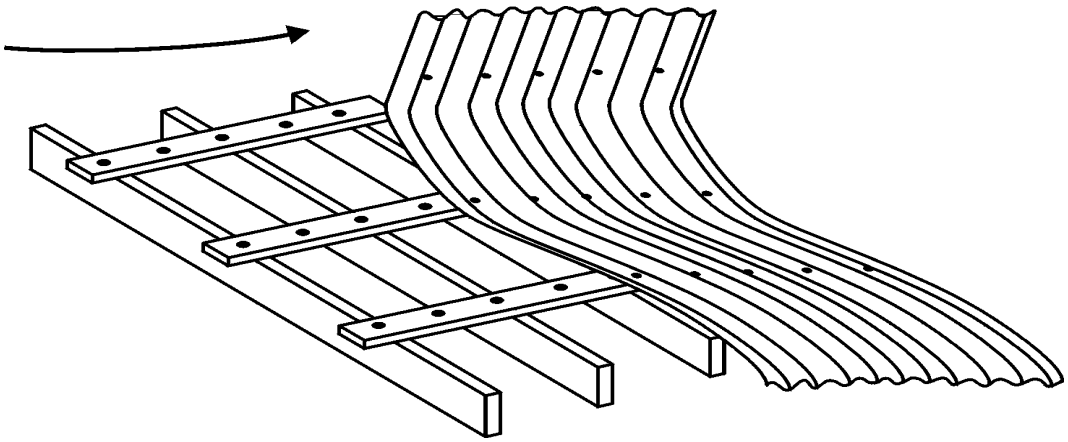
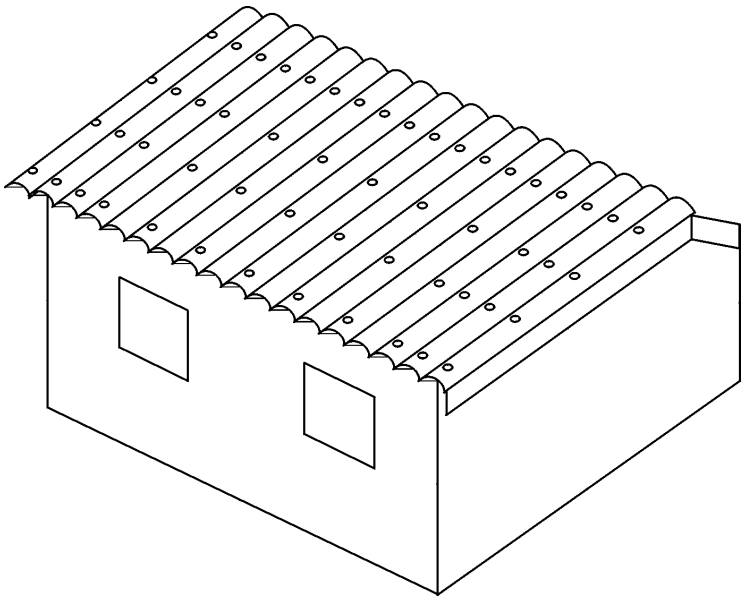


Guide to Safe Building Practices



Guide to Safe Building Practices

This is a guide for tradesmen, builders and contractors to help them build, repair and retrofit buildings and particularly roofs, with the details that will give good resistance to damage from hurricanes and other hazards.

Contents

1 Introduction

Good building work is a compromise between cost, utility and resistance to damage.

Safe building practices are based on experience, ie. what gets damaged during a storm (earthquake, etc). Building codes generally do not specify good practice, but simply a level of resistance to forces to be attained. The shape and design of a building affects the forces imposed upon it, while the materials and strength of the connections determines the resistance to those forces. Good building practice in a country is a combination of shape and design, materials and connections that can resist extreme events in a culturally acceptable way

One must also look at the effects of siting, or the need to move or rebuild the building out of the way if necessary (for flooding, landslide, storm surge)

This guide concentrates on strengthening the parts that suffer damage (on the basis that one “shouldn’t fix what isn’t broken”)

You, the local builders and contractors, know what gets damaged, and the following guide cannot be complete, given the experience gained over the last few years. The list should be added to and adjusted for local details (all islands are different)

“Retrofitting” usually means in this use “going back to strengthen”, but is also now taken to mean to “bring up to a standard”, or to include the maintenance

and replacement that should have been done. This is a “standard” of resistance to, say, hurricanes.

