SITE PRACTICE

In this section each site operation is considered and recommendations given to ensure that trussed rafters are handled, erected and fixed correctly. The causes and remedies of some common misalignments are discussed, and accepted tolerances are given.

Delivery

Delivery is made to site on suitable transport provided by the Gang-Nail truss fabricator. The truss fabricator will normally bear responsibility for the trussed rafters up to the point where they are off-loaded onto site: thereupon they become the responsibility of the contractor.

The delivery should be checked to ensure that it complies with the specification and that the quantities and dimensions are correct. Any discrepancies must immediately be brought to the attention of the supplier.

Site Storage

Site storage is intended to be temporary prior to erection. The fabrication and delivery of trussed rafters should, therefore, be organised to minimise the storage time both at the manufacturer's premises and on site. Where storage on site is likely to exceed two weeks, or during bad weather, trussed rafters should be protected by a waterproof cover which is arranged so as to allow free access of air for ventilation.

Trussed rafters should at all times be stored to avoid contact with the ground and vegetation and should be so supported as to prevent any distortion. Preferably, they should be stored vertically, on bearers located at the points of support assumed in the design, and with suitable props to maintain them in the vertical position.

Some manufacturers and builders prefer however to invert the trussed rafters and support them in special frameworks clear of the ground. When trussed rafters are stored horizontally they should be supported on bearers located at every joint, with additional intermediate supports for long spans.

Ensure by careful planning that trusses are stacked in the order they will be required. Damage caused by rough handling often results where this is not done, as the next truss required is located in the middle of the group.

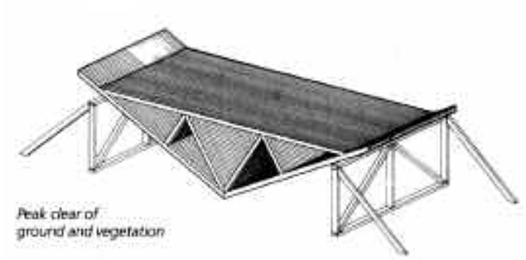
Vertical Storage

Where trusses are stored in the upright position, stacking should be carried out against a firm and safe support. They should be supported at the positions where the wall plate would normally occur and at such a height as to ensure that any rafter overhang clears the ground (Figure 9.01).

FIGURE 9.01 *VERTICAL STORAGE*

Care is required when removing the props or releasing the banding, since there may be a tendency for the trusses to spring forward and consequently topple over. Where the trussed rafters are stored inverted, support must generally be provided near to the rafter node points (Figure 9.02). If approved in writing by the Trussed Rafter Designer, they may also be supported at the ceiling tie node points.

FIGURE 9.02 *INVERTED STORAGE*



Horizontal Storage

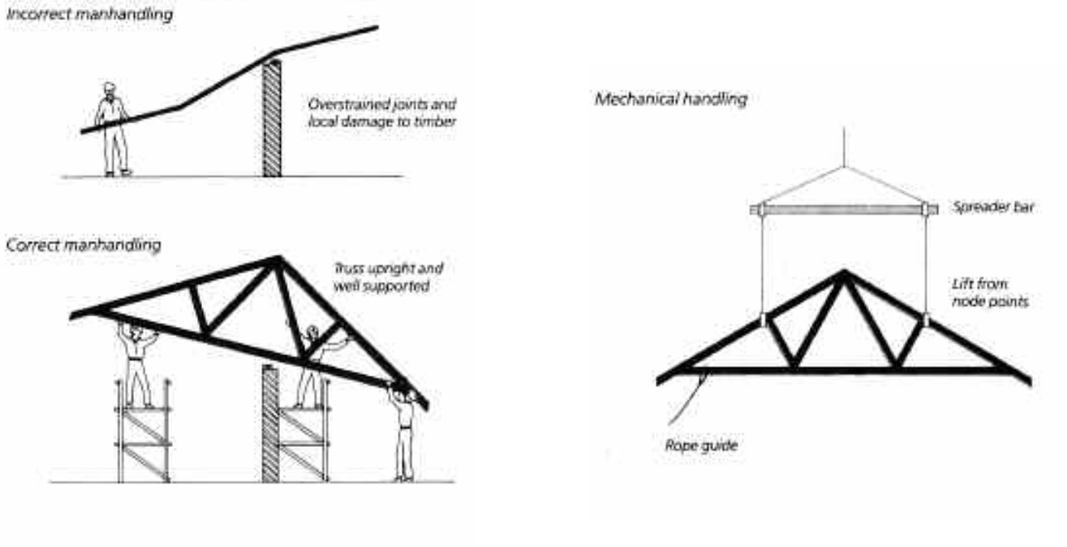
Where trusses are laid flat, bearers should be placed to give level support at close centres, sufficient to prevent long-term deformation of all truss members. If subsequently bearers are placed at different heights, they should be vertically in line with those underneath.

