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937-1 DESCRIPTION

937-1.01 Scope – This work shall consist of the partial-depth or full-depth repair of unsound concrete, spallings and holes; and sealings of cracks and surface in bridge concrete deck in accordance with these specifications and in conformity with the lines, grades, details and notes shown on the plans or established by the Engineer.

Each word, sentence, section or article of this document is independent. Not applying parts of it does not imply that it cannot be enforced afterwards nor invalidates the remaining provisions.

937-2 MATERIALS

937-2.01 Materials shall conform to the applicable specifications of the Standard Specifications for Road and Bridge Construction. Materials shall be as specified or as shown on the details and notes in the plans.

937-2.02 Deck Patching Material – The Deck Patching Material shall be of two types (Polymer Concrete, and Accelerated Strength Concrete) as follows:

a. Polymer Concrete – The Polymer Concrete shall be a high strength, non-shrink material conforming to the following requirements:

1. The Polymer Concrete shall consist of a liquid resin, powder filler, and coarse aggregates. The mix of Polymer Concrete shall attain a minimum compressive strength of 4,000 psi at 4 hours. The minimum compressive strength shall conform to the requirements of ASTM C 39 and AASHTO T 22. The Polymer Concrete shall resist the typical road chemicals including fuels, oils and others, and it shall be used in Patching Areas less or equal than 2.0 square meters.

2. The Polymer Concrete shall be capable of providing a permanent patch in concrete and gaining the required strength in a manner that allows the roadway to be opened to traffic within four (4) hours of placement at temperatures ranging from 60º to 90ºF while maintaining all contract quality and durability requirements.

3. The pot life of the Polymer Concrete shall have a range of 8 to 15 minutes minimum and be consistent over a temperature range of 60º to 90ºF.

4. The coarse aggregates shall conform to the Article 937-2.06-a of this specification.
5. The Contractor shall submit the product technical data sheets and Manufacturer's certifications for review and approval by the Engineer. When required by the Engineer, the Contractor shall also submit certified test reports for approval.

6. Material shall be factory packaged in strong moisture proof bags or containers capable of withstanding shipping, handling and storage without breakage. Material shall have a storage life of at least one year. Each container shall be clearly labeled including:

   (a) Manufacturer's name and batch number.

   (b) Component designation, if two or more components.

   (c) Mixing directions and ratios.

   (d) Potential hazards and precautions.

7. Acceptance of the material will be on the basis of certification by the Manufacturer that the material meets these requirements. However, failure by the material to perform adequately in actual use shall be just cause for rejection regardless of certification.

8. The bond strength of the Polymer Concrete in partial-depth repairs shall be verified in the field by the Contractor under the inspection of the Engineer, and it shall conform to the requirements of ASTM C 1583. Bond strength testing the Polymer Concrete in partial-depth repairs including all necessary equipments, labor or any other incidental cost shall be subsidiary item to de "*Polymer Concrete*" pay item. Failure of the Polymer Concrete placed to meet the bond strength requirements shall be cause for the rejection and removal of Polymer Concrete.

b. <u>Accelerated Strength Concrete</u> – The Accelerated Strength Concrete shall be a rapid strength material conforming to the following requirements:

   1. The mix of Accelerated Strength Concrete shall consist of a homogeneous mixture of cement, fine aggregates, coarse aggregates, water, and chemical admixtures. The concrete mix may also contain fly ash, silica fume, ground granulated blast-furnace slag (GGBS) or a combination thereof. The mix of Accelerated Strength Concrete shall attain a minimum

compressive strength of 5,000 psi at 7 days. The minimum compressive strength shall conform to the requirements of ASTM C 39 and AASHTO T 22. The Accelerated Strength Concrete shall resist the typical road chemicals including fuels, oils and others, and it shall be used in Patching Areas greater than 2.0 square meters.

2. **Temperature of Accelerated Strength Concrete:**

   a. Maximum temperature of fresh concrete containing no set controlling admixtures shall not exceed 80 degrees F (27°C) at the time of placement.

   b. Maximum temperature of fresh concrete containing set controlling admixtures shall not exceed 90 degrees F (32°C) at the time of placement.

   c. The maximum temperature of fresh concrete containing calcium nitrite shall be 80 degrees F (27 °C).

3. The proportioning of Accelerated Strength Concrete shall meet the following requirements:

   (a) The Contractor shall design the concrete mixes and determine the proportions of concrete to conform to these specifications and ensure that the concrete mix proportions are adequate to meet at least the minimum standards of practice for the concrete's intended use. The minimum required average compressive strength of concrete used as basis for selection of concrete proportions (f'cr) shall conform to the requirements of American Concrete Institute, ACI-318 section 5.3 "Proportioning on the basis of field experience or trial mixtures or both". The volumetric proportioning methods such as outlined in the American Concrete Institute (ACI) Standard 211.1, "Recommended Practice for Selecting Proportions for Normal Weight Concrete", or other approved volumetric proportioning methods, shall be employed in the design of mixes.

   (b) The Contractor shall submit for the record, prior to the start of concreting operations, the proposed mix ingredients and proportions certified by a professional engineer (legally authorized to practice engineering in Puerto Rico). Submit separate mix designs for each mix to be used or whenever a change in fine or coarse aggregates source occurs.

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The Contractor shall submit a Certificate of compliance for all materials proposed to be used in the production of each type concrete mix for the project except for Cement and Supplementary Cementitious Material (SCM). This certification shall be made by a professional engineer (legally authorized to practice engineering in Puerto Rico) and provide information identifying the source of raw materials, manufacturing facility and supplier of each material. Any changes in the source of raw materials, manufacturing facilities and/or suppliers of any of the materials shall require that the contractor conduct trial mixes to verify that the performance of concrete meets all specification requirements. The Contractor shall provide certified laboratory test results performed on the concrete trial mix to the Engineer prior to their use in the project.

The concrete mix design submittal shall contain as a minimum the following information:

a. Contractor and PRHTA project identification.
b. Intended location of pour and mix identification
c. Plant location and identification
d. Source of cement
e. Amount, percent of cement replacement, for each supplementary cementitious material (SCM) in the mix (lbs/cy).
f. Amount and source of each fine and coarse aggregate (lbs/cy).
g. Report individual aggregate properties of individual aggregates per Specification 703-1 and 703-2
h. Specific gravities of mix constituents
i. Dry (AASHTO T-27 without T-11) and wet (AASHTO T-27 with T-11) aggregate gradings to be used (both individual and combined gradations). In addition, report combined grading on the FHWA 0.45 power chart and the percent retained graph. The following sieve sizes shall be used for reporting combined gradation: 2-inch, 1 1/2-inch, 1-inch, ¾-inch, ½-inch, 3/8-inch, #4, #8, #16, #30, #50, #100 and #200. Calculate and report the coarseness and workability factor of the combined gradation. The Coarseness factor (CF) and the workability factor (WF) will be calculated as follows:

CF = (% Retained above 3/8-inch sieve) / (% Retained above #8 sieve) x 100

WF = (% Passing #8 sieve + ((2.5 x amount of cementitious material – 564) / 94)

j. Nominal Maximum Size of Aggregates and Size Number as per ASTM C-33
k. Fineness modulus of fine aggregate.

l. Dosage and source of chemical admixtures (oz/cw) and (oz/cy)
m. Total water content (lb/cy)
n. Water to cementitious ratio (w/cm)
o. Cement Content (lb/cy)
p. Cementitious Content (lb/cy)
q. Slump (in.)
r. Certified laboratory reports on the tests performed on trial mixes including:

1. Slump (in.)
2. Fresh Concrete temperature (F)
3. Air Content (%)
4. Compressive strength at specified time (psi), including the data used to determine the minimum required average compressive strength of concrete used as basis for selection of concrete proportions (f'cr).
5. Split Tensile strength at specified time (psi) (AASHTO T-198)
6. Unit weight (lbs/cy)
7. Total air content (%)
8. Drying shrinkage (%)

In the event that the proportions of concrete mixture designed by the Contractor does not produce concrete meeting the performance requirements for strength and the other requirements of this specification, the Contractor shall adjust the mix accordingly at no additional cost to the Authority. With this, the Contractor shall submit new certified test results for the adjusted concrete mix. No concrete, shall be placed until the Contractor executes the corrective measures submitted to obtain the required strength.

Whenever the Contractor modifies the concrete mix, other than minor (3%) adjustment in the relative quantities of fine and coarse aggregates, he shall submit copy of the new mix design to the Engineer together with copies of test results of the new mix for approval before using the mix in the project.

In the event ready-mixed concrete from a commercial plant is used by the Contractor, such concrete and plant shall meet the requirements of AASHTO M-157 except as modified by these specifications and shall have been inspected and approved by the Authority for use on its projects within the last six months.

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The concrete mix shall be of adequate fresh concrete properties to be placed, consolidated and finished without segregation or defects that will affect the performance of the concrete in service.

