Concrete Construction

27108-06, Introduction to Concrete, Reinforcing Materials, and Forms

Concrete Construction

- When you have completed this module, you will be able to do the following:
  - Identify the properties of concrete.
  - Describe the composition of concrete.
  - Perform volume estimates for concrete quantity estimates.
  - Identify types of concrete reinforcement materials and describe their uses.
  - Identify various types of footings and explain their uses.
  - Identify the parts of various types of forms. Erect, plumb, and brace a simple concrete form with reinforcement.

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- **Concrete** is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time.
- Most concretes used are lime-based concretes such as Portland cement concrete

Concrete Construction

- When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily placed and molded into shape.
- The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses.

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- Often, additives (such as pozzolans or superplasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material.
- Most concrete is placed with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

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- Famous concrete structures include the Hoover Dam, the Panama Canal, and the Roman Pantheon.
- The earliest large-scale users of concrete technology were the ancient Romans, and concrete was widely used in the Roman Empire.
- The Colosseum in Rome was built largely of concrete, and the concrete dome of the Pantheon is the world's largest unreinforced concrete dome.

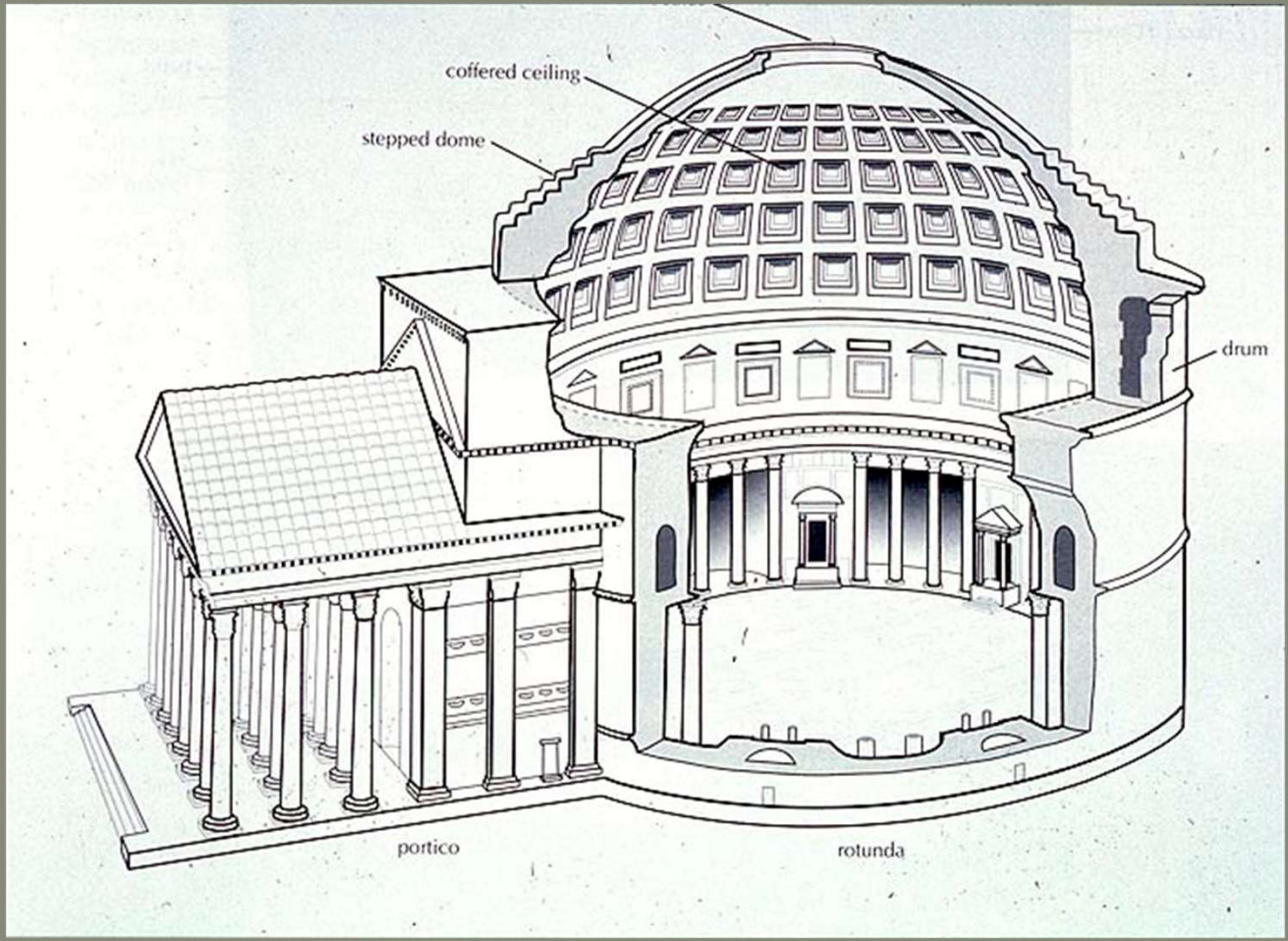
The Roman Coliseum

The Roman Pantheon, finished 128 AD, is still the largest unreinforced solid concrete dome in the world.

