



American Concrete Institute®
Advancing concrete knowledge

Field Guide to Concrete Repair Application Procedures

ACI Fall 2011 Convention
October 16 – 20, Cincinnati, OH

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ACI Web Sessions

The audio for this web session will begin momentarily and will play in its entirety along with the slides.

However, if you wish to skip to the next speaker, use the scrollbar at left to locate the speaker's first slide (indicated by the icon in the bottom right corner of slides 9, 26, 41, and 54). Click on the thumbnail for the slide to begin the audio for that portion of the presentation.

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ACI is bringing you this Web Session in keeping with its motto of "Advancing Concrete Knowledge." The ideas expressed, however, are those of the speakers and do not necessarily reflect the views of ACI or its committees.

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ACI Web Sessions are recorded at ACI conventions and other concrete industry events. At regular intervals, a new set of presentations can be viewed on ACI's website free of charge.

After one week, the presentations will be temporarily archived on the ACI website or made part of ACI's Online CEU Program, depending on their content.

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Visit www.concrete.org/education/edu_online_CEU.htm for more information.



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ACI Conventions

ACI conventions provide a forum for networking, learning the latest in concrete technology and practices, renewing old friendships, and making new ones. At each of ACI's two annual conventions, technical and educational committees meet to develop the standards, reports, and other documents necessary to keep abreast of the ever-changing world of concrete technology.

With over 1,300 delegates attending each convention, there is ample opportunity to meet and talk individually with some of the most prominent persons in the field of concrete technology. For more information about ACI conventions, visit www.aciconvention.org.

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This ACI Web Session includes 4 speakers presenting at the ACI fall convention held in Cincinnati, OH, October 16 – 20, 2011.

Additional presentations will be made available in future ACI Web Sessions.

Please enjoy the presentations.


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**Field Guide to Concrete Repair
Application Procedures**

ACI Fall 2011 Convention
October 16 – 20, Cincinnati, OH

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Patrick "Doc" Watson, is based in Madison, Wisconsin, and is employed by BASF Building Systems, Shakopee, MN as a Technical Product Specialist. He is an active member of the International Concrete Repair Institute. He is also a member of ACI Committees 546, Repair of Concrete; 308, Curing; 302, Guide to Construction of Slabs; 364, Rehabilitation of Concrete; and E706, Concrete Repair Education. He has authored several articles and Association documents. Doc is a frequent speaker for industry groups and a regular speaker at International ACI, ICRI, and ASCE events. He has taught concrete repair and construction of slabs programs at several North American University programs.

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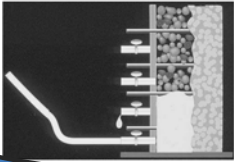
RAP Bulletins

aci RAP Bulletin 9
American Concrete Institute®
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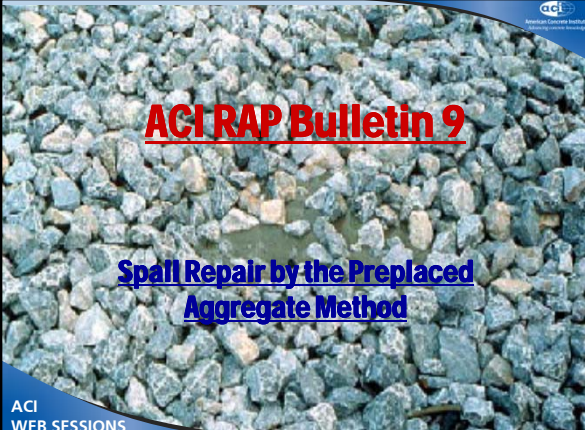
FIELD GUIDE TO
CONCRETE REPAIR
APPLICATION PROCEDURES

**Spall Repair by
the Preplaced
Aggregate Method**

By Patrick "Doc" Watson



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**Spall Repair by the Preplaced
Aggregate Method**

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Where to Use this Method



500,000 cubic yard pre-placed aggregate project.

