MATERIAL SPECIFICATION FOR AGGREGATES - MISCELLANEOUS

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1004.01 SCOPE

This specification covers material requirements for aggregates for use as clear stone, granular sheeting, gabion stone, mortar sand, rip-rap, rock protection, truck arrester bed aggregate and winter sand.

1004.02 REFERENCES

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

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General
OPSS 1010 Aggregates - Base, Subbase, Select Subgrade and Backfill Material

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM):
DSM #3.05.25 Aggregates: Surface Friction Courses

MTO Laboratory Testing Manual:
LS-601 Materials Finer than 75 µm Sieve in Mineral Aggregates by Washing
LS-602 Sieve Analysis of Aggregates
LS-604 Relative Density and Absorption of Coarse Aggregate
LS-607 Determination of Percent Crushed Particles in Processed Coarse Aggregate

LS-608 Determination of Percent Flat and Elongated Particles in Coarse Aggregate
LS-610 Organic Impurities in Sands for Concrete
LS-614 Freezing and Thawing of Coarse Aggregate
LS-616 Petrographic Analysis of Fine Aggregate
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-625 Guidelines for Sampling of Aggregate Materials
LS-631 Determination of Presence of Plastic Fines in Aggregates

MTO Forms:
PH-D-10 Aggregate Sample Data Sheet

ASTM International

C87/87M-10 Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
D6473-10 Standard Test Method for Specific Gravity and Absorption of Rock for Erosion Control

1004.03 DEFINITIONS

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

Clear Stone means a graded aggregate intended for use in drainage, backfill, bedding, and other applications.

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.

Gabion Stone means a graded fractured rock aggregate intended for use in gabion baskets and gabion mats.

Granular Sheeting means a graded granular aggregate material intended for use as a protective surface layer on erodible soil slopes.

Mortar Sand means a fine aggregate intended for application in Portland cement based mortars.

Nominal Maximum Size means the largest sieve in the applicable specification upon which 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.

Pit-Run Material means material excavated directly from an existing bank in a pit and delivered to the job site without further processing, i.e., crushing, screening, washing, and classifying.

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 specified requirements.

Referee Testing means testing of a material property or attribute for the purpose of resolving acceptance.

Rip-Rap means a well graded, fractured rock or crushed reclaimed concrete intended for use as slope protection in hydraulic channels.

Rock Protection means a well graded, fractured rock or crushed reclaimed concrete intended for use as general slope protection.

Spheroidal Particle means when the ratio of the greatest dimension in the longitudinal axis compared to the least dimension in a plane perpendicular to the longitudinal axis is less than 2:1.

Truck Arrester Bed Aggregate means a single-sized aggregate used in runaway truck lanes to slow and stop the progress of vehicles.

Winter Sand means a fine aggregate intended for application to roadways during winter conditions to improve frictional properties of the pavement surface.

1004.05 MATERIALS

1004.05.01 General

The requirements of OPSS 1001 shall apply to this specification.

All aggregate source materials shall be clean, hard, durable particles free of earth, humus, clay or other coatings, clay lumps, shale or shaley partings and other deleterious materials. Aggregates may be sands, gravels, cobbles, boulders, or quarried rock. Reclaimed asphalt pavement, reclaimed hydraulic cement concrete, glass, other reclaimed materials, and slag materials shall not be used. When reclaimed materials are permitted by this specification or specified in the Contract Documents, they shall be homogeneously blended. When reclaimed hydraulic cement concrete is permitted, it shall not contain loose reinforcing material and shall be free of protruding metal.

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.

Irrespective of compliance or non-compliance with the gradation and physical property requirements of this specification, aggregates may be accepted or rejected on the basis of field performance, as determined by the Owner.

1004.05.02 Clear Stone

Clear stone may be 53.0 mm, 19.0 mm Type I, 19.0 mm Type II, 16.0 mm, 13.2 mm, or 9.5 mm and shall meet the physical property requirements shown in Table 1 and the gradation requirements shown in Table 2.

1004.05.03 Granular Sheeting

Granular sheeting shall meet the physical property requirements shown in Table 3 and the gradation requirements shown in Table 4.