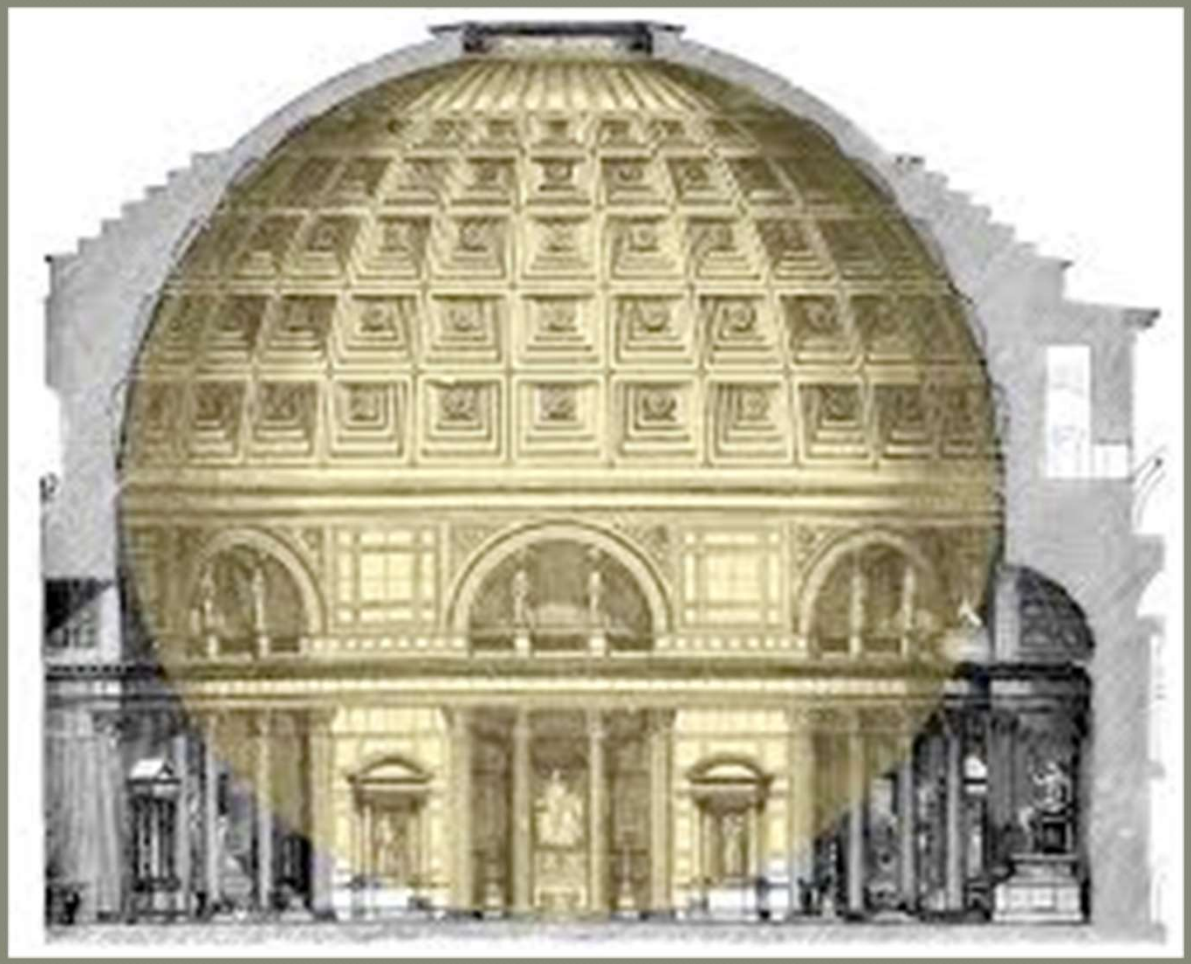
The rear of the Roman Pantheon, from above.

The Roman Pantheon, from above.

A design drawing of the Roman Pantheon.



