SECTION 01235 - REPAIR DAMAGED CONCRETE

(Follow all instructions. If there are no instructions above a subsection, paragraph, sentence, or bullet, then include it in the project. The specifications may be modified to include project specific specifications, but all additions, deletions, or modifications must be sent to the ODOT Technical Resource and State Specifications Engineer for review and approval.)

Section 01235, which is not a Standard Specification, is included in this Project by Special Provision.

Description

01235.00 Scope - In addition to the requirements of Section 01201, Section 01210, Section 01215, and Section 01260, this Work consists of:

- Locating and removing damaged concrete and replacing it with pumped repair mortar.
- Removing Non-Essential Near-Surface Metal in areas larger than 1/2 square foot and long cavities such as those from removal of a piece of wire more than 12 inches long and filling cavities with pumped repair mortar.

01235.02 Timing - Begin the Work only after the entire surface within the Work area has been cleaned to remove dirt, grease, oils, laitance, paint, sealers, coatings, and other deleterious material according to Section 01260.

Provide temporary shoring of Work areas when required by 01235.50 before removing existing concrete.

Mark boundaries for excavating concrete and boundaries for adding concrete cover before locating surface metal according to Section 01215.

Place and cure repair mortar before preparing anode surfaces according to Section 01260

01235.03 Submittals - Submit the following according to 00150.37. Within 21 Calendar Days after receipt of submittals, the Engineer will review the submittals and designate them in writing as "approved", "approved as noted", or "returned for correction". At least 21 Calendar Days before beginning concrete repair Work, submit the following:

(a) Repair Mortar -

- A description of all relevant constituents and properties of the Material. Data published by manufacturer is acceptable unless certifications of the material characteristics are required by these Specifications.
- For prepackaged products, the manufacturer's certification that the furnished Material meets the requirements of 01235.11.
- The Specifications subsection with which each repair mortar complies

- If proposing an alternate repair mortar to those specified in 01235.10, test data demonstrating compliance with 01235.10.

For alternate repair mortar submit three 4 by 8-inch cylinders of patch Material cast in the presence of the Engineer using the proposed mix proportions, admixtures, and mixing and application Equipment, at least 7 Calendar Days before starting concrete repair Work. Cast and cure the cylinders according to AASHTO T 23 or AASHTO R 39.

Submit records of mix proportions and which mix design was used in each repair location. Maintain and provide records that are complete enough to be able to match repaired bridge areas with the mix records.

(b) Concrete Repair Procedure -

- Manufacturer's specifications and operating instructions for all Equipment
- Details of each step to accomplish the Work
- Steps to maintain quality control of all newly applied mortar
- Plan to maintain records of verification of mix proportions for all repair mortar mixed on-site
- Plan to maintain records identifying the mix design for each repaired area

Do not begin Work until written approval is received from the Engineer.

Submit stamped shoring drawings and design calculations according to 00150.35, at least 21 Calendar Days before starting concrete removal.

01235.04 Procedure Qualification - Demonstrate in the presence of the Engineer, proposed procedures and Equipment for patching and curing.

The Engineer will evaluate the results and determine whether procedures are accepted or rejected.

01235.05 Acceptance Criteria – The Work performed under this Section is acceptable if it passes the tests described below.

After the repair mortar has cured, and in the Engineer's presence, conduct a delamination survey of all repaired areas, as follows:

- Sound all repaired areas with a hammer.
- Mark boundaries of all delamination in the repaired areas.
- Identify the following delaminations for repatching:
  - All delaminations greater in area than a three inch diameter circle.
  - All delaminations with a dimension greater than five inches.
- Verify that delamination survey results are repeatable by spot checking using a different surveyor.
- When a spot check finds a non-repeatable result, re-survey the area surveyed since the latest repeatable spot check.

After repairing repatched areas repeat the survey. Repeat the survey and repair procedure until all areas of unsound repair mortar have been successfully repaired.

Perform quality control testing according to 01235.47.

Provide material for verification testing according to 01235.48.

If a core tested for pull-off strength according to 01235.47 has Sand pockets or voids, fully remove the defects and repair the affected area.

Materials

01235.10 Repair Mortar - Provide one of the following repair mortars with the required admixture as specified in 01235.14:

- BASF MasterEmaco S 440MC
- Alternative repair mortar conforming to the following:
  - Non-polymer flowable micro-concrete
  - Suitable for pumping
  - At least 3,000 psi 28-Day compressive strength
  - “Low” potential for cracking and no cracking in 28 Calendar Days when tested according to ASTM C1581, including Appendix
  - Electrical resistivity in the range of 2,000 to 20,000 ohm-cm

Submit proposed alternate repair mortar for approval according to 01235.03.

