

THERMOPLASTIC PAVEMENT MARKINGS

1.0 THERMOPLASTIC PAVEMENT MARKINGS FOR ASPHALT PAVED SURFACES

1.1 DESCRIPTION

1. The work of this section includes the supply of materials and installation of hot extruded inlaid and surface applied thermoplastic reflective pavement markings on asphaltic surfaces at locations shown on attached tables or plans.

1.2 WARRANTY AND MAINTENANCE WORK

1. The Warranty period will be five (5) years for inlaid and three (3) years for surface applied thermoplastic markings from the date of Substantial Completion Certificate. During this Warranty Period, the Contractor shall remedy all defects of the work itself. The Engineer will provide the Contractor with written notice of all defects observed within the Warranty Period. The maintenance shall be a continuous operation and shall be carried out until expiration of the Warranty Period, at which time the Contractor's liability shall cease, unless there is an outstanding order from the Engineer requiring the Contractor to correct some of the maintenance that has not been completed.
2. The Contractor shall supply the City of Lethbridge with a written warranty and maintenance guarantee for retention of at least 90% of shoulder and centre line, and 80% of all other markings at the end of the warranty period. In the event that above minimum retention is not met due to either material or installation failure, the Contractor will either:
 - (a) replace the missing sections to the satisfaction of the Engineer at no additional cost to the City of Lethbridge; or,
 - (b) reimburse the City of Lethbridge at the same rate the contract was awarded for the quantity of line missing as decided by the Engineer.

2.0 PRODUCTS

2.1 THERMOPLASTIC PAVEMENT MARKINGS

1. The materials shall be manufactured to be applied by extrusion onto the pavement in molten form with glass spheres mixed in and also dropped onto the material immediately after it is applied.
2. The material will be manufactured and applied to the pavement so that the material will not smear, spread, crack, and/or separate from the pavement

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surface under normal traffic conditions and ambient air temperatures between -40 °C and +40 °C.

3. The exposed thermoplastic face will have the same wet pavement skid resistance as the pavement surface into which it is extruded.
4. The compound shall not deteriorate by contact with sodium chloride, calcium chloride, or other chemicals used against formation of ice on roadways or streets, or because of oil content of pavement materials or from oil droppings from traffic.
5. In the plastic state, the materials shall not give off fumes which are toxic or otherwise injurious to persons or property. The materials shall not breakdown or deteriorate if held at the plastic temperature for a period of four (4) hours, or by reason of four (4) reheatings to the plastic temperature. The temperature versus viscosity characteristics of the plastic material shall remain constant up to four (4) reheatings, and shall be the same from batch to batch. There shall be no obvious change in colour of the material as the result of up to four (4) reheatings, or from batch to batch.
6. To ensure the best possible adhesion, the compound as specified, shall be installed in a melted state at a minimum temperature of 160 °C, and a maximum temperature of 220 °C, and the material shall be kept at these temperatures for up to four (4) hours.

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2.2 REFLECTORIZATION

1. During manufacturing, reflectorizing glass shall be mixed into the material to the extent of not less than twenty (20%) percent, nor more than fifty (50%) percent by weight of material.
2. Glass spheres shall also be automatically applied to the surface of the material at a uniform rate of approximately one and one-half kilograms (1.5 kg) of glass spheres to every ten (10) square meters of line (150 grams/m²). These glass spheres shall be dropped onto the thermoplastic material while it is in a molten state immediately after it has been extruded onto the pavement.

2.3 DRYING TIME

1. The material will be considered dried when a vehicle can drive over the material with no adverse affect to the material or vehicle. The drying time shall not exceed a characteristic straight line curve, the lower limits of which are two (2) minutes at an air temperature of 10°C, the upper limits of which are fifteen (15) minutes at an air temperature of 32°C, both temperatures measured at a maximum relative humidity of seventy (70%) percent.