Handling

Normally the greatest stress which truss joints will undergo is that caused by handling. It is important, therefore, to carefully plan the handling of trusses, taking into account weight, size, access, lift height and whether manual or mechanical handling is required (Figure 9.04).

Wherever possible the points for lifting should be at the eaves joints, with the truss in the vertical plane - apex uppermost. Handling should always be carried out with the utmost care to avoid possible damage to both timber and connector plates. Gang-Nail fabricators are able to provide unit weights and advice on any special precautions for handling trussed rafters.

FIGURE 9.04 *MECHANICAL HANDLING AND MANHANDLING TRUSSED RAFTERS*



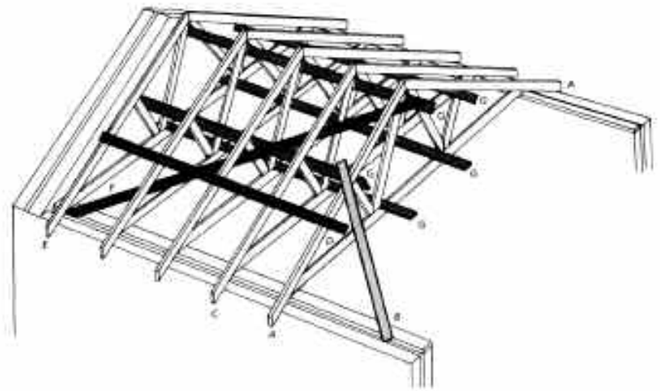
Erection Procedure

The Builder should consider, in conjunction with the Building Designer, the erection procedures to be used and the provision of temporary bracing, rigging and any other specialised equipment required to enable the trussed rafters to be erected safely, without damage, in accordance with design requirements and having due regard to possible windy conditions.

Supports should be prepared as indicated in Section 5 to the correct level and position. Guidance on trussed rafter bracing is given in Section 7, but the contractor must refer to the specific details issued by the Building Designer.

The following procedure illustrated in Figure 9.05 is suggested for most domestic size roofs. It is assumed that the wall plates have been checked and are level and that the correct holding-down fixings have been made by the builder. The erection team must also have studied and fully understood all relevant drawings and details before work commences.

FIGURE 9.05 *ERECTION METHOD FOR DOMESTIC ROOFS*



(a) Mark the position of each trussed rafter along both wall plates.

(b) Erect the first trussed rafter, designated A, at the position which will coincide with the uppermost point of the diagonal brace (F) when it is installed later. Use the temporary raking braces (B) fixed to the rafter members and the wall plates to hold this trussed rafter in the correct position, straight and vertical. For clarity, only one raking brace is shown in Figure 9.05, but these should be fixed to both rafter members and be of sufficient length to maintain the trussed rafter in position during the erection of the remaining trussed rafters.

(c) Erect trussed rafter (C) and brace back to (A) with temporary battens (D) at suitable intervals along the rafter and ceiling tie members. Repeat this procedure until the last trussed rafter (E) is erected, checking by eye to ensure an acceptable ceiling and rafter plane is achieved.

(d) Fix the permanent diagonal braces (F) ensuring that each top end is as high up the last trussed rafter (A) as is possible and that each bottom end extends over the wall plate to which it should be nailed. For clarity, only one permanent brace is shown in Figure 9.05, but these should be installed on both sides of the roof.

(e) Fix the longitudinal members (G) making sure that the ceiling ties are accurately spaced at the correct centres.

(f) Fix all remaining longitudinal, diagonal and chevron bracing required on the internal members of the trussed rafters, as specified.

(g) Additional trusses may be erected by temporarily bracing off the completed end.

Erection Tolerance

Immediately prior to fixing the permanent bracing and tiling battens or sarking, all trussed rafters should be checked for straightness and vertical alignment. Whilst every effort should be taken to erect trussed rafters as near vertical as possible, the maximum permitted deviations from the vertical given in BS5268:Part 3 are shown in Table 9.01.

