


6145 Permaphalt membrane system application



Melter loaded with 6145 HRA membrane and heated to 375F and up to 410F in Canada. Priming the concrete has been completed with TremPrimer.



Reemay installed over 1.5MM(60
mils) of 6145 installed to cracks.
Neoprene would have been used if
the cracks were larger than 2mm

Two construction workers are shown installing a waterproofing membrane on a concrete surface. One worker is using a brush to apply a liquid material to the surface, while the other is standing nearby. A roll of the membrane material is visible on the ground.

Option-1

This option is a non-reinforced membrane
system other than cracks/cold joints and drains

6145 HRA
2.5mm(100mils)

2178 protection or
PowerPLY



Option-1

Option-1



Protection with 2" min overlap - seams covered with 6145 HRA membrane and sealed.

Option-1

This crack was 1.5mm(60mils. They opted for neoprene to cover crack as 6/ft of the 190/ft was over 2mm(80-90mils. They suspected the entire crack would eventually be just over 2mm wide.

Cold joint shows no cracking.
It was done with 2014 reemay over 1.5mm(60mils of 6145 membrane

Option-1



The 6145 and protection now carries over the reinforced cracks/cold joints


Option-1

Reglet chosen over termination bar



In this particular case, we allowed the use of 4" 2010 mesh then reemay to the upturns. Someone caulked the floor parapet transition prior to Tremco's involvement. Expensive but very affective method. We found (through lab test) the sealant compatible on 1700/ft with 6145 over top. 560/ft of sealant was not compatible. Tremco's MSUP primer was used to seal the caulking the day before the 6145 was installed.

Option-1



Caulking was done to routed parapets to prevent water from infiltrating the backside of the upturned membrane.

Scupper transfer drains were completely detailed with 6145. Neoprene on the bottom with reemay on the sides about 1" - 2" up.

Option-1



2" to 6" overlap with 6145 as tack coat

Option-2



6145 fully reinforced HRA system. Note with option-2, the reemay fabric throughout the entire system

Note the termination bar without any reglets. The term bar was installed to hold the neoprene sheet to the 6145 HRA and wall. There was not enough room to keep the membrane below the asphalt height to install reemay over the neoprene reinforcing sheet. Second, the specification did not include the extra cost of the sloped asphalt pavement to the wall in order to gain membrane height. Term bar was the only option. The term bar and neoprene will be covered with another 2mm(80mils of 6145 with protection.



Option-2




Termination bar receiving 6145 to fully cover.

Option-2



Neoprene applied to upturn

Note: Your local Tremco sales technical rep may alter this type of upturn depending location/region and specific design requirements.




Inside corner cut to fit

Note the overlap

Outside corner cut to fit







more 6145 then reemay
if this option is chosen.

Note: Your local Tremco sales technical rep
may alter this type of upturn depending
location/region and specific design
requirements.

Note the reglet. All reinforcement will be kept below the reglet. Only 6145 enters or covers the reglet. This reglet was 3/8" wide by 5/8" deep. Adjust reglets for surface rebar.



All reinforcement can be adjusted for height of pavement

Reemay installed over neoprene as an option. No termination bar will be used here.

The spec here called for 3" 100/psi insulation over drain board. 4" granular. 3" asphalt paving in 2 lifts



Parking deck over curtain wall. Post will be capped with a proper crash post when complete. Neoprene sheet being prepared. 6145 will extend up and band clamped to post with protection.

Tremco Expansion joint installed and detailed with 6145 riding up the sides of the elastomeric expansion blockout. The expansion seal was raised to meet the asphalt height.

Option-2



Asphalt was placed with rubber wheeled spreaders.
The asphalt specified was HL-3HS High stability
asphalt pavement.

Option-2

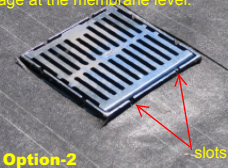
An aerial photograph of a road construction site. A large, roughly triangular area of newly laid asphalt pavement is visible, labeled 'Option-2' in yellow text. The asphalt is dark and textured, contrasting with the lighter, unpaved ground surrounding it. The shape of the paved area suggests a specific engineering or construction choice for a road intersection or turn-off.



Option-2

Asphalt pavement HL-3HS
installed at 310F with 97%
compaction.

All drains have membrane clamping rings. Note the molded drainage slots. This facilitates water drainage at the membrane level.



Option-2



Drain being prepared for 6145 membrane



6145 HRA membrane applied at 1.5mm(60mils
to primed deck



Neoprene sheet applied to hot rubber



Plastic backing to be removed



Plastic backing removed



Neoprene will be cut after they install the reemay and more 6145 right over the drains. They will heat the knife then cut. Once cut, more 6145 will be brushed to the inside of the drain to bond the neoprene down into the drain about 1 - 2"

Note, the cold joint was reinforced with neoprene sheet. The architect and structural engineer decided on neoprene over reemay fabric reinforcement because 12/ft of this 345 foot joint failed to meet the criteria for reemay fabric reinforcement. They suspected, if 12/ft of this joint fails the criteria in the summer months, the entire joint may exceed the criteria and surpass 2mm(80 to 90mils in the winter as the deck gets cold.

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Update: Sure enough, the structural engineer was correct. The joint acted like an expansion joint. Measurement Feb-22-2006 showed 2.7mm to 2.9mm


Option-2

Option-2

Preparing for another roll of reemay fabric.

6145 HRA is a seamless rubberized membrane.



A photograph showing three construction workers on a flat roof. One worker in a white shirt and dark pants is on the left, another in a white shirt and dark pants is in the center using a long-handled tool, and a third in a black tank top and jeans is on the right. They are installing a dark, reflective membrane over a white underlayment. A red arrow points from the top left towards the workers. Another red arrow points from the yellow text box to the worker in the center.


Notched squeegees are not allowed. Must be flat without notches.

Option-2

reemay installed to
the hot 6145
membrane.




Option-2

A photograph showing three construction workers on a flat roof. One worker in the foreground is kneeling, wearing a white shirt, dark pants, a white cap, and gloves, rolling a white fabric. Another worker stands behind him, using a long-handled broom to push the fabric. A third worker is visible in the background. A red arrow points from the text box to the broom. The roof surface is covered with a white fabric, and a blue metal edge is visible on the right.

Broom or tile roll the
reemay fabric into the
hot 6145 membrane

Option-2

Option-2

A construction worker in a black tank top and blue jeans is using a long-handled roller with a green brush head to depress a white reemay fabric on a dark roof. The worker is moving from right to left. In the background, there are various construction materials and equipment, including a red pickup truck and a blue trailer. A red arrow points from the text box to the roller.

**Rollers also work to
depress the reemay fabric**

A black, rectangular wheeled spreader is positioned on a ship's deck. The spreader has a handle on the left side and two small wheels at the bottom. It is being used to cast a 6145 membrane. The background shows the ship's deck and a body of water.

