Interior Design Materials

Concrete Based Materials

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Lecture Content:

- Cement
- Mortar
- Grout
- Overlays
- Cast stone
- Terrazzo
- Concrete

Cement

is made of finely pulverized clay and limestone and used as an ingredient in **concrete** or **mortar**

Cement is **calcined**, that is, heated to a high temperature without melting or fusing. It acts as a **binder**, a substance that sets and hardens independently and can hold other materials together. In concrete, it binds **aggregates** (stones and sand or other filler material) into a strong, solid mass.

Types of Cement

Cured cement is a hard, dense solid with a rough texture. The uniform gray or white texture of cement combines with the color and texture of aggregates in concrete. Cement lacks the durability of concrete and cracks and crumbles readily.

Different types of cement

Types of Cement

- **Hydraulic cement** is any cement that hardens with the addition of water.
- Today's **Portland cement** is a hydraulic cement made by burning a mixture of clay and limestone in a rotary **kiln** fired by powdered coal or natural gas

- White Portland cement is selected primarily for its aesthetic appeal.

- Interior floors and precast concrete products are made with either type of normal Portland cement

TYPES OF CEMENT:

1. Ordinary Portland Cement
2. Rapid Hardening Cement (or) High Early Strength cement
3. Extra Rapid Hardening Cement
4. Sulphate Resisting Cement
5. Quick Setting Cement
6. Low Heat Cement
7. Portland Pozzolana Cement
8. Portland Slag Cement
9. High Alumina Cement
10. Air Entraining Cement
11. Supersulphated Cement
12. Masonry Cement
13. Expansive Cement
14. Colored Cement
15. White Cement

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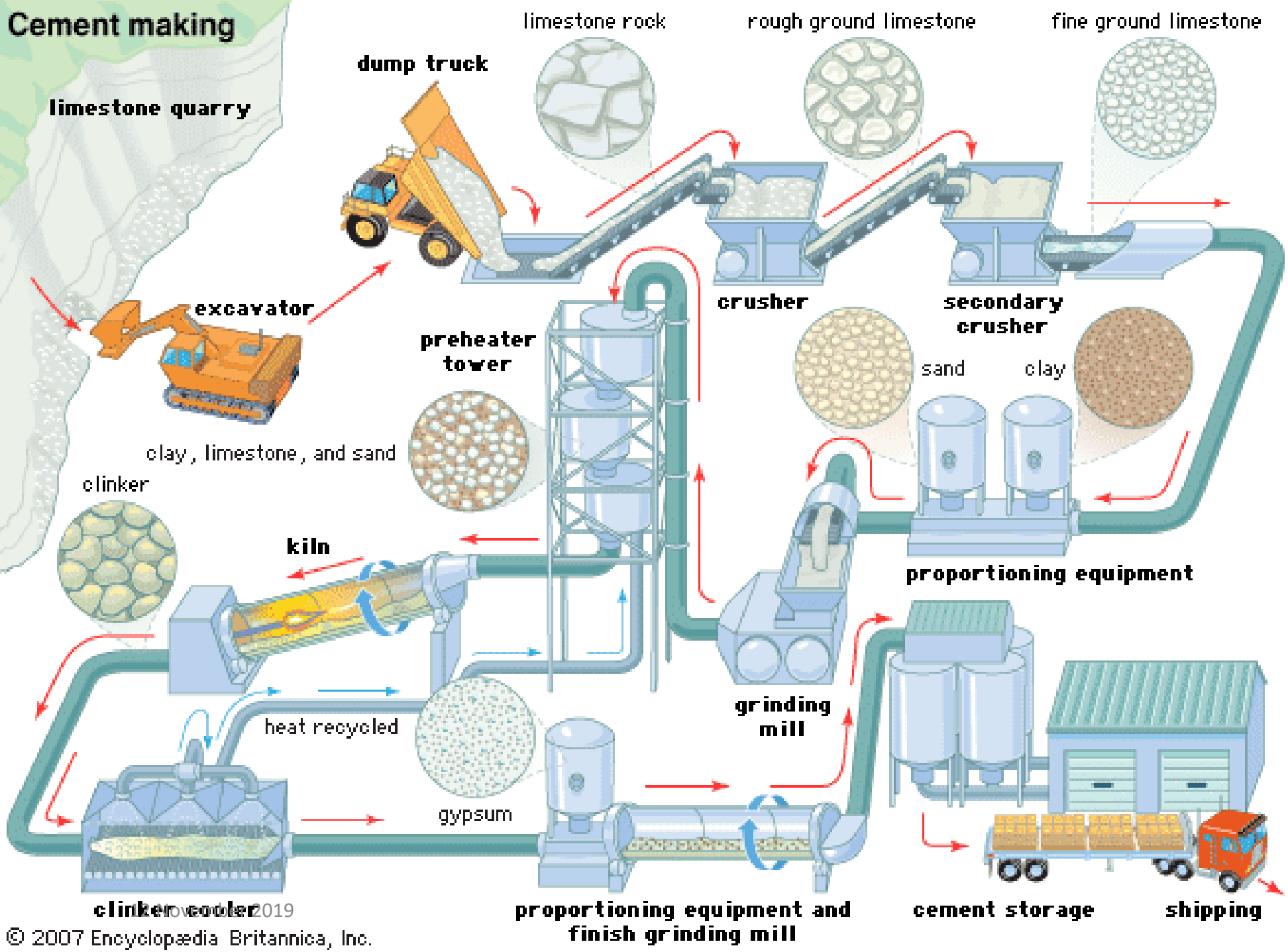
Manufacturing Cement

