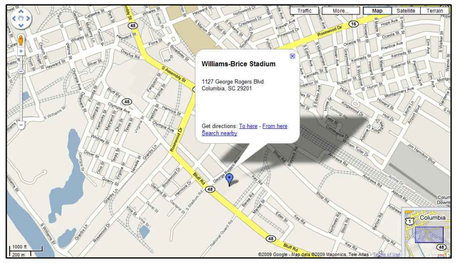
WILLIAMS BRICE STADIUM

Structural Repairs

CP00394073-FM00458985

University of South Carolina



VICINITY PLAN
NOT TO SCALE

ABBREVIATIONS

A.C.T.	ACOUSTICAL CEILING TILE
ALUM.	ALUMINUM
BD	BOARD
BLKG	BLOCKING
C.J.	CONTROL JOINT
C.T.	CERAMIC TILE
CMU	CONCRETE MASONRY UNIT
CONC.	CONCRETE
CONT.	CONTINUOUS
CPT	CARPET
CR	CLASSROOM
DTL.	DETAIL
E.J.	EXPANSION JOINT
ELEC.	ELECTRICAL
EQ	EQUAL
EXIST/EXG	EXISTING
EXP	EXPANSION
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FF	FINISH FLOOR
FLR	FLOOR
FTG	FOOTING
GALV	GALVANIZED
GC	GENERAL CONTRACTOR
GR	GUARDRAIL
GWB	GYPSUM WALL BOARD
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HR	HANDRAIL
I.D.	INSIDE DIAMETER
INSUL	INSULATION
MECH	MECHANICAL
MFR	MANUFACTURER
MB	MARKER BOARD
M.O.	MASONRY OPENING
N.I.C.	NOT IN CONTRACT
O.C.	ON CENTER
O.D.	OUTSIDE DIAMETER
OPNG	OPENING
P.B.	PROMETHEAN BOARD
PL	PLATE
PLUMB	PLUMBING
PR	PAIR
PT	PRESSURE TREATED
REINF	REINFORCED
REQ'D	REQUIRED
SCHED	SCHEDULE
SHT.	SHEET
SIM.	SIMILAR
SS	STAINLESS STEEL
STL.	STEEL
STOR.	STORAGE
TB	TACKBOARD
TEMP	TEMPERED
PT	PRESSURE TREATED
TYP.	TYPICAL
VCT	VINYL COMPOSITION TILE
VERT	VERTICAL
WD	WOOD

NOTE: FOR ABBREVIATIONS NOT NOTED ABOVE CONTACT ARCHITECT.

PROJECT CONTACTS

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INDEX OF DRAWINGS

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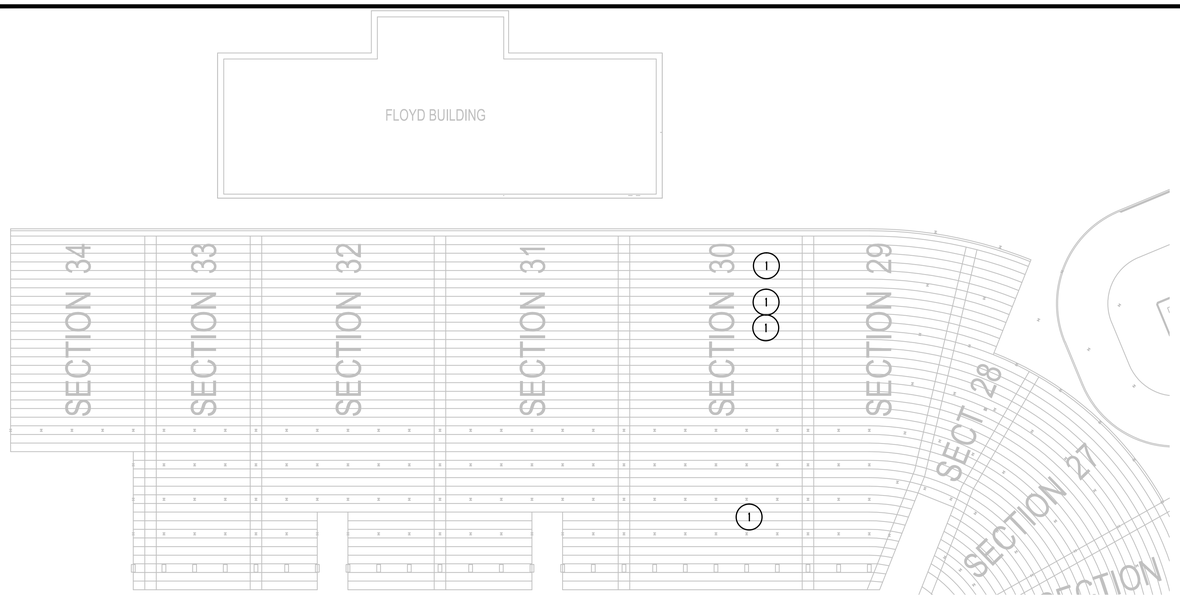
WILLIAMS BRICE STADIUM - STRUCTURAL REPAIRS - SUMMER 2014
UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, SOUTH CAROLINA

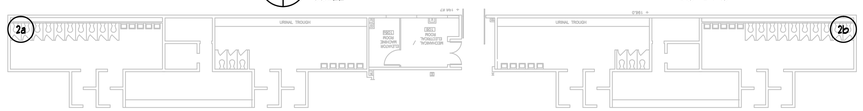
REVISIONS:

DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014
SHEET TITLE: TITLE, INDEX & ABBREVIATIONS
SHEET NO: T101



1/201/201 PARTIAL PLAN VIEW - NORTH STANDS

SCALE 1/16" = 1'-0"



1/201/201 PARTIAL PLAN VIEW - NORTH STANDS-GROUND

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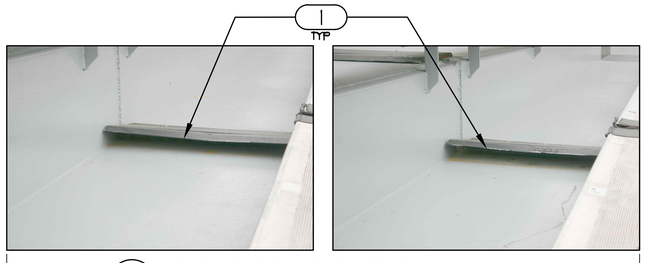
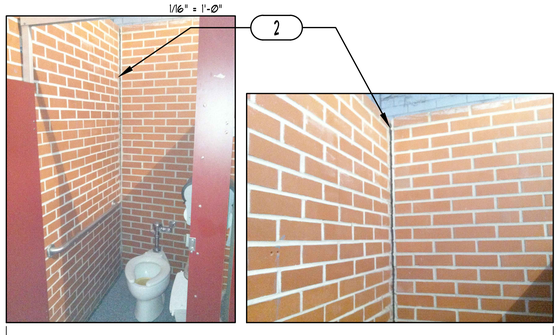
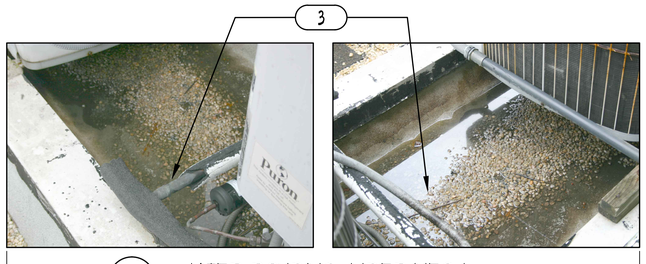


1 EXP. JT. CONDITION (TYPICAL) @ SEC. 30 - ROWS 9, 31, 33, 35, & 37

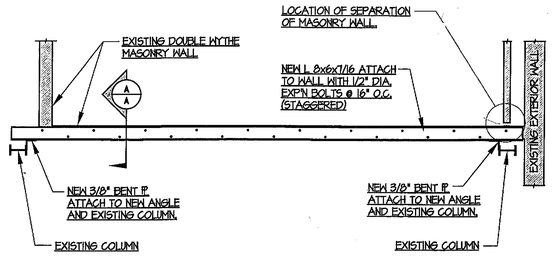


2a MASONRY WALL SEPARATING AT CORNER OF GROUND LEVEL WOMEN'S RESTROOM #4

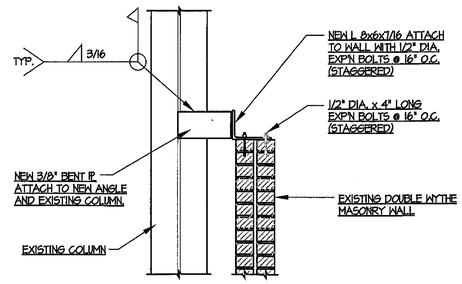
2b MASONRY WALL SEPARATING AT CORNER OF GROUND LEVEL WOMEN'S RESTROOM #4



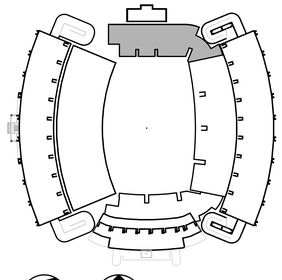
3 WATER PONDING UNDER MECH. UNITS ON ROOF OF FLOYD BLDG.