2.4 PHYSICAL REQUIREMENTS - PAVEMENT MARKINGS

1. **Colour:** After setting, the marking shall be brilliant white or yellow, free from dirt or tint, and shall be identical to white 513-301, and identical to yellow 505-308. The colours 513-301, and 505-308, are established by Canadian Government Specifications Board 1-GP-126-1965. The material shall not contain organic coloring matter and shall not discolour in sunlight.
2. **Brightness:** Value obtained with the Gardner Multi-purpose Reflectometer when measuring 0°C to 45°C. Daylight luminous directional reflectance with the green filter. The rating obtained shall not be less than seventy (70%) percent for white, or forty-five (45%) percent for yellow.
3. **Water Absorption:** Materials shall have no more than 0.5 (0.5%) percent by weight of retained water when tested by ASTM designation D-570, Water Absorption of Plastics procedure (A) (24 hr. Immersion) at 23°C.
4. **Softening Point:** Materials shall have a softening of not less than 90°C, as determined by ASTM designation E-28, Method of Test by Ring and Ball Apparatus.
5. **Specific Gravity:** Specific Gravity of thermoplastic compound at 25°C shall be from 1.95 to 2.05.

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6. **Abrasion Resistance:** The material shall have a maximum weight loss of 1.0 grams when subjected to 200 revolutions on a Taber Abrader at 23 C, using H-22 calibrade under a test load of 500 grams. The test panel will be prepared by forming representative lots of material at a thickness of 3.175 on a 25 cm steel panel, 1.27 mm thick. The wearing surface shall be kept wet during the test.
7. **Chemical Resistance:** 5 cm x 5 cm test sections shall show no signs of degradation after exposure to:
- 1) 5% NaCl (24 hr Immersion)
 - 2) 5% NaCl (24 hr Immersion)
 - 3) Lubrication Oil (1 hr Spot Test)

2.5 GENERAL REQUIREMENTS - GLASS BEADS

1. **Imperfections:** The surface of the spheres shall be smooth and free from film, scratches and pits. At least eighty (80%) percent shall be true spherical shape, and free from milkiness, dark or air inclusions, and other defects.
2. **Index of Refraction:** The liquid immersion method of 25 C, may be used to determine the refractive index of glass spheres. A refractive index of 1.50 to 1.60 is required.
3. **Gradation:** The spheres shall meet the following gradation requirements when testing in accordance with ASTM designation D-1214.
1. Spheres included in the manufacture of the thermoplastic material:

U.S. Standard Sieve	% Passing
Passing #270 um	80 - 100
Passing #100 um	0 - 10

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2. Spheres for application on molten thermoplastic material:

Passing #900 um	90 - 100
Passing #3300 um	20 - 50
Passing #200 um	0 - 10

3.0 EXECUTION

3.1 GENERAL

1. The equipment used to install hot, extruded, inlaid pavement markings shall be capable of constructing markings that are uniform in all dimensions. The edges of markings shall be square. The equipment shall be maneuverable so that straight lines can be followed and curved lines can be installed in a true arc. Extruded thermoplastic material shall be inlaid to a depth as specified up to 10 mm below the pavement surface and when extruded, the top surface of the markings shall be 2.0 mm above the adjacent pavement and the groove completely filled. Reflective glass spheres shall be applied to the top surface of the extruded pavement marking by means of an automatic dispenser attached to the equipment in such a manner that the glass spheres are dispensed almost instantaneously onto the marking. Cuttings resulting from the construction of inlay for the markings shall be completely removed from the right-of-way and disposed of by the Contractor. Existing asphaltic concrete pavement shall be in place forty-eight (48 hr) hours prior to any grooves being cut.

3.2 EXISTING PAVEMENT MARKINGS

1. Where the location of the new thermoplastic markings conflict with existing pavement markings, such as paint, the existing markings shall be removed by sandblasting.

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3.3 APPLICATION

1. **Road Surface:** The road surface must be clean of any coarse of fine material and completely dry. All grooves must be clean and dry before the material is installed.
2. **Application Temperature:** Ambient temperature for placing thermoplastic pavement markings is -10°C to $+40^{\circ}\text{C}$. To ensure the best possible adhesion, the material shall be applied in a melted state at a temperature of 170°C to 220°C markings.
3. **Longitudinal Joints:** The thermoplastic markings shall not be installed over a longitudinal joint or seam.

