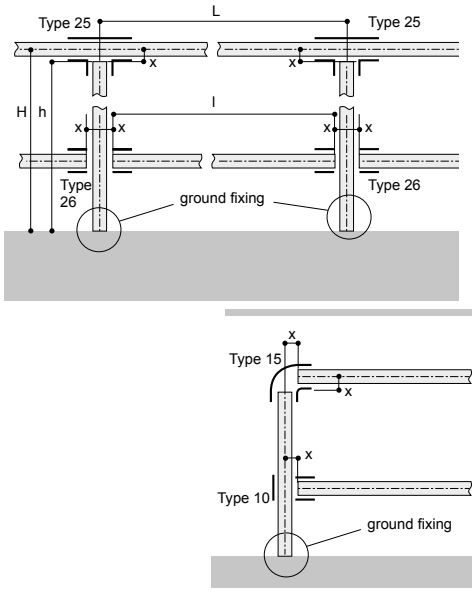
Straight and Level Guard Rail

Using Types 10, 15, 20, 21, 25 and 26 or L10, L15, L20, L21, L25 and L26



Where:

L = distance between centers of uprights

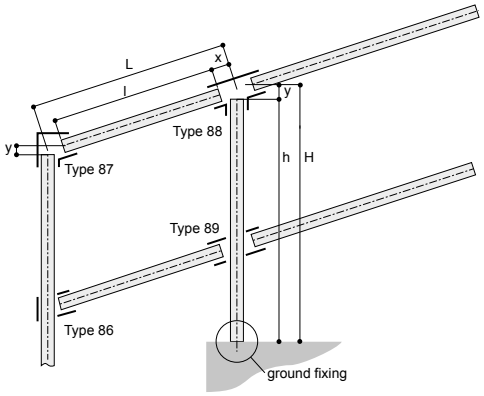
l = length of horizontal pipe

H = distance from ground to centre line of top-rail

h = length of upright pipe

Guardrailing up Slopes 0°–11°

Using Types 86, 87, 88 and 89



Where the upright remains vertical, i.e. ramps and stairways, (i) dimension 'x' to be subtracted from the upright centre dimension measured on the slope to give rail length. (l = L – 2x); (ii) dimension 'y' to be added to the centre dimension to give the length of the upright (H = h + y + ground fixing).

Table 1

Dimension 'x' for fittings above, including Types 35, 40 and L35*

Fitting Size	x (in.)
3	–0.5
4	–0.5
5	–0.5
6	–0.625
7	–0.875
8	–1
9	–1.125

Table 1 gives details of dimension 'x' in the formula: l = L – 2x
To calculate rail lengths and uprights use the formula: h = H – x ± (ground fixing)*

Note: When reducing fittings are being used care must be taken to use the correct 'x' dimension. (i.e., Type 10-87, vertical pipe size 8, horizontal pipe size 7. To find the correct length of the horizontal pipe, the length 'x' is that for the size 8 vertical pipe.) When using Types 35 and 40 the above 'x' dimension should be used. Although guardrailing is normally constructed in size 6, 7 and 8 pipe, Table 1 shows the cutting length for all Kee Klamp pipe sizes, and can therefore be applied to many other rectangular structures.

*When using Kee Lite bases, L61, L62, L69, L140, L150 and L152, "ground fixing" dimension will be zero.

Table 2

Rails

Angle of Slope	Size 8 Fittings 'x' (in.)
0° to 4°	–1
5° to 9°	–1.125
10° to 11°	–1.25

Table 2 gives details of dimensions required for calculating the rail lengths, where angles are between 0° and 11°.

Table 3

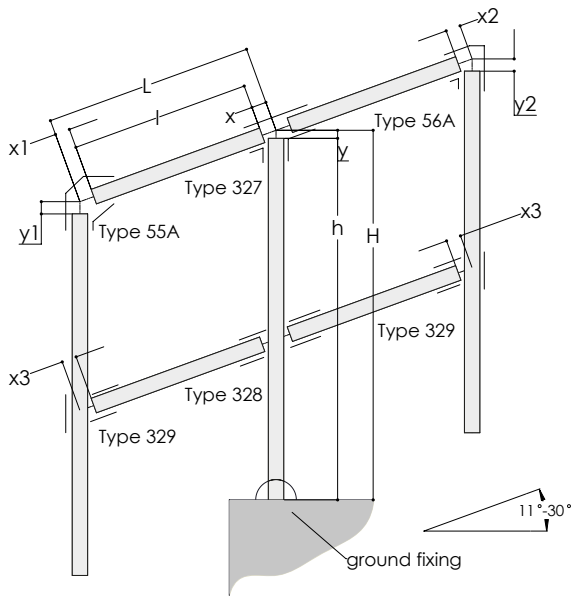
Uprights

Angle of Slope	Size 8 Fittings 'y' (in.)
0° to 4°	–1
5° to 9°	–1.125
10° to 11°	–1.25

