AODRO Newsletter

VOL. 11 NO. 1 MARCH 1993

Rebuilding following TC VAL continues in Western Samoa. Here a school soon to be rebuilt by Rotary F.A.I.M. Australia's volunteer teams. (Photo: Lionel Pavey)

REPRESENTING the Australian community **SERVING** the victims of disaster

CONTRIBUTING to skilled and coordinated international disaster response

HOUSING AND CYCLONES: reducing vulnerability of Samoan *fales*

Mr Barry Blake, BE, MEngSc, FIE Aust.,
Executive Director, AODRO

Transcript of talk prepared for an NGO Workshop in Western Samoa (September 1992).

INTRODUCTION

The Samoan *fale* is a traditional design of house that is well suited to the climate and culture of Samoa. Its use of local materials and its open design make it both inexpensive and comfortable. The three basic elements of a *fale* are (i) its roof (traditionally made of thatch but nowadays being replaced by corrugated iron); (ii) timber posts around the perimeter of the house to support the roof; and (iii) floors that are covered with fine coral, other pebbly material or, nowadays, cement mortar. There are no walls as such but matting shutters can be rolled down at night or when it is raining.

Until recent times, Samoa has not experienced regular cyclones, and so cyclone resistance has not been a significant factor in the minds of traditional builders. Nevertheless, the traditional *fale*, properly built, has significant capacity to withstand strong wind. Over recent times, as Western technology has encroached upon traditional building practices, some inappropriate materials and construction methods have rendered many *fales* very vulnerable to damage or complete destruction in strong wind.

While a *fale* cannot be expected to provide protection to its occupants during a tropical cyclone, it can be expected to remain largely intact under the buffeting of cyclonic storms. This is provided that it has been properly maintained and its timber is not rotting.

The following is a description of some points that need to be considered when choosing a site for a house and some suggestions about how to construct a strong *fale* to minimise the risk of it collapsing in any of the typical failure modes.

SITING

(a) Avoid exposed coastal locations

Coastlines, particularly those facing the approaching cyclone, are very vulnerable to wind and storm surge. *Fales* built on a beach front can be flooded by storm surge and destroyed by breaking waves. Even those well behind the beach area run a risk of being inundated by the uprush of storm surge and battered by strong winds sweeping in from the sea.

(b) Avoid hill tops

Hill tops are particularly exposed to strong winds and offer no protection to a house.

(c) Avoid steep-sided valleys

Steep-sided valleys that are open-ended can act like wind tunnels which channel the wind and increase its velocity. Building in such valleys increases the risk from wind damage. If these valleys open onto the sea, they may be subject also to flooding from uprushing storm surge.

(d) Avoid low river terraces

Cyclonic rains will drain into available creeks and rivers, causing them to swell and flood adjacent banks and low terraces. One should not build close to creeks and rivers if it is wished to avoid the prospect of having one's house destroyed by flood.

***Fale Tele* with typical Samoan design roof made from thatch**

(e) Seek sheltered location

Seek locations that are naturally sheltered from offshore winds by hills and vegetation. Trees and other tall vegetation will act as a break to strong winds. Houses should be at a distance from the windbreak of at least the height of the tallest windbreak tree.

WIND-RESISTANT CONSTRUCTION

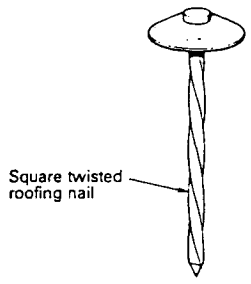
(a) To prevent wind lifting roof cladding from battens

The remedy is a matter of tying the cladding securely to the battens. In the case of thatch, it is a matter of tying each panel of thatch to each rib that supports it. This is a slow and tedious process but it is worth the effort. Thatch is an excellent material for roofs because it is light and waterproof. It will also allow a certain amount of air to pass through, which helps to reduce pressure differences between the inside and the outside of the house during strong winds. The more leaf one uses by placing the panels closer together, the more overlap there is of the thatch panels and the more watertight the roof becomes.

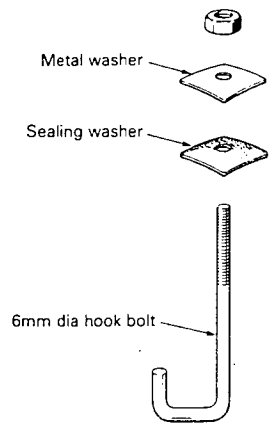
In the case of corrugated iron roofing, experience has shown that simply nailing the sheeting to the roof battens (purlins) is inadequate. Strong winds buffet the sheeting causing it to pull against the nail heads. Nail holes tear and enlarge as the uplift pressure on the sheeting waxes and wanes. Nail heads can break off or might not be large enough to retain the sheeting in place.