4. The mix of Accelerated Strength Concrete shall have a Maximum Cementitious Content of 825 (lbs. /cu. yd.). The Maximum Cementitious Content (lbs. /cu. yd.) refers to the total weight of Cement, , ground granulated blast-furnace slag, silica fume and fly ash added to the concrete expressed in lbs./cu. yd. When Table 937-1 requires coarse aggregate size #7 or #8, the maximum cementitious content (lbs. /cu. yd.) could be increased up to 15%.

5. All Supplementary Cementitious Materials (SCM) shall meet the following requirements:

1. Silica Fume can be used in concrete as a cement replacement on an equal weight basis. Maximum amounts of silica fume are in the range of up to six percent (6%) of the total weight of the cementitious material. The SCM limits presented above include any Silica Fume present in ASTM 1157 cements.

2. Fly ash can be used in concrete as a cement replacement on an equal weight basis. Maximum amounts of fly ash are in the range of up to thirty percent (30%). The SCM limits presented above include any Fly ash present in AASHTO M240 Type IP (MS) and ASTM 1157 cements.

Fly Ash for use with Portland cement or Performance Hydraulic Cements shall conform to the requirements of AASHTO M-295, Class F only. In addition, fly ash shall meet the following requirements:

a) Loss on Ignition is limited to a maximum of 2 percent.

b) Sulfur trioxide (SO_3) is limited to a maximum of 3 percent.

c) Available alkalis (expressed as Na_2O equivalent) is limited to a maximum of 1.5 percent.

d) The optional chemical requirements of AASHTO M-295 Table 1A shall apply in all cases.

e) Fly Ash shall not be substituted for Type IP blended cements.

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3. Grade 100 or Grade 120 Ground Granulated Blast-Furnace Slag (GGBFS) can be use as a cement replacement on an equal weight basis. Maximum amounts of ground granulated blast-furnace slag are in the range of up to sixty five percent (65%) added as a cement replacement on an equal weight basis of the cement being replaced. The SCM limits presented above include any Slag present in AASHTO M240 Type IS (MS) and ASTM 1157 cements.

a. The Contractor shall submit notarized material certificates for each Supplementary Cementitious Materials proposed to be used in conformance with Section 106.06 of the General Provisions.

b. Ternary and quaternary systems using Portland cement, Performance Hydraulic Cements, Class F fly ash, Slag and Silica Fume are encouraged. The individual amounts of Supplementary Cementitious Materials shall comply with previous sections. In ternary and quaternary systems the total combined amount of fly ash and silica fume as a cement replacement shall meet the limits for fly ash used alone for Cement replacement. The total combined amount of fly ash, silica fume, and slag as a cement replacement shall meet the limits for slag used alone for Cement replacement.

6. The bond strength of the Accelerated Strength Concrete in partial-depth repairs shall be verified in the field by the Contractor under the inspection of the Engineer, and it shall conform to the requirements of ASTM C 1583.

937-2.03 Water – The water used in mixing or curing concrete shall be free of oil, salt, acid, alkali, sugar, organic contaminants, or other substance injurious to the finished product. The water will be tested in accordance with and shall meet the suggested requirements of AASHTO T 26. Water known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass or other deleterious substances.

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937-2.04 Hydraulic Cement

a. **Hydraulic Cement** - All hydraulic cement shall meet Specification 701 - "Hydraulic Cement" as modified in this Section.

b. **Portland Cement –** All Portland Cement shall meet AASHTO M-85 or blended Portland cement meeting AASHTO M-240 and the following requirements:

Provide cement that meets the requirements of AASHTO M-240, Type IP (MS) or Type IS (MS). As an alternative provide a combination of AASHTO M-85 Type I, Type II or Type V cement and an AASHTO M-295 Class F fly ash, an AASHTO M-307 Silica Fume and/or an AASHTO M-302 Ground Granulated Blast-Furnace Slag having a sulfate expansion at 180 days of less than 0.10 percent when tested according to ASTM C-1012 using cementitious materials from the same sources as those proposed for use in the project. The pozzolan constituent of Type IP (MS) shall be in the range of 15 to 25 percent by weight of the Portland-pozzolan cementitious material on an equal weight basis (1:1).

c. **Performance Hydraulic Cements –** Provide Hydraulic Cements meeting the requirements of ASTM 1157 "*Performance Specifications for Hydraulic Cements"* for one of the following types MS(R), HS(R), MH(R) or LH(R).

The Contractor shall furnish mill certificates of the cement with the requirements of these specifications. When Type IP (MS), Type IS (MS) or Performance Hydraulic Cements (ASTM 1157) cement is used, the mill certificates shall include the amount of SCM used expressed as percentage on weight basis. Cement may also be accepted from pre-tested and approved bins. However, the Authority may sample and test the cement at any time, at its discretion and require additional mill certificates. Cement shall be protected from rain and moisture by storing in suitable weatherproof bins or buildings. Any cement damaged by moisture or which fails to meet any of the specified requirements will be rejected and shall be removed from the work site.

Cement stored by the Contractor for a period longer than 60 days shall require the Engineer's approval before being used in the work. Stored cement shall meet the specification requirements at any time after storage when retesting is ordered by the Engineer.

Cement of different brands, types, or from different mills shall be stored separately.

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937-2.05 Fine Aggregate – Shall be clean and conform to the requirements of Section 703-1 of Specification 703 - Aggregates, except that the grading shall conform to Grading A of Table 703-1 and that manufactured sand shall not be used as fine aggregate for all concrete that is to serve as the travel way to vehicular traffic (unless they are produced from a pre-approved aggregate source that meets a minimum polishing value of 48 as determined by ASTM D 3319).

937-2.06 Coarse Aggregate

a. All aggregates shall be clean and sound and shall comply with AASHTO M 80 and M 6. Shall meet the requirements specified in Article 703-2 - of Specification 703 Aggregates, except that the gradings in Table 703-2 are to be limited to those included in Table 937-1 of this specification. In addition, for concrete that is to serve as the travel way for vehicular traffic, such as concrete pavements, bridge decks and bridge approach slabs, the coarse aggregate shall have a minimum polishing value of 48 as determined by ASTM D 3319
b. Coarse Aggregate Size Number for Accelerated Strength Concrete shall be as per Table 937-1

Table 937-1
REQUIRED COARSE AGGREGATE SIZE NUMBER

Repair Thickness	Size(s) Number(s) (ASTM C-33)
2" (0.051 m)	7,8
3" (0.076 m)	6,67
≥ 4" (0.102 m)	57,5,56

937-2.07 Chemical Admixtures - All chemical admixtures shall meet the requirements of Specification Section 711 - "Concrete Curing Materials and Admixtures" as modified in this section. Use all admixtures in accordance with manufacturers' recommendations. All admixtures must be submitted to the Engineer for approval prior to their use in the production of concrete. All chemical admixtures shall be protected from excessive temperature and direct sunlight in accordance with Manufacturer specifications.

a. Do not use admixtures which have not been incorporated and tested in accepted and approved mix designs.

b. Contractor shall submit the manufacturer's written certification of compliance with the specifications per Section 106.06 of the General Provisions.

c. Use only admixtures that are compatible with each other, and that produce the desired concrete properties.

d. Water Reducing and Set Controlling Admixtures shall meet the requirements of AASHTO M-194.

e. Use only admixtures containing less than 0.05 percent chloride ions.

f. The use of calcium chloride as an admixture shall not be permitted.

g. When calcium nitrite is added to the concrete mix a water reducing retarding admixture (Type D) and a high range water reducing admixture (Type F) shall be used. Other corrosion inhibitors may be evaluated at the convenience of the Authority based upon the properties indicated below. Submit the following data and certification for the corrosion inhibitor:

1. Test results and performance data for each of the Physical Requirements (Table 1) of AASHTO M-194 for any type of admixture.

2. The contractor shall submit the corrosion inhibitor documentation, either in the form of literature or a letter from an authorized representative of the manufacturer, which documents that the chloride protection level meets or exceeds fifteen (15) lb/cy. Whenever used, the corrosion inhibitor shall be dosed at the required application rate to achieve the required level of chloride protection as stated above.

h. Water reducing, set retarding, or superplasticizers chemical admixtures may be used at the option of the Contractor but subject to approval by the Engineer. The Contractor shall designate in advance the particular types, trade names and manufacturer of admixtures that he proposes to use and only such admixtures as are approved by the Engineer shall be incorporated into the concrete.

i. Retarding admixtures may be used when the setting time of concrete must be retarded for proper placement. The quantity of admixture added to the mix shall be the minimum required for minimum retardation consistent with placing conditions. Retarding admixtures, when used, shall be added at the plant.

j. Use high range water reducing admixture in concrete mixtures incorporating silica fume.

k. Shrinkage reducing admixtures (SRA) may be used. The Contractor shall submit with the concrete mix proposal the particular type, trade name, manufacturer, proposed dosage rate, manufacturer's product data, and recommendations for use, test results, and performance data of the SRA. If approved, no other SRA as shall be incorporated into the concrete.

