
# Site Engineering Guide

## PROFILES: CONTROLLING EARTHWORKS

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# PROFILES: CONTROLLING EARTHWORKS

## INTRODUCTION

Profiles are used to control earthworks on site and will probably be one of the first duties undertaken on a site, used to control the reduced excavation. Applicable to drainage, pipelines, foundations, road construction and any other hard standing which is either level or set to a gradient the principle and methods remain the same.

Although the use of profiles for some of the activities listed has declined, due to the advent and popularity of lasers in construction, the technique should still be learnt as not all projects will warrant the availability of a laser level.

## SETTING OUT PROFILES FOR DRAINAGE

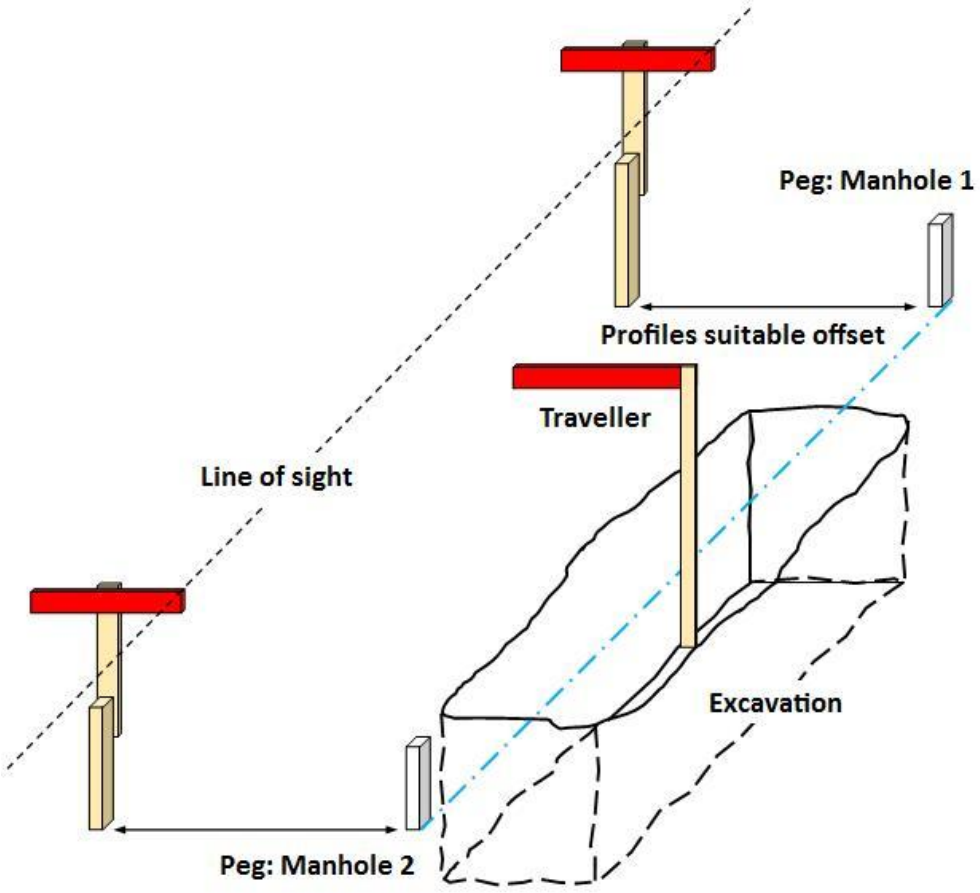



Figure 1: Profiles for a drainage

1. Set out the position of the manhole centres and the centre line of the drain excavation using pins or pegs.
2. Drive stakes in plumb at a suitable offset with the distance between them no greater than 20 m, perpendicular to the line of the drain excavation. When determining the offset, consider the required working room of machinery excavating and any need for access/spoil storage.

3. Take levels on top of each of the stakes and the existing ground level at each manhole position, recording in your field book.
4. Determine the level of the drain relative to each stake position.
5. Using the ground levels taken at the manhole positions, determine the maximum depth of excavation.
6. Using the maximum excavation depth determine the traveller length by adding 0.8 metres, the traveller length should ideally be a multiple of 0.5 metres and so you may need to round up your calculated traveller length accordingly.

