to CSA A23.2-27A, Attachment A2, Guidelines for Evaluating the Field Performance of Aggregates: Field and Laboratory Testing, with the exception that the structure or pavement shall be at least 15 years old. In addition, the concrete being evaluated to determine the field performance of an aggregate shall:

- a) Have been used for equivalent or more severe applications;
- b) Have been subjected to equivalent or more severe exposure conditions;
- c) Not contain supplementary cementing materials that may have mitigated or improved things like freeze/thaw performance, scaling resistance or alkali-aggregate reactivity of aggregates in concrete, and;
- d) Contain the equivalent cement and alkali content, as the laboratory tests stated in this specification for the evaluation of alkali-aggregate reactivity.

The Owner may reject the use of any concrete aggregate on the basis of past field performance in any structure or pavement of any age.

1002.05.02 Fine Aggregate

1002.05.02.01 General

Fine aggregates used in concrete pavement surfaces and exposed concrete bridge deck driving surfaces shall have a minimum insoluble residue (IR_{R75}) of 60%. Where a fine aggregate proposed for use does not meet this requirement, one or more fine aggregates from an alternate source may be blended with the proposed aggregate to meet this requirement.

1002.05.02.02 Grading Requirements

Unless the Contract Administrator has agreed to allow a special grading, fine aggregates shall meet the requirements shown in Table 2. The fineness modulus for any sample shall not vary by more than 0.20 from the sample upon which initial acceptance was based.

1002.05.02.03 Mineral Filler

Mineral fillers shall be limited to use in self-consolidating concrete. When mineral fillers are added to the mix, they shall be inert, non-plastic, free of clay, and added as a separate ingredient to the mix.

1002.05.02.04 Physical Property Requirements

The fine aggregate shall meet the physical property requirements specified in Table 3.

1002.05.03 Coarse Aggregate

1002.05.03.01 Grading Requirements

1002.05.03.01.01 General

Coarse aggregate grading requirements shown in Tables 4 and 5 represent the upper and lower limits allowed.

1002.05.03.01.02 Concrete Structures, Sidewalks, Curb and Gutter

The nominal maximum aggregate size shall be 19.0 mm, unless specified elsewhere in the Contract Documents. Grading of the coarse aggregate shall meet the requirements shown in Table 4. Stockpiling aggregates in individual size fractions and blending them to meet the grading requirements, shown in Table 4, shall be permitted.

1002.05.03.01.03 Concrete Pavement and Concrete Base

The grading bands for the individual coarse aggregate components used in concrete pavement and concrete base are shown in the first two columns of Table 5, for information purposes only. Aggregates shall be stockpiled as individual size fractions and blended in the mix. The blended aggregates shall meet the combined grading requirements specified in the last column of Table 5.

1002.05.03.01.04 Concrete Patches, Refacing, and Overlays

The nominal maximum aggregate size shall be 13.2 mm for concrete patches, refacing, and overlays 100 mm or less in thickness. When the thickness of the repair exceeds 100 mm, the nominal maximum aggregate size shall be 19 mm. Grading of the coarse aggregate shall be within the limits shown in Table 4.

1002.05.03.02 Physical Property Requirements

The coarse aggregate shall meet the physical property requirements specified in Table 6.

1002.05.03.02.01 Scaling Resistance

Coarse aggregate composed of at least 80% siliceous aggregates as determined by LS-609, shall be tested in a salt scaling test according to LS-412 together with either the fine aggregate that the coarse aggregate is intended to be used with, or a fine aggregate from the same geographic area as the coarse aggregate.

For the purposes of this specification, the concrete for LS-412 shall be proportioned with 355 kg/m³ of Type GU hydraulic cement and shall have a plastic air content of 7.0 ± 1.5% and a slump of 80 ± 20 mm.

Testing shall be performed, according to LS-412, on the finished surface of the slabs and the maximum permitted loss shall be as specified in Table 6. Such testing shall not be performed on formed surfaces.

Testing shall be done prior to the first use of an aggregate from a pit or quarry in concrete.

