



Purpose

Notify WSDOT staff of updated Standard Specification and Construction Manual requirements for structural repairs.

Guidance

WSDOT staff involved in design and construction of structures are encouraged to review revisions to Standard Specifications 6-01.16, 9-20.1, 9-20.2 and to Construction Manual SS 6-01.16.

These changes permit structural repairs without change orders. In addition, they have:

- Created a new specification 6-01.16 *Repair of Defective Work* that defines Working Drawing submittal requirements for structural repairs and expand pre-approved structural repair procedures beyond concrete precast plants
- Modified or added repair language referencing 6-01.16 in sections 6-02.3(25)H and 6-02.3(28)E
- Retitled 9-20.1 to *Patching Material for Cement Concrete Pavement*
- Moved current requirements under 9-20.2 to be under 9-20.1 and fixed a few ASTM references
- Added a new section to the vacated 9-20.2 titled *Patching Material for Concrete Structure Repair* to be used with the new preapproved repair procedure in Standard Specification 6-01.16(2)A *Concrete Spalls and Poor Consolidation (Rock Pockets, Honeycombs, Voids, etc.)*
- Updated references in 5-01 and 5-05 to 9-20.1

Construction Project Engineers must determine if repair procedures require engineering and if preapproved repair procedures are appropriate for the specific repair situation in consultation with the Assistant State Construction Engineer (ASCE) and an appropriate licensed professional engineer (such as the engineer-of-record, the Bridge Technical Advisor (BTA), etc.). Guidance is provided in Construction Manual SS 6-01.16.

Background

The Contractor may be required to repair defective structural work per Standard Specification 1-05.7 and 1-07.13 requirements. Previously, it was unclear if these repairs were changes to the Contract requiring a change order. The purpose of these changes was to provide clarity on this issue. Consequently, it was necessary to develop structural repair submittal requirements.

Expansion of pre-approved structural repair procedures beyond concrete precast plants was included as an attempt to establish expectations and to reduce repair submittal requirements for common problems.



The current Standard Specification 9-20.1 and 9-20.2 requirements were intended to apply to Cement Concrete Pavement, but this was not clear in the organization or titles of these sections.

These revised specifications were reviewed by the Headquarters Material Office, the Fabrication Inspection Office, the AGC/WSDOT Structures Team, the ACEC/WSDOT Structures Team, the Headquarters Bridge & Structures Office and the Headquarters Construction Office.

Implementation Plan

Changes to the Standard Specifications were published in the August 2018 Standard Specification Amendments. Changes to the Construction Manual were published in the August 2018 Construction Manual Update.

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5-01 Cement Concrete Pavement Rehabilitation

5-01.2 Materials

Materials shall meet the following requirements of the following sections:

Cement 9-01

Fine Aggregate 9-03

Coarse Aggregate 9-03

Combined Aggregate 9-03

Joint Filler 9-04.1

Joint Sealants 9-04.2

Closed Cell Foam Backer Rod 9-04.2(3)A

Dowel Bars 9-07.5

Tie Bars 9-07.6

Concrete Patching Material 9-20.1

Curing Materials and Admixtures 9-23

Water 9-25

Epoxy Resins (bonding agents) 9-26

Parting Compound shall be a curing compound, grease or other substance approved by the Engineer.

5-01.3(1)A1 Concrete Patching Materials

1. Materials – The prepackaged concrete patching material and the aggregate extender shall conform to Section 9-20.1.

2. Submittals and Mix Approval – The Contractor shall use the Manufacturer's recommended proportions for the mix design to be submitted to the Engineer for the concrete patching material. The Contractor's submittal shall include the mix proportions of the prepackaged concrete patching material, water, aggregate extender, and the proposed sources for all aggregates. If not approved for use on the QPL, submit test data indicating compliance with Section 9-20.1.

