



Green Home

Physics Project

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Introduction:

The purpose of this project isn't merely doing it for the sake of the name project or as a task. Rather the project is meant to allow us to explore just what all is constructing a house about.

As the population grows and resources are depleted and misused, it becomes increasingly important to take care of our environment and put a lot of consideration on effect of houses and us on our surroundings.

Thus now this project's aim isn't just designing any house. But an eco-friendly house. A house that will not harm the environment but still be a very comfortable and affordable place.

Of course this isn't a task so easy and one that can be done in a day or two or by anyone. Here our science skills, understanding come into play. Using these tools, we must explore and investigate:

- How the physical properties of a house effects its environment?
- What materials are best suitable for a task?
- Measuring how green a house is.
- How to construct a truly green house?
- Power source and systems importance.

Below are data sheets, 8 in total, one for each objective where I have carefully investigated different aspects of designing a house.

The Data sheets:

OBJECTIVE 1

REDUCE THE NEED FOR ARTIFICIAL HEATING AND COOLING BY USING EFFICIENT ACTIVE COOLING SYSTEM AND TECHNIQUES.

Requirement:

Considering the fact that the house design is essentially for an area in UAE, we have to note that the weather should be expected to have a humid and dry weather mostly, all year round. Esp. with hot boiling Summer's that can exceed 45 degrees Celsius. So we need to design a cooling system using one system or even a group of system incorporated to keep the house within cool and the air clean. But other factors also need to be considered such as efficiency of the system, maintenance, cost and effectiveness. Active cooling system use energy to keep the circulating air cool but for a truly green house, one needs to consider and design several passive cooling systems. Passive house design is a way to design your home so that you can naturally keep it cool or warm as needed, using heat absorbed from the sun, careful use of shade, the right window treatments, insulation and ventilation principles. In an ideal passively cooled home, 'active' cooling systems like fans and air conditioners are barely needed at all.

Challenges:

Active cooling systems are effective yet can be expensive to install and maintain as they use a lot of energy. Esp. in UAE, maintaining a cooling system accounts for about 60% energy usage.

Another challenge would be that the house design is usually build by keeping in mind a different cooling system and so when another system is used, it proves to be ineffective.

Also Refrigerate air conditioners are notoriously energy hungry (use a lot if electricity) and Air Conditioner Refrigerant used is harmful to the environment and damages the ozone layer.

Evaporative cooling systems can be run on solar power too, but they consume water. This might make them less effective if considering the fact that they would be used for years and years. Although they normally use a lot less electricity than refrigerate air conditioners.

Geothermal heat pump air conditioners are also an excellent choice but impossible to put into effect here in UAE. (Much like several other methods.)

A lot of countries grow vines upon trellis which acts like a shading structure by absorbing and blocking sunlight. Winter leaves fall and allows heat to warm the house. But growing them here in UAE would be difficult considering the climate and soil.

Water roof sprinkling methods are effective yet waste a lot of water and this isn't really a good choice esp. considering all year round.

Existing Methods:

1. *Fans*
2. *Evaporative cooling*
3. *Refrigerated air conditioning*
4. *Fan forced ventilation*

Above are found to be the top common active cooling systems used within the UAE.

Evaporation cooling system are fairly straightforward system, they yes the evaporation technique (thus the name) like our body uses sweat to keep us cool. As water is evaporated, energy is lost from the air, reducing the temperature. So it requires water as well as

electricity. Evaporative coolers can be very effective in both reducing energy bills and avoiding that crumbly, air-conditioned space feeling.

Refrigerated air conditioning or our common AC works much like Refrigerator having common parts such as: Condenser, Compressor, evaporator and a motoring device.

Fan forced ventilation and a 24-hour cooling strategy to reduce heat gain during the day, and make use of cool night air to keep the air within the house warm for the next morning.