Too often it is not possible, because of technical or financial reasons, to bring a building up to the desired level of strength. A judgement must be made as to what detail or connection poses the highest risk, and an attempt made to address this area (to strengthen the weakest link in the chain). Often, this has to be done using less-than-ideal methods, but, as long as the technical person understands the failure mechanism, experience will provide some options to serve the purpose.

2 What is a hurricane?

Hurricanes are intense storms that affect the tropics, that “rotate” in an anti-clockwise fashion, with the highest winds just outside an “eye”, a relatively still area in the centre of the storm. The whole system may be hundreds of miles across, and moving slowly, may take many hours or days to pass over a particular spot.

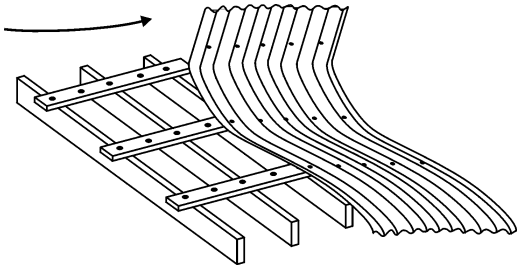
Apart from high winds, which will vary in direction and cause violent shaking of building elements, there are flying objects, falling trees and posts, and often heavy rainfall, which softens the ground.

3 What gets damaged and the reasons

The following are the most common areas of damage from storm winds

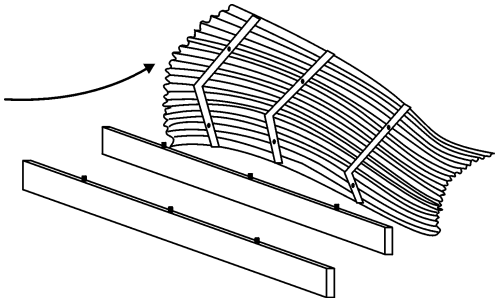
Damage

<u>Sheeting comes off</u>



Poorly fixed, not enough fixings
Sheeting too thin, tears off fixings, or nail heads too small
Overhangs too large
Trees cause damage to roof

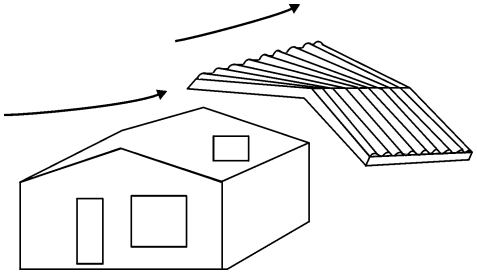
<u>Purlins damaged/come off</u>



Rotten timber from leaks or termites
Too few to carry the load, too wide spacing
Gables exposed, increasing the force

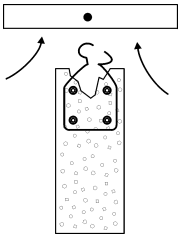
Roof comes off

Rafters not properly held down to wallplates
Wallplates not held down to walls
Too flat pitch giving greater uplift
Verandahs connected to main roof

