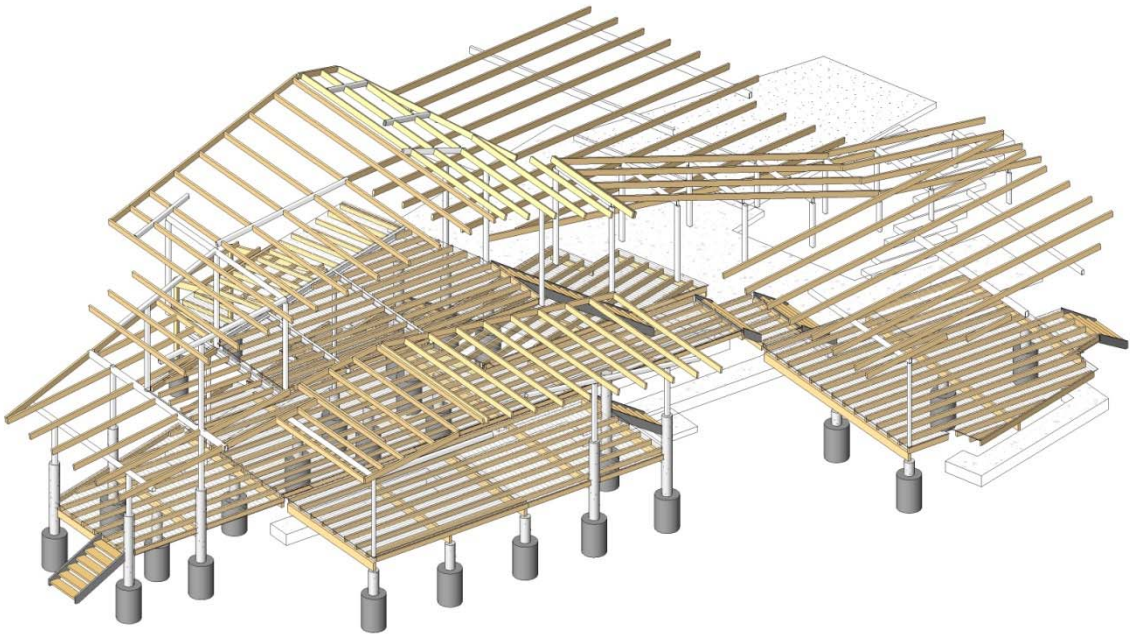
Building Strong and Cool in the Tropics



a free report for tropical residents by

studio mango
tropical architecture and planning

Introduction

Many people's reaction to the threat of a cyclone is that they want to build a concrete bunker to survive. Let's face it, Yasi was scary bearing down on us, and only a fool wouldn't be worried. But let's look at what actually happened where Yasi hit hard around Mission Beach, Cardwell and Tully.

Some concrete buildings crumbled in the onslaught, and many older timber houses also fared badly. However what was surprising to many people is that the vast majority of houses dating from the late eighties and newer sustained only very minor damage.

Why? Because building codes changed dramatically after Cyclone Tracy and have been improving ever since. Expect some minor tightening of the codes following Yasi. While this has meant additional expense, it also means you can feel safe and secure through the worst nature can throw at us.

What's Thermal Mass?

So what's wrong with still wanting a concrete bunker? Well, cyclones are relatively rare. Yes, there's a few every season, but they have to target your piece of coast, and be of sufficient strength to do damage. They last maybe a day. Do you really want to live in bunker the other 364 days of the year?

There's another problem with concrete and masonry homes in the tropics. They can often be lot hotter than a timber or steel house. This is because of a property called 'thermal mass'. Thermal mass is the capacity of a material to store heat. Concrete and brick are heavy materials and they can store heat. Anyone who has lived in a concrete block home with an unshaded wall facing west can attest to this.

If you read up on energy efficient homes from temperate regions, thermal mass is generally considered very important. This is because it can be used to store daytime northern winter sun and re-radiate it at night, or store summer night time 'coolth' and absorb day time heat.

However in the tropics, having an energy efficient home means having a house that mostly relies on cross ventilation through open windows. This means the ambient temperature inside is much the same as the temperature outside. It's the action of air movement across your body that provides a cooling effect.

We also don't have much diurnal temperature change, just a couple of degrees overnight during summer, so concrete doesn't get much cooler overnight than the ambient day time temperature.

If your concrete or masonry walls are un-insulated and unshaded they will work against you, storing up day time heat all day and re-radiating it into your house all night long. Very uncomfortable.