PLAN VIEW OF MASONRY WALL



DETAIL A/A



TRUE NORTH PROJECT NORTH KEY PLAN

LEGEND:

(x) OR (x) ▶ PHOTO REFERENCE, THIS SHEET.

NOTE: PHOTOS MAY BE OUT OF SEQUENCE, BUT ARE NUMBERED TO MATCH OWNER'S STRUCTURAL REPORT.

GENERAL NOTES:

1. THIS WORK CONSISTS OF A VARIETY OF STRUCTURAL RELATED REPAIR WORK THROUGHOUT THE STADIUM AS DOCUMENTED IN THE OWNER'S "STRUCTURAL INSPECTION FOR WILLIAMS BRICE STADIUM", DATED MARCH 2014.
2. THE CONTRACTOR IS TO VISIT THE SITE AND FAMILIARIZE HIMSELF WITH THE COMPLETE WORK SCOPE AND ALL RELATED CONDITIONS PRIOR TO BID. ANY QUESTIONS OR DISCREPANCIES WITH THE INFORMATION SHOWN HEREIN MUST BE DIRECTED TO THE ARCHITECT PRIOR TO BID.
3. THE WORK IS TO BE PERFORMED BY AN EXPERIENCED CONCRETE RESTORATION CONTRACTOR TO REPAIR CRACKED AND BROKEN CONCRETE SLABS, BEAMS AND PRECAST MEMBERS TO PREVENT FUTURE PROBLEMS FROM WATER SEE PAGE, FREEZING, CONCRETE SEPARATION, EXPANSION JOINT PROBLEMS AND RUSTING OF REINFORCEMENT EMBEDDED ANCHORS AND OTHER FASTENERS.
4. THE CONTRACTOR WILL HAVE ACCESS TO THE STADIUM MONDAY THROUGH FRIDAY AND TIME ON WEEKENDS ONLY IF APPROVED BY THE OWNER 7 DAYS IN ADVANCE OF SUCH WEEKEND. ALL WORK MUST BE COMPLETED BY FRIDAY, AUGUST 22, 2014. THE CONTRACTOR IS TO STRATEGIZE HIS SCHEDULE BASED ON THE SCOPE OF WORK TO MEET THIS DEADLINE.
5. ALL TEMPORARY FACILITIES, WILL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. THE CONTRACTOR IS REQUIRED TO MAINTAIN A CLEAN WORK SITE AT ALL TIMES. THE WORK AREA MUST BE CLEANED UP AT THE END OF EACH DAY MINIMUM. CONTRACTOR SHALL NOT ALLOW TRASH OR DEBRIS TO BECOME WIND BORNE SO AS TO LITTER UP ADJACENT AREAS OF THE STADIUM.
7. SEE SHEET A204 FOR CONCRETE SPALL REPAIR.
8. ALL WORK SCOPE AREAS ARE TO BE CLEANED AND LEFT IN LIKE NEW CONDITION.
9. THE CONTRACTOR IS TO AVOID DAMAGE TO ADJACENT WORK. ANY DAMAGED NEWLY PAINTED SURFACES WILL BE RECOATED AT NO COST TO THE OWNER.
10. PROPER CURING TIME MUST BE PROVIDED AT ALL CONDITIONS REQUIRING PAINTING OR COATING.
11. THE CONTRACTOR IS RESPONSIBLE FOR ALL LIFE SAFETY METHODS & PRACTICES.
12. PAINTING - ALL PAINTING PRODUCTS ARE TO BE BY SHERWIN WILLIAMS IN ORDER TO MATCH EXISTING RECENTLY COATED SYSTEMS. ALL WORK MUST BE IN STRICT ACCORDANCE WITH PAINT MANUFACTURER'S WRITTEN INSTRUCTIONS. ALL COLORS ARE TO MATCH EXISTING. COATING MATERIALS WILL BE PROVIDED BY THE OWNER, HOWEVER, ALL POWER TOOL CLEANING, TREATMENT OF RUST CONDITIONS AS REQUIRED, AND ANY OTHER PREPARATION REQUIRED PER THE PAINT MANUFACTURER'S WRITTEN INSTRUCTIONS, ARE THE RESPONSIBILITY OF THE CONTRACTOR.

KEY NOTES:

(1) PROVIDE SLOT FOR MOVEMENT IN JOINT COVER AT UNANCHORED SIDE AND PROVIDE ADDITIONAL ANCHOR FOR HOLD DOWN. TOP OF NEW ANCHOR TO BE FLUSH WITH TOP OF COVER.

(2) PROVIDE MASONRY WALL STABILIZATION PER STRUCTURAL DETAILS THIS SHEET. REMOVE LOOSE MORTAR, RE-POINT HORIZONTAL JOINTS AT CORNER AND PROVIDE BACKEROD AND NP-1 SEALANT AT VERTICAL CORNER JOINT CONTINUOUS. COLORS TO MATCH EXISTING BRICK MORTAR. PRIME AND PAINT ALL NEW STEEL ALONG WITH TOUCH UP AT EXISTING COLUMNS PER KEYNOTE #1 ON SHEET A205.

(3) AT BOTH SETS OF MECHANICAL CURBS, REMOVE GRAVEL ALONG LOW END CURBS TO ALLOW FOR PROPER WATER DRAINAGE TOWARD EXISTING ROOF DRAINS AT EACH END OF CURBS. REPLACE ALL EXPIRED CONDENSATE PIPING INSULATION AND PROVIDE COATING/SEALER AT NEW INSULATION. THE INSULATION FOR THE TUBING SHALL BE 1" THICK ARMAFLEX COVERED WITH ALUMINUM JACKET. COORDINATE SCHEDULE WITH OWNER TO ALLOW FOR PROPER ENVIRONMENTAL TESTING PRIOR TO STARTING WORK.

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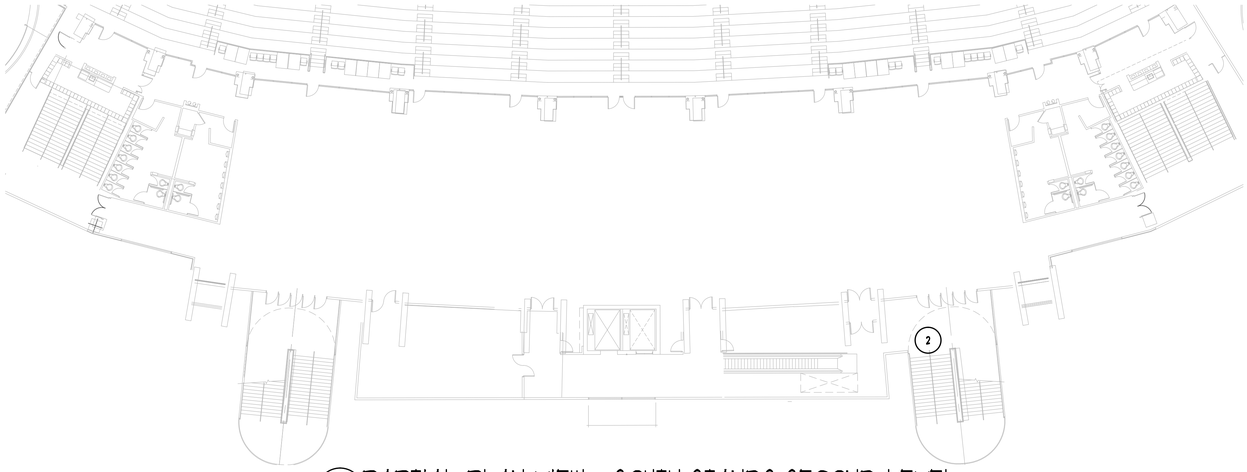
WILLIAMS BRICE STADIUM - STRUCTURAL REPAIRS - SUMMER 2014
UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, SOUTH CAROLINA

REVISIONS:

DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014

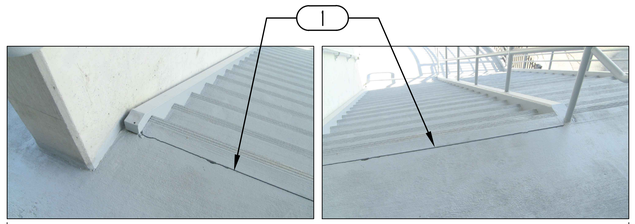
SHEET TITLE: PARTIAL PLAN VIEW- NORTH STANDS AND FLOYD BUILDING

SHEET NO: A201



2 2017/2021 PARTIAL PLAN VIEW - SOUTH STANDS SECOND LEVEL

SCALE 1/16" = 1'-0"



1 SURFACE CRACK AT EXTERIOR STAIR LANDING @ 2ND LEVEL OF CREW'S BLDG

LEGEND:

(X) OR (X) ▶ PHOTO REFERENCE, SHEET.A2Ø3

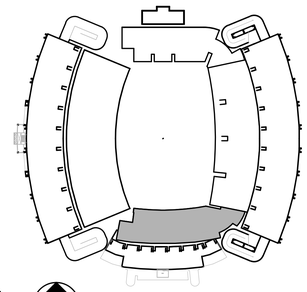
NOTE: PHOTOS MAY BE OUT OF SEQUENCE, BUT ARE NUMBERED TO MATCH OWNER'S STRUCTURAL REPORT.