For quarries, the bench from which the aggregate is selected for testing shall be identified and approval of the aggregate shall only apply to the bench from which the aggregate was tested. Aggregate processed from other benches within the same quarry shall also require the same testing prior to use.

Once an aggregate has been approved for use in concrete, the test results shall remain valid for that use, as long as the aggregate is still being extracted from the same bench and/or geological formation within the quarry.

For a pit or quarry, and at the discretion of the Owner, the approval shall remain valid provided that the aggregate is still representative of the original aggregate that was tested and approved.

In addition, once a pit source, and for quarries a bench/formation and lithology, is listed on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates or the Aggregate Sources List for Concrete Base/Pavement Coarse Aggregates and, at the discretion of the Owner, the same aggregate type being respectively produced from the same pit

source or bench/formation and lithology from the same quarry, have not changed, then the need for further testing according to LS-412, shall be waived by the Owner.

Irrespective of the waiving of these requirements, the warranty provisions of the Contract Documents shall apply.

However, if in the opinion of the Owner the extraction conditions within a pit or quarry have changed significantly so that the original test results are no longer representative of the same aggregate type currently being produced, then at the Owner's discretion, LS-412, shall be repeated for that aggregate.

1002.05.03.02.02 D-Line Cracking

Coarse aggregate from pit sources or from carbonate (e.g. limestone and dolostone) bedrock quarries used for concrete pavement and concrete base, except for aggregate produced from the Oxford, Gull River, or Bobcaygeon Formations, shall be tested for resistance to freezing and thawing according to ASTM C 666/C 666M Procedure A.

For the purposes of this specification, ASTM C 666/C 666M shall be conducted using the following parameters:

- a) The concrete for the test shall be proportioned to the combined grading shown in Table 5, with 325 kg/m³ of Type GU hydraulic cement, a plastic air content of 6.5 ± 1.5%, and a slump of 50 ± 20 mm.
- b) The fine aggregate shall be that which is intended for use with the coarse aggregate or a fine aggregate from the same geographic area as the coarse aggregate.
- c) A minimum of three beams shall be tested.
- d) Procedure A shall be modified so that each freeze cycle takes 10.5 ± 1 hour.
- e) The test shall be conducted for 350 cycles.

The average change in length of the beams tested shall be no more than ± 0.0350%. The average fundamental transverse frequency (FTF) shall not be less than 90% of the FTF at an age of 14 Days.

Testing, according to ASTM C 666/C 666M Procedure A and as modified above, shall be done prior to the first use of an aggregate from a pit or quarry source in concrete pavement or concrete base.

For quarries, the bench from which the aggregate is selected for testing shall be identified. Approval of the aggregate shall only apply to the identified bench from which the aggregate was tested. Aggregate processed from any other benches within the same quarry shall also require the same testing prior to use. Once an aggregate has been approved for use in concrete pavement or base, the test results shall remain valid for that use as long as the aggregate is still being extracted from the same bench and/or geological formation within the quarry.

For a pit or quarry and at the discretion of the Owner, the approval shall remain valid provided that, the aggregate is still representative of the original aggregate that was tested and approved.

In addition, once a pit source and, for quarries a bench/formation is listed on the current Ontario Ministry of Transportation Regional Concrete Aggregate Sources List for Concrete Base/Pavement Coarse Aggregate, the need for further testing according to ASTM C 666/C 666M Procedure A shall be waived by the Owner. Irrespective of the waiving of these requirements, the warranty provisions of the Contract Documents shall apply. However if, in the opinion of the Owner the extraction conditions within a pit or quarry have changed significantly so that the original test results are not representative of the aggregate currently being produced, then at the Owner's discretion, ASTM C 666/C 666M Procedure A, as modified above, shall be repeated for that aggregate.

1002.05.03.03 Lightweight Aggregate

Lightweight aggregate shall be according to ASTM C 330/C 330M.

