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# MATERIAL SPECIFICATION FOR AGGREGATES - BASE, SUBBASE, SELECT SUBGRADE, AND BACKFILL MATERIAL

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## 1010.01 SCOPE

This specification covers the requirements for granular aggregate materials for use in subgrade, subbase, base, gravel surface course, shouldering and bedding and backfill to sewers, culverts, and other structures.

## 1010.02 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**

Laboratory Testing Manual:
LS-601 Material Finer than 75 μm Sieve in Mineral Aggregates by Washing
LS-602 Sieve Analysis of Aggregates
LS-607 Percent Crushed Particles in Processed Coarse Aggregate
LS-614 Freezing and Thawing of Coarse Aggregate

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MTO Forms:
PH-D-1A Granular A Gradation Computation Acceptance & Payment Adjustment Sheet
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PH-D-1SSM SSM Gradation Computation Acceptance & Payment Adjustment Sheet
PH-D-10 Aggregate Sample Data Sheet

**1010.03 DEFINITIONS**

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

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

**Delivery Sample** means a random sample taken at the point of loading or discharge from delivery vehicles.

**Duplicate 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.

**Fines** means material passing the 75 μm sieve when tested according to LS-601 or LS-602.

**Gradation Test** means a test used to determine the particle size distribution of an aggregate or soil material by sieving.

**Lot** means a specific quantity of material from a single source or a specified amount of construction assumed to be produced by the same process.

**Mean** means the arithmetic average of a set of data.

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

**Production Property** means an attribute or feature of an aggregate or soil material, including gradation, that is introduced through the manufacturing process (i.e., crushing, screening, blending etc.). Tests are carried out to measure the affects of the process on the material.

**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.

**Random Numbers** means numbers generated by chance, and recorded in random number tables.

**Random Sample** means a sample based on random numbers so that any portion of a lot or sublot has an equal opportunity of being selected.

**Range** means the difference between the largest and the smallest measurements in a set of data.

**Road Sample** means a random sample taken from road construction after placement and spreading of the material in the work, but prior to compaction.

**Steel Slag** means the non-metallic product resulting from the production of steel in a basic oxygen furnace or an electric arc furnace.

## 1010.05 MATERIALS

### 1010.05.01 General

Aggregates for Granular A, O, B, M and SSM shall be according to OPSS 1001, unless otherwise specified in this specification, and shall conform to the requirements of Table 2 and Table 3 when tested according to the test methods identified herein.

Aggregates shall be clean, hard, durable particles and shall be produced from material free of earth, humus, clay coatings, and clay lumps or fragments of any size or shape. When tested according to LS-630, the total amount of wood shall not exceed 0.1% by mass, and the total amount of clay brick, gypsum, gypsum plaster wallboard and other contaminants shall not exceed a combined total of 1.0% by mass.

When reclaimed asphalt pavement (RAP), post-consumer glass or ceramic material is used, it shall be homogeneously blended in a manner acceptable to the Contract Administrator.

Steel slag shall not be used.

### 1010.05.02 Granular O

Aggregates for Granular O shall be produced from a quarry or from boulders, cobbles or gravel retained on the 50 mm sieve. Recycled or reclaimed materials, including hydraulic cement concrete, RAP, slag, glass, and ceramic are not permitted.

### 1010.05.03 Granular A and M

Aggregates for Granular A and M shall be produced from one or a blend of the following:

a) Boulders, cobbles, gravel, sand, and fines from naturally formed deposits.

b) A quarry or talus.

c) Reclaimed hydraulic cement concrete.

d) Iron blast furnace slag or nickel slag.

Granular A and M aggregates may include up to 30% by mass of asphalt coated particles derived from RAP, and not more than a combined total of 15% by mass of glass or ceramic material or both, unless specified elsewhere in the Contract Documents.

Granular A or M produced with RAP containing steel slag aggregates is acceptable for unpaved shouldering purposes only. Such materials shall be stockpiled separately.

### 1010.05.04 Granular B

Granular B may be of Type I, Type II, or Type III.

Aggregates for Granular B shall be aggregates produced from one or a blend of the following, subject to the following restrictions:

a) Boulders, cobbles, gravel, sand, and fines from naturally formed deposits.

b) A quarry or talus.

c) Reclaimed hydraulic cement concrete.

d) Iron blast furnace slag or nickel slag.