***Tip***

*When calculating the dig levels don't forget to allow for any bedding material in the trench as required on the details.*

7. Add the traveller length to each of the relative drain levels and subtract the top of stake level to obtain the profile level above or below the top of each stake.
8. Manufacture 'T' pieces using two pieces of timber, adding lengths together if required to obtain the required length, the profiles overall length should be a minimum of 250mm larger than the required length for fixing to the stake.
9. Measuring from the top of the 'T' or rail down mark the required length on the timber, driving a nail at this point and through will make fixing later easier, along with starting off several nails. Also mark the profile number and size of traveller. Continue until all the required profiles are built.
10. Paint the rail of each profile board before fixing, any bright colour such as yellow or red work best
11. Offering the profile 'T' to each stake lowering until the nail is resting on the top of the peg, fix using one nail. Check top of profile for level using a boat level, if satisfactory use further nails to fix until solid.

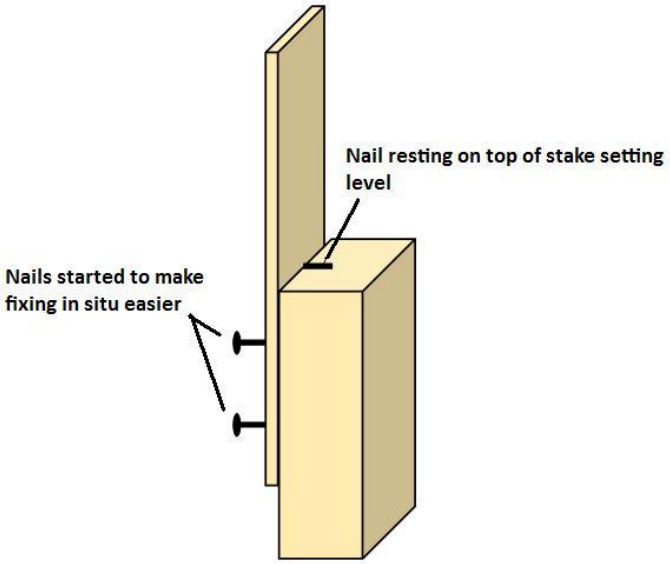



Figure 2

***Tip***

*When fixing the profile board to the stake, having set the profile board up already as in the figure 2, placing your shin against the back of the stake as you drive in the nails, this limits the amount of disturbance caused to the stake.*

12. Visually check the line of profiles for any discrepancies and adjust if required.
13. Construct the traveller writing on, with permanent marker the size. On the traveller you can have as many rails as required, one for excavation, top of bed and soffit of pipe, just don't forget to label clearly

14. Ensuring the page in your field book is appropriately titled and filled in will make locating the information at a later date if you need to repair or replace damaged profiles much quicker.

⚠ ***Safety Tip***

*Make sure when finished that no nails protrude as to pose a safety issue, by hammering them over.*

**WORKED EXAMPLE**

The figures 3 and 4 detail a worked example of drainage requiring the erection of profiles.