1002.05.04 Deleterious Expansion Other than Alkali Aggregate Reaction

Aggregates that produce excessive expansion or cracking of concrete through reactions other than AAR shall not be used in concrete.

The combined coarse and fine aggregate used in a concrete mix shall a total of less than 0.001% by mass of lime (CaO) or periclase (MgO); a total of less than 1.0% by mass of gypsum, anhydrite or other sulphate minerals; no steel slag or glass; and based on chemical analysis such as combustion/infrared absorption using a Leco sulphur analyzer, a total of less than 1.0% by mass of sulphur.

1002.07 PRODUCTION

1002.07.01 Aggregate Processing, Handling, and Stockpiling

Processed aggregates shall be separated into fine and coarse aggregates and stockpiled separately. Aggregates separated during processing, aggregates secured from different sources, aggregates from the same source but of different gradings, or from a new bench in a quarry, or aggregates resulting from a significant change in production that affects physical quality shall be stockpiled separately.

For sampling and testing purposes, separate stockpiles of at least 1000 tonnes shall be provided for:

- a) The fine aggregate grading shown in Table 2 and for each different coarse aggregate grading shown in Tables 4 or 5 that will be used in the mix; and
- b) Each different aggregate component within the coarse and fine gradings referred to above, if one or more of the individual aggregate components are derived either from a different source location or from a different lithology within the same source location.

Where blended aggregates are allowed as specified in the General clause of the Fine Aggregate subsection then, one of the following shall also be provided:

- a) A single stockpile of at least 1000 tonnes of uniformly-blended fine aggregate that will be used in the mix; or
- b) The proportions of each fine aggregate component in the mix.

Where a blended coarse aggregate is used in the mix, then one of the following shall also be provided:

- a) A single stockpile of at least 1000 tonnes of uniformly-blended coarse aggregate that will be used in the mix; or
- b) The proportions of each individual aggregate component in the blended coarse aggregate that will be used in the mix.

For small quantities, such as for concrete repairs, being placed in isolated areas, where enough space may not be available, the 1000 tonne minimum stockpiles required, in the statements listed above, may be reduced to 500 tonnes, upon request and at the discretion of the Contract Administrator.

Where blended fine or coarse aggregates are to be used in the work, the proportions shall be submitted at the same time as Form A of the concrete mix design. If the proportions are changed, then the revised proportions and a new Form A shall be submitted.

Aggregates that have become mixed with foreign matter of any description, or aggregates that have become mixed with each other, shall not be used and shall be removed from the stockpile immediately.

Aggregate shall be retained in stockpiles for at least 24 hours before use. Suitable stockpile locations include the construction site and the site of batching of the concrete. Other locations may be used for stockpiles provided they are acceptable to the Contract Administrator.

1002.08 QUALITY ASSURANCE

1002.08.01 General

The laboratory designated by the Owner shall carry out QA testing for purposes of ensuring that aggregates used in the Work are according to the physical property and grading requirements of this specification. Individual test results shall be forwarded to the Contractor as they become available.

The Owner shall be responsible for all costs associated with testing for QA purposes, unless otherwise specified in this specification.

1002.08.02 Alternative to LS-614

LS-614 shall be used for acceptance, unless written notification to the Contract Administrator to replace it with LS-606 for acceptance is received prior to sampling of the applicable materials for QA purposes. Provided the Contract Administrator has received such a request, LS-606 shall be used. Otherwise, conformance to LS-614 shall be required.

When notification is provided after QA testing using LS-614 has been initiated, the Contractor shall then be charged \$750.00 for each test initiated, which includes the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

1002.08.03 Special Grading for Fine Aggregate

Prior to samples being taken for QA purposes, the Contractor may submit a written request to the Contract Administrator to use a fine aggregate with a grading that falls outside the limits shown in Table 2. This request shall include test data necessary to demonstrate that the material shall produce concrete of acceptable quality and meet all relevant requirements specified elsewhere in the Contract Documents. The assessment of performance shall include, but not be limited to, the following tests: compressive strength, splitting tensile strength, and drying shrinkage.