Aggregates for Granular B Type I and Type III may include up to 30% by mass of asphalt coated particles derived from RAP, and not more than a combined total of 15% by mass of glass or ceramic material or both. RAP containing steel slag aggregates shall not be permitted.

Aggregates for Granular B Type II shall only be produced from a quarry or from talus, iron blast furnace slag, or nickel slag. Recycled materials shall not be permitted.

**1010.05.05 Select Subgrade Material (SSM)**

Aggregates for select subgrade material shall be produced only from natural deposits of non-plastic silt, sand, and gravel material. Recycled or reclaimed materials of any type shall not be permitted.

## 1010.08 QUALITY ASSURANCE

### 1010.08.01 General

The laboratory designated by the Owner shall carry out QA testing for purposes of ensuring that aggregates used in the Work conform to the physical and production 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.

QA testing for physical properties may be waived by the Contract Administrator when the delivered quantity of Granular A, O, B, M, or SSM is less than 5,000 tonnes.

#### 1010.08.01.01 Sampling

QA samples shall be taken according to the Contract Documents and LS-625 and shall be road samples or delivery samples obtained from the Work at a location determined by the Contract Administrator. When required, the Contractor shall provide a front-end loader to obtain material for QA samples.

When it is not possible to take road or delivery samples, samples of compacted material taken with the permission of the Owner shall be used for QA acceptance purposes.

In the event that the Contractor is unavailable to take a sample, no further materials shall be placed in the Work until the required QA samples have been taken.

QA sampling and testing shall be based on lots that are established for each aggregate type; Granular A, O, B, M, and SSM. When more than one aggregate source is used, separate lots shall also be established for each source. When aggregates are produced from materials that are extracted from within the right-of way, each area within a 1,000 m segment of the right-of-way or within a radius of 500 m of the extraction operation located within the right-of-way shall be considered equivalent to a single aggregate source for QA acceptance purposes. When aggregates are produced with blended or reclaimed materials or both, QA testing shall be performed on the final product.

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. Metal or cardboard containers are unacceptable. QA samples shall be identified both inside and outside of the sample container. Data to be included with QA samples shall be according to MTO form PH-D-10.

The Contractor shall deliver all samples to the appropriate laboratory in a condition that is suitable for testing.

All QA samples shall be duplicate samples. One of the samples shall be randomly selected for testing by the QA laboratory and the remaining sample shall be retained by the QA laboratory for possible referee testing.

**1010.08.01.02 Sample Size**

The mass of each QA sample shall meet the requirements shown in Table 4. When more than 30 kg of material is required, the total sample shall be recombined prior to testing.

**1010.08.02 Physical Properties**

At least one set of duplicate QA samples of each aggregate to be used in the Work shall be randomly sampled from lots of 25,000 tonnes or part thereof for physical properties. All materials delivered to the Work shall be included within a lot.

**1010.08.02.01 Testing of Physical Properties**

The QA laboratory shall carry out testing for each physical property requirement shown in Table 2, as applicable for each QA sample.

**1010.08.02.02 Acceptance of Physical Properties**

The acceptability of a lot for physical properties may result in payment at full price, payment at a reduced price, or rejection.

A lot shall be deemed to be acceptable for physical properties if all of the test results for the samples of aggregates representing that lot meet the requirements shown in Table 2.

If a tested sample of aggregates representing a lot does not meet all of the requirements shown in Table 2, then a reduced price payment of 20% of the tender price shall be given for that lot for physical properties, as long as the lot is not rejectable and the applicable test results for that sample:

a) do not exceed the requirement for LS-614 by more than 25% of the specified value.

b) do not exceed the requirement for LS-618 by more than 10% of the specified value.

c) do not identify plastic fines within the material, when determined according to LS-631 and acceptance test results for LS-602 are not subject to a payment adjustment on the 75µm sieve.

d) meet all other physical property requirements of this specification.

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

The reduced price payment for the lot given above shall be in addition to any payment reduction determined according to the Acceptance Based on LS-602 and LS-607 clause for production properties.

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

**1010.08.03 Production Properties**

All lots for production properties shall be divided into four sublots of approximately equal tonnage and one duplicate QA sample shall be randomly obtained from each sublot.

For each tender item, the Contract Administrator shall estimate the quantities of granular materials obtained from each different source or process. Then, for each of those individual sources or processes, the Contract Administrator shall identify the number and size of each lot to be sampled and tested using the lot schedule shown in Table 1.

