Unit 10
Construction Materials — Types and Uses

Learning Objectives
After completing this unit, you will be able to:
• Identify a variety of basic materials used in construction.
• Identify the basic components of concrete.
• Explain different concrete construction methods.
• Describe different types of masonry brick, block, and mortar.
• Classify wood as hardwood or softwood.
• Recognize different structural steel shapes.
• Describe various types of glass, plastic, and insulation.
• Identify symbols representing materials on a drawing.

Technical Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admixture</td>
<td>Lintels</td>
</tr>
<tr>
<td>Adobe brick</td>
<td>Loose-fill insulation</td>
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<td>Aggregates</td>
<td>Lumber</td>
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<td>Angles</td>
<td>Mosaic tiles</td>
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<tr>
<td>Ashlar</td>
<td>Nonferrous metals</td>
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<tr>
<td>Bent glass</td>
<td>Patterned glass</td>
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<td>Bond</td>
<td>Paving brick</td>
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<td>Bond beams</td>
<td>Plastics</td>
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<td>Plate glass</td>
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<tr>
<td>Cement</td>
<td>Quarry tile</td>
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<td>Ceramic tiles</td>
<td>Reflective insulation</td>
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<tr>
<td>Concrete</td>
<td>Reinforcing bars</td>
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<tr>
<td>Concrete brick</td>
<td>Rigid insulation</td>
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<tr>
<td>Concrete masonry unit</td>
<td>Rough-sawn lumber</td>
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<td>Cut stones</td>
<td>Rubble</td>
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<td>Ferrous metals</td>
<td>Safety glass</td>
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<td>Firebrick</td>
<td>Sand-lime brick</td>
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<td>Fired clay tile</td>
<td>Single-wythe walls</td>
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<td>Flexible insulation</td>
<td>Sheet glass</td>
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<td>Float glass</td>
<td>Stained glass</td>
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<td>Gage system</td>
<td>Stone masonry</td>
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<td>Glass block</td>
<td>Stretcher</td>
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<tr>
<td>Glazed brick</td>
<td>Structural clay tile</td>
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<tr>
<td>Gravel</td>
<td>Structural steel</td>
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<td>Grout</td>
<td>Surfaced lumber</td>
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<td>Headers</td>
<td>Terra cotta</td>
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<td>Hydration</td>
<td>Thermal insulation</td>
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<tr>
<td>Insulating glass</td>
<td>Welded wire fabric</td>
</tr>
<tr>
<td>Kiln-burned brick</td>
<td>(WWF)</td>
</tr>
<tr>
<td>Laminating</td>
<td></td>
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Division 31 – Earthwork

Aggregates (also referred to as gravel) are used for many different construction applications. In building construction, they are typically used as subbase support under concrete slabs, foundation and underground drainage, fill around pipes, and as one of the three basic concrete ingredients. See Figure 10-1. Aggregates start out as solid rock in the earth’s crust, and over many thousands of years, are broken down by freeze/thaw cycles and other natural action into pieces of various sizes. The larger pieces are called coarse aggregates or gravel; the smaller pieces are usually referred to as sand or fine aggregates.

There are various kinds of aggregates, such as:
- **Pea gravel**, small rounded pieces ranging in diameter from 1/4” to 3/8”.
- **River gravel**, larger aggregates dredged from river bottoms, banks, and flood plains.

**Characteristics of aggregates are:**
- Soundness
- Chemical stability
- Abrasion resistance
- Grading and sieve analysis
- Percentage of crushed particles
- Particle shape

Division 03 – Concrete

Concrete is one of the oldest building materials, having been used by the Romans as early as 100 B.C. Concrete is a mixture of cement,
sand, coarse and fine aggregates, admixtures, and water. When first mixed, it is plastic (able to flow and be shaped) and can be cast to take the shape of the formwork provided.

Hardening of the concrete is caused by a chemical reaction between the cement and water called hydration. Most mixtures of concrete set within 4–12 hours, depending on the temperature, the volume of the pour, type of cement, and admixtures. When the temperature is below 70°F (20°C), the reaction slows. Very little chemical reaction takes place below 40°F (4°C), and almost none occurs at 32°F (0°C). The rule of thumb is: if you are comfortable, the concrete is comfortable. Concrete continues to harden for months after the initial set, but most placements reach their compressive or design strength within 28 days. Forms can be removed after one to several days or when the concrete can support itself. This should be determined by an engineer.

Types of Cement

Cement binds the concrete mix together. There are a number of types of cement. The most common, used for general construction, is called Type I Normal Portland cement. Another variation used in construction is white Portland cement. It is light-colored and used chiefly for architectural effects. White Portland cement is made from carefully selected raw materials and develops the same strength as the normal gray-colored Portland cement.