Table 3 gives details of dimensions required for calculating the upright lengths, where angles are between 0° and 11°.

Guardrail Up Slopes 11° to 30°

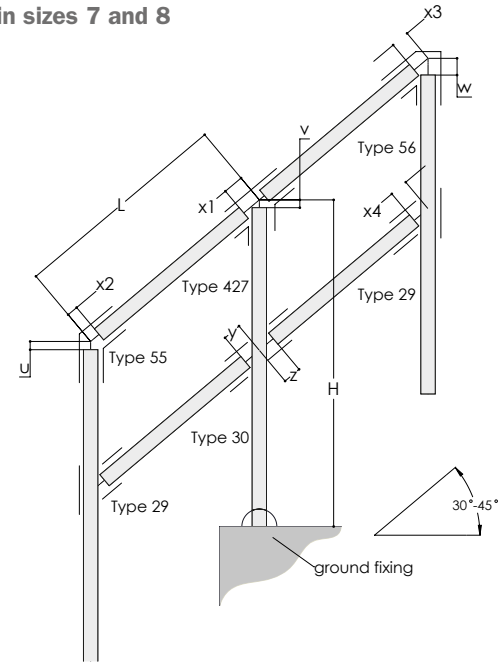
Using Types 55A, 56A, 327, 328 and 329 size 7 and 8



Where the upright remains vertical, i.e. stairways (i) dimension x, x1, x2, x3 to be subtracted from the upright centers; dimension (L) to give the rail length; (ii) dimension y, y1 and y2 for determining the upright length.

Guardrail up Slopes 30° to 45°

Using Types 29, 30, 55, 56 and 427 in sizes 7 and 8



Where the upright remains vertical, i.e. stairways (i) dimension x, x1, x3, y & z to be subtracted from the upright centers; dimension (L) to give the rail length; (ii) dimension u, v and w for determining the upright length.

Table 1

Rails

Angle Of Slope	Fitting Size 7				8			
	x	x1	x2	x3	x	x1	x2	x3
11°	-1.02	-0.98	-1.38	-2.05	-1.14	-0.63	-1.38	-2.01
15°	-1.1	-0.83	-1.81	-2.09	-1.22	-1.06	-1.85	-2.05
20°	-1.18	-0.63	-1.89	-2.17	-1.34	-0.83	-1.93	-2.13
25°	-1.3	-0.59	-2.05	-2.32	-1.5	-0.87	-2.09	-2.24
30°	-1.46	-0.31	-2.24	-2.52	-1.65	-0.59	-2.32	-2.44

Table 1 gives details of dimensions required for calculating the rail lengths, where angle are between 11° & 30°.

Table 2

Uprights

Angle Of Slope	Fitting Size 7			8		
	y	y1	y2	y	y1	y2
11°	+0.28	-0.39	-1.1	+0.24	-0.28	-1.3
15°	+0.28	-0.43	-0.98	+0.24	-0.31	-1.18
20°	+0.28	-0.51	-1.34	+0.24	-0.39	-1.5
25°	+0.28	-0.59	-1.69	+0.24	-0.39	-1.89
30°	+0.28	-0.71	-2.09	+0.24	-0.55	-2.32

Table 2 gives details of dimensions required for calculating the upright lengths.