1004.05.04 Mortar Sand

Mortar sand shall consist of natural sand, or with the approval of the Contract Administrator, other inert materials with similar characteristics, or combinations thereof, having hard, strong, durable particles.

Mortar sand shall meet the physical property requirements shown in Table 5 and the gradation requirements shown in Table 6.

1004.05.05 Gabion Stone, Rip-Rap and Rock Protection

Gabion stone, rip-rap and rock protection shall meet the physical property requirements shown in Table 7 unless one of the following apply:

a) The gabion stone, rip-rap or rock protection is from a source on the ministry's DSM list; or

b) Acceptance by the Owner based on a written request for consideration containing the following:

   i. Prior test results demonstrating that the physical requirements are according to Table 7.
   ii. The testing has been done within 12 months of the material being used in the Work.
   iii. Field performance has continually been satisfactory.

Gabion stone, rip-rap and rock protection shall meet the gradation requirements shown in Table 8.

1004.05.06 Truck Arrester Bed Aggregate

Truck arrester bed aggregate shall be pit-run material meeting the physical property requirements shown in Table 9 and the gradation requirements shown in Table 10. In addition, truck arrester bed aggregate shall meet the following shape requirements:

a) Rounded particles shall be a minimum of 30% by mass. Rounded particles shall be determined by the procedure given in LS-607, reporting the percentage of rounded particles instead of crushed particles. The test specimen size shall be a minimum of 3,000 g passing the 26.5 mm sieve and retained on the 19 mm sieve.

b) Spheroidal particles shall be a minimum of 50% by mass. Spheroidal particles shall be determined by the procedure given in LS-608, using a figure-eight calliper in which the ratio of the opening at one end to that at the other end is 2:1 instead of 4:1. The test specimen size shall be a minimum of 3,000 g passing the 26.5 mm sieve and retained on the 19 mm sieve.

1004.05.07 Winter Sand

Winter sand shall meet the physical property requirements shown in Table 11 and the gradation requirements shown in Table 12.

1004.07 PRODUCTION

1004.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates separated during processing shall be placed in individual stockpiles. Processed aggregates secured from different sources and aggregates from the same source but of different gradations shall be placed in individual stockpiles.

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

1004.08 QUALITY ASSURANCE

1004.08.01 General

Each aggregate, with the exception of mortar sand, shall be randomly sampled in lots according to Table 13.

When the quantity of aggregate material is insufficient for a complete lot and the quantity is:

a) Less than one-half the quantity of a complete lot, then that quantity shall be added to the previous lot.
b) Greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.

Mortar sand shall be sampled and tested at the discretion of the Contract Administrator.

The Contract Administrator shall be allowed access to all sampling locations.

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

Test data for each aggregate type shall be managed independently. When more than one source is used for supplying material, test data from each source and product shall be managed independently.

1004.08.02 Sampling

Sampling shall be according to LS-625 and taken at the time and location determined by the Contract Administrator. Samples shall be of sufficient mass to conduct the necessary gradation and physical property tests of the material. Minimum sample size requirements for aggregate types listed in Table 14 shall be according to Table 14.

Unless specified in the Contract Documents, all samples shall be taken from materials delivered to the Working Area. Each sample shall be treated as a discrete sample and not combined or blended with any other sample. When material contains blended or reclaimed aggregates or both, sampling shall be performed on the final blended product.

Duplicate samples shall be obtained for each aggregate used in the Work.

New or clean sample containers shall be provided for sampling by the Contractor. Containers shall be 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.

Samples shall be identified both inside and outside of the sample container. The Contract Administrator shall seal each sample container at the time and place of sampling. Data to be included with samples shall be according to the requirements of MTO Form PH-D-10, Aggregate Sample Data Sheet.

1004.08.03 Testing and Retention of Samples

1004.08.03.01 General

When the Contract Administrator has elected to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sealed sample for referee testing, if required.

1004.08.03.02 Winter Sand

Following delivery, winter sand shall be subject to a visual inspection of the stockpile to determine the presence of oversize material. Oversize particles may be confirmed with a 9.5 mm sieve.