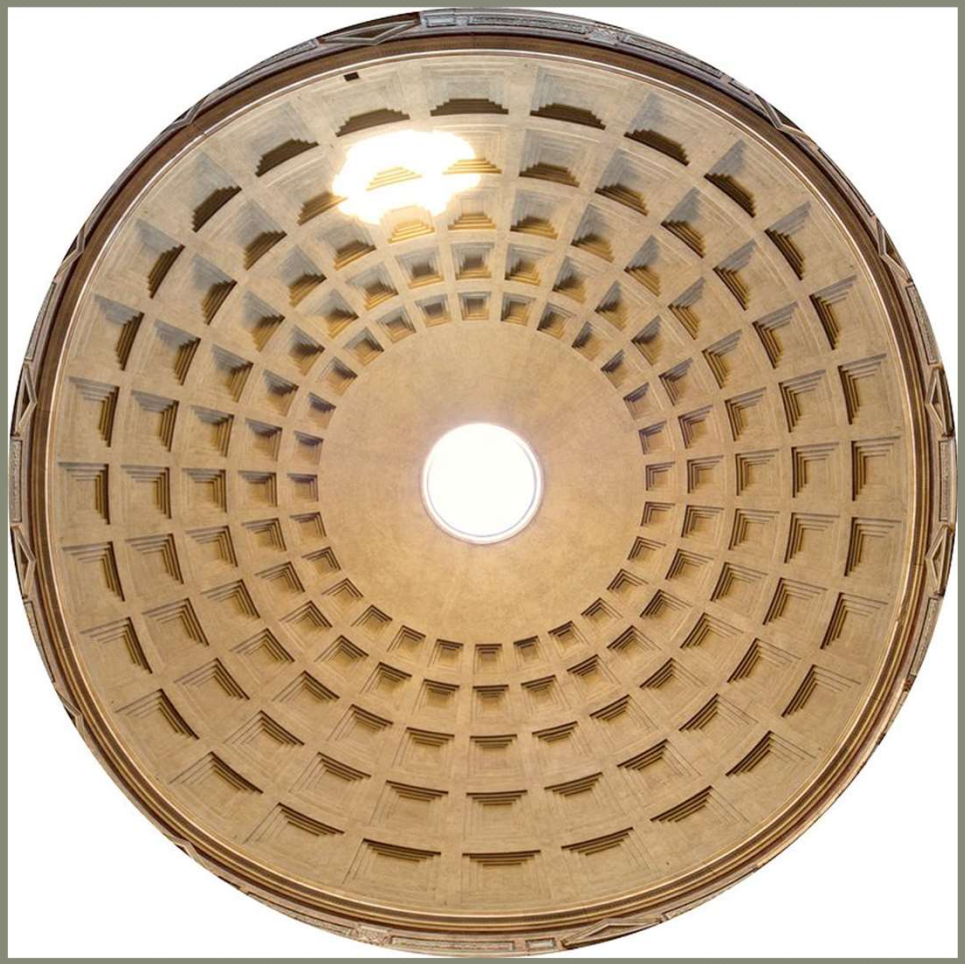
The strength of the dome of the Roman Pantheon is derived from the strength of a sphere.



The interior of the Roman Pantheon.

The interior dome of the Roman Pantheon.

The interior of the Pantheon dome, seen from beneath. The concrete for the coffered dome was laid on molds, probably mounted on temporary scaffolding.



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- Today, large concrete structures are usually made with reinforced concrete.
- After the Roman Empire collapsed, the use of concrete became rare until the technology was redeveloped in the mid-18th century.
- Today, concrete is the most widely used man-made material.

Concrete Construction

- Etymology
  - The word concrete comes from the Latin word "*concretus*" (meaning compact or condensed), the perfect passive participle of "*concrescere*", from "*con*-" (together) and "*crescere*" (to grow).

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- Mix Design. The mix design depends on the type of structure being built, how the concrete is mixed and delivered, and how it is placed to form the structure.

