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Appendix A - Job-Aid Checklists

A.1 Bridge Cleaning

Description

Remove all salt, dirt, and debris from the deck and supporting members, bearings, pedestals, capbeams, and bridge seats. Unplug and clean the drainage system (scuppers, open joint troughs, and downspouts) on the bridge. Clean debris and vegetation from around the structure and approaches.

Project Objectives

Remove dirt and debris that traps moisture and de-icing salt to prevent corrosion and to enable elements to function properly. Ensure proper drainage on and around the bridge.

Labor Skills

Physical labor

Materials and Equipment

- Clean water
- Equipment
- Water trailer
- Sewer snake
- Long-handle scrapers
- Square-point shovels
- Brush clippers and saw
- High-pressure water pump with hoses, etc.
- 175-CFM air compressor with hoses, etc.
- Ladders and scaffolding
- Brooms
- Personal safety equipment
- Wheel barrow

Procedure

- Coordinate with Agency Environmental Unit and obtain any necessary permits from the State Environmental Agency, US Army Corps of Engineers, or EPA, particularly for acceptable months, to wash at environmentally sensitive or protected streams.
- Prepare the work-zone (e.g., traffic control, environmental protection, other equipment).
- Cut and remove vegetation from around substructures and approaches, minimizing removal to limit habitat loss, erosion, and sedimentation.
- Collect and remove trash, dirt, and other debris on and around the bridge (including underside, supporting elements, and approaches) by sweeping, shoveling, vacuuming, or other suitable methods.
- Loosen dirt and debris with scrapers and brooms as necessary.
- Properly dispose of all collected material. If sand, dirt, or other similar material is

to be disposed of on-site, place it in an upland area from which it cannot enter a stream, water body or wetland.

- Pressure or flood wash the structure, generally beginning at the highest point and working downward, using a water source and pressures that are recommended by the bridge owner or agency. Carefully avoid excessive pressure that may damage paint, grout, or other materials.

Figure A.1 Bridge Washing

- Flush scuppers and drainage system, but prevent sediment and debris from discharging into streams and other surface-water bodies.
- Remove scupper gratings and downspout clean-out plugs to flush and snake trapped debris, as necessary.
- Use caution to control water pressure used in flushing drainage systems.
- Portions of structures with loose paint chips should not be pressure-washed, and care should be taken to collect and properly dispose of any dislodged paint chips

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Consider safety needs for feature crossed and utility lines.
- Identify and avoid pathogen carrying debris (bird droppings). If debris is to be removed, use appropriate PPE and follow latest OSHA/Health Department guidance.

A.2 Sealing Cracks and Joints in Bituminous Wearing Surface

Description

Clean out and seal cracks and joints in bituminous wearing surface to protect the underlying structural deck.

Project Objectives

Minimize or eliminate water and chlorides entering the structure through these cracks and extend the life of the asphalt-cement-concrete wearing surface.

Labor Skills

Physical labor

Materials

- Crack-sealer meeting ASTM D 6690 or polymer-based "healer/sealer"
- Blasting sand
- Equipment
- Crack-sealer heater/melter
- Wand, hoses, and nozzles
- Air compressor with hoses, etc.
- Shovels and brooms
- Concrete saw (crack-chaser)
- Sandblaster
- Personal safety equipment
- Grinder
- Putty knife

Procedure

- Prepare the work-zone (i.e., traffic control, environmental protection, equipment).
- Loosen and shovel off heavy dirt deposits.
- Clean wearing surface by sweeping and/or using compressed air.
- Clean cracks and joints using water or compressed air, and a grinder or putty knife to scrape out larger deposits or old joint material.
- Prepare joint surfaces by sandblasting, sawcutting, or grinding, if necessary.
- Clean all loose dirt and sandblast material generated by joint surface preparation from pavement surface.
- Cracks and joints should be clean and dry before applying sealing material.
- Apply D 6690 crack sealer or Polymer-based material liquid joint sealer to joints and cracks according to manufacturer instructions, allowing adequate time for material to dry.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.

Figure A.2 Applying a Crack Sealer

A.3 Crack Sealing in Portland Cement Concrete Decks

Description

Applying ASTM D 6690 Joint and Crack sealant to cracks in concrete bridge decks. Also, applying epoxy injection and sealers such as HMWM.

Project Objectives

Minimize or eliminate water and chlorides entering the structure through these cracks. Extend the service life of the existing bridge deck.

Labor Skills

Physical labor

Materials

- Crack-sealer meeting ASTM D 6690
- Blasting sand

Equipment

- Crack-sealer heater/melter
- Wand, hoses, and nozzles
- Air compressor with hoses, etc.
- Shovels and brooms
- Walk behind concrete router
- Sandblaster
- Personal safety equipment
- Grinder and putty knife

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Clean deck by sweeping and/or using compressed air.
- Clean cracks and joints using water or compressed air, and a grinder or putty knife to scrape out larger deposits or old joint material.
- Using concrete router, route channel along existing crack to a depth of +/- 1 inch.


Figure A.3 Crack Sealing in Concrete Decks

- Remove debris from routing operation.
- Sandblast routed crack, clean up sandblasting debris.
- Surface must be clean, dry, and temperatures must be correct.

- Using tar pot with wand, install properly heated crack sealer (ASTM 6690) into prepared crack.
- Allow sealer to reach initial set prior to opening area to traffic.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Avoid excessive material that may reduce skid resistance.

A.4 Sealing Concrete Decks

Description

Apply sealant to concrete deck, curbs, sidewalks, and fascia and apply liquid deck sealer where appropriate.

Project Objectives

Maintain waterproof integrity of the deck wearing-surface to prevent water and chlorides from reaching the reinforcing steel.