Option-2

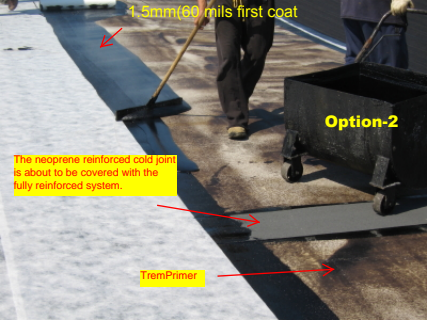
Both wheeled spreaders or 5-gallon steel pails used to cast 6145 membrane

1.5mm(60 mils first coat

Option-2

The neoprene reinforced cold joint is about to be covered with the fully reinforced system.

TremPrimer





Option-2



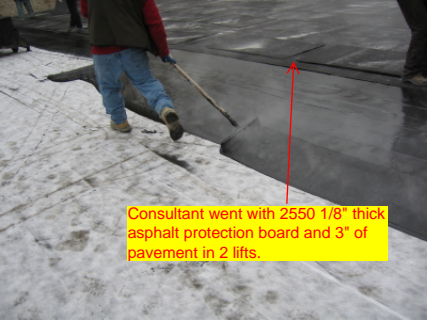
Who's getting the coffee

I'll take a Labatts Blue
"EH"

Option-2



1.5mm(60 mils
second coat of 6145



Consultant went with 2550 1/8" thick asphalt protection board and 3" of pavement in 2 lifts.

Protection installed to 6145 while
membrane is still very hot



Canada. Temp 18F

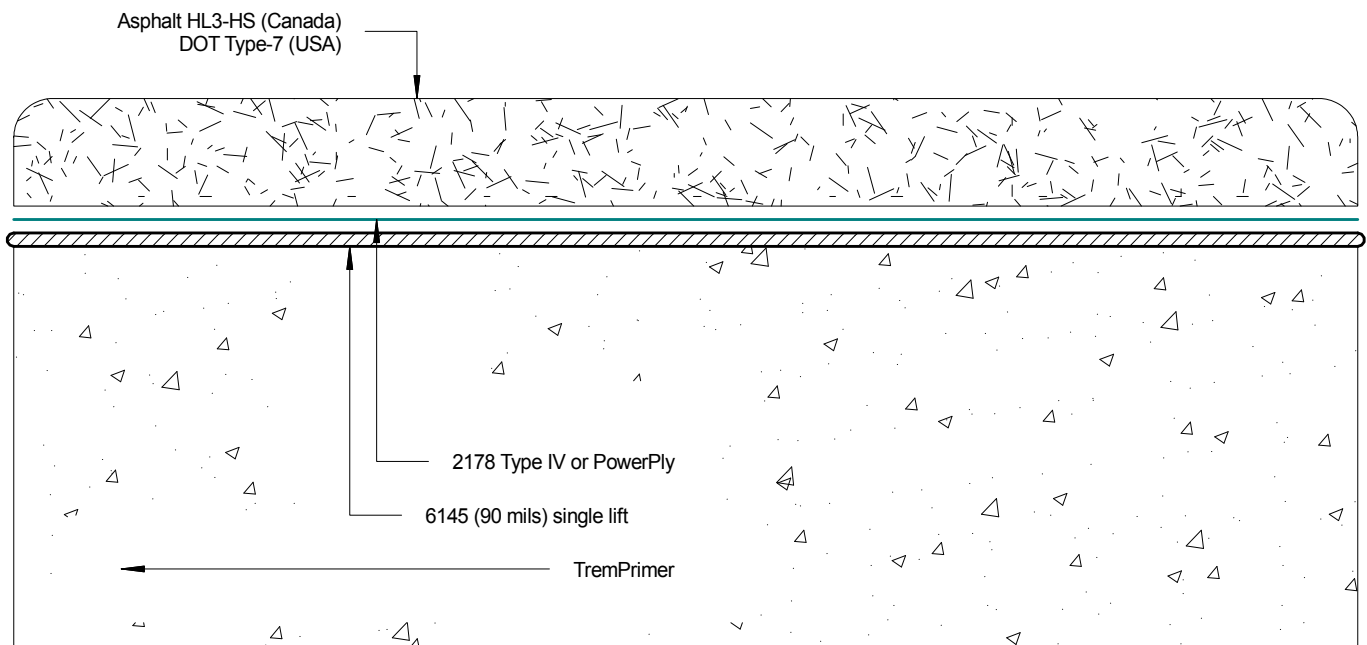


Permaphalt System Option-1

Shown: 6145 HRA membrane single lift system

Detail>> D-1441-184A

Option-1. No fabric reinforcement to entire deck with the exception of upturns and cracks/cold joints/drains



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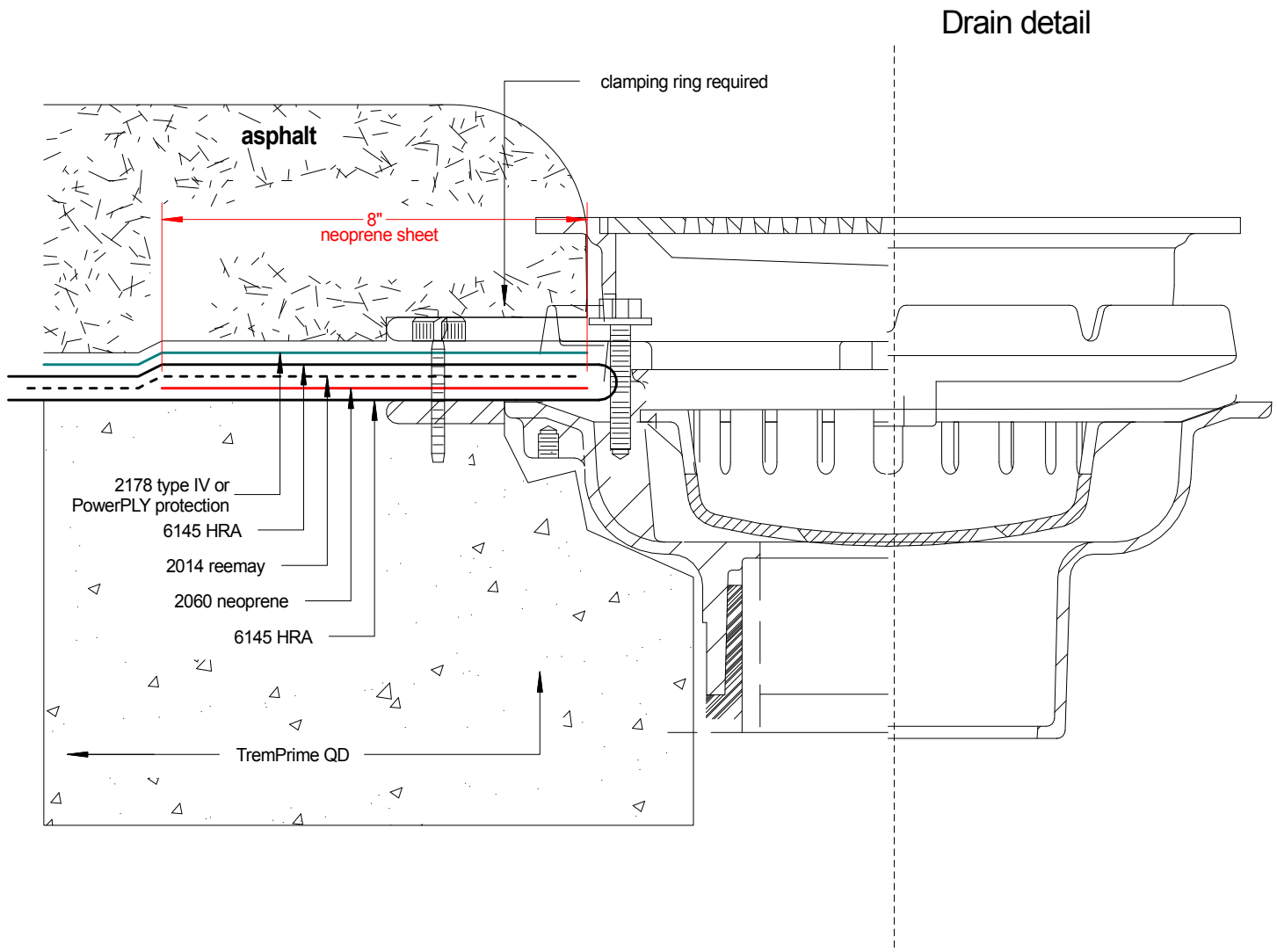
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<u>Drawn by:</u> G.M.	<u>Approved:</u> <>	<u>Scale:</u>
<u>Project:</u>		