The remedy is to use suitable fixings in adequate quantities. Suitable fixings include the following:

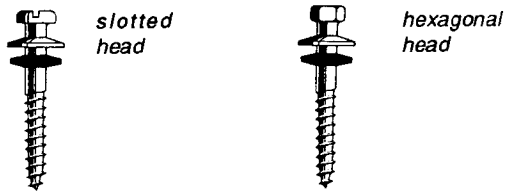
(i) Self-sealing nails, spring head or washered (galvanised)



(ii) Hook bolts and washer (galvanised)



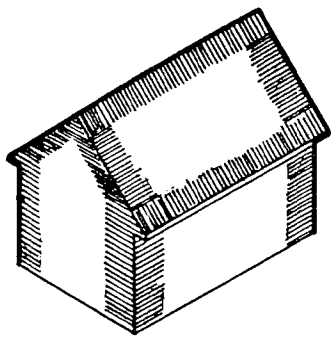
(iii) Cyclone screws with washer



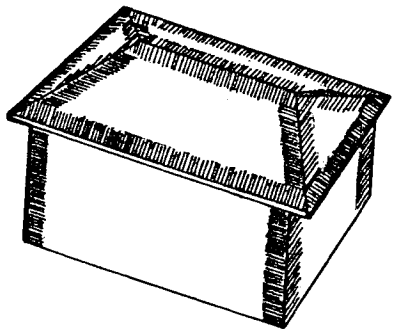
Besides having suitable fixings, it is necessary to have them in the right place and in adequate number. Experience has shown that areas near the edges of roofing surfaces experience the highest local uplift forces and need to be the most securely connected. These critical areas, about 3 ft (900 mm) wide, are illustrated in Figure 1. In these areas, battens (purlins) need to be spaced at 1' - 6" (450mm) intervals and roofing iron needs to be secured along each batten at least every second corrugation. Fixings, of course, should be made through the crests of corrugations to minimise water penetration.

(b) To prevent wind lifting roofing from rafters

Many roofs blow off in cyclones when the cladding material, with battens attached, pulls away from the rafters. The two pronged approach to preventing this is (a) to have double the number of battens (1' - 6" spacing) in the critical edge areas illustrated in Figure 1; and (b) to securely tie every batten to each rafter wherever they cross. Lashing each joint with suitable tie wire or with a flat steel strap are ways of securing these connections (see Figure 2).



(a) Regions of Gable roofed building that experience high local negative pressures



(b) Regions of a hip roofed building that experience high local negative pressures

Figure 1. All the roof areas near to edges such as gables, eaves, ridges and hips, need extra fixing.

A typical modern fale with corrugated iron roof.

(c) To prevent roof blowing apart at ridge

With low pitched roofs particularly, there can be a strong tendency during a cyclone for both sides of the roof to be sucked upwards and outwards so that the roof tears apart along the ridge line. The means of combating this is essentially to tie opposite rafters together. This can be done with timber cleats as illustrated in Figure 3.

(d) To prevent roof lifting off posts

In cyclonic winds it is possible for a whole roof structure to lift off a *fale* like a giant parachute and for it to crash against the nearest coconut trees or another house. Preventing the roof from lifting off in this manner is essentially a matter of tying it down to the wall structure or to the posts that support it. The posts must be strong enough to support the weight of the roof but it is the connections between the rafters and the posts via the top wallplate that are critical to tying the roof down in strong winds. The required connections are of two types:

(i) rafters to the wallplate; and
(ii) the wallplate to the tops of posts.

These connections can be made with either tie wire or galvanised steel strapping as illustrated in Figure 4.

(e) To prevent breakage of rafters or other roof members

Breakage occurs because the rafter or other timber member is not strong enough for the job it is supposed to do. Sometimes the cross section of the piece of timber is too small. In other cases, it might have once been large enough, but over time, through decay or insect attack, it has lost its original strength.

The right size of timber to use for a particular member depends on many factors that require expert assessment. The size of the *fale* and the type of timber being used are just two of these factors. Home building manuals will give good advice on the choice of timber sizes and the spacing of key members such as rafters. Experienced builders and building inspectors are other sources of good advice.