Provide hand patching Materials complying with 01201.10.

01235.11 Prepackaged Product - Premixed and prepackaged concrete provided for on-site mixing is acceptable if approved by the Engineer. Furnish packages containing cement and Aggregate according to these Specifications with no silica fume, fly ash, or any other porosity-reducing admixture.

01235.12 Non-Conductive Resin - Furnish non-conductive resin conforming to 1201.11.

01235.13 Embedded Steel - Furnish un-galvanized steel whenever welded wire fabric or other metal is to be embedded in the mortar.

01235.14 Admixtures - Use only admixtures approved by the Engineer.

When admixtures are used to reduce water-cement ratio or retard or accelerate the development of strength, use only admixtures compatible with the cement used, at the rate specified by the manufacturer.

01235.15 Hollow Wall Anchors - Furnish one of the following plastic hollow wall anchors:

- Powers 2345 Nylon Zip-It
- Simpson Strong Tie SWN06 Nylon Sure Wall Drywall Anchor

- ITW Red Head EZP100 Nylon E-Z Drywall Anchor

01235.16 Water - Furnish water according to 02020.

Construction

001235.40 Access; Containment; Disposal - Provide Work access and debris containment according to Section 00253.

Dispose of waste according to 00290.20.

01235.41 Locating and Marking - Locate and mark all damaged concrete and surface defects.

Locate surface defects such as rock pockets or delaminated finishing coatings or mortars by visual inspection. Mark boundaries for patching all surface defects which do not sound as damaged concrete and are not located over a rebar or it is obvious that rebar corrosion is not associated with the surface defect.

Locate damaged concrete by visual inspection and by sounding the concrete surface with a 16 ounce masonry hammer. Mark as damaged concrete all areas where damaged concrete is visually obvious or is suspected based on sounding with a hammer. Where sounding indicates possible delamination and the concrete surface appears sound, with no obvious damage, use a bar locator to determine rebar location and cover depth. Remove concrete according to 01235.41 from a four inch wide by eight inch long exploration area centered over the rebar, and extend the exploration area along the rebar until rebar that is free of rust scale or pitting is exposed. Mark the exploration area as damaged concrete.

Mark boundaries for concrete removal around all:

- Damaged concrete
- Shallow rebar, if the reinforcement is a prefabricated mesh
- Patches that were located and marked according to Section 01215

Do not use angles sharper than 45 degrees in defining the repair boundaries. Make all repairs at least four inches wide in each direction. While conforming to these guidelines, draw repair boundaries that minimize the effort needed to saw and excavate.

The Engineer will perform verification surveys of selected sections of the Work and determine the final quantity of repairs. Do not begin concrete removal until the Engineer has completed the verification surveys of the selected sections.

01235.42 Concrete Removal - Saw-cut the boundaries of concrete to be removed, to a depth just missing the reinforcing bars or to a depth of 1/2 inch, whichever is less. Saw cuts shall not overrun at the corners of the marked boundaries. Saw cutting is not required if the Contractor can consistently provide, by another technique, a minimum 1/2-inch deep excavation surface that is uniformly perpendicular to the original concrete.

Remove concrete within the marked boundaries with high-pressure waterjet blasting Equipment, pneumatic hammers, chipping guns, manual picks and chisels, or other

Equipment approved by the Engineer. Do not use pneumatic hammers heavier than a nominal 15-pound class. Remove concrete in such a way that removal of sound concrete beyond established boundaries is kept to a minimum. When working around reinforcing bars, avoid loosening the reinforcement or fracturing the concrete around it beyond the repair area.

Remove all damaged concrete within the marked boundaries to the depth of sound concrete. In areas where the reinforcing bar lacks bond with the existing concrete, continue to excavate to 1/2 inch beyond the depth of the reinforcing bar. In areas where it is difficult to determine if the reinforcing bar lacks bond with the existing concrete, do not excavate beyond the depth of the reinforcing bar if a 4-inch wide exploration area shows the reinforcing bar to be free of rust scale or pitting, and the reinforcing bar is not separated from the remaining concrete. Limit removal to no more than one inch above the bottom mat reinforcing bar in deck soffits. If further excavation is required to remove all damaged concrete, inform the Engineer and do not proceed until approved.

Do not remove sound concrete over shallow rebar.

Verify that all damaged concrete has been removed by sounding with a 16-ounce hammer.

