

What is Passive Solar design? - A beginner's guide.

(Seminar notes from Nelson Eco Fest August 2008)

Passive: - **there is nothing to do...**

Solar: - **the sun is involved...**

Design: - **its not by accident...**

ALL houses have some degree of passive solar heating...

Firstly, nearly ALL houses have some degree of passive solar heating, just the way your car does when you leave it in the sun...

It's called the **Greenhouse effect** and it's to do with light waves and heat waves being just different frequencies of the same energy. Light comes through glass (and back out) but heat waves do not.

That's not to say that heat may be transmitted through glass, it certainly can be, but by conduction rather than radiation, IE Glass absorbs radiant heat then conducts it through to radiate out into the outside air.

So the trick is to use that abundant and free energy to heat our houses...

But not just when the sun is shining, as even your average house will be warm at that time. I'm talking about **later that night**, the next morning **when frost is on the ground** and even later that day when it starts raining and blowing a southerly. **Do you think its possible?**

A carefully designed roof overhang.....

Well OK lets consider, we get the sunshine through the windows, that's the first part and it works best facing those windows **towards true north**, because that's where you will get the most sunshine during a whole day.

But what about summer, you don't want the sun in the house? – A **carefully designed roof overhang** can allow low angle winter sun in - and keep high angle summer sun out. Its just another 'cool' way that working with nature reaps benefits without cost!

So how do we keep the heat in and store it?

So, now we have the solar energy in the house, now how do we keep it there and store it somehow for later?

Well another phenomenon of nature will help us with that. Have you ever passed by a rock face or masonry wall in the evening after the sun has been shining on it earlier? You can feel the **warmth radiating from the rock** or wall.

That sunshine must have been stored in the material for it to re radiate so much that you can feel it. **A cat knows this**, watch where it lays.

So why don't we put rock inside our houses?

Well that's pretty much what we do. We call it **Thermal Mass** and any dense material does the job, like brick, concrete, adobe and even water works well.

The ancient Aztecs...

The Aztecs or maybe the Inca's (I can't remember which and it doesn't matter) dug trenches around their corn beds and kept them filled with shallow water. The Andes is high altitude, its sunny during the day but freezes at night.

Archaeologists **couldn't figure out** what the water trenches were for, because it could be seen it wasn't just for irrigation. They also couldn't figure out how they grew corn **at that altitude with those frosts.**

It turned out the **water was being used as thermal mass**, soaking up the heat of the sun during the day and storing it during the night, radiating heat as it cooled down.

There was **just enough heat residue in the water** to keep the frost at bay and protect the plants, thus allowing food to be grown successfully all year round using the **natural law of thermodynamics.**

Now it pays to find several reasons...

It pays to find several reasons to have all that thermal mass in the house because it can be **expensive**. The obvious building element that is very common is the **concrete slab floor**, it's already a floor, and so lets use it as Mass too.

But here comes the **first lifestyle adjustment** to enable all this to work, you have to **rip up the carpet!**

In fact anything covering the slab floor and keeping sunlight off it is **not going to help** us, - except ceramic or terracotta tiles etc or a similar dense material that is bonded well to the slab.

You think tiled floors are cold?

Now I can here many of you here **thinking tiled or exposed concrete floors are cold**, and you would be right *unless* you bring that '**design**' factor into play. If the tiled or exposed concrete floors are **exposed to direct** and even to a lesser extent, reflected sunlight, then that mass will **soak up the heat and store it for later.**

So why not use walls made of thermal mass?

Why not use walls made of thermal mass instead of lighter weight materials? Walls are good for holding up the roof and separating one room from another, Mass walls may cost more, but we are adding a third use for them – heat storage devices.

Mass Walls and floors need to be available to sunlight....

Again, it is **very important** to ensure that whatever mass devices you have in your house, be it floor slabs or mass walls, they need to be **available to sunlight**, preferably directly but some can be subject to reflected sunlight, and definitely placed in a room **receiving sunlight for at least 6 hours** of the day in winter.