6145 Permaphalt HRA Membrane System

Shown: 6145 HRA installation to drain c/w
2060 neoprene 2014 reemay

Detail>> D-1064-6A



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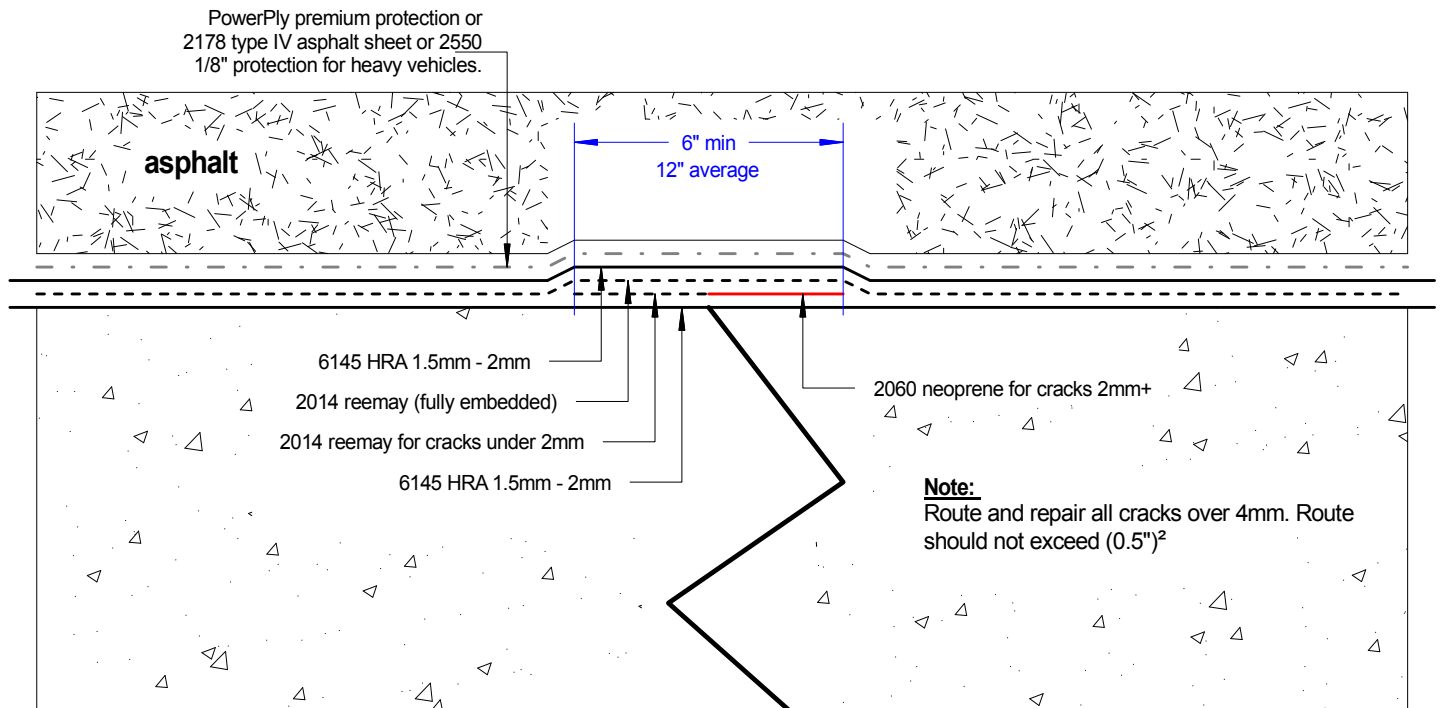
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<u>Date:</u> Jul-17-2008		<u>Drawing No.</u> D-1064-6A
<u>Drawn by:</u> G.M.	<u>Approved:</u> <>	<u>Scale:</u>
<u>Project:</u>		



6145 Permaphalt HRA Membrane System
shown: crack reinforcement to concrete substrate

Detail>> D-1063-2A



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<u>Date:</u> July-17-2008		<u>Drawing No.</u> D-1063-2A
<u>Drawn by:</u> G.M.	<u>Approved:</u> <>	<u>Scale:</u>
<u>Project:</u>		