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Purpose of the Repair

Use Preplaced Aggregate (PPA) For:

- Structural Repairs

Underwater Repairs

Repairs in Tight, Congested Areas

- Repairs where shrinkage cannot be tolerated
- Repairs where dense cover is desired

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When to Use PPA

- o Vertical, overhead and horizontal repairs
- o Structural or cosmetic
- o Thickness or depth of 2" (50mm) or more
- o For structural mass concrete
- o For shrinkage free underpinning
- o Dam faces, piers and abutments and bullnoses
- o Bridge footings in moving water
- o Where cofferdams are not practical
- o For nuclear shielding
- o Column jacketing
- o Mass concrete
- o Grouting & anchoring precast flood walls
- o Depends on the limits of your imagination

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Needed Surface Preparation



- ICRI 310.2-1997
- ICRI 310.1R-2008

Repair the cracks
Saturate the surface
Install any specified reinforcement
Corrosion protection

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Aggregate Material Selection

Aggregate Selection

Gradation as per ACI 304
Sound
Non-reactive
Void spacing 35-50%
Clean

Grout

- HIGH ELECTRICAL RESISTIVITY	- PREPACKAGED QUALITY CONTROL
- MADE TO BE PUMPED INTO PLACE	- ONE COMPONENT ADD ONLY WATER
- VERY HIGH BOND STRENGTH	- RESISTS CHEMICALS IN WASTE WATER
- SHRINKAGE COMPENSATED	- READILY AVAILABLE


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Aggregate



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Grout



- Fluid
- Non Shrink
- Non-Bleed
- Sulfate resistant
- High density
- Freeze thaw durable
- Prepackaged
- No gas forming agents

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Safety Considerations

- Pre job meeting
- MSDS
- Protective Eye wear and clothing
- OSHA
- Qualified Divers



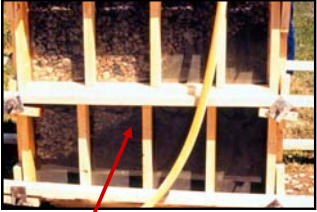
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Step-by-Step Procedures

- Pre qualify all methods and materials
- Contractor mock up
- Check Surface Preparation
- Form
- Place aggregate
- Pump grout
- Remove Form
- Admire Results

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Contractor Mock UP

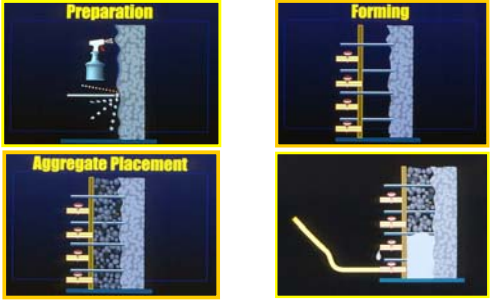


- Experienced contractors.
- Plexiglas mock up
- Site aggregate & grout.

*Note grout flow, one inlet on right, from top.

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Steps




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Checking the Repair



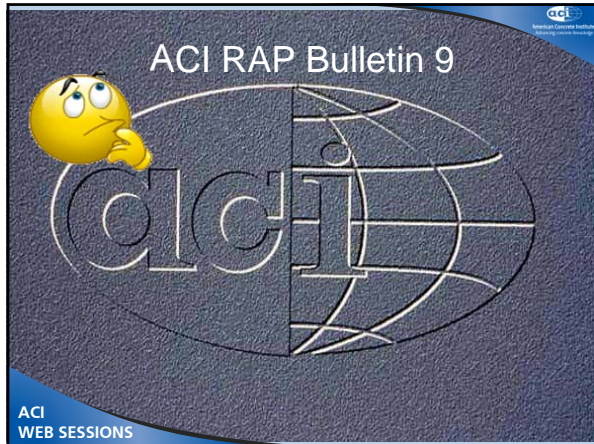
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Final Check of the Repair