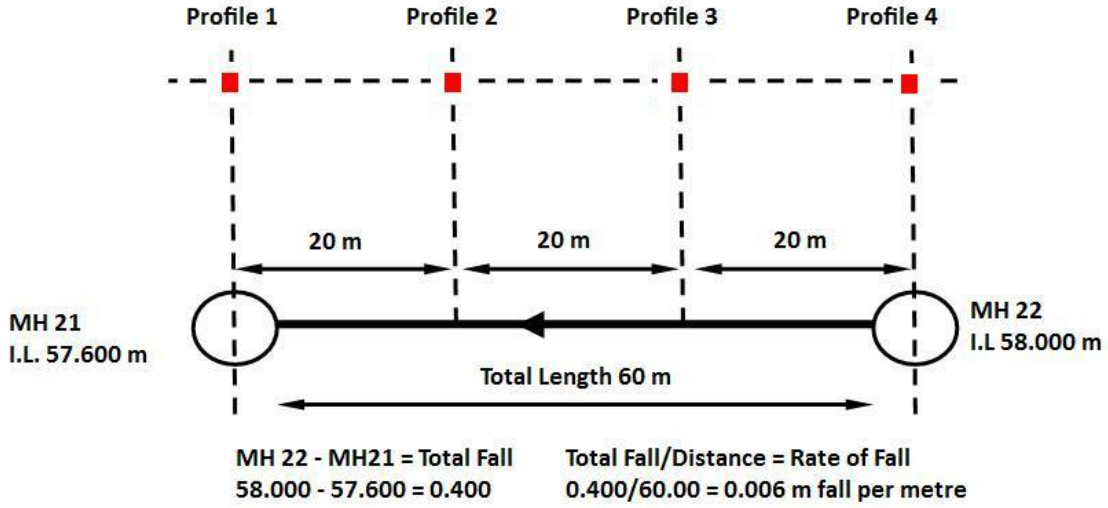



Figure 3: Sketch of worked example

Date: 10-06-2010 Taken for: Profiles for MH21-22

From: Blue Peg TBM 59.650 AOD To:

| BACK SIGHT | INTER-MEDIATE | FORE SIGHT | COLLIMATION OR H.P.C | REDUCED LEVEL | DISTANCE | REMARKS |
|---|---|---|---|---|---|---|
| 1.189 | | | 60.839 | 59.650 | | Blue Peg TBM (59.650 AOD) |
| | 1.404 | | | 59.435 | | MH 21 GL (I.L. – CL = 1.835 DIG) |
| | 0.851 | | | 59.988 | 0.0 | Pro 1 (I.L. 57.600) |
| | 0.972 | | | 59.867 | 20.0 | Pro 2 (I.L. 57.730) |
| | 0.947 | | | 59.892 | 40.0 | Pro 3 (I.L. 57.860) |
| | 0.895 | | | 59.944 | 60.0 | Pro 4 (I.L. 58.000) |
| | | 1.237 | | 59.602 | | MH 22 GL (I.L. – CL = 1.602 DIG) |
| | | | | | | |
| Profiles: | I.L+ Trav | Stake Lvl | Δ Profile | | | Max Dig Approx 2m |
| Pro 1 | 60.100 | 59.988 | +0.112 | | | Therefore use: **2.5m Traveller** |
| Pro 2 | 60.230 | 59.867 | +0.363 | | | |
| Pro 3 | 60.360 | 59.892 | +0.468 | | | |
| Pro 4 | 60.500 | 59.944 | +0.556 | | | |
| | | | | | | |

Figure 4: Field book recording of worked example

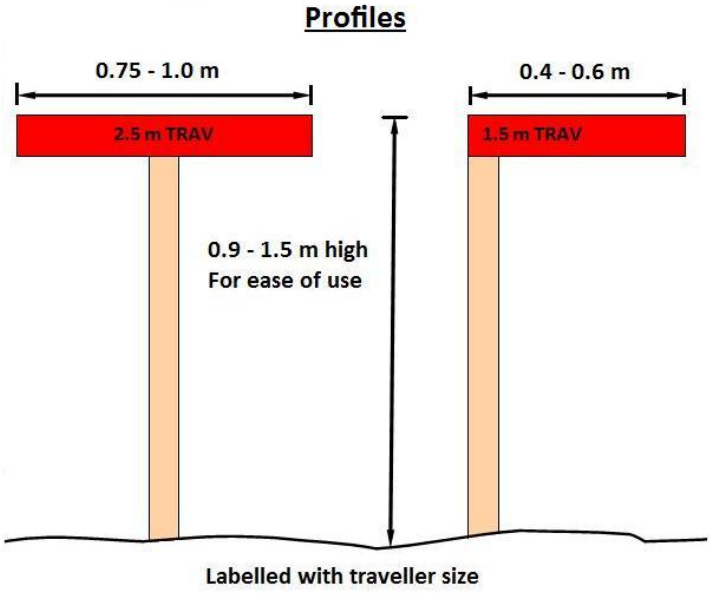
***Tip***

*Having calculated the sight line in the worked example i.e. the invert level plus the traveller length, ensures that you already have a level for the top of the profile, which you can use to take compare with any check levels you take on the tops of the rails.*