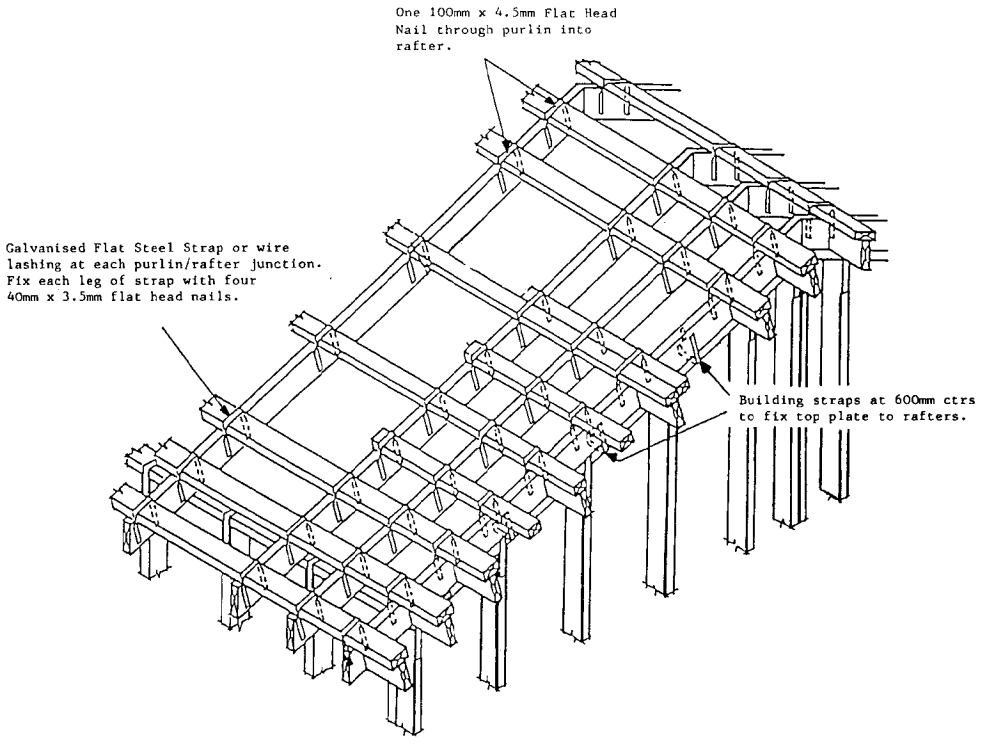


Figure 2. Having more battens (purlins) around roof edges and tying battens to rafters wherever they cross will ensure that the roof will resist being lifted from its rafters

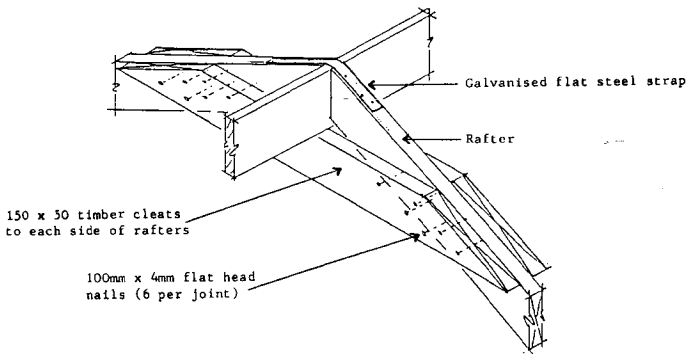


Figure 3. Add cleats to roof structure to tie rafters together as a stable truss

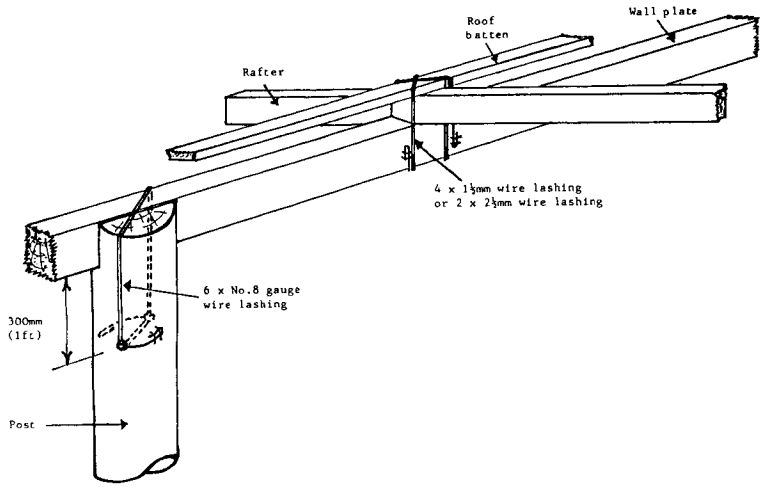
Once a house is built it needs periodic maintenance. Timber that has rotted or been attacked by insects will need to be replaced. Fixings that have broken, rusted or worked loose should also be replaced.

