Reading and Interpreting Construction Drawings, Course #403 Presented by:

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I. INTRODUCTION

Construction drawings are used to communicate the architectural and engineering design of a construction project. There are two types of construction drawings: (1) Pictorial drawings and (2) Orthographic projections. Pictorial drawings are called 'renderings' and are used for presentations and are not intended to show construction details. Orthographic projections are used in construction projects and show different views of the subject such as a building. Each view is taken from a different reference point and allows all the details of a structure. The views used in construction drawings are the top, front, side, and back. The top view is called a 'plan drawing'. Front. Side, and back views are called 'elevations'. A view of the interior of the building is called 'section' or 'interior elevation'. Reading construction drawings is the gathering of information from a drawing. It involves two principal elements: visualization and interpretation. Visualization is the ability to create a mental image of a building from a set of working drawings. A study of drawing reading principles and learning to sketch will help one visualize construction drawings. Interpretation is the ability to understand lines, symbols, dimensions, notes, and other information on the working drawings.

I.1. **Type of drawings**

Drawings are usually arranged in the approximate order of construction. A set of drawings consists of: Civil (C-1, C-2, etc), Structural (S-1, S-2, etc), Architectural (A-1, A-2, etc), Electrical (E-1, E-2, etc), Mechanical (M-1, M-2, etc), and Plumbing (P-1, P-2, etc).

Civil engineering drawings (C) include plot or site plans, utilities, easements, grading,and landscape details. The site plan can also include contour lines, walks, driveways, property lines, building setbacks, and utility locations.

Structural drawings (S) include foundation, structural steel, building support system, and roof framing system along with sections and details.

Architectural drawings (A) include floor plans, elevations, building sections, door and window schedules, and room finishes. The floor plan is an important drawing because it provides the most important information and acts as a reference for the location of additional sections and details. The floor plan shows floor finishes, walls, doors, stairways, fire places, built-in cabinets, and mechanical equipment. Elevations are views of the exterior features of the building. Usually a minimum of four elevation drawings is needed to show the design of all sides of the structure. Sections are views showing the building as if it were cut apart. They show walls, stairs and other details not clearly shown in other drawings. Sections taken through the short dimension of a building are known as 'transverse sections'. Those taken through the long

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dimension are known as 'longitudinal sections'. Detail drawings are prepared for complex building components and unusual construction such as an arch, a cornice, a structural steel connection or a retaining wall. Schedules are lists of materials needed in the construction process. A schedule normally lists the item, an identification mark, size, number required, and any other useful information. Different type of schedules include: door schedules, window schedules, lighting fixture schedules, and room finish schedules.

The Electrical drawings (E) include the electrical wiring, lighting plan, reflected ceiling plan, and panel schedules.

The Mechanical drawings (M) include heating, ventilating, and air conditioning (HVAC) plans, plumbing plans, sprinkler systems, and schedule for pipe and fittings, HVAC equipment, and plumbing fixtures.

The plumbing plan (P) shows the layout for the hot and cold water systems, the sewage disposal system, and the location of plumbing fixtures.

Structural framing plans (S) may be included in a set of plans for the framing of the roof, floors, and various elevation or wall sections.

II. READING MEASURING TOOLS

Tools used in construction industry are: framing squares, bench rules, steel rules, and tapes. In the customary (also called English) measurement system, the distances are divided into feet, inches, and fractions of an inch. The rule used with this system is called 'fractional rule'. In metric system, the divisions are in meters, centimeters, and millimeters. This rule is called 'metric rule'.

II.1. **Fractional rule** – This rule is divided into 16ths. See Figure II.1. In this figure, the inch is divided into 16 parts. Thus, each small division is 1/16th of an inch.

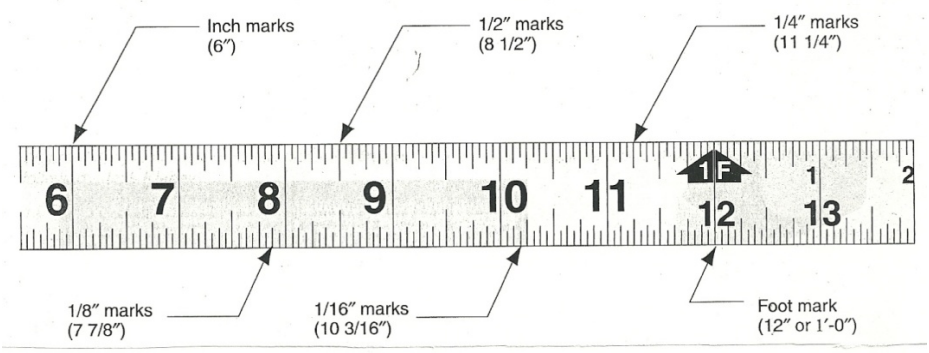

Figure II.1. Measuring Tape

II.2. **Metric rule** – The basic unit of linear measure in the metric system is the meter (m). Other linear units are either fractions or multiples of a meter. The most common units are the following:

Unit	Abbreviation	Equal to
Millimeter	mm	$1/1000^{th}$ m
Centimeter	cm	$1/100^{th}$ m
Kilometer	km	1000 m

Metric dimensions are better to work because they can be added or subtracted more easily than English units. However, the customary system is used almost exclusively in this country. The relationship between the customary and the metric systems is given below:

1 inch = 25.4 millimeters

1 foot = 304.8 millimeters

1 yard (3 feet) = 914.4 millimeter

39.37 inches = 1 meter

Figure II.2 illustrates the above relationship.

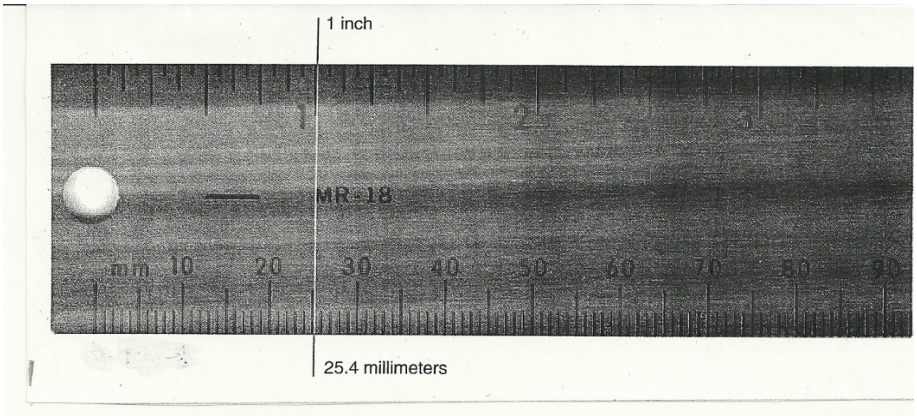

Figure II.2 Relationship between Inch and Millimeter

III. LINES AND SYMBOLS

III.1. Lines - Several types of lines are used in construction drawings. These are known as 'alphabet lines'. All lines are drawn in the same color. Some vary in width. Some are solid, others are a combination of broken lines. Each conveys a different meaning. Figure III.1 illustrates some common lines and are explained below:

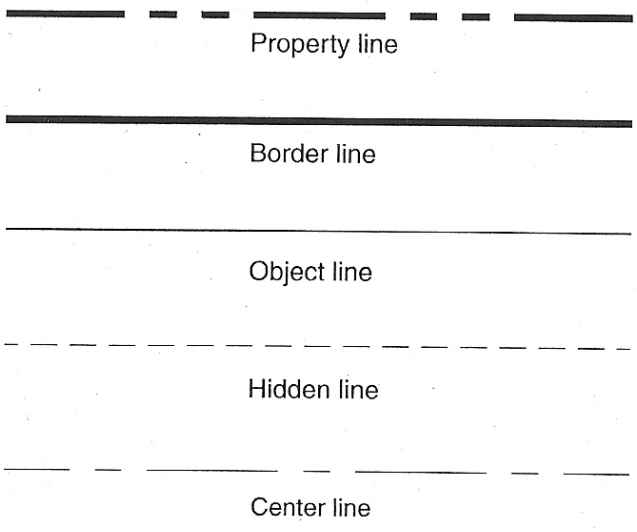

Figure III.1. Common Lines

- Property line – The property line is an extra heavy line made up of long dashes and alternating with two short dashes.
- Border line – Border lines are located near the edge of the sheet of the drawing paper. They are also used to separate the various portions of the drawing such as the title block, notes, and the revision block.
- Object line – Object lines represent the main outline of the features of the object, building, or walk. The object line is a heavy, continuous line showing all edges and surfaces.

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- Hidden line – Hidden lines are medium-weight and are composed of short dashes. They define edges and surfaces that are not visible in a particular view. One must look for another view in the set of drawings to find where these edges occur. Hidden lines are omitted if they do not clarify the drawings.

- Equipment, and fixtures. The center line is also used to indicate a finished floor line. The line is light in weight and composed of alternating long and short dashes.

- Dimensioning and extension lines – Dimension and extension lines are thin lines that indicate the extent and direction of dimensions. See Figure III.2 for an illustration.

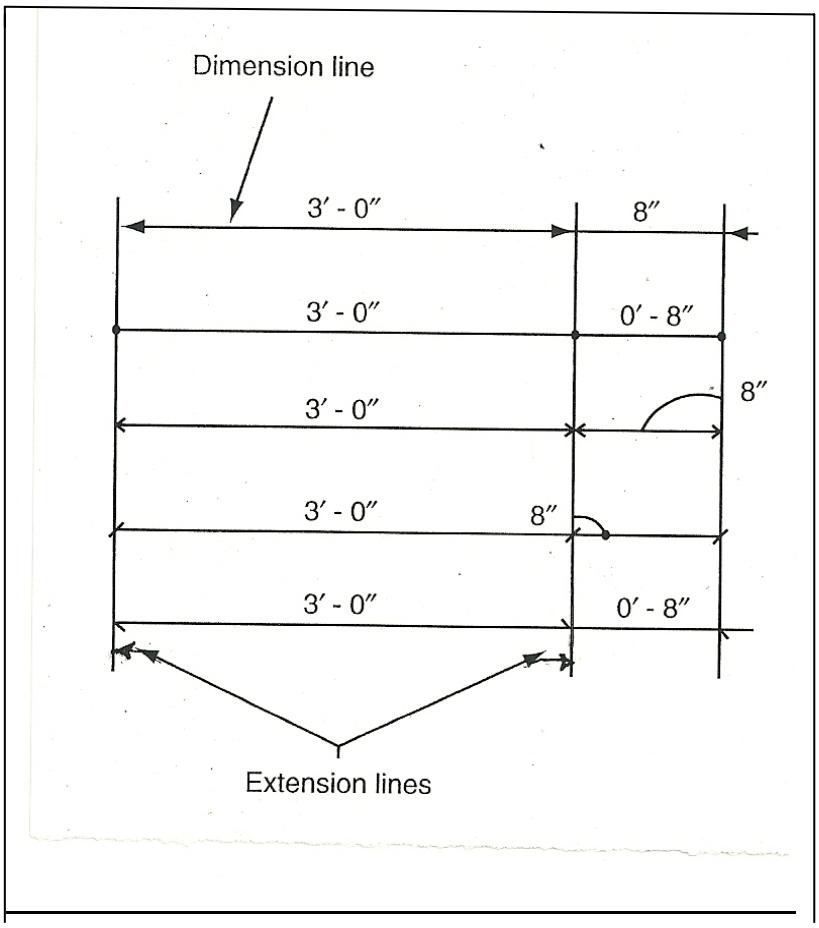


Figure III.2 Dimension and Extension Lines

- Dimension lines extend the length of the distance being measured. A marking device such as an arrow, dot or tickmark, is placed at the end of the dimension line.

Extension lines are drawn perpendicular to the dimension line to specify the features between which the dimension applies.

- Break lines – Break lines are used to indicate that an object continues but is not shown on the drawing or to indicate that the object's full length is not shown to save space. See Figure III.3 for an illustration.

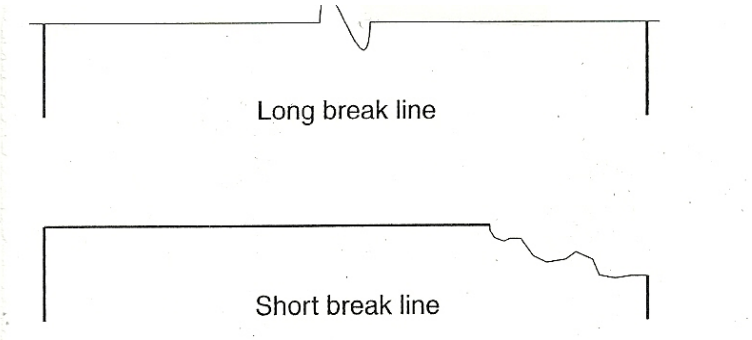


Figure 3.3 Break Lines

- Section cutting lines – Section cutting lines are used with sectional views. See Figure III.4 for an example.

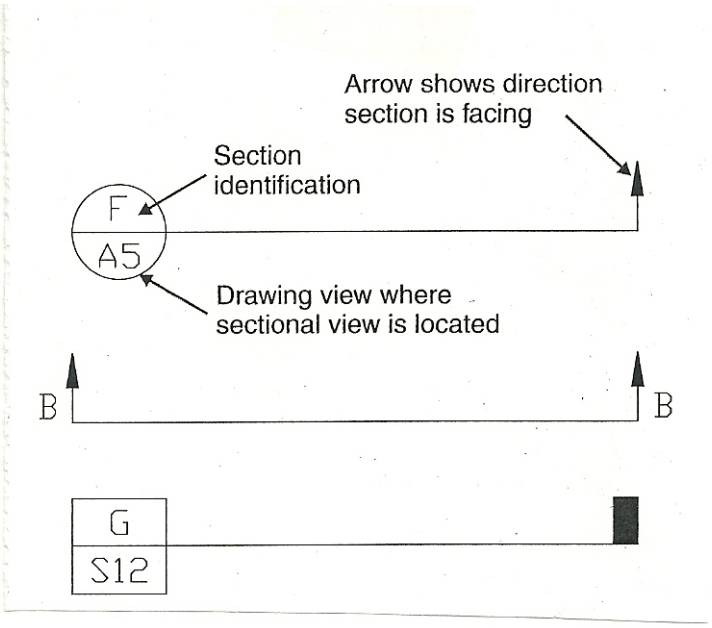


Figure III.4 Section Cutting Lines

- A section cutting line marks the part of the drawing being "cut" to create a sectional view. Arrows on the end of the line indicate the direction from which the section is being viewed. If the sectional view is on another drawing, the drawing number is included with the section identification.
- Section lines and rendering – Section lines, also called 'crosshatch lines' are thin lines, usually drawn at a 45^0 angle. See Figure III.5 for an example.

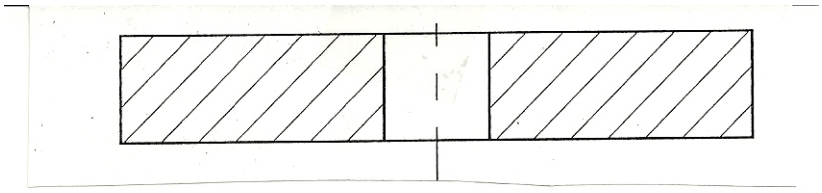
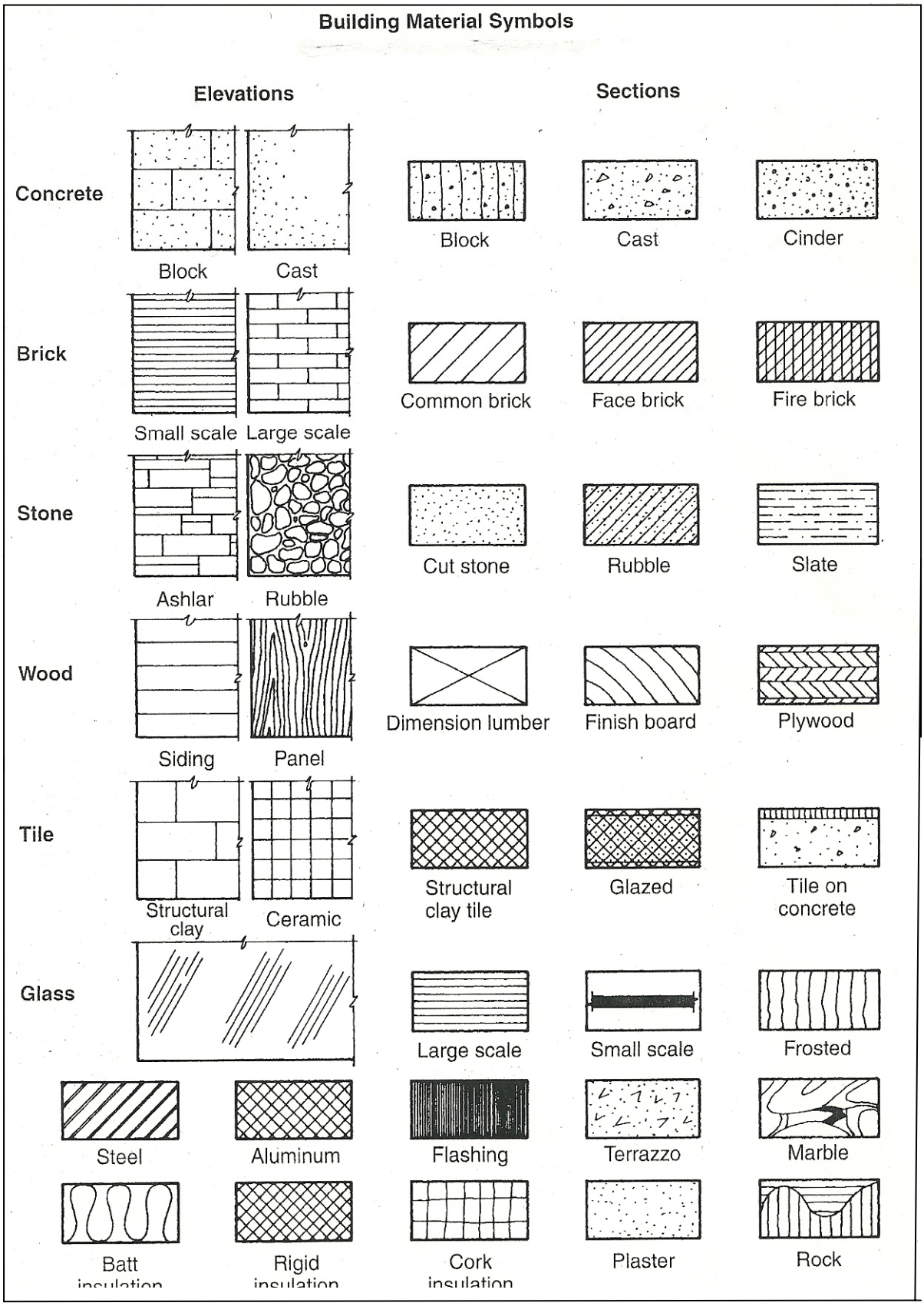


Figure III.5 Section Lines

- (They are used in a sectional view to show material that has been "cut" by the cutting-plane line.

