Note: The 314 implemented in April 2025 replaces 314, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE, BASE, SURFACE, SHOULDER, SELECTED SUBGRADE, AND STOCKPILING

TABLE OF CONTENTS

314.01 SCOPE

This specification covers the requirements for the construction of Subbase, Base, roadway surface, Shoulder, and edge ramping for bituminous pavements, selected subgrade and stockpiling at specified sites.

~~**314.01.01 Specification Significance and Use**~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario~~

~~Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**314.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

314.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 350	Concrete Pavement and Concrete Base
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

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

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-282	Method of Test for Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures.
LS-706	Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

314.03 DEFINITIONS

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

Selected Subgrade means a granular material meeting the requirements of Select Subgrade Material (SSM), as specified in OPSS 1010, which is used to replace unsuitable native soils or raise the existing grade or both, in order to meet the final subgrade grading requirements, specified in the Contract Documents.

Tolerance means a construction working tolerance only that is considered to be:

a) Minus when it is:

   i. narrower than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
   ii. lower in elevation than the Contract standard when pertaining to vertical dimensions.

b) Plus when it is:

   i. wider than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
   ii. higher in elevation than the Contract standard when pertaining to vertical dimensions.

314.05 MATERIALS

314.05.01 Aggregates

Aggregates used for Base, Subbase and selected subgrade applications shall be according to OPSS 1010.

314.05.02 Water

Water shall be free of any contaminants that could adversely affect the environment or the placement and compaction of materials for Base, Subbase and selected subgrade applications.

314.05.03 RAP Shouldering

RAP obtained from Contract milling operations may be used for shouldering, as long as the RAP, at the time of use, has:

a) 100% by mass passing the 26.5 mm sieve and no more than 75% by mass passing the 4.75 mm sieve; and

b) No visible contamination, as determined by the Contract Administrator.

RAP obtained from any other sources will not be acceptable for shouldering without written consent from the Owner.

314.06 EQUIPMENT

314.06.01 Water

Equipment used for applying water to granular materials in order to meet compaction requirements for Base, Subbase and selected subgrade applications shall be equipped with variable flow control to uniformly and completely wet the material without causing the material to be eroded away. The equipment operator shall also have the capability to monitor and change the flow while the equipment is moving.

314.07 CONSTRUCTION

314.07.01 Subbase, Base, Surface, and Selected Subgrade

All materials shall be kept free from clay and other types of deleterious material. Construction operations shall not disturb underlying work.

All materials shall be placed in uniform lifts without segregation.

Except as provided under the Modified Layer Compaction Method clause:

a) Granular B, Type II shall be placed in accordance with the compaction methods specified in the Granular B, Type II clause such that the thickness of the compacted layer is not greater than 150 mm.

b) All other materials shall be placed such that the thickness of the compacted layer is not greater than 150 mm.

In all cases, each lift shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent lift, when applicable.

Prior to closing down operations for each Day, the Subbase material shall be bladed and compacted and, if necessary, covered with sufficient Base material to carry traffic.

The Base shall be maintained to the tolerances in grade and cross-section and to the specified density until Contract Completion or, if the Contract includes paving, until the Base surface is paved.

314.07.02 Winter Grading

Any areas where materials used for Subbase, Base, selected subgrade or other fill applications are being placed shall be free of ice and snow. Frozen material shall not be incorporated into the Work. Materials used for Subbase, Base, selected subgrade or other fill applications shall not be placed over frozen ground.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified material shall be built along the outside edges of each bituminous pavement construction course. Such ramps shall be at a height level with the pavement course and fall away from its edge at a slope not steeper than 4H:1V. Care shall be taken to prevent any ramping material from being spilled or pushed onto the pavement. Any material that is spilled shall be removed immediately without damage to the pavement and the surface thoroughly cleaned with the use of a power broom or other suitable means.

Prior to paving any section, only sufficient material to construct the ramps shall be placed on the Shoulders. No other Shoulder material shall be placed until the conditions, as detailed in the Shoulders subsection, have been attained.

Edge ramps shall be completed prior to opening adjacent pavement to traffic.

314.07.04 Shoulders

Material used for shouldering shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Prior to commencing Shoulder construction, all debris and deleterious material shall be removed from the Shoulder area.

Shouldering operations shall commence as soon as, but not before, the following pavement conditions are met:

a) Bituminous Pavements

Placement of material for shouldering operations shall not commence along any section of pavement, until at least 6 hours have elapsed from the time of completion of the final bituminous pavement course in that section. In addition, for pavement sections that are already open to traffic, all shouldering operations shall be completed within 24 hours of their commencement. In all cases where a pavement section is not yet open to traffic, the shouldering shall be completed prior to opening that pavement section to traffic. The material shall be placed in lifts not greater than 300 mm in thickness prior to compaction.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed prior to opening the concrete base or concrete pavement to traffic.

All Shoulder construction material shall be conveyed from the transport vehicle onto the Shoulder area. End dumping of Shoulder construction material directly on to the adjacent pavement surface or directly on to the Shoulder shall not be permitted. The material shall be uniformly distributed within the specified Shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified Shoulder limits without overspill.

Any Shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

314.07.04.01 RAP Shouldering

RAP shouldering shall be according to and at the locations specified in the Contract Documents.

314.07.05 Compaction

314.07.05.01 General

Each lift of material shall be compacted as specified below prior to the placement of the next lift.

The rate of placing material shall be controlled by the adequacy of the compaction obtained.

314.07.05.02 Compaction Requirements

314.07.05.02.01 Granular B, Type II

Granular B Type II shall be placed and compacted at a moisture content which is no more than 0.5 % above and no more than 1.5% below its optimum moisture content according to LS-706.

The material shall not be dumped into position but shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other equipment approved by the Contract Administrator.

The placement of the first lift of material over wet or weak subgrade shall be monitored and the placement and compaction procedure modified as required, with the approval of the Contract Administrator, to minimize subgrade disturbance. Localized, unusually wet or weak subgrade areas shall be identified to the Contract Administrator for possible treatment.

In restricted zones as specified in OPSS 501, Granular B, Type II shall be compacted using hand-operated vibratory equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW. Where confined areas are less than the minimum width and where such equipment cannot be used safely, then smaller vibratory hand-operated tampers shall be used. One hundred percent compaction coverage with a minimum of four passes shall be provided in all cases.

In non-restricted zones, Granular B, Type II shall be compacted using single drum, vibratory, smooth steel drum rollers, with a minimum operating mass of 5,000 kilograms and minimum operating dynamic force of 75 kN. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

Regardless of the minimum number of passes being specified, additional passes may be required, at the discretion of the Contract Administrator.

314.07.05.02.02 All Other Granular Materials

The compaction requirements shall be according to OPSS 501.

314.07.05.02.03 Shoulders

Where granular material is being placed around guiderail and sign posts at the shoulders, it shall be compacted using hand-operated vibratory equipment according to OPSS 501.

314.07.05.02.03.01 Lift Thicknesses Less than 100 mm

If the lift thickness for grade correction at the shoulders is less than 100 mm, compaction testing using a nuclear gauge may be waived at the discretion of the Contract Administrator.

Where compaction testing using a nuclear gauge is waived, the granular material being used shall be placed and compacted at a moisture content which is no more than 0.5 % above and no more than 1.5% below its optimum moisture content according to LS-706.

Where the shoulder is wide enough, the granular material shall be compacted using a single drum, vibratory, smooth steel drum roller, with a minimum operating mass of 5,000 kilograms and a minimum operating dynamic force of 75 kN. Where narrower shoulders prevent such equipment from being effectively used, the granular material shall be compacted using hand-operated vibratory compaction equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW.

In either case, wherever compaction testing using a nuclear gauge is waived, a minimum of four passes shall be completed and where possible, each pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

Regardless of the minimum number of passes being specified, additional passes may be required, at the discretion of the Contract Administrator.

314.07.05.02.04 RAP Shouldering

314.07.05.02.04.01 Compaction Acceptance Based on LS-706

Where 100% RAP is being placed for shouldering, RAP shall be compacted, according to OPSS 501, with the following changes and clarifications:

1.a) The RAP shall be considered to be a granular material;

2.b) All lots shall be no more than 500 m long and have 4 sublots;

3.c) Target densities shall be established, based on LS-706, according to the last paragraph of the Target Density clause in OPSS 501; and

4.d) The moisture content readings obtained from a nuclear gauge shall be adjusted by deducting the AC- bias of the gauge for the purpose of calculating the field dry density. The AC-bias of the gauge shall be determined, at the start of the compaction work for the Contract, using the difference between the average moisture content readings measured using the nuclear gauge, at a minimum of 6 random locations and the field moisture content of samples of the RAP taken at the same locations. The moisture content of the RAP samples shall be determined according to the Determination of Moisture Content section of LS-282. A new AC-bias shall be generated whenever a different nuclear gauge is employed for the compaction work carried out on the Contract.

314.07.05.02.04.02 Compaction Acceptance Based on Specified Compaction Methods

Compaction acceptance, as described in the Compaction Acceptance Based on LS-706 clause, given above, may be waived at Regional discretion.

In this case, the RAP shouldering shall be placed and compacted at a moisture content which is no less than 2% lower than and no more than 1.0% greater than its optimum moisture content, as determined according to LS-706 and the Determination of Moisture Content section of LS-282 for the moisture content of the RAP. However, if the moisture content of the compacted RAP is being measured using a nuclear gauge, then those measurements must be adjusted for the AC-bias of the gauge, as described in part 4 of the list given in the Compaction Acceptance Based on LS-706 clause given above.

Where the shoulder is wide enough, the RAP shouldering shall be compacted using a single drum, vibratory, smooth steel drum roller, with a minimum operating mass of 5,000 kilograms and a minimum operating dynamic force of 75 kN. Where narrower shoulders or guide rails prevent such equipment from being effectively used, then the RAP shall be compacted using hand-operated or excavator-mounted vibratory compaction equipment. Hand-operated equipment shall have a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW.

In all cases, a minimum of four passes shall be completed and where possible, each pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

Regardless of the minimum number of passes being specified, additional passes may be required, at the discretion of the Contract Administrator.

314.07.05.03 Modified Layer Compaction Method

Material may be placed in layers thicker than permitted under the Subbase, Base, Surface, and selected subgrade subsection, subject to the following provisions:

a) All materials, with the exception of Granular B, Type II shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.

b) Granular B, Type II shall be placed in uniform layers with a compacted depth not to exceed the values shown in Table 1 for various sizes of single drum, vibratory, smooth wheel drum rollers. Both the minimum operating mass and the minimum operating dynamic force requirements shown in Table 1 shall be met for the roller used. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

c) Prior to placing material in layers as described in a) or b) above depending on the type of granular material

used, the ability of the proposed method to achieve satisfactory compaction shall be demonstrated to the satisfaction of the Contract Administrator by means of a two-lane trial area. The trial area location shall be approved by the Contract Administrator. At least 48 hours prior to any work commencing on the trial area, full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be submitted to the Contract Administrator. The areas designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length. Approval will follow within one Business Day after satisfactory completion of the compaction trial area.

d) When the Contract Administrator, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:

   i. Should it be necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, approval to change the system shall be obtained from the Contract Administrator, who may require a further trial area.
   ii. If, at any time, tests show that a previously-approved system is no longer producing the required degree of compaction, changes shall be made as necessary to satisfy the requirements of this specification.

314.07.06 Tolerances

The surface of the uppermost layer of granular material and each granular course shall be bladed, shaped, and compacted to produce the grade and cross-section specified in the Contract Documents, within the tolerances shown in Table 2.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

314.07.07 Stockpiling of Granular Material

Sites for stockpile construction, specified in the Contract Documents, shall be cleared and grubbed, regardless of stockpile height, according to OPSS 201. Organic soil underlying the stockpile location shall be removed and the site cleaned up prior to stockpile construction. Stockpiles shall be constructed, including the supply and placement of a pad upon which the materials are to be stockpiled, according to OPSS 1001.

314.07.08 Grade Checks

The Contract Administrator shall be notified within 12 hours when each Subbase or Base course has been completed, including Shoulders, and prior to the next course being placed.

The Contractor shall be responsible for carrying out all grade checks to ensure that horizontal and vertical grading tolerances are met.

Grade checks shall be carried out on all finished granular surfaces. Grade checks of granular grading surfaces shall be based on horizontal and vertical grading tolerances, as specified in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the grading templates, or when grading templates are not available, at the frequency requirements shown for the layout specified elsewhere in the Contract Documents.

314.07.09 Submission of Grade Checks

All grade checks concerning horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade.

When grading templates are available, the Contractor shall sign and certify on the grading template that the components of the work indicated on that template have been correctly constructed to the specified line and grade tolerances. If a template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 to the Contract Administrator.

314.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

314.08 QUALITY ASSURANCE

314.08.01 General

The Owner may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Acceptance

If the Contract Administrator chooses not to take QA grade checks or if the QA grade checks conform to those determined by the Contractor, the work shall then be accepted.

However, if any discrepancies between the QA and the Contractor's grade checks are found, then, at the discretion of the Owner, additional QA grade checks may be carried out in any other location.

If the finished grade or cross-section or both are not within the tolerances specified in the Tolerances subsection, then:

a) The Contract Administrator shall notify the Contractor and advise where the tolerances have not been met, including overbuilding of the width of a granular course.

b) The Contractor shall be charged for each station where the tolerances have not been met, at the rate specified in the Basis of Payment section.

c) The Contractor shall bring the granular surface to within the specified tolerances for grade, at no additional cost to the Owner.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

314.09.01.01 Granular A, B Type I, B Type II, B Type III, M and O
Granular A, B Type I, B Type II, B Type III, M, and O Stockpiled
Granular A, B Type I, B Type II, B Type III, M, and O from Stockpile
Select Subgrade Material, Compacted
RAP Shouldering

314.09.01.01.01 Tonne

When payment is by the tonne:

a) When the Contractor supplies Granular A and M composed of air-cooled iron blast-furnace slag or nickel slag, the payment quantities shall be determined by applying the following factors:

i. The total measured mass of air-cooled iron blast-furnace slag incorporated into the work shall be multiplied by a factor of 1.116.
ii. The total measured mass of nickel slag incorporated into the work shall be multiplied by a factor of 0.85.

b) When Granular B is composed of slag, the payment quantities shall be determined by comparing the density of the material to the average density of granular material as set by the Owner for that specific area and applying the conversion factors that have been determined to the weighed tonnes.

c) When granular material is composed of slag, it is necessary to determine the amount of overrun or underrun. Such overrun and underrun shall be the difference between the tender quantity and the payment quantity as determined by applying the foregoing factors to the weighed tonnes.

314.09.01.01.02 Cubic Metre

When payment is by cubic metre, one of the following methods shall be used as determined by the Contract Administrator:

a) End Area Method

i. At Source

The volume of material shall be measured at the source in its original location and computed in cubic metres by the method of average end areas.

Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

The volume of boulders removed from borrow pits that cannot be accommodated in embankments or any other areas acceptable to the Owner, shall be deducted.

ii. In Place

When the measurement for payment of material in its original location is impractical, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

The truck box method shall only be used when the Contract Administrator deems that the quantities are too small or the end area method is impractical for other reasons.

In this case, measurement for payment shall be based on the total volume in cubic metres of loose granular material, calculated by the Contract Administrator, from estimated percentages of the pre-determined capacity of each truck box determined from measurements of its dimensions.

Each truck that the Contractor intends to use shall be uniquely and readily identifiable to the satisfaction of the Contract Administrator.

314.09.01.01.03 Square Metre

When payment is by square metre, the area shall be based on that shown in the Contract Documents.

314.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

314.10 BASIS OF PAYMENT

314.10.01

Granular A - Item
Granular A, Stockpiled - Item
Granular A, from Stockpile - Item

Granular B Type I - Item
Granular B Type I, Stockpiled - Item
Granular B Type I, from Stockpile - Item

Granular B Type II - Item
Granular B Type II, Stockpiled - Item
Granular B Type II, from Stockpile - Item

Granular B Type III - Item
Granular B Type III, Stockpiled - Item
Granular B Type III, from Stockpile - Item

Granular M - Item
Granular M, Stockpiled - Item
Granular M, from Stockpile - Item

Granular O - Item
Granular O, Stockpiled - Item
Granular O, from Stockpile - Item

RAP Shouldering - Item
Select Subgrade Material, Compacted - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

As specified in the Acceptance subsection, $250.00 shall be deducted from payment for each station where the QA grade check of the finished grade is found to be outside of the specification limit.

Any additional grading carried out to correct grades that are not within the tolerances specified in the Tolerances subsection shall be carried out at no additional cost to the Owner.

Where a finished granular course exceeds the horizontal tolerances specified in the Tolerances subsection and the material outside that tolerance has been left in place, the Owner shall deduct from payment the theoretical quantity of material placed outside of that tolerance, based on a conversion factor of 2.0 t/m³, regardless of the type of granular material used.

TABLE 1
Modified Layer Compaction Thickness for Granular B, Type II
Single Drum, Vibratory, Smooth Wheel Drum Roller

Minimum Operating Mass kg	Minimum Operating Dynamic Force kN	Maximum Layer Depth After Compaction mm
5,000	75	300
8,000	150	450
12,000	250	600
15,000	350	750

TABLE 2
Allowable Tolerances for Finished Granular Surfaces

Tolerances From Specified Grade and Cross - Section	Finished Granular Courses mm	Finished Granular Surfaces Immediately Beneath Bituminous Courses, Sidewalks, and Curb and Gutter mm		Finished Granular Surfaces Immediately Beneath Concrete Courses, Sidewalks, and Curb and Gutter mm
		When the Finished Grade is Controlled by Fixed Components Such as Existing Pavements and Curbs	All Others	
Vertical	+ 30 - 30	+ 10 - 10	+ 30 - 30	+ 10 - 10
Horizontal	+ 30 - 0	+ 10 - 0	+ 30 - 0	+ 10 - 0
Surface Deviation (Note 1)	15	10		10

Notes:

1. The maximum gap between a granular surface and the underside of a 3 m rigid metal straightedge, placed anywhere and in any direction on that surface.

~~**Appendix 314-A, November 2015**~~
~~**FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**~~

~~**Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.**~~

~~**Designer Action/Considerations**~~

~~No information provided here.~~

~~**Related Ontario Provincial Standard Drawings**~~

~~No information provided here.~~

Note: The 314 implemented in April 2025 replaces 314, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE, BASE, SURFACE, SHOULDER, SELECTED SUBGRADE, AND STOCKPILING

TABLE OF CONTENTS

314.01 SCOPE

This specification covers the requirements for the construction of Subbase, Base, roadway surface, Shoulder, and edge ramping for bituminous pavements, selected subgrade and stockpiling at specified sites.

314.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 201 Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 350 Concrete Pavement and Concrete Base
OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

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

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-282 Method of Test for Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures.
LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

314.03 DEFINITIONS

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

Selected Subgrade means a granular material meeting the requirements of Select Subgrade Material (SSM), as specified in OPSS 1010, which is used to replace unsuitable native soils or raise the existing grade or both, in order to meet the final subgrade grading requirements, specified in the Contract Documents.

Tolerance means a construction working tolerance only that is considered to be:

a) Minus when it is:

   i. narrower than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
   ii. lower in elevation than the Contract standard when pertaining to vertical dimensions.

b) Plus when it is:

   i. wider than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
   ii. higher in elevation than the Contract standard when pertaining to vertical dimensions.

314.05 MATERIALS

314.05.01 Aggregates

Aggregates used for Base, Subbase and selected subgrade applications shall be according to OPSS 1010.

314.05.02 Water

Water shall be free of any contaminants that could adversely affect the environment or the placement and compaction of materials for Base, Subbase and selected subgrade applications.

314.05.03 RAP Shouldering

RAP obtained from Contract milling operations may be used for shouldering, as long as the RAP, at the time of use, has:

a) 100% by mass passing the 26.5 mm sieve and no more than 75% by mass passing the 4.75 mm sieve; and

b) No visible contamination, as determined by the Contract Administrator.

RAP obtained from any other sources will not be acceptable for shouldering without written consent from the Owner.

314.06 EQUIPMENT

314.06.01 Water

Equipment used for applying water to granular materials in order to meet compaction requirements for Base, Subbase and selected subgrade applications shall be equipped with variable flow control to uniformly and completely wet the material without causing the material to be eroded away. The equipment operator shall also have the capability to monitor and change the flow while the equipment is moving.

314.07 CONSTRUCTION

314.07.01 Subbase, Base, Surface, and Selected Subgrade

All materials shall be kept free from clay and other types of deleterious material. Construction operations shall not disturb underlying work.

All materials shall be placed in uniform lifts without segregation.

Except as provided under the Modified Layer Compaction Method clause:

a) Granular B, Type II shall be placed in accordance with the compaction methods specified in the Granular B, Type II clause such that the thickness of the compacted layer is not greater than 150 mm.

b) All other materials shall be placed such that the thickness of the compacted layer is not greater than 150 mm.

In all cases, each lift shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent lift, when applicable.

Prior to closing down operations for each Day, the Subbase material shall be bladed and compacted and, if necessary, covered with sufficient Base material to carry traffic.

The Base shall be maintained to the tolerances in grade and cross-section and to the specified density until Contract Completion or, if the Contract includes paving, until the Base surface is paved.

314.07.02 Winter Grading

Any areas where materials used for Subbase, Base, selected subgrade or other fill applications are being placed shall be free of ice and snow. Frozen material shall not be incorporated into the Work. Materials used for Subbase, Base, selected subgrade or other fill applications shall not be placed over frozen ground.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified material shall be built along the outside edges of each bituminous pavement construction course. Such ramps shall be at a height level with the pavement course and fall away from its edge at a slope not steeper than 4H:1V. Care shall be taken to prevent any ramping material from being spilled or pushed onto the pavement. Any material that is spilled shall be removed immediately without damage to the pavement and the surface thoroughly cleaned with the use of a power broom or other suitable means.

Prior to paving any section, only sufficient material to construct the ramps shall be placed on the Shoulders. No other Shoulder material shall be placed until the conditions, as detailed in the Shoulders subsection, have been attained.

Edge ramps shall be completed prior to opening adjacent pavement to traffic.

314.07.04 Shoulders

Material used for shouldering shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Prior to commencing Shoulder construction, all debris and deleterious material shall be removed from the Shoulder area.

Shouldering operations shall commence as soon as, but not before, the following pavement conditions are met:

a) Bituminous Pavements

Placement of material for shouldering operations shall not commence along any section of pavement, until at least 6 hours have elapsed from the time of completion of the final bituminous pavement course in that section. In addition, for pavement sections that are already open to traffic, all shouldering operations shall be completed within 24 hours of their commencement. In all cases where a pavement section is not yet open to traffic, the shouldering shall be completed prior to opening that pavement section to traffic. The material shall be placed in lifts not greater than 300 mm in thickness prior to compaction.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed prior to opening the concrete base or concrete pavement to traffic.

All Shoulder construction material shall be conveyed from the transport vehicle onto the Shoulder area. End dumping of Shoulder construction material directly on to the adjacent pavement surface or directly on to the Shoulder shall not be permitted. The material shall be uniformly distributed within the specified Shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified Shoulder limits without overspill.

Any Shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

314.07.04.01 RAP Shouldering

RAP shouldering shall be according to and at the locations specified in the Contract Documents.

314.07.05 Compaction

314.07.05.01 General

Each lift of material shall be compacted as specified below prior to the placement of the next lift.

The rate of placing material shall be controlled by the adequacy of the compaction obtained.

314.07.05.02 Compaction Requirements

314.07.05.02.01 Granular B, Type II

Granular B Type II shall be placed and compacted at a moisture content which is no more than 0.5 % above and no more than 1.5% below its optimum moisture content according to LS-706.

The material shall not be dumped into position but shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other equipment approved by the Contract Administrator.

The placement of the first lift of material over wet or weak subgrade shall be monitored and the placement and compaction procedure modified as required, with the approval of the Contract Administrator, to minimize subgrade disturbance. Localized, unusually wet or weak subgrade areas shall be identified to the Contract Administrator for possible treatment.

In restricted zones as specified in OPSS 501, Granular B, Type II shall be compacted using hand-operated vibratory equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW. Where confined areas are less than the minimum width and where such equipment cannot be used safely, then smaller vibratory hand-operated tampers shall be used. One hundred percent compaction coverage with a minimum of four passes shall be provided in all cases.

In non-restricted zones, Granular B, Type II shall be compacted using single drum, vibratory, smooth steel drum rollers, with a minimum operating mass of 5,000 kilograms and minimum operating dynamic force of 75 kN. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

Regardless of the minimum number of passes being specified, additional passes may be required, at the discretion of the Contract Administrator.

314.07.05.02.02 All Other Granular Materials

The compaction requirements shall be according to OPSS 501.

314.07.05.02.03 Shoulders

Where granular material is being placed around guiderail and sign posts at the shoulders, it shall be compacted using hand-operated vibratory equipment according to OPSS 501.

314.07.05.02.03.01 Lift Thicknesses Less than 100 mm

If the lift thickness for grade correction at the shoulders is less than 100 mm, compaction testing using a nuclear gauge may be waived at the discretion of the Contract Administrator.

Where compaction testing using a nuclear gauge is waived, the granular material being used shall be placed and compacted at a moisture content which is no more than 0.5 % above and no more than 1.5% below its optimum moisture content according to LS-706.

Where the shoulder is wide enough, the granular material shall be compacted using a single drum, vibratory, smooth steel drum roller, with a minimum operating mass of 5,000 kilograms and a minimum operating dynamic force of 75 kN. Where narrower shoulders prevent such equipment from being effectively used, the granular material shall be compacted using hand-operated vibratory compaction equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW.

In either case, wherever compaction testing using a nuclear gauge is waived, a minimum of four passes shall be completed and where possible, each pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

Regardless of the minimum number of passes being specified, additional passes may be required, at the discretion of the Contract Administrator.

314.07.05.02.04 RAP Shouldering

314.07.05.02.04.01 Compaction Acceptance Based on LS-706

Where 100% RAP is being placed for shouldering, RAP shall be compacted, according to OPSS 501, with the following changes and clarifications:

a) The RAP shall be considered to be a granular material;

b) All lots shall be no more than 500 m long and have 4 sublots;

c) Target densities shall be established, based on LS-706, according to the last paragraph of the Target Density clause in OPSS 501; and

d) The moisture content readings obtained from a nuclear gauge shall be adjusted by deducting the AC- bias of the gauge for the purpose of calculating the field dry density. The AC-bias of the gauge shall be determined, at the start of the compaction work for the Contract, using the difference between the average moisture content readings measured using the nuclear gauge, at a minimum of 6 random locations and the field moisture content of samples of the RAP taken at the same locations. The moisture content of the RAP samples shall be determined according to the Determination of Moisture Content section of LS-282. A new AC-bias shall be generated whenever a different nuclear gauge is employed for the compaction work carried out on the Contract.