5-05 Cement Concrete Pavement

5-05.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement 9-01

Fine Aggregate 9-03

Coarse Aggregate 9-03

Combined Aggregate 9-03

Joint Filler 9-04.1

Joint Sealants 9-04.2

Corrosion Resistant Dowel Bars 9-07.5(2)

Tie Bars 9-07.6

Concrete Patching Material 9-20.1

Curing Materials and Admixtures 9-23

Water 9-25

Epoxy Resins 9-26

Cementitious materials are considered to be the following: portland cement, blended hydraulic cement, fly ash, ground granulated blast furnace slag, microsilica fume, and metakaolin.

6-01.16 Repair of Defective Work

6-01.16(1) General

When using repair procedures that are described elsewhere in the Contract Documents, the Working Drawing submittal requirements of this section shall not apply to those repairs unless noted otherwise.

Repair procedures for defective Work shall be submitted as Type 2 Working Drawings. Type 2E Working Drawings shall be submitted when required by the Engineer. As an alternative to submitting Type 2 or 2E Working Drawings, defective Work within the limits of applicability of a pre-approved repair procedure may be repaired using that procedure. Repairs using a pre-approved repair procedure shall be submitted as a Type 1 Working Drawing.

Pre-approved repair procedures shall consist of the following:

- The procedures listed in Section 6-01.16(2)
- For precast concrete, repair procedures in the annual plant approval process documents that have been approved for use by the Contracting Agency.

All Working Drawings for repair procedures shall include:

- A description of the defective Work including location, extent and pictures
- Materials to be used in the repair. Repairs using manufactured products shall include written manufacturer recommendations for intended uses of the product, surface preparation, mixing, aggregate extension (if applicable), ambient and surface temperature limits, placement methods, finishing and curing.
- Construction procedures
- Plan details of the area to be repaired
- Calculations for Type 2E Working Drawings

Material manufacturer's instructions and recommendations shall supersede any conflicting requirements in pre-approved repair procedures.

The Engineer shall be notified prior to performing any repair procedure and shall be given an opportunity to inspect the repair work being performed.

6-01.16(2) Pre-approved Repair Procedures

6-01.16(2)A Concrete Spalls and Poor Consolidation (Rock Pockets, Honeycombs, Voids, etc.)

This repair procedure shall be limited to the following areas:

- Areas that are not on top roadway surfaces (with or without an overlay) including but not limited to concrete bridge decks, bridge approach slabs or cement concrete pavement
- Areas that are not underwater
- Areas that are not on precast barrier, except for the bottom 4 inches (but not to exceed 1 inch above blockouts)
- Areas that do not affect structural adequacy as determined by the Engineer.

The repair procedure is as follows:

1. Remove all loose and unsound concrete. Impact breakers shall not exceed 15 pounds in weight when removing concrete adjacent to reinforcement or other embedments and shall not exceed 30 pounds in weight otherwise. Operate impact breakers at angles less than 45 degrees as measured from the surface of the concrete to the tool and moving away from the edge of the defective Work. Concrete shall be completely removed from exposed surfaces of existing steel reinforcing bars. If half or more of the circumference of any reinforcing bar is exposed, if the reinforcing bar is loose or if the bond to existing concrete is poor then concrete shall be removed at least $\frac{3}{4}$ inch behind the reinforcing bar. Do not damage any existing reinforcement. Stop work and allow the Engineer to inspect the repair area after removing all loose and unsound concrete. Submit a modified repair procedure when required by the Engineer.
2. Square the edges of the repair area by cutting an edge perpendicular to the concrete surface around the repair area. The geometry of the repair perimeter should minimize the edge length and should be rectangular with perpendicular edges, avoiding reentrant corners. The depth of the cut shall be a minimum of $\frac{3}{4}$ inch, but shall be reduced if necessary to avoid damaging any reinforcement. For repairs on vertical surfaces, the top edge should slope up toward the front at a 1-vertical-to-3-horizontal slope.
3. Remove concrete within the repair area to a depth at least matching the cut depth at the edges. Large variations in the depth of removal within short distances should be avoided. Roughen the concrete surface. The concrete surface should be roughened to at least Concrete Surface Profile (CSP) 5 in accordance with ICRI Guideline No. 310.2R, unless a different CSP is recommended by the manufacturer.
4. Inspect the concrete repair surface for delaminations, debonding, microcracking and voids using hammer tapping or a chain drag. Remove any additional loose or unsound concrete in accordance with steps 1 through 3.
5. Select a patching material in accordance with Section 9-20.2 that is appropriate for the repair location and thickness. The concrete patching material shall be pumpable or self-consolidating as required for the type of placement that suits the repair. The patching material shall have a minimum compressive strength at least equal to the specified compressive strength of the concrete.
6. Prepare the concrete surface and reinforcing steel in accordance with the patching material manufacturer's recommendations. At a minimum, clean the concrete surfaces (including perimeter edges) and reinforcing steel using oil-free abrasive blasting or high-pressure (minimum 5,000 psi) water blasting. All dirt, dust, loose particles, rust, laitance, oil, film, microcracked/bruised concrete or foreign material of any sort shall be removed. Damage to the epoxy coating on steel reinforcing bars shall be repaired in accordance with Standard Specification 6-02.3(24)H.
7. Construct forms if necessary, such as for patching vertical or overhead surfaces or where patching extends to the edge or corner of a placement.
8. When recommended by the manufacturer, saturate the concrete in the repair area and remove any free water at the concrete surface to obtain a saturated surface dry (SSD) substrate. When recommended by the manufacturer, apply a primer, scrub coat or bonding agent to the existing

surfaces. Epoxy bonding agents, if used, shall be Type II or Type V in accordance with Section 9-26.1.

9. Place and consolidate the patching material in accordance with the manufacturer's recommendations. Work the material firmly into all surfaces of the repair area with sufficient pressure to achieve proper bond to the concrete.
10. The patching material shall be textured, cured and finished in accordance with the patching material manufacturer's recommendations and/or the requirements for the repaired component. Protect the newly placed patch from vibration in accordance with Section 6-02.3(6)D.
11. When the completed repair does not match the existing concrete color and will be visible to the public, a sand and cement mixture that is color matched to the existing concrete shall be rubbed, brushed, or applied to the surface of the patching material and the concrete.

6-02.3(25)H Finishing

The Contractor shall apply a Class 1 finish, as defined in Section 6-02.3(14), to:

1. The exterior surfaces of the outside girders; and
2. The bottoms, sides, and tops of the lower flanges on all girders, including the top of the bottom slab between the tub girder webs.

All other girder surfaces shall receive a Class 2 finish.

The interface on girders that contact a cast-in-place concrete deck shall have a finish of dense, screeded concrete without a smooth sheen or laitance on the surface. After vibrating and screeding, and just before the concrete reaches initial set, the Contractor shall texture the interface. This texture shall be applied with a steel brooming tool that etches the surface transversely leaving grooves $\frac{1}{8}$ to $\frac{1}{4}$ inch wide, between $\frac{1}{8}$ and $\frac{1}{4}$ inch deep, and spaced $\frac{1}{4}$ to $\frac{1}{2}$ inch apart.

On prestressed concrete wide flange deck girders, deck bulb tee girders, ribbed section girders and double tee girders, the Contractor shall test the top surface for flatness and make corrections in accordance with Section 6-02.3(10)D3 except that the straightedge need not exceed the width of the girder top flange when checking the transverse direction. The top surface shall be finished in accordance with Section 6-02.3(10)D6.

The Contractor may repair defects in **precast members** ~~the girder provided the repair is covered in the annual plant approval package~~ **in accordance with Section 6-01.16.** ~~Any repairs that are not covered by the annual plant approval process shall be submitted to the Engineer as Type 2 Working Drawings or shall be submitted through the email resolution process.~~

6-02.3(28)E Finishing

The Contractor shall provide a finish on all relevant concrete surfaces as defined in Section 6-02.3(14), unless the Plans or Special Provisions require otherwise.