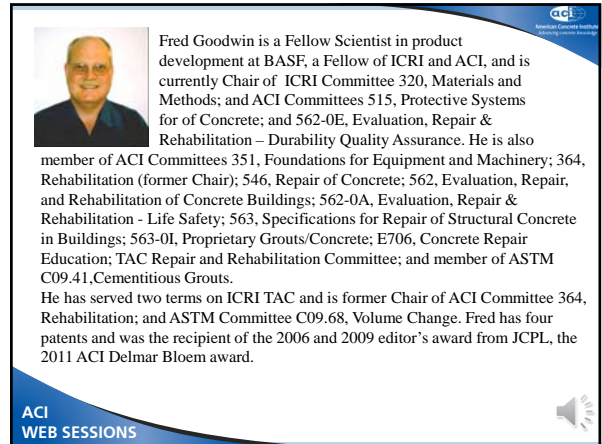
Grout inlet

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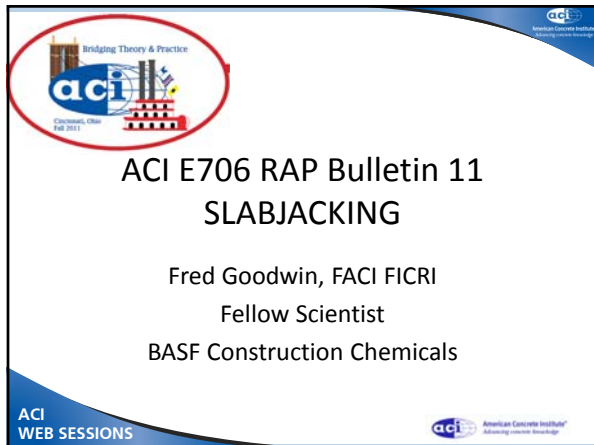
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Fred Goodwin is a Fellow Scientist in product development at BASF, a Fellow of ICRI and ACI, and is currently Chair of ICRI Committee 320, Materials and Methods; and ACI Committees 515, Protective Systems for of Concrete; and 562-0E, Evaluation, Repair & Rehabilitation – Durability Quality Assurance. He is also member of ACI Committees 351, Foundations for Equipment and Machinery; 364, Rehabilitation (former Chair); 546, Repair of Concrete; 562, Evaluation, Repair, and Rehabilitation of Concrete Buildings; 562-0A, Evaluation, Repair & Rehabilitation - Life Safety; 563, Specifications for Repair of Structural Concrete in Buildings; 563-0I, Proprietary Grouts/Concrete; E706, Concrete Repair Education; TAC Repair and Rehabilitation Committee; and member of ASTM C09.41, Cementitious Grouts.

He has served two terms on ICRI TAC and is former Chair of ACI Committee 364, Rehabilitation; and ASTM Committee C09.68, Volume Change. Fred has four patents and was the recipient of the 2006 and 2009 editor's award from JCPL, the 2011 ACI Delmar Bloem award.

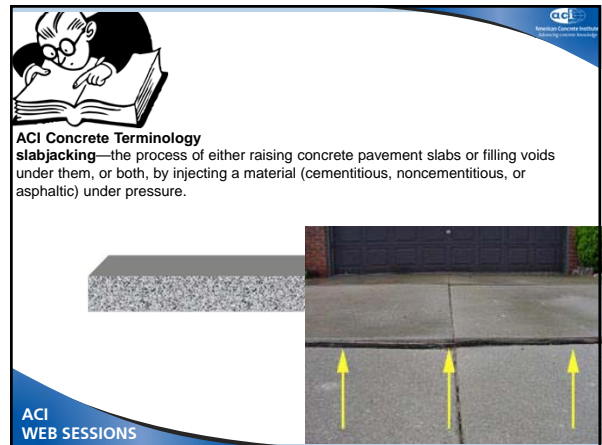
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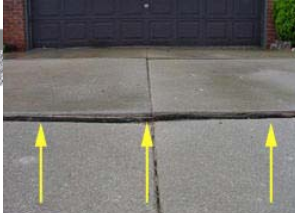
ACI E706 RAP Bulletin 11
SLABJACKING