314.07.05.02.04.02 Compaction Acceptance Based on Specified Compaction Methods

Compaction acceptance, as described in the Compaction Acceptance Based on LS-706 clause, given above, may be waived at Regional discretion.

In this case, the RAP shouldering shall be placed and compacted at a moisture content which is no less than 2% lower than and no more than 1.0% greater than its optimum moisture content, as determined according to LS-706 and the Determination of Moisture Content section of LS-282 for the moisture content of the RAP. However, if the moisture content of the compacted RAP is being measured using a nuclear gauge, then those measurements must be adjusted for the AC-bias of the gauge, as described in part 4 of the list given in the Compaction Acceptance Based on LS-706 clause given above.

Where the shoulder is wide enough, the RAP shouldering shall be compacted using a single drum, vibratory, smooth steel drum roller, with a minimum operating mass of 5,000 kilograms and a minimum operating dynamic force of 75 kN. Where narrower shoulders or guide rails prevent such equipment from being effectively used, then the RAP shall be compacted using hand-operated or excavator-mounted vibratory compaction equipment. Hand-operated equipment shall have a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW.

In all cases, a minimum of four passes shall be completed and where possible, each pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

Regardless of the minimum number of passes being specified, additional passes may be required, at the discretion of the Contract Administrator.

314.07.05.03 Modified Layer Compaction Method

Material may be placed in layers thicker than permitted under the Subbase, Base, Surface, and selected subgrade subsection, subject to the following provisions:

a) All materials, with the exception of Granular B, Type II shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.

b) Granular B, Type II shall be placed in uniform layers with a compacted depth not to exceed the values shown in Table 1 for various sizes of single drum, vibratory, smooth wheel drum rollers. Both the minimum operating mass and the minimum operating dynamic force requirements shown in Table 1 shall be met for the roller used. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

c) Prior to placing material in layers as described in a) or b) above depending on the type of granular material used, the ability of the proposed method to achieve satisfactory compaction shall be demonstrated to the satisfaction of the Contract Administrator by means of a two-lane trial area. The trial area location shall be approved by the Contract Administrator. At least 48 hours prior to any work commencing on the trial area, full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be submitted to the Contract Administrator. The areas designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length. Approval will follow within one Business Day after satisfactory completion of the compaction trial area.

d) When the Contract Administrator, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:

   i. Should it be necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, approval to change the system shall be obtained from the Contract Administrator, who may require a further trial area.
   ii. If, at any time, tests show that a previously-approved system is no longer producing the required degree of compaction, changes shall be made as necessary to satisfy the requirements of this specification.

314.07.06 Tolerances

The surface of the uppermost layer of granular material and each granular course shall be bladed, shaped, and compacted to produce the grade and cross-section specified in the Contract Documents, within the tolerances shown in Table 2.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

314.07.07 Stockpiling of Granular Material

Sites for stockpile construction, specified in the Contract Documents, shall be cleared and grubbed, regardless of stockpile height, according to OPSS 201. Organic soil underlying the stockpile location shall be removed and the site cleaned up prior to stockpile construction. Stockpiles shall be constructed, including the supply and placement of a pad upon which the materials are to be stockpiled, according to OPSS 1001.

314.07.08 Grade Checks

The Contract Administrator shall be notified within 12 hours when each Subbase or Base course has been completed, including Shoulders, and prior to the next course being placed.

The Contractor shall be responsible for carrying out all grade checks to ensure that horizontal and vertical grading tolerances are met.

Grade checks shall be carried out on all finished granular surfaces. Grade checks of granular grading surfaces shall be based on horizontal and vertical grading tolerances, as specified in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the grading templates, or when grading templates are not available, at the frequency requirements shown for the layout specified elsewhere in the Contract Documents.

314.07.09 Submission of Grade Checks

All grade checks concerning horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade.

When grading templates are available, the Contractor shall sign and certify on the grading template that the components of the work indicated on that template have been correctly constructed to the specified line and grade tolerances. If a template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 to the Contract Administrator.

314.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

314.08 QUALITY ASSURANCE

314.08.01 General

The Owner may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Acceptance

If the Contract Administrator chooses not to take QA grade checks or if the QA grade checks conform to those determined by the Contractor, the work shall then be accepted.

However, if any discrepancies between the QA and the Contractor's grade checks are found, then, at the discretion of the Owner, additional QA grade checks may be carried out in any other location.

If the finished grade or cross-section or both are not within the tolerances specified in the Tolerances subsection, then:

a) The Contract Administrator shall notify the Contractor and advise where the tolerances have not been met, including overbuilding of the width of a granular course.

b) The Contractor shall be charged for each station where the tolerances have not been met, at the rate specified in the Basis of Payment section.

c) The Contractor shall bring the granular surface to within the specified tolerances for grade, at no additional cost to the Owner.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

314.09.01.01 Granular A, B Type I, B Type II, B Type III, M and O
Granular A, B Type I, B Type II, B Type III, M, and O Stockpiled
Granular A, B Type I, B Type II, B Type III, M, and O from Stockpile
Select Subgrade Material, Compacted
RAP Shouldering

314.09.01.01.01 Tonne

When payment is by the tonne:

a) When the Contractor supplies Granular A and M composed of air-cooled iron blast-furnace slag or nickel slag, the payment quantities shall be determined by applying the following factors:

   i. The total measured mass of air-cooled iron blast-furnace slag incorporated into the work shall be multiplied by a factor of 1.116.
   ii. The total measured mass of nickel slag incorporated into the work shall be multiplied by a factor of 0.85.

b) When Granular B is composed of slag, the payment quantities shall be determined by comparing the density of the material to the average density of granular material as set by the Owner for that specific area and applying the conversion factors that have been determined to the weighed tonnes.

c) When granular material is composed of slag, it is necessary to determine the amount of overrun or underrun. Such overrun and underrun shall be the difference between the tender quantity and the payment quantity as determined by applying the foregoing factors to the weighed tonnes.

314.09.01.01.02 Cubic Metre

When payment is by cubic metre, one of the following methods shall be used as determined by the Contract Administrator:

a) End Area Method

   i. At Source

   The volume of material shall be measured at the source in its original location and computed in cubic metres by the method of average end areas.

   Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

   The volume of boulders removed from borrow pits that cannot be accommodated in embankments or any other areas acceptable to the Owner, shall be deducted.

   ii. In Place

   When the measurement for payment of material in its original location is impractical, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

The truck box method shall only be used when the Contract Administrator deems that the quantities are too small or the end area method is impractical for other reasons.

In this case, measurement for payment shall be based on the total volume in cubic metres of loose granular material, calculated by the Contract Administrator, from estimated percentages of the pre-determined capacity of each truck box determined from measurements of its dimensions.

Each truck that the Contractor intends to use shall be uniquely and readily identifiable to the satisfaction of the Contract Administrator.

314.09.01.01.03 Square Metre

When payment is by square metre, the area shall be based on that shown in the Contract Documents.

314.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

314.10 BASIS OF PAYMENT

314.10.01

Granular A - Item
Granular A, Stockpiled - Item
Granular A, from Stockpile - Item

Granular B Type I - Item
Granular B Type I, Stockpiled - Item
Granular B Type I, from Stockpile - Item

Granular B Type II - Item
Granular B Type II, Stockpiled - Item
Granular B Type II, from Stockpile - Item

Granular B Type III - Item
Granular B Type III, Stockpiled - Item
Granular B Type III, from Stockpile - Item

Granular M - Item
Granular M, Stockpiled - Item
Granular M, from Stockpile - Item

Granular O - Item
Granular O, Stockpiled - Item
Granular O, from Stockpile - Item

RAP Shouldering - Item
Select Subgrade Material, Compacted - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

As specified in the Acceptance subsection, $250.00 shall be deducted from payment for each station where the QA grade check of the finished grade is found to be outside of the specification limit.

Any additional grading carried out to correct grades that are not within the tolerances specified in the Tolerances subsection shall be carried out at no additional cost to the Owner.

Where a finished granular course exceeds the horizontal tolerances specified in the Tolerances subsection and the material outside that tolerance has been left in place, the Owner shall deduct from payment the theoretical quantity of material placed outside of that tolerance, based on a conversion factor of 2.0 t/m^3, regardless of the type of granular material used.

TABLE 1
Modified Layer Compaction Thickness for Granular B, Type II
Single Drum, Vibratory, Smooth Wheel Drum Roller

Minimum Operating Mass kg	Minimum Operating Dynamic Force kN	Maximum Layer Depth After Compaction mm
5,000	75	300
8,000	150	450
12,000	250	600
15,000	350	750

TABLE 2
Allowable Tolerances for Finished Granular Surfaces

Tolerances From Specified Grade and Cross - Section	Finished Granular Courses mm	Finished Granular Surfaces Immediately Beneath Bituminous Courses, Sidewalks, and Curb and Gutter mm		Finished Granular Surfaces Immediately Beneath Concrete Courses, Sidewalks, and Curb and Gutter mm
		When the Finished Grade is Controlled by Fixed Components Such as Existing Pavements and Curbs	All Others	
Vertical	+ 30 - 30	+ 10 - 10	+ 30 - 30	+ 10 - 10
Horizontal	+ 30 - 0	+ 10 - 0	+ 30 - 0	+ 10 - 0
Surface Deviation (Note 1)	15	10		10

Notes:

1. The maximum gap between a granular surface and the underside of a 3 m rigid metal straightedge, placed anywhere and in any direction on that surface.

Ontario Provincial Standard Specifications (OPSSs)					
331	November 2015	April 2025	TBD	Rev: Construction Specification for Full Depth Reclamation with Expanded Asphalt Stabilization is implemented. The specification has been updated to new PROV format with no technical content changes. Legacy Appendix A removed. Applicable content from SSP 331F02 has been incorporated into OPSS 331.	Mike Pearsall
Standard Special Provisions (SSPs)					
331F02	September 2022	April 2025	TBD	Rev: SSP Amendment to Construction Specification for Full Depth Reclamation with Expanded Asphalt Stabilization is revised. Applicable content has been incorporated into OPSS 331.	Mike Pearsall
331S03	April 2021	April 2025	TBD	Rev: SSP Amendment to Construction Specification for Full Depth Reclamation with Expanded Asphalt Stabilization is revised to reflect the new publication version of OPSS 331.	Mike Pearsall

Note: The 331 implemented in April 2025 replaces 331, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

TABLE OF CONTENTS

331.01 SCOPE

This specification covers the requirements for in-place full-depth reclamation of the existing hot mix asphalt (HMA) pavement and underlying granular base; shaping and compacting the unstabilized material; if required, adding and blending corrective aggregates or active filler or both; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

~~331.01.01 Specification Significance and Use~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**331.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

331.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 313	Hot Mix Asphalt - End Result
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1101	Performance Graded Asphalt Cement
OPSS 1301	Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-602	Sieve Analysis of Aggregates

LS-625 Sampling of Granular Materials
LS-806 Practice for Mix Design of Full-Depth Reclamation Mixtures with Expanded Asphalt
SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats
Ontario Traffic Manual (OTM):

OTM Book 7 - Temporary Conditions

ASTM ~~Publications:~~International

D5/D5M-20 Standard Test Method for Penetration of Bituminous Materials
D2041/D241M-19 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures

American Association of State Highway and Transportation Officials (AASHTO)

R 66-16 Sampling of Asphalt Materials

331.03 DEFINITIONS

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

Active Filler means substances that chemically alter the mix properties.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed materials to meet the expanded asphalt mix requirements.

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Expanded Asphalt Mix (EAM) means the mixture of reclaimed materials; corrective aggregate or active filler or both, if required; and expanded asphalt.

Expanded Asphalt Mix (EAM) Mat means a pavement course which comprises Expanded Asphalt Mix.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Reclaimed Material means the mixture of reclaimed existing asphalt pavement and granular base.

Unstabilized Material means the mixture of reclaimed existing asphalt pavement and granular base; and corrective aggregate or active filler or both, if required.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. ~~-~~These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material and to establish the

necessity for corrective aggregate and/or active filler. The dry tensile strength shall be a minimum of 225 kPa and the tensile strength ratio shall be a minimum of 50%.

For bidding purpose only, the design rate of the expanded asphalt shall be as specified in the Contract Documents.

The mix design shall be carried out according to the LS-806. The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the grade, manufacturer, and supplier of the PGAC.

b) The percent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.

c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.

d) The optimum moisture content, the mix design bulk relative density, and the air void for the EAM. Air void shall be according to ASTM D2041, Supplemental Procedure for Asphalt Mixtures Containing Porous Aggregate.

e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.

f) The amount of water to be added to the mix.

g) Maximum field rate adjustment allowed to the design rate without adverse effects to mix properties.

h) Recovered penetration for the binder of the existing pavement according to ASTM D5M.

i) Type, source, gradation and quantity of corrective aggregate, if required.

j) Type, source and quantity of active filler, if required.

331.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of EAM operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

331.05 MATERIALS

331.05.01 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The Additional Testing Requirements and Categories for PGAC table in OPSS 1101 shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

331.05.02 Corrective Aggregates

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed material at the application rate determined in the mix design. Corrective aggregate shall meet the physical property requirements of OPSS 1010 for Granular A.

331.05.03 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed material at the application rate determined in the mix design.

When any of the strength requirements as specified in Section 331.04.01 is not met, active filler such as Portland cement, hydrated lime, and/or quick lime can be considered to be added into the EAM. Portland cement shall be according to OPSS 1301. The maximum cement content to added asphalt content ratio shall be 1:2.5 or the maximum quantity of Portland cement is limited to 1.5 % by dry mass of the combined RAP and granular materials, whichever is less.

When the plasticity index of the EAM is less than 10, the maximum quantity of hydrated lime, or quick lime is limited to 1.5 % by dry mass of the combined RAP and granular materials. When the plasticity index is larger than 10, the EAM shall be pre-treated with an amount of hydrated lime based on the result of the initial consumption of lime (ICL) test as per LS-806.

331.05.04 Water

Water shall be clean and free from oil, acid, alkali, organic matter or other deleterious substances.

331.05.05 Reclaimed Material

The gradation requirement for reclaimed material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

The reclaimer-stabilizer shall be capable of reclaiming the existing asphalt pavement and underlying granular base to the depths specified in the Contract Documents, incorporating corrective aggregate or active filler or both into the mix, adding expanded asphalt in a controlled manner, and producing a uniform mix.

The reclaimer-stabilizer shall be fitted with an automatic sensor system to accurately maintain a preset depth of cut within a tolerance of 10 mm and shall have a minimum 2.0 m wide cutting drum.

The reclaimer-stabilizer shall have an asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the unstabilized material. In order to mix the unstabilized material with the expanded asphalt, the reclaimer-stabilizer shall include the following features:

a) A system to control and regulate the application of expanded asphalt in relation to travel speed and mass of material within a tolerance of ± 3.0% by volume of asphalt cement.

b) A system to monitor and control all aspects of the mixing process, including percent expanded asphalt, rate of application, and percent water for optimum compaction.

c) A system of nozzles that provides uniform application of the expanded asphalt across the full width of treatment. The application system shall be adjustable for varying widths of treatment.

The aggregate delivery vehicle shall have a system for controlled application of the corrective aggregate.

331.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade shall be used to place the EAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

In-place full depth reclamation including mixing, shaping and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall be shaped and compacted to match the adjacent lane prior to closing down operations each day.

Expanded asphalt stabilization shall not proceed during periods of rain or when the surface is in a saturated condition.

Traffic, including construction traffic, shall be kept off the freshly placed EAM until such time as it is able to carry traffic without damage. The Contractor shall be responsible for repair of damaged EAM.

The HMA course(s) shall not be placed on the EAM until the following requirements have been met:

a) The EAM has been allowed to cure for a minimum of 3 Days.

b) It has been demonstrated that the EAM meets all the requirements of this specification.

c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

The existing asphalt pavement and underlying granular base shall be reclaimed to the depths and widths specified in the Contract Documents.

The graded surface of the reclaimed material, including existing shoulders shall be according to the surface tolerance requirements of OPSS 301. Reclaimed material exceeding 50 mm in size shall be removed from the work. The material shall be compacted according to OPSS 501.

331.07.03 Expanded Asphalt Trial Section

Prior to carrying out expanded asphalt stabilization, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out expanded asphalt stabilization according to this specification by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact EAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing EAM on another Contract within the last 12 months.

The trial section shall be a minimum of 3,500 m² or the equivalent of one tanker load of asphalt cement. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the expanded asphalt stabilization work based on an acceptable visual assessment of the trial section according to the requirements of the Grading and Compacting the Expanded Asphalt Mix subsection. When EAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the EAM meets the requirements of the Surface Appearance subsection.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section according to the Repairing and Re-Evaluating subsection.

331.07.04 Expanded Asphalt Stabilization

Expanded asphalt stabilization shall be to the depth and limits detailed in the Contract Documents. The overlap between successive passes of the reclaimer-stabilizer shall be a minimum of 100 mm and a maximum of 150 mm.

If required, corrective aggregate or active filler or both shall be added to the roadway prior to stabilizing.

In areas that are inaccessible to the reclaimer-stabilizer equipment, existing asphalt pavement shall be removed and replaced with a minimum 100 mm of binder course hot mix placed flush with the adjacent EAM surface.

331.07.04.01 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material, or any build-up dust generated by the milling machine.

331.07.04.02 Mixing

The expanded asphalt shall be added at the design rate. Expanded asphalt expansion ratio and half-life shall be checked using the test nozzle on the recycling unit or mixer for each load of asphalt delivered to the site, where appropriate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.30% of the design rate and mixed to produce a uniformly coated mix that can be compacted to the specified density.

331.07.05 Compacting the Expanded Asphalt Mix

The surface of the EAM shall be uniform in texture and free of surface defects.

Granular material shall be compacted according to OPSS 501.

The compacted surface of the EAM shall be according to the surface tolerances as specified in this specification.

331.07.06 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the EAM mat is able to carry traffic without damage.

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance of the EAM shall be based on the following criteria:

a) Surface Appearance

b) Asphalt Cement Content

c) Tensile Strength of EAM

d) Thickness

e) Surface Tolerance

f) Compaction

g) Reclaimed Material Gradation

h) Corrective Aggregates, if required.

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

331.08.02 Sampling

331.08.02.01 Lot Size

A lot size shall be a maximum of 50,000 m² of expanded asphalt stabilization divided into 10 sublots of equal size. The lot size may be adjusted at the discretion of the Contract Administrator and after discussion with the Contractor, prior to starting the work and when changes occur in the mix design or in the sequence of expanded asphalt stabilization. The maximum sublot size shall be 5,000 m². The minimum number of sublots in a lot shall be three.

331.08.02.02 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO R66 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Sample containers supplied by the Contractor shall be triple tight steel containers or suitable containers that can be sealed to prevent leakage or contamination.

331.08.02.03 Corrective Aggregate

Where the quantity of corrective aggregate is greater than 5,000 tonnes, two 25 kg samples shall be taken in the presence of the Contract Administrator for each 25,000 tonnes of material produced, and whenever material is produced from a new source or new bench in a quarry, or whenever a significant change in production of materials occurs.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

331.08.02.~~05~~04 Expanded Asphalt Mix

For the purpose of accepting the asphalt cement content, samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per sublot. To obtain a set of samples, one 15 kg sample of unstabilized material shall be obtained immediately following in-place full depth reclamation and, from the same approximate location, a second 15 kg sample of EAM immediately following stabilization. The maximum sampling depth shall be 100 mm. ~~–~~The second sample may be obtained after placement and prior to compaction.

The samples shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. The samples shall be transported in a manner that avoids stacking and extreme temperatures.

331.08.02.~~06~~05 Reclaimed Material Gradation

For the purpose of determining the reclaimed material gradation, 30 kg of reclaimed material samples shall be taken from each of five randomly selected sublots for every lot.

331.08.03 Acceptance Criteria

331.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on SP-027 manual after the EAM mat has been opened to traffic. The finished EAM surface shall have a uniformly smooth texture and be free from surface defects of ravelling, deformation, flushing, and rutting prior to placement of the HMA overlay.

331.08.03.02 Asphalt Cement Content

For each sublot, the sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization, shall be tested for total asphalt cement content according to LS-282. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. ~~–~~The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of a lot shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.03 Tensile Strength

Samples of EAM shall also be tested for dry tensile strength and wet tensile strength according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and

b) No individual sublot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and

b) No individual sublot wet tensile strength is less than 75 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

331.08.03.03.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable tensile strength test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The referee testing shall be conducted by taken slab samples at random locations within the sublot as directed by the Contract Administrator. The total of six slab sample shall be dry cut 150 mm x 150 mm and removed intact from the EAM mat. The tensile strength test shall follow either the Method A or Method B procedure, as per LS-297.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in rejection of the tensile strength, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

331.08.03.04 Thickness

Thickness of the EAM shall be measured by the Contract Administrator at a minimum frequency of one thickness measurement per sublot. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for the lot are met when the following are satisfied:

a) At least 90% of all thickness measurements are equal to or greater than the specified thickness minus 20 mm, and

b) No individual thickness measurement for the lot is less than the specified thickness minus 30 mm.

331.08.03.05 Surface Tolerance

The surface tolerance of any EAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the EAM surface, including the edge of the EAM, in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the EAM greater than 10 mm according to OPSS 301.

331.08.03.06 Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials and at a minimum frequency of one QA measurement per sublot. Compaction requirements of the EAM placed for the lot are met when the following are satisfied:

a) The lot average of all compaction measurements is greater than or equal to 97% of the target density; and

b) No individual compaction measurement for the sublot is less than 95% of the target density.

331.08.03.07 Expanded Asphalt Mix Gradation

If the EAM does not meet the gradation requirements, the Contractor shall submit an action plan of mediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

331.08.03.08 Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical property requirements of Granular A according to OPSS 1010.

331.08.04 Repairing and Re-Evaluating

331.08.04.01 General

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full lane width.

For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the reclaimer-stabilizer equipment. For other repairs based on the lot and sublot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313. All repairs shall be made using the same equipment as was used during initial production and placement.

All repairs will be re-evaluated and retested according to Acceptance Criteria subsection.

331.08.04.02 Surface Appearance

Unacceptable EAM due to the surface appearance defects, including any area damaged or contaminated by traffic, by water added by Contractors during compaction, or by nature, shall be reprocessed by the reclaimer-stabilizer. If required, additional expanded asphalt shall be added during reprocessing.

Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 313.

331.08.04.03 Asphalt Cement Content

For sublots with insufficient asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of asphalt cement during reprocessing. For sublots with excessive asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of corrective aggregates during reprocessing. The unacceptable sublots are repaired until the corresponding lot mean is within the acceptance tolerance.

331.08.04.04 Tensile Strength

The rejectable sublots shall be reprocessed by the reclaimer-stabilizer, if required, with addition of asphalt cement during reprocessing until the corresponding lot mean is above the acceptance criterion. Alternatively, the EAM mat shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator.

331.08.04.05 Thickness

For sublots with insufficient thickness, the Contractor shall determine the limits of the unacceptance EAM based on additional measurement. The pavement segments with insufficient thickness shall be overlaid with binder course or surface course with additional thickness so as to compensate for the insufficient thickness as found in EAM layer.

331.08.04.06 Surface Tolerance

To meet the specified surface tolerance, all deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.

331.08.04.07 Compaction

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by HMA approved by the Contract Administrator.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Measurement of full-depth reclamation with expanded asphalt stabilization shall be by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate, active filler or other additives, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable EAM shall be at no extra cost to the Owner.

PGAC shall be included in the Full-Depth Reclamation with Expanded Asphalt Stabilization item.

Repair of unacceptable EAM shall be carried out at no extra cost to the Owner.

The additional expanded asphalt, if required, added during reprocessing of unacceptable EAM shall be carried out at no extra cost to the Owner.

Repair of areas of EAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

331.10.02 Traffic Control with Pilot Vehicles

Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.

Appendix 331-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The 331 implemented in April 2025 replaces 331, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

TABLE OF CONTENTS

331.01 SCOPE

This specification covers the requirements for in-place full-depth reclamation of the existing hot mix asphalt (HMA) pavement and underlying granular base; shaping and compacting the unstabilized material; if required, adding and blending corrective aggregates or active filler or both; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

331.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 313	Hot Mix Asphalt - End Result
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1101	Performance Graded Asphalt Cement
OPSS 1301	Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-602	Sieve Analysis of Aggregates
LS-625	Sampling of Granular Materials
LS-806	Practice for Mix Design of Full-Depth Reclamation Mixtures with Expanded Asphalt
SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

Ontario Traffic Manual (OTM):

OTM Book 7 - Temporary Conditions

ASTM International

D5/D5M-20	Standard Test Method for Penetration of Bituminous Materials
D2041/D241M-19	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures

American Association of State Highway and Transportation Officials (AASHTO)

R 66-16	Sampling of Asphalt Materials

331.03 DEFINITIONS

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

Active Filler means substances that chemically alter the mix properties.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed materials to meet the expanded asphalt mix requirements.

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Expanded Asphalt Mix (EAM) means the mixture of reclaimed materials; corrective aggregate or active filler or both, if required; and expanded asphalt.

Expanded Asphalt Mix (EAM) Mat means a pavement course which comprises Expanded Asphalt Mix.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Reclaimed Material means the mixture of reclaimed existing asphalt pavement and granular base.

Unstabilized Material means the mixture of reclaimed existing asphalt pavement and granular base; and corrective aggregate or active filler or both, if required.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material and to establish the necessity for corrective aggregate and/or active filler. The dry tensile strength shall be a minimum of 225 kPa and the tensile strength ratio shall be a minimum of 50%.

For bidding purpose only, the design rate of the expanded asphalt shall be as specified in the Contract Documents.

The mix design shall be carried out according to the LS-806. The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the grade, manufacturer, and supplier of the PGAC.

b) The percent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.

c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.

d) The optimum moisture content, the mix design bulk relative density, and the air void for the EAM. Air void shall be according to ASTM D2041, Supplemental Procedure for Asphalt Mixtures Containing Porous Aggregate.

e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.

f) The amount of water to be added to the mix.

g) Maximum field rate adjustment allowed to the design rate without adverse effects to mix properties.

h) Recovered penetration for the binder of the existing pavement according to ASTM D5M.

i) Type, source, gradation and quantity of corrective aggregate, if required.

j) Type, source and quantity of active filler, if required.

331.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of EAM operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

331.05 MATERIALS

331.05.01 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The Additional Testing Requirements and Categories for PGAC table in OPSS 1101 shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

331.05.02 Corrective Aggregates

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed material at the application rate determined in the mix design. Corrective aggregate shall meet the physical property requirements of OPSS 1010 for Granular A.