The Contractor may repair defects in precast members in accordance with Section 6-01.16.

9-20 Concrete Patching Material, Grout, and Mortar

9-20.1 Patching Material for Cement Concrete Pavement

Concrete patching material ~~will~~ shall be prepackaged mortar extended with aggregate. The amount of aggregate for extension shall conform to the manufacturer's recommendation.

9-20.2 Specifications

Patching mortar and patching mortar extended with aggregate shall contain cementitious material and meet the requirements of Sections 9-20.21(1) and 9-20.21(2). The Manufacturer shall use the services of a laboratory that has an equipment calibration verification system and a technician training and evaluation process per AASHTO R 18 to perform all tests specified in Section 9-20.1.

9-20.21(1) Patching Mortar

Patching mortar shall conform to the following requirements:

Compressive Strength	ASTM Test Method	Specification
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
Length Change		
at 28 days	C 157	0.15 percent maximum
Total Chloride Ion Content	C 1218	1 lb/yd ³ maximum
Bond Strength		
at 24 hours	C 882 (As modified by C 928, Section 89.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672 (As modified by C 928, Section 89.4)	1 lb/ft ² maximum

9-20.21(2) Patching Mortar Extended With Aggregate

Patching mortar extended with aggregate shall meet the following requirements:

Compressive Strength	ASTM Test Method	Specification
at 3 hours	C 39	Minimum 3,000 psi

at 24 hours	C 39	Minimum 5,000 psi
Length Change		
at 28 days	C 157	0.15 percent maximum
Bond Strength		
at 24 hours	C 882 (As modified by ASTM C928, Section 9.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672	2 Maximum Visual Rating
Freeze thaw	C 666	Maximum expansion 0.10% Minimum durability 90.0%

9-20.21(3) Aggregate

Aggregate used to extend the patching mortar shall meet the requirements of Section 9-03.1(4) and be AASHTO Grading No. 8. A Manufacturers Certificate of Compliance shall be required showing the aggregate source and the gradation. Mitigation for Alkali Silica Reaction (ASR) will not be required for the extender aggregate used for concrete patching material.

9-20.21(4) Water

Water shall meet the requirements of Section 9-25.1. The quantity of water shall be within the limits recommended by the manufacturer.

9-20.2 Patching Material for Concrete Structure Repair

Concrete patching material shall be a prepackaged mixture of portland or blended hydraulic cement, aggregate, and admixtures. Fly ash, ground granulated blast furnace slag and microsilica fume may be used. The concrete patching material may be shrinkage compensated. The concrete patching material shall also meet the following requirements:

- Compressive strength of 6000 psi or higher at 28 days in accordance with AASHTO T 22 (ASTM C 39), unless noted otherwise
- Bond strength of 250 psi or higher at 28 days or less in accordance with ASTM C 1583 or ICRI 210.3R
- Shrinkage shall be 0.05 percent (500 microstrain) or lower at 28 days in accordance with AASHTO T 160 (ASTM C 157) as modified by ICRI 320.3R
- Permeability shall be 2,000 coulombs or lower at 28 days in accordance with AASHTO T 277 (ASTM C 1202)
- Freeze-thaw resistance shall have a durability factor of 90 percent or higher after a minimum of 300 cycles in accordance with AASHTO T 161 Procedure A (ASTM C 666)

- Soluble chloride ion limits in Section 6-02.3(2) shall be satisfied

SS 6-01.16 Repair of Defective Work

The purpose of this section is to contractually allow structural repairs without requiring a change order and to define requirements for structural repairs. It is not intended to overwrite or duplicate submittal requirements or require submittals for repairs described elsewhere in the Contract Documents.

