

DOE Fundamentals

ENGINEERING SYMBOLOGY, PRINTS, AND DRAWINGS

Module 6

**Engineering Fabrication, Construction, and Architectural
Drawings**

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OBJECTIVES

TERMINAL OBJECTIVE

- 1.0 Given an engineering fabrication, construction, or architectural drawing, **READ** and **INTERPRET** basic dimensional and tolerance symbology, and basic fabrication, construction, or architectural symbology.

ENABLING OBJECTIVES

- 1.1 **STATE** the purpose of engineering fabrication, construction, and architectural drawings.
- 1.2 Given an engineering fabrication, construction, or architectural drawing, **DETERMINE** the specified dimensions of an object.
- 1.3 Given an engineering fabrication, construction, or architectural drawing, **DETERMINE** the maximum and minimum dimensions or location of an object or feature from the stated drawing tolerance.

ENGINEERING FABRICATION, CONSTRUCTION, AND ARCHITECTURAL DRAWINGS

This chapter describes the basic symbology used in the dimensions and tolerances of engineering fabrication, construction, and architectural drawings. Knowledge of this information will make these types of prints easier to read and understand.

- EO 1.1 **STATE** the purpose of engineering fabrication, construction, and architectural drawings.
- EO 1.2 Given an engineering fabrication, construction, or architectural drawing, **DETERMINE** the specified dimensions of an object.
- EO 1.3 Given an engineering fabrication, construction, or architectural drawing, **DETERMINE** the maximum and minimum dimensions or location of an object or feature from the stated drawing tolerance.

Introduction

This chapter will describe engineering fabrication, construction, and architectural drawings. These three types of drawings represent the category of drawings commonly referred to as blueprints. Fabrication, construction, and architectural drawings differ from P&IDs, electrical prints, and logic diagrams in that they are drawn to scale and provide the component's physical dimensions so that the part, component, or structure can be manufactured or assembled. Although fabrication and construction drawings are presented as separate categories, both supply information about the manufacture or assembly of a component or structure. The only real difference between the two is the subject matter. A fabrication drawing provides information on how a single part is machined or fabricated in a machine shop, whereas a construction drawing provides the construction or assembly of large multi-component structures or systems.

Fabrication drawings, also called machine drawings, are principally found in and around machine and fabrication shops where the actual machine work is performed. The drawing usually depicts the part or component as an orthographic projection (see module 1 for definition) with each view containing the necessary dimensions. Figure 1 is an example of a fabrication drawing. In this case, the drawing is a centering rest that is used to support material as it is being machined.

Construction drawings are found principally at sites where the construction of a structure or system is being performed. These drawings usually depict each structure/system or portion of a structure/system as an orthographic projection with each view containing the necessary dimensions required for assembly. Figure 2 provides an example of a construction print for a section of a steel roof truss.

