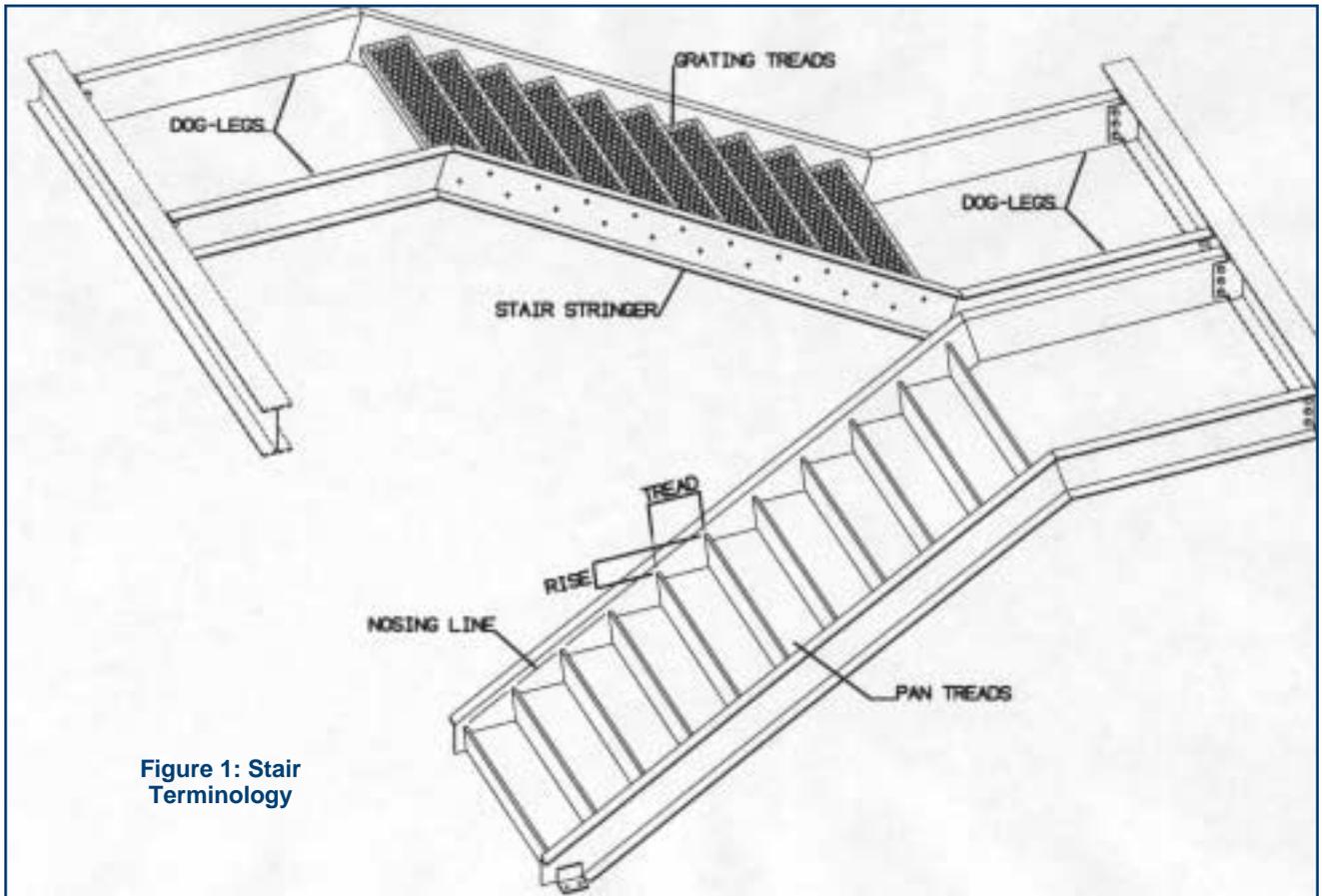


# DETAILING STAIRS:

## *Basic Principles & Common Practices*



**Figure 1: Stair Terminology**

**By Andrew J. Bellerby**

*This article is designed to provide an introduction to detailing stairs. It explains the basic principles and common practices of detailing stairs, both by hand and with automated programs.*

*Covered in this article are typical stairs in American and Canadian industrial and commercial buildings, where grating and concrete-filled pans are used. This article does not cover ornamental or circular stairs.*

### **STRUCTURAL STEEL COMPONENTS**

**Tread:** The tread is the piece of steel that makes up the steps of the stair.

The tread can be made from grating or from pans (both shown in Figure 1). Grating is typically used in industrial buildings while pans are usually used in commercial structures. The grating type of tread is plate, but the pan shape dips down so that the concrete can be poured into its base.

