

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 15

NON-SKID POLYMER OVERLAY

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15.1 General

Resurfacing concrete bridge decks with non-skid polymer wearing surface consists of the repair of deck concrete, and application of a thin, flexible, multi-layered, polymer-aggregate wearing surface.

This specification shall be used in conjunction with the "Specification for the Supply of Polymer Resins used in Polymer Overlays (B405)" and "Specification for Seed Aggregates used in Polymer Membranes and Overlays (B392)". The work includes mobilization, traffic accommodation, surface preparation and patching.

The Degussa Degadur System (MMA) is an approved alternate for the polymer overlay as specified. The Degussa Degadur System (MMA) does not meet the compressive strength and physical requirements of the "Specification for the Supply of Polymer Resins used in Polymer Overlay (B405)", and is applied in a different manner, but all other requirements of the specification shall still apply.

15.2 Materials

All polymer materials including aggregates shall be protected from moisture, dust, or other contaminants. Any wet or otherwise contaminated materials will be rejected.

15.2.1 Polymer

The polymer and the polymer mortar shall meet the requirements of the "Specification for the Supply of Polymer Resins used in Polymer Overlay (B405)".

The following products are currently approved by the Department for use in this work:

- Flexolith
- Flexogrid

15.2.2 Degadur System (MMA)

The DEGADUR B71 primer, DEGADUR 330 basecoat, and DEGADUR 410 sealer resins shall have the specified properties at the age of seven days noted below.

PROPERTIES OF DEGADUR RESINS					
Property	Units	Primer	Basecoat	Sealer	Test Method
Density	g/cm ³	1.05	1.01	0.98	--
Viscosity*	cps	220-330	1100-1300	450-550	ASTM D2393
Hardness	Shore D	83	56	61	ASTM D2240
Water Absorption	%	0.1	0.1	0.1	ASTM D570
Tensile Strength	MPa	29	8	9	ASTM D638
Elongation @ Break	%	3	300	140	ASTM D638

* at time of mixing

15.2.2.1 Initiator (MMA)

The initiator for the MMA resins shall be a 50% Benzoyl Peroxide powder such as AKZO Chemicals Inc., CADOX BFF-50, or an approved equivalent. Dosage rates shall be in accordance with the MMA Manufacturer's recommendations issued in the Degadur Catalyst Design Table.

15.2.2.2 Promoter (MMA)

The promoter required for use with the MMA resins at application temperatures below 4°C shall be N, N-Dimethyl-p-toluidine such as R.S.A. Corporation DMPT or an approved equivalent. Dosage rates shall be according to the MMA Manufacturer's recommendations.

15.2.2.3 Degadur Basecoat (MMA)

The basecoat shall have the specified properties at the age of seven days noted below.

PROPERTIES OF DEGADUR BASECOAT			
Property	Units	Required Value	Test Method
Compressive Strength*	MPa	16-21	ASTM C109
Tensile Strength	MPa	3-5	ASTM D638
Elongation @ Break	%	6	ASTM D638
Flexural Strength	MPa	9-10	ASTM C580 mod
Freeze/Thaw Resistance	--	Pass	ASTM C666
Bond Strength to Concrete	MPa	1.7 minimum	ACI 503R
Coefficient of Thermal Expansion	10E-5/K	7.9	DIN
Vicat Temperature	°C	50	DIN

* Samples shall consist of 1 volume of Degadur Basecoat to 1 volume of Steilacoom.

The tests listed shall be conducted by a CSA approved testing lab, and shall include infrared and gas chromatography analysis (in accordance with BT008 Test Procedure for Finger Printing Sealers Using Infrared Spectroscopy and Gas Chromatographic Separation) for each component. All tests, including the spectro-analysis, shall be done on the same samples of material.

15.3 Aggregates

15.3.1 Seed Aggregate

The overlay aggregate provided by the Contractor shall conform to the current "Specification for Seed Aggregates Used in Polymer Membrane and Overlays" (B392). The seed aggregates currently approved by the Department are Indag # 8 and Steilacoom 6X10 Bridge Topping.