937-2.08 Measuring and batching of materials shall be done at a batching plant. The measuring equipment and batching plant, and the measuring and batching procedures followed shall be in accordance with the requirements of AASHTO M-157.

937-2.09 Concrete may be mixed at a central plant, in truck mixers or at the site as described in these specifications. The mixing and delivery of concrete shall be in accordance with the requirements of AASHTO M-157 as modified and supplemented by the following paragraphs of this article.

a. The Contractor shall supply concrete at a rate consistent with placement operations as determined by the Engineer. The intervals between deliveries of batches shall not be so great as to allow the concrete in place to harden partially.

b. The Engineer may order discontinuing the use of any type of concrete mixing or transporting units that fail to meet the specification requirements.

c. Volumetric batching and continuous mixing mobile equipment may be used if approved by the Engineer. In such case, the batching and mixing shall be in accordance with AASHTO M-241.

d. When an approved retarding admixture is authorized, the 1-hour limitation between the introduction of the cement to the aggregates and discharge at the site may be increased to the amount stipulated in the previously submitted certified mix design. This time limitation may be exceeded if the concrete is of such slump and workability that it can be placed and consolidated properly without the addition of water to the batch.

e. The entire contents of the mixer shall be removed from the drum before materials for another batch are placed therein. Upon cessation of mixing for a period exceeding one hour the mixer shall be thoroughly cleaned. The delivery unit shall also be completely emptied, cleaned and free from concrete and wash water before receiving the next load of concrete.

f. When a truck mixer or agitator is approved for mixing or delivery of concrete, the addition of water shall be as per ASTM C-94.

g. Certification of Batches - Before unloading at the site of delivery, the concrete supplier shall furnish to the Engineer delivery tickets containing the following information concerning the concrete in the truck. The tickets shall be issued to the truck operator at the proportioning plant for each load.

(1) Name and number of batch plant
(2) Serial number of ticket
(3) Date and truck number
(4) Name of Contractor
(5) Specific designation of job (name and location)
(6) Specific class of concrete in conformance with job specifications
(7) Volume of concrete (cubic yards)
(8) Batching tickets with a list of all the constituents and the amount of each one used for the mix (target and actual weights)
(9) For central mixed concrete, time when first mixing was completed at the central mix plant.
(10) For transit mixed concrete and truck-mixed concrete, time when the cement was introduced to the aggregates
(11) Name and quantity of admixtures, if any.
(12) Spaces to indicate time when discharge commenced and when completed.

The Authority may, at its discretion, inspect the weights at the batch plant. The Contractor shall provide all necessary facilities to assist the inspector in performing this task.

h. Delivery - The organization supplying concrete shall have sufficient plant capacity and transporting equipment to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete. The methods of delivering and handling the

concrete shall be such as will facilitate placing with the minimum of rehandling and without damage to the structure or the concrete.

i. Tempering - The concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial set shall not be used. Tempering concrete by adding water or by other means will not be permitted.

937-2.10 Structural Bonding Agent – The Structural Bonding Agent shall be an Epoxy-Cementitious type as well as provide anti-corrosion coating for the steel reinforcement. The Contractor shall submit the product technical data sheets and Manufacturer's certifications for review and approval by the Engineer. When required by the Engineer, the Contractor shall also submit certified test reports for approval. The Structural Bonding Agent shall not be applied in the field or incorporated in to the work without prior approval by the Engineer.

a. The material properties shall meet the requirements specified in the following parameters and specifications:

Minimum Pot Life.....	30 minutes at 100 degrees F	
Minimum Bond Strength at 24 hr. Open Time.....	2,500 psi	(ASTM C 882)
Minimum Compressive Strength at 28 days.....	8,000 psi	(ASTM C 109)
Minimum Flexural Strength at 28 days.....	1,000 psi	(ASTM C 348)
Minimum Splitting Tensile Strength at 28 days.....	600 psi	(ASTM C 496)

b. Acceptance of the material will be on the basis of Manufacturer's certification establishing the material meets the contract requirements. However, failure by the material to perform adequately in actual use shall be just cause for rejection regardless of certification.

c. Material shall be factory packaged in strong moisture proof bags or containers capable of withstanding shipping, handling and storage without breakage. Material shall have a storage life of at least one year.

937-2.11 Structural Crack Healer / Sealer – The Structural Crack Healer / Sealer shall be a low-viscosity epoxy crack healer / sealer and high-strength adhesive for structures exposed to pneumatic tire traffic, water, chlorides, and chemical attacks. The Structural Crack Healer / Sealer shall meet the requirements specified in ASTM C 881 and AASHTO M 235 Specifications. The Contractor shall submit the product technical data sheets and Manufacturer's certifications for review and approval by the Engineer. When required by the Engineer, the

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Contractor shall also submit certified test reports for approval. The Structural Crack Healer / Sealer shall not be applied in the field or incorporated in to the work without prior approval by the Engineer.

a. The material properties shall meet the requirements specified in the following parameters and specifications:

Maximum Viscosity (low, Grade 1)……	90 cps	(ASTM D 2393)
Minimum Pot Life.....…….....	15 minutes at 100 degrees F	
Minimum Bond Strength at 2 days in 73°F.....….....	1,300 psi	(ASTM C 882)
Minimum Compressive Strength at 7 days in 73°F.....	10,000 psi	(ASTM D 695)
Minimum Flexural Strength at 7 days in 73°F……......	9,000 psi	(ASTM D 790)
Minimum Tensile Strength at 7 days in 73°F.....…	7,000 psi	(ASTM D 638)

b. Acceptance of the material will be on the basis of Manufacturer's certification establishing the material meets the contract requirements. However, failure by the material to perform adequately in actual use shall be just cause for rejection regardless of certification.

c. Material shall be factory packaged in strong moisture proof bags or containers capable of withstanding shipping, handling and storage without breakage. Material shall have a storage life of at least one year.

937-2.12 Epoxy Resin Binder Coat – The Epoxy Resin Binder Coat shall be a medium-viscosity and moisture-tolerant epoxy resin Type III binder for skid-resistant. The Epoxy Binder Coat shall meet the requirements specified in ASTM C 881 and AASHTO M 235 Specifications. An approved aggregate shall be broadcasted to the Epoxy Binder Coat. The Contractor shall submit the product technical data sheets and Manufacturer's certifications for review and approval by the Engineer. When required by the Engineer, the Contractor shall also submit certified test reports for approval. The Epoxy Resin Binder Coat shall not be applied in the field or incorporated in to the work without prior approval by the Engineer.

a. The material properties shall meet the requirements specified in the following parameters and specifications:

Maximum Viscosity (medium, Grade 2)……	2700 cps	(ASTM D2393)
Minimum Pot Life.....…….…….....…..	30 minutes at 100 degrees F	
Minimum Bond Strength at 2 days in 73°F….....	1,000 psi	(ASTM C 882)
Minimum Compressive Strength at 14 days in 73°F...	7,000 psi	(ASTM D 695)
Minimum Flexural Strength at 14 days in 73°F.....	4,000 psi	(ASTM D 790)
Minimum Tensile Strength at 14 days in 73°F..…..…	2,000 psi	(ASTM D 638)

b. Acceptance of the material will be on the basis of Manufacturer's certification establishing the material meets the contract requirements. However, failure by the material to perform adequately in actual use shall be just cause for rejection regardless of certification.

c. Material shall be factory packaged in strong moisture proof bags or containers capable of withstanding shipping, handling and storage without breakage. Material shall have a minimum storage life of one year.

937-2.13 Corrosion Inhibitor – The Corrosion Inhibitor shall be a low-viscosity combination of amino alcohols, and inorganic inhibitors. It shall protect or reduce the corrosion in reinforced concrete structures exposed to pneumatic tire traffic, water, chlorides, and chemical attacks. The product shall meet the requirements specified in ASTM G 109 Specification with a viscosity less than 25 centipoise (CPS). The Corrosion Inhibitor shall not be slippery when the product dries. The Contractor shall submit the product technical data sheets and Manufacturer's certifications for review and approval by the Engineer. When required by the Engineer, the Contractor shall also submit certified test reports for approval. The Corrosion Inhibitor shall not be applied in the field or incorporated in to the work without prior approval by the Engineer.

a. Acceptance of the material will be on the basis of Manufacturer's certification establishing the material meets the contract requirements. However, failure by the material to perform adequately in actual use shall be just cause for rejection regardless of certification.

b. Material shall be factory packaged in strong moisture proof bags or containers capable of withstanding shipping, handling and storage without breakage. Material shall have a storage life of at least one year.