Innovations:

- 1. Shade Windows and mount in vinyl frames (Passive cooling)*
- 2. Night Breeze Cooling system (works well in UAE)*
- 3. Install double glazing*
- 4. Curtains with a thermal backing*
- 5. Radiant barriers on roofs. Paint it silvery white.*

While shading Windows and curtains with a thermal backing can cut down as much as half of the heat energy within the house, it is effectively cheap and practical. Windows could also be mounted with vinyl frames which blocks a lot of sunlight in hot summer days. They do the shading on the outside where it is most effective and keep air cool within. Frames can be cheap and are available for all types of Windows.

The Night Breeze system is like a perfect combination of heating, ventilation cooling, and air conditioning and provides fresh-air ventilation. It uses cool nighttime air, pumped through a home to remove the heat stored during daytime. This way comfortable temperatures can be maintained throughout the day with little or no need for conventional air-conditioning methods. It is less expensive and works well in desert wind blows due to the fact that sand has low thermal capacity.

Radiant barriers on roofs will block at least 40% of the radiation which is the main cause of heating and painting roofs white and

silvery instead of dark and rough will ensure maximum radiation is reflected and not absorbed which would heat up the house.

These innovations are ideally considered by their measure of effectiveness, practicality, availability, cost and which most suitable in a desert area like UAE.

OBJECTIVE 2

MAXIMISE NATURAL DAYLIGHT TO MINIMISE THE NEED OF ARTIFICIAL LIGHTINGS.

Requirement:

Artificial lightening's such as lamps, bulbs and lights use electricity to provide light day and night. While the need for such artificial lightening's is necessary during night time, having to use them in the morning is a waste of electricity. Thus a house needs to be designed carefully to make full use of sun's light energy.

Challenges:

Placing a lot of Windows everywhere in this house would make it look rather garish and Windows kept in wrong angles would result light coming in to the house at different angles. This can sometimes be unpleasant and thus Window size, position and type must be considered. Window walls are very scenic and can be very effective in lightening but may easily heat up the house.

Existing Methods:

1. *Windows*
2. *Window wall*
3. *Reflective surfaces*
4. *Mirrors*

These techniques are common in UAE where lightening is an important factor in house beautification and where Windows cannot be left open.

Placing a mirror on a wall adjacent to a window or opposite a window is a popular method. When placed adjacent, a mirror will mimic the window and make it seem like you have more windows in the wall. When placed opposite, the mirror will reflect light and views from the window.

Reflective surfaces like a back-painted glass backsplash can bounce light around and give the impression of more light when windows are limited.

Innovations:

- 1. Ceilings a little lighter than walls*
- 2. Skylights and Roof light systems*
- 3. Remove obstacles*

Flat white is best if your walls are white, but if you have dark walls, be sure to go with a slightly lighter color on the ceiling.

Skylights and roof light systems are an amazing way to place Windows without having to make the house look crowded with Windows. Since they are placed on the top with an angle such that light falls on the ground and scatters nicely, it illuminates the house perfectly. It's very beautiful too.

Removing obstacles is necessary. During house construction and design making sure that no other structure blocks the window faces is vital. This will ensure maximum light from sun is used to illuminate the house rather than artificial lightening which can be expensive.

OBJECTIVE 3

USE OF SAFE INSULATION MATERIAL- THERMAL AND ELECTRICAL INSULATION.

Requirement:

To insulate the heat energy to maintain an optimum temperature in the house. Considering UAE, the maximum heat energy insulation is the best esp. in summer. Electrical insulation is vital. It allows to maintain a proper current and avoid sparks, charge discharges, short circuits and fire.

Challenges:

UAE being on the equator, has a hot humid all round weather which can heat up the rooftops and the house much more. And the sun rays hit directly which increases the heat energy per area. Causing the house within to heat up. Thermal insulations are not always effective and can be costly. Maintaining acceptable temperatures in buildings (by heating and cooling) uses a large proportion of global energy consumption.