1004.08.03.03 Gabion Stone, Rip-Rap and Rock Protection,

Unless specified in the Contract Documents, the laboratory designated by the Owner shall carry out QA testing of physical properties according to Table 7.

The Contract Administrator shall carry out the QA testing at the Working Area for gradation requirements according to Table 8.

1004.08.03.01 Winter Sand

Following delivery, winter sand shall be subject to a visual inspection of the stockpile to determine the presence of oversize material. Oversize particles may be confirmed with a 9.5 mm sieve.

1004.08.04 Acceptance

QA test results shall be used for acceptance purposes, except when referee testing of any aggregate or a visual examination of winter sand has been carried out.

When QA test results show that the material meets the applicable gradation and physical property requirements of this specification, the material shall be accepted.

When QA test results show that the material does not meet the applicable requirements of this specification, then all the aggregates in that lot shall be considered rejectable and removed from the Work at no cost to the Owner.

The Contract Administrator shall notify the Contractor that material represented by the test result shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data.

1004.08.05 Referee Testing

1004.08.05.01 General

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 is not as specified in the Contract Documents.

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

The retained duplicate sample(s) shall be used for each attribute referee testing that is invoked.

All referee test results for a lot 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 and the cost of transporting the samples of that lot.

1004.08.05.02 Gabion Stone, Rip-Rap and Rock Protection

Upon receiving the Contractor's written request, the Contract Administrator may elect to carry out the referee testing directly after the QA testing.

The Contract Administrator shall carry out the referee testing for gradation requirements according to Table 8 on 20 stone particles they randomly choose at the Working Area.

TABLE 1
Physical Property Requirements for Clear Stone

MTO Laboratory Test	MTO Test Number	Nominal Maximum Size			
		53 mm	19 mm		16 mm, 13.2 mm, and 9.5 mm
			Type I	Type II	
Wash Pass 75 µm Sieve, Guideline B, % maximum	LS-601	2.0	2.0	2.0	2.0
Percent Crushed Particles, % minimum	LS-607	-	50	60	60
Micro-Deval Abrasion, Coarse Aggregate, % maximum loss	LS-618	25	25	25	25

TABLE 2
Gradation Requirements for Clear Stone

Sieve Size	Gradation (LS-602), Percent Passing					
	Nominal Maximum Size					
	53 mm	19 mm		16 mm	13.2 mm	9.5 mm
		Type I	Type II			
63 mm	100	-	-	-	-	-
53 mm	90 - 100	-	-	-	-	-
26.5 mm	-	100	100	-	-	-
19.0 mm	0 - 15	85 - 100	90 - 100	100	-	-
16.0 mm	-	-	65 - 90	96 - 100	100	-
13.2 mm	-	-	-	67 - 86	96 - 100	100
9.5 mm	-	0 - 55	20 - 55	29 - 52	50 - 73	95 - 100
6.7 mm	-	-	-	-	-	20 - 45
4.75 mm	-	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10
75 µm	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0

TABLE 3
Physical Property Requirements for Granular Sheeting

MTO Laboratory Test	MTO Test Number	Requirement
Percent Crushed Particles, % minimum	LS-607	60
Petrographic Requirement, Fine Aggregate, Part A	LS-616	(Note 1)
Micro-Deval Abrasion, Coarse Aggregate, % maximum loss (Note 2)	LS-618	30
Micro-Deval Abrasion, Fine Aggregate, % maximum loss	LS-619	35
Plastic Fines	LS-631	NP

Notes:

1) Requirements for only materials north of the French/Mattawa Rivers: For materials with > 4.0% passing the 75 µm sieve, the amount of mica passing the 150 µm sieve and retained on the 75 µm sieve shall not exceed 10% of the material on that sieve. Prior data demonstrating compliance with this requirement shall be acceptable provided that such testing has been done within the past 5 years and the Contractor can show to the satisfaction of the Owner that field performance has continued to be acceptable.

2) The requirement for the coarse aggregate Micro-Deval abrasion loss test shall be waived if the material has more than 80% passing the 4.75 mm sieve.