Sanitary-type pans, which are common in hospitals, have an additional lip that prevents dirt from falling into the corner of the pan.

*(Pan and grating treads are shown in Figure 2.)*

**Stringers:** The stringers support the ends of the treads. Stringers are often rectangular hollow sections, channels or plate. The top of the stringer is connected either to a supporting beam or to a

dog leg (see Figure 3).

The bottom of the stringer is connected to a supporting beam, a dog leg, or the ground. If attached to a supporting beam, the stringer can be bolted or welded. If attached to a dog leg, the stringer will be welded.

**Supporting Beam:** The supporting beam supports the stringer or the dog leg (if it exists). Each stringer can be independently supported. Alternately, both stringers can be supported with the same supporting beam. The supporting beams are usually wide flange sections or channels.

**Dog legs:** The location of the supporting beams determines whether dog legs are actually needed (*as shown in Figure 4*). A dog leg is needed when a viable connection cannot be made to the supporting beam directly from the stringer. The dog leg can be the support for the landing at the top of the stair, if one exists.

**Special pans:** These are required at the top and bottom of a pan stair. One special pan closes the stair against the concrete or platform, and the other pan closes off the top of the stair (*see Figure 5*).

Figure 2: Grating and Pan Threads

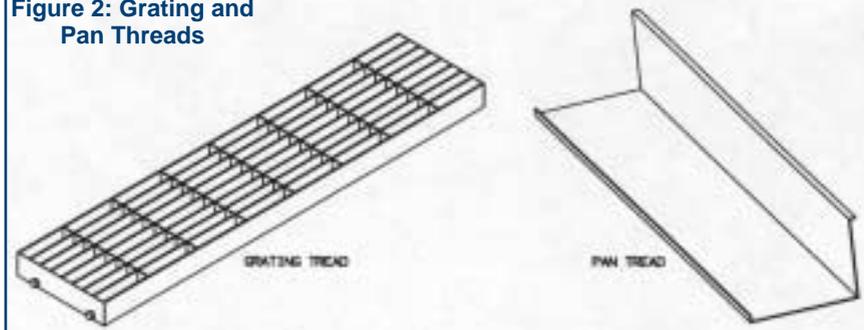


Figure 3: Typical Stringer & Dog Leg Connection

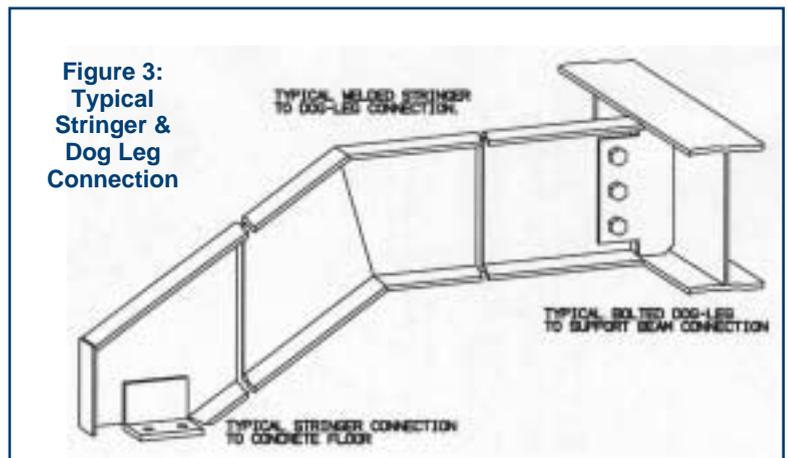
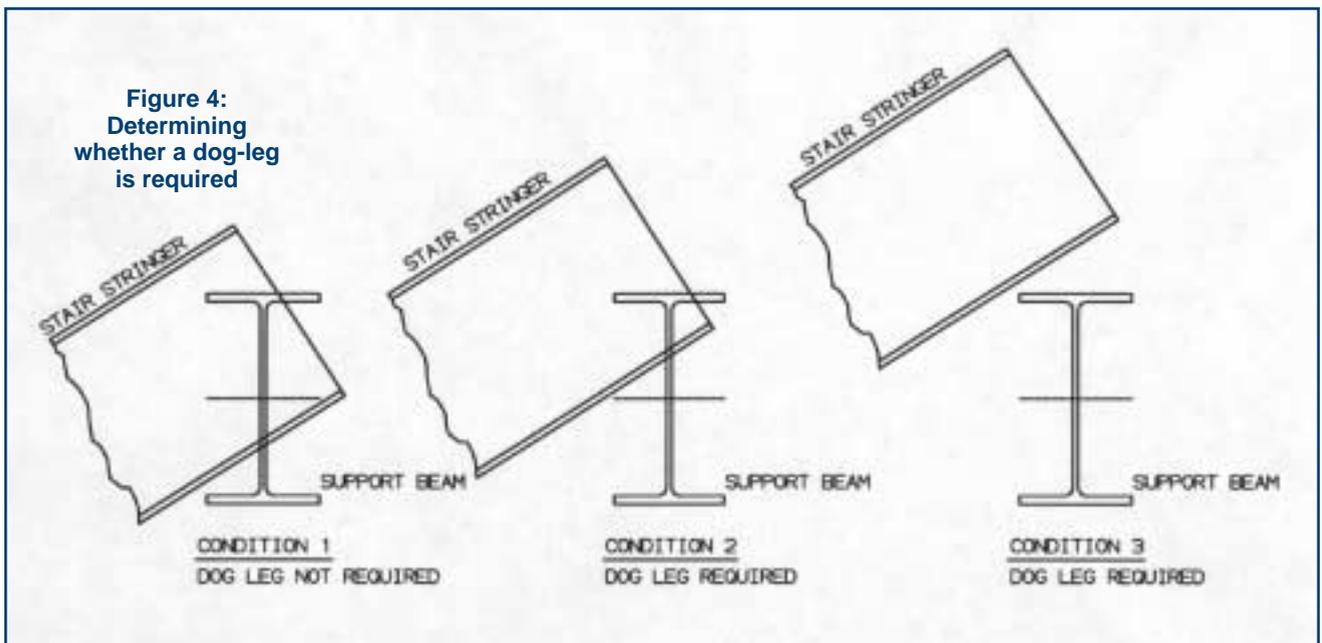