- Portland cement consists of over 30 raw materials, primarily calcium silicates, aluminates, and aluminoferrites

- In simplified form, the process of manufacturing cement begins with obtaining raw materials and crushing and grinding them into raw meal. This is fed into a kiln, which uses one of several complex processes to produce clinker. The clinker is cooled, mixed with additives, and sent through another grinder to produce cement



Environmental Impacts of Cement

- Portland cement plants are usually located near the material's source. The calcium materials for Portland cement are usually obtained from open-face quarries. Approximately one-third of the mass of these materials is lost as carbon dioxide (CO_2) in the kiln, giving cement a large carbon footprint.

Energy Use and Emissions

- The production of cement is an energy intensive process. Cement constitutes about 12 percent of the materials in concrete, but accounts for about 92 percent of concrete's embodied energy.

- Most of the energy consumed in cement production is used to operate rotary cement kilns fired with coal, natural gas, and occasionally oil.

Alternative Cements

- Carbon negative cement (CNC) is a new formulation for cement that replaces the traditional mix of calcium carbonate compounds with magnesium oxides and silicates. Cement made with magnesium silicate does not generate CO2 and absorbs it in use.

Specifying Cement

- American Society for Testing and Materials (ASTM) Specification C-150 /C150M Standard Specification of Portland Cement describes ten types of Portland cement along with several subtypes.
- Interior floors and precast concrete products are made with Type I, normal Portland cement, which is available in white or gray.

- **Cement Type** **Description**

Type I	Normal
Type II	Moderate Sulfate Resistance
Type II (MH)	Moderate Heat of Hydration (and Moderate Sulfate Resistance)
Type III	High Early Strength
Type IV	Low Heat Hydration
Type V	High Sulfate Resistance

- For blended hydraulic cements – specified by ASTM C595 – the following nomenclature is used:

- **Cement Type** **Description**

Type IL	Portland-Limestone Cement
Type IS	Portland-Slag Cement
Type IP	Portland-Pozzonlan Cement
Type IT	Ternary Blended Cement

Applications for Cement

- Cement-based materials with interior applications include mortar, grout, cementitious backer board, cement-based overlays, and cast stone. Terrazzo is also covered in this section.

Mortar

- Mortar is a workable cement-based paste used to bind masonry units together and fill gaps between them. When it sets, mortar bonds with the stone, bricks, or blocks to create a rigid structure. Cement mortar consists of portland cement, sand, and water.