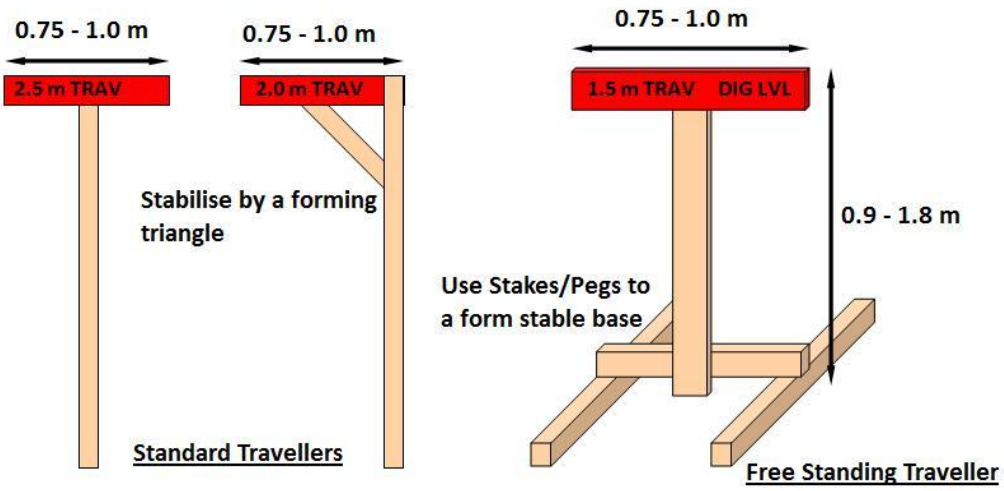
**GUIDELINE SIZES**

Figure 5 and 6 below feature guideline sizes for profiles, travellers and free standing travellers.

For travellers, where possible they should be one solid length of substantial timber and true, this ensures that they are both durable and will not flex giving incorrect readings.




Above: Figure 5: Profile guide sizes Below: Figure 6: Traveller guide sizes



***Tip***

*When providing profiles, you MUST explain the setting out to the operatives. YOU should also periodically check the works as they progress and ensuring that they are being used correctly.*

**PROFILES FOR ROADS & FORMATIONS**

Profiles for road construction are usually provided at a particular chainage and offsets in pairs. Typically profiles will be positioned every 10 metres. Depending on the cross sectional construction of the road as can be seen in figure 7, the profile boards may need to be more involved.

It is important to remember that the positioning of the profile is critical if dealing with any fall, if the profile is positioned beyond/outside the specified level point you will need to take this into consideration otherwise your gradients will not be correct.

