Compiled by M. Holland

Turnout Geometry - Calculations

To those modellers who prefer to avoid mathematics; the majority of turnouts can be drawn using the information given in the tables within the body of the text and in the following data sheets, so this one can be safely ignored. This sheet is for those modellers who like to know how the information is derived or wish to draw turnouts not covered in the tables.

As described in Section 2.5 there are two approaches to drawing a turnout. One makes use of pre-cut templates to produce the curves and the other uses dimensions derived from the prototype.

Note: The quoted radius on most commercial templates is measured to the centreline of the curve.

Pre-cut templates

The location of a second point to simplify aligning the curved template can be achieved in two ways. The simpler of the two, used to calculate the table in 2.5.1 c), makes use of right angle triangles but has the danger that the result involves the subtraction of two nearly equal quantities and, unless care is taken, can be susceptible to errors. The second is more complex but the second point derived is the gauge intersection point that, with the heel length, gives the overall length of the turnout.

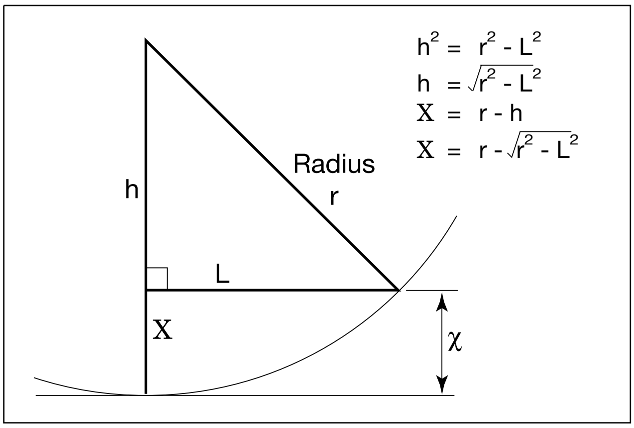
Method 1

This is based on the properties of a right-angled triangle and the sketch shows the development of the formula. By using a known length for L measured along the switch angle construction line a second point on the closure rail curve can be found, making it easier to align the curve template. The calculation is within the range of most pocket calculators.

Example

The length L can be any suitable length but for drawing convenience a length of 200mm is selected.

$$\text{Offset } X = 1600 - \sqrt{1600^2 - 200^2}$$
$$= 1600 - \sqrt{2560000 - 40000}$$
$$= 1600 - \sqrt{2520000}$$
$$= 1600 - \quad 1587.5$$
$$= 12.5\text{mm}$$



Note: If a template of the correct curvature is not available to complete the drawing, by calculating two or three additional offsets at convenient intervals (say, every 100mm) a series of offset points can be marked. These can be joined using a flexible drawing curve.

Derived dimensions

Method 2

This method involves two basic formulae:-

1 Radius of turnout curve - R_t

$R_t = X_d \times X(G - h_d)$

and

2 Lead (heel to crossing) with no straight before the crossing - L_T

$L_T = X(G - h_d) - \dfrac{(G-h_d)}{4X}$

Where $X_d = \dfrac{\alpha \times ß}{\alpha - ß}$

" $X = \dfrac{2 \times \alpha \times ß}{\alpha + ß}$

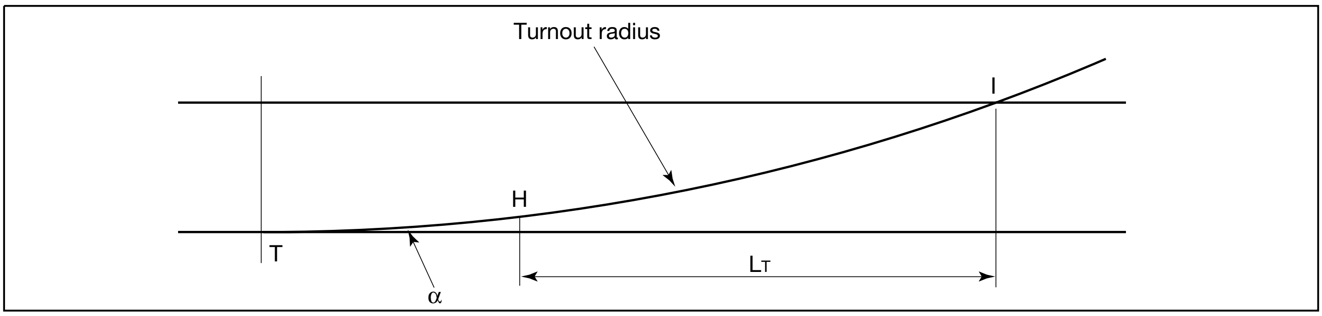
" α = Switch angle of 1 in α

" ß = Crossing angle of 1 in ß

" G = Track Gauge

" h_d = Heel divergence

= heel clearance + railhead width



Example - using the same curve radius (R_T = 1600mm) and marrying it to a 12ft straight switch having a switch angle of 25.3 (α) for 0 Fine and a heel divergence (h_d) of 3.35mm, the crossing angle is found from (1):-

$$1600 = \frac{2 \times 25.3 \times ß}{25.3 + ß} \times \frac{25.3 \times ß}{25.3 - ß} \times (32.0 - 3.35)$$

$$1600(25.3 + ß)(25.3 - \beta) = 36677\ ß^2$$

$$1024144 - 1600\ ß^2 = 36677\ ß^2$$

$$ß^2 = \frac{1024144}{38277}$$

ß = 5.17 (1 in 5.17)