Table 3

Rails

Angle Of Slope	Fitting Size 7						8					
	x1	x2	x3	x4	y	z	x1	x2	x3	x4	y	z
30°	-1.54	-0.79	-2.17	-1.46	-1.93	-2.17	-1.77	-0.87	-1.93	-1.69	-2.36	-2.91
35°	-1.73	-0.63	-2.4	-1.57	-1.97	-2.13	-1.97	-0.71	-2.17	-1.85	-2.36	-2.91
40°	-1.85	-0.79	-2.8	-1.77	-2.01	-2.09	-2.17	-0.83	-2.6	-2.05	-2.4	-2.91
45°	-1.97	-1.02	-3.35	-2.01	-3.58	-2.09	-2.17	-1.02	-3.19	-2.32	-2.68	-2.6

Table 3 gives details of dimensions required for calculating the rail lengths, where angle are between 30° & 45°

Table 4

Uprights

Angle Of Slope	Fitting Size 7			8		
	u	v	w	u	v	w
30°	-0.67	+0.2	-1.89	-0.98	+0.24	-1.93
35°	-0.63	+0.2	-2.32	-0.83	+0.24	-2.32
40°	-0.31	+0.12	-2.72	-0.55	+0.24	-2.72
45°	+0.08	-0.04	-3.15	-0.08	-0.16	-3.19

Table 4 gives details of dimensions required for calculating the upright lengths.

Guardrail up slopes 30° to 45°

Using 325, 325A, 326, size 7 and 8

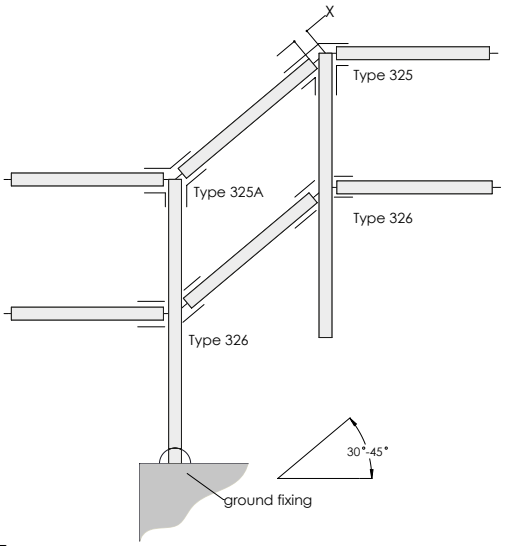


Table 5

Rails

Angle Of Slope	Fitting Size 7 x	Fitting Size 8 x
30°	-1.85	-2.24
35°	-2.05	-2.44
40°	-2.32	-2.72
45°	-2.68	-3.11

Table 5 gives details of dimensions required for calculating the rail lengths, where angle are be-tween 30° & 45°.

Guardrail up slopes 30° to 45°

Using 320RH, 320LH, 321RH and 321LH size 7 and 8

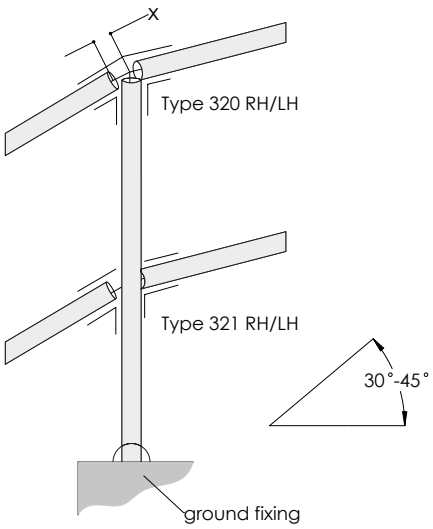


Table 6

Rails

Angle Of Slope	Fitting Size 7 x	Fitting Size 8 x
30°	-2.17	-2.44
35°	-2.36	-2.68
40°	-2.64	-2.99
45°	-3.03	-3.39

Table 6 gives details of dimensions required for calculating the rail lengths, where angle are between 30° & 45°.

Slope Fittings

The latest addition to the Kee Klamp portfolio is an extension to the current range of slope fittings designed to enhance the building of guardrail along staircases and ramps particularly when the slope is greater than 30°. The range introduces single fittings to cater for situations where currently a combination of fittings is required. Not only does this improve the aesthetics of the finished guardrail but it also allows for a quicker and easier install. The range of slope fittings is available in Size 7 (outer diameter 1¼") and Size 8 (outer diameter 1 ½") designed for use with steel piping to ASTM A53.

Kee Klamp fittings are iron castings manufactured to the requirements of BS EN 1562 & BS EN 1563. They are supplied hot dip Galvanized to ASTM A123.