331.05.03 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed material at the application rate determined in the mix design.

When any of the strength requirements as specified in Section 331.04.01 is not met, active filler such as Portland cement, hydrated lime, and/or quick lime can be considered to be added into the EAM. Portland cement shall be according to OPSS 1301. The maximum cement content to added asphalt content ratio shall be 1:2.5 or the maximum quantity of Portland cement is limited to 1.5 % by dry mass of the combined RAP and granular materials, whichever is less.

When the plasticity index of the EAM is less than 10, the maximum quantity of hydrated lime, or quick lime is limited to 1.5 % by dry mass of the combined RAP and granular materials. When the plasticity index is larger than 10, the EAM shall be pre-treated with an amount of hydrated lime based on the result of the initial consumption of lime (ICL) test as per LS-806.

331.05.04 Water

Water shall be clean and free from oil, acid, alkali, organic matter or other deleterious substances.

331.05.05 Reclaimed Material

The gradation requirement for reclaimed material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

The reclaimer-stabilizer shall be capable of reclaiming the existing asphalt pavement and underlying granular base to the depths specified in the Contract Documents, incorporating corrective aggregate or active filler or both into the mix, adding expanded asphalt in a controlled manner, and producing a uniform mix.

The reclaimer-stabilizer shall be fitted with an automatic sensor system to accurately maintain a preset depth of cut within a tolerance of 10 mm and shall have a minimum 2.0 m wide cutting drum.

The reclaimer-stabilizer shall have an asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the unstabilized material. In order to mix the unstabilized material with the expanded asphalt, the reclaimer-stabilizer shall include the following features:

a) A system to control and regulate the application of expanded asphalt in relation to travel speed and mass of material within a tolerance of ± 3.0% by volume of asphalt cement.

b) A system to monitor and control all aspects of the mixing process, including percent expanded asphalt, rate of application, and percent water for optimum compaction.

c) A system of nozzles that provides uniform application of the expanded asphalt across the full width of treatment. The application system shall be adjustable for varying widths of treatment.

The aggregate delivery vehicle shall have a system for controlled application of the corrective aggregate.

331.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade shall be used to place the EAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

In-place full depth reclamation including mixing, shaping and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall be shaped and compacted to match the adjacent lane prior to closing down operations each day.

Expanded asphalt stabilization shall not proceed during periods of rain or when the surface is in a saturated condition.

Traffic, including construction traffic, shall be kept off the freshly placed EAM until such time as it is able to carry traffic without damage. The Contractor shall be responsible for repair of damaged EAM.

The HMA course(s) shall not be placed on the EAM until the following requirements have been met:

a) The EAM has been allowed to cure for a minimum of 3 Days.

b) It has been demonstrated that the EAM meets all the requirements of this specification.

c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

The existing asphalt pavement and underlying granular base shall be reclaimed to the depths and widths specified in the Contract Documents.

The graded surface of the reclaimed material, including existing shoulders shall be according to the surface tolerance requirements of OPSS 301. Reclaimed material exceeding 50 mm in size shall be removed from the work. The material shall be compacted according to OPSS 501.

331.07.03 Expanded Asphalt Trial Section

Prior to carrying out expanded asphalt stabilization, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out expanded asphalt stabilization according to this specification by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact EAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing EAM on another Contract within the last 12 months.

The trial section shall be a minimum of 3,500 m^2 or the equivalent of one tanker load of asphalt cement. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the expanded asphalt stabilization work based on an acceptable visual assessment of the trial section according to the requirements of the Grading and Compacting the Expanded Asphalt Mix subsection. When EAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the EAM meets the requirements of the Surface Appearance subsection.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section according to the Repairing and Re-Evaluating subsection.

331.07.04 Expanded Asphalt Stabilization

Expanded asphalt stabilization shall be to the depth and limits detailed in the Contract Documents. The overlap between successive passes of the reclaimer-stabilizer shall be a minimum of 100 mm and a maximum of 150 mm.

If required, corrective aggregate or active filler or both shall be added to the roadway prior to stabilizing.

In areas that are inaccessible to the reclaimer-stabilizer equipment, existing asphalt pavement shall be removed and replaced with a minimum 100 mm of binder course hot mix placed flush with the adjacent EAM surface.

331.07.04.01 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material, or any build-up dust generated by the milling machine.

331.07.04.02 Mixing

The expanded asphalt shall be added at the design rate. Expanded asphalt expansion ratio and half-life shall be checked using the test nozzle on the recycling unit or mixer for each load of asphalt delivered to the site, where appropriate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.30% of the design rate and mixed to produce a uniformly coated mix that can be compacted to the specified density.

331.07.05 Compacting the Expanded Asphalt Mix

The surface of the EAM shall be uniform in texture and free of surface defects.

Granular material shall be compacted according to OPSS 501.

The compacted surface of the EAM shall be according to the surface tolerances as specified in this specification.

331.07.06 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the EAM mat is able to carry traffic without damage.

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance of the EAM shall be based on the following criteria:

a) Surface Appearance

b) Asphalt Cement Content

c) Tensile Strength of EAM

d) Thickness

e) Surface Tolerance

f) Compaction

g) Reclaimed Material Gradation

h) Corrective Aggregates, if required.

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

331.08.02 Sampling

331.08.02.01 Lot Size

A lot size shall be a maximum of 50,000 m² of expanded asphalt stabilization divided into 10 sublots of equal size. The lot size may be adjusted at the discretion of the Contract Administrator and after discussion with the Contractor, prior to starting the work and when changes occur in the mix design or in the sequence of expanded asphalt stabilization. The maximum sublot size shall be 5,000 m². The minimum number of sublots in a lot shall be three.

331.08.02.02 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO R66 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Sample containers supplied by the Contractor shall be triple tight steel containers or suitable containers that can be sealed to prevent leakage or contamination.

331.08.02.03 Corrective Aggregate

Where the quantity of corrective aggregate is greater than 5,000 tonnes, two 25 kg samples shall be taken in the presence of the Contract Administrator for each 25,000 tonnes of material produced, and whenever material is produced from a new source or new bench in a quarry, or whenever a significant change in production of materials occurs.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

331.08.02.04 Expanded Asphalt Mix

For the purpose of accepting the asphalt cement content, samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per sublot. To obtain a set of samples, one 15 kg sample of unstabilized material shall be obtained immediately following in-place full depth reclamation and, from the same approximate location, a second 15 kg sample of EAM immediately following stabilization. The maximum sampling depth shall be 100 mm. The second sample may be obtained after placement and prior to compaction.

The samples shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. The samples shall be transported in a manner that avoids stacking and extreme temperatures.

331.08.02.05 Reclaimed Material Gradation

For the purpose of determining the reclaimed material gradation, 30 kg of reclaimed material samples shall be taken from each of five randomly selected sublots for every lot.

331.08.03 Acceptance Criteria

331.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on SP-027 manual after the EAM mat has been opened to traffic. The finished EAM surface shall have a uniformly smooth texture and be free from surface defects of ravelling, deformation, flushing, and rutting prior to placement of the HMA overlay.

331.08.03.02 Asphalt Cement Content

For each sublot, the sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization, shall be tested for total asphalt cement content according to LS-282. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of a lot shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.03 Tensile Strength

Samples of EAM shall also be tested for dry tensile strength and wet tensile strength according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and

b) No individual sublot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and

b) No individual sublot wet tensile strength is less than 75 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

331.08.03.03.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable tensile strength test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The referee testing shall be conducted by taken slab samples at random locations within the sublot as directed by the Contract Administrator. The total of six slab sample shall be dry cut 150 mm x 150 mm and removed intact from the EAM mat. The tensile strength test shall follow either the Method A or Method B procedure, as per LS-297.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in rejection of the tensile strength, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

331.08.03.04 Thickness

Thickness of the EAM shall be measured by the Contract Administrator at a minimum frequency of one thickness measurement per sublot. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for the lot are met when the following are satisfied:

a) At least 90% of all thickness measurements are equal to or greater than the specified thickness minus 20 mm, and

b) No individual thickness measurement for the lot is less than the specified thickness minus 30 mm.

331.08.03.05 Surface Tolerance

The surface tolerance of any EAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the EAM surface, including the edge of the EAM, in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the EAM greater than 10 mm according to OPSS 301.

331.08.03.06 Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials and at a minimum frequency of one QA measurement per sublot. Compaction requirements of the EAM placed for the lot are met when the following are satisfied:

a) The lot average of all compaction measurements is greater than or equal to 97% of the target density; and

b) No individual compaction measurement for the sublot is less than 95% of the target density.

331.08.03.07 Expanded Asphalt Mix Gradation

If the EAM does not meet the gradation requirements, the Contractor shall submit an action plan of mediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

331.08.03.08 Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical property requirements of Granular A according to OPSS 1010.

331.08.04 Repairing and Re-Evaluating

331.08.04.01 General

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full lane width.

For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the reclaimer-stabilizer equipment. For other repairs based on the lot and sublot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313. All repairs shall be made using the same equipment as was used during initial production and placement.

All repairs will be re-evaluated and retested according to Acceptance Criteria subsection.

331.08.04.02 Surface Appearance

Unacceptable EAM due to the surface appearance defects, including any area damaged or contaminated by traffic, by water added by Contractors during compaction, or by nature, shall be reprocessed by the reclaimer-stabilizer. If required, additional expanded asphalt shall be added during reprocessing.

Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 313.

331.08.04.03 Asphalt Cement Content

For sublots with insufficient asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of asphalt cement during reprocessing. For sublots with excessive asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of corrective aggregates during reprocessing. The unacceptable sublots are repaired until the corresponding lot mean is within the acceptance tolerance.

331.08.04.04 Tensile Strength

The rejectable sublots shall be reprocessed by the reclaimer-stabilizer, if required, with addition of asphalt cement during reprocessing until the corresponding lot mean is above the acceptance criterion. Alternatively, the EAM mat shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator.

331.08.04.05 Thickness

For sublots with insufficient thickness, the Contractor shall determine the limits of the unacceptance EAM based on additional measurement. The pavement segments with insufficient thickness shall be overlaid with binder course or surface course with additional thickness so as to compensate for the insufficient thickness as found in EAM layer.

331.08.04.06 Surface Tolerance

To meet the specified surface tolerance, all deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.

331.08.04.07 Compaction

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by HMA approved by the Contract Administrator.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Measurement of full-depth reclamation with expanded asphalt stabilization shall be by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate, active filler or other additives, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable EAM shall be at no extra cost to the Owner.

PGAC shall be included in the Full-Depth Reclamation with Expanded Asphalt Stabilization item.

Repair of unacceptable EAM shall be carried out at no extra cost to the Owner.

The additional expanded asphalt, if required, added during reprocessing of unacceptable EAM shall be carried out at no extra cost to the Owner.

Repair of areas of EAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

331.10.02 Traffic Control with Pilot Vehicles

Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.

Amendment to OPSS 331, ~~November 2015~~April 2025

~~331.02 REFERENCES~~

~~Section 331.02 of OPSS 331 is amended by the deletion of the following:~~

~~Ministry of Transportation Publications:~~
~~LS-200 Penetration of Bituminous Materials~~

~~American Association of State Highway and Transportation Officials (AASHTO):~~
~~T 40-02 Sampling Bituminous Materials~~

~~Wirtgen GmbH Publication:~~
~~Wirtgen Cold Recycling Technology manual, 1st edition, 2012~~

~~Section 331.02 of OPSS 331 is amended with the addition of the following:~~

~~Ministry of Transportation Publications:~~
~~LS-806 Practice for Mix Design of Full-Depth Reclamation Mixtures with Expanded Asphalt~~

~~American Association of State Highway and Transportation Officials (AASHTO):~~
~~R 66-16 Sampling of Asphalt Materials~~

~~ASTM Publications:~~
~~D5/D5M-20 Standard Test Method for Penetration of Bituminous Materials~~
~~D2041/D241M-19 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures~~

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirement

~~The first paragraph of Subsection 331.04.01 of OPSS 331 is amended by deleting the last sentence in its entirety and replacing it with the following:~~

~~The dry tensile strength shall be a minimum of 225 kPa and the tensile strength ratio shall be a minimum of 50%.~~

~~The third paragraph of Subsection 331.04.01 of OPSS 331 is amended by deleting the first sentence in its entirety and replacing it with the following:~~

~~The mix design shall be carried out according to the LS-806.~~

~~The last paragraph of Subsection 331.04.01 of OPSS 331 is amended by deleting point d) and h) in its entirety and replacing it with the following:~~

~~d) The optimum moisture content, the mix design bulk relative density, and the air void for the EAM. Air void shall be according to ASTM D2041, Supplemental Procedure for Asphalt Mixtures Containing Porous Aggregate.~~

~~h) Recovered penetration for the binder of the existing pavement according to ASTM D5M.~~

Subsection 331.04.01 of OPSS 331 is amended by the addition of the following:

The design rate of the expanded asphalt shall be as specified in Table 1, which is for bidding purpose only. The Contractor shall prepare a mix design to determine the design rate for the Contract.

~~Table~~TABLE 1
Design Rate of the Expanded Asphalt at Various Locations

Location in Contract	Pulverizing Depth (mm)	Average Depth of HMA Layer (mm)	Foaming Depth (mm)	Design Rate of the Expanded Asphalt (%)
*	*	*	*	*

[* Designer Fill-Ins for Table 1, See Notes to Designer]

~~**331.05 MATERIALS**~~

~~**331.05.01 Performance Graded Asphalt Cement**~~

~~The second sentence of Subsection 331.05.01 of OPSS 331 is deleted in its entirety and replaced with the following:~~

~~The Additional Testing Requirements and Categories for PGAC table in OPSS 1101 shall not apply.~~

~~**331.05.03 Active Filler**~~

~~The second paragraph of Subsection 331.05.03 of OPSS 331 is deleted in its entirety and replaced with the following:~~

~~When any of the strength requirements as specified in Section 331.04.01 is not met, active filler such as Portland cement, hydrated lime, and/or quick lime can be considered to be added into the EAM. Portland cement shall be according to OPSS 1301. The maximum cement content to added asphalt content ratio shall be 1:2.5 or the maximum quantity of Portland cement is limited to 1.5 % by dry mass of the combined RAP and granular materials, whichever is less.~~

~~When the plasticity index of the EAM is less than 10, the maximum quantity of hydrated lime, or quick lime is limited to 1.5 % by dry mass of the combined RAP and granular materials. When the plasticity index is larger than 10, the EAM shall be pre-treated with an amount of hydrated lime based on the result of the initial consumption of lime (ICL) test as per LS-806.~~

~~**331.05.05 Expanded Asphalt Mix**~~

~~Subsection 331.05.05 of OPSS 331 is deleted in its entirety and replaced with the following:~~

331.05.05 Reclaimed Material

The gradation requirement for reclaimed material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

331.06 EQUIPMENT

331.06.03 Pilot Vehicle

Subsection 331.06.03 of OPSS 331 is deleted in its entirety.

331.07 CONSTRUCTION

331.07.04 Expanded Asphalt Stabilization

Subsection 331.07.04 of OPSS 331 is amended with the addition of the following clause:

331.07.04.01 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material, or any build-up dust generated by the milling machine.

331.07.04.02 Mixing

The expanded asphalt shall be added at the design rate. Expanded asphalt expansion ratio and half-life shall be checked using the test nozzle on the recycling unit or mixer for each load of asphalt delivered to the site, where appropriate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.30% of the design rate and mixed to produce a uniformly coated mix that can be compacted to the specified density.

331.07.06 Traffic Control with Moving Vehicles

Subsection 331.07.06 of OPSS 331 is deleted in its entirety and replaced with the following:

331.07.06 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the EAM mat is able to carry traffic without damage.

331.08 QUALITY ASSURANCE

331.08.01 General

Under subsection 331.08.01, bullet point g) is deleted in its entirety and replaced by the following:

g) Reclaimed Material Gradation.

331.08.02 Sampling

Subsection 331.08.02 of OPSS 331 is amended by the addition of the following clause:

331.08.02.06 Reclaimed Material Gradation

For the purpose of determining the reclaimed material gradation, 30 kg of reclaimed material samples shall be taken from each of five randomly selected sublots for every lot.

331.08.02.02 Performance Graded Asphalt Cement

Clause 331.08.02.02 of OPSS 331 is amended by deleting its first sentence and replaced by the following:

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO R66 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots.

331.08.02.05 Expanded Asphalt Mix

Clause 331.08.02.05 of OPSS 331 is amended by deleting its second paragraph.

331.08.03 Acceptance Criteria

331.08.03.03 Tensile Strength

Clause 331.08.03.03 of OPSS 331 is amended by addition of the following clause:

331.08.03.03.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable tensile strength test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The referee testing shall be conducted by taken slab samples at random locations within the sublot as directed by the Contract Administrator. The total of six slab sample shall be dry cut 150 mm x 150 mm and removed intact from the EAM mat. The tensile strength test shall follow either the Method A or Method B procedure, as per LS-297.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in rejection of the tensile strength, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

~~**331.10 BASIS OF PAYMENT**~~

~~Section 331.10 of OPSS 331 is amended by the addition of the following subsection:~~

~~**331.10.02 Traffic Control with Pilot Vehicles**~~

~~Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.~~

NOTES TO DESIGNER:

***** Designer Fill-Ins for Table 1

In the first column, insert the location of EAM with various pulverizing depths, foaming depths, and design rate of the expanded asphalt. This could be a highway number, or a particular feature of the contract, such as chainage.

In the second column, insert the pulverizing depth, i.e., the total reclaimed depth.

In the third column, insert the average thickness of the HMA layer for the location.

In the fourth column, insert the proposed foaming depth, i.e., the depth to which expanded asphalt is added.

In the fifth column, insert the design rate of the expanded asphalt according to the design rate of the pre-engineering mix design as prepared by the Owner, or calculated by the formula as defined in the Contract Design, Estimating and Documentation (CDED) manual.

WARRANT: Always with this tender item.

FULL-DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION - Item No.

Special Provision No. 331F02 April 2025

Amendment to OPSS 331, April 2025

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirement

Subsection 331.04.01 of OPSS 331 is amended by the addition of the following:

The design rate of the expanded asphalt shall be as specified in Table 1, which is for bidding purpose only. The Contractor shall prepare a mix design to determine the design rate for the Contract.

TABLE 1
Design Rate of the Expanded Asphalt at Various Locations

Location in Contract	Pulverizing Depth (mm)	Average Depth of HMA Layer (mm)	Foaming Depth (mm)	Design Rate of the Expanded Asphalt (%)
*	*	*	*	*

[* Designer Fill-Ins for Table 1, See Notes to Designer]

NOTES TO DESIGNER:

***** Designer Fill-Ins for Table 1

In the first column, insert the location of EAM with various pulverizing depths, foaming depths, and design rate of the expanded asphalt. This could be a highway number, or a particular feature of the contract, such as chainage.

In the second column, insert the pulverizing depth, i.e., the total reclaimed depth.

In the third column, insert the average thickness of the HMA layer for the location.

In the fourth column, insert the proposed foaming depth, i.e., the depth to which expanded asphalt is added.

In the fifth column, insert the design rate of the expanded asphalt according to the design rate of the pre-engineering mix design as prepared by the Owner, or calculated by the formula as defined in the Contract Design, Estimating and Documentation (CDED) manual.

WARRANT: Always with this tender item.

FULL-DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION - Item No.

Amendment to OPSS 331, ~~November 2015~~April 2025 - Reduced Tensile Strength Requirement for Low Volume Road

331.01 SCOPE

Section 331.01 of OPSS 331 is amended by the addition of the following:

This also includes the reduced tensile strength requirements for the design and testing of expanded asphalt mix (EAM) for low volume roads where the design life equivalent single axle load (ESAL) is less than one million.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

The last sentence of the first paragraph of Subsection 331.04.01 of OPSS 331 is deleted in its entirety and replacing by the following:

The dry tensile strength shall be a minimum of 175 kPa and the tensile strength ratio shall be a minimum of 50%.

331.08 QUALITY ASSURANCE

331.08.03 Acceptance Criteria

331.08.03.03 Tensile Strength

Clause 331.08.03.03 of OPSS 331 is deleted in its entirety and replaced by the following:

Samples of EAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

a) The mean dry tensile strength of the lot is equal to or greater than 175 kPa; and

b) no individual sublot dry tensile strength is less than 150 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

a) The mean wet tensile strength of the lot is equal to or greater than 75 kPa; and

b) no individual sublot wet tensile strength is less than 55 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

WARRANT: With this tender item in consultation with the Regional Geotechnical Section.

FULL-DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION - Item No.

Special Provision No. 331S03 April 2025

Amendment to OPSS 331, April 2025 - Reduced Tensile Strength Requirement for Low Volume Road

331.01 SCOPE

Section 331.01 of OPSS 331 is amended by the addition of the following:

This also includes the reduced tensile strength requirements for the design and testing of expanded asphalt mix (EAM) for low volume roads where the design life equivalent single axle load (ESAL) is less than one million.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

The last sentence of the first paragraph of Subsection 331.04.01 of OPSS 331 is deleted in its entirety and replacing by the following:

The dry tensile strength shall be a minimum of 175 kPa and the tensile strength ratio shall be a minimum of 50%.

331.08 QUALITY ASSURANCE

331.08.03 Acceptance Criteria

331.08.03.03 Tensile Strength

Clause 331.08.03.03 of OPSS 331 is deleted in its entirety and replaced by the following:

Samples of EAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

a) The mean dry tensile strength of the lot is equal to or greater than 175 kPa; and

b) no individual sublot dry tensile strength is less than 150 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

a) The mean wet tensile strength of the lot is equal to or greater than 75 kPa; and

b) no individual sublot wet tensile strength is less than 55 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

WARRANT: With this tender item in consultation with the Regional Geotechnical Section.

Ontario Provincial Standard Specifications (OPSSs)					
333	November 2015	April 2025	TBD	Rev: Construction Specification for Cold In-Place Recycling is implemented. The specification has been updated to new PROV format with no technical content changes. Legacy Appendix A removed. Applicable content from SSP 333S04 has been incorporated into OPSS 333.	Mike Pearsall
Standard Special Provisions (SSPs)					
333S04	September 2022	N/A	TBD	Can: SSP Amendment to Cold In-Place Recycling is cancelled. Applicable content has been incorporated into OPSS 333.	Mike Pearsall

Note: The 333 implemented in April 2025 replaces 333, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

TABLE OF CONTENTS

333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing emulsified asphalt, and spreading and compacting the cold in-place recycled (CIR) mix.

~~**333.01.01 Specification Significance and Use**~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**333.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

333.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges

MTO Laboratory Testing Manual:
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602 Sieve Analysis of Aggregates

LS-804 Practice for Mix Design of Cold Recycled Mixtures with Emulsified Asphalt

Ontario Traffic Manual (OTM):
OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D5/D5M-20 Standard Test Method for Penetration of Bituminous Materials
D6752/D 6752M-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

AASHTO Publication

PP 86-17 Standard Practice for Emulsified Asphalt Content of Cold Recycled Mixture Designs

333.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, emulsified asphalt, and water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for the lot established according to LS-300 by the QA testing laboratory, and used to determine the per cent compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out CIR mix design. Where the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the type, manufacturer, and supplier of the emulsified asphalt.

b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of emulsified asphalt.

c) Emulsion information to confirm the particle charges (anionic or cationic) and cohesion properties of the emulsified asphalt and RAP to ensure material compatibility. ~~–~~Emulsified asphalt residue content and penetration shall be provided.

d) The optimum fluid content, the mix design bulk relative density, and the air void for the CIR mix.

e) The amount of water to be added to the mix.

f) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.

g) Recovered penetration for the binder of the existing pavement according to ASTM D5M.

h) Type, source and quantity of active filler, if required.

The mix design shall be according to LS-804 and satisfy either the Marshall Stability or Indirect Tensile Strength requirements.

If Indirect Tensile Strength test is being used as the CIR mix design requirement, the mix design shall meet the following requirements:

Dry Indirect Tensile Strength	Minimum 225 kPa; and
Tensile Strength Ratio	Minimum 50%

If Marshall Stability test is being used as the CIR mix design requirement, the mix design shall meet the following requirements:

Unsoaked Marshall Stability	Minimum 5,560 N; and
Retained Marshall Stability	Minimum 60%

Regardless which mix design method was selected, the Unsoaked Marshall Stability, Retained Marshall Stability, Dry Indirect Tensile Strength and Tensile Strength Ratio shall be provided as part of the submission. The primary design method shall provide the full set of testing data, and for information purposes only, the secondary design method shall provide the testing data for one-point design only.

The Contractor can elect to perform additional testing by following AASHTO PP 86, for information only.

333.04.02 Submission Requirements

A copy of the mix design document shall be submitted to the Contract Administrator a minimum of ~~seven~~7 Business Days prior to the start of the CIR production.

Proposals for the use of alternative emulsified asphalt material listed under OPSS 1103 shall be submitted in writing to the Contract Administrator a minimum of ~~seven~~7 Business Days prior to the intended use of the alternate product.~~–~~ The Owner may consider the use of other emulsified asphalt on trial basis, based on the documentation provided.

Within ~~four~~4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design and alternative emulsified asphalt material documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

333.05 MATERIALS

333.05.01 Reclaimed Asphalt Pavement

The gradation requirement for RAP shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

333.05.02 Emulsified Asphalt

Emulsified asphalt shall be according to OPSS 1103 and be compatible with the process and materials used.

The Owner may consider the use of other emulsified asphalt on trial basis, based on the documentation provided.

333.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.05.04 Active Filler

When any of the strength requirements as specified in Subsection 333.04.01 Design Requirements are not met, active filler such as Portland cement, hydrated lime, or quick lime may be added into the CIR mix. Portland cement shall be according to OPSS 1301, and its quantity is limited to one-third the quantity of residual asphalt of emulsion by mass. The maximum quantity of hydrated lime, or quick lime is limited to 1.0% by dry mass of RAP.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A screening and sizing unit capable of processing the RAP.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.

d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.

e) A means of monitoring and controlling the addition of water.

f) A mixing unit capable of producing a uniform and thoroughly blended CIR mix.

333.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIR mix. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Compaction equipment for control strips shall have a minimum static weight of 11,000 kg.

333.06.04 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. Cold in-place recycled mix shall not be placed after September 1st without the written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. The work shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Any damage to the CIR mat shall be repaired.

The wearing surface shall not be placed on the CIR mat until the following requirements have been met:

a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.

b) The specified moisture content has been achieved according to the Acceptance Criteria section.

c) The specified density has been achieved according to the Compaction subsection.

d) All defective areas in the CIR mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, the trial section shall be repaired or removed and replaced until the CIR meets the requirements of the Surface Appearance subsection.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIR mix.

Existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The emulsified asphalt added shall not be less than 1.2%.

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

333.07.06.01 Compaction Testing Target Density

Compaction acceptance shall be according to the Acceptance Criteria for Compaction clause and shall be based on the target density. A control strip for the determination of the target density shall be constructed at the start of CIR mix production. The control strip shall be constructed according to Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges. Levelling sand may be used to provide a flat surface for the nuclear moisture and density gauge when open coarse texture CIR mix is encountered. A minimum notice of ~~two~~2 Business Days shall be given to the Contract Administrator prior to the construction of the control strip.

The Owner shall be provided access to complete the following tests according to the Compaction Testing clause:

a) Compaction testing of the control strip.

b) Establishment of the target density.

c) Compaction acceptance testing.

Compaction acceptance testing shall be performed once compaction has been completed on the CIR mat. Compaction acceptance shall be achieved prior to opening to traffic.

333.07.06.02 Target Density

A new control strip shall be constructed, and a new target density established for every 100,000 m² of CIR mix production and whenever any one of the following situations arises:

a) A different mix design is applied to the pavement section.

b) The existing pavement material significantly changes in surface roughness, gradation, composition, or layer thickness as determined by the Contract Administrator.

c) A different nuclear moisture and density gauge is to be used for the sublot testing.

The new target density shall apply to the calculations according to the Acceptance Criteria subsection for all sublots constructed after the establishment of a new target density.

333.07.07 Surface Appearance

The compacted CIR mat shall be smooth and constructed to the crossfall and grade as specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and free of severe segregation and longitudinal streaks, moderate to severe raveling, rutting and flushing, and free of fat spots, oil spills, roller marks, and other defects.

333.07.08 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the CIR mat is able to carry traffic without damage.

333.07.09 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material, or any built-up dust generated by the milling machine.

333.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance of the CIR mix shall be based on the following criteria:

a) Surface Appearance

b) Surface Tolerance

c) Moisture Content

d) Compaction

e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.02 Sampling

333.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIR production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

333.08.02.02 Cold In-Place Recycling Material

Samples of CIR material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

333.08.02.02.01 Slabs

At least ~~four~~4 Business Days prior to the planned overlay of the CIR mat, three slab samples of the CIR material shall be obtained from each sublot. ~~-~~The three slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. ~~-~~Each slab sample shall be dry cut 150 mm × 150 mm and removed intact from the CIR mat.

One slab sample shall be used to test for bulk relative density, one slab sample shall be used to test for moisture content, and another sample is retained for referee. ~~-~~The result of the moisture content will be used for both the moisture acceptance, and moisture adjustment for compaction calculation according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve moisture content and/or compaction in the rejected sublot. The Contractor shall be charged the cost of additional tests.

333.08.02.02.02 RAP Gradation

For the purpose of determining the RAP gradation, 30 kg of RAP samples prior to application of emulsion shall be taken from each of five randomly selected sublots for every lot.

333.08.02.02.03 Sampling for Indirect Tensile Strength and Marshall Stability

Two 15 kg samples of the CIR shall be obtained from each sublot, taken at random locations as directed by the Contract Administrator. ~~-~~One of the 15 kg sample shall be used to test for dry tensile strength and wet tensile strength according to LS-297, for information only. ~~-~~The other 15 kg sample shall be used to test for Marshall Stability according to AASHTO PP 86, for information only.

333.08.02.03 Emulsified Asphalt

Samples of emulsified asphalt used in the mix shall be taken at the job site from the tankers according to the Contractor's health and safety plan at a frequency of three sets of samples per Contract randomly taken from three different lots. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of

samples shall be a minimum of 2 full four-litre containers. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

333.08.03 Acceptance Criteria

333.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIR mat has been opened to traffic. The finished CIR surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

333.08.03.02 Surface Tolerance

The surface tolerance of any CIR surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIR surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIR greater than 6 mm.

333.08.03.03 Moisture Content

The QA laboratory shall test one sample from each sublot to determine the moisture content of CIR mix according to LS-282, and the test result of the moisture content shall be rounded to one decimal place according to LS-100. The test result for each sublot shall be used to compute the lot mean for moisture content of CIR mix.

The moisture content of CIR mix acceptance shall be based on the mean moisture content of the lot and the moisture content of the individual sublots. The lot is acceptable if the lot mean moisture content is equal to or less than 2% with no individual sublot's moisture content greater than 3%. The lot is rejectable if the lot mean moisture content of CIR mix is greater than 3%. Any sublot with its moisture content greater than 3% shall be deemed rejectable.

If the lot mean moisture content of CIR mix is less than 3% and greater than 2%, the Contractor may elect to accept a payment reduction or repair for the lot. The payment reduction shall be calculated according to Table 2. If the Contractor elects to repair the lot in lieu of a payment reduction, the lot shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.03.03.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable moisture test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties.

If the referee testing results in rejection of the moisture content, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

333.08.03.04 Compaction

333.08.03.04.01 Compaction Testing

Quality assurance for the compaction of CIR mix shall consist of taking five random field wet density and moisture content measurements from each sublot of compacted CIR mix and using them to calculate the Quality Index (Qi) according to Compaction Measurement of Cold In-Place Recycling Pavements Using Nuclear Moisture and Density Gauges.

333.08.03.04.02 Acceptance Criteria for Compaction

When Qi for a sublot is equal to or greater than 1.49, the sublot shall be accepted; otherwise, the sublot shall be rejected for compaction.

333.08.03.04.03 Rejected Sublots

If a sublot is rejected for compaction, the sublot shall be recompacted, with adjustment to the moisture content if required, until satisfactory compaction is achieved. The recompacted sublot shall be retested and the compaction re-evaluated according to the Acceptance Criteria subsection.

333.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

333.08.04 Repairing and Re-Evaluating

CIR mix that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and sublot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

When repairs are made to rejectable sublots or those sublots that the Contractor elects to repair due to the non-conformance of the moisture content requirements, the lot shall be re-evaluated and re-decisioned for payment reduction. The original lot shall be divided into two reconfigured lots in the following way: All acceptable sublots (with moisture content equal to or less than 2%) shall be grouped as one lot and shall receive the full Contract price. The remaining sublots shall be grouped as another lot and shall use the retest results of the repaired sublots to calculate the mean lot moisture content, and shall be accepted either at the full Contract price, or subjected to a payment reduction, or deemed rejectable.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR mix placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of active filler or other additives to the mix, including any emulsion that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

333.10.02 Payment Reduction for Moisture Content

When test results show that the moisture content payment factor for the lot is less than 1.000 and the Contractor is not required to or does not elect to repair the lot, the payment reduction for the lot shall be as follows:

(1.000 – Payment Factor) x item price x lot quantity

For purposes of payment reduction, the term item price means the Contract price of the applicable tender item.

For purposes of re-decision after repairs, the lot quantity is the area of the reconfigured lot.

333.10.03 Traffic Control with Pilot Vehicles

Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.

TABLE 1
Acceptance Criteria and Repair Requirements for CIR Mix

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Moisture Content	Non-conformance for moisture Content as per the Moisture Content subsection of the Acceptance Criteria.	> 3% for Moisture Content of Lot or Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Reprocess with a recycling train (Note 2), or 2) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Compaction	Non-conformance for compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIR mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.

Notes:
1) Defect and severity definitions according to SP-027.
2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

TABLE 2
Moisture Content of CIR Mix Payment Factors

Moisture Content Payment Factors Acceptance Criteria	Classification	Payment Factor, PFT
MC ≤ 2%	Acceptable	1.000
2% < MC ≤ ~~-~~3%	Payment Reduction	1 – TODRF x (MC - 2)/10
MC > 3%	Rejectable	N/A
Where: MC = the mean of the lot sample of moisture content of CIR Mix in percent calculated to one decimal place according to LS-100. PFT = the payment factor for moisture content calculated to three decimal places according to LS-100. TODRF = Tender Opening Date Reduction Factor according to Table 3.		

TABLE 3
Tender Opening Date Reduction Factor

Year of Tender Opening	Tender Opening Date Reduction Factor
2015	0.65
2016	0.8
2017	1.0

Appendix 333-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The 333 implemented in April 2025 replaces 333, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

TABLE OF CONTENTS

333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing emulsified asphalt, and spreading and compacting the cold in-place recycled (CIR) mix.

333.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges

MTO Laboratory Testing Manual:

LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-300	Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306	Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602	Sieve Analysis of Aggregates
LS-804	Practice for Mix Design of Cold Recycled Mixtures with Emulsified Asphalt

Ontario Traffic Manual (OTM):
OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D5/D5M-20	Standard Test Method for Penetration of Bituminous Materials
D6752/D 6752M-11	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

AASHTO Publication

PP 86-17 Standard Practice for Emulsified Asphalt Content of Cold Recycled Mixture Designs

333.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, emulsified asphalt, and water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for the lot established according to LS-300 by the QA testing laboratory, and used to determine the per cent compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out CIR mix design. Where the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the type, manufacturer, and supplier of the emulsified asphalt.

b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of emulsified asphalt.

c) Emulsion information to confirm the particle charges (anionic or cationic) and cohesion properties of the emulsified asphalt and RAP to ensure material compatibility. Emulsified asphalt residue content and penetration shall be provided.

d) The optimum fluid content, the mix design bulk relative density, and the air void for the CIR mix.

e) The amount of water to be added to the mix.

f) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.

g) Recovered penetration for the binder of the existing pavement according to ASTM D5M.

h) Type, source and quantity of active filler, if required.

The mix design shall be according to LS-804 and satisfy either the Marshall Stability or Indirect Tensile Strength requirements.

If Indirect Tensile Strength test is being used as the CIR mix design requirement, the mix design shall meet the following requirements:

Dry Indirect Tensile Strength	Minimum 225 kPa; and
Tensile Strength Ratio	Minimum 50%

If Marshall Stability test is being used as the CIR mix design requirement, the mix design shall meet the following requirements:

Unsoaked Marshall Stability	Minimum 5,560 N; and
Retained Marshall Stability	Minimum 60%

Regardless which mix design method was selected, the Unsoaked Marshall Stability, Retained Marshall Stability, Dry Indirect Tensile Strength and Tensile Strength Ratio shall be provided as part of the submission. The primary design method shall provide the full set of testing data, and for information purposes only, the secondary design method shall provide the testing data for one-point design only.

The Contractor can elect to perform additional testing by following AASHTO PP 86, for information only.

333.04.02 Submission Requirements

A copy of the mix design document shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of the CIR production.

Proposals for the use of alternative emulsified asphalt material listed under OPSS 1103 shall be submitted in writing to the Contract Administrator a minimum of 7 Business Days prior to the intended use of the alternate product. The Owner may consider the use of other emulsified asphalt on trial basis, based on the documentation provided.

Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design and alternative emulsified asphalt material documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

333.05 MATERIALS

333.05.01 Reclaimed Asphalt Pavement

The gradation requirement for RAP shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

333.05.02 Emulsified Asphalt

Emulsified asphalt shall be according to OPSS 1103 and be compatible with the process and materials used.

The Owner may consider the use of other emulsified asphalt on trial basis, based on the documentation provided.

333.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.05.04 Active Filler

When any of the strength requirements as specified in Subsection 333.04.01 Design Requirements are not met, active filler such as Portland cement, hydrated lime, or quick lime may be added into the CIR mix. Portland cement shall be according to OPSS 1301, and its quantity is limited to one-third the quantity of residual asphalt of emulsion by mass. The maximum quantity of hydrated lime, or quick lime is limited to 1.0% by dry mass of RAP.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A screening and sizing unit capable of processing the RAP.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.

d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.

e) A means of monitoring and controlling the addition of water.

f) A mixing unit capable of producing a uniform and thoroughly blended CIR mix.

333.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIR mix. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Compaction equipment for control strips shall have a minimum static weight of 11,000 kg.

333.06.04 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. Cold in-place recycled mix shall not be placed after September 1st without the written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. The work shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Any damage to the CIR mat shall be repaired.

The wearing surface shall not be placed on the CIR mat until the following requirements have been met:

a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.

b) The specified moisture content has been achieved according to the Acceptance Criteria section.

c) The specified density has been achieved according to the Compaction subsection.

d) All defective areas in the CIR mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, the trial section shall be repaired or removed and replaced until the CIR meets the requirements of the Surface Appearance subsection.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIR mix.

Existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The emulsified asphalt added shall not be less than 1.2%.

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

333.07.06.01 Compaction Testing Target Density

Compaction acceptance shall be according to the Acceptance Criteria for Compaction clause and shall be based on the target density. A control strip for the determination of the target density shall be constructed at the start of CIR mix production. The control strip shall be constructed according to Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges. Levelling sand may be used to provide a flat surface for the nuclear moisture and density gauge when open coarse texture CIR mix is encountered. A minimum notice of 2 Business Days shall be given to the Contract Administrator prior to the construction of the control strip.

The Owner shall be provided access to complete the following tests according to the Compaction Testing clause:

a) Compaction testing of the control strip.

b) Establishment of the target density.

c) Compaction acceptance testing.

Compaction acceptance testing shall be performed once compaction has been completed on the CIR mat. Compaction acceptance shall be achieved prior to opening to traffic.

333.07.06.02 Target Density

A new control strip shall be constructed, and a new target density established for every 100,000 m² of CIR mix production and whenever any one of the following situations arises:

a) A different mix design is applied to the pavement section.

b) The existing pavement material significantly changes in surface roughness, gradation, composition, or layer thickness as determined by the Contract Administrator.

c) A different nuclear moisture and density gauge is to be used for the sublot testing.

The new target density shall apply to the calculations according to the Acceptance Criteria subsection for all sublots constructed after the establishment of a new target density.

333.07.07 Surface Appearance

The compacted CIR mat shall be smooth and constructed to the crossfall and grade as specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and free of severe segregation and longitudinal streaks, moderate to severe raveling, rutting and flushing, and free of fat spots, oil spills, roller marks, and other defects.

333.07.08 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the CIR mat is able to carry traffic without damage.

333.07.09 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material, or any built-up dust generated by the milling machine.

333.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance of the CIR mix shall be based on the following criteria:

a) Surface Appearance

b) Surface Tolerance

c) Moisture Content

d) Compaction

e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.02 Sampling

333.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIR production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

333.08.02.02 Cold In-Place Recycling Material

Samples of CIR material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

333.08.02.02.01 Slabs

At least 4 Business Days prior to the planned overlay of the CIR mat, three slab samples of the CIR material shall be obtained from each sublot. The three slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab sample shall be dry cut 150 mm × 150 mm and removed intact from the CIR mat.

One slab sample shall be used to test for bulk relative density, one slab sample shall be used to test for moisture content, and another sample is retained for referee. The result of the moisture content will be used for both the moisture acceptance, and moisture adjustment for compaction calculation according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve moisture content and/or compaction in the rejected sublot. The Contractor shall be charged the cost of additional tests.

333.08.02.02.02 RAP Gradation

For the purpose of determining the RAP gradation, 30 kg of RAP samples prior to application of emulsion shall be taken from each of five randomly selected sublots for every lot.

333.08.02.02.03 Sampling for Indirect Tensile Strength and Marshall Stability

Two 15 kg samples of the CIR shall be obtained from each sublot, taken at random locations as directed by the Contract Administrator. One of the 15 kg sample shall be used to test for dry tensile strength and wet tensile strength according to LS-297, for information only. The other 15 kg sample shall be used to test for Marshall Stability according to AASHTO PP 86, for information only.

333.08.02.03 Emulsified Asphalt

Samples of emulsified asphalt used in the mix shall be taken at the job site from the tankers according to the Contractor's health and safety plan at a frequency of three sets of samples per Contract randomly taken from three different lots. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

333.08.03 Acceptance Criteria

333.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIR mat has been opened to traffic. The finished CIR surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

333.08.03.02 Surface Tolerance

The surface tolerance of any CIR surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIR surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIR greater than 6 mm.

333.08.03.03 Moisture Content

The QA laboratory shall test one sample from each sublot to determine the moisture content of CIR mix according to LS-282, and the test result of the moisture content shall be rounded to one decimal place according to LS-100. The test result for each sublot shall be used to compute the lot mean for moisture content of CIR mix.

The moisture content of CIR mix acceptance shall be based on the mean moisture content of the lot and the moisture content of the individual sublots. The lot is acceptable if the lot mean moisture content is equal to or less than 2% with no individual sublot's moisture content greater than 3%. The lot is rejectable if the lot mean moisture content of CIR mix is greater than 3%. Any sublot with its moisture content greater than 3% shall be deemed rejectable.

If the lot mean moisture content of CIR mix is less than 3% and greater than 2%, the Contractor may elect to accept a payment reduction or repair for the lot. The payment reduction shall be calculated according to Table 2. If the Contractor elects to repair the lot in lieu of a payment reduction, the lot shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.03.03.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable moisture test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties.

If the referee testing results in rejection of the moisture content, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

333.08.03.04 Compaction

333.08.03.04.01 Compaction Testing

Quality assurance for the compaction of CIR mix shall consist of taking five random field wet density and moisture content measurements from each sublot of compacted CIR mix and using them to calculate the Quality Index (Qi) according to Compaction Measurement of Cold In-Place Recycling Pavements Using Nuclear Moisture and Density Gauges.

333.08.03.04.02 Acceptance Criteria for Compaction

When Qi for a sublot is equal to or greater than 1.49, the sublot shall be accepted; otherwise, the sublot shall be rejected for compaction.

333.08.03.04.03 Rejected Sublots

If a sublot is rejected for compaction, the sublot shall be recompacted, with adjustment to the moisture content if required, until satisfactory compaction is achieved. The recompacted sublot shall be retested and the compaction re-evaluated according to the Acceptance Criteria subsection.

333.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

333.08.04 Repairing and Re-Evaluating

CIR mix that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and sublot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

When repairs are made to rejectable sublots or those sublots that the Contractor elects to repair due to the non-conformance of the moisture content requirements, the lot shall be re-evaluated and re-decisioned for payment reduction. The original lot shall be divided into two reconfigured lots in the following way: All acceptable sublots (with moisture content equal to or less than 2%) shall be grouped as one lot and shall receive the full Contract price. The remaining sublots shall be grouped as another lot and shall use the retest results of the repaired sublots to calculate the mean lot moisture content, and shall be accepted either at the full Contract price, or subjected to a payment reduction, or deemed rejectable.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR mix placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of active filler or other additives to the mix, including any emulsion that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

333.10.02 Payment Reduction for Moisture Content

When test results show that the moisture content payment factor for the lot is less than 1.000 and the Contractor is not required to or does not elect to repair the lot, the payment reduction for the lot shall be as follows:

(1.000 – Payment Factor) x item price x lot quantity

For purposes of payment reduction, the term item price means the Contract price of the applicable tender item.

For purposes of re-decision after repairs, the lot quantity is the area of the reconfigured lot.

333.10.03 Traffic Control with Pilot Vehicles

Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.

TABLE 1
Acceptance Criteria and Repair Requirements for CIR Mix

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Moisture Content	Non-conformance for moisture Content as per the Moisture Content subsection of the Acceptance Criteria.	> 3% for Moisture Content of Lot or Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Reprocess with a recycling train (Note 2), or 2) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Compaction	Non-conformance for compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIR mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.

Notes:
1) Defect and severity definitions according to SP-027.
2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

TABLE 2
Moisture Content of CIR Mix Payment Factors

Moisture Content Payment Factors Acceptance Criteria	Classification	Payment Factor, PFT
MC ≤ 2%	Acceptable	1.000
2% < MC ≤ 3%	Payment Reduction	1 – TODRF x (MC - 2)/10
MC > 3%	Rejectable	N/A
Where: MC = the mean of the lot sample of moisture content of CIR Mix in percent calculated to one decimal place according to LS-100. PFT = the payment factor for moisture content calculated to three decimal places according to LS-100. TODRF = Tender Opening Date Reduction Factor according to Table 3.		

TABLE 3
Tender Opening Date Reduction Factor

Year of Tender Opening	Tender Opening Date Reduction Factor
2015	0.65
2016	0.8
2017	1.0

Ontario Provincial Standard Specifications (OPSSs)					
335	November 2015	April 2025	TBD	Rev: Construction Specification for Cold In-Place Recycling with Expanded Asphalt is implemented. The specification has been updated to new PROV format with no technical content changes. Legacy Appendix A removed. Applicable content from SSP 335S04 has been incorporated into OPSS 335.	Mike Pearsall
Standard Special Provisions (SSPs)					
335S04	September 2022	N/A	TBD	Can: SSP Amendment to Cold In-Place Recycling with Expanded Asphalt is cancelled. Applicable content has been incorporated into OPSS 335.	Mike Pearsall
335S06	April 2021	April 2025	TBD	Rev: SSP Amendment to Construction Specification for Cold In-Place Recycling with Expanded Asphalt is revised to reflect the new publication version of OPSS 335.	Mike Pearsall

Note: The 335 implemented in April 2025 replaces 335, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

TABLE OF CONTENTS

335.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing expanded asphalt, and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

~~335.01.01 Specification Significance and Use~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**335.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

335.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges

MTO Laboratory Testing Manual:
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602 Sieve Analysis of Aggregates
LS-805 Practice for Mix Design of Cold Recycled Mixtures with Expanded Asphalt

Ontario Traffic Manual (OTM):
OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D5/D5M-20	Standard Test Method for Penetration of Bituminous Materials
D2041/D2041M-19	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures
D 6752-11	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

R 66-16 Sampling of Asphalt Materials

335.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) means the in-place mixture of existing reclaimed asphalt pavement (RAP), active filler, and expanded asphalt.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) Mat means a pavement course which comprises Cold In-Place Recycled Expanded Asphalt Mix

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for each sublot established according to LS-297, and used to determine the per cent compaction.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples that are representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The mix design shall meet the following requirements:

a) The design rate of the expanded asphalt shall be a minimum of 1.0%.

b) The dry tensile strength shall be a minimum of 225 kPa and the tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the LS-805. Mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the grade, manufacturer, and supplier of the PGAC.

b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.

c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.

d) The optimum moisture content, the mix design bulk relative density, and the air void for the CIREAM mix. Air void shall be according to ASTM D2041, Supplemental Procedure for Asphalt Mixtures Containing Porous Aggregate.

e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.

f) The amount of water to be added to the mix.

g) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.

h) Recovered penetration for the binder of the existing pavement according to ASTM D5M.

i) Type, source and quantity of active filler, if required.

335.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIREAM operations. Within 4 Business Days commencing after the day of delivery of all required documents for the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

335.05 MATERIALS

335.05.01 Reclaimed Asphalt Pavement

The gradation requirement for RAP shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. ~~-~~The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

335.05.02 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The additional testing requirements according OPSS 1101 Table 2 Additional Testing Requirements and Categories for PGAC shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

335.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.05.04 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design.

When any of the strength requirements as specified in Subsection 335.04.01 Design Requirements are not met, active filler such as Portland cement, hydrated lime, or quick lime may be considered to be added into the CIREAM. Portland cement shall be according to OPSS 1301. The maximum cement content to added asphalt content ratio shall be 1:2.5. The maximum quantity of hydrated lime is limited to 1.0% by dry mass of RAP.

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A screening and sizing unit capable of processing the RAP.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.

d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.

e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of ± 3.0% by volume of asphalt cement.

f) A mixing unit capable of producing a uniform and thoroughly blended CIREAM.

335.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIREAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

Compaction equipment shall be selected to achieve the required compaction. Compaction equipment for control strips shall have a minimum static weight of 11,000 kg.

335.06.04 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

335.07 CONSTRUCTION

335.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIREAM depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

335.07.~~03~~02 Operational Constraints

Cold in-place recycled expanded asphalt mix (CIREAM) shall not be placed after September 1st without the written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. Cold in-place recycled expanded asphalt mix shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. Any damage to the CIREAM mat shall be repaired.

The wearing surface shall not be placed on the CIREAM mat until the following requirements have been met:

a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.

b) The specified tensile strength has been achieved according to the Quality Assurance section.

c) The specified density has been achieved according to the Compaction subsection.

d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIREAM mat. The 30 Day requirement may be waived by the Contract Administrator if the CIREAM does not meet the requirements of this specification and is subject to repair.

335.07.03 Cold In-Place Recycling Expanded Asphalt Trial Section

Prior to carrying out CIREAM, the ability to successfully carry out CIREAM according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIREAM has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIREAM work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected

by visual assessment, the trial sections shall be repaired or removed and replaced until the CIREAM meets the requirements of the Surface Appearance subsection.

335.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIREAM work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

All existing crack sealant shall be removed and disposed of prior to CIREAM reclaiming operations.

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. Expanded asphalt expansion ratio and half-life shall be checked using the test nozzle on the recycling unit or mixer for each load of asphalt delivered to the site, where appropriate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIREAM that can be compacted to the specified density. The expanded asphalt added shall not be less than 1.0%.

335.07.06 Compaction

335.07.06.01 Compaction Testing Target Density

Compaction acceptance shall be according to the Acceptance Criteria for Compaction clause and shall be based on the target density. A control strip for the determination of the target density shall be constructed at the start of CIREAM production. The control strip shall be constructed according to Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges. Levelling sand may be used to provide a flat surface for the nuclear moisture and density gauge when open coarse texture CIREAM mix is encountered. A minimum notice of two Business Days shall be given to the Contract Administrator prior to the construction of the control strip.

The Owner shall be provided access to complete the following tests according to the Compaction Testing clause:

a) Compaction testing of the control strip.

b) Establishment of the target density.

c) Compaction acceptance testing.

Compaction acceptance testing shall be performed once compaction has been completed on the CIREAM mat. Compaction acceptance shall be achieved prior to opening to traffic.

335.07.06.02 Target Density

A new control strip shall be constructed, and a new target density established for every 100,000 m² of CIREAM production and whenever any one of the following situations arises:

a) A different mix design is applied to the pavement section.

b) The existing pavement material significantly changes in surface roughness, gradation, composition, or layer thickness as determined by the Contract Administrator.

c) A different nuclear moisture and density gauge is to be used for the sublot testing.

The new target density shall apply to the calculations according to the Acceptance Criteria subsection for all sublots constructed after the establishment of a new target density.

335.07.07 Surface Appearance

The compacted CIREAM mat shall be smooth and constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and free of severe segregation and longitudinal streaks, moderate to severe raveling, rutting and flushing, and free of fat spots, oil spills, roller marks, and other defects.

335.07.08 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the CIREAM mat is able to carry traffic without damage.

335.07.09 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material or any built-up dust generated by the milling machine.