Table 4.1: Mortar Mixes

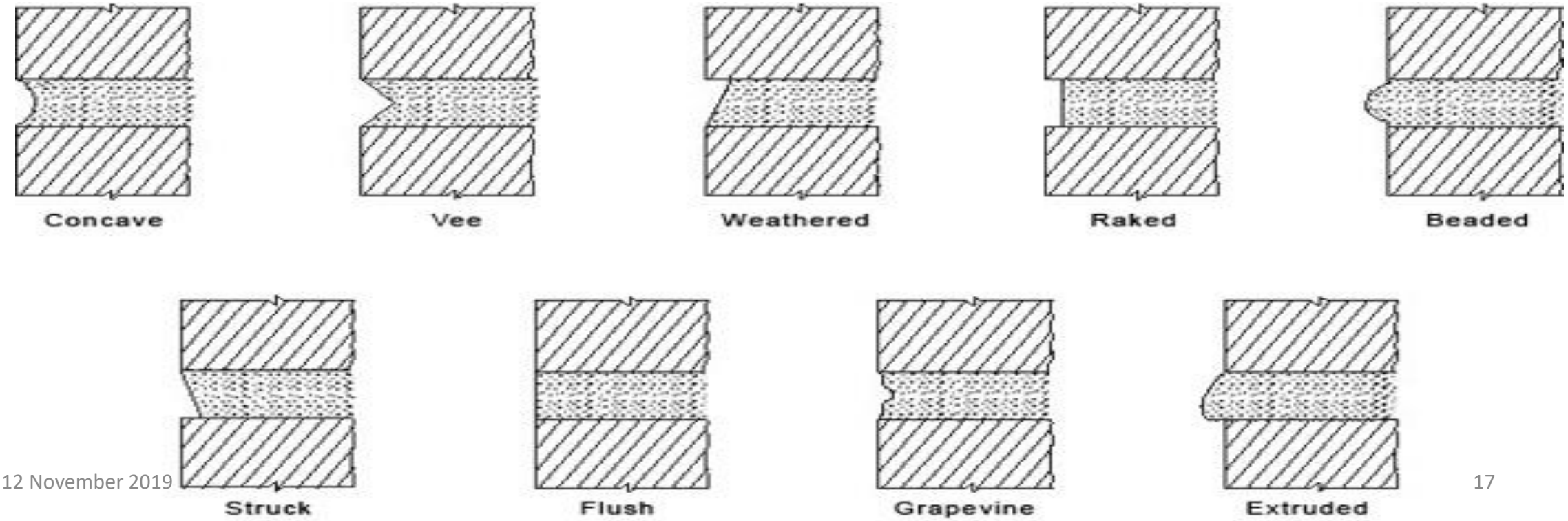
Mix Type	Description
Mixed on-site	From cement, lime, sand, and water; can customize
Premixed masonry cement	Premixed Portland cement and other ingredients, mixed with sand and water on site; stone, block, and brick masonry
Lime mortar	Mixture of lime, sand, and water; historic buildings
Mortar for glass block	White sand, cement, and lime; provides a decorative and waterproof joint

Mortar Joints

- Mortar joints vary from (6 to 13 mm) thick but are typically (10 mm).

  The type of joint used determines the appearance of the shadow line

  that gives texture to masonry walls



Grout

- Grout is a fluid cement mortar designed to flow smoothly and easily. It is used to fill narrow cavities in masonry and bind adjoining materials into a solid mass.

Overlays

- Cement-based overlays blend cement, sand, and additives to improve performance, wear resistance, and appearance. They are also used to smooth and level uneven concrete surfaces and to resurface interior floors.