As technology wraps our life more and more, more devices are bought and used. Sometimes these devices are very energy hungry with high power that means their wires carry a lot of current which is amount of charge per second. Proper insulation will allow current to flow to the desired device and not leak out causing a spark or a fire or a shortcut. Which it not properly insulated damages the device and the house.

Existing Methods:

1. *Polyurethane foam*
2. *Window insulation film*
3. *Fiberglass insulation*
4. *Plastics used for electrical insulation*

Fiberglass also called glass-wool insulation is the most common insulation used to insulate roofs worldwide. Fiberglass Insulation is:

Relatively cheap to buy and easy to install

Has good heat and cooling properties and is

Made from up to 70% recycled glass.

Fiberglass Insulation involves melting the raw materials, glass and sand at temperatures of around 1550°C. The liquid glass is then spun rapidly and extruded out of small holes to form fibers. These fibers are then coated with a resin to bind them together and shaped into batts. Fiberglass insulation is generally inexpensive insulation to buy and easiest to install - so it is no wonder it is the most common insulation used for homes and roofs. The main environmental benefit of fiberglass insulation is that it is manufactured out of up to 70% recycled glass. Fiberglass is one of the most resistant materials to fire - it requires extremely high temperature to burn.

One of the best commercially available choices of insulation material is polyurethane foam. It has good thermal insulating properties, low moisture-vapor permeability, high resistance to water absorption, relatively high mechanical strength and low density. In addition, it is relatively easy and economical to install.

Window insulation film was discussed in objective 1 as well. It is used to block radiation.

Plastic are electrical insulators and thus work best for electrical insulation. They are cheap and have replaced rubber.

Innovations:

1. *Rubber insulation*
2. *Cellulose*

Rubber Insulation is used to offer protection against condensation on cold surfaces and retard heat gain on hot applications; in addition to exceptional resistance to UV radiation and high temperatures. They are environmentally friendly CFC free, flexible elastomeric thermal insulation.

Cellulose insulation is perhaps one of the eco-friendliest forms of insulation. Cellulose is made from recycled cardboard, paper, and other similar materials and comes in loose form. Because of the

compactness of the material, cellulose contains next to no oxygen within it. Without oxygen within the material, this helps to minimize the amount of damage that a fire can cause.

OBJECTIVE 4

ENERGY EFFICIENT WATER AND ELECTRICITY MANAGEMENT

Requirement:

Water and electricity is required to power almost everything nowadays. It is essential for a house to be designed considering the most efficient and feasible supply of water heating and electricity supply. Several methods some Eco friendly some not are available so it becomes important to carefully consider the best option.

Challenges:

A lot of methods used now for electricity supply is unfortunately not Eco friendly and have adverse harmful effects on environment around us but are relatively cheaper thus making them popular. Water heating reversible methods are quite expensive initially to install but may prove cost effective in a long run. So the energy supply must be cheap, effective and feasible.

Existing Methods:

1. *Fuel*
2. *Water heaters from tankers*

Innovations:

1. Solar panels
2. Solar heating system
3. LED lights (Eco friendly)

When I consider UAE it's obvious that a location such as UAE receives a lot of direct sunlight making it a hot climate. It seems to be a waste to burn fuel for electricity supply while we could make use of the free sunlight that is so abundant and thus renewable and doesn't harm the environment so I just installing solar panels in my house design on top of the roof where it can get the most sunlight.

Using the same sunlight energy, I intend to design my house such that it uses a system such as SWH (solar heating system) where the storage tank is horizontally mounted immediately above the solar collectors on the roof. No pumping is required as the hot water naturally rises into the tank through thermosiphon flow.

SWH systems are designed to deliver hot water for most of the year. However, in winter there sometimes may not be sufficient solar heat gain to deliver sufficient hot water. In this case a gas or electric booster is used to heat the water.

LED renewable lights cost more upfront but will prove to be cost effective as they use less energy and are long lasting.