Figure 4: Determining whether a dog-leg is required



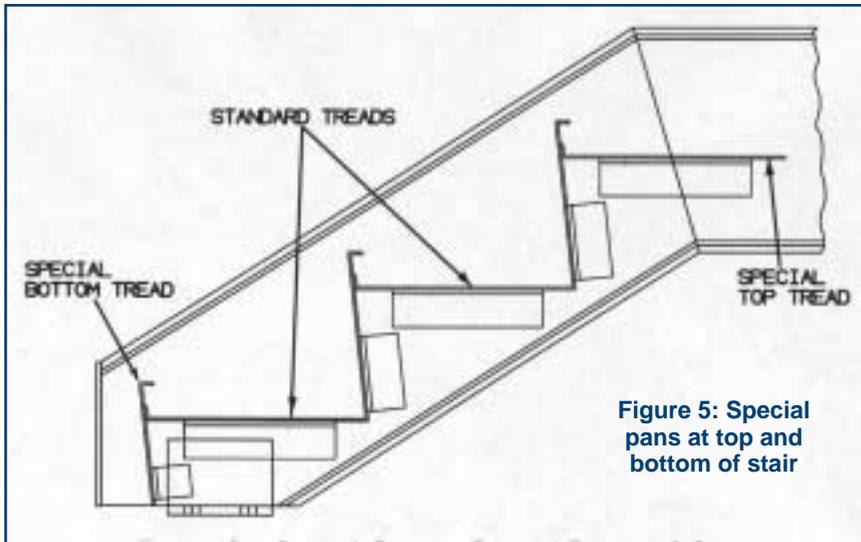


Figure 5: Special pans at top and bottom of stair

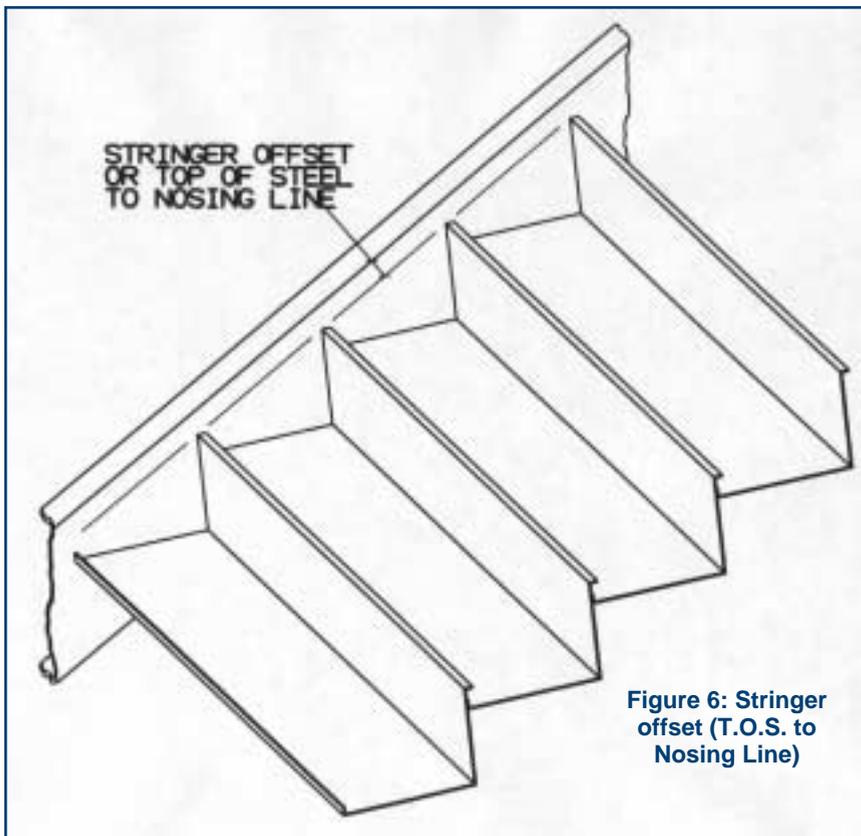


Figure 6: Stringer offset (T.O.S. to Nosing Line)

## LOCATION

The main parameters for locating the stairs are:

- Rise and tread
- Nosing points and nosing line
- Stringer offset values
- Dog leg to nosing point height
- Safe rise and safe run
- Number of treads

An explanation of these terms follows:

**Rise and tread:** Although the actual stair step is called the tread, there is also a measurement, as shown in Figure 1, which is termed the 'tread'. This is the horizontal distance between two consecutive treads. The rise is the vertical distance between two consecutive treads.

**Nosing line and nosing points:** In order for the stair to be set up properly, every corner of every tread should pass through a single line. That line is called the nosing line, and the corner points on the tread through which the line traverses are called the nosing points.

**Stringer offset value (top of steel of stringer to nosing line):** As shown in Figure 6, the stringer offset is the perpendicular distance between the top of steel of the stringer and the nosing line. The stringer offset value is required for locating the stringer in space.

**Dog leg to nosing point height:** Where dog legs are required (i.e. cases where the stringer can't directly make a viable connection to the supporting beam), it is necessary to locate the dog legs. The top dog leg to nosing point height is the distance from the top nosing point to the top of steel of the top dog leg. The bottom dog leg to nosing point height is the distance from the bottom nosing point to the top of steel of the bottom dog leg.

**Safe rise and safe run:** The following general guidelines are typically used for indoor stairs in insuring that the stair is safe:

- $\frac{3}{16}$  maximum variation in rise or tread is allowable.
- $2 \times \text{rise} + \text{tread}$  should be between 24" and 25".
- Rise + tread should be between 17" and 17½".
- Angle of the stair should be between 20 and 50 degrees.

*Note: tread minimum and rise maximum, as well as other important parameters are governed by local or state codes.*

**Number of treads:** The number of treads is obtained by dividing the total rise by the safe rise, or alternately by dividing the total run by the safe run.