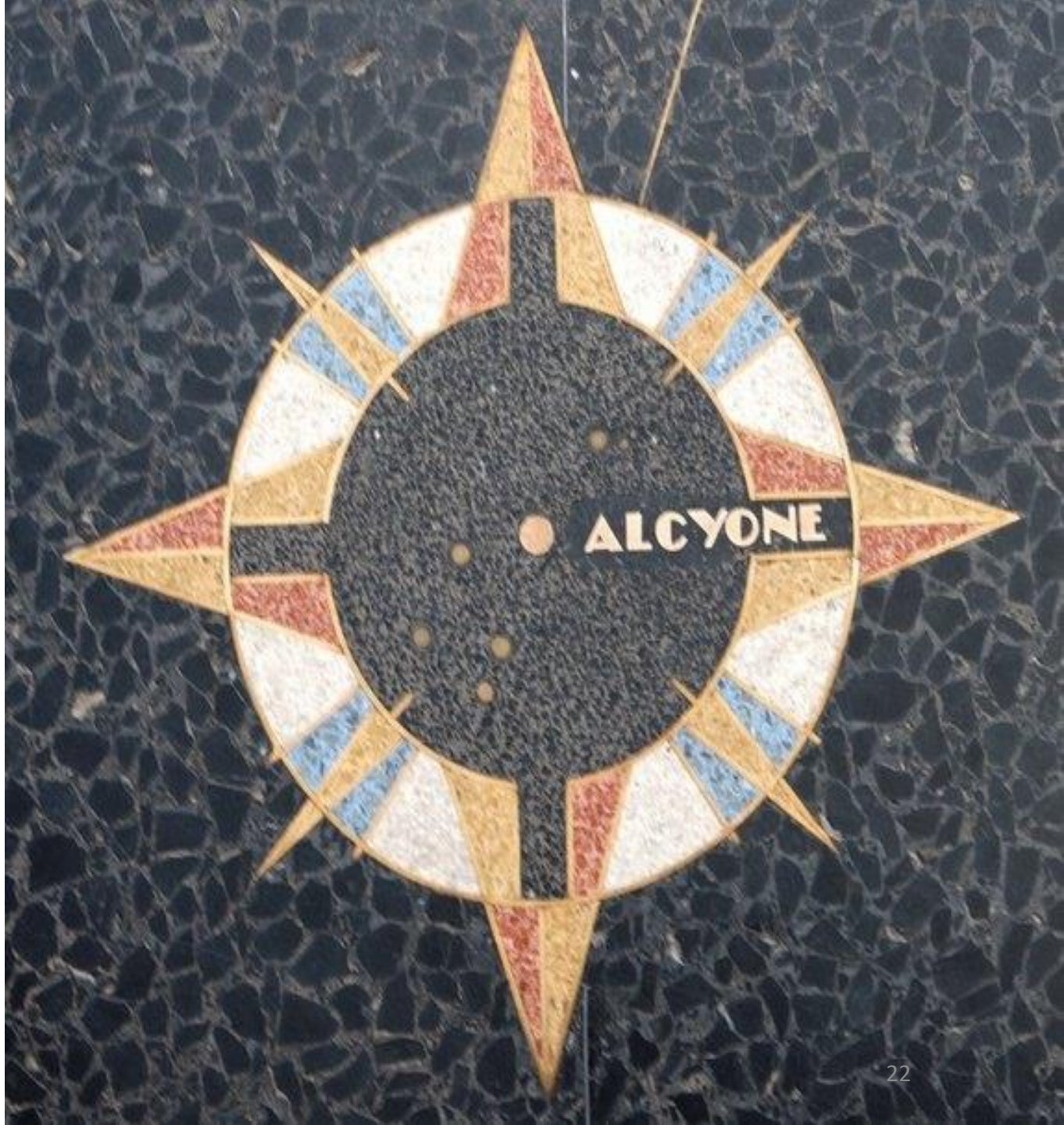
Cast stone

- Cast stone is a concrete **masonry** product simulating natural-cut stone and is used in architectural applications. Cast stone is used for architectural features: trim, or ornament; facing buildings or other structures; and for garden ornaments. Cast stone mixtures are blends of natural stone aggregates bonded with white cement. Finishes vary from very smooth to heavily distressed. Both standard and custom colors are available.

TERRAZZO

- Terrazzo is a dense, extremely durable, smooth flooring material with a speckled appearance. Terrazzo is composed of an aggregate set in a matrix binder to hold the chips in place. It is either poured in place or precast, and is used primarily for floor and wall treatments. The size and colors of the aggregate and the color of the binder determine the terrazzo's final coloring

- Poured terrazzo is set with aluminum or vinyl divider strips. Terrazzo can be customized into unusual shapes and contours for either precast or on-site applications. It can also be set into precision- cut forms to create logos, medallions, text, or abstract patterns.