Thermal mass can still work for you in the tropics, but it has to be very well shaded and preferably insulated on the outside, and it won't provide as much storage of 'coolth' that it would in a temperate climate.

If you are using air conditioning, thermal mass can also work against you as it will store the 'coolth' you are pumping into the room, meaning a space cools down slower, and if uninsulated, will eventually radiate out the other side of the masonry wall.

The Timber Alternative

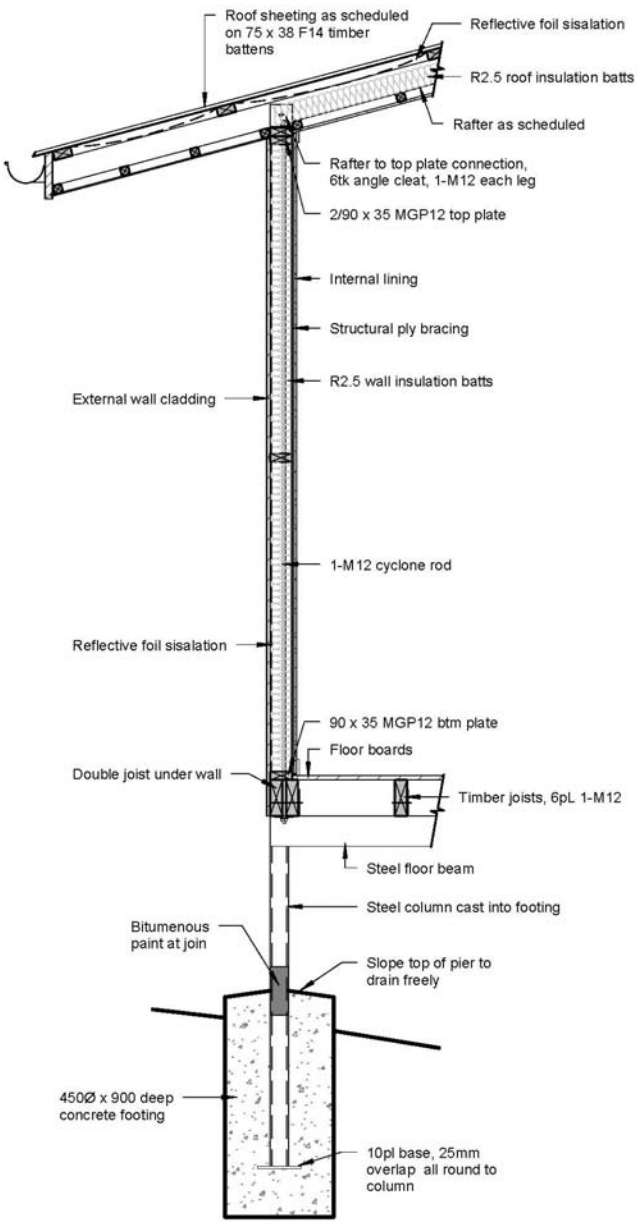
The alternative is to build in timber or steel construction. This is similar to traditional Queenslander construction but these days will be fully insulated, termite proof, and with low maintenance claddings to the outside.

There's a whole variety of cladding options that provide variety and visual interest compared to the usual mono-textured masonry house.

Timber is also a renewable resource and less carbon and energy intensive than concrete.

This type of construction is easier to keep naturally cool in the tropics, and more efficient if you do use air-conditioning. Like Queenslanders these houses are usually up on steel stumps, and can be high or low set.

They suit sloping sites, or the space under can be used for cars and storage. They are more flood proof than slab-on-ground houses. Raised floors also mean you can have a timber floor; softer underfoot than tile and naturally beautiful.



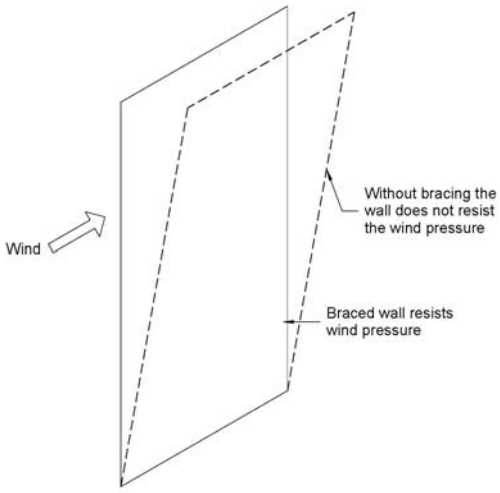
Building Strong

Modern timber and steel houses survived cyclone Yasi with only minor damage. The diagram above shows why.