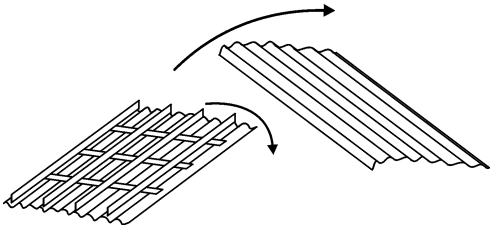


Rafters come out of walls

Links lapped at top

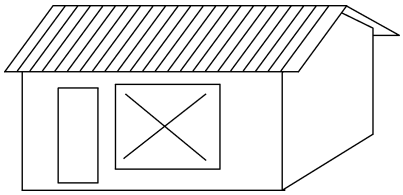


Two sides of roof separate
No ties to hold roof together at ridge



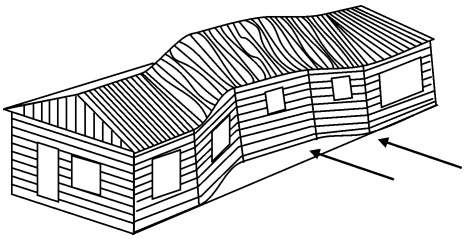
Windows fail

Too large, no protection



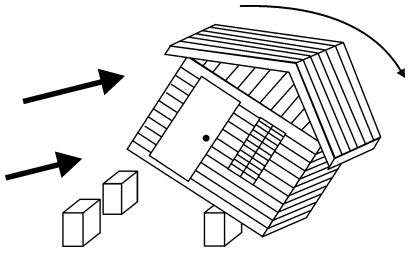
Timber walls blow over

No bracing in straight, long walls
Roof comes off, leaving wall to stand alone



Timber buildings blow off footings

No positive connection to hold down building



4 Repairing roofs

Roofing repairs should start with an assessment of the damage. This needs to both assess the overall situation, such as whether the damage warrants demolition, or whether the roof is still the proper shape. The connections between each element from galvanize sheet to foundation are like the links in a chain, any one of which may fail. The assessment needs to decide down to which connection in the chain the roof should be dismantled in order to start rebuilding. When exposing elements of the roof, it is wise to bring all connections up to standard, as the roof or rafters may not have blown off because the sheeting came off first. If the sheeting is properly fixed, the same rafters may then be the weakest connection and fail next time.

5 Retrofitting roofs

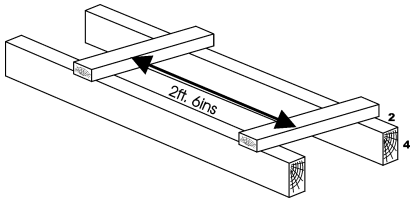
Safer building practices address these areas of damage – strengthening the connections that carry the load from the sheeting (mainly an uplift load) down to the ground. When these standards are applied to an existing roof, it is termed “retrofitting”

These connections are:
1. Galvanized sheeting fixings
2. Purlin/lath fixings
3. Rafter fixings
4. Wall to foundations

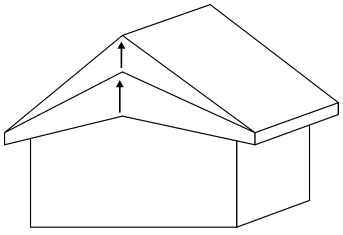
and in addition,
5. Collar ties (rafter to rafter)
6. Window shutters and hinges
7. Bracing timber walls

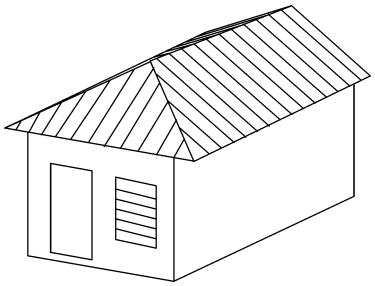
Retrofitting activities include

1. Replacing purlins and adding if necessary to close the spacing

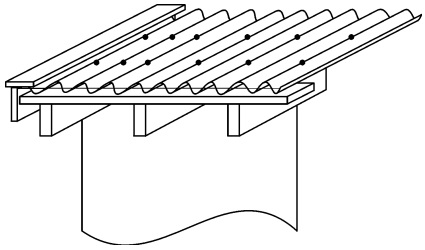


2. Raising roof pitch especially when repairing extensive damage

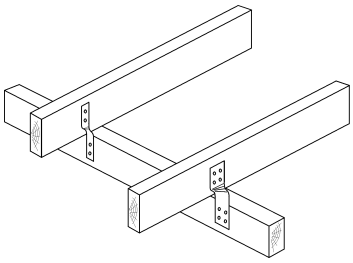




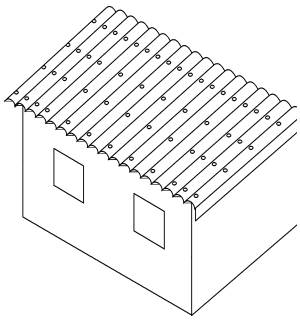
3. Replacing roof with a hip roof if re-roofing