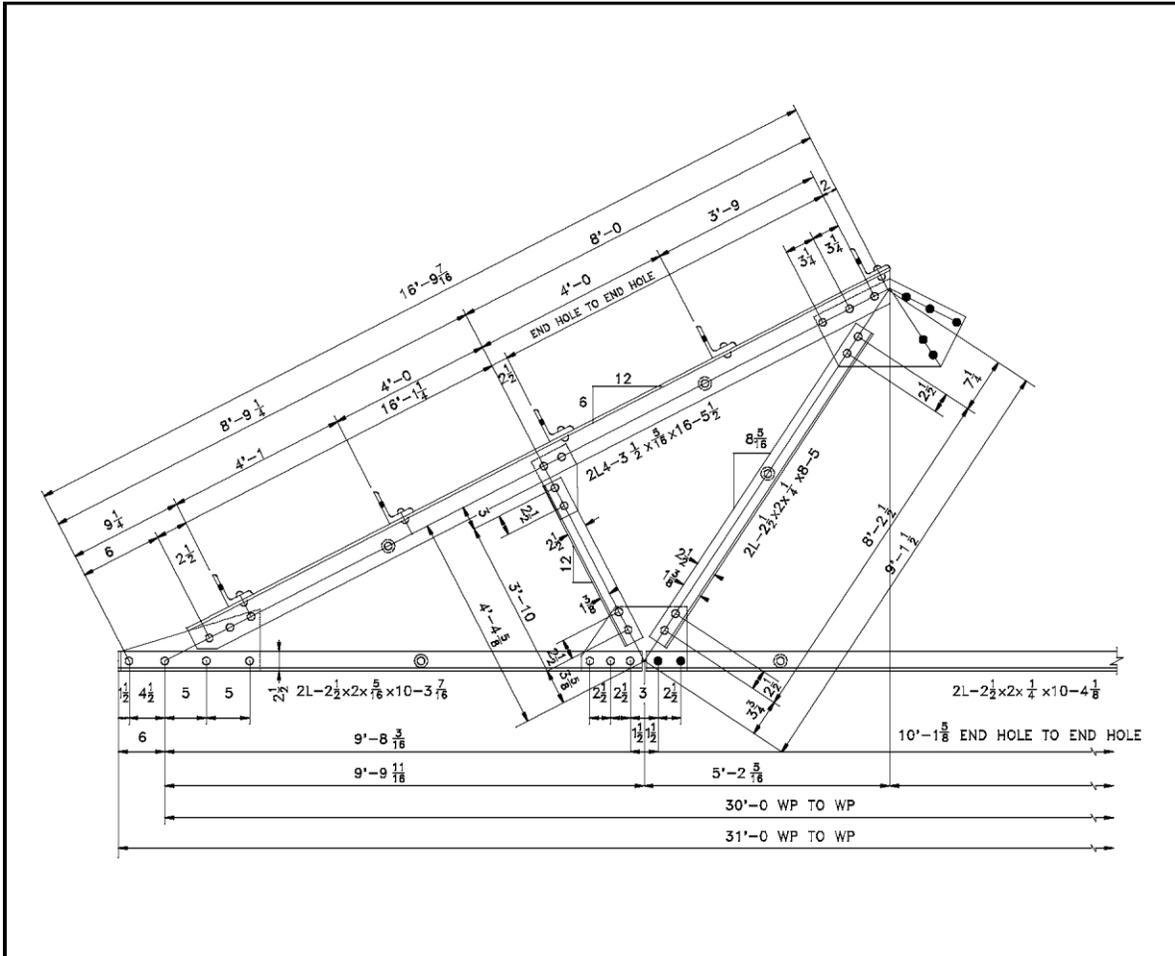


Figure 2 Example of a Construction Drawing

Architectural drawings are used by architects in the conceptual design of buildings and structures. These drawings do not provide detailed information on how the structure or building is to be built, but rather they provide information on how the designer wants the building to appear and how it will function. Examples of this are location-size-type of doors, windows, rooms, flow of people, storage areas, and location of equipment. These drawings can be presented in several formats, including orthographic, isometric, plan, elevation, or perspective. Figure 3 provides an example of an architectural drawing, of a county library.