(f) To prevent the wall posts from lifting out of their foundations

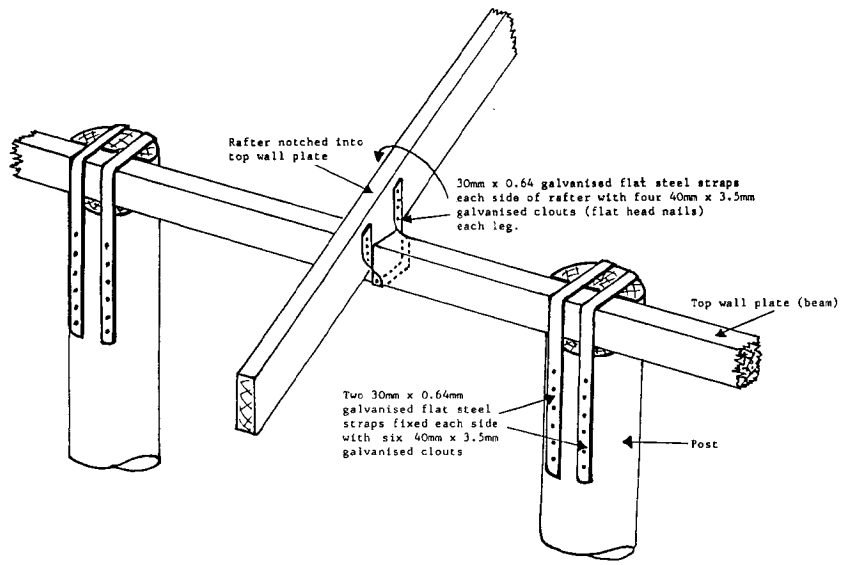
Cyclone winds will tend to pull a *fale* out of the ground. To prevent this occuring the wall posts need to be firmly anchored in their foundations. This can be achieved by such means as fixing a timber key to the bottom of the post as illustrated in Figure 5.

(g) To prevent sideways collapse of *fale*

Preventing sideways failure is a matter of having sufficient shear stiffness across the width of the house. This stiffness is given mainly by the stiffness of the wall posts and by the firmness of their embedment below the floor level. Post ends should be set into holes in firm ground below the mound of broken rock on which the floor is made. Stone should be packed firmly around the posts so that they resist being pushed over sideways. The larger the diameter of the post, the more stable the *fale* is likely to be.



Method 1 - Tie wire connections



Method 2 - Steel straps used to connect rafters to wallplate

Figure 4 . Alternative methods of connecting the roof to the fale wall so as to prevent the roof lifting off during a cyclone.

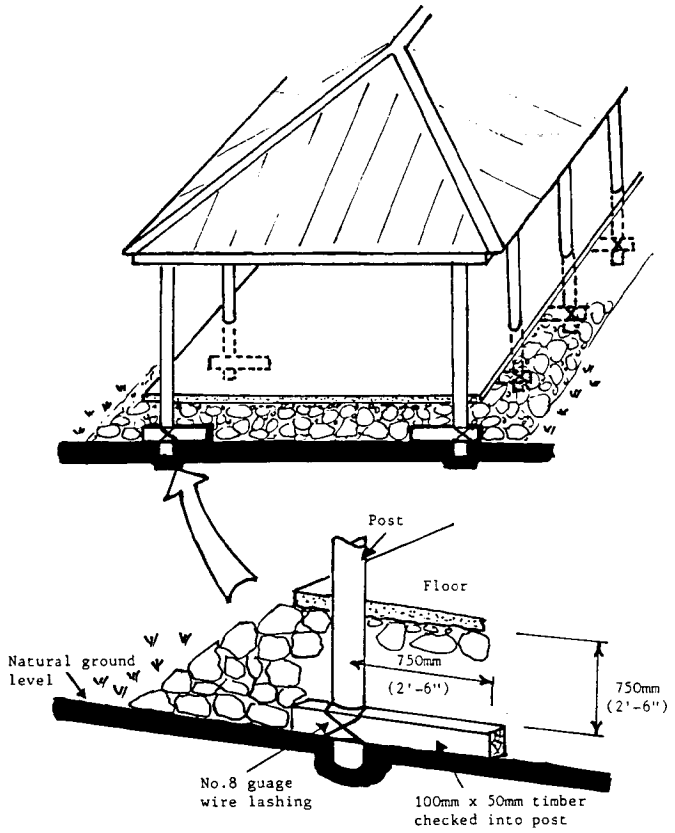


Figure 5. A method of keying timber posts into foundations

SUMMARY

The vulnerability of *fales* to tropical cyclones can be reduced, first by selecting a protected site and then by building the *fale* soundly. Sound construction starts with the selection of sound materials and then requires the services of a builder who understands the way strong winds can destroy a house. The builder must ensure that every component of the structure is fixed securely so that there is a continuous chain of strongly connected building parts from the roof cladding down to where the wall posts are embedded into the ground. Good materials and strong connections are the essential requirements if *fales* are to withstand cyclonic conditions.