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937-2.14 Sampling and Testing - Except for Polymer Concrete Bond Strength, acceptance and laboratory testing will be performed by the Authority.

a. Compliance with the requirements included in the above articles will be determined in accordance with the following AASHTO standards:

Sampling Fresh Concrete	T 141
Size of Aggregates	T 27
Consistency (Slump)	T 119
Weight per Cu. Ft. and Air Content	T 121
Temperature of Fresh Concrete	C1064
Air Content of Freshly Mixed Concrete (Pressure Method)	T 152
Air Content of Freshly Mixed Concrete (Volumetric Method)	T 196
Making and Curing Concrete Test Specimens in the Field	T 23
Compressive Strength of Cylindrical Concrete Specimens	T 22
Concrete Bond Strength	C1583
Split Tensile Strength	T-198

b. Sampling frequency for compressive strength testing shall be one set of six cylinders shall be obtained from each lot of 7.65 cubic meters or fraction thereof placed each type of Deck Patching Material per bridge deck for testing at seven (**7**) days. The specimens shall be taken, handled and transported by the Contractor to the designated PRHTA laboratory, under the supervision of the Engineer. The transportation of concrete specimens requires special handling by the Contractor. As a minimum, the Contractor shall assure that cylinder specimens are enclosed in a rigid container and that they be surrounded by a minimum of three inches of adequate padding material (for example, dry fine graded sand). The Contractor shall properly secure the transportation container in order to prevent excessive movement that may cause contact between the specimens. It shall be the Contractor's responsibility to coordinate transportation at least 36 hours in advance of the proposed concrete pour with the Engineer and PRHTA Material Testing Office laboratory. The Contractor shall furnish at no additional cost to the Authority all personnel, materials, and equipment necessary to comply with these requirements. All compressive strength and permeability testing for

acceptance shall be based only on the concrete cylinder samples obtained from each lot during mix placement operation.

c. For Accelerated Strength Concrete, the contractor shall cast one 3' x 3' x 6" element from lot of 7.65 cubic meters of Deck Patching Material or fraction thereof for future re-testing. The Deck Patching Material specimen shall be cast next to the represented Patch Area and shall be consolidated and cured under the same conditions. The concrete and forms for the 3' x 3' x 6" element will not be measured for payment but shall be furnished by the Contractor without additional compensation. The Contractor shall drill core samples of the hardened concrete element at his expense but under the direction and supervision of the Engineer, to be tested at the Authority's laboratory. The following criteria shall govern the coring program:

(1) The obtaining and testing of drilled cores shall be in accordance with AASHTO T 24 and T 22.

(2) The cores shall be drilled no earlier than 2 days and no later than 3 days after the pouring of the concrete element.

(3) A minimum of three cores shall be taken for each concrete element. Cores shall be taken at random locations selected by the Engineer.

(4) The transportation of concrete core specimens is the responsibility of the Contractor and requires special handling by the Contractor. In addition, the transportation from the project site to the designated PRHTA Materials Testing Laboratory shall be performed under the direct supervision of the Engineer. It shall be the Contractor's responsibility to coordinate transportation at least 36 hours in advance of the proposed concrete pour with the Engineer and PRHTA Material Testing Office laboratory. As a minimum, the Contractor shall assure that core specimens are enclosed in a rigid container and that they be surrounded by a minimum of three inches of adequate padding material (for example, dry fine graded sand) around each core. The Contractor shall properly secure the transportation container in order to prevent excessive movement that may cause contact between the specimens. The Contractor shall furnish at no additional cost to the Authority all personnel, materials, and equipment necessary to comply with these requirements.

(5) The contractor shall properly remove and disposed the 3’ x 3’ x 6” element after coring operations at no additional cost to the Authority.

d. Additional sets of specimens will be made as needed to determine when forms may be removed or when a structure may be put into service or if the Engineer deems it necessary to determine the acceptability of Deck Patching Material. No additional cost to the Authority will be made for any additional set.

e. The Contractor shall furnish at his expense single use plastic molds four (4) inches in diameter by eight (8) inches long (4” x 8”) with lids, conforming to AASHTO M 205 and T 23 that are necessary to comply with the required frequency of sampling. As a subsidiary obligation, when using single use plastic molds, the Contractor shall furnish stripping tools such as Gilson HM160, Humbold H-3041S/H-3041SM, Myers ST-1/ST-2, or approved equal for removing the sample from the mold. Cardboard molds will not be accepted. The concrete for the test specimens will not be measured for payment but shall be furnished by the Contractor without additional compensation.

f. The following fresh concrete tests as shall be made from lot of 7.65 cubic meters of the Deck Patching Material or fraction thereof placed each day per bridge deck from which test cylinders are taken: Slump, Unit Weight, Air Content, and Temperature. Additional tests could be required as determined by the Engineer to check the consistency of the Deck Patching Material.

g. **Split Tensile Strength** - The Engineer, at his discretion, may require the Contractor to take a set of two cylinders from at random locations to perform Split Tensile Strength tests to compare results with the mix design submittals.

(1) All cylinders for sampling and testing shall be four (4) inches in diameter by eight (8) inches long (4” x 8”).

(2) The Contractor shall furnish at his expense all single use plastic molds with manufacturer provided lids, conforming to AASHTO M-205 and T-23 that are necessary to comply with the required frequency of sampling. As a subsidiary obligation, when using single use plastic molds, the Contractor shall furnish stripping tools such as Gilson HM160, Humbold H-3041S/H-3041SM, Myers ST-1/ST-2, or approved equal for removing the sample from the mold. Cardboard molds shall not be accepted.

(3) The concrete for the test specimens will not be measured for payment but shall be furnished by the Contractor without additional compensation.

The Engineer, at his discretion, may require the Contractor to wash out the mortar from fresh Deck Patching Material samples, to compare the mix aggregates with mix design sources or perform laboratory tests.

h. The bond strength of Deck Patching Material in partial-depth repairs shall be a minimum of 200 psi as determined by Pull-Off Test of ASTM C 1583 for each patching area. Bond strength testing of the Deck Patching Material in partial-depth repairs, including all necessary equipments, labor or any other incidental cost shall be subsidiary item to de "*Deck Patching*" pay item. Bond strength testing shall be performed by a certified technician at locations determined by the Engineer and under his supervision. Failure of the Deck Patching Material placed to meet the bond strength requirements shall be cause for the rejection and removal of Deck Patching Material.

i. All of the field sampling tests requirements for fresh concrete included in this section shall be performed by a certified technician as determined by the Engineer and under his supervision. The certified technician shall possess an active Field Testing Technician Certification from the ACT Technician Training Certification Program or an active certification from American Concrete Institute as Field Testing Technician Grade I.

937-2.15 Basis of Acceptance of Deck Patching Material

a. In general, the acceptability of the quality of the Deck Patching Material delivered to or made at the jobsite will be based on slump tests, air content test, aggregate tests, bond strength tests, and on the results of standard compressive strength tests of representative samples at 7 days as covered by these specifications. However, this does not relieve the responsibility of the Contractor for the Deck Patching Material during placement, consolidation, finishing, curing and protection prior to final acceptance by the Authority. Failure of the material to provide intended performance due to improper installation or placement shall be cause for rejection and removal of Deck Patching Material.

b. Failure of the Coarse Aggregate to meet the polishing value requirements shall be cause for the rejection and removal of Deck Patching Material for use on vehicular travel ways.

c. The compressive strength of the quantity of Deck Patching Material placed and represented by one set of cylinders shall be determined as the average of six cylinders comprising the set. If the Engineer determined that any cylinder shows evidence of improper sampling, molding, handling, curing or testing, the test result of such defective cylinder shall be discarded and the compressive strength of the Deck Patching Material represented shall be determined from the test results of the remaining cylinders. Low strength shall not be a basis for discarding a cylinder test result.

d. The compressive strength level of each Type of Deck Patching Material will be considered satisfactory if both of the following requirements are met:

   l. If the compressive strength represented by one set of cylinders equals or exceeds the specified compressive strength. .

   2. When the compressive strength of one set of cylinders fails to meet the compressive strength requirement of the paragraph above, but is within 500 psi from specified the Deck Patching Material will be considered acceptable at a reduced unit price as specified in Article **937-5.09**

e. All Deck Patching Material represented by a cylinder set which shows a strength falling below the specified value by more than 500 psi will be considered deficient and will be rejected, removed and disposed of at the Contractor's expense. The removal shall be performed in such a manner as will not cause damage to the remaining Deck Patching Material or to other units of the structure.

f. For Accelerated Strength Concrete, the Contractor may elect to request re-testing of the Deck Patching Material classified as deficient under paragraph "e" above. When approved by the Engineer, the Contractor's request for retesting shall be submitted in writing within 14 days after placement of the Deck Patching Material represented by the failing lot.

g. The core strength shall be the average of all cores tested. The concrete represented by the core tests will be considered acceptable if the average of the cores is equal to at least 85 percent of the specified compressive strength and if no single core test is less than 75 percent of the specified compressive strength. If concrete represented by the cores fails to meet any of the above requirements will be considered rejected. No farther re-testing will be permitted.

h. When the Contractor request re-testing of the Deck Patching Material as per paragraph "f" and the core strength values meet the acceptance criteria specified in paragraph "g", the core strength values will be used for acceptance computations. The resulting values divided by 0.85 will be substituted in the acceptance computations and will be subjected to the strength acceptance criteria specified for computing the deficiency "D" and the applicable price reductions.

i. **Intentionally Omitted**.