Fred Goodwin, FACI, FICRI
Fellow Scientist
BASF Construction Chemicals

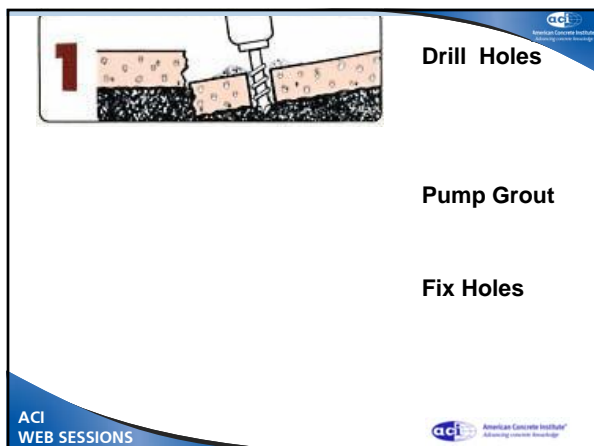
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ACI Concrete Terminology
slabjacking—the process of either raising concrete pavement slabs or filling voids under them, or both, by injecting a material (cementitious, noncementitious, or asphaltic) under pressure.

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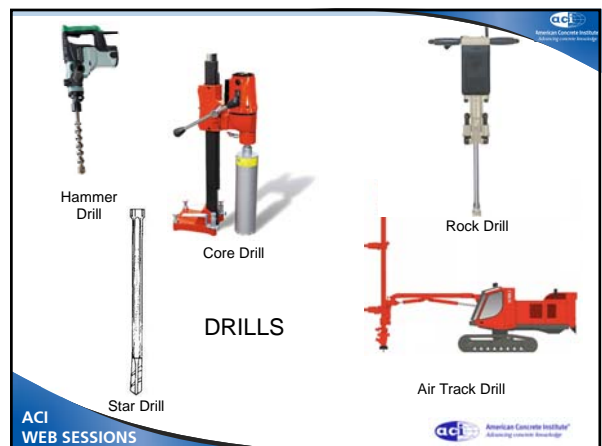


Drill Holes

Pump Grout

Fix Holes

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DRILLS

Hammer Drill

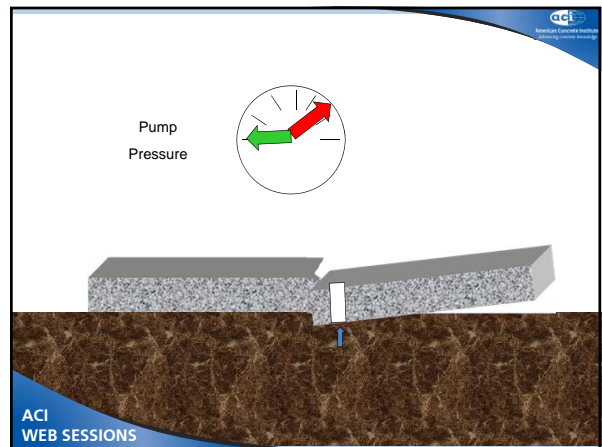
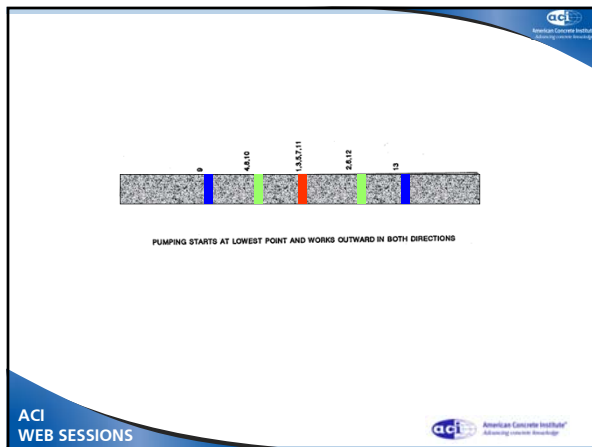
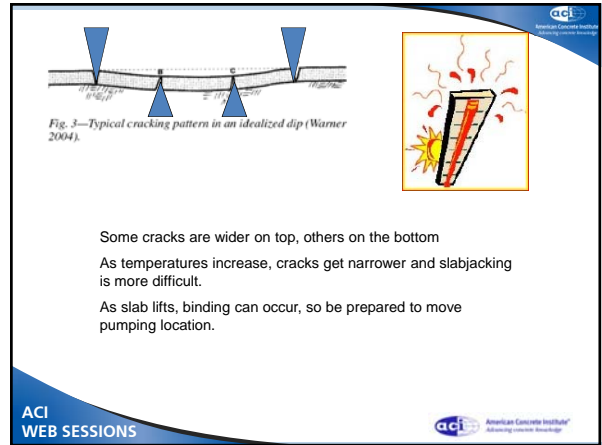
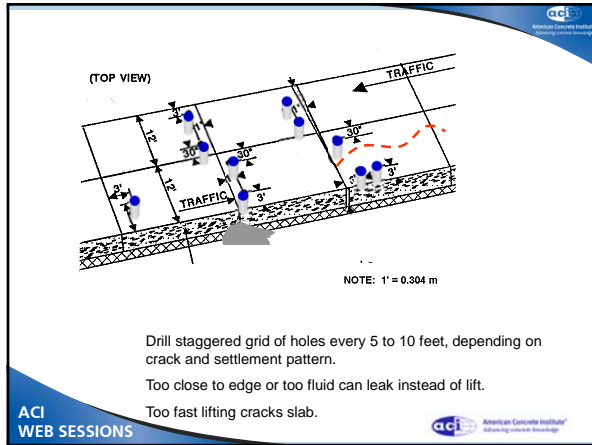
Core Drill