GENERAL NOTES:

REFER TO SHEET A2Ø1.

KEY NOTES:

1 PROVIDE TRAFFIC RATED JOINT SEALANT CONTINUOUS AT CONCRETE SEPARATION. COLOR TO MATCH ADJACENT SURFACES.



TRUE NORTH PROJECT NORTH KEY PLAN

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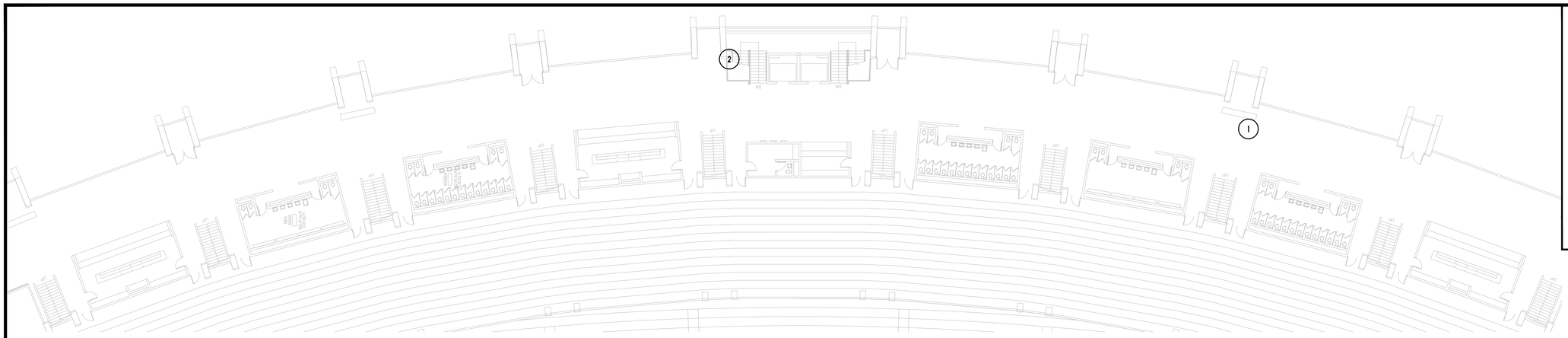
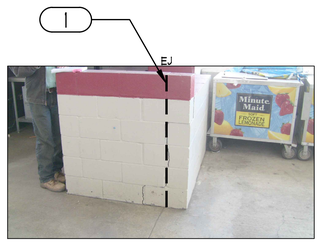
DATE: JULY 2014
SHEET TITLE: PARTIAL PLAN VIEW - SOUTH STANDS SECOND LEVEL
SHEET NO: A202

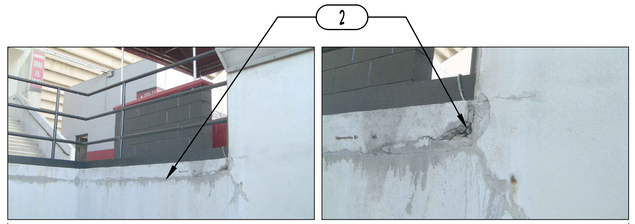


2 204|204 PARTIAL PLAN VIEW - EAST STANDS UPPER CONCOURSE

SCALE 1/16" = 1'-0"



1 CRACKED BLOCKED WALL BETWEEN UPPER CONCOURSE SEC. 404 & 405



2 SPALLING CONCRETE @ UPPER CONCOURSE AROUND STAIRWELL OPENING AT ELEVATOR BETWEEN SEC. 410 & 411

LEGEND:

(x) OR (x) ▶ PHOTO REFERENCE, THIS SHEET.

NOTE: PHOTOS MAY BE OUT OF SEQUENCE, BUT ARE NUMBERED TO MATCH OWNER'S STRUCTURAL REPORT.

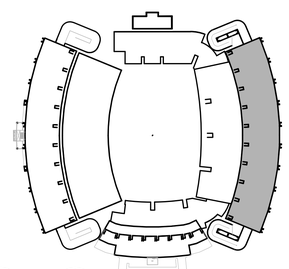
GENERAL NOTES:

REFER TO SHEET A201.

KEY NOTES:

(1) CAREFULLY REMOVE CORNER OF EXISTING MASONRY WALL AND RE-CONSTRUCT LEAVING ¾" EXPANSION JOINT (EJ) AS SHOWN. PROVIDE BACKER ROD & SEALANT AND REPAINT BOTH LEGS OF THE WALL TO MATCH EXISTING.

(2) REMOVE LOOSE CONCRETE AND CLEAN. APPLY RUST INHIBITOR TO EXPOSED STEEL. APPLY CONCRETE REPAIR MORTAR SIKA TOP 123 PLUS AND ARMATEC 110. FINISH TO MATCH ADJACENT SURFACE.



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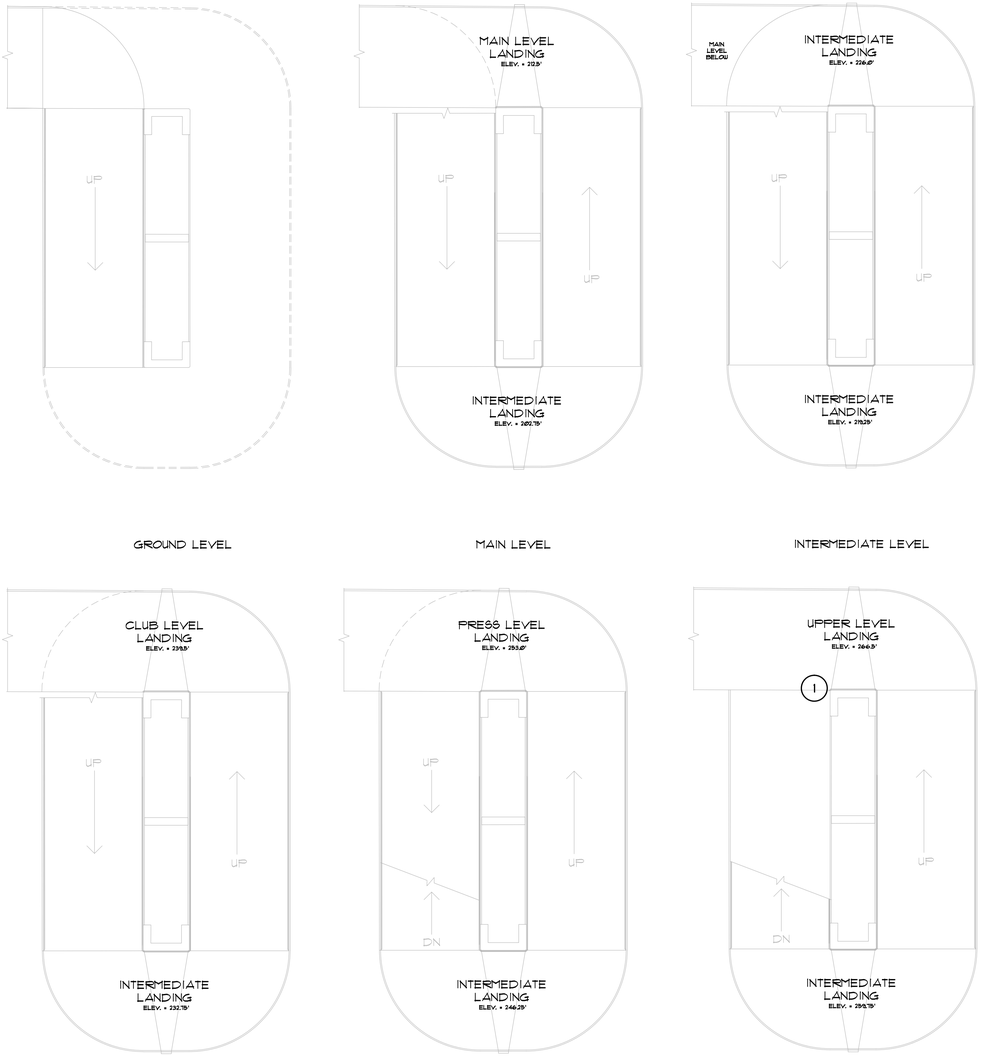
UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, SOUTH CAROLINA

REVISIONS:

DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014

SHEET TITLE: PARTIAL PLAN VIEW - EAST STANDS UPPER CONCOURSE

SHEET NO: A203



1 (20/20) NORTHWEST RAMP PLAN VIEWS

SCALE 1/16" = 1'-0"

1 EXPOSED REBAR IN SPALLING CONCRETE WALL @ UPPER LEVEL LANDING

LEGEND:

(x) OR (x) ▶ PHOTO REFERENCE, THIS SHEET.