937-3 CONSTRUCTION REQUIREMENTS

937-3.01 General

a. The partial-depth and full-depth slab repairs of bridge concrete deck shall be performed according to the details and notes shown on plans.

b. Concrete patching operations will be conducted in one lane at a time and in a manner that offers minimum inconvenience to public traffic. The work shall be accomplished in coordination with other operations in progress within an area. Speed control measurements shall be in place when traffic is allowed through the bridge and until final curing is completed. Speed control measurements are subsidiary items of Deck Patching Material.

c. A Bridge Concrete Deck Repair Pre-Construction Meeting discussing surface preparation, Deck Patching Material placement and curing shall be held at the jobsite at least 10 working days before beginning of deck repair operations. The contractor shall coordinate with the Engineer at least 10 working days in advance; the proposed meeting the time, place, and agenda of the meeting to ensure the attendance of representatives of all subcontractors and suppliers involved in the deck repair process. The engineer may require at his discretion the presence of any additional personnel.

At this meeting the contractor shall submit a deck repair plan that includes all work related to surface preparation, Deck Patching Material production, placement, and curing. The Contractor shall also discuss its quality control procedures as well as the contract quality assurance and acceptance requirements. The presence of the contractor, its subcontractors, concrete supplier, specialty material suppliers for structural bonding agent, structural crack healer/sealer and corrosion inhibitor (impregnated) is mandatory. Also, the Engineer and the inspectors will attend this meeting.

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The contractor shall submit to the Engineer a revised deck repair plan that includes any changes, revisions made and agreements reached during the Bridge Concrete Deck Repair pre-construction meeting. The revised construction plan shall be submitted at least 5 working days before the proposed repair operation. No deck repair operations shall be conducted until the Engineer has accepted the plan. The Bridge Concrete Deck Repair pre-construction meeting and the deck repair plan are subsidiary work to the applicable Deck Patching Material items in the project at no additional cost to the Authority. This plan shall include all applicable items as determined by the Engineer but shall not be limited to the following:

a. All equipment to be used during the procedures including contingency equipments.
b. Procedures for surface preparation, placing, consolidating, finishing and curing. The procedures shall include a detailed CPM showing all the activities required to successfully construct the patch and its interrelationships.
c. Measures to effectively maintain the evaporation rate throughout the placement area below the limits required in this specification. Such procedures may include but are not limited to the following:
   1) Produce, deliver, and place concrete at the lowest acceptable temperature to conform to evaporation rate limits.
   2) Erecting windbreaks to effectively reduce the wind speeds throughout the placement area.
   3) Fog spraying throughout the placement area to effectively increase the relative humidity.
   4) Placing concrete at favorable ambient temperature conditions.
d. Use of vibrators
e. Concrete placing rate
f. Contingency measurements
g. Safety and security provisions
h. Use of retarding admixtures, setting time of concrete for proper placement. Minimum retardation consistent with placing conditions.
i. Compliance with PRHTA concrete plant inspection requirements
j. Contractor Quality Control Procedures
k. Contract Quality Assurance and Acceptance Requirements
l. MOT and speed control measurements
m. Other applicable requirements or procedures included in this specification.

e. Deck Patching Material shall be properly protected from adverse hot weather conditions before, during and after placement as established in the approved deck repair construction plan and the following requirements:

1. The initial Deck Patching Material placement temperature shall not exceed the values set in this specification. All necessary precautions shall be taken to see that the Deck Patching Material is promptly placed on arrival at the job and immediately vibrated after placement. The Deck Patching Material shall be protected from excessive drying during finishing and curing operations which shall be performed without delay as soon as possible. The Contractor shall provide, at no cost to the Authority, the necessary equipment to perform relative humidity, - wind speed, air temperature and Deck Patching Material temperature testing. Said equipment shall be calibrated at least once a year.

2. Concrete shall only be placed when any combination of air temperature, relative humidity, concrete temperature and wind speed is expected to result in an evaporation rate as follows:

a) 0.2 pound per square foot per hour or less for concretes with total cementitious content below 564 (lb./cy)

b) 0.1 pound per square foot per hour or less for concrete with total cementitious content of 564 (lb./cy) or more

c) To determine the combination of air temperature, relative humidity, concrete temperature, and wind speed resulting in the critical evaporation rate, Figure 1 shall be employed.

3. If original placing procedures proved not effective, the Contractor shall implement appropriate corrective measures as established in the accepted A Bridge Concrete Deck Repair Plan per Section **937-3.01-c** at no extra cost to the Authority. In no case shall the concrete temperature exceed values stated elsewhere in this specification.

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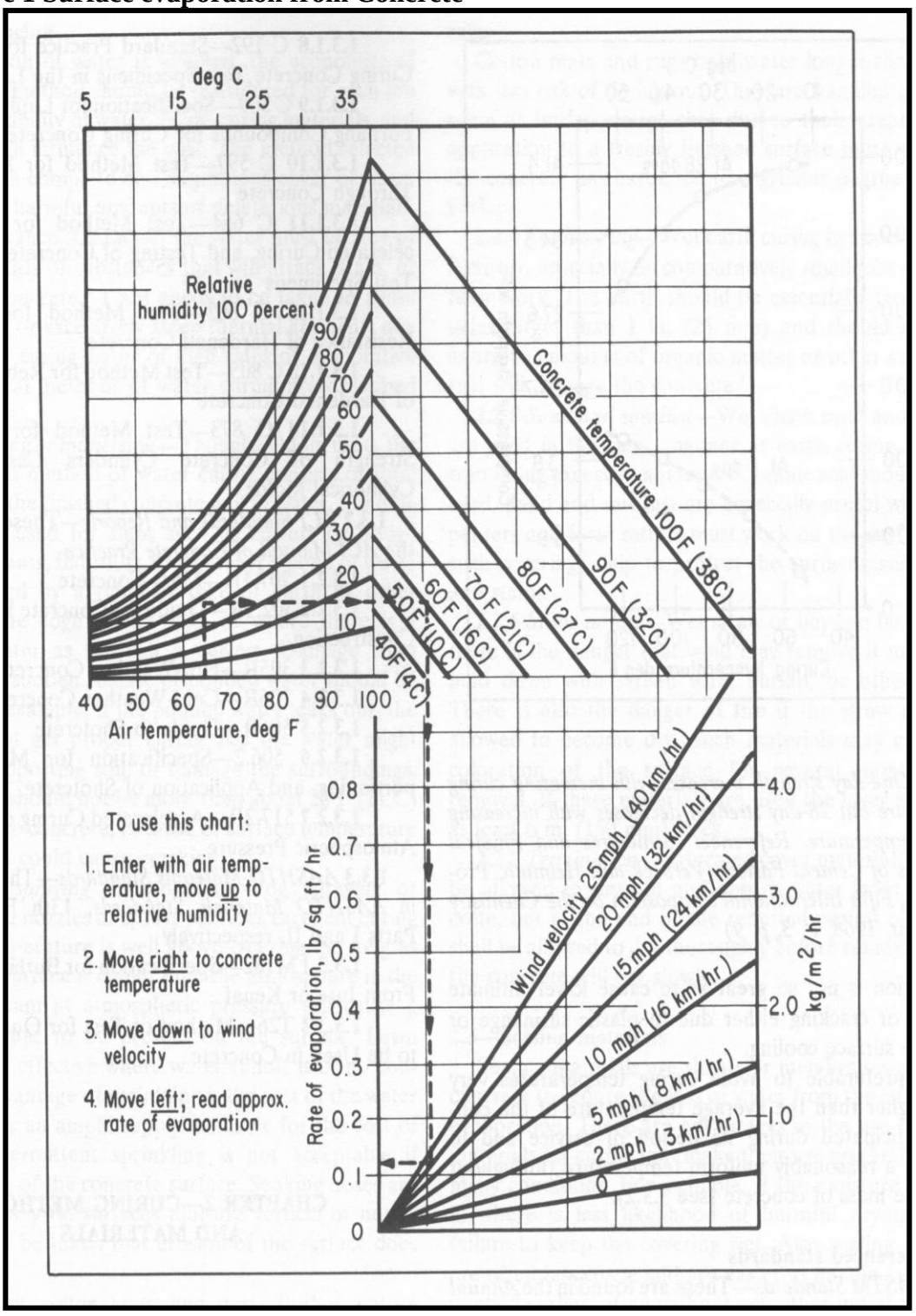
Figure 1 Surface evaporation from Concrete



f. Temperature of bridge deck upper surface for partial depth repairs shall not exceed 90 degrees F at the time of application of structural bonding agent. Temperature of formwork surface for full depth repair shall not exceed 90 degrees F at the time of Deck Patching Material placement. .