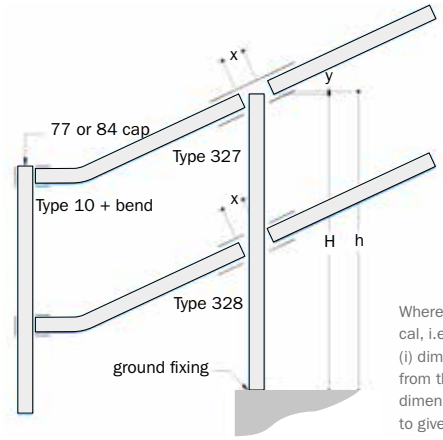
A Kee Klamp fitting can support an axial load of 2000 lbs. per set screw tightened to a torque of 29ft.lbs. In common with all Kee Klamp products, the threaded recesses of each fitting are covered with Threskoat protective coating to provide enhanced corrosion resistance and all grub screws are manufactured in case hardened steel coated with Kee Coat for corrosion protection.

Features and Benefits

- Kee Klamp is the best known brand of slip-on pipe fittings available for over 80 years
- Manufactured to stringent quality standards to ensure consistent performance
- Extended range of slope fittings gives greater design flexibility
- Adjustability in the fittings allows greater on-site tolerances to be met
- Using single fittings rather than pairs speed up installation times

Guardrailing up Slopes 11°–30°

Using Adjustable Fittings, Types 327 and 328



Where the upright remains vertical, i.e. ramps and stairways, (i) dimension 'x' to be subtracted from the upright centers dimension measured on the slope to give rail length. (l = L –2x); (ii) dimension 'y' to be added to the centre dimension to give the length of the upright (h = H + Y + ground fixing).

Table 4

Rails

Angle of Slope	Size 7 Fittings: 'x' (in.)	Size 8 Fittings: 'x' (in.)
11°	-1.1	-1.18
15°	-1.26	-1.38
20°	-1.26	-1.5
25°	-1.38	-1.61
30°	-1.61	-1.73

Table 4 gives details of dimensions required for calculating the rail lengths, where angles are between 11° and 30°.

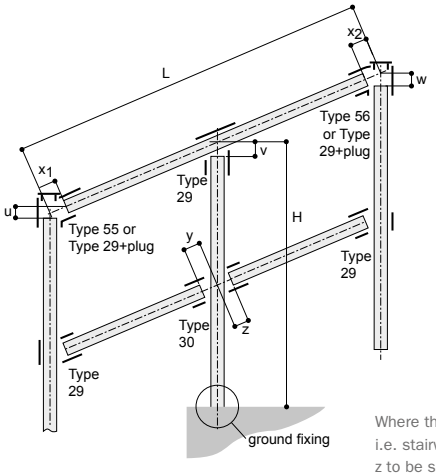
Table 5

Angle of Slope	Size 7 Fittings: 'y' (in.)	Size 8 Fittings: 'y' (in.)
11°	+0.63	+0.75
15°	+0.63	+0.75
20°	+0.51	+0.63
25°	+0.51	+0.63
30°	+0.51	+0.51

Table 5 gives details of dimensions required for calculating the upright lengths, where angles are between 11° and 30°.

Guardrailing up Slopes 30°–45°

Using Adjustable Fittings, Types 29, 30, 55 and 56 or Types L29 and L30 size 6, 7 and 8



Where the upright remains vertical, i.e. stairways (i) dimension x, y, or z to be subtracted from the upright centers: dimension (L), to give the rail length; (ii) dimension u, v and w for determining the upright length.

Table 6

Rails

Angle of Slope	Size 6 Fitting			Size 7 Fitting			Size 8 Fitting		
	x (in.)	y (in.)	z (in.)	x (in.)	y (in.)	z (in.)	x (in.)	y (in.)	z (in.)
30°	–1.25	-2.125	-1.375	-1.625	-2.5	-1.625	-1.75	-3	-2.125
35°	-1.375	-2	-1.5	-1.75	-2.375	-1.75	-2	-2.875	-2.25
40°	-1.5	-1.875	-1.63	-1.875	-2.25	-1.875	-2.125	-2.5	-2.375
45°	-1.75	-1.75	-1.75	-2.125	-2	-2	-2.375	-2.5	-1.625

Table 6 gives details of dimensions required for calculating the rail lengths, where angles are between 30° and 45°.

