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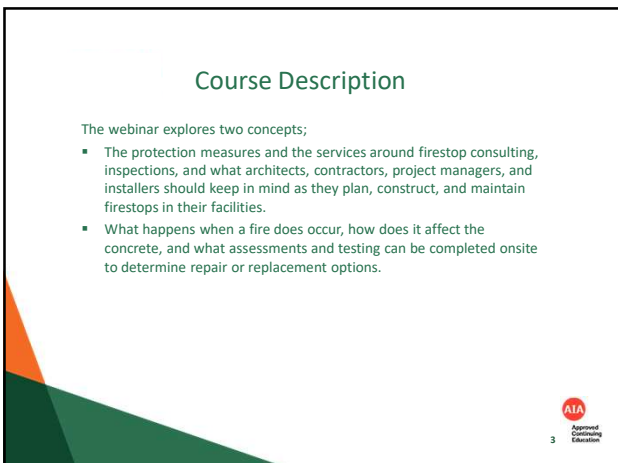
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### Learning Objectives


At the end of this program, participants will be able to:

Firestop Services:

- Understanding of Firestop Systems
- Discuss what makes a complete firestop system, design, installation and special inspection requirements.

Fire Damage:

- What happens to concrete in a fire.
- Discuss the processes completed for the assessment, and testing to determine the structural integrity of the concrete.



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### Firestop



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### What is Firestopping

International Firestop Council defines fire stopping as:

- "A process where certain materials, some specifically manufactured, are used to resist or stop the spread of flames and its by-products through openings in rated walls, floors or floor/ceiling assemblies."



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### Where is Firestopping Required?

Fire stopping is part of a balanced approach to fire protection in buildings:

- Detection**
- Containment**
- Suppression**



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### Why is Firestopping Required?

- Fire sprinklers suppress flames, NOT smoke and gasses
- 75% of all fire deaths are caused by smoke inhalation
- 57% of people killed in fires are not in the room of the fire's origin
- 47% of survivors could not see more than 12 feet
- Smoke travels at 120 to 420 feet per minute



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### Why Firestop?

- Mandated by Codes
  - IBC
  - NFPA
  - IFC
- Protection of Life
- Protect Property



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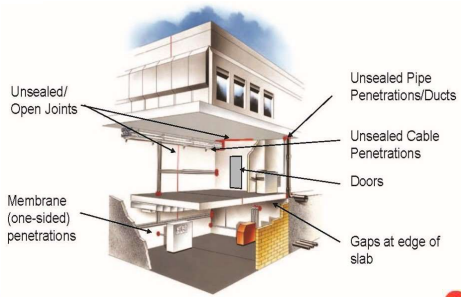
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### Areas That Allow for Fire/Smoke Spread



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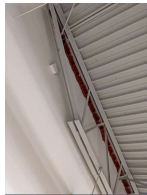
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### How do Firestop Products Work?

- Through-penetration firestop products work by filling the voids around the penetrating items in the rated wall or floor.
  - Intumescent material- expands as it heats up, sealing off the opening when the penetrant melts away.
- Joint firestop allows for movement between floors/walls.



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### Types of Firestop Systems

- Through-penetrations** – pipes, ducts, cable bundles through walls & floors
- Membrane penetration firestops** – pipes or cables penetrating one side of a rated wall or floor
- Fire resistant joint systems** – horizontal or vertical joints at rated corridors or stair enclosures
- Perimeter fire barrier systems** – Edge of Slab or curtain wall assemblies



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### How Firestop Systems are Tested

**F-Rating (Code Required):** Flame does not pass through for duration of test & passes hose stream test

**T-Rating (Code Required):** The time it takes the non-fire side of the assembly to reach 400°F & passes hose stream test

**L-Rating (Code Required for Barriers):** The amount of air leakage through the FS system at ambient and 400°F.

**W-Rating (Spec Required):** The amount of water leakage through the FS system with 36" of water column for 72 hours.



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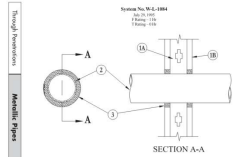
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### UL Assembly (Penetration)



- 1. Workmanship:** The firestop system is installed in accordance with the manufacturer's instructions and the assembly is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 2. Fire Rating:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is rated for a minimum of 1 hour.
- 3. Hose Stream Test:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 4. Temperature Rise:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 5. Air Leakage:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 6. Water Leakage:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).