937-3.02 Equipment

a. The Contractor shall use sawing equipment adequate in size and power to saw cut the joints and other sides of the areas to be patched to the required widths and depths.

b. A lightweight power chipping hammer or hand tools shall be used for removal of defective concrete. Only power operated equipment, capable of producing a surface profile International Concrete Repair Institute (ICRI) Concrete Surface Profile (CSP) 6 to 8 shall be used. The contractor shall provide to the Engineer, as subsidiary item of Deck Patching Material, one set of ICRI CSP evaluation specimens. The lightweight power chipping hammer shall be pneumatic or electric hammers and these shall not be heavier than 20 pounds. The lightweight power hammers, and chipping tools shall not be operated at an angle exceeding 60 degrees relative to the surface of the bridge deck or approach slabs. Such tools may be started in the vertical position but must be immediately tilted to a 60 degree operation angle.

c. The power operated shotblasting equipment shall be a self-contained cleaning system and dust collector. Only power operated equipment, capable of producing a surface profile International Concrete Repair Institute (ICRI) Concrete Surface Profile (CSP) 6 to 8 shall be used. The contractor shall provide to the Engineer, as subsidiary item of Deck Patching Material, one set of ICRI CSP evaluation specimens. This equipment shall use steel shot or pellet. It must be able to discharge reused shots or pellets, and contaminants into a separator that automatically recycles the cleaned abrasive and discharges dust and surface contaminants into a dust collector. The size and hardness of the shot, the flow of the shots or pellets, the forward speed, and the number of passes shall be as recommended by the Equipment's Manufacturer and approved by the Engineer. The cleaning residue shall be contained and removed by the shotblasting equipment.

d. The hydrodemolishing equipment shall be used for removal of defective concrete in areas greater than 30 square meters. Only power operated equipment, capable of producing a surface profile International Concrete Repair Institute (ICRI) Concrete Surface Profile (CSP) 6 to 8 shall be used. The contractor shall provide to the Engineer, as subsidiary item of Deck

Patching Material, one set of ICRI CSP evaluation specimens. The hydrodemolishing equipment shall consist of filtering and pumping units operating in conjunction with remote-controlled robotic device. The hydrodemolishing equipment requires the use of the vacuum cleanup system. The vacuum cleanup system shall be equipped with fugitive dust control devices and be capable of removing wet debris and water all in the same pass. Provide equipment capable of washing the bridge deck with pressurized water prior to the vacuum operation to dislodge all debris and slurry from the bridge deck surface. This equipment must operate at a noise level of less than 90 decibels at a distance of 50 feet from either the powerpac unit or the remote robot. It must be capable of working 24 hours per day with at least 80 percent on the job production availability. Water used for this operation shall be potable, river, lake or stream water. Areas of the deck not accessible or otherwise convenient to hydrodemolition operations shall be treated with lightweight power chipping hammer as per Article 937-3.02b.

1. Once the operating parameters of the hydrodemolishing equipment are defined by programming and calibration, they shall not be changed as the machine progresses across the bridge deck or deck unit, in order to prevent the unnecessary removal of sound concrete below the required minimum removal depth. The Contractor shall exercise care to avoid removal of sound concrete below the required depth.

2. Operation of the hydrodemolishing equipment shall be performed by the supervised by qualified personnel certified as such by the Equipment's Manufacturer.

3. The Contractor shall provide for the disposal of runoff water generated by the hydrodemolition process. The contractor shall obtain any required permits and shall comply with applicable regulations concerning such water disposal. The Contractor shall exercise care to protect existing berm slopes from scouring by water jet or runoff water.

4. The Contractor shall provide adequate lighting as required to allow for the safe conduct of nighttime removal operations, and shall obtain the Engineer's approval for same, exercising care to avoid any hazardous glare in the direction of oncoming traffic.

5. The Contractor shall maintain, on the job site, and inventory of common wear parts and replacement accessories for the equipment adequate to assure that routine maintenance tasks can be performed readily without undue project delay.

6. Removal of concrete debris shall be accomplished by hand or by mechanical means, and shall be accomplished directly following the hydrodemolition process, to prevent the debris from re-setting or re-adhering to the surface or remaining sound concrete. Any removal debris which is allowed to re-settle or to re-adhere to the surface of sound concrete shall be carefully removed by the Contractor, and the Contractor shall exercise care to avoid any damage to the remaining sound concrete. Debris shall be disposed of as provided for in the plans.

937-3.03 Unsound Concrete Identification

a. Prior to beginning concrete patching operations, all surface of bridge concrete deck shall be sounded for identifying and measuring the unsound concrete, delaminations and damage areas following the ASTM D 4580. The operations of Sounding Test for identifying and measuring of unsound concrete, delaminations and damage areas shall be realized by the Contractor under the inspection of the Engineer. The Engineer shall certify the areas of unsound concrete, delaminations and damage areas to be removed.

b. The equipment for Sounding Test shall be provided by the Contractor as specified by ASTM D 4580. The Sounding Test and Equipment shall be considered a subsidiary obligation of the Contractor with its cost included in the "Deck Patching Material" pay item.

937-3.04 Preparation and Patching

a. After the certification of unsound areas, the Contractor shall cut to a maximum depth of 0.025 meter with a sawing equipment and avoid the cutting of the existing steel reinforcement. The minimum distance for limit of saw cutting shall be 0.60 meter in all sides of the unsound concrete, except in the partial-depth slab repair, the minimum distance for limit of saw cutting shall be 0.30 meter. All cuts shall be made at right angles as shown on the details.

b. After the limit of saw cutting is defined, the unsound concrete shall be removed carefully with a lightweight power chipping hammer, shotblasting equipment and/or hydrodemolishing equipment for defective areas. Remove the debris and clean the surface.

c. The existing steel reinforcement shall not be damaged, and it shall remain during the removal of the unsound concrete. When more than half rebar diameter is exposed, or the Engineer deem necessary, concrete around rebar shall be removed to allow proper bonding of patching material to the reinforcement. The minimum mount or concrete around rebar to be removed shall be one inch (1"). The existing steel reinforcement shall be straightened and it shall be cleaned with water blasting in all corroded or dirty areas. The damaged steel reinforcement must be cut off and replaced, but allowing sufficient lap splice to connect the new rebar.

d. All surface of concrete slab to be repaired and steel reinforcement shall be dried, cleaned, free from all dust, laitance oil, and any foreign material before applying the Structural Bonding Agent and placing the Deck Patching Material.

e. For partial-depth slab repair, all surface of slab concrete to be repaired shall be treated with a Structural Crack Sealer before applying the Structural Bonding Agent and placing the Deck Patching Material.

f. All surface of concrete slab to be repaired shall be treated with a Structural Bonding Agent before placing the Deck Patching Material. The Structural Bonding Agent shall be broomed into the surface with a stiff bristle broom. The thickness of application shall be an average of 20 to 25 mils. If the concrete substrate absorbs the Structural Bonding Agent, another coat shall be applied. The Structural Bonding Agent shall be applied within the time limits recommended by the Manufacturer but shall not to exceed one and half (1.5) hours before placing the Deck Patching Material.

g. Place in situ the Deck Patching Material. The Deck Patching Material shall meet the requirements of this specification.

h. The Deck Patching Material shall be cured in accordance of the Article 937-3.08 of this specification.

i. The Contractor shall apply a Structural Crack Sealer around of Patching Area at top of construction joint.

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937-3.05 Falsework

a. The Contractor shall be responsible for designing and constructing safe and adequate falsework which provides the necessary rigidity, supports the loads imposed, and produces in the finished structure the lines and grades indicated on the plans.

b. The Contractor shall furnish, upon request of the Engineer, detailed working drawings and design calculations of the falsework for bridges. The acceptance of such drawings and the falsework inspection by the Engineer will in no way relieve the Contractor of full responsibility for the adequacy and safety of the falsework.

c. Falsework which cannot be founded upon a solid footing shall be supported by falsework piling which shall be spaced, driven and removed in a manner approved by the Engineer. No additional compensation will be paid for the use and removal of falsework piling.

d. Falsework shall be set to give the finished structure the specified camber plus an allowance for shrinkage and settlement. The weight of the finishing screed for bridge decks and other construction loads and their effect on the required camber shall be considered by the Contractor in the design of the falsework.

e. Suitable screw jacks or hardwood wedges shall be incorporated into the falsework and adjusted to take up any settlement in the formwork either before or during the placing of Deck Patching Material.

