

Construction Materials Consultants, Inc.

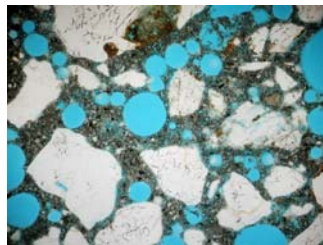
Petrographic Examinations

CMC is the nation's leading firm in petrographic (microscopical) examinations of cement, aggregate, concrete, mortar, grout, masonry, stone, and tile products. Petrographic examination encompasses a variety of microscopical examinations and supplementary chemical analysis of construction materials, which are very helpful to evaluate the quality, composition, integrity, and causes of failure or poor performance. CMC has state-of-the-art laboratories, facilities, and experience for petrographic examinations of construction materials.

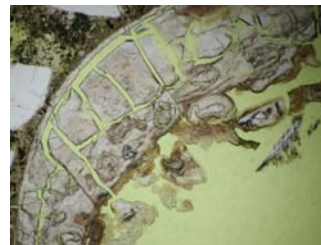
There are four ASTM Standards for petrographic examinations:

- ASTM C 295: Petrographic Examinations of Aggregates
- ASTM C 457: Air-Void Analysis of Concrete and Mortar
- ASTM C 856: Petrographic Examinations of Hardened Concrete
- ASTM C 1324: Petrographic Examinations of Mortar

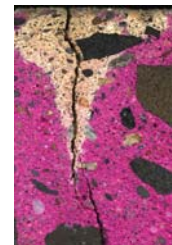
The procedures can be extended to analyses of masonry units, dimension stone, natural stone, and tile products. Petrographic examination is the most reliable method for failure investigation of any construction project.



Air-entrained Concrete



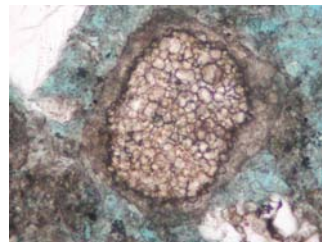
Alkali-Silica Gel in a Void



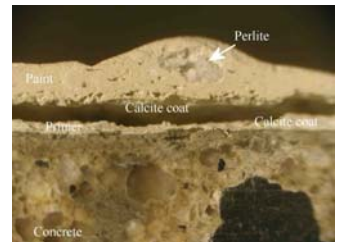
Carbonation



Secondary deposits in a void



Coarse cement grain



Paint De-bonding

CMC

Construction Materials
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For detailed information about
other testing, evaluation, and
consulting services, please visit
us online at:

www.cmc-concrete.com

*Materials Characterization Consider Petrography for
Quality Evaluation Durability Evaluation Failure Investigation*

CONSTRUCTION MATERIALS

Following is a list of various construction materials that are possible to examination by petrography for quality evaluation, characterization, and failure investigation:

Cement & Pozzolan

- Portland Cements and Clinker
- Blended cements containing fly ash, ground granulated blast-furnace slag, silica fume, limestone filler, rice husk ash, calcined clay, and metakaolin
- Expansive Cements
- High Early Strength Cements
- High Alumina Cement
- Gypsum Products
- Lime Products

Aggregate

- Crushed stone
- Natural Sand & Gravel
- Blast-furnace Slag
- Lightweight aggregates
- Heavyweight aggregates
- Manufactured Sand Aggregate
- Recycled concrete aggregate
- Aggregate Unsoundness
- Alkali-Aggregate Reactivity
- Deleterious Constituents in Aggregates

Concrete

- Portland Cement Concrete
- Blended Cement Concrete
- High Performance Concrete
- Fiber Reinforced Concrete
- Lightweight Concrete
- Precast, Prestressed Concrete Products
- Polymer-modified Concrete
- Self-consolidated concrete

Masonry & Mortar

- Portland cement-lime Mortar
- Masonry cement Mortar
- Ancient (lime, lime-pozzolan) Mortar
- Gypsum-based Mortar
- Clay Masonry Units (Brick, Structural Clay Tile, and Terra Cotta)
- Concrete Masonry Units
- Other Cementitious Masonry Units (Calcium Silicate Bricks, Concrete Bricks)
- Stone Masonry Units

Tile & Other Flooring-Covering Materials

- Glazed and Unglazed Ceramic Tile
- Porcelain Tile
- Mosaic Tile
- Quarry Tile
- Vinyl Tile
- Terra-Cotta Tile
- Natural Stone tile
- Cement Body Tile
- Decorative Tile
- Cementitious or Epoxy-based Terrazzo Floor
- Magnesium oxychloride-based flooring
- Gypsum-based underlayments (e.g., Gypcrete)
- Various new proprietary cementitious and polymer-based flooring materials