III.2. **Symbols –** A number of symbols are commonly used on construction drawings. These symbols represent building materials and fixtures. Normally, symbols are identified in a legend which is a list of symbols and their corresponding meanings. Figure III.6, shown in the next three pages, exhibits the different symbols.


Building Material Symbols
Elevations
Sections
Concrete
Block
Cast
Block
Cast
Cinder
Brick
Small scale
Large scale
Common brick
Face brick
Fire brick
Stone
Ashlar
Rubble
Cut stone
Rubble
Slate
Wood
Siding
Panel
Dimension lumber
Finish board
Plywood
Tile
Structural clay
Ceramic
Structural clay tile
Glazed
Tile on concrete
Glass
Large scale
Small scale
Frosted
Steel
Aluminum
Flashing
Terrazzo
Marble
Batt insulation
Rigid insulation
Cork insulation
Plaster
Rock

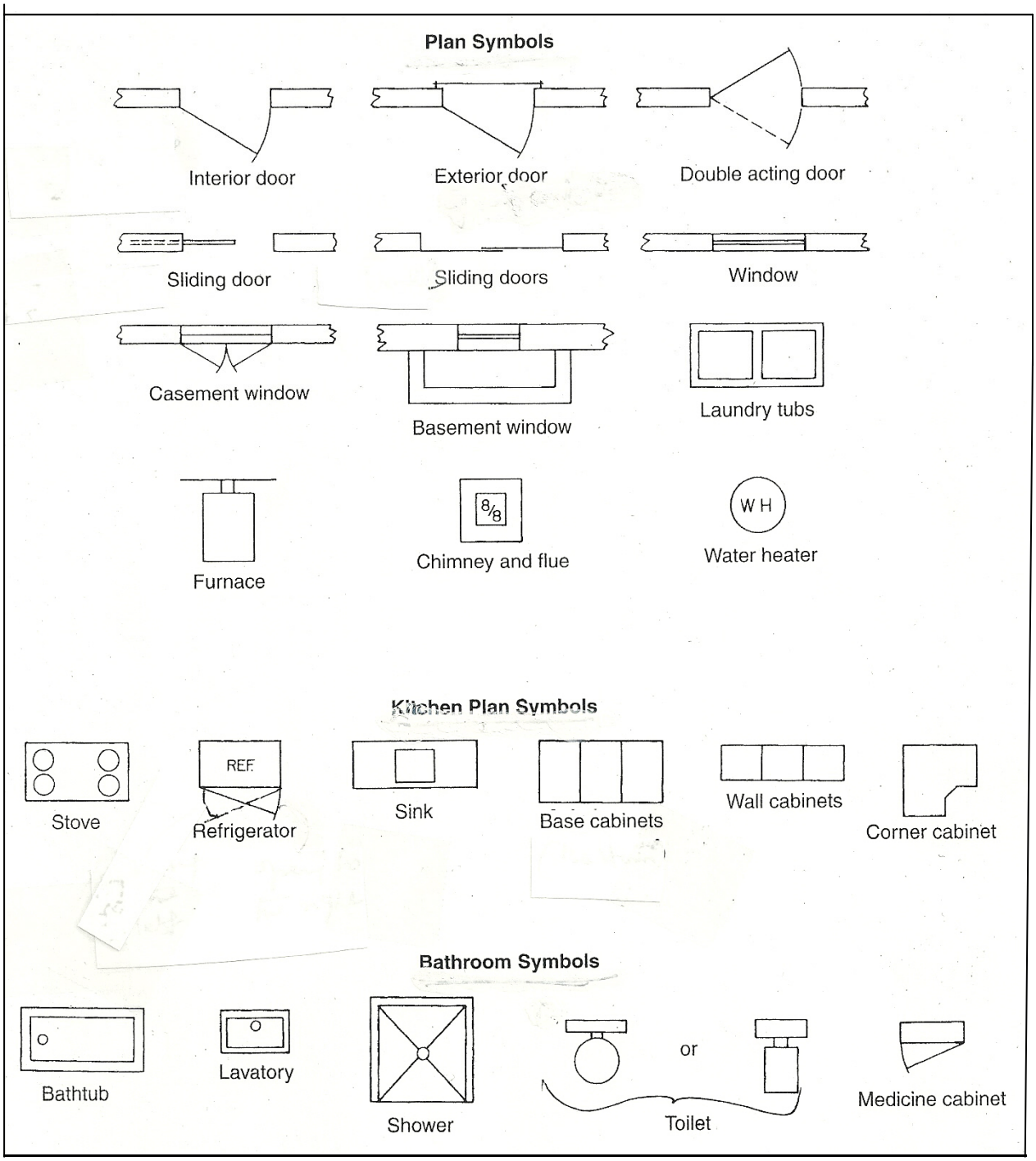


Figure III.6 List of Symbols

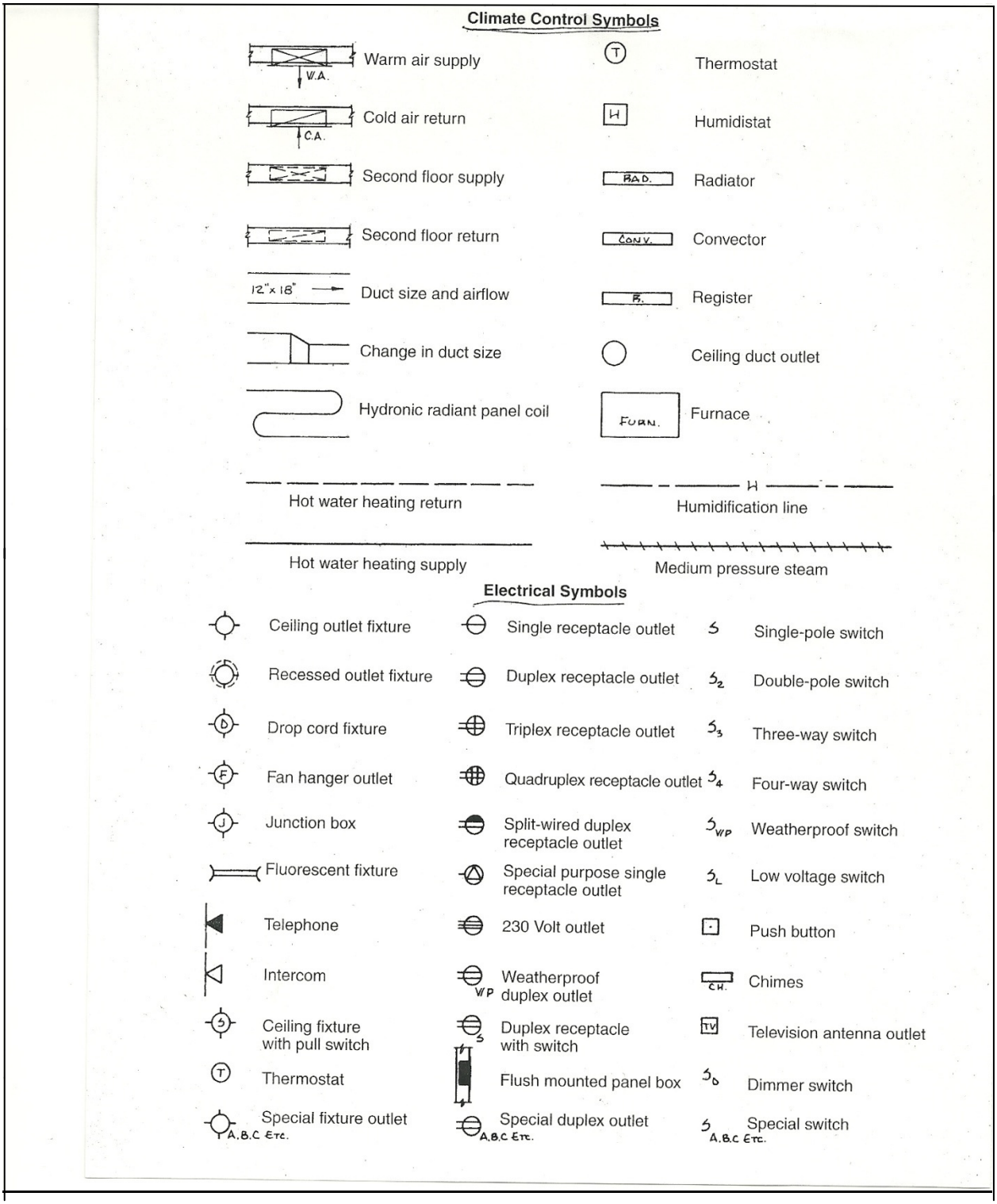


Figure III.6 List of Symbols

IV. ORTHOGRAPHIC DRAWINGS

Nearly all drawings used on a construction project are orthographic drawings. They are preferred because more details can be shown. These drawings are created using orthographic projection, a process by which an object or structure is described using various views. Each view defines one face, or side, of the object. The views of an orthographic drawing are projected at a right angle (90^0) to each other. The best way to visualize this is by cutting and unfolding a cardboard box as shown in Figure IV.1.

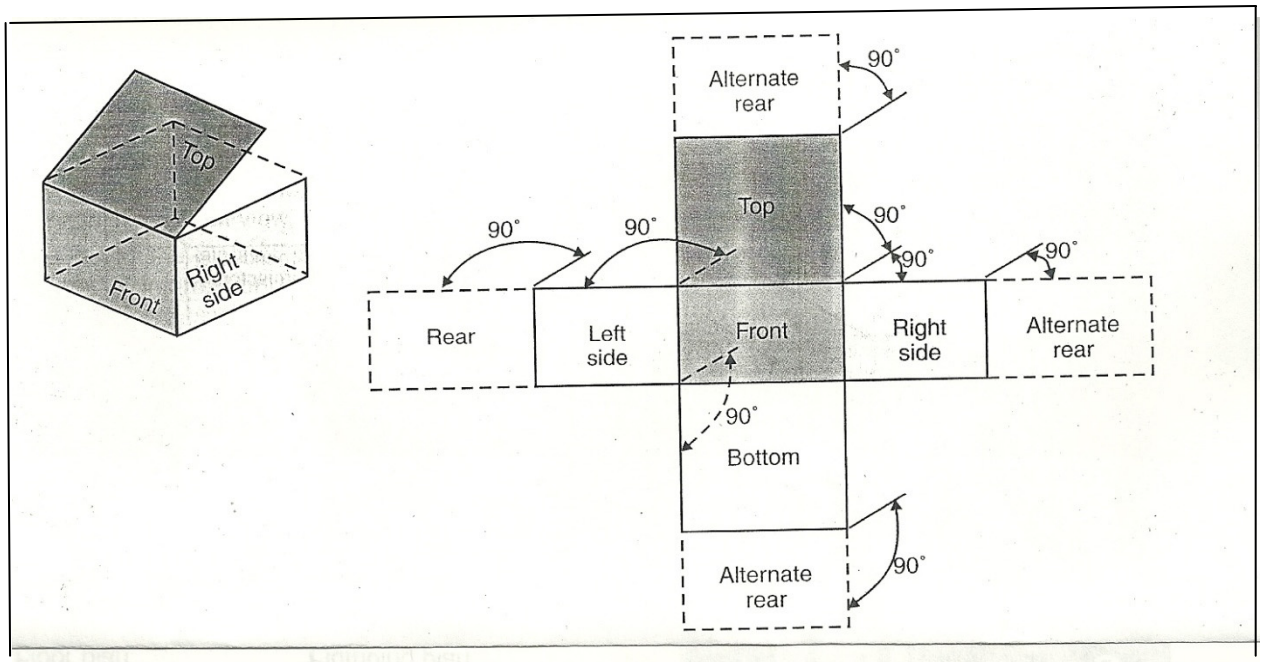


Figure IV.1 Projection of Orthographic Views

The front view remains in position. The four adjoining views revolve 90^0 around the "folds" bringing them into the same plane as the front view. The rear view is shown next to the left side view, but it could be shown in several alternate positions, as indicated. If an object is placed inside a glass cube and viewed through any of the cube's six sides, only one face of the object can be seen. Each view through a side of the cube would create one orthographic view as shown in Figure IV.2.

IV.1. **Creating orthographic drawings**

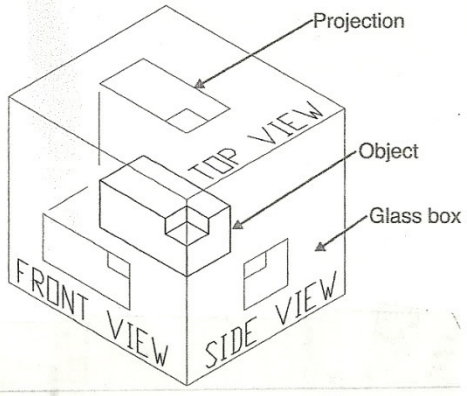


Figure IV.2 Object within a Glass Cube

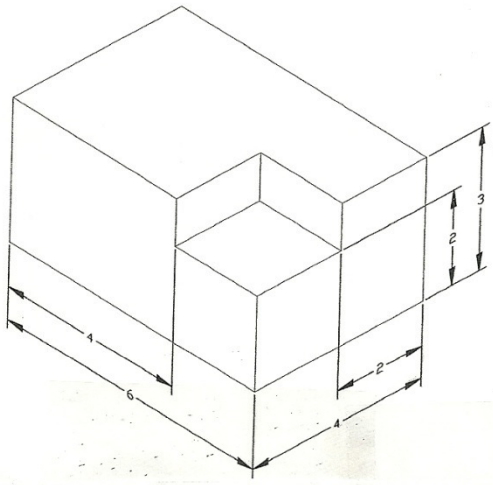


Figure IV.3 Block with a Notch Cut

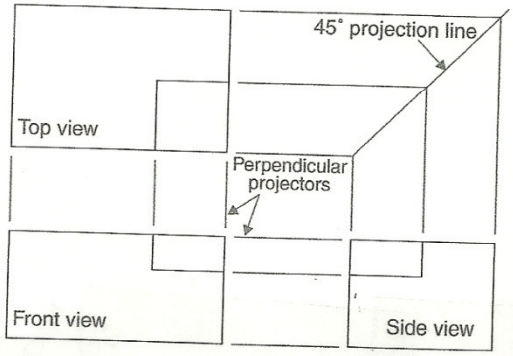


Figure IV.4 Orthographic View of the Notched Block

Figure IV.2 shows an object within a glass cube. The cube has six sides and if the object is viewed through any of the sides, only one face of the object would be seen. Each view through the side of the cube would create one orthographic view. Figure IV.3 shows a block with a notch cut into one corner. The orthographic drawing of the block is shown in Figure IV.4. Referring to this figure the procedure listed below is followed for creating an orthographic drawing.

1. Begin by drawing the front view. All views should be drawn to scale. Select the object's position so that most of the features are located on the front, side, and top.

2. At every edge and feature shown on the front view, perpendicular projectors are drawn in the vertical and horizontal directions. These construction lines are drawn lightly, and erased when the drawing is complete.

3. Draw the top and side views. The projection lines connect common features between views.

4. From the front edge of the top view, draw a horizontal projection line. Draw a vertical projection line from the front edge of the side view.

5. At the intersection of these lines, draw a line at a 45^0 angle. Projection lines for features common to the top and side views will intersect at this line.

IV.2. **Construction drawings –** For construction drawings, different views of the building such as floor plans and elevations are obtained using orthographic projection.

IV.2.1. **Plan views –** The top view of the building is called a 'plan view'. Plan views are taken at different levels throughout the building. In complicated buildings, each floor may require multiple plan views to illustrate all construction details.