01235.43 Surface Preparation - Abrasive-blast or water blast all concrete surfaces that are to receive repair mortar to remove all debris, loose concrete, concrete pulverized during removal, scale, and loose rust. Abrasive-blast exposed reinforcing bars according to SSPC Standard SP6 "Commercial Blast Cleaning" or equivalent procedure. Do not allow prepared surfaces to remain exposed more than 36 hours before placing repair mortar.

Prepare surfaces that are to receive repair mortar with a surface profile according to International Concrete Repair Institute (ICRI) Guideline 310.2R-2013 surface profile CSP 6.

Provide hollow wall anchors conforming to 01235.15 for concrete surfaces that are to receive more than one inch of repair mortar and have reinforcing bar spacing greater than nine inches. Install anchors by drilling 1/4-inch diameter holes 1/2 to 3/4 inch deep on a nine-inch maximum grid in the concrete substrate. Apply non-conductive resin and insert anchors. Remove excess resin from the concrete substrate.

01235.44 Repair Mortar Installation - Install repair mortar patches as follows:

(a) Forms - Provide smooth-surfaced form Materials. Provide adequate support and bracing of forms to prevent deflection under the weight and pressure of new concrete, and to prevent vibration damage to mortar during setting and curing. Leave forms in place for a minimum of 72 hours after concrete placement.

Provide watertight form Materials and a watertight form system to prevent loss of water during presoaking repair mortar placement, and curing. Incorporate enough pumping ports to ensure consistent placement, drains for flushing, and enough vent holes or vent tubes to allow air to escape extreme surface irregularities and remote cavities. Limit port spacing to prevent mortar segregation.

Provide forms that can readily be removed and reinstalled for presoaking, flushing, and blowdown, and for verification of saturated surface dry condition.

(b) Pre-soak - Saturate the substrate concrete for at least 24 hours before application of repair mortar, using either a watertight form kept full of water or saturated burlap or foam Material packed inside the forms, in contact with the entire existing concrete surface, and soaked frequently, or any other method demonstrated to produce saturated surface dry condition.

After the substrate has been saturated, temporarily remove the form and, immediately before placing mortar, remove all dust, dirt, and other debris by flushing the surface with water pressurized to at least 60 psi, followed by blasting with clean compressed air to remove excess water. Provide a damp surface free of standing water (saturated surface dry condition) and free of contaminants when applying repair mortar. Light surface rust that appears during the pre-soak stage does not need to be removed. When the concrete surface is in saturated surface dry condition and free of contaminants, and reinforcement is clean or has only light surface rust, immediately reinstall the forms and place mortar.

(c) Mixing - When a package of prepackaged repair mortar is opened, mix the entire contents of the package. Do not allow packaging to be mixed into the repair mortar.

Mix repair mortar according to the manufacturer's instructions, including, but not limited to, mixing speed, mixing time, and mixing Equipment.

(d) Placing Repair Mortar - Pump repair mortar and achieve thorough and uniform hydration without the use of excess water.

Do not pump mortar before acceptance of saturated surface dry condition by the Engineer.

Follow all of the manufacturer's recommendations regarding temperature and weather conditions during mortar placement, and:

- Do not pump mortar during freezing weather, or if temperatures are likely to drop below freezing during the cure period.
- Ensure that substrate, surface and ambient air temperatures are at least 40 °F and rising when mortar is applied, and remain above 40 °F for at least 24 hours after application.
- Do not apply mortar to frosted surfaces

Provide adequate pumping pressure into each port to ensure mortar completely fills the cavity and mortar is observed at all vents. Vibrate only if approved in advance by the Engineer.

(e) Miscellaneous Metal - Electrically connect all welded wire fabric or other metal installed to facilitate repair mortar placement to existing metal reinforcement, and fasten securely to remain 1/2 inch clear of final finished surface. Do not use galvanized or coated Materials.

(f) Adjacent Surface Protection - Protect surfaces outside the repair area from mortar overshoot and drip, and remove the excess Material from these areas after the application has been completed.

(g) Mix Records - Record mix proportions for all mortar mixed on-site at the start of each mortar placement operation and every time proportions or additives are changed.

Repair surface defects with hand patching Materials. Observe QPL remarks and follow manufacturer's guidelines for application.

01235.45 Curing and Finishing - Take care to avoid cracks in the new mortar due to excessive surface evaporation in the dry, controlled environment of the containment Structure. Continuously cure all newly applied mortar for a minimum of 72 hours.

Finish all exposed surfaces and surface defects to straight and true lines, as shown. Provide a Class 2~~1~~ surface finish according to 00540.53(c~~a~~) on all exposed surfaces and a general surface finish according to 00540.53(a~~c~~) on all other surfaces, with no coating on any surface unless otherwise directed.