Or the mass will suck the heat out of you!!!

Otherwise that thermal mass will be like the 'Elba', **it just does what it should**, it absorbs heat. The problem is, if there is no available free heat it will take it from the warmest thing in the room and that is YOU! - Then you will feel cold as it **sucks the heat out of you**.

If there is too much mass - for the available light...

What I am talking about is what many owners of poorly designed so-called solar houses experience, **the thermal mass can work against you** if there is too much of it for the available light or if its placed too far out of the sunlight's reach.

So it is very important to find the **correct balance** of available sunlight and surface area of massive walls or floor. Its also important to keep the mass quite thin, around 100mm (or 4 inches) depending on how dense it is, because there is **not enough time of exposure** for thicker mass to absorb the heat energy.

Insulation??

Ok, **now there is one other very important component** to this entire concept, if it is to work at all, - and that is some device to **slow the heat from escaping** out of the building, ie; **insulation!**

Insulation for me **is the cheapest way of achieving** some degree of energy efficiency and yet I hear stories a lot about people finding ways of just putting in code levels to save on their building costs. I believe this is the **biggest false economy mistake** one can make!

Cost of insulation?

Lets look at the cost of insulation. My company is specifying **full levels of insulation** in the houses we design for clients and my own building projects, that is we are **filling up the available wall and ceiling spaces** with as much insulation as those elements will take, as well as floor insulation, and the cost for an **average house size is only around \$5000!**

That's **not a lot against the cost of the whole house**. Most people spend that on a heat pump or two, something you can certainly save on, in a passive solar house. **Double-glazing** is also important, as **more heat is lost through windows** than any part of the house. New homes are now required to double glaze anyway, but it pays to **minimise windows on south**, east and west sides while maximising windows on the north side.

OK let's re-cap. What do we need?

Sunlight

- face the rooms to be heated due north and make sure trees and hills are not blocking the sun in winter when sun angles are low.
- Design roof overhangs to allow low sun angles in winter and omit high sun angles in summer.

Thermal Mass – expose a concrete slab and/or heavy weight walls to sunlight for at least 6 hours of the day. Make sure the mass gets the sunlight or you will make it worse than not having the mass.

Insulation - spend the money; fill up your ceilings and walls with good quality insulation. I use **recycled wool** because I think it's the best but any appraised product will do the job.

The concrete floor insulation is also important, we use **50mm thick polystyrene** until I can find something more eco friendly. But it is more important to **insulate the edge foundation** so that heat that you have carefully stored in the concrete slab does not just **escape to the frosty ground** a few centimetres away from your warm slab.

There is nothing to do!!

Then just sit back and enjoy your warm solar heated home, there is nothing to do and no heating bills to pay. The **only thing you might want to do** is open the **curtains** when the sun comes up and close them when it goes down, to help keep the heat in, but that's what **we all do anyway** right?

Reticulated warm water floor heating?

Some of my clients request a **reticulated warm water floor heating system** using solar panel collectors on the roof. Yes this will work if designed and set up correctly. It will also cost you around \$25000 and will need some electricity to pump the water and some **maintenance** every few years. Its called an **active solar system** rather than a passive system, if that is what you want, then go for it, it is still using solar energy and very effectively too, but it is NOT 'Passive' Solar Design.

I just want to stress the 'design' part of this subject.

There are many **subtleties involved** to ensure the **system works correctly** and to maximum efficiency (and to stop it working against you!). For example the **ratio of north glazing area** to exposed thermal mass area is **critical**, not just to enable the mass to absorb enough heat energy, but also so that your home **does not over heat during the day**.

And I am talking about **over heating in winter**, when **opening a window** is not a good solution because that **wastes the energy** before it can be absorbed by the mass.

This talk was designed to introduce you...

This talk was designed to introduce you to the concept and general way that **passive solar heating works**, so that you **understand** it better. It is **not meant to give you the tools** to go away and be a successful energy efficient designer, it takes **a bit longer** to learn it than that.

Thanks very much for your interest.

Mark Fielding