Labor Skills

Physical labor

Materials

- Water
- Blasting sand
- Sealer (silanes, siloxanes, silicone, polymers, HMWM)
- Steel shot

Equipment

- Paint/herbicide spray unit
- Truck with pumps and spray bar
- Air compressor with hoses, etc.
- Shovels and brooms
- Paint rollers and brushes
- Sandblaster
- Personal safety equipment
- Steel-shot blaster
- Various hand tools

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Loosen and shovel off heavy dirt deposits.
- Clean deck by washing, sweeping, and/or using compressed air.
- Sandblast or shotblast in accordance with sealer manufacturer recommendations.
- Surface must be clean and dry, temperatures in accordance with sealer manufacturer recommendations, and wind calm.
- Apply sealer according to manufacturer's instructions, controlling application rate to avoid running or puddle formation. Use multiple coats, if necessary.

Figure A.4 Sealing Concrete Deck Example (Courtesy of MDOT)

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Use caution because of flammability of some products.
- Vapors of some sealers can be irritants to eyes and throat.

A.5 Replacing Asphalt Wearing Surface

Description

Remove entire existing bituminous wearing surface, and install waterproofing membrane and new bituminous wearing surface.

Project Objectives

Install a wearing surface that provides a smooth skid resistant riding surface and waterproofing protection for underlying structural deck.

Labor Skills

Physical labor

Materials

- Asphalt concrete
- Membrane waterproofing system
- Water
- Blasting sand
- Solvent for cleanup
- Plastic pipe
- Concrete-repair material
- Wire screening/mesh

Equipment

- Dump-truck
- Loader
- Milling machine
- 450-CFM air compressor with hoses, etc.
- Concrete saw
- Electrical generator
- Bituminous spreader
- Roller(s) and plate compactor
- Water tank
- Shovels and rakes
- Core drill
- Squeegees and pails
- Brooms and brushes
- Sandblaster
- Personal safety equipment
- Various hand tools

Procedure

- Check load rating to ensure that bridge can safely support weight of new wearing surface. The load rating should be updated to reflect any additional loads, including additional wearing surfaces.
- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Remove existing wearing surface by milling and/or hand methods.
- Remove material from the site using a loader and heavy dump-trucks.

- Remove dirt and smaller debris by sweeping and shoveling.
- Clean deck with compressed air and prepare surface by sandblasting.
- Make deck repairs as necessary.
- Sandblast repaired areas and again blow the deck clean.
- Drill weep holes and install plastic drain pipes, if necessary.
- Apply waterproof membrane according to manufacturer instructions, depending on type (preformed sheet membrane or liquid membrane).
- Place and roll asphalt concrete (2-inch minimum compacted).

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.

A.6 Lubricating Bearings

Description

Jack structure, clean, and lubricate all appropriate bearings and pin-and-hanger connections. Spot-paint these items if required.

Project Objectives

Ensure that bearings function properly to transfer loads from superstructure to substructure, and allow proper movement of the superstructure.

Labor Skills

Physical labor

Materials

- Water
- Blasting sand
- Paint
- Penetrating oil
- Lubricating oil
- Grease

Equipment

- Hydraulic jacks
- Ladders and scaffolding
- Water trailer
- 150-CFM air compressor with hoses, etc.
- High-pressure water pump
- Sandblaster
- Personal safety equipment
- Stiff brushes
- Various hand tools
- Scaling hammer
- Steel grinder

Procedure

- Develop jacking plan (performed by a licensed engineer).
- Prepare work-zone (i.e., traffic control, environmental protection, ladders and scaffolding, equipment).
- Flush the bearings with high-pressure water or air to remove loose material.
- Remove rust and scale from bearings by scraping, wire brushing, or sandblasting, and re-flush, making sure the bearing is not damaged by rust and scale removal.
- Jack structure pursuant to jacking plan and remove bearings, if necessary for proper service, depending on type of bearing.
- Clean and grind bearing surfaces to a smooth finish.
- Grease or oil bearing wearing surfaces as required, depending on bearing type.

Figure A.5 Penetrating Spray Grease Used on Bearings (Courtesy of PennDOT)

- Prime and paint non-bearing surfaces, as necessary.
- Re-install bearing and lower bridge pursuant to jacking plan, if necessary

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Considerations associated with jacking.
- Restrict traffic during jacking operation.
- Consider environmental and worker safety issues (i.e., asbestos, lead, pathogens).

A.7 Sealing Concrete Substructures

Description

Apply sealant to cap beams, seats, and pedestals, and other substructure elements.

Project Objectives

Maintain waterproof integrity of substructure elements to prevent water and chlorides from penetrating the concrete and reaching the reinforcing steel.

Labor Skills

Physical labor

Materials

- Water
- Blasting sand
- Sealer (silanes, siloxanes, silicone, polymers, epoxies)
- Steel shot

Equipment

- Backpack (handheld) sprayer
- Scrapers and stiff brushes
- Air compressor with hoses, etc.
- Shovels and brooms
- Paint rollers and brushes
- Sandblaster
- Personal safety equipment
- Steel-shot blaster
- Barrel pump with hose and spray attachment
- Various hand tools
- Respirator

Procedure

- Prepare work zone (i.e., traffic control, environmental protection, ladders and scaffolding, equipment).
- Loosen and shovel off heavy dirt deposits.
- Clean substructure elements by washing or using compressed air.
- Sandblast, shotblast, or use stiff brushes and scrapers to loosen material if necessary in accordance with sealer manufacturer recommendations
- The surface must be clean and dry.
- Temperatures within manufacturer requirements and winds calm.
- Apply sealer according to manufacturer instructions. Begin sealing at the bottom of the element and work up, controlling application rate to avoid excess running. Use multiple coats, if necessary.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Use caution because of flammability of some products.
- Vapors of some sealers can be irritants to eyes and throat.

A.8 Painting Bridge Steel

Description

Prepare and repaint paintable bridges.

Figure A.6 Painting Project with Approved Containment System

Project Objectives

Protecting the steel from corrosion and prevent steel section loss.