TABLE 4
Gradation Requirements for Granular Sheeting

Sieve Size	Gradation (LS-602), Percent Passing
150 mm	100
63 mm	-
37.5 mm	57 - 100
26.5 mm	50 - 90
13.2 mm	35 - 65
4.75 mm	20 - 40
1.18 mm	10 - 23
300 µm	5 - 13
150 µm	0 - 10
75 µm	0 - 8

TABLE 5
Physical Property Requirements for Mortar Sand

MTO Laboratory Test	Test Number	Requirement
Organic Impurities, Organic Plate Number	LS-610	3 (Note 1)
Mortar Strength Test	ASTM C 87/C87M	(Note 2)

Notes:

1) When the fine aggregate for use as mortar sand is subjected to this test, it shall not produce a darker colour than the standard solution or Organic Plate Number 3. However, a fine aggregate failing this test may be approved by the Owner, if it meets the requirements of the Mortar Strength Test according to ASTM C 87.

2) Mortar specimens comprised of fine aggregate for use as Mortar Sand and hydraulic cement shall develop a compressive strength at the age of 7 Days, of not less than 90% of the strength developed by a mortar prepared in the same manner, with the same cement and with graded Ottawa sand having a fineness modulus of 2.40 $\pm$ 0.10.

TABLE 6
Gradation Requirements for Mortar Sand

Sieve Size	Gradation (LS-602), Percent Passing
4.75 mm	100.0
2.36 mm	95 - 100
1.18 mm	60 - 100
600 μm	35 - 80
300 μm	15 - 50
150 μm	2 - 15
75 μm	0 - 5.0

TABLE 7
Physical Property Requirements for Gabion Stone, Rip-Rap and Rock Protection

MTO Laboratory Test	Test Number	Gabion Stone and Rip-Rap	Rock Protection
Specific Gravity, minimum	ASTM D 6473 (Note 1)	2.50	2.50
Absorption, % maximum		2.0	2.0
Flat and Elongated Particles, % maximum	LS-608 (Note 2)	15	15
Micro-Deval Abrasion Coarse Aggregate, Grading A % maximum loss	LS-618 (Note 3)	25	25

Notes:

1) These requirements shall be based on the average test results for at least 5 pieces of rock when the source is macroscopically uniform or at least 8 pieces of rock when the source is macroscopically non-uniform. In addition, no individual piece of tested rock shall have a specific gravity less than 2.30 or and absorption greater than 3.5%.

2) These requirements shall be based on measurements taken of at least 20 randomly-chosen pieces of rock either in stockpile at the source or after being delivered to the site.

3) Testing using LS-618 may be carried out on another aggregate product that is being simultaneously produced from the same crushing stage as Rip-Rap, Gabion Stone or Rock Protection, as long as the other aggregate product being produced is sufficient for sampling and testing, according to the requirements of the procedure. As an example, if the Contractor can show that both Rip-Rap and Granular A which meets the requirements of OPSS 1010, are being simultaneously produced from a primary crusher, a sample of the Granular A may be used for acceptance testing, in-lieu of testing a sample of Rip-Rap.

TABLE 8
Gradation Requirements for Gabion Stone, Rip-Rap and Rock Protection

Mass (kg)	Approximate Dimension of an Equivalent Cube in cm (Note 1)	Gradation, percent less than mass specified (Note 2)				
		Gabion Stone		Rip-Rap		Rock Protection
		G-3	G-10	R-10	R-50	
330	50.0	-	-	-	-	100
75	30.5	-	-	-	100	↑ Well-Graded ↓
50	26.5	-	-	-	70 - 90	
25	21.0	-	-	-	40 - 55	
15	18.0	-	100	100	-	
10	15.5	-	90 - 100	70 - 90	-	
5	12.5	100	-	40 - 55	-	
3	10.5	90 - 100	-	-	-	0 - 10
2.5	10.0	-	0 - 5	-	0 - 15	-
0.5	6.0	0 - 5	-	0 - 15	-	-

Notes:

1) These dimensions are for estimating purposes only and are based on material having a specific gravity of 2.65.