In addition, if circumstances such as the closure of the construction season or changes in production or delivery result in a lot not being completed, then the Contractor shall notify the Contract Administrator prior to the first sample is taken within that lot, in order for the Contract Administrator to adjust the sublot sizes equally to accommodate the reduced tonnage. If such notification is not given in time, then acceptance shall be based on the number of sampled sublots that are available for the incomplete lot. All lots shall be deemed to be complete at the end of each calendar year.

**1010.08.03.01 Testing of Production Properties**

The QA laboratory shall conduct sieve analysis according to LS-602 and determine test results for each sieve designation shown in Table 3. The QA laboratory shall also carry out testing for percent crushed particles according to LS-607, particles with two or more crushed faces according to LS-617, and amount of asphalt coated particles according to LS-621, as applicable.

**1010.08.03.02 Acceptance of Production Properties**

Test results from each sublot within a lot shall be combined to determine the mean and the range of the lot for each test.

**1010.08.03.02.01 Acceptance Based on LS-602 and LS-607**

All lot means and ranges for test results carried out according to LS-602 and LS-607, as applicable, shall be computed to one decimal place and reported on the appropriate MTO form by the Contract Administrator, as indicated below:

| | |
|---|---|
| Granular A | PH-D-1A |
| Granular O | PH-D-1O |
| Granular B, Types I, II or III | PH-D-1B |
| Granular M | PH-D-1M |
| SSM | PH-D-1SSM |

The acceptability of a lot based on LS-602 and LS-607 may result in payment at full price, payment at a reduced price, or rejection.

A complete or incomplete lot shall be deemed to meet the applicable requirements for LS-602 and LS-607, if the mean of the test results for that lot is within the limits shown in Table 3 and the range of the test results for that lot is within the limits shown in Table 5.

Lots that are subject to a total payment adjustment factor of more than 25% in respect of lot mean and range are deemed to be rejected and shall be removed from the Work at no cost to the Owner.

When a complete or incomplete lot does not meet the requirements of LS-602 and LS-607, is not subject to removal, but the Contractor chooses to use the lot or for some reason it cannot be totally excluded from the Work, then at the request of the Contractor, an adjusted payment calculated according to the following formula shall be allowed in lieu of removal:

PAYMENT REDUCTION = lot quantity (tonnes) x item price ($/tonne) x payment adjustment factor (%)

Where:

The lot quantity shall be expressed in tonnes as determined according to Table 6, and the item price shall be according to one of the following:

a) The contract price for the items having the tender quantity in tonnes.

b) $21.50 per tonne for Granular A, O, and M; $15.50 per tonne for Granular B Type II; $15.00 per tonne for Granular B Type I and Type III; and $8.50 per tonne for SSM where bidding is not by tender quantity such as lump sum Contracts.

In addition, the payment adjustment factor, in percent, shall be equal to the sum of the adjustment points determined as follows:

a) Adjustment points shall be applied for each 0.1% that the mean gradation falls outside the gradation specification limits for each sieve, according to Table 7.

b) 0.1 adjustment points shall be applied for each 0.1% that the range exceeds the maximum acceptable range for each sieve.

c) 0.2 adjustment points shall be applied for Granular A or M for each 0.1% that the lot mean falls below the applicable limits for percent crushed.

The reduced price payment for the lot given above shall be in addition to any payment reduction determined according to the Acceptance of Physical Properties clause.

**1010.08.03.02.02 Acceptance Based on LS-617 or LS-621**

A lot shall be deemed to meet the applicable requirements of this specification for LS-617 or LS-621, if the mean value of the test results for that lot is within the limits shown in Table 3. When the mean value of the test results for that lot does not meet these requirements, the material shall be considered deficient and managed according to the requirements specified elsewhere in the Contract Documents.

**1010.08.04 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 lot 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 samples for all sublots shall be used for referee testing of the lot.
All referee test results shall replace the respective QA tests 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 the referee testing of that lot, including the cost of transporting the samples to the referee laboratory at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing of that lot.