Types of cement include:

- Type I, Normal Cement (most common)
- Type II, Moderate Sulfate Resistance (slow-reacting)
- Type III, High Early Strength (fast-setting)
- Type IV, Low Heat of Hydration (low heat generation)
- Type V, High Sulfate Resistance

These other types of cements, along with aggregates and admixtures, are available to produce special types of concrete. Type IV is low heat generation for large construction building foundation projects, such as dams. Others have high early strength to produce concrete that sets faster than normal, permitting earlier form removal and thus speeding construction. Still others are more resistant to deterioration caused by sulfates and alkalis in the soil.

Concrete Mixes

A concrete mix should be designed to produce the desired result. Characteristics and properties of concrete depend on the materials, and their proportions, that make up the mixture. This will determine the workability, strength, durability, economy, volume stability, and appearance of the finished hardened concrete. Enough water is added to make the mix plastic, so that it will flow into the forms. Too much water, however, will reduce the strength and durability of the concrete, so the contractor needs to be careful. A typical mix would consist of 10% cement, 15% water, 25% fine aggregates, 45% coarse aggregates, and 1% to 5% entrained or entrapped air.

Any material added to the concrete mix — other than cement, sand, aggregate, and water — is known as an admixture. Admixtures are used to make the mix more workable, retard or speed up hardening, increase freeze resistance, or increase chemical resistance. Common admixtures to concrete include air-entrainment, used to improve durability in freeze/thaw environments; retarders, used to slow down the initial set of fresh concrete, especially in hot weather; accelerators, used to speed up the initial set of fresh concrete in cold weather; water reducers, used to reduce the amount of water required for a desired workability and water-to-cement ratio for strength, and coloring agents, used for altering the color of the concrete mixture. Concrete is typically transported to the jobsite in a ready-mix truck.

Reinforced Concrete

Concrete has great compressive strength, but very little tensile (pulling) strength. To overcome this weakness, concrete is cast around steel reinforcing bars. These bars (commonly referred to as “rebar”) have high tensile strength. As the concrete hardens, it grips the steel to form a bond. The size of the bar is indicated by the bar number, which is a multiple of 1/8". For example, a #4 bar is 1/2” in diameter (4 × 1/8” = 1/2”). See Figure 10-3. Refer to Unit 12 for more information.

Reinforcing bars are round in shape, with projections (called deformations) formed in the rolling process to strength bonding with the concrete. Bars are placed after the forms are constructed, Figure 10-4. The concrete is then cast around the bars.
Sheets of wire mesh also are used for reinforcement. **Welded wire fabric (WWF)** is a prefabricated material used to reinforce concrete slabs, floors, and pipe. It consists of a mesh of steel wires welded together, Figure 10-5. It is available in sheets and rolls. There are two types of welded wire fabric: smooth (or plain), designated by a W; and deformed, designated D. The “D” fabric has deformations along the wire to better develop anchorage in the concrete. Previously, the fabric was specified by gage number, and some drawings still use this system.

Welded wire fabric is further designated by numbers. An example is 6x8–W8.0xW4.0. The first number (6) gives the spacing of the longitudinal wire in inches. The second number (8) gives the spacing of the transverse wires in inches. The first letter-number combination (W8.0) gives the type and size of the longitudinal wire. The second combination (W4.0) gives information on the transverse wire.

In the example given, the longitudinal wires are 6” apart. The transverse wires are 8” apart. The longitudinal wire is smooth and has a cross-sectional area of 0.08 in². The second combination (W4.0) gives information on the transverse wire. In the example given, the transverse wires are 6” apart. The transverse wire is also smooth with an area of 0.04 in². Figure 10-6 lists some of the common stock styles of welded wire fabric. See Figure 10-1 for how to indicate mesh in a slab. Figure 10-7 shows how mesh is placed in a concrete slab.

**Division 04 – Masonry**

Masonry structures are made from a number of smaller units held together with a bonding material known as mortar. Masonry units are manufactured as brick, concrete block, stone and clay tile. Mortar is a cementitious material that bonds the individual units together. Almost all masonry construction must be reinforced with metals. Like concrete, masonry has good compressive strength and poor tensile strength.

**Brick Masonry**

Brick masonry uses units (bricks) that are manufactured, rather than removed from quarries. There are many types:

- **Adobe brick.** Natural sun-dried clays or earth and a binder.
- **Kiln-burned brick.** Natural clays or shales (sometimes with other materials added, such as coloring) molded to shape, dried, and fired for hardness.
- **Sand-lime brick.** A mixture of sand and lime, molded and hardened under steam pressure and heat.
- **Concrete brick.** A mixture of Portland cement and aggregates, molded into solid or cored units and hardened chemically.
- **Building brick.** Usually called “common brick,” this is the most-used type. It is used for walls, backing, and other applications where appearance is not important.
- **Face brick.** Like concrete, masonry has good compressive strength and poor tensile strength.
- **Firebrick.** Used where masonry units are subjected to extreme heat, such as fireplaces, incinerators, and industrial furnaces.