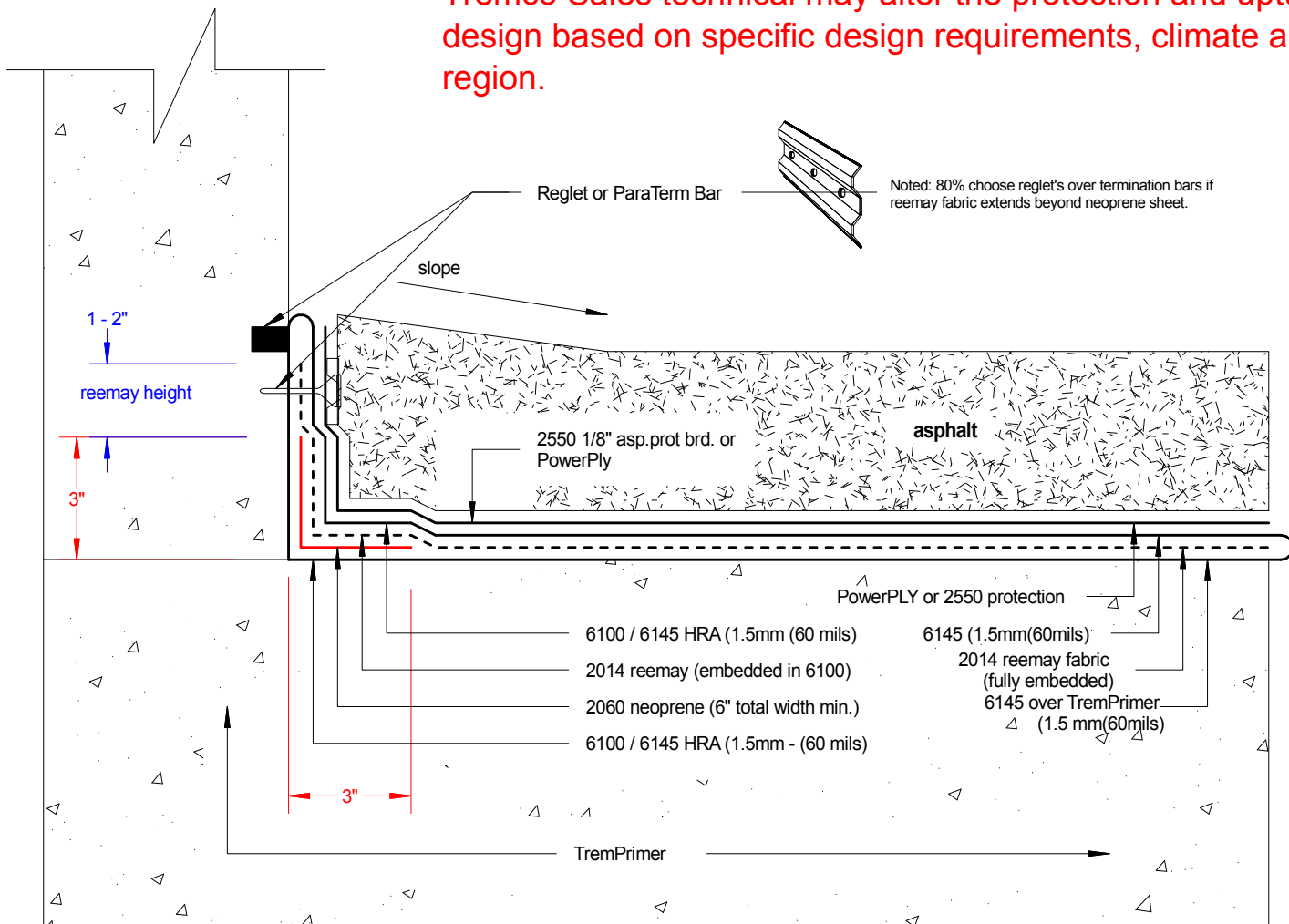
6100 / 6145 HRA membrane system. Application to concrete parking or ramp.

Shown: 6145 HRA for southern climates. 6100 and 6145 for northern climates.

Note: 6100 HRA with 2550 protection for southern climates is acceptable where asphalt pavements are 2.5" minimum.

detail>>> D-943-5B

Tremco Sales technical may alter the protection and upturn design based on specific design requirements, climate and region.



Note: The 2178 protection is used 10% of the time in southern climates where reemay fabric is used in the membrane. Reason, the fully reinforced membrane system is thicker than non-reinforced 6145 membrane. The thicker the membrane, the softer the membrane is as a substrate to the asphalt pavement. Talk with your local Tremco sales technical rep for options.

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<u>Date:</u> Jun-16-2011		<u>Drawing No.</u> D-943-5B
<u>Drawn by:</u> G.M.	<u>Approved:</u> <>	<u>Scale:</u>
<u>Project:</u> typical		

PERMAPHALT SYSTEM- Asphalt Mix and Installation Specification

Description: The following mix design is specifically intended for use with the Permaphalt Traffic Deck System. The asphalt is intended to be laid in a single lift with a minimum thickness of 2" (52mm) and becomes an integral part of the system, which incorporates the TP 6145 waterproofing membrane. The asphalt overlay is intended to provide a stable wearing surface, which provides long-term protection to the TP 6145 membrane.

Specification: The mix incorporates a unique, uniform balance of coarse and fine aggregates as required for the hot mix type, mixed with asphalt cement. The aggregates and asphalt cement shall be combined to produce a hot mix conforming to the asphalt cement content, gradation and Marshall Properties as listed below:

Sieve Size (mm)												
%A.C	26.5	19.0	16.0	13.2	9.5	4.75	2.36	1.18	0.60	0.30	0.15	0.08
5.3-7.0	100	100	100	99.4	82.5	55.0	48.0	32.3	20.5	12.4	7.4	4.9
Percent Particles Passing												

Marshall Properties:

Minimum Marshall Stability (Newton's @ 60° C)	14,000
Minimum Marshall Flow (Units of 0.25mm @ 3.5% Air voids)	8-14
Air voids (%)	3-5
Minimum Voids in mineral aggregates (%)	14.5
Minimum Compaction of Marshall Density (%)	96

Installation:

1. Asphalt wearing course shall be installed at a minimum depth of 2" (5.08 cm) in a single pass with a mechanical, self-propelled rubber wheeled spreader.
2. Wearing course shall be rolled even and compressed with a steel-wheeled roller of a minimum 3000lbs. (1400kg.).
3. All termination points of wear course shall have a positive up-turn to allow for drainage.

D.O.T. Type 7 may be an option.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS 1150
NOVEMBER 2008**

**MATERIAL SPECIFICATION FOR
HOT MIX ASPHALT**

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1150.01 SCOPE

This specification covers the requirements for the materials, equipment, and methods to be followed for proportioning and mixing hot mix asphalt, including recycled mixes and mixes for miscellaneous work.

1150.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

1150.01.02

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.

1150.02

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.

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1101	Performance Graded Asphalt Cement

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-261	Preparation of Marshall Specimens
LS-262	Bulk Relative Density of Compacted Bituminous Mixtures
LS-263	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
LS-264	Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265	Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-283	Resistance to Stripping of Asphalt Cement in Bituminous Mixture by Marshall Immersion

- LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-307 Design Procedure for Recycled Hot Mix

American Association of State Highway and Transportation Officials (AASHTO)

M320-05 Performance-Graded Asphalt Binder

Asphalt Institute Publications (AI)

MS-2, Sixth Edition Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types

1150.03 DEFINITIONS

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

AMRL means the AASHTO Materials Reference Laboratory.

Binder Course means a hot mix asphalt (HMA) course between a surface course and either a granular base course or stabilized base course, an existing pavement, or another HMA binder course.

Blending Aggregates means any coarse or fine aggregate that is added to HMA in order to produce hot mix that is according to this specification.

CCIL means the Canadian Council of Independent Laboratories.

Field Adjustment to the JMF means adjustments to the target gradation or asphalt cement content or both of a mix without a redesign of the HMA, resulting in a revised job-mix formula (JMF).

HL, Hot Mix, Mixture, Mix, and Hot Mix Asphalt means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Hot Mix Types means those specified in Table 1.

Job-Mix Formula means the percentage passing on each designated sieve of the total mass of aggregate and the amount of asphalt cement as a percentage by mass of the mixture that are based on specified mix design procedures, and when mixed results in a paving mixture that is according to this specification.

Levelling Course means a HMA course of variable thickness used to eliminate transverse and longitudinal irregularities on an existing surface prior to placing an HMA binder or surface course.