15.3.2 Basecoat Filler Aggregate (Degussa Degadur System MMA)

Materials used in the basecoat shall consist of clean, dry (less than 0.2% moisture), angular grained silica sand and shall be free from dirt, clay, asphalt, and other organic materials. Materials shall conform to the following sieve analyses:

GRADATION OF BASECOAT FILLER AGGREGATES (MMA)						
0.045 mm Ground Silica Flour						
A minimum of 90% shall pass the 0.045 mm sieve.						
Basaltic Sand						
Sieve, mm	4.750	2.360	1.000	0.600	0.300	0.150
% Passing	99-100	92-100	61-70	45-65	10-20	0-10

15.4 Patching Materials

Type NH patching materials meeting the requirements of "Specification for the Supply of Bridge Concrete Patching Materials" (B391) may be used in place of concrete in partial depth repair provided they are used in accordance with the manufacturer's instructions.

Samples of the mixed patching material will be tested by the contractor according to ASTM C109 and in compliance with the Frequency of Test Table included in Clause 15.7.8 "Testing and Strength Requirements". The average of three cubes will be used for acceptance and determination of payment range or rejection of the work as specified in the table below.

28 Day Minimum Compressive Strength as per Manufacturers Specified Strength Requirement	Amount of Payment
100% and above	Full bid price
90% to 99.9%	Bid price less \$25.00 per square metre
80% to 89.9%	Bid price less \$50.00 per square metre
70% to 79.9%	Bid price less \$100.00 per square metre
65% and below	Will be rejected

The Contractor shall pay all costs for testing, including but not limited to making test cubes, transporting cubes to an independent certified testing laboratory of his choice, storage, curing, breaking and providing written reports of the test results to the Consultant.

All patches consisting of Type NH patching materials shall be cured for 14 days and tested for moisture in accordance with section 15.7.3 prior to the application of polymer overlay.

15.5 Crack Repair

All deck cracks more than 2 metres in length and greater than 0.3 mm wide shall be treated with a Type 1c sealer meeting the current "Material Testing Specifications for Concrete Sealers" (B388). Application of the sealer shall be prior to shotblasting of the concrete deck, and shall consist of a 100 mm strip applied at the coverage rate as shown on the Approved Type 1c Sealer List. Payment for crack repair will be considered incidental to the Contract and no separate or additional payment will be made.

15.6 Bridge Deck Repair

Bridge deck repair consists of; Surface Patching, Partial Depth Repair, or Full Depth Repair.

Type of Patch	Depth of Patch (mm)	Repair Material	Description
Surface Patching	6 to 15	Polymer Mortar	Removal of surface deterioration without exposing rebar
Partial Depth Repair	15 to 200	Concrete	Chipping below corroded rebar and sandblasting of rebar is required
Full Depth Repair	Full depth of deck	Concrete	Forming of the underside of the deck is required

The concrete to be used for Partial and Full Depth Repair shall be Class HPC as specified in Section 4 "Cast-In-Place Concrete" of the Specifications for Bridge Construction.

15.6.1 Surface Patching

The Contractor shall patch surface voids and depressions in excess of 6 mm. The Consultant shall determine the area to be patched.

Polymer mortar, applied in accordance with the Manufacturer's instructions and these specifications, shall be used where surface patching is required. The patching polymer mortar shall consist of 3½–4½ volumes of an approved aggregate to each volume of polymer. The mortar shall yield a 40 MPa minimum compressive strength when tested at 7 days using 50 mm cube specimens, as described in Clause 15.7.8 "Testing and Strength Requirements".

Prior to placement of the polymer mortar, the surface of the concrete shall be shotblasted and/or sandblasted in accordance with Clause 15.7.1 "Surface Preparation".

The areas to be patched shall be primed with a 75 mm wide band of liquid polymer along their perimeter. The polymer mortar surface patch shall be placed while the liquid polymer primer is liquid or tacky, and to the original gradeline or as directed by the Consultant.

Measurement and mixing of polymer components and aggregates shall be done in accordance with Clause 15.7.4 "Batching and Mixing of Polymer".

Aggregate shall be placed over the fresh patch in sufficient quantity to ensure a rough surface for bonding to the polymer overlay. Smooth textured patches will be rejected.