**Common Stock Styles of Welded Wire Fabric**

<table>
<thead>
<tr>
<th>New designation (by W-number)</th>
<th>Old designation (by steel wire gage)</th>
<th>Steel Area (in²/ft)</th>
<th>Weight (lb/100 ft²)</th>
<th>Roll</th>
</tr>
</thead>
<tbody>
<tr>
<td>6x6–W1.4xW1.4</td>
<td>6x6–10x10</td>
<td>.028</td>
<td>.028</td>
<td>21</td>
</tr>
<tr>
<td>6x6–W2.0xW2.0</td>
<td>6x6–8x8*</td>
<td>.040</td>
<td>.040</td>
<td>29</td>
</tr>
<tr>
<td>6x6–W2.9xW2.9</td>
<td>6x6–6x6</td>
<td>.058</td>
<td>.058</td>
<td>42</td>
</tr>
<tr>
<td>4x4–W1.4xW1.4</td>
<td>4x4–10x10</td>
<td>.080</td>
<td>.080</td>
<td>58</td>
</tr>
<tr>
<td>4x4–W2.5xW2.0</td>
<td>4x4–8x8*</td>
<td>.087</td>
<td>.087</td>
<td>62</td>
</tr>
<tr>
<td>4x4–W4.0xW4.0</td>
<td>4x4–4x4</td>
<td>.120</td>
<td>.120</td>
<td>85</td>
</tr>
</tbody>
</table>

*Exact W-number size for 8 gage is W2.1
**Exact W-number size for 2 gage is W5.4
• Paving brick. Used in driveways or areas where abrasion is a concern. Special bricks also are available in unusual shapes for window sills, rounded corners, and other nonstandard applications.

Brick Symbols
Brick is indicated on plan and section drawings with 45° crosshatch lines. For common brick, the lines are widely-spaced; for face brick, the spacing is narrower. See Figure 10-8.

Brick Positions
Bricks can be positioned in different ways. These positions are used by the architect to develop a design or style in the building, as well as to add to the structural strength of the brickwork. Each position has a name that identifies it. For example, the most common position is the stretcher, Figure 10-10. It is laid in a flat position, lengthwise with the wall. Bricks in the stretcher position make up a large portion of most walls. In some bonds, such as the common bond (also called American bond), every sixth or seventh course is turned 90°. This is done to improve appearance or to tie the face brick with the backing wall. Bricks laid in this manner are called headers, and the course is referred to as a header course.

Brick Lay-up
Brick walls can be laid up as single-wythe walls that are 8″ or more in thickness. These can be solid or have two or more cells (spaces) in them. Sometimes the cells of the brick are filled with granular insulation. Various masonry walls are shown in Figure 10-11.

Concrete Masonry Units (CMU)
Another popular and widely used building material is the concrete masonry unit, which is formed from Portland cement, sand, and gravel. See Figure 10-12. By using different aggregates, such as sand, gravel, expanded shale, and pumice, the manufacturer can control the weight, strength, and acoustical properties of the CMU. CMUs are made in a variety of sizes, shapes, and densities to meet specific construction needs. The most popular is the standard block, with dimensions of 7 5/8″×7 5/8″×15 5/8″. When 3/8″ of mortar is used, this becomes an 8″×8″×16″ module. Another common block size is the 3 5/8″×7 5/8″×15 5/8″.

Concrete Block Symbols
Symbols for concrete block in plan and section views are the same as concrete with the addition of lines crosswise of the run. Refer to Figure 10-10. The elevation view symbol for concrete block is the same as poured concrete with lines added to represent the block pattern.

Figure 10-14 shows the various types of concrete blocks available.

Stone Masonry
The most common materials used in stone masonry are granite, limestone, marble, sandstone, and slate. Like concrete, stone has been used as a building material for many centuries. In the past, stones were used for structural members, roofing, and finishing. Due to the development of new materials and methods of construction, stones are now used mainly for their decorative value.

Rubble consists of stones as they come from the quarry or are gathered from a field or stream. Such stones may be smooth with rounded edges or may be rough and angular. The random rubble wall consists of stones laid in an irregular pattern with varying sizes and shapes. Other rubble patterns are coursed, mosaic, and strip.
Ashlar stones are squared stones that have been laid in a pattern but not cut to dimensions. There are several ashlar patterns:

- **Regular**: Uniform continuous height.
- **Stacked**: Tends to form columns.
- **Broken range**: Squared stones of different sizes laid in uniform courses, but broken range within a course.
- **Random range**: Neither course nor range remain uniform.