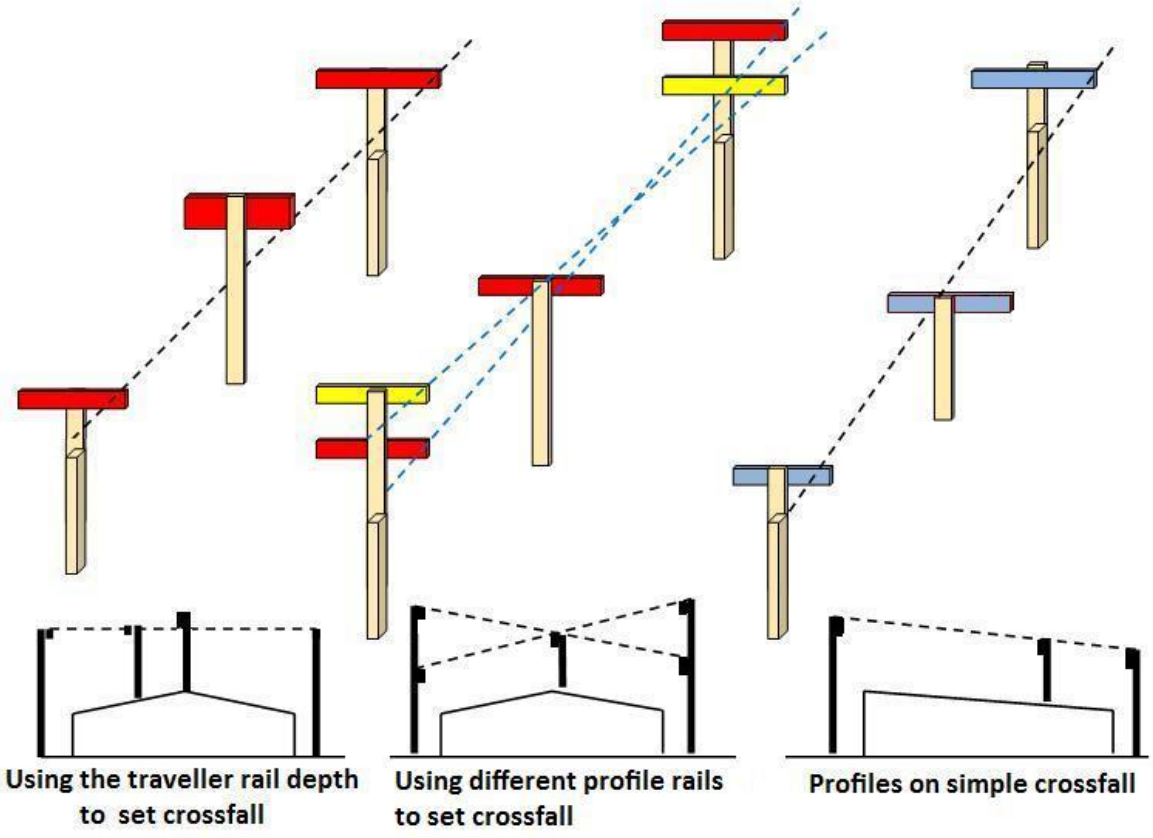



Figure 7: Profiles for road cross falls

**BATTER BOARDS**

Batter boards or rails, consist of two stakes with a board between set at the correct gradient for the slope. They can be used for either a cutting or an embankment, the process remains much the same, and figure 8 shows a typical arrangement for an embankment.

The traveller should be set at a pre-determined length, typically anything between 1.0 and 1.5m and the setting out of the stake nearest the toe of the embankment/batter or top of the cutting should be a consistent offset used throughout, typically 1.0 m

The steps detailed below will cover the setting out of batter boards for a road or similar situation.

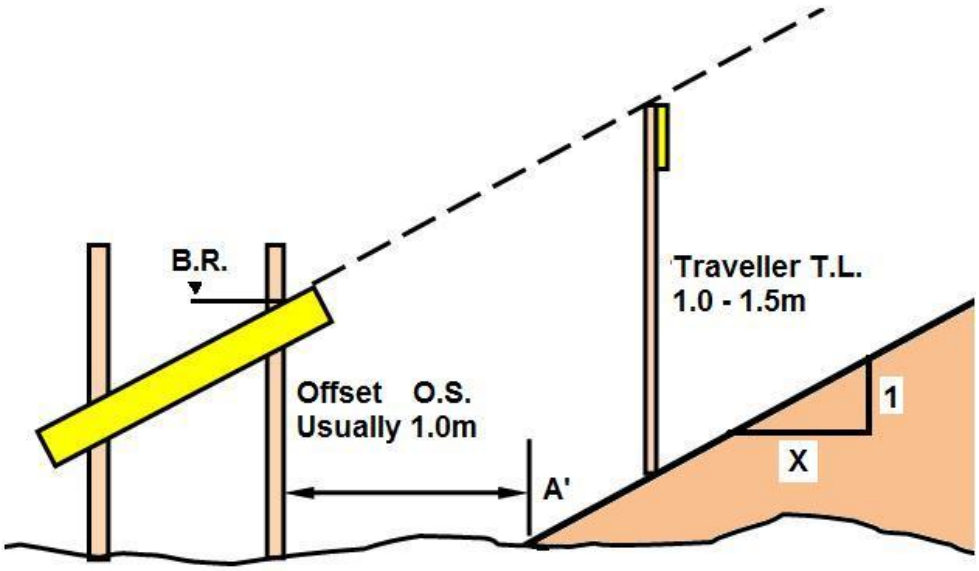



Figure 8: Batter rails for an embankment

1. Calculate or determine the design level for the top of the embankment or toe of the cutting whichever is applicable.
2. Determine the gradient of the slope, if not specified on the contract drawings. If the cutting/embankment is to be maintained then a gradient of 1 in 3 is the maximum allowable, the design team will be able to give better advice with this.
3. Take an initial ground level at the centre point of your road having already set out and compare with the design level; this will determine if you are dealing with a cutting or an embankment.
4. Calculate the initial offset to the embankment toe or cutting edge based on the level just taken A and using the following formula, reference to figure 9