When the Degussa Degadur System is used, the surface patching of the deck and curb shall be done with an approved 100% solids MMA mortar supplied by the Manufacturer of the methacrylate polymer overlay. Application shall be completed according to the Manufacturer's instructions.

Payment for **Surface Patching** will be made at the unit price bid per square metre of surface patching, which price shall include surface preparation, full compensation for the cost of furnishing all labour, equipment, materials, tools and incidentals necessary to complete the work.

15.6.2 Partial and Full Depth Repair

In areas where partial depth and full depth repair are required, Clauses 20.3.2 "Partial Depth Repairs" and 20.3.3 "Full Depth Repairs" shall apply.

All concrete shall be cured for 28 days and tested for moisture in accordance with Clause 15.7.3 prior to the application of polymer overlay.

15.6.3 Surface Defects and Tolerances

The requirements for all new surface patching, partial and full depth repair shall conform to Clause 4.16.6 "Surface Defects and Tolerances".

All patching and levelling requires acceptance by the Consultant prior to commencing the overlay. Failure to obtain acceptance may be cause for rejection of the overlay.

15.7 Polymer Construction

The polymer coverage rates shown below are based on undiluted polymer applied to a clean shotblasted deck surface or previously applied seeded polymer layer. Where the deck surface is spalled, scaled, or roughened by surface preparation, to depths up to 6 mm, the coverage rates shall be increased. Additional polymer material may also be required due to coarse texturing or grooving of the deck surface, or porosity of the concrete. The first layer shall extend up the full height of the vertical face of curbs and medians, and up 200 mm on the vertical faces of parapets. The Contractor shall obtain the Consultant's acceptance prior to increasing, for any reason, the minimum polymer coverage requirements. No separate or additional payment will be made for any additional polymer required.

MINIMUM POLYMER COVERAGE REQUIREMENTS (ℓ/m^2)			
WEARING SURFACE CLASS	1st Layer	2nd Layer	3rd Layer
A	1.33	2.00	0.30
B	1.33	2.00	N/A
C	1.33	0.30	N/A

MINIMUM MMA POLYMER COVERAGE REQUIREMENTS FOR DEGUSSA DEGADUR SYSTEM (MMA) (ℓ/m^2)			
WEARING SURFACE	Primer Layer	Premixed Basecoat Layer	Sealer Layer
Degussa Degadur System	0.40	5.00	0.67

15.7.1 Surface Preparation

In order to prevent bond failures at overlay edges at high impact locations, 10 mm deep by 10 mm wide grooves shall be cut by router or saw and sandblasted in close proximity and parallel to all deck joints, snow slots, deck drains and all other transverse edges. These grooves or keys are intended to provide increased anchorage for the overlay and shall be filled with polymer and seeded in conjunction with application of the first layer. Rough spots exceeding 3 mm in height on or adjacent to, deck joints shall be ground to provide a smooth transition prior to placement of the overlay.

Proper surface preparation is essential to ensure adequate bond strength between the polymer wearing surface and deck concrete. The deck concrete surface shall be prepared by shotblasting to remove all bond inhibitors including concrete laitance, asphaltic material, sealers and oil, and to expose the coarse aggregate in the substrate concrete. Those areas which are inaccessible to shotblasting, such as the vertical faces of the curbs, medians, and parapets shall be similarly prepared by sandblasting.

If in the opinion of the Consultant, reblasting is required in the event of rain, delay in applying the overlay, or subsequent leakage onto the deck of other contaminants, it shall be done at the Contractor's expense.

15.7.2 Deck Layout for the Overlay

Prior to the application of each layer, the Contractor shall submit a sketch to the Consultant showing the deck surface divided into segments which will be covered by each polymer batch. The length of each segment shall be determined by taking into account the overlay width, vertical faces,

surface roughness, coverage rate, the amount of polymer in each batch, and losses in application equipment and containers.

After review of the sketches by the Consultant, the Contractor shall apply masking tape to the boundaries of the work area, except where these boundaries abut an existing polymer overlay mat of the same layer. The end of each overlay segment shall be marked at these boundaries. For the first layer only the layout area shall extend up the full height of the vertical curb and median faces and up 200 mm on the vertical faces of parapets. No overlay work shall commence until all layout by masking tape has been acceptably completed.