TABLE 9.01 *MAXIMUM PERMISSIBLE DEVIATIONS FROM VERTICAL*

Rise of trussed rafter (m)	1	2	3	4 or more
Deviation from vertical (mm)	10	15	20	25

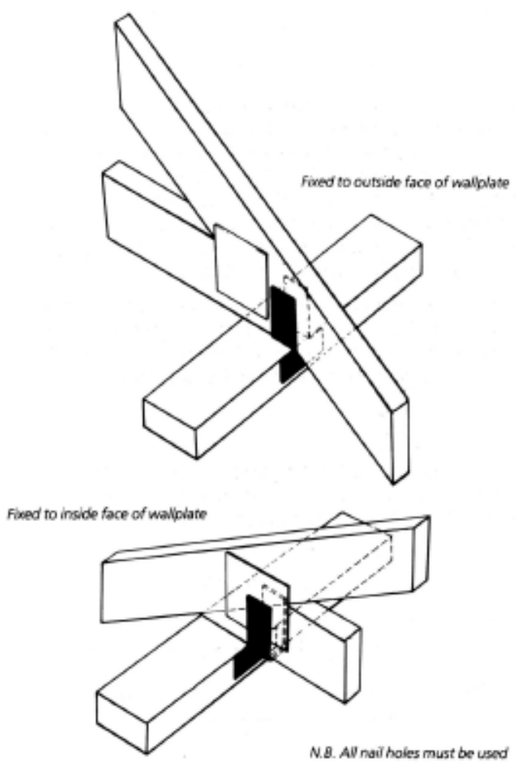
After erection, a maximum bow of 10mm may be permitted in any trussed rafter member, provided it is adequately secured in the complete roof to prevent the bow from increasing. For rafter members, this maximum bow is measured from a line between the apex and eaves joint.

Fixing

Gang-Nail trussed rafters are computer designed components, manufactured under quality controlled factory conditions. The same care should be applied when fixing the trusses and it is strongly recommended that truss clips are used to secure the trussed rafter to the wall plates or bearing points (Figure 9.06).

Skew nailing should only be considered where the workmanship on site is of a sufficiently high standard to ensure that the fasteners, joints, timber members and bearings will not be damaged by careless positioning or overdriving of the nails. The minimum fixing at each bearing position should consist of two 4.5mm x 100mm long galvanised round wire nails, which are skew nailed from each side of the trussed rafter into the wall plate or bearing. Where nailing through the punched metal plate cannot be avoided, the nails should be driven through the holes in the fasteners.

FIGURE 9.06 *TRUSS CLIP FIXING*

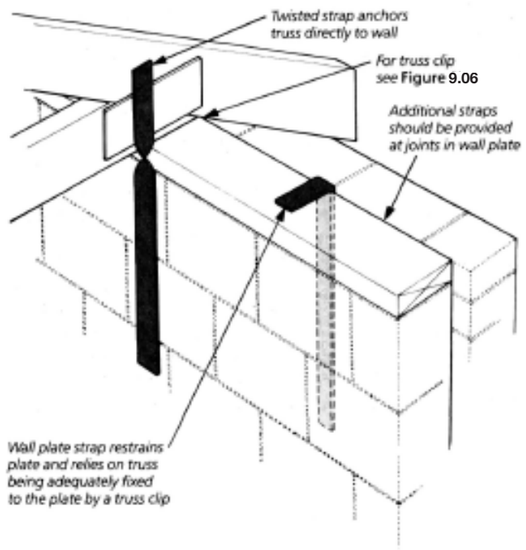


Under conditions where wind uplift forces are greater than the dead load , the truss clip and anchorage strap should be used (Figure 9.07).

SECTION 9

SITE PRACTICE

FIGURE 9.07 *RESTRAINT AGAINST UPLIFT*



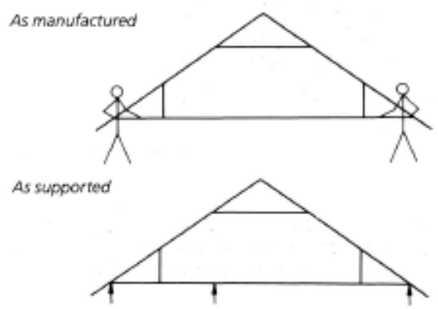
Trussed rafters should be supported only at the designed bearing points. It is advisable, therefore, to erect internal non-loadbearing walls after the roof tiling has been completed. This allows deflection to take place under dead load and reduces the risk of cracks appearing in ceiling finishes. Alternatively, if partitions are of brick or block, the final course can be omitted until the tiling has been completed.