NOTE: PHOTOS MAY BE OUT OF SEQUENCE, BUT ARE NUMBERED TO MATCH OWNER'S STRUCTURAL REPORT.

GENERAL NOTES:

REFER TO SHEET A201.

KEY NOTES:

(1) REMOVE LOOSE CONCRETE AND CLEAN. APPLY RUST INHIBITOR TO EXPOSED STEEL. APPLY CONCRETE REPAIR MORTAR SIKA TOP 123 PLUS MORTAR SIKA TOP 123 PLUS AND ARMATEC 110. FINISH TO MATCH ADJACENT SURFACE.

CORROSION RELATED SPALL REPAIRS:

- SOUND SURROUND AREA, SAW CUT, & CLEAN TO DEPTH OF NO LESS THAN ¼". CHIP & CLEAN, CHASE CORROSION UNTIL CLEAN STEEL IS FOUND. STEEL MUST BE EXPOSED A MINIMUM OF FINGER WIDTH ON ALL SIDES. REMOVE ALL CORROSION FROM REINFORCEMENT STEEL OR ANY OTHER FEROUS OBJECT.
- COAT REINFORCEMENT STEEL WITH 2 COATS OF SIKA ARMATEC 110 REINFORCEMENT PRIMER PENETRATING OF MIGRATING INHIBITORS ARE REQUIRED.

PATCH MATERIALS

VERTICAL OR OVERHEAD SHALLOW SPAL REPAIRS	SIKATOP 123 PLUS
FORMED & POURED DEEP SPAL REPAIR	SIKACRETE 211
FORMED & POURED SHALLOW SPAL REPAIRS	SIKATOP 111 PLUS
HORIZONTAL SHALLOW SPAL REPAIRS	SIKATOP 122 PLUS

- IN AREA WITHOUT STEEL, EXISTING CONCRETE SUBSTRATES ARE TO BE CLEANED & PRE-SOAKED TO PROVIDE A THOROUGHLY SATURATED DRY CONDITION WITH NO STANDING WATER.
- APPLY SCRUB COAT OF REPAIR MATERIAL. NEVER ALLOW TO DRY OUT PRIOR TO PLACING REPAIR MATERIAL. IMMEDIATELY APPLY REPAIR MATERIAL WHEN SCRUB COAT IS STILL WET.
- AFTER FINISHING IS COMPLETE, WET CURE & COVER USING POLYETHYLENE & BURLAP FOR A PERIOD OF 48 HOURS MINIMUM AFTERWARDS.

THE ABOVE PROCEDURES ARE LISTED AS A GUIDE ONLY. THE CONTRACTOR IS TO PERFORM ALL REPAIR WORK IN STRICT ACCORDANCE WITH THE PRODUCT MANUFACTURER'S WRITTEN INSTRUCTIONS AND IN ACCORDANCE WITH ACI REPAIR APPLICATION PROCEDURES. ACI RAP BULLETINS ARE PROVIDED AT THE END OF THESE DRAWINGS FOR ADDITIONAL INFORMATION.

ALL REPAIR PRODUCTS ARE TO BE OBTAINED FROM A SINGLE SOURCE MANUFACTURER. MANUFACTURER MUST BE ISO9001 CERTIFIED. THE PRODUCTS LISTED ARE BY SIKA CORPORATION EQUAL PRODUCTS BY BASF & EUCLID ARE ACCEPTABLE WHEN APPROVED BY ARCHITECT PRIOR BID.

THE CONTRACTOR IS TO PROVIDE A FORMAL SUBMITTAL OF PRODUCT DATA PER TYPE OF APPLICATION WITH IN SEVEN DAYS OF ISSUANCE OF NOTICE TO PROCEED FROM OWNER. CONTRACTOR'S SUBMITTAL MUST ALSO INCLUDE, UPON REQUEST, DOCUMENTATION DEMONSTRATING RESTORATION CONTRACTOR'S REQUIRED 10 YEARS OF EXPERIENCE AND LISTING OF LIKE PROJECTS.

THE CONCRETE REPAIR/RESTORATION CONTRACTOR MUST HAVE A MINIMUM OF TEN YEARS EXPERIENCE ON LIKE PROJECTS & CONCRETE RESTORATION WORK.

THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING & PROVIDING PERIODIC INSPECTIONS (1/WEEK MINIMUM) BY THE CONCRETE REPAIR PRODUCT MANUFACTURER AND PROVIDE WEEKLY REPORTS TO THE ARCHITECT.

JOINT SEALANTS

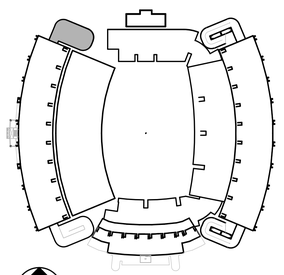
SIKA FLEX 1a
SIKA FLEX 2c NS
(PRIMERS AND BOND BREAKERS AS REQUIRED)
CLOSED CELL BACKER ROD AS APPROVED BY JOINT SEALANT MANUFACTURER.

EXPANSION JOINTS:

VERTICAL WALL JOINTS - WABO SEISMIC WEATHER SEAL MODEL "SWS" BY WATSON BOWMAN ACME CORP. COLOR SELECTED BY ARCHITECT. SUBMIT SAMPLES FOR COLOR SELECTION.

FLOOR JOINT COVERS AT METAL TREADS - WABO SAFETY FLEX JOINT COVER, 12" WIDE BY WATSON BOWMAN ACME CORP. BLACK.

EQUAL PRODUCTS BY MM SYSTEMS AND BALCO, INC. ARE ACCEPTABLE. CONTRACTOR IS TO INCLUDE ALL COMPONENTS FOR A COMPLETE AND WATER TIGHT SYSTEM.



TRUE NORTH PROJECT NORTH

KEY PLAN

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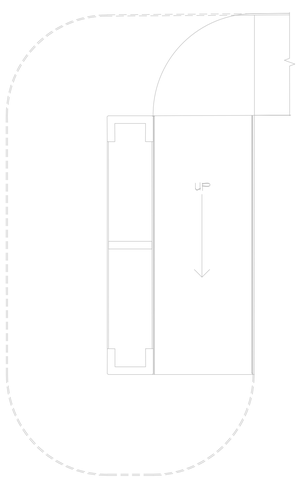
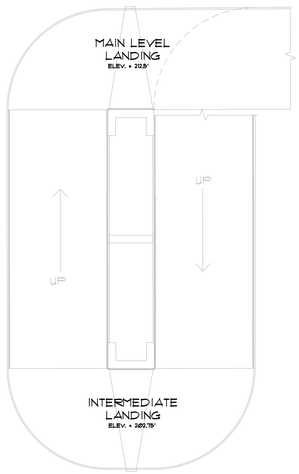
REVISIONS:

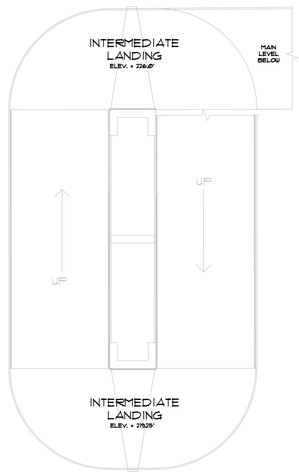
DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014
SHEET TITLE: NORTHWEST RAMP PLAN VIEWS
SHEET NO: A204



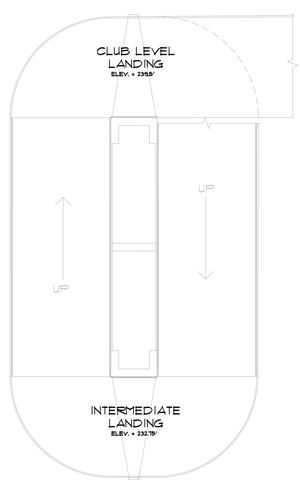
GROUND LEVEL



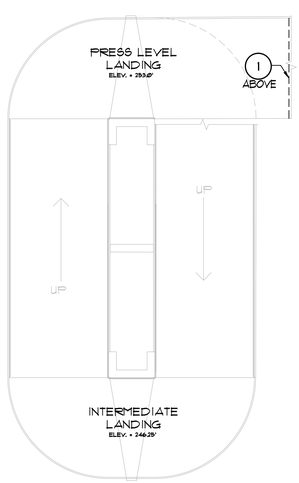
MAIN LEVEL



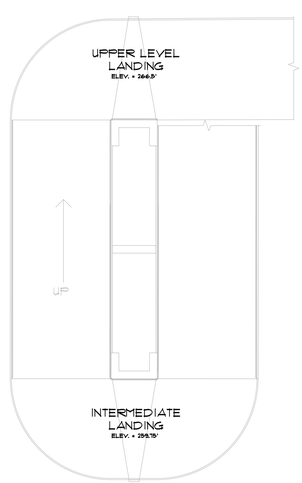
INTERMEDIATE LEVEL



CLUB LEVEL



PRESS LEVEL



UPPER LEVEL

LEGEND:

(X) OR (X) ▶ PHOTO REFERENCE, THIS SHEET.