Labor Skills

- Physical labor
- Industrial painting

Materials

- Approved paint for bridges
- Blasting sand/recycle abrasive (steel shot)

Equipment

- Scrapers, stiff wire brushes, and other hand tools
- Dust containment equipment
- Dust collectors
- Containment system and tarps
- Additional protection equipment for lead paint (wash stations, DECON trailers, etc.)
- Air compressor with hoses, etc.
- Sandblaster
- Abrasives recycle unit
- Sand recovery/Containment
- Paint rollers and brushes
- Personal safety equipment
- Various hand tools
- Power tools (Needle guns, grinders, and scalers)
- Power brushes
- Paint sprayer – airless spray pump
- Ladders/Scaffold

- Wet film thickness gauge

Figure A.7 Wet Film Thickness Gauge

- Prepare work zone (e.g., traffic control, environmental protection, ladders and scaffolding, equipment).

Figure A.8 Containment and Recovery System in Prepared Work Zone

- Remove deteriorated paint using sand or steel shot blasting, power chippers, power brushes, needle scalers, other power tools, or hand tools – vacuum power tools.

Figure A.9 Mechanical Removal of Paint

- Use care to contain dust, blasting sand, and paint chips while preparing steel.

Figure A.10 Interior of the Dust Containment System

- Remove paint and clean to the level specified by the specifications and recommendations for the paint being used.
- The surface and atmospheric conditions must be in accordance with the paint manufacturer recommendations, typically dry surfaces, temperatures over 40 °F, and less than 85 percent humidity.
- Apply paint neatly with roller, brush or sprayer according to manufacturer instructions.

Figure A.11 Example of Painting

- Work paint into all crevices to completely coat steel (stripe coat)
- If multiple coats are necessary, apply following coats after preceding coat is fully cured.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site
- Paint being removed may contain lead, asbestos, or other heavy metals and should be handled appropriately
- Vapors of some paint can be irritants to eyes and throat
- Containment structures, when required, should be constructed in accordance with the project specifications
- Consider environmental and worker-safety issues (e.g., lead exposure)

A.9 Spot Painting Bridge Steel

Description

Prepare and spot paint isolated areas paintable bridges.

Figure A.12 Painting Project with Approved Containment System

Project Objectives

Protecting the steel from corrosion and prevent steel section loss.

Labor Skills

- Physical labor
- Industrial Painting

Materials

- Approved paint for bridges

Equipment

- Scrapers, stiff wire brushes, and other hand tools
- Dust containment equipment
- Dust collectors
- Additional protection equipment for lead paint (wash stations, DECON trailers, etc.)
- Air compressor with hoses, etc.
- Paint rollers and brushes
- Personal safety equipment
- Various hand tools
- Power tools (needle guns, grinders, and scalers)
- Power brushes
- Paint sprayer – airless spray pump
- Ladders/Scaffold
- Wet film thickness gauge

Figure A.13 Wet Film Thickness Gauge

- Prepare work zone (i.e., traffic control, environmental protection, ladders and scaffolding, equipment).
- Remove deteriorated paint using power chippers, power brushes, needle scalers, other power tools, or hand tools – vacuum power tools.

Figure A.14 Mechanical Removal of Paint

- Use care to contain dust, blasting sand, and paint chips while preparing steel.
- Remove paint and clean to the level specified by the specifications and recommendations for the paint being used.
- The surface and atmospheric conditions must be in accordance with the paint manufacturer recommendations, typically dry surfaces, temperatures over 40 °F, and less than 85 percent humidity.
- Apply paint neatly with roller, brush or sprayer according to manufacturer instructions.

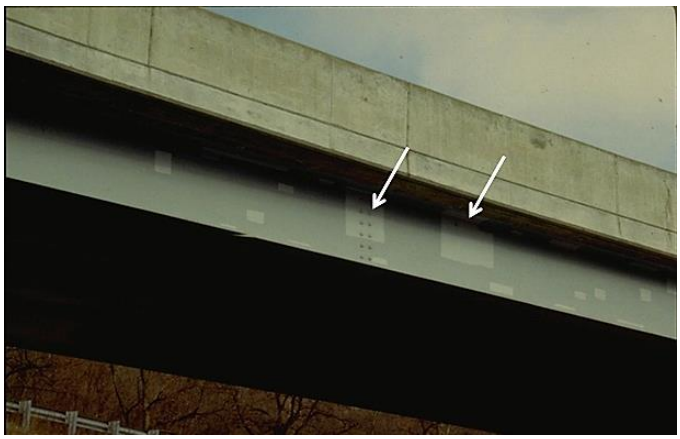

Figure A.15 Example of Spot Painting

- Work paint into all crevices to completely coat steel (stripe coat)
- If multiple coats are necessary, apply following coats after preceding coat is fully cured.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site
- Paint being removed may contain lead, asbestos, or other heavy metals and should be handled appropriately
- Vapors of some paint can be irritants to eyes and throat
- Containment structures, when required, should be constructed in accordance with the project specifications
- Consider environmental and worker-safety issues (e.g., lead exposure)

A.10 Repairing Concrete Decks

Description

Remove and replace damaged portions of structural concrete deck and reinforcing steel.

Project Objectives

To restore structural integrity of the deck, provide a smooth riding surface, and improve safety of the traveling public.

Labor Skills

- Physical labor
- Carpenter
- Cement Masonry
- Ironworker

Materials

- Steel shot
- Blasting sand
- Reinforcing steel
- Water
- Portland cement concrete (or other patching material)

Equipment

- Concrete saw
- 450-CFM air compressor with hoses, etc.
- Electrical generator
- Sandblaster
- Concrete mixer
- Pneumatic hammer (less than 30 pounds)
- Shovels and pickaxe
- Brooms and brushes
- Sounding hammer
- Various hand tools
- Personal-safety equipment
- Steel-shot blaster

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Identify and mark extent of damaged portions. Repair areas should be roughly rectangular.
- Protect area under the deck, if repairs are likely to be full depth prior to demolition
- Sawcut perpendicular to the deck surface outside the damaged area to a depth of 1 inch.
- Remove deteriorated concrete using pneumatic hammers and hand tools to 1 inch below the reinforcing steel.