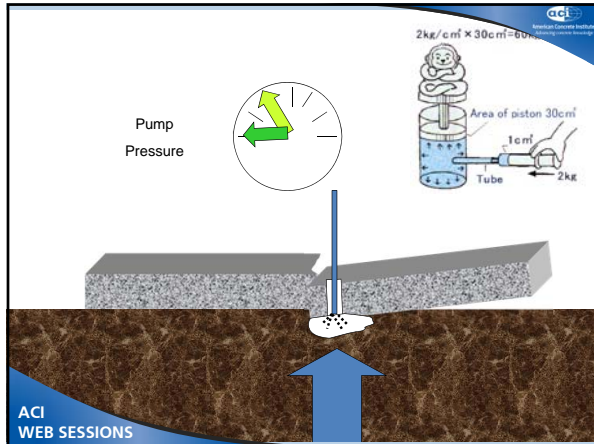
Rock Drill

Star Drill

Air Track Drill

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BEFORE	AFTER
BEFORE	AFTER
BEFORE	AFTER

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BASF, The Chemical Company

Fred Goodwin, FICRI, FACI
 Fellow Scientist
 Beachwood, OH

Thank You!

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John S. Lund, P.E., Manager of Martin/Martin's Structural Investigation Team, has over 25 years of experience in the structural assessment, evaluation and investigation of buildings, including field observation and due diligence services. He is a Chair of ACI Committee 546, Repair of Concrete; and member of ACI Committees 364, Rehabilitation; E706, Repair Application Procedures; and TAC Repair and Rehabilitation Committee. He is also member and past President of the ICR Rocky Mountain Chapter (2006). He is a recognized expert in the evaluation and repair of concrete structures and he provides comprehensive investigation and analysis of buildings and structural components including renovations, expansions, structural failures, moisture intrusion and material deterioration. His experience includes foundation failure, soil/structure interaction, defective construction, code compliance, product failures, drainage problems, and structural damage due to wind, snow, flood, fires and explosions.


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Methacrylate Flood Coat
 Field Guide to Concrete Repair
 Application Procedures

John S. Lund, PE

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What are Methacrylates?