The WSDOT Project Engineer shall consult with the ASCE and an appropriate licensed professional engineer (such as the engineer-of-record, the Bridge Technical Advisor (BTA), the State Bridge Construction Engineer, etc.) to make a determination of whether a repair procedure that is not pre-approved requires engineering as well as whether a pre-approved repair procedure is appropriate for use for the intended repair.

Pre-approved repair procedures for precast and prestressed concrete plants are located in their annual approval document. They are reviewed and approved by the State Construction Office. The process is described in the WSDOT Materials Manual, Standard Practice QC 6 and QC 7.

Working drawing submittals for repairs are primarily intended to provide the Engineer an opportunity to review and comment on repair procedures, facilitate proper inspection of the repair work, provide documentation of the repair, and assist the Engineer in preparation of the as-builts. All repairs shall be documented in the as-builts.

When construction issues at precast / prestressed concrete plants and steel fabrication plants need to be expedited, the fabricator may prepare a problem resolution form describing the problem and proposed resolution. The fabricator notifies the WSDOT Fabrication Inspection Office and receives their concurrence the problem has been accurately described on the Problem Resolution document. The concurrence is noted on the problem resolution form. The document is then emailed to both the Contractor (the Contractor forwards this on to the WSDOT Project Engineer) and to the WSDOT Construction Office. The email addresses "structuralsteelpr@wsdot.wa.gov" for steel structures and "precastpr@wsdot.wa.gov" for precast concrete structures distribute to all of the WSDOT Construction Engineers and to the WSDOT Seattle Inspection Office. The WSDOT Construction Office reviews the document and prepares a recommendation for the WSDOT Project Engineer. The WSDOT Project Engineer and the WSDOT Construction Office work together to address the fabricators proposed problem resolution. The WSDOT Project Engineer will send the approval (or disapproval) to the Contractor and the WSDOT Fabrication Inspection Office.

SS 6-01.16(2)A Concrete Spalls and Poor Consolidation (Rock Pockets, Honeycombs, Voids, etc.)

This pre-approved repair procedure requires the Engineer to make a determination of whether the intended repair may affect structural adequacy. The WSDOT Project Engineer shall consult with the ASCE and an appropriate licensed professional engineer (such as the engineer-of-record, the Bridge Technical Advisor (BTA), the State Bridge Construction Engineer, etc.) to make this determination.

Repairs that may be considered to affect structural adequacy include but are not limited to:

- Areas that extend deeper than the outer layer of reinforcement in members (or portions of members) that are or will be in compression such as columns, walls and portions of beams. Note that many repairs in compression areas will be able to be effective over time as the original undamaged concrete creeps and transfers compression to the repair. This is especially true for high strength, low shrinkage repair materials.

- Areas in concrete that are already loaded by subsequent actions such as prestressing, release of falsework, subsequent material placement, or applied earth pressure
- Areas with significant reinforcing steel damage, corrosion or section loss.
- Areas with significant overhead work
- Areas that have been previously repaired
- Areas adjacent to post-tensioning anchorages
- Areas with numerous or large spalls in the concrete surface

The full extent of the damage may not be known until the damaged concrete is removed. For this reason the Contractor is directed to stop work after initial concrete removal. The Project Engineer may require the Contractor to submit a modified repair procedure. This may be appropriate when the area or volume of concrete is significantly greater than originally estimated or reinforcement/embedments are damaged or displaced. Other unforeseen conditions may also arise which may bring the validity of the pre-approved repair procedure into question. The WSDOT Project Engineer should consult with the ASCE and appropriate licensed professional if it is suspected that the pre-approved repair is no longer appropriate. The WSDOT Project Engineer can then require a revised repair procedure be submitted by the Contractor.

Shrinkage-compensating repair materials are made with an expansive cement or expansive component system in which initial expansion, if properly restrained, offsets strains caused by drying shrinkage. Shrinkage-compensating repair materials may not be appropriate if the repair area will not sufficiently restrain the initial expansion of the repair material with forms, surrounding concrete and reinforcement passing through the repair area.