937-3.06 Forms

a. Forms for all exposed Deck Patching Material surfaces shall be made from one or more of the following materials:

   1. Faced with exterior type plywood
   2. Lumber dressed at least on one side and two edges
   3. Metal
   4. Plastic
   5. Fiberglass

b. All forms shall be well constructed, carefully aligned, substantial and firm, securely based and fastened together in final position. They shall be strong enough to prevent the plastic Deck Patching Material from bulging the forms

between supports and to withstand the action of mechanical vibrators. They shall be so constructed as to produce mortar-tight joints and smooth, even Deck Patching Material surfaces.

c. Forms shall be designed to resist the pressure resulting from plastic Deck Patching Material weighting 150 pounds per cubic foot, a live load allowance of 50 pound per square foot on horizontal surfaces, and other live loads incidental to the construction operations. Deck Patching Material misshapen by bulges or deformations caused by inadequate forms shall be removed or corrected as ordered by the Engineer at the Contractor's expense.

d. Forms shall be filleted and chamfered as shown on plans, and shall be given a bevel or draft in the case of all projections, such as girders and copings, to assure easy removal.

e. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 2.5 centimeters from the face without injury to Deck Patching Material. In case wire ties are permitted, suitable cones shall be provided. The cavities shall be filled with cement mortar and the surface left sound, smooth, even and uniform in color.

f. Where the bottom of the forms is inaccessible, the lower form boards shall be left loose or other provisions made so that extraneous material may be removed from the forms immediately before placing the Deck Patching Material.

g. All forms shall be treated with an approved form coating prior to placing reinforcement and wood forms shall be saturated with water immediately before placing the Deck Patching Material. The form coating to be used can be of any acceptable commercial quality which permit the easy removal of the forms and will not discolor or stain the Deck Patching Material. After the forms are treated with form coating, the forms shall be covered by a white plastic sheet in the area where the Deck Patching Material will be placed.

h. The specifications for forms, as regards design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and coating, also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet be designed to hold the forms rigidly together and to allow removal without injury to the Deck Patching Material. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease or other foreign matter.

i. Stay-in-place metal forms will not be permitted unless specifically shown on the plans. In such case, the Contractor shall submit detailed shop drawings, samples, specifications and any other information complying with Specification 715 – "Structural Metals".

j. All forms shall be set and maintained true to the line designated until the Deck Patching Material is sufficiently hardened. When forms appear to be unsatisfactory in any way, either before or during the placing of Deck Patching Material, the Engineer will order the work stopped until the defects have been corrected.

k. Forms to be reused shall be maintained in good conditions as to tightness and surface smoothness at all times. Any warped or bulged lumber shall be resized before being used. Unsatisfactory forms shall not be used and shall be removed immediately from the site of the work.

937-3.07 Curing of Deck Patching Material

a. General

1. Curing shall be initiated immediately after placing and finishing. Curing shall be done so that moisture is always present and shall be an integral part of the mix operations. Improperly cured Patching Area will be considered defective and the Engineer will stop all the Contractor's mix placing operations until proper curing procedures are put into effect.

2. The Polymer Concrete shall be cured as recommended by Product's Manufacturer.

3. The Accelerated Strength Concrete shall be cured following the Water Method of this specification.

4. The Contractor will be held responsible for any cracking of the Patching Area and will be the Contractor's responsibility to repair or remove and replace the affected Patching Area at no cost to the Authority.

b. Water Method

Curing shall be conducted as follows:

(i) **Phase I** - Interim Curing: From the time of initial strike off of the

concrete until finishing is completed and Phase II curing is in place, the unformed surfaces of Deck Patching Material shall be fogged at all times. Fogging equipment shall be capable of applying water in a fine mist, not a spray. The fog shall be produced using equipment which pumps water or water and air under high pressure through a suitable atomizing nozzle. The equipment shall be hand operated and sufficiently portable for use in the direction of any prevailing wind. It shall be adaptable for intermittent use as directed by the Engineer to prevent excessive wetting of the concrete surface.

(ii) **Phase II** – Initial Curing: The Deck Patching Material shall be cured by supplying additional moisture to exposed surfaces of the concrete until Phase III curing is implemented. This work includes protecting the Deck Patching Material from the sun and providing a system to maintain the Deck Patching Material continuously and thoroughly wet for the required amount of time. This work shall be performed as soon as possible.

The Contractor shall use a burlap or cotton mat system with white plastic or other suitable moisture retaining material that achieves the requirements of paragraph above.

Any method which results in the concrete being alternately wet and dry will be considered improper curing procedure.

(iii) **Phase III** – Final Curing **-** This method shall consist of preventing moisture loss from the concrete by the use of a membrane forming, white pigmented, curing compound as approved by the Engineer. This membrane shall retard the loss of water and reduce the temperature rise in the concrete exposed to the sun's radiation. Final curing shall be performed following manufacturers recommendations before allowing traffic over the new concrete. The Contractor shall provide the Engineer with all manufacturers technical specifications and application recommendations at the Bridge Concrete Deck Repair Pre-Construction Meeting.

The liquid membrane-forming compound shall be delivered in the manufacturer's original, clean, sealed containers. No liquid membrane-curing compound shall be accepted in containers other than manufacturer's original.

The curing compound shall be thoroughly mixed within an hour before use. It shall be of such character that the film will harden within 30 minutes after application.

The curing compound shall be applied by power-operated atomizing spray equipment to obtain a uniform coating in accordance with the manufacturer recommendations. The surface shall be sprayed in one direction and then followed within 30 minutes with a second application sprayed at right angles to the first one.

The rate of application of curing compound will be as recommended by the manufacturer but not less than one gallon of liquid coating for each 15 square meters of concrete surface.

If the contractor cannot obtain a uniform curing compound membrane throughout the entire surface by means of spraying equipment, then the membrane shall be applied by brush or roller.

937-3.08 Removal of Falsework and Forms

a. Falsework and forms shall not be removed without the consent of the Engineer; however, the Engineer's consent shall not relieve the Contractor of responsibility for the safety of the work. Forms may only be removed if the temperature differential between the Deck Patching Material within the forms and the ambient is less than or equal to 8°F. Provisions shall be made to monitor the internal temperature of the Deck Patching Material within the forms through the use of thermocouples or similar techniques.

b. When Deck Patching Material strength tests are used for controlling the removal of forms and supports, such removal shall not begin until the Deck Patching Material has attained the percentage of the design strength specified in the contract documents. Deck Patching Material strength tests used for this purpose may include, in addition to test cylinders, Penetration Resistance of Hardened Concrete (ASTM C 803), Rebound Number of Hardened Concrete (ASTM C 803) and Pullout Strength or Hardened Concrete (ASTM C 900), subject to approval by the Engineer.

c. If falsework and forms removal is not controlled by cylinder tests, the falsework and forms for the various parts of the structure shall not normally be removed before the time indicated below has elapsed after placing the Deck Patching Material, unless otherwise specified in the contract documents or authorized by the Engineer. The exact number of days shall be determined by the Engineer and will be dependent on the curing conditions and other factors.

1. Slabs supported on stringers or prestressed concrete girders ……..7 days

2. Continuous slabs …….……14 days

d. Items (1) and (2) above apply to falsework and forms supporting the full load of the Deck Patching Material. Side forms and forms not supporting and loads may be removed after 12 hours to facilitate the finishing of exposed faces.

e. The above periods may be reduced as directed by the Engineer when early strength Deck Patching Material is used.

f. Methods of form removal likely to cause overstressing of the Deck Patching Material shall not be used. Supports shall be removed in such manner as to permit the Deck Patching Material to uniformly and gradually take the stress due to its own weight.

g. Centers shall be gradually and uniformly lowered in such manner as to avoid injurious stresses in any part of the structure. In arch structures of two or more spans, the sequence of striking centers shall be specified or approved by the Engineer.

937-3.09 Surface Testing

a. After curing is completed, the Deck Patching Material will be visually inspected for cracking or other damage, and inspected for delaminations and bond failures by the use of a chain drag or other suitable device as specify by ASTM D 4580.

b. The affected portions of the Deck Patching Material surface shall be removed and replaced. Any delaminated or unbonded portions of the wearing surface or portions damaged by rain shall be removed and replaced.

c. After completion of the wet cure, the surface shall be tested for flatness and corrected.

d. All corrective work will be at the Contractor's expense including the bridge concrete deck corrections.

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937-3.10 Corrosion Inhibitor and Sealer Treatments

a. All surface of bridge concrete deck and approach slabs shall be dried, cleaned, free from all dust, laitance oil, and foreign material for corrosion inhibitor and sealer treatments. The equipment for cleaning shall not produce microcracks in the bridge concrete deck and approach slabs. The Contractor shall use a shot blasting equipment for the cleaning of surface of bridge concrete deck and approach slabs.

b. *Impregnating of Corrosion Inhibitor in Concrete Substrate Surface* - All surfaces of bridge concrete deck and approach slabs shall be impregnated with a Corrosion Inhibitor.

c. *Sealing of Cracks in Concrete Substrate* - Any cracks in bridge concrete deck and/or approach slabs shall be sealed with a Structural Crack Healer / Sealer. Except, the cracks exceeding 3/8 inch in depth shall be repaired by methods approved by the Engineer.

d. *Sealing of Construction Joints in Patching Areas* – Any construction joints of Patching Areas shall be sealed with a Structural Crack Healer / Sealer.

e. *Sealing of Bridge Concrete Deck Surface* - All surfaces of bridge concrete deck and approach slabs shall be sealed with a Structural Crack Healer / Sealer. An application of approved sand may be broadcasted to the Structural Crack Healer / Sealer for temporary traffic following by the recommendations of the Manufacturer. The Contractor shall remove any loose sand.