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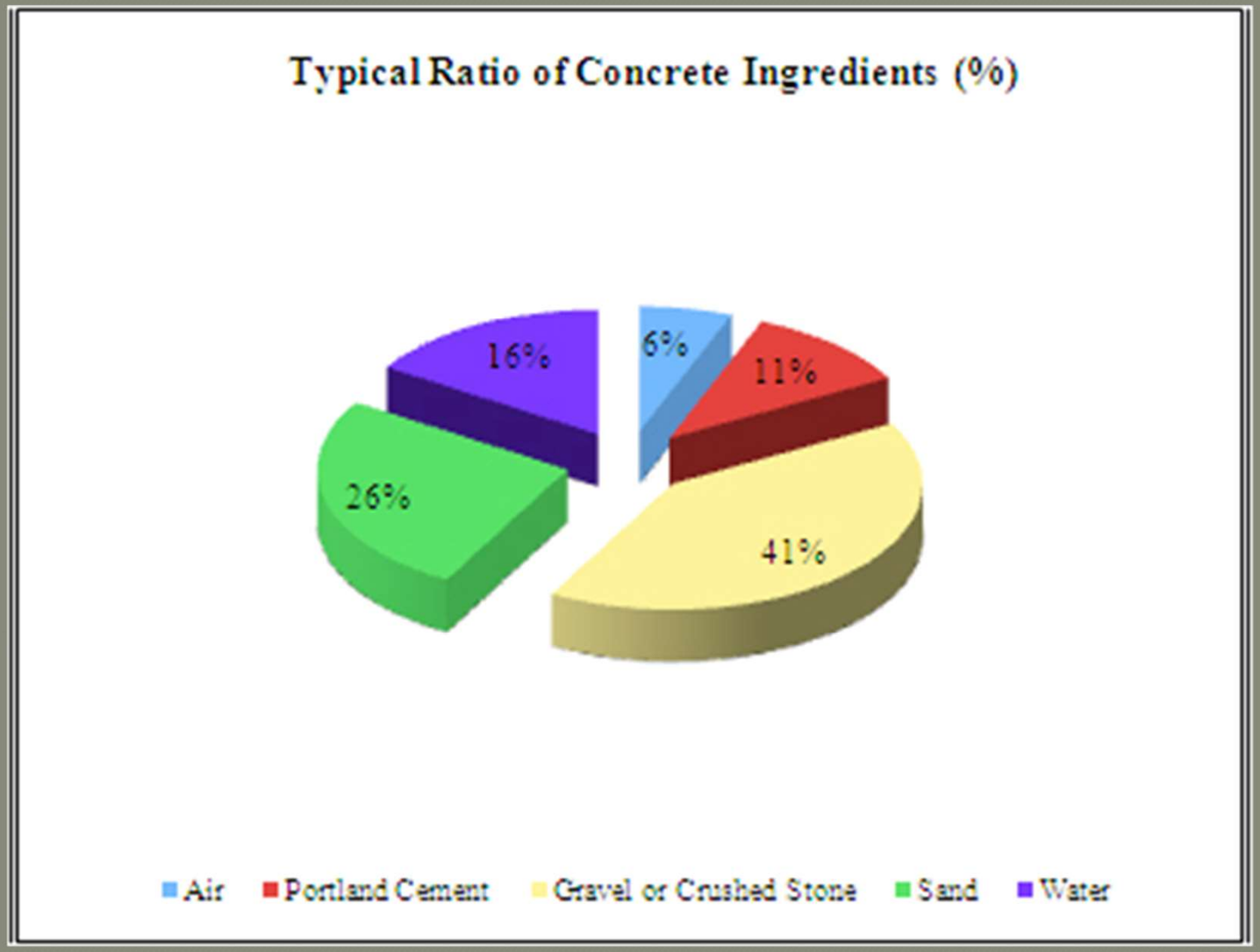

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- Many types of concrete are available, distinguished by the proportions of the main ingredients.
- In this way or by substitution for the cementitious and aggregate phases, the finished product can be tailored to its application.
- Strength, density, as well chemical and thermal resistance are variables.

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- Concrete has great compression strength, but little tensile strength, and there must be reinforced.
  - Compression Strength. Compression strength is the capacity of a material or structure to withstand downward loads tending to reduce size.
  - Tensile Strength. Tensile strength is the resistance of a material to breaking under tension.

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- Aggregate consists of large chunks of material in a concrete mix, generally a coarse gravel or crushed rocks such as limestone, or granite, along with finer materials such as sand.

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- Cement, most commonly Portland cement, is associated with the general term "concrete."
- Other cementitious materials such as fly ash and slag cement, are sometimes added as mineral admixtures - either pre-blended with the cement or directly as a concrete component - and become a part of the binder for the aggregate.

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- To produce concrete from most cements, water is mixed with the dry powder and aggregate, which produces a semi-liquid slurry that can be shaped, typically by pouring it into a form.

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- The concrete solidifies and hardens through a chemical process called hydration.
- The water reacts with the cement, which bonds the other components together, creating a robust stone-like material.

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- Chemical admixtures are added to achieve varied properties.
- These ingredients may accelerate or slow down the rate at which the concrete hardens, and impart many other useful properties including increased tensile strength, entrainment of air, and/or water resistance.

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- Reinforcement is often included in concrete.
- Concrete can be formulated with high compressive strength, but always has lower tensile strength.
- For this reason it is usually reinforced with materials that are strong in tension, typically steel rebar.

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- Mineral admixtures are becoming more popular in recent decades.
- The use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation, and the discovery that such materials often have complementary and valuable properties.

- The most conspicuous of these are:
  - fly ash, a by-product of coal-fired power plants,
  - ground granulated blast furnace slag, a byproduct of steelmaking, and
  - silica fume, a byproduct of industrial electric arc furnaces.

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- The use of these materials in concrete reduces the amount of resources required, as the mineral admixtures act as a partial cement replacement.
- This displaces some cement production, an energetically expensive and environmentally problematic process, while reducing the amount of industrial waste that must be disposed of.
- Mineral admixtures can be pre-blended with the cement during its production for sale and use as a blended cement, or mixed directly with other components when the concrete is produced.