**TABLE 1**
**Lot Schedule for Sampling and Testing**

| Quantity for Each Source or Process (tonnes) | Gran A, O, and M | Granular B (Type I, II, III) and SSM |
|---|---|---|
| < 1,000 | Sampling and testing may be waived at the discretion of the Contract Administrator | |
| 1,000 - 5,000 | One lot | One lot |
| > 5,000 (Note 1) | 5,000 tonne lots up to 20,000 tonnes, and 10,000 tonne lots thereafter | 10,000 tonne lots up to 20,000 tonnes, and 20,000 tonne lots thereafter |

Note:

1. When the quantity of granular material is insufficient for a complete lot and is:
   a) less than one-half the quantity of a complete lot, that quantity shall then be added to the previous lot; or
   b) greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.

**TABLE 2**
**Physical Property Requirements**

| Laboratory Test | MTO Test Number | Granular | | | | | Select Subgrade Material |
|---|---|---|---|---|---|---|---|
| | | A | B | | M | O | |
| | | | Type I & III | Type II | | | |
| Unconfined Freeze-Thaw, % maximum loss | LS-614 | - | - | - | - | 15 | - |
| Micro-Deval Abrasion (Coarse Aggregate), % maximum loss | LS-618 | 25 | 30 (Note 1) | 30 | 25 | 21 | 30 (Note 1) |
| Micro-Deval Abrasion (Fine Aggregate), % maximum loss | LS-619 | 30 | 35 | 35 | 30 | 25 | - |
| Amount of Contamination | LS-630 | (Note 2) | | | | | |
| Plastic Fines | LS-631 | NP (Non-Plastic) | | | | | |
| Determination of Permeability, k | LS-709 | (Note 3) | | | | | |

Notes:

1. The coarse aggregate micro-Deval abrasion loss test requirement shall be waived if the material has more than 80% passing the 4.75 mm sieve.
2. Granular A, B (Type I & III), or M may contain up to 15% by mass crushed glass or ceramic material or both. Granular A, O, B (Type I &III), and M shall not contain more than 1.0% by mass of any combination of wood, clay brick, gypsum, gypsum wall board, or plaster. Granular B (Type II) and SSM shall not contain more than 0.1% by mass of wood.
3. For materials north of the French/Mattawa Rivers only, the coefficient of permeability, k shall be greater than $1.0 \times 10^{-4}$ cm/s or alternatively, when past field experience has demonstrated satisfactory performance. Prior data demonstrating compliance with this requirement for k shall be acceptable provided that such testing has been done within 5 years of the material being used and field performance has continually been shown to be satisfactory.

**TABLE 3**
**Production Requirements**

| Lab Test | MTO Test Number | Sieve | Granular | | | | | | SSM |
|---|---|---|---|---|---|---|---|---|---|
| | | | **A** | **B Type I** (Note 2) | **B Type II** | **B Type III** (Note 2) | **M** | **O** | |
| **Sieve Analysis, % passing** | LS-602 | 150 mm | - | 100 | - | 100 | - | - | 100 |
| | | 106 mm | - | - | 100 | - | - | - | - |
| | | 37.5 mm | - | - | - | - | - | 100 | - |
| | | 26.5 mm | 100 | 50.0-100 | 50.0-100 | 50.0-100 | - | 95.0-100 | 50.0-100 |
| | | 19.0 mm | 85.0-100 (87.0-100) Note 3 | - | - | - | 100 | 80.0-95.0 | - |
| | | 13.2 mm | 65.0-90.0 (75.0-95.0) Note 3 | - | - | - | 75.0-95.0 | 60.0-80.0 | - |
| | | 9.5 mm | 50.0-73.0 (60.0-83.0) Note 3 | - | - | 32.0-100 | 55.0-80.0 | 50.0-70.0 | - |
| | | 4.75 mm | 35.0-55.0 (40.0-60.0) Note 3 | 20.0-100 | 20.0-55.0 | 20.0-90.0 | 35.0-55.0 | 20.0-45.0 | 20.0-100 |
| | | 1.18 mm | 15.0-40.0 | 10.0-100 | 10.0-40.0 | 10.0-60.0 | 15.0-40.0 | 0-15.0 | 10.0-100 |
| | | 300 μm | 5.0-22.0 | 2.0-65.0 | 5.0-22.0 | 2.0-35.0 | 5.0-22.0 | - | 5.0-95.0 |
| | | 150 μm | - | - | - | - | - | - | 2.0-65.0 |
| | | 75 μm | 2.0-8.0 (2.0-10.0) Note 4 | 0-8.0 (0-10.0) Note 4 | 0-10.0 | 0-8.0 (0-10.0) Note 4 | 2.0-8.0 (2.0-10.0) Note 4 | 0-5.0 | 0-25.0 |
| **Percent Crushed Particles, % minimum** | LS-607 | - | 60 | - | 100 | - | 60 | 100 | - |
| **2 or more Crushed Faces, % minimum** | LS-617 | - | - | - | - | - | - | 85 Note 5 | - |
| **Asphalt Coated Particles, Coarse Aggregates, % maximum** | LS-621 | - | 30 | 30 | 0 | 30 | 30 | 0 | 0 |