IV.2.1.1. **Floor plan –** The floor plan shows the layout of the building and shows walls, doors, windows, rooms, and stairs. Other items such as plumbing and electrical can also be shown if space is available. Floor plans are drawn usually to scale 1/48 or $1/4^{''} = 1^{'}\text{-}0^{''}$. A separate drawing is made for each floor including the basement.

IV.2.1.2. **Foundation plan –** The foundation plan is similar to the floor plan, except it shows the foundation of the building and includes basement, foundation walls, slabs, piers, and footings.

IV.2.1.3. **Framing plan** – Framing plan shows the layout of the structural members supporting a floor or roof. A framing plan is often included for each floor. If there is room, detail drawings of the connections between members may be included.

IV.2.1.4. **Electrical plan** – Electrical plan includes location of receptacles, switches, and fixtures. Another type of electrical plan, the 'reflected ceiling plan' includes ceiling-mounted light fixtures.

IV2.1.5. **Plumbing plan** – The plumbing plan shows heating and circulating equipment, supply and waste systems, plumbing fixtures, and the spot where the water pipe enters the building.

IV.2.1.5. **Mechanical plan** – A mechanical plan shows the heating, ventilating, and air conditioning system (HVAC) and any mechanical equipment and systems located in the building.

IV.2.2. **Elevations** – Elevations are orthographic, exterior views of a building and show features such as the style of the building, doors, windows, chimneys, and moldings. Elevations are designated as 'Front', 'Right', 'Left', and 'Rear'. They may be also identified by the plan direction that the elevation faces such as 'East elevation' and 'West elevation' etc. Interior elevations may be provided to show the construction of a particular interior wall or area. The basement or foundation walls and footings are shown with hidden lines on elevations.

IV.2.3. **Sections** – Besides the plans and elevations, it may be necessary to show the "inside" of a wall, cabinet, or roof structure to clarify construction procedures. When the drawing is an imaginary "cut" through a wall or other feature, it is known as sectional view or section. Sections are provided for walls, cabinets, chimneys, stairs, and other features whose construction is not shown clearly on the plan or elevation. Figure IV.5, shown below, is an example of a sectional view showing construction details.

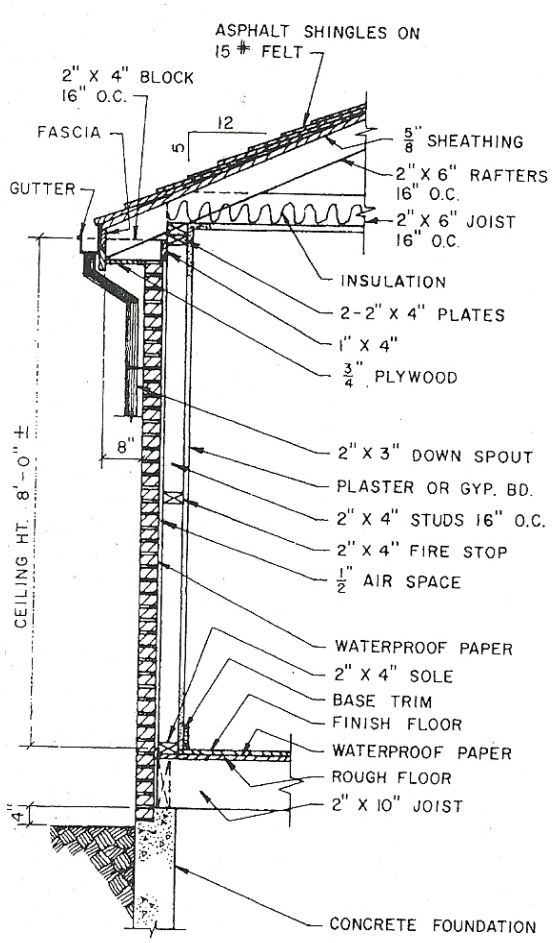


Figure IV.5 Sectional View

IV.2.4. **Details** – Due to the scale at which construction drawings are usually made, certain features are not clearly shown on the plan, elevation, or sectional views. These features will require a large-scale illustration to provide information necessary for construction. In these situations a detailed drawing is used. Details are drawn at a larger scale than plans, elevations, and sections and usually take precedence over drawings shown in less detail. Figure IV.6 is an example for a detail drawing. Detail drawings may be placed on the same sheet as the plan or elevation views or on a separate sheet and referenced by detail and sheet number.

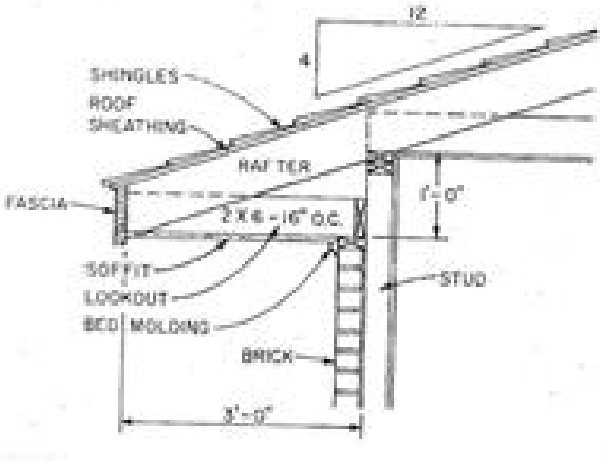


Figure IV.6 Details of a Cornice

V. SCALE READING AND DIMENSIONING

Construction drawings are drawn to a reduced scale (smaller than actual size). The scale of a particular plan, elevation, or detail is indicated on the sheet either in the title block or beneath the drawing itself. On a drawing, the scale is defined in the following manner: SCALE: ¼" = 1' – 0". This means that a ¼" length on the scale drawing is equal to a length of one foot in reality.

V.1. **Architect's scale** – In addition to referring to the relative size at which a drawing has been made, the term 'scale' also refers to the instrument (ruler) used to measure distances on a drawing. The most common scale used in this country is the architect's scale; the engineer's scale is also used. Both measure in customary units. The architect's scale can be used to measure distances on a drawing by matching the drawing scale to the appropriate scale listed on the instrument. Architect's and engineer's scales are available in both three-sided (triangular) and flat forms (two sided). Typical scales found on a three-sided architect's scale are listed on the following table.

Scale	Smallest tick mark
3/32"	3"
3/16"	2"
1/8"	2"
1/4"	1"
3/8"	1/2"
3/4"	1/4"
1/2"	1/4"
1"	1/8"
1 ½"	1/16"
3"	1/16"

The scale most commonly used for floor plans in the customary measurement system is

1/4" = 1' -0" or 1/48 size (there are forty-eight 1/4" units in 1'). This is commonly referred to as quarter scale. Normally scales for detail drawings range from 1/2" = 1' -0" to full size. When measuring a distance with an architect's scale the method shown in Figure V.1 must be used.

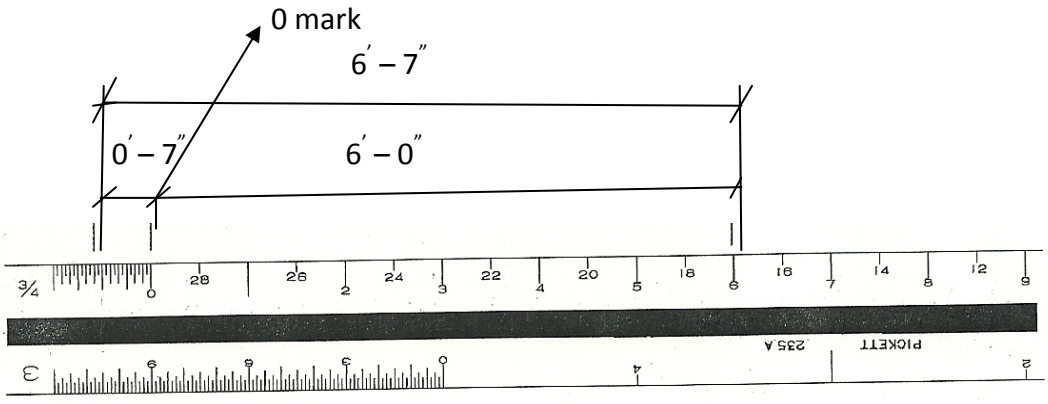


Figure V.1 Architect's Scale

Place the scale on the drawing such that one end of the line is past the 0 mark into the parts of a foot and inches area. Next, align the other end of the line with the nearest foot mark. Note the inches and fractions beyond the 0 mark, and add that measurement to the indicated number of feet to find the distance represented by the line. A properly prepared drawing will include all needed dimensions. Scaling a drawing for measurements not provided must be done carefully.

V.2. **Engineer's scale** – The engineer's scale is typically used on civil drawings such as the site plans and highway projects. Engineer's scales are referred to in whole numbers and are related to so many feet per inch. A "20 scale" would be noted as 1" = 20' – this means every inch on the drawing equals 20 feet in reality. The purpose of the engineer's scale is to be able to lay out larger areas of a project and get the project on one drawing. Typical scales found on a three-sided engineer's scale are:

1" = 10' (also can represent 100', 1000' or even10,000')
1" = 20' (" " 200', 2000' " 20,000')
1" = 30' (" " 300', 3000' " 30,000')
1" = 40' (" " 400', 4000' " 40,000')
1" = 50'(" " 500', 5000' " 50,000')
1" = 60'(" " 600', 6000' " 60,000')

Figure V.2 shows the measurement of a line using engineer's scale of 1″ = 10′.

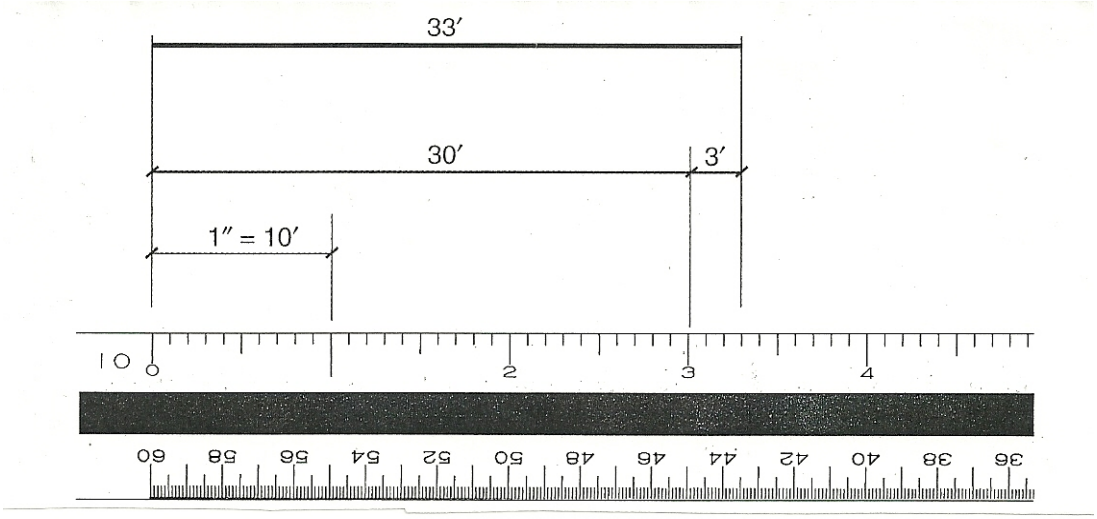


Figure V.2 Engineer's Scale

V.3. **Metric system** – The metric system of measurement has seen little use in this country primarily because metric construction standards have not been established. Once metric standards have been adopted and metric modular materials become available, metric dimensioning will be used. The metric scale closely representing the customary quarter-inch scale (1/48) size is the 1:50 scale (1/50 size) in which a two-centimeter length on the drawing equals a one-meter (100 cm) length on the actual object.

V.4. **Dimensioning technique** – A dimension line can terminate in an arrowhead, dot, or tick mark. The dimensions can be written above, below, or within the dimension line. Any dimension that can be needed during construction should be included on the drawing. Unnecessary dimensions should not be included.

V.4.1. **Dimensioning floor plans–T**he dimensions on the floor plan must be correct because other drawings will use floor plan as their basis. Dimensions of walls, windows, and doors are included. When dimensioning walls, different types of walls are dimensioned differently. Masonry walls dimensioned to their exterior surface as in Figure V.3

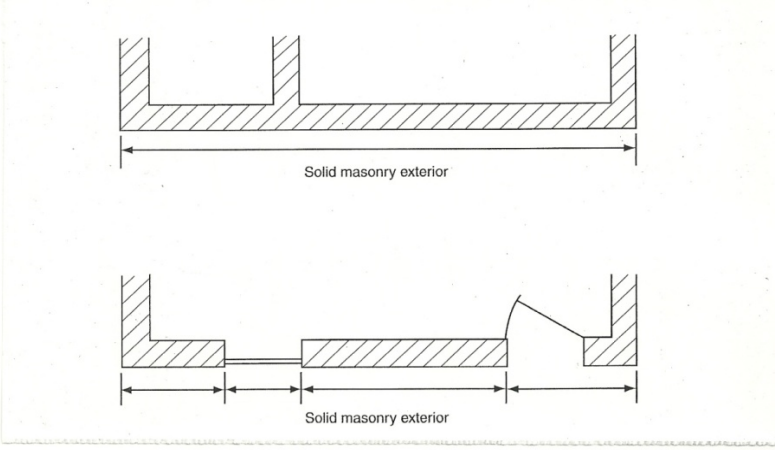


Figure V.3 Dimensioning Masonry Walls

Dimensions of exterior walls of frame and brick-veneer buildings usually start at the exterior surface of the stud wall as in Figure V.4.

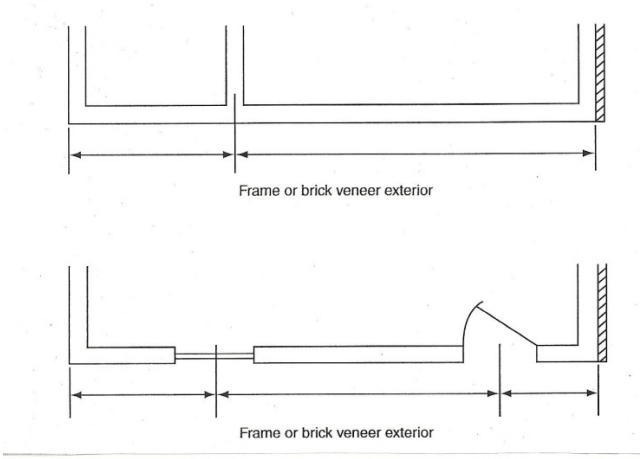


Figure V.4 Dimensioning Windows in Masonry and Frame Buildings

Interior walls are usually dimensioned to the center or side of partitions. Window and door openings are located by their center lines for frame construction. For masonry construction, these openings are dimensioned to the edges of the masonry surface openings.

V.4.2. **Dimensioning elevations** – Dimensions provided on elevation drawings are those related to the vertical plane. Footing thickness, depth of footing below grade, floor and ceiling heights, window and door heights, and chimney height are provided on elevation

drawings. In addition to vertical dimensions, information is provided through notes on grade information, materials, and special details. Roof slope is usually given on a drawing as a slope triangle. This diagram represents the ratio between 'rise' (change in elevation from top to bottom of roof) and 'run' (one-half the entire span of the building). A typical slope would be 4:12 or 4 units of rise for 12 units of run.

VI. PLOT DRAWINGS

VI.1. **Features of plot drawings –** A plot drawing is usually called a plot plan or a site plan. It is a view from above the property that shows the location of the building on the lot. Many features as shown below may be shown on the plot plan:

- Lot and block number or address.
- Bearing (direction) and length of property lines.
- North arrow.
- Dimensions of front, rear, and side yards.
- Location of other accessory buildings (carport, garage, etc).
- Location of walks, drives, fences, and patios.
- Location of easement setbacks.
- Location of utilities (gas, electric, water, and sewage).
- Elevations at the various locations.
- Trees and shrubs to be retained.
- Grades and topography of the site.

VI.1.1. **North arrow –** The north arrow indicates the north direction and will help to visualize the structure. If the walls of the building are not parallel to the compass directions, a 'plan north' may be designated. The plan north will be slightly different from the true north. A plan north is provided so that there is a reference direction aligned with the building.

VI.1.2. **Property lines** – Lines outlining the building plot are called property lines. The length and bearing (direction) of each property line is identified on the plot plan. Bearing is expressed as degrees east or west or north or south and given in degrees, minutes, and seconds. (A minute is $1/60^{th}$ of a degree, a second is $1/60^{th}$ of a minute). When the property line is a curve instead of a straight line, it is identified by a radius, length of curve, and its angle of tangency.

VI.1.3. **Contour lines** – Contour lines are lines that identify the ground elevation. All points along a contour line are at the same elevation. The elevation of the line is listed. See Figure VI.1.