15.7.3 Weather Conditions, Dryness of Concrete Substrate and Polymer Layers

The work shall be done in suitable conditions of temperature, wind, dust, and moisture. If weather factors or moisture conditions of the substrate concrete are detrimental to the acceptable placement of overlay, the work shall be suspended until suitable conditions exist. Mixing, placing and curing of polymer shall be done at ambient air and substrate concrete temperatures between 10°C and 27°C.

The concrete substrate, including concrete patching and repairs shall be completely dry before the first layer of polymer is applied. Subsequent layers of polymer shall not be applied until previous layers are completely cured. Presence of moisture will be determined by the modified ASTM D4263, "Standard Test Method for Indicating Moisture in Concrete by Plastic Sheet Method". This test shall be carried out on the concrete substrate as well as on previous placed polymer overlays. The Contractor shall place a minimum of four test windows, per application area, at different time periods. The test windows shall consist of three layers of clear and one layer of black heavy duty 6 ml poly, 1000 mm x 500 mm located in moisture prone areas. The test windows shall be heated at a temperature of 55°C continuously for a time period of 6 hours for each test and at a time duration, period and frequency of test, as determined by the Consultant. Timing of the test windows shall not start until the temperature of the concrete surface has reached 55°C. This will not relieve the Contractor from his responsibility to ensure that the overlay does not debond. The Contractor shall provide four, 500 watt halogen lamp and a portable electric generator (3500 watt) and carry out the required testing which will be considered incidental to the Contract and no separate or additional payment will be made.

Application of the first layer is recommended when there is sufficient evidence of declining deck concrete temperatures.

15.7.4 Batching and Mixing of Polymer

Batching and mixing shall be done in accordance with the Manufacturer's instructions. The polymer shall be completely and thoroughly mixed before being deposited onto the deck. Any polymer not meeting the specification will be rejected, removed, and replaced at the Contractor's expense.

The temperature of the unmixed polymer constituents shall be between 10°C and 27°C. The polymer material shall be mixed in batches no larger than 20 l. Each component shall be measured to within an accuracy of 3%. All containers shall be clean and free of contaminants of hardened polymer. Containers used for mixing and blending shall not be used for measuring.

In the absence of the Manufacturer's time limit for mixing, the minimum time for mixing shall be 3 minutes, however, for the Degussa Degadur System, the mixing time is a function of temperature.

Attention shall be taken to blend the polymer adjacent to the mixing container surfaces. The presence of air, water bubbles or other contaminants in the mixed polymer will be cause for rejection of that batch.

The deck and adjacent areas shall be protected from spillage of polymer, solvents, and other materials. Any spilled materials shall be removed by the Contractor.

15.7.5 Application of Polymer Resin

Upon the Consultant's acceptance of the prepared deck surface and completion of the layout, the polymer shall be applied in accordance with the Manufacturer's instructions regarding mixing, blend time, temperature, time between layers, pot life, method of application, condition of substrate and any other requirements.

All cold joints in the overlay shall be offset 25 mm from cold joints of previous layers of the overlay. To ensure straightness, masking tape shall be applied along the perimeter of all areas to be overlay as well as along all steel deck joints, drains, curb faces or other edges of the layers of overlay. The first layer of polymer shall extend up the full height of the concrete curb and median faces and up 200 mm on the vertical faces of parapets. All masking tape used to define the boundaries of each segment shall be completely removed prior to gelling of the polymer.

The Contractor shall spread the polymer uniformly over the premeasured area using a squeegee and roller brush to carefully work the polymer into the surface and obtain the required coverage. Spiked footwear will be permitted for use by workers involved in the application work, but only prior to gelling of the polymer and with the constraint that all damage or defects in the surface will be repaired. Spreading and levelling of fresh polymer shall be completed while the material is in a state of low viscosity, and within seven minutes of batching. Failure to comply with the seven minute limit may result in rejection of the batch. Application of material which has begun to gel and increase in viscosity will not be permitted.

Application of the third layer of polymer (tie coat) shall be by airless spraying only. The polymer shall not be cut back with any solvents. This does not apply to the Degussa Degadur System, where the sealer layer may be applied with a roller.

The Contractor shall prevent or repair all bubbles, blisters, pinholes or other defects.