Figure A.16 Deteriorated Concrete Removal (Courtesy of Kwikbond Polymers)

- Periodically sound the remaining concrete.
- Sandblast or shotblast the concrete substrate to remove loose concrete and roughen surface to provide a sound bond.
- Sandblast exposed steel to remove rust and other contaminants.
- Fasten additional reinforcing steel to the existing steel if section loss is 20 percent or more.
- Form underside of deck for any full-depth repairs.
- Prior to placing patch, the concrete should be saturated surface dry (SSD). If appropriate for the repair material being used, a bonding agent may be applied. Any use of bonding agent must be done in strict conformance with the manufacturer recommendations in order for the bonding agent to perform properly. In particular, the concrete/concrete patch material must be applied within the “open time” of the bonding agent.

Figure A.17 Bonding Agent Application

- Place new concrete or patching material (depending on repair depth) prior to set up of bonding agent.

Figure A.18 Mixing Patching Material (left) and Patch Concrete Placement (right)

- Broom-finish surface of the patch.
- Provide for proper cure to avoid shrinkage cracks.

Figure A.19 Example of Wet Cure

Safety Considerations

Typical work-zone procedures as appropriate for specific site.

A.11 Repairing/Replacing Joints

Description

Repair or remove and replace deteriorated or damaged sections of joint systems, including surrounding concrete. Perform this work on all types of joint systems, as required.

Project Objectives

Provide proper operation of the joint system and safety for the traveling public.

Labor Skills

- Physical labor
- Welding

Materials

- Concrete/elastomeric material
- Blasting sand
- Compression gland, or liquid seal
- Compression-seal lubricant/sealant
- Structural steel shape (armor angle or extrusion)
- Expanded polystyrene board and backer rod
- Epoxy anchor capsules and anchoring devices
- Forming lumber
- Welding rod
- Solvent for cleanup

Equipment

- Welder
- 175-CFM air compressor with hoses, etc.
- Electrical generator
- Sandblaster
- Concrete mixer
- Pneumatic hammer (less than 30 pound)
- Concrete vibrator
- Concrete saw
- Rubber seal installation tools
- Joint levelers
- Hammer drill
- Various hand tools
- Personal-safety equipment
- Oxygen/acetylene or oxygen/propane torches

Procedure

- Prepare work-zone (e.g., traffic control, environmental protection, equipment).
- Sawcut and chip out concrete adjoining joint.

Figure A.20 Chipping out Concrete at Joint

- Remove existing joint system.

Figure A.21 Removed Joint System

- Prepare box out for new joint system.
- Set, level, drill, anchor, and weld armor angle/extrusion.

Figure A.22 Box Preparation for New Joint

- Sandblast all concrete and steel surfaces.
- Place expanded polystyrene board and backer rod (pourable joints).
- Set joint opening at appropriate width. Consult an engineer.
- Place concrete/elastomeric material and cure.
- Install seal.

Safety Considerations

Typical work-zone procedures as appropriate for specific site.

A.12 Repairing/Replacing Steel Members

Description

Repair or replace deteriorated or damaged steel sections.

Project Objectives

To re-establish structural load-carrying capacity of steel bridge elements.

Labor Skills

- Steel Fabrication
- Welding
- Iron Work
- Painting

Materials

- Steel
- Blasting sand
- High-strength bolts
- Welding rod
- Paint

Equipment

- 175-CFM air compressor with hoses, etc.
- Magnetic drill
- Welder
- Paint rollers and brushes
- Scrapers and stiff brushes
- Vacuum paint-removal tools Grinder
- Electrical generator
- Sandblaster
- Oxygen/acetylene or Oxygen/propane torches
- Shroud
- Various hand tools
- Personal-safety equipment
- Jacks may be needed depending on the location and size of the members being repaired or replaced. Jacking may be needed to remove load from member so it can be repaired/replaced.
- Cranes may be needed depending on the location and size of the members being repaired. Large pieces of steel will require a crane.

Procedure

- Develop repair plan.
- CONSULT A LICENSED PROFESSIONAL ENGINEER.
- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Provide temporary support for affected members, as necessary. Figure A.19 shows temporary support of truss end post

Figure A.23 Temporary Support

- Prepare steel area to be repaired by removing paint, rust, dirt, etc.
- Remove paint using vacuum-shrouded power tools.
- Remove rust using vacuum-shrouded tools, wire brushes, scrapers.
- Remove loose dirt and grime with compressed air or high-pressure water.
- Perform repair as required.

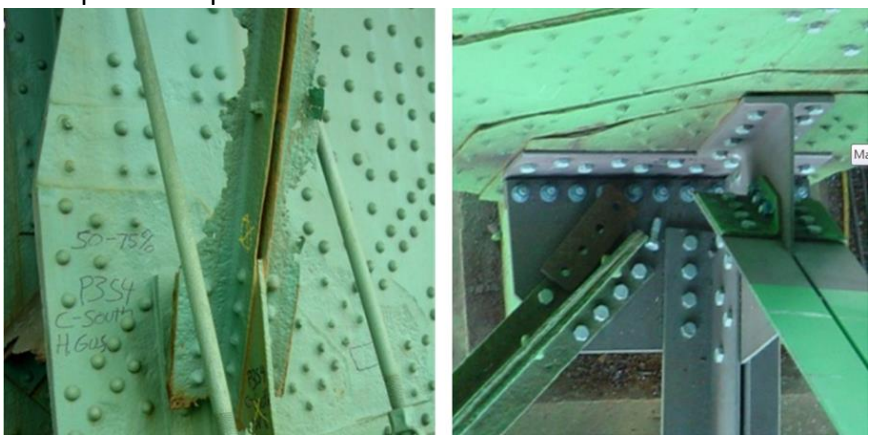

Figure A.24 Example of Steel Member Repair

- CAUTION: Only certified welders should weld structural steel members.
- Conduct any necessary non-destructive testing.
- Prime and spot-paint treated area.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- DO NOT attempt steel repairs without proper knowledge and qualifications.
- Consider environmental and worker-safety issues (i.e., lead exposure).