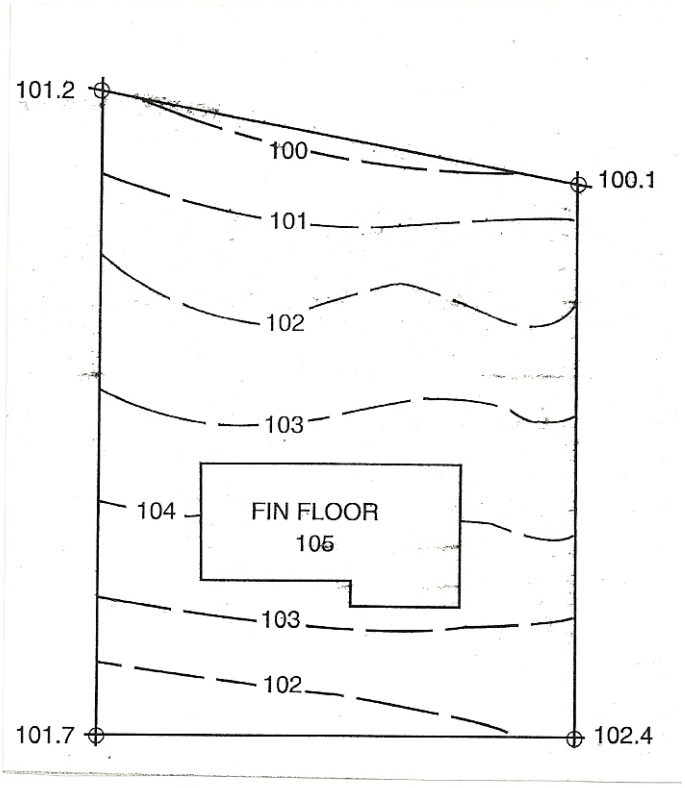


Figure VI.1 Contour Lines with Elevation and General Plot Layout

The interval between contour lines (the change in the vertical distance) can be any convenient distance such as 1′, 5′, or 10′. If the interval is too small, there will be too many contour lines and the drawing will become crowded and hard to interpret. If the interval is too large, some detail will be lost. Contour lines that are far apart indicate a gradual slope of the land and lines that are close together indicate a deep slope. See Figure VI.2.

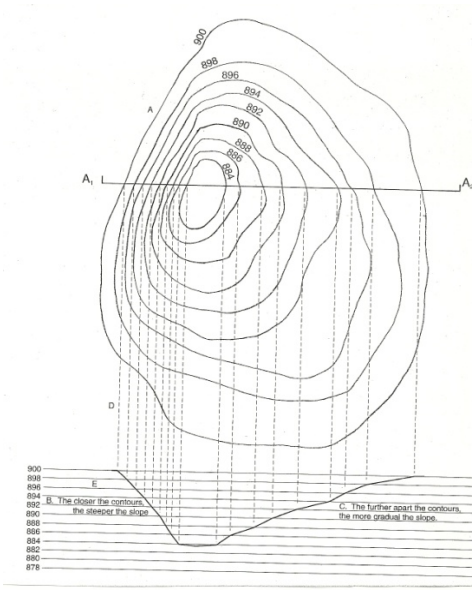


Figure VI.2 Contour with Section

Figure VI.3 indicates the topography and section as a pond or valley with the numbers decreasing toward the middle.

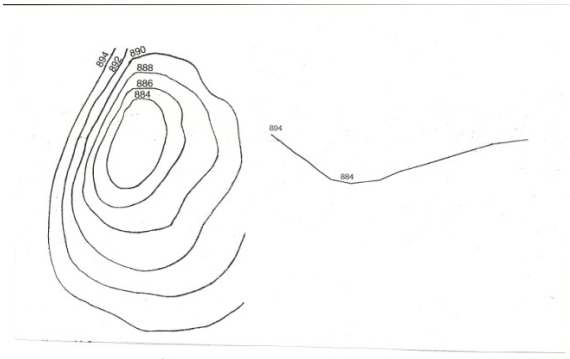


Figure VI.3 Contour Lines with Decreasing Elevations Toward the Middle

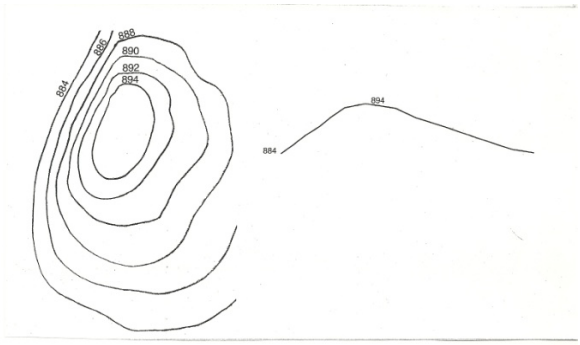


Figure VI.4 Contour Lines with Increasing Elevations Toward the Middle

Figure VI.4 shows the same configuration with the elevation numbers increasing toward the middle, indicating a hill in plan. Contour lines are long, freehand dashed lines. When it is desired to show both the original grade and a finish grade of contour, the original is shown in short dashed lines, the finish grade in solid lines See Figure VI.5.

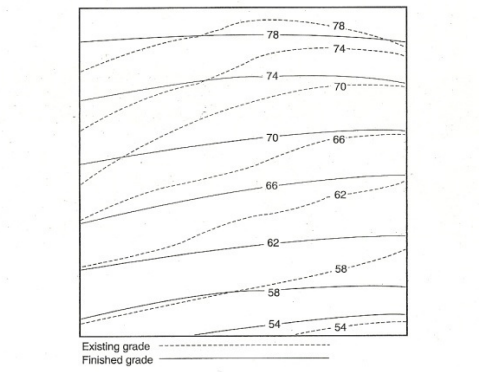


Figure VI.5 Contour Lines with Original and Finished Grade

The elevations on a particular plot are referenced to a local permanent marker of known elevation, such as a survey marker plate, a fire hydrant, or a manhole cover.

VI.1.4. **Topographic features**–The topography (location and elevation of features) is often displayed on the plot plan. Topographic features include natural objects such as trees or shrubs, and human-made objects. Figure VI.6 illustrates common topographical symbols

used on plans. Plot plans should also include a list of symbols used to identify features. This list is called a 'legend'.

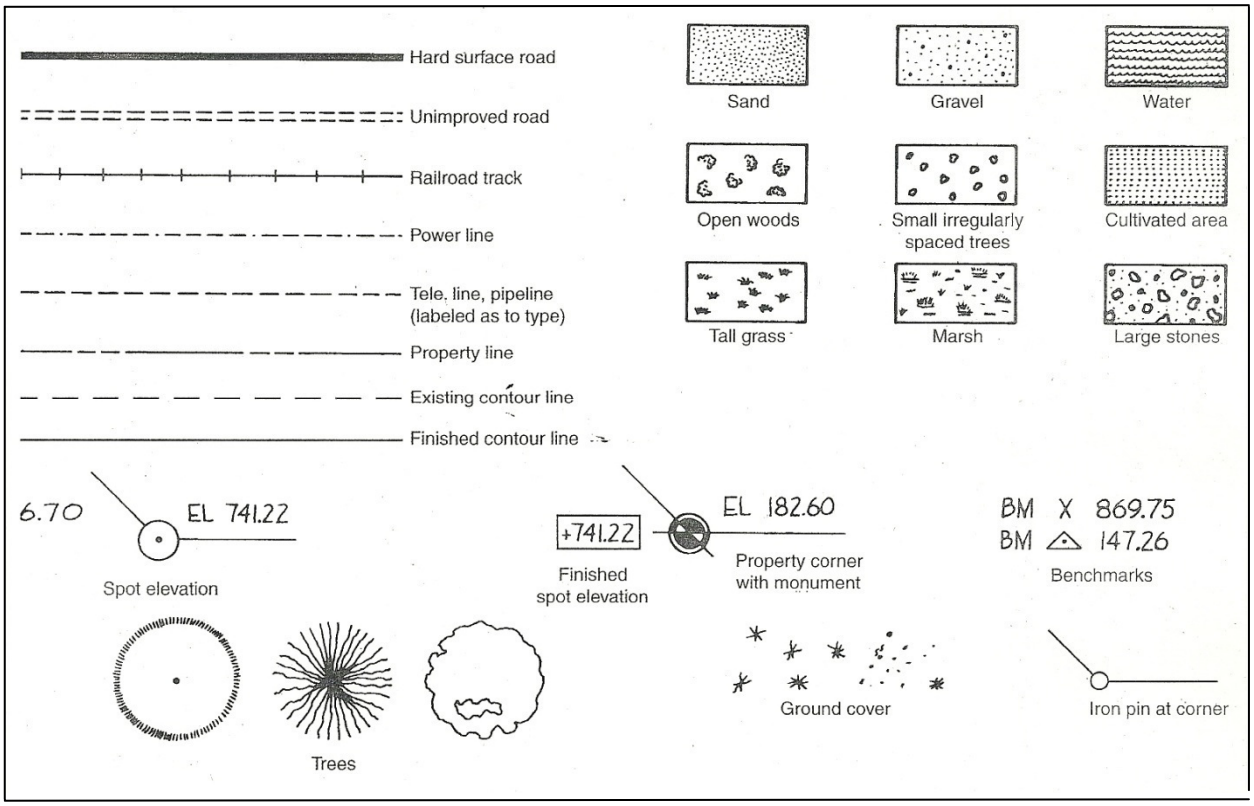


Figure VI.6 Common Topographic Symbols

VI.1.5. **Building location** – An outline of the structure is shown on the plot plan. Often the elevation of the first floor is also included. The distances from the property lines to the building are shown. Most local building codes specify a minimum distance between the building and the property lines. This distance is called a 'setback distance'. This distance can also be shown on the plot plan. The connections between the main utility lines and the building are shown on the plot plan. Underground pipes and cables are shown as dashed lines. These lines are identified on the drawing using abbreviations defined in the legend.

VII. FOUNDATION DRAWINGS

Once the building has been located on the plot and the required site clearance and excavation is complete, work starts on the concrete footings and foundation walls. The details of construction for the footings and foundation walls for the building are found on the foundation plan (or basement plan).

VII.1. **Footings** – Footings are the "feet" upon which the entire building rests. See Figure VII.1

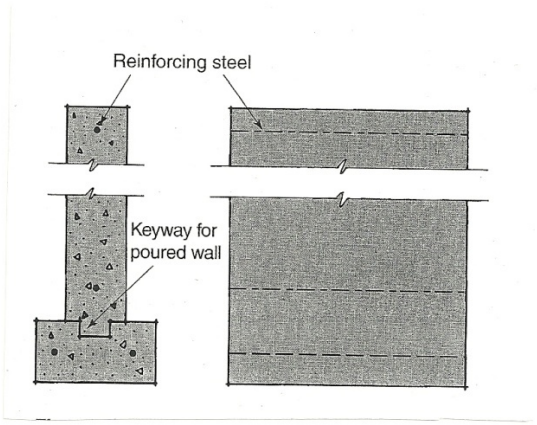


Figure VII.1 Footing

The sizes of the footings are shown on the foundation plan or on a detail of the foundation plan. There are many types of foundation systems as shown below:

- Footings and walls.
- Grade beams.
- Auger cast piles.
- Caissons.
- Steel H-piles.

Footings are also required under columns. These footings are usually wider and thicker than those for foundation walls because the column loads are concentrated on one spot. Fireplace

chimneys and similar concentrations of weight also require larger footings. Footings must rest on undisturbed soil below the frost line, the deepest point to which the ground will freeze in a given location. The local building code will give the depth of the frost line, and how far below it the bottoms of the footings must be placed. When a poured concrete foundation wall is to be erected on the footing, the drawing may call for a 'keyway' to be cast in the footing to anchor the wall as shown in Figure VII.1. On the foundation plan, footings are shown as hidden lines as shown in Figure VII.2

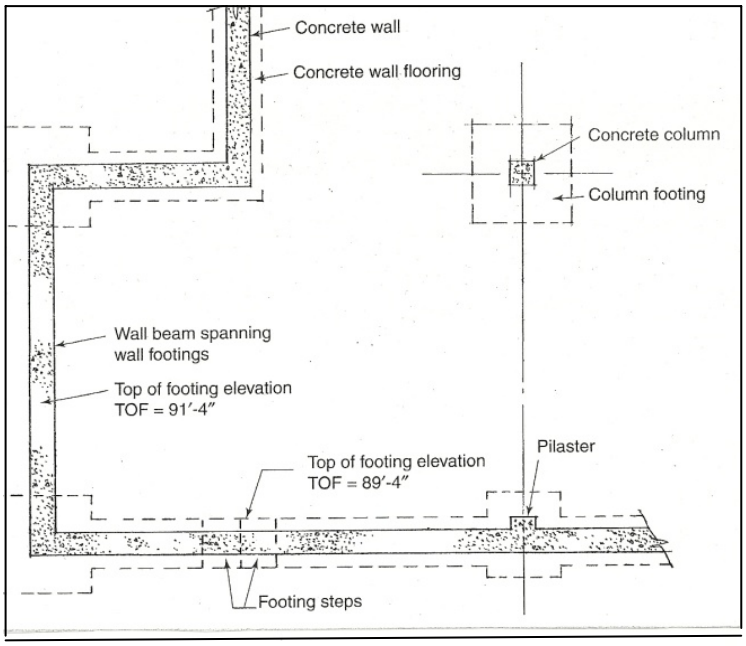


Figure VII.2 Wall & Footing Partial Foundation Plan

The width of the footing under the foundation walls and columns is shown. Reinforcing rods are shown as dots in sectional views. On elevation drawings, these rods are shown as long dashed lines.

VII.2. **Foundation walls –** Foundation walls are the base of the building. They transfer the weight of the building to the footings and to the ground below. Foundation walls and columns are shown as solid lines on the foundation plan and as hidden lines in elevation views. A foundation wall section is shown in Figure VII.3.

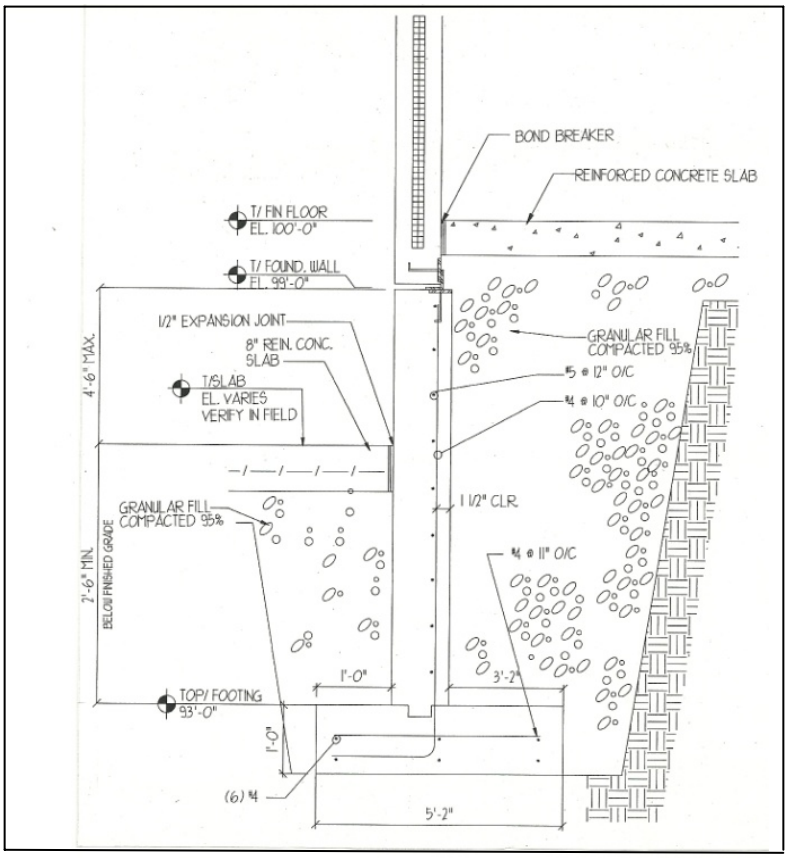


Figure VII.3 Foundation Wall Section

Fire places and chimneys are shown on the foundation plan with appropriate dimensions and necessary details for construction.

VII.3. **Auger cast piles –** This type of foundation is drilled with a 12″ – 14″ steel auger to the appropriate design depth. While the drilling shaft is being raised out of the hole, concrete is pumped down the shaft to fill up the cavity. In an auger cast pile system on a drawing there are several auger cast piles clustered together. They are topped with a pile cap to make the cluster work as a total load system as shown in Figure VII.4.