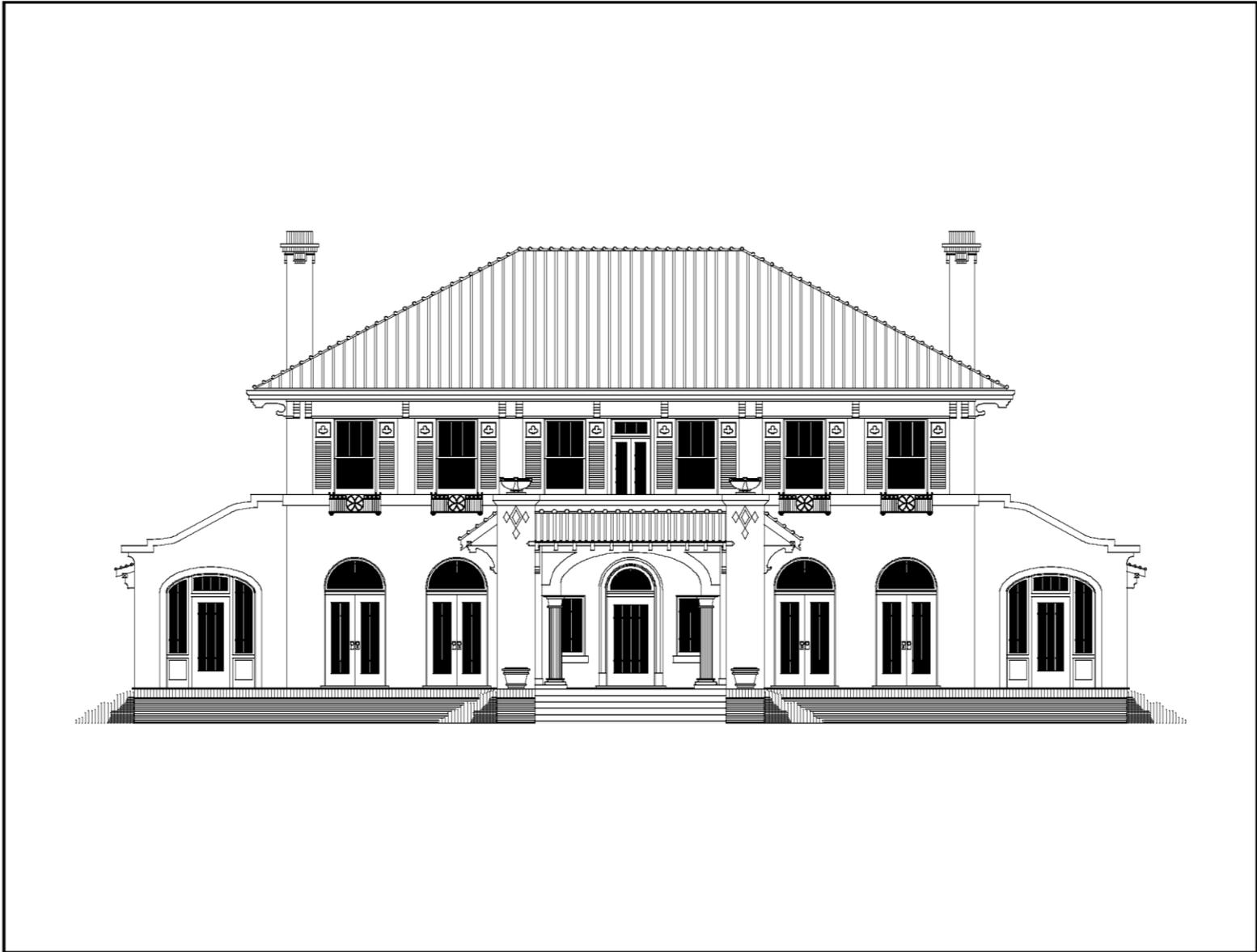


Figure 3 Example of an Architectural Drawing

Dimensioning Drawings

For any engineering fabrication, construction, or architectural drawing to be of value, exact information concerning the various dimensions and their tolerances must be provided by the drawing. Drawings usually denote dimensions and tolerances per the American National Standards Institute (ANSI) standards. These standards are explained in detail in Dimensioning and Tolerancing, ANSI Y14.5M - 1982. This section will review the basic methods of denoting dimensions and tolerances on drawings per the ANSI standards.

Dimensions on a drawing can be expressed in one of two ways. In the first method, the drawing is drafted to scale and any measurement is obtained by measuring the drawing and correcting for the scale. In the second method, the actual dimensions of the component are specified on the drawing. The second method is the preferred method because it reduces the chances of error and allows greater accuracy and drawing flexibility. Because even the simplest component has several dimensions that must be stated (and each dimension must have a tolerance), a drawing can quickly become cluttered with dimensions. To reduce this problem, the ANSI standards provide rules and conventions for dimensioning a drawing. The basic rules and conventions must be understood before a dimensioned drawing can be correctly read.

Dimensioning and Tolerance Symbology, Rules, and Conventions

When actual dimensions are specified on a print, the basic line symbols that are illustrated by Figure 4 are used.

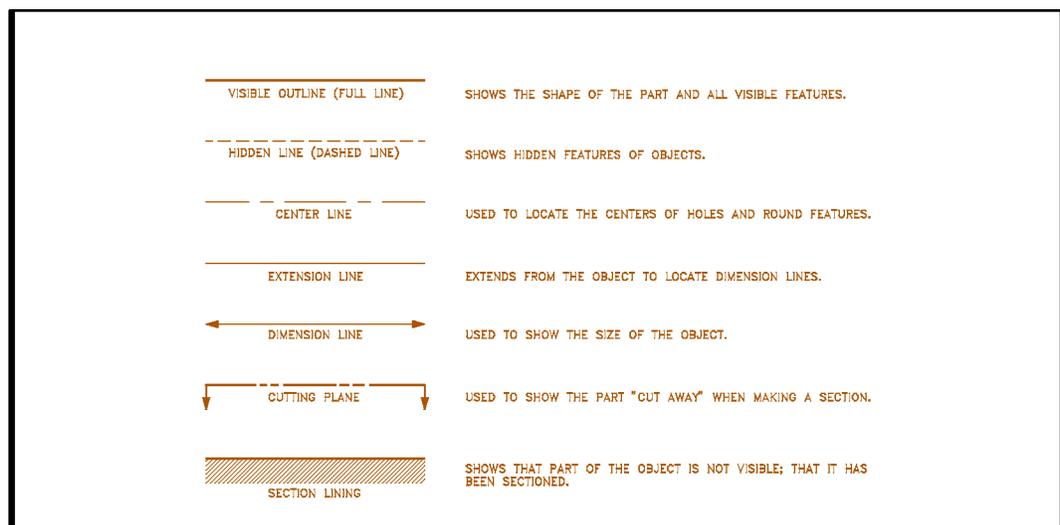
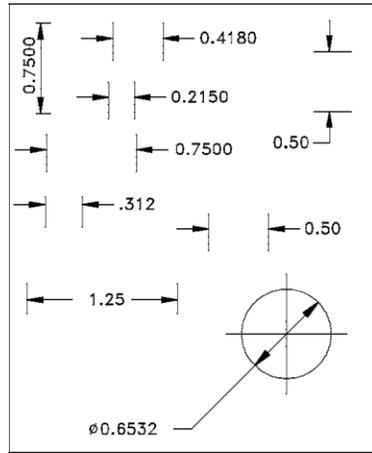
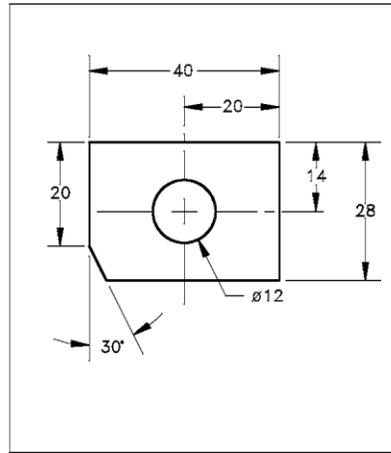


Figure 4 Types of Dimensioning Lines

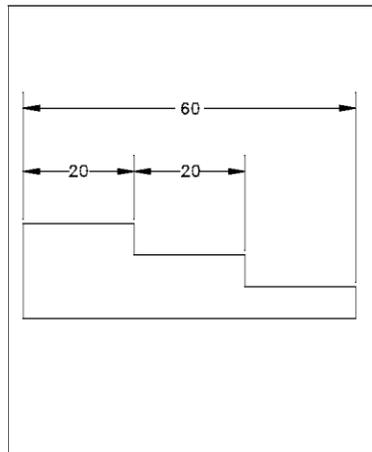
Figure 5 provides examples of the various methods used on drawings to indicate linear, circular and angular dimensions.