NOTE: PHOTOS MAY BE OUT OF SEQUENCE, BUT ARE NUMBERED TO MATCH OWNER'S STRUCTURAL REPORT.

GENERAL NOTES:

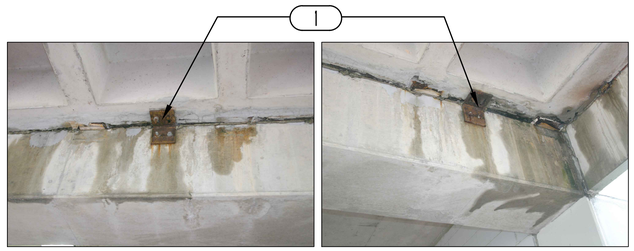
REFER TO SHEET A2Ø1.

KEY NOTES:

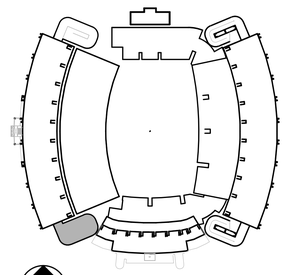
(1) POWER TOOL CLEAN TO REMOVE ALL CORROSION. APPLY RUST INHIBITING PRE-PRIMER MACROPOXY 920(B58T00Ø1Ø1). FOLLOW WITH MACROPOXY 646 FAST CURE EPOXY (B58W00610). APPLY TOP COAT OF ACROLON 218HS POLYURETHANE-GLOSS. (TYPICAL FOR 4 ANGLE CONNECTIONS.

1/2 A2Ø1 SOUTHWEST RAMP PLAN VIEWS

SCALE 1/16" = 1'-Ø"



(1) CORRODED ANGLES AT SOUTH WEST RAMP CONNECTION TO WEST STANDS - EXECUTIVE LEVEL



KEY PLAN

TRUE NORTH PROJECT NORTH

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Carter
Sease
Architects
PA
412 Meeting Street
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South Carolina

STATE OF SOUTH CAROLINA
JUMPER CARTER SEASE ARCHITECTS, PA WEST COLUMBIA
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WILLIAMS BRICE STADIUM - STRUCTURAL REPAIRS - SUMMER 2014
UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, SOUTH CAROLINA

REVISIONS:

DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014
SHEET TITLE: SOUTHWEST RAMP PLAN VIEWS
SHEET NO: A205

ACI RAP Bulletin 4

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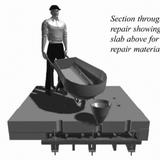
FIELD GUIDE TO CONCRETE REPAIR APPLICATION PROCEDURES

Surface Repair Using Form-and-Pour Techniques

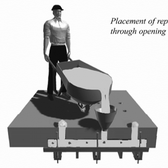
What are the safety considerations?

Job site safety practices include, but are not limited to, the following where applicable:

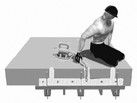
- Material Safety Data Sheets (MSDS) available;
- Protective clothing worn by workers handling or exposed to hazardous materials;
- Use of protective eyewear during pumping and placement of repair materials;
- Availability of eye wash facilities; and
- Use of respirators and ear protection during demolition.



Section through overhead repair showing opening in slab above for placement of repair material.



Placement of repair material through opening in slab.



Pencil vibrator is used to consolidate repair material in cavity.

Fig. 3—Material placement: horizontal application.

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Repair material is brought to the repair site via concrete buggy or other suitable means. Five-gallon buckets make useful tools to deposit repair material into form.

After the repair material is placed into cavity, vibrators are inserted into placement and consolidated. It is recommended that consolidation be done in lifts of no more than 2 to 3 ft (0.7 to 1 m).

Curing compound is immediately rolled or sprayed onto repaired surfaces after formwork is removed. Proper curing will help ensure repair material does not have premature drying and cracking, and the material develops its full strength.

Fig. 4—Material placement: vertical application.

ACI RAP Bulletin 4

Field Guide to Concrete Repair Application Procedures

Surface Repair Using Form-and-Pour Techniques

Reported by ACI Committee E706

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Introduction

The form-and-pour placement technique is a multistep process of preparation, formwork construction, and placement of repair materials. Repair materials are placed in the cavity between the formwork and the prepared substrate with buckets, pumps, chutes, or buggies. The form-and-pour technique allows the use of many different castable repair materials. Placeability is the primary consideration material selection. Depending on the consistency of the repair material, consolidation is accomplished by vibration, rodding, or when the material has extremely high slump (self consolidating), no additional steps may be required.

What is the purpose of this repair?

The primary purpose of this type of repair is to restore the structural integrity, or concrete cover requirements, or both, for the damaged element.

When do I use this technique?

This technique is commonly used on vertical surfaces such as walls, columns, and other combinations such as beam sides and bottoms. When used to repair slab soffits, the repair material is typically placed through holes or openings cut through the slab. Adhesive bonding agents or grouts are not commonly used with this technique. A trial installation is highly recommended for each project, to verify the preparation, material, and placement technique using quality-control procedures outlined at the end of this document.

The form-and-pour technique offers many advantages:

- Many different types of repair materials can be used;
- Repair material can be placed around reinforcing steel; and
- Formwork protects against early-age drying that promotes cracking.

The primary limitation of the form-and-pour technique is that formwork installation makes it more labor-intensive than alternative placement methods such as shotcrete or hand application (see Fig. 1).

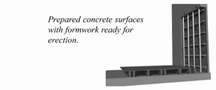
How do I prepare the surface? (Fig. 2)

Regardless of the repair method, surface preparation is essentially the same. Concrete is removed until sound concrete is located. Exposed bars are undercut, and surfaces are cleaned with high-pressure water, or are abrasively blasted. With form-and-pour techniques, it is important to understand how the existing surfaces will permit the repair material to penetrate and flow. On partial-depth vertical repairs, the upper edges of vertical surfaces should be trimmed to eliminate potential pockets of entrapped air and promote complete filling from the location of the chute. Refer to page 5 for step-by-step preparation procedures.

Step 1—Sound the concrete to locate areas of delamination.

Step 2—Remove unsound concrete with a 15-lb chipping hammer. Hammers larger than a 15-lb class may cause damage to the substrate and reinforcement.

Step 3—Mark the perimeter of the repair area. Layout should be simple square or rectangular shapes.



Prepared concrete surfaces with formwork ready for erection.

Fig. 1(a).

Section view through repair showing formwork and chute at top for placement of repair material.

Fig. 1(b).

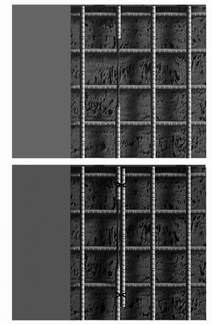


Fig. 2—Lipping of supplemental reinforcement.

Step 4—Sawcut the perimeter of the repair. Note: sawcut should not be deeper than the cover over reinforcement.

Step 5—Repair reinforcement as necessary. When reinforcing steel is heavily corroded and the diameter is reduced, consult a structural engineer for repair procedures. For many applications, supplemental reinforcement can be lapped to adjacent damaged bars, as shown (see Fig. 2).

Step 6—Clean reinforcing steel and concrete with abrasive blasting.

How do I select the proper repair material?

Constructibility requirements for repair materials used with the form-and-pour technique are limited only by their ability to be transported to the formwork cavity. Maximum aggregate size should not exceed 25% of the space between the formwork and the substrate, or 50% of the distance between the reinforcing steel and the substrate—whichever is smaller. In general, the largest practical maximum size aggregate should be used to minimize drying-shrinkage and reduce the potential for cracking of the repair. Mixtures with high flowability (high slump) will make the placement easier; however, do not sacrifice a low water-cement ratio (≤0.40) for high slump. Use high-range water-reducing admixtures as necessary. Prepackaged repair materials, which are designed for high-flow placement, include shrinkage-compensating additives, and are appropriate for many applications. All mixture proportions should be optimized to minimize drying shrinkage. Shrinkage testing in accordance with ASTM C 157 measured over a 120-day period is recommended.

What equipment do I need?

Placement equipment may include either concrete buggies, buckets, or concrete pumps. Concrete pumps should be sized for the type of repair material being placed. If the repair is mixed on site, a portable mixer is required. Check with the manufacturer of the product to determine the recommended type of mixer.

STEP 1

Sounding of concrete to locate areas of delamination.