OBJECTIVE 5

EFFICIENT USAGE OF ALTERNATIVE SOURCES OF ENERGY

Requirement:

In winter when solar panels can't help produce all the energy required by the house it become necessary to consider other power supply options.

Challenges:

It is tricky to find energy supply that are renewable yet cheap. So this is basically the main challenge.

Existing Methods:

1. *Fuel*
2. *Geothermal*
3. *Biomass*

Innovations:

1. *Wind turbines*

A wind turbine is a device that converts kinetic energy from the wind into electrical power. Larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. This can reduce electricity bill. As it uses wind energy which is renewable.

OBJECTIVE 6

MINIMIZE SOUND POLLUTION BOTH INSIDE AND OUT.

Requirement:

Disturbing sound seep into our house through those pathways known as windows and doors, as well as floors, walls and ceilings. To decrease sound, you must obstruct or dampen the sound wave.

That's when designing a house, it must consider noise-blocking requirements.

Challenges:

Noise pollution, or sound pollution as it is often called, is a major factor in causing increased stress levels which can lead to health issues. For some people, extensive exposure to noise pollution can cause anxiety and a feeling of stress without any perceived cause. Thus sound pollution needs to be decreased and controlled. Blocking

sound and absorbing sound are two different things. And sometimes some sound blocking is impossible. This is when sound needs to be absorbed before it gets into the house. There are two main ways to create more quiet at home: 1. adding surfaces that absorb the sound, or reverberation, before it gets to your ears, and 2. blocking it entirely.

Existing Methods:

2. *double-glazing glass*
3. *Sound Absorbent Materials in walls*
4. *In-wall insulation*
5. *solid-wood-core doors*

The choice of glass used in windows has also been found to make a difference: double-glazing glass can reduce traffic noise by up to 57 percent compared to standard single-glazed glass.

Sound absorbent materials can reduce noise inside a building. Heavy, dense materials such as masonry or brick walls are better for sound reduction, but there are also lightweight solutions available, such as in-wall insulation.

For the best sound blocking, install a solid-wood-core door; its mass will dampen sound.

Innovations:

1. *Careful home design and bedroom arrangement*
2. *Floating hardwood*
3. *Caulking Windows*
4. *Foam*

Simplest solutions include careful home design. Planning ahead when designing your home or undertaking any renovations can make a difference to the impact noise will have on your everyday living. When allocating space, consider placing driveways and garages away from bedrooms and living rooms. Likewise, making

bedrooms and quiet living spaces further away from noise sources such as main roads may reduce the impact of such noise.

Floating hardwood are very effective methods of sound proofing. This type of flooring installation includes a gap between the subfloor and your actual floors, which effectively dampens sound.

A lot of outside noise can seep in through windows. A mere 1 percent gap in the sound barrier transmits 50 percent of sound. Caulking around your windows, sealing any gaps will help a lot.

While vacuum is far more expensive to use as sound insulation, foam which has a lot of trapped air can effectively reduce noise pollution and is cheap.

OBJECTIVE 7

MINIMIZE THE LOSS OF BIO- DIVERSITY

Requirement:

There are several important ways in which humans can slow biodiversity loss, although there is no way to bring back the species that have already gone extinct. We need to consider this when designing a house by making sure it's completely Eco friendly and syncs well with nature rather than disturbing it.

Challenges:

As human population grows more and more, more resources are required. Instead of looking for long term solutions, humans see through only short term ones. By cutting down trees for more land. Little do they know, it's not just a mere loss of a number of trees but what we have gained(land) is nothing compared to what we have lost. The habitat of several diverse species who have their own niche. And as biodiversity lowers, an ecosystem becomes weaker and weaker. Until it starts dying.

Existing Methods:

1. *Protecting Areas*
2. *Permission and legal action before cutting down forests*
3. *Promoting Sustainability*

Introducing laws that protect the environment and its species.