The roof is screwed down to timber or steel battens. Steel roof sheeting has been thoroughly tested and fixing requirements upgraded since cyclone Larry. Roof battens are screwed to rafters, trusses or purlins and these are bolted to the wall plates or to steel roof beams. The wall is then tied to the floor frame with continuous 12mm steel rods at 1200mm centres. The floor in turn is bolted to a steel sub-frame that is cast into the heavy concrete footings. These provide the mass to hold the building down in a cyclone. Thus there is a strong connection from roof to footings.

Imagine turning your house upside down and shaking it. That's what it has to survive in a cyclone.

That brings us to bracing. Bracing makes the walls stiff so they don't fold under horizontal wind pressures. Plywood is commonly used. On buildings with a lot of windows and not much wall to place bracing, a steel portal frame may be needed. This is similar to an industrial shed frame on a domestic scale. You can also use some masonry for bracing particularly if its internal so its thermal mass is fully shaded.



Windows and doors remain the weak point, whether you are building in timber or masonry. Windows have to be certified for a given wind rating. This depends on your exposure, so if you have an isolated building up on a hill it will need to be a lot stronger than nestled among other houses on the flat.

Impact damage is the hardest element of a cyclone to control. Again a timber house can be a strong as a masonry one in resisting crushing, and a missile such as piece of timber can punch through a masonry wall as well as a timber wall.

Windows are the weak point and you can consider cyclone shutters or plywood panels that can be fixed over openings in storm events. These days most larger windows will have toughened or laminated glass that provides some impact protection.

Some people still choose to have a cyclone shelter which is one room that has extra protection from impact damage.

Staying Cool

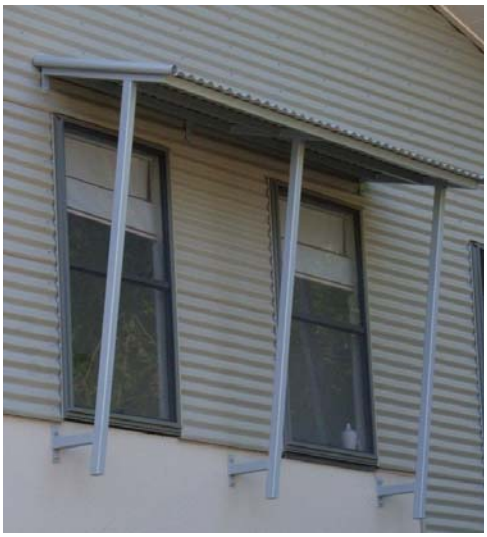
So you've chosen timber or steel framed construction because you're satisfied it's strong and secure and will be cooler than a masonry house. What else can you do to stay cool?

Here's our five key strategies you can use to have a cooler house:

- Shade and sun control
- Cross ventilation
- Insulation
- Thermal chimneys
- Outdoor Living

Shade and sun control

Your roof acts as big hat keeping the sun off your house. You need to try to shade your walls and windows as well. You can do this with big overhangs; 900mm is common. This also gets rain well away from your walls. You can also use awnings, particularly to east and west where sun angles are lower.



Use awnings to shade windows

We recommend steel roofing. Tiles have thermal mass and will continue radiating heat downwards through the night. They are also subject to impact damage in a cyclone. It only takes a couple to break and you will have sodden ceilings.

Keeping the sun out means thinking carefully about window placement and the type of windows. You can use solid aluminium or timber louvres in places to control sun while allowing breezes. There are also a range of solar glasses that allow light with reduced heat gain.

Remember though that you still need good natural light levels. A dark and gloomy wet season house is depressing and breeds mould.

Cross ventilation

You need to keep the breeze flowing and this means cross ventilation or openings on at least 2 sides of a room. Think about the layout of rooms so they can achieve cross ventilation, for example, placing bedrooms on corners. Queenslanders often

had vents over internal doors to help, and you can have internal windows such as timber louvres to maintain privacy.

Also think about where the breeze is coming from. In Far North Queensland the south easterly predominates but we also get some east and north easterlies. So it can make sense to orient your house to the east to maximise breezes. This is quite different from the advice given in temperate climates to orient north.