Embankment: = **O + [(D+A) X]**
Cutting: = **O + [(A-D) X]**

Where:

D = Design level for top of embankment/toe of cutting
O = offset of D from centre line
A = initial Ground level
X = slope gradient 1:X
A = All subsequent ground levels taken at a calculated theoretical toe of embankment/top of cutting

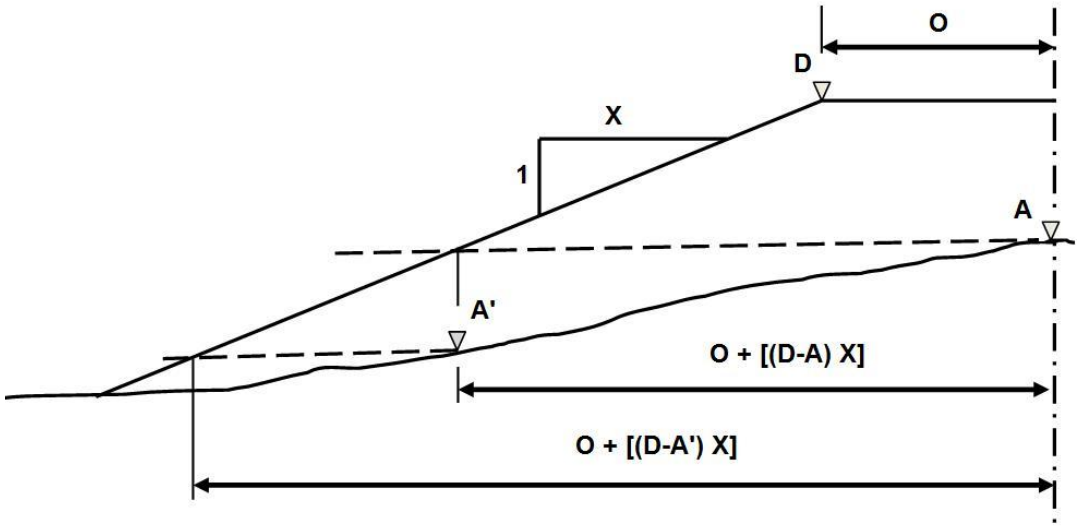



Figure 9

5. Measure out the distance calculated using one of the other formulas and take another level. Recalculate the position using one of the formulas, measure and level.
6. Repeat this process until the level taken is within 100mm of the previous ground level taken.
7. Now the position and level of the rail for the cutting/embankment can be established using the following formula with reference to figure 8: -

**B.R = [A' + T.L.] ±*[O.S. x (1/X)]**

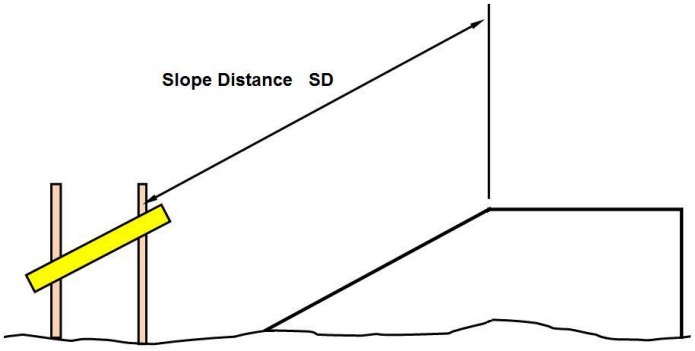
* - For embankment
\+ For cutting

Where:

B.R = batter rail
A' = calculated toe/top level
T.L. = traveller Length
O.S. = offset from toe/top to inside profile stake
X = slope gradient 1: X

8. Create a suitable template (triangle) and use in conjunction with a boat level to establish the gradient on the rails as in figure 10.
9. The slope distance (SD) must be calculated and clearly marked on the batter rail, this is calculated using the following formula: -

**SD** = $\sqrt{[[(\boldsymbol{D}-\boldsymbol{A'})\boldsymbol{X^2}+[\boldsymbol{D}-\boldsymbol{A'}]^2}+\sqrt{[(\boldsymbol{O.S.}^2)+[\boldsymbol{O.S.}*\boldsymbol{X^2}}$




Left: Figure 10

10. Check line of profiles visually for any discrepancies and adjust as required.

**PROFILES FOR SETTING OUT LINES**

Profiles can be used to control much more than level, standard ‘T’ profiles if positioned correctly can be used to form simple lines using them as offset points or alternatively for more precise positioning ‘H’ profiles can use used to denote both line and level. Figure 11 shows the typical sizing of ‘H’ profiles.