1002.08.04 Sampling

Sampling shall be according to CSA A23.2-1A and LS-625. QA samples shall be randomly taken during production from stockpiles located at the concrete plant, or in the absence of a stockpile at the plant, from stockpiles at the aggregate source.

The Contractor shall provide new or clean sample bags or containers that are constructed to prevent the loss of any part of the material or contamination or damage to the contents during shipment. Sample containers shall be securely fastened. Metal or cardboard containers are unacceptable. The sample shall be identified both inside and outside of the sample container. Data to be included with the sample shall be according to MTO form PH-D-10.

For physical properties, at least one set of duplicate QA samples of each coarse and each fine aggregate component from each individual source shall be randomly sampled from lots according to the schedule shown in Table 1.

For gradation, separate sets of lots shall be developed, according the schedule shown in Table 1, for each:

- a) Individual coarse aggregate component being used for structural concrete in this Contract.
- b) Individual coarse aggregate component being used for concrete pavement and base in this Contract or, at the discretion of the Contract Administrator, for the combined coarse aggregate being used in concrete pavement and base for this Contract, if a stockpile of such aggregate has been provided.
- c) Individual fine aggregate component being used in this Contract or, at the discretion of the Contract Administrator, for the combined fine aggregate being used for this Contract, if a stockpile of such aggregate has been provided.

Each of the gradation lots shall be divided into two sublots of approximately equal tonnage or cubic metres, as applicable, and one set of duplicate QA samples shall be randomly obtained from each subplot.

In the event that the Contractor is unavailable to take samples, no further material shall be placed in the Work until the required QA samples have been taken. The Contract Administrator shall seal each sample container at the time and place of sampling.

One of the duplicate QA samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sample for referee testing purposes.

1002.08.04.01 Sample Size

The mass of each QA sample shall meet the requirements of Table 7. When more than 30 kg is required, the total sample shall be recombined by the QA laboratory prior to testing.

1002.08.05 Acceptance

The aggregates within a lot of concrete shall be deemed to be acceptable if all of the test results for the samples of aggregates representing that lot meet all applicable requirements of this specification.

Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

1002.08.05.01 Acceptance for Physical Properties

The physical properties of a lot of aggregates shall be deemed to be acceptable if all of the test results for the sample representing that lot meet all of the requirements shown in Tables 3 and 6, for the fine and coarse aggregates, respectively.

If the tested sample of aggregates representing a lot of concrete does not meet all of the requirements of this specification, then a reduced price payment of 5% of the tender price shall be given for each cubic metre of concrete left in the work that includes any of the aggregates within that lot, as long as the applicable results for that sample:

- a) Do not exceed the requirement for LS-614 or LS-606 if it has been accepted by the Owner as an alternative to LS-614, by more than 25% of the specified value.
- b) Do not exceed a petrographic number of 135 for concrete pavement and 150 for structural concrete when tested according to LS-609;

- c) Do not exceed the requirement for LS-618 by more than 10% of the specified value; and
- d) Meets all other requirements of this specification.

For concrete tender items with units of measurement other than m³ or m², the 5% reduced price payment, mentioned above, will be based on the portion of the bid price represented by the volume, in m³, of the tender item or items that the deficient aggregate sample represents.

Should the test results for any sample of aggregates representing a lot of concrete not meet the requirements listed above, then all of the aggregates within that lot shall be considered rejectable and any concrete that includes those aggregates shall be removed from the Work at no cost to the Owner.

1002.08.05.02 Acceptance for Gradation

The gradation of a lot shall be deemed to be acceptable, based on LS-602, if the test results for the samples representing that lot meet all of the requirements of the specification.

The percent passing each sieve shall be computed to one decimal place for each individual test result representing a subplot and the average of the two test results within an aggregate lot.

1002.08.05.02.01 Acceptance of Special Grading for Fine Aggregate

If the Owner has accepted a fine aggregate for a lot according to the Special Grading for Fine Aggregate subsection, then, for each individual sieve within the gradation accepted by the Owner, the percent passing for at least one of the two test results as well as the average of the two test results shall both be within 5% of the target percent passing for that sieve.