Mix Design means the design of the proportions of aggregates, asphalt cement, and additives when uniformly mixed results in an acceptable HMA in accordance with the specified method.

Mixes for Miscellaneous Work means HMA used for miscellaneous work such as the paving of shoulders, boulevards and sidewalks, and the construction of curb and gutter and spillways. These mixes do not meet normal HMA gradation and mix design requirements.

Performance Graded Asphalt Cement (PGAC) means an asphalt binder that is an asphalt-based cement produced from petroleum residue, either with or without the addition of non-particulate modifiers, according to AASHTO M320.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full depth removal.

Recycled Hot Mix (RHM) means an HMA that contains RAP.

Surface Course means the HMA wearing course of any flexible or composite pavement.

1150.04 DESIGN AND SUBMISSION REQUIREMENTS

1150.04.01 Design Requirements

1150.04.01.01 Mixture Requirements for Design Purposes

The mixture made during mix design shall be according to the requirements specified in Tables 2, 3, 4, 5, 6, and 7.

The JMF shall be according to the requirements specified in Tables 2 and 3.

1150.04.01.01.01 Reclaimed Asphalt Pavement Proportions

The use of:

- a) Up to 15% by mass of RAP shall be permitted for HL 3, HL 3F, HL 4, and HL 4F surface course mixes.
- b) Up to 30% by mass of RAP shall be permitted for HL 4, HL 8, and medium duty binder mixes.
- c) When 31 to 50% by mass of RAP is proposed for HL 4 or HL 8 binder mixes, written approval by the Contract Administrator shall be obtained for the mix design, including PGAC modification.
- d) Over 50% by mass of RAP is not permitted for any mix.

1150.04.01.02 Mix Design

1150.04.01.02.01 General

The mix design shall be the responsibility of the Contractor. The job-mix formula selected for use by the Contractor shall produce hot mix that is in accordance to all requirements specified in the Contract Documents.

1150.04.01.02.02 Mix Design Method

The Contractor shall use a laboratory that has current CCIL Type A Certification or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator to conduct all mix designs, designate the mix proportions, and prepare the job-mix formula. For all mixes, except those that contain RAP, the mix design procedures and tests shall be in accordance to the Marshall Method in the Asphalt Institute Manual Series No. 2, MS-02, following the LS-261, LS-262, LS-263, LS-264, LS-265, and LS-283 tests and the requirements detailed herein. Mix design procedures for mixes that contain RAP shall be according to LS-307.

All mixes shall be designed using 75 blows per side of the test specimen with a manual compaction hammer or a mechanical equivalent to 75 blows per side of the test specimen with a manual compaction hammer.

The aggregate gradings used for the mix design may be gradings provided by the Contractor or the actual gradings of the mix design aggregate samples. However, when the mix is to be produced from a plant that returns fines to the mixture or the aggregate gradations change during production due to aggregate breakdown, appropriate adjustments shall be made to the mix design gradations.

When a mix contains additives and the source of asphalt cement changes from that used in the mix design, tests shall be re-done to verify the dosage of such additives.

RAP as processed and ready for use in a HMA shall be tested by the Contractor using test LS-282 or LS-292 to determine the average percentage asphalt cement and the average gradation for the extracted reclaimed asphalt pavement aggregates.

1150.04.01.02.03 Changes to the Job-Mix Formula and the Mix Design

Changes to the JMF shall be permitted when it has been determined that the mix properties specified in the Contract Documents are not being met. All changes are subject to the conditions specified below.

Changes to the material proportions based on process control test results shall be permitted without a new mix design, but further hot mix production shall be subject to conditions imposed by the Contract Administrator. In this situation, when the Contractor changes the JMF, the Contract Administrator shall review the revised JMF for conformance to the mix properties with the Contract requirements. Within 1 Business Day of the modified JMF being received in full by the Contract Administrator, the Contract Administrator shall provide in writing conditional permission to construct HMA or the reason why permission is being withheld.

A new mix design and mix designation documents and a new JMF shall be completed when:

- a) A material is eliminated.
- b) A new material is added.
- c) It is not possible to comply with the maximum permitted fine aggregate blending ratio.
- d) Changes to the material proportions have not resulted in correction of the problems with the mix.
- e) The net impact of all adjustments to the original JMF exceed any of the maximum field adjustments specified in Table 8.

The new mix design, new JMF documents, and new samples, if required, for monitoring purposes shall be delivered to the Contract Administrator. The new mix design shall be accepted or rejected within 5 Business Days, which commence when all of the required samples and documents have been submitted.

1150.04.01.03 Anti-Stripping Additives

The Contractor shall determine the need for and the amount of anti-stripping additive required using LS-283.

The need for and the amount of anti-stripping additive required shall not be affected by any previous determination made with respect to the same or any other aggregate source.

Regardless of the hot mix type, the amount of liquid anti-stripping additive either specified in the Contract Documents or determined through mix design procedure shall be a percentage of the total asphalt cement required.

The amount of anti-stripping additive required shall be the greater of the:

- a) Amount required to provide a minimum of 70% retained stability, as determined by LS-283.
- b) Minimum dosage requirements outlined in the Owner's pre-qualified products list for asphalt aggregates.

Whenever an anti-stripping additive is required, the following applies:

- a) For all DFC mixes or other mixes consisting of more than 75% dolomitic sandstone or meta-arkose aggregates or combinations thereof, the anti-stripping additive shall be hydrated lime ($\text{Ca}(\text{OH})_2$) with a minimum dosage requirement of 1% by mass of the total dry aggregate.
- b) For all other combinations of aggregates, the anti-stripping additive may be hydrated lime or a chemical agent.

Anti-stripping additive shall be used according to supplier information. The following information on the hydrated lime anti-stripping additive shall be provided to the Contract Administrator:

- a) Documentation that the hot mix shall be produced in accordance to all requirements of the Contract.
- b) Amount of hydrated lime to be used as determined in the mix design procedures.
- c) Complete information on how the hydrated lime is to be used and how the hydrated lime is to be incorporated into the mixture.
- d) The amount of hydrated lime as a percentage of the mass of the aggregate.

1150.04.02 Submission Requirements

1150.04.02.01 Mix Design

A minimum of 10 Business Days prior to the start of the paving operation, the proposed mix design and JMF shall be submitted in writing to the Contract Administrator. The Contract Administrator shall provide in writing the permission to construct using the documentation referred to above or the reason why the permission is being withheld within 10 Business Days of submission of all the required samples and documents.

1150.04.02.01.01 Changes to the Job-Mix Formula and the Mix Design

When the Contractor changes the JMF, the revised JMF shall be submitted in writing to the Contract Administrator.

When the Contractor submits a new mix design, it must be accompanied by samples for monitoring purposes, if required; a Mix Design Report; and the supporting documents as detailed in the Documents clause of the Submission Requirements subsection.

1150.04.02.02 Samples for Monitoring Purposes

Representative samples of the materials to be used in the work shall be provided to the Contract Administrator at the same time that the mix design and JMF documents are submitted.