A.13 Repairing Sheared Anchor Bolts/Replacing Bearings

Description

Jack structure and repair or replace bearing systems or system components for all types of bearings, as required.

Project Objectives

Ensure that bearings function properly to transfer loads from superstructure to substructure, and allow proper movement of the superstructure.

Labor Skills

- Physical labor
- Iron worker

Materials

- Steel flat stock
- Threaded rod
- Chemical Grout
- Anchor bolts
- Grease
- Paint
- Bolts/nuts
- Concrete (or other patching material)
- Water
- New elastomeric bearings or other replacement bearings

Equipment

- Hydraulic jacks
- Grinders
- Magnetic drill
- Air compressor with hoses, etc.
- Electrical generator
- Scalers, wire brushes
- Ladders and scaffolding
- Various hand tools
- Oxygen/acetylene torches
- Personal safety equipment
- Welder mask, gloves, apron
- High-pressure water pump with hoses, etc.

Procedure

1. Repair sheared anchor bolts on slider bearings by installing anchor straps in front of bearing base plates and properly lubricating sliding surfaces.
   - Develop repair plan, including jacking plan. Consult a licensed engineer.
   - Measure pedestal width and hole locations.
   - In shop, cut straps to size, drill holes in straps, and paint.
   - Prepare work-zone (i.e., traffic control, environmental protection, ladders and scaffolding, equipment).

- Drill holes in pedestal at planned strap locations to required depth.
- Set threaded rods in holes using chemical anchor. Be sure rods are properly aligned.
- Jack structure pursuant to jacking plan and remove bearings.

Figure A.25 Example of Jacked Structure

- Remove rust and scale from bearings by scraping and wire brushing, and re-flush, making sure the bearing is not damaged by rust and scale removal.
- Reinstall bearings and install anchor straps.
- Place dry lube pads and grease on sliding surface.
- Lower structure pursuant to jacking plan.
- Prime and paint bearing non-wearing surfaces as necessary.

2. Replace roller-nest bearings with elastomeric bearings or pads.

- Develop repair plan, including jacking plan. Consult a licensed engineer.
- Fabricate filler plates for new bearings in shop, based on repair plan.
- Prepare work-zone (i.e., traffic control, environmental protection, ladders and scaffolding, equipment).
- Jack structure pursuant to jacking plan.

Figure A.26 Example of Jacked Structure for Bearing Replacement

- Remove old bearings.

Figure A.27 Example of Bearing Removal

- Drill holes in pedestal and install new anchor bolts.
- Install new elastomeric pads or elastomeric bearings and filler plates, as necessary.
- Lower structure pursuant to jacking plan.
- Prime and paint bearing non-wearing surfaces, as necessary.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Restrict traffic during jacking operation.
- Consider environmental and worker-safety issues (e.g., asbestos exposure).

A.14 Repairing Concrete Substructures

Description

Remove and replace damaged portions of substructure concrete and reinforcing steel.

Project Objectives

To restore structural integrity of the substructure and bridge.

Labor Skills

- Physical labor
- Carpenter
- Cement masonry
- Ironworker

Materials

- Blasting sand
- Shim plate
- Reinforcing steel
- Water
- Portland cement concrete (or other patching material)

Equipment

- Concrete saw
- 450-CFM air compressor with hoses, etc.
- Electrical generator
- Sandblaster
- Sounding hammer
- Pneumatic hammer
- Concrete mixer
- Concrete pump
- Hydraulic pump
- Brooms and brushes
- Various hand tools
- Personal-safety equipment

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Identify and mark extent of damaged areas of substructure concrete.
- Install temporary support of superstructure as required.
- Sawcut outside (perimeter) deteriorated areas. Cuts should be dovetailed to hold repair concrete.
- Remove deteriorated concrete, using pneumatic hammers and hand tools, and expose reinforcing steel to allow placing of concrete behind reinforcing steel - 1 inch beyond steel.

Figure A.28 Deteriorated Concrete Removal

- Periodically sound remaining concrete to determine concrete condition.
- Clean the area using sandblasting.
- Fasten additional reinforcing steel to replace or repair existing steel as necessary to reestablish steel to as-built condition.
- Form area to be repaired.

Figure A.29 Examples of Forms

- Saturate the concrete substrate to a Saturated Surface Dry (SSD) condition.
- Apply grout or other bonding agent to existing concrete surfaces if recommended for use with patch material and consistent with local practice. If bonding agent is used it must be applied in strict compliance with manufacturer recommendations.
- Place new concrete or patching material. (Apply pneumatic concrete as an alternative).
- Provide proper cure to ensure durable concrete and to avoid shrinkage cracking.
- Remove forms.
- Patch any surface defects resulting from forming.

Safety Considerations

Typical work-zone procedures as appropriate for specific site.

A.15 Repairing Erosion or Scour

Description

Repair undermined foundations and/or scoured or eroded stream channels with concrete, grout, stone fill, or riprap.

Project Objectives

To protect integrity of bridge substructures and to ensure they continue to function as intended.

Labor Skills

Physical labor

Materials

- Gravel
- Bedding material
- Geotextile fabric
- Rip-rap
- Concrete materials
- Heavy stone fill
- Grout
- Grout bags
- Bulldozer
- Skid-steer loader
- Backhoe
- Hydraulic excavator
- Dump truck(s)
- Crane
- Barge
- Concrete pump
- Core drill
- Various hand tools
- Grout mixer
- Personal-safety equipment

Procedure

1. **Repair Undermined Foundation**

   - Coordinate with Agency Environmental Unit and obtain any necessary permits from State Environmental Department, and/or US Army Corps of Engineers, and consult with environmental agencies, as required.
   - Also coordinate with the Agency Geotechnical Engineering, structural engineering and Hydraulic Engineering staff on a repair procedure.
   - Prepare work-zone (i.e., traffic control, environmental protection, temporary coffer dams, equipment).
   - Construct cofferdams and de-water unless using tremie concrete or grout bags
   - Remove silt and other fine material deposited under the foundation.