Table 7

Uprights

Angle of Slope	Size 6 Fitting			Size 7 Fitting			Size 8 Fitting		
	u (in.)	v (in.)	w (in.)	u (in.)	v (in.)	w (in.)	u (in.)	v (in.)	w (in.)
30°	0.625	-1.25	+1	+0.25	-1.625	+1.125	+1.875	-1.75	+1.25
35°	0.375	-1.375	+0.75	+2	-1.75	+0.875	+2.125	-2	+1
40°	0.125	-1.5	+0.5	+1.625	-1.875	+0.5	+2.5	-2.125	+0.5
45°	1.75	-1.75	+0.125	+1.25	-2.125	+0.125	+3	-2.375	+0.125

Table 7 gives details of dimensions required for calculating the upright lengths, where angles are between 30° and 45°.

Table 8

Uprights and rails using Types 55 and 56 – Size 8 only

Angle	u (in.)	x_1 (in.)	w (in.)	x_2 (in.)
20° to 29°	-0.75	-0.75	-2	-2
30° to 39°	-0.625	-0.625	-2.375	-2.375
40° to 49°	-0.5	-0.5	-2.75	-2.75
50° to 59°	-0.5	-0.5	-	-
60° to 69°	-0.375	-0.375	-	-
70° to 79°	-0.375	-0.375	-	-
80° to 88°	-0.25	-0.25	-	-

Table 8 gives details of dimensions required for calculating the upright lengths.

Shelving

Using Type 46 or L46

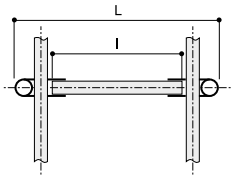


Table 9

Shelving with carrying rails positioned on the outside of the upright

Fitting Size	x (in.)
4	-3.875
5	-5.25
6	-6.375
7	-7.75
8	-9
9	-10.875

Table 9 gives the dimension 'x' to be subtracted from overall shelf width 'L' to give the length of the cross rail in the formula l = L – x. (Dimension x accounts for the use of two Type 46 or L46 fittings.)

Pallet Racking

Using Type 46 or L46

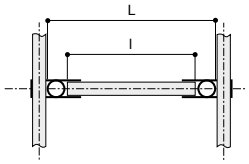


Table 11

Pallet racking with the carrying rails on the inside of the upright

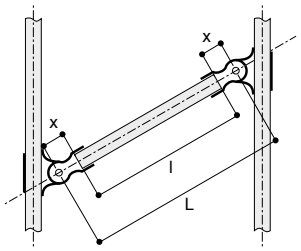
Fitting Size	x (in.)
4*	-1.875
5*	-2.38
6*	-7.88
7	-3.38
8	-4
9	-5

Table 11 gives dimension 'x' which must be subtracted from the overall width of the carrying rails, to give the length of the cross rail in the formula:
l = L – x. (Dimension x accounts for the use of two Type 46 or L46 fittings.)

*Pallet racking is not recommended in less than size 7 pipe.

Construction of Braces and Struts

Using Types C50, C51, C52 and C53 or LC50, LC51 and LC52



When using multiple pipe sizes in one structure, Types F50-5 to F50-9 or LF50-6 to LF50-8 can all be combined with:
M50-5 to M50-9 LM50-6 to LM50-8
M51-5 to M51-9 LM50-6 to LM50-8
M52-5 to M52-8 LM52-6 to LM52-8
M53-8
to construct combination fittings (i.e. C50-75, C50-85, C51-655, C52-855 and C53-888).

Table 10

Shelving with carrying rails positioned on the outside of the upright.

Fitting Size	x (in.)
4	-0.5
5	-1
6	-1
7	-1
8	-1
9	-1.25

Table 10 gives details of dimension 'x' to be subtracted to give the pipe length required for use with two Type F50 or LF50 fittings in the formula l – L – 2x.

Note: Dimension 'L' is the length from pivot point to pivot point. The distance from upright to upright is dependent on the angle of the strut.