15.7.5.1 Degadur Base Coat (MMA)

The basecoat mixture shall be prepared by blending the silica flour and basaltic sand components with the resin in a suitable container (e.g. 20 l pail), followed by the addition and subsequent blending of the initiator. The mixture shall be applied over clean, dry, cured primer surfaces at the coverage rate specified in Clause 15.7, "Polymer Construction", using an approved spreading method. The applicator shall take care to allow the ridges between passes to self-level before broadcasting aggregate. Small areas may be touched up with a steel trowel.

The deck layout may be subdivided into coverage areas corresponding to a maximum of 150 l of MMA mix rather than 20 l as specified in Clause 15.7.2 "Deck Layout for the Overlay".

Applicators shall not walk on a polymer layer after 4 minutes from time of placement.

15.7.5.2 Degadur Sealer (MMA)

The sealer mixture shall be applied to the cured and swept basecoat using paint rollers and brushes. Application shall be in a “dip-and-roll” manner from containers holding no more than 8 ℓ at a time; sealer shall not be poured directly onto the deck.

15.7.6 Seeding of Aggregate

The Contractor shall seed the first and second layer of polymer for Class A and B wearing surfaces and the first layer for Class C wearing surfaces. When the Degussa Degadur System (MMA) is used, the basecoat layer shall be seeded. The full height of the vertical face of curbs and median and up 200 mm of the vertical faces of the parapets shall not be seeded. The aggregate shall be seeded into the fresh polymer before gelling or increase in viscosity occurs. It shall be broadcast into the fresh polymer in such a manner that no ripples or waves are created and no segregation of the aggregate occurs. The aggregate shall impact the fresh polymer surface in a near vertical direction. Improper seeding technique will result in the work being suspended until proper methods are employed. The aggregate shall be placed so that an excess quantity covers the entire surface of the fresh polymer, no polymer is visible, and the surface has a dry appearance. As the aggregate settles into the fluid polymer, all “wet” spots which appear in the surface shall be promptly re-seeded before the polymer becomes viscous. At no time shall the Contractor disturb previously placed aggregate in an effort to cover “wet” surface spots. Once gelling begins, walking on the overlay will not be permitted until it has properly cured.

If insufficient aggregate has been placed and the “wet” areas harden to form glassy, resin-rich areas, the Contractor shall remove these areas to sound concrete, redo the deck surface preparation and replace the overlay.

After curing of the previous placed overlay and on acceptance of the Consultant, all excess aggregate or other contaminants shall be removed by power sweeping and air blasting. After cleaning to the satisfaction of the Consultant, the subsequent layer of polymer shall be applied.

Additional cleaning will be required if application of the subsequent layer of polymer is delayed and the overlay surface has become contaminated.

In the event that any layer of polymer material is subjected to rain or any other form of damage, the contractor shall do vertical pull out tests to confirm the adequacy of the material. This test consists of bonding a 64 mm diameter sandblasted steel disk to the prepared substrate by using an approved polymer, and pulling it from the substrate by applying a vertical force.

The polymer overlay in question will not be accepted unless at least 75% of the bonded steel disk surface has retained substrate concrete exceeding 3 mm in depth. At the discretion of the Consultant the pull-out test may be carried out on any polymer layer. The minimum acceptable bond strength on normal weight concrete shall be 3.0 MPa. The Contractor shall repair all bond test locations with polymer overlay in accordance with this specification. The pull out equipment and repair of the polymer overlay will be considered incidental to the Contract.

15.7.7 Smoothness of Overlay Surface

Larger smoothness defects of the bridge deck, as determined by the Consultant shall be repaired by surface patching. Minor defects inherent in the concrete deck shall be smoothed by the application of the polymer overlay.

Roughness attributable to the overlay will be tested with a 3 m long straight edge. When placed anywhere in any direction on the surface except across the crown, the gap between the bottom of the straight edge and the surface of the overlay shall not exceed 3 mm. Overlays not meeting the criteria will be rejected, removed and replaced at the Contractor's expense.

The location and number of measurements taken will be at the discretion of the Consultant.