However, if both of the requirements given above are not met, then all of the aggregates within the affected lot shall be considered rejectable.

1002.08.05.02.02 Acceptance of Gradation for All Other Fine and Coarse Aggregates

With the exception of a fine aggregate accepted by the Owner, according to the Special Grading For Fine Aggregate subsection, a complete or incomplete lot shall be deemed to meet the applicable requirements for gradation if, for each individual sieve, the percent passing for at least one of the two test results as well as the average of both test results representing the two sublots within an aggregate lot, shall be within the acceptable limits shown in Table 2 for a fine aggregate and the applicable limits shown in Tables 4 or 5, for the applicable coarse aggregate.

Should the test results for any sample of aggregates representing a lot of concrete not meet the requirements listed above, then all of the aggregates within that lot shall be considered rejectable.

1002.08.06 Referee Testing

The Contractor may invoke referee testing for one or more attributes by submitting a written request to the Contract Administrator within 5 Business Days following notification that the aggregate does not meet the requirements of this specification.

Referee testing shall be carried out as specified herein and elsewhere in the Contract Documents.

The retained duplicate QA sample shall be used for referee testing.

All referee test results shall replace the respective QA test results for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, then the Contractor shall be responsible for the cost of referee testing of that lot including the costs for transportation of the referee samples at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples representing that lot.

TABLE 1
Lot Schedule for Sampling and Testing

Total Quantity of Each Tender Item With the Same Concrete Mix Design		Minimum Lot Schedule (Notes 2 and 3)
Concrete Pavement and BaseTender Items (m ²)	Structural and all Other Concrete Tender Items (m ³) (Note 1)	
< 150	< 15	Sampling and testing may be waived at the discretion of the Contract Administrator, except for concrete repairs or critical structural elements, as described in Note 2.
150 to 10,000	15 to 500	One lot
>10,000	> 500	Concrete Pavement: 10,000 m ² lots Structural and all Other Concrete: 500 m ³ lots
Notes:		
<ol style="list-style-type: none"> For tender items with units of measurement other than m³, the quantities shall be converted to m³, in order to establish the lot schedule. At the discretion of the Contract Administrator, some tender items constructed using the same mix design may be combined together to meet the specified quantities. At the discretion of the Contract Administrator, concrete repairs, individual sections of bridge decks or critical structural elements such as cast-in-place girders, cantilever extensions etc., may have their own lot or lots, regardless of the tender item quantity. Where the remaining quantity of the applicable tender item is insufficient to form a complete lot and is: <ol style="list-style-type: none"> Less than one-half the quantity of a complete lot, then that quantity shall be added to the previous lot, or Greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot. 		

TABLE 2
Grading Requirements for Fine Aggregates, LS-602 (Note 1)

MTO Sieve Designation	Percent Passing
9.5 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	50-85
600 µm	25-60
300 µm	10-30
150 µm	0-10
75 µm	0-3 (Natural Sand) 0-6 (Manufactured Sand)
Note:	
<ol style="list-style-type: none"> Fine aggregates shall have no more than 45% passing any sieve and retained on the next consecutive sieve. The fineness modulus shall be a minimum of 2.3 and a maximum of 3.1. 	

**TABLE 3
Physical Property Requirements for Fine Aggregate(s)**

MTO or CSA Test Number (Note 1)	Laboratory Test	Acceptance Limit (Note 2)
LS-610	Organic Impurities, Organic plate number	3 (Note 3)
LS-613	Insoluble Residue, (IR _{R75}) minimum % retained on the 75 µm sieve	60 (Note 4)
LS-619 or CSA A23.2-23A	Micro-Deval Abrasion, % maximum loss	20
LS-620 or CSA A23.2-25A (Note 5)	Accelerated Mortar Bar, % maximum at 14 Days	0.150 (Note 6)
CSA A23.2-14A (Note 5)	Concrete Prism Expansion, % maximum at 1 year	0.040 (Note 7)
CSA A23.2-26A or LS-615	Potential Alkali-Carbonate Reactivity of Quarried Carbonate Rock (Note 8)	Chemical composition shall plot in the non-expansive field of Fig. 1 of test method