Creating protected areas where human activity is limited is the best way to prevent deforestation and exploitation of organisms and the resources they need to survive. In order to truly make a difference, much planning needs to go into the creation of a protected area.

Sustainable agriculture is much better for the environment than grazing and cropping that rely on clearing swathes of forest or field.

Innovations:

1. *Preventing Species Introductions*
2. *Slowing Climate Change*
3. *Educating people*

It is often much easier and less expensive to prevent a problem from developing in the first place than to try to fix it once it occurs. This is the case with invasive species, which can wreak havoc when introduced to ecosystems that aren't prepared to deal with them. Many governments prohibit bringing foreign plants and animals into their countries without authorization; some even go so far as to disinfect landing planes and the shoe-bottoms of people on them.

Climate change is the documented cause of several extinctions that we know about, and has likely caused hundreds of species to go extinct about which we may never know. Any efforts as individuals, organizations, or governments, to slow current human-caused global warming is a step towards slowing biodiversity loss.

Education is a powerful tool, and the more people know about biodiversity loss, the more they will be prepared to help slow it. Spreading the word about detrimental human effects on plants and

animals can encourage people to change their ways and effect changes to preserve biodiversity.

OBJECTIVE 8

TO WITHSTAND NATURAL CALAMITIES LIKE EARTHQUAKE.

Requirement:

Most of the damage we associate with earthquakes involves human-built structures: people trapped by collapsed buildings or cut off from vital water or energy supplies. How a quake will affect the people of a city has a lot to do with how the city, its residents, and nearby governments have engineered structures and pipelines.

Because shorter buildings are stiffer than taller ones, when planning the seismic safety of a building, a house must be designed to withstand great forces.

Challenges:

When the ground beneath a building shakes, it makes the building sway as the energy of a quake's waves moves through it.

Earthquake-resistant structures are intended to withstand the largest earthquake of a certain probability that is likely to occur at their location. This means the loss of life should be minimized by preventing collapse of the buildings for rare earthquakes while the loss of functionality should be limited for more frequent ones. The test for such measures and techniques involves planning, construction and computer simulations which are expensive projects sometimes.

Existing Methods:

- 1. Make it stiff and strong*
- 2. Base isolation*
- 3. Combined vibration control*

Base isolation is a collection of structural elements which should substantially decouple a superstructure from its substructure resting on a shaking ground thus protecting a building or non-building structure's integrity.

In earthquake engineering, vibration control is a set of technical means aimed to absorb seismic energy waves to reduce its impacts in building and non-building structures. Such as Mass dampers which absorb the resonant portions of the whole wave frequencies band.

Innovations:

1. *metallic roller bearing*
2. *Steel beam*
3. *Beams and slabs for support*

Drawers and cupboards and doors automatic lock

Beams can be designed to form plastic hinges which allow them to absorb to absorb all the energy and change the resonate frequency.

Slabs should be designed to not fall off.