335.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance of the CIREAM shall be based on the following criteria:

a) Surface Appearance

b) Surface Tolerance

c) Compaction

d) Tensile Strength

e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

335.08.02 Sampling

335.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIREAM production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

335.08.02.02 Cold In-Place Recycled Expanded Asphalt Mix Samples

Samples of CIREAM material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

335.08.02.02.01 Loose Samples

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each sublot, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength and wet tensile strength according to LS-297.

335.08.02.02.02 RAP Gradation

For the purpose of determining the RAP gradation, 30 kg of RAP samples shall be taken prior to the application of expanded asphalt from each of five randomly selected sublots for every lot.

335.08.02.03 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO R66 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Samples of PGAC used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory as specified in the Contract Documents.

335.08.03 Acceptance Criteria

335.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIREAM mat has been opened to traffic. The finished CIREAM surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

335.08.03.02 Surface Tolerance

The surface tolerance of any CIREAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIREAM surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIREAM greater than 6 mm.

335.08.03.03 Compaction

335.08.03.03.01 Compaction Testing

Quality assurance for the compaction of CIREAM shall consist of taking five random field wet density and moisture content measurements from each sublot of compacted CIREAM and using them to calculate the Quality Index (Qi) according to Compaction Measurement of Cold In-Place Recycling Pavements Using Nuclear Moisture and Density Gauges.

335.08.03.03.02 Acceptance Criteria for Compaction

When Qi for a sublot is equal to or greater than 1.49, the sublot shall be accepted; otherwise, the sublot shall be rejected for compaction.

335.08.03.03.03 Rejected Sublots

If a sublot is rejected for compaction, the sublot shall be recompacted, with adjustment to the moisture content if required, until satisfactory compaction is achieved. The recompacted sublot shall be retested and the compaction re-evaluated according to the Acceptance Criteria subsection.

335.08.03.04 Tensile Strength of Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and

b) No individual sublot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when:

a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and

b) No individual sublot wet tensile strength is less than 75 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

335.08.03.04.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable tensile strength test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The referee testing shall be conducted by taken slab samples at random locations within the sublot as directed by the Contract Administrator. The total of six slab sample shall be dry cut 150 mm × 150 mm and removed intact from the CIREAM mat. The tensile strength test shall follow either the Method A or Method B procedure, as per LS-297.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in rejection of the tensile strength, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

335.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

335.08.04 Repairing and Re-Evaluating

CIREAM that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and sublot acceptance, the minimum length shall follow the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

Measurement of CIREAM placed shall be by area in square metres.

335.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of active filler or other additives to the mix, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIREAM material shall be at no extra cost to the Owner.

PGAC shall be included in the CIREAM item.

Repair of an unacceptable CIREAM mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the CIREAM item.

Repair of areas of CIREAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

335.10.02 Traffic Control with Pilot Vehicles

Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.

TABLE 1
Acceptance Criteria and Repair Requirements for CIREAM

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot. For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).

Notes:
1) Defect and severity definitions according to SP-027.
2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

Appendix 335-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The 335 implemented in April 2025 replaces 335, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

TABLE OF CONTENTS

335.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing expanded asphalt, and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

335.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges

MTO Laboratory Testing Manual:

LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306	Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602	Sieve Analysis of Aggregates
LS-805	Practice for Mix Design of Cold Recycled Mixtures with Expanded Asphalt

Ontario Traffic Manual (OTM):
OTM Book 7 - Temporary Conditions

SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D5/D5M-20	Standard Test Method for Penetration of Bituminous Materials
D2041/D2041M-19	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures
D 6752-11	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

R 66-16	Sampling of Asphalt Materials

335.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) means the in-place mixture of existing reclaimed asphalt pavement (RAP), active filler, and expanded asphalt.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) Mat means a pavement course which comprises Cold In-Place Recycled Expanded Asphalt Mix

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for each sublot established according to LS-297, and used to determine the per cent compaction.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples that are representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The mix design shall meet the following requirements:

a) The design rate of the expanded asphalt shall be a minimum of 1.0%.

b) The dry tensile strength shall be a minimum of 225 kPa and the tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the LS-805. Mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

a) Information on the grade, manufacturer, and supplier of the PGAC.

b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.

c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.

d) The optimum moisture content, the mix design bulk relative density, and the air void for the CIREAM mix. Air void shall be according to ASTM D2041, Supplemental Procedure for Asphalt Mixtures Containing Porous Aggregate.

e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.

f) The amount of water to be added to the mix.

g) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.

h) Recovered penetration for the binder of the existing pavement according to ASTM D5M.

i) Type, source and quantity of active filler, if required.

335.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIREAM operations. Within 4 Business Days commencing after the day of delivery of all required documents for the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

335.05 MATERIALS

335.05.01 Reclaimed Asphalt Pavement

The gradation requirement for RAP shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve. The gradation shall be measured based on unextracted washed gradation according to the procedures in LS-602, with full range of gradation sizes provided for information purposes only.

335.05.02 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The additional testing requirements according OPSS 1101 Table 2 Additional Testing Requirements and Categories for PGAC shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

335.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.05.04 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design.

When any of the strength requirements as specified in Subsection 335.04.01 Design Requirements are not met, active filler such as Portland cement, hydrated lime, or quick lime may be considered to be added into the CIREAM. Portland cement shall be according to OPSS 1301. The maximum cement content to added asphalt content ratio shall be 1:2.5. The maximum quantity of hydrated lime is limited to 1.0% by dry mass of RAP.

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.

b) A screening and sizing unit capable of processing the RAP.

c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.

d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.

e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of ± 3.0% by volume of asphalt cement.

f) A mixing unit capable of producing a uniform and thoroughly blended CIREAM.

335.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIREAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

Compaction equipment shall be selected to achieve the required compaction. Compaction equipment for control strips shall have a minimum static weight of 11,000 kg.

335.06.04 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

335.07 CONSTRUCTION

335.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIREAM depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

335.07.02 Operational Constraints

Cold in-place recycled expanded asphalt mix (CIREAM) shall not be placed after September 1st without the written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. Cold in-place recycled expanded asphalt mix shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. Any damage to the CIREAM mat shall be repaired.

The wearing surface shall not be placed on the CIREAM mat until the following requirements have been met:

a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.

b) The specified tensile strength has been achieved according to the Quality Assurance section.

c) The specified density has been achieved according to the Compaction subsection.

d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIREAM mat. The 30 Day requirement may be waived by the Contract Administrator if the CIREAM does not meet the requirements of this specification and is subject to repair.

335.07.03 Cold In-Place Recycling Expanded Asphalt Trial Section

Prior to carrying out CIREAM, the ability to successfully carry out CIREAM according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIREAM has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIREAM work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the trial sections shall be repaired or removed and replaced until the CIREAM meets the requirements of the Surface Appearance subsection.

335.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIREAM work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

All existing crack sealant shall be removed and disposed of prior to CIREAM reclaiming operations.

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. Expanded asphalt expansion ratio and half-life shall be checked using the test nozzle on the recycling unit or mixer for each load of asphalt delivered to the site, where appropriate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIREAM that can be compacted to the specified density. The expanded asphalt added shall not be less than 1.0%.

335.07.06 Compaction

335.07.06.01 Compaction Testing Target Density

Compaction acceptance shall be according to the Acceptance Criteria for Compaction clause and shall be based on the target density. A control strip for the determination of the target density shall be constructed at the start of CIREAM production. The control strip shall be constructed according to Compaction Measurement of Cold In-Place Recycled Pavements Using Nuclear Moisture and Density Gauges. Levelling sand may be used to provide a flat surface for the nuclear moisture and density gauge when open coarse texture CIREAM mix is encountered. A minimum notice of two Business Days shall be given to the Contract Administrator prior to the construction of the control strip.

The Owner shall be provided access to complete the following tests according to the Compaction Testing clause:

a) Compaction testing of the control strip.

b) Establishment of the target density.

c) Compaction acceptance testing.

Compaction acceptance testing shall be performed once compaction has been completed on the CIREAM mat. Compaction acceptance shall be achieved prior to opening to traffic.

335.07.06.02 Target Density

A new control strip shall be constructed, and a new target density established for every 100,000 m² of CIREAM production and whenever any one of the following situations arises:

a) A different mix design is applied to the pavement section.

b) The existing pavement material significantly changes in surface roughness, gradation, composition, or layer thickness as determined by the Contract Administrator.

c) A different nuclear moisture and density gauge is to be used for the sublot testing.

The new target density shall apply to the calculations according to the Acceptance Criteria subsection for all sublots constructed after the establishment of a new target density.

335.07.07 Surface Appearance

The compacted CIREAM mat shall be smooth and constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and free of severe segregation and longitudinal streaks, moderate to severe raveling, rutting and flushing, and free of fat spots, oil spills, roller marks, and other defects.

335.07.08 Traffic Control with Pilot Vehicles

Traffic shall be controlled with pilot vehicles according to OTM, Book 7.

The pilot vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until the CIREAM mat is able to carry traffic without damage.

335.07.09 Longitudinal Joints

For achieving continuity and integrity in the paved area, the minimum overlap between two successive lanes in longitudinal joints shall be 150 mm. In addition, the face of the joints shall be inspected between the milling unit and paving unit to make sure it is free of excessive loose material or any built-up dust generated by the milling machine.

335.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance of the CIREAM shall be based on the following criteria:

a) Surface Appearance

b) Surface Tolerance

c) Compaction

d) Tensile Strength

e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

335.08.02 Sampling

335.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIREAM production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

335.08.02.02 Cold In-Place Recycled Expanded Asphalt Mix Samples

Samples of CIREAM material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

335.08.02.02.01 Loose Samples

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each sublot, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength and wet tensile strength according to LS-297.

335.08.02.02.02 RAP Gradation

For the purpose of determining the RAP gradation, 30 kg of RAP samples shall be taken prior to the application of expanded asphalt from each of five randomly selected sublots for every lot.

335.08.02.03 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO R66 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Samples of PGAC used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory as specified in the Contract Documents.

335.08.03 Acceptance Criteria

335.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIREAM mat has been opened to traffic. The finished CIREAM surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

335.08.03.02 Surface Tolerance

The surface tolerance of any CIREAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIREAM surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIREAM greater than 6 mm.

335.08.03.03 Compaction

335.08.03.03.01 Compaction Testing

Quality assurance for the compaction of CIREAM shall consist of taking five random field wet density and moisture content measurements from each sublot of compacted CIREAM and using them to calculate the Quality Index (Qi) according to Compaction Measurement of Cold In-Place Recycling Pavements Using Nuclear Moisture and Density Gauges.

335.08.03.03.02 Acceptance Criteria for Compaction

When Qi for a sublot is equal to or greater than 1.49, the sublot shall be accepted; otherwise, the sublot shall be rejected for compaction.

335.08.03.03.03 Rejected Sublots

If a sublot is rejected for compaction, the sublot shall be recompacted, with adjustment to the moisture content if required, until satisfactory compaction is achieved. The recompacted sublot shall be retested and the compaction re-evaluated according to the Acceptance Criteria subsection.

335.08.03.04 Tensile Strength of Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and

b) No individual sublot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when:

a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and

b) No individual sublot wet tensile strength is less than 75 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

335.08.03.04.01 Referee Testing

A written request may be made to the Contract Administrator for referee testing within 3 Business Days of receiving a rejectable tensile strength test result. Referee testing shall be carried out by a laboratory designated by the Owner from a roster maintained for this purpose.

The referee testing shall be conducted by taken slab samples at random locations within the sublot as directed by the Contract Administrator. The total of six slab sample shall be dry cut 150 mm × 150 mm and removed intact from the CIREAM mat. The tensile strength test shall follow either the Method A or Method B procedure, as per LS-297.

The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in rejection of the tensile strength, the referee testing shall be at no addition cost to the Owner. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

335.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

335.08.04 Repairing and Re-Evaluating

CIREAM that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and sublot acceptance, the minimum length shall follow the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

Measurement of CIREAM placed shall be by area in square metres.

335.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of active filler or other additives to the mix, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIREAM material shall be at no extra cost to the Owner.

PGAC shall be included in the CIREAM item.

Repair of an unacceptable CIREAM mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the CIREAM item.

Repair of areas of CIREAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

335.10.02 Traffic Control with Pilot Vehicles

Traffic control with pilot vehicles shall be included under the Temporary Traffic Control Signs item.

TABLE 1
Acceptance Criteria and Repair Requirements for CIREAM

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompact the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot. For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).

Notes:
1) Defect and severity definitions according to SP-027.
2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.

COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX - Item No.

Special Provision No. 335S06 April ~~2021~~2025

Amendment to OPSS 335, ~~November 2015~~April 2025 - Reduced Tensile Strength Requirement for Low Volume Road

335.01 SCOPE

Section 335.01 of OPSS 335 is amended by the addition of the following:

This also includes the reduced tensile strength requirements for the design and testing of cold in-place recycled expanded asphalt mix (CIREAM) for low volume roads where the design life equivalent single axle load (ESAL) is less than one million.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

Point b) of the first paragraph of Subsection 335.04.01 of OPSS 335 is deleted in its entirety and replaced by the following:

b) The dry tensile strength shall be a minimum of 175 kPa and the tensile strength ratio shall be a minimum of 50%.

335.08 QUALITY ASSURANCE

335.08.03 Acceptance Criteria

335.08.03.04 Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix

Clause 335.08.03.04 of OPSS 335 is deleted in its entirety and replaced by the following:

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

a) The mean dry tensile strength of the lot is equal to or greater than 175 kPa; and

b) no individual sublot dry tensile strength is less than 150 kPa.

Wet tensile strength requirements for the lot are met when:

a) The mean wet tensile strength of the lot is equal to or greater than 75 kPa; and

b) no individual sublot wet tensile strength is less than 55 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

WARRANT: With this tender item in consultation with the Regional Geotechnical Section.

COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX - Item No.

Special Provision No. 335S06 April 2025

Amendment to OPSS 335, April 2025 - Reduced Tensile Strength Requirement for Low Volume Road

335.01 SCOPE

Section 335.01 of OPSS 335 is amended by the addition of the following:

This also includes the reduced tensile strength requirements for the design and testing of cold in-place recycled expanded asphalt mix (CIREAM) for low volume roads where the design life equivalent single axle load (ESAL) is less than one million.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

Point b) of the first paragraph of Subsection 335.04.01 of OPSS 335 is deleted in its entirety and replaced by the following:

b) The dry tensile strength shall be a minimum of 175 kPa and the tensile strength ratio shall be a minimum of 50%.

335.08 QUALITY ASSURANCE

335.08.03 Acceptance Criteria

335.08.03.04 Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix

Clause 335.08.03.04 of OPSS 335 is deleted in its entirety and replaced by the following:

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

a) The mean dry tensile strength of the lot is equal to or greater than 175 kPa; and

b) no individual sublot dry tensile strength is less than 150 kPa.

Wet tensile strength requirements for the lot are met when:

a) The mean wet tensile strength of the lot is equal to or greater than 75 kPa; and

b) no individual sublot wet tensile strength is less than 55 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

WARRANT: With this tender item in consultation with the Regional Geotechnical Section.

Ontario Provincial Standard Specifications (OPSSs)					
342	November 2015	April 2025	TBD	Rev: Construction Specification for Grinding of Centreline and Shoulder Rumble Strips in Asphalt is implemented. The specification has been updated to new PROV format with no technical content changes. Legacy Appendix A removed.	Mike Pearsall

Note:
The 342 implemented in April 2025 replaces 342, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR THE GRINDING OF CENTRELINE AND SHOULDER RUMBLE STRIPS IN ASPHALT

TABLE OF CONTENTS

342.01 SCOPE

This specification covers the requirements for the installation of centreline rumble strips (CRS) into the surface course of asphalt pavement, and the grinding of shoulder rumble strips (SRS) into the surface course of fully or partially paved asphalt shoulders.

~~342.01.01 Specification Significance and Use~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~342.01.02 Appendices Significance and Use~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

342.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 313	Hot Mix Asphalt ~~–~~ - End Result
OPSS 510	Removal
OPSS 710	Pavement Marking

342.06 EQUIPMENT

The construction equipment shall employ a rotary type cutting head capable of installing rumble strips with a smooth surface to the lines and dimensions as specified in the Contract Documents.

342.07 CONSTRUCTION

342.07.01 General

Centreline rumble strips (CRS) shall be installed at the centreline of the highway as specified in the Contract Documents.

Shoulder rumble strips (SRS) shall be installed at the partially paved asphalt shoulder or fully paved asphalt shoulder as specified in the Contract Documents.

The pavement surface shall be cleaned and all debris shall be disposed of as specified elsewhere in the Contract Documents.

342.07.02 Placement

Centreline rumble strips and SRS shall not be placed within 200 mm of routed and filled transverse joints.

Centreline rumble strips shall be installed prior to the final pavement markings being placed.

Shoulder rumble strips shall be installed after the final pavement markings have been placed. Any damage to the final pavement markings shall be repaired according to OPSS 710.

Where SRS are installed in conjunction with a bicycle buffer zone, the SRS shall be installed prior to the placement of the outer pavement marking edge line.

342.07.03 Tolerances

Tolerances for the width and depth of each rumble strip groove shall be as specified in the Contract Documents. If any one of these tolerances is exceeded in more than two grooves within a one metre length section, the section shall be rejected.

Rejected sections shall be repaired or assessed a payment reduction as directed by the Contract Administrator.

Rejected sections shall be repaired by partial depth asphalt removal according to OPSS 510, replacement of the hot mix asphalt according to OPSS 313, the reinstallation of rumble strips according to this specification, and reinstatement of damaged pavement markings according to OPSS 710. The depth of the partial depth removal shall be 50 mm and the width shall be 500 mm centred over the rumble strip. However, when this will result in a narrow remaining width of asphalt pavement on either side that is less than 300 mm, the removal width shall be extended to include the narrow width of asphalt pavement.

342.09 MEASUREMENT FOR PAYMENT

342.09.01 Actual Measurement

342.09.01.01 Shoulder Rumble Strips - Asphalt
Centreline Rumble Strips - Asphalt
Shoulder Rumble Strips for Bicycle Buffer Zone - Asphalt

Measurement of rumble strips shall be by horizontal length in metres in which the CRS or SRS have been placed.

342.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

342.10 BASIS OF PAYMENT

342.10.01 Shoulder Rumble Strips - Asphalt – Item
Centreline Rumble Strips - Asphalt - Item
Shoulder Rumble Strips for Bicycle Buffer Zone – Asphalt - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 342-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The 342 implemented in April 2025 replaces 342, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR THE GRINDING OF CENTRELINE AND SHOULDER RUMBLE STRIPS IN ASPHALT

TABLE OF CONTENTS

342.01 SCOPE

This specification covers the requirements for the installation of centreline rumble strips (CRS) into the surface course of asphalt pavement, and the grinding of shoulder rumble strips (SRS) into the surface course of fully or partially paved asphalt shoulders.

342.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result
OPSS 510 Removal
OPSS 710 Pavement Marking

342.06 EQUIPMENT

The construction equipment shall employ a rotary type cutting head capable of installing rumble strips with a smooth surface to the lines and dimensions as specified in the Contract Documents.

342.07 CONSTRUCTION

342.07.01 General

Centreline rumble strips (CRS) shall be installed at the centreline of the highway as specified in the Contract Documents.

Shoulder rumble strips (SRS) shall be installed at the partially paved asphalt shoulder or fully paved asphalt shoulder as specified in the Contract Documents.

The pavement surface shall be cleaned and all debris shall be disposed of as specified elsewhere in the Contract Documents.

342.07.02 Placement

Centreline rumble strips and SRS shall not be placed within 200 mm of routed and filled transverse joints.

Centreline rumble strips shall be installed prior to the final pavement markings being placed.

Shoulder rumble strips shall be installed after the final pavement markings have been placed. Any damage to the final pavement markings shall be repaired according to OPSS 710.

Where SRS are installed in conjunction with a bicycle buffer zone, the SRS shall be installed prior to the placement of the outer pavement marking edge line.

342.07.03 Tolerances

Tolerances for the width and depth of each rumble strip groove shall be as specified in the Contract Documents. If any one of these tolerances is exceeded in more than two grooves within a one metre length section, the section shall be rejected.

Rejected sections shall be repaired or assessed a payment reduction as directed by the Contract Administrator.

Rejected sections shall be repaired by partial depth asphalt removal according to OPSS 510, replacement of the hot mix asphalt according to OPSS 313, the reinstallation of rumble strips according to this specification, and reinstatement of damaged pavement markings according to OPSS 710. The depth of the partial depth removal shall be 50 mm and the width shall be 500 mm centred over the rumble strip. However, when this will result in a narrow remaining width of asphalt pavement on either side that is less than 300 mm, the removal width shall be extended to include the narrow width of asphalt pavement.

342.09 MEASUREMENT FOR PAYMENT

342.09.01 Actual Measurement

342.09.01.01 Shoulder Rumble Strips - Asphalt
Centreline Rumble Strips - Asphalt
Shoulder Rumble Strips for Bicycle Buffer Zone - Asphalt

Measurement of rumble strips shall be by horizontal length in metres in which the CRS or SRS have been placed.

342.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

342.10 BASIS OF PAYMENT

342.10.01 Shoulder Rumble Strips - Asphalt - Item
Centreline Rumble Strips - Asphalt - Item
Shoulder Rumble Strips for Bicycle Buffer Zone - Asphalt - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Ontario Provincial Standard Specifications (OPSSs)					
501	November 2014	April 2025	TBD	Rev: Construction Specification for Compacting is implemented. The specification has been updated to new PROV format with no technical content changes. Legacy Appendix A removed. Gender neutral language updated. Applicable content from SSP 105S22 has been incorporated into OPSS 501.	Mike Pearsall
Standard Special Provisions (SSPs)					
105S22	August 2021	N/A	TBD	Can: SSP Amendment to Compacting is cancelled. Applicable content has been incorporated into OPSS 501.	Mike Pearsall

Note: The 501 implemented in April 2025 replaces 501, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR COMPACTING

TABLE OF CONTENTS

501.01 SCOPE

This specification covers the requirements for compaction of earth and granular materials.

~~501.01.01 Specification Significance and Use~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**501.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

501.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 401 Trenching, Backfilling, and Compacting

Ontario Provincial Standards Specifications, Materials

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

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

MTO Forms:
PH-CC-009 Field Compaction Report

ASTM International

~~D 6938~~D6938-10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

501.03 DEFINITIONS

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

Backfill Material means as defined in OPSS 401.

Bedding Material means as defined in OPSS 401.

Cover Material means as defined in OPSS 401.

Earth means as defined in OPSS 206.

Embedment Material means as defined in OPSS 401.

Rut means a sunken track or groove made at the surface by the passage of vehicles.

Utility Structures means maintenance holes, catch basins, valve chambers, ditch inlets, and other similar structures used to access services such as sewer, water, electric, and telephone to carry out maintenance and repair work.

501.05 MATERIALS

501.05.01 Granular Material

Granular material shall be according to OPSS 1010.

501.05.02 Water

Water shall be free of contaminants that could adversely affect fill material or the environment.

501.06 EQUIPMENT

501.06.01 Compaction

501.06.01.01 General

The type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required, and space available.

Compaction equipment for control strips shall have a minimum static weight of 9,000 kg.

501.06.01.02 Hand Operated Vibratory Equipment

Hand operated vibratory equipment shall have a power output no greater than 9.9 kW.

501.06.02 Water

Equipment for applying water shall be capable of uniform distribution with proper flow control.

501.06.03 Nuclear Moisture and Density Gauge

Each nuclear moisture and density gauge (gauge) shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent against certified density and moisture reference blocks. In addition, the Density Standard Count and the Moisture Standard Count shall be within 2.0% and 4.0%, respectively, of the most recent calibration values. The registered owner of the gauge shall maintain a valid Radioisotope License for each gauge.

501.07 CONSTRUCTION

501.07.01 General

The method of placing and lift thickness of earth or granular material shall be according to the specifications that govern the Work. When not specified, the lift thickness of earth shall not exceed 300 mm and the lift thickness for granular materials shall not exceed 150 mm.

When field testing indicate that the required degree of compaction cannot be obtained with the equipment in use or the procedure being followed, the operations shall be modified so that the equipment and procedures will produce the required results.

501.07.02 Restricted Zones

Hand operated vibratory type compaction equipment shall be used behind all retaining structures to compact fill material within restricted zones as follows:

a) Abutments and Retaining Walls

An area within a plane extending from the base of the back face of the wall where it contacts the footing upwards at a slope of 1H:1.5V to a maximum distance of 2.5 m from the wall.

b) Wingwalls

An area within 1.5 m from the back face of the wall.

501.07.03 Water for Compaction

Water shall be applied, as necessary, to achieve the degree of compaction required.

When the Contract includes a separate item for water for compaction, the water shall be applied with the approval of the Contract Administrator.

501.07.04 Quality Control

501.07.04.01 General

Quality control (QC) testing shall be carried out to ensure that earth and granular materials used in the Work are compacted according to the requirements as specified in the Contract Documents.

Field density and field moisture determinations shall be made according to ASTM ~~D 6938~~D6938.

501.07.04.02 Compaction Requirements

501.07.04.02.01 General

Compaction testing shall be based on material placed and compacted in the Work on a lot-by-lot basis according to the Lot Testing clause.

Compaction acceptance shall be according to the Acceptance clause and shall be based on target densities established according to the Target Density clause, QC compaction field test results, and, where applicable, a statistical analysis of those results.

501.07.04.02.02 Submission of Test Data

Prior to construction of a control strip, a copy of all QC laboratory test results for LS-706 required by the Control Strip clause to determine optimum moisture content (OMC) of the control strip material shall be delivered to the Contract Administrator.

All field test results and associated information relating to the control strip, including target density, lot location, lift thickness, probe depth, moisture content, wet density, and all QC lot compaction calculations shall be recorded at the time of testing on MTO form PH-CC-009. ~~-~~This form shall be available at any time for review, upon request, and shall be submitted to the Contract Administrator prior to placement of any subsequent lift and within 2 Business Days following the completion of a lot.

501.07.04.02.03 Test Equipment and Operator Training

501.07.04.02.03.01 General

Field density and field moisture measurements for QC compaction testing of earth and granular materials shall be carried out using gauges and ancillary equipment.

Only qualified operators using properly calibrated gauges shall conduct QC compaction testing.

501.07.04.02.03.02 Nuclear Moisture and Density Gauge Requirements

A copy of a valid calibration certificate, including the make, model number, and serial number for each gauge, shall be submitted to the Contract Administrator, prior to use of the gauge in compaction testing.

In addition, the Contract Administrator may request that the operator perform a standardization procedure according to ASTM ~~D 6939~~D6939.

If the gauge does not meet the standardization requirements or exhibits malfunctions of any kind, the gauge shall be replaced.