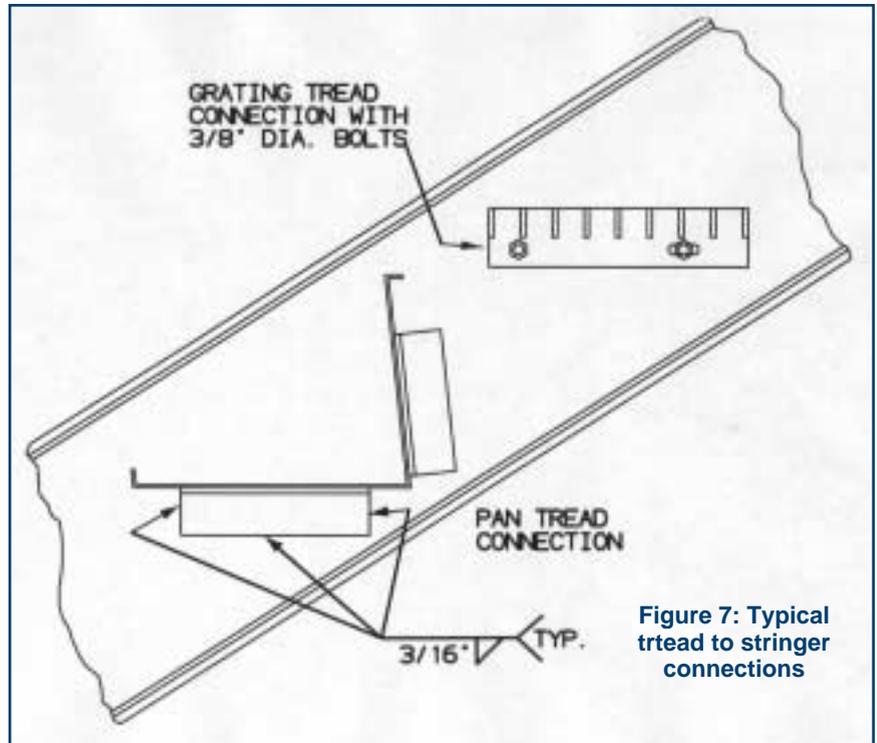
## CONNECTIONS

**Grating to stringer:** A typical grating to stringer connection is shown in Figure 7. The grating manufacturer specifies the location of the bolt holes.

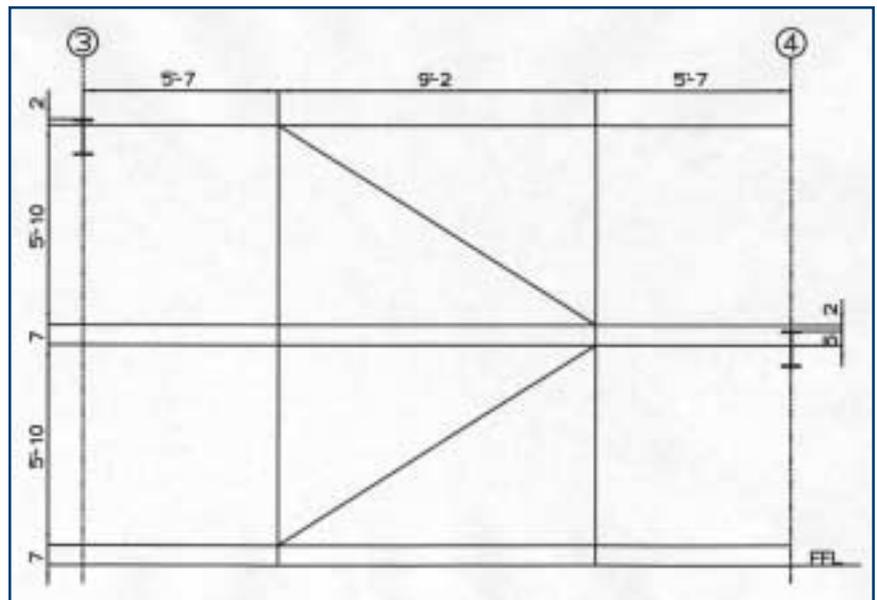
**Pan to stringer:** A typical pan to stringer connection is shown in Figure 7. Other connection types include double angles with a square rod bent around the pan and welded to both the pan and the stringer.

**Stringer to dog leg:** A common stringer to dog leg connection is shown in Figure 3. This is a welded connection with both ends mitered.

**Stringer to ground:** A common stringer to concrete floor connection is shown in Figure 3.



**Figure 7: Typical tread to stringer connections**



**Sketch 1: Stair nosing set-out points**

## HAND DETAILING OF STAIRS

**Information from the engineer:** The detailer must first review the engineer's layout drawings to determine whether or not all the required information is present (see "Information which designers should provide to detailers"). If this information is not present then the detailer should submit an RFI to the engineer.