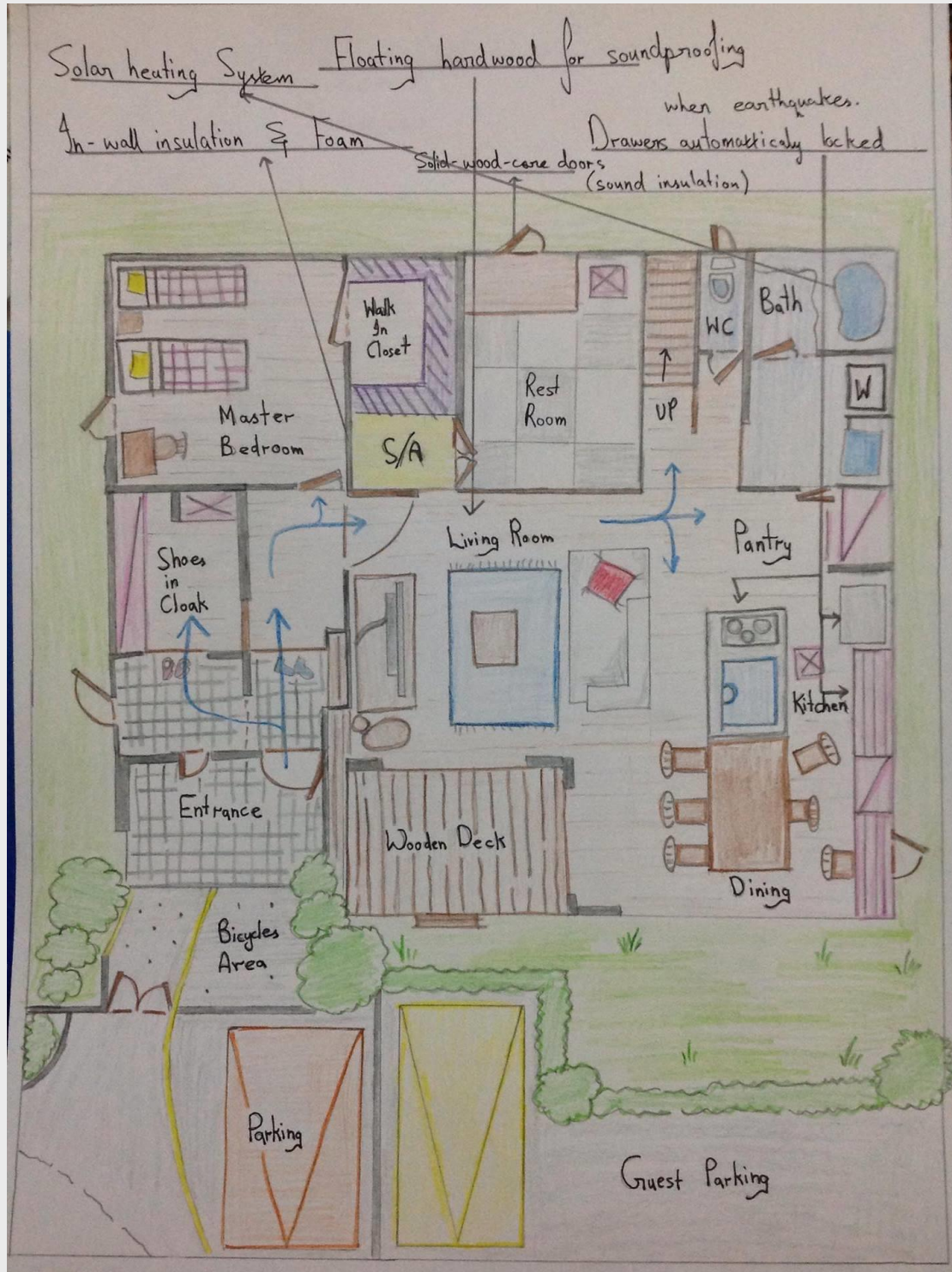
Steel beam in ground helps hold the whole framework together.

A metallic roller bearing is a base isolation device which is intended for protection of various building and non-building structures against potentially damaging lateral impacts of strong earthquakes.