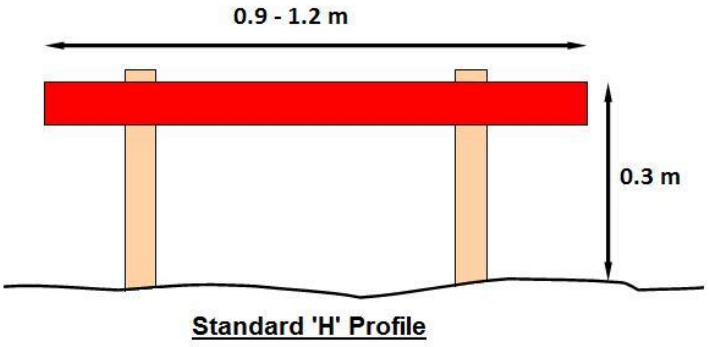



Figure 11

Used for setting out structures and footings, with the top of the bar set at a significant level such as finished floor level (FFL) or other determined on site. Lines can be drawn between profiles and the positioning of brick and block work below ground ‘plumbed’ as can be seen in figure 12.

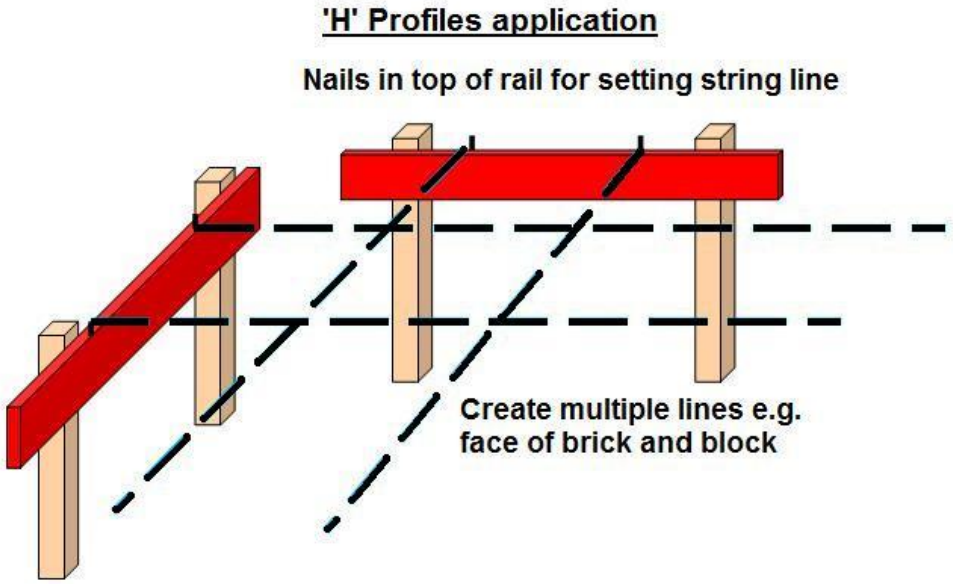



Figure: 12

**THE CROSS BONE SOLUTION**

The process of constructing profiles using timber has been updated and revised with the advent of the cross bone profiling product. Cross bone is an entirely reusable system made entirely of plastic components, available as part of a package or individually. The

manufacturer of the cross bone suggest that using their system, will take half the time to construct timber profiles, the system is applicable to both standard profiles and batter rails.

All this in a package that is easily transferable between projects therefore saving on wastage of timber and through the use of the special ground spike if the site suffers from vandalism the profiles can be removed at the end of a shift and then set back out the following day without any loss of accuracy.


For more details about the cross bone package please refer to www.cross-bone.co.uk for more details and suppliers.