- Place sand bags, forms, or bagged concrete along vertical face of foundation.
- Drill holes through footing, approximately 3-feet apart.
- Pump concrete or grout through holes, vibrating concrete to consolidate it.
- Remove forms.
- As alternative, place grout bags along vertical face of foundation and pump concrete into grout bags until full. Repeat as necessary.
- Place stone fill or riprap protection around foundation as noted below.

2. Repair Scour Hole

- Coordinate with Agency Environmental Unit and obtain any necessary permits from State Environmental Department, and/or US Army Corps of Engineers, and consult with environmental agencies, as required.
- Also coordinate with the Agency Geotechnical Engineering and or Hydraulic Engineering staff on a repair procedure.
- Prepare work-zone (i.e., traffic control, environmental protection, temporary coffer dams, equipment).
- Remove silt and other fine material deposited into the scour hole, if possible.
- Place gravel or bedding material in the scour hole, as required. Place geotextile fabric over the bedding material.
- Place stone into scour hole. Shape stone as close as possible to existing channel elevation. Consult an engineer to determine the appropriate size riprap for stream conditions.
- Safety Considerations: Typical work-zone procedures as appropriate for specific site
- Work near water requires additional precautions such as Personal Floatation Devices (PFD's), ring buoys, skiffs, fall protection, etc.

A.16 Placing Thin Polymer Overlays

Description

Apply thin polymer overlay to concrete deck where appropriate.

Project Objectives

Maintain waterproof integrity of the deck wearing-surface portion to prevent water and chlorides from reaching the reinforcing steel.

Labor Skills

Physical labor

Materials

- Polymer Components
- Blasting sand
- Aggregates
- Steel shot
- Solvent for cleanup
- Sand

Equipment

- Air compressor with hoses, etc.
- Mixing paddle
- Sandblaster
- Screed
- Steel-shot blaster
- Spiked shoes
- Shovels, scrapers, and brooms
- Personal safety equipment
- Rakes, squeegees, and pails
- Respiratory equipment
- Mortar mixer or bucket
- Various hand tools

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Loosen and shovel off heavy dirt deposits.
- Clean deck by washing, sweeping, and/or using compressed air.
- Steel shot blast and sandblast.
- Apply test patches to verify cleaning method.
- Surface must be clean, dry, and temperatures must be within polymer manufacturer specifications.
- Apply polymer according to manufacturer instructions, controlling application rate to avoid running and irregular surfaces.
- Apply second coat if necessary.
- Broadcast aggregate on surface of overlay to create a friction surface.

Figure A.30 Broadcasting Aggregate by Hand

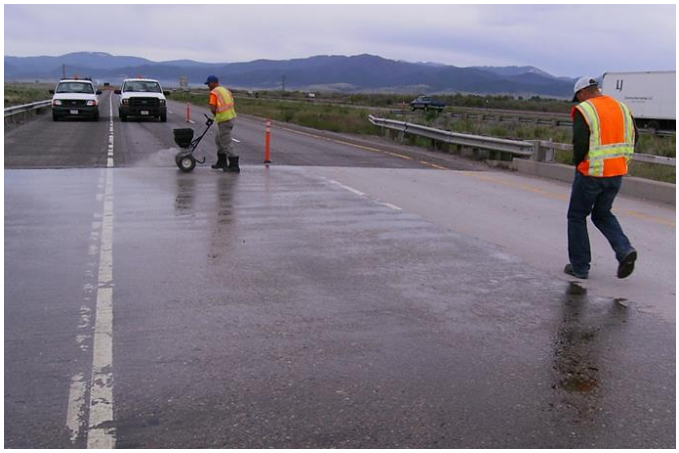

Figure A.31 Broadcasting Aggregate with Hand Operated Spreader (Courtesy of Kwikbond Polymers)

Figure A.32 Broadcasting Sand using a Mechanized Application (Courtesy of MDOT)

- Allow sufficient time for overlay to cure before permitting traffic on it.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Use caution because of flammability of some products.

A.17 Shotcrete Repairs

Description

Application of pneumatically placed Portland cement/sand mixture for structural concrete repairs.

Project Objectives

- Provide form free structural repairs to concrete structures.

Labor Skills

- Physical labor
- Skill/training of operator

Materials

- Type I or II Portland cement
- Potable water
- Clean/washed mason sand
- Waterproofing cementing compound
- Curing agent

Equipment

- Air compressor
- Coalescing filter
- Sandblaster
- Various hand tools
- Pneumatic hammer (less than 30 pounds)
- Brooms and brushes
- Sounding hammer
- Shotcrete
- Application equipment
- Personal-safety equipment

Figure A.33 Shotcrete Mixing Equipment

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Identify and mark extent of damaged portions.
- Test patches to verify ability of operator.
- Remove deteriorated concrete using pneumatic hammers and hand tools to 1 inch below the reinforcing steel.
- Periodically sound the remaining concrete.
- Clean the area using sandblasting.
- Sandblast exposed steel to remove rust and other contaminants.
- Fasten additional reinforcing steel to the existing steel if section loss is 20 percent or more.
- Existing concrete should be Saturated Surface Dry (SSD) prior to application of neat cement paste, or sand cement grout mix. Follow manufacturer recommendations for waterproof cementing compound, or epoxy bonding agent.
- Screen/mix the Portland cement and mason sand.
- Apply mix to chipped area with low volume shotcrete applicator gun.

Figure A.34 Shotcrete Applicator Gun

- Screed/finish the new repair
- Apply Curing agent coat to repaired area, unless wet cure is being used. If wet cure is being used, cover appropriately and keep wet for curing period
- Daily clean low volume shotcrete unit at the end of the day

Safety Considerations

- Typical work-zone procedures as appropriate for specific site
- Fall safety procedures
- Scaffolding erection procedures

A.18 Full Depth Bridge Deck Repairs

Description

Perform full depth repairs of bridge decks as necessary.