501.07.04.02.03.03 Operator Requirements

Each operator shall have been trained in the safe operation, transportation, and handling of the gauge.

Prior to conducting QC compaction testing, the operator shall provide acceptable proof of proficiency in the use of a gauge and the correct procedures to determine lot and sublot sizes, field dry density, percent relative compaction, mean, standard deviation, and the Quality Index of a compacted lot of material by submitting one of the following:

a) a gauge operator certification document or card from a training program acceptable to the Owner and conducted within the Province of Ontario within the last 2 years; or

b) a document (e.g., instruction notice or letter) signed by the Owner showing that the operator has demonstrated proficiency on a Contract either constructed or being constructed for the same Owner within the same construction year as the compaction testing being carried out for this Contract.

If the operator cannot provide either of the two documents stated above, then at the Contract Administrator's discretion, the operator shall demonstrate ~~his or her~~their proficiency to the Owner. In this case, arrangements shall be made with the Contract Administrator regarding the schedule, location, and materials for such demonstrations. The first 2 demonstrations may include up to 5 operators and 5 gauges and shall be carried out at no charge. Additional demonstrations shall be charged at the rate of $500. Where a demonstration is carried out, acceptability of the operator shall be valid for the current calendar year only.

501.07.04.02.04 Target Density

New target densities shall be established for each separate component of the Work (e.g., backfilling of a trench, construction of a granular base, or placement of cover) at the following times:

a) For earth and granular materials:

   i. At the time of initial use of each source.
   ii. When there is a perceptible change in the appearance or gradation of the materials or both.
   iii. At least once per calendar year on all carry-over Contracts.

b) For earth being placed:

   i. As backfill, after QC lots representing 2000 tonnes or 1000 m^3 of material have been completed, whether accepted or rejected, based on one set of target density values, or
   ii. For all other purposes, after each 10 QC lots of material have been completed, whether accepted or rejected, based on one set of target density values.

c) For granular materials being placed:

   i. As backfill, or at the discretion of the Contract Administrator, any other areas, after QC lots representing 5000 tonnes or 2500 m^3 of material have been completed, whether accepted or rejected, based on one set of target density values, or
   ii. For all other purposes, after each 25 QC lots of material have been completed, whether accepted or rejected, based on one set of target density values.

The new target density shall be established by the construction of a control strip according to the Control Strip clause, except the new target density shall be based on the maximum dry density (MDD) as determined by LS-706 not more than 14 Days prior to placing the material, when:

a) Placing material in confined areas that do not allow equipment meeting the requirements specified in the Compaction clause to be used.

b) With the consent of the Contract Administrator, a control strip cannot be reasonably constructed or is impractical.

The MDD used for the new target density shall be the average of the MDD calculated from a minimum of three independent samples selected from the materials to be used.

501.07.04.02.04.01 Control Strip

Prior to construction of a control strip:

a) A minimum notice of 24 hours shall be given to the Contract Administrator, and

b) The optimum moisture content (OMC) of the material shall be determined according to LS-706.

Each control strip shall consist of a single uniform lift not more than 0.30 m in depth and covering at least 400 m^2 in area. The surface of each control strip shall be graded flat.

Prior to compaction, the field moisture content of the control strip material shall be determined using a nuclear gauge at a minimum of three randomly selected locations. The average moisture content at those three locations shall be within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material. If the average moisture content is not within this range, the moisture content of the material shall be uniformly adjusted (e.g. by adding water and re-mixing or scarifying and drying). The material shall then be graded flat and re-tested using a nuclear gauge. This process shall be repeated until the average moisture content of the material, at a minimum of three randomly selected locations, is within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material.

When the OMC is within the acceptable range, the compaction equipment shall make six passes over the entire surface of the control strip. A pass shall be deemed to be compaction of the full width of the control strip in one direction only. The field wet density and field moisture content shall be determined at a minimum of three randomly selected locations. The dry density shall be calculated for each of these locations and the average dry density used as the initial value for the dry density.

All passes of the compaction equipment for the control strip shall be carried out in vibratory mode at a speed of no more than 5 km/hour.

The compaction equipment shall then make two additional passes over the entire surface of the control strip.

A minimum of three separate random field density and moisture content determinations shall then be made, and a new average dry density shall be calculated.

If the new average dry density exceeds the previous value by more than 0.030 t/m^3, then additional passes of the equipment shall be carried out as described above. If the new average dry density does not exceed the previous value by more than 0.030 t/m^3, then the compaction of the control strip shall be considered satisfactory and complete.

Upon satisfactory completion of the control strip, an additional seven field wet density and moisture content tests shall be taken at random locations and the dry density values determined. The final dry density of the control strip, which shall be deemed to be the target density, shall be the average of the dry density values determined at these seven additional random locations plus the three most recent values that were determined upon completion of the control strip.

501.07.04.02.05 Lot Testing

For compaction control, a unique set of lots distinguished from each other by an appropriate letter or number designation, shall be established for each of the following:

a) Each separate component of the Work (e.g., backfilling a structure or a trench or construction of a granular base).

b) Materials from different sources.

c) Materials with different compaction properties.

d) When recompaction is carried out following restoration, scarification, or placement of additional material onto previously tested and accepted lots.

e) When directed by the Contract Administrator.

The individual lots within each unique set of lots shall be consecutively numbered and with no duplication. Lot sizes shall not exceed the limits as shown in Table 1.

All visibly soft or loose areas shall be compacted prior to testing.

For the situations described in Table 1, Part IV, a minimum of 2 field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into 4 equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each sublot and the results used to calculate the Quality Index according to the Quality Index clause.

In addition, regardless of the situation, when a lot of material is split between both sides of a pipe, sewer, or culvert, at least one field density and moisture content test shall be taken on each side of that pipe, sewer, or culvert.

The gauge probe shall extend to the full depth of the lift, unless otherwise allowed by the Modified Layer Compaction Method according to OPSS 206. The probe shall not extend beyond the lift being tested.

During the compaction process, the field wet density value and moisture content for each gauge test shall be recorded on MTO form PH-CC-009. The field dry density of each sublot shall then be calculated as a percentage of the target density to the nearest 0.1%. The mean and standard deviation and the Quality Index, where applicable, of the field dry density values shall be calculated to the nearest 0.1% and recorded on the form for each lot.

MTO form PH-CC-009 shall be constantly updated with new test data and the associated calculations completed as the testing is being done. This form shall be made available to the Contract Administrator at any time, upon request.

501.07.04.02.06 Quality Index

The Quality Index (Q_i), shall be calculated from the mean ($\bar{x}$) and standard deviation (s) of the percent target density which has been determined from all sublots within a QC compaction lot during the compaction process. The values for Quality Index, lot mean, and lot standard deviation shall be computed as follows:

a) For materials placed in embankments within 50 m of a structure; placed as bedding, embedment, cover or backfill material to pipes, sewers, or culverts; or placed as backfill to structures, utility structures, or small foundations (e.g., anchor blocks, sign posts, and formwork):

For earth materials: $Q_i = \frac{\bar{x} - 95}{s}$ For granular materials: $Q_i = \frac{\bar{x} - 98}{s}$

b) For materials placed in all other situations:

For earth materials: $Q_i = \frac{\bar{x} - 90}{s}$ For granular materials: $Q_i = \frac{\bar{x} - 95}{s}$

Where:

Q_i = Quality Index, calculated to two decimal places.

$\bar{x}$ = Lot mean, the statistical value that describes the arithmetic average of sublot test results (dry density expressed as a percentage of the target density). Lot mean is the sum of individual sublot test results divided by the number of test results, calculated to 0.1% as follows:

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4}{4} = \frac{1}{4}\sum_{i=1}^{4} x_i$$

S = Lot standard deviation (σ_{n-1}), the statistical value that describes the distribution of sublot test results (dry density expressed as a percentage of the target density) about the lot mean. Standard deviation is the square root of the sum of the squares of the difference between each sublot test result and the lot mean divided by the number of test results minus one. It is calculated to 0.1% using the following expression:

$$s = \sqrt{\frac{\sum_{i=1}^{4} (x_i - \bar{x})^2}{3}}$$

501.07.04.02.07 Acceptance

For the situations described in Table 1, Part IV, acceptance or rejection of a QC lot for compaction shall be based on 2 or more random field density and moisture content tests taken within the lot. For a lot to be acceptable, all tests shall be at least 100% and 98% of the target density established for granular and earth materials, respectively. Otherwise, the QC lot shall be rejected for compaction.

For all other situations, acceptance or rejection of a QC lot for compaction shall be established by calculation of the Quality Index, according to the Quality Index clause. When Q_i has a value equal to or greater than 1.47, the QC lot shall be accepted; otherwise, the lot shall be rejected for compaction.

Accepted QC lots damaged by vehicular traffic shall be restored prior to placement of any overlying material. Surfaces of accepted QC lots with ruts greater than 50 mm in depth in earth or 25 mm in depth in granular materials shall be regraded and the upper lift recompacted to meet the specified compaction requirements. Materials that cannot be successfully recompacted shall be removed and replaced with new material.

501.07.04.02.07.01 Rejected Lots

If a QC lot is rejected for compaction, the lot shall be recompacted with adjustment to the moisture content, as required, until satisfactory compaction is achieved. The recompacted lot shall be retested and a decision made, as described in the Acceptance clause.

When compaction of a QC lot does not meet the acceptance criteria and when the Contract Administrator has been satisfied that this is not a result of the Contractor's operation or equipment, a new target density shall be established for that operation.

501.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

501.08 QUALITY ASSURANCE

501.08.01 General

Field density and field moisture determinations shall be made in accordance with ASTM ~~D 6938~~D6938.

501.08.02 Compaction

501.08.02.01 General

The Contract Administrator shall conduct random testing or inspection of QC records or both to establish the acceptability of the QC compaction testing and verification of the field moisture content, field dry density, OMC, MDD, target density, and the Quality Index, where applicable.

The Contract Administrator may verify that the target density established for a control strip is based on the use of suitable compaction equipment. Provided that the MDD and OMC values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

Reasonable access to a control strip or to compacted QC lots shall be provided prior to placement of subsequent lifts of material. Subsequent lifts, including HMA, may not be placed until QA testing has been conducted or waived by the Contract Administrator.

501.08.02.02 Gauge Verification

Gauge verification QA shall consist of taking four random field density and moisture content measurements of a compacted lot or control strip and the subsequent calculation of the average dry density. The maximum dry density (MDD) of the material within the compacted lot or control strip as determined by LS-706 shall be used for gauge verification.

The QC gauge test results shall be considered valid provided that the difference between the average percentage of the MDD determined by QC gauge test results and the average percentage of the MDD determined by QA gauge test results for the same material is no more than 4%. If the discrepancy between the QA and QC gauge test results is more than the 4%, an investigation shall take place to resolve the discrepancy. The investigation may include but is not limited to verification of appropriate probe depth, as well as parts d) and e) according to the Compaction clause.

501.08.02.03 Compaction

For the situations described in Table 1, Part IV, compaction QA shall consist of taking 2 or more random field density and moisture content measurements of each compacted lot and the subsequent determination of percent target density.

For all other situations, compaction QA shall consist of taking 4 random field density and moisture measurements of a compacted lot or control strip and the subsequent calculation of the Quality Index for the lot.

Provided that the lot is acceptable, according to the requirements specified in the Acceptance clause, no further action shall be taken.

However, if the lot is rejected based on compaction testing or demonstrates errors in QC reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include, but is not limited to, any of the following:

a) Recompaction of the lot.

b) Retesting of the lot by the Contractor.

c) Establishment of a new target density by control strip.

d) Re-inspection of the gauge or operator or both by the Owner.

e) Recalibration of the gauges.

f) Removal of unsuitable materials.

501.08.02.04 Quality Control Records Inspections

QC records of the lot or control strip selected by the Contract Administrator shall be inspected for calculation errors, missing test data, or improper lot quantities. If errors or omissions are found that identify insufficiently compacted or improperly or untested lots, the Contractor shall make all such lots available and recompact or retest these lots or both so that they comply with the specified compaction requirements.

501.08.02.05 Charges

The Contract Administrator shall charge the Contractor $450.00 for each lot that requires retesting which has been identified through QA compaction testing or a review of QC records. In addition, immediately following the discovery of a discrepancy or inadequate compaction, all new lots shall be subjected to QA compaction testing prior to acceptance. If any of the new lots do not meet the specified compaction requirements, the Contractor shall be charged a fee of $450.00 for each lot. These conditions shall continue until 3 consecutive new lots have met the specified compaction requirements.

501.09 MEASUREMENT FOR PAYMENT

501.09.01 Actual Measurement

501.09.01.01 Water for Compaction

Measurement of water for compaction shall be in cubic metres using one of the following methods:

a) The mass of the water shall be determined by weighing as specified in the Contract Documents. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 m^3.

b) The water tank shall be measured and its volume computed in cubic metres.

c) The water shall be measured through a water meter of approved design.

501.10 BASIS OF PAYMENT

501.10.01 Compaction

Payment at the Contract price of the appropriate tender item requiring compaction of earth and granular materials shall be full compensation for all labour, Equipment, and Material to do the work of compacting, including the water used for compaction, unless the Contract contains a separate tender item for Water for Compaction.

Any work required to repair or remove and replace damaged QC lots accepted shall be at no additional cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density shall be at no additional cost to the Owner.

Replacement of a gauge shall be at no additional cost to the Owner.

Any work required to recompact or retest material as a result of QA compaction testing or QC records inspection shall be at no additional cost to the Owner.

501.10.02 Water for Compaction - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for water for compaction, the Contract price for the tender item in which the water for compaction is used shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Compaction Lot Size

Part	Construction	Lot Size
I	Earth embankments, granular base, granular subbase, and granular shoulders.	Every lift, 500 m maximum length. (Note 1)
II	Structure approach fill for earth.	Every lift, 50 m maximum length
III	Bedding, embedment, cover, or backfill material for pipe and sewer sections > 20.0 m in length that are being placed in one operation, earth or granular.	Every lift, 200 m maximum length.
IV	Bedding, embedment, cover, or backfill material for pipes and sewer sections ≤ 20.0 m in length that are being placed in one operation or backfill to utility structures or small foundations (e.g., anchor blocks, sign posts, and formwork), earth or granular.	Every lift, 20 m maximum length.
V	Structure backfill and culvert bedding, embedment, cover, or backfill material, granular.	Every lift for every stage of construction.

Note:

1. The width of the lot shall be the limits established for the placement of current material only and shall not include adjacent material to be placed at a future date.

~~**Appendix 501-A, November 2014**~~
~~**FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**~~

~~**Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.**~~

~~**Designer Action/Considerations**~~

~~No information provided here.~~

~~**Related Ontario Provincial Standard Drawings**~~

~~No information provided here.~~

Note: The 501 implemented in April 2025 replaces 501, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR COMPACTING

TABLE OF CONTENTS

501.01 SCOPE

This specification covers the requirements for compaction of earth and granular materials.

501.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 401 Trenching, Backfilling, and Compacting

Ontario Provincial Standards Specifications, Materials

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

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

MTO Forms:
PH-CC-009 Field Compaction Report

ASTM International

D6938-10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

501.03 DEFINITIONS

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

Backfill Material means as defined in OPSS 401.

Bedding Material means as defined in OPSS 401.

Cover Material means as defined in OPSS 401.

Earth means as defined in OPSS 206.

Embedment Material means as defined in OPSS 401.

Rut means a sunken track or groove made at the surface by the passage of vehicles.

Utility Structures means maintenance holes, catch basins, valve chambers, ditch inlets, and other similar structures used to access services such as sewer, water, electric, and telephone to carry out maintenance and repair work.

501.05 MATERIALS

501.05.01 Granular Material

Granular material shall be according to OPSS 1010.

501.05.02 Water

Water shall be free of contaminants that could adversely affect fill material or the environment.

501.06 EQUIPMENT

501.06.01 Compaction

501.06.01.01 General

The type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required, and space available.

Compaction equipment for control strips shall have a minimum static weight of 9,000 kg.

501.06.01.02 Hand Operated Vibratory Equipment

Hand operated vibratory equipment shall have a power output no greater than 9.9 kW.

501.06.02 Water

Equipment for applying water shall be capable of uniform distribution with proper flow control.

501.06.03 Nuclear Moisture and Density Gauge

Each nuclear moisture and density gauge (gauge) shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent against certified density and moisture reference blocks. In addition, the Density Standard Count and the Moisture Standard Count shall be within 2.0% and 4.0%, respectively, of the most recent calibration values. The registered owner of the gauge shall maintain a valid Radioisotope License for each gauge.

501.07 CONSTRUCTION

501.07.01 General

The method of placing and lift thickness of earth or granular material shall be according to the specifications that govern the Work. When not specified, the lift thickness of earth shall not exceed 300 mm and the lift thickness for granular materials shall not exceed 150 mm.

When field testing indicate that the required degree of compaction cannot be obtained with the equipment in use or the procedure being followed, the operations shall be modified so that the equipment and procedures will produce the required results.

501.07.02 Restricted Zones

Hand operated vibratory type compaction equipment shall be used behind all retaining structures to compact fill material within restricted zones as follows:

a) Abutments and Retaining Walls

An area within a plane extending from the base of the back face of the wall where it contacts the footing upwards at a slope of 1H:1.5V to a maximum distance of 2.5 m from the wall.

b) Wingwalls

An area within 1.5 m from the back face of the wall.

501.07.03 Water for Compaction

Water shall be applied, as necessary, to achieve the degree of compaction required.

When the Contract includes a separate item for water for compaction, the water shall be applied with the approval of the Contract Administrator.

501.07.04 Quality Control

501.07.04.01 General

Quality control (QC) testing shall be carried out to ensure that earth and granular materials used in the Work are compacted according to the requirements as specified in the Contract Documents.

Field density and field moisture determinations shall be made according to ASTM D6938.

501.07.04.02 Compaction Requirements

501.07.04.02.01 General

Compaction testing shall be based on material placed and compacted in the Work on a lot-by-lot basis according to the Lot Testing clause.

Compaction acceptance shall be according to the Acceptance clause and shall be based on target densities established according to the Target Density clause, QC compaction field test results, and, where applicable, a statistical analysis of those results.

501.07.04.02.02 Submission of Test Data

Prior to construction of a control strip, a copy of all QC laboratory test results for LS-706 required by the Control Strip clause to determine optimum moisture content (OMC) of the control strip material shall be delivered to the Contract Administrator.

All field test results and associated information relating to the control strip, including target density, lot location, lift thickness, probe depth, moisture content, wet density, and all QC lot compaction calculations shall be recorded at the time of testing on MTO form PH-CC-009. This form shall be available at any time for review, upon request, and shall be submitted to the Contract Administrator prior to placement of any subsequent lift and within 2 Business Days following the completion of a lot.

501.07.04.02.03 Test Equipment and Operator Training

501.07.04.02.03.01 General

Field density and field moisture measurements for QC compaction testing of earth and granular materials shall be carried out using gauges and ancillary equipment.

Only qualified operators using properly calibrated gauges shall conduct QC compaction testing.

501.07.04.02.03.02 Nuclear Moisture and Density Gauge Requirements

A copy of a valid calibration certificate, including the make, model number, and serial number for each gauge, shall be submitted to the Contract Administrator, prior to use of the gauge in compaction testing.

In addition, the Contract Administrator may request that the operator perform a standardization procedure according to ASTM D6939.

If the gauge does not meet the standardization requirements or exhibits malfunctions of any kind, the gauge shall be replaced.

501.07.04.02.03.03 Operator Requirements

Each operator shall have been trained in the safe operation, transportation, and handling of the gauge.

Prior to conducting QC compaction testing, the operator shall provide acceptable proof of proficiency in the use of a gauge and the correct procedures to determine lot and sublot sizes, field dry density, percent relative compaction, mean, standard deviation, and the Quality Index of a compacted lot of material by submitting one of the following:

a) a gauge operator certification document or card from a training program acceptable to the Owner and conducted within the Province of Ontario within the last 2 years; or

b) a document (e.g., instruction notice or letter) signed by the Owner showing that the operator has demonstrated proficiency on a Contract either constructed or being constructed for the same Owner within the same construction year as the compaction testing being carried out for this Contract.

If the operator cannot provide either of the two documents stated above, then at the Contract Administrator's discretion, the operator shall demonstrate their proficiency to the Owner. In this case, arrangements shall be made with the Contract Administrator regarding the schedule, location, and materials for such demonstrations. The first 2 demonstrations may include up to 5 operators and 5 gauges and shall be carried out at no charge. Additional demonstrations shall be charged at the rate of $500. Where a demonstration is carried out, acceptability of the operator shall be valid for the current calendar year only.

501.07.04.02.04 Target Density

New target densities shall be established for each separate component of the Work (e.g., backfilling of a trench, construction of a granular base, or placement of cover) at the following times:

a) For earth and granular materials:

   i. At the time of initial use of each source.
   ii. When there is a perceptible change in the appearance or gradation of the materials or both.
   iii. At least once per calendar year on all carry-over Contracts.

b) For earth being placed:

   i. As backfill, after QC lots representing 2000 tonnes or 1000 m^3 of material have been completed, whether accepted or rejected, based on one set of target density values, or
   ii. For all other purposes, after each 10 QC lots of material have been completed, whether accepted or rejected, based on one set of target density values.

c) For granular materials being placed:

   i. As backfill, or at the discretion of the Contract Administrator, any other areas, after QC lots representing 5000 tonnes or 2500 m^3 of material have been completed, whether accepted or rejected, based on one set of target density values, or
   ii. For all other purposes, after each 25 QC lots of material have been completed, whether accepted or rejected, based on one set of target density values.

The new target density shall be established by the construction of a control strip according to the Control Strip clause, except the new target density shall be based on the maximum dry density (MDD) as determined by LS-706 not more than 14 Days prior to placing the material, when:

a) Placing material in confined areas that do not allow equipment meeting the requirements specified in the Compaction clause to be used.

b) With the consent of the Contract Administrator, a control strip cannot be reasonably constructed or is impractical.

The MDD used for the new target density shall be the average of the MDD calculated from a minimum of three independent samples selected from the materials to be used.

501.07.04.02.04.01 Control Strip

Prior to construction of a control strip:

a) A minimum notice of 24 hours shall be given to the Contract Administrator, and

b) The optimum moisture content (OMC) of the material shall be determined according to LS-706.

Each control strip shall consist of a single uniform lift not more than 0.30 m in depth and covering at least 400 m^2 in area. The surface of each control strip shall be graded flat.

Prior to compaction, the field moisture content of the control strip material shall be determined using a nuclear gauge at a minimum of three randomly selected locations. The average moisture content at those three locations shall be within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material. If the average moisture content is not within this range, the moisture content of the material shall be uniformly adjusted (e.g. by adding water and re-mixing or scarifying and drying). The material shall then be graded flat and re-tested using a nuclear gauge. This process shall be repeated until the average moisture content of the material, at a minimum of three randomly selected locations, is within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material.

When the OMC is within the acceptable range, the compaction equipment shall make six passes over the entire surface of the control strip. A pass shall be deemed to be compaction of the full width of the control strip in one direction only. The field wet density and field moisture content shall be determined at a minimum of three randomly selected locations. The dry density shall be calculated for each of these locations and the average dry density used as the initial value for the dry density.

All passes of the compaction equipment for the control strip shall be carried out in vibratory mode at a speed of no more than 5 km/hour.

The compaction equipment shall then make two additional passes over the entire surface of the control strip.

A minimum of three separate random field density and moisture content determinations shall then be made, and a new average dry density shall be calculated.

If the new average dry density exceeds the previous value by more than 0.030 t/m^3, then additional passes of the equipment shall be carried out as described above. If the new average dry density does not exceed the previous value by more than 0.030 t/m^3, then the compaction of the control strip shall be considered satisfactory and complete.

Upon satisfactory completion of the control strip, an additional seven field wet density and moisture content tests shall be taken at random locations and the dry density values determined. The final dry density of the control strip, which shall be deemed to be the target density, shall be the average of the dry density values determined at these seven additional random locations plus the three most recent values that were determined upon completion of the control strip.

501.07.04.02.05 Lot Testing

For compaction control, a unique set of lots distinguished from each other by an appropriate letter or number designation, shall be established for each of the following:

a) Each separate component of the Work (e.g., backfilling a structure or a trench or construction of a granular base).

b) Materials from different sources.

c) Materials with different compaction properties.

d) When recompaction is carried out following restoration, scarification, or placement of additional material onto previously tested and accepted lots.

e) When directed by the Contract Administrator.

The individual lots within each unique set of lots shall be consecutively numbered and with no duplication. Lot sizes shall not exceed the limits as shown in Table 1.

All visibly soft or loose areas shall be compacted prior to testing.

For the situations described in Table 1, Part IV, a minimum of 2 field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into 4 equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each sublot and the results used to calculate the Quality Index according to the Quality Index clause.

In addition, regardless of the situation, when a lot of material is split between both sides of a pipe, sewer, or culvert, at least one field density and moisture content test shall be taken on each side of that pipe, sewer, or culvert.

The gauge probe shall extend to the full depth of the lift, unless otherwise allowed by the Modified Layer Compaction Method according to OPSS 206. The probe shall not extend beyond the lift being tested.

During the compaction process, the field wet density value and moisture content for each gauge test shall be recorded on MTO form PH-CC-009. The field dry density of each sublot shall then be calculated as a percentage of the target density to the nearest 0.1%. The mean and standard deviation and the Quality Index, where applicable, of the field dry density values shall be calculated to the nearest 0.1% and recorded on the form for each lot.

MTO form PH-CC-009 shall be constantly updated with new test data and the associated calculations completed as the testing is being done. This form shall be made available to the Contract Administrator at any time, upon request.

501.07.04.02.06 Quality Index

The Quality Index (Q_i), shall be calculated from the mean ($\bar{x}$) and standard deviation (s) of the percent target density which has been determined from all sublots within a QC compaction lot during the compaction process. The values for Quality Index, lot mean, and lot standard deviation shall be computed as follows:

a) For materials placed in embankments within 50 m of a structure; placed as bedding, embedment cover, or backfill material to pipes, sewers, or culverts; or placed as backfill to structures, utilit structures, or small foundations (e.g., anchor blocks, sign posts, and formwork):

For earth materials: $Q_i = \frac{\bar{x} - 95}{s}$ For granular materials: $Q_i = \frac{\bar{x} - 98}{s}$

b) For materials placed in all other situations:

For earth materials: $Q_i = \frac{\bar{x} - 90}{s}$ For granular materials: $Q_i = \frac{\bar{x} - 95}{s}$

Where:

Q_i = Quality Index, calculated to two decimal places.