STEP 2

Unsound concrete removed with 15-lb chipping hammer. Hammers larger than a 15-lb class may cause damage to substrate and reinforcement.

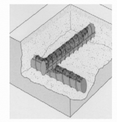
STEP 3

Mark perimeter of repair area. Layout should be simple geometric shapes.

STEP 4

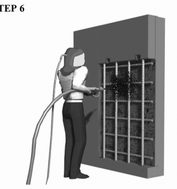
Sawcutting perimeter of repair Note: sawcut should not be deeper than cover over reinforcement. Remove sound concrete within sawcut area.

***STEP 5:** Reinforcement repair. When reinforcing steel is heavily corroded and the diameter is reduced, consult a structural engineer for repair procedures. For many applications supplemental reinforcement can be lapped to adjacent damaged bars, as shown.*



***Important Note:** If corroded reinforcing bars are encountered in the preparation process, then concrete surrounding the bars must be removed to fully expose the full circumference. Clearance under the bar should not be less than 3/4 in. (19 mm), or 1/4 in. (6 mm) greater than the largest aggregate size of the repair mixture, whichever is greater.*

STEP 6



Cleaning of reinforcing steel and concrete with abrasive blast.

Types of Tensile Breaks

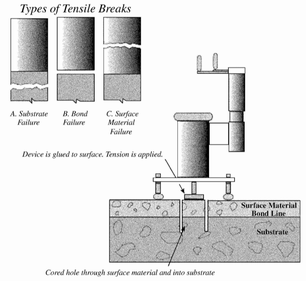


Fig. 5—Test procedure.

Preconstruction meeting

Prior to proceeding with the repair, a preconstruction meeting is recommended. The meeting should include representatives from all participating parties (owner, engineer, contractor, materials manufacturer, etc.), and specifically address the parameters, means, methods, and materials necessary to achieve the repair objectives.

Repair procedure

Formwork construction—Formwork must accommodate the mass and pressure of the repair material. Design of the forms should follow standard practice for cast-in-place concrete construction. Formwork is best attached directly to the concrete surface with expansion anchors or rock anchors designed for coil rod. In cases of repair of slab soffits (underside), scaffold frames or shoring posts can be used to support the formwork tight against the concrete surfaces. When expansion/rock anchors are used, ensure anchors are firmly set in place to prevent slippage under load. Preloading of rock anchors with coil rod can be accomplished with a center-hole jack applying loads to the coil rod with a stand-off. Forms should be constructed to fit tightly against existing surfaces. Preformed gaskets or cast-in-place foam work well on difficult-to-match surfaces. Placement openings or chutes are required to place the repair material behind vertical forms. Chutes should be constructed to permit development of a hydraulic head above the prepared upper edges of the concrete surface. This will provide for repair material supply into these upper horizontal zones after concrete is consolidated. For large, vertical surfaces exceeding 10 ft (3 m) in height, multiple lifts should be considered to reduce free-fall segregation and excessive formwork pressures. Formwork for overhead surfaces does not require openings for placement of repair materials. Generally, placement occurs through openings in the slab from above.

Material placement—Prior to placement of the repair material, moisture conditioning of the prepared surface should provide for saturated-surface dry conditions. It is important not to overwet the surface. Saturated surfaces will prevent proper bonding because the surface pores are clogged with water, unable to absorb the repair material. Mixed repair material is brought to the formed area via whatever transport technique is appropriate for the situation. This may include buckets, pumpline, buggies, or wheelbarrows. For vertical surfaces, material is placed into the chute or opening. External or internal vibration is a must for almost all mixture consistencies. Some self-leveling repair materials, also known as self-consolidating, can be placed without vibration. When the cavity is filled, extra care should be taken to ensure that the uppermost surfaces are filled adjacent to the chute or opening where placement occurs. Rodding or tamping can ensure proper filling. Formwork should be left in place for the prescribed curing period. After stripping of formwork, any spaces not filled should be trimmed, cleaned, and dry-packed. Placement of a membrane curing compound is recommended immediately after removal of formwork.

How do I check the repairs?

After stripping of forms, various tests can be performed to confirm that the repair material was thoroughly consolidated and that adequate bond to the substrate was achieved. A uniaxial bond test can be performed by drilling through the repair into the substrate. A bonded plate attached to the core is pulled until rupture occurs. The location of the failure should be reviewed. Bond values typically exceed 100 psi (0.7 MPa) and, in most cases, exceed 150 psi (1 MPa). These tests are performed in accordance with ACI 503R Appendix (see Fig. 5).

The complete repair area should also be hammer-sounded to locate voids and delaminations within the top 6 in. (150 mm). Any hollow sounds may indicate poor bond or voids.

Sources for additional information

1. "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion," No. 03730, International Concrete Repair Institute, 1995, 5 pp.

2. "Guide for Selecting and Specifying Concrete Repair Materials," No. 03733, International Concrete Repair Institute, 1996, 34 pp.

3. ACI Committee 347, "Guide to Formwork for Concrete (ACI 347-01)," American Concrete Institute, Farmington Hills, Mich., 2001, 32 pp.

4. ACI Committee 546, "Concrete Repair Guide (ACI 546R-96)," American Concrete Institute, Farmington Hills, Mich., 1996, 41 pp.

5. ACI Committee 503, "Use of Epoxy Compounds with Concrete (503R-93)," American Concrete Institute, Farmington Hills, Mich., 1998, 28 pp.

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REVISIONS:

DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014

SHEET TITLE:
ACI RAP BULLETIN 4 SURFACE REPAIR USING FORM AND POUR TECHNIQUES

SHEET NO:
A206

ACI RAP Bulletin 6

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FIELD GUIDE TO CONCRETE REPAIR APPLICATION PROCEDURES

Vertical and Overhead Spall Repair by Hand Application

ACI RAP Bulletin 6
(Reapproved 2010)

Field Guide to Concrete Repair Application Procedures

Vertical and Overhead Spall Repair by Hand Application

Reported by ACI Committee E706

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Introduction

One of the most common application methods for repairing concrete is by hand troweling mortars. This method can be used to repair spalled or deteriorated concrete (Fig. 1) or to resurface vertical, overhead, and horizontal concrete surfaces. Applying repair materials by hand does not require significant equipment and is ideal for shallow surface repairs, especially in areas with limited or difficult access. While both portland cement-based and resin-based repair mortars have been used for trowel-applied vertical and overhead repairs, this field guide focuses on the application of portland cement-based repair materials.

Before any concrete repair is initiated, the root cause of the damage should be determined with a thorough condition survey of the structure. Typical causes of concrete damage can include corrosion of embedded metals from exposure to chloride ions from deicing salts or sea spray in coastal areas; disintegration from freezing-and-thawing cycles when the concrete is saturated with water; or deterioration from chemical attack. Understanding the cause of the deterioration, the owner's repair objectives, and the in-service environment of the concrete structure will help in the proper selection of repair materials and application methods.

The technique of hand troweling repair mortars requires the selection of a sag-resistant mortar and attention to detail during application to achieve an adequately consolidated repair that is well-bonded to the concrete substrate. The successful installation is a function of good surface preparation, application techniques, curing procedures, and properties of the repair material selected.

What is the purpose of this repair?

Hand-applied repair mortars replace damaged concrete and are generally recommended for thin repairs that are cosmetic in nature. Thin overlays of mortar can also be applied to renovate deteriorated vertical and overhead concrete surfaces. This technique, when properly executed, improves the appearance of the deteriorated structure and provides additional protection to the concrete surface.

When do I use this method?

Structural repair projects generally require other repair methods such as form and cast-in-place, grouted pre-placed aggregate repair, or shotcrete. Experienced workers using wood floats, sponges, or steel trowels can achieve a variety of finishes with trowel-applied mortars. Hand application has been used to repair vertical and overhead surfaces including walls, columns, beams, soffits, and building facades.

Placement thickness can vary depending on the type of materials selected and the size, depth, and orientation of the repair cavity. Placement thickness can range from 1/8 to 2-3/4 in. (3 to 70 mm) on vertical surfaces, and 1/8 to 1 in. (3 to 25 mm) on overhead surfaces in a single layer. Deeper placements may require repair material to be placed in additional layers.

How do I prepare the surface?

The recommended steps in properly preparing the surface to receive a hand-applied mortar are as follows:

Fig. 1—Concrete delamination.

Fig. 2—Bulk concrete removal.

1. *Bulk concrete removal and edge conditioning*— Loose, delaminated concrete should be removed until the substrate consists of sound concrete (Fig. 2). Where corrosion of the reinforcement exists, continue bulk removal along the reinforcing steel and adjacent areas with evidence of corrosion-induced damage that would inhibit bonding of repair materials. Bulk concrete removal should include undercutting the corroded reinforcing steel by approximately 3/4 in. (19 mm). The shape of the prepared cavity should be kept as simple as possible–generally square or rectangular in shape. The edges of the patches should be sawcut perpendicular to the surface to a depth of 1/2 in. (13 mm) to avoid feather edging the repair material (Fig. 3).