**Cut stones**, also known as dimensional stones, are cut and finished at the mill to meet the specifications of a particular construction job. Each stone is numbered for location. Unlike ashlar masonry, which is laid largely at the design of the mason, cut stones are laid according to the design of the architect.

**Structural Clay Tile**

*Structural clay tile* is made of materials similar to brick, but it is a larger building unit. It has many uses in construction — as load-bearing walls, backup for curtain walls, and fireproofing around structural steel. Rectangular open cells pass through each unit, and tile comes in a variety of shapes and sizes.
Clay tile has largely been replaced with hollow brick and concrete masonry units. Most masonry walls today are composite walls of a finish surface material and a less expensive backup material.

Terra cotta is a type of structural clay tile principally used for nonbearing ornamental and decorative effects.

Gypsum Blocks

Gypsum masonry blocks are used primarily for interior nonbearing walls, fire-resistant partitions, and enclosures around structural steel. Made from gypsum and a binder of vegetable fiber or wood chips, they can be given a plaster finish coat.

Mortar

Mortar is the binding agent used to hold masonry units together. Mortar also compensates for the differences in brick and stone sizes. Metal ties and reinforcement are secured in mortar. Mortar consists of cement, hydrated lime, sand, and water.

The American Society for Testing and Materials has established standards for mortar. There are five different standardized types:

- **Type M** has high compressive strength and good durability. It is used for unreinforced underground masonry.
- **Type S** is also a high-strength mortar. Although its compressive strength is not as high as Type M, it has a stronger bond and greater lateral strength. It also has the greatest tensile strength of any mortar type. Type S is used for reinforced masonry, unreinforced masonry subjected to bending, and in situations where mortar is the only connection between face brick and backing brick.
- **Type N** is a medium-strength, general-use mortar. It is best used for exposed, above-ground masonry.
- **Type O** is low-strength mortar used for interior, nonbearing masonry. This type of mortar should not be used in applications that will be exposed to freezing temperatures.
- **Type K** has very low strength and should only be used for interior applications when strength is not a concern.

Gypsum blocks have a face size of 12” × 30” and come in thicknesses of 2”, 3”, 4”, and 6”.

Masonry Accessories

Besides the masonry units and mortar, additional details are needed in masonry construction. Bond beams, joints, lintels, and flashing are needed to complete a wall.

Bond Beams

Concrete masonry walls are usually reinforced horizontally and vertically by constructing a reinforced beam or column within the wall. This is done by pouring grout (a flowable mixture of sand and cement) around reinforcing steel inserted in the units. Special channel blocks are used to form the horizontal bond beams, using reinforcing steel and mortar or grout. Vertical pilasters or bond beams are formed by inserting reinforcing bars in a vertical cell after the wall is laid, then filling the cell with grout. Bond beams are typically used over masonry wall openings such as windows and doors, the top of walls or anywhere that additional strength is required in the wall construction. See Figure 10-14 for a typical detail showing a bond beam.

Lintels

Lintels are members placed in masonry walls above door and window openings. Lintels are supported on either side of the opening. They can be made of precast concrete, steel, or other materials. The door and window schedule will often include the size and type of lintel used.

Masonry Joint Reinforcement

Masonry walls are reinforced by placing various anchors, ties, and rods in the mortar joints. These reinforcing units are produced in many sizes and shapes for different applications. Reinforcing devices are called out directly on the prints or in applicable building codes.
Division 05 – Metals

Metal is used extensively in the construction industry. Large commercial buildings use structural steel. Construction jobs make use of metal windows, doors, studs, beams, joists, wall facings, roofing, plumbing, and hardware.

Kinds of Metals

Metals can be divided into two categories, ferrous and nonferrous. **Ferrous metals** contain iron as a principal element, and usually have magnetic properties. They typically have more strength than nonferrous metals. **Nonferrous metals** contain no iron and do not have magnetic properties. They are typically lighter and less strong than ferrous metals.

**Ferrous Metals**

- **Iron.** Iron is malleable, ductile, magnetic, and silver white in color. There are many kinds of iron, such as pig iron, cast iron, and wrought iron. Iron is one of the principal ingredients of steel.
- **Steel.** An iron-based alloy with a carbon content ranging from 0.2% to 2.0%. Depending on the intended use, steel has many chemical compositions. Carbon steel, alloy steel, mild steel, medium steel, tool steel, spring steel, and stainless steel are a few of the varieties available.