937-3.11 Coating for Bridge Concrete Deck Surface

a. For skid-resistant, the Contractor shall apply an Epoxy Resin Binder Coat over surface of bridge concrete deck and approach slabs, if the bridge concrete deck and approach slabs will not cover with concrete overlay or bituminous surface course, and it is required.

b. An application of approved aggregate shall spread over the Epoxy Resin Binder Coat for frictional properties.

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937-4 METHOD OF MEASUREMENT

937-4.01 The *Deck Patching Material* will be measured by the cubic meter in accordance with the dimensions of each Type and Depth shown on the plans or ordered by the Engineer. No deductions in volume will be made for the volume of steel reinforcement, drainage holes, pipes and conduits less than 30 centimeters in diameter.

937-4.02 The *Impregnating of Corrosion Inhibitor in Concrete Substrate Surface* will be measured by the square meter of surface impregnated and accepted. No separate measurement will be made for surfaces ordered by the Engineer to be re-sealed due to improper installation or damages caused by the Contractor's operations.

937-4.03 The *Sealing of Cracks in Concrete Substrate* will be measured by the linear meter of cracks sealed and accepted. No separate measurement will be made for cracks ordered by the Engineer to be re-sealed due to improper installation or damages caused by the Contractor's operations.

937-4.04 The *Sealing of Construction Joints in Patching Areas* will be measured by the linear meter of construction joints sealed and accepted. No separate measurement will be made for construction joints ordered by the Engineer to be re-sealed due to improper installation or damages caused by the Contractor's operations.

937-4.05 The *Sealing of Bridge Concrete Deck Surface* will be measured by the square meter of surface sealed and accepted. No separate measurement will be made for surfaces ordered by the Engineer to be re-sealed due to improper installation or damages caused by the Contractor's operations.

937-4.06 The *Coating for Bridge Concrete Deck Surface* will be measured by the square meter of surface covered and accepted. No separate measurement will be made for surfaces ordered by the Engineer to be recovered due to improper installation or damages caused by the Contractor's operations.

937-4.07 The *Partial-Depth Removal of Bridge Concrete Deck* will be measured by the square meter of surface removed and accepted. No separate measurement will be made for surfaces ordered by the Engineer to be removed due to incompleted scarification depth or damages caused by the Contractor's operations.

937-4.08 The *Full-Depth Removal of Bridge Concrete Deck* will be measured by the square meter of deck removed and accepted. No separate measurement will be made for

deck ordered by the Engineer to be removed due to incompleted scarification depth or damages caused by the Contractor's operations.

937-4.09 The Deck Patching Material for the test specimens will not be measured directly for payment but shall be considered as a subsidiary of the Contractor.

937-5 BASIS OF PAYMENT

937-5.01 Deck Patching Material (Type), Partial-Depth and Full-Depth

a. The completed and accepted quantities of each Type and Depth of *Deck Patching Material*, measured as Article 937-4.01, will be paid for at the contract unit price per unit of measurement except as specified in Article 937-5.09. Such prices and payment shall constitute full compensation for all saw cutting, cleaning, placing, finishing and curing, including the furnishing of all required materials, and for all equipment, tools, labor, tests and incidentals necessary to complete each item as required by the plans and specifications.

b. The unit prices of each Type and Depth of Deck Patching Material include full compensation for furnishing, cleaning and placing or applying all subsidiary items necessary to complete the bridge concrete deck repair such as steel reinforcement, temporary forms, Structural Bonding Agent and Miscellaneous Materials called for in the contract documents unless they constitute or are specifically covered by other pay items included in the contract.

c. The full compensation for furnishing of equipments and operations for Sounding Test, removal of existing concrete for Patching Areas except using the hydrodemolishing and/or shotblasting equipment, and removal of existing bituminous or concrete patchs and overlays on bridge concrete deck shall be included in the unit prices of each Type and Depth of Deck Patching Material.

d. No separate pay allowance will be made for any increased Cement content, for any admixtures, nor for any finishing of any description for concrete surfaces indicated on the plans or required by the specifications.

e. No additional payment will be made for any Type and Depth of Deck Patching Material over dimensions stipulated in the contract documents nor for strength in excess of that specified. No payment will be made for the removal and disposal of any Type and Depth of Deck Patching Material found deficient and not accepted.

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937-5.02 Impregnating of Corrosion Inhibitor in Concrete Substrate Surface – The completed and accepted quantities of *Impregnating of Corrosion Inhibitor*, measured as Article 937-4.02, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all the cleaning and impregnating, including the furnishing and placing or applying of Corrosion Inhibitor and all required materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.03 Sealing of Cracks in Concrete Substrate – The completed and accepted quantities of *Sealing of Cracks in Concrete Substrate*, measured as Article 937-4.03, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all saw cutting, cleaning and sealing, including the furnishing and placing or applying of Structural Crack Healer / Sealer and all required materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.04 Sealing of Construction Joints in Patching Areas – The completed and accepted quantities of *Sealing of Construction Joints in Patching Areas*, measured as Article 937-4.04, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all saw cutting, cleaning and sealing, including the furnishing and placing or applying of Structural Crack Healer / Sealer and all required materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.05 Sealing of Bridge Concrete Deck Surface – The completed and accepted quantities of *Sealing of Bridge Concrete Deck Surface*, measured as Article 937-4.05, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all the cleaning and sealing, including the furnishing and placing or applying of Structural Crack Healer / Sealer, approved sand and all required materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.06 Coating for Bridge Concrete Deck Surface – The completed and accepted quantities of *Coating of Bridge Concrete Deck Surface*, measured as Article 937-4.06, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all the covering, including the furnishing and placing or applying of Epoxy Resin Binder Coat,

approved aggregate and all required materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.07 Partial-Depth Removal of Bridge Concrete Deck – The completed and accepted quantities of *Partial-Depth Removal of Bridge Concrete Deck*, measured as Article 937-4.07, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all the partial-depth removal of the reinforced concrete bridge deck, cleaning, and removal of debris resulting of chipping, shotblasting and/or hydrodemolition process, including the furnishing and operating of lightweight power chipping hammer, shotblasting and/or hydrodemolishing equipment, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.08 Full-Depth Removal of Bridge Concrete Deck – The completed and accepted quantities of *Full-Depth Removal of Bridge Concrete Deck*, measured as Article 937-4.08, will be paid for at the contract unit price per unit of measurement. Such prices and payment shall constitute full compensation for all the full-depth removal of the reinforced concrete bridge deck, cleaning, and removal of debris resulting of chipping, shotblasting and/or hydrodemolition process, including the furnishing and operating of lightweight power chipping hammer, shotblasting and/or hydrodemolishing equipment, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

937-5.09 Price Reduction – Each Type and Depth of Deck Patching Material found deficient in strength but which is accepted by the Authority under the provision of Article 937-2.15 of this specification will be paid for at a reduced unit price.

a. The reduction in unit price of each Type and Depth of Deck Patching Material will be computed in accordance with the following formula:

   $R = 0.05\ D$

   where R = Percentage reduction in unit price of the Deck Patching Material.

   D = Deficiency in psi from the specified strength.

b. The price reduction will be applied to the lot represented by the strength test subject to the following:

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1. No price reduction will be applied when the deficiency "D" does not exceed 100 psi.

2. Drilling and testing cores shall not be permitted for price reduction.

937-5.10 Payment will be made under:

Pay Item	**Pay Unit**
Deck Patching Material (Polymer Concrete), Partial-Depth	Cubic Meter
Deck Patching Material (Accelerated Strength Concrete), Partial-Depth	Cubic Meter
Deck Patching Material (Polymer Concrete), Full-Depth	Cubic Meter
Deck Patching Material (Accelerated Strength Concrete), Full-Depth	Cubic Meter
Impregnating of Corrosion Inhibitor	Square Meter
Sealing of Cracks in Concrete Substrate	Linear Meter
Sealing of Construction Joints in Patching Areas	Linear Meter
Sealing of Bridge Concrete Deck Surface	Square Meter
Coating for Bridge Concrete Deck Surface	Square Meter
Partial-Depth Removal of Bridge Concrete Deck, _____ (Depth)	Square Meter
Full-Depth Removal of Bridge Concrete Deck	Square Meter