01235.46 Essential Near-Surface Metal - For sound concrete in the following areas of high visual impact provide electrical isolation of Essential Near-Surface Metal identified in 01215.40 with resin buildup on shallow rebar. Coat the concrete over the Essential Near-Surface Metal with two-inch wide strips of non-conductive resin before abrasive-blasting:

- Bottom surface of girders, cross beams, and sidewalk stringers.
- Outer surface of exterior girders, box girders, or sidewalk stringers.
- All sidewalk bracket surfaces.
- Sidewalk soffits except areas of prefabricated mesh where both dimensions exceed 12 inches.
- All columns, spandrel, and abutment walls.
- All arch rib and strut surfaces.
- Web walls in bents and cross bracing in arches.

For sound concrete in all other areas provide electrical isolation of Essential Near-Surface Metals identified in 01215.40 with mortar buildup on shallow rebar. Use hand tools to prepare the existing surface according to 01235.43. Form raised patches to provide at least 1/2 inch of clearance between Essential Near-Surface Metal and surface of the patch and install repair mortar according to 01235.43.

For damaged concrete, provide additional mortar build-up on shallow rebar as needed to achieve at least 1/2 inch of cover between the Essential Near-Surface Metal and the surface of the repair.

01235.47 Quality Control Testing - For each 500 square feet of applied mortar placed on the Bridge, but not less than once per production Work shift, cast three 4 by 8-inch cylinders in single-use plastic molds, at the same time and under the same conditions as placement on the Bridge. Cast and cure strength specimens according to AASHTO T 23 or AASHTO R 39. Test the cylinders for compressive strength after 28-Day cure according to AASHTO T 22. The minimum acceptable 28-Day compressive strength (f'c) of cylinders is 3000 psi.

Following a 7-Day cure, core one three-inch-diameter test specimen at a location designated by the Engineer, from each 500 square feet of newly applied mortar placed on the Bridge

surface but not less than one specimen from each Day's production. Locate cores to avoid rebar and to have sufficient length to extend into the original Bridge concrete. Do not break cores free before testing. Perform pull-off strength tests of the cores in the presence of the Engineer once dolly adhesive has fully cured. Individually seal the cores taken from the test panel in plastic bags and tag them for identification.

Measure the core pull-off strength according to ASTM C1583. The minimum acceptable pull-off strength is 175 psi or as directed by the Engineer. Conduct the test until failure.

If any quality control test fails to meet the minimum requirements, any or all mortar represented by that test may be rejected by the Engineer.

01235.48 Verification Testing - For each 1,500 square feet of applied mortar placed on the Bridge, cast three 4 by 8-inch cylinders in single-use plastic molds, at the same time and under the same conditions as placement on the Bridge. Cast and cure strength specimens according to AASHTO T 23 or AASHTO R 39. Deliver these specimens to the Engineer within 48 hours of casting for verification testing by the Agency.

01235.49 Deficient Repair Mortar - All repair mortar represented by a failed verification test will be rejected regardless of any passing quality control tests. Replace all repair mortar that is rejected based on quality control testing or verification testing, or that are found deficient in respect to any of the specified criteria, as directed. Further testing will be allowed to identify the extent of deficient repair mortar in the quality control test area represented at no additional cost to the Agency. If additional areas are found to be deficient, repair the represented production test area, as directed. Repairs include, but are not limited to, removal and replacement of repair mortar.

"Deficient repair mortar" includes new repair mortar with alligatored surface or uncontrolled cracks that are visible without magnification after completion of abrasive blasting.

Repair small crevices a maximum of 0.4 inch deep and 0.1 inch wide at the edge of a repair area with non-conductive resin at no additional cost to the Agency. Cut out pockets and other defects and replace with new repair mortar according to the Specifications.

Temporary

(The EOR shall review the Bridge Program Unit load ratings for the structures included in the Project. Delete options that do not apply to the structures included in the project. If multiple structures exist on a Project, clearly define which options are acceptable for each structure.)

01235.50 Concrete Removal Limits - Prevent damage to Bridge structural components during concrete removal and repair. For the purposes of this subsection, repaired concrete is defined as past repairs to the Structure or repair mortar that has been wet cured for the minimum requirement of this Section. Limits defined in the subsection only apply to removal of concrete and pumped patch sizes may be larger when not in conflict with this subsection.

When the concrete removal requirements of 01235.50 cannot be met, design shoring to support the entire dead load, live load, and wind load of member(s) being protected, with a safety factor not less than 2.0. Construct shoring according to "AASHTO Construction Handbook for Bridge Temporary Works" except if in conflict with the Specifications.