2) The gradation shall be determined by individually weighing a minimum of 20 randomly-chosen stone particles from a sample taken from the stockpile representing a lot then comparing the total mass of the stone particles within each fraction with the total mass of all of the stone particles measured in the sample. For pieces of rock with masses that are larger than 25 kg, the approximate dimension of the equivalent cube determined using an average of the three rectilinear measurements of the piece shall be allowed, in lieu of weighing.

TABLE 9
Physical Property Requirements for Truck Arrester Bed Aggregate

MTO Laboratory Test	MTO Test Number	Requirement
Wash Pass 75 µm Sieve, Guideline B, % maximum	LS-601	1.0
Absorption, % maximum	LS-604	2.0
Unconfined Freeze-Thaw, % maximum loss	LS-614	6
Micro-Deval Abrasion, Coarse Aggregate, % maximum loss	LS-618	21

TABLE 10
Gradation Requirements for Truck Arrester Bed Aggregate

Sieve Size (mm)	Gradation (LS-602), Percent Passing
37.5	100
26.5	90 - 100
19.0	0 - 10

TABLE 11
Physical Property Requirements for Winter Sand

Laboratory Test	MTO Test Number	Requirement
Micro-Deval Abrasion, fine aggregate, % maximum loss	LS-619	25 (Note 1)

Notes:

1) When obtained from sources on St. Joseph Island, Manitoulin Island, or areas of Ontario south and west of a boundary delineated by the Severn River, Provincial Highway 12, and Provincial Highway 7 east of Highway 12.

TABLE 12
Gradation Requirements for Winter Sand

Sieve Size	Gradation (LS-602), Percent Passing
9.5 mm	100.0 (Note 1)
6.7 mm	97 - 100
4.75 mm	90 - 100
2.36 mm	50 - 95
1.18 mm	20 - 90
600 μm	0 - 70
300 μm	0 - 35
150 μm	0 - 15
75 μm	0 - 5.0

Notes:

1) In addition to LS-602, this shall be confirmed by visual inspection of the stockpile.

2) The minimum size of the test sample shall be 5 kg. Following oven drying, the sample shall be sieved on the 9.5 mm, 6.7 mm, and 4.75 mm sieves. Material passing the 4.75 mm sieve shall be split to an appropriate size according to LS-602 for subsequent washing and fine sieving. The final grading shall be calculated according to LS-602 as the percentage of material passing each sieve based on the total mass of the oven dried sample.

TABLE 13
Lot Sizes

Aggregate Type	Units of Measurement	Physical Properties and Gradation (Based on Tender Quantities)		
Clear Stone	tonnes (t)	< 200 t: at CA's discretion	200 - 5000 t: One lot	> 5000 t: 5000 t lots
Gabion Stone	m^3 of gabion baskets	< 100 m^3: at CA's discretion	100 - 1000 m^3: One lot	> 1000 m^3: 1000 m^3 lots
Granular Sheeting	m^2	< 200 m^2: at CA's discretion	200 - 5000 m^2: One lot	> 5000 m^2: 5000 m^2 lots
Rip-Rap	m^2	< 200 m^2: at CA's discretion	200 - 5000 m^2: One lot	> 5000 m^2: 5000 m^2 lots
Rock Protection	m^3	< 200 m^3: at CA's discretion	200 - 5000 m^3: One lot	> 5000 m^3: 5000 m^3 lots
Truck Arrester Bed	tonnes (t)	< 5000 t: One lot	> 5000 t: 5000 t lots	
Winter Sand	tonnes (t)	< 500 t: at CA's discretion	500-10000 t: One lot	> 10000 t: 10000 t lots

TABLE 14
Sample Size Requirements

Aggregate	Nominal Maximum Size (mm)	Minimum Sample Size (kg)
Clear Stone	53	80
	19.0	20
	16.0	15
	13.2	15
	9.5	10
Granular Sheeting	-	25
Mortar Sand	-	10
Rip-Rap / Gabion Stone / Rock Protection (for physical properties only)	-	25 (consisting of stone particles from 2 to 5 kg each)
Truck Arrestor Bed Aggregate	-	75
Winter Sand	-	10