Project Objectives

Extend service life of existing structure until future major rehabilitation. Improve rideability of wearing surface.

Labor Skills

- Physical labor
- Carpenter
- Cement mason
- Ironworker

Materials

- Blasting sand
- Reinforcing steel
- Water
- Portland cement concrete (or other patching material)

Equipment

- Concrete saw
- 450-CFM air compressor with hoses, etc.
- Electrical generator
- Sandblaster
- Concrete mixer
- Pneumatic hammer (less than 30 pounds)
- Shovels and pickaxes
- Brooms and brushes
- Sounding hammer
- Various hand tools
- Personal-safety equipment

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Identify and mark extent of damaged portions. Repair areas should be roughly rectangular.
- Sawcut outside the damaged area (straight cuts) – 1 inch.
- Remove deteriorated concrete using pneumatic hammers.
- Periodically sound the remaining concrete.
- Clean the area using sandblasting.
- Sandblast exposed steel to remove rust and other contaminants.

Figure A.35 Deteriorated Concrete Removal and Exposed Steel Cleaned

- Fasten additional reinforcing steel to the existing steel if section loss is 20 percent or more.
- Construct form on underside of deck repairs. Ensure there is sufficient bracing on bottom side of deck form to avoid failure of formwork when concrete is placed. A heavy gauge tie wire (9 wire) can be used to help tie form to existing rebar.

Figure A.36 Example of Form Constructed on Deck Underside

- Make sure repair area is clean.
- Follow repair material manufacturer recommendation for surface preparation (wet hole, dry hole).
- Available repair materials include Portland cement concrete, Elastomeric concrete, or "Liquid" concrete.
- Mix repair material as per manufacturer recommendations placed in full depth repair.
- Fill repair, consolidate as recommended, then finish surface.
- Place aggregate for friction on surface as necessary.
- Open deck back up to traffic following appropriate cure time (again as per manufacturer recommendation) and strength gain.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site
- Fall safety procedures
- Scaffolding erection procedures

A.19 Bonded FRP Repairs to Concrete

Description

Repair damaged portions of concrete.

Project Objectives

To restore structural integrity of the concrete.

Labor Skills

- Physical labor
- Carpenter
- Mason

Materials

- Glass or carbon fiber fabric
- Polymer resin and hardener
- Solvent for cleanup
- Blasting sand
- Water

Equipment

- Pressure washer
- Sandblaster
- Sounding hammer
- Pneumatic hammer
- Hand roller
- Various hand tools
- Personal-safety equipment
- Resin manufacturer recommended equipment for application and impregnation of resin
- Respirators

Procedure

- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Identify and mark extent of damaged areas of concrete.
- Surface preparation and column wrap should include the full exposed column height plus 2 feet below ground.
- All concrete surfaces should be repaired (including spalls and delaminations) and epoxy injection crack sealing performed. Surface should be free of sharp edges that can damage the fabric. Surface voids and depressions should be filled with epoxy.
- Surface should be completely dry at the time of application of fabric. Newly repaired or patched surface should be cured at least 7 days prior to wrapping.
- One prime coat of manufacturer resin should be applied to the surface and should be allowed to become tacky to touch.
- Fabric, usually about 2 to 3 feet wide, should be saturated at the job site with resin (usually epoxy) using the specified fiber-resin ratio.

- Saturated fabric should be wrapped around the column by hand lay-up, using methods that produce a uniform, constant tensile force that is distributed across the entire width of fabric.

Figure A.37 Hand Lay-Up of Saturated Fabric

- Entrapped air, if any, should be rolled out before the resin sets.
- Subsequent layer(s) should be applied continuously (or spliced) until specified number of layers is achieved at a section. Adjacent sections should use a butt joint.
- The system should be protected against water and rainfall for at least 4 days following installation.
- After the system is cured, a protective topcoat is applied to the fiberwrap surface.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site
- Fall safety procedures
- Scaffolding erection procedures
- Vapors of some resins can be irritants to eyes and throat

A.20 Repairing Paved Slope Protection

Description

Repair undermined or eroded paved slope protection with concrete, grout, precast concrete blocks or stone slope paving.

Project Objectives

To protect integrity of bridge substructures by reducing the probability that soils will be erode from beneath and around the abutment.

Labor Skills

Physical labor

Materials

- Gravel
- Geotextile Fabric
- Rip-rap
- Concrete
- Precast Concrete Pavers
- Grout
- Air Compressor
- Chipping hammer
- Concrete saw
- Backhoe
- Plate Tamper
- Dump truck(s)
- Concrete pump
- Core drill
- Various hand tools
- Grout mixer
- Personal-safety equipment

Procedure

- Coordinate with Agency Environmental Unit and obtain any necessary permits from State Environmental Department, and/or US Army Corps of Engineers, and consult with environmental agencies, as required.
- Coordinate with the Agency Geotechnical Engineering and or Hydraulic Engineering staff on a repair procedure.
- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Remove damaged and unstable slope paving.
- Sound existing slope paving to determine if there is any undermining, or voids. Depending on the extent of the voids the choice must be made whether to try to fill the void with the slope protection in place, or remove the slope protection.
- For slope protection with voids that is remaining in place, Drill holes through paving approximately, approximately 3-feet apart.
- Pump concrete or grout through holes, vibrating concrete to consolidate it.

- In areas where slope paving has been removed, the soil beneath should be filled with gravel or crushed stone and compacted
- Place the new slope paving on the compacted stone/gravel taking care to match the grades of the existing slope paving. Form, if the repair is cast in place concrete, place pavers if they are being used.
- Remove forms as required.
- Safety Considerations: Typical work-zone procedures as appropriate for specific site
- Work near water requires additional precautions such as Personal Floatation Devices (PFD's), ring buoys, skiffs, fall protection, etc.

Figure A.38 Paved Abutment Slope Repair. Before repair (left) and After (right). (Courtesy of Georgia DOT)

A.21 Repairing Stone Slope Protection

Description

Repair undermined or eroded stone slope protection with new riprap (stone fill).