2. *Final surface cleaning*— Use abrasive blasting (Fig. 4) to remove residual dust, debris, fractured concrete, and contaminants that prevent proper bonding. If abrasive blasting is not feasible, pressure washing using a minimum 3000 psi (250 MPa) may be acceptable depending on the bond strength required. Blowing with oil-free compressed air or alternately, the use of a vacuum, may be appropriate if dust is still present after the blasting. The final surface texture should be rough, with approximately a 1/4 in. (6 mm) amplitude (Fig. 5) (Concrete

Fig. 3—Edge conditioning.

Fig. 4—Final surface cleaning.

Fig. 5—Properly prepared surface.

Surface Profile [CSP] No. 6 to 9 per ICRI Technical Guideline No. 310.1R-2008);

3. *Treatment of exposed reinforcement*—Bond-inhibiting corrosion should be removed from the reinforcing steel by an abrasive blasting wire wheel or needle scaler. If the cross-sectional area of the reinforcing steel has been significantly reduced, a structural engineer should be consulted. If a reinforcing steel coating has been specified, apply the coating after the reinforcing steel has been cleaned (Fig. 6).

4. *Substrate saturation*—Most portland cement-based materials require the base concrete to be in a saturated, surface dry (SSD) condition prior to application to prevent a rapid loss of moisture from the repair material and into the substrate. An SSD condition is achieved when the body of the concrete is saturated and free surface water and puddles have been removed from the surface of the concrete. An SSD surface is not recommended if a polymer bonding agent is to be used. When using polymer bonding agents, follow the manufacturer's recommended surface preparation requirements. The general recommendations previously given may be influenced by several factors, including:

- Desired roughness profile of the prepared surface (This may be specified by the manufacturer of the repair product);
- Method of surface preparation, including chipping hammers, abrasive blasting, high-pressure water-blasting, or hydrodemolition;
- Possible contamination of the surface by chemicals, oils, or grease; possible carbonation; and methods of removing contaminants or carbonated concrete;
- Repair material manufacturer's recommendations (Ask for technical data sheets and installation bulletins and read the printed instructions on the packaging.); and
- Treatment of existing cracks and joints.

For additional information, consult the recommendations of the International Concrete Repair Institute (ICRI) Guidelines No. 310.2-1997, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Overlays," or No. 310.1R-2008, "Guide for Surface Preparation for Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion."

How do I select the right material?

Hand- or trowel-applied repair materials are generally proprietary, prepackaged, cementitious products. Portland cement-based materials designed for hand application may also include polymers, silica fume, shrinkage-compensating materials, and other additives for enhanced physical properties and improved handling.

Specifiers, applicators, and owners can consult ACI 546.3R-06, "Guide for the Selection of Materials for the Repair of Concrete," or ICRI Guideline No. 320.2R-2009, "Selecting and Specifying Materials for Repair of Concrete Surfaces," for a useful checklist for prioritizing desired material properties. Manufacturers' technical data sheets should be consulted for material properties.

The physical property requirements such as drying shrinkage, permeability, freezing-and-thawing resistance, and mechanical properties vary from project to project depending on the expected service conditions. The properties critical to the long-term success of the repair should be determined during the evaluation phase and be specified.

Fig. 6—Treatment of exposed reinforcement.

Other factors that may influence the selection of repair materials include desired application thickness, rate of strength gain, ease of application, color, and in-place cost.

For some hand-applied repairs, sealers or decorative or protective coatings may be used to provide additional protection to the base concrete, to enhance aesthetics, or both. When this is the case, confirm the required curing and drying time (or maximum moisture content) with the sealer or coating manufacturer before application commences. For more information, consult ACI 515.1R, "Guide to Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete."

What equipment do I need?

Typical equipment needed for hand-applied repair mortars includes:

- A suitable mixer unit such as a drill/paddle/pail combination for small repairs (Fig. 7), or paddle-type mortar mixers for larger applications;
- Air compressor, sawcutting equipment, blades, abrasive blast equipment;
- Water-measuring device to ensure that proper amounts of mixing water are used; and
- Finishing, handling, and testing tools required by the specification or good concreting practices.

Be sure that necessary equipment and tools are on site and in proper working order. Have backup equipment or alternate methods planned and available.

What are the safety considerations?

Concrete repair mortars are hazardous materials and should be treated as such. Job-site safety practices should include the following where applicable:

- Applicable material safety data sheets (MSDS) should be on hand;
- Machinery and equipment used must have the correct safety guards and warnings in place;
- Workers should wear protective gloves and other clothing needed to prevent skin contact with wet, highly alkaline cementitious materials;

Fig. 7—Typical equipment to mix materials.

- A face shield or safety glasses are needed to provide eye protection;
- Eye wash facilities should be available on the job site.
- Dust masks are needed for workers operating or working near the material mixer and forced-air respirators used for abrasive blasting;
- Hearing protection must reduce sound levels reaching the inner ear to limits that are specified by the United States Occupational Safety and Health Administration (OSHA); and
- Confirm that adequate ventilation is available in closed spaces before operating equipment that emits dangerous exhaust fumes.

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Preconstruction meeting

Prior to proceeding with the repair, a preconstruction meeting is recommended. The meeting should include representatives for the owner, engineer, contractor, materials manufacturer, and any other parties needed to explain the means, methods, and materials necessary to achieve the repair objectives. See ICRI Guideline No. 320.2R-2009, "Guide to Selecting and Specifying Materials for Repair of Concrete Surfaces."

Repair procedure

1. *Apply the repair material.*

- Mix the material following the manufacturers' recommendations;
- Scrub a thin bond coat of the repair mortar into the SSD substrate, thus filling pores to ensure intimate contact and to help prevent sloughing or sagging of repair

Fig. 8—Hand application of repair material.

Fig. 9—Spray application of curing compound.

materials on vertical and overhead surfaces. Alternatively, apply a bonding agent if required by the manufacturer or the repair specification;

- Apply the material with adequate pressure before the bond coat dries (Fig. 8). Thoroughly consolidate the repair material into the corners of the patch and around any exposed reinforcement in the repair zone. Full encapsulation of the reinforcement is important for long-term durability; and
- If a second lift is required, thoroughly roughen the surface of the first lift by scoring the soft mortar to achieve an aggressive finish, similar in profile to the prepared concrete substrate. This process will promote additional mechanical bond between lifts. If the second lift will not be immediately applied, keep the first lift moist until application of the second lift. After the first lift has reached final set, moisten the surface of the first lift, scrub in a thin layer of fresh mortar, and apply the second lift of material. Once the desired thickness has been achieved, strike off level with the adjacent concrete.

2. *Finish and cure the repair.*

- Finish the repair material to produce a final finished appearance as required by the project specifications. Because of the nonbleeding, "sticky" nature of many of these materials, the use of an evaporation control film may be helpful; and
- As with all portland cement-based materials, proper curing will provide enhanced physical properties. Good curing procedures prevent rapid moisture loss at early ages. Consult the product manufacturer for curing instructions. Curing will generally be conducted in accordance with ACI 308R, "Guide to Curing Concrete." The use of curing compounds (Fig. 9) that comply with the moisture retention requirements of ASTM C309, or moist curing are common curing methods.

How do I check the repair?

Requirements may include:

- Before and after photos;
- Confirmation of acceptable surface preparation. This may include observing the surface amplitude profile. Alternatively, direct tension testing of the prepared surface will provide quantitative data regarding the level of surface preparation achieved;
- Material testing performed by a qualified testing agency;
- Sounding the cured repair for delaminations;
- In-place direct tensile bond testing of the hardened, cured repair to the base concrete using methods similar to those described in ICRI Technical Guideline No. 210.3-2004, "Guide to Using In-Situ Tensile Pull-Off Tests to Evaluate Bond of Concrete Surface Materials," published by the International Concrete Repair Institute. Important observations include maximum stress, expressed in psi or MPa, and failure mode (base concrete, bond line, or cohesive failure of the mortar).

References

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UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, SOUTH CAROLINA

REVISIONS:

DRAWN BY: SL
CHECKED BY: KM
COMM NO: 14103
DATE: JULY 2014

SHEET TITLE:
ACI RAP BULLETIN 6
VERTICAL AND OVERHEAD SPALL REPAIR BY HAND

SHEET NO:
A207

ACI RAP Bulletin 7

American Concrete Institute®
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FIELD GUIDE TO CONCRETE REPAIR APPLICATION PROCEDURES

Spall Repair of Horizontal Concrete Surfaces

ACI RAP Bulletin 7
(Reapproved 2010)

Field Guide to Concrete Repair Application Procedures

Spall Repair of Horizontal Concrete Surfaces

Reported by ACI Committee E706

*Primary author.