Substituting ß in (2)

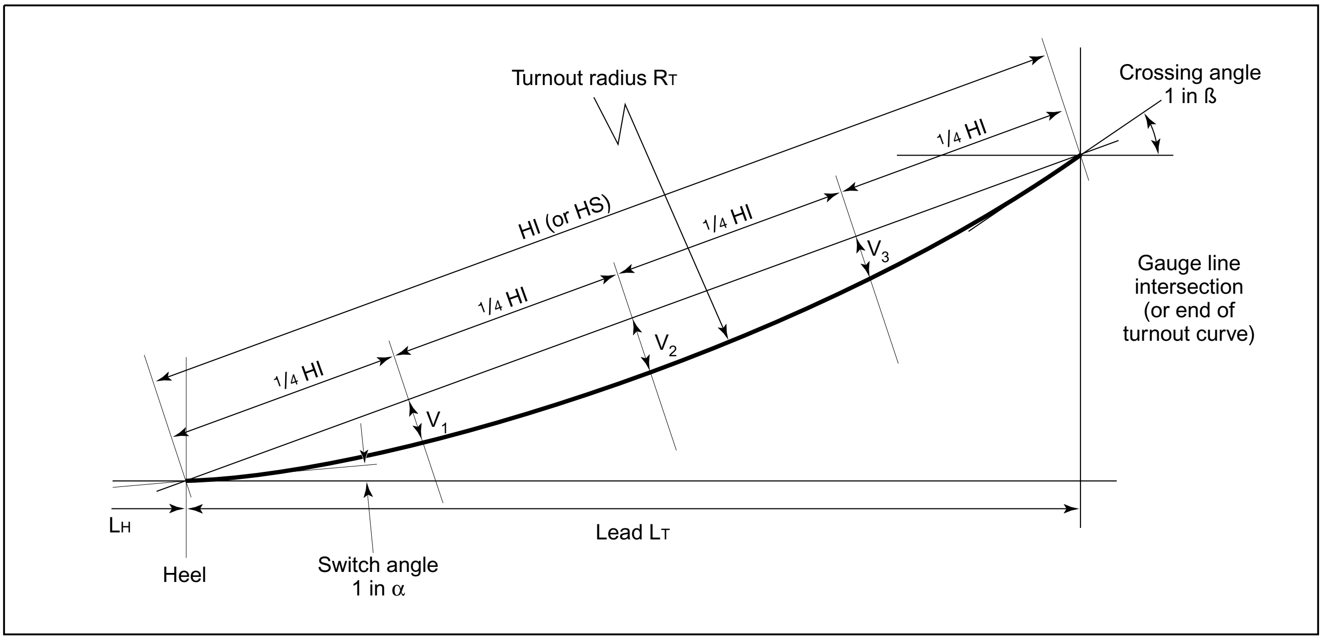
$$L_T = \frac{2 \times 25.3 \times 5.17 \times 28.65}{25.3 + 5.17} - \frac{28.65(25.3 + 5.17)}{4 \times 2 \times 25.3 \times 5.17}$$

$$= 248.4 - 0.8$$

$$= 247.6\text{mm}$$

The gauge intersection calculated is that given by the template and has a crossing angle of 1 in 5.17. If the crossing angle is increased to a standard value, say 5.5, and this figure substituted in (2), the Lead is increased slightly and a tangent can be drawn from the curve to give a straight entry to the crossing.

Calculating turnout curve offsets



In addition to the two formulae above, an additional formula (3) gives the offset distances from the chord joining the heel to the gauge intersection. These lie on the curve and locate the closure rail. They are listed in the data sheets D2.2.3.1 to D2.2.3.4.

3 Offset of chord joining switch heel to gauge intersection - V2

$$V_2 = \frac{G - H_d}{4} \times \frac{\alpha - ß}{\alpha + ß}$$

V_1 and $V_3 = 0.75V_2$

The overall length of the turnout (Full lead) from the toe to the crossing nose is given in (4).

4 Full lead - L $= L_t + L_h + L_n$
Where L_h = Heel length and L_N = Nose distance.

Certain set dimensions that appear in the calculations will vary depending on the modelling standards adopted and the practice of the railway company being modelled.

Source: British Railway Track - Design, Construction and Maintenance. 3rd Edition. Published by the Permanent Way Institution, 1964.