HOLISTIC RESILIENT ECO-EFFICIENT SCHOOLS in the PHILIPPINES

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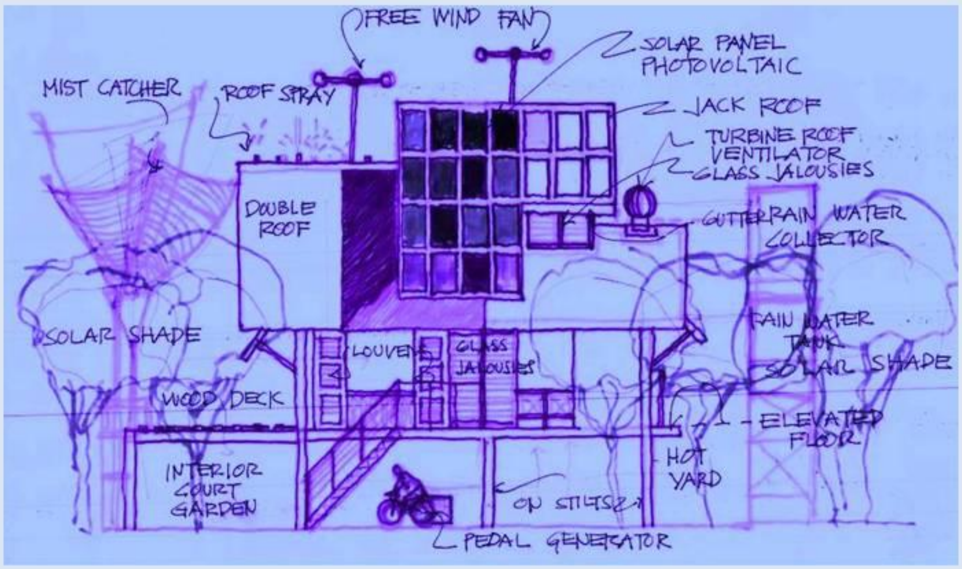

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REPORT ON:

UN ESCAP- DOST 7- CHORA ARCHITECTS WORKSHOPS ON THE HOLISTIC RESILIENT URBAN INFRASTRUCTURE DEVELOPMENT FOR BOTH NATIONAL AND LOCAL LEVEL

National (Manila), Cebu City, Tagbilaran City and Tacloban City

A. General

National and Local workshops on Hoilistic Resilient Urban Infrastructure Development were conducted in Manila, Cebu City, Tagbilaran City, and Tacloban City. All Cities and surrounding regions experienced the devastating effect of "Typhoon Haiyan" thought to be the strongest to hit the Philippines; and destructive effect of the recent earthquake except for the National Capital Region. It was implied that knowledge imparted is of great help in formulating policies both national and local levels of the Government. Furthermore, they found the ideas presented relevant and useful specifically ideas on the holistic resilient eco-efficient school (UNESCAP-DOST 7- CHORA architects) and the eco-efficient water development and integrated storm water management (DOST 7 –UN ESCAP project) in disaster preparedness and post disaster management as well as in housing.

The workshop exposes the weakness of current policies and ordinances. These are manifested by outdated and unsustainable codes, unavailability of planning guide, absence of adaptive and resilient codes, and education needed on current and future policies.

National Building Code

It was further suggested that good practices in eco -efficient water, storm management be included in the national building code.

Education

One of the most interesting and note-worthy aspect during the course of the workshop's discussion is education. Ideas including its benefits were brought up on incorporating and integrating holistic, resilient eco-efficient infrastructure in Engineering and Architectural curriculum. It is implied that education starts in the grade school level specially the knowledge of eco-efficient water development and storm water management on small scale level.

Disaster Preparedness

Mostly the participants in Cebu, Tagbilaran and Tacloban workshops Resiliency linked to disaster preparedness and disaster management. These areas experienced the devastating effects of typhoon “haiyan” and the 2013 earthquake. The ideas presented specifically the holistic and resilient infrastructure which offer the idea of build and design better. The idea of storm water management, rain water harvesting and the concept of typhoon- earthquake resistant structure designs are needed in today’s normal – “the new normal”. Implied was the concept of the inclusion in disaster management and disaster planning.

Capacity Building

In the course of the workshop, discussions were made regarding building capacities for both national and local levels. Discussions focused on disaster stricken areas specifically in Bohol and Leyte areas were people are in a slow process of rebuilding their lives. Queries were made on UN ESCAP capacity building programs be made available if there is any that might suit to present and future conditions in these areas.

Policy:

a. Promote sustainable initiatives and practices in protecting the environment and for a sustainable Philippines.
b. That government and the private sector demonstrate commitment to holistic resilient eco-efficient program by resilient adopting good practices and incorporating good these good practices to the National building Code.
c. That Holistic Resilient eco-efficient infrastructure features and good practices be included in the disaster management plan as well as mitigation and adaptation strategies for a responsive and resilient future.
d. That the policy makers and government promotes and support sustainable
e. Rain water harvesting and storm water management be incorporated in the national Building code as well as national and local policies as they are needed resource in times

of emergency and disaster.

f. Support sustainable application waste water and waste water management to protect our water sources and aquifers. That the government shall institute measure regulations and implement programs and projects that prevents the depletion of water resources. Support sustainable application rain water run-of management to protect the environment and prevent flooding.

B. General Concerns

The following concerns and issues were discussed;

1. Concerns and ideas were entertained with regards to the applicability of Holistic Resilient eco-efficient Urban infrastructure‘s applicability to rural setting, questions on how “Holistic Resilient Urban Infrastructure” be translated into rural and small community infrastructures specifically eco-efficient water infrastructure.

2. In local workshops conducted specifically in the cities of Tagbilaran, Bohol and Tacloban City Leyte, the participants stated the need of information from UN ESCAP regarding best practices of holistic, resilient eco-infrastructure. There were concerns on transfer of knowledge gained from the workshop to community, colleagues and local government line agencies.

3. Mostly in local workshops (Cebu, Tagbilaran and Tacloban) suggested that UN ESCAP we promote Holistic and Resilient Infrastructure to higher authorities as policy guide. There were discussions on the positive technical inputs relating to application. The problem stated in reference to this issue is on how to promote “Holistic Resilient Eco-Efficient infrastructure Concept”, one of the suggestion is go directly to higher level of government instead of going directly to the local government line agencies. It was expressed and suggested that it is not possible for them to implement unless the upper structure of government order then to do so.

4. Another important aspect is how to translate this knowledge to the basic unit of the Philippines society which are the "Barangays". Clearly the workshops on local level imparted a very important knowledge that they want workshop's positive inputs reach the lowest level of the Philippines society which are the "Barangays".

5. The integration of Holistic and Resilient eco-efficient infrastructure in school curriculum.

6. As part of information dissemination more training and workshops should be conducted as part of awareness and education related to the environment and disasters.

7. It is further suggested that in order to improve further discussion on the advantages and disadvantages taking into consideration material specification and system. It is implied that the theory is good with room for improvement. They further suggested that adjustments be made in reference to different setting whether urban, rural, lowlands and upland.

8. There are questions on whether UN ESCAP support such Holistic Resilient Eco-efficient Infrastructure related projects and other ESCAP project initiative on local level meaning per municipality basis. Representative from local governments want to avail of UN ESCAP project program but do not know how to access or avail of such project.

9. There were concerns on how ESCAP can help in capacity building specially in disaster stricken areas such as Bohol and Leyte.

10. The Department of Public Works and Highway suggested that this workshop to the secretary of Public Works and Highways.

11. Great concern for sub-standard building materials flooding the market.

C. Specifics Discussions and Observations:

Manila (National) comments:

- Someone from the DOST pointed out that there is an existing wind tunnel facility in UP Diliman which might be very useful for CHORA's current study on green schools, considering that the simulations CHORA based for their designs is only limited to the virtual world.
- Someone pointed out the importance of the architecture profession because of the difference of the outputs between an engineer and an architect. It is noted then there is still a big misinformation on what is the scope of work of both the architect and the engineer. Both are in essence, relevant to the realization of an optimal built environment which is meant for the public good and the environment, as well.

Tacloban comments:

- Mr. Archimedes Vergara *(DPWH, A-2)* & Mr. Zotico Pastelero *(LGU Palo, Municipal Engineer)*
  - They are concerned if the Green School Buildings presented, has been applied by DepEd especially that they have lots of buildings to be constructed after the calamities last year. Is DepEd still currently using their old practices for their future projects?
- Mr. Andres Abusman *(EVSU- College of Architecture, Dean)*
  - He is very concerned with the materials used in the Green School Buildings, what materials were used, what are the alternatives, and how much will it cost.
- Ms. Jam Colas *(NEDA VIII, EDS II)*
  - Asks for complete drawings of the Green School Buildings. He asks if he can get a copy of it and if it is already ready for implementation.
- Ms. Gerardo Peñeda *(DSWD, Engineer)*
  - Stated that if we plan to change the DSWD's system or practices of construction, It should be directed to the national board of DSWD, since LGUs focused on

implementations of DSWD projects and they only follow instructions from national.

- People suggested to compare the base cost of the resilient school buildings with the prototype developed by DEPED to determine the costs and benefits of each subsystem employed.
- People are wary if the emerging school concept will tip over.
- People mentioned that the cost to maintain the Korean stormwater system with its filters is more expensive than the savings gained from utilizing the system. However an Engr. said that people can improvise a lesser cost system utilizing chlorine and basic filtration systems.
- Somebody suggested to merge the wastewater cistern with a ram pump so that energy savings can be realized. The height differential of the roof and the rainwater cistern is enough to drive the ram pump.
- People suggested that CHORA present to the heads of the regional offices like the DPWH for the construction of schools, and DEPED for the specification of schools in the province so that people with more decision-making authority can assess and directly apply the ideas that are presented since the people in the forum cannot directly apply the knowledge gained.

Bohol Comments:

- They are concerned if the Green School Buildings presented has been proven and has been built.
- They asked on the mechanism on how will the structure floats.
- They asked if there are certain areas that we have considered for testing such buildings.
- They questioned why "No Build Zone" policy is not strictly implemented.
- They asked why we did not invite the LGU. Especially the municipalities located on coastal areas.
- They suggested the idea of making use of waste water from septic tanks be filtered, processed and turned into a potable water.

- They shared how the lack of proper compilation of building plans of local projects contributed to the crippling of the rate of progress of rebuilding after a certain disaster.
- They suggested that there should always be a soft copy of the building plans to be saved in a cloud network in case of the possibility that the hard copies be destroyed or lost.

Cebu Comments

- For the emerging school concept, people suggested that the design be calculated if design is feasible for rapidly rising, turbulent water flow since.
- People asked about the integrity of the floating structure if there is a way to mitigate the floating structure from tipping over due to the turbulent flow of the water.
- Someone suggested whether it was possible for the office to coordinate with the Cebu Province for the construction of a pilot school that was damaged by the typhoon Yolanda, since there were still a number of units that needs to be constructed.
- People asked and suggested that the resilient green school concept be presented to the Department of Education so that the basic ideas can be disseminated.
- There needs to be a venue for thought leaders to coordinate with one another, the academe, the non-profit section, private and public sectors to merge their ideas.

Specific Comments for all Regional Workshops

- The participants asked this same question (participants from Bohol, Cebu, and Tacloban), about the technical details of the school concepts and where they can procure the drawings so that it can be integrated into their projects.

- Everyone also asked copies of the presentations. We gave copies to some who has USBs with them, but for those we have not given copies, we assured them they will be linked to the website UNESCAP will make where all presentations will be available for them.
- Participants also wished that workshops like what we conducted be conducted as well to municipalities, barangays, since they are the direct implementer of these proposals, especially the Green School Buildings, Water and waste management.

- Everyone also asked when will be a prototype of the Green School Building/s be made. People are amazed by the concept, but it would require a concrete prototype for them to be convinced that he buildings are very feasible, especially the floating/Emerging Structure.
- Some also commented on the Water management applied by DOST 7 in their office building in Cebu, that the facility came out to be really expensive, affordability of the other regions to make use of such technology is such a doubt. Though it has proven itself to be effective.

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Holistic Resilient Eco-Efficient School in the Philippines

EXECUTIVE SUMMARY

Introduction:

Climate Change has a disastrous impact on housing settlements and people. Climate change causes disasters that will affect food security; furthermore it affects our well-being and will eventually result to death, bio-diversity loss and economic loss. We need to understand the impact of climate change, its impact to the built environment, the environment and sustainable development.

The Philippines is being identified as one of the most vulnerable country when it comes to hazards and disaster. It is considered as one of the most disaster prone country because of its location and it makes it more vulnerable to many forms of disasters. Vulnerable are the elderly, children, person with disability and women. Vulnerable are the poor, greater number are in the urban areas mostly those in slums, creeks, beside the waterways, under bridges and coastal areas. Disasters affects sustainable development of the Philippines, it increases the level of risk and vulnerability on security, environment (both the physical and the natural environment), sustainable economic growth and well-being. It affects lives and property and food security.

Philippines is located on the western rim of the pacific and circum-pacific seismic belt. It is highly vulnerable and subject to all kind of hazards such as storms, typhoons, earthquakes, floods, volcanic eruption, droughts, landslide and other kinds of natural hazards.

Extremely devastating and destructive effects as manifested by the recent earthquake that hit the central Philippines and Typhoon “Haiyan” (code name Yolanda) greatly affected the vulnerable groups and sustainable development in the Philippines. The extreme sad state of devastation suppresses human spirit and degraded the physical environment. It was a reminder on how manmade and natural hazards event destroy property, the environment and generate casualties. It gives us the opportunity to review, revise policies and plan for a resilient and sustainable Philippines.

Resiliency, Adaptation and Sustainable Development

(Socio-economic- environment- cultural sustainability)
Resiliency is the ability to bounce back after a disaster, the ability to use available resources that involves the capacity to cope with ambiguity and the capacity to successfully traverse extreme conditions and challenges.

With the recent series of disaster events, we saw the need to review, upgrade, revised existing codes and policies related to disasters and sustainability. In sustainability this includes, food security, health and well being, capacity building, shelter, economic and protecting the environment. It is also important to note that in resiliency, comes with it is adaptation. Adaptation as an approach is a response that seeks to reduce vulnerability to the effects of climate change. Adaptation is an approach that can be a tool for resiliency.

Holistic Resilient, Eco-efficient Green School

The concept of holistic eco- green and resilient schools enhances capacity building, motivate resiliency, promotes adaptation as an approach and enhances resiliency and disaster preparedness. Holistic eco- green and resilient schools play will act as key driver to enhance the harmonized development of green growth and environment as well as resiliency.

It will further enable stakeholders and policy makers to discuss issues related to existing policies, finding ways and means to revise and upgrade existing policies that will address and suggest revision and upgrade existing policies towards the environment, water and waste water, disasters and the adverse impact of climate change. Furthermore this will promote sensitivities to eco-efficient resource management and resiliency towards disasters and the effect of adverse impact of climate change.

The principle approach to advance holistic Eco- Green and Resilient Designed School address issues of resiliency and adaptation to the adverse effect of climate change, disastrous effects of disasters and sustainable development.

It is a Holistic approach of resiliency and disaster preparedness through design models, incorporating mitigating design elements addressing environmental concerns and climate change and disaster resilient designs.

Objective of Holistic Resilient, Eco-efficient Green School

The objective is to promote and motivate resiliency, adaptation as an approach to a resilient, disaster prepared and sustainable Philippines. With the objective stated Holistic, Eco-efficient Green School shall become a driver to enhance the capacity of concerned and Central and Local Government / Policy Makers and Decision Makers to revise, upgrade and formulate policies related to resiliency and sustainability for sustainable development.

Resilient eco-efficient infrastructure has the ability to reduce the vulnerabilities, magnitude, and the time of disruptive events. Resilient result depends on the ability to anticipate, absorb, adapt and recover from a disastrous event.

Integrated design are achieved through inexpensive assessment of the anticipated all-hazards performance of the built environment and using these results in developing standards and guidance for providing enhanced design of a resilient building and infrastructure.

The objective can be done in the form of training materials and disseminate them with the aim of enhancing capacity of the concerned central and local government officials/ policy and decision makers in the Philippines.

Holistic Resilient Design Approach Principle

The approach is the summation of two resilient principles incorporated together to be able to come-up with a holistic resilient design. It is a combination of design character of a resilient design and design element of a green school. The approach principle ensures three important facets of sustainability namely;
- Resiliency
- Environmental Protection-Preservation and Environmental Sustainability
- Sustainable Development.

Holistic Resilient Structure- Infrastructure Characteristic

Aside from the properties of a resistant and adaptable to all form of hazards, resilient structure must have the character of multiple functional use in times of emergencies and disaster. The character of flexibility of functional use such as social and cultural aside from emergency use is an important factor of a resilient structure. Resilient structure shall have universal application properties, meaning it is applicable to all gender, disabilities and age.

Another character of a resilient structure / school is eco-efficient –green school. Combinations of these characters will result to holistic resilient school/ structure.

The Benefits of Holistic Resilient Structure/ School
Green- Eco-efficient school:

Economic: Climate change causes disasters and calamities affecting lives, property and food security and that will result to economic loss. Building resilient structures resist typhoon's destructive effects thereby minimizing damages for both property and lives.

Social: Prevents and minimizes social displacement. It will partially address issues on cycle of rebuilding every after disaster.

Environment: Eco- efficient infrastructure helps protect and preserve the environment and mitigate the disastrous effects of climate change. Building resilient structures minimize waste and debris brought about by structure damaged by typhoons

Resilient:
Resiliency addresses climate related pressures with adaptability as an approach. Resiliency is focus on anticipated climate change impact and quantitative effects on the built environment.
There are benefits identified to a resilient school/structure/school and they are;
- The preservation of cultural and heritage structures, residences, and other infrastructure.
- The ability to recover in a short time after a disaster, enhances the capacities to bounce back after a disaster
- Reduce damage to building and infrastructure

- Preservation and protection of life by improving reliability back-up emergency system
- Resilient structure can provide shelter and a venue for community service
- Increase community resiliency capacity

Eco-efficient Green School:

Eco-efficient Green School addresses the needs of energy and resource conservation as well as social values and environmental consequences.

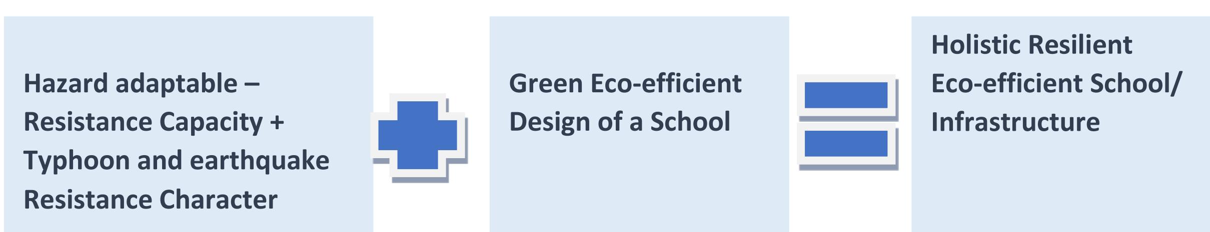
Green Design Practices for the Green School are taken into account such as;

1. Appropriate Site Selection
2. Use of Passive Cooling design
3. The use of Natural Barriers as Solar Heat Protection
4. Natural LightingSound Waste Water Management
5. Use Dimensional Planning and other Material Efficiency Strategies.
6. Use Materials and Construction Systems that are of Low Carbon Footprint
7. Use Alternative Energy and Renewable Energy
8. The Use of Natural Barriers as Solar Heat Protection
9. Use of sustainable, Eco-Friendly Materials in Promoting Resource Conservation
10. Recycle Materials and Re-use , Used Building Materials
11. Simple and Easy to Build Structure Design
12. Use Different Architectural Elements That Considers Different Socio-Cultural – Religious Layers of our Society
13. Rainwater harvesting
14. Environment water Return
15. Rainwater Overflow
16. Waste and waste water management

RAINWATER OVERFLOW CISTERN

The Proposed Holistic Resilient Eco-efficient School/Infrastructure Design

The proposed resilient eco-efficient infrastructure shall be the integration of a Hazard adaptable-resistance capacity and typhoon and earthquake resistance characters integrated with green-eco-efficient green school design



The three main conceptual principles anchors for coming up for a Holistic Resilient Eco-efficient School are;

1. Bio-mimicry: human anatomy as basis for designing structural frame- 60% of our upper body weight is carried by the lower body. Analogous to the human body is the proposed resilient structural frame of a school / infrastructure. Human body part and joints allows the body to react with balance the dead loads and external loads which are the wind load, motion. Similarly, parallel is the same with the structural frame of the body. It allows the structure more flexibility in times disaster events and movements including the direct load-dead load of the structure and live load.

2. Hydrodynamic- the principles of hydrodynamics when use as a design principle in buildings allows the building to behave with least resistance to water in times of flooding, storm surges and tsunami. It will develop the building to be resistant to hazards both natural and manmade.

3. Aerodynamic: the principle of aerodynamics when use as an element of design allows the building to resist during high wind pressures in times of typhoon and disasters. Aerodynamic design allows wind and air to flow freely along the surface of the building. Free flowing with least resistance.

The above mentioned conceptual design anchors for holistic resilient eco-efficient school changes and affect the form, plan and design and structural component of existing building design. It affect existing building codes and policies as well as building designs and allows us to review, revise and upgrade policies and code for a resilient future.

The proposed resilient eco-efficient green school design will be the driver for stakeholders to work for the standardization of building system and material specification for resilient future.
Another aspect is for the attainment of a simple warning system that is effective low cost and functional to areas.

The Conceptual Process

Architects, Engineers, Urban and Rural Planners, Urban Designers, stakeholders and government will have to deal with resiliency to the adverse effects climate change, the different types of hazards and natural disasters. This refers to resilient building design and construction, as well as in the building code provisions for protection against natural hazards.

Two core concepts that we have to address for a resilient eco-efficient school designs are;

a. Multi hazard design
b. Performance based design.

The two core concepts are the basis of the development of resilient eco-efficient building technology.

Multi-hazard design:

Recognizes the fundamental characteristics of hazards and how they interact, so that design for protection becomes integrated with all the other design demands. It is the integration of design for protection that characterizes a multi-hazard design.

Performance-based design: is a process of conducting a systematic investigation of performance of past disaster events to ensure that the specific concerns of building owners and users are addressed, instead of relying on only the minimum requirements of the building code for protection against hazards.

Building codes focus on providing life safety, while property protection is secondary. Performance-based design provides additional levels of protection that cover property damage and functional operational and management interruption.

Codes and Standards

Codes and standards should be reviewed by all sectors whether Government or the private sectors and stakeholders organizations should participate in an effort to support development of an integrated of code and standard provisions that integrate resilience into design, construction and operations of buildings and infrastructure.

Policy Guide

- Holistic Resilient Eco Resilient Green School shall be guided by the principle that it should last long and stand the test of time. Test of time meaning proposed policies are result of a process of analysis-synthesis of historical data of the magnitude of effects of hazards, risks and disasters. Another aspect is flexibility and adaptable functional characteristics important to resiliency and adaptability.
- Historical data of disaster event help provide information on how to come up with policies related to preparedness and that is emergency preparedness and disaster preparedness. These actions of preparedness ids very vital in formulating policies related to resiliency and disaster preparedness.
- Universal Design- universality of design deals with functional use related to gender, disability, and all ages. Existing codes are outdated when it comes to universal functionality.
- Consider three important aspect that affects a resilient sustainable development and they are sustainable/ green design, Disaster-Hazard- Typhoon and earthquake resistant aspect of the holistic resilient eco-efficient structure. Existing codes and policies will have to be reviewed, revise or upgraded for a resilient and sustainable development
- Preservation and protection of the environment
- In the formulation of policies involve the community. It is very important that we involve the community in the decision making process.
- Lastly policies for innovativeness shall be promoted for innovativeness is one of the tool of resiliency and sustainability.

Suggested Policies:

In our study on damaged schools by typhoon “Haiyan” we observed that current and existing policies on school building and infrastructure are outdated. There is a need to review existing codes and policies related to building’s capacity to withstand the adverse effect of climate change and the impact of disaster events. We saw the need to revise and upgrade existing policies and codes on construction and design with resistance capacity resiliency, eco-efficient, and sustainability. Furthermore future codes and policies should deal with vulnerability of the vulnerable, its protection and safety.

Of the schools damaged by typhoon “Haiyan” North of Cebu we it was observed that the following flaws are the main causes of damages because of the outdated policies, codes and building laws. We covered around 1,800 damaged classrooms and that was only a fourth of schools damaged by the typhoon. We have these observations;

1. That school building does not conform to standards and codes.
2. That there are different types of school building and to name a few “Marcos Type School Buildings”, “Bagong Lipunan School Buildings”, “Gwen Type School Buildings”, DEPED School Building, DPWH schools etc. These school buildings have different kinds of construction system considering even if it is in the same school building type.
3. As notice those damaged school were of poor workmanship, having poor joint connection and with different construction system.
4. These damaged schools were using sub-standard building materials and construction system.
5. Apparently when these schools were constructed there was an absence of proper construction supervision and administration.
6. Lack of monitoring of the standard of construction material supplied, delivered and applied.
7. Sub-standard building material- Current construction materials available in the market are of three types. The premium which is more or less the standard, the standard which is below standard and below standard which below sub-standards. It is very difficult to comprehend but this is what is happening here in the Philippines.
   With the above observation we recommend that concerned government agency monitoring building materials available in the market should upgrade its monitoring system, impose stiff-huge penalties an upgrade existing policies and laws. It is not enough that we leave it all to Government but the private sector shall help monitor in order to build safer communities.
8. Existing school building designs do not have resilient eco-efficient green design elements. It is important that codes and policies be adjust to have resilient, eco-efficient green elements to be able to address the adverse effects of climate change and disasters.
9. Include eco-efficient in the design of school building as well as waste and water management.

10. We concluded that instead of retrofitting damaged school building we decided to recommend to construct new school building that include resilient, eco-efficient schools.
11. We also saw the need to build capacities through skills upgrading program to upgrade the construction professionals and workers with new construction system using construction materials and systems that are resilient and sustainable.
12. The whole system of the construction industry should upgrade through training, education and information dissemination about adaptation, resiliency and sustainability.
13. Encourage policy and decision makers to promotes disaster preparedness, emergency preparedness and motivate the citizenry to promote environmental sustainability.
14. Promote Holistic Resilient Eco-efficient school building ensures sustainability and act as a driver for the Search-Research and Use Renewable Energies, Promote Sustainable Initiatives and Practices in Protecting the Environment.
15. That government must demonstrate commitment to green building program, comply with eco-sustainable building programs and policies, promote and encourage the adoption of green building practices and encourage active participation by the private sector.

16. That policy maker support sustainable application waste water and waste water management to protect our water sources and aquifers. That the government shall institute measure regulations and implement programs and projects that prevents the depletion of water resources. Support sustainable application rain water run-of management to protect the environment and prevent flooding.

What we hope to achieve:

-Formulate architectural and planning guidelines in graphical form and in detailed planning intervention in mitigating disasters. These should be done through workshop of the different planning professionals such as Architects, Urban Designers, Regional Planners and Environmental planners.

The goal is to formulate guidelines for the design and plan of structures that exhibit resilient and adaptable features and characteristics. (ex. 1:5 ration minimum slope roofing inclination-aerodynamic designs. Other example is the use of natural barriers as protection against the elements.

Material Quality and Standards

Is this what we call new normal with materials of sub-standard quality?

- Undertake or call for a supplier's workshop together with DTI, NEDA and Building Industry professionals to ascertain the what? Why? Where? How Much? These are the issues that should be addressed in procuring the standard building materials.
- The above workshop shall be the basis for specifying and application construction building materials for re**silient and typhoon resistant structures.**

Warning system:

Let DOST and LGU’s Study the appropriate warning system needed in each locality. The goal is to upgrade and educate people for disaster preparedness.   Easy to manage and operate is always an effective system. Media is an effective medium to disseminates and educate the all levels of our citizenry.

TABLE OF CONTENTS

CHAPTER 1

THE PROBLEM AND ITS PURPOSE

I. Overview

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) has been promoting through its Environment and Development Division (EDD) eco-efficient urban infrastructure as one of the key tracts in shifting towards a green growth and green economy in the Asia-Pacific region since 2008.

A project called "Pilot implementation of the low carbon green growth roadmap for Asia and the Pacific" is being implemented targeting developing countries in the region. Capacity building activities aim at policy makers in the developing countries in the region through the development and implementation of infrastructure design and planning particularly water and energy infrastructure.

Today one of the major if not the most important development challenges the Philippines and other disaster prone countries are how disaster resilient the growth will be. The capacity to absorb and recover from disasters and the effects of adverse impact of climate change are to be included in strategic planning and design of spatial elements and infrastructure. The inclusion of vulnerable groups is an important element that should be considered in the design of resilient infrastructure. Equally important is building capacities, capacity to respond to challenges in times of disasters, whether man-made or the impact of adverse effects of climate change.

Resilient design must integrate eco-efficient design criteria and risk reduction design element to be able to protect social, cultural, economic and environmental assets. Protection is one but the other aspect is capacity building enhancing capacities for local and national officials, decision makers and policy makers (enhance awareness, competence and skills).

According to data and statistics show that from the year 1980-2010, with over 363 natural disasters ranging from earthquakes to storms and floods in the Philippines, with over 32,956 casualties, averaging over a thousand per year. The affected population totals to over 116M in a span of 30 years, averaging 3,748,788 persons per year. Record shows average economic damages, on the other hand, sums up to about 10 billion pesos per year. The recent Typhoon Haiyan, alone have killed 6,300 people, injured over 28,000 with still, over 1,000 missing. (Prevention Web)

Considered one of the world's most vulnerable countries to natural calamities like floods, earthquakes and typhoons, the Philippines is at the forefront of disaster resiliency efforts. With a significant portion of its population living in makeshift structures in slum areas specifically in urban centers, the need for disaster-resilient schools/ structures is urgent. There is a sense of urgency for holistic eco-efficient structures are needed to be able to save lives and minimize disastrous impact on infrastructures, environment and economy. What is needed is a resilient community. With calamities and disasters as important challenges for a sustainable Philippines, we need to strengthen local government as well as national government's capacities in sustainability and resiliency for sustainable development of the Philippines. Two vital components of resiliency are disaster preparedness and disaster recovery, but one very important strategy is adaptation. Adaptation incorporated with disaster resistance properties and adding green eco-efficient and resiliency results to sustainability.

The Promotion of Holistic Eco-efficient Green School in Urban Areas

Taking the setting with Philippines as one of the world's most vulnerable countries to natural calamities, huge and significant number of vulnerable population are in urban centers. Mostly they live in makeshift houses along creeks, coastline, under bridges, along elevated sites, in lowlands and slum areas. They live in high risk areas and there is an urgency to address issues on resiliency for environmental and developmental sustainability. There is a need to enhance the capacities to be able to survive and minimize the disastrous impact of disasters.

The Resilience efforts aims to contribute to national efforts to build community resilience and reduce vulnerability to natural hazards by enhancing capacities of local government units (LGUs) and other stakeholders towards good governance in Disaster Risk Reduction and Management (DRRM). It has three main complementary components—policy development, capacity enhancement and improved coordination—that contribute to enhancing the resilience of communities against the effects of calamities and disasters. Furthermore, through its green design and eco-efficiency components it brings about environmental sustainability and sustainable environment.

Weakness of Current Policies

1. Outdated National Building Codes, Regulations and Ordinances. As the magnitude and strength of current disaster increases both climate change induce and natural disasters there is a need for codes with increased capacities and resistant properties.

2. Lack of Education and Information on the different kinds of disasters, its terminology and its characteristic and appropriate disaster responses. This is what happened in Tacloban, Leyte in the last typhoon "Haiyan" where they confused storm surges and tsunami. The confusion left huge casualties.

3. Unavailability (None) of Planning and design building construction guide for a resilient and disaster resistant infrastructure.

4. The need a policy that covers effective information dissemination of warning system information that might cover multi-media usage.

5. Improve and upgrade resilient adaptive building codes and land use policies that include resiliency, adaptability addressing the issues of disaster preparedness and recovery.

6. The construction industry professionals are not thoroughly familiar with the present Building Code. There should be refresher course on National Building Code on a periodic

basis to ensure sufficient knowledge and prevent errors.

7. Upgrading of land use and zoning criterion that considers hazards, risk and vulnerability issues for any land development.

8. Office of the Building Official: OBO power should be strengthened power for the implementation of standards and monitor workmanship in construction. Found in the current disasters that struck the Philippines are poor workmanship and building using sub-standard building materials.

9. Upgrading of building construction system and methods: upgrade and revise existing building construction that will result will ensure increased resistant capacity resilient to the disaster and the adverse effects of climate change.

10. Weak illegal construction law and implementation system.

11. Sub-standard quality building materials floods the market.

There is a problem with strict implementation of the law against selling sub-standard building materials and products. There should be strict monitoring from the government agency in charge and private sector. Insufficient information dissemination and education program regarding building material products mandatory list by the Department of Trade and Industries.

Holistic Low Cost Resilient Eco-efficient Green School

Alongside this setting a low-cost holistic resilient eco-efficient school design are needed. The design includes climate change and disaster resistant design and shall be disseminated in the form of training materials whose purpose is to enhance capacities of concerned local and national government officials, policy and decision makers in the Philippines.

Added dimension: Low Cost Design

Low Cost Design Characteristics:

a. Requires not so high skilled workers
b. Uses available local materials (cut the cost of transporting)
c. Use simple construction technology and easy to build
d. Does not requires high tech solution

Low Cost Design Approach:

The design of holistic eco-efficient green school shall be approach with a design process that considers the different socio-cultural- historical- religious layers of the Philippines in terms of architecture and infrastructure. The process includes the processing of important architectural design and structural design elements that promotes eco-efficiency, green design and structural design component that resist disasters specifically earthquakes, typhoons, flooding and storm surges.

Careful examination shall be done in reference to capacities, technology, building system application and available skills. In general a review and filter information of resources and capacities to be able to come up with a low cost holistic resilient green school.

To be able to come up with a low cost resilient structure careful consideration of skills required, technology used (traditional versus high technology) and availability of sustainable building materials in a certain locality.

II. Introduction

The Philippines is an archipelago that consists of 7,107 islands with three main island groups namely Luzon, Visayas and Mindanao. It is bounded on the West by the South China Sea, on the South by the Sulu Sea, on the East by the Pacific ocean, and on the North by the Luzon Strait near Taiwan. Its abundant natural resource makes it is one of the world’s greatest in terms of biodiversity. It covers 300,000 square kilometers (115,831 sq. miles) and a population of 99 million.