Notes:

1. LS-615 (or CSA A23.2-26A), LS-619, LS-620 (or CSA A23.2-25A) and CSA A23.2-14A shall apply to each individual fine aggregate component in the mix. LS-610 and LS-613 shall be carried out either on samples taken from a stockpile of the blended fine aggregate intended to be used in the mix or from samples taken from stockpiles of each individual fine aggregate component and later combined in the laboratory to the proportions provided with Form A, prior to testing. All sampling and blending shall be as specified in the Aggregate Processing, Handling, and Stockpiling subsection.
2. If the fraction of a coarse aggregate passing the 4.75 mm sieve represents more than 10% of the grading of that aggregate, by mass, then that fraction of the individual coarse aggregate shall also meet these requirements.
3. Blended fine aggregate that produces a colour darker than standard colour No. 3 shall be considered to have failed this requirement. However, a failed blended fine aggregate may be used if comparative mortar specimens prepared according to ASTM C 87/C 87M meet the following requirements:
 - a) Mortar specimens prepared using unwashed fine aggregate shall have a 7-Day compressive strength that is a minimum of 95% of the strength of mortar specimens prepared using the same fine aggregate washed in a 3% sodium hydroxide solution. Type GU Hydraulic cement shall be used.
 - b) The setting time of the unwashed fine aggregate mortar specimens shall not differ from the washed fine aggregate mortar specimens by more than 10%.
4. This requirement shall apply to all fine aggregates used in hydraulic cement concrete pavement and exposed concrete bridge deck driving surfaces (parking lots are excluded). Fine aggregates not meeting the IR_{R75} requirement may be uniformly blended with other suitable fine aggregate(s), in order to increase the IR_{R75} to a minimum of 60%.
5. The need for data to demonstrate compliance with this test shall be waived by the Contract Administrator, if the fine aggregate component is from a source listed on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates.

Note that, if the fine aggregate in the mix is comprised of one (or more) individual fine aggregate component(s) which come from a source location or from a lithology within a source which is not listed as acceptable on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates, then the requirements for this test shall not be waived for each of the unlisted aggregate component(s).
6. An aggregate that fails this requirement may be accepted, provided the requirements of CSA A23.2-14A are met.
7. An aggregate need only meet this requirement if it fails the requirements of CSA A23.2-25A. Test data shall have been obtained within the past 18 months from aggregate that is from the same source and processed in the same manner as the material intended for use.
8. This requirement only applies to an aggregate produced from quarried Gull River and Bobcaygeon Formations of southern and eastern Ontario. These dolomitic limestones outcrop on the southern margin of the Canadian Shield from Midland to Kingston and in the Ottawa-St. Lawrence Lowlands near Cornwall.

TABLE 4
Grading Requirements for Coarse Aggregate, LS-602
Structural Concrete, Sidewalks, Curb and Gutter, Patches, Refacing and Overlays

Nominal Maximum Size	19.0 mm	16.0 mm	13.2 mm	9.5 mm	6.7 mm
MTO Sieve Designation, mm	Percent Passing				
26.5	100	-	-	-	-
19.0	85-100	100	100	-	-
16.0	65-90	96-100	-	-	-
13.2	-	67-86	90-100	100	100
9.5	20-55	29-52	40-70	85-100	-
6.7	-	-	-	-	75-100
4.75	0-10	0-10	0-15	10-30	40-80
2.36	-	-	-	0-10	0-20

TABLE 5
Grading Requirements for Coarse Aggregate, LS-602
Concrete Pavement or Concrete Base

Nominal Maximum Size	For Information Purposes Only		Combined Grading Used For Acceptance (Note 1)
	37.5 mm	19.0 mm	
MTO Sieve Designation mm	Percent Passing		
53.0	100	-	100
37.5	90-100	-	95-100
26.5	20-55	100	-
19.0	0-15	85-100	35-70
9.5	0-5	20-55	10-30
4.75	-	0-10	0-5

Note:
1. The grading shown here shall be determined either from a sample of blended coarse aggregate intended for use in the mix, or from separate samples of the individual coarse aggregate components which are combined in the laboratory according to the proportions provided along with the mix design submission, as specified in the Aggregate Processing, Handling, and Stockpiling subsection.