Where non-loadbearing partitions are pre-made or site constructed using timber studding, they should be an easy fit and must not be forced against the underside of the trussed rafter. (See also Section 5 'Support Conditions').

Symmetry

In some instances, trussed rafters may appear to be symmetrical when being handled, but are not supported symmetrically (Figure 9.08).

FIGURE 9.08 *SYMMETRY IN TRUSSES*



The manufacturer will attempt to locate the splice joints in the chord members symmetrically about the centreline. In the example shown in Figure 9.08, this is often not possible and erection instructions will be issued stating clearly where the splice joints are to be located in the final structure.

Erection of Hip Ends

Section 4 describes in detail the general arrangement of a number of hip ends and hip corners. The procedure outlined here is for the erection of a standard centres hip end, but the principles can be applied to other hip layouts.

The hip girder is a primary structural member made up of two or three hip trusses nailed together. It is strongly recommended that the girder is nailed together by the supplier to ensure it performs correctly. Where the units are supplied loose for nailing together on site, the correct number of plies and the nailing pattern stipulated by the supplier must be followed.

The erection sequence (Figure 9.09) is then as follows:

(1) Fix the first standard truss a distance of half its span along the wall plate measured to the face of the truss. (Figure 9.09a).

(2) Complete the erection of the standard trusses and brace them.

(3) Fix the ledger rail to the first standard truss at a height to suit the hip board.

(4) Measure the span of the monopitch truss and transpose this dimension onto the wall plate. A simple check is to measure from this mark to the face of the truss A. It should be equal to (Number of Intermediates + 1) x truss spacing
Thus, for 2 intermediates, and truss centres of 600:
(2 + 1)x 600= 1800
Mark the position of the intermediate truss(es) on the wall plates. (Figure 9.09b).

(5) Erect the girder and intermediate trusses using temporary bracing. (Figure 9.09c).

(6) Using a string line from the corner to the apex of the standard truss, cut back the flying rafters allowing for the width of the hip board. Note: Only the flying rafter can be cut, on no account must plates be interfered with or the main body of the truss cut or notched.

(7) Nail a truss shoe to the bottom chord of the girder and fix the central monopitch truss. (Figure 9.09d).

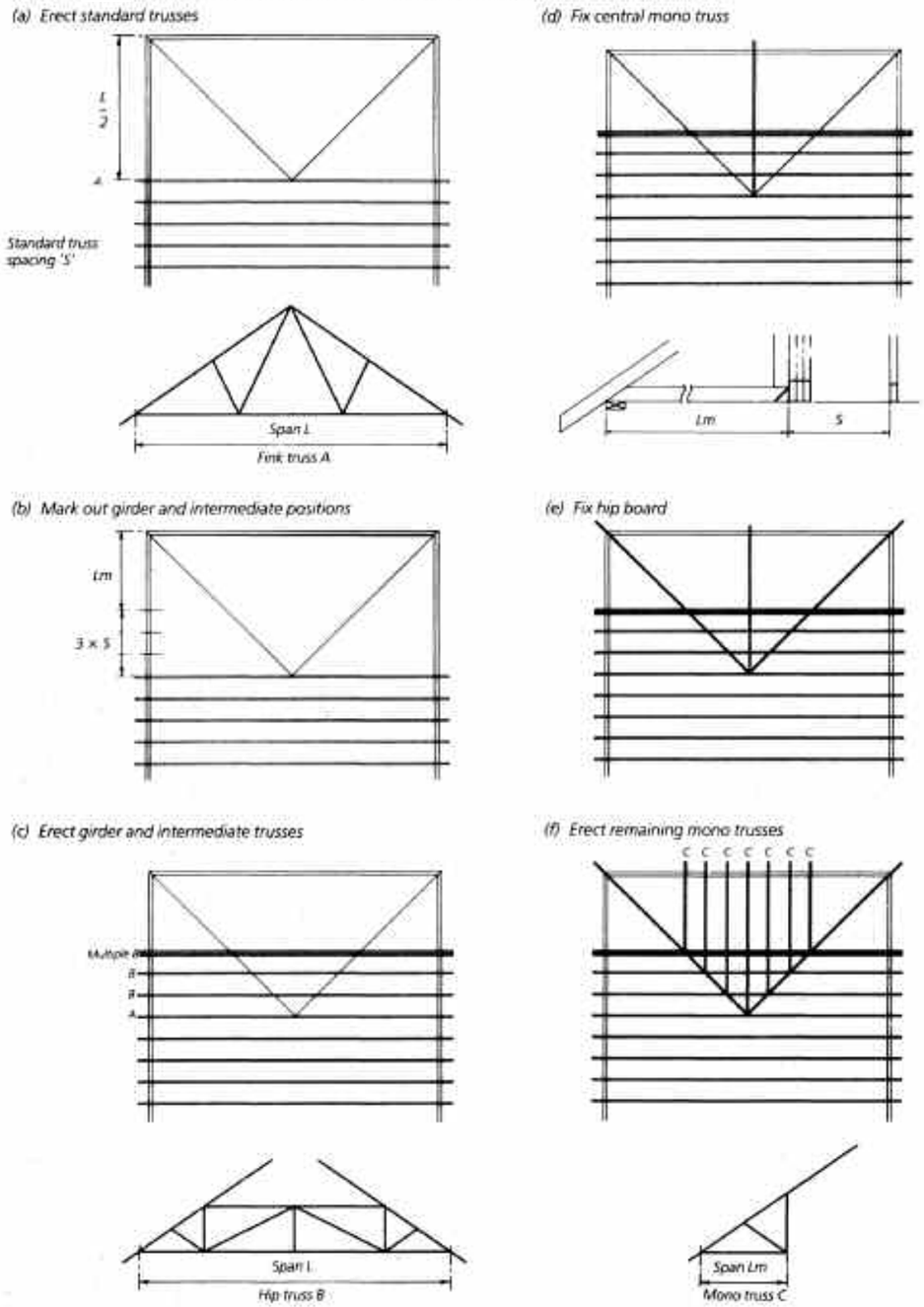
(8) Erect the hip boards, carefully cutting the birdsmouth support at the wall plate, girder and ledger. (Figure 9.09e).

