

CHAPTER 6 SITE LAYOUT

Section I. BUILDING LAYOUT

OBJECTIVES

The objectives of surveying for building construction are to lay out the proposed structure according to prepared plans and to mark the controlling points of the structure in the manner that is most useful to the construction forces. This marking consists of indicating the corners of the building and other horizontal and vertical positions by means of stakes, batter boards with string lines, drill holes, cut-and-fill notations, and similar conventional methods.

The actual layout of the building is usually preceded by some form of reconnaissance and location survey. The following procedures are typical of major building projects:

- Performing reconnaissance (aerial, map, and ground).

- Selecting site (paper and instrument).
- Establishing control (horizontal and vertical).
- Taking topography (plane table or transit stadia).

ORIENTATION

The building and its foundation are positioned according to the controlling dimensions and references appearing on prepared plans. The dimensions and references include the overall length and width of the structure, distances to road centerlines and to other structures, measurements within the structure itself, and miscellaneous determinations concerning the approaches and rights-of-way.

LAYOUT OF A SIMPLE BUILDING

The plans for construction of a building give the location and elevation of the work relative to existing utilities and survey control marks. The dimensions of the building are part of the necessary data for establishing line and grade. Figure 6-1 illustrates atypical building layout using the following steps.

- (1) Establish baseline AB and locate CD by measurement.
- (2) At point C, turn 90 degrees from B and locate corner stakes E and F by measurement.

- (3) Locate points H and G from point D in the same way.
- (4) Check diagonals (EH and FG) by the formula $c = \sqrt{a^2 + b^2}$ (where c is the diagonal and a and b, the two sides).
- (5) Install batter boards.
- (6) Establish line and grade.