**Surface Treatments**

Metals used in construction may have protective or decorative surface treatments applied to them. Treatments include:

- **Chroming.** Chromium applied as a finish to a metal surface.
- **Galvanizing.** Coating steel or iron with zinc to resist rusting. Galvanized iron is widely used for flashings and other applications where weather tends to corrode metals.
- **Rusting.** Certain steels are designed to form a protective layer of rust, a reddish-brown surface coating formed when the metal is exposed to moisture and air.
- **Electroplating.** An adherent metallic coating deposited by electrolysis. Electrolysis is a process that uses electrical current to migrate positively- and negatively-charged ions from electrodes to the metal product.

**Steel in Construction**

Steel is the most widely used metal in construction, with applications ranging from structural support to reinforcement to decorative uses.

**Brass.** This metal is widely used for door and window hardware, trim, grilles, and railings. Brass is copper with zinc as its principal alloy element.

**Bronze.** A copper-tin alloy, bronze also can contain various other elements, such as aluminum or silicon. Bronze resists corrosion and is widely used for ornamental architectural products.

**Nonferrous Metals**

- **Aluminum.** Pure aluminum and aluminum alloys are used in many building applications where resistance to corrosion is important. Aluminum that is 99% pure is soft and ductile, but weak. Aluminum is typically used in such building applications as flashing, downspouts, some kinds of roofing, doors and trim, Mullions for windows, etc. Aluminum also is made as an alloy with copper added for strength and casting uniformity. Aluminum alloys are made in structural shapes for use as H-beams, I-beams, and angles. Aluminum is also used for such ductwork, screens, and electrical wiring.

**Figure 10-14.** Detail showing a bond beam in a concrete masonry unit wall.

**Figure 10-15.** Gages, weights, and thicknesses of steel sheets.

**Figure 10-16.** Structural steel beams, columns, web joists, and other shapes are widely used in construction projects. These workers are installing a column onto a concrete footing.

**Table 10-1.**

<table>
<thead>
<tr>
<th>Steel manufacturer’s standard gage number</th>
<th>Weight, psf</th>
<th>Equivalent sheet thickness (in.)</th>
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<tr>
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<td>0.2242</td>
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<tr>
<td>6</td>
<td>8.1250</td>
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<td>6.8750</td>
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<td>10</td>
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<td>12</td>
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<td>14</td>
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<tr>
<td>22</td>
<td>1.2500</td>
<td>0.0299</td>
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<tr>
<td>24</td>
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<td>38</td>
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### Descriptive Name

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<th>Nominal Size</th>
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<tr>
<td></td>
<td></td>
<td>Height</td>
<td>Weight/Ft in Lb.</td>
</tr>
<tr>
<td>Wide flange shapes</td>
<td>W</td>
<td>W21 × 142</td>
<td>21 × 13</td>
</tr>
<tr>
<td>Miscellaneous shapes</td>
<td>M</td>
<td>M8 × 6.5</td>
<td>8 × 2 1/4</td>
</tr>
<tr>
<td>American standard beams</td>
<td>S</td>
<td>S8 × 23</td>
<td>8 × 4</td>
</tr>
<tr>
<td>American standard channels</td>
<td>C</td>
<td>C6 × 13</td>
<td>6 × 2</td>
</tr>
<tr>
<td>Miscellaneous channels</td>
<td>MC</td>
<td>MC8 × 20</td>
<td>8 × 3</td>
</tr>
<tr>
<td>Angles — equal legs</td>
<td>L</td>
<td>L6 × 6 × 1/2*</td>
<td>6 × 6</td>
</tr>
<tr>
<td>Angles — unequal legs</td>
<td>L</td>
<td>L8 × 6 × 1/2*</td>
<td>8 × 6</td>
</tr>
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<td>Bulb angles</td>
<td>BL</td>
<td>BL6 × 3 1/2 × 17.4</td>
<td>3 1/2 × 6</td>
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<td>Structural tees (cut from wide flange)</td>
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<td>WT12 × 60</td>
<td>12</td>
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<td>Structural tees (cut from miscellaneous shapes)</td>
<td>MT</td>
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<td>Structural tees (cut from Am. Std. beams)</td>
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<td>ST9 × 35</td>
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<td>Tees</td>
<td>T</td>
<td>T5 × 11.5</td>
<td>3 × 5</td>
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<tr>
<td>Wall tee</td>
<td>AT</td>
<td>AT8 × 29.2</td>
<td>4 1/8 × 7 1/4</td>
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<td>Elevator tees</td>
<td>ET</td>
<td>ET4 × 24.5</td>
<td>4 1/8 × 5 1/2</td>
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<tr>
<td>Zees</td>
<td>Z</td>
<td>Z4 × 15.9</td>
<td>6 × 3 1/2</td>
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*Figure 10-17. Some examples of structural steel shapes.*

### Wood Classification

Woods are broadly classified as either hardwoods or softwoods. There are many varieties used for construction. These classifications are not an exact measure of hardness or softness (because this varies) but a general classification based on type of tree. In addition to hardness or softness, woods vary in strength, weight, texture, workability, and cost. Building specifications usually indicate the type and grade of lumber to be used in different parts of the construction.

