

A6788: Concrete, Cast Stone, and Mortar (Spring 2025)

Norman R. Weiss and Heather Hartshorn

Session B, Mondays, 2:00-5:00 PM

Preservation Technology Lab (655 Schermerhorn Ext.)

Course Description:

The use of mortar and stucco originated in the Neolithic period. The Romans expanded this technology with the development of cast-in-place concrete construction. This course discusses the growing importance of these materials and techniques during the Industrial Revolution, reviewing discoveries that led to the development of novel lime- and cement-based compositions from the late 18th century to the present. By the 20th century, advances in technology transformed concrete and precast from functional engineering media into the most expressive and sculptural substances of modernism.

The visual simplicity of these the materials belies the complexity of their curing and aging mechanisms. Materials science is the fundamental tool used to examine history, and to define suitable repair, replication and maintenance methods for masonry and concrete structures. Key topics are binder types and curing mechanisms; the role of aggregates and admixtures; building performance criteria; construction/manufacturing methods; and laboratory evaluation. It is one of a series of courses on architectural materials recommended to historic preservation students focusing on technical conservation issues.

Readings:

Relevant readings will be posted to CourseWorks for every session, and these will supplement and clarify the material covered in class. In some cases, the lectures will build on knowledge derived directly from the readings. We will try to reserve a few minutes at the start of each class to give you an opportunity to ask questions and/or to render opinions on the readings.

Participation (40% of total grade):

All students are expected to take an active role in the class. Do not apologize for your questions, even if they seem tangential. Answering them is why we love teaching this course! We will do our best to make the course content understandable and interesting. Please be fully engaged. Interrupt lectures for clarification, and feel free to challenge us with thoughtful arguments.

Weekly essays (10% each = 60% of total grade):

Students are required to complete a short essay following each class session. The essay should write about a topic of their choosing that was covered in the class lecture or the assigned readings. The essay should cover 1) why the topic is of interest to the student in the context of the material discussed during the lecture and 2) include a summary and commentary on one scholarly source that was NOT included in the assigned readings or additional resources provided by the professors. Essays are due via email to Norman and Heather by the beginning of the class session the following week.

Lecture Schedule:

March 10, Class 1: Introduction; Mortar and Stucco components and performance (plan to get dirty)

- Terminology by use/composition
- Mixing materials and examining properties - lab component
- Mixes and workability
- Strength, set time, and durability
- Shrinkage, adhesion, and appearance as performance criteria

March 24, Class 2: Raw materials

- Binders: limes, cements, gypsum, pozzolan-based
- Sand, gravel, and crushed stone; particle size distribution and shape
- Air-entrainers, water-reducers, and set-controllers
- Pigments

March 31, Class 3: History of concrete/cast stone and evolution of construction technology (Part 1)

April 7, Class 4: History of concrete/cast stone and evolution of construction technology (Part 2)

- Artificial stone and “artistic concrete”
- Concrete in Europe
- American pioneers (including Fowler, Hyatt, and Earley)
- Reinforcement
- “Scientific” mix design and w/c
- Formwork
- Transit mixing

April 14, Class 5: Failure mechanisms

- Surface defects
- Carbonation and environmental weathering
- Freeze-thaw distress
- Sulfate attack
- Alkali-aggregate reactions

April 21, Class 6: Repair and maintenance of concrete

- Cleaning
- Water-repellents and MCI's
- Crack injection
- Patching
- Carbon fiber strengthening