Aluminium louvres control western sun while allowing ventilation

Orienting you house to the eastern breeze will mean more exposure to sun. If you do this you need to make sure you control hot east and western sun.

Ask your neighbours about local breezes. For example houses near hill slopes can sometimes get a late afternoon breeze flowing down the hill because of air cooling faster at the top of the hill. Local geography can also channel breezes different ways.

Pick windows that can control rain such as louvres, casements and hoppers. Sliding windows are the most affordable but can only open 50% and have poor rain protection so be careful where you use them.

If you need insect screens remember they block around 30% of the breeze, so you may need more openings to compensate.

While there may be times you still want to use air conditioning make sure you have ceiling fans as well. These help during periods of poor breezes and provide 2-3 degrees cooling effect. Using them in conjunction with your air conditioning means you can run your air conditioner at a higher temperature, saving money and avoiding condensation problems. If you run your air conditioning very cold on a humid day it will cause condensation within your walls that can encourage mould, rot and termites.

Insulation

While your big roof will keep direct sun off, heat can be transmitted through into your house. The same applies to walls. Additionally, if you use air conditioning, you need

to keep the cool in and not let it radiate out. Insulation does this and is mandatory under the Building Code.

There are two basic types of insulation: reflective foils and bulk batts. They both have pros and cons. Reflective foils rely on air gaps either side, and this can be difficult to ensure. They can also lose efficiency over time if they get dusty. Batts can get less effective through compaction over time, and if moist from condensation also lose efficiency. Sometimes you can use a combination of methods to get the required rating; for example, a reflective foil over your roof battens and bulk batts in the ceiling space.

If you plan to use air conditioning a lot, consider insulating your floor as well. Or, if there is one room that will be cooled more than the rest of the house, you might insulate these internal walls.

Of course if you have lots of windows, they add up to a great big hole in your insulated envelope. You can get double glazed windows but they are generally not considered cost effective in the tropics. Plus, if you are using your house right they will be open most of the time!

Thermal chimneys

Thermal chimneys are simply about providing places where hot air can naturally rise and vent out of your building. Most people have seen 'whirly birds' on roofs that vent hot air from within a ceiling space, but you should also consider venting living spaces. This can be done in a number of ways.

A raking or cathedral ceiling will allow hot air within a space to rise up and placing windows up high gets it out.

A raking ceiling with high level windows for venting hot air

If you have a flat ceiling consider some high level windows to remove hot air. A flat ceiling with all the windows at a standard 2.1 metres means a layer of hot air builds up under the ceiling. You can also vent hot air through a ceiling and out the roof.

Try to place your high level vents on the opposite side to the breeze (ie. west). This means the rising hot air works in conjunction with prevailing wind pressures to be even more effective.

Outdoor Living

This might seem obvious but you need to plan for an outdoor living space from the beginning to ensure it relates well to the house, particularly the kitchen.

It also needs to get a breeze, although it can borrow one that flows through the house.

Outdoor living as an important part of energy efficient tropical living has now been officially recognised by Queensland building codes.

Outdoor living is part of our tropical lifestyle. This deck has extra awnings to the south to block driving rain.

A house receives an extra star rating for an outdoor living area with an insulated roof and a ceiling fan.

This recognises that outdoor living in the tropics needs a roof to shade and shelter you through sun and downpours. Make sure its big enough to shelter you from driving rain and hot low sun.

If you can afford to make it big enough for both a dining table, and some casual chairs. One of the lovely characters of a timber house is that your outdoor living area will probably be set up off the ground and use decking boards for flooring rather than tiles.

Summary

Modern timber and steel houses are very safe, have been subject to extensive testing and their construction is regulated by rigorous building codes. They can also be a lot cooler than a masonry home. If you do use masonry make sure it is very well shaded and preferably insulated.

Use a big roof and awnings to keep your house shaded, insulate walls and roofs, make sure you have good cross ventilation, get hot air up and out and have a useable and sheltered outdoor living space.

Of course a home is about more than cyclone strength and staying cool, it's about your lifestyle, a place to raise a family, and a place to relax. Make sure your home is the best you can build by getting independent professional advice and custom design for your lifestyle, your site and your style.

About the Author:

James Maude is a registered Architect and a Director of Studio Mango Architects. He has worked in Cairns for 17 years and has extensive experience in tropical design and energy efficient homes.

He has won the Cairns Affordable Housing and Small Lot Home design competitions, and his design for Studio 197 was FNQ House of the Year in 2009.