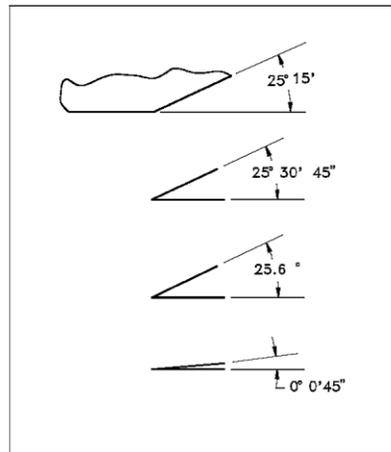
DECIMAL INCH DIMENSIONS



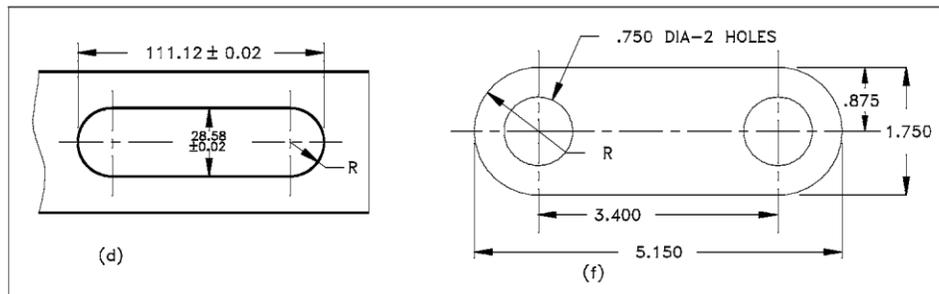
APPLICATION OF DIMENSIONS



GROUPING OF DIMENSIONS



ANGULAR DIMENSIONS



CIRCULAR DIMENSIONS

Figure 5 Example of Dimensioning Notation

When a drawing is dimensioned, each dimension must have a tolerance. In many cases, the tolerance is not stated, but is set to an implied standard. An example is the blueprint for a house. The measurements are not usually given stated tolerances, but it is implied that the carpenter will build the building to the normal tolerances of his trade (1/8-1/4 inch), and the design and use of the blueprints allow for this kind of error. Another method of expressing tolerances on a drawing is to state in the title block, or in a note, a global tolerance for all measurements on the drawing.

The last method is to state the tolerance for a specified dimension with the measurement. This method is usually used in conjunction with one of the other two tolerancing methods. This type of notation is commonly used for a dimension that requires a higher level of accuracy than the remainder of the drawing. Figure 6 provides several examples of how this type of tolerancing notation can appear on a drawing.

Tolerances are applied to more than just linear dimensions, such as 1 ± 0.1 inches. They can apply to any dimension, including the radius, the degree of out-of-round, the allowable out-of-square, the surface condition, or any other parameter that effects the shape and size of the object. These types of tolerances are called geometric tolerances. Geometric tolerances state the maximum allowable variation of a form or its position from the perfect geometry implied on the drawing. The term geometry refers to various forms, such as a plane, a cylinder, a cone, a square, or a hexagon. Theoretically these are perfect forms, but because it is impossible to produce perfect forms, it may be necessary to specify the amount of variation permitted. These tolerances specify either the diameter or the width of a tolerance zone within which a surface or the axis of a cylinder or a hole must be if the part is to meet the required accuracy for proper function and fit. The methods of indicating geometric tolerances by means of geometric characteristic symbols are shown in Figure 6. Examples of tolerance symbology are shown in Figure 7.