(9) Complete the erection of the monopitch trusses, trimming the flying rafters as necessary and nailing all flying rafters to the hip board. (Figure 9.09f).

(10) Fix in place the loose ceiling joists using mini hangers.

(11) Cut and fix the loose rafters.

FIGURE 9.09 *ERECTION OF STANDARD CENTRES HIP SYSTEM*



Erection of Two-Part Trusses

Section 4 describes the various types of two-part trusses that can occur. For erection purposes, these can be divided into those that are structurally connected and those which are independent.

Structurally Connected

The structural connection can be horizontal or vertical, although the latter seldom occurs. The units can be joined together prior to erection or erected using temporary supports and then connected together. The choice of method is influenced by a number of factors, including design, access, building height and lifting capacity. The chosen method should therefore be agreed between the Trussed Rafter Designer, Building Designer and Contractor following the principles outlined earlier.

Structurally Independent

An important point to note, and one that should be strictly adhered to, is that the erection and bracing of the lower section should be completed before commencing erection of the upper section. For both sections, the erection principles described earlier should be applied, and the bracing should be in accordance with Section 7.

Tolerances

The objective of each stage in the construction cycle is to produce a functional building that is pleasing to the eye. To achieve this, it is necessary to understand the tolerances that can occur at each stage and how they relate to one another.

Trussed Rafters

BS5268:Part 3 requires that within each specified design, the overall horizontal and vertical dimensions of a trussed rafter (Figure 9.10) should not deviate from the specified dimensions by more than the following:

For spans not greater than 7.50m: ±6mm

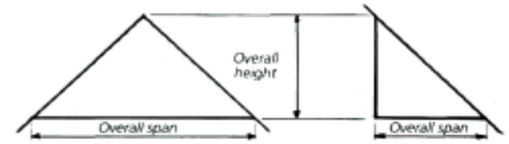
For spans greater than 7.50m but

not greater than 12.0m: ±9mm

For spans greater than 12.0m: ±12mm

In addition, within any continuous roof the differences between the overall horizontal and vertical dimensions of similar trussed rafters should not exceed 10mm. For these purposes a continuous roof is defined as any unbroken length of roof over a building, as distinct from the roof areas over separate dwellings. Although not specifically referred to by BS5268: Part 3, it is reasonable also to expect all other node points not to vary by more than 10mm from one another in any one continuous roof.