### Division 06 – Wood and Plastics

Wood continues to be one of the chief building materials. Figure 10-20. It is used for structural framing (rough carpentry), trim, floors, walls, and cabinetry (finish carpentry and architectural woodwork). Relative to its weight, wood has high strength in compression, tension, and bending. It also has excellent impact resistance. While steps have been taken to substitute other materials, wood remains a valuable and widely-used residential construction material.

*Figure 10-18. This steel frame is designed to support the entire weight of the building.*

*Figure 10-19. Open-web steel joists combine strength with lightweight.*
lumber dressed on two sides, and “S4S” for lumber that is surfaced or planed on all four sides.

**Plywood** is a wood product made of several layers of lumber arranged with the grain at right angles in each successive layer and bonded with an adhesive. An odd number of layers is used, so that the grain of the face and back are running in the same direction. The panels are usually 4’ × 8’ in size, and are available in finished thicknesses ranging from 1/8” to over 1”. Because of its modular size and uniformity, plywood speeds construction and is considered an economical building material. **Interior plywood** is bonded with an adhesive that is water-resistant. It is used for cabinetry, rough flooring, and finished walls. **Exterior or structural** plywood is bonded with a waterproof adhesive. It is used for wall sheathing, finished walls, roof sheathing, and concrete forms.

### Glue-laminated Timber

The process of **laminating** (bonding layers of lumber together with glue) has made it possible to span larger distances and change traditional construction techniques. Wood beams, arches, and other members of nearly any size and shape can be fabricated. These laminated products are made of kiln-dried lumber and prepared for interior and exterior use. These beams are usually prefabricated at the factory and delivered to the job with protective wrapping.

### Division 09 – Finishes

Finishes are the visible surfaces of a building, such as gypsum wallboard, paint or wallpaper, ceramic tile, carpeting, wood flooring, and acoustical ceilings. Finishes are, in part, delineated on the drawings and specified in a room finish schedule. Refer to Figure 1-10.

### Gypsum Wallboard and Plaster

Gypsum wallboard and plaster products consist of a core of air-entrained gypsum between two layers of treated paper. Wallboard comes in standard 4’ × 8’ sheets, but is available in 4’ × 9’ and 4’ × 12’. If ordered in truckload quantities, almost any special size desired can be produced. Wallboard is fastened to wood or metal studs with nails or screws, and varies in thickness from 1/4” to 1”. Joints are sealed with a joint compound and paper tape to provide a smooth, even surface. The wall can be painted, papered, or given a surface texture to enhance its appearance.

Lath for gypsum plaster walls is available in 16” × 48” sheets with thicknesses of 3/8” and 1/2”. The lath is fastened to the studs and a three-coat gypsum plaster finish — scratch coat, brown coat, and finish coat — is applied.

**Building papers** are available in a variety of types suitable for sheathing walls and roofs. Some papers are reinforced for strength and tear resistance. Building papers are treated with asphalt, plastic, tar, or other materials. The building paper is usually specified on the print or in the specifications.

### Ceramic Tile

There are many kinds of ceramic tiles, commonly referred to merely as “tile,” for use on floors, walls, and other surfaces. Ceramic tile is made from nonmetallic minerals, fired at a very high temperature.

- **Ceramic tiles** come in sizes from 3/8” square to 16” × 18” units. Popular wall sizes are 4 1/4” × 4 1/4”, 4 1/4” × 6”, and 6” × 6”.

- **Hexagonal** and **octagonal** tiles are also available. The tiles can be glazed or unglazed. Glazed tiles are usually 5/16” thick. Unglazed (faience) tiles vary from 7/16” to 3/4” thick.

- **Mosaic tiles** can be laid to form a design or pattern. They are normally smaller than 6” (typically 1”) square, and can be glazed or unglazed.

- **Quarry tile** is used for floor coverings and is produced from clays that provide a wear-resistant surface.

- **Fired-clay tile** is used primarily for floor coverings. It is produced from clays and is fired in a kiln to harden the surface.