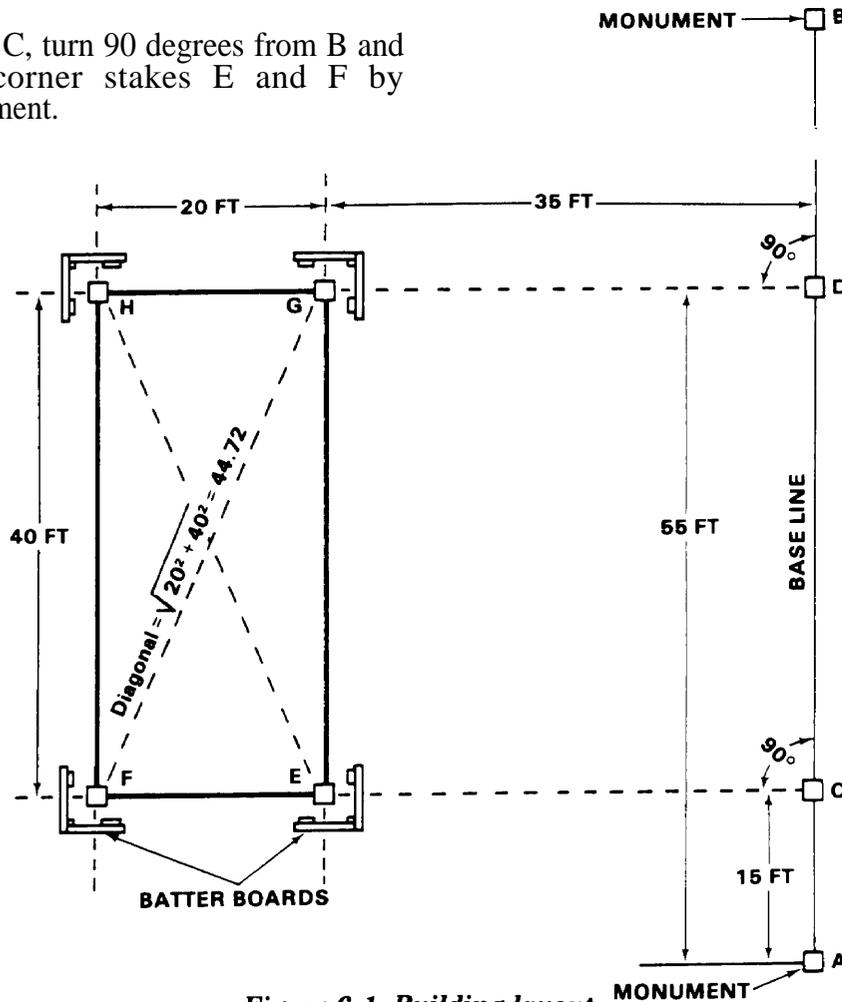


Figure 6-1. Building layout

BATTER BOARDS

The surveyor locates the corners of the building and determines the elevation of its foundation by carrying forward elevations from a benchmark, or other point of known

elevation, to the foundation. To mark the general location, the surveyor sets stakes or slats. These will guide the initial excavation and rough grading. However, the stakes will

be disturbed or destroyed during this work, and some more suitable marks must be placed to continue the construction. These suitable marks are called batter boards. The surveyor uses these temporary devices to mark the outline and grade of the structure and any special construction inside or outside.

Placement

Batter boards of two 2- by 4-inch stakes driven into the ground and a crosspiece of 1- by 6-inch lumber nailed to each stake. The surveyor drives the stakes about 3 to 4 feet away from the building line so they will not be disturbed by the construction but will be far enough apart to straddle the line to be marked. Note that in figure 6-2 only three stakes, one of them being a common post for two directions, are driven on outside corners. The length of the stakes is determined by the required gradeline. They must be long enough to accept the 1- by 6-inch crosspiece to mark the grade. The surveyor cuts the 1- by 6-inch crosspiece long enough to join both stakes and nails it firmly to them after the grade has been established. The top of the crosspiece becomes the mark from which the grade will be measured.

Use of Instrument. The surveyor sets all batter boards for one structure to the same grade or level line. An instrument is used to locate the building lines and mark them on the top edge of the crosspiece. A nail is driven at each of these marked points. A cord stretched over the top edge of two batter boards and held against the nails defines the building line and grade elevation.

Use of Cord. Sometimes, an instrument is not available for marking the building line on the batter boards. If the corner stakes have not been disturbed, the surveyor can transfer the building line to the batter boards by stretching a cord over the batter boards and using plumb bobs held over the corner stakes. The surveyor moves the cord on each batter board until it just touches both plumb bob strings, marks the position of the cords, and drives in the nails.

Procedures

The surveyor sets and marks the batter boards as follows:

- (1) After the corner stakes are laid out, drive 2- by 4-inch stakes 3 to 4 feet outside of