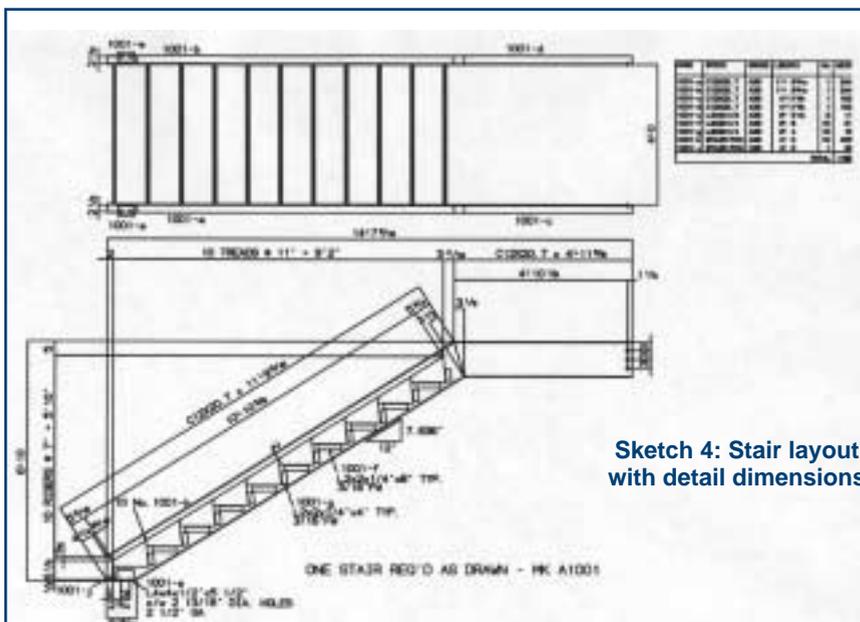
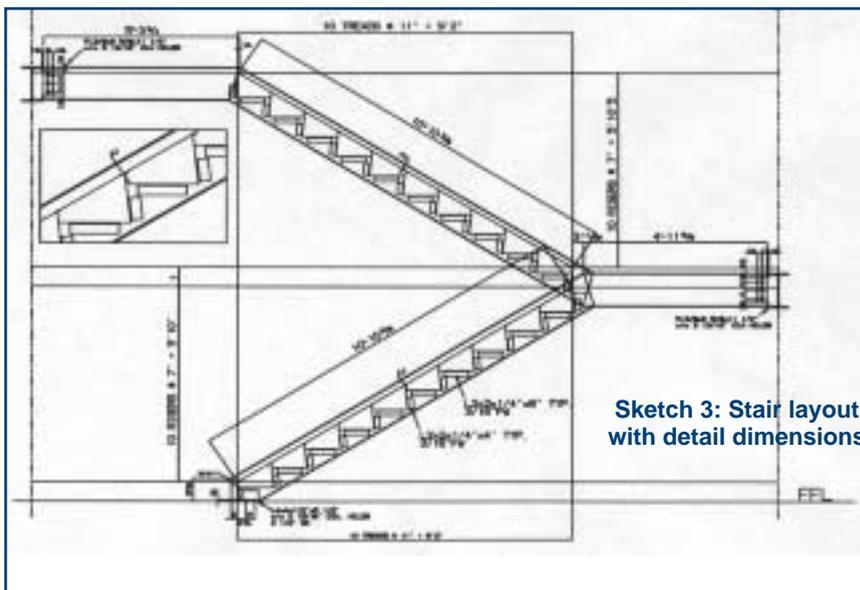
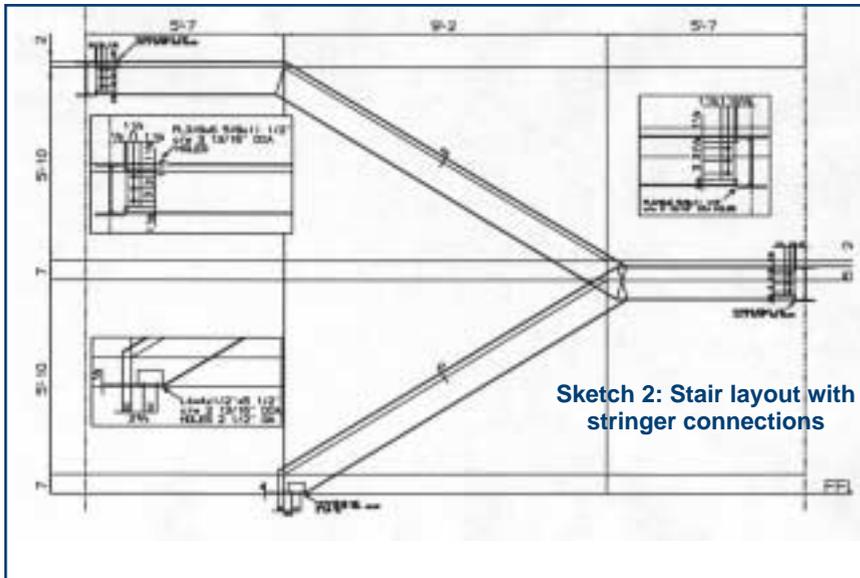
**Layout of the nosing points:** If the required information is available, then the supporting steel can be drawn to scale using construction lines, and the nosing lines can be drawn. See *Sketch 1*.