### Tile-setting Materials

There is a wide variety of tile-setting materials available for use, based on flooring types and final use of the tiling products. Typically, ceramic tile is set in Portland cement, latex adhesive, or epoxy mortar. Figure 10-21 shows two applica-

tions: tile set on plywood using a cementitious backer board with a bond coat, and tile set directly on a concrete slab surface.

The joints between the tiles are grouted, with different types of grout available to meet varying kinds of joint and tile exposure. The grout consists of Portland cement modified to meet various joint conditions.

### Glass

Glass is a ceramic material formed at temperatures above 2300°F (1260°C). It is made from sand (silica), soda (sodium oxide), and lime (calcium oxide). Other chemicals can be added to change its characteristics.

**Float glass** is the most common type of glass. A continuous ribbon of molten glass flows out of a furnace and floats on a bath of molten tin. Irregularities melt out and the glass becomes flat. The ribbon of glass is fire-polished and annealed, without grinding or polishing. Over 90% of the world’s flat glass is made by the float process.

After the float process, other processes can further modify the properties of the glass, producing several types:

- **Sheet glass** is commonly used for windows in thicknesses of 3/32” (single strength, or “SS”) and 1/8” (double strength, or “DS”). Thicker glass is sheet glass that is 3/16” to 7/16” in thickness.

- **Plate glass** is sheet glass that has been heat-treated during forming, producing a brilliant surface that is ground and polished when cooled.

- **Bent glass** is produced by heating annealed glass to the point where it softens so it can be pressed over a form.

- **Safety glass** was developed to overcome the hazards of sheet glass in large, exposed, or public areas. Three types of safety glass are available: tempered, laminated, and wired glass.

- **Tempered glass** is developed by heating annealed glass to near its melting point, then chilling it rapidly. This creates high compression on the exterior surfaces and high tension internally, making the piece of glass three to five times as strong as...
annealed glass. Tempered glass can be broken, but it shatters into small, pebble-like pieces rather than sharp slivers. Tempered glass must be ordered to the exact size needed before tempering, because it cannot be cut, drilled, or ground after it has been tempered.

Laminated glass consists of a layer of vinyl between sheets of glass. The layers are bonded together with heat and pressure. This glass can be broken, but the plastic layers hold the small, sharp pieces in place.

Wired glass has a wire mesh molded into its center. Wired glass can be broken, but the wire holds the pieces together. Wired glass can be obtained with an etched finish, a sandblasted finish, or a patterned finish.

Insulating glass is a unit of two or more sheets of glass separated by an air space that is dehydrated and sealed. These units serve as a good insulator for heat and sound transfer. A typical insulating glass installation in a window sash is shown in Figure 10-22.

Plastics have many uses in construction. Plastic laminates serve as counter tops, door veneer, and wall surfacing. Panels of wood or gypsum are printed, textured, and given a plastic vinyl coating. Plastic rain gutters and downspouts collect and distribute rain water. Plastic pipes are used for water-transmission, sprinkling, drainage, and sewage systems.

Plastics are also used for many trim and ornamental items, such as moldings on doors and simulated wood carvings. Plastic materials are usually noted on the drawing and detailed in the specifications.

The purpose of thermal insulation is to reduce heat transmission through walls, ceilings, and floors. When the outdoor temperature is warm, insulation keeps the heat from entering the structure. When the outdoor temperature is cool, insulation helps keep the warm air indoors.

Insulation is manufactured in a variety of forms and types to meet specific construction requirements. Each type will have an R-value (resistance to heat transfer), depending on the manner of application and amount of material. A high R-value means good insulation qualities. Insulation materials are classified as:

- Flexible (blanket or batt).
- Loose-fill.
- Reflective.
- Rigid (structural and nonstructural).

Flexible insulation is available in blanket and batt form. Blankets come in widths suitable to fit 16" and 24" stud and joist spacing and in thicknesses of 1" to 3 1/2". The body of the blanket is made of mineral or vegetable fiber, such as rock wool, glass wool, wood fiber, or cotton. Organic materials are treated to resist fire, decay, insects, and vermin. Blankets are covered with a paper sheet on one or both sides. The vapor barrier is installed facing the warm side of the wall. Batt insulation is made of the same material as blankets, in thicknesses of 2" to 6" and lengths of 24" and 48".

Insulating glass is a unit of two or more sheets of glass separated by an air space that is dehydrated and sealed. These units serve as a good insulator for heat and sound transfer. A typical insulating glass installation in a window sash is shown in Figure 10-22.
Loose-fill insulation is available in bags or bales. It is either poured, blown, or packed in place by hand. Loose-fill insulation is made from rock wool, glass wool, wood fibers, shredded redwood bark, cork, wood pulp products, vermiculite, sawdust, and shavings. This type of material is suited for insulating sidewalls and attics of buildings. It is also used to fill cells in block walls.