TABLE 6
Physical Property Requirements for Coarse Aggregate(s)

MTO, CSA or ASTM Test Number (Note 1)	Laboratory Test	Acceptance Requirements (Notes 2 and 3)	
		Pavement	Structures, Sidewalk, Curb and Gutter, and Concrete Base
LS-412	Scaling Resistance Due to De-Icing Chemicals, maximum loss after 50 cycles of freezing and thawing. (Notes 4 and 5)	0.80 kg/m ²	
LS-601 (Guideline A)	Wash Pass 75µm, % maximum - for gravel - for crushed rock	1.0 2.0	1.0 2.0
LS-604 or CSA A23.2-12A	Absorption, % maximum	2.0	2.0 (Note 6)
LS-608	Flat and Elongated Particles, % maximum	20	20
LS-609	Petrographic Number, Concrete, maximum	125	140
	Contamination and Unacceptable Minerals	Note 7	
	Siliceous Aggregates Related to LS-412	Note 4	
LS-614 or CSA A23.2-24A	Unconfined Freeze-Thaw, % maximum loss (Note 8)	6	6
LS-618 or CSA A23.2-29A	Micro-Deval Abrasion, % maximum loss	14	17
LS-620 or CSA A23.2-25A	Accelerated Mortar Bar Expansion, % maximum at 14 Days (Notes 9 and 10)	0.150 (Note 11)	0.150 (Note 11)
ASTM C 666/C 666M	D-Line Cracking, Average change in length of 3 tested beams, % Average FTF. (Note 12)	no more than ± 0.0350%, ≥ 90% of the FTF at 14 days	<u>For Concrete Base Only:</u> no more than ± 0.0350%, ≥ 90% of the FTF at 14 days
CSA A23.2-14A	Concrete Prism Expansion Test, % maximum at one year (Notes 9 and 13)	0.040	0.040
CSA A23.2-26A or LS-615	Potential Alkali-Carbonate Reactivity of Quarried Carbonate Rock (Note 14)	Chemical composition shall plot in the non-expansive field of Fig. 1 of test method	
Alternative Requirement for LS-614			
LS-606	Magnesium Sulphate Soundness Loss, 5 Cycles, % maximum (Note 8)	12	12
Notes:			
<p>1. LS-412, LS-618, LS-620 (or CSA A23.2-25A), ASTM C 666/C 666M, CSA A23.2-14A and CSA A23.2-26A shall apply to each individual coarse aggregate component in the mix. The remaining tests shown in this table shall be carried out either on samples taken from a stockpile of the blended coarse aggregate intended to be used in the mix or from samples taken from stockpiles of each individual coarse aggregate component and later combined in the laboratory to the proportions provided with Form A, prior to testing. All sampling and blending shall be as specified in the Aggregate Processing, Handling, and Stockpiling subsection.</p> <p>2. If the fraction of any coarse aggregate component, passing the 4.75 mm sieve represents more than 10% of the grading of that aggregate by mass, then that fraction of the individual coarse aggregate component shall also meet the fine aggregate requirements given in Table 2.</p>			