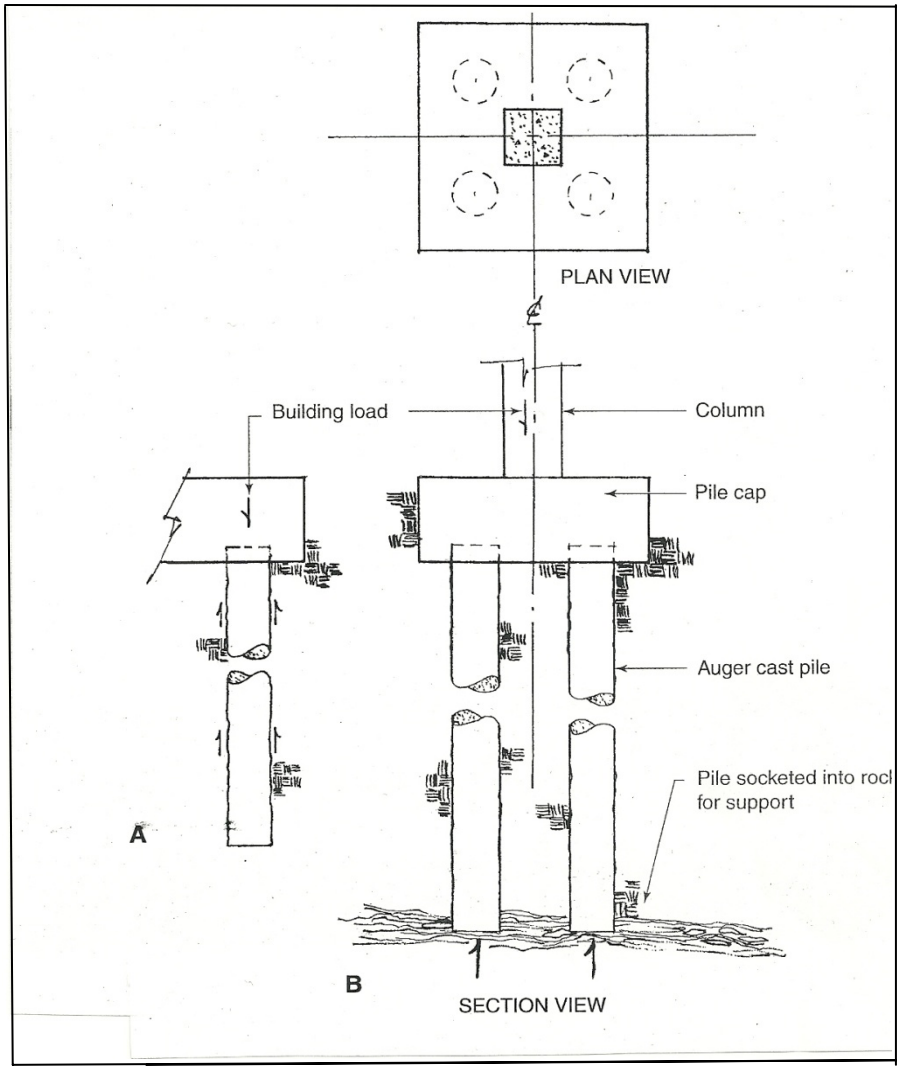


Figure VII.4 Section and Plan of Auger Cast Pile
A – Friction pile. B – Bearing pile

VII.4. **Caissons** – Caissons are also drilled to the design depth and are usually from 18″ – 72″ in diameter. The drill is then removed and the bottom of the caisson tested for soil load capacity. After the hole passes inspection, a steel reinforcing cage is installed, and the hole is filled with concrete.

VII.5. **Steel piles–**A steel pile is a long H-shaped (H-pile) or round (pipe pile) steel member that is hammer-driven into the earth. The pile is driven to a suitable support stratum or driven to friction resistance of the soil (this type of pile is referred to as a friction pile). On a drawing with this type of foundation system, several steel piles can be seen clustered together and topped with a pile cap to make the cluster work as total load system. See Figure VII.5.

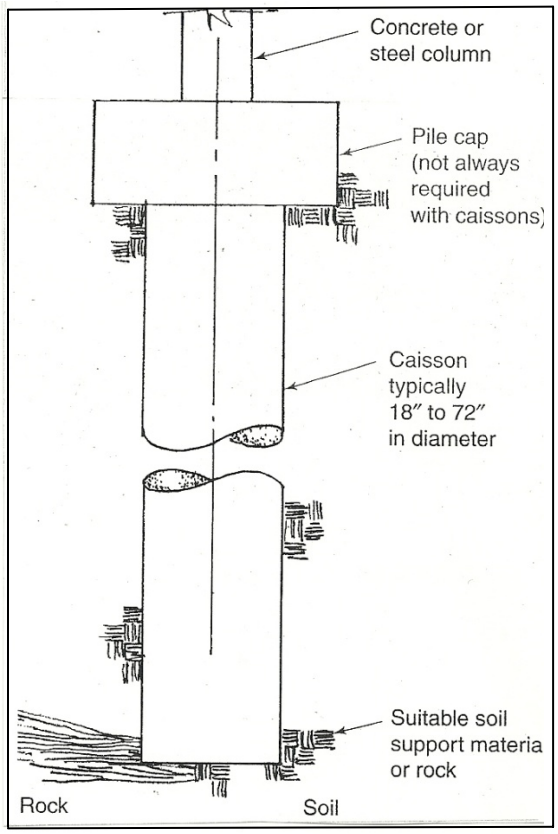


Figure VII.5 Steel H-Pile Foundation

VII.6. **Slab-on-grade –** A concrete slab poured at ground level is called slab-on-grade. Concrete slabs are used as both basement floors and main floors. Floating slab construction uses a monolithic slab (one continuous unit) as in Figure VII.6.

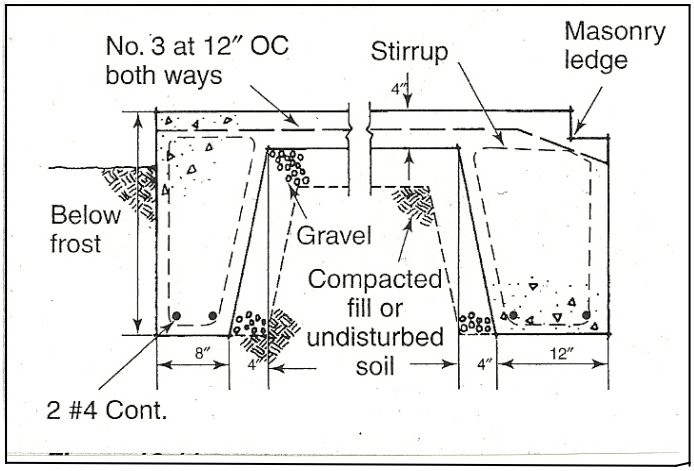


Figure VII.6 Monolithic Slab Foundation

Another method of producing a slab floor is to pour the foundation walls to floor height. Then, the area within the walls is filled with soil and gravel. Finally, the floor is poured within the walls, separated by an expansion joint as shown in Figure VII.7.

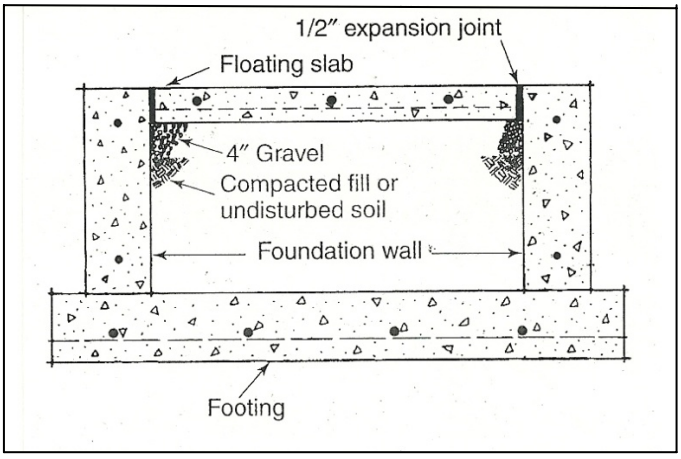


Figure VII.7 Slab Floor within the foundation Walls

Load-bearing walls over slab floors require a thickened slab as in Figure VII.8. These areas are indicated by hidden lines and a note.

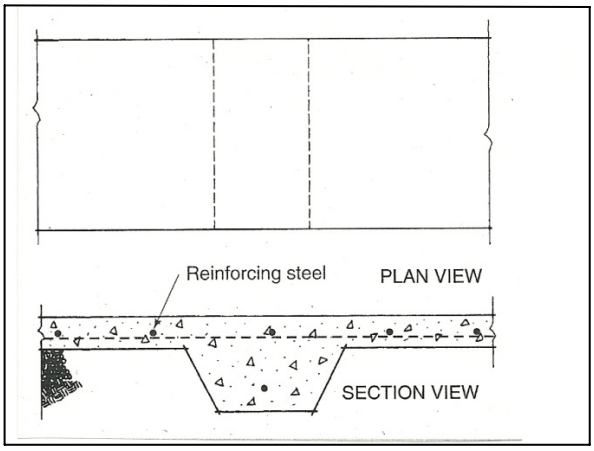


Figure VII.8 Thickened Slab Below Load-bearing Wall

VII.7. **Foundation elevations –** Elevations for a foundation are marked on the foundation plan view. Depending on the type of foundation, the elevations will be given for various parts of the system. For wall footings, the top of the footing is given and sometimes the bottom of the footing will also be marked as an elevation. For auger cast piles, caissons, and steel piles, the top of the pile cap is the elevation given.

VII.8. **Slab reinforcement –** Steel reinforcing rods or welded wire fabric are cast in the concrete when a slab is subjected to drying shrinkage. Reinforcement is also used when the concrete slab is expected to be subjected to tension due to the settling of a dirt fill or heavy load. A typical note specifying welded wire fabric in a concrete floor would read as: " #4 @12″ o/c EW OVER 4″ ABC.

VII.9. **Waterproofing foundations–**Water proofing of foundation walls is needed in areas where soil and climatic conditions demand protection from underground water. Residential waterproofing usually consists of mopping the outside of the foundation wall with tar or asphalt. Sometimes a polyethylene sheet is applied over the tar. Drawings for a foundation to be waterproofed will have a heavy black line on the exterior wall with a note indicating location. A layer of crushed rock or gravel is laid below the floor area. This layer is then covered with a heavy plastic vapor barrier to keep the dampness in the ground from transferring to the slab.

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VIII. FRAMING DRAWINGS

VIII.1. **Wood framing –** Wood is the most widely-used residential construction material due to its availability and affordability. Wood has proven to be a durable, dependable material for houses. The methods of wood framing are widely known.

VIII.2. **Floor frames –** The basic components of a floor frame, shown in Figure VIII.1, are explained below:

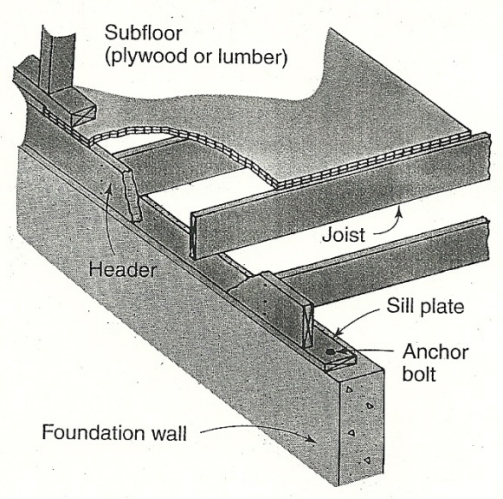


Figure VIII.1 Floor Frame Components

Sill plate: The sill plate is a board attached to top surface of the foundation wall. Anchor bolts cast in the concrete are used for the connection. A 2 x 6 member is often used for the sill plate.

Header: The header is nailed to the top of the sill plate at its exterior edge. The header is positioned with its longer cross-sectional dimension vertical. The header is of the same size as the joists attached to it.

Joists: The ends of these floor-support beams rest on the sill plate, and are nailed to the header. Joists are normally spaced 12" – 16" apart. Common lumber sizes used as joists are 2x8, 2x10, and 2x12.

Subfloor: The joists and header are covered with subflooring. A sheet material such as plywood is normally used and the subfloor is nailed to the joists. The finished floor will cover the subfloor. Figure VIII.2 shows additional floor framing members.

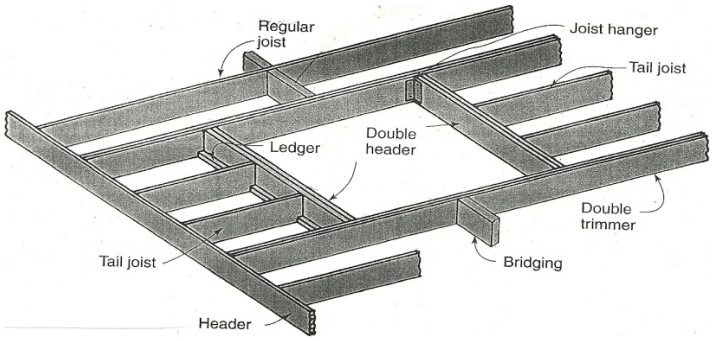


Figure VIII.2 Additional Floor Framing Members

Double header: When an opening that disrupts the framing pattern is needed, a double header, same size as the joists, is installed perpendicular to the joists.

Double trimmer: Two joists are nailed together next to an opening.

Tail joist: These are joists interrupted by an opening. They normally run between the double header and the sill plate.

Ledger: A ledger is a small piece of lumber, such as 2x2, nailed to the side of the double header, at its bottom edge. This piece serves as a ledge on which the tail joists rest. Notches must be cut into the joists.

Bridging: These small members are connected between the sides of the adjacent joists. Bridging provides lateral stability for the joists and helps to transmit load between the joists. Many types of bridging are used: joist-sized members, crossed 2x4s, or crossed metal bars.

The floor framing system is often shown on the floor plan. The sizes of the members are given. Joists will be specified in manner similar to "2x12 JOISTS 16" O.C." (on center), followed by marks to indicate direction of the span.

A 2x12 member is used for each joist. The joists are spaced 16" from one another. Joists on a plan represent the joists above the level shown.

VIII.3. **Dimensioning floor frames** – Normally, dimensions for exterior walls are given to the outside of the stud wall for frame and brick veneer buildings. See Figure VIII.3

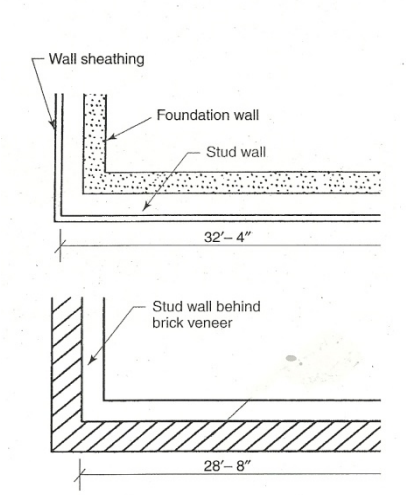


Figure VIII.3 Dimensioning of Exterior Wall

A note may be added to the drawing to read :"*exterior dimensions are to outside of studs; interior dimensions are to center of studs*". Drawings should be checked carefully to verify the dimensioning practice used. Usually interior walls of frame construction are dimensioned to their edges, but sometimes to their centerlines. Masonry interior walls are dimensioned to their faces, with the wall thickness also dimensioned. Houses that have second stories smaller than the first are called one-and-a-half story houses. These houses usually involve 'knee walls' (short walls joined by a sloping ceiling) and dormers. Split level houses have floor plans in which the levels are separated by half-flight of stairs. Many variations are called for in framing of this type of structure.

VIII.4. **Wall frames** – There are three basic types of light frame construction: platform, balloon, and park-and-beam.

VIII.4.1. **Platform framing** – Platform framing, also known as western framing, is the most widely-used type. The first floor is built on top of the foundation, so it resembles a platform when the subflooring is complete. The first floor and wall sections are raised and a second-floor platform is built on top of these walls. Then, the second-floor wall sections are raised and another platform for the second story ceiling is constructed. Each floor is a separate unit built on the structure below. See Figure VIII.4.

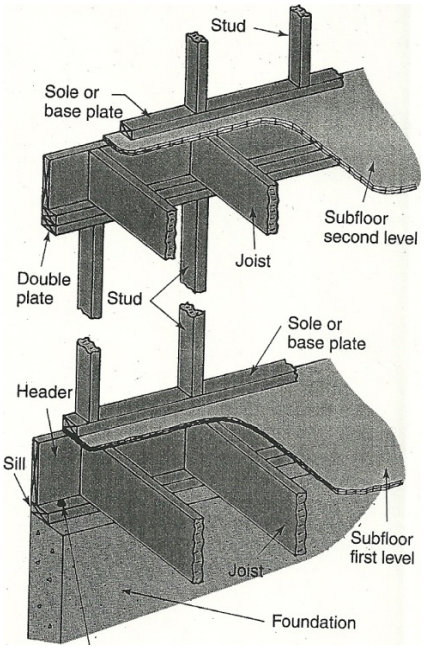


Figure VIII.4 Platform Framing

VIII.4.2. **Balloon framing -** Balloon framing is not used to any large extent today. In this type of framing, the studs extend unbroken from the first floor sill plate to the top plate of the highest floor. Second floor joists rest on a member called a 'ribbon' which is set into the studs. See Figure VIII.5.

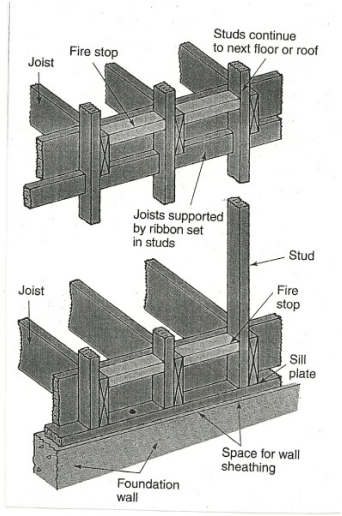


Figure VIII.5 Balloon Framing

VIII.4.3. **Plank-and-beam-framing** – This framing consists of heavy timber material for posts in wall sections and 2″ thick plank material supporting floor and roof sections. The structural members are placed at wider intervals than in other methods of framing. This type of framing lends itself to extensive use of glass and exposed wood sections.