Project Objectives

To protect integrity of bridge substructures by reducing the probability that soils erode beneath and around the abutment.

Labor Skills

Physical labor

Materials

- Gravel/crushed stone
- Geotextile Fabric
- Rip-rap
- Grout
- Backhoe
- Hydraulic Excavator
- Plate Tamper
- Dump truck(s)
- Concrete pump
- Core drill
- Various hand tools
- Grout mixer
- Personal-safety equipment

Procedure

- Coordinate with Agency Environmental Unit and obtain any necessary permits from State Environmental Department, and/or US Army Corps of Engineers, and consult with environmental agencies, as required.
- Coordinate with the Agency Geotechnical Engineering and or Hydraulic Engineering staff on a repair procedure.
- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Remove loose debris, soil or vegetation in the area to be repaired.
- Fill any gullies, voids, or erosion holes with compacted gravel/crushed stone.
- If it is the agency practice to use a bedding geotextile, place it over the gravel.
- Place riprap to the lines and grades required to match existing riprap slope protection
- If riprap slope protection is grouted, place grout in voids between pieces of riprap stone.
- Safety Considerations: Typical work-zone procedures as appropriate for specific site
- Work near water requires additional precautions such as Personal Floatation Devices (PFD's), ring buoys, skiffs, fall protection, etc.

Figure A.39 Stone Abutment Slope Repair. Before Repair (left) and After (right). (Courtesy of Georgia DOT)

A.22 Repairing/Replacing Steel Truss Ends

Description

Repair or replace deteriorated or damaged steel at ends of truss.

Project Objectives

To re-establish structural load-carrying capacity of steel truss.

Labor Skills

- Steel fabrication
- Welding
- Iron work
- Painting

Materials

- Steel
- Blasting sand
- High-strength bolts
- Welding rod
- Paint

Equipment

- 175-CFM air compressor with hoses, etc.
- Magnetic drill
- Welder
- Paint rollers and brushes
- Scrapers and stiff brushes
- Vacuum paint-removal tools, grinder
- Electrical generator
- Sandblaster
- Oxy-acetylene torch/propane torches
- Shroud
- Cut off saw
- Various hand tools
- Personal-safety equipment

Procedure

- Develop repair plan.
- CONSULT A LICENSED PROFESSIONAL ENGINEER.
- Prepare work-zone (i.e., traffic control, environmental protection, equipment).
- Provide temporary support for affected members, as necessary.
- Carefully remove any damaged or deteriorated members that are to be replaced in a manner that will not damage any adjacent members to be retained or repaired. Removal may require flame cutting, drilling, or sawing.
- Prepare steel area to be repaired by removing paint, rust, dirt, etc.
- Remove paint using vacuum-shrouded power tools.
- Remove rust using vacuum-shrouded tools, wire brushes, scrapers.
- Remove loose dirt and grime with compressed air or high-pressure water.

- Replace or repair pins, gusset plates, eye-bars, tension members, compression members, as called for in the repair plan.

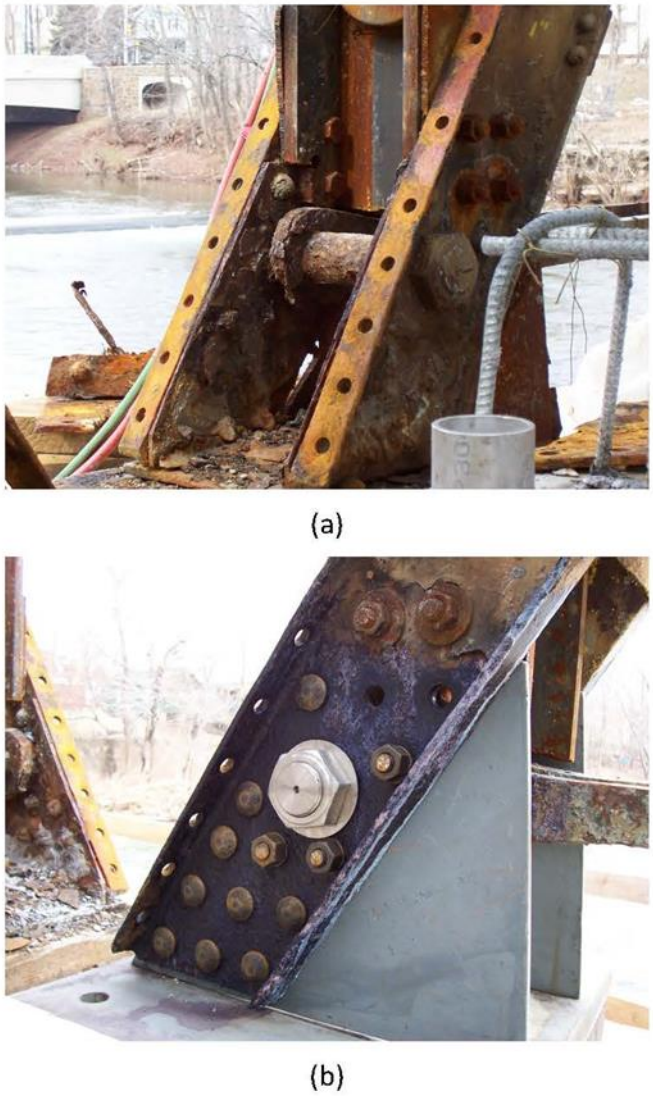

Figure A.40 Example of Truss End Repair (a) Before and (b) After

- CAUTION: only certified welders should weld structural steel members.
- Conduct any necessary non-destructive testing.
- Prime and spot-paint treated area.

Safety Considerations

- Typical work-zone procedures as appropriate for specific site.
- Truss End Repairs will require an engineer to develop a repair plan as well as a plan to support the truss during repairs.
- DO NOT attempt steel repairs without proper knowledge and qualifications.
- Consider environmental and worker-safety issues (i.e., lead exposure).