The samples shall be labelled with the Contract number, material type, material source, and date of sampling (i.e., yyyy-mm-dd). The samples of coarse aggregate, fine aggregate, and blending aggregates shall be identified.

Each material sample shall be packaged separately and the samples shall be in containers that are clean, closed, and shall not rupture when lifted or handled. Each filled sample container shall have a maximum mass of 25 kg.

The minimum sample quantities shall be as specified in Table 9.

The Contract Administrator shall be provided with a copy of the mix design and JMF documents that shall be signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work. When the Owner has a Bituminous Mix Design Report form, that form may be required along with other supporting documents. Information shall be provided in a legible manner. The documents shall include the following information, as a minimum:

- a) Contract number, item number, and mix type for which the mix design and JMF were completed and a description of the usage of the mix on the Contract.
- b) All test results, mix design work sheets, and graphs.
- c) Material proportions and sources, including the Owner's Mineral Aggregate Inventory for the aggregate sources, when such information is available. The amount of RAP in per cent by mass and volumetric data shall also be included.
- d) Designation of the fine aggregate and the coarse aggregate.
- e) PGAC and source and per cent by mass of the required new asphalt cement.
- f) A graph of the temperature-viscosity relationship for the PGAC that is to be used in the mix shall be produced according to LS-261.
- g) Information on additives, including source, type, per cent by mass of asphalt cement, and test results according to LS-283, when anti-stripping tests are required.
- h) Information regarding fines that are returned to the mix, aggregate breakdown during production, and the resultant change in the aggregate gradations.
- i) For both coarse and fine aggregates, complete grading and volumetrics are required.
- j) The per cent air voids, Marshall flow, voids in mineral aggregate, and Marshall stability of the mixture selected and the mix design criteria to be met for each test.
- k) Graphs of the air voids, Marshall flow, voids in mineral aggregate, and Marshall stability of the mixture plotted against asphalt cement content.
- l) Aggregate absorptions.
- m) Bulk relative density and saturated surface dry density for each aggregate.
- n) Mix bulk relative density.
- o) Mix maximum relative density.
- p) Mix maximum relative density and surface dry density, where applicable.
- q) Extracted bulk relative density, percentage asphalt cement, and gradation for the RAP used in the mix, when RAP is permitted for use.
- r) All visual observations made during the design process with particular attention and comments regarding stripping and coating for both the coarse and fine aggregates.
- s) The JMF.

- t) The mixing and compaction temperature used in the mix design and the compaction temperature of the reheated mixture to be employed in the testing of the production mix.
- u) The typical mix weight to produce a briquette with a height of 63.5 mm \pm 1.5 mm.

1150.05 MATERIALS

1150.05.01 Asphalt Cement

Asphalt cement shall be performance graded asphalt cement according to OPSS 1101.

The supply and use of asphalt cement shall be as specified in the Contract Documents.

1150.05.02 Aggregates

Aggregates shall be according to OPSS 1003.

1150.05.02.01 Reclaimed Asphalt Pavement

RAP, where permitted in a HMA, shall be according to the aggregate requirements of OPSS 1003 for the mix type specified in the Contract Documents. Absorption, freeze thaw, and magnesium sulphate requirements do not apply to RAP.

RAP that is contaminated with deleterious material shall not be used and shall be removed from the work. RAP shall be stockpiled conforming to the stockpiling requirements for coarse aggregates according to OPSS 1001.

Process control sampling and testing of the reclaimed asphalt pavement shall be as specified in the Contract Documents.

1150.05.03 Silicone

When added to the asphalt cement, silicone oil shall be less than five parts per million of asphalt cement.

1150.05.04 Filler

Filler shall be according to OPSS 1003.

1150.06 EQUIPMENT

1150.06.01 Requirements for all Mixing Plants

The equipment shall be such that the HMA produced shall meet this specification and shall demonstrate adequate control and documentation of the HMA materials, mixing temperature, and storage for monitoring and production purposes.

When required by the Contract Administrator, all equipment shall be on the site and available for inspection before operations are commenced and during production operations.

1150.06.02 Truck Scales

Truck scales shall be according to the requirements of the Contract Documents.

1150.07 PRODUCTION

1150.07.01 General

The hot mix shall be produced to meet the submitted JMF or the adjusted JMF that was accepted in writing by the Contract Administrator.

The Contractor shall be responsible for the quality and characteristics of the mixture. If the hot mix produced does not meet the requirements of this specification, hot mix production shall stop and appropriate corrections shall be made to the process.

The Contractor is responsible for the process control and condition of all materials during the handling, blending, and mixing operations. The Contractor is responsible for determining and making all necessary adjustments in proportioning materials used to produce HMA to meet the Contract requirements.

1150.07.02 Operational Constraints

The JMF is the target to which the hot mix shall be compared to determine the acceptance of the aggregate gradation and asphalt cement. HMA shall not be placed until the Contract Administrator provides permission in writing to proceed with a submitted JMF.

The JMF shall remain in effect until the Contract Administrator receives any requested changes in writing and approves them.

1150.07.03 Handling of Materials

1150.07.03.01 Aggregate Stockpile Requirements

Before any production of the mixture is started, stockpiles of each size and gradation of aggregate shall be provided at the asphalt plant site. Each stockpile shall contain sufficient aggregate for one full Day's production of hot mix, before that Day's paving begins.

1150.07.03.02 Aggregates

1150.07.03.02.01 General

Aggregates shall be loaded into the cold feed bins in a manner that prevents the mixing of separate sizes of aggregates.

1150.07.03.02.02 Batch and Continuous Mixing Plants

When delivered to the mixing plant, the heated and dried aggregate shall be at a temperature consistent with proper mixing and laying of the mix. Surfaces of all dried aggregates shall be free of carbon or unburnt fuel oil.

1150.07.03.03 Anti-Stripping Additives

1150.07.03.03.01 Liquid Anti-Stripping Additives

Anti-stripping additive shall be handled and mixed with the asphalt cement according to the manufacturer's recommendations.

The Contractor shall provide the Contract Administrator with the following documentation:

- a) Verification that the chemical anti-stripping additive shall remain stable in the heated asphalt cement for a minimum of 4 Days.

- b) Type and dosage of anti-stripping additive used.
- c) Time, date (i.e., yyyy-mm-dd), and temperature when anti-stripping was added to the asphalt cement.

If the liquid anti-stripping additive is added to the asphalt cement at the refinery or asphalt cement depot, the Contractor shall provide the Contract Administrator with the above documentation in the form of a weighbill or bill of lading that accompanies each tanker of asphalt cement delivered.

If liquid anti-stripping additive is added to the asphalt tank at the hot mix plant, the liquid agent may be added to the asphalt tank by an in-line metering device or by another means, provided the above documentation is given to the Contract Administrator for each batch of asphalt cement to which anti-stripping agent is added.

If a liquid anti-stripping additive is not added to the asphalt tank, a continual record of the process for adding the additive shall be provided to the Contract Administrator in addition to the above documentation each time liquid anti-stripping additive is metered into the asphalt cement.

The Contract Administrator shall be provided with an approved statement of calibration for any metering device used to add the liquid anti-stripping additive.