15.7.8 Testing and Strength Requirements

Two weeks prior to commencement of work, the Contractor shall be responsible for testing of infrared and gas chromatography analysis (in accordance with BT008) for each polymer component, compressive strength of the polymer mortar, modulus elasticity of the polymer, and grain size analysis of the aggregate. These results shall be provided to the Consultant for review.

During placement of the polymer, samples of the mixed polymer material will be randomly selected by the Consultant and the Contractor shall cast sets of three 50 mm cubes for compressive strength testing in accordance with test method ASTM C-109. These tests will be used for acceptance and determination of payment range or rejection of the work as specified in the applicable table below entitled "Partial Payment Schedule". The test cubes will be cast at a ratio of 22 volumes of approved aggregate to 1 volume of mixed polymer and cured for seven days in dry lab conditions. When the Degussa Degadur System is used, the test cubes will be cast at a ratio of 1 part base coat and 1 part approved aggregate, by volume and cured for seven days.

The compressive strength will be the maximum load measured or the load causing a 2.5 mm deflection, whichever occurs first. (This modified ASTM C-109 test method will also be used for acceptance testing of proposed overlay materials.) The compression test will be done using a steady loading rate of 0.5 MPa \pm 0.05 MPa per second.

The acceptable range of 7-day compressive strength for the polymer shall be 40 MPa to 70 MPa.

The MMA product shall have a 7-day compressive strength range of 16 MPa or over.

The Department reserves the right to reject any overlay whatsoever which does not meet the applicable strength requirements. The Department may however, at the discretion of the Consultant, accept overlay which fails to meet the compressive strength range. In this case payment will be made in accordance with the following tables.

PARTIAL PAYMENT SCHEDULE FOR LOW STRENGTH POLYMER	
7-Day Compressive Strength (MPa)	Percentage of Unit Price
Between 40.0 and 70.0	100
38.0 to 40.0 or 70.0 to 72.0	90
36.0 to 38.0 or 72.0 to 74.0	80
34.0 to 36.0 or 74.0 to 76.0	70
32.0 to 34.0 or 76.0 to 78.0	60
30.0 to 32.0 or 78.0 to 80.0	50
Below 30.0 or over 80.0	Rejected

PARTIAL PAYMENT SCHEDULE FOR LOW STRENGTH MMA OVERLAY	
7-day Compressive Strength (MPa)	Percentage of Unit Price
16 and Over	100
15.0 to 15.9	90
14.0 to 14.9	80
13.0 to 13.9	70
12.0 to 12.9	60
11.0 to 11.9	50
Below 11.0	Rejected

Compressive strength tests may be carried out on any layer of the overlay. If a test result of any layer is below that specified, the reduced unit price shall apply to the full overlay thickness. Where compressive strength tests have been done on more than one layer, the lowest strength test result will be used to determine adjustment of the unit price. Each test will represent the 100 m² area poured during that batching operation. The Consultant will determine the test location of each test. The Contractor shall cast a set of three cubes to the frequency of test listed below.

Frequency of Test	
Deck Area (m²)	No. of Tests (Set of 3 Cubes)
1 - 500	4
501 - 1000	8
1001 - 2000	14
2001 - 3000	20
3001 - 4000	24

The Contractor shall pay all costs for testing, including but not limited to making test cubes, transporting cubes to an independent certified testing laboratory of his choice, storage, curing, breaking, and providing written reports of the polymer test results to the Consultant.

15.7.9 Opening to Traffic

The polymer overlay surfaces shall not be opened to traffic until a minimum of 60% of the 7 day compressive strength or 3.0 MPa of tensile strength is achieved based on the last batch of the day.

It is recommended that the Contractor casts one additional set of cubes from the last batch of the day and have these tested at his cost. The cubes shall be cured in the field at ambient air temperature prior to testing.

No traffic will be allowed on the polymer overlay until all layers are acceptably placed and confirm to the strength requirement.

15.8 Payment

Payment for **Polymer Wearing Surface** will be made at the unit price bid per square metre of deck resurfaced, which price shall include surface preparation, full compensation for the cost of furnishing all labour, equipment, materials, tools and incidentals necessary to complete the work. The areas of the curb, median, deck joint or parapet vertical faces will be considered incidental and will not be included in the area of polymer wearing surface to be paid.