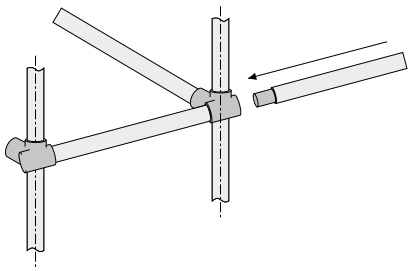
Table 12

Additional pipe length to reach topmost fitting's termination

Fitting Size	z (in.)
3	+1
4	+1.125
5	+1.25
6	+1.5
7	+1.875
8	+2
9	+2.38

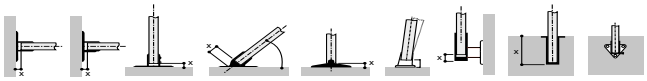
The length of the longitudinal member can be calculated from multiples of the length of the bay between the centers of uprights, plus dimension 'z' in Table 12. Dimension z accounts for the length of pipe needed to go through the topmost fitting to the fitting's termination. This also applies to constructions using fitting Type 45.

Longitudinal pipes are joined using fittings Type 14 or 18 couplings (use of Type 18 is not recommended as a load bearing joint), which must be positioned to occur at the edge of the Type 46 fitting, and must not all occur in the same bay at alternate levels.



Spigots can be either pipes or rods, riveted into position, or the Type 18 fitting. When using the latter, a gap of 3/4" must be allowed for the set screw fixing.

Base and Wall Fixings*



Type 60 | Type 61 L61 | Type 62 L62 69 L69 623 | Type 63 363 | Type 59 | Type 67 3°-11° | Type 64 65 L164 | Type 66 | Type 68 L68 115 265

Table 13

Flange Type	x (in.)
59	-0.39
60	-0.39
61	-0.24
62	-0.24
67	-0.24
623	-0.47

Table 13 gives details of the ground fixing dimension 'x', to be subtracted from the height 'H' to give the length of the upright 'h'.

Table 14

Angle	x (in.)
45°	-1.5
50°	-1.25
60°	-1
65°	-0.5

Table 14 gives details of the ground fixing dimension 'x', for Type 63-6 only, to be subtracted to give the length of the upright for each angle condition.

Table 15

Angle	x (in.)
11°	-1.5
15°	-1.26
20°	-0.98
25°	-0.79
30°	-0.47

Table 15 gives details of the ground fixing dimension 'x' for Type 363, to be subtracted to give the length of the upright for each angle condition.

Table 16

Fitting Size	x (in.)
6	-0.25
7	-0.25
8	-0.25

Table 16 gives the dimension 'x' to be subtracted from the length of the upright for fitting Types 64, 65, 67, 68, 115, 265, L68 and L164.

Table 17

Fitting Size	x (in.)
6	+4.5
7	+5
8	+5

Table 17 gives the ground fixing dimension 'x', to be added to the upright member to allow for the setting into the socket Type 66.

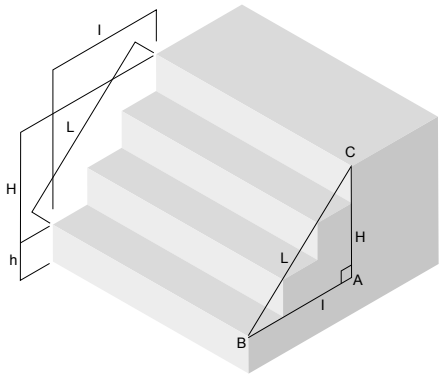
*When using Kee Lite bases and flanges, "ground fixing" dimension (x) will be zero, except when using flanges L164, L68 and LC58.

Constructing Circles and Triangles

Worked Example

Slopes and radii present no problem to the Kee Klamp Galvanized railing systems. Fitting Types 27, 28, 29, 30, C50, C51, C52, 55, 56, 86, 87, 88 and 89 (and the 90 range pedestrian guardrail fittings) are designed to allow for raked handrail while keeping the uprights vertical. Pipe can be bent and radiused to suit most situations. Also, true lengths have to be determined where braces and struts are being used.

Consider the following concrete single flight staircase.



Where
H = Vertical height from 1st nosing to last nosing.
h = Vertical height from ground level to 1st nosing.
I = Horizontal dimension from 1st nosing to last nosing.
L = Hypotenuse dimension (Pitch Line) from 1st nosing to last nosing.

Known Data		Formula for Side and Angle	
H & L	$I = \sqrt{(L^2 - H^2)}$	$\text{Sin } B = \frac{H}{L}$	$C = 90° - B$
L & I	$H = \sqrt{(L^2 - I^2)}$	$\text{Sin } C = \frac{I}{L}$	$B = 90° - C$
H & I	$H = \sqrt{(H^2 - I^2)}$	$\text{Tan } B = \frac{H}{I}$	$C = 90° - B$

Note: The table can be used to solve angles and true lengths for braces and struts.