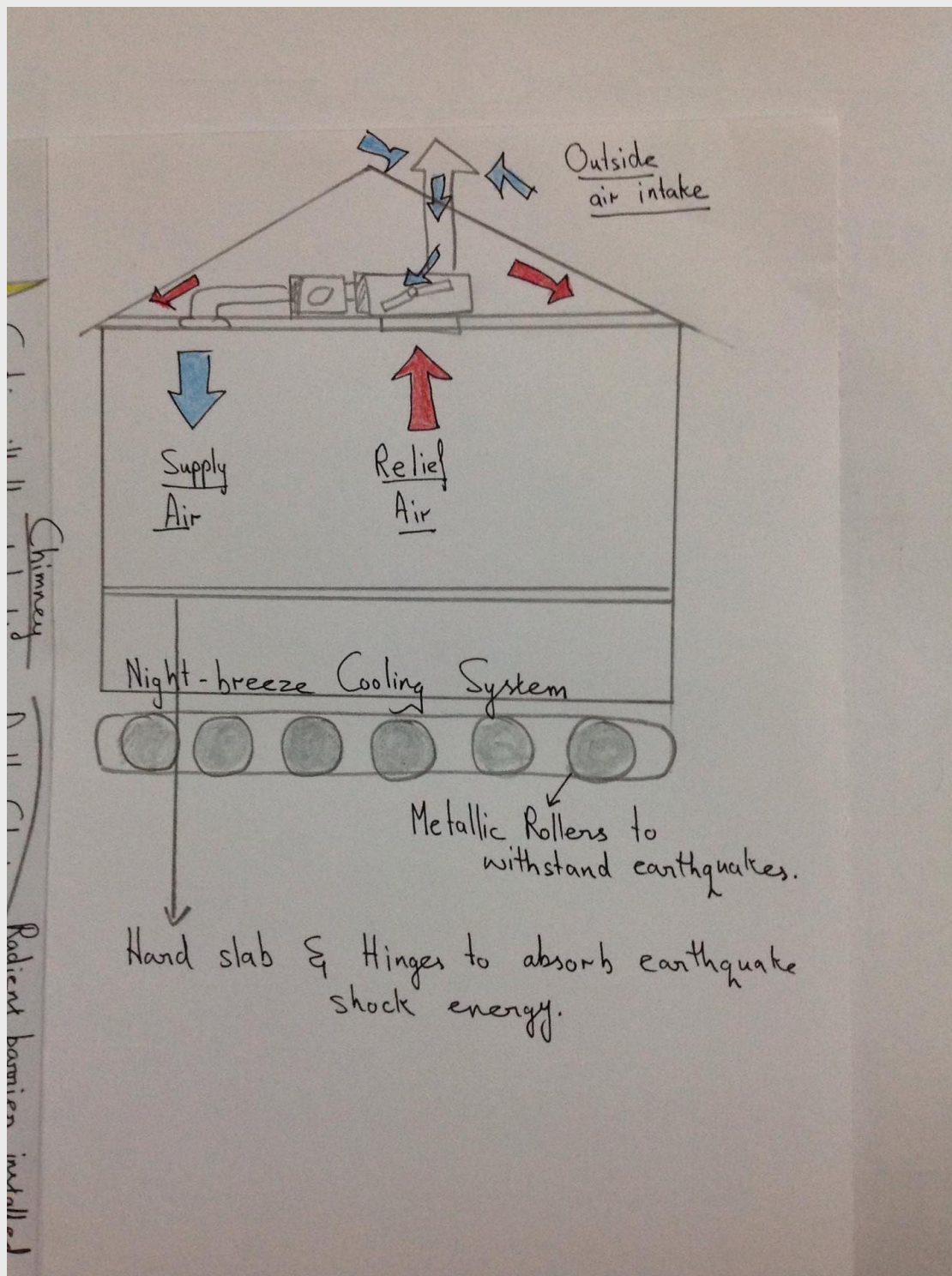
This bearing support may be adapted, with certain precautions, as a seismic isolator to skyscrapers and buildings on soft ground. They are more expensive but more effective.

Smart magnetic locks that lock fridges, doors and drawers when earthquake strikes.

Blue Print of the Design:







3D Visualization



Created using an app.

End Note and Conclusion:

It was fun exploring the different aspects which are considered when building a house and now it will help me better understand how houses are build and what is used.

It also helped me use my creativity and science skills esp. physics to come up with new innovations and create my very own eco home!

It also made me realize how contrary to what people usually think building an eco-home isn't that difficult or expensive. It just needs a lot of careful planning.

At the end of the day it was all worth it.

The End!