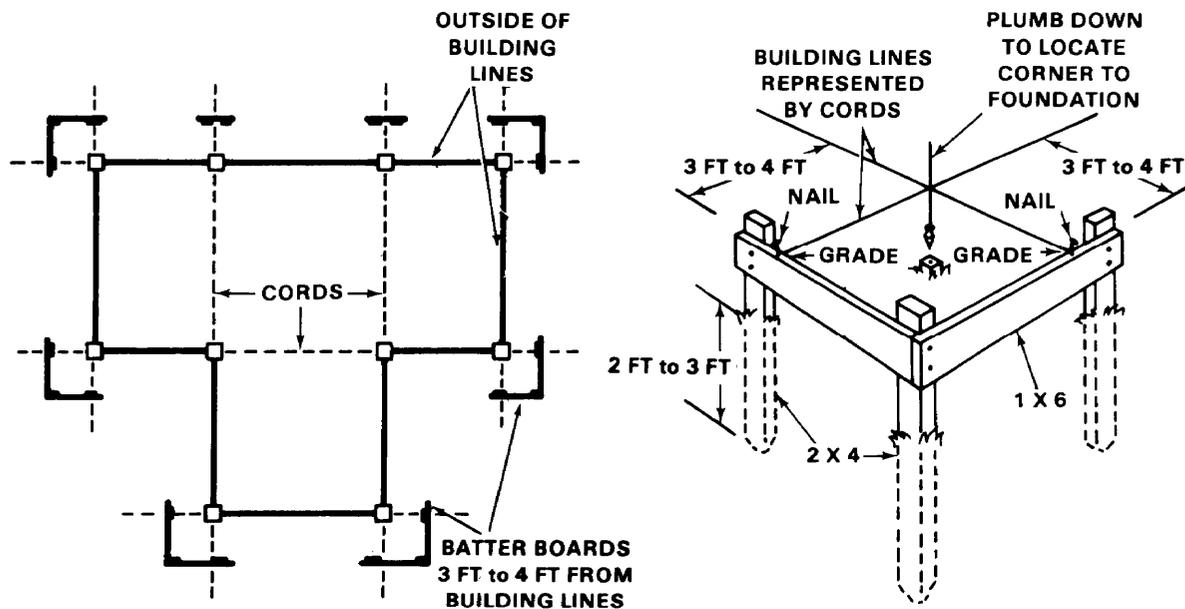


Figure 6-2. Batter boards

each corner. These are selected to bring all crosspieces to the same elevation.

- (2) The surveyor marks these stakes at the grade of the top of the foundation or at some whole number of inches or feet above or below the top of the foundation. Use a level to mark the same grade or elevation on all stakes.
- (3) Nail 1- by 6-inch boards to the stakes to the top edge of the boards and flush with the grade marks. Mark the distance in crayon on these boards.
- (4) Locate the prolongation of the building lines on the batter boards by using an instrument or a line and plumb bob.
- (5) Drive nails into the top edges of the batter boards to mark the building line.

INTERIOR TRANSFER OF LINE AND GRADE

Occasionally, it is necessary to transfer lines and grades from outside to inside a building and to the upper stories for establishing wall faces, floor levels, and columns or for setting machinery precisely. The surveyor does this by traversing and leveling.

Location

The surveyor locates instrument stations outside of the building to establish a line that, when extended, will intersect the building at a window or doorway. The instrument is set

on the station farthest from the building and sighted on the point nearest the building. The surveyor transfers the line to the building by sighting the instrument on a plumb bob held in an upper-story window.

From this point, the line is extended in any direction inside the building by setting up on the point and using the outside stations as a backsight. The line is prolonged by double centering. Because of the short sights used, the surveyor may accurately set an angle that is to be turned to clear an obstruction and then measure by repetition.

Direct Leveling

To transfer vertical control into a building, the surveyor uses direct leveling, if possible. For elevation transfer to an upper story, a steel tape is suspended with a weight attached to the lower or zero end. To insure accuracy, the weight should approximately equal the normal tension of the fully supported tape minus one half of the weight of the suspended portion of the tape. A level is set up on the first floor, and a reading is taken on the suspended tape.

Another reading is taken on the tape with a level set on the upper floor. This gives data from which the HI of the instrument on the upper floor are computed. A rod is now held on some point on the upper floor to be used as a benchmark and its elevation determined. The surveyor may also establish elevations on the second floor by using the rod upside down (often called an inverted rod) and marking the elevation on a wall.

Section II. UTILITIES LAYOUT

DRAINAGE

Utilities drainage refers to the sewer systems for surface water and liquid waste. The design and location of a drainage or storm sewer system will depend upon the size and topography of the area to be drained, the intensity of rainfall expected, the runoff characteristics of the area, and the location

of the disposal point. The area to be drained includes the installation and any area around it that will drain into the installation. The intensity of the rainfall in inches per hour is based on records of past storms. The runoff characteristics are determined by the type of soil and ground cover.

DESIGN AND LOCATION

Using the factors mentioned and the best available topographic map of the area, the surveyor designs and locates the sewer lines on paper. Once the paper location is accomplished, the centerline of the ditch is staked and profile levels run. The profile and grade lines are plotted and cut stakes set.

After the trench is dug, batter boards are set for the alignment of pipes and placement of manholes or drop inlets. The surveyor usually places batter boards for sewer alignment at intervals of 10 to 25 feet and sets them on edge across the trench (figure 6-3). Then the surveyor determines the interval between batter boards, the station number, and the elevation of the sewer grade at each batter board.