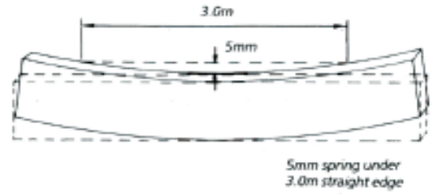
FIGURE 9.10 *OVERALL DIMENSIONS*



For the purposes of this figure only the overall span is shown irrespective of support positions

The timber must also satisfy the deviation allowance of BS5268: Part 3, which permits the maximum spring to be 5mm per 3m length (Figure 9.11). The jig will largely remove any spring at the node points and it is therefore only realised at mid-bay. Rarely is an accumulation of nodal deviation and spring a problem to the alignment of finishes.

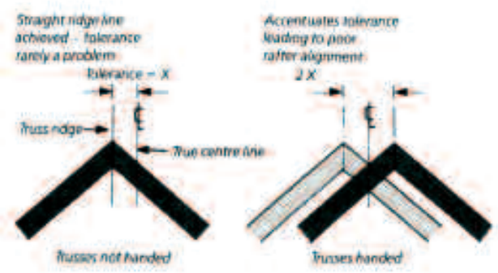
FIGURE 9.11 *SPRING IN TIMBER*



The effect of manufacturing tolerances can be doubled by 'handing' trusses (Figure 9.12). This is sometimes done by accident during erection, or by instruction from misguided supervisory staff who believe the handing of chord splices produces a stronger roof. The design of a splice joint takes account of all stress criteria and trusses should never be handed but erected relative to their neighbour as they were in the jig.

Some manufacturers mark one rafter so it is easy on site to see if trusses have been handed. Another convenient check is to compare the bottom chord splices. Since the trusses will have been manufactured with common splice positions, they can often be used to indicate where handing has occurred.

FIGURE 9.12 *HANDING OF TRUSSED RAFTERS*



Support Structure

Unless some form of factory manufactured frame is used, building dimensions will often be found to vary by ±25mm in plan dimension and ±25mm in level. In a large number of cases these tolerances are taken up during roof construction without detriment to the finishes or structure, for example Figure 9.13.

In some instances, or with some building shapes, these tolerances do cause poor alignment and remedial action will be required (Figure 9.14).

FIGURE 9.13 *SITE TOLERANCES – WALL PLATE LEVELS*

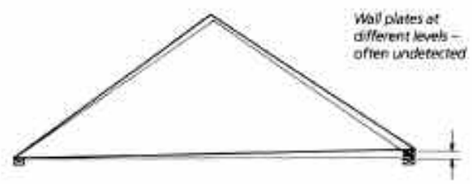
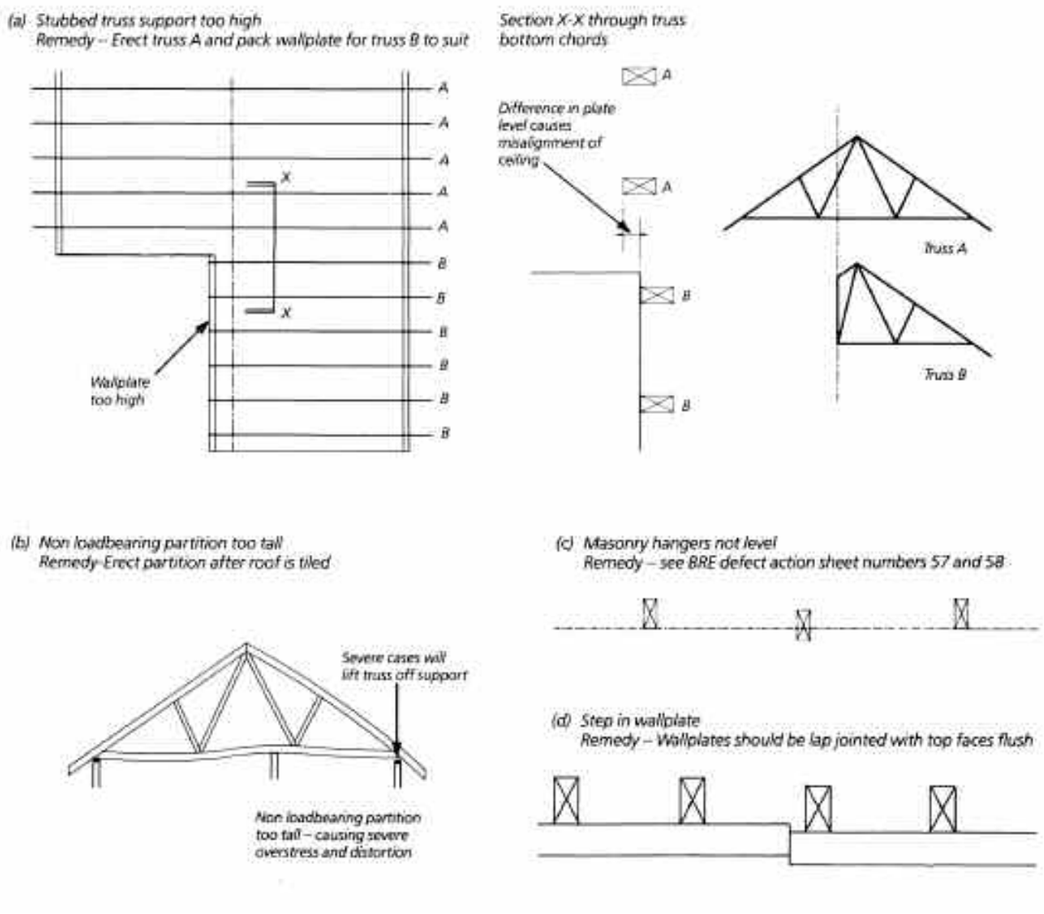