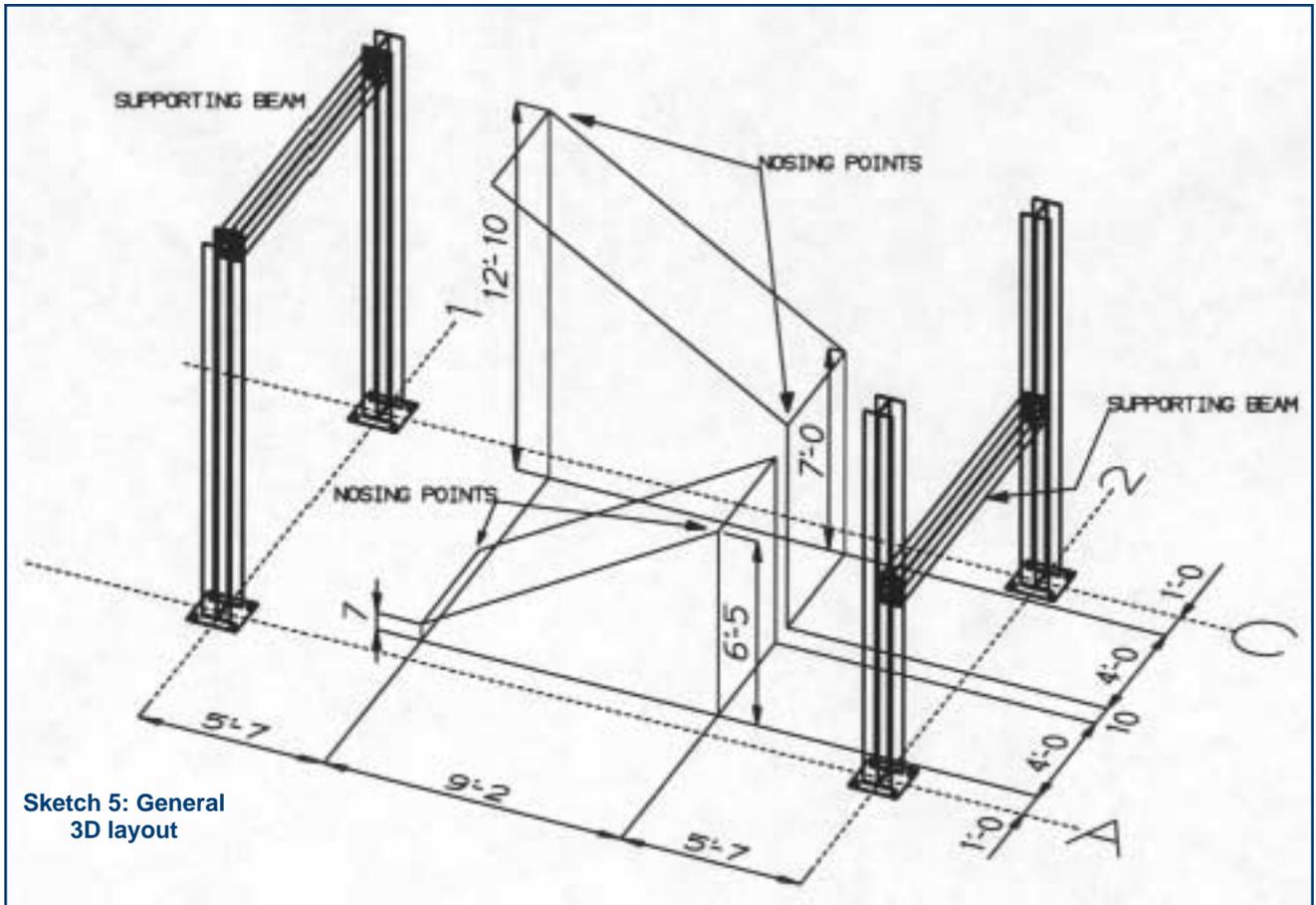
**Adding the main members:** Next, draw the main stringers, and if required, draw the dog legs onto the stair layout. See Figure 5 for the method of determining whether dog legs are required. Once the main members are in position then the stringer connections are detailed both to the concrete floor and / or to the supporting steel. See *Sketch 2*.