- Methacrylates are liquid resins used to seal concrete slabs and structurally heal narrow, shallow cracks.
- Supplied in two or three component packaging and mixed on site immediately prior to application
- Types of Methacrylates are High Molecular Weight and Reactive
- Similar in application and performance to super low viscosity epoxies
- Penetrating by gravity alone, fills pores in horizontal concrete surfaces and bond small cracks

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Causes of Cracking



- Corrosion of reinforcing steel
- Freeze/thaw damage
- Sulfate attack
- Alkali-aggregate reactions (AAR)
- Improper practices during original construction
- Poor concrete mix design
- Adding too much water at site
- Inadequate subgrade preparation
- Poor joint design or construction
- External forces such as structural overload

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Purpose of Repair

- What is the purpose of a methacrylate flood-coat?
 - Fill and bond shrinkage cracks
 - Seal the slab against water, salts, other deleterious chemicals
 - Repair cracks and improve traffic wear
 - For structural repairs, consult structural engineer for evaluation (difficult to ensure full-depth filling of cracks)


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Using Methacrylates

- When do I use a Methacrylate Flood Coat?
 - Horizontal surfaces only – though can be used on sloped surfaces such as parking garage ramps with some extra precautions
 - Can be used to repair bridge decks, parking garages, industrial floors or concrete slabs
 - Not effective for repairing cracks caused by steel corrosion or AAR
 - Skid resistance should be considered when exposed to heavy traffic and high speeds
 - Not effective for moving cracks caused by thermal changes, structural loads, resistant or relief joints
 - Flood coat will seal slab and fill open cracks
 - Methacrylates are not effective in repairing moving cracks
 - Most methacrylates can resist movement up to 5% to 10% of the crack width. Specialized bridge deck methacrylate can resist up to 25% to 30%

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Prepare the Surface



- How do I prepare the surface?
 - Surface should be clean, dry and free of oil, grease, dust, paint, sealers or other potentially bond-breaking materials
 - Shotblast or sandblast to ICR1 CSP-3 to CPS-5 surface profile
 - Clean deeper cracks with compressed air
 - Compressed air must be free of oil and moisture
 - Waterblasting is generally not sufficient or recommended

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Materials

- How do I select the right materials?
 - Two types of Methacrylates
 - Reactive and High Molecular Weight
 - Consider ambient temperatures
 - Methacrylates can be modified for a longer or shorter set time.
 - Use shorter set time materials when necessary to open slab to traffic quickly
 - Temperature range of 35 to 95 degrees Fahrenheit
 - Applications made in the cooler times of day when placing in hot weather, especially when bonding deeper cracks
 - Aggregate can be broadcast into the floor coat to improve traction on surfaces
 - Methacrylates have a strong odor
 - Keep area from contact with public
 - Avoid areas of close proximity to building air intake vents

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Equipment

- What equipment do I need?
 - Shotblast or sandblast for surface preparation
 - Compressed air
 - 30 mesh dry aggregate for filling larger cracks (1/8" or wider)
 - Clean mixing/measuring buckets
 - Proper proportioning is critical
 - Low speed drill and mixing paddle
 - Access to power or generator
 - Methacrylate
 - 1 gallon per 100-150 sf
 - Flat squeegee or roller
 - 8 to 60 mesh dry aggregate
 - Aggregate at the rate of 15-20 pounds per 100 sf
 - Protective footwear with raised cleats
 - Safety equipment

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Safety

- What are the safety considerations?
 - MSDS on site
 - Protective Clothing
 - Safety glasses and gloves
 - Full face respirators
 - Enclosed, poorly ventilated areas
 - Eye wash facilities
 - Materials are flammable
 - Keep away from heat, flames, sources of ignition
 - Ventilate closed spaces
 - Notify occupants
 - Component formulations
 - Mix with extreme care
 - **Never mix catalyst and promoter directly together**
 - Follow manufacturer's instructions

Methacrylates are hazardous materials

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Preconstruction

- Preconstruction meeting is recommended
 - Representatives from all parties should attend
 - Owners, engineers, contractors, materials manufacturer, etc.
 - Specifically address:
 - Parameters, means, methods, materials and safety precautions

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Repair Procedure


- Shotblast or sandblast to CSP-3 to CSP-5 surface
- Use compressed air to remove dust/concrete chips
- Seal bottom of crack if underside of slab is available
- Pre-fill all cracks 1/8" or wider
- Mix resin in strict accordance with manufacturer's recommendations
- Flat squeegee or roll flood coat of mixed resin. Cover approximately 100 – 150 sq per gallon.
- Remove all excess resin
- Second coat if cracks are over 1/2 inch deep or if concrete surface is porous
- 20 minutes after applying final coat, broadcast aggregate at the rate of 15-20 pounds per 100 sf
- Allow to methacrylate to fully cure before allowing traffic – approximately 1 hour for Reactive and 3-4 hours for High Molecular Weight at 70 degree Fahrenheit is typical.
- How do I check the repairs?
 - Audit the quality of material
 - Core to verify depth of penetration into cracks when depth is critical

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Questions?

Thank you!

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Dave VanOcker leads CVM's Facilities Renewal Group, specializing in forensic diagnostics, repair and rehabilitation of building envelope systems & parking structures. With a degree in civil engineering and 30+ years of institutional and commercial client experience, Dave has structural and building science expertise with a broad range of historic and contemporary building structures. Repair, rehabilitation, and restoration programs are conducted under his guidance, and are tailored to meet to specific client requirements drawing from his extensive experience with a wide array of project delivery methods. Dave is an active member and leader on ACI Committees E706, Concrete Repair Education; 364, Rehabilitation (Chair); 546, Repair of Concrete; and 563, Specifications for Repair of Structural Concrete in Buildings.

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ACI Committee E706 Repair Application Procedures

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Hydrodemolition

- High pressure water
- Removal, preparation & cleaning
- Non-Impact Method

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When To Use Hydrodemolition ?

- Partial & Full Depth Removals

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Where To Use Hydrodemolition ?

- Bridge Decks
- Substructures
- Columns & Piers
- Abutment Walls
- Retaining Walls
- Barrier Walls
- Expansion Joints
- Deck Replacement

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Considerations For Using Hydrodemolition

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Cleanup of Debris from Hydrodemolition


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Cleanup of Debris from Hydrodemolition



4" Vacuum Hood

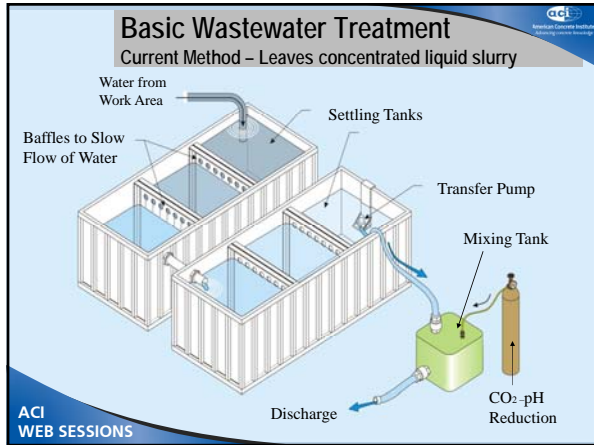
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Waste Disposal from Hydrodemolition



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Waste Disposal from Hydrodemolition




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Safety Precautions with Hydrodemolition



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Questions

Committee E 706
Repair Application Procedures




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Related Documents

Repair Application Procedures *(click on each topic)*

- RAP-1: Structural Crack Repair by Epoxy Injection
- RAP-2: Crack Repair by Gravity Feed with Resin
- RAP-3: Spall Repair by Low-Pressure Spraying
- RAP-4: Surface Repair Using Form-and-Pour Techniques
- RAP-5: Surface Repair Using Form-and-Pump Techniques
- RAP-6: Vertical and Overhead Spall Repair by Hand Application
- RAP-7: Spall Repair of Horizontal Concrete Surfaces
- RAP-8: Installation of Embedded Galvanic Anodes
- RAP-9: Spall Repair by the Preplaced Aggregate Method
- RAP-10: Leveling and Reprofilling of Vertical and Overhead Surfaces
- RAP-11: Slabjacking
- RAP-12: Concrete Repair by Shotcrete Application
- RAP-13: Methacrylate Flood Coat
- RAP-14: Concrete Removal Using Hydrodemolition



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