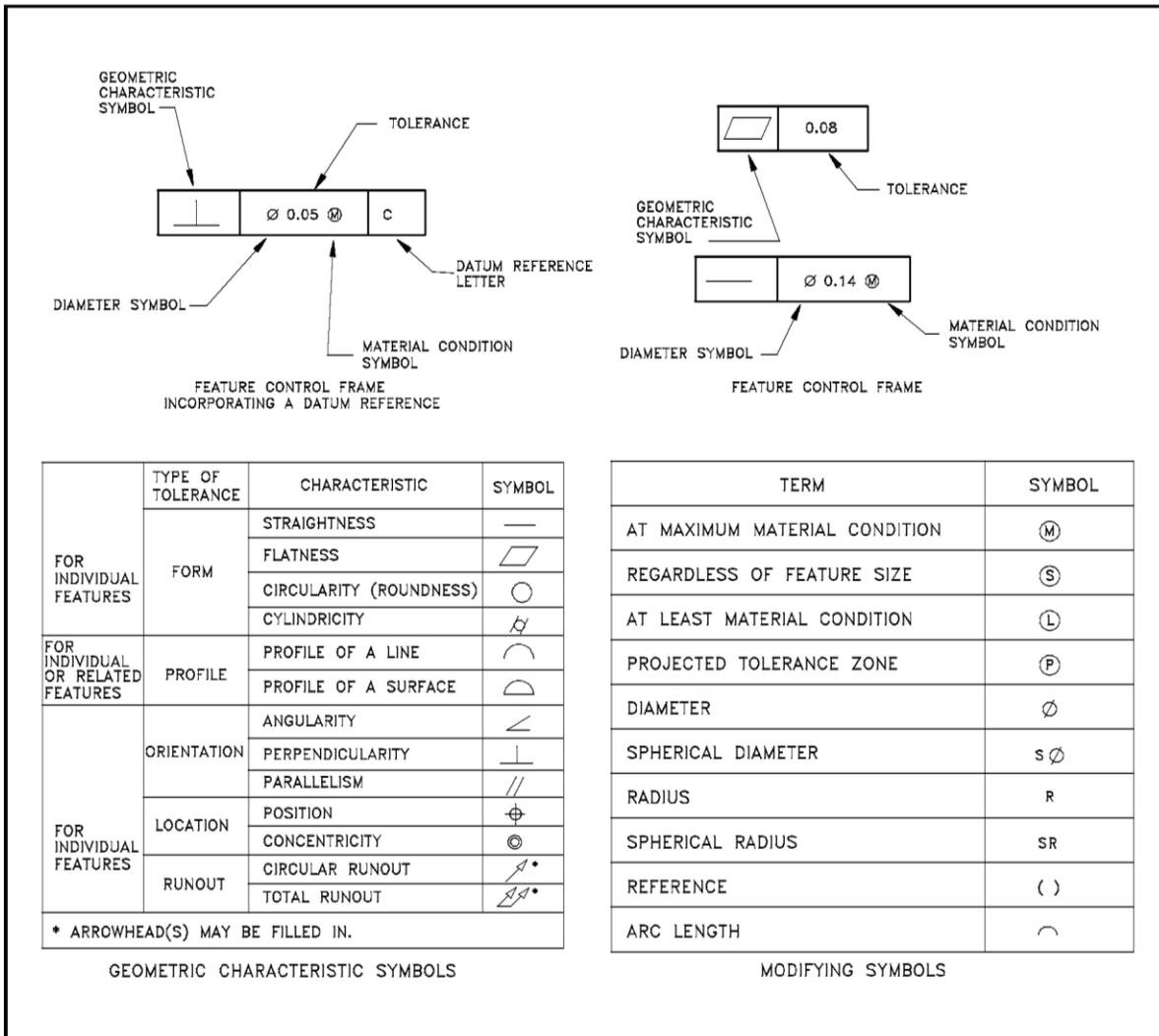


Figure 6 Symboly Used in Tolerancing Drawings

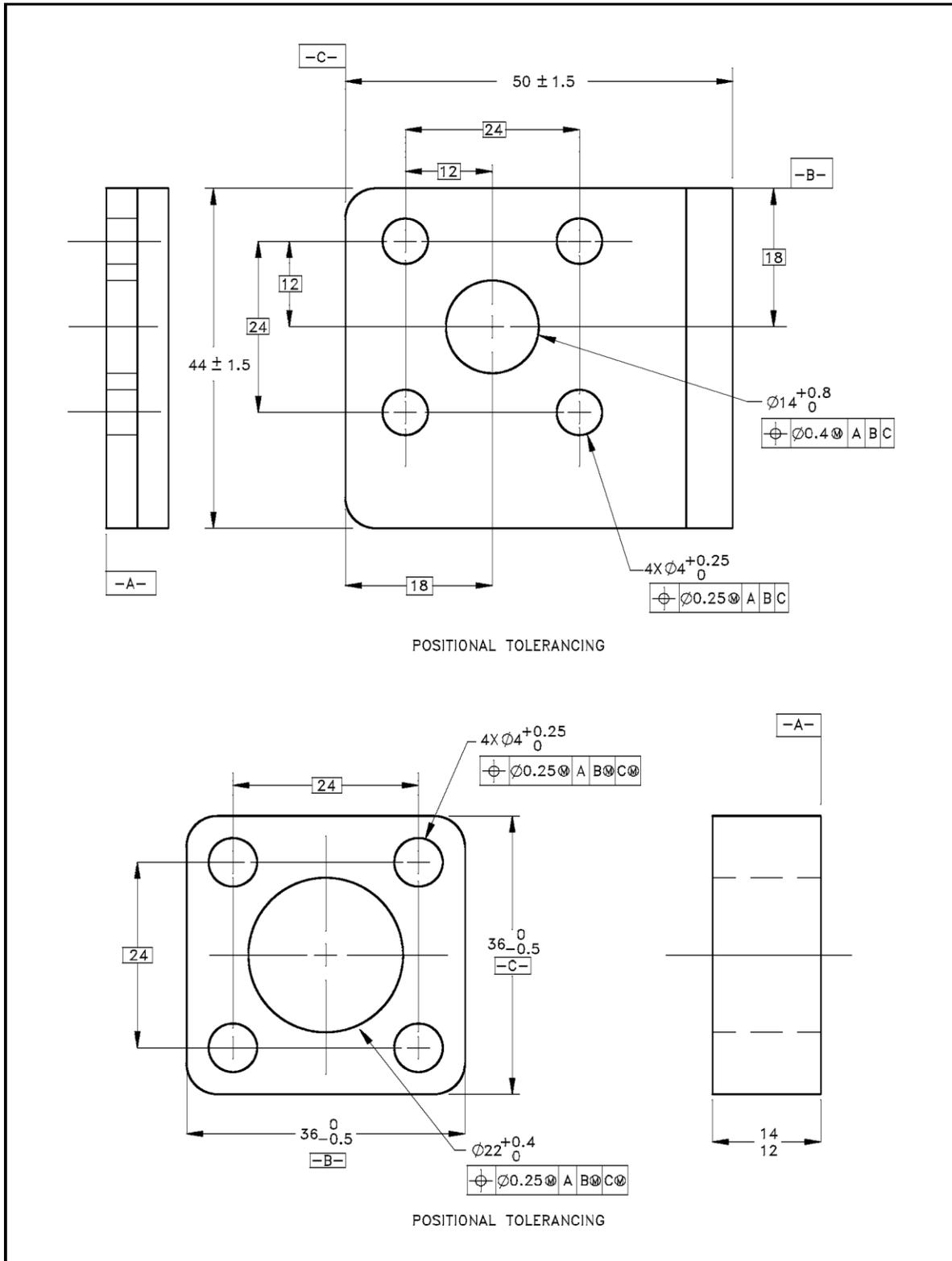


Figure 7 Examples of Tolerance Symboly

Because tolerances allow a part or the placement of a part or feature to vary or have a range, all of an object's dimensions cannot be specified. This allows the unspecified, and therefore non-toleranced, dimension to absorb the errors in the critical dimensions. As illustrated in Figure 8 (A) for example, all of the internal dimensions plus each dimension's maximum tolerance adds up to more than the specified overall dimension and its maximum tolerance. In this case the length of each step plus its maximum tolerance is $1 \frac{1}{10}$ inches, for a maximum object length of $3 \frac{3}{10}$ inches. However the drawing also specifies that the total length of the object cannot exceed $3 \frac{1}{10}$ inches. A drawing dimensioned in this manner is not correct, and one of the following changes must be made if the part is to be correctly manufactured.

To prevent this type of conflict, the designer must either specify different tolerances for each of the dimensions so that the length of each smaller dimension plus its maximum error adds up to a value within the overall dimension plus its tolerance, or leave one of the dimensions off, as illustrated in Figure 8 (B) (the preferred method).

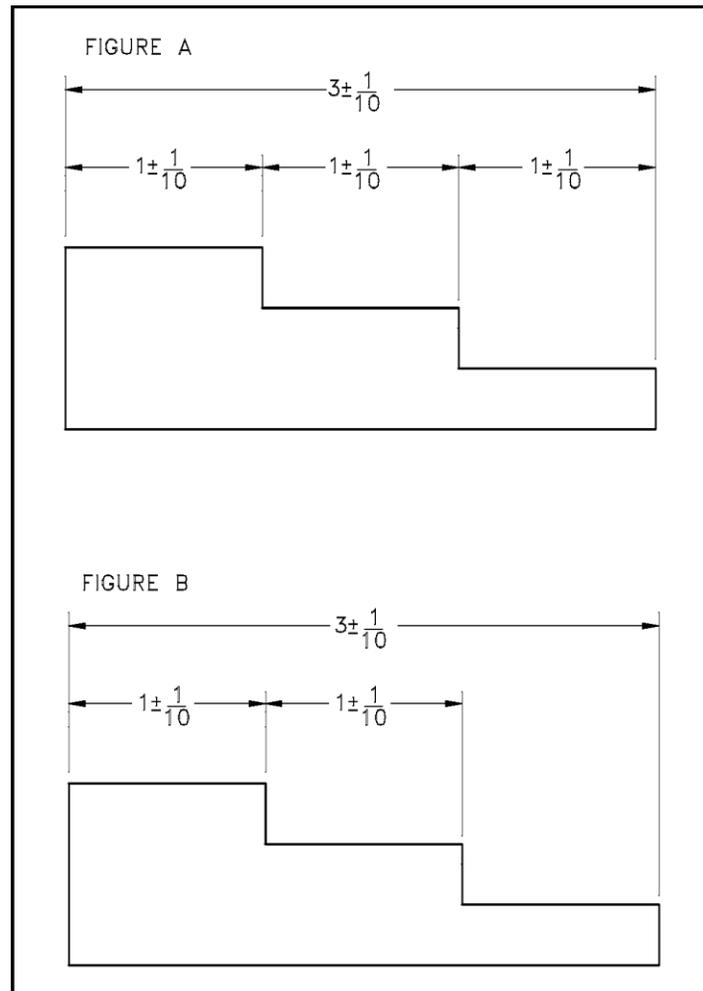


Figure 8 Example of Tolerancing

Summary

The important information in this chapter is summarized below.