Various components of a wall frame are illustrated in Figure VIII.6 and are described below:

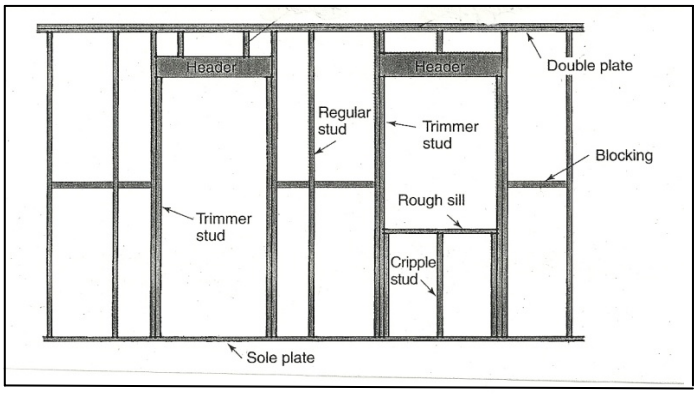


Figure VIII.6 Wall Frame Components

- Sole plate: This serves as a base for the wall frame. The sole plate is the same size member as the studs (normally 2x4 or 2x6) and is nailed to the subfloor.
- Studs: Studs are the vertical members in the wall frame, running from the sole plate to the top plate. Studs are normally 2x4 or 2x6 members.
- Header: When some studs must be left out to make room for a window or room, a header is used to distribute the weight of the building around the opening. Most common way of constructing headers is to run two 2x4 members sideways and insert a 3/8″ spacer. The header is nailed in place.
- Trimmer stud: A stud is always located on either side of a header. Next to these studs and below the header, trimmer studs are placed. A trimmer stud extends from the sole plate to the bottom of the header. It is attached to both the stud at the side and to the header.
- Rough sill: A rough sill is positioned to support a window.
- Cripple stud: Cripple studs are short and extend between the top plate and the header or the sole plate and rough sill. They are similar to trimmer studs, but are not paired with an adjacent stud.

- Blocking: Blocking is used to prevent the spread of the fire from floor-to-floor through stud and spaces.

- Top plate: The top plate (shown in Figure VIII.6 as a double plate) rests above the studs. The next level of joists or rafters is supported by the top plate.

Interior walls that carry the ceiling or floor load from above are called' load bearing partitions'. Usually they are located over a beam or bearing wall. See Figure VIII.7.

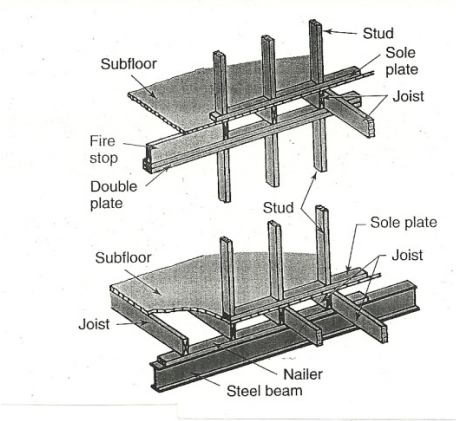


Figure VIII.7 Load-bearing Partitions

VIII.5. **Schedules** – Doors and window schedules give the number and size of all doors and windows in the building. See Figure VIII.8 for a typical door schedule.

Door Schedule

Mark	Type	Size	Material	Frame	Remarks
A	1	3′–0″ × 7′–0″ × 1¾″	Hollow Metal	Hollow Metal	Closer and Threshold
B	1	3′–0″ × 7′–0″ × 1¾″	Hollow Metal	Hollow Metal	Closer
C	2	2′–8″ × 7′–0″ × 1¾″	Hollow Metal	Hollow Metal	Closer and Kick Plate
D	2	3′–0″ × 7′–0″ × 1¾″	Hollow Metal	Hollow Metal	Closer
E	2	3′–0″ × 7′–0″ × 1¾″	Hollow Metal	Hollow Metal	Closer

Figure VIII.8 A Typical Door Schedule

Units listed in the schedule are referenced to the plan view with a letter or number. Some times, rough opening size is provided in the schedule.

VIII.6. **Sectional views –** Sectional views of walls are drawn to a larger scale and included on the drawings to clarify construction details. The section locations are identified on the plan view with a reference line. Full sections are cut through width or length of a building. These

sectional views show features such as floors, walls, and ceilings as sections. Features beyond the cutting plane are shown as they appear in the interior of a building.

VIII.7. **Roof frames –** Sketches of various roof styles found in house construction are shown in Figure VIII.9. The style of the roof is most easily identified in elevation drawings.

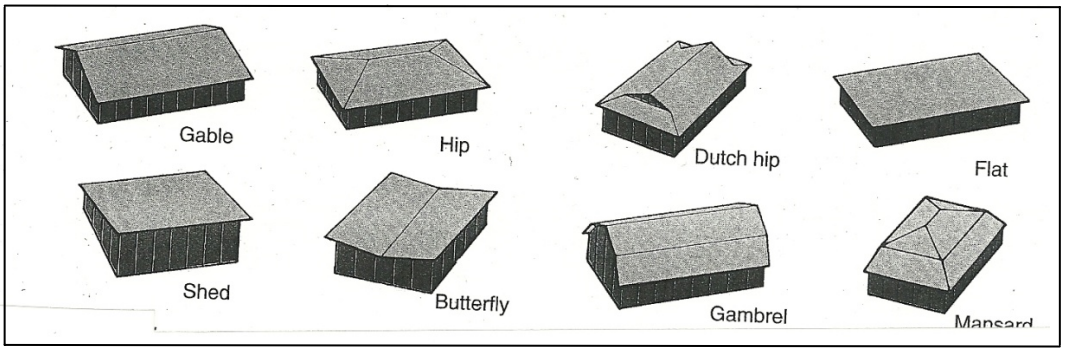


Figure VIII.9 Common Roof Styles

Figure VIII.10 illustrates some common terms used in roof framing:

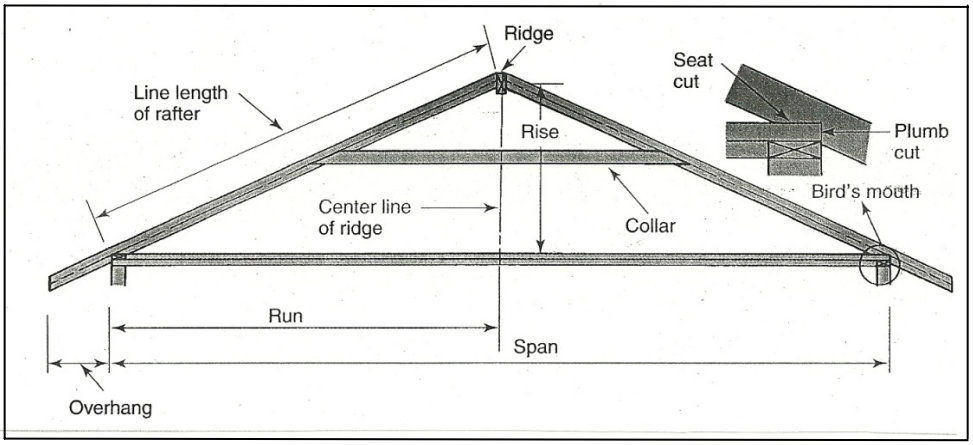


Figure VIII.10 Common Roof Framing Terms

IX. PLUMBING DRAWINGS

In most residences, plumbing consists of the water distribution system, sewage disposal system, and piping needed for heating and cooling systems. Sometimes, piping diagrams are unnecessary. Symbols on the plan drawings locate fixtures such as sinks, water closets, floor drains, and exterior hose bibs. The plumber installs the system in accordance with the specifications and local government codes. Plumbers must coordinate their work assignment with other craftspeople, because plumbing takes place during three different stages of construction:

- Initial stage provides for the service entrance of the water supply and sewer drain to the building are made prior to the pouring of the foundation.
- The next stage is the rough-in plumbing, which includes installing water supply pipes and sewage drain pipes. The rough-in work is performed before the slab is poured in slab-on-grade construction and before wall-covering materials are placed on the wall framing.
- The final stage is the finish plumbing, which includes the installation and connection of fixtures after the floor and walls are finished.

IX.1. **Water distribution system** – The water distribution system includes the main supply line to the building from the municipal water meter, individual well, or other source of supply. All pipes that take water from the main to the various service outlets (water heaters, sinks, water closets, hose bibs etc.) are called distribution pipes. The distribution system also includes all of the control valves. Symbols for plumbing fixtures are pictorial representatives of the fixtures and they are shown on the plan views and on interior elevation views. The most commonly used symbols for plumbing are shown in Figure IX.1

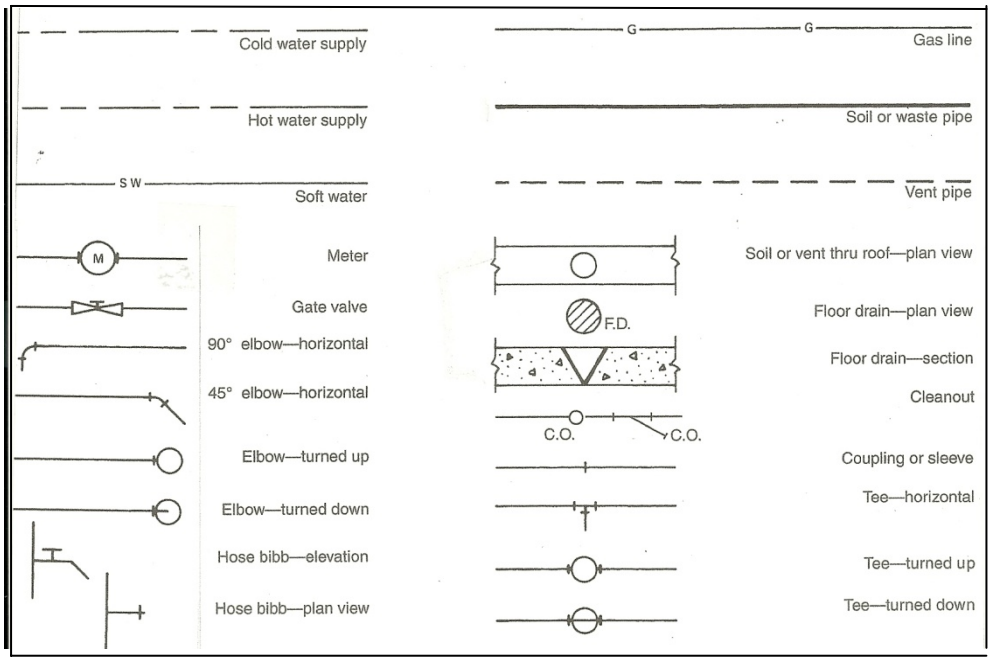


Figure IX.1 Common Plumbing Symbols

IX.2. **Distribution piping materials** – Piping materials used for water distribution include copper, galvanized steel, brass, and plastic. Copper and plastic are the most common. Copper piping should not be embedded in concrete slabs, masonry walls, or footings. When it is necessary for the pipe to go through a slab or a wall, a plastic sleeve or a larger pipe should be placed between the copper water pipe and concrete. This will permit movement due to expansion of the copper. Galvanized steel pipe has great strength and dimensional stability. The galvanized coating protects the pipe against rusting. Brass pipe is used for highly-corrosive water. This type of pipe would be used in situations such as coastal areas where saltwater is used for cooling, baths, or other applications. Plastic pipe is used extensively. Three of the most common types are acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC), and polybutylene. Plastic pipes and fittings use solvent-welded joints. Figure IX.2 shows an isometric view of the water distribution system.

IX.3. **Sewage disposal system –** The sewage disposal system is also known as the drain/waste/vent (DWV) system. It includes a vertical soil (waste) stack, a vent, and a trap for each fixture. The waste stack carries the waste water to the building drain, to the building sewer line outside the building, and to the public sewer or septic tank. At the base of each stack, fittings called 'cleanouts' (CO) are installed to provide access to clean out the clogged line with a plumber's rod or tape. Piping can be shown on plan and elevation views, but often an isometric drawing of the system is provided.

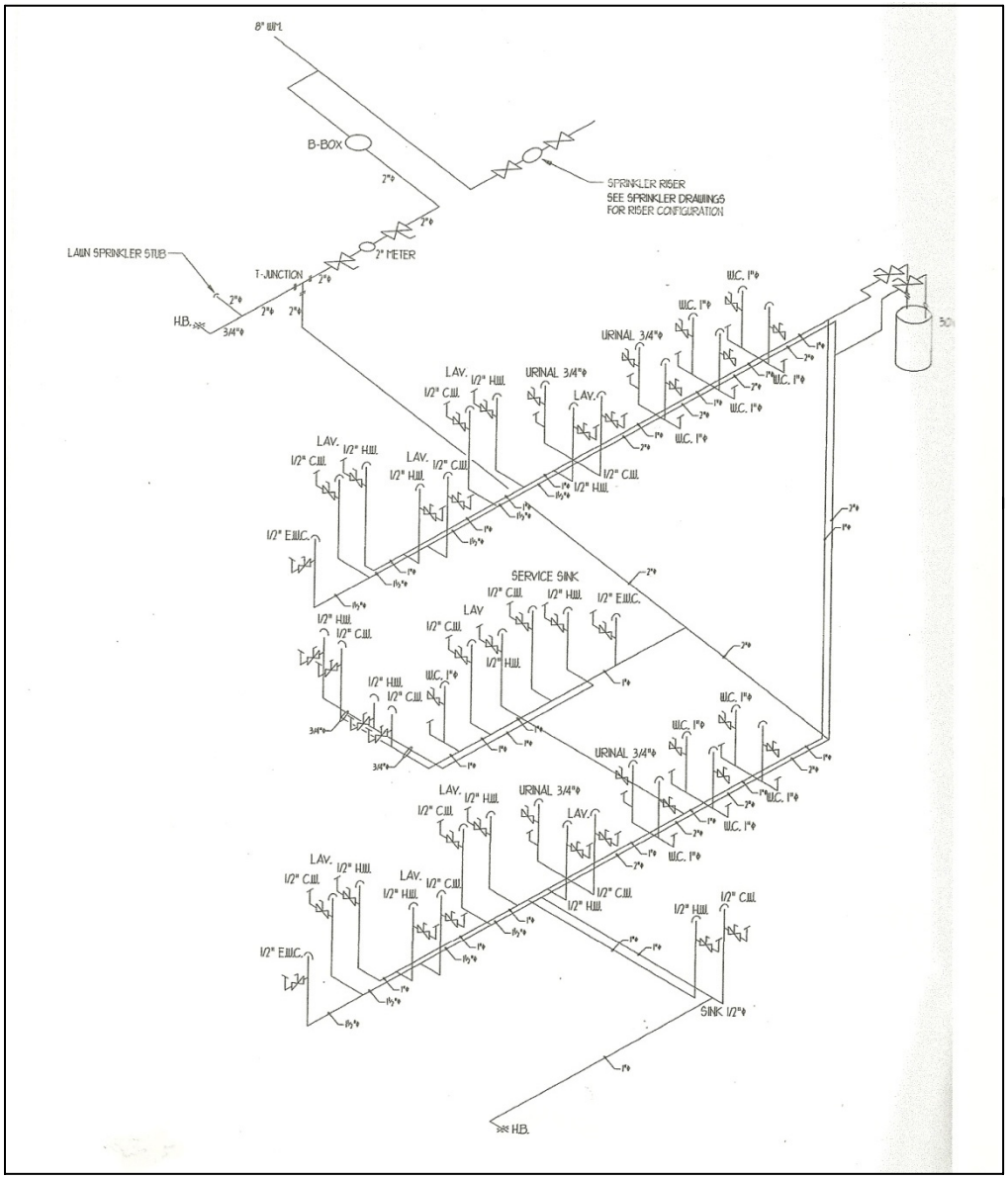


Figure IX.2 Water Distribution System (Isometric View)

IX.4. **Sewage piping materials** – Sewage disposal systems can be made from many different kinds of pipe materials. Cast-iron, copper, and plastic pipes are used. Cast-iron pipe has good strength and resistance to corrosion. Copper and plastic pipes are used extensively because of ease of installation.

IX.5. **Gas and fuel oil systems** – Sometimes, the piping for gas or oil heating system is included in the plumbing drawing. Materials most commonly used for gas piping are black wrought iron,

galvanized steel, or yellow brass. Copper tubing is banned by most building codes because it corrodes when exposed to some gases. Black wrought iron pipe is often required by building codes for piping combustible gases, such as natural gas.

IX.6. **Plumbing codes** – Model codes such as the 'Uniform Plumbing Code' and the local government code control all aspects of plumbing work. These include the kind and sizes of pipe used, locations of traps and cleanouts, plumbing fixture requirements, venting provisions, and connections to water supply and sewer lines. These codes also specify the leak testing to be conducted on water supply lines and waste lines.

X. HVAC DRAWINGS

Heating, ventilating, and air-conditioning (HVAC) systems produce the movement of air within a building. This air may be heated or cooled, then moved to another location to change the air conditions. The HVAC system makes a space more comfortable for the people occupying it. The treatment involves controlling the temperature, humidity (moisture in the air), and air cleanliness. To accomplish the desired air conditioning in a building, a heating system and a cooling system are needed.

HVAC plans are drawn on the floor plan of the structure. Symbols for heating and cooling systems are shown in Figure X.1.