1150.07.03.03.02 Hydrated Lime

When hydrated lime is added to the mix, it shall be added to all aggregates requiring an anti-stripping agent by one of the following methods:

- a) Hydrated lime slurry shall be homogeneously mixed with the aggregate in a pugmill or tumble mixer, prior to entering the asphalt plant.
- b) Hydrated lime shall be homogeneously mixed with wetted aggregate in a pugmill or tumble mixer, prior to entering the asphalt plant. The wetted coarse and fine aggregate shall have a sufficient moisture content to ensure uniform and complete adhesion of lime to the aggregate.
- c) Hydrated lime shall be homogeneously mixed with the aggregate at the pit or quarry, prior to delivery of the limed aggregate to the hot mix plant.

Regardless of the mixing equipment or procedure used, the aggregate shall possess a uniform and homogeneous coating of hydrated lime. Aggregate treated with hydrated lime shall be used within the same construction season it is treated. Aggregate that was treated and stored from a previous construction season may only be used if the Contract Administrator agrees to a written proposal from the Contractor. The written proposal shall verify the effectiveness of the stored aggregate, indicate the sampling protocol used, and include the current test results from samples that indicate the aggregate meets the Contract requirements for retained stability.

1150.07.04 Preparation of the Mixture

Proportioning and mixing of materials shall be of sufficient accuracy and duration to produce a uniform homogeneous mixture in which all particles of the aggregate are thoroughly and uniformly coated.

The temperature of the mixture, except for RHM, as it is discharged from the mixer shall be controlled within the temperature range that corresponds to the PGAC manufacturer's recommending mixing temperature.

1150.08 QUALITY ASSURANCE

1150.08.01 General

The Contractor shall obtain for the Contract Administrator, within 1 Business Day of submission of request in writing, the right to enter upon the premises of any of the material manufacturers, suppliers, plants, laboratories, or equipment for purposes pertaining to the work, to carry out such inspection, sampling, and testing as specified or as requested by the Contract Administrator.

TABLE 1
Hot Mix Types

Hot Mix Type (Note 1)	Abbreviation	Summary of Hot Mix Use and Properties
Dense Friction Course	DFC	A dense-graded surface course mix with high frictional resistance for high volume roads. Aggregates have an identical gradation to HL 1 aggregates with a maximum aggregate size of 16 mm. Premium 100% crushed aggregates are used for fine and coarse aggregates that are from the same source. (Note 2)
Hot Laid 1	HL 1	A dense-graded surface course mix with a premium quality coarse aggregate. It is used on high volume roads and has a maximum aggregate size of 16 mm. Coarse aggregates are 100% crushed material. (Note 2)
Hot Laid 2	HL 2	A sand mix used primarily as a levelling course on existing pavements or a surface course on low speed traffic areas requiring a thin overlay. It is also used to fill wide cracks and has 100% of the aggregate passing the 9.5 mm sieve size.
Hot Laid 3	HL 3	A dense-graded surface course mix for intermediate volume roads with a maximum aggregate size of 16 mm.
Hot Laid 3 High Stability	HL 3HS	A dense-graded padding and levelling mix of high stability. The coarse aggregate conforms to the physical requirements of HL 3 with a maximum aggregate size of 16 mm. The fine aggregate conforms to the same physical requirements as HDBC. Coarse and fine aggregates are 100% crushed material.
Hot Laid 3 Fine	HL 3F	A fine-graded mix used as a surface course where hand work is necessary for placement. It is also used on low volume roads, driveways, boulevards, etc. The maximum aggregate size is 16 mm.
Hot Laid 4	HL 4	A dense-graded mix used as a surface or binder course on low volume roads. The maximum aggregate size is 19 mm.
Hot Laid 4 Fine	HL 4F	A fine graded mix used as a surface course where hand work is necessary for placement. It is also used on low volume roads, driveways, boulevards, etc. The maximum aggregate size is 19 mm.
Hot Laid 8	HL 8	A coarse-graded binder course mix. The maximum aggregate size is 26.5 mm.
Medium Duty Binder Course	MDBC	A binder course mix intended for use in locations where rutting and deformation is likely to occur due to frequent heavy traffic loading. A minimum of 80% of the coarse aggregates must have two crushed faces and the maximum aggregate size is 26.5 mm.
Heavy Duty Binder Course	HDBC	A high stability binder mix designed to provide superior resistance to rutting. Both fine and coarse aggregates are 100% crushed material. The maximum aggregate size is 26.5 mm.
Notes: 1. Specification requirements for the RHM are identical to those of the new hot mixes. 2. As listed in the Owner's pre-qualified products list for coarse aggregates for HL 1, DFC, and fine aggregates for DFC.		

TABLE 2
Gradation Requirements - Mix Design Criteria

Mix Types	Percentage Passing by Dry Mass of Aggregates											
	Sieves											
	mm								µm			
	26.5	19.0	16.0	13.2	9.5	4.75	2.36	1.18	600	300	150	75
DFC and HL 1			100	98-100	75-90	(Note 1)	36-64	25-58	16-45	7-26	3-10	0.5
HL 2					100	85-100	70-90	50-75	30-55	15-55	5-16	3-8
HL 3 and HL 3HS			100	98-100	75-90	50-60	36-60	25-58	16-45	7-26	3-10	0-5
HL 3F			100	98-100	85-94	65-75	52-75	36-72	23-56	10-32	3-12	0-6
HL 4		100	98-100	83-95	62-82	45-60	27-60	16-60	8-47	4-27	1-10	0-6
HL 4F		100	98-100	90-98	80-92	65-80	52-80	36-72	21-56	10-32	3-12	0-6
HL 8 and MDBC	100	94-100	77-95	65-90	48-78	30-50	21-50	12-49	6-38	3-22	1-9	0-6
HDBC	100	94-100	77-95	65-90	48-78	(Note 2)	21-54	12-49	6-38	3-22	1-9	0-6

Notes:

- HL 1 mix for use on facilities with a posted speed of less than 80 km/h shall contain a maximum of 60% by volume of the total aggregates passing the 4.75 mm sieve. The coarse aggregates used shall be approved for HL 1 and shall be listed in the Owner's pre-qualified product list.

HL 1 mix for use on facilities with a posted speed of 80 km/h or greater shall contain a maximum of 50% by volume of the total aggregates passing the 4.75 mm sieve. The coarse aggregates used shall be approved for HL 1 and shall be listed in the Owner's pre-qualified product list.

DFC mix shall contain from 50 to 55% by volume of the total aggregates passing the 4.75 mm sieve. The coarse and fine aggregates used shall be from the same source approved for DFC and listed in the Owner's pre-qualified product list.
- HDBC shall contain from 35 to 52% by volume of the total aggregates passing the 4.75 mm sieve.