Introduction

Horizontal surface repair is common on slabs either elevated or on grade. Deterioration may be caused by corrosion of embedded reinforcement resulting in delamination and spalling. Other common causes include freezing-and-thawing deterioration and chemical attack. After an evaluation of the deterioration by an engineer, a plan should be developed including objectives and specifications for the repair. Steps for repairs that include layout, removals, edge preparation, mixing, bonding, placement, and curing have been included below as a step-by-step guide for use by field personnel.

What is the purpose of this repair?

The purpose of spall repair is to repair deteriorated concrete, repair damaged reinforcing steel, and replace the lost concrete section.

When do I use this method?

This method should be used for repairing spalls on horizontal surfaces such as structural slabs, exterior slabs on ground, balconies, and interior floors.

How do I prepare the surface?

Regardless of the repair method, surface preparation is essentially the same. Unsound concrete is removed. Exposed bars are undercut and surfaces are cleaned with high-pressure water (3000 psi minimum) or are abrasively blasted. Follow the steps outlined below:

Surface preparation

Step 1—Sound the concrete surfaces to locate delaminated areas. This may be done as described in ASTM D4580-03(2007), "Standard Practice for Measuring Delamination in Concrete Bridge Decks by Sounding."

Step 2—Mark the perimeter of the repair area. Preferable layout will result in simple geometric shapes with few re-entrant corners.

Step 3—Sawcut the perimeter of the repair. To avoid damaging reinforcement, the sawcut should not be deeper than the cover over the reinforcement. If the delamination is caused by corrosion, but the area of corroded reinforcing isn't apparent, use chipping hammers to expose the reinforcement until areas of uncorroded bars are found. Then sawcut an area that encompasses the boundaries of corrosion that have been established.

Step 4—Perform initial concrete removal with either 15-lb or 30-lb jackhammers. Jackhammers larger than 30 lb may cause damage to reinforcement, reinforcement bond to surrounding concrete, and remaining concrete. Use 15-lb jackhammers for final removal and detailing around the reinforcing steel.

Step 5—If exposed bars are corroded, concrete surrounding the bar should be fully removed to expose the corroded bar, regardless of how much of the bar is corroded. Removals around the bar should allow the hand to pass under the bar. Clearance around the bar should be approximately 3/4 in. (20 mm).

Step 6—If corroded bars are found and the bars have loss of cross section, a structural engineer should be consulted.

Step 7—Final cleaning of the exposed reinforcement and concrete is required. Use of high-pressure water or abrasive

Fig. 1—Sound the concrete surface to locate delaminated areas. Chain drags can be used for sounding.

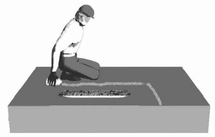

Fig. 2—Mark the perimeter of the repair area using simple geometric shapes and minimizing re-entrant corners.

Fig. 3—Sawcut the repair perimeter, but no deeper than the thickness of the concrete cover over the reinforcement.

Fig. 4—Initial concrete removal within the sawcut area, using a 15- or 30-lb jackhammer. Use 15-lb jackhammer for final removal.

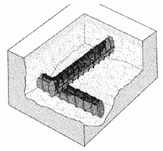

Fig. 5—If corrosion is present, remove enough concrete to fully expose the corroded bar.

Fig. 6—Remove enough concrete so clearance beneath bars is about 3/4 in.

blasting is required to remove loose and bond-inhibiting materials.

Placement procedures

Step 8—Pre-wet concrete surfaces before placing repair materials. Concrete surfaces receiving repair materials should be saturated surface-dry (SSD). An SSD condition is

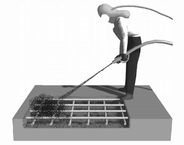

Fig. 7—Clean the exposed concrete and reinforcing bars with high-pressure water or abrasive blasting.

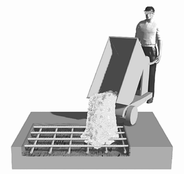

Fig. 8—Place repair material into the prepared cavity by buggy, pump, or other conveying method.

achieved when the body of the concrete is saturated and free surface water and puddles have been removed from the surface of the concrete. Wetting the surface immediately before placing material may result in standing water and water-filled surface pores. This condition will result in poor bond between the repair material and the concrete substrate.

Step 9—Use of bonding agents is optional. The most common bonding agents are composed of cement and water mixed together to form a broomable slurry. When a cement slurry is used, care should be exercised so the slurry doesn't dry prior to placement of the repair material. Manufactured bonding agents can also be used. Follow manufacturer instructions for use of these materials. Certain repair material mixture proportions and placement conditions may not require a separate bonding agent. If a manufactured (bagged) product is used, follow the manufacturer's instructions. Follow the procedures outlined in the preceding section of this document. This will ensure that the placement methods and materials will result in adequate bond.

Step 10—Mix bagged repair material in accordance with the manufacturer's instructions. If using ready mixed

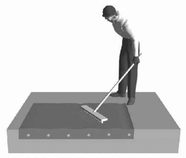

Fig. 9—Strike off, then float the repaired surface.

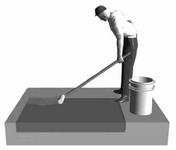

Fig. 11—Cure with wet coverings, or use a spray- or roller-applied curing compound as shown here.

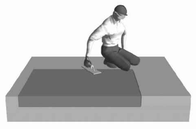

Fig. 10—After floating, trowel or broom the surface.

concrete, follow project specifications for mixing and transport requirements.

Step 11—Place repair material into the prepared cavity by buggy, pumpline, or other acceptable method.

Step 12—Consolidate the repair material into the cavity using either a vibrating screed or internal vibrator. Vibration allows the repair material to flow around the reinforcing steel and also come into intimate contact with the existing concrete substrate. This will promote maximum bond between the new material and the substrate. Entrapped air will also be removed in this step.

Step 13—Screed the repair material.

Step 14—Float the repair material.

Step 15—Trowel the repair material or broom the surface for texture.

Step 16—Cure the repair in accordance with the manufacturer's recommendations (if the material is bagged). If the repair uses ready-mixed or site-mixed concrete, place wet burlap and a polyethylene sheet over the repair for a minimum of 7 days. An alternative to wet burlap is the use of a spray-applied curing compound.

How do I select the right material?

If ready mixed concrete is used for the repairs, a water-cementitious material ratio (*w/cm*) of not more than 0.40 should be used. Compressive strength should be greater than the original concrete and should not be less than 4000 psi. Other properties such as low shrinkage may be desirable and should be specified by the owner's representative. Prepackaged materials specially designed for the repair of concrete surfaces can also be used. Selection should be based on meeting the specified properties outlined by the owner's representative. Refer to ACI 546.3R-06, "Guide for the Selection of Materials for the Repair of Concrete," for more information.

What equipment do I need?

- Sawcutting equipment and blades
- Chipping hammers
- Air compressor
- Abrasive blast equipment
- Concrete mixing and placing equipment
- Concrete finishing tools

What are the safety considerations?

- Eye protection is required for demolition and cleaning operations.
- Hearing protection must reduce sound levels reaching the inner ear to limits on these levels that are specified by OSHA.
- Respiratory protection is required when airborne dust or vapors are produced.
- Skin should be protected from chemicals and cement.
- Material Safety Data Sheets (MSDS) should be available for materials on the job site.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. ACI does not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations including, but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.

Preconstruction meeting

Prior to proceeding with the repair, a preconstruction meeting is recommended. The meeting should include representatives from participating parties (owner, engineer, contractor, materials manufacturer), and specifically address the parameters, means, methods, and materials necessary to achieve the repair objectives.

How do I check the repair?

- Check surface preparation in two ways. First, the surface should be free of dust or other bond-inhibiting materials. A visual check is the first thing to do. The visual check should observe the surface for signs of dust or anything that may cause the repair material not to bond to the visible surface. The second check is to sound the area with a hammer to locate any delaminations that may still exist beneath the prepared surface.
- Test the repair-material properties to ensure the material meets the desired or specified properties. Compressive strength is the most common test. Samples of the material should be placed into the standard cylinder molds used for concrete testing and sent to a lab for testing.
- Check bond using a pull-off test. This test requires core drilling through the repair into the substrate approximately 1/2 in. (12 mm); the concrete core should remain attached to the substrate. Minimum core diameter is 2 in. (50 mm). After core drilling, a steel plate is glued to the top of the core. A specially designed pulling device is attached to the steel plate and is used to pull the plate until failure of the concrete occurs with the core. The force required to break the core is divided by the area of the core resulting in a value expressed in psi (pounds per square inch) or MPa (megaPascals). A target value above 150 psi (1 MPa) is recommended. In some cases, however, values below 150 psi (1 MPa) and above 100 psi (0.7 MPa) are acceptable. If the test results are below 100 psi (0.7 MPa), critically review materials and procedures to develop a plan for improving the bond strength of the repair. More information regarding this procedure is given in ICRI Technical Guideline No. 03739, "Guide to Using In-Situ Tensile Pull-Off Tests to Evaluate Bond of Concrete Surface Materials," published by the International Concrete Repair Institute.

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DATE: JULY 2014
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SHEET NO: A208