Reflective insulation, Figure 10-23, is designed to reflect radiant heat. It is made from aluminum foil, sheet metal with tin coating, and paper products coated with a reflective oxide composition. To be effective, the reflective surface must face an air space of at least 3/4". When the reflective surface contacts another material, such as a wall or ceiling, the reflective properties are lost along with its insulating value. This material is often used on the back of gypsum lath and blanket insulation.

Rigid insulation is made of a fiberboard material in sheet form. Common types are made from processed wood, sugarcane, and other fiber. These produce a lightweight, low-density product with good heat and acoustical insulating qualities. Rigid insulation is used as sheathing for walls and roof decks when additional insulation is needed.

Material Symbols on Drawings

Besides showing the location and sizes of different construction components, drawings also identify the materials that are used. Materials are identified in several ways:

- A section of a drawing may contain a pattern that is unique to a specific material.
- Often, materials are specified in the notes included on a drawing. This allows for easy reference.
- Materials are also included in the project specifications.

Materials may be shown differently in plan, elevation, and section views. For example, in Figure 10-24, concrete is represented in the section view as small dots with a scattering of small triangular shapes. On plan views, concrete is shown blank or with the concrete hatch pattern. If the concrete area is large, the pattern may be shown in portions, rather than the entire outline.

Section views that cut across structural framing members show these pieces with an “×” within each member. Finished lumber (trim, fascia boards, moldings) in section shows the wood end grain. For a wood frame wall on the plan view, the usual practice is to leave the wall blank, Figure 10-24. Some architects shade this area lightly to better outline the building and its partitions.

When shown in small scale, plywood is represented with the same symbol as lumber. In section (if the scale permits), lines may be drawn to indicate the plies (not necessarily the exact number). In elevation views, wood siding and panels are represented as shown in Figure 10-24. Symbols for glass consist of a single line on plan drawings and section drawings. The symbol may consist of several lines on large scale drawings. Glass areas in elevation views are left plain or consist of a series of random diagonal lines.
Test Your Knowledge
Write your answers in the spaces provided.

1. True or False? Concrete is stronger when it is in tension (pulled) than it is in compression (pushed).

2. When preparing a batch of concrete, which of the following would not be included?
   A. Water
   B. Cement
   C. Aggregate (sand, gravel)
   D. Chemical admixtures
   E. All of these items could be included in the mix.

3. Which mortar type is best-suited for situations requiring high lateral strength?
   A. Type M
   B. Type S
   C. Type N
   D. Type O
   E. None of the above.

4. What is the difference between interior and exterior plywood?
   A. The type of wood used
   B. The size of the sheets
   C. The type of adhesive used
   D. The thickness of the sheets
   E. Interior and exterior plywood are identical.

5. The steel beam identification W8×15 represents a wide-flange beam
   A. 8″ deep and weighing 15 lbs. per linear foot
   B. 8″ deep and 15″ wide
   C. 8″ wide and 15″ deep
   D. 8″ deep and 15′ long
   E. None of the above is correct.

6. True or False? Nonferrous metals contain little or no aluminum.

7. True or False? Concrete completely hardens within 48 hours after it is poured.

8. Which of the following is not considered to be a type of safety glass?
   A. Wired glass
   B. Plate glass
   C. Laminated glass
   D. Tempered glass
   E. All of these are types of safety glass.

9. True or False? Prestressed concrete beams are normally larger than a standard reinforced concrete beam of equal strength.

10. True or False? An air space between two sealed panes of glass serves as good insulation.

11. What type of cement would you use in the winter to make the concrete set up faster?
    A. Type I normal cement
    B. Type III high early strength
    C. You wouldn't make concrete in the winter because it might freeze
    D. Use a retarder admixture

12. Give the actual diameter of the reinforcing steel bar listed below:
    A. #9
    B. #4
    C. #8
    D. #5
    E. #18

13. Where would you commonly find rip-rap used?

14. Name the brick positions in the walls indicated below.

15. What are the two basic kinds of metal?
    A. Ferrous and nonferrous
    B. Steel and copper
    C. Steel and aluminum
    D. Brittle and malleable

16. What shape does each of the following designs for structural steel indicate?
    A. W
    B. S
    C. C
    D. L

17. Which of the shapes in Question 16 is commonly used as a beam in structural steel buildings?

18. What causes concrete to harden?
    A. Dehydration
    B. Evaporation
    C. Consolidation
    D. Hydration

19. What is the system used to measure the thickness of sheet metal products?
Insulation and sealants have become important construction materials as homeowners demand more energy-efficient houses from their builders. (Owens Corning)