3. When a concrete surface including pavements and exposed bridge decks is subject to vehicular traffic, the physical requirements for "Pavement" shown in this table shall apply to the aggregates used in the mix.
4. As specified in the Scaling Resistance clause, LS-412 shall be conducted on any aggregate component of a mix which has at least 80% siliceous aggregates as determined by LS-609. However, this testing will be waived if the aggregate is from the same bench/formation in a quarry which the Owner has already tested once and approved or, is listed on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates or the Aggregate Sources List of Concrete Base/Pavement Coarse Aggregates – See Note 5., AS LONG AS, at the discretion of the Owner, the aggregate under consideration is still representative of the aggregate that the Owner originally approved.
5. Note that, if the coarse aggregate in the mix is comprised of one (or more) individual coarse aggregate component(s) which come from a source location or from a lithology within a source which is not listed as acceptable on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Structural Concrete Fine and Coarse Aggregates, then the requirements for this test shall not be waived for each of the unlisted aggregate component(s).
6. Where an air-cooled blast-furnace slag aggregate is used, the allowable maximum value for Micro-Deval shall be 21% for structures and the allowable maximum value for Absorption shall be according to the Owner's requirements for slag aggregate.
7. The coarse aggregate shall contain:
 - a) No steel slag or glass; and
 - b) Less than 1.0% by mass of gypsum, anhydrite or other sulphate minerals.
8. The requirement for this test shall be waived provided that the Contractor has submitted a written request that the coarse aggregate meet the alternative requirements for LS-606, magnesium sulphate soundness, as specified in the Alternative to LS-614 clause.
9. The need to demonstrate compliance with this requirement shall be waived by the Contract Administrator, if the aggregate component:
 - a) Is from a source on the current Ontario Ministry of Transportation Regional Aggregate Sources List (ASL) for Structural Concrete Fine and Coarse Aggregates or the Aggregate Sources List of Concrete Base/Pavement Coarse Aggregates – see Note 5.; and
 - b) In accordance with the requirements of Note 13., the aggregate is NOT found to be potentially expansive due to alkali-carbonate reaction, as determined by CSA A23.2-26A or LS-615.
10. An aggregate that fails to meet these requirements shall be accepted by the Contract Administrator, provided that the requirements of CSA A23.2-14A are met.
11. If the aggregate is produced from quarried sandstone, siltstone, granite or gneiss, the expansion shall be less than 0.080% after 14 Days. If an aggregate is produced from quarried Gull River, Bobcaygeon, Verulam, or Lindsay Formations, the expansion shall be less than 0.100% after 14 Days.
12. As specified in the D-Line Cracking clause, this test shall be conducted on any aggregate component of a mix that will be used in concrete pavement or base which has been produced either from a pit source OR, with the exception of the Oxford, Gull River or Bobcaygeon Formations, from quarried carbonate (e.g. limestone and dolostone) bedrock. However, the testing will be waived if the aggregate is from the same bench/formation in a quarry which the Owner has already tested once and approved or is listed on the current Ontario Ministry of Transportation Regional Aggregate Sources List for Concrete Base/Pavement Coarse Aggregates – See Note 5. AS LONG AS, at the discretion of the Owner, the aggregate under consideration is still representative of the aggregate that the Owner originally approved.
13. An aggregate needs to meet this requirement only if it fails the requirements of either CSA A23.2-25A, or CSA A23.2-26A or LS-615. The test data shall have been obtained within the past 18 months from aggregate from the same location within the source as that to be used in the Work. If this test is conducted to show that an aggregate deemed potentially expansive by CSA A23.2-26A or LS-615 does not exceed 0.040% after one year, then chemical analysis, CSA A23.2-26A or LS-615, shall be provided to show that the aggregate intended for use has the same chemical composition as the material tested in CSA A23.2-14A.
14. This requirement only applies to an aggregate produced from quarried Gull River and Bobcaygeon Formations of southern and eastern Ontario. These dolomitic limestones outcrop on the southern margin of the Canadian Shield from Midland to Kingston and in the Ottawa-St. Lawrence Lowlands near Cornwall.

TABLE 7
Sample Size

Material	Minimum Mass, kg (Note 1)
Fine aggregate	15
19 mm coarse aggregate	25
37.5 mm coarse aggregate	50

Note:

1. Individual sample containers shall hold no more than 30 kg of aggregate. When more than 30 kg is required, additional sample containers shall be used.