TABLE 3
Asphalt Cement Content - Mix Design Criteria

Hot Mix Type		% Asphalt Cement Content, minimum by mass of mixture
HL 1, HL 3, and HL 4		5.0
DFC	100% Trap Rock Aggregate	4.8
	100% Dolomitic Sandstone Aggregate	5.1
	100% Meta-arkose	5.1
	100% Gneiss	5.1
HL 2		6.0
HL 3F and HL 4F		5.5
HDBC, MDBC, and HL 8		4.7
HL 3HS		5.0

TABLE 4
Air Voids - Mix Design Criteria

Hot Mix Type	% Air Voids
All mixes, except HL 2 Surface and DFC	4.0 ± 0.5
HL 2 Surface	5.0 ± 0.5
DFC	3.5 ± 0.3

TABLE 5
Marshall Flow - Mix Design Criteria

Minimum Marshall Flow: Units of 0.2 mm at 3.5% Air Voids	
All mixes, except HL 2, HL 3F, and HL 4F	8
HL 2, HL 3F, and HL 4F	9

TABLE 6
Marshall Stability - Mix Design Criteria for All Paving Mixtures

Minimum Marshall Stability: N at 60 °C	
Surface Course, except for HL 2, HL 3F, HL 4F, and HL 3HS	8,900
Binder, Levelling, and Padding Courses, except for HL 2, HL 3F, HL 4F, HL 3HS, and HDBC	8,000
HL 2, HL 3F, and HL 4F Surface Course	5,800
HL 2, HL 3F, and HL 4F Levelling and Binder Courses	4,400
HL 3HS and HDBC	12,000

TABLE 7
VMA Requirements - Mix Design Criteria

Voids in Mineral Aggregate (VMA), % minimum (Note 1)									
Hot Mix Type	Passing 4.75 mm Sieve by Mass	Nominal Maximum Particle Size							
		2.36 mm	4.75 mm	9.5 mm	13.2 mm	16.0 mm	19.0 mm	26.5 mm	37.5 mm
All Mixes Except HL 2 and DFC (Note 2)	40%				13.5	13.0	12.5	11.5	11.0
	45%				14.0	13.5	13.0	12.0	11.5
	50%				14.5	14.0	13.5	12.5	12.0
	55%				15.0	14.5	14.0	13.0	12.5
	60%				15.5	15.0	14.5	13.5	13.0
	more than 60%	21	18	16	16.0	15.5	15.0	14.0	13.5
HL 2		21.0	18.0	16.0					
Notes: 1. The per cent voids in compacted mineral aggregate allowing for volume of absorbed asphalt, per cent VMA, is based on the nominal maximum particle size of the total aggregate. Nominal maximum particle size is the sieve next larger than the designated large sieve on which no more than 90% of the total aggregate is accumulatively passing. 2. The per cent voids in mineral aggregate and asphalt cement film thickness in DFC mix based on MS-02 shall be reported in the mix design.									

TABLE 8
Permitted Field Adjustment to a Job-Mix Formula

JMF Property	Maximum Field Adjustment
Asphalt cement content	± 0.2%
Per cent RAP	- 5.0%
Per cent passing 26.5 mm, 19.0 mm, and 16.0 mm sieves	± 5.0%
Per cent passing 13.2 mm and 9.5 mm sieves	± 4.0%
Per cent passing 4.75 mm, 2.36 mm, and 1.18 mm sieves	± 3.0%
Per cent passing 600 µm, 300 µm, and 150 µm sieves	No limits
Per cent passing 75 µm sieve	± 1.0%

TABLE 9
Minimum Sample Quantities for Mix Design Monitoring

Material	Quantity
Asphalt cement	4 L evenly split between 2 containers
Aggregate	75 kg of each type
RAP	75 kg, required when RAP contained in the mix
Fines material passing 75 μ m sieve	5 kg, when the mix is to be produced with a plant that returns fines to the mixture
Any other material samples including anti-stripping agents to be used in HMA	Quantity large enough to allow for a complete mix design

Appendix 1150-A, November 2008 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

OPSS 1150 has been updated to include the requirements of OPSS 1149, Material Requirements; OPSS 1155, Medium Duty Binder Course Mix and sections of OPSS 1154, Hot Mix Containing Reclaimed Asphalt Pavement. Excluded from this specification are the previously covered Electrically Conductive Mix and Open Friction Course Mix.

The designer shall specify the PGAC grade required for each HMA specified. The designer should be aware that high temperature PGAC grade adjustments may be required for facilities experiencing a high volume of heavy commercial traffic and a high frequency of slow moving or stop and start operations.

The designer may reduce mix stability requirements based on traffic volumes of less than 1,000 vehicles per lane or the fact that the facility type such as driveways, boulevards, and pathways may not require the Mix Marshall Stability specified. For mixes with reduced Marshall stability, Appendix 1150-B should be invoked by reference in the Contract Documents.

Based on local aggregate performance, the designer may reduce the 100% crushed requirement for HL 3HS. If so, Appendix 1150-C should be invoked by reference in the Contract Documents.

The designer should be aware that for low absorption aggregates, minimum asphalt cement contents may require adjustment.

The designer should specify the percentage of coarse aggregate in the HL 1 mix based on the posted traffic speed. A finer HL 1 mix allows more workability and may be more appropriate for use in urban areas. (Table 2)

The designer should be aware that RAP is permitted in all mixes except DFC, HL 1, HL 2, HL 3HS, and HDBC. (1150.04.01.01.01)

In this specification, HDBC and HL 3HS require 100% crushed aggregates from bedrock or oversize sources. The designer should specify in the Contract Documents where conditions require the aggregate to be only from an aggregate source.

When RAP is incorporated into the HMA, the designer should consider the grade of the PGAC according to the Ontario Superpave Implementation Committee current guidelines for use of PGAC in recycled hot mix.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 1150-B, November 2008

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Marshall Stability Design Criteria for Lower Traffic Volume Facilities

OPSS 1150, Hot Mix Asphalt, is amended as follows:

Table 6 is deleted in its entirety and replaced by the following:

TABLE 6
Marshall Stability - Mix Design Criteria for All Paving Mixtures

Minimum Marshall Stability: N at 60 °C	
Surface Course, except for HL 2, HL 3F, and HL 4F	6,700
Binder, Levelling, and Padding Courses, except for HL 2, HL 3F, and HL 4F	5,800
HL 2, HL 3F, and HL 4F Surface Course	5,800
HL 2, HL 3F, and HL 4F Levelling and Binder Courses	4,400

Appendix 1150-C, November 2008

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Marshall Stability Design Criteria When 100% Crushed Requirement for the Aggregates Used in HL 3HS Do Not Apply

OPSS 1150, Hot Mix Asphalt, is amended as follows:

Table 6 is deleted in its entirety and replaced by the following:

TABLE 6
Marshall Stability - Mix Design Criteria for All Paving Mixtures

Minimum Marshall Stability: N at 60 °C	
Surface Course, except for HL 2, HL 3F, HL 4F, and HL 3HS	8,900
Binder, Levelling, and Padding Courses, except for HL 2, HL 3F, HL 4F, HL 3HS, and HDBC	8,000
HL 2, HL 3F, and HL 4F Surface Course	5,800
HL 2, HL 3F, and HL 4F Levelling and Binder Courses	4,400
HDBC	12,000
HL 3HS	14,000