Notes:

1. When Granular B is used for granular backfill for pipe subdrains, 100% of the material shall pass the 37.5 mm sieve.
2. When RAP is blended with Granular B Type I or Type III, 100% of the RAP shall pass the 75 mm sieve. Conditions in Note 1 supersede this requirement.
3. When the aggregate is obtained from an iron blast furnace slag source.
4. When the aggregate is obtained from a quarry or blast furnace slag or nickel slag source.
5. When Granular O is produced from boulders, cobbles, or gravel retained on the 50 mm sieve.

**TABLE 4**
**Sample Size**

| **Material** | **Minimum Mass of Field Samples (kg)** (Note 1) |
|---|---|
| Granular O, A, M; Granular B, SSM (100% passing 26.5 mm sieve) | 25 |
| Granular B, SSM | 50 |

Notes:

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.

**TABLE 5**
**Range Requirements For Gradation (LS-602)**

| **MTO Sieve** | **Maximum Acceptable Range** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Granular** | | | | | | **SSM** |
| | **A** | **B Type I** | **B Type II** | **B Type III** | **M** | **O** | |
| 150 mm | - | 1 | - | 1 | - | - | 1 |
| 106 mm | - | - | 1 | - | - | - | - |
| 37.5 mm | - | - | - | - | - | 1 | - |
| 26.5 mm | 1 | - | 30.0 | - | - | 5.0 | - |
| 19.0 mm | 8.0 | - | - | - | 1 | 8.0 | - |
| 13.2 mm | 20.0 | - | - | - | 16.0 | 17.0 | - |
| 9.5 mm | 20.0 | - | - | - | 18.0 | 17.0 | - |
| 4.75 mm | 18.0 | - | 22.0 | - | 18.0 | 18.0 | - |
| 1.18 mm | 18.0 | - | 18.0 | - | 18.0 | 12.0 | - |
| 300 μm | 12.0 | 50.0 | 12.0 | 25.0 | 12.0 | - | - |
| 75 μm | 5.0 | 7.0 | 5.0 | 7.0 | 5.0 | 4.0 | 15.0 |

**TABLE 6**
**Lot Quantity Determinations for Adjusted Payments**

| **Item** | **Road or Delivery Samples** |
|---|---|
| Items having the tender quantity in tonnes. | The quantity measured for payment by weighing. |
| All other items. | The weighed quantity when available; otherwise the theoretical quantity calculated by the Contract Administrator using a conversion factor of 2.0 tonnes per cubic metre. |

**TABLE 7**
**Adjustment Points**

| MTO Sieve Designation | Adjustment Points Per 0.1% Deviation from Specified Limit | | | | |
|---|---|---|---|---|---|
| | **Granular A** | **Granular B** | **Granular M** | **Granular O** | **SSM** |
| 150 mm | - | 0.1 (Note 1) | - | - | 0.1 |
| 106.5 mm | - | 0.1 (Note 2) | - | - | |
| 37.5 mm | - | - | - | 0.1 | - |
| 26.5 mm | 0.1 | 0.1 | - | 0.1 | 0.1 |
| 19.0 mm | 0.1 | - | 0.1 | 0.1 | - |
| 13.2 mm | 0.1 | - | 0.1 | 0.1 | - |
| 9.5 mm | 0.1 | - | 0.1 | 0.1 | - |
| 4.75 mm | Excess Passing 0.5 / Insufficient Passing 0.2 | | | | 0.1 |
| 1.18 mm | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 300 μm | 0.1 | 0.1 | 0.1 | - | 0.1 |
| 150 μm | - | - | - | - | 0.1 |
| 75 μm | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 |

Notes:
1. Granular B Type I and Type III only.
2. Granular B Type II only.