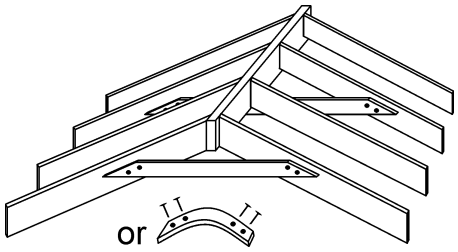
4. Boxing eaves, reducing overhangs,
edge capping especially at gable ends



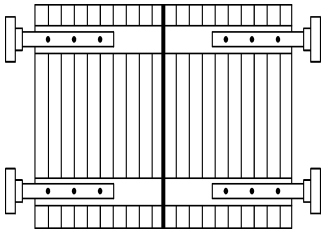
5. Adding hurricane straps/clips



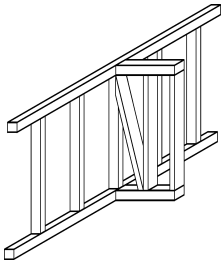
6. Adding sheeting nails or screws



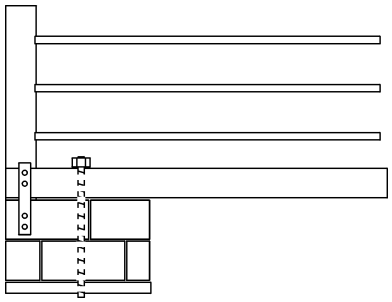
7. Adding collar ties, one every 2 rafters



8. Adding hurricane shutters with strong hinges and fasteners

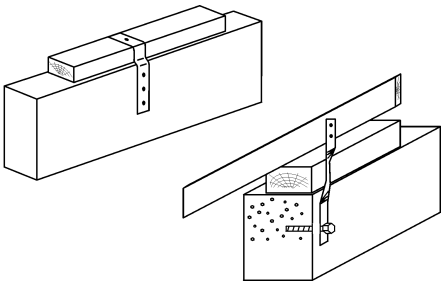


9. Adding bracing to timber walls



10. Strapping to foundations or building masonry footings with bolted connection

11. Strapping wall plates to walls using extra straps



12. Strapping rafters to walls if the wall plate connection is suspect

6 What "standard" should the construction and connections be raised to?

The following are basic, conservative standards designed to produce disaster resistance houses, with a level of "redundancy" to allow for resistance even when some damage has occurred. If a building does not meet the standard, for instance, for overhang, it means that the uplift forces will be greater, and therefore a greater load will be put on the fixings. If there are more fixings, generally the force is less on any single unit, increasing the safety factor.

- Overhangs are less than 18" at eaves and gables unless special provision is made. Preferable overhang 12" (300 mm) or less.
- Roof pitch at least 22 degrees (or 1 in 4), preferably over 30 degrees
- Roof is hip shaped, preferable to gable
- All timber used in roofing will be pressure treated lumber or otherwise treated against termite attack
- Wall plate, minimum 4" x 3" (100x75 mm) to be held down by ½ " (12 mm) bolts spaced at least at 4ft (1200 mm) , preferable 3ft (900 mm), centres or other approved method
- Rafters will be secured by twisted metal hurricane straps or galvanized hurricane clips, one per rafter, or other approved method.
- Rafters will be at maximum spacing 2ft 6inch (750 mm), preferably 2ft. (600 mm)
- Every second pair of rafters will be connected against separation by collar ties or approved straps at the ridge

- Purlins (Laths) will be minimum section 1 x 4 inch (25 x 100 mm) set at maximum spacing 2ft 6inch (750 mm) and secured with two nails at each rafter intersection. Alternately, 2x3 inch (50 x 75 mm) minimum purlins fixed with one screw per rafter may be used.

- Steel based sheeting to be at least 26 gauge thickness (preferably 24 gauge.) Aluminum based sheeting to be at least 22 gauge thickness

- Sheeting is fixed at every corrugation at gables, every second corrugation at eaves and ridge, (preferably every corrugation), and every third in the center of the roof.

- Sheets are fixed with dome headed sheeting nails using timber fillets as spacers, drive screws with washers or with bolts and washers are preferable