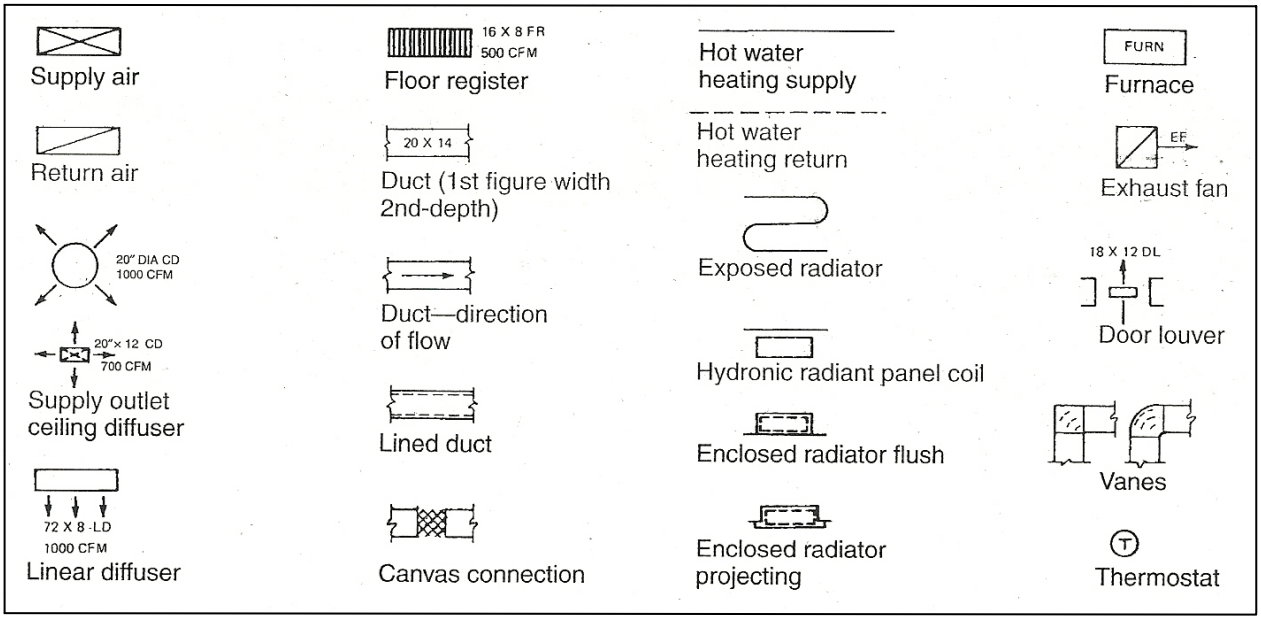


Figure X.1 Air conditioning Symbols

X.1. **Heating system** – There are three types of heating systems used in new construction: forced-air, hydronic (hot water), and electric radiant heating.

X.1.1. **Forced-air system - I**n a forced-air system, the heated air from the furnace or heat pump chamber is transferred by means of a motor-driven fan through a series of ducts to registers or diffusers in the various rooms. Cool air is gathered through registers near the floor and

returned to the heating unit through ducts and a filtering system to be reheated and re-circulated. Sources of heat for forced-air systems are natural gas, liquefied petroleum gas (LPG), oil, coal, or electricity. Drawings often specify the airflow rate at a given point in cubic feet per minute (CFM).

X.1.2. **Hydronic heating system –** In a hydronic heating system, water is heated to a temperature of 200^0 F (90^0C) in a boiler. Then, the hot water is circulated by a pump and piping system to convectors in the spaces to be heated. Drawings, when provided, are superimposed over the floor plan or given in an isometric diagram.

X.1.3. **Electric radiant heating** – Electric radiant heating is usually provided by wires embedded in the ceilings, walls, or floors and base boards of the building. Radiant heat is given off by the materials (such as concrete or plaster) that are warmed by resistance induced in the wires embedded in them. Heating system drawings can be superimposed over the floor plans on a separate diagram provided with appropriate notes. When drawings are not provided, the amount of heat required for each space is noted on the floor plan.

X.2. **Cooling systems** – Cooling systems can be grouped as unit systems (window or wall mounted) and remote systems (refrigeration equipment located away from the area to be conditioned). A third system, evaporative system, is used in special circumstances.

X.2.1. **Unit cooling systems**– Unit cooling systems are provided to cool a room and are installed in a window or space provided in an exterior wall. Very little construction is installed in their installation.

X.2.2. **Remote cooling systems** – Remote cooling systems have the condensing unit in a remote space away from the area to be cooled. The evaporator is in the main duct, where a fan forces air past the cooling coils and circulates the air to the rooms to be cooled.

X.2.3. **Evaporative cooling systems–**Evaporative cooling systems are most effective in dry climates where the relative humidity is low (20% or less). The system functions by moving air rapidly over a pad of loose fibers that is kept moist by a water spray mist. The air is cooled as it passes through the pad, and then carried through a duct system to the rooms. The supply duct layout for an evaporative cooling system is similar to that of a forced-air system.

X.3. **Air filters –** Most heating and cooling systems provide a means of filtering the air that flows through the system. The filters usually have an adhesive or oil coat that collect lint and dust particles. These filters may be disposable or washable. An electrostatic filter is usually a separate unit added to the system. It is noted on the heating and cooling plan and detailed in the specifications.

XI. ELECTRICAL DRAWINGS

XI.1.**Electrical plans** – An electrical plan shows the locations of the distribution panel, receptacles, switches, and lights. Some of the more common symbols used on electrical drawings are shown in Figure XI.1.

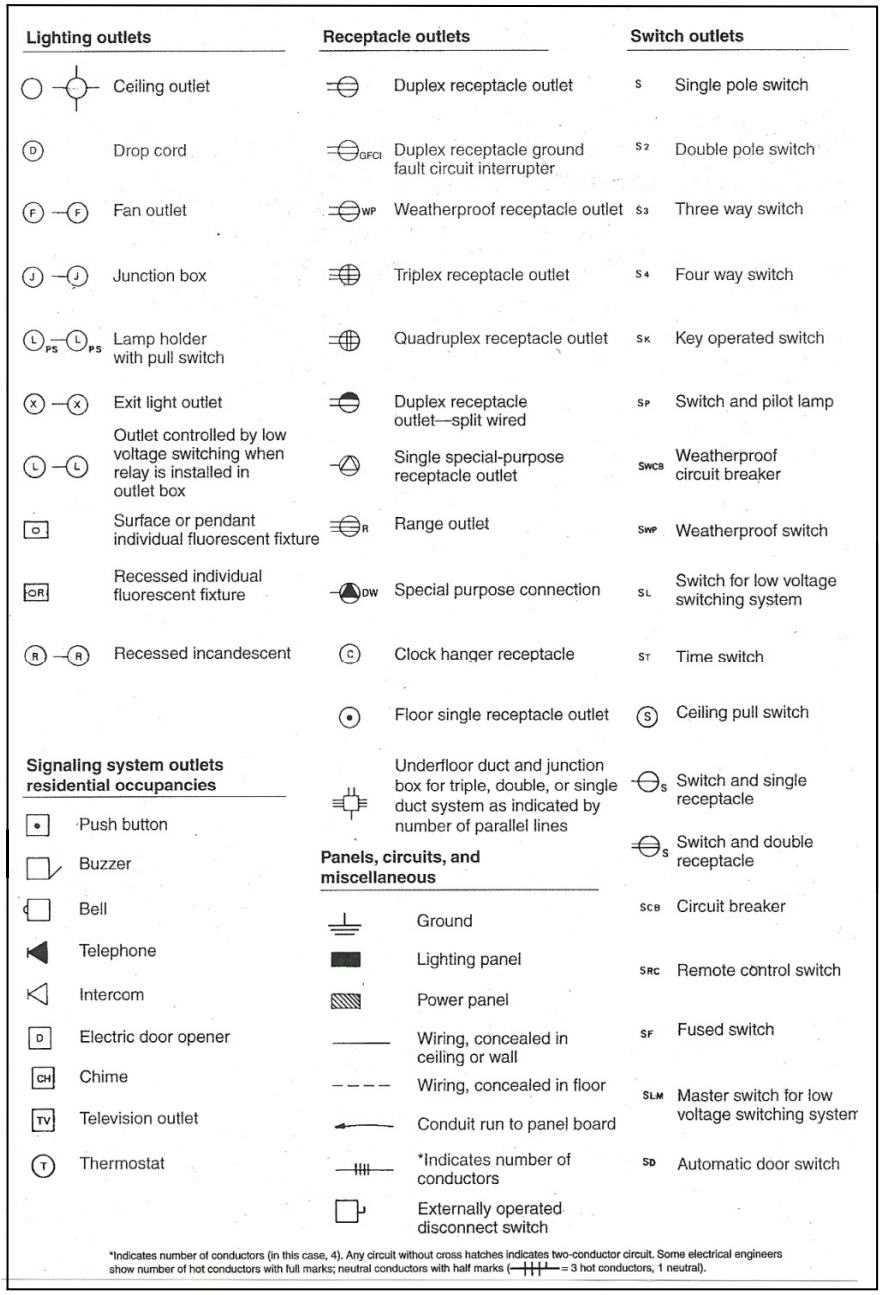


Figure XI.1 Common Symbols on Electrical Plan

A legend listing the symbols is usually shown on the electrical plan. Broken lines indicate which outlets and switches are connected. However, the path of the wiring is not necessarily where the lines are drawn. The electrical plan may also show the wire and conduit sizes. The lines show the starting and ending pointsof the conduit run. Again, the line does not show the exact location where the conduit should be located.

XI.2. **Wiring diagrams**– A wiring diagram, as shown in Figure XI.2, is used when wiring details cannot be shown clearly on the plan.

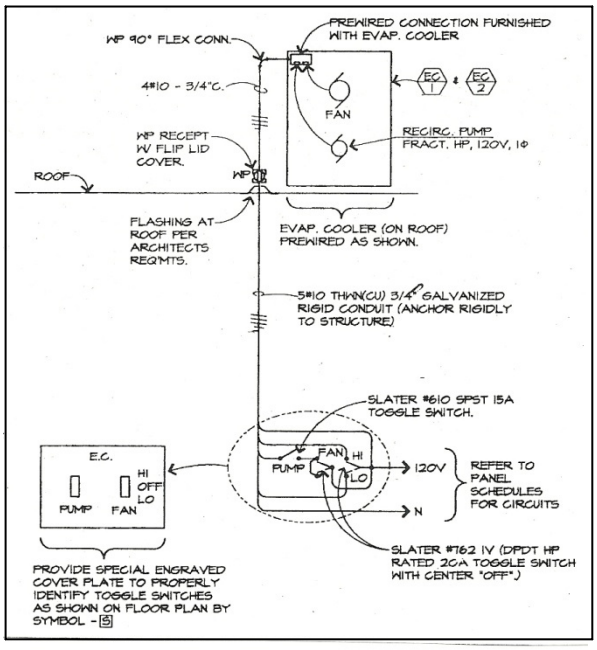


Figure XI.2 Typical Control Wiring Diagram

Wiring diagrams correspond to a specific piece of equipment. The types of wire running between the equipment and its power source, sensors, gauges, and other related equipment are shown.

XI.3. **One-line diagrams –** One-line diagrams are schematic drawings as shown in Figure XI.3. They show which pieces of equipment are connected electrically and what is used to connect them.

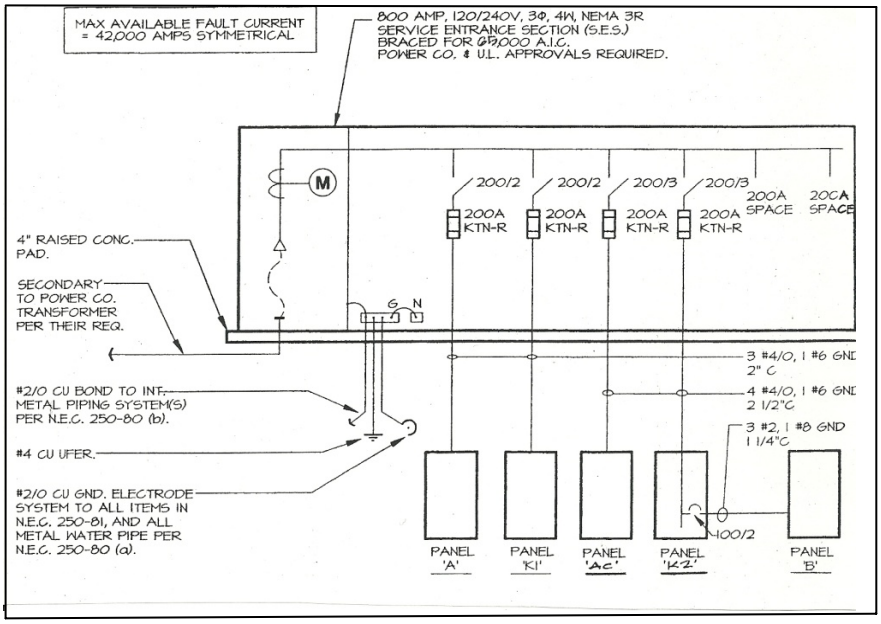
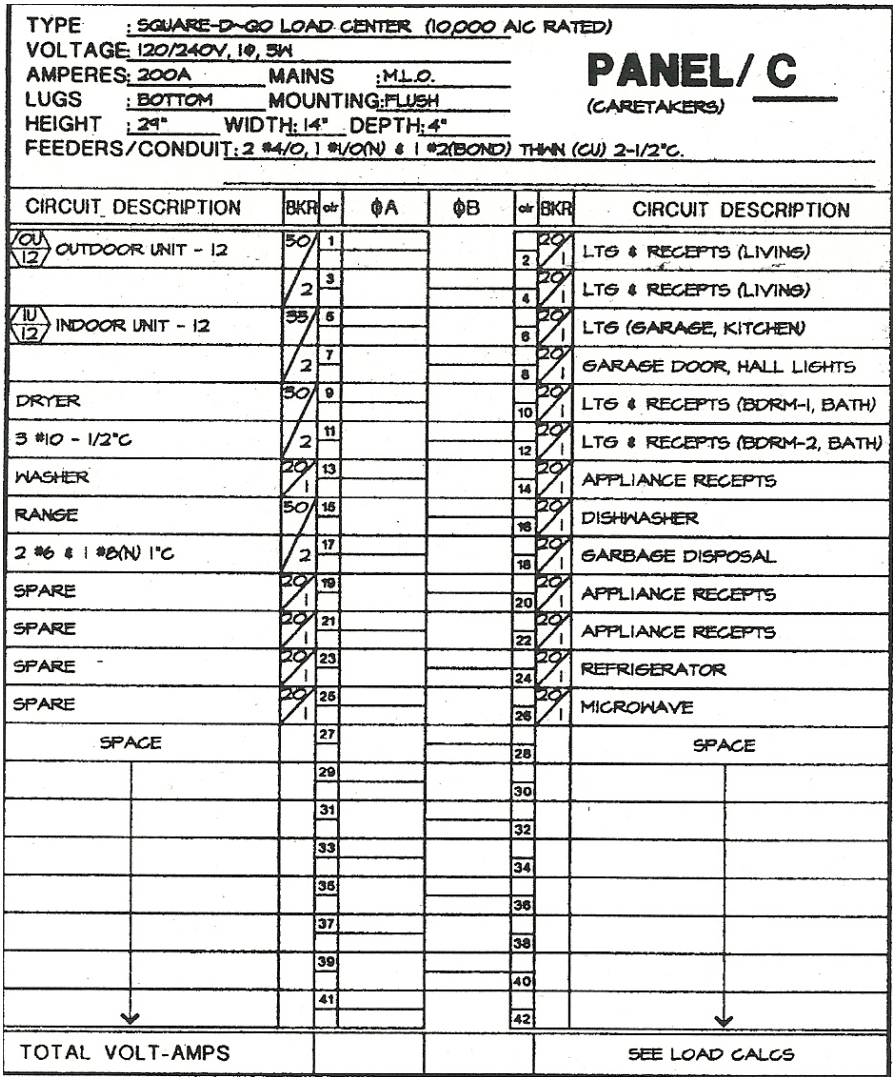


Figure XI.3 One Line Diagram

XI.4. **Schedules –** There are many kinds of Schedules used with electrical drawings and the following three are mostly used.

XI.4.1. **Panel schedule** – All the information associated with a circuit breaker box (also called lighting panel, power panel, breaker panel, or distribution panel) is included in the panel schedule as shown in Figure XI.4. The voltage entering the box, the number and size of the breakers, and a brief description of the devices protected by the breakers are included.



TYPE : SQUARE-D-QO LOAD CENTER (10,000 AIC RATED)
VOLTAGE: 120/240V, 1Φ, 3W
AMPERES: 200A MAINS : M.L.O.
LUGS : BOTTOM MOUNTING: FLUSH
HEIGHT : 29" WIDTH: 14" DEPTH: 4"
FEEDERS/CONDUIT: 2 #4/0, 1 #1/0(N) & 1 #2(BOND) THWN (CU) 2-1/2"C.

PANEL/ C
(CARETAKERS)

CIRCUIT DESCRIPTION	BKR	ckt	ΦA	ΦB	ckt	BKR	CIRCUIT DESCRIPTION
OU 12 OUTDOOR UNIT - 12	50/2	1			2	20/1	LTG & RECEPTS (LIVING)
		3			4	20/1	LTG & RECEPTS (LIVING)
IU 12 INDOOR UNIT - 12	55/2	5			6	20/1	LTG (GARAGE, KITCHEN)
		7			8	20/1	GARAGE DOOR, HALL LIGHTS
DRYER	30/2	9			10	20/1	LTG & RECEPTS (BDRM-1, BATH)
3 #10 - 1/2"C		11			12	20/1	LTG & RECEPTS (BDRM-2, BATH)
WASHER	20/1	13			14	20/1	APPLIANCE RECEPTS
RANGE	50/2	15			16	20/1	DISHWASHER
2 #6 & 1 #8(N) 1"C		17			18	20/1	GARBAGE DISPOSAL
SPARE	20/1	19			20	20/1	APPLIANCE RECEPTS
SPARE	20/1	21			22	20/1	APPLIANCE RECEPTS
SPARE	20/1	23			24	20/1	REFRIGERATOR
SPARE	20/1	25			26	20/1	MICROWAVE
SPACE		27			28		SPACE
		29			30		
		31			32		
		33			34		
		35			36		
		37			38		
		39			40		
		41			42		
TOTAL VOLT-AMPS							SEE LOAD CALCS

Figure XI.4 Panel Schedule

XI.4.2. **Lighting schedule** – In a lighting schedule, the permanently-mounted light fixtures used in the project are listed. Each fixture is marked on the drawing with an identifying letter that references the schedule. The brand of fixture, catalog number, and power requirements are listed.