FIGURE 9.14 *MISALIGNMENT RESULTING FROM LEVEL OF SUPPORTS*



Erection

This can be divided into setting out measurements and the actual erection. Dealing with the setting out aspect first, it must be appreciated that since the trussed rafters are factory made, they must be located in the correct position or they may not fit the roof geometry.

Obviously the problem does not exist for a straight run of trusses but will be noticeable for hip ends and other roof shapes where the trusses are not all parallel. The hipped roof in Figure 9.15 shows clearly the result of poor positioning of the apex truss. To prevent this problem the Building Designer should produce a layout plan, providing clear setting out information which must be adhered to on site.

FIGURE 9.15 *APEX TRUSS MISPOSITIONED*

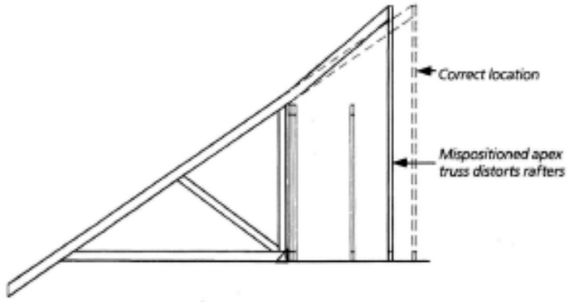
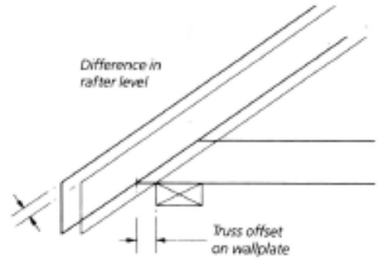


Figure 9.16 shows how the erection of the truss onto the wall plate can affect the rafter alignment. This is more acute for steeper pitches but is rarely a problem by itself.

FIGURE 9.16 *TRUSS MISPOSITIONED ON WALLPLATE*



Although the individual tolerances have, for simplicity, been treated in isolation, it is their interaction that influences the ceiling or rafter alignment. It has not been possible to obtain authoritative tolerances for plasterboard and tiles, but experience suggests that differences in level between adjacent members at 600mm spacing of 10mm are rarely a problem as isolated cases. Where problems are highlighted, building tolerances and erection are usually the major contributory factors and, with reasonable care, it should be possible to largely eradicate these. Site staff are encouraged to check all possible tolerances before rejecting the trusses, as rarely are the trusses the main cause of any misalignment.

Remedial Work

Even experienced members of the project team frequently underestimate the strength of trussed rafters and in particular Gang-Nail connector plates. Given in Figure 9.17 is a joint using small Gang-Nail connectors and a joint of equivalent strength using nailed plywood gussets. This clearly demonstrates the strength of the Gang-Nail connector plates and why it is important to refer any truss damage to the supplier, to enable a properly engineered repair solution to be designed.

In no circumstances should a trussed rafter be cut or otherwise modified or repaired except in accordance with precise written or drawn instructions issued and approved by the Trussed Rafter Designer.

FIGURE 9.17 *JOINTS OF EQUIVALENT STRENGTH*