However, its location along the western rim of the "Pacific Ring of Fire" (circum-Pacific seismic belt) and close proximity to the equator makes the country prone to both earthquakes and typhoons. In fact, the Philippines is identified as the most vulnerable country when it comes to disasters and disaster-related events. It is considered as the most disaster prone because of its location and makes it vulnerable to many forms of disasters. It is highly vulnerable and subject to all kind of hazards such as droughts, earthquakes, floods, landslides, typhoons, and volcanic eruptions among others. Sixty percent (60%) of the total land area of the Philippines is exposed to multiple hazards making 74% of the population vulnerable to the effects of multiple hazards.

The National Climate Change Action Plan (NCCAP) states that the Philippines ranked highest in the world with reference to vulnerability to the adverse impacts of climate change. The Philippines frequently experiences suffering cause by natural disasters – earthquakes, floods, typhoons, and other disaster related events. It greatly affects those who are mostly vulnerable especially the DDUI's (depressed, deprived, underserved, and isolated - they are mostly children, women, and the poor.

The effects of a series of disasters hitting the Philippines can have a disastrous impact on the lives of people and the environment. An extremely devastating and destructive effects as manifested by the recent earthquake that hit the central Philippines and Typhoon "Haiyan" (codename: Yolanda) greatly affected the vulnerable groups and sustainable development in the Philippines. The extreme sad state of devastation suppresses human spirit and degraded the physical environment.

A result of the recent successive disasters is the need to upgrade the infrastructure systems and design for resilient schools that can withstand earthquakes, flooding, and typhoon related hazards. The recent disasters serve as the driver to innovate and adopt this new form of resilient and adaptive infrastructure. The resilient green school model addresses and mitigates the adverse effects of disasters while at the same time protecting the environment.

The proposed “Green School Model’ hopes to mitigate hazards, educate decision makers, and motivate citizens to indulge and participate in disaster preparedness efforts not only by government efforts alone but in cooperation with the private sector. There is also a need to upgrade government policies and building codes to be able to address the adverse impacts of climate change.

A. Historical Overview of Disasters

According to a World Bank study on disaster risk management for priority countries in the East Asia and the Pacific, the Philippines ranks 8th in multiple hazards hotspot list. Below are the list of hazards that the country is most vulnerable to:

1. *Earthquakes*

The Philippine Institute of Volcanology and Seismology (PhiVolcS) has recorded 12 destructive earthquakes in the last 40 years. The most damaging earthquake in recorded Philippine history is the 1976 Mindanao Earthquake which killed 6,000 people and damaged properties worth $400 million at current valuations.

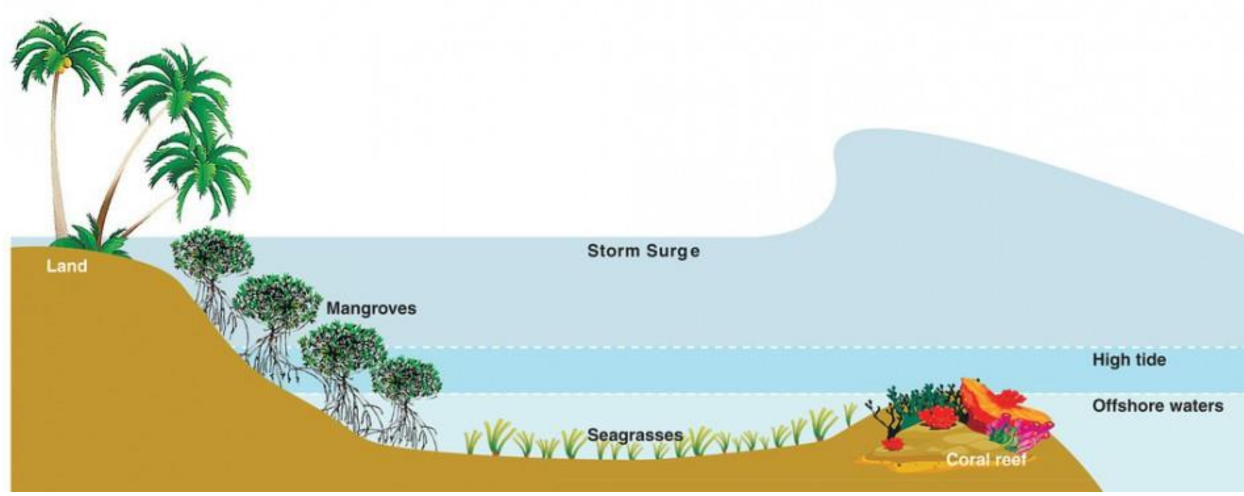
The next most damaging is the 1990 Central Luzon Earthquake which killed roughly 1,000 people and caused damage to properties worth $400 million at current valuations.

The recent October 15, 2013 earthquake in Bohol Island was also a destructive earthquake and affected the nearby Island of Cebu along with some smaller islets.

2. *Floods*

Floods are usually caused by typhoons, tropical depression, and heavy rains. There are also other causes such as dam failures and drainage failures.

3. *Storm Surges*



4. *Typhoons*

An average of 20 typhoons enters the Philippines yearly. Among these, five to seven typhoons are forecast to be strong enough to cause major damage to property and the economy.

5. *Volcanoes*

There are 220 volcanoes throughout the archipelago and 22 of them are active volcanoes. The volcanoes which are among the most active with recent major eruptions are Mt Mayon, Mt Bulusan, Mt Canlaon, and Taal Volcano. The most destructive eruption in recent times is the one produced by Mt Pinatubo when it erupted in 1991.

B. Determinants of Vulnerability to Natural Disasters in the Philippines

1. *Urbanization*

Rapid urbanization in the country has led to the proliferation of informal and overcrowded settlements, mostly in slums and other hazard-prone areas. Informal settlers are among the most vulnerable sector in society when it comes to earthquakes, flooding, and typhoons since majority of them live in unstable makeshift housing.

2. *Environmental degradation*

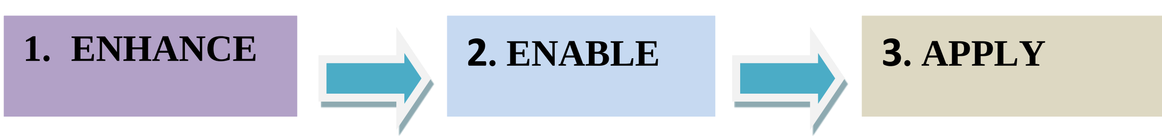
Environmental degradation has hugely contributed to the increasing natural disaster occurrence in the Philippines. The depletion of our natural resources and the destruction of our natural environment are caused by population growth, destructive environmental practices, and defects in the implementation of land-use plans. While some of the more recent flash floods, landslides and drought occur due to exposure to typhoons, these aforementioned hazards are increasing numbers and intensities because most of the land cover which can mitigate them is depleted.

3. *Climate change*

Climate change also makes the Philippines more vulnerable to natural hazards. In the last 15 years alone, the country recorded some of the strongest, deadliest and most destructive typhoons known to man. Climate change is manifested by rising sea levels, frequent droughts and stronger typhoons. The expected sea level rise alone will make 70 percent of the 1,500 municipalities located along the coast vulnerable. The country is also experiencing drought or El Niño resulting to agricultural and economic losses.

III. Purpose

The main purpose of the project can be summarized into three processes;



1. **Enhance**: To enhance the capacity of the policymakers and decision makers at the national and local level.
2. **Enable**: To enable the policy makers at the national and local level.
3. **Apply**: To apply the concepts of eco-efficiency in water-energy infrastructure

design and planning in the context of a green economy and sustainable urban development

All of the above-mentioned processes are in support of the internationally agreed development goals outlined in the Millennium Declaration for the region.

IV. Objective

The main objective of a "Disaster-Resilient, Eco-Efficient, and Holistic Green School Model" is to improve the school building's capacity to resist disaster related pressures while at the same time incorporating eco-efficient architectural designs in the Philippine context. The designs that are developed are aspired to be environmentally friendly, low energy consumption, and resistant to disasters (e.g. earthquakes, floods, storm surges, tsunami, and typhoons).

The "Disaster-Resilient, Eco-Efficient, and Holistic Green School Model" will play as one of the key drivers to enhance disaster preparedness, harmonize disaster threats, promote growth, and protect the environment, while at the same time enabling the stakeholders to include the students so that they will be sensitive to disaster related issues, eco-efficient resource management and climate change impact mitigation. A related goal is for the development of a resilient and sustainable Philippines. The "Disaster-Resilient, Eco-Efficient, and Holistic Green School" architectural designs will serve as design models with the goal of fostering the harmonized development of disaster resistant schools through disaster preparedness, environmental awareness and understanding the holistic resilient approach green school concepts, purposes and designs.

The specific objectives of the work include:

1. **Develop**: To develop holistic resilient and eco-efficient school buildings incorporating the conceptual design of a low-cost green school that is resistant to earthquakes, floods, and typhoons.
2. **Disseminate**: To conduct and organize training workshops at the national and provincial levels. The identified places are Manila for the national; and Cebu,

Leyte and Bohol for the provincial levels.

3. **Enhance**: To enhance the capacity of the policy and decision makers for both the national and local governments.
4. **Discuss**: To discuss issues regarding existing policies whether to upgrade, revise, or promote new policies that promote resiliency for the ecologically sustainable economic development of the Philippines.

V. Mission

The mission for the project includes:

1. To conceptualize a design for an "Eco-Efficient, Holistic and Resilient Structure" that will foster environmental awareness, and disaster preparedness while at the same time promoting the understanding of the underlying concepts and purposes of the designs.
2. We aim that the "Eco-Efficient, Holistic and Resilient Structure" be the driver for the government and its policymakers to support, promote and formulate effective policies for implementation.

VI. Questions

There are questions such as:

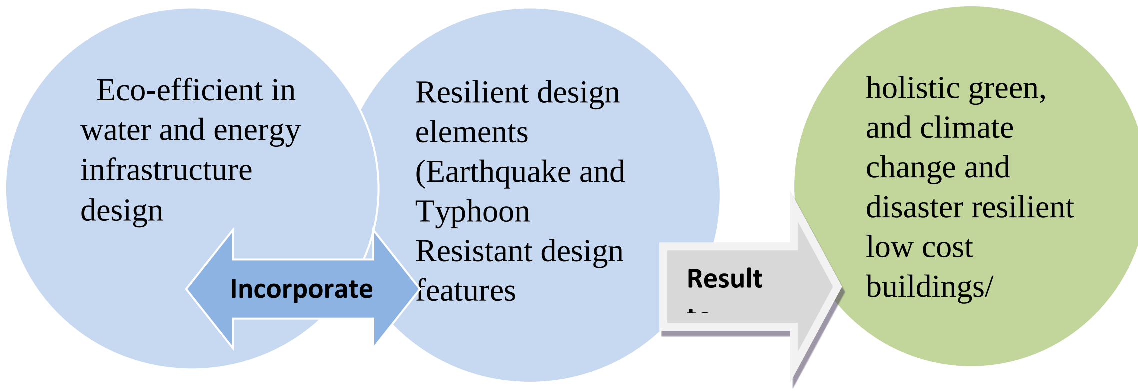
1. Is this the new normal?
2. How prepared are we?
3. Are we designing for the new normal?

There are also question about resiliency and adaptability to climate change adverse effects:

1. Will the solutions protect lives and the environment?
2. Are the solutions offered short term or long term?
3. Does it address the issue of climate change and environmental sustainability holistically?

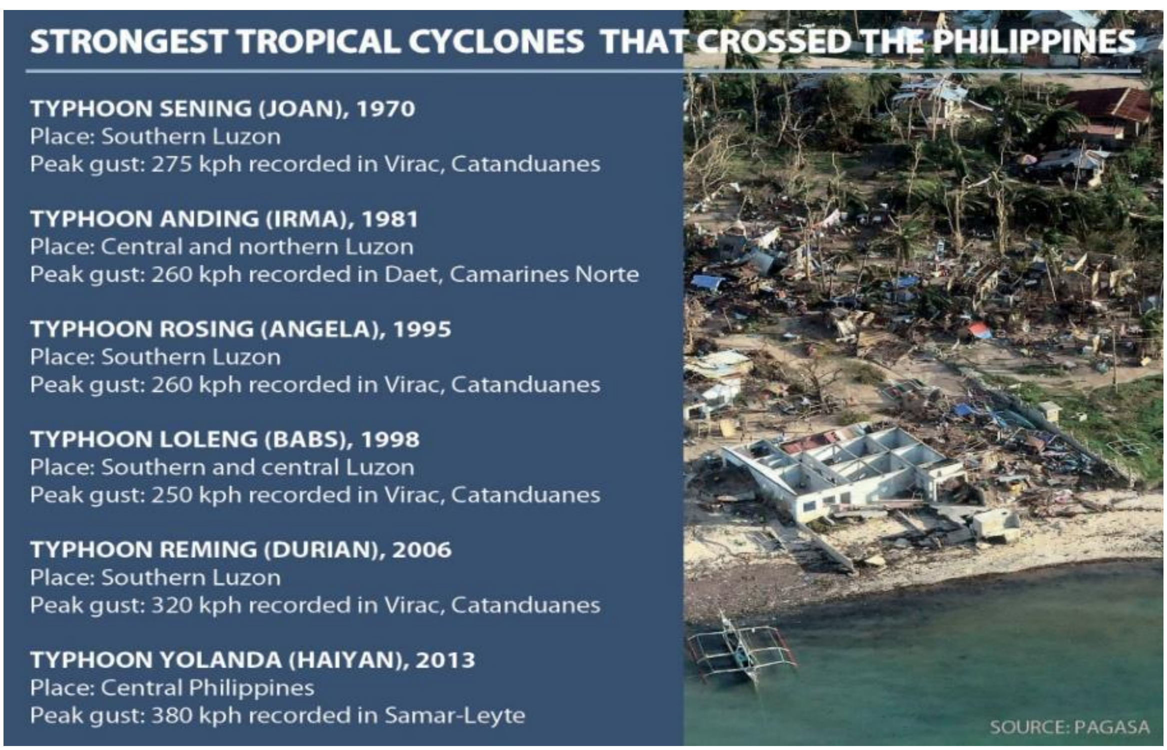
VII. Approach

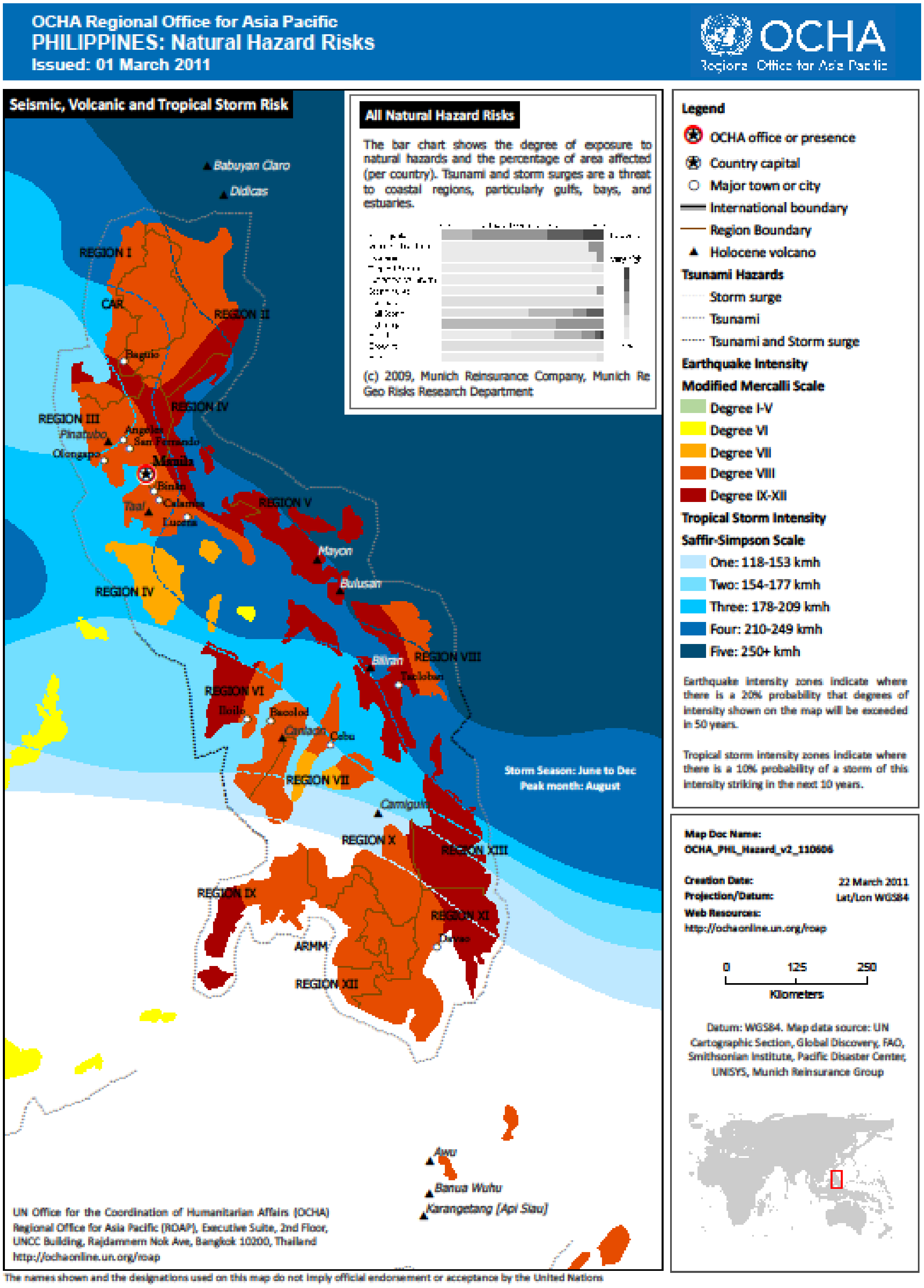
We have to design, develop and plan holistic green, and climate change and disaster resilient low cost buildings/ school. The approach is to incorporate the design elements of green school and add elements of disaster-resilient design to buildings (i.e. resistant to earthquakes, floods, and typhoons).



VIII. The New Normal

THE STRONGEST TROPICAL CYCLONE THAT CROSSED THE PHILIPPINE




OCHA Regional Office for Asia Pacific
PHILIPPINES: Natural Hazard Risks
Issued: 01 March 2011
OCHA
Regional Office for Asia Pacific
Seismic, Volcanic and Tropical Storm Risk
All Natural Hazard Risks
The bar chart shows the degree of exposure to natural hazards and the percentage of area affected (per country). Tsunami and storm surges are a threat to coastal regions, particularly gulfs, bays, and estuaries.
(c) 2009, Munich Reinsurance Company, Munich Re Geo Risks Research Department
Legend
OCHA office or presence
Country capital
Major town or city
International boundary
Region Boundary
Holocene volcano
Tsunami Hazards
Storm surge
Tsunami
Tsunami and Storm surge
Earthquake Intensity
Modified Mercalli Scale
Degree I-V
Degree VI
Degree VII
Degree VIII
Degree IX-XII
Tropical Storm Intensity
Saffir-Simpson Scale
One: 118-153 kmh
Two: 154-177 kmh
Three: 178-209 kmh
Four: 210-249 kmh
Five: 250+ kmh
Earthquake intensity zones indicate where there is a 20% probability that degrees of intensity shown on the map will be exceeded in 50 years.
Tropical storm intensity zones indicate where there is a 10% probability of a storm of this intensity striking in the next 10 years.
Babuyan Claro
Didicas
REGION I
CAR
REGION II
Baguio
REGION III
REGION IV
Pinatubo
Angeles
San Fernando
Olongapo
Manila
Binan
Calamba
Taal
Lucena
REGION V
Mayon
Bulusan
REGION IV
Biliran
REGION VIII
Tacloban
REGION VI
Iloilo
Bacolod
Canlaon
Cebu
REGION VII
Storm Season: June to Dec
Peak month: August
Camiguin
REGION X
REGION XIII
REGION IX
REGION XI
Davao
ARMM
REGION XII
Awu
Banua Wuhu
Karangetang [Api Siau]
UN Office for the Coordination of Humanitarian Affairs (OCHA)
Regional Office for Asia Pacific (ROAP), Executive Suite, 2nd Floor,
UNCC Building, Rajdamnern Nok Ave, Bangkok 10200, Thailand
http://ochaonline.un.org/roap
Map Doc Name:
OCHA_PHL_Hazard_v2_110606
Creation Date: 22 March 2011
Projection/Datum: Lat/Lon WGS84
Web Resources:
http://ochaonline.un.org/roap
0 125 250
Kilometers
Datum: WGS84. Map data source: UN Cartographic Section, Global Discovery, FAO, Smithsonian Institute, Pacific Disaster Center, UNISYS, Munich Reinsurance Group
The names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations

CHRONOLOGY OF RECENT EARTHQUAKES IN THE PHILIPPINES

March 17, 1973, Ragay Gulf, M 7.0 - Calauag town, Quezon was worst-hit. Water, electric and telegraph lines snapped. Damaged roads, railroads and bridges travel to and from the Bicol Region **Aug. 17, 1976, Moro Gulf, M 7.9** Worst hit were the Cotabato provinces. But the tsunami that struck 700 kilometers of Moro Gulf coastline hit Lanao del Sur and Pagadian City (Zamboanga del Sur) hardest. Homes 500 meters of the Pagadian coast were destroyed. The toll: 4,791 dead, 2,288 missing, 9,928 injured. The tsunami caused 85 percent of the deaths. **Aug. 17, 1983, Laoag, M 6.5-** At Intensity 7, it is believed to be the second largest earthquake to hit Laoag City after the March 19, 1931 earthquake, which had intensities of 7 to 9. The toll: 16 dead, 47 injured **July 16, 1990, Luzon, M 7.8-** Worst-hit were Nueva Ecija, Nueva Vizcaya and Benguet. Baguio hotel collapsed. Liquefaction hit La Union's swampy areas. Subsidence occurred in Tarlac and	**1948, Panay, M 8.1-** It damaged heritage churches in Iloilo Province. **Aug. 2, 1968, Casiguran, M 7.3 -** Felt at Intensity 8 in Casiguran Town, Aurora; it damaged buildings near Binondo and Escolta in Manila. The six-story Ruby Tower collapsed in Binondo, killing 268. Total toll: 270 dead, 261 injured **Feb. 8, 1990, Bohol, M 6.8 -** Jagna, Duero, Guindulman, Garcia Hernandez and Valencia towns were inundated when sea waves caused Duero's Alijuan River to flow inland. Some 182 structures collapsed, including two centuries-old churches. The toll: 6 dead, more than 200 injured. **Nov. 15, 1994, Oriental Mindoro, M 7.1-** A tsunami up to 8.5 meters high moved up to 250 meters inland. It swept a floating power barge inland and wrecked 7,566 homes. Eight bridges were impassable for days. Some 78 people died (49 by drowning); 430 were injured. **Feb. 15, 2003, Masbate, M6.2-** Felt at

Metro Manila. More than 1,200 died. Property and infrastructure damage was at least P10 Billion **March 6, 2002, Sultan Kudarat, M 6.8-** Felt at Intensity 9 in Palimbang town, Sultan Kudarat; Intensity 8 in Maitum (Sarangani) and Lebak (Sultan Kudarat), it killed 14, injured 144 and damaged homes, roads, bridges, mosques, school buildings, a megadike and other structures **Aug. 31, 2012, Eastern Samar, M7.7-** The quake hits off Guiuan, felt in more than 40 areas in the country, killed one. Bridges and roads in Eastern Samar and Southern Leyte cracked or tilted.	Intensity 8 in Sta. Cruz, Palanas and Suba, Dimasalang, it damaged homes, bridges, slope protection ripraps, river control systems and the Masbate-Cataingan Road. In a 1973 Masbate temblor, large fragments of limestone cliffs in Ticao Island fell into the sea. **Oct 15 ,2013 Bohol M7.2-** Affected six provinces in central Visaya and Western Visayas death toll 222, 797 injured, P2.2 bilion pesos damaged to public infrastructure, Bohol and Cebu churches were damaged or destroyed

With the above chronology of earthquakes and typhoons, we see that disasters can be induced by climate change, humans, or nature. Climate change is here to stay and we have to pursue a strategy of adaptation, eco-sustainability and resiliency to be able to take the challenge. Thus, there is a need to design resilient infrastructure that can address these challenges.

CHAPTER 2

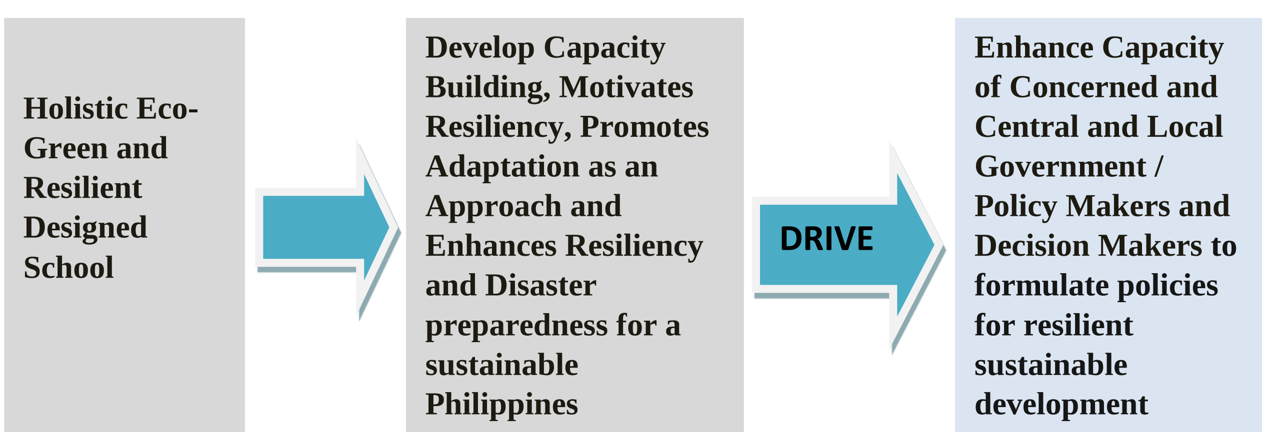
DEVELOPING DISASTER-RESILIENT, ECO-EFFICIENT, AND HOLISTIC-GREEN SCHOOL DESIGNS

The Philippines is identified as highly vulnerable to natural disasters and the adverse effects of climate change. It is for this purpose that we aim to conceptualize designs for Disaster-Resilient, Eco-Efficient, and Holistic Green Schools that are applicable to the Philippines and other countries in the ASEAN and Pacific Region to mitigate and address the adverse impacts of climate change.

The concept of disaster-resilient, eco-efficient, and holistic green schools enhances capacity building, motivates resiliency, and promotes adaptation as an approach that complements disaster preparedness. These schools will act as the key drivers to enhance the harmonized development of green growth and the environment as well as resiliency.

It will further enable stakeholders and policy makers to discuss issues related to existing policies, finding ways and means to revise and upgrade existing policies that will address and suggest revision and upgrade existing policies towards the environment, water and waste water, disasters and the adverse impact of climate change. Furthermore this will promote sensitivities to eco-efficient resource management and resiliency towards disasters and the effect of adverse impact of climate change.

I. Objective Flow



The objective can be done in the form of training materials and disseminate them with the aim of enhancing capacity of the concerned central and local government officials/ policy and decision makers in the Philippines.

II. Principle Approach

Holistic Approach

Disaster Resilient Design Model- Typhoon and Earthquake Resistant and othe form of hazards and Risks + ***Green School Design*** = ***Holistic Green-Climate Change and Disaster Resilient School Design***

The principle approach to advance the Disaster-Resilient, Eco-Efficient, and Holistic Green School Model is to address issues of resiliency and adaptation to the adverse effects of climate change, and other disasters and sustainable development.

It is a holistic approach to resiliency and disaster preparedness through design models that is adaptable and resistant to earthquakes, floods, and typhoons, while incorporating mitigating design elements addressing environmental concerns

The "Green School Concept" itself is conceived to be an instrument of learning where the students are not just afforded with quality education but furthermore aided with environmentally sensitive school buildings, that successfully adapts all of the good practices encouraging the reduction of greenhouse gases, efficient use of resources, all for environmental sustainability. This to enhance awareness and understanding on the issue of environmental conservation and hopefully, motivate communities to live sustainably.

III. Disaster-Resilient, Eco-Efficient, Holistic Green School Concepts

Combination of Comparative Characters and its Resultants
Green School + Resilient School (Infrastructure) = Holistic Resilient School

Green School	+	**Resilient (Infrastructure)**	=	**Holistic Resilient School**

The approach that is taken is "The School Building that Teaches/The School that Educates, The School Building that Shelters" and "a school that is disaster resilient exhibiting earthquake, flood, and typhoon resistant character". Furthermore, the school structure is adaptable with multiple functions in times of emergencies and disasters.

A. Disaster-Resilient Infrastructure Characteristics

- Exhibits adaptability to the adverse effects of climate change
- Resistant to the adverse effects of climate change and related disasters exhibiting earthquake, flood, and typhoon resistant properties
- Multiple and flexible in function in times of emergencies, calamities and disasters
- Application of Universal Design principles

B. Eco-Efficient School Characteristics and Benefits

1. Characteristics

- Multiplicity of function
- Adapt all good practices on green schools which will encourage the reduction of greenhouse gases, efficient use of resources, all for environmental sustainability

2. Benefits

- Environment

- Social
- Economic

C. Resultant: The Disaster-Resilient, Eco-Efficient, and Holistic Green School

The Disaster-Resilient, Eco-Efficient, and Holistic Green School exhibits a combination of characteristics of an eco-efficient green school and a disaster-resilient infrastructure. It is a low carbon green school with adaptability, resiliency, and sustainability design elements.

- Positive contributory factors to society, education and environment, and promotes resiliency to climate change effects and disasters
- Typhoon and Earthquake Resistance Schools
- Stable and structurally safe evacuation shelter
- Promotes Disaster Preparedness
- Motivates citizens regarding emergency preparedness
- Sustainably prepared in times of disaster in reference to water and power
- Rainwater harvesting is an important attribute regarding the need of water during emergencies and disasters.
- Reduce ecological footprints
- Healthy School Environment for the students and staff
- Conducive to learning environment
- Promote ecological sustainability by pursuing green building and maintenance practices.
- Adaptable school to climate change effects
- Provide sustainable nutritional food supplements
- Sustainable means of income for sustainable maintenance and operation
- Multiplicity of purpose and function- an added dimension will be stable and structurally sound emergency shelter in times extreme disaster. (primary purpose and function: school, alternative function: a space for public gathering and community meetings (social centres), Election voting centres, and emergency shelter in times of climate change effects like typhoons, flood disaster manmade

or natural

- The school as an instrument of learning, associates the environment closely as an interactive tool including objects, colour, texture, size, breeze, sustainable features, and arrangement within as an additional experience to augment the learning process.
- The use of tree buffers not only as solar shades but also wind buffer especially during storms and typhoons.
- Carbon Neutral
- Rainwater harvesting is an important attribute regarding the need of water during emergencies and disasters.
- Waste Management
- Sustainable Operation and Management

IV. Multiple Approach Dimension

Holistic Green school shall exhibit the following multiple approach dimensions:

Approach Dimension 1:
Resilient Character of the School Building

Approach Dimension 2:
Eco- Efficient Green Building properties such as Water, Waste Management and Energy

Approach Dimension 3:
School and community functional space relationship and Disaster Preparedness

Approach Dimension 4:
Combined traditional system of construction, taking into consideration the different socio-cultural- historical layers of society and consider low and high technology system with low construction cost and high impact on the

A. Benefits

1. **Economic Benefits**

   Climate change causes disasters and calamities affecting lives, property and food security and that will result to economic loss. Building resilient structures resist typhoon's destructive effects thereby minimizing damages for both property and lives.

2. **Social**

   Prevents and minimizes social displacement. It will partially address issues on cycle of rebuilding every after disaster.

3. **Environment**

   Eco-efficient infrastructure helps protect and preserve the environment and mitigate the disastrous effects of climate change. Building resilient structures minimize waste and debris brought about by structure damaged by typhoons.

CHAPTER 3

RESILIENT AND ECO-EFFICIENT DESIGN SCHOOL MODELS

I. What is resilience?

Resilience is the capacity to bounce back after a disturbance or interruption at various levels- individuals, household, communities and regions. Through resilience we can maintain livable conditions in the event of natural disasters, loss of power and water or any other interruption in normally available services (Resilient Design Institute)

Resilient design: is the intentional design of buildings, landscapes, communities, and regions in response to these vulnerabilities.

II. Resilient School Design Models

- Resilient design models shall include typhoon and earthquake resistant cost efficient design elements.
- Resilient schools shall be safe enough to be a shelter and place of refuge (multiplicity of function).
- Resilient school shall be designed to address climate related pressures with adaptability as an approach.
- Resilient school building guideline or building guidelines shall be prepared to help in awareness and enhancing capacity of designers, builders, decision makers and policy makers.
- Resilient design pave the for building laws review, upgrade and formulate new standards.

III. Guidelines and Criteria

A. Earthquake Resistant School Guidelines in Planning and Design

There are things that we have to consider in building resilient schools which are earthquake resistant:

- Consider in the design of school buildings that can withstand an earthquake of intensity 8 to intensity 9.
- Site selection matters- select sites that are safe and not identified as hazard areas. Away from ground shaking, ground rupture, rain induced landslide, earthquake and landslide induced.
- Try and develop structural system solutions that are resilient in features.
- Design and develop innovative structural system solutions that are resilient in features.
- Consider the relevant structural design system tested from our past historical-socio- cultural layers. Study how and why they survived the different forms of disaster and apply as a resilient design element to come up with a holistic resilient school design.
- Consider emergency access in the design

B. Flood and Typhoon Resistant School Guidelines in Planning and Design

There are things that we have to consider in building resilient schools which are typhoon resistant:

- Consider resiliency and adaptability in design and planning.
- Consider emergency access in the design
- Consider in the design of school buildings that can withstand storms with maximum winds 275 to 390 kilometers per hour. In other words upgrade existing building laws and standards.
- Consider the location in planning, build on safe zones identified as safe area from identified hazards zones. Away from storm surge hazard identified area as well as build on safe zones no build setback as protection from tsunami.
- Build and design always on the maximum and to some extend higher standards.
- Innovative- consider in the design theory of least resistance taking into consideration aero-dynamic forms
- Design and develop innovative structural system solutions that are resilient in features.