XI.4.3. **Equipment schedule** – An equipment schedule, as shown in Figure XI.5, is similar to a lighting schedule. It lists equipment instead of light fixtures. More detailed wiring and power information is included in the equipment schedule.

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MK	HP	KW	LOAD / EA.	VOLTS-φ	DISC. SW./LPN-RK FUSES	FEEDERS / CONDUIT
IU INDOOR UNITS						
1 THRU 4 6, 8	3/4	8.0	41.7A	230 - 1	60/2P W (2) 60A	2 #6&1 #8 (BOND) THWN (CU)-1"C
5, 9	1/3	5.0	25.4A	230 - 1	60/2P W (2) 35A	2 #8&1 #8 (BOND) THWN (CU)-3/4"C
7	1/5	3.0	15.2A	230 - 1	30/2P W (2) 20A	2 #10&1 #10 (BOND) THWN (CU)-1/2"C
10, 11	-	1.0	8.3A	120 - 1	MANUAL MOTOR STARTER	2 #12&1 #12 (BOND) THWN (CU)-1/2"C
12	1/2	5.0	27.0A	230 - 1	60/2P W (2) 35A	2 #8&1 #8 (BOND) THWN (CU)-3/4"C
OU OUTDOOR UNITS						
1, 2, 4, 8	-	-	27.9A	230 - 1	WP, 60/2 W(2) 40A	2 #8&1 #8 (BOND) THWN (CU)-3/4"C
3, 6	-	-	36.3A	230 - 1	WP, 60/2 W(2) 50A	2 #6&1 #8 (BOND) THWN (CU)-1"C
5, 9	-	-	15.1A	230 - 1	WP, 30/2 W(2) 20A	2 #10&1 #10 (BOND) THWN (CU)-1/2"C
7	-	-	10.5A	230 - 1	WP, 30/2 W(2) 15A	2 #12&1 #12 (BOND) THWN (CU)-1/2"C
10, 11	-	-	10.0A	120 - 1	WP, 30/2 W(1) 15A	2 #12&1 #12 (BOND) THWN (CU)-1/2"C
12	-	-	25.4A	230 - 1	WP, 30/2 W(2) 35A	2 #8&1 #8 (BOND) THWN (CU)-3/4"C
EC EVAP. COOLERS						
1, 2	1/2	-	9.8A	120 - 1	SEE CONTROL DIAGRAM THIS SHEET	

Figure XI.5 Equipment Schedule

XI.5. **Electrical circuits –** A circuit is the path of electricity from a source (distribution panel) through the components (receptacles, lights) and back to the source. Circuits are numbered on the diagram and connected by a heavy line, ending in an arrow that indicates the circuit is connected to the distribution panel. Electricity is brought into the building by way of the service entrance through the meter and on to the distribution panel. For most residences, one distribution panel is sufficient. There are branch circuits as shown below:

- General lighting circuits used primarily for lighting and small portable appliances such as radios, TV sets, and vacuum cleaners.
- General appliance circuits used for those outlets along the kitchen counter serving toasters, waffle irons, mixers, and other appliances.
- Individual appliance circuits used for major appliances that require large amounts of electricity, such as range-ovens, washers, dryers, and water heaters.
- Equipment circuits that furnish power to motor-driven equipment.

- Dedicated circuits for computers and other special equipment that cannot tolerate voltage fluctuations or interruptions.

XI.6. **Ground fault circuit interrupters (GFCI)–**The use of a GFCI is defined in the 'National Electrical Code' and they are installed in areas where moisture may be present or where the user of an electrically powered tool or appliance could come in contact with a grounded metal surface. The use of a GFCI is defined in the National Electrical Code (NEC). A GFCI will open the circuit if a current leakage or fault (to ground) occurs in excess of 0.006 amperes. These interruptions occur when the difference in current entering and current leaving the circuit are not identical. The GFCI automatically senses the fault and turns off the power within 25 to 30 milliseconds. These devices must be used in the following situations:

- In kitchens where receptacles are within $6' - 6''$ of the sink.
- In bath rooms.
- In garages where moisture is present or there is direct access to grade, unless the receptacle is not readily accessible or is dedicated to a fixed appliance, such as a freezer.
- For exterior receptacles where access to grade is possible.

XII. WELDING DRAWINGS

Welding is one of the principal means of fastening members in structural steel work. The American Welding Society (AWS) has developed standard procedures for using symbols to indicate the location, size, strength, geometry, and details of a weld.

XII.1. **Welding symbols –** There is a difference between a weld symbol and a welding symbol. The weld symbol indicates the specific type of weld while the welding symbol, as in Figure XII.1, consists of the weld symbol and the following elements:

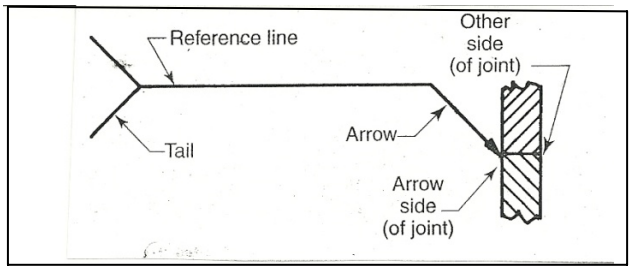

Figure XII.1 Basic Welding Symbol

- The 'reference line' is the horizontal line portion of a welding symbol. It has an arrow at one end and a tail at the other. In some instances, the reference line may be vertical.
- An arrow is used to connect the welding symbol reference line to one side of the joint to be welded. This is considered as the 'arrow side' of the joint. The side opposite the arrow is termed the 'other side' of the joint.
- Notes are placed within the 'tail' to designate the welding specification, process, or other reference.

XII.2 **Basic weld symbols -** The basic weld symbols for various types of welds are shown in Figure XII.2. If the symbol is above the reference line, the weld is placed on the arrow side of the joint. If the symbol is below the reference line, the weld is made on the other side of the joint. If both symbols are present, the weld is made on both sides of the joint.

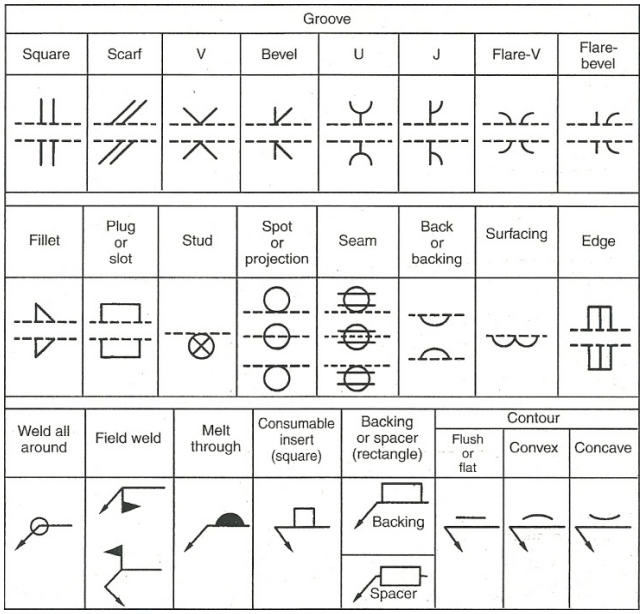

Figure XII.2 Basic Weld Symbols

XII.3 **Weld dimensions -** These are drawn on the same side of the reference line as the weld symbol. See Figure XII.3 (A). When the dimensions are covered by a general note, the welding symbol need not be dimensioned as in Figure XII.3 (B). When both welds have the same dimensions, one or both can be dimensioned as in Figure XII.3 (C). The pitch of staggered intermittent weld is shown to the right of the weld as in Figure XII.3 (D).

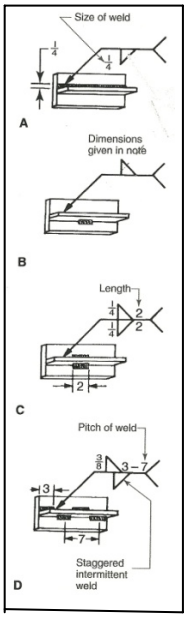

Figure XII.3 Weld Dimensions

XII.4. **Types of weld –** The following are the usual welds in practice:

XII.4.1. **Fillet weld** - Fillet weld is to be flat, or convex-faced or concave-faced, as in Figure XII.4. They are indicated by a contour symbol next to the weld symbol.

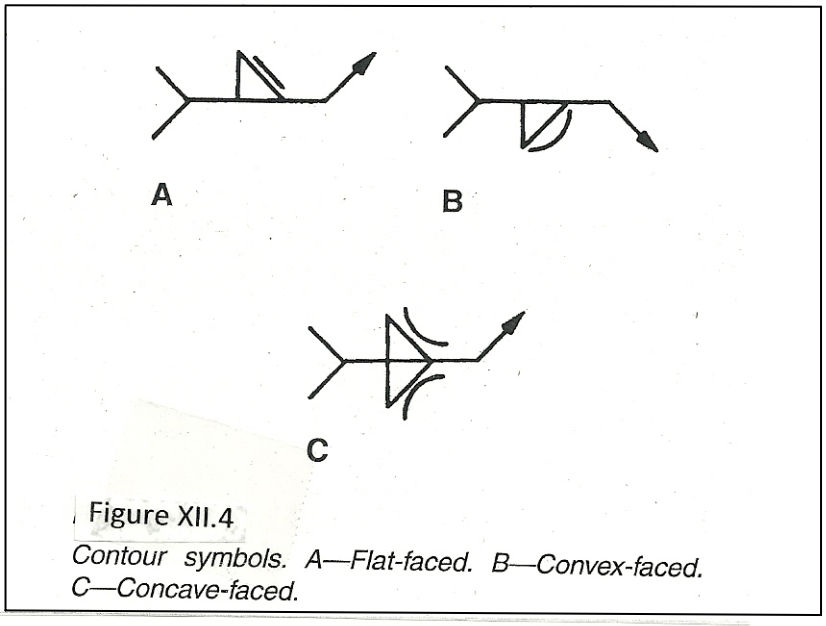

Figure XII.4
Contour symbols. A—Flat-faced. B—Convex-faced. C—Concave-faced.

XII.4.2. **Groove weld** - The groove angle is shown on the same side of the reference line as the weld symbol. The size (depth) of groove weld is shown to the left of the weld symbol. The root opening of a groove weld is shown inside the weld symbol as in Figure XII.5.

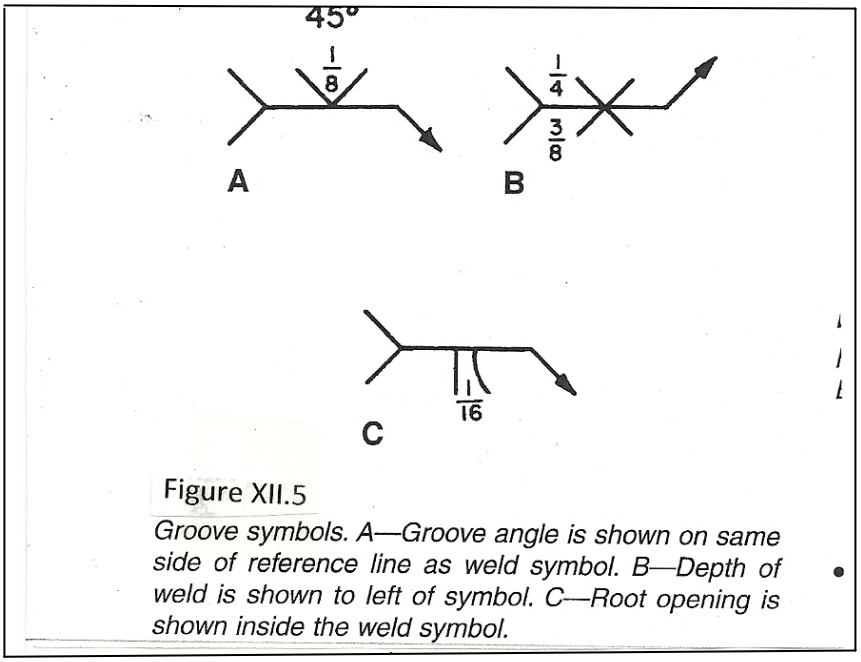

Figure XII.5

Groove symbols. A—Groove angle is shown on same side of reference line as weld symbol. B—Depth of weld is shown to left of symbol. C—Root opening is shown inside the weld symbol.

XII.4.3. **Spot weld** - These are specified by their diameter, strength in pounds, pitch (center-to-center), and number of welds as shown in Figure XII.6.

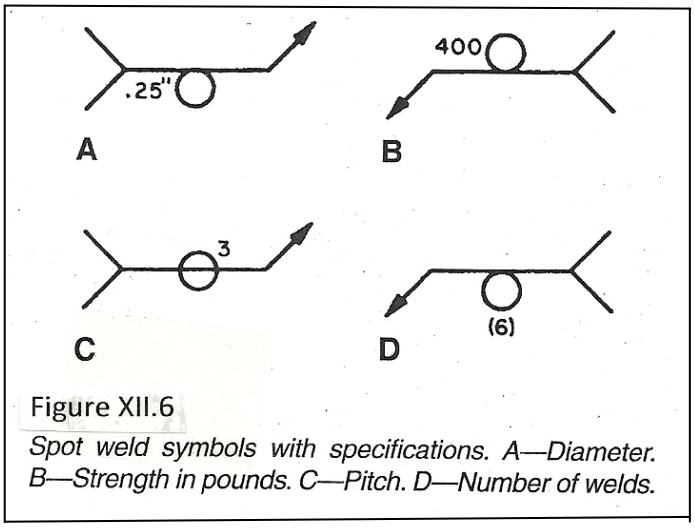

Figure XII.6

Spot weld symbols with specifications. A—Diameter. B—Strength in pounds. C—Pitch. D—Number of welds.

XII.4.4. **All around weld** - The weld all-around symbol, as shown in Figure XII.7, indicates that the weld extends completely around a joint.

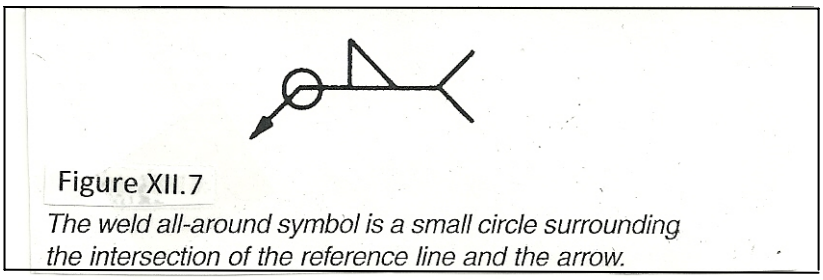

Figure XII.7
The weld all-around symbol is a small circle surrounding the intersection of the reference line and the arrow.

XII.4.5. **Field weld** – For this type of weld, a symbol, as shown in Figure XII.8, consisting of a small line and triangle originating at the intersection of the reference line and arrow is provided. This symbol identifies welds to be made at the construction site, rather than in the assembly shop.

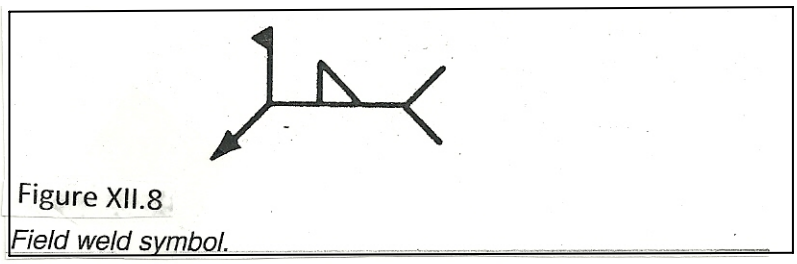

Figure XII.8
Field weld symbol.

XII.4.6. **Melt through weld** – For this type of weld, a symbol indicates where 100% joint or member penetration is required from one side. See Figure XII.9. When these welds are to be finished by machine or some other means, a contour symbol is added.

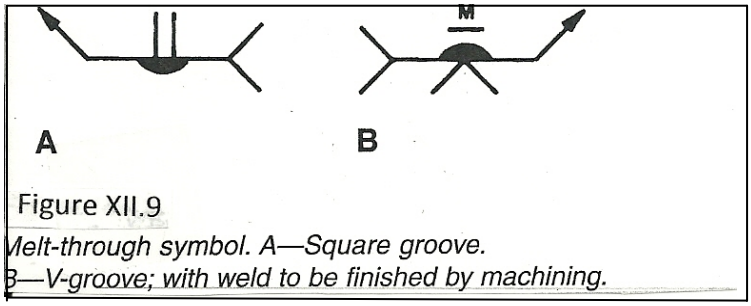

Figure XII.9
Melt-through symbol. A—Square groove. B—V-groove; with weld to be finished by machining.