**Adding the Pans or Grating Treads:** Draw in the gratings or pans along the nosing line at the calculated positions. If a pan stair is being detailed, only the top, bottom and one typical intermediate pan are required to draw the nosing line. See *Sketch 3*.

**Completing the Detail:** After the completion of the stair diagram the dimensions for fabrication can be calculated and added to the detail. The weights must also be calculated for the Bill of Materials to complete the stair drawing. See *Sketch 4*.

*The entire process in 2-D, including drawing the connections, can be completed in about two to three hours.*





Sketch 5: General 3D layout

### 3-D STAIRS

Because fabrication and erection of stairs is a 3-dimensional problem, using 3-dimensional modeling can be a very useful method of detailing. In 3-D, the detailer models a physical full size representation of the structure, and the computer then automatically produces the fabrication drawings. The detailer can walk around the structure and view it from any perspective, and build any connection. Every aspect of the structure is seen on the screen in front of the detailer so potential problem areas can be eliminated immediately. *The general layout for 3D stairs is shown in Sketch 5.*

**Method of producing stairs in 3-D:** A stair will usually connect either to concrete or to a steel platform, so the detailer must tell the computer which type of platform to use.

The detailer specifies whether a pan or a grating tread will be used, the number of risers required, the stringer section size and the stringer offset (or distance from top of steel of stringer to the nosing line). The tread vs. rise ratio and whether the stair is generally safe (see the section on 'safe rise and safe run') are automatically determined.

If a standard rise and tread are selected then the pan can be picked from a database of existing sections. If not, then the new pan section will be created automatically (*an automatically modeled pan is shown in Figure 8*). The detailer can specify dimensions for the tread thickness and the toe space but the tread and rise is automatically determined.

*From beginning to end, the entire stair, including modeling the stair, producing the drawing and drawing the connections, can*

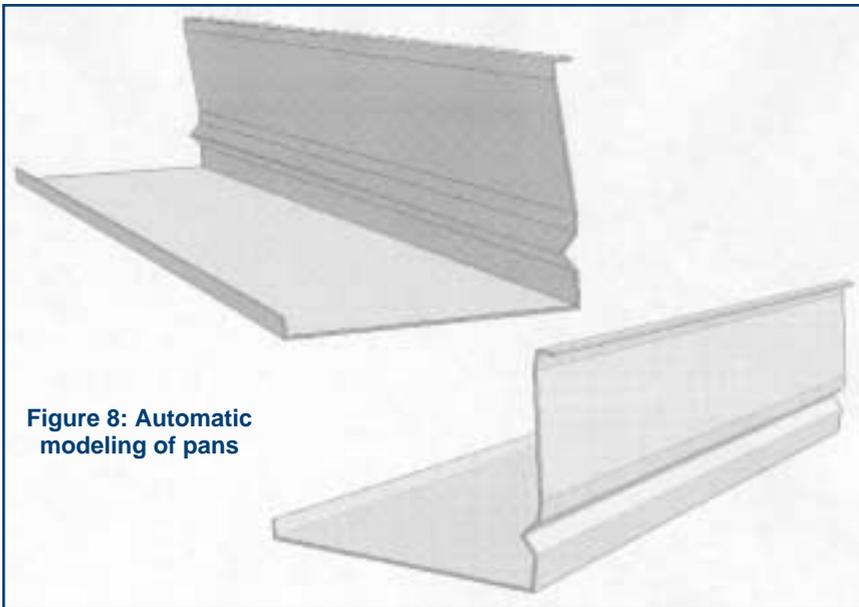
*be completed in less than 10 minutes.*

### Conclusions

Stairs can be detailed manually in 2D, or automatically in 3D. Although complex, manual drafting is very common and is widely used. Automatic detailing of stairs in 3D is becoming increasingly common because it is simple and fast, helps the checker (because the stair can be visualized in 3-D), and ensures a good fit and subsequent ease of erection.

#### Information which designers should provide to detailers

- Number of treads and the rise (typically given as 16@6½")
- Stringer size and type of stringer (i.e. channel, or tube)
- Supporting beam sizes and positions
- Nosing points (if possible)
- Connection details (if possible)



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