Step 1

From a simple site survey or information from a working drawing, obtain the following dimensions.

Note: For greater accuracy, vertical dimensions should be taken by means of a Dumpy Level or a Theodolite.
H = vertical height from the 1st nosing to the last (140cm).
L = pitch line, the diagonal dimension from the 1st nosing to the last (240cm).

Step 2

From the table to determine angle B we use;
Sin B = 55 / 96, Angle B = 35°

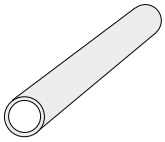
Ramps can be dealt with in a similar way. Most ramps have a stated gradient (e.g. 1:12); for every 12 units traversed horizontally, 1 unit of vertical height is obtained.

How to Make Jigs for Railing Posts

Set-up

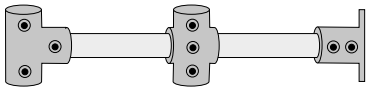
Step 1

Start with pre-cut pipe.



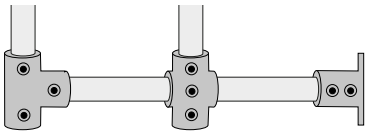
Step 2

Measure and locate fittings on first post only.



Step 3

Lay post horizontal, and insert two pieces of scrap pipe. This is all that's involved in setting up your jig! From this point, duplicate posts can be produced by unskilled labor, without further measuring, at the rate of 20–30 posts per hour.

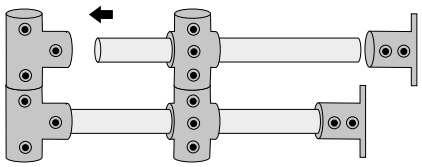


Utilising Jigs for Railing Posts

Production

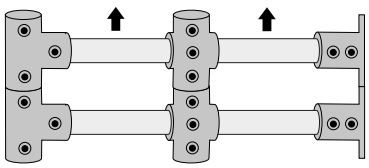
Step 1

Set top and middle fittings in place, unfastened, on the two pieces of scrap pipe.



Step 2

Insert pre-cut pipe into fittings, then add flange.



Step 3

Simply tighten set screws, then lift off.

Wire Mesh Infill

Infilling is normally constructed from 2" x 2" 0.13", 1" x 1" x 0.13" or 2" x 1" x 0.13" wire mesh welded to a 0.31" Rod frame, and is fixed into position using standard Fitting Types 81 and 82. (NB: Types 81 and 82 require cut outs on mesh less than 1.26" square.)

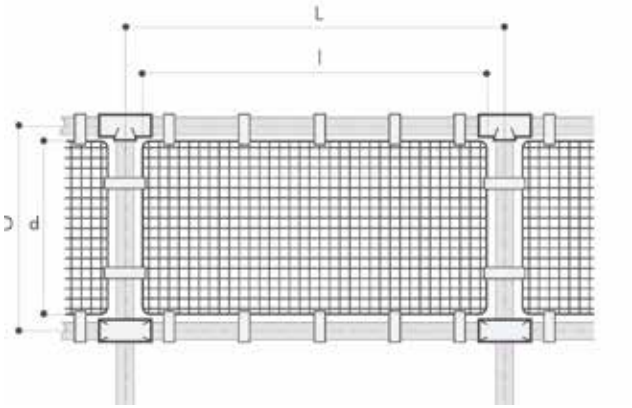


Table 20

Fitting Size	x (in.)
5	-2.36
6	-2.99
7	-3.39
8	-3.50
9	-3.86

Table 20 gives the dimensions to be subtracted from the centre dimensions 'L' and 'D' of the structure to give the formulae l = L – x and d = D – x.

Warning: The spacing of panel clip Types 81 and 82 should not exceed 17.72" centers. The safety attachment incorporated in the panel clip Types 81 and 82 cannot be used with mesh less than 1.26".

Pipe Bending

Table 21

Fitting Size	R (in.)
3	2.24
4	2.24
5	3.54 or 3.86
6	4.02
7	5.31
8	5.98
9	7.99

Table 21 gives details of standard radius 'R' of the pipe bent by Kee Safety Ltd. If the standard radii below are not suitable, pipe sizes 5 to 9 can be rolled to any radius above a minimum of 19.69".