Engineering Fabrication, Construction, and Architectural Drawings Summary

- The purpose of a fabrication drawing is to provide the information necessary to manufacture and machine components.
- The purpose of construction drawings is to provide the information necessary to build and assemble structures and systems.
- The purpose of architectural drawings is to provide conceptual information about buildings and structures.
- This chapter reviewed the basic symbology used in dimensioning engineering fabrication, construction, and architectural drawings.

ENGINEERING FABRICATION, CONSTRUCTION, AND ARCHITECTURAL DRAWING, EXAMPLES

The information presented in the previous chapter is reviewed in this chapter through the performance of reading drawing examples.

Examples

To aid in understanding the material presented in this module, practice reading the following prints by answering the questions. The answers are on the page following the last example.

Example 1

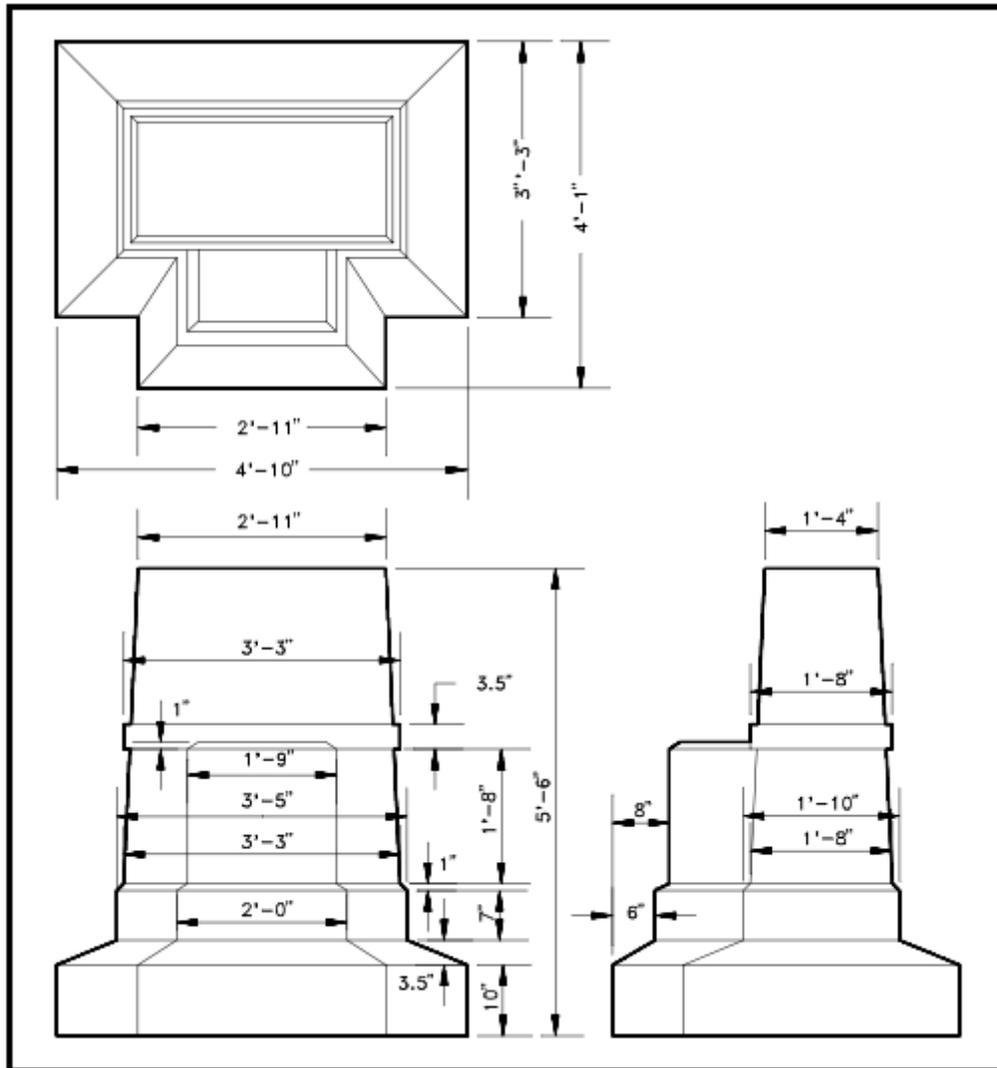


Figure 9 Example 1

1. What is the overall height of the structure?
2. What is the width (front-to-back) of the structure?
3. What is the difference between the width (front-to-back) and the width (side-to-side) of the base of the structure?