$\bar{x}$ = Lot mean, the statistical value that describes the arithmetic average of sublot test results (dry density expressed as a percentage of the target density). Lot mean is the sum of individual sublot test results divided by the number of test results, calculated to 0.1% as follows:

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4}{4} = \frac{1}{4}\sum_{i=1}^{4} x_i$$

S = Lot standard deviation (σ_{n-1}), the statistical value that describes the distribution of sublot test results (dry density expressed as a percentage of the target density) about the lot mean. Standard deviation is the square root of the sum of the squares of the difference between each sublot test result and the lot mean divided by the number of test results minus one. It is calculated to 0.1% using the following expression:

$$s = \sqrt{\frac{\sum_{i=1}^{4} (x_i - \bar{x})^2}{3}}$$

501.07.04.02.07 Acceptance

For the situations described in Table 1, Part IV, acceptance or rejection of a QC lot for compaction shall be based on 2 or more random field density and moisture content tests taken within the lot. For a lot to be acceptable, all tests shall be at least 100% and 98% of the target density established for granular and earth materials, respectively. Otherwise, the QC lot shall be rejected for compaction.

For all other situations, acceptance or rejection of a QC lot for compaction shall be established by calculation of the Quality Index, according to the Quality Index clause. When Q_i has a value equal to or greater than 1.47, the QC lot shall be accepted; otherwise, the lot shall be rejected for compaction.

Accepted QC lots damaged by vehicular traffic shall be restored prior to placement of any overlying material. Surfaces of accepted QC lots with ruts greater than 50 mm in depth in earth or 25 mm in depth in granular materials shall be regraded and the upper lift recompacted to meet the specified compaction requirements. Materials that cannot be successfully recompacted shall be removed and replaced with new material.

501.07.04.02.07.01 Rejected Lots

If a QC lot is rejected for compaction, the lot shall be recompacted with adjustment to the moisture content, as required, until satisfactory compaction is achieved. The recompacted lot shall be retested and a decision made, as described in the Acceptance clause.

When compaction of a QC lot does not meet the acceptance criteria and when the Contract Administrator has been satisfied that this is not a result of the Contractor's operation or equipment, a new target density shall be established for that operation.

501.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

501.08 QUALITY ASSURANCE

501.08.01 General

Field density and field moisture determinations shall be made in accordance with ASTM D6938.

501.08.02 Compaction

501.08.02.01 General

The Contract Administrator shall conduct random testing or inspection of QC records or both to establish the acceptability of the QC compaction testing and verification of the field moisture content, field dry density, OMC, MDD, target density, and the Quality Index, where applicable.

The Contract Administrator may verify that the target density established for a control strip is based on the use of suitable compaction equipment. Provided that the MDD and OMC values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

Reasonable access to a control strip or to compacted QC lots shall be provided prior to placement of subsequent lifts of material. Subsequent lifts, including HMA, may not be placed until QA testing has been conducted or waived by the Contract Administrator.

501.08.02.02 Gauge Verification

Gauge verification QA shall consist of taking four random field density and moisture content measurements of a compacted lot or control strip and the subsequent calculation of the average dry density. The maximum dry density (MDD) of the material within the compacted lot or control strip as determined by LS-706 shall be used for gauge verification.

The QC gauge test results shall be considered valid provided that the difference between the average percentage of the MDD determined by QC gauge test results and the average percentage of the MDD determined by QA gauge test results for the same material is no more than 4%. If the discrepancy between the QA and QC gauge test results is more than the 4%, an investigation shall take place to resolve the discrepancy. The investigation may include but is not limited to verification of appropriate probe depth, as well as parts d) and e) according to the Compaction clause.

501.08.02.03 Compaction

For the situations described in Table 1, Part IV, compaction QA shall consist of taking 2 or more random field density and moisture content measurements of each compacted lot and the subsequent determination of percent target density.

For all other situations, compaction QA shall consist of taking 4 random field density and moisture measurements of a compacted lot or control strip and the subsequent calculation of the Quality Index for the lot.

Provided that the lot is acceptable, according to the requirements specified in the Acceptance clause, no further action shall be taken.

However, if the lot is rejected based on compaction testing or demonstrates errors in QC reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include, but is not limited to, any of the following:

a) Recompaction of the lot.

b) Retesting of the lot by the Contractor.

c) Establishment of a new target density by control strip.

d) Re-inspection of the gauge or operator or both by the Owner.

e) Recalibration of the gauges.

f) Removal of unsuitable materials.

501.08.02.04 Quality Control Records Inspections

QC records of the lot or control strip selected by the Contract Administrator shall be inspected for calculation errors, missing test data, or improper lot quantities. If errors or omissions are found that identify insufficiently compacted or improperly or untested lots, the Contractor shall make all such lots available and recompact or retest these lots or both so that they comply with the specified compaction requirements.

501.08.02.05 Charges

The Contract Administrator shall charge the Contractor $450.00 for each lot that requires retesting which has been identified through QA compaction testing or a review of QC records. In addition, immediately following the discovery of a discrepancy or inadequate compaction, all new lots shall be subjected to QA compaction testing prior to acceptance. If any of the new lots do not meet the specified compaction requirements, the Contractor shall be charged a fee of $450.00 for each lot. These conditions shall continue until 3 consecutive new lots have met the specified compaction requirements.

501.09 MEASUREMENT FOR PAYMENT

501.09.01 Actual Measurement

501.09.01.01 Water for Compaction

Measurement of water for compaction shall be in cubic metres using one of the following methods:

a) The mass of the water shall be determined by weighing as specified in the Contract Documents. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 m^3.

b) The water tank shall be measured and its volume computed in cubic metres.

c) The water shall be measured through a water meter of approved design.

501.10 BASIS OF PAYMENT

501.10.01 Compaction

Payment at the Contract price of the appropriate tender item requiring compaction of earth and granular materials shall be full compensation for all labour, Equipment, and Material to do the work of compacting, including the water used for compaction, unless the Contract contains a separate tender item for Water for Compaction.

Any work required to repair or remove and replace damaged QC lots accepted shall be at no additional cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density shall be at no additional cost to the Owner.

Replacement of a gauge shall be at no additional cost to the Owner.

Any work required to recompact or retest material as a result of QA compaction testing or QC records inspection shall be at no additional cost to the Owner.

501.10.02 Water for Compaction - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for water for compaction, the Contract price for the tender item in which the water for compaction is used shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Compaction Lot Size

Part	Construction	Lot Size
I	Earth embankments, granular base, granular subbase, and granular shoulders.	Every lift, 500 m maximum length. (Note 1)
II	Structure approach fill for earth.	Every lift, 50 m maximum length
III	Bedding, embedment, cover, or backfill material for pipe and sewer sections > 20.0 m in length that are being placed in one operation, earth or granular.	Every lift, 200 m maximum length.
IV	Bedding, embedment, cover, or backfill material for pipes and sewer sections ≤ 20.0 m in length that are being placed in one operation or backfill to utility structures or small foundations (e.g., anchor blocks, sign posts, and formwork), earth or granular.	Every lift, 20 m maximum length.
V	Structure backfill and culvert bedding, embedment, cover, or backfill material, granular.	Every lift for every stage of construction.

Note:

1. The width of the lot shall be the limits established for the placement of current material only and shall not include adjacent material to be placed at a future date.

Ontario Provincial Standard Specifications (OPSSs)					
539	November 2014	April 2025	TBD	Rev: Construction Specification for Temporary Protection Systems is implemented. The specification has been updated to new PROV format with no technical content changes. Legacy Appendix A removed. Applicable content from SSP 105S09 has been incorporated into OPSS 539.	Mike Pearsall
Standard Special Provisions (SSPs)					
105S09	March 2018	N/A	TBD	Can: SSP Amendment to Temporary Protection Systems is cancelled. Applicable content has been incorporated into OPSS 539.	Mike Pearsall

Note: The 539 implemented in April 2025 replaces 539, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR TEMPORARY PROTECTION SYSTEMS

TABLE OF CONTENTS

539.01 SCOPE

This specification covers the requirements for the design, construction, maintenance, monitoring, and removal of a temporary protection system made necessary by excavation, embankment construction, dewatering, or other work.

~~539.01.01 Specification Significance and Use~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**539.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

539.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 906	Structural Steel for Bridges
OPSS 942	Prestressed Soil and Rock Anchors

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1601	Wood Material, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

S6-06 Canadian Highway Bridge Design Code

Ontario Ministry of Labour

Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended

American Association of State Highways Transportation Officials (AASHTO)

AASHTO Guide Design Specification for Bridge Temporary Works, 1st Edition with Interim Revisions

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025 General Requirements for the Competence of the Testing and Calibration Laboratories

539.03 DEFINITIONS

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

Anchor means:

a) A system consisting of prestressed tendons or non-prestressed rods installed in predrilled holes and encapsulated in grout or concrete. ~~-~~A system that derives its load carrying capacity in bond between the grout and concrete body and the surrounding soil or rock; or

b) A tie back to a deadman.

Bracing means the system of walers, struts, anchorages, and like members that connect frames, shores, or panels of a sheathing system to resist external pressures and to provide stability against lateral movement.

Cofferdam means a watertight enclosure.

Dredge Line means the exposed lower limit of the protection system.

Erector means a supervisory person that undertakes the construction of a protection system.

Protection System means the construction necessary to mechanically support existing or proposed work so that its function shall not be affected or construction necessary to support work such as open excavations during actual construction operations for safety and convenience.

Raker means a structural member inclined to the front of the shoring wall providing lateral support.

Shoring Wall means a structural wall consisting of wood, steel, or concrete or any combination of these materials that supports earth or rock and any structure, materials, Utilities, or other facility contained in or on the supported earth or rock mass.

Top of Shoring Wall means the upper limit of the protection system.

539.04 DESIGN AND SUBMISSION REQUIREMENTS

539.04.01 Design Requirements

539.04.01.01 General

The protection system shall be designed for the performance level as specified in the Contract Documents.

Except for Owner designed protection systems, the Contractor shall be responsible for the complete detailed design of the protection system required to carry out the work as specified in the Contract Documents.

Protection systems that are not as specified in the Contract Documents shall be assigned an appropriate performance level for design by the design Engineer. The Contract Administrator shall review the performance level selected at the time of submission of the specified Working Drawings.

The geotechnical and foundation portions of the design shall be based on a method published in AASHTO Guide Design Specification for Bridge Temporary Works and in general conformance with CAN/CSA-S6. The design shall be appropriate for the specific site conditions. Design methods not meeting the AASHTO and CSA design specifications may only be used on this Contract, if approved by the Owner.

A protection system shall be designed to provide protection for excavations at the locations as specified in the Contract Documents and at any other location where the stability, safety, or function of an existing structure or Utility may be impaired by construction work.

The temporary slope geometry used to determine requirements of the protection system shall be according to the Occupational Health and Safety Act.

Performance levels for protection systems are as follows:

Performance Level	Maximum Angular Distortion	Maximum Horizontal Displacement
1a	1:1000	5 mm
1b	1:1000	10 mm
2	1:200	25 mm
3	1:100	50 mm

Where:

Angular Distortion = $\pm \Delta/H$

Δ = Horizontal displacement in mm at height H
H = Height in mm above dredge line to point of measurement or height above the nearest system restraining support.

When performance level 1a is specified, the bracing system shall be preloaded.

Where the bracing systems are preloaded, the effects of the preload shall not cause damage to adjacent facilities.

Protection systems with a face within a horizontal distance of 1/3H of any part of a structure foundation shall be designed for performance level 1a.

539.04.01.02 Designer Qualifications

The design Engineer and design-checking Engineer shall have demonstrated expertise for the work. As well, the design Engineer and design-checking Engineer shall have a minimum of 5 years experience in designing protection systems of similar nature and scope to the required work.

One person shall not perform both the design Engineer and design-checking Engineer roles for a protection system.

539.04.01.03 Design Assumptions

The design assumptions shall accurately represent the subsurface conditions prevalent at the site and shall be specific to the type of protection system used. The design shall address the subsurface conditions at the project site as specified in the Contract Documents.

539.04.01.04 Vertical and Horizontal Loadings

Vertical and horizontal design loadings used shall represent existing conditions and accepted design practice. Future loadings that are known and may affect the protection system during its useful life shall be considered.

539.04.02 Submissions

539.04.02.01 Working Drawings

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to commencement of the protection system installation, for information purposes only. ~~–~~Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

Prestressed anchor submissions shall be according to OPSS 942.

When other authorities are involved, 1 set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction. ~~–~~The requirements of each authority shall be satisfied prior to commencement of the protection system installation.

The Contractor shall have a copy of the Working Drawings at the site during protection system installation.

For protection systems that are not specified in the Contract Documents, the Contractor shall submit the Working Drawings for these systems to the Contract Administrator at least 3 weeks prior to the commencement of any construction.

The following information and details shall be shown on the Working Drawings:

a) Plans, Elevations, and Details

   i. Location of protection system and station limits.
   ii. Plan and elevation of shoring showing the extent of the protection system.
   iii. Details of the shoring system, including cross-sections.
   iv. Details of internal bracing.

b) Design Criteria

   i. Pressure diagrams including values of horizontal and vertical loads, dead load, and live load surcharge.
   ii. Design assumptions and parameters.
   iii. Anchor bond stresses.
   iv. Pile design.
   v. Anchor system stressing schedule specifying working loads, stressing loads, and lock in loads.
   vi. Details of preload, when required.
   vii. For protection systems not specified in the Contract Document, the performance level shall be designated.

c) Materials

   i. Grade of structural steel and grade and species of structural wood.
   ii. Concrete strengths.
   iii. Grout strengths.

iv. Details of protection from rain and frost action.
v. Wood lagging and size.
vi. Mill certificates or test reports from an independent organization certified by the Standards Council of Canada certifying that the steel meets the requirements of the grade, where specified.
vii. Details of patented accessories, including load test data.

d) Installation Procedure

i. Installation sequence and procedure, including to the installation of piling, lagging, anchor systems, and rakers.

e) Monitoring Method

i. The proposed method of monitoring the performance of the protection system during installation and use. The method of monitoring shall be consistent with the requirements specified in the Quality Control subsection.

f) Removal of Protection System

i. The details of the procedures associated with the removal of the protection system indicating: method, sequence of work, and removal limits, except when the protection system is specified in the Contract Documents to be left in place.

539.04.02.02 Amendments to Protection Systems

Work shall not proceed on amendments to the protection system until the Contractor has received sealed and signed approval to proceed from the design Engineer and design-checking Engineer and has submitted a copy of the approval to the Contract Administrator.

Amendments to the protection system shall be submitted to the Contract Administrator on revised Working Drawings bearing the seal and signature of the design Engineer and design-checking Engineer.

539.04.02.03 Preconstruction Survey

Prior to commencing the work, the Contractor shall submit to the Contract Administrator, a condition survey of property and structures that may be affected by the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site within a horizontal distance of $2H_w$ from the face of the protection system, where H_w is the height of the wall from the ground surface to the dredge line.

539.04.02.04 Materials

539.04.02.04.01 Structural Steel

539.04.02.04.01.01 Mill Certificates

The Contractor shall submit to the Contract Administrator at the time of delivery 1 copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, casings, and sheet piles.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificates verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements.

The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

For Contractor designed protection systems using previously used structural steel that a mill test certificate is not available and coupons have not been tested to verify the steel's material properties, a mill test certificate is not required when the yield strength specified on the Working Drawings does not exceed 250 MPa. If the yield strength specified exceeds 250 MPa, the Contract Administrator may request that the material be tested to confirm the material properties indicated on the Working Drawings. The costs of this testing shall be at the expense of the Owner if the test results indicate that the material is according to the Working Drawings, and at the expense of the Contractor if the test results indicate that the material is not according to Working Drawings.

539.05 MATERIALS

539.05.01 Wood

Wood shall be according to OPSS 1601.

Wood shall be of the size, grade, and species shown on the Working Drawings and shall be in sound condition, free from defects that may impair its strength. Wood lagging does not have to be grade-stamped.

539.05.02 Proprietary Shoring and Patented Accessories

Where proprietary shoring or patented accessories are to be used, the Contractor shall follow the manufacturers' recommendations for load carrying capacity. The recommended load carrying capacities shall be supported by test results from an accredited testing laboratory approved by the Owner.

539.05.03 Concrete

Concrete shall be according to OPSS 1350.

539.05.04 Other Materials

The design Engineer may consider other suitable materials when sufficient information is available to quantify the allowable design loads or when the manufacturer's recommendations regarding load carrying capacities are supported by test results from an independent organization accredited by the Standards Council of Canada.

539.07 CONSTRUCTION

539.07.01 General

The Contractor shall be responsible for the design, materials, construction, maintenance, monitoring, and removal of a temporary protection system.

The erector shall be experienced in the method of construction of protection systems. Such experience shall have been obtained within the preceding 5 years on projects of similar nature and scope to the required work.

Protection systems shall be built according to the specifications and the Working Drawings.
Piling shall be according to OPSS 903 and the Working Drawings.

Concrete construction shall be according to OPSS 904. Concrete shall be placed in the dry. Where cofferdams are used, they shall be sealed sufficiently to permit concrete to be placed in the dry.

The Contractor shall carry out dewatering, as required, to facilitate the installation of the protection system.

Tremie concrete shall be placed according to the requirements of OPSS 904.

Structural steel shall be according to OPSS 906 and the Working Drawings.

Prestressed anchors shall be supplied, installed, and stressed according to OPSS 942.

The protection system shall be protected from the detrimental effects of rain and frost action.

Material used in the protection system shall remain the property of the Contractor.

Loss of soil from behind the shoring shall be prevented during and following the installation of the lagging.

539.07.02 Removal of Protection Systems

Protection systems may be left in place, unless otherwise specified.

Where protection systems are left in place, the top shall be removed to at least 1.2 m below the finished grade or ground level or at least 0.6 m below the streambed.

Where protection systems are specified for removal or the Contractor elects to remove, the method and sequence of removal shall be so that there shall be no damage to the new work, existing work, and facility being protected.

All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

539.07.03 Quality Control

539.07.03.01 General

In addition to the quality control measures instituted by the Contractor, the Contractor shall complete a preconstruction condition survey and monitor the protection system installation as specified herein, and as shown on the Working Drawings.

539.07.03.02 Inspection of Welds

The Contractor shall be responsible for visual inspection of all welds. Any required testing of welds shall be as specified by the design Engineer of the protection system.

539.07.03.03 Monitoring

539.07.03.03.01 General

Monitoring shall be conducted by a Registered Ontario Land Surveyor or an Engineer according to the program submitted with the Working Drawings.

The minimum requirements for monitoring shall include the survey measurements of scaled targets attached to the shoring wall at the elevations specified. The scaled targets shall be placed at a maximum spacing of 6 m with targets placed at the extreme ends and the targets distributed between the outer limits. The survey targets shall be monitored for horizontal displacement from the vertical at the frequency specified.

All test results, observations, and records, including the preconstruction survey, taken during construction and operation of the protection system shall be available on the site for review by the Contract Administrator.

If movement of the protection system is more rapid than is expected, or if movement approaches the allowable limit, the Contract Administrator shall be notified immediately and suitable measures shall be taken to ensure stability of the protection system and to ensure movement does not exceed the performance level specified in the Contract Documents.

539.07.03.03.02 Excavation Depths Less Than or Equal to Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top of the protection system at each construction stage during the installation. After installation, the above readings shall be taken every two weeks.

The Contractor's Engineer shall inspect the following Work:

a) Installation of the protection system, including excavation to dredge line.

b) Removal of the protection system.

539.07.03.03.03 Excavation Depths Exceeding Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top, at each restraint point, at the dredge line, and halfway between the restraint points at each construction stage during the installation of the protection system. After installation, the above readings shall be taken weekly.

The Contractor's Engineer shall inspect the following Work:

a) Layout and extent of protection system.

b) Piling.

c) Installation of protection system, including excavation to dredge line.

d) Removal of protection system.

539.07.03.04 Certificates of Conformance

539.07.03.04.01 Excavation Depths Less Than or Equal to Three Metres

For protection systems to facilitate excavation depths less than or equal to 3 m and provided that surcharge loading due to vehicular traffic, construction equipment and materials, or other is beyond a horizontal distance defined by a 1H : 2V line projected from the dredge line at the face of the protection system to the roadway surface, the Contractor's Engineer shall inspect and verify that the that the protection system was installed, monitored, and subsequently removed according to the Contract Documents.

A Certificate of Conformance shall be submitted to the Contractor Administrator upon completion of the installation of the protection system.

A Certificate of Conformance shall be submitted to the Contractor Administrator upon completion of the removal of the protection system.

Should the traffic be within a horizontal distance defined by a 1H: 2V line projected from the dredge line at the face of the protection system to the roadway surface, the Certificate of Conformance requirements as specified in the Excavation Depths Exceeding Three Metres clause shall apply.

539.07.03.04.02 Excavation Depths Exceeding Three Metres

For protection systems to facilitate excavation depths that exceed 3 m or should traffic, construction equipment and materials, or other be within a horizontal distance defined by a 1H:1V line projected from the dredge line at the face of the protection system to the roadway surface.

The Contractor's Engineer shall inspect and verify that the materials have been supplied and installed according to the Contract Documents. A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the materials.

The Contractor's Engineer shall inspect and verify and that the protection system was installed, monitored, and subsequently removed according to the Contract Documents. A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the removal of the protection system.

539.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

539.10 BASIS OF PAYMENT

539.10.01 Protection System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate item for protection systems, the Contract price for the items directly associated with the protection system shall include full compensation for all labour, Equipment, and Material to do the work described in this specification.

Appendix 539-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.

Note: The 539 implemented in April 2025 replaces 539, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR TEMPORARY PROTECTION SYSTEMS

TABLE OF CONTENTS

539.01 SCOPE

This specification covers the requirements for the design, construction, maintenance, monitoring, and removal of a temporary protection system made necessary by excavation, embankment construction, dewatering, or other work.

539.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 903 Deep Foundations
OPSS 904 Concrete Structures
OPSS 906 Structural Steel for Bridges
OPSS 942 Prestressed Soil and Rock Anchors

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1601 Wood Material, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

S6-06 Canadian Highway Bridge Design Code

Ontario Ministry of Labour

Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended

American Association of State Highways Transportation Officials (AASHTO)

AASHTO Guide Design Specification for Bridge Temporary Works, 1st Edition with Interim Revisions

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025 General Requirements for the Competence of the Testing and Calibration Laboratories

539.03 DEFINITIONS

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

Anchor means:

a) A system consisting of prestressed tendons or non-prestressed rods installed in predrilled holes and encapsulated in grout or concrete. A system that derives its load carrying capacity in bond between the grout and concrete body and the surrounding soil or rock; or

b) A tie back to a deadman.

Bracing means the system of walers, struts, anchorages, and like members that connect frames, shores, or panels of a sheathing system to resist external pressures and to provide stability against lateral movement.

Cofferdam means a watertight enclosure.

Dredge Line means the exposed lower limit of the protection system.

Erector means a supervisory person that undertakes the construction of a protection system.

Protection System means the construction necessary to mechanically support existing or proposed work so that its function shall not be affected or construction necessary to support work such as open excavations during actual construction operations for safety and convenience.

Raker means a structural member inclined to the front of the shoring wall providing lateral support.

Shoring Wall means a structural wall consisting of wood, steel, or concrete or any combination of these materials that supports earth or rock and any structure, materials, Utilities, or other facility contained in or on the supported earth or rock mass.

Top of Shoring Wall means the upper limit of the protection system.

539.04 DESIGN AND SUBMISSION REQUIREMENTS

539.04.01 Design Requirements

539.04.01.01 General

The protection system shall be designed for the performance level as specified in the Contract Documents.

Except for Owner designed protection systems, the Contractor shall be responsible for the complete detailed design of the protection system required to carry out the work as specified in the Contract Documents.

Protection systems that are not as specified in the Contract Documents shall be assigned an appropriate performance level for design by the design Engineer. The Contract Administrator shall review the performance level selected at the time of submission of the specified Working Drawings.

The geotechnical and foundation portions of the design shall be based on a method published in AASHTO Guide Design Specification for Bridge Temporary Works and in general conformance with CAN/CSA-S6. The design shall be appropriate for the specific site conditions. Design methods not meeting the AASHTO and CSA design specifications may only be used on this Contract, if approved by the Owner.

A protection system shall be designed to provide protection for excavations at the locations as specified in the Contract Documents and at any other location where the stability, safety, or function of an existing structure or Utility may be impaired by construction work.

The temporary slope geometry used to determine requirements of the protection system shall be according to the Occupational Health and Safety Act.

Performance levels for protection systems are as follows:

Performance Level	Maximum Angular Distortion	Maximum Horizontal Displacement
1a	1:1000	5 mm
1b	1:1000	10 mm
2	1:200	25 mm
3	1:100	50 mm

Where:

Angular Distortion = $\pm \Delta/H$

Δ = Horizontal displacement in mm at height H
H = Height in mm above dredge line to point of measurement or height above the nearest system restraining support.

When performance level 1a is specified, the bracing system shall be preloaded.

Where the bracing systems are preloaded, the effects of the preload shall not cause damage to adjacent facilities.

Protection systems with a face within a horizontal distance of 1/3H of any part of a structure foundation shall be designed for performance level 1a.

539.04.01.02 Designer Qualifications

The design Engineer and design-checking Engineer shall have demonstrated expertise for the work. As well, the design Engineer and design-checking Engineer shall have a minimum of 5 years experience in designing protection systems of similar nature and scope to the required work.

One person shall not perform both the design Engineer and design-checking Engineer roles for a protection system.

539.04.01.03 Design Assumptions

The design assumptions shall accurately represent the subsurface conditions prevalent at the site and shall be specific to the type of protection system used. The design shall address the subsurface conditions at the project site as specified in the Contract Documents.

539.04.01.04 Vertical and Horizontal Loadings

Vertical and horizontal design loadings used shall represent existing conditions and accepted design practice. Future loadings that are known and may affect the protection system during its useful life shall be considered.

539.04.02 Submissions

539.04.02.01 Working Drawings

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to commencement of the protection system installation, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

Prestressed anchor submissions shall be according to OPSS 942.

When other authorities are involved, 1 set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction. The requirements of each authority shall be satisfied prior to commencement of the protection system installation.

The Contractor shall have a copy of the Working Drawings at the site during protection system installation.

For protection systems that are not specified in the Contract Documents, the Contractor shall submit the Working Drawings for these systems to the Contract Administrator at least 3 weeks prior to the commencement of any construction.