Do not combine any of the following methods without the Engineer's approval. Prevent damage to structural components by one or more of the following methods:

(a) General - Removal Work is unlimited for concrete removal on all structural components, except arches and columns, to the centerline depth of the reinforcement closest to the surface being worked on and not behind reinforcement.

(b) Bottom Surface of Girders - Limit concrete removal on the bottom surface of girders to four-foot-long sections separated by at least eight feet of intact un-repaired or repaired concrete. Limit concrete removal to 1/2 inch above the highest longitudinal bar in the bottom reinforcement.

(c) Sides of Girders and Crossbeams - Limit concrete removal on the sides of girders and crossbeams higher than 1/2 inch above the highest longitudinal bar in the bottom reinforcement to one side of girder or crossbeam centerline at a time. Limit the length of removal to the spacing between two stirrups separated by at least the spacing between four stirrups of intact un-repaired or repaired concrete.

(d) Girders - Eliminate live loading on the girder by closing the Traffic Lane, according to 00220.40(e), above the girder and limit concrete removal to one side of girder centerline at a time. Do not use this method to protect any girder within two feet of Project centerline unless both lanes can be closed as shown or directed.

(e) Bottom Surface of Crossbeams - Limit concrete removal on the bottom surface of crossbeams to sections of concrete no longer than 22D, where D equals longitudinal bar diameter (bar width for square bars), separated by a distance of at least 44D. Limit concrete removal to one inch above the highest longitudinal bar in the bottom reinforcement.

(f) Top Surface of Girders or Crossbeams - Limit concrete removal on the top surface of girders or crossbeams to sections of concrete no longer than 22D, where D equals longitudinal bar diameter (bar width for square bars), separated by a distance of at least 44D. Limit concrete removal to 1/2 inch below the lowest longitudinal bar in the top reinforcement. If the bottom surface also requires repair beyond the centerline depth of the reinforcement nearest the surface at the same section, complete each repair separately or limit removal to one side of the component centerline at a time.

(g) Columns and Arches - Limit concrete removal on columns and arches to sections of concrete covering two hoop bars and a vertical height of 22D, where D equals vertical or primary bar diameter (bar width for square bars), separated by a distance of at least 44D. Limit concrete removal to 1/2 inch inside the vertical bars on columns and longitudinal bars on arches.

(h) Deck Soffits - Limit concrete removal on deck soffits to half the section of the deck. Limit removal length and width to twice the smallest spacing between two parallel reinforcement bars in the mat closest to the surface.

(i) Abutments and Pier Walls -

(1) Repairs at Least 24 Inches Thick - Limit concrete removal on abutments and pier walls at least 24 inches thick to sections of concrete covering up to 10 square feet, separated by a distance of at least three feet. Limit concrete removal to 1/2 inch behind the reinforcement closest to the surface.

(2) Repairs less than 24 Inches Thick - Limit concrete removal on abutments and pier walls less than 24 inches thick to sections of concrete covering two vertical bars and a vertical height of 22D, where D equals vertical bar diameter (bar width for square bars), separated by a distance of 44D. Limit concrete removal to 1/2 inch inside the longitudinal bars.

Measurement

01235.80 Measurement - No measurement of quantities will be made for locating damaged concrete.

The quantities of repair damaged concrete will be measured on the area basis, and will be the outside measurement of each area marked for concrete removal and verified by the Engineer, not including areas marked for mortar buildup on shallow rebar. Measurement will be made before concrete removal.

The quantities of mortar buildup on shallow rebar will be measured on the area basis, and will be the outside measurement of each area marked for concrete removal and verified by the Engineer containing shallow rebar. Measurement will be made before concrete removal.

The quantities of resin buildup on shallow rebar will be measured on the area basis. Measurement will be the outside measurement of each area marked for resin buildup and verified by the Engineer. Measurement will be made before resin placement.

The quantities of repair surface defects will be measured on the area basis. Measurement will be the outside measurement of the defect prior to patching.

Payment

01235.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Locate Damaged Concrete	Lump Sum
(b) Repair Damaged Concrete	Square Yard
(c) Mortar Buildup on Shallow Rebar	Square Yard
(d) Resin Buildup on Shallow Rebar	Square Yard
(e) Repair Surface Defects	Square Yard

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor and Incidentals necessary to complete the Work as specified.

No separate or additional payment will be made for providing mix proportions or mix design records.

No payment will be made for repair of initially sound concrete that is micro-fractured or otherwise damaged by the Contractor's operations.