C. Benefits of Eco-Efficient Planning and Design Guidelines

1. Environmental Benefits

Helps sustain the environment and helps mitigate the adverse impact of climate change and address the issues of:

- Storm water management
- Temperature Moderation
- Emission Reduction
- Water conservation

2. Social and Health Benefits

- Brings about a healthy and productive society
- Improves the user's health, comfort, productivity
- Increase a healthy indoor environment

3. Economic Benefits

Multiplier effect of cost reduction that is:

- Energy and water savings
- Lower operational management budget

IV. Holistic Resilient and Eco-Efficient School Conceptual Approach

The Conceptual Approach of a Holistic Resilient School is a combination of three features and characteristic as enumerated above as design and planning guidelines for a resilient school. The above guidelines set the parameter as criteria in formulating the design and plan for a holistic resilient school. The criteria set are grouped into three features and characters and they are

- Earthquake Resistant Features
- Flood Resistant Features
- Typhoon Resistant Character
- Eco–Efficient Green School

CHAPTER 4

CASE STUDY OF POST-HAIYAN (YOLANDA) SCHOOL REHABILITATION PLAN

Case Study: Post-"Yolanda" School Rehabilitation Plan
Northern Cebu, Cebu Province, Philippines

By: Koradesigngroup: Cris Cyril C. Abbu, Myla Gador, and Joy Lim Abbu

A case study of schools damaged by 2013 typhoon "Haiyan" codename "Yolanda" entitled: "Post Typhoon Yolanda School Rehabilitation Plan".

Koradesigngroup was commissioned to do the study by The Ramon Aboitiz Foundation Inc. (RAFI) to assess and ascertain the extent of damage, review the system of construction and materiality standards, standard of construction and workmanship and implementation. Part of the study is to come up with technical design solutions on how to rehabilitate, retrofit, repair and rebuild schools damaged by typhoon "Haiyan" Most importantly the will be guide on what appropriate intervention to take in rehabilitating damaged school.

I. General Statement

With an average of 20 typhoon visits our country annually and we need to adapt to climate change adverse effects. There is a need to reinforce and upgrade the standards for construction system, specifications, and design. There is a need to retrofit, rebuild existing schools specially those damaged by the recent typhoon "Yolanda". The reason behind the above statement is that most of the damaged schools found in Northern Cebu are designed not as typhoon and earthquake resistant structure. Evidently roofs were blown away and structures partially or completely collapsed.

What is important is no repair shall be done unless existing damaged schools are reinforced and retrofitted with the purpose of having to resistant typhoons and earthquakes. There will be two profiles of schools for retrofitting actions namely;

A. **Inland Schools**
B. **Coastal Schools**

The purpose for such profiles shall be to identify the level of intervention in term of cost and complexities of the damages. This will at least ensure appropriate allocation of resources in accordance to level of intervention.

C. Considerations

DIMENSIONS THAT SHOULD BE CONSIDERED

Extent of damage

Specification and system of Construction

Workmanship

Stability and Economic Life of the Structure Typhoon and Earthquake Resistant

→ ***Appropriate Intervention***

OTHER COST THAT WILL HAVE TO BE CONSIDERED

ECONOMIC COST

ENVIRONMENTAL COST

SOCIAL COST

II. Needs Assessment

Over 1,200 classrooms needs intervention and this affects 50,000 students in Northern Cebu, Philippines. Below are the observation and intervention that should be considered:

III. Observation, Comments and Intervention

If we are to fix and roof damage school, we should consider looking into the system and method of construction, materials use, workmanship, and most importantly the design. When the next typhoon comes we are to make sure that what was installed and repaired will still be in place. Then there is this cost implication of repairing again.

There is a need to retrofit by reinforcing the existing schools structure whether partially minimal damaged and or major damaged. The existing structure will have to be reinforced structurally to be able to withstand future disasters.

Noticeably- there is an absence of a roof beam, which is very essential in load distribution whether dead load or live load. No collar plate and or ridge block to hold both rafters at the apex.

A. Observation in Summary

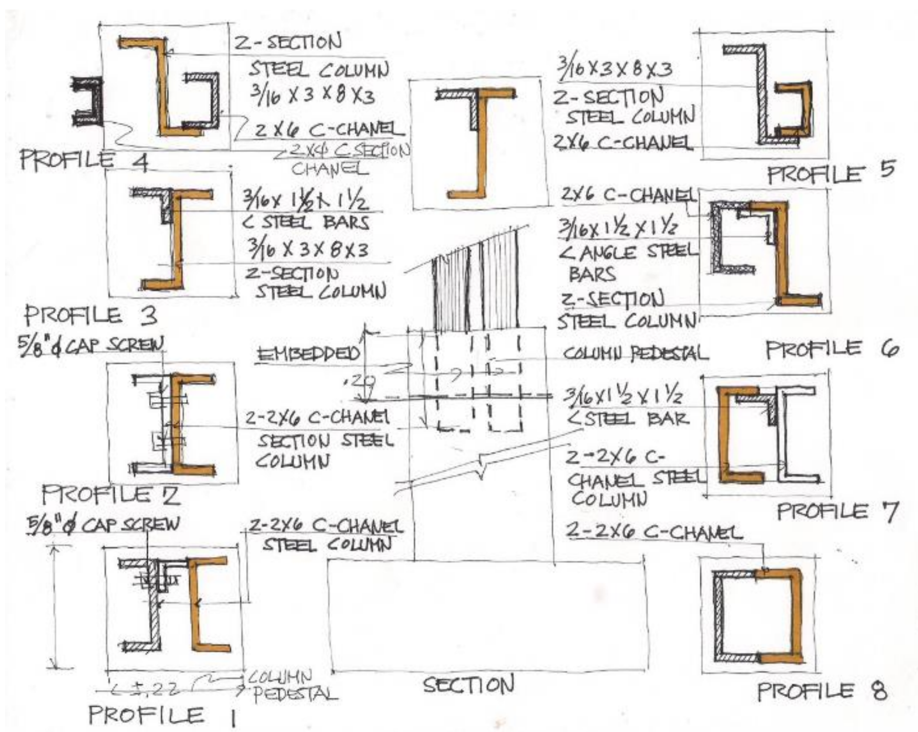
1. Sub-standard school design both architectural and structural
2. Poor workmanship
3. Used sub-standard building materials

4. Sub-standard joint and anchorage attachment
5. Absence of insulating features from heat transfer
6. Insufficient reinforcement
7. Absence of gutter system that collects rainwater
8. Insufficient ratio student per classroom rating
9. Apparently there is lack of construction monitoring in the erection of these schools as seen in sub-standard workmanship, material and building system.
10. Lack of construction material monitoring in production and standards.
11. Lack of construction standard monitoring available in the market.
12. Corruption is an issue here.

B. Graphic Illustration of Schools Damaged During Typhoon Haiyan (Yolanda)

1. Existing Column Pedestal

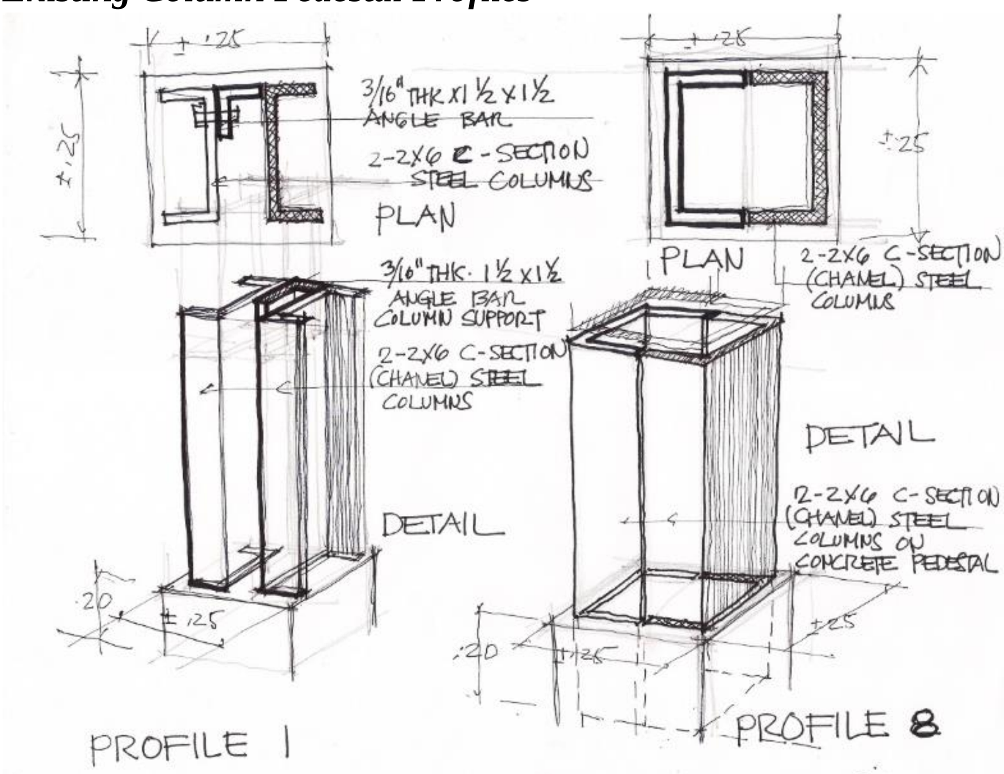
There are 8 existing column pedestal configuration: clearly there is an absence of standards

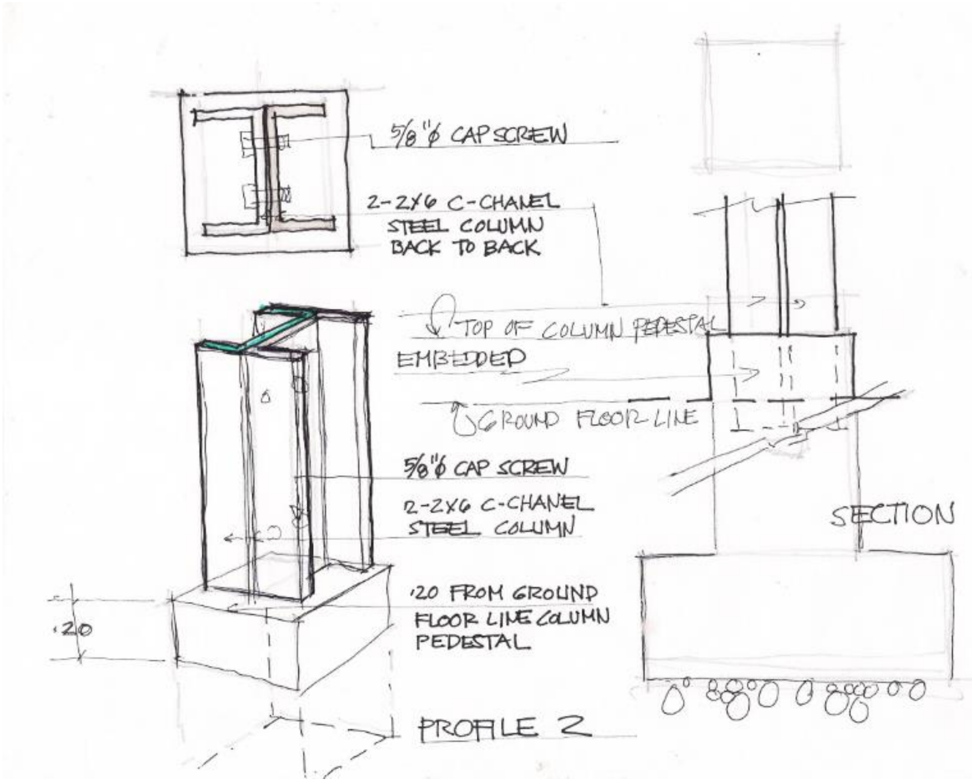


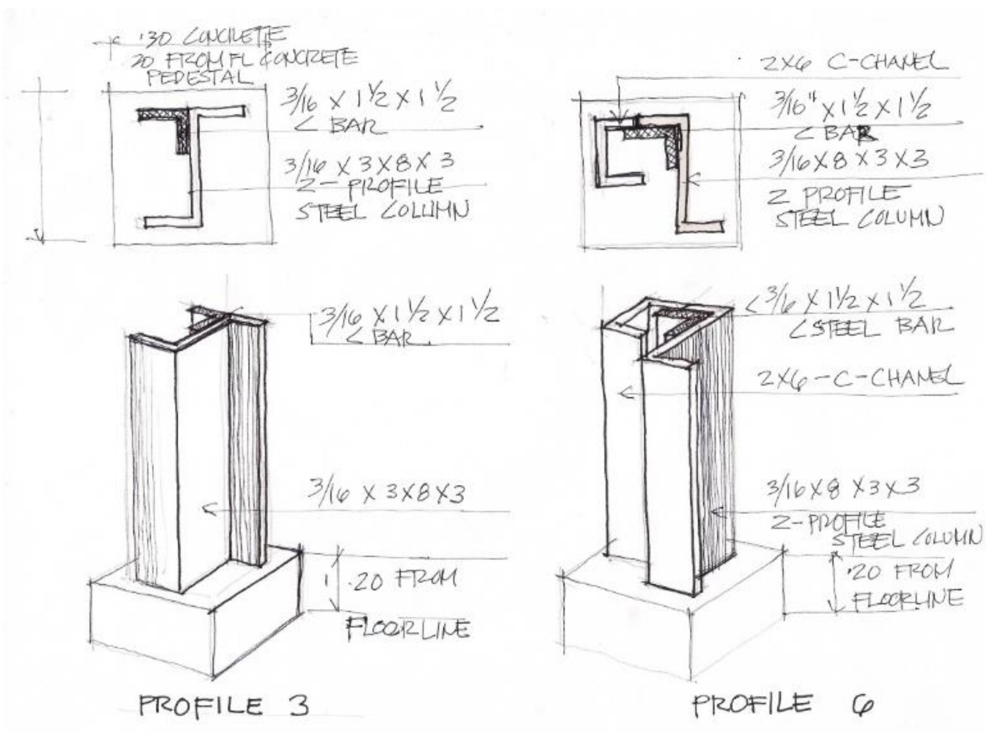
- Column Pedestal is mounted .20 meters from the floor line when the structural component should be at .30 meters
- That the above pictures shows sub-standard embedment of steel columns
- The steel column section shown are composite material used as columns
- That the concrete inappropriate concrete mixture
- That the steel colunm members shows corrosion
- Steel member lacks coat protection
- Sub-standard steel columns sec tion used
- Poor workmanship both concreting and welding works

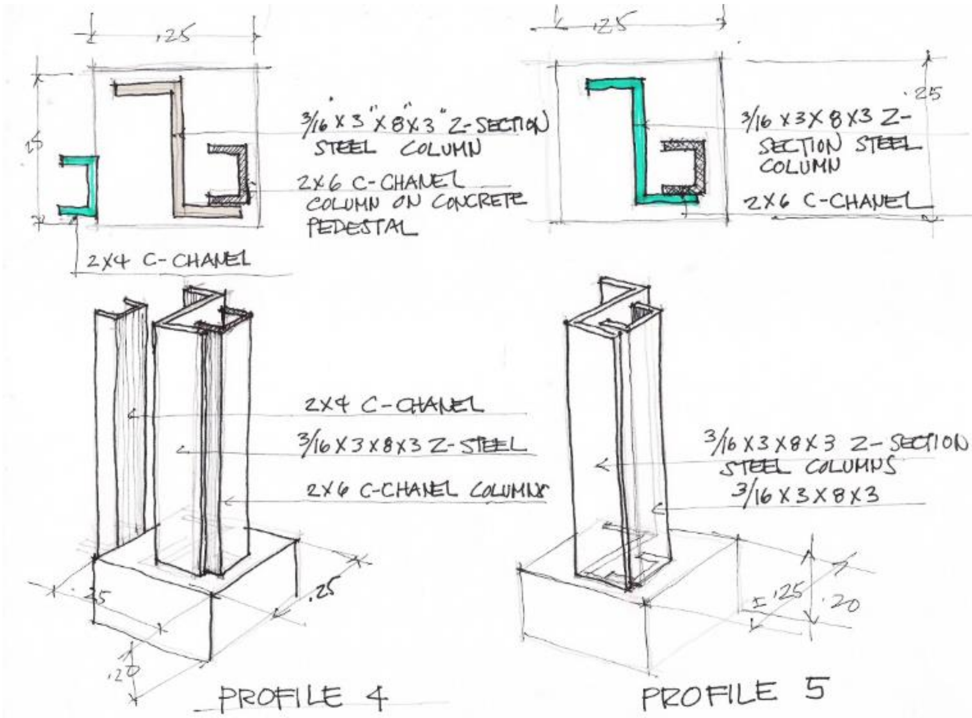
- No protected Concrete colunm pedestal concrete covering
- Different column pedestal design and installation-
- Some column pedestal shown buckling action and effects
- Inconsistencies on the system of construction, specifically jointry, material specification applied and work and material applicability
- There should be one column pedestal design for easier implementation and monitoring

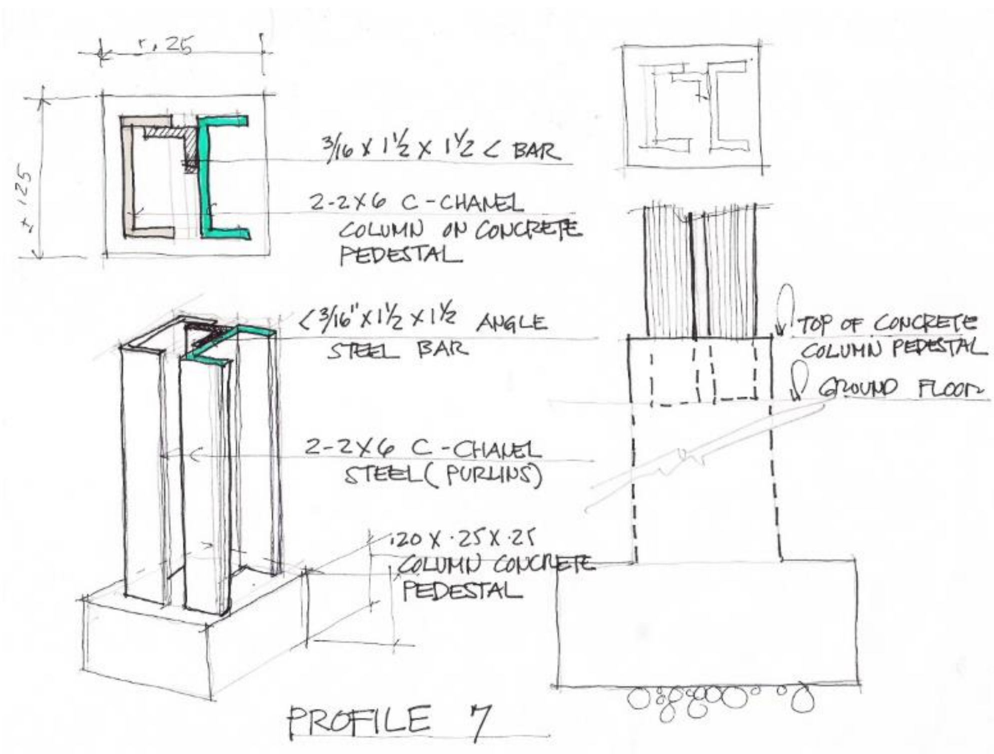
2. *Existing Column Pedestal Profiles*




5/8"ø CAP SCREW
2-2X6 C-CHANEL
STEEL COLUMN
BACK TO BACK
TOP OF COLUMN PEDESTAL
EMBEDDED
GROUND FLOOR LINE
5/8"ø CAP SCREW
2-2X6 C-CHANEL
STEEL COLUMN
SECTION
.20 FROM GROUND
FLOOR LINE COLUMN
PEDESTAL
.20
PROFILE 2


.30 CONCRETE
.20 FROM FL CONCRETE
PEDESTAL
3/16 X 1 1/2 X 1 1/2
∠ BAR
3/16 X 3 X 8 X 3
Z- PROFILE
STEEL COLUMN
2X6 C-CHANEL
3/16" X 1 1/2 X 1 1/2
∠ BAR
3/16 X 8 X 3 X 3
Z PROFILE
STEEL COLUMN
3/16 X 1 1/2 X 1 1/2
∠ BAR
3/16 X 1 1/2 X 1 1/2
∠ STEEL BAR
2X6 - C - CHANEL
3/16 X 3 X 8 X 3
.20 FROM
FLOORLINE
3/16 X 8 X 3 X 3
Z- PROFILE
STEEL COLUMN
.20 FROM
FLOORLINE
PROFILE 3
PROFILE 6


3/16 X 3" X 8 X 3" Z-SECTION STEEL COLUMN
2X6 C-CHANEL COLUMN ON CONCRETE PEDESTAL
2X4 C-CHANEL
2X4 C-CHANEL
3/16 X 3 X 8 X 3 Z-STEEL
2X6 C-CHANEL COLUMNS
PROFILE 4
3/16 X 3 X 8 X 3 Z-SECTION STEEL COLUMN
2X6 C-CHANEL
3/16 X 3 X 8 X 3 Z-SECTION STEEL COLUMNS
3/16 X 3 X 8 X 3
PROFILE 5


3/16 X 1½ X 1½ ∠ BAR
2-2X6 C-CHANEL COLUMN ON CONCRETE PEDESTAL
∠3/16" X 1½ X 1½ ANGLE STEEL BAR
2-2X6 C-CHANEL STEEL (PURLINS)
.20 X .25 X .25 COLUMN CONCRETE PEDESTAL
TOP OF CONCRETE COLUMN PEDESTAL
GROUND FLOOR
PROFILE 7

IV. Solutions and Interventions

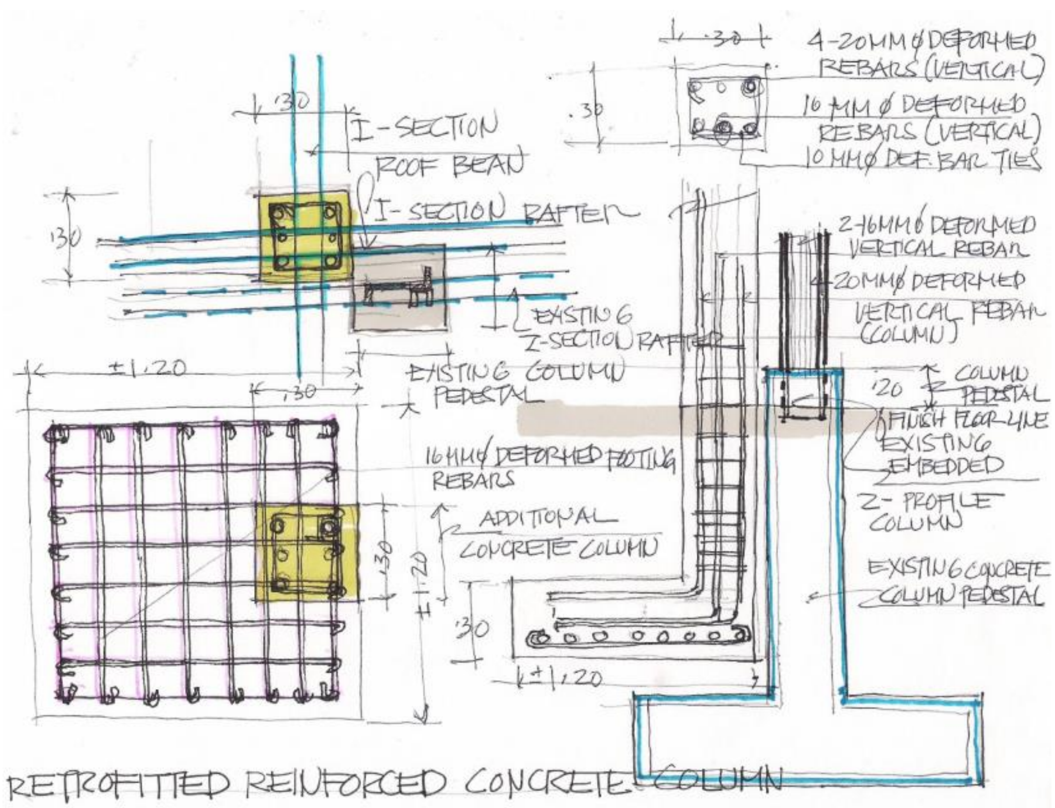
A. Retrofitting-Rehabilitation

Note: While we highly recommend that it is better to build new resilient schools buildings (typhoon and earthquake resistant building), there are certain cost implications. But taking into consideration the yearly cycle of typhoon, it is better to build a stable and resilient school building than to repair and renovate after every typhoon comes. We need to build stable and resilient schools since they are always a place of refuge in times of calamities, disasters and emergencies.

B. Coastal

- Add a Reinforced Concrete Column: adjacent to the existing column axis of the exterior of the school building.
- Add intermediate Columns along each and every structural span- if applicable-

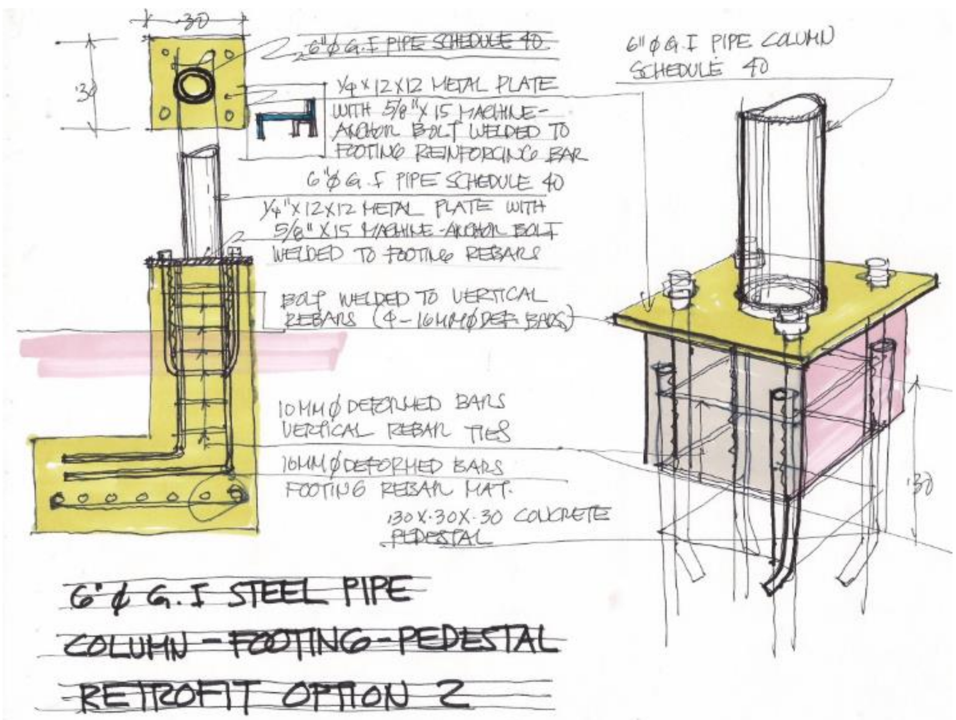
1. Reinforced Concrete Columns



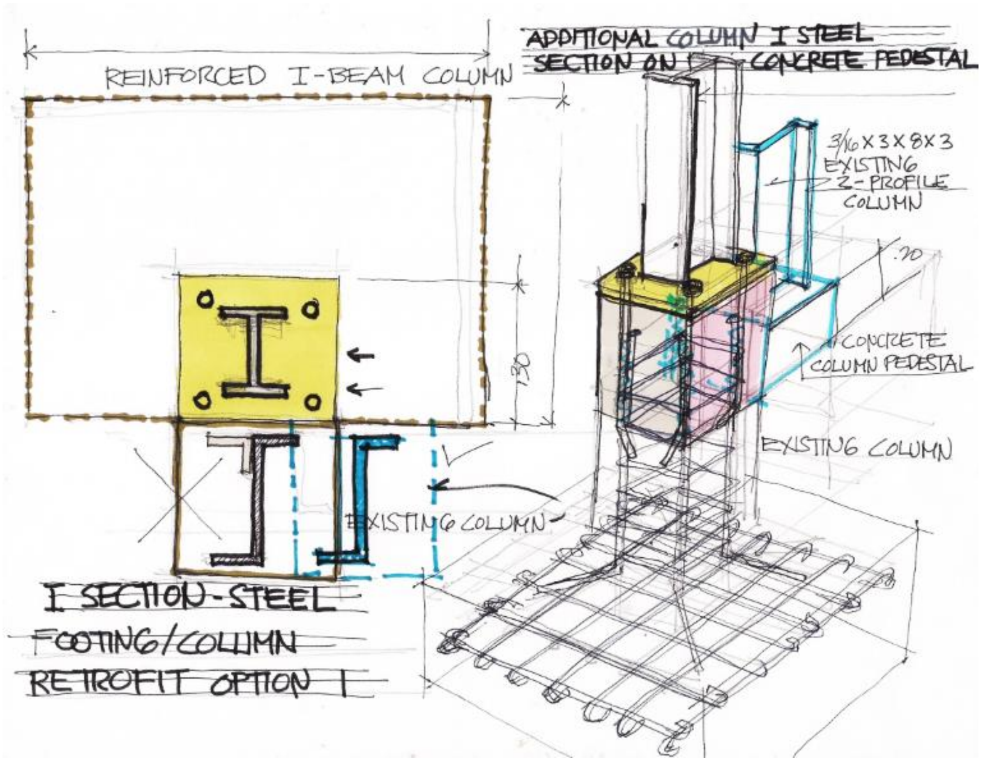
C. Inland - Either Design of Composite Steel on Column Pedestal

- Add a Composite Type Column Pedestal: adjacent to the existing column axis of the exterior of the school building.
- Add intermediate Columns along each and every structural span- if applicable-
- There a problem in maintaining correct installation and workmanship, good and strict monitoring compliance system shall be enforced religiously with huge penalties in every infraction.
- Monitor material standard and make sure that the specified standards are installed.

1. 6" G.I. Pipes on Metal Plate Concrete Column Pedestal

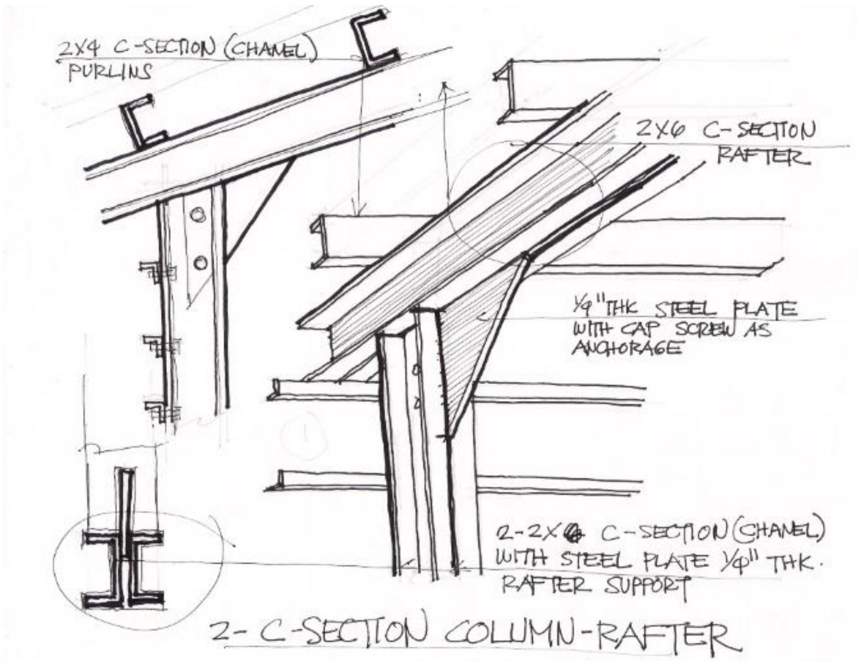


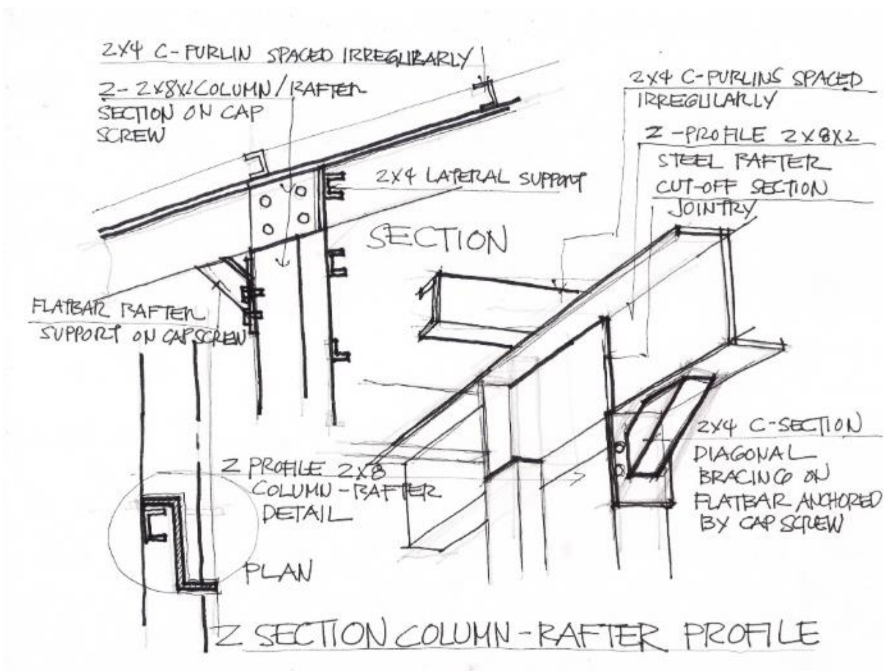
2. I-Section Steel Column on Metal Plate Concrete Pedestal

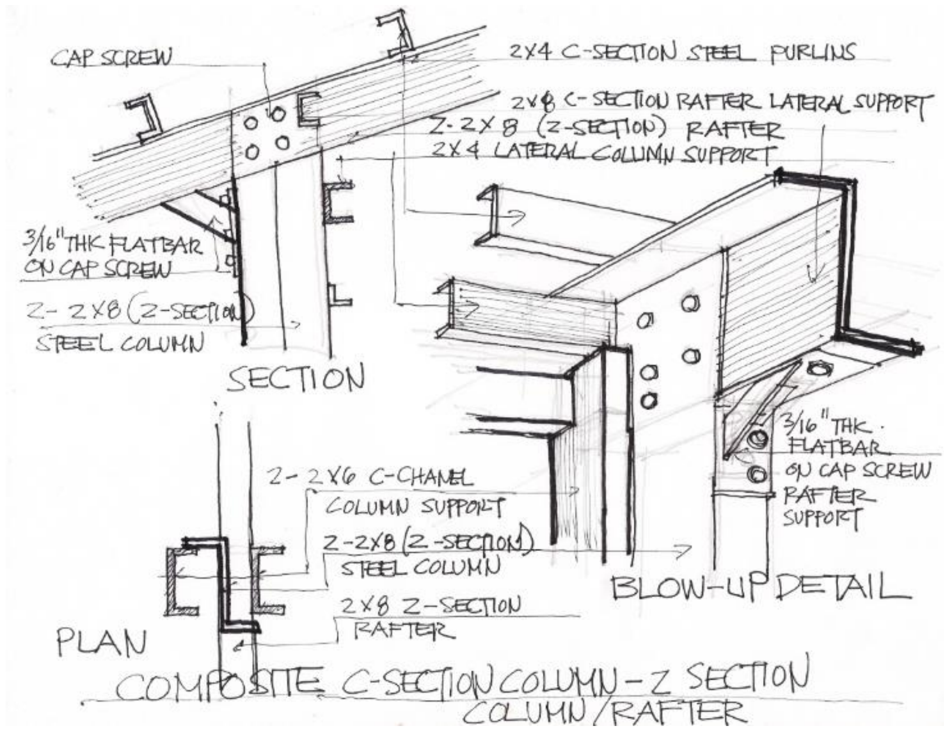


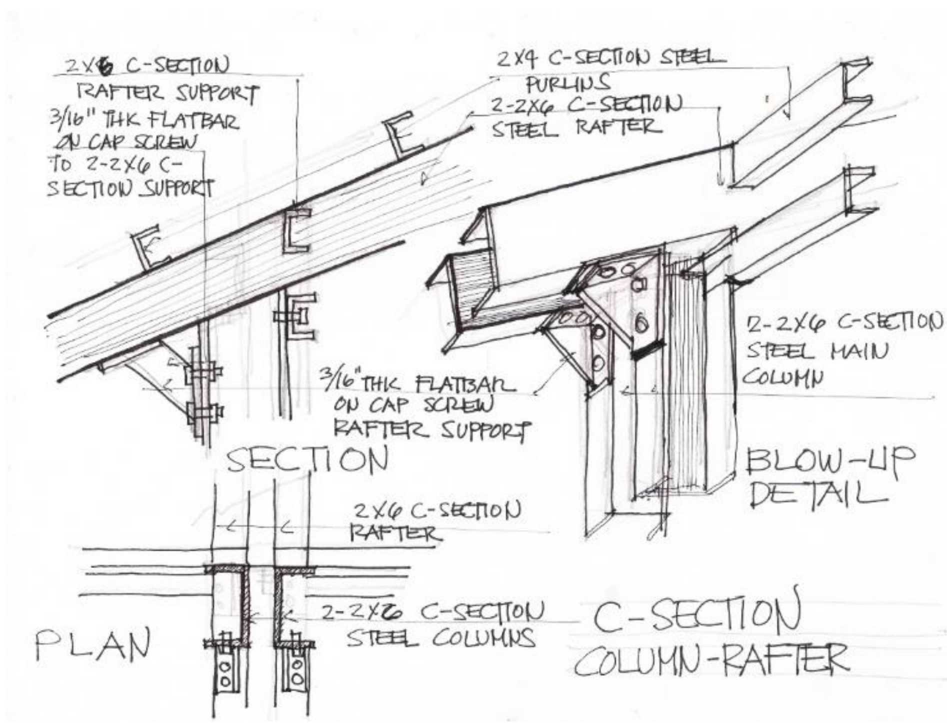
3. Existing Columns Roof Beams Connection - Rafter and Joinery

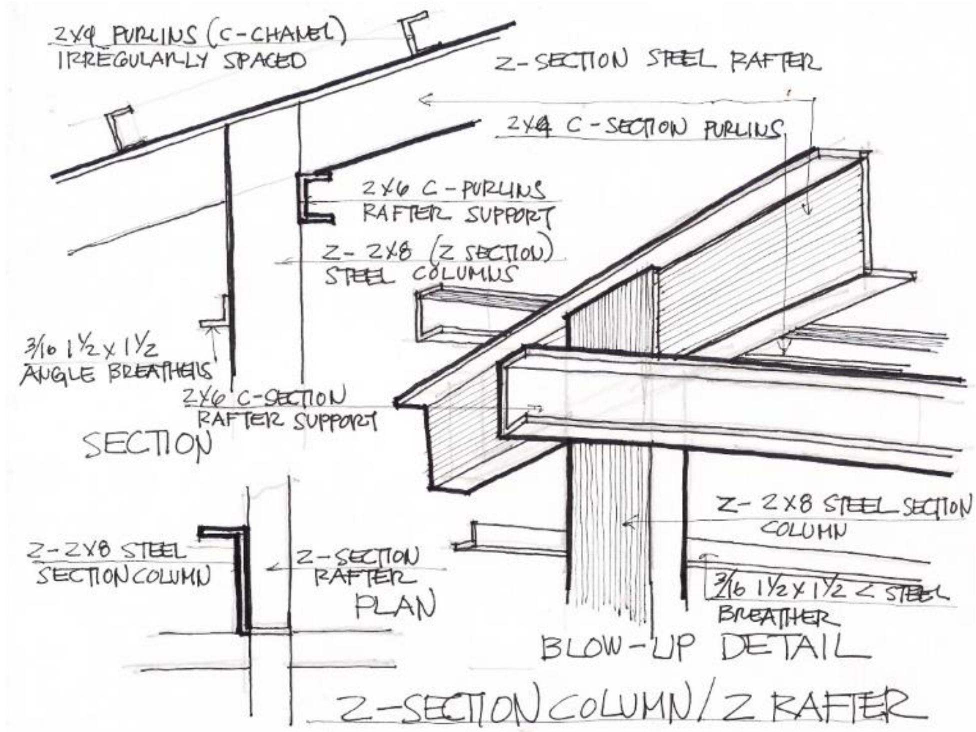
Observation: Different profiles of column/rafter installation designs were noticed. There are no roof beams for dead load and live load distribution. Please refer to the illustrations below. All installation and system in this item are below standards.


2X4 C-SECTION (CHANEL)
PURLINS
2X6 C-SECTION
RAFTER
1/4" THK STEEL PLATE
WITH CAP SCREW AS
ANCHORAGE
2-2X C-SECTION (CHANEL)
WITH STEEL PLATE 1/4" THK.
RAFTER SUPPORT
2- C-SECTION COLUMN-RAFTER

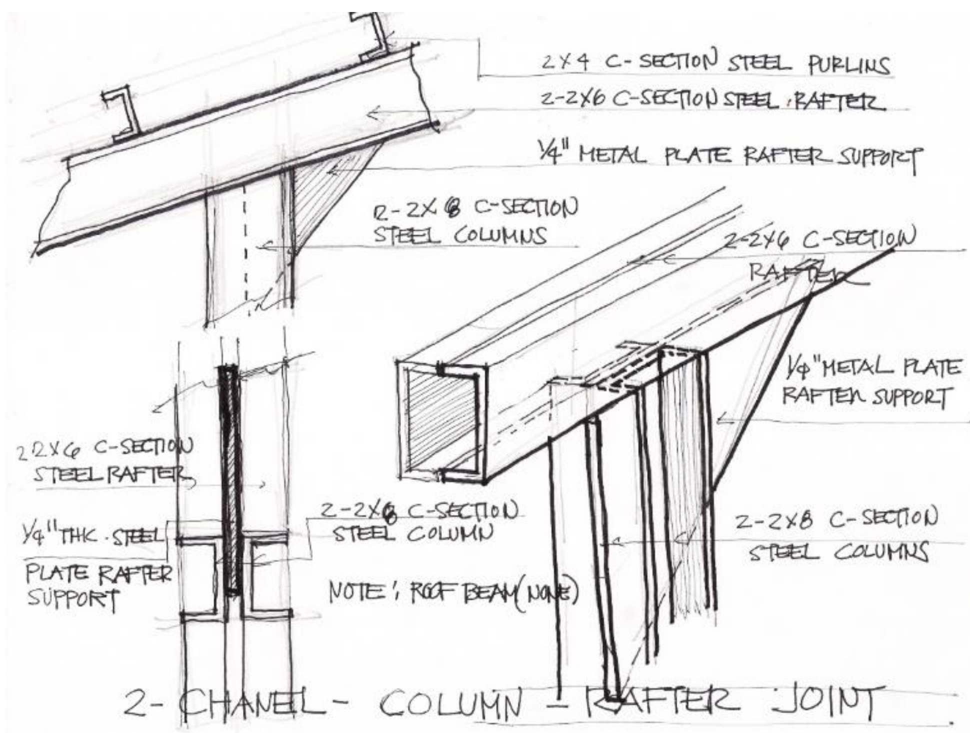

2X4 C-PURLIN SPACED IRREGUBARLY
2- 2X8X2 COLUMN/RAFTER
SECTION ON CAP
SCREW
2X4 LATERAL SUPPORT
SECTION
2X4 C-PURLINS SPACED
IRREGULARLY
Z-PROFILE 2X8X2
STEEL RAFTER
CUT-OFF SECTION
JOINTRY
FLATBAR RAFTER
SUPPORT ON CAPSCREW
2X4 C-SECTION
DIAGONAL
BRACING ON
FLATBAR ANCHORED
BY CAP SCREW
Z PROFILE 2X8
COLUMN-RAFTER
DETAIL
PLAN
Z SECTION COLUMN-RAFTER PROFILE


CAP SCREW
2X4 C-SECTION STEEL PURLINS
2X8 C-SECTION RAFTER LATERAL SUPPORT
2-2X8 (Z-SECTION) RAFTER
2X4 LATERAL COLUMN SUPPORT
3/16" THK FLATBAR ON CAP SCREW
2-2X8 (Z-SECTION) STEEL COLUMN
SECTION
3/16" THK. FLATBAR ON CAP SCREW RAFTER SUPPORT
2-2X6 C-CHANEL COLUMN SUPPORT
2-2X8 (Z-SECTION) STEEL COLUMN
2X8 Z-SECTION RAFTER
BLOW-UP DETAIL
PLAN
COMPOSITE C-SECTION COLUMN - Z SECTION COLUMN/RAFTER


C-SECTION RAFTER SUPPORT
3/16" THK FLATBAR ON CAP SCREW TO 2-2X6 C-SECTION SUPPORT
2X4 C-SECTION STEEL PURLINS
2-2X6 C-SECTION STEEL RAFTER
2-2X6 C-SECTION STEEL MAIN COLUMN
3/16" THK FLATBAR ON CAP SCREW RAFTER SUPPORT
SECTION
BLOW-UP DETAIL
2X6 C-SECTION RAFTER
C-SECTION STEEL COLUMNS
PLAN
C-SECTION COLUMN-RAFTER



2X4 PURLINS (C-CHANEL)
IRREGULARLY SPACED
Z-SECTION STEEL RAFTER
2X4 C-SECTION PURLINS
2X6 C-PURLINS
RAFTER SUPPORT
Z-2X8 (Z SECTION)
STEEL COLUMNS
3/16 1½x1½
ANGLE BREATHERS
2X6 C-SECTION
RAFTER SUPPORT
SECTION
Z-2X8 STEEL SECTION
COLUMN
Z-2X8 STEEL
SECTION COLUMN
Z-SECTION
RAFTER
PLAN
3/16 1½x1½ ∠ STEEL
BREATHER
BLOW-UP DETAIL
Z-SECTION COLUMN/Z RAFTER



2X4 C-SECTION STEEL PURLINS
2-2X6 C-SECTION STEEL RAFTER
¼" METAL PLATE RAFTER SUPPORT
2-2X8 C-SECTION
STEEL COLUMNS
2-2X6 C-SECTION
RAFTER
¼" METAL PLATE
RAFTER SUPPORT
2 2X6 C-SECTION
STEEL RAFTER
¼" THK. STEEL
PLATE RAFTER
SUPPORT
2-2X8 C-SECTION
STEEL COLUMN
NOTE: ROOF BEAM (NONE)
2-2X8 C-SECTION
STEEL COLUMNS
2-CHANEL-COLUMN-RAFTER JOINT

D. Intervention Solution

1. Retrofitting- Rehabilitation

a. General

- Parallel rafter shall be installed to help out carry the load of the roof as well as the live- load- wind load.
- Roof beam shall be installed for load distribution-for the dead and live loads
- Spacing of the steel channel purlins shall be spaced .40 meters on centre- both ways. It is “must” that we fix the purlins spacing first before we install the roof. Installed steel purlins are spaced on different distance thereby manifesting non-compliance with specification and designs.
- Suggested “rafter steel profile - “C” channel and or I-steel profile rafter for Inland Schools
- Concrete column using I-steel beam as roof beams and rafter for coastal dimension
- Steel section as columns with i-steel beams as roof beams and steel rafter
- Metal plate shall be used as anchor plates for machine bolts to be welded to the reinforcing bars and the I-profile steel roof beams.
- Metal strap ¼” thick shall be welded and bound the roof beams and the steel rafter as well as the steel purlins

All the above instruction, system and method of instruction shall insure stronger and stable attachment of the upper structure and super structure.

b. Inland Schools

i. Columns

- 6” G.I. pipe schedule 40 Column- pedestal and or I-steel beam rafter as columns
- I-Steel Section Column on concrete pedestal

ii. Roof Beams

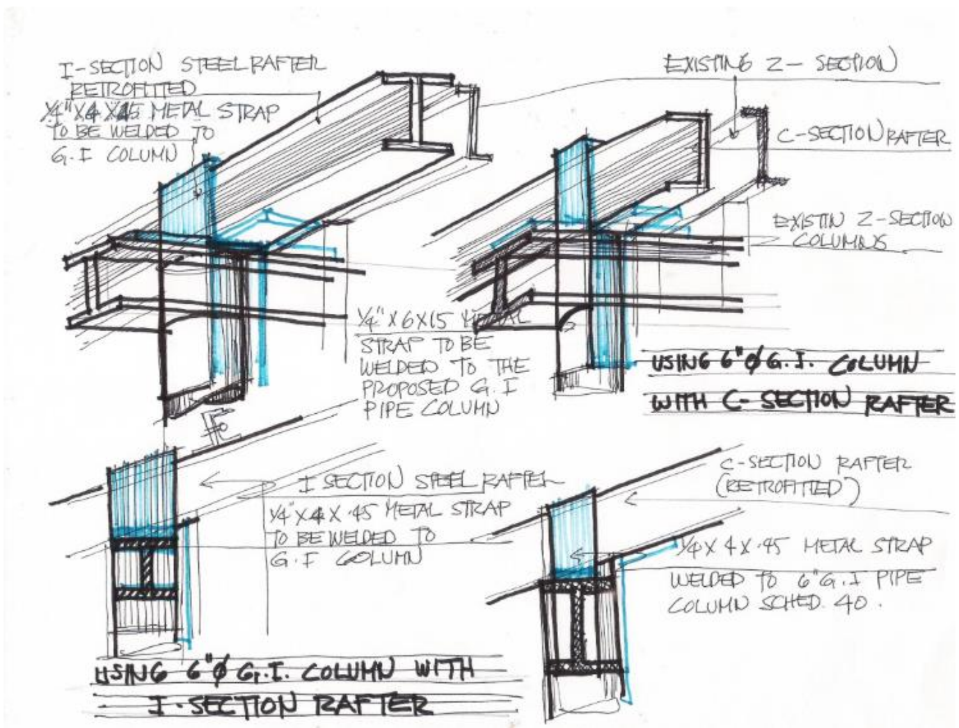
- I steel section roof Beam

iii. Rafter

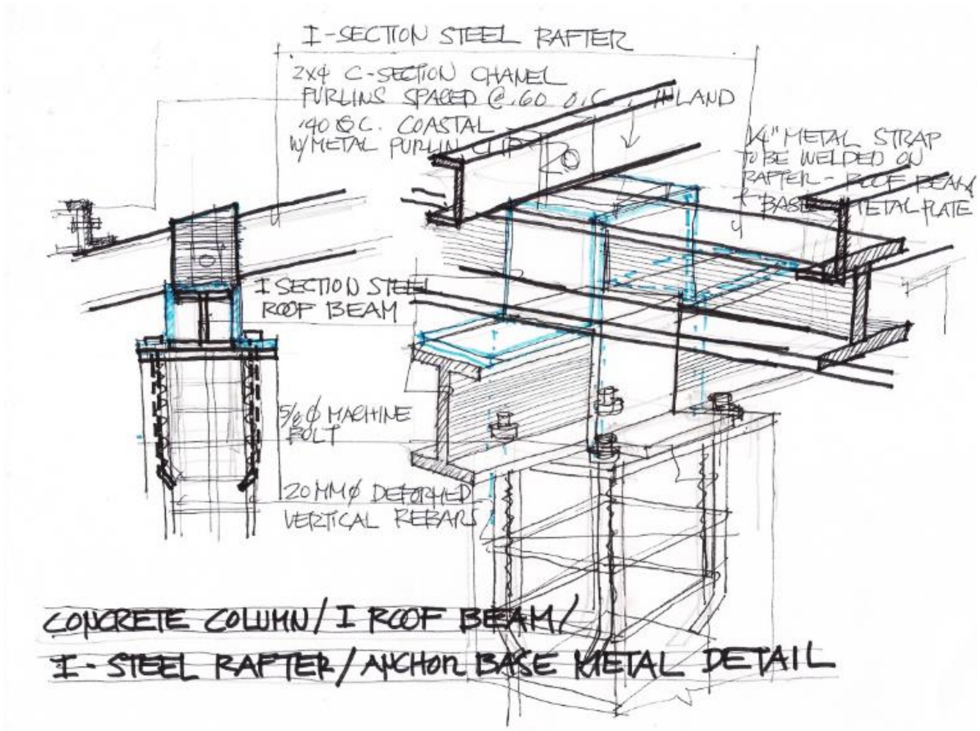
- I-steel section Rafter

iv. Purlins

- 2x4 C- Steel channel
- A roof is proposed to be installed for the purpose of load distribution (Live and Dead load)



c. Coastal Schools

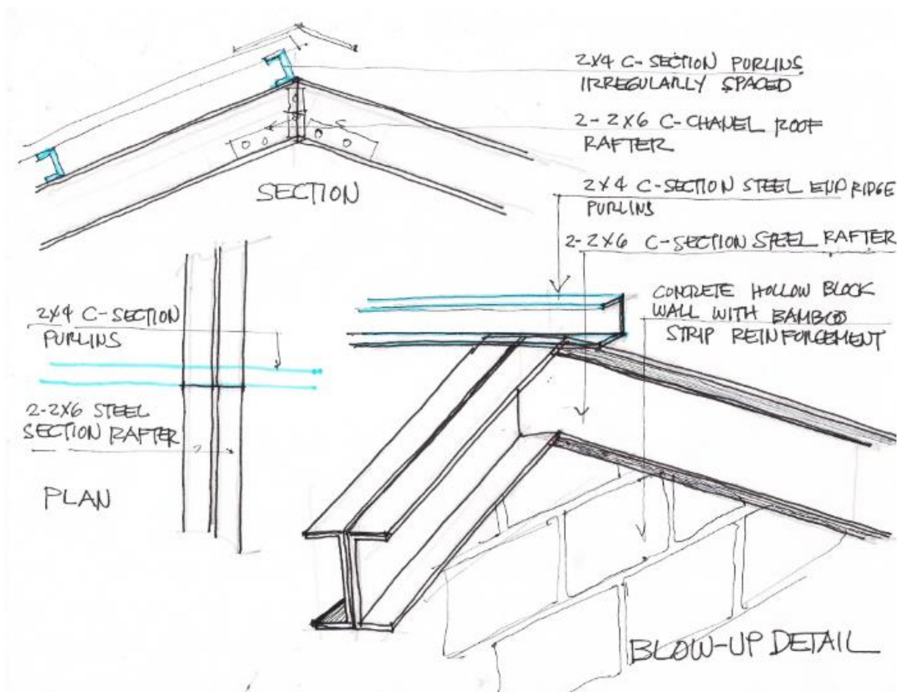


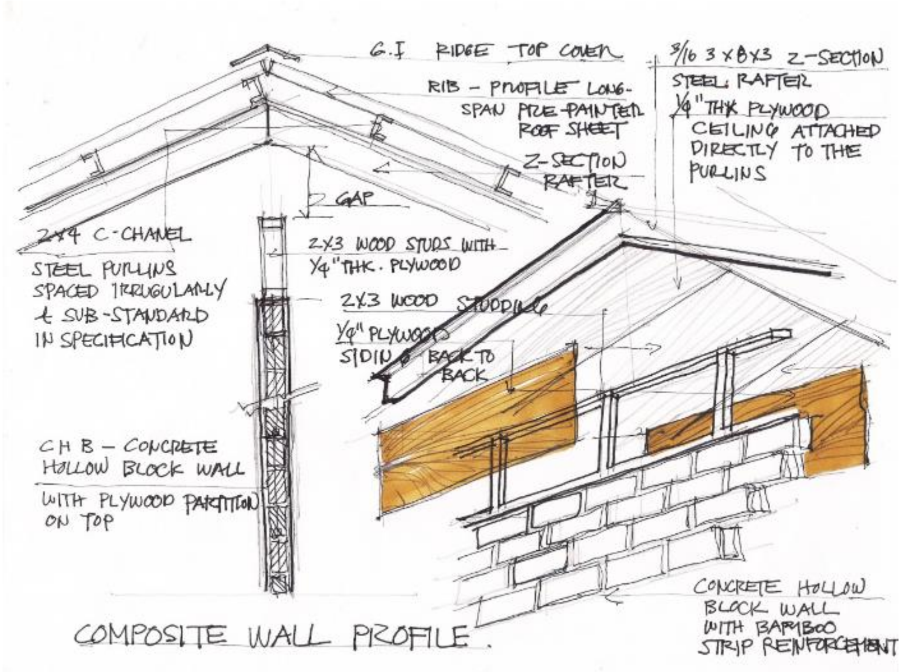
*i. **Steel Rafter Ridge – Apex Connection, Ceiling, Walls and Rafter Block***

1. Rafter Ridge Connection -Existing Schools Rafter Purlin Layout

Collapsed Roof Structure of a school building: The above pictures show failure of the roofing system which is sub-standard attachment of steel rafter, using sub-standard materials and wrong system of construction jointry.

ii. Illustrations of Existing Schools Rafter – Purlins Layout.

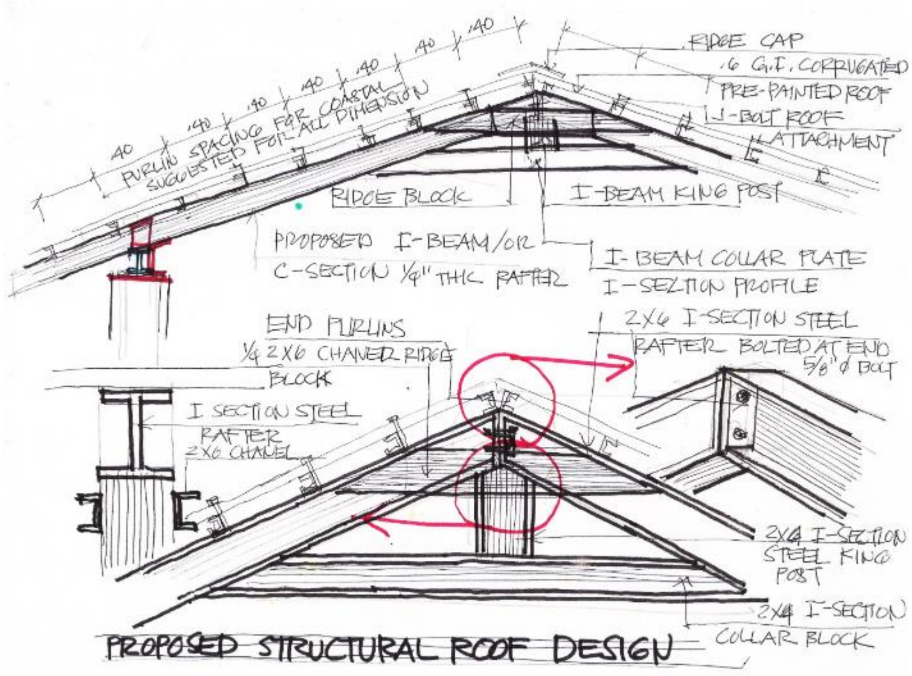




1. *Ridge Rafter Joint Observation*

- Ridge- rafter connection block and joints are not anchored properly. It is connected and joined by a cap screw – a sub-standard workmanship and design.
- The rafter uses are of "Z"- profile with minimal thickness
- The purlins are installed in various distances and not equally distributed
- There are no ridge-purlins on the other side of the rafter
- The method use for connecting both rafters is by cut-off method
- The material used are of two profiles; the "Z" and "C"profiles
- At times they use angle bar with bolts to join both rafter
- commonly the anchorages are of bolt and cap screw and not welded

iii. Solution



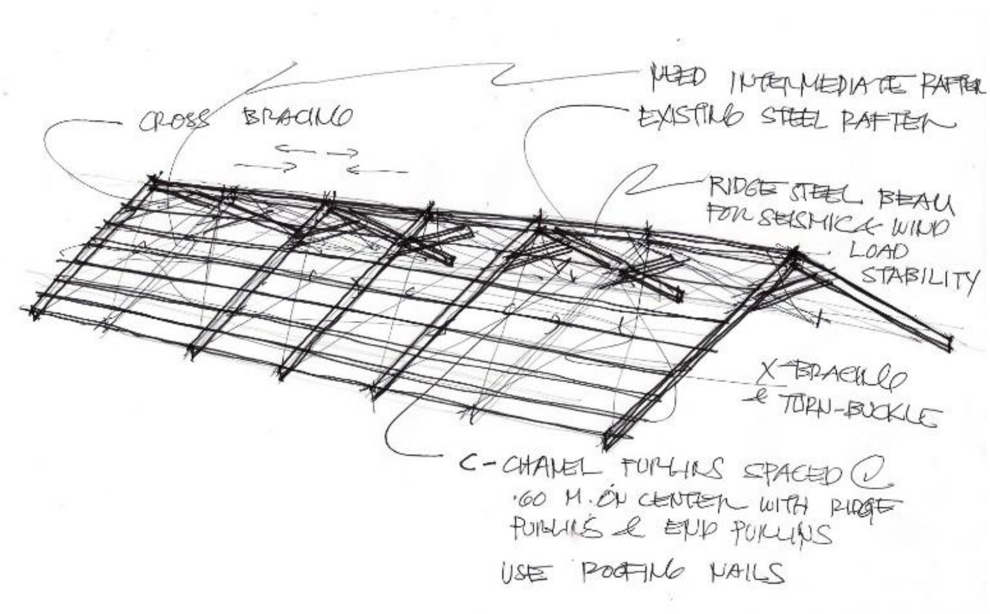
iv. Proposed Connection and Attachments

1. Firstly both ends of the rafter along the ridge shall be bolted of welded
2. Secondly, ¼" x 2x6 C channel a ridge block shall be installed on both steel I- beam ¼ x4x6 section
3. Thirdly a collar plate ¼"x2x6 I-Beam section be installed to connect both sides of the A- frame – welded at both ends
4. A king post shall be in place. Use ¼"x4x6 I Steel section
5. 2x 4 C Channel purlins shall be spaced at .40 meters on centre bothways
6. Roof attachment to the purlins shall be J-Bolt preferably. If we use texscrew with fastener as wrap strap.
7. Roof insulation shall be installed to cut on heat transfer

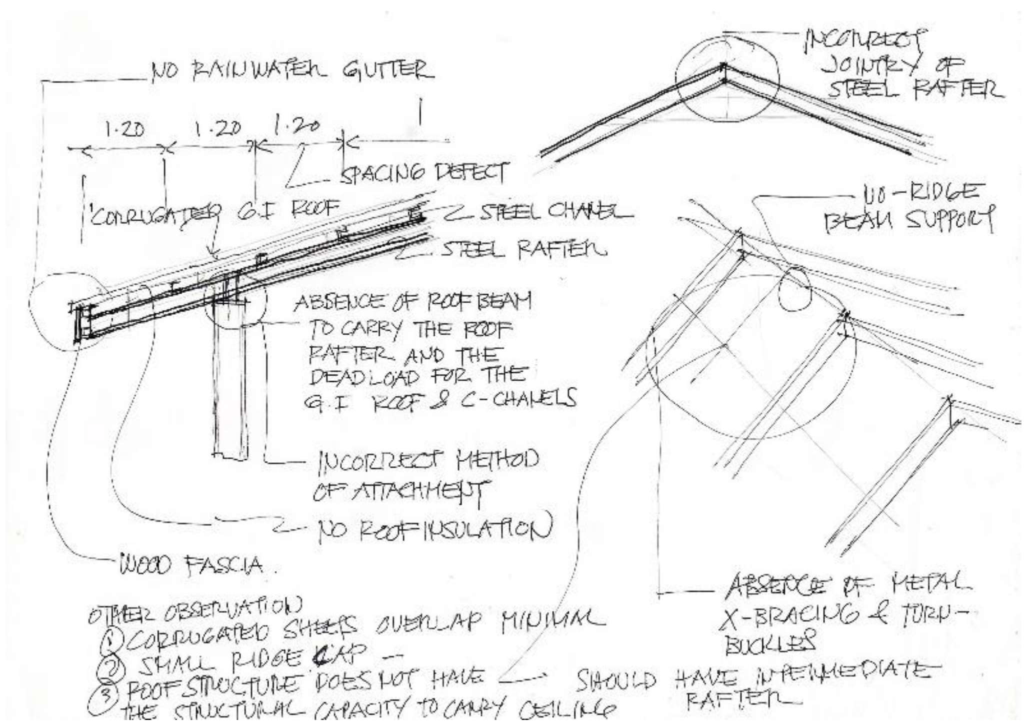
2. General Recommendations

It is observe that a large number of school building as beyond repair, those school that collapse and with a large structural damage. It is also observed that some schools buildings can still be saved through retrofitting process though it entails huge cost. We have to rehabilitate schools with a goal of being structurally stable that of an earthquake and typhoon resistant school building. In light of these observations, we recommend that we rebuild all damaged schools to a holistic resilient school building.

a. General Observation



Some notes:

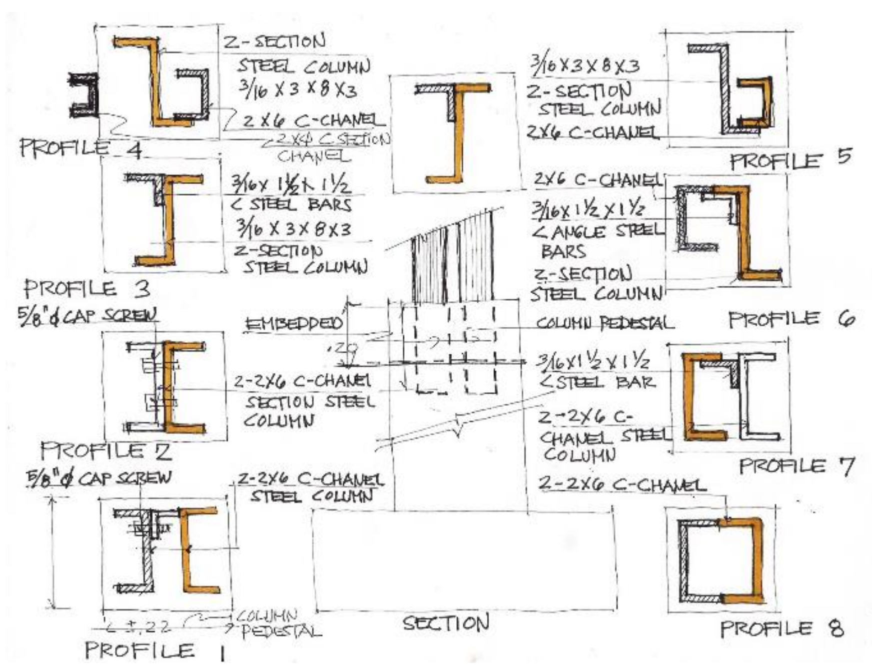


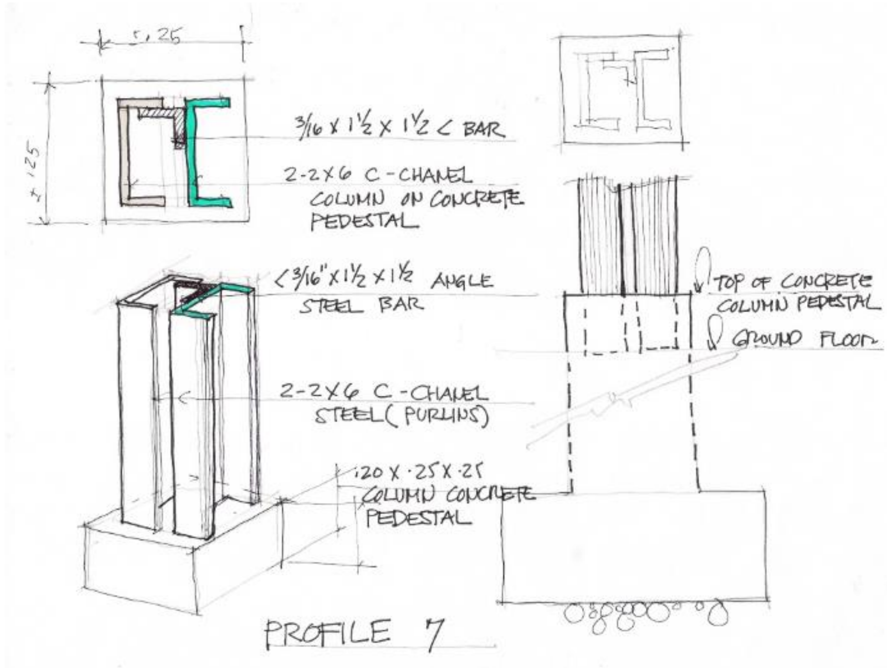
b. Roof Framing

- The Purlins are spaced irregularly with spacing .65m, ,70, .80 meters at times specifically on the eaves edge at 1.05 meters. These are sub-standard spacing of purlins and will translate into sub-standard roofing installation. Absent were standards and work monitoring.
- That there is the absence of roof beams in some most cases for transfer loading.
- No collar plate holding both rafters
- No intermediate rafter at every after bay
- Sub-standard steel rafter installed and sub-standard installation
- Absence of Ridge horizontal beam
- Poor workmanship

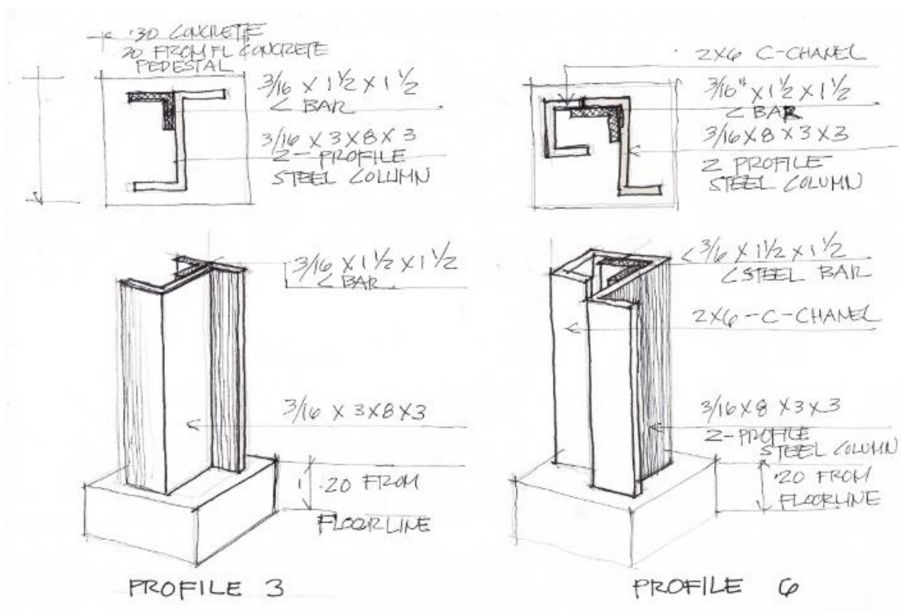
c. Existing School Structural Component

i. 8 Column Pedestal Profiles

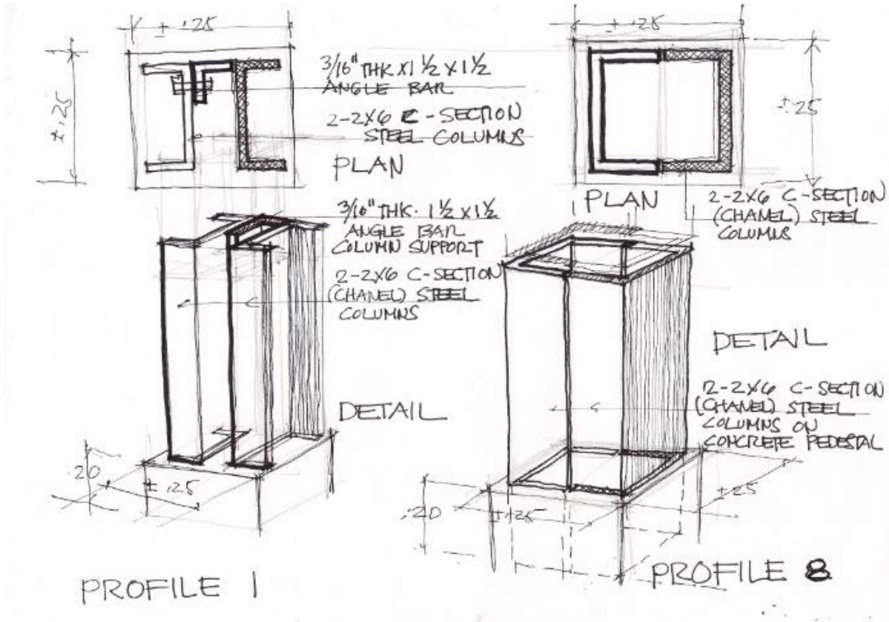


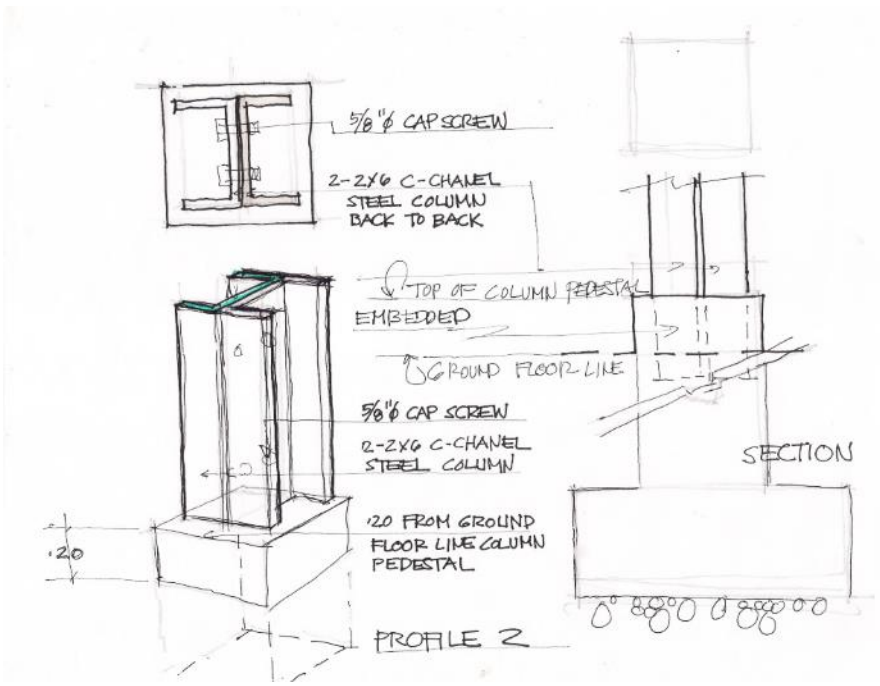


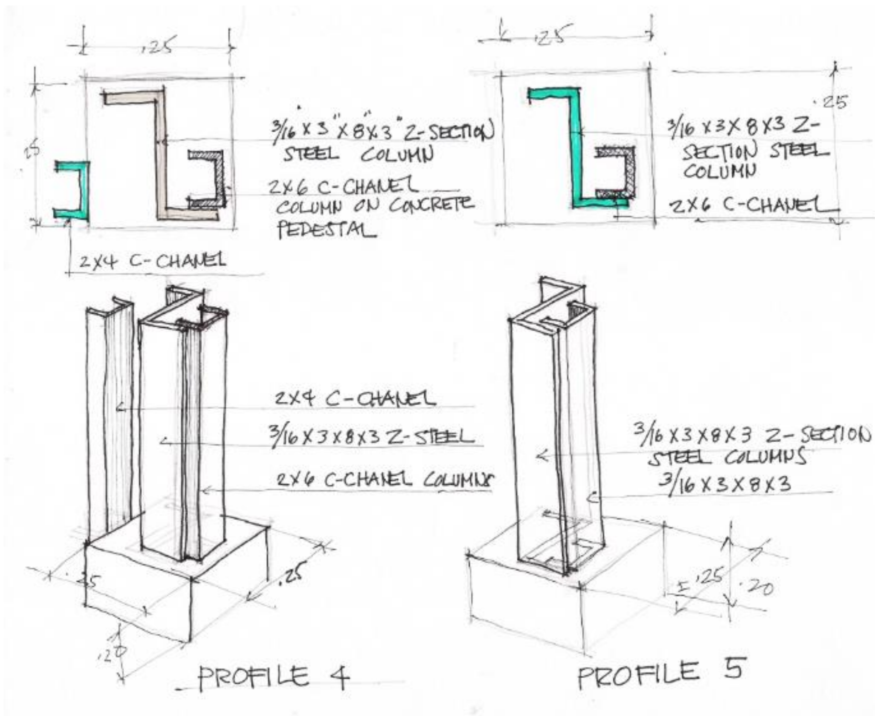
5.25
.125
3/16 x 1½ x 1½ ∠ BAR
2-2x6 C-CHANEL COLUMN ON CONCRETE PEDESTAL
∠3/16" x 1½ x 1½ ANGLE STEEL BAR
2-2x6 C-CHANEL STEEL (PURLINS)
.20 x .25 x .25 COLUMN CONCRETE PEDESTAL
TOP OF CONCRETE COLUMN PEDESTAL
GROUND FLOOR
PROFILE 7



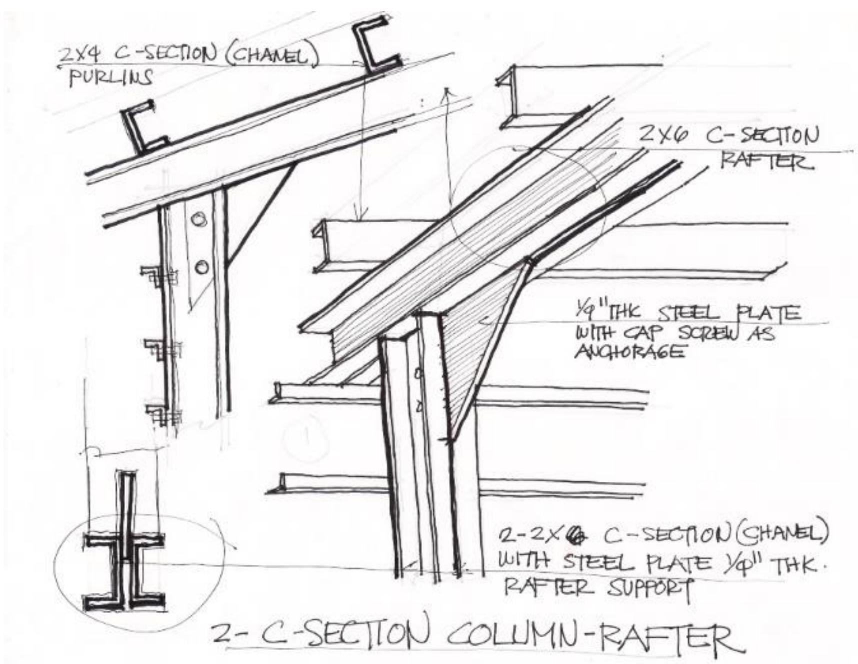
.30 CONCRETE
.20 FROM FL CONCRETE PEDESTAL
3/16 x 1½ x 1½ ∠ BAR
3/16 x 3 x 8 x 3 Z-PROFILE STEEL COLUMN
3/16 x 1½ x 1½ ∠ BAR
3/16 x 3x8x3
.20 FROM FLOORLINE
PROFILE 3
2x6 C-CHANEL
3/16" x 1½ x 1½ ∠ BAR
3/16 x 8 x 3 x 3 Z PROFILE STEEL COLUMN
∠3/16 x 1½ x 1½ ∠ STEEL BAR
2x6 - C-CHANEL
3/16 x 8 x 3 x 3 Z-PROFILE STEEL COLUMN
.20 FROM FLOORLINE
PROFILE 6

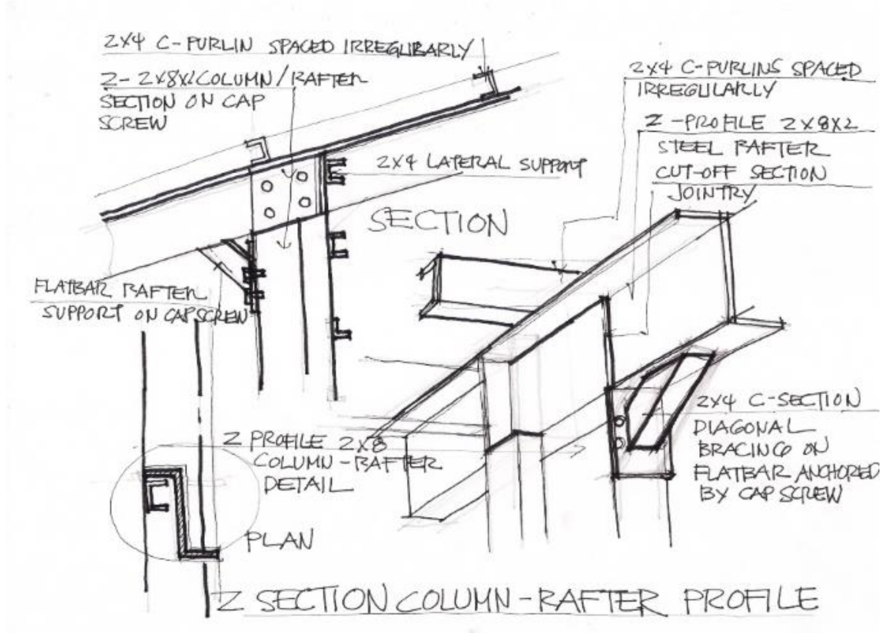

±.25
3/16" THK x 1 1/2 x 1 1/2
ANGLE BAR
2-2x6 C-SECTION
STEEL COLUMNS
PLAN
3/16" THK. 1 1/2 x 1 1/2
ANGLE BAR
COLUMN SUPPORT
2-2x6 C-SECTION
(CHANEL) STEEL
COLUMNS
DETAIL
PROFILE 1
PLAN
2-2x6 C-SECTION
(CHANEL) STEEL
COLUMNS
DETAIL
2-2x6 C-SECTION
(CHANEL) STEEL
COLUMNS ON
CONCRETE PEDESTAL
PROFILE 8

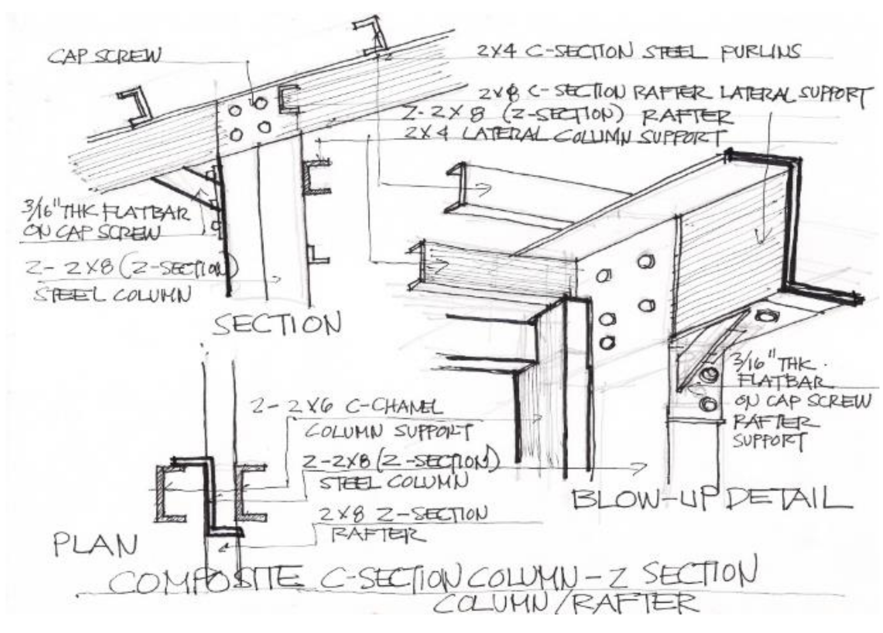

5/8"ϕ CAP SCREW
2-2x6 C-CHANEL
STEEL COLUMN
BACK TO BACK
TOP OF COLUMN PEDESTAL
EMBEDDED
GROUND FLOOR LINE
5/8"ϕ CAP SCREW
2-2x6 C-CHANEL
STEEL COLUMN
.20 FROM GROUND
FLOOR LINE COLUMN
PEDESTAL
.20
SECTION
PROFILE 2

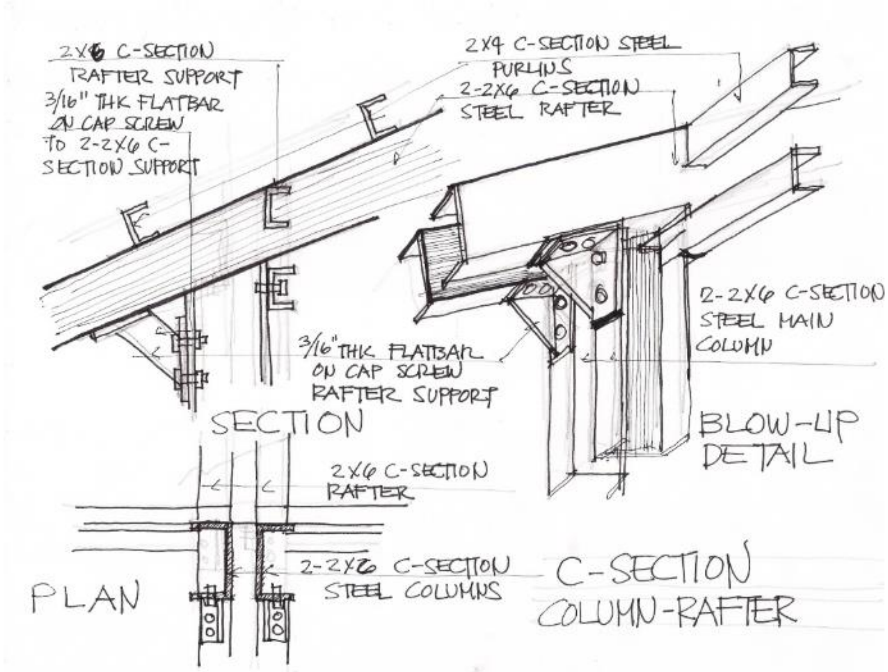


ii. Existing Column Rafter Detail Profile

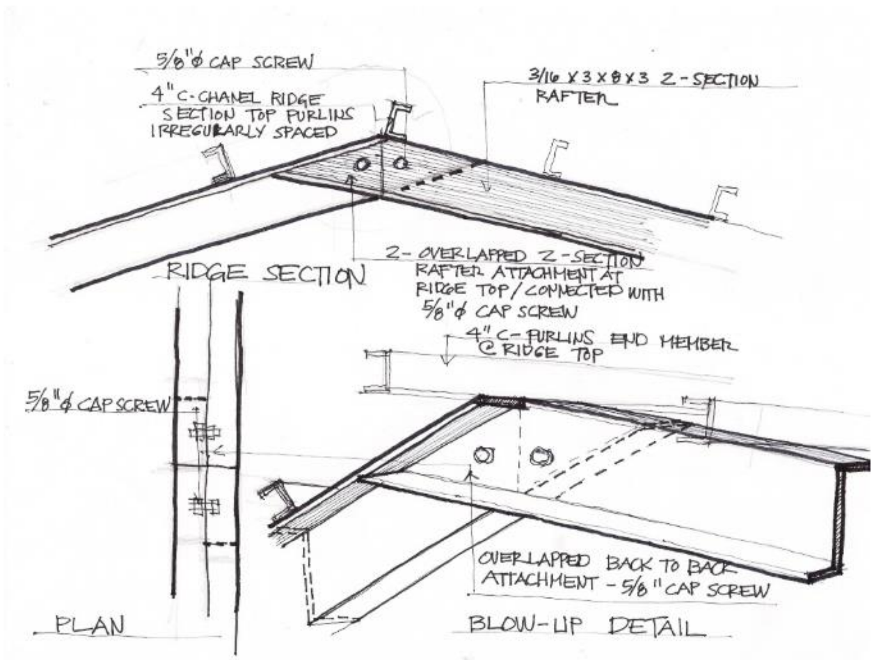


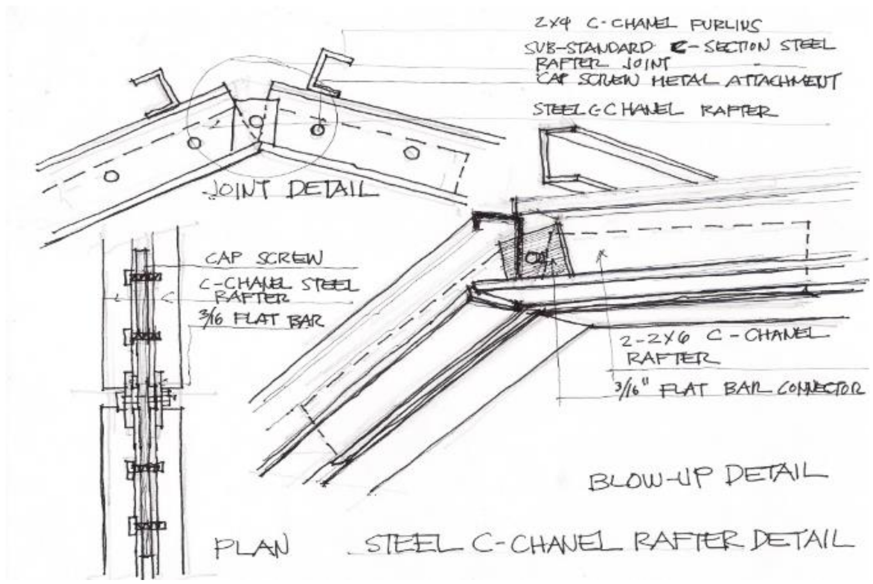

2X4 C-PURLIN SPACED IRREGURARLY
Z-2X8X2COLUMN/RAFTER SECTION ON CAP SCREW
2X4 C-PURLINS SPACED IRREGULARLY
Z-PROFILE 2X8X2 STEEL RAFTER CUT-OFF SECTION JOINTRY
2X4 LATERAL SUPPORT
SECTION
FLATBAR RAFTER SUPPORT ON CAPSCREW
2X4 C-SECTION DIAGONAL BRACING ON FLATBAR ANCHORED BY CAP SCREW
Z PROFILE 2X8 COLUMN-RAFTER DETAIL
PLAN
Z SECTION COLUMN-RAFTER PROFILE


CAP SCREW
2X4 C-SECTION STEEL PURLINS
2X8 C-SECTION RAFTER LATERAL SUPPORT
Z-2X8 (Z-SECTION) RAFTER
2X4 LATERAL COLUMN SUPPORT
3/16" THK FLATBAR ON CAP SCREW
Z-2X8 (Z-SECTION) STEEL COLUMN
SECTION
3/16" THK. FLATBAR ON CAP SCREW RAFTER SUPPORT
2-2X6 C-CHANEL COLUMN SUPPORT
Z-2X8 (Z-SECTION) STEEL COLUMN
2X8 Z-SECTION RAFTER
BLOW-UP DETAIL
PLAN
COMPOSITE C-SECTION COLUMN-Z SECTION COLUMN/RAFTER

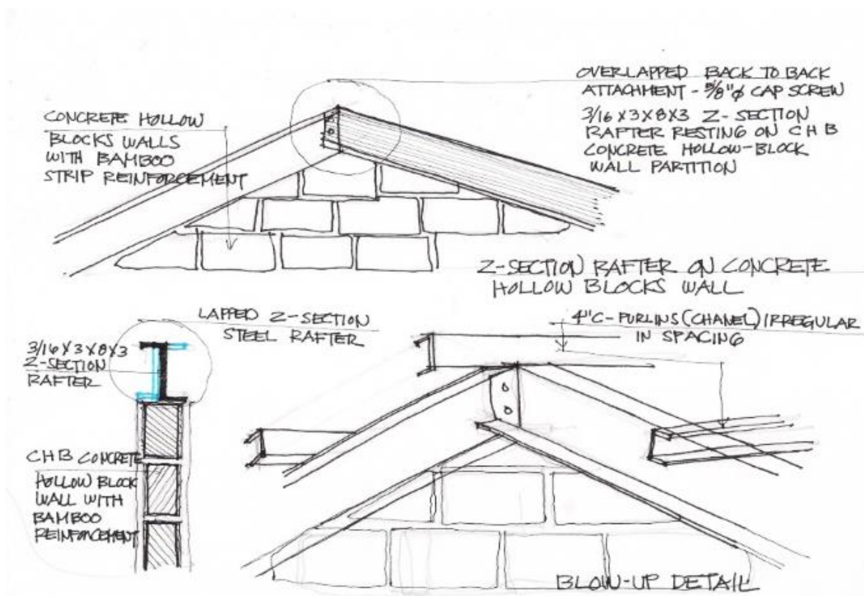


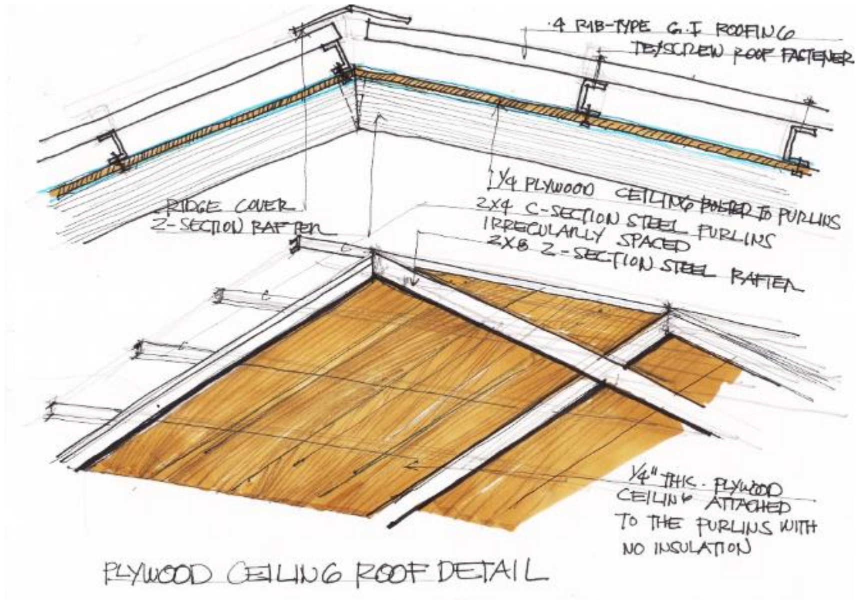
iii. Existing Ridge Rafter Joint Connection



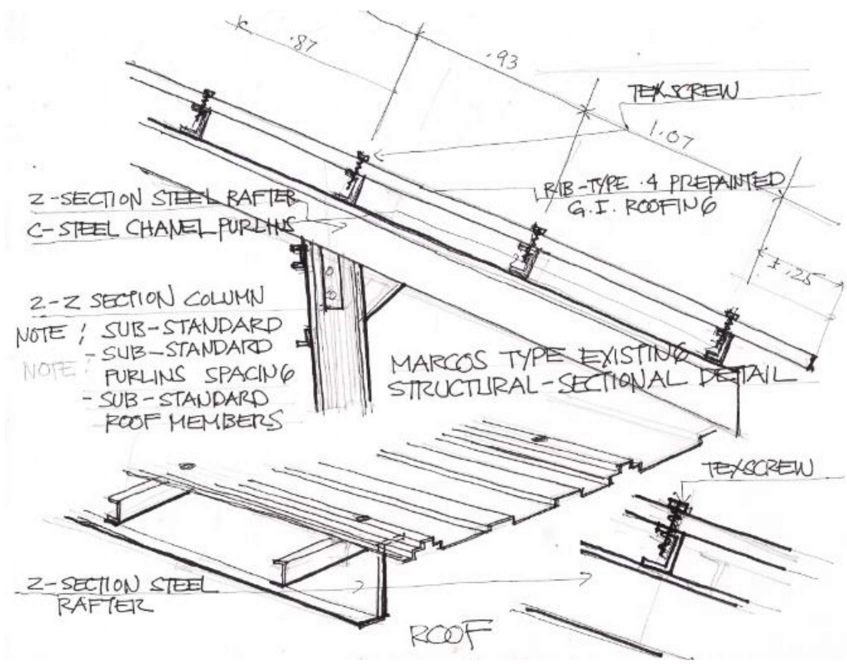


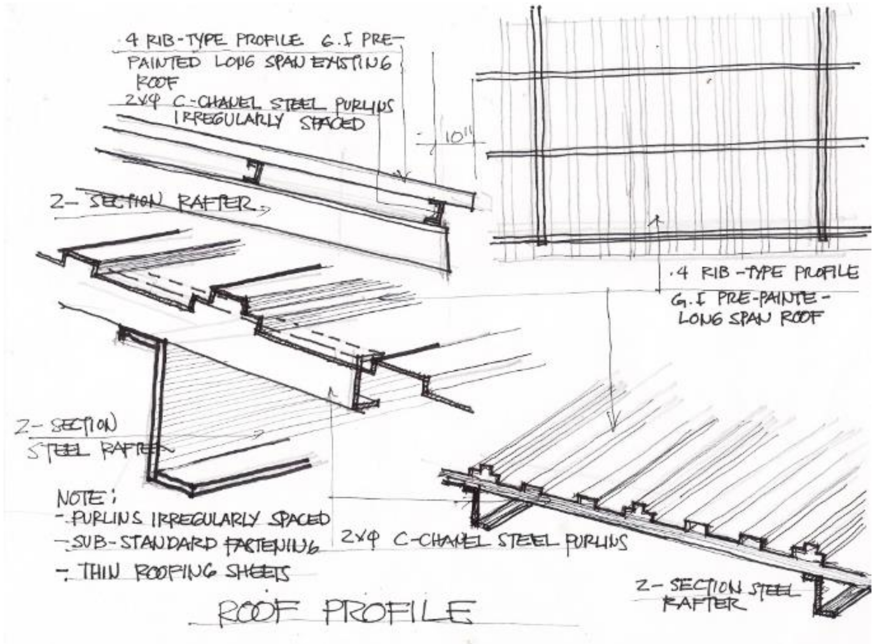
iv. Existing-Composite Wall Profile with Rafter on Top-Ceiling Purlins Connection





v. Existing Roof Eaves Detail





d. **Question: A Guide for decisions for intervention**

i. Shall we intervene by retrofitting and setting of standards depending in the level of damage?

ii. Shall we set a standard for all repair and intervention regardless of the damage affecting the school? Meaning one intervention plan for all damaged schools

iii. Shall we follow the idea of having the schools ready for the 2014 June school opening even if school structures requires longer time frame to rehabilitate and repair?

iv. What are the perceive effects if we follow the idea of the schools be ready by 2014 June;

1. Standards
2. Sacrifice the level of resiliency
3. Deadline
4. Workmanship

v. What are the things that should be sacrifice?

1. Resiliency features
2. the level of intervention meaning that we should categorize the damage status example. roofing only, etc.) and intervene by fixing and

reinforcing the roof structure and columns.

vi. Shall we adopt the pre-Yolanda intervention by RAFI and add resilient design both architecturally and structurally? (more stable structure and complete intervention approach)

e. Situation

i. DEPED and other organization are simply repairing the damages done and installing roof

ii. RAFI doing retrofitting and repair works specifically pre- Yolanda

V. Recommendations and Proposals

It is observe that a large number of school building as beyond repair, those school that collapse and with a large structural damage. It is also observed that some schools buildings can still be saved through retrofitting process though it entails huge cost. We have to rehabilitate schools with a goal of being structurally stable that of an earthquake and typhoon resistant school building. In light of these observations, we recommend that we rebuild all damaged schools to a holistic resilient school building.

A. Recommendation

We have to rehabilitate schools with a goal of having a structurally stable structure that is of an earthquake and typhoon resistant school building. In light of these observations, we recommend that we rebuild all damaged schools with an approach of having a holistic resilient school building

- There is a need to retrofit and reinforce the damaged schools existing structures to be able to adapt to future disasters whether manmade or natural and or adverse effects of climate change
- And that retrofitting and structural reinforcement of existing schools is a "must" before any repair intervention is being done
- Work on for standardization of building system and material specification of school building with resilient and adaptability features to climate change effect

- Recommend for the upgrading of building laws
- That we take notice of materials in the market for clearly there sub-standard materials being sold. (ex. Roofing sheets have a base metal dimension with paint coating included sold as .4, .5, .6 thickness)
- It is highly recommended that we use corrugate sheet profile as the main specified profile. Corrugated profile is the most stable and strong profile compared to other roof profiles.
- It is recommended that appropriate solution for retrofitting shall differ from schools located along the coastal front and different retrofitting solution for schools located inland. Recommended also were two dimensions of retrofitting; coastal and inland.
- It is highly recommended that we harvest rainwater by installing a gutter system, rainwater distribution system as well as rainwater storage for use

B. Proposals

1. General Proposal

We propose to have two dimension of intervention

a. Coastal
b. Inland

2. Goals of Intervention

- To repair and rehabilitate schools or rebuild and reconstruct damaged by typhoon Yolanda in Northern Cebu, Cebu, Philippines

3. Areas to Consider

- Time
- Resources
- Cost

4. *Cost determinant*

- Depending on the extent of damage
- Define the level of damage and intervene by strengthening the columns and the roof structure
- Depending on the level of intervention

5. *Level of Intervention*

- Retrofit structurally and architecturally or repair
- Infuse resilient features in rehabilitation

6. *Resilient Features*

- Architectural Component
- Structural Component

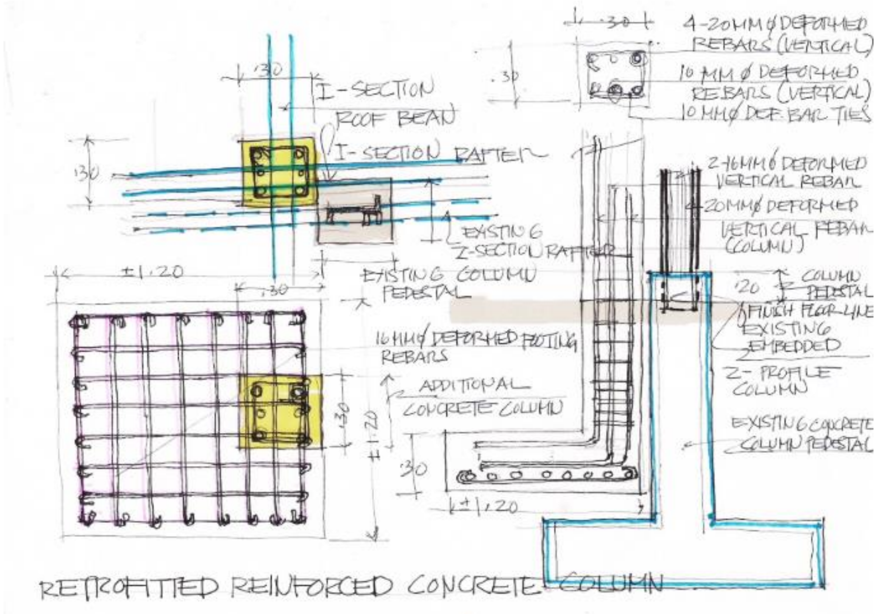
7. *Initial Proposal of Intervention*

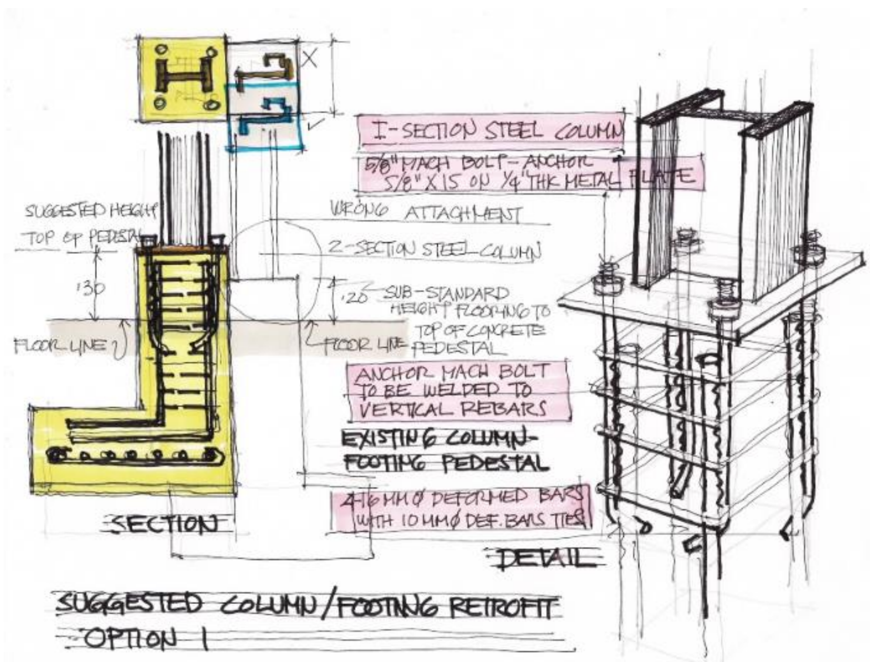
a. Columns: 3 Approaches of Intervention

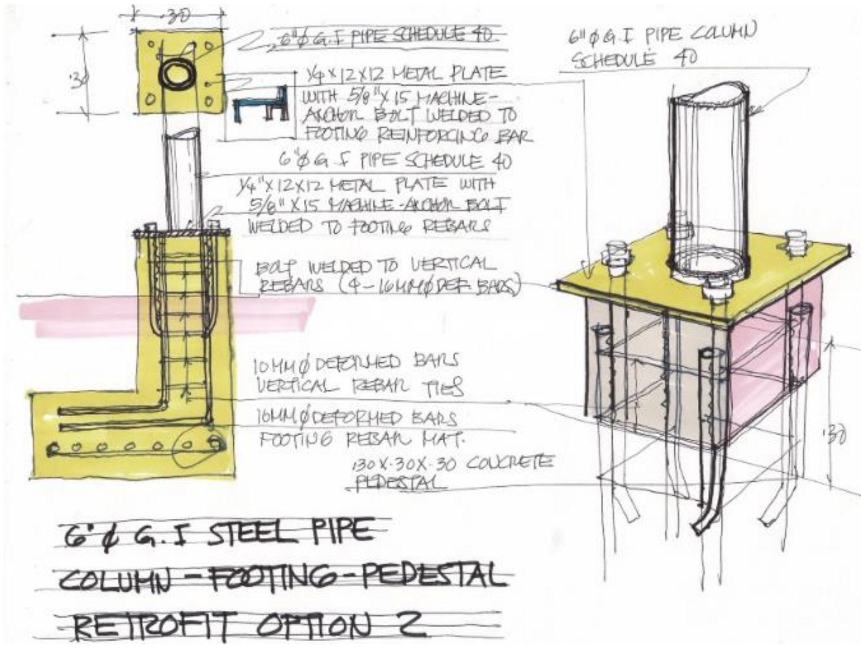
i. Reinforced Concrete Columns

ii. I SECTION steel column on Concrete Pedestal

iii. G.I. Pipe column on Concrete Pedestal


4-20MM Ø DEFORMED REBARS (VERTICAL)
10 MM Ø DEFORMED REBARS (VERTICAL)
10 MM Ø DEF. BAR TIES
I-SECTION ROOF BEAM
I-SECTION RAFTER
EXISTING Z-SECTION RAFTER
EXISTING COLUMN PEDESTAL
2-16MM Ø DEFORMED VERTICAL REBAR
20MM Ø DEFORMED VERTICAL REBAR (COLUMN)
COLUMN PEDESTAL
FINISH FLOOR-LINE
EXISTING EMBEDDED
Z-PROFILE COLUMN
16 MM Ø DEFORMED FOOTING REBARS
ADDITIONAL CONCRETE COLUMN
EXISTING CONCRETE COLUMN PEDESTAL
RETROFITTED REINFORCED CONCRETE COLUMN

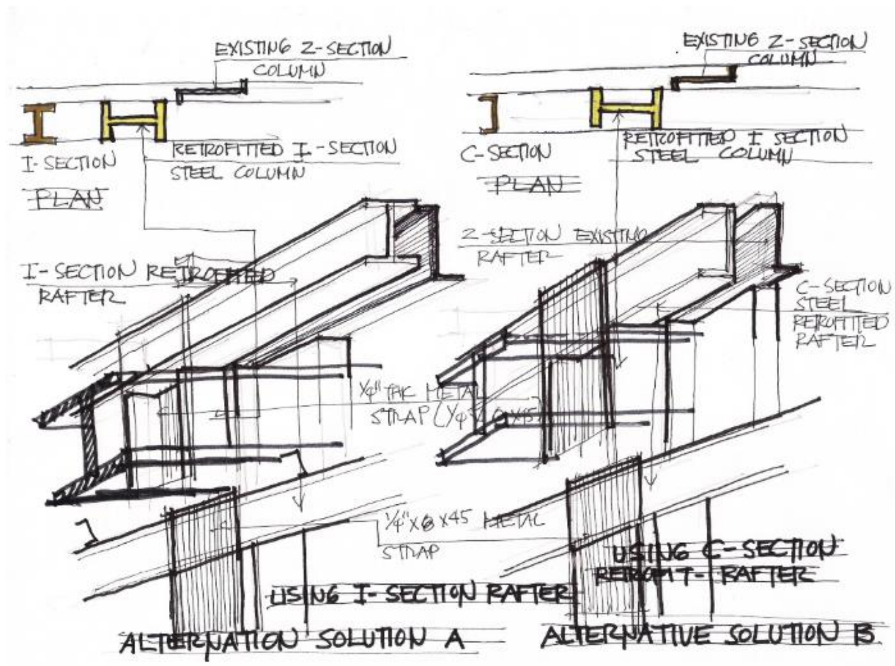

I-SECTION STEEL COLUMN
5/8" MACH BOLT - ANCHOR 5/8" X 15 ON 1/4" THK METAL PLATE
SUGGESTED HEIGHT TOP OF PEDESTAL
WRONG ATTACHMENT
Z-SECTION STEEL COLUMN
SUB-STANDARD HEIGHT FLOORING TO TOP OF CONCRETE PEDESTAL
FLOOR LINE
ANCHOR MACH BOLT TO BE WELDED TO VERTICAL REBARS
EXISTING COLUMN-FOOTING PEDESTAL
4-16 MM Ø DEFORMED BARS WITH 10 MM Ø DEF. BARS TIES
SECTION
DETAIL
SUGGESTED COLUMN/FOOTING RETROFIT OPTION 1

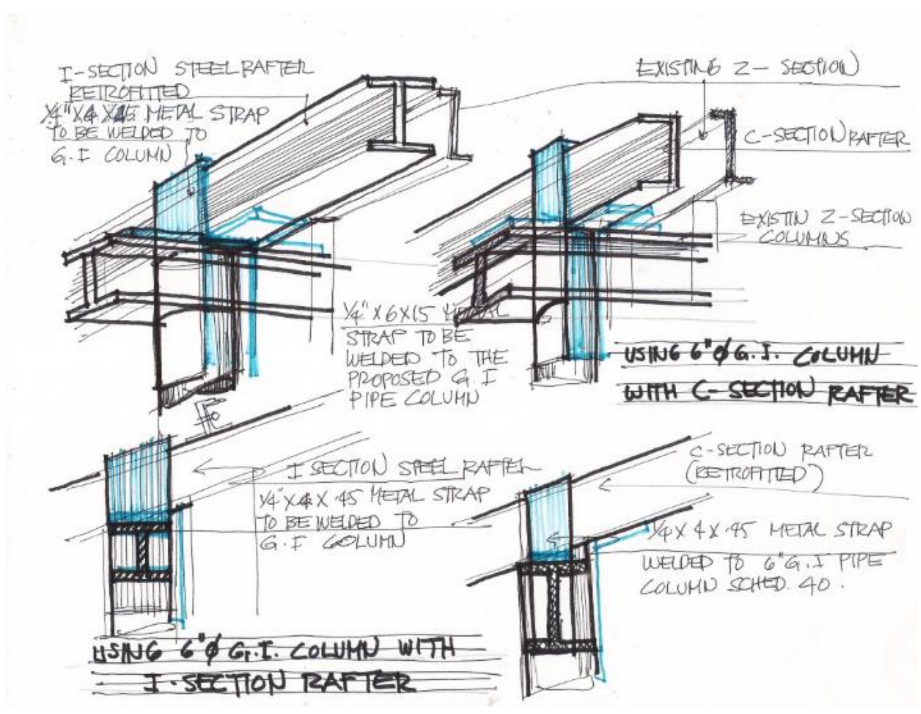


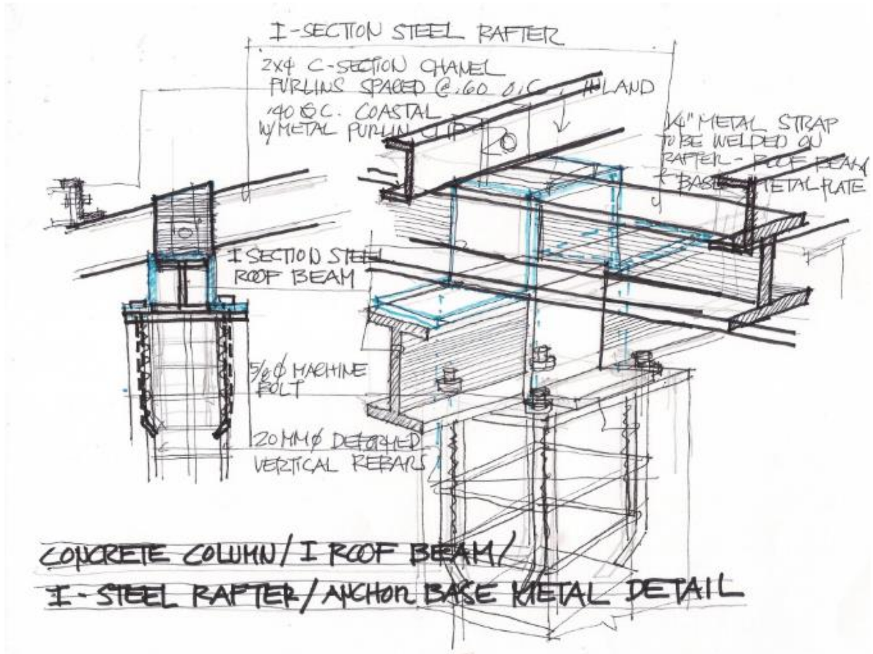
b. Column-Roof Beam-Rafter Joinery

1. Reinforced Concrete Column-Roof Beam- Steel Rafter Jointry
2. I-SECTION Steel column on Pedestal to I-SECTIION roof beam – Steel rafter connection
3. I-SECTION G.I. Pipe steel column - I-SECTION roof beam – Steel rafter

NOTE: A ROOF IS SUGGESTED TO BE INSTALLED FOR TRANSFER LOADING

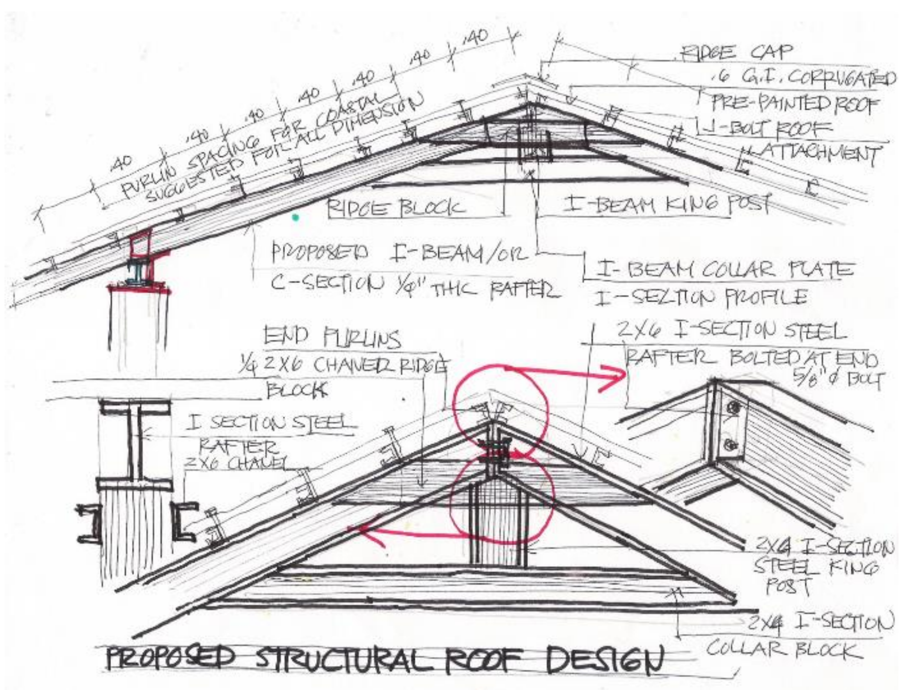

EXISTING Z-SECTION COLUMN
I-SECTION
PLAN
RETROFITTED I-SECTION STEEL COLUMN
EXISTING Z-SECTION COLUMN
C-SECTION
PLAN
RETROFITTED I SECTION STEEL COLUMN
Z-SECTION EXISTING RAFTER
I-SECTION RETROFITTED RAFTER
C-SECTION STEEL RETROFITTED RAFTER
¼" THK METAL STRAP
¼"X6X45 METAL STRAP
USING I-SECTION RAFTER
USING C-SECTION RETROFIT-RAFTER
ALTERNATION SOLUTION A
ALTERNATIVE SOLUTION B.

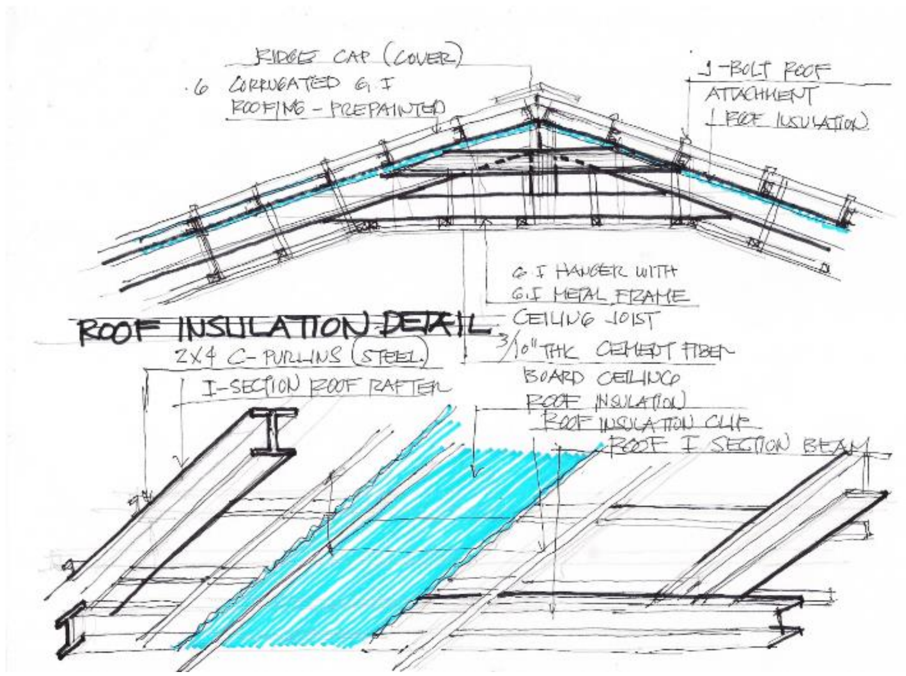

I-SECTION STEEL RAFTER RETROFITTED
¼"X4X45 METAL STRAP TO BE WELDED TO G.I COLUMN
EXISTING Z-SECTION
C-SECTION RAFTER
EXISTIN Z-SECTION COLUMNS
¼"X6X15 METAL STRAP TO BE WELDED TO THE PROPOSED G.I PIPE COLUMN
USING 6"Ø G.I. COLUMN WITH C-SECTION RAFTER
I SECTION STEEL RAFTER
¼"X4X.45 METAL STRAP TO BE WELDED TO G.I COLUMN
C-SECTION RAFTER (RETROFITTED)
¼X4X.45 METAL STRAP WELDED TO 6"G.I PIPE COLUMN SCHED. 40.
USING 6"Ø G.I. COLUMN WITH I-SECTION RAFTER



c. Suggested Rafter Connection

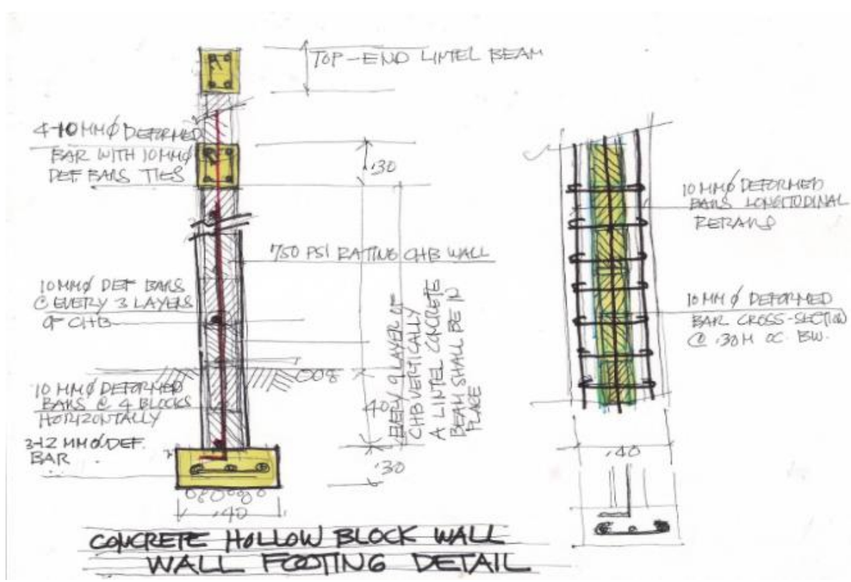
- With ridge block
- With collar block and vertical support
- All are to be welded and both ends of the rafter bolted





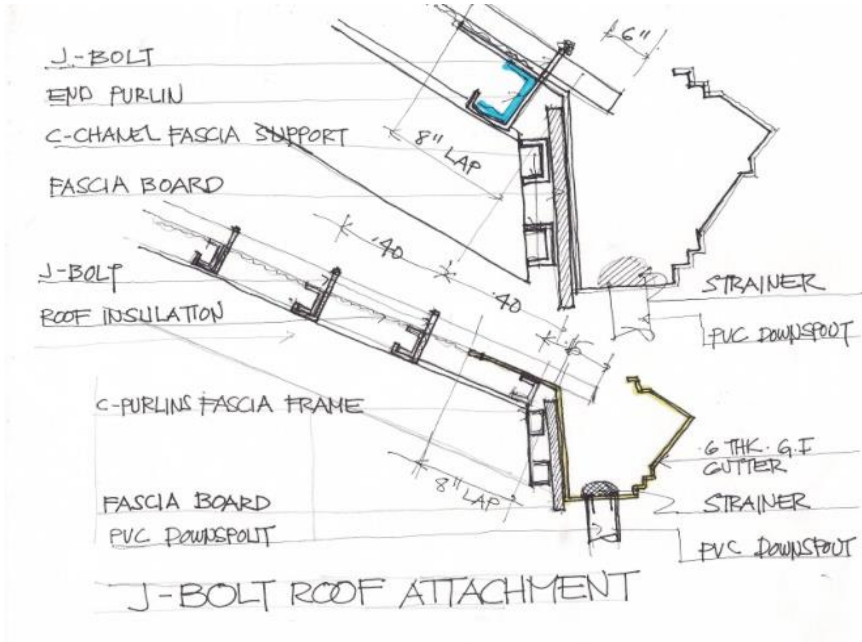
d. Suggested Concrete Hollow Block Wall and Wall Footing and Gutter Detail (Rainwater Collector)

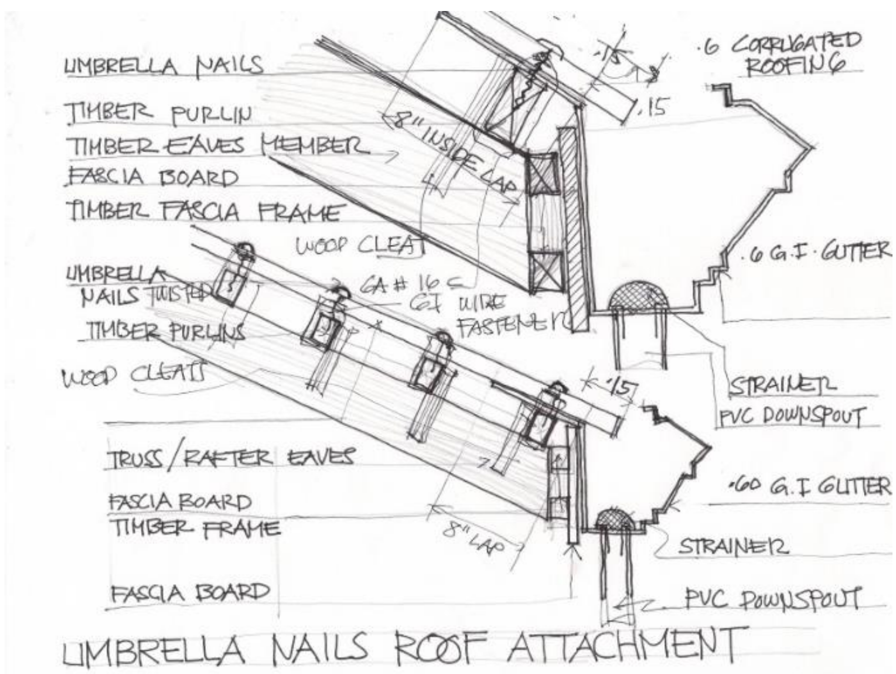
i. Concrete Hollow Block Wall and Wall Footing - for Concrete hollow block walls partition



ii. Gutter and Purlin Details and Fastening (Suggested purlins spacing .40

meters and fastening shall be texscrew with wire strap, J-Bolt for steel structure and texscrew with strap on wood purlins on wood cleats)





8. Process for Implementation

Note : As Suggested by Koradesigngroup

a. Conduct a suppliers meeting: the purpose of the supplier's forum is to hear from the manufacturers and suppliers the different material properties, standards, availability, cost and product quality comparison.

b. To be acquainted with new products that are sustainable and resilient available in the market for repair and rehabilitation of the damaged schools

c. Guide for specification

STANDARDS SAMPLE COMPUTATION

CHECKING STANDARDS: G.I. Sheets

G.I. SHEET COMPUTATION

This is a sample computation for checking weight given thickness and size of G.I. sheet.

Weight/sheet=7.85 kg/mm x thickness in mm x length in meter x width in meter

Example: 0.3mm G.I. sheets 3ftx8ft = 7.8kg/mm x 0.3x 0.9x 2.4 (3ftx 8ft)

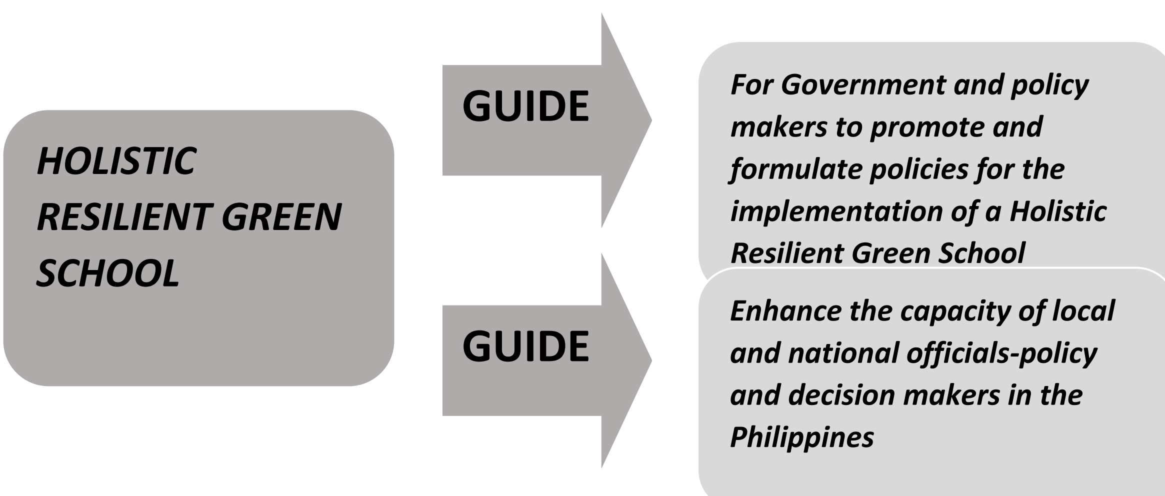
= 5.08 kg/sht

There are different standards in the market today.For example the base metal dimensions of roofing material manufactured and produced. There is a need for new standards and guidelines in the production of standards. Currently there are three kinds of standard available in the market today;

- Standard
- Below standard
- Premium

C. Conclusion and Recommendation Summary

- Evidently present school structures (buildings) were mostly damaged. Unlike the "Gabaldon" type schoolwhich are declared as heritage buildings withstood the devastating wind pressure of the typhoon. It is important that we take notice of resilient features that "Gabaldon type" of school building and use it in upgrading and redesigning current school building. " Gabaldon school building survived the test of time, disasters natural and manmade.
- The damaged schools are of sub-standard in design both structurally and architecturally.
- There is a need to review, re-design, upgrades the standards of school building design and plan with resiliency as the main concept.
- We commend that we upgrade building guidelines and codes to be able to respond to current and future challenges when it comes to typhoon, earthquake and related calamities.
- We recommend that upgrading of laws and bearing with it stiff penalties in monitoring the production of standard building materials.
- We also recommend the review and upgrading of laws regarding monitoring of sub-standard construction building materials available in the market
- There is a need for information dissemination on the current situation and what is to be proposed as resilient school.



CHAPTER 5

TSUNAMI AND EARTHQUAKE EFFECTS ON STRUCTURE

The Philippines is considered as one of the most disaster prone countries in the world. Its geographical location makes it vulnerable to any kinds of disaster. It lies on the pacific seismic belt and west pacific prone to typhoons, floods, volcanic eruption, droughts and other natural hazards. Multiple hazard land area exposure in the country is 60% and vulnerability is 74% amongst the populace. The Philippines ranks 8th of countries exposed to multiple hazards according to World Bank's Natural disaster hotspot list.

The recent earthquake in Bohol and Cebu last October 15, 2013 open the opportunity for policy makers and planners to think and rethink on how to respond the challenges of disasters. It affected six provinces in Central Visaya and Western Visayas with death toll 222, 797 injured, P2.2 bilion pesos damaged to public infrastructure. Furthermore destroyed and damaged were historical and heritage structure that included churches and other heritage structures.

Attached issues are issues of vulnerability and resiliency. There is this components that should be considered like socio-economic effect, physical and psychological effects. With this premise it is imperative that we should plan for a resilient future.

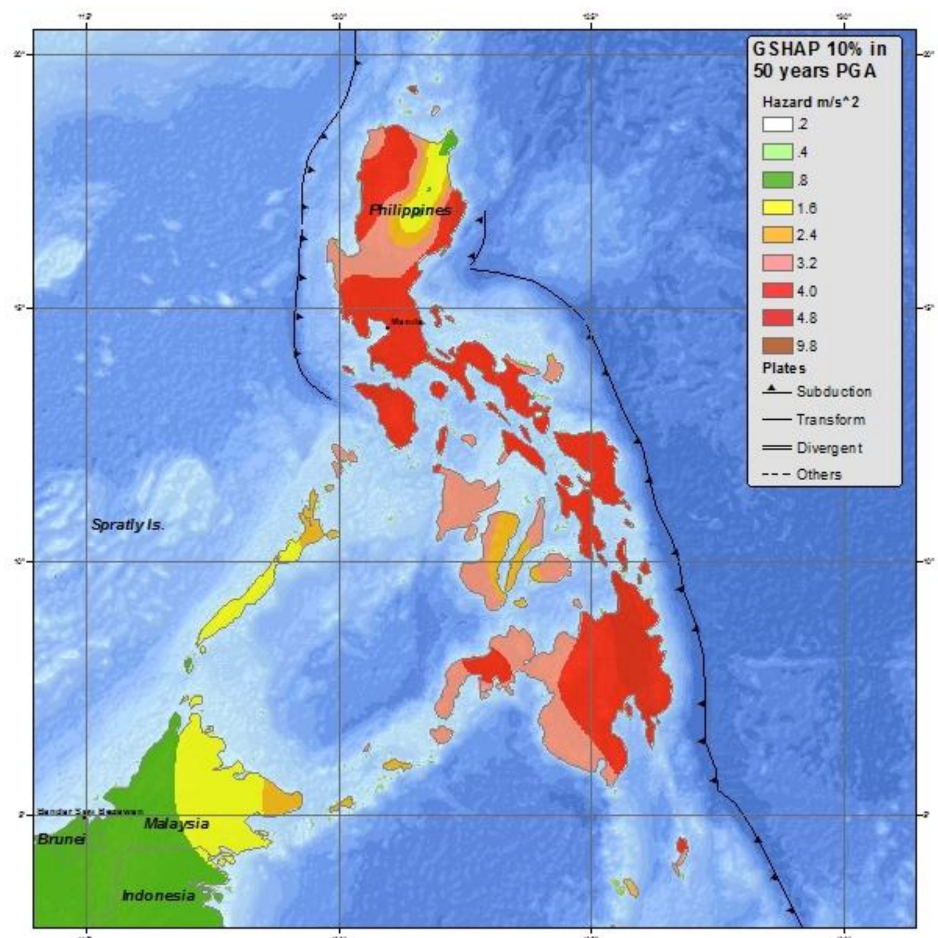
I. Lesson for Philippines

The recent calamity in Bohol and Cebu act as an eye-opener for Metro Manila and other regions in the Philippines. The earthquake that struck the Visayan region is of the same magnitude that could strike the Philippines at any given time that could lead to unprecedented damage.

A study by PHILVOLCS and JICA (Japan International Cooperation Agency) an earthquake with a magnitude similar to that of Bohol will strike in Metro Manila can damage 40% of the total number of residential buildings and can kill 34,000 persons and injured 100,000 more. There will be casualties by secondary causes.

What happened in Bohol can open to an opportunity to improve a chance to build better and to be more resilient and adaptable to the adverse effects of climate change. Furthermore this gives us opportunity to build and increase our capacities to handle disaster related challenges. It enhances our capacity to adapt, to do relief works and rehabilitation.

Other positive aspect is it gives us the opportunity to review, revise, upgrade, formulates policies and building codes that will promote resiliency and the protection of the environment.


GSHAP 10% in 50 years PGA
Hazard m/s^2
.2
.4
.8
1.6
2.4
3.2
4.0
4.8
9.8
Plates
Subduction
Transform
Divergent
Others
Philippines
Spratly Is.
Malaysia
Brunei
Indonesia

II. Structural Concepts

A. Kinds of Structural Failures

1. Component of Joint Failure

Component failure refers to the failure of structural element. This kind of failure which were along the joint makes the structure completely unusable. This refers to joints where the columns and beams meet and intersect. Failure also depends on the type of structure and materiality. Mostly it is categorize as concrete and steel except structures that uses indigenous material.

2. Steel

Moment resisting frames- most damaged observe failures are on joint column and beam. Welding failure and incorrect system of installation of shear tab and steel plate welded to column and shear transfer like lack of flanges and defects.

3. Reinforced Concrete Structure

Moment resisting frames are vulnerable to earthquakes. In times earthquake the movement (swaying back and forth movement) of concrete slab and or roof deck subject the frame to pressures. The frames mentions are the beams and columns resist and respond by grinding the concrete between the columns and beams that will resort to failure.

B. Material Properties

1. Reserve Strength

This concept stems from proportional predictable force resistance versus the actual structural resistance gap. The larger the gap the more safe and large gaps can be achieve additional resistance. With additional resistance factor structure have reserve strength to counter extreme forces.

2. Quality of Concrete

The quality of concrete is also a factor.

Concrete has a high compressive strength but low tensile strength. This can be compensated by reinforcing steel in anticipation of tension along beams and columns.

It has its advantages, first its economical, and prone to buckling.

Suggested steel reinforcement grades;

ASTM A 615:

Grade 40: ƒy _ 40 ksi

Grade 60: ƒy _ 60 ksi

C. Building Collapse Hazards

Building Collapse Hazards to life are of two components;

1. Structural component of the structure and
2. Non- structural component

Building failure and building collapse hazard may lead to;

1 Continued use occupancy and functionality of the building

2. Non-continuance of occupancy which is demolition and may lead to rebuilding of the original structures retrofitted with resilient features to be able to respond to future hazards.

3. Erection of a new resilient structure that is eco- efficient and sustainable.

D. Holistic Design Approach for Earthquake and Typhoon Resistant

Incorporate Prescriptive design standards with Performance based resilient-eco-efficient design standard will result to a Holistic Resilient design.

Prescriptive Design Standards + **Performance based resilient- eco-efficient design standard** = **Holistic Resilient Design.**

E. Performance Based Design Process

The process involves evaluation of performance during hazards events, disasters both natural and manmade, calamities and other conditions and the adverse effects of climate change. It assesses actual responses of buildings and its performance in reference to the functionality, capacity and stability of buildings. It starts with identifying acceptable risk with appropriate level of performance of the building including its system. The tolerance level depends on the different tolerable level of damage to building's system and users regardless of the type of hazards

Type of damage according to hazards

a. **Mild Impact**: this kind of impact level is not of structural damage but safe to occupy and use. Non structural elements in this impact level are of minimal damage with system fully functional and with minimal hazardous materials released to the environment.

b. **Moderate Impact**: the damage impact is repairable specifically the structural component. Repairs and clearing and clean-up work shall be done to be able to make fully functional again. It is expected that there will be delay on re-occupancy for the reason that the building will undergo repair. In this kind of level non structural components are operational with moderate injuries and with a likelihood of a life loss. This impact there is minimal community risk on the release of hazardous material materials to the environment.

c. **High Impact**: This kind of impact subjects the building to significant damage to its structural elements though with expected small falling debris. Non- structural systems will be damaged and cannot be used. The structure will undergo possible structural repairs and delay in re- occupancy is expected. This kind of impact is characterized by high risk life threat with injuries significant in numbers. Single life loss maybe possible but the likelihood of multiple lives lost is relatively low.

With high community risk relocation is required and highly suggested. All this resulted to damaged structures and the release of hazardous materials to the environment.

d. **Severe Impact**: Structural damage of the structure is technically beyond repair and not feasible. With severe impact the building will not be safe for occupancy. Additional loads will cause the building to collapse. Non structural component of the structure are expected to be damaged and will not be functional. There will be multiple injuries and multiple loss of life. Life and environmental hazards are very high and will require relocation.

III. Earthquakes

What causes the building or structure to fail in times of earthquake?

A. Earthquake Movement

Earthquakes move the ground in a sudden motion and a series of shock waves at short intervals in an up and down and side by side movement.

B. Building Behavioral Characteristic on Earthquakes

Buildings and structures are design carry their own weight which is the dead load and live loads. Buildings structural design should take into account earthquake and wind resistance factor in the design and construction.

During earthquake the side by side movements were most damaging and causes poorly designed buildings to collapse. Worst if earthquake shock movement comes in a series of wave movement indicating bigger sway movement that will lead to failure.

Liquefaction of soil allows taller Buildings oscillate in accordance with frequency of the shock waves and cause the buildings to tilt.

C. Calculating Earthquakes

Seismic scale is use to calculate the severity of earthquakes

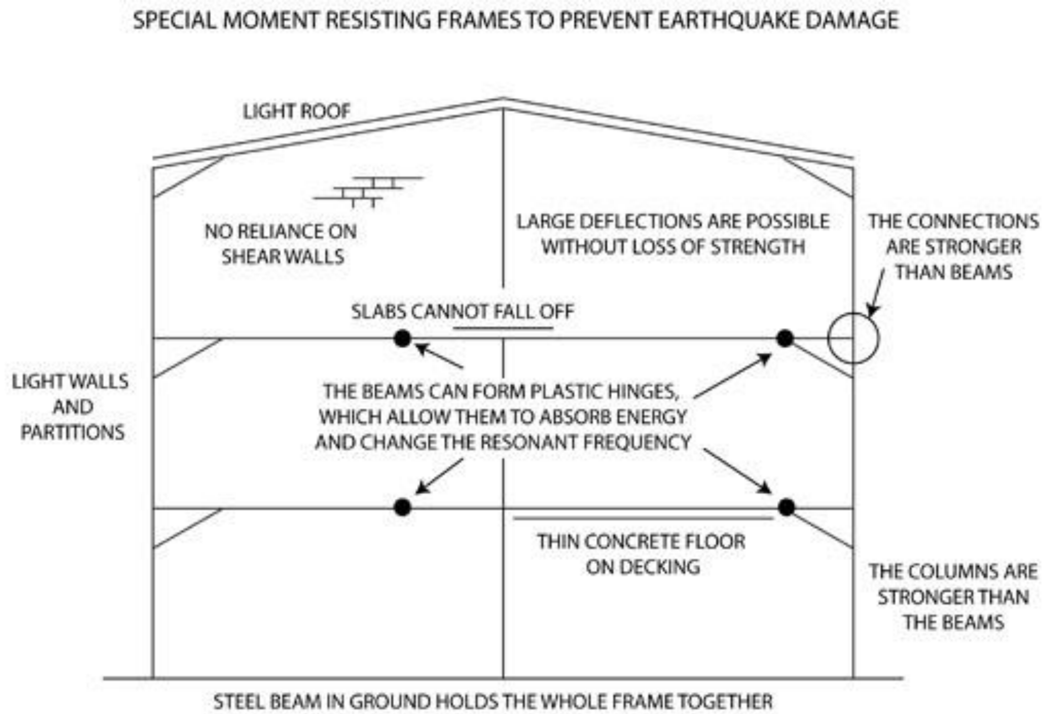
Magnitude scale: the original force of energy is measured on magnitude scale

Intensity scale: is measure of intensity of shaking at any given point on the Earth's surface. It is the maximum value of shaking intensity, or the area of intense shaking. Intensity rating may vary in area.

D. Earthquake-Resistant Design Guidelines

How do we design Earthquake Resistant Structures?

- Make the roof as light as possible
- If the building is of two storey or more make the roof and floors light
- Prevent footings from moving in different direction by installing and incorporating a ground beam on footings. This is also called tie beams. Tie beams or ground beams absorb energy and changes the resonant frequency of the structural frame leaving it entirely as the same strength as it was designed.
- Outer columns give more sway than the inner columns. Outer or perimeter column of the building should be design with more strength than the inner columns. Inner columns do not have strong sway resistance than the outer columns.
- Ensure a strong column – to beam connection
- Timber buildings are preferred in earthquake areas for they are light and reduce earthquake effects.



Rollo Reid

C Eng FIStrucE, Director, Reid Steel.

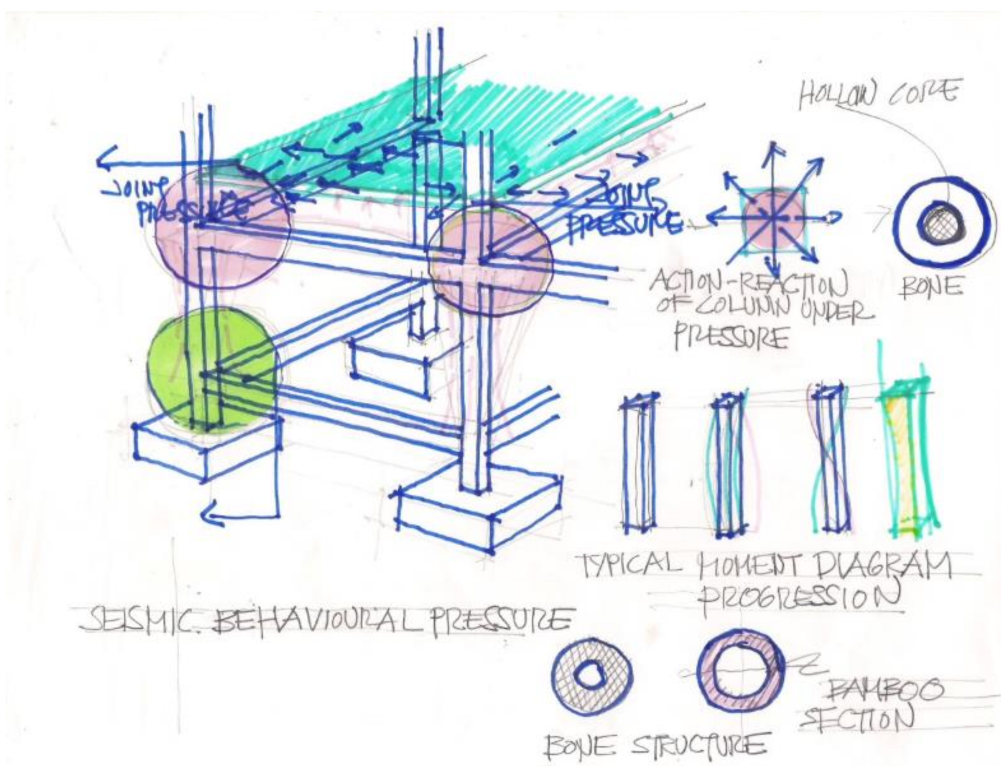


Illustration by koradesigngroup

IV. Tsunami

Tsunami is a series of water waves caused by the displacement of a large volume of body of water, generally an ocean or a large lake. Earthquake, volcanic eruption and other underwater explosions (including detonations of underwater nuclear devices, landslide, glaziers calving, meteorites impacts and other disturbances above or below water all have the potential to generate a Tsunami (Wikipedia)

A. What are the effects of Tsunami on buildings?

Buildings block the path of tsunami as it pushes inland. It cause load pressure overload. The deeper the water the greater the pressure the more the stronger the impact and erodes the soils.

B. Ways to resist waves cause by tsunami

- Rough ground surface reducing effects of waves, it is always good to preserve vegetation along coastal areas for inland and the sea. Inland vegetation help reduce the waves impact. Manmade or natural barriers help reduce the impact of tsunami. Mangroves, swamps, and reefs should be preserve and develop to be able to help break the waves. Manmade wave barrier are wave breakers and other artificial barriers.
- Never build low level buildings along the shoreline, work for a design where the structures along the coastline should be raised for a minimum of one storey high so the water can flow under. The suspended flooring preferably concrete and with stable framing if well designed can resist strong force of the wave.
- Building shall be laid in a slightly diagonal manner to as to let the water flow. Make use of the theory of least resistance.
- In planning leave gaps in between buildings for water to dissipate
- All structural components should have excellent fixed construct joint from frame to footing foundation for strong resistance.
- Timber buildings are not advisable tsunami prone area, it likened to a ship they float and timber component is a negative factor against life and property (wood debris may destroy houses and other structure and increase the risk of safety to the

people).

- Maintain a no- build zone along coastal hazard area. Build along safe zone identified by government as safe build area. These areas mostly are located along elevated areas.
- To balance tourism and planning some areas shall be identified as touristic area where resilient structures design will be a requirement.

C. Tsunami Resistant Buildings

- To avoid wave surges, the building should not be built along projected water path.
- Structure should be raise to a minimum of a storey high (On stilt design concept) with the main functional floor suspended.
- The buildings should have a narrow front configuration, with gaps between building and layout on diagonal angle for water to dissipate.
- The building shall be designed with eco-efficiency in mind and concept to be able for sustainability.

V. Storm Surge

Storm surge is an offshore rise of water associated with low-pressure weather system, tropical cyclones and strong extra-tropical cyclones. Storm surges are caused primarily by high winds pushing on the ocean's surface causing the water to pile up higher than the ordinary sea level.

Storm Surge is an abnormal rise of water generated by a storm over and above predicted astronomical tide. Storm surge is simply water that is pushed toward the shore by the force of the winds swirling around the storm. Wind waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides. The greatest potential of loss of lives is storm surge.

Storm Tide: is the water level rise during a storm due to the combination of storm surge and the astronomical tide.

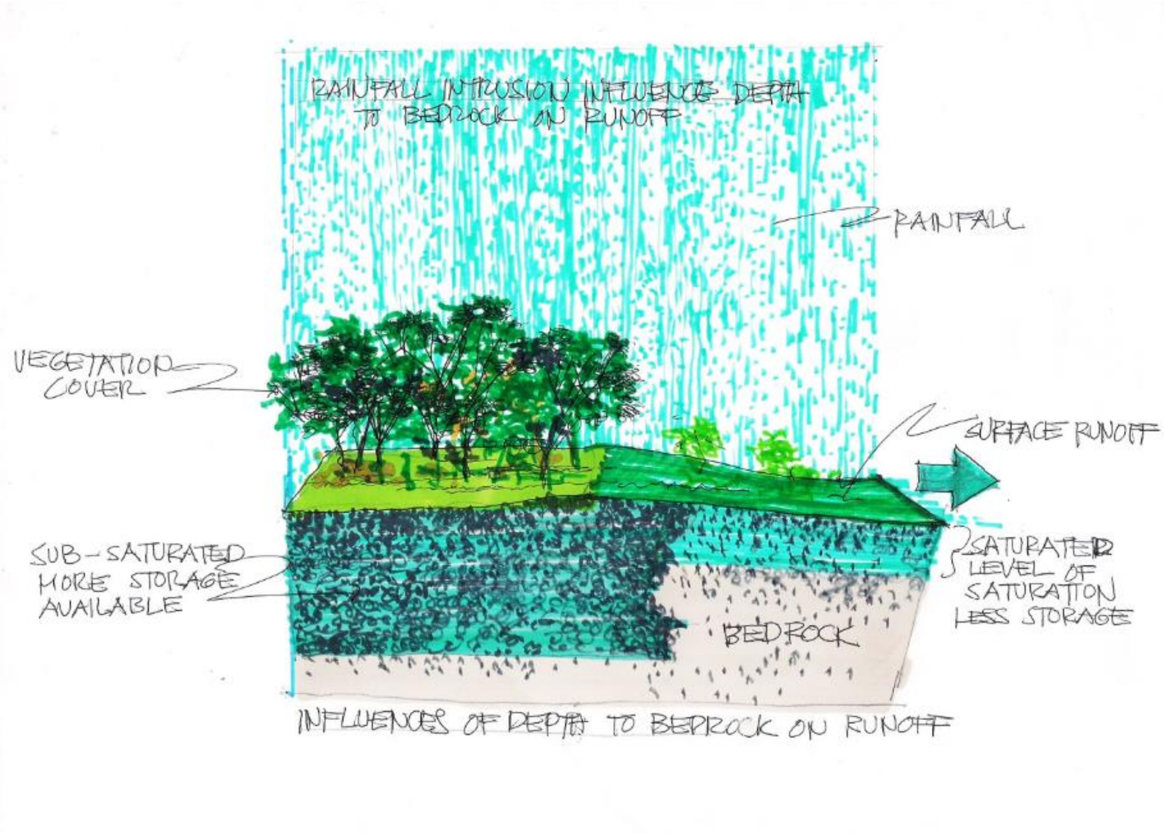
Total Water Level = Storm Surge + Tides + Waves + Freshwater Input

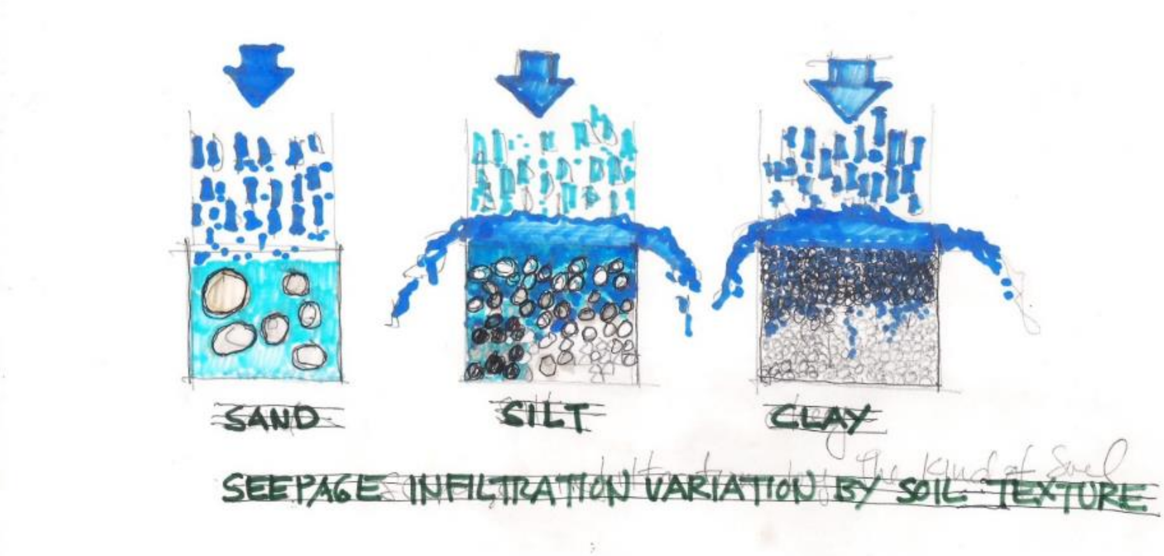
VI. Flood

According to the national Weather Service weather Forecast office Flood is defined as an abnormal overflow of water into normally dry land. Flood is an inundation of a normally dry area caused by rising water in an existing waterway, such as river, stream, or drainage ditch.

Flood: An overflow of water onto normally dry land. The inundation of a normally dry area caused by rising water in an existing waterway, such as a river, stream, or drainage ditch

and stagnation of water at or near the point where the rain fell. Flooding is a longer term event than flash flooding: it may last days or weeks.





Flash flood: A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through river beds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam.

CHAPTER 6

HAZARDS DATA AS A GUIDE IN PLANNING AND DESIGN- ITS RELEVANCE AND IMPORTANCE ON POLICY AND DECISION AND MAKING

Discussion in this chapter will highlight the importance of hazard data, type of data usage and the data relevance in decision making process and policy guide. Highlighted will be the type of hazards, its needed data and its intended use in formulating resilient designs and plans. Furthermore, historical data will be a guide in decision making process in formulating and upgrading building codes and policies for a resilient eco-efficient sustainable Philippines.

Included are solution inputs that will be mitigating structural measures may it be natural or in infrastructure for training, education and upgrading of codes. Hazard data are vital inputs in the process in designing holistic resilient- adaptable structures that is eco-efficient.

The inclusion of hazard data in the design process are guiding considerations in formulating holistic resilient structure with three guiding principles namely aerodynamics, hydrodynamics and bio-mimicry.

I. Types of Hazards - Hazard Data and Its Usage

Hazard data are tools for designers and planners in formulating policies, guidelines and infrastructure resilient and adaptable designs. Hazard data are very important inputs that determine the processes, analysis and outcome in formulating and drafting a sustainable development plan that is eco-efficient and resilient. Furthermore, it is equally important for these data to be analyzed and processes in the preparation of a disaster management and rehabilitation plans.

These data are tools in the upgrading of structural and resilient capacities in current and future infrastructures may it be retrofitting or a resilient eco-efficient design to address natural disasters and the adverse effects of climate change.

HAZARDS	TYPE OF DATA/USE
Cyclone	Land Cover data/Wind barriers (trees, buildings); damage (flying objects, fallen trees)-Natural wind barrier protection, vegetations that absorbed water and delays flooding. It might dictate the form of the structure Elevation data/Wind acceleration; coastal surge intrusion Bathymetry (shoreline water depth)/Storm-surge hazard modeling- It can be a tool for indentifying and enforcement of the no-build zones Identification of Evacuation areas and relocation sites as well as floor Height of infrastructure. Wind speed maps-wind: speed can determine the structural design component determining its bearing capacities and architecturally the plan configuration and profile of the roof and slope Coastline and still-water elevation maps/Storm-surge hazard modeling: Can be use as a tool in designing and determining the structural capacities for both inland and off shore storm surge barrier. These barriers can be of artificial or natural, natural barrier are most efficient in terms of eco-sustainability.
Drought	Drought Precipitation and rain gauge data/Rainfall records and trends Global humidity-This type of data can be a tool in establishing and planning of rain water storage system for use in times of emergencies. Furthermore, this will be a tool in the preparation of resilient sustainable plan for a sustainable development.
Earthquake	Earthquake Soil maps/Ground motion patterns

Soil and ground conditions maps/Liquefaction susceptibility

Fault line map

Landslide potential data/Post-earthquake landslide potential

The above mentioned data needed determine the structural capacities and design of earthquake resistant structures. Seismic historical data are determinants in establishing no build zones and force relocation areas. It indicates habitable and non habitable areas. Most importantly these data are determinants for earthquake mitigating measures.

Fire	Fire Fuel maps, land cover maps/Fire fuel sources Critical weather data (low humidity, wind) Land elevation/Predict fire speed Fire barrier stop are needed in bush fires specifically during drought and dry months. Type abovementioned data is an aid in identifying barrier buffer zones for fire spread control.
Flood	Flood Digital Elevation Model) or Digital Terrain Model (DTM) for bare earth/Predict water flow/Contour data/Complements Historic precipitation data/Soil data/Areas of water infiltration Locations of river and hydraulic structures (bridges, dams, levees) Flood control measures and flood mitigation plan uses these type of data in formulating policies and designs for an adaptable and resilient environment. Flood basins are effective mitigating instruments in delaying flooding. Vegetation rehabilitation, forestation and re-forestation are very important natural ecologically efficient mitigating measure. Architecturally, flooding dictates elevation of floor, plan configuration, and building form, all for a floor resistant resilient structures.

Landslide	Slope data (DEM, DTM)/Areas of susceptibility Soils maps/Areas of high susceptibility/Land cover No build zones are established and identified through these data. Mitigating measures of forestation, re-forestation and establishment of green buffer use these type of data for disaster risk management measures.
Tsunami	Bathymetry (shoreline water depths)/Tsunami hazard modeling Coastline still-water elevations/Tsunami hazard modeling Elevation data/Tsunami intrusion Tsunami resiliency measures use these types of data in formulating policies and designs for an adaptable and resilient environment. Water diversion infrastructures, contour water guides and flood control instruments for both inland and offshore are tsunami mitigating plan uses these data as design and planning basis. Vegetation rehabilitation, forestation and re-forestation are very important natural ecologically efficient mitigating measure. Natural vegetation is one of the most effective in delaying and slowing tsunami water rush incorporating contouring actions. Architecturally, flooding dictates elevation of floor, plan configuration, and building form, all for a flood resistant resilient structures. The above mentioned data are tools in decision making in establishing no build zones, areas as protection against the elements and safe areas

II. Earthquake Hazards and Effects Reflected on Maps

Earthquake: the effects of earthquakes can result and trigger another form of hazards. These hazards are the after effects of an earthquake event. Hazard's historical events and data in the form of maps are useful tools in planning and design of resilient structures.

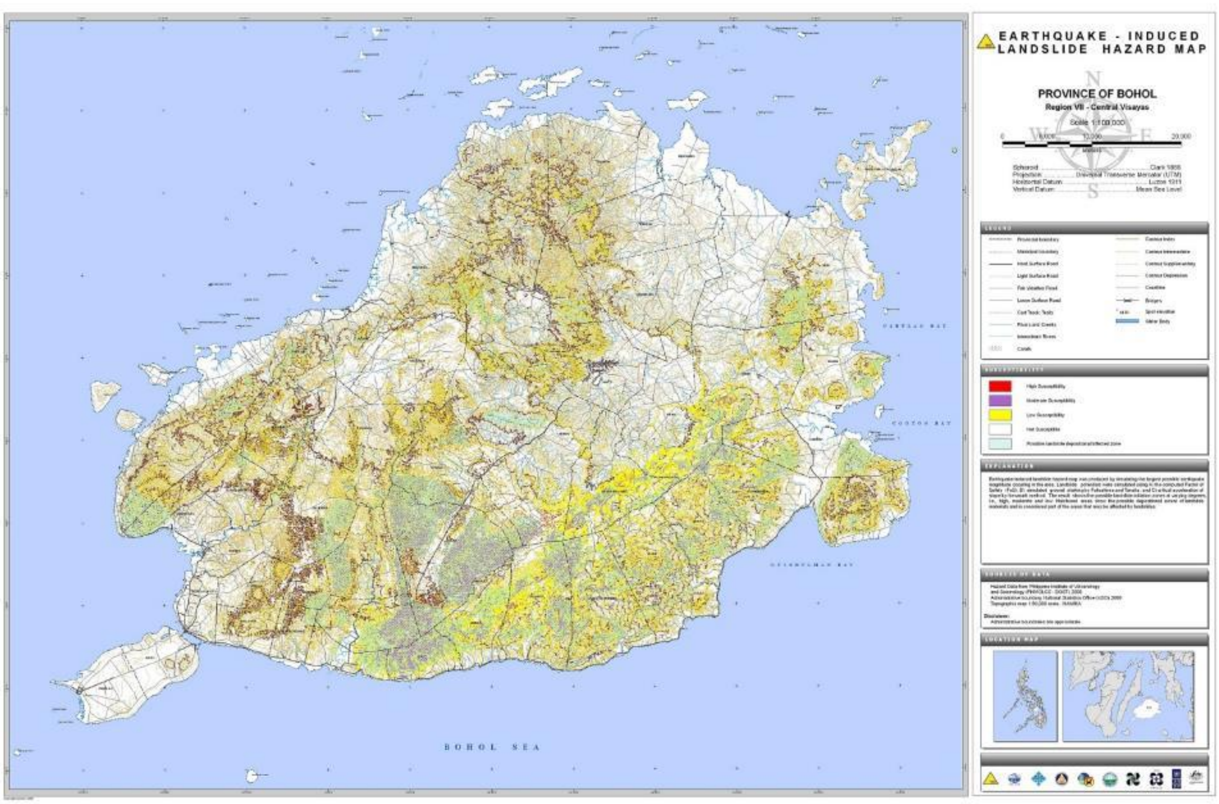
Hazard maps are useful guide in formulating policies and upgrading existing codes. Maps below are Bohol Island Hazard map as released by the Provincial Planning and Development Office in Bohol, Philippines.

A. Earthquake Induced Landslide Maps

Earthquake induced landslide: is a form of hazard resulting from an earthquake, historical data can be used as planning guide in formulating policies and disaster management framework. So when an earthquake occurs in a mountainous area it is expected that landslide may take effect.

The landslide magnitude depends on the given earthquake magnitude which is influence by the earthquake's depth, topography and prior weather conditions. When ground is wet, with less vegetation, and less stable a landslide may occur.

Below is a sample map of earthquake induced landslide of the Island of Bohol, Philippines.



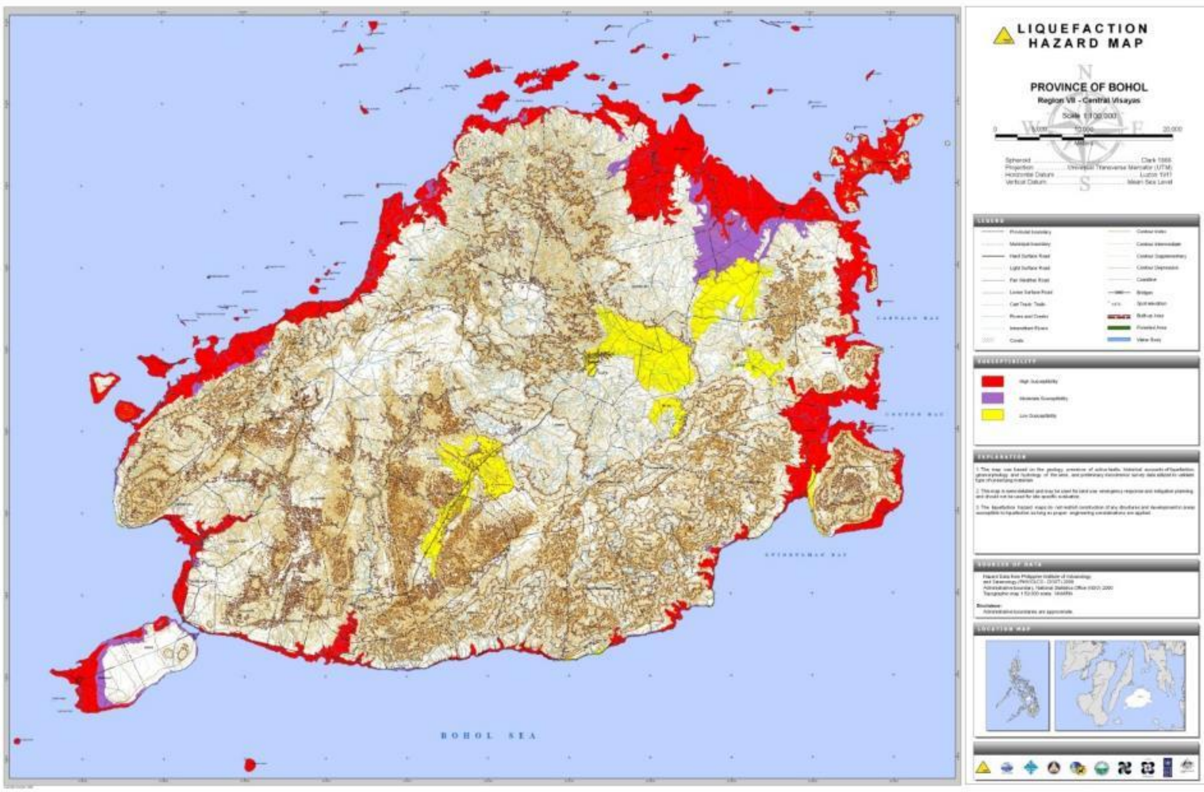
B. Ground Rupture Map

Ground Rupture: Ground rupture hazard is the kind of hazard that can be found in areas hit by a powerful earthquakes. Continuous seismic movement ruptures the ground that can be of hazard to the populace.

Ground rupture occurs during earthquakes and is being manifested by the breaking of the earth's surface when it is a near surface fault.

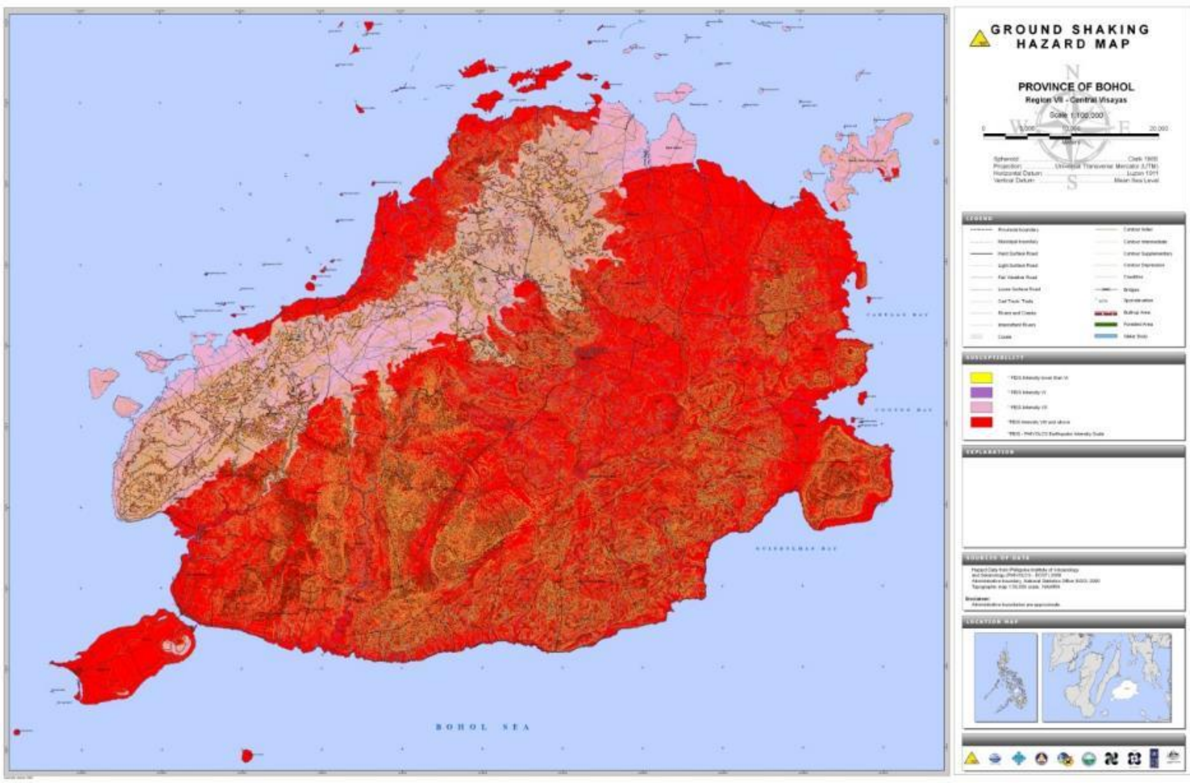
C. Liquefaction Hazard Map

In geology, soil liquefaction refers to the process by which water-saturated, unconsolidated sediments are transformed into a substance that acts like a liquid, often in an earthquake. By undermining the foundations and base courses of infrastructure, liquefaction can cause serious damage.

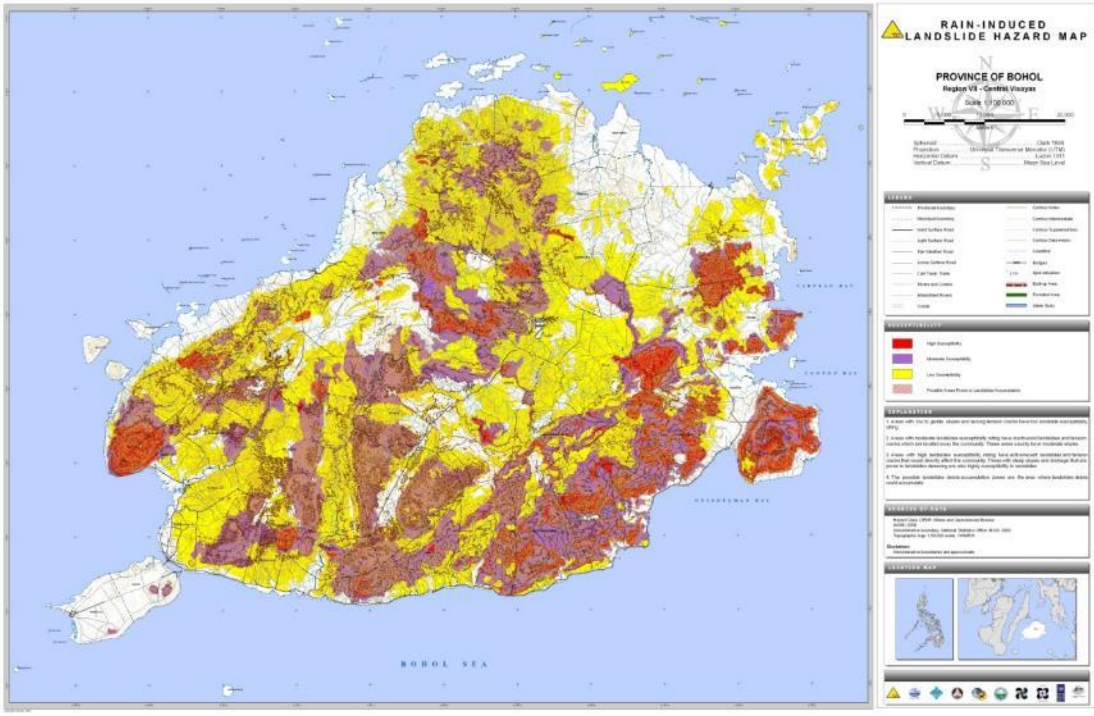


D. Ground Shaking Map

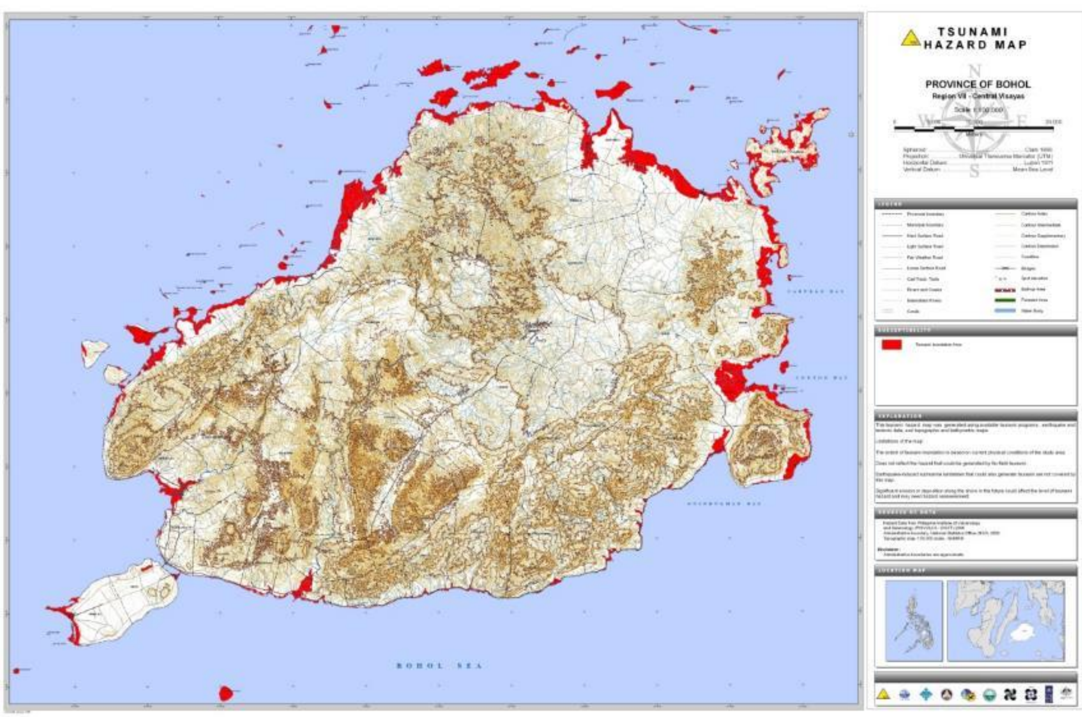
Ground shaking: ground shaking event occur after an earthquake event. These are aftershocks that occur after a major earthquake. Aftershocks can be in different magnitude and intensity. Series of aftershocks after an earthquake result to heavy damages.



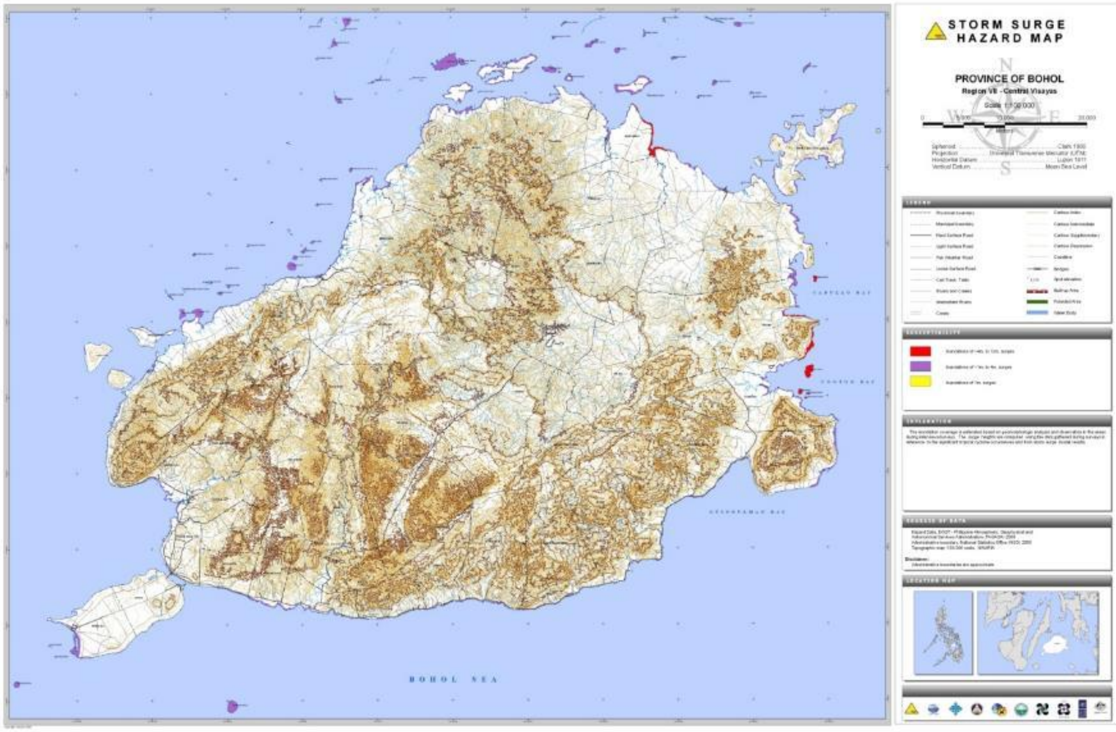
E. Rain Induced Landslide Map



F. Bohol Tsunami Data Map



G. Storm Surge Hazard Map



III. Areas of Concern for Hazard Maps

While hazard maps are very important tools to be able to mitigate, formulate policies, enhance disaster preparedness building capacities and upgrade code for a resilient sustainable development, there are points of concerns that should be tackled. There are questions like;

a. There are questions on warning system effectiveness. Are they outdated? Can warning systems be translated to simpler form for clear understanding among the people?

b. Then there is this question on the kind of warning system that is most effective in dealing with disaster hazards.

c. There is a need for an effective information dissemination system with regards to hazard maps interpretations for clear understanding of what should be done in disaster preparedness and post disaster rehabilitation.

d. Are these maps readily available for policy and decision makers?

Hazard Maps are very important tool and guide for those in government both local and national to formulate policies and codes. Hazard maps information most importantly help save lives and properties if effectively use.

CHAPTER 7

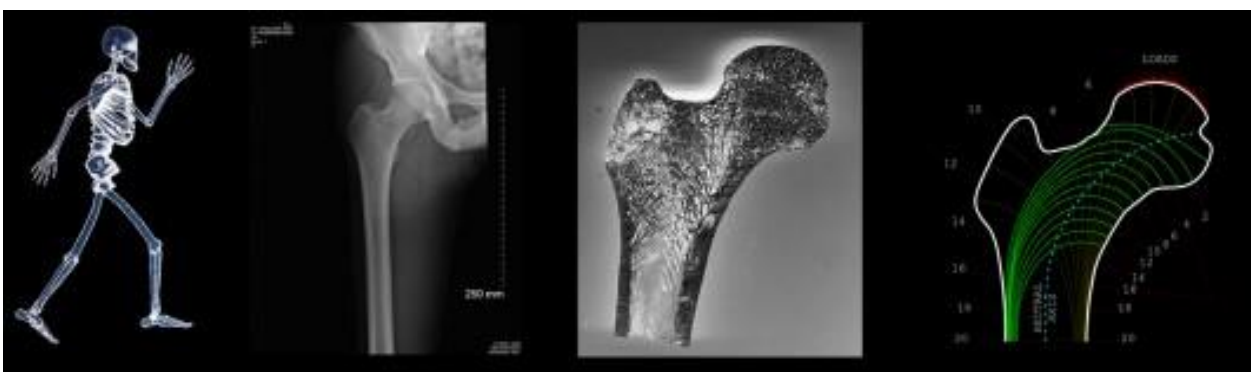
ARCHITECTURAL PHILOSOPHIES, THEORIES AND PRINCIPLES A GUIDE FOR HOLISTIC RESILIENT SCHOOLS DESIGN

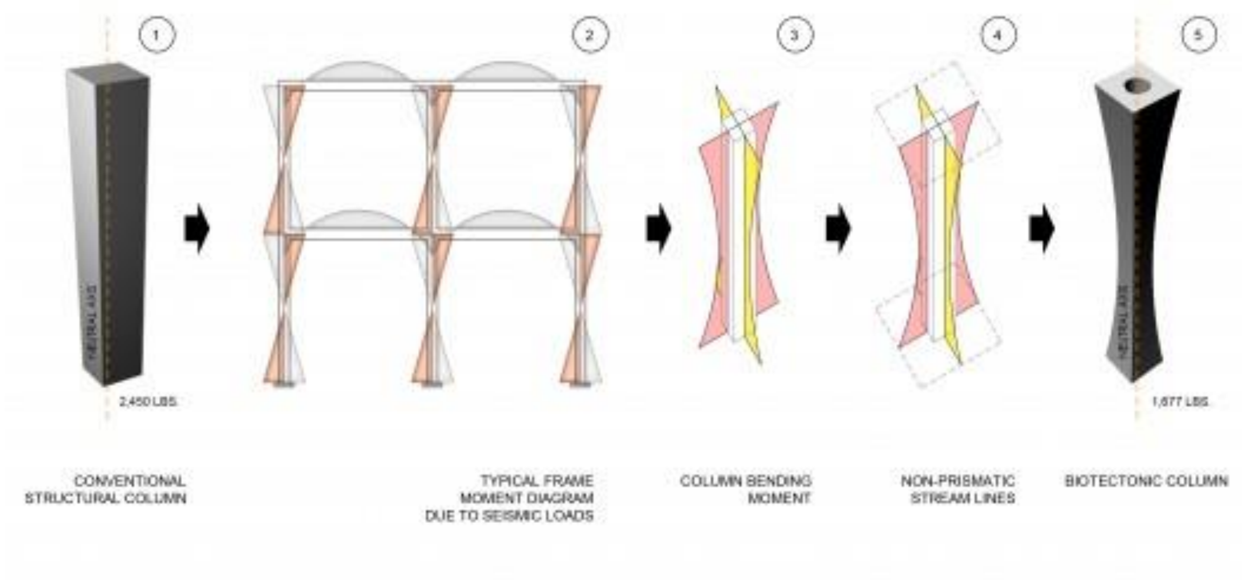
I. Conceptual Takeoff

A. Biomimicry

The philosophy of biomimicry always takes into account nature as constant reference in design performance. It is an ecological approach in design to improve building disaster resilience. It is a thought anchored on how nature reacts to pressures and relate this to infrastructure.

Bio-structural Analogues in Architecture, By the Singaporean Architect Joseph Lim (2009) emphasize that "Central to the idea of a design strategy in developing the architectural concept, is a form of technological thinking which drew inspiration from other forms of knowledge".





As wrote by the biologist D’Arcy W. Thompson, every form in Nature is essentially the product of the diagram of forces acting on it or which have acted on it.

In simpler terms the heaviest part of the human body is the upper part which is carried by the lower part. The joints allow flexibility in movements responding to absorbing shear pressure and weight pressure and external pressure as well (external pressure like the wind and other load factors).

Illustration by: Body World Exhibits: Center for Life Tomorrow

It is a architectural and structural concept where the weight of the upper body is being absorb by the lower part of the body and how the lower part of the body reacts to such pressures.

Recent earthquakes prove the inefficiency of current buildings performance, professional to plan with an adaptation in mind as an approach. Adaptation to seismic behavioral characteristics and its effects is an approach meant to improve resiliency performance of a structural.

Concept Note on Biomimicry

As a conceptual takeoff, human anatomy is a very important analogy of a stable structural frame design of a building. The upper load in the building being carried by the lower part of the building which are the foundation and the columns. The human form offers design elements of flexibility, stability, durability and balance under the stress of movement, external factors such as wind, environmental stresses and weight (load).

B. Aero-dynamics

Wikipedia defines Aerodynamics as a branch of dynamics concerned with studying the motion of air, particularly when it interacts with a solid object, Understanding the motion of air around an object (often called a flow field) enables the calculation of forces and moments acting on the object. In many aerodynamics problems, the forces of interest are the fundamental forces of flight: lift, drag, thrust, and weight. . Of these, lift and drag are aerodynamic forces, i.e. forces due to air flow over a solid body.

The National Aeronautics and Space Administration (NASA) is the agency of the United States government that is responsible for the nation's civilian space program and for aeronautics and aerospace research. Defines Aerodynamics as;

Aerodynamics is the way air moves around things. The rules of aerodynamics explain how an airplane is able to fly. Anything that moves through air reacts to aerodynamics. A rocket blasting off the launch pad and a kite in the sky react to aerodynamics. Aerodynamics even acts on cars, since air flows around cars. The word comes from two Greek words: aerios, concerning the air, and dynamis, which means force. Aerodynamics is the study of forces and the resulting motion of objects through the air.

According to Tony Foal;

- Wind intends to have laminar flow (parallel flow of air without distraction) around a good shape). In his illustration it is a curve configuration
- When Turbulent flow around a bad shape drag is proportional to the wake. A wake is the region of flow recirculation immediately behind a moving or stationary solid body, caused by the flow of surrounding fluid around the body.
- Too steep an angle result to separation and increase drag
- When configuration is of a shallow angle with sharp cut-off leaves smaller wake and less drag.
- Aero dynamic shape of building significantly reduces wind resistance to building.

Forms and details of a building and structure help mitigate and reduces wind load on a structure.

The benefits of an aero dynamic form;

- Curve corner reduces wind resistant and allows wind to flow through the curve surface.
- The curve configuration reduces wind induced vibrations.
- Diagonal placement of buildings allows wind to flow

Concept Note on Aero-dynamics

The principle of aero dynamic is vital in the design process of coming up with holistic resilient school. It will be a tool to conceptualize a form and shape where there is less drag, allow wind and air to flow to be able to come up with a resilient design specially the roof.

C. Hydrodynamics (Fluid Dynamics)

In physics, fluid dynamics is a sub-discipline of fluid mechanics that deals with fluid flow—the natural science of fluids in motion. It has several sub-disciplines itself, including aerodynamics and hydrodynamics. Wikipedia

It important that we understand water dynamics to be able to design holistic resilient structure that will addresses and mitigates the effects of flooding. It will affect its form and plan configuration and influence how resilient structure looks

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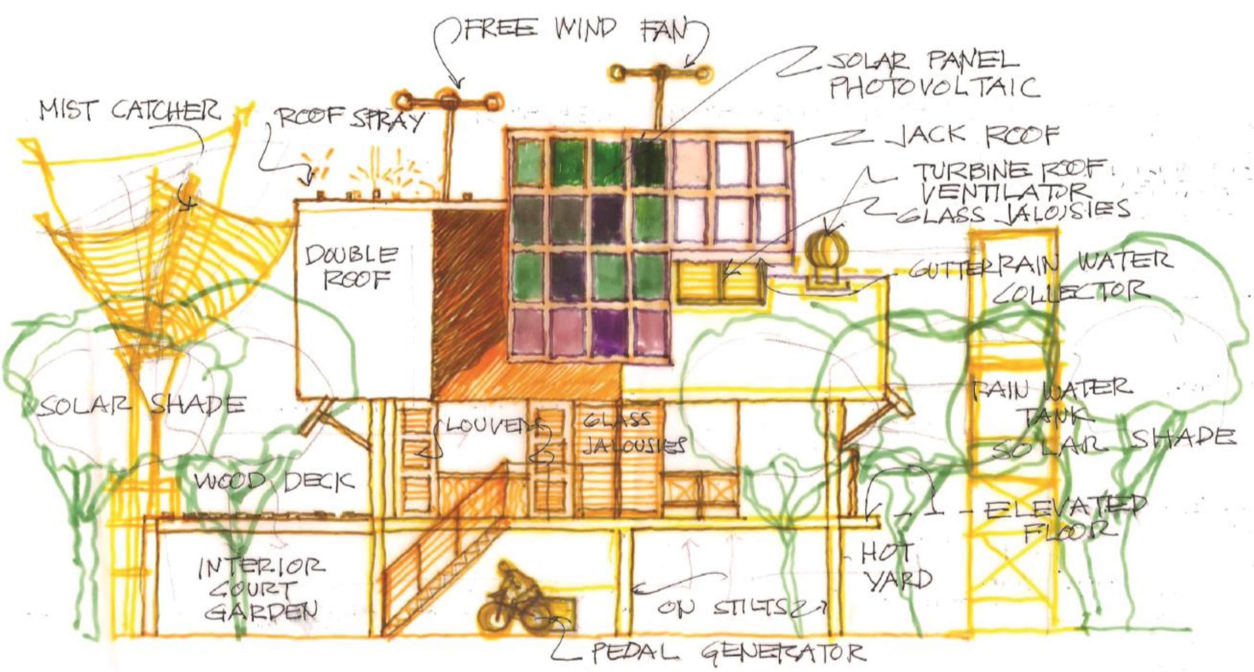
CHAPTER 8

ARCHITECTURAL THEORIES, PRACTICES AND PROTOTYPE MODELS FOR ECO-EFFICIENT SCHOOLS DESIGN

Borne out of social responsibility, the key design conceptual takeoff, "Education as a means of fighting poverty and protecting the environment", the green school is envisioned to be adaptable to climate change effects. Climate change has not only threaten lives and properties but also, contribute to the depletion of natural resources. It is thus, relevant to create buildings that matter to our time.

A building that teaches concept, incorporating new ideas in building designs. A design element that relates to the environment, that is a teaching tool and as well as an effective architectural element. The design must be an environmentally sensitive design, a building that teaches about environmental conservation, a building that teaches sustainability, a school building that teaches respect for the environment and whose students promote and lead in protecting the earth and its resources.



I. Green Practices and Design

Adapting green practices helps minimize carbon footprints.

A. Siting:

- This starts with the selection of site well suited to take advantage of mass transit. As much as possible, protect and retain existing landscaping and natural features.
- Select plants that have low water and pesticide needs, and generate maximum plant trimmings.
- Use compost and mulches, this will save water and time
- Use recycled content paving materials, furnishings, and mulches to help close the recycling loop.

B. Passive Cooling:

- Maximize cross-ventilation by designing doors and windows to take advantage of prevailing winds.
- Take advantage of the "stack effect": Warm air rises as cooler air comes in. Placing vents along the ceiling allows warm air to escape, resulting in cooler interiors.
- Water installations, such as inland fish farm can lower the ambient temperature by as much as one full degree through evaporative cooling. Situate them so they cool the air as it enters the school building.
- Minimize heat gain by plotting the sun's path beforehand and designing preventive measures for the hottest parts of the school and insulate against heat by using architectural elements and locally available building materials.
- The design should adapt and conform to passive cooling principle. A structure adaptable for pocket ventilation spaces and breathers could easily be installed.

C. Natural Lighting:

- Develop strategies to provide natural lighting. Studies have shown that it has a positive impact on productivity and wellbeing.
- Situate windows and doors to make full use of natural sunlight and minimize the need for artificial light.
- Full open windows for maximum light penetration

- Solar tubes and skylights are a low-cost solution for interior parts of the school without accessible windows.
- When using artificial light, use energy-efficient LED or compact fluorescent bulbs.

D. Water Management:

- One way to conserve precious drinking water is to install a "grey" water system, which is basically a tank or cistern for collecting rainwater and used water from drains. Grey water can be used for irrigating plants and flushing toilets.
- Rainwater harvesting: for organic farming or hydroponic farming and or inland fish farm.
- Minimize wastewater by using ultra low-flush toilets, low-flow shower heads, and other water conserving fixtures.
- Use a water budget approach that schedules irrigation for landscaping.
- Incorporate rain water harvesting system and storage
- Plan site water run-off system storage for emergency use (fire fighting and building maintenance operation)

E. Carbon Footprint:

- Be mindful of the environmental impact your building creates during its construction.
- Local indigenous materials have a much smaller carbon footprint than imported materials.
- Use recycled or repurposed material whenever feasible, such as adobe from the foundation work, or planking from previous structures.
- Set aside as much of the land area as you can for greenery.
- Use low volatile organic compound (VOC) paint; it's better for the environment.

F. Alternative Energy And Renewable Energy:

- Consider alternative energy sources such as photovoltaic[1] and fuel cell that are now available in new products and applications. Renewable energy sources provide a great symbol of emerging technologies for the future.
- Wind energy as power and ventilating source.

[1] Photovoltaic (PV) is a technology that converts sunlight directly into electricity.

- Solar panels can also be used to generate supplementary power for energy saving - efficient operational management cost.

G. The Use Of Natural Barriers As Solar Heat Protection:

- Use trees, plants, proper site selection and site orientation as natural solar shades and wind buffer.
-

H. The Use Of Sustainable, Eco-Friendly Building Materials:

- Use sustainable wood products.
- Use locally readily available sustainable building materials and of low or no VOC materials.
- Select sustainable construction materials and products by evaluating several characteristics such as reused and recycled content, zero or low off gassing of harmful air emissions, zero or low toxicity, sustainably harvested materials, high recyclability, durability, longevity, and local production. Such products promote resource conservation and efficiency.
-

I. The Use Of Re-Useable And Recycleable Materials:

- Using recycled-content products also helps develop markets for recycled materials that are being diverted from landfills.
- Utilize recyclable and reusable materials such as plastic bottles as architectural elements in the school building.
- Reuse and recycle construction and demolition materials.
-

J. Use Simple And Easy To Build Structure Design:

- Use modular designs
- Flexibility in design
-

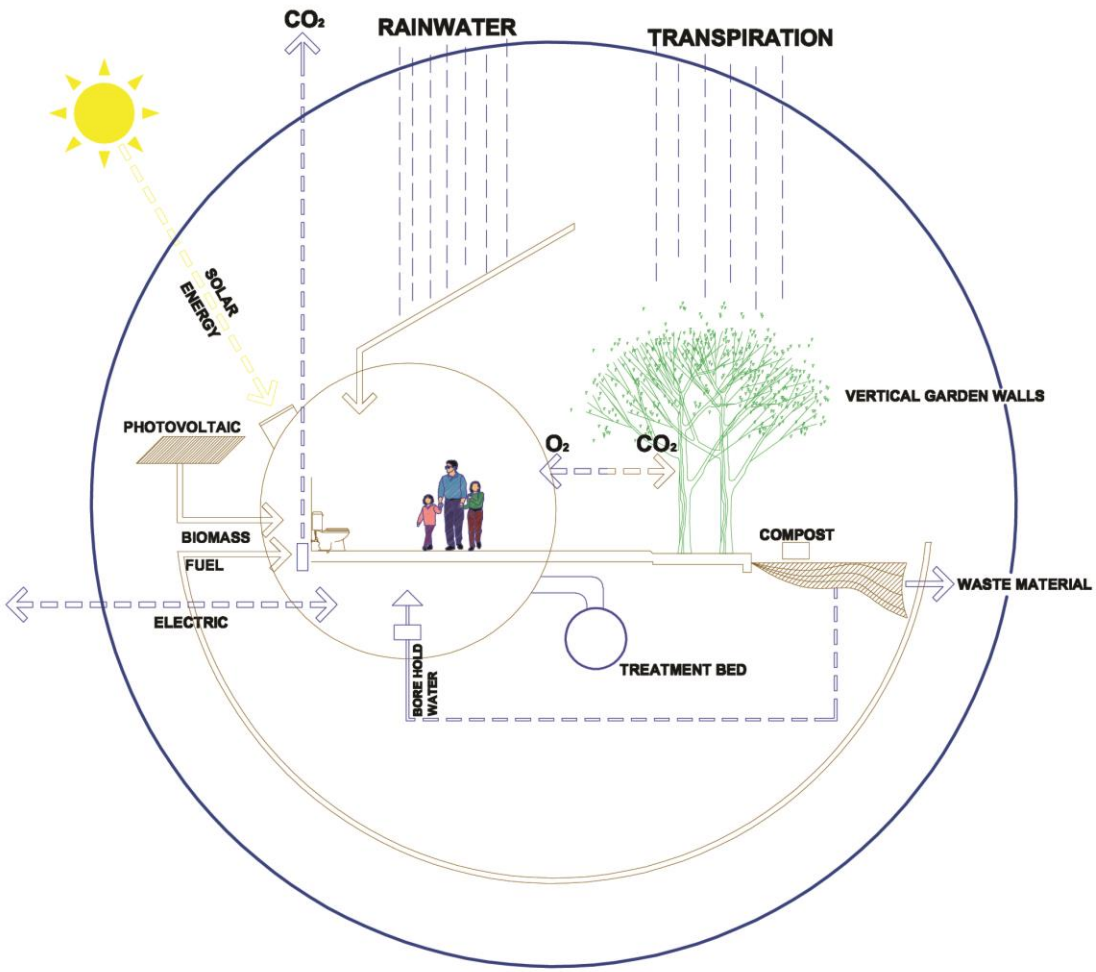
K. Use Different Architectural Elements:

- Use distinctive architectural elements as shades and ventilation tool to cool the interior spaces.
- Maximize light colors for roofing and wall finish materials; install high R-value wall and ceiling insulation; and use minimal glass on east and west exposures.
-

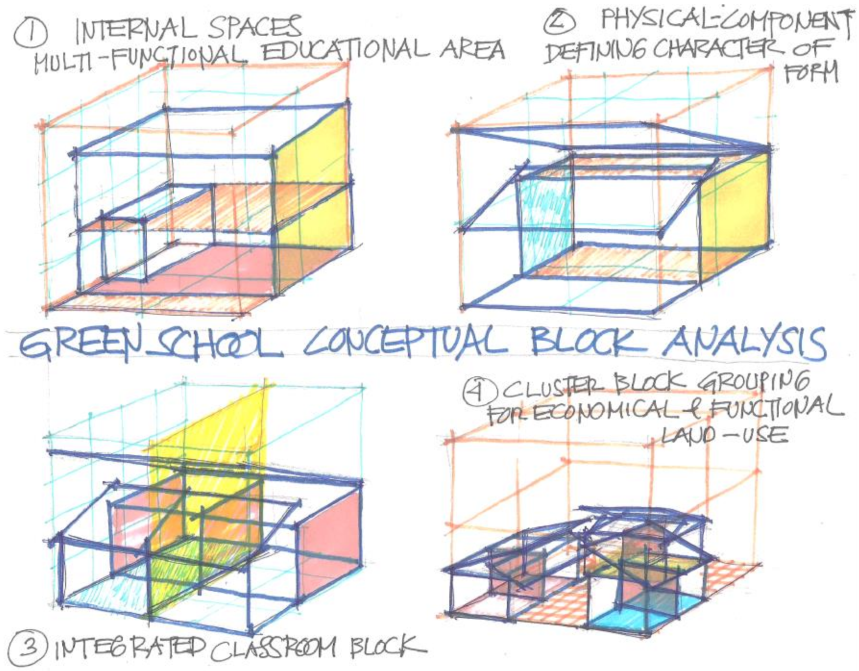
L. Use Dimensional Planning And Other Material Efficiency Strategies.

- These strategies reduce the amount of building materials needed and cut construction costs. Design rooms conforming to standard-sized wallboard and plywood sheets.

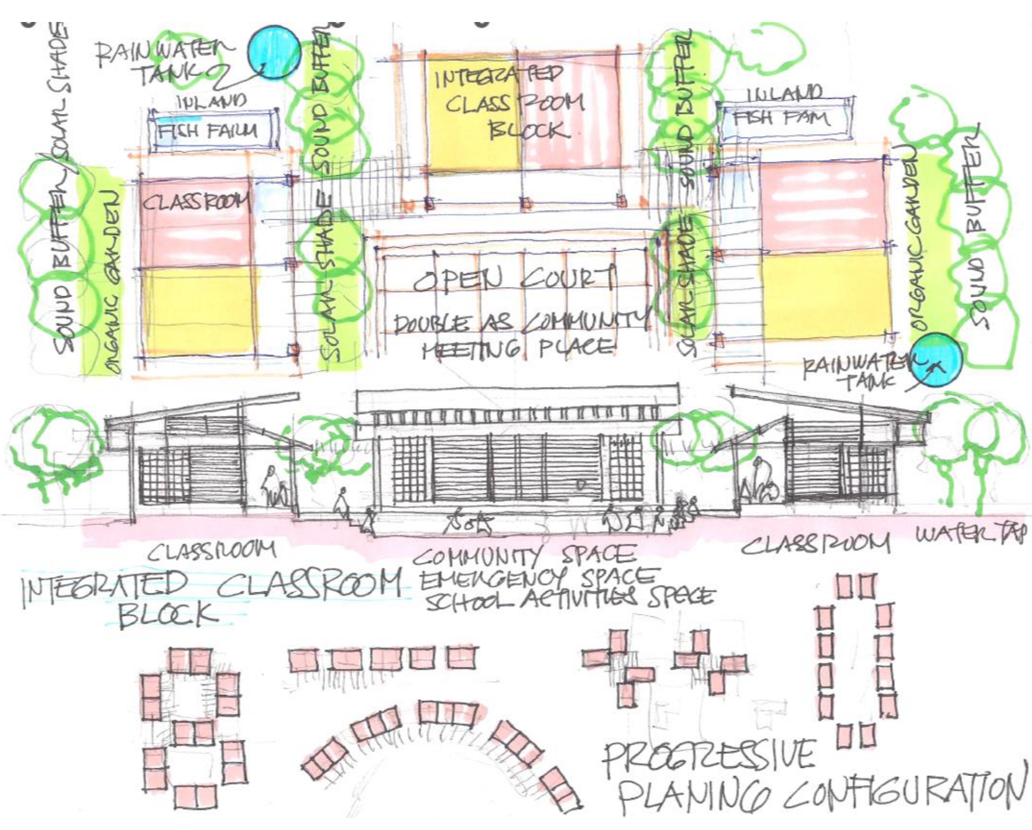
II. Conceptual Eco-House Diagram



III. Conceptual Block Analysis



IV. Progressive Planning Configuration



V. Green and Sustainable Applications

A. Rainwater Harvesting

Rain water is collected from the roof to the gutter, and stored in elevated tanks to supply water by gravity to the school's toilet facilities, gardening, and other use.

BENEFITS:

- Conserves water
- Physically demonstrates to the students/community the sustainable attribute of rainwater harvesting
- Available even when power is interrupted
- Reduces run-off and erosion
- Available even when storms & disaster strike
- Available immediately for fire suppression
- Reduces mosquito breeding grounds (Dengue Fever)
- Thermal mass can naturally cool buildings

1. Rain water is collected from the roof to the gutter, and stored in elevated tanks to supply water by gravity to the school's toilet facilities, gardening, and other use.

2. When the rainwater tank runs empty, especially during dry season, tanks will draw water from public water supply dictated by the rise and fall of the float valve.

3. Overflow from overhead tanks will be stored in the cistern below to accumulate excess rainwater. Water will then be pumped up for reuse

4. The water drawn from the public water supply.

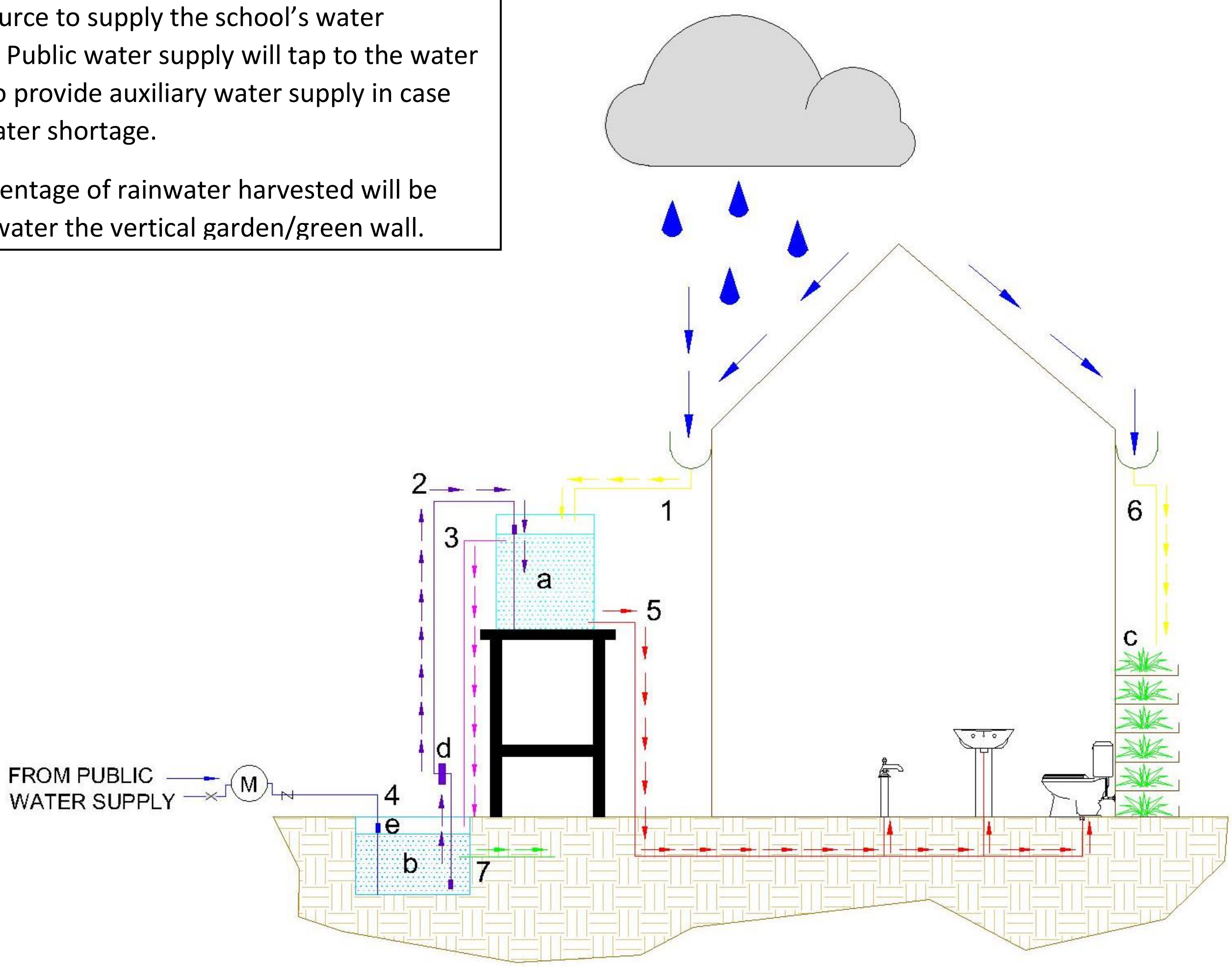
5. Harvested rainwater will serve as the main water source to supply the school's water demand. Public water supply will tap to the water cistern to provide auxiliary water supply in case of rainwater shortage.

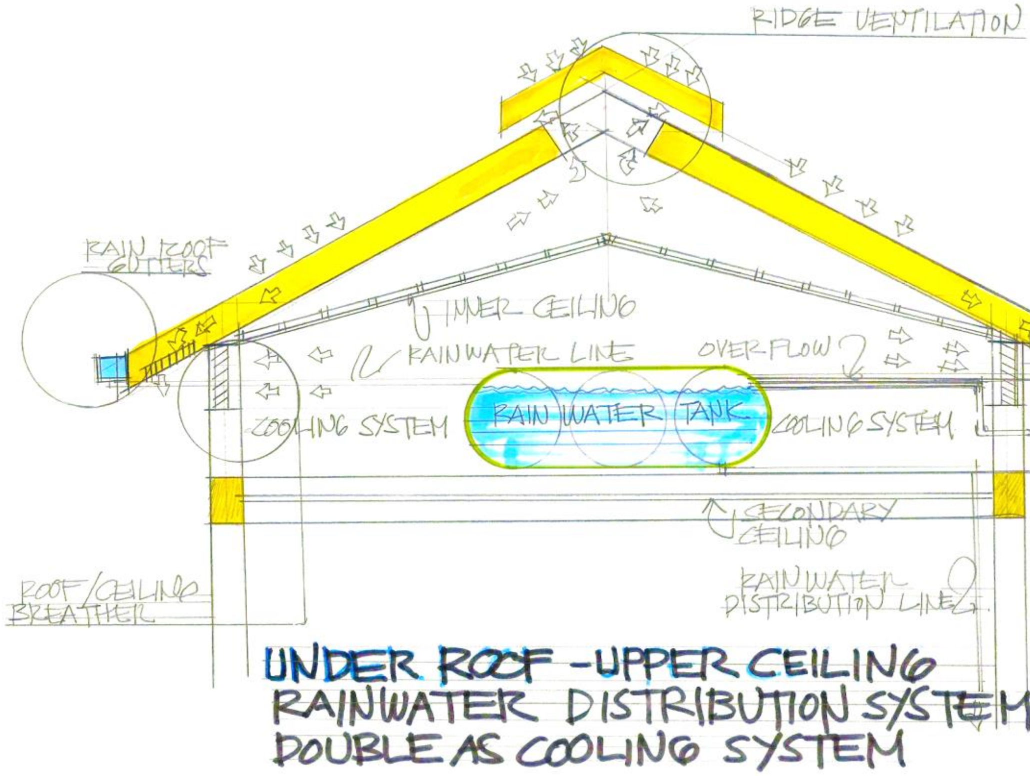
6. A percentage of rainwater harvested will be used to water the vertical garden/green wall.

a.) Rainwater Tank

b.)Rainwater Overflow Cistern

c.) Vertical Garden/Green Walls





B. White Roofs

White roofs reduce heat transfer to the inner spaces of the building by reflecting heat back to space.