Types of Terrazzo

	Description
Standard (S)	Ground and polished finish consisting mainly of relatively small stone chips, with resin or cement-based binders
Designer (D), Exotic (E)	Use specialty aggregates, available only with epoxy resin binders; more expensive
Venetian (V)	Large stone chips, with smaller chips filling spaces; usually use Portland cement binders
Palladiana	Cut or fractured marble slabs set by hand in the desired pattern, with smaller chips set into the spaces between
Rustic (R)9	Uniformly textured finish exposes rough chips, usually in a Portland cement binder; exterior use

- Precast terrazzo
- is poured into molds, then moisture cured, ground, polished, or otherwise finished.
- It is installed with a fluid-applied sealant. Precast terrazzo tile is available as flat base, wainscot, treads, and risers.

Environmental Impacts of Terrazzo

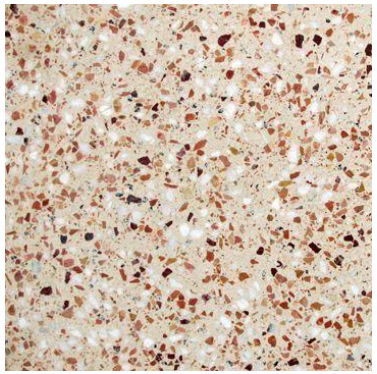
- Terrazzo is a durable and easily maintained material that often lasts the life of a building and can be restored cost effectively. On-site manufacturing minimizes waste and transportation.
- Sealers for cement-based terrazzo systems may contain VOCs. Thin set epoxy terrazzo systems are available with VOC-free formulas.

Applications for Terrazzo

- Terrazzo is used for floors, counters, bar tops, tabletops, and vanities.

Precast terrazzo is available as tiles, steps, treads and risers, bases, planters, wall panels, windowsills, thresholds, and outdoor furniture.

Standard shapes are available, and custom designs are possible.



Specifying and Cost Factors for Terrazzo

- The selection of an installation system depends on whether the subfloor will be concrete or wood, and if there are any limits on thickness or weight. Precast panel sizes and the location of metal divider strips are also considered.

Installing Terrazzo

- Terrazzo is constructed in sand cushion, bonded, monolithic, epoxy, polyacrylate, or rustic installations.
- Precast terrazzo tiles and bases are usually installed, finished, and polished on a cement/sand base. Stair treads and risers consist of a 1/2″ (13 mm) thick terrazzo topping or precast pieces on a 3/4″ (19 mm) underbed

CONCRETE

- Concrete is an artificial stone-like material made by mixing cement and aggregates (Gravel+sand) with enough water to cause the cement to set, binding the entire mass. Concrete is widely used as a building material, and appears in interiors as both an integral and an applied finish.

Physical Properties

- Concrete is plastic and malleable when newly mixed and can be formed into almost any shape. Concrete is strong and durable in compression and becomes stronger with time. Its **tensile** strength can be improved by the addition of steel reinforcement. Concrete is inherently fire-resistant and accepts a wide variety of surface finishes and textures.

- The appearance of concrete depends on the composition of the concrete mix and the design of formwork used. Surface treatments applied after concrete is cast and the quality of workmanship are especially important for interior finishes.

Types of Concrete

- Concrete used in building construction is either cast in place or precast.
- Cast-in place concrete is poured into formwork on site. Ready-mixed concrete constitutes the majority of concrete used in building construction. It is typically delivered to the site by truck

- Precast concrete products are made in a factory under controlled conditions. Precast products are used for structural and nonstructural uses

Manufacturing of Concrete

- Aggregates for concrete are dug from gravel pits or along rivers, or crushed from larger rocks. They are selected by size, durability, shape, texture, and abrasion and skid resistance.
- Mixing cement and aggregate with water produces a chemical reaction that causes the process of hydration, a chemical reaction that links the cement particles together with the aggregates.

Hydration

- Most of the hydration and strength gain takes place in the first month, but it continues at a slower rate for many years. Concrete is normally specified according to the compressive strength it will develop within 28 days after placement.