3.4 TRAFFIC CONTROL AND WORK AREA

1. At all times keep traffic congestion to a minimum. Undertake work from one lane only and all men, materials, and equipment to be contained as much as possible to prevent excessive delay and inconvenience to traffic.
2. Operate all equipment or combination of equipment used in the application, including the grinder, vacuum machine or sweeper, material applicator and cone truck within 100 m at any time.
3. Work Restrictions: Work on any roadway may be restricted by the Engineer during the following time periods:
 - 0700 - 0900 hours
 - 1600 - 1800 hours
 - 2200 - 0700 hours (in or near residential or built-up areas)
4. No grooving of the roadway will be permitted in any one day beyond what can be cleaned and inlaid with thermoplastic material in that day.

3.5 PREMARKING

1. The Contractor is responsible for premarking all work. Premarking shall be done on a clean, dry surface. All premarking shall be done with premarking paint approved by the Engineer.
2. All premarking shall be approved by the Engineer prior to the installation of thermoplastic pavement markings. Changes in the alignment of markings that do not correspond to the plans may be made in the field by the Engineer. Any changes made in the field shall be recorded by the Contractor on plans issued by the Owner and returned to the Owner within seven (7) working days after completion of the job.

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3. Any premarkings lines remaining after a period of six (6) weeks shall be removed or blacked out by the Contractor at his expense.
4. Final markings shall be installed as soon as possible, but no later than seven (7) calendar days after premarking.

3.6 ADHESION TO PAVEMENT

1. Make all tests and take all samples necessary to assure adequate adhesion between the thermoplastic material and the pavement. Acceptance of this contract is evidence that the Contractor is satisfied that no adhesion problems will be encountered.

3.7 WORKMANSHIP

1. The pavement markings shown on the plans were designed, where possible, in compliance with the Uniform Traffic Control Manual for Canada. If conflict arises as to the interpretation between the plans and the Uniform Traffic Control Device Manual, precedence shall be given to the plans.
2. Continuity Lines shall be a single line, 100 mm wide, white in colour and broken. The continuity line shall consist of a line three (3) metre long with a three (3) metre skip distance between lines in a consecutive pattern. The depth of the continuity line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
3. Dividing Lane Lines shall be 100 mm wide, white in colour, and solid or broken. The broken dividing line shall consist of a line three (3) metres long with a six (6) metre skip distance between lines in a consecutive pattern. The depth of directional dividing line markings shall be 7 mm, 5 mm below and 2 mm above pavement surface, unless otherwise specified.
4. Guide Lines shall be a single line, 100 mm wide, white in colour and broken. The continuity line shall consist of a line 0.5 metre long with a 0.5 metre skip distance between lines in a consecutive pattern. The depth of the guide line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
5. Centerlines shall be a single line or double line, 100 mm wide, yellow in colour and continuous. Centerlines shall be surface applied unless otherwise specified.
6. Edge Lines shall be a single line, 100 mm or 200 mm wide, white in colour and continuous. The depth of the edge line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
7. Stop Bar Lines shall be a single line, 600 mm wide, white in colour and continuous. The depth of the stop bar line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.

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8. Zebra Crossing Lines shall be 600 mm wide, white in colour and continuous. The distance between the 600 mm zebra crossing markings shall be 600 mm. The depth of the zebra crossing line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
9. Pedestrian Crossing Lines shall be 200 mm wide, white in colour and continuous. The depth of the pedestrian crossing line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
10. Diagonal Gore Area Lines shall be 600 mm wide, white in colour and continuous in a chevron formation. The depth of the diagonal gore area line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
11. Pedestrian Crossing "X" Lines shall be 500 mm wide, white in colour and continuous forming a "X" shape. The depth of the pedestrian crossing "X" line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
12. Railway Crossing Lines shall be a double line 300 mm wide, white in colour and continuous. The depth of the railway crossing line markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.
13. Arrows shall be white in colour and in compliance with the Uniform Traffic Control Manual for Canada. The depth of the arrow markings shall be 7 mm, 5 mm below, and 2 mm above the pavement surface unless otherwise specified.