The term sewer grade is interchangeable with such other terms as invert grade, pipe grade, flow line, and grade line elevation. They all mean the same thing, the elevation of the low point on the inside circumference of the pipe. All sewer lines are designed with this elevation as the controlling factor. The surveyor must set all grade marks

on the batter boards between two successive manholes at the same distance above the invert grade.

Battens

The surveyor nails battens (small pieces of wood) to the batter boards to indicate sewer alignment. All battens are set vertically on the same side of the batter boards, with the same edges directly over the centerline of the sewer. As work progresses, the surveyor must check the alignment of these battens frequently. This is done by sighting past the edges marking the centerline. Any batten that has been moved or disturbed will be visible immediately.

Sighting Cords

The surveyor uses a sighting cord stretched parallel to the centerline of the sewer at a uniform distance above the invert grade to transfer line and grade into the trench. After computing the invert elevation, the surveyor adds an even number of feet to establish the elevation of the cord at each batter board. This position is marked on the centerline edge of each batten by a nail. The sighting

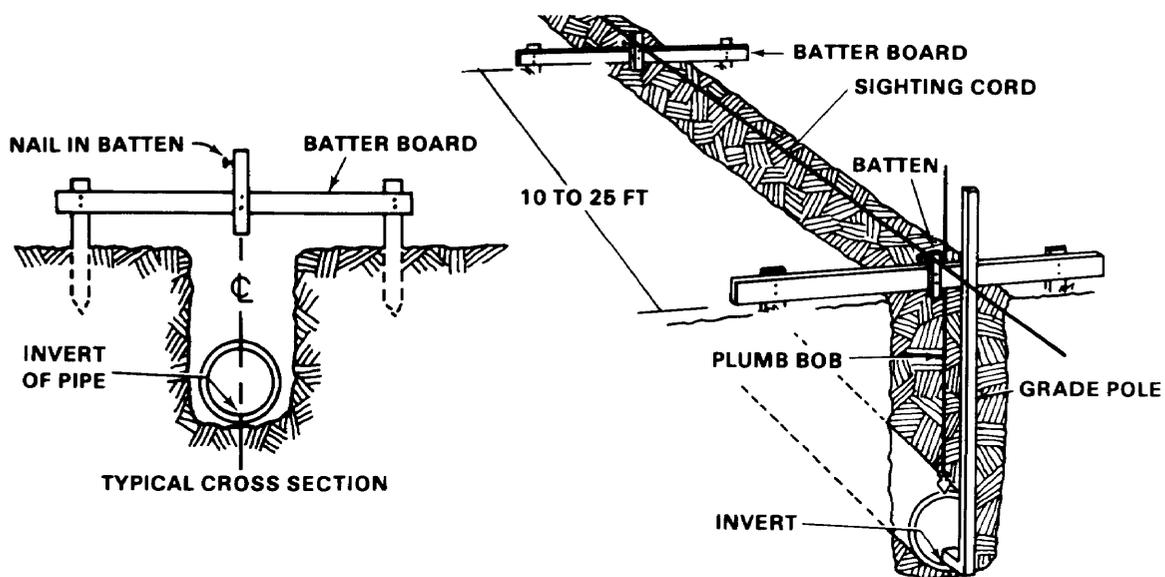


Figure 6-3. Sewer alignment

cord is fastened to the battens at these nails and this establishes the alignment of the sewer. The centerline is directly below the cord, and the sewer invert grade is at the selected distance below the cord.

Grade Transfer

To transfer the grade, usually in feet or feet and inches, from the sighting cord to the pipe, the surveyor uses a rod or stick called a grade pole, with a mark at a distance from the foot

piece equal to the distance between the sighting cord and the invert grade (figure 6-3). The foot piece is placed on the invert of the pipe, and the rod plumb is held. The pipe end is then raised or lowered until the mark on the grade pole is on a horizontal line with the cord. A plumb line is held lightly against the cord and the pipe shifted sideways until its crown is directly below the point of the plumb bob. The grade pole is again placed in position, held plumb, and its mark checked against the cord.