Environmental Impacts of Concrete

- The raw materials used in both cement and concrete are widely available in large quantities. The distance and quality of the sources affect transportation energy use, water use for washing, and dust generation. Once hardened, concrete is a generally safe, inert material. Concrete does not off-gas or deteriorate indoor air quality in occupied buildings, although some admixtures may. The durability of concrete extends its useful life. Its heat storage abilities and thermal mass have passive solar applications.

Embodied Energy

- Cement production is one of the most energy-intensive of all industrial manufacturing processes. The 12 percent of concrete that consists of cement accounts for 92 percent of concrete's embodied energy. The other components of concrete—sand, crushed stone, and water—are much less energy intensive.

Water Use

- The water used to wash the insides of concrete trucks, tools, and related equipment is highly alkaline, and toxic to aquatic life. Concrete companies are increasingly adopting closed-loop water recycling at plants, and collecting and properly disposing of water from rinsing of trucks and chutes at building sites.

Health Considerations

- The most common health problem associated with concrete is its caustic, abrasive, and drying properties when in contact with the skin. Some additives to concrete contain formaldehyde compounds that could cause health problems.
- Concrete floors and walls with moisture problems may support the growth of mold and mildew. Insulation of cold concrete surfaces helps solve the problem.

Applications for Concrete

- In addition to its structural uses, precast concrete is used for planters, furniture, sinks, fireplace surrounds, and other objects. Decorative concrete integrally colored throughout is available. Newer color admixtures have improved batch-to-batch consistency and fading problems.

Concrete Fireplace Surrounds

- Concrete fireplace surrounds are fire resistant with good heat retention and the ability to be molded into virtually any form . Precast concrete fireplace surrounds are available that can be cut to fit unique shapes. Many fireplace surrounds are made of glass fiber reinforced concrete (GFRC).

Concrete Sinks

- Concrete sinks and vessels are made in many shapes. Vessel sinks resemble a bowl set on a countertop; they are available precast as well as made of cast stone. Integral sinks are designed in one piece with the countertop

Translucent Concrete

- Translucent or light-transmitting concrete is made by casting thousands of optical fibers into concrete . The fibers run parallel to each other between two surfaces of the concrete. After casting, the material is cut into panels, blocks, or tiles. The surface is then usually polished to a semi gloss or high-gloss finish
- its use to nonstructural applications.
- The fibers transmit light very efficiently, but as they make up only 4 percent to 5 percent of the material

Cost Factors for Concrete

- Estimating costs for concrete floor slabs by adding up all of the individual components (i.e., formwork, reinforcing, concrete, placement, and finishing) is accurate but time-consuming, and not practical for concrete work that is only a small part of a project.

- Materials costs for precast concrete are higher than for site poured concrete, but may be offset by savings in labor and scheduling efficiencies.
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Finishes for Concrete

- The appearance of concrete surfaces is modified by changing the size, shape, texture, or color of the coarse and fine aggregates, and by exposing varying amounts of the aggregate on the surface

Finish	Description
Hand troweled	Concrete finished with trowel for nonporous surface
Textured	Chemicals or sandblasting expose aggregate
Broom	Simple light or coarse nonslip finish
Rock salt	Speckled pattern of shallow indentations
Stamped	Color usually from dry-shake powder
Stenciling	Masked-off area is sandblasted, colored, etched
Acid staining	Translucent permanent stains; easy to maintain for countertops, sinks, showers
Concrete dyes	Penetrate concrete surface, layered color; protect with sealer or wax
Ground High gloss	Shiny, dirt-resistant finish with no waxes, coatings; impregnating sealer
Engraved concrete	Designs stained, then uncolored pattern routed out, looks like grout line
Self-leveling overlays	Fluid polymer-modified toppings can be stained or dyed; also underlayment for other floor coverings

Decorative Finishes

- Color is added to concrete in several ways (Figures 4.26–4.28). Dry-shake color hardeners produce a durable, dense, and abrasion-resistant surface with brighter or unusual colors

Concrete Sealers

- Concrete sealers are primarily used to block surface moisture. Some must be applied directly to the substrate and may receive topical coatings or be used in multicomponent systems. Others should not be used with topical coatings.