Why roof slopes of 1.0º should generally not be specified

Architectural drawings often specify a roof slope of 1º. Unfortunately, this can be problematic for the following reasons (and can sometimes result in slopes as low as 0º):

(a) Where the roof is supported on the timber rafters which are parallel to the roof sheeting (i.e. there are timber roof battens perpendicular to the roof sheeting), deflections of the rafter will increase the roof slope at the high end and decrease the roof slope at the low end. This is indicated in the Figure 1 below, where it can be seen that, for a symmetrical loading (eg a uniformly distributed load), then

- The slope in the centre will be the slope of the rafter with no deflection

- The slope at the high end will increase by the rotation at the high end

- The slope at the low end will <u>decrease</u> by the rotation at the low end

Note that it can be readily shown that if the rafter has a long-term deflection of Span / 300, the rotation at the low end will decrease from 1.0 degrees to 0.4 degrees approx. Refer to page 2 for details.

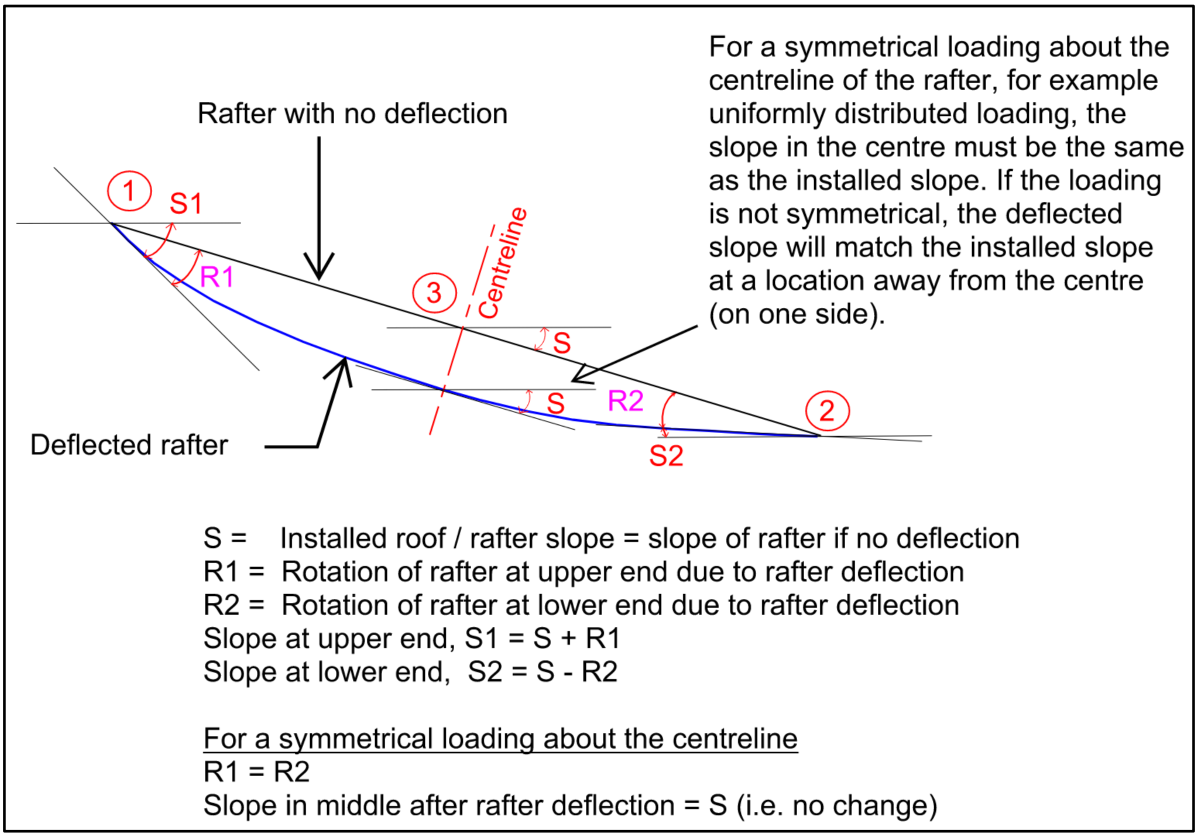

Figure 1 – Analysis of roof slopes due to rafter rotations

(b) Even if adjustments are made to the battens during construction to compensate for the rafter rotations (i.e. deeper battens were used towards the centre of the rafters), long term creep deflection of the timber rafters would still occur. For seasoned timber (which is typically used) the short term (elastic) deflections due to dead loads approximaltey double in the long term.

(c) The problem is compounded if additional dead loads are added to the roof (such as due to solar panels or solar hot water services) after the roof sheeting has been installed

(d) At slopes as low as 1 degree, the installed slope is more susceptible to being incorrectly installed due to construction tolerances

(e) On reactive clay sites, differential foundation movements could potential affect very low roof slopes.

Why roof slopes of 1.0º should generally not be specified (cont.)

Example of a roof rafter supporting a UDL (Uniformly Distributed Load)

AS/NZS 1170.0:2002 *Structural design actions Part 0: General principles* provides guidance on serviceablity limits for structural members. Appendix C *Guidelines for Serviceabilty Limit States (Informative)*, Table C1, suggests that the mid-span deflection of Roof members (trusses, rafters etc) should not exceed Span / 300 (also referred to as 'L/300', where L= Span).

For a roof rafter supporting a Uniformly Distributed Load, the rotation at the ends for a deflection of L/300, is determined as below:

Beam with UDL

Deflection at mid-span = $\frac{5 w L^4}{384 EI}$

Rotation at supports = $\frac{w L^3}{24EI}$

If Deflection = L/300

Then $wL^3 = \frac{384 EI}{5 \times 300}$

⇨ Rot = $\frac{384}{24 \times 5 \times 300}$ = 0.0107 radians x (180/π) = **0.61º**

If you start with a 1.5º roof slope, the slope at the lower end would then be 0.9º approx. However, it is unlikely that the rafter deflection has been designed right on the limit, and hence the roof sheeting slope at the lower end is not likely to be less than 1.0º. For these reasons, 1.5º appears to be a reasonable minimum roof slope to specify. However, it is the responsibility of the building designers to select the appropriate roof slope.

Hopefully this article provides designers with an awareness of the considerations regarding specifying very low roof slopes.