Example 2

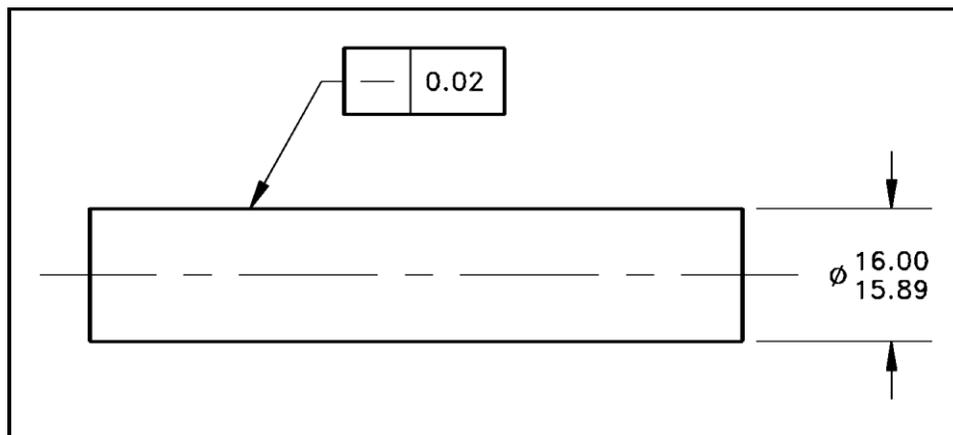


Figure 10 Example 2

1. What is the geometric characteristic being given a tolerance?
2. What is the maximum diameter of the shaft?
3. What is the minimum diameter of the shaft?

Example 3

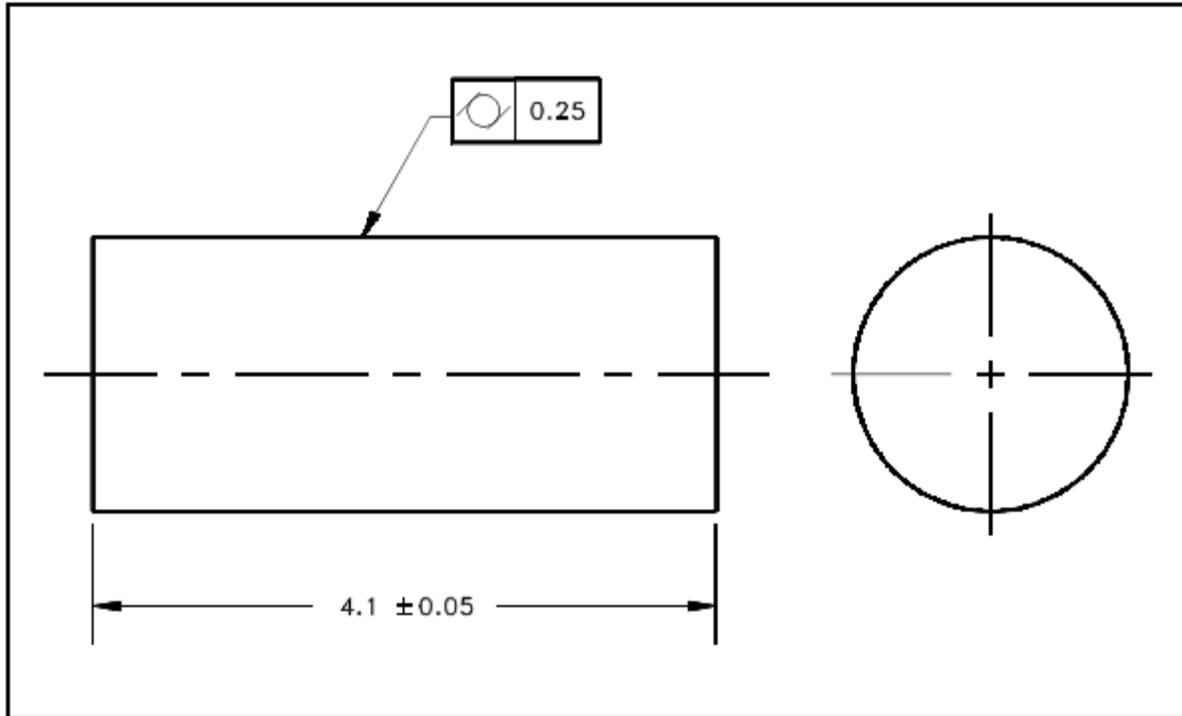


Figure 11 Example 3

1. What is the geometric characteristic being given a tolerance?
2. What is the maximum length of the cylinder?
3. What is the minimum length of the cylinder?

Answers to example 1.

1. 5' 6"
2. 4' 1 "
3. 9" (4' 10" side-to-side distance - 4' 1" front-to-back distance)

Answers to example 2.

1. Using Figure 6, the straight line in the geometric characteristic box indicates "straightness." This implies that the surface must be straight to within 0.02 inches.
2. 16.00 inches
3. 15.89 inches

Answers to example 3.

1. Using Figure 6, the circle with two parallel bars in the geometric characteristic box indicates "Cylindricity," or how close to being a perfect cylinder it must be (in this case 0.25 inches).
2. 4.15 inches. The nominal length of 4.1 plus the tolerance of 0.05.
3. 4.05 inches. The nominal length of 4.1 minus the tolerance of 0.05.

Summary

The important information in this chapter is summarized below.

**Engineering Fabrication, Construction, and Architectural Drawing Exercise
Summary**

- This chapter reviewed the material on dimensioning and tolerancing engineering fabrication, construction, and architectural drawings