The following information and details shall be shown on the Working Drawings:

a) Plans, Elevations, and Details

   i. Location of protection system and station limits.
   ii. Plan and elevation of shoring showing the extent of the protection system.
   iii. Details of the shoring system, including cross-sections.
   iv. Details of internal bracing.

b) Design Criteria

i. Pressure diagrams including values of horizontal and vertical loads, dead load, and live load surcharge.
ii. Design assumptions and parameters.
iii. Anchor bond stresses.
iv. Pile design.
v. Anchor system stressing schedule specifying working loads, stressing loads, and lock in loads.
vi. Details of preload, when required.
vii. For protection systems not specified in the Contract Document, the performance level shall be designated.

c) Materials

i. Grade of structural steel and grade and species of structural wood.
ii. Concrete strengths.
iii. Grout strengths.
iv. Details of protection from rain and frost action.
v. Wood lagging and size.
vi. Mill certificates or test reports from an independent organization certified by the Standards Council of Canada certifying that the steel meets the requirements of the grade, where specified.
vii. Details of patented accessories, including load test data.

d) Installation Procedure

i. Installation sequence and procedure, including to the installation of piling, lagging, anchor systems, and rakers.

e) Monitoring Method

i. The proposed method of monitoring the performance of the protection system during installation and use. The method of monitoring shall be consistent with the requirements specified in the Quality Control subsection.

f) Removal of Protection System

i. The details of the procedures associated with the removal of the protection system indicating: method, sequence of work, and removal limits, except when the protection system is specified in the Contract Documents to be left in place.

539.04.02.02 Amendments to Protection Systems

Work shall not proceed on amendments to the protection system until the Contractor has received sealed and signed approval to proceed from the design Engineer and design-checking Engineer and has submitted a copy of the approval to the Contract Administrator.

Amendments to the protection system shall be submitted to the Contract Administrator on revised Working Drawings bearing the seal and signature of the design Engineer and design-checking Engineer.

539.04.02.03 Preconstruction Survey

Prior to commencing the work, the Contractor shall submit to the Contract Administrator, a condition survey of property and structures that may be affected by the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site within a horizontal distance of $2H_w$ from the face of the protection system, where H_w is the height of the wall from the ground surface to the dredge line.

539.04.02.04 Materials

539.04.02.04.01 Structural Steel

539.04.02.04.01.01 Mill Certificates

The Contractor shall submit to the Contract Administrator at the time of delivery 1 copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, casings, and sheet piles.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificates verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

For Contractor designed protection systems using previously used structural steel that a mill test certificate is not available and coupons have not been tested to verify the steel's material properties, a mill test certificate is not required when the yield strength specified on the Working Drawings does not exceed 250 MPa. If the yield strength specified exceeds 250 MPa, the Contract Administrator may request that the material be tested to confirm the material properties indicated on the Working Drawings. The costs of this testing shall be at the expense of the Owner if the test results indicate that the material is according to the Working Drawings, and at the expense of the Contractor if the test results indicate that the material is not according to Working Drawings.

539.05 MATERIALS

539.05.01 Wood

Wood shall be according to OPSS 1601.

Wood shall be of the size, grade, and species shown on the Working Drawings and shall be in sound condition, free from defects that may impair its strength. Wood lagging does not have to be grade-stamped.

539.05.02 Proprietary Shoring and Patented Accessories

Where proprietary shoring or patented accessories are to be used, the Contractor shall follow the manufacturers' recommendations for load carrying capacity. The recommended load carrying capacities shall be supported by test results from an accredited testing laboratory approved by the Owner.

539.05.03 Concrete

Concrete shall be according to OPSS 1350.

539.05.04 Other Materials

The design Engineer may consider other suitable materials when sufficient information is available to quantify the allowable design loads or when the manufacturer's recommendations regarding load carrying capacities are supported by test results from an independent organization accredited by the Standards Council of Canada.

539.07 CONSTRUCTION

539.07.01 General

The Contractor shall be responsible for the design, materials, construction, maintenance, monitoring, and removal of a temporary protection system.

The erector shall be experienced in the method of construction of protection systems. Such experience shall have been obtained within the preceding 5 years on projects of similar nature and scope to the required work.

Protection systems shall be built according to the specifications and the Working Drawings.
Piling shall be according to OPSS 903 and the Working Drawings.

Concrete construction shall be according to OPSS 904. Concrete shall be placed in the dry. Where cofferdams are used, they shall be sealed sufficiently to permit concrete to be placed in the dry.

The Contractor shall carry out dewatering, as required, to facilitate the installation of the protection system.

Tremie concrete shall be placed according to the requirements of OPSS 904.

Structural steel shall be according to OPSS 906 and the Working Drawings.

Prestressed anchors shall be supplied, installed, and stressed according to OPSS 942.

The protection system shall be protected from the detrimental effects of rain and frost action.

Material used in the protection system shall remain the property of the Contractor.

Loss of soil from behind the shoring shall be prevented during and following the installation of the lagging.

539.07.02 Removal of Protection Systems

Protection systems may be left in place, unless otherwise specified.

Where protection systems are left in place, the top shall be removed to at least 1.2 m below the finished grade or ground level or at least 0.6 m below the streambed.

Where protection systems are specified for removal or the Contractor elects to remove, the method and sequence of removal shall be so that there shall be no damage to the new work, existing work, and facility being protected.

All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

539.07.03 Quality Control

539.07.03.01 General

In addition to the quality control measures instituted by the Contractor, the Contractor shall complete a preconstruction condition survey and monitor the protection system installation as specified herein, and as shown on the Working Drawings.

539.07.03.02 Inspection of Welds

The Contractor shall be responsible for visual inspection of all welds. Any required testing of welds shall be as specified by the design Engineer of the protection system.

539.07.03.03 Monitoring

539.07.03.03.01 General

Monitoring shall be conducted by a Registered Ontario Land Surveyor or an Engineer according to the program submitted with the Working Drawings.

The minimum requirements for monitoring shall include the survey measurements of scaled targets attached to the shoring wall at the elevations specified. The scaled targets shall be placed at a maximum spacing of 6 m with targets placed at the extreme ends and the targets distributed between the outer limits. The survey targets shall be monitored for horizontal displacement from the vertical at the frequency specified.

All test results, observations, and records, including the preconstruction survey, taken during construction and operation of the protection system shall be available on the site for review by the Contract Administrator.

If movement of the protection system is more rapid than is expected, or if movement approaches the allowable limit, the Contract Administrator shall be notified immediately and suitable measures shall be taken to ensure stability of the protection system and to ensure movement does not exceed the performance level specified in the Contract Documents.

539.07.03.03.02 Excavation Depths Less Than or Equal to Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top of the protection system at each construction stage during the installation. After installation, the above readings shall be taken every two weeks.

The Contractor’s Engineer shall inspect the following Work:

a) Installation of the protection system, including excavation to dredge line.

b) Removal of the protection system.

539.07.03.03.03 Excavation Depths Exceeding Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top, at each restraint point, at the dredge line, and halfway between the restraint points at each construction stage during the installation of the protection system. After installation, the above readings shall be taken weekly.

The Contractor’s Engineer shall inspect the following Work:

a) Layout and extent of protection system.

b) Piling.

c) Installation of protection system, including excavation to dredge line.

d) Removal of protection system.

539.07.03.04 Certificates of Conformance

539.07.03.04.01 Excavation Depths Less Than or Equal to Three Metres

For protection systems to facilitate excavation depths less than or equal to 3 m and provided that surcharge loading due to vehicular traffic, construction equipment and materials, or other is beyond a horizontal distance defined by a 1H : 2V line projected from the dredge line at the face of the protection system to the roadway surface, the Contractor's Engineer shall inspect and verify that the that the protection system was installed, monitored, and subsequently removed according to the Contract Documents.

A Certificate of Conformance shall be submitted to the Contractor Administrator upon completion of the installation of the protection system.

A Certificate of Conformance shall be submitted to the Contractor Administrator upon completion of the removal of the protection system.

Should the traffic be within a horizontal distance defined by a 1H: 2V line projected from the dredge line at the face of the protection system to the roadway surface, the Certificate of Conformance requirements as specified in the Excavation Depths Exceeding Three Metres clause shall apply.

539.07.03.04.02 Excavation Depths Exceeding Three Metres

For protection systems to facilitate excavation depths that exceed 3 m or should traffic, construction equipment and materials, or other be within a horizontal distance defined by a 1H:1V line projected from the dredge line at the face of the protection system to the roadway surface.

The Contractor's Engineer shall inspect and verify that the materials have been supplied and installed according to the Contract Documents. A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the materials.

The Contractor's Engineer shall inspect and verify and that the protection system was installed, monitored, and subsequently removed according to the Contract Documents. A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the removal of the protection system.

539.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

539.10 BASIS OF PAYMENT

539.10.01 Protection System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate item for protection systems, the Contract price for the items directly associated with the protection system shall include full compensation for all labour, Equipment, and Material to do the work described in this specification.

Ontario Provincial Standard Specifications (OPSSs)					
578	April 2017	April 2025	TBD	Rev: Construction Specification for Placement of Unshrinkable Fill is implemented. The specification has been updated to new PROV format with no technical content changes.	Mike Pearsall

Note: The 578 implemented in April 2025 replaces 578, April 2017 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR THE PLACEMENT OF UNSHRINKABLE FILL

TABLE OF CONTENTS

578.01 SCOPE

This specification covers the requirements for the placement of unshrinkable fill.

~~578.01.01 Specification Significance and Use~~

~~This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.~~

~~Use of this specification or any other specification shall be according to the Contract Documents.~~

~~**578.01.02 Appendices Significance and Use**~~

~~Appendices are not for use in provincial Contracts as they are developed for municipal use, and then, only when invoked by the Owner.~~

~~Appendices are developed for the Owner's use only.~~

~~Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner.~~

~~Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.~~

~~Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.~~

~~The decision to use any appendix is determined by an Owner after considering their Contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.~~

578.02 REFERENCES

~~When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.~~

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

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 517	Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-407	Method of Test for Compressive Strength of Moulded Cylinders
LS-610	Organic Impurities in Concrete Sands
LS-618	The Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-619	The Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

MTO Forms:

PH-CC-322	Concrete Construction Report

CSA Standards

A23.1	Table 3, Additional requirements for concrete subjected to sulphate attack*
A23.2-3B	Total or Water-Soluble Sulphate Ion Content of Soil*
A23.2-8B	Water-Soluble Sulphate Ion Content of Recycled Aggregates Containing Crushed Concrete*
A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens*
A23.2-5C	Slump and Slump Flow of Concrete *
A3001	Cementitious Materials for Use in Concrete**

* [Part of CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

** [Part of CSA A3000-13 Cementitious Materials Compendium]

ASTM International

~~D 1411~~D1411-09~~-~~ Standard Test Methods for Water-Soluble Chlorides Present as Admixtures in Graded Aggregate Road Mixes

578.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Unshrinkable Fill means a self-compacting cement treated aggregate with flowable consistency and controlled low strength properties.

578.04 DESIGN AND SUBMISSION REQUIREMENTS

578.04.01 Design Requirements

Unshrinkable fill shall be according to the following:

a) The mix shall be designed to provide appropriate strength and performance characteristics for the intended use, and to meet the requirements as specified in the contract documents.

b) The unshrinkable fill shall contain 25 kg/m3 of Type GU or GUL cement according to CSA A3001 and may contain additional supplementary cementing materials to aid in placement.

c) The mix may contain foaming agents to aid in placement.

d) Slump at point of discharge shall be a minimum of 150 mm and the unshrinkable fill shall be uniformly mixed throughout.

e) The material shall be designed such that it can flow into the excavation and fill the entire space without vibration, and without segregation.

f) The 28-Day compressive strength shall be a maximum of 0.40 MPa.

578.04.02 Submission Requirements

The Contractor shall be responsible for designing the unshrinkable fill mix and shall submit the unshrinkable fill mix design according to OPSS 1350 except the use of reclaimed concrete material and the amount used expressed in percent by mass of the total aggregate shall be identified on Forms A and B.

578.05 MATERIALS

578.05.01 Cementing Materials

Cementing materials shall be according to OPSS 1301.

578.05.02 Water

Water shall be according to OPSS 1302.

578.05.03 Aggregates

Aggregates shall be according to OPSS 1001 and this specification.

Except as noted below or elsewhere in the Contract Documents, aggregates may be sands, gravel, quarried rock or reclaimed concrete material provided the source is of such a nature and extent as 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 OPSS 1001 and 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 or another source is selected.

Fine and coarse aggregates shall meet the grading requirements of Table 1 and the physical property requirements of Table 2.

578.05.03.01 Reclaimed Concrete Material

Reclaimed concrete material may be used up to a maximum of 25 % by mass of the total aggregate. Reclaimed concrete material shall not be used in unshrinkable fill to be placed in contact with sulphate-bearing soil or ground water with sulphate.

578.06 EQUIPMENT

578.06.01 Mixing Equipment

A central mixing, dry batch plant, capable of accurately proportioning aggregate, cement, and water shall be used. The plant shall be certified according to OPSS 1350.

578.06.02 Transport Equipment

Unshrinkable fill shall be transported to the site by means of ready mix trucks.

578.07 CONSTRUCTION

578.07.01 Operational Constraints

Where vehicular traffic, including construction equipment, is to be accommodated, the unshrinkable fill shall be protected by covering it with a steel plate suitable for the traffic loading for a minimum of 24 hours.

Hot mix asphalt or any other material shall not be placed on unshrinkable fill until a minimum of four hours after the placing of unshrinkable fill.

578.07.02 Unshrinkable Fill Placement Requirements

Individual loads of unshrinkable fill shall be placed within 2 hours from the time of batching.

When placed into excavations, unshrinkable fill shall be placed so that it fills the entire excavation without voids beneath horizontal projections or in other locations within the excavation. When unshrinkable fill is to be placed in an excavation subject to the entry of flowing water, the excavation shall be dewatered according to OPSS 517 prior to placement of the unshrinkable fill.

When placed adjacent to culverts, arches, rigid frames, integral abutments and piers, the unshrinkable fill shall be placed in alternating layers on each side of the structure to balance the earth pressure forces. Unless specified in the Contract Documents, the unshrinkable fill layers shall not exceed 500 mm in thickness and the height of the layers shall be approximately the same. At no time shall the elevation difference between the sides be greater than 500 mm. Each layer shall set for a minimum of four hours before a new layer is placed.

When shoring, bracing, or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, and this support system is to be removed, it shall be removed as filling proceeds to ensure stability of the excavation.

The unshrinkable fill material shall be protected from cold weather according to OPSS 350 with the exception that unshrinkable fill shall be protected from freezing after placement but need not be monitored with thermocouples nor maintained above 15^{o} C.

578.07.03 Field Sampling and Testing

The Contractor shall be responsible for testing of slump, casting, initial storage and transportation of cylinders for compressive strength determination by the Owner.

Field sampling and testing of concrete shall be performed by a person holding either of the following certifications:

a) CCIL Certified Concrete Testing Technician, or

b) ACI Concrete Field Testing Technician, Grade 1.

Such persons shall have a valid original card issued by the certifying agency in their possession at all times.

Unshrinkable fill shall be tested for slump according to CSA A23.2-5C when directed by the Contract Administrator. Unshrinkable fill that does not meet the slump requirement shall be adjusted to meet the slump requirement or rejected and removed from the Working Area.

For the determination of compressive strength, a set of two cylinders, 150 mm diameter 300 mm long, shall be cast each Day of production and placement, when directed by the Contract Administrator. When there is more than one supplier of unshrinkable fill, a separate set of two cylinders for each supplier shall be cast each Day of production and placement.

Cylinders shall be cast and transported according to CSA A23.2-3C except that only cardboard moulds shall be used to cast the test cylinders. A disc of wax paper matching the inside diameter of the cylinder mould shall be placed at the base of the cylinder mould prior to casting. The interior sidewalls of the cardboard mould shall be treated with a light coating of release agent.

For the first 24 hours after casting, test cylinders shall be stored within the Working Area either covered or in a shaded area.

Test information shall be recorded on MTO form PH-CC-322, a copy of which shall be submitted with each set of compressive strength cylinders.

The Contractor shall transport the cylinders to the designated quality assurance laboratory specified in the Contract Documents, for testing.

578.08 QUALITY ASSURANCE

578.08.01 Testing Requirements

Compressive strength testing shall be according to LS-407. The results of the set of two cylinders cast each Day shall be averaged to provide the test result for the Day.

578.08.02 Acceptance

Unshrinkable fill shall be accepted when:

a) The material does not deform under traffic loading.

b) The compressive strength requirements are met.

c) Materials used comply with the requirements of this specification.

578.09 MEASUREMENT FOR PAYMENT

578.09.01 Actual Measurement

Measurement of unshrinkable fill shall be by volume in cubic metres.

578.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

578.10.0 BASIS OF PAYMENT

578.10.01 Unshrinkable Fill – Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Aggregate Gradation Requirements, LS-602 (Note 1)

Sieve Designation	Percent Passing
26.5 mm	100
75 µm	0-5

Notes:

1. Test samples shall be prepared by blending all aggregate components based on their individual percentages stated in the mix design.

TABLE 2
Aggregate Physical Property Requirements

Test Number	Laboratory Test	Acceptance Limit
LS-610	Organic Impurities, Organic plate number (Note 1)	3
LS-619	Micro-Deval Abrasion, fine aggregates, maximum (Note 2)	30%
LS-618	Micro-Deval Abrasion, coarse aggregates, maximum (Note 2)	25%
CSA A23.2-3B CSA A23.2-8B	Sulphate content (SO_4), maximum (Note 3)	1.5%
ASTM D1411	Water soluble chloride maximum, (Note 4)	0.010%

Notes:

1. For the natural sand component only. An aggregate that produces a colour darker than standard colour No. 3 shall be considered to have failed this requirement.
2. Test samples shall be prepared by blending all aggregate components based on their individual percentages stated in the mix design. The blended aggregate shall be split on the 4.75 mm sieve and the individual coarse and fine aggregate fractions set aside for testing as required.
3. For unshrinkable fill in contact with permanent concrete elements, the limit of SO_4 shall be a maximum of 0.20% unless the permanent concrete element meets the requirements of S1, S2, or S3 of CSA A23.1-14 Table 3 as appropriate.
4. This requirement is specified where the unshrinkable fill will be in direct contact with concrete or steel pipe.

Note: The 578 implemented in April 2025 replaces 578, April 2017 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR THE PLACEMENT OF UNSHRINKABLE FILL

TABLE OF CONTENTS

578.01 SCOPE

This specification covers the requirements for the placement of unshrinkable fill.

578.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 350 Concrete Pavement and Concrete Base
OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General
OPSS 1301 Cementing Materials
OPSS 1302 Water
OPSS 1350 Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:
LS-407 Method of Test for Compressive Strength of Moulded Cylinders
LS-610 Organic Impurities in Concrete Sands
LS-618 The Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-619 The Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

MTO Forms:
PH-CC-322 Concrete Construction Report

CSA Standards

A23.1 Table 3, Additional requirements for concrete subjected to sulphate attack*
A23.2-3B Total or Water-Soluble Sulphate Ion Content of Soil*
A23.2-8B Water-Soluble Sulphate Ion Content of Recycled Aggregates Containing Crushed Concrete*
A23.2-3C Making and Curing Concrete Compression and Flexural Test Specimens*
A23.2-5C Slump and Slump Flow of Concrete *
A3001 Cementitious Materials for Use in Concrete**

* [Part of CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

** [Part of CSA A3000-13 Cementitious Materials Compendium]

ASTM International

D1411-09 Standard Test Methods for Water-Soluble Chlorides Present as Admixtures in Graded Aggregate Road Mixes

578.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Unshrinkable Fill means a self-compacting cement treated aggregate with flowable consistency and controlled low strength properties.

578.04 DESIGN AND SUBMISSION REQUIREMENTS

578.04.01 Design Requirements

Unshrinkable fill shall be according to the following:

a) The mix shall be designed to provide appropriate strength and performance characteristics for the intended use, and to meet the requirements as specified in the contract documents.

b) The unshrinkable fill shall contain 25 kg/m3 of Type GU or GUL cement according to CSA A3001 and may contain additional supplementary cementing materials to aid in placement.

c) The mix may contain foaming agents to aid in placement.

d) Slump at point of discharge shall be a minimum of 150 mm and the unshrinkable fill shall be uniformly mixed throughout.

e) The material shall be designed such that it can flow into the excavation and fill the entire space without vibration, and without segregation.

f) The 28-Day compressive strength shall be a maximum of 0.40 MPa.

578.04.02 Submission Requirements

The Contractor shall be responsible for designing the unshrinkable fill mix and shall submit the unshrinkable fill mix design according to OPSS 1350 except the use of reclaimed concrete material and the amount used expressed in percent by mass of the total aggregate shall be identified on Forms A and B.

578.05 MATERIALS

578.05.01 Cementing Materials

Cementing materials shall be according to OPSS 1301.

578.05.02 Water

Water shall be according to OPSS 1302.

578.05.03 Aggregates

Aggregates shall be according to OPSS 1001 and this specification.

Except as noted below or elsewhere in the Contract Documents, aggregates may be sands, gravel, quarried rock or reclaimed concrete material provided the source is of such a nature and extent as 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 OPSS 1001 and 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 or another source is selected.

Fine and coarse aggregates shall meet the grading requirements of Table 1 and the physical property requirements of Table 2.

578.05.03.01 Reclaimed Concrete Material

Reclaimed concrete material may be used up to a maximum of 25 % by mass of the total aggregate. Reclaimed concrete material shall not be used in unshrinkable fill to be placed in contact with sulphate-bearing soil or ground water with sulphate.

578.06 EQUIPMENT

578.06.01 Mixing Equipment

A central mixing, dry batch plant, capable of accurately proportioning aggregate, cement, and water shall be used. The plant shall be certified according to OPSS 1350.

578.06.02 Transport Equipment

Unshrinkable fill shall be transported to the site by means of ready mix trucks.

578.07 CONSTRUCTION

578.07.01 Operational Constraints

Where vehicular traffic, including construction equipment, is to be accommodated, the unshrinkable fill shall be protected by covering it with a steel plate suitable for the traffic loading for a minimum of 24 hours.

Hot mix asphalt or any other material shall not be placed on unshrinkable fill until a minimum of four hours after the placing of unshrinkable fill.

578.07.02 Unshrinkable Fill Placement Requirements

Individual loads of unshrinkable fill shall be placed within 2 hours from the time of batching.

When placed into excavations, unshrinkable fill shall be placed so that it fills the entire excavation without voids beneath horizontal projections or in other locations within the excavation. When unshrinkable fill is to be placed in an excavation subject to the entry of flowing water, the excavation shall be dewatered according to OPSS 517 prior to placement of the unshrinkable fill.

When placed adjacent to culverts, arches, rigid frames, integral abutments and piers, the unshrinkable fill shall be placed in alternating layers on each side of the structure to balance the earth pressure forces. Unless specified in the Contract Documents, the unshrinkable fill layers shall not exceed 500 mm in thickness and the height of the layers shall be approximately the same. At no time shall the elevation difference between the sides be greater than 500 mm. Each layer shall set for a minimum of four hours before a new layer is placed.

When shoring, bracing, or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, and this support system is to be removed, it shall be removed as filling proceeds to ensure stability of the excavation.

The unshrinkable fill material shall be protected from cold weather according to OPSS 350 with the exception that unshrinkable fill shall be protected from freezing after placement but need not be monitored with thermocouples nor maintained above 15^{o} C.

578.07.03 Field Sampling and Testing

The Contractor shall be responsible for testing of slump, casting, initial storage and transportation of cylinders for compressive strength determination by the Owner.

Field sampling and testing of concrete shall be performed by a person holding either of the following certifications:

a) CCIL Certified Concrete Testing Technician, or

b) ACI Concrete Field Testing Technician, Grade 1.

Such persons shall have a valid original card issued by the certifying agency in their possession at all times.

Unshrinkable fill shall be tested for slump according to CSA A23.2-5C when directed by the Contract Administrator. Unshrinkable fill that does not meet the slump requirement shall be adjusted to meet the slump requirement or rejected and removed from the Working Area.

For the determination of compressive strength, a set of two cylinders, 150 mm diameter 300 mm long, shall be cast each Day of production and placement, when directed by the Contract Administrator. When there is more than one supplier of unshrinkable fill, a separate set of two cylinders for each supplier shall be cast each Day of production and placement.

Cylinders shall be cast and transported according to CSA A23.2-3C except that only cardboard moulds shall be used to cast the test cylinders. A disc of wax paper matching the inside diameter of the cylinder mould shall be placed at the base of the cylinder mould prior to casting. The interior sidewalls of the cardboard mould shall be treated with a light coating of release agent.

For the first 24 hours after casting, test cylinders shall be stored within the Working Area either covered or in a shaded area.

Test information shall be recorded on MTO form PH-CC-322, a copy of which shall be submitted with each set of compressive strength cylinders.

The Contractor shall transport the cylinders to the designated quality assurance laboratory specified in the Contract Documents, for testing.

578.08 QUALITY ASSURANCE

578.08.01 Testing Requirements

Compressive strength testing shall be according to LS-407. The results of the set of two cylinders cast each Day shall be averaged to provide the test result for the Day.

578.08.02 Acceptance

Unshrinkable fill shall be accepted when:

a) The material does not deform under traffic loading.

b) The compressive strength requirements are met.

c) Materials used comply with the requirements of this specification.

578.09 MEASUREMENT FOR PAYMENT

578.09.01 Actual Measurement

Measurement of unshrinkable fill shall be by volume in cubic metres.

578.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

578.10.0 BASIS OF PAYMENT

578.10.01 Unshrinkable Fill - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Aggregate Gradation Requirements, LS-602 (Note 1)

Sieve Designation	Percent Passing
26.5 mm	100
75 µm	0-5

Notes:

1. Test samples shall be prepared by blending all aggregate components based on their individual percentages stated in the mix design.

TABLE 2
Aggregate Physical Property Requirements

Test Number	Laboratory Test	Acceptance Limit
LS-610	Organic Impurities, Organic plate number (Note 1)	3
LS-619	Micro-Deval Abrasion, fine aggregates, maximum (Note 2)	30%
LS-618	Micro-Deval Abrasion, coarse aggregates, maximum (Note 2)	25%
CSA A23.2-3B CSA A23.2-8B	Sulphate content (SO_4), maximum (Note 3)	1.5%
ASTM D1411	Water soluble chloride maximum, (Note 4)	0.010%

Notes:

1. For the natural sand component only. An aggregate that produces a colour darker than standard colour No. 3 shall be considered to have failed this requirement.
2. Test samples shall be prepared by blending all aggregate components based on their individual percentages stated in the mix design. The blended aggregate shall be split on the 4.75 mm sieve and the individual coarse and fine aggregate fractions set aside for testing as required.
3. For unshrinkable fill in contact with permanent concrete elements, the limit of SO_4 shall be a maximum of 0.20% unless the permanent concrete element meets the requirements of S1, S2, or S3 of CSA A23.1-14 Table 3 as appropriate.
4. This requirement is specified where the unshrinkable fill will be in direct contact with concrete or steel pipe.