Dimension Stone

- Limestone
- Granite
- Sandstone and other Quartz-based stones
- Marble
- Slate, Roofing Slate
- Verde Antique

Plaster

- Portland-cement Plaster (Stucco)
- Swimming pool plasters on shotcrete or concrete
- Gypsum Plaster
- Drywall and Plaster Products

Other Materials

- Fill Materials
- Subgrade Materials
- Clay Minerals
- Various chemical admixtures (organic and inorganic) and property-enhancing additives for concrete and masonry industries
- Repair and Patching Grouts & Mortars
- Anchoring Grouts & Mortars
- Proprietary shrinkage-compensating cementitious products
- Shotcrete & shotcrete products
- Concrete and Mortar Pipes (Prestressed Concrete Cylinder Pipe, Reinforced Concrete Pipe, Sewer Pipe)
- Concrete Chimney
- Various new cementitious products
- Architectural cast stones
- Aggregates used in bituminous concrete

FORENSIC INVESTIGATION

Following is a list of various examples of forensic investigations of construction materials, which can be successfully diagnosed by petrographic examinations:

Cement and Aggregate

- Undesirable strength development of a cement
- Unusual setting of a cement
- Cement burn
- Cement unsoundness
- Suitability of a foreign cement
- Aggregate reactivity
- Aggregate unsoundness
- Potentially deleterious constituents in blast-furnace slag aggregates
- Potentially popout-forming aggregates (alkali-silica reactive or water absorptive aggregate)

Concrete

- Deviation from project specifications
- Surface distress (Scaling, Spalling, Discoloration, Pop-outs, Mortar Lift-offs, Salt-scaling, Delamination, Dusting, Cracking, Blistering, Abrasion, Impact, Erosion)
- Concrete cracking by various shrinkage and expansion mechanisms
- Concrete slab curling and cracking
- Corrosion of reinforcing steel in concrete
- Alkali-aggregate reactions
- Internal and External Sulfate attacks
- Delayed Ettringite Formation (DEF)
- Seawater attacks
- Efflorescence, Staining, Discoloration
- Reasons for lower-than-designed Strength; Slow strength gain
- Delayed hydration of free lime & magnesia in hardened concrete
- Physical salt attacks (Salt hydration distress)
- Acid and alkali attacks
- Surface abrasion, Impact, and Erosion
- Freezing of Plastic or Hardened Concrete; Deteriorations due to cyclic freezing and thawing
- Abnormal setting (delayed or accelerated setting)
- Fire attack and related cracking and strength loss
- Concrete burn
- Concrete pipe and sewer pipe deteriorations

Masonry

- Cracking, disintegration, discoloration (staining and efflorescence), and debonding
- Water leakage in masonry walls
- Jointing mortar softening and disintegration

- Compositional evaluation of an ancient mortar to determine a suitable repointing mortar in the restoration of a historic masonry structure
- Failures related to deviation from project specifications
- Failures related to cyclic freezing and thawing
- Failures related to moisture penetration

Tile and Floor Covering

- De-bonding of ceramic, vinyl, or stone floor tiles
- Tile cracking due to moisture-related expansion
- Bumps, Blisters, Discoloration
- Terrazzo failures
- Floor tile lifting and debonding due to moisture-related or other expansions of setting bed mortar and/or jointing grout
- Moisture related problems and other floor covering failures
- Blistering, discoloration, and other distress on a floor covering product due to improper material, poor workmanship, or various internal expansive chemical reactions in the concrete substrate
- Cracking, softening, and disintegration of gypsum floor underlayments due to poor material, improper workmanship, or improper design

Plaster

- Stucco cracking, corrosion of metal lath, delamination, debonding, softening, discoloration and staining, aggregate popout, deviation from project specifications
- Swimming pool plaster deteriorations, e.g., cracking, spot etching, staining, discoloration, corrosion of steel, delamination, erosion
- Gypsum plaster failures related to moisture, improper materials, or poor workmanship

Paint and Other Surface Films

- Paint blistering and debonding from drywall
- Paint debonding and blistering from concrete floor
- Delamination of a film-forming surface sealer from a concrete surface

Stone

- Cracking, debonding, delamination, curling, and bowing of stone panels due to volume instability by moisture and/or thermal fluctuations and hysteresis
- Stone failures related to cyclic freezing and thawing at saturated conditions
- Discoloration and staining in stone panels
- Various deteriorations of cast stones and other architectural stones
- Failures related to improper design or installation