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### UL Assembly (Joint)



- 1. Workmanship:** The firestop system is installed in accordance with the manufacturer's instructions and the assembly is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 2. Fire Rating:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is rated for a minimum of 1 hour.
- 3. Hose Stream Test:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 4. Temperature Rise:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
- 5. Air Leakage:** The firestop system is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418) and is tested in accordance with the UL Standard for Fire-Resistant Penetration Assemblies (UL 1418).
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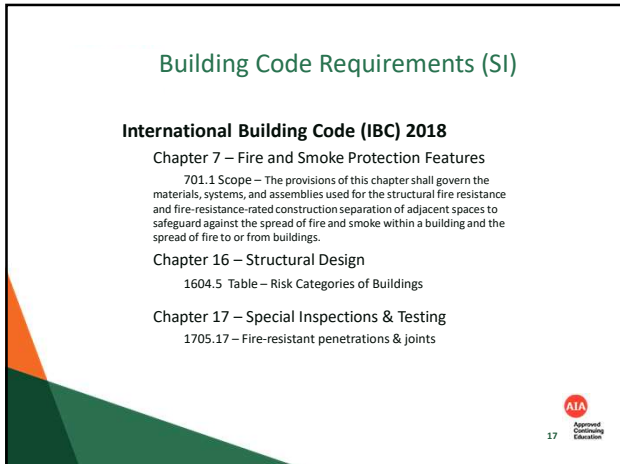
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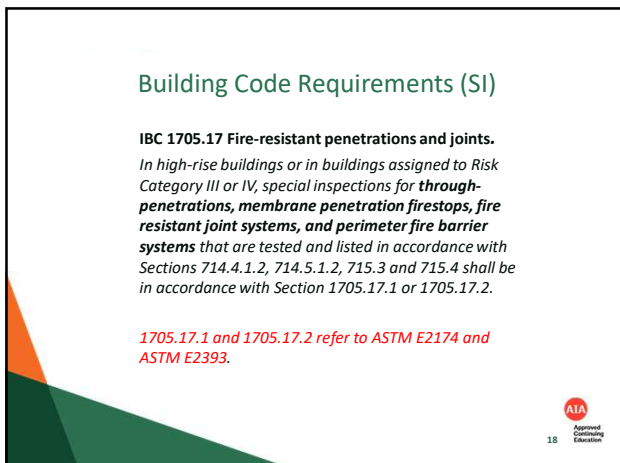
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**ASTM E2174 Summary**  
Standard Practice for On-Site Inspection of Installed Firestops.

10.8 The inspector shall verify and document that the firestop systems required in the inspection documents have been installed. – verification that **100% of firestop systems are installed.**

10.10 The inspector shall verify that every firestop system inspected as required by 10.12.2 is in accordance with the manufacturers instructions.

10.11 The inspector shall verify compliance of the firestop system by observing the installation process and by taking and recording measurements of the substrates and materials being installed or by destructive examination of completed installations



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**ASTM E2174 Summary**  
Standard Practice for On-Site Inspection of Installed Firestops.


10.12 Inspection frequency shall depend on the method of inspection and the scope of the project. The method of inspection shall be one of the following:

**Visual Inspection**

10.12.1 The inspector shall be on site during installation and randomly witness a **minimum of 10 % of each type of firestop system** being installed, or

**Destructive Testing**

10.12.2 The inspector shall conduct a post installation inspection, which shall require destructive type verification of the firestop system and repair of the firestop system. **A minimum of 2 %, but not less than one, of each type of firestop system shall be inspected per floor or for each area of a floor when a floor is larger than 10,000 ft<sup>2</sup> (946.7 m<sup>2</sup>). An area consists of 10,000 ft<sup>2</sup> or less.**



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**ASTM E2393 Summary**  
Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers


**Visual Inspection**

10.12.1 The inspector shall be on site during installation and randomly witness a **minimum of 5 % of total linear feet of each type of fire resistive joint system** being installed, or

**Destructive Testing**

10.12.2.2 Inspection shall consist of a **minimum of one sampling per type of joint system per 500 lineal feet.**

**NOTE 11—The AA may determine the types of fire resistive joint systems and subsequently the number of each type that is to be inspected in addition to the minimum required by this practice.**



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## Firestop Inspection Procedures

1. Project Information & Roles
  - Project Name/Project Number
  - AA (Authorizing Authority)
  - AHJ (Authority Having Jurisdiction)
  - General Contractor/Construction Manager
  - Inspector
  - Installer(s)

3.2.2 *authority having jurisdiction (AHJ)*—the designated authority, or their duly authorized representative, charged with the administration and enforcement of the local fire code or building code, or both.

3.2.3 *authorizing authority (AA)*—the designated person, or organization, or their duly authorized representative, charged with the administration and enforcement of the provisions of this inspection document.

*Note 2*—Examples of the AA include the responsible architect, engineer, building owner, or their representative.



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## Firestop Inspection Procedures

2. Inspection Documents
  - Life/Safety Plans
  - Specific firestop system details included on plans?
  - What requirements are being spec'd
  - Submittals

3.2.5 *inspection document*—any information provided to the inspector by the AA that is to be used as the basis for the inspection process. This information shall include, but is not limited to, project specifications, contract drawings, Listed Designs, judgments, manufacturer's instructions and designs, building codes, and other documentation.



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## Responsibilities

7. Inspection Documents
  - 7.1 The inspection documents shall be reviewed by and acceptable to the AA and AHJ.
  - 7.2 The AA shall be responsible for ensuring that the inspection documents do not contain conflicting information.
  - 7.3 The AA shall provide the inspector with a complete set of inspection documents at least ten working days prior to the inspection. The inspector shall review all inspection documents prior to conducting any inspection. When the inspector believes that the inspection documents contain conflicting information or documentation that the inspector believes is insufficient to perform the inspection, the inspector shall submit written notification of the potential conflict and obtain written clarification from the AA before conducting any inspection.
  - 7.4 As part of the inspection documents, Listed Designs shall be provided for every firestop, as a reference against which to compare the installation. As an alternative for every case where a Listed Design does not exist for a particular application, a judgment issued by the firestop product manufacturer or an accredited testing laboratory, and acceptable to the AHJ, shall be provided as a reference against which to compare and inspect the installation.



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### Firestop Inspection Procedures

4. Identify Firestop Systems Manufacturer
  - Typically, better to have one manufacturer for all trades
5. Obtain Shop Drawing Submittals per spec
  - May be one submittal for all firestop assemblies
  - Each trade may have to submit separate fire stop submittal
6. Distribution List for Reports
  - Typically copied to responsible subcontractor, GC, and AHJ if requested



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### Firestop Inspection Procedures

7. Identify Installers
  - One firestop installer or each trade?
8. Schedule
  - Pre-con meeting with responsible trades or part of firestop training session
  - Preliminary walk-through
  - Schedule for visual inspections & destructive testing

X1.2 The procedures discussed in this practice should be established at a mandatory pre-construction meeting attended by representatives of the owner, general contractor, the subcontractors responsible for creating penetrations or openings, the firestop installer and the inspector.



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### Firestop Inspection Procedures

9. Reporting Format
  - Daily reports – Required to be sent the next business day.
    - Pass
    - Fail
    - Reinspection
    - Work-in-Progress
  - Final report – Separate from any other final reports.



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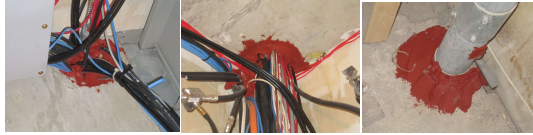
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### Firestop Inspection Typical Issues



1. Submittals are usually insufficient
2. Firestop materials often utilized incorrectly
3. Not installed according to the UL Listed Assembly
4. Incorrect UL Assembly selected



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### Fire Damage Assessment



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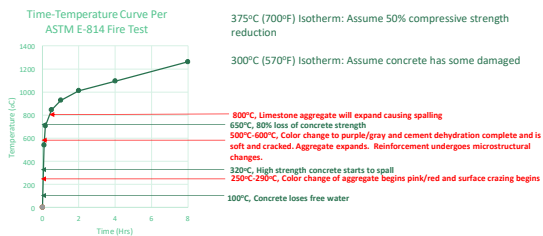
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### How is Concrete Affected by Fire?



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### Where to Start?



- Gather information prior to site visit.
- Drawings
  - Information about the event
  - What tools might be needed for the site assessment
    - Ladders/lifts
    - NDT equipment vs. visual only
  - Formulate a tentative plan with the understanding that it will likely change while onsite.

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### Visual Site Assessment

- Complete an initial walk-thru.
- Locate a control area- what was the condition of the structure prior to the fire?
- Take A LOT of photos!



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### Visual Site Assessment

Identify and locate these indicators:

- Soot/Smoke
- Melted interior finishes
- Friable surfaces
- Discoloration
- Spalling/Cracking
- Differential movement
- Any other anomalies



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### Visual Site Assessment

Conditions of interior finishes/electrical or mechanical equipment



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### Visual Site Assessment

Soot or Lack of soot



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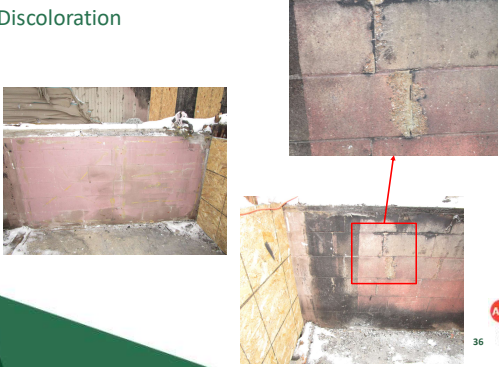
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### Visual Site Assessment

Discoloration



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Visual Site Assessment

Cracking



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Visual Site Assessment

Spalling



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Visual Site Assessment

Movement



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### Non-Destructive Testing

Generally Noninvasive

- May mean different things depending on your point of view.
- Are cores extracted from a structure noninvasive?

ACI Definition – “Any test performed that causes no structurally significant damage to the concrete”

ICRI Definition- “examination of materials and structures in ways that do not impair future usefulness and serviceability in order to detect, locate, and measure discontinuities, defects, and other imperfections to assess integrity, properties, and uniformity, and to measure geometrical characteristics”



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### Non-Destructive Testing

Selection of Methods

- Understanding the situation
- Determine the “GOALS” of the investigation
- Understanding advantages and limitations of different test methods

Practical Considerations

- Cost
- Timeline
- Physical Access
- Reliability



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### Non-Destructive Testing

Tests:

- Sounding
- Rebound Hammer
- Ground Penetrating Radar (GPR)
- Ultrasonic Pulse Velocity (UPV)
- Impact Echo (IE)



Refer to ICRI Guideline No. 210.4R-2021 for additional methods.



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### Non-Destructive Testing- Sounding



- Running a chain along the surface of the concrete or tapping the surface on the concrete with a hammer.
- A distinctive hollow or “tin” sound is heard at locations of delaminations.



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### Non-Destructive Testing- Rebound Hammer

- Use the rebound hammer to make comparisons between control area and potential damaged area.
- This is not a test to determine compressive strengths.



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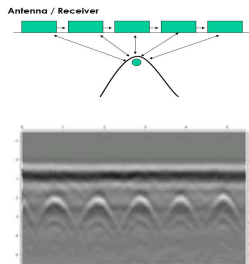
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### Non-Destructive Testing- Ground Penetrating Radar (GPR)

- A GPR “event” is an electromagnetic pulse and the returning responses
- Responses are recorded over a set time window
- By compiling GPR events we create a time slice (depth) profile
- Detect and locate reinforcement



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### Non-Destructive Testing- Ultrasonic Pulse Velocity

- Ultrasonic Stress Wave
- Pitch & Catch Method
- Pick initial arrival time
- Calculate wave "speed"

Guideline No. 210.4-2009/ ACI 228.2R-10, Figure 2.2.1

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### Non-Destructive Testing- Impact Echo

- Mechanically induce stress wave
- Record returning wave(s)
- Detect flaws based on returning waveforms

Guideline No. 210.4-2009/ ACI 228.2R-10, Figure 2.2.5

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### Petrographic Analysis

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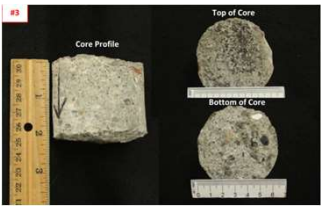
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### Petrographic Analysis

Evaluations:

- Discoloration
- Microcracks/Cracks
- Carbonation



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Core Profile

Top of Core

Bottom of Core

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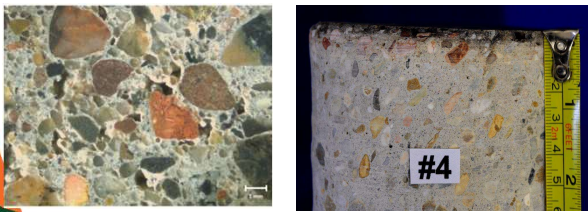
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### Petrographic Analysis

Discoloration



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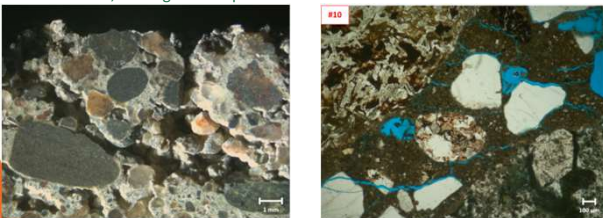
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### Petrographic Analysis

Friable surface, missing cement paste

Horizontal Cracking



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Petrographic Analysis

Carbonation



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Key Take Aways

- Containment of fire with the use of firestop systems is key to reducing property loss and protecting life.
- During a fire, concrete is a good material to withstand a fire but its not impenetrable.

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**BRAUN**  
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This concludes The American Institute of Architects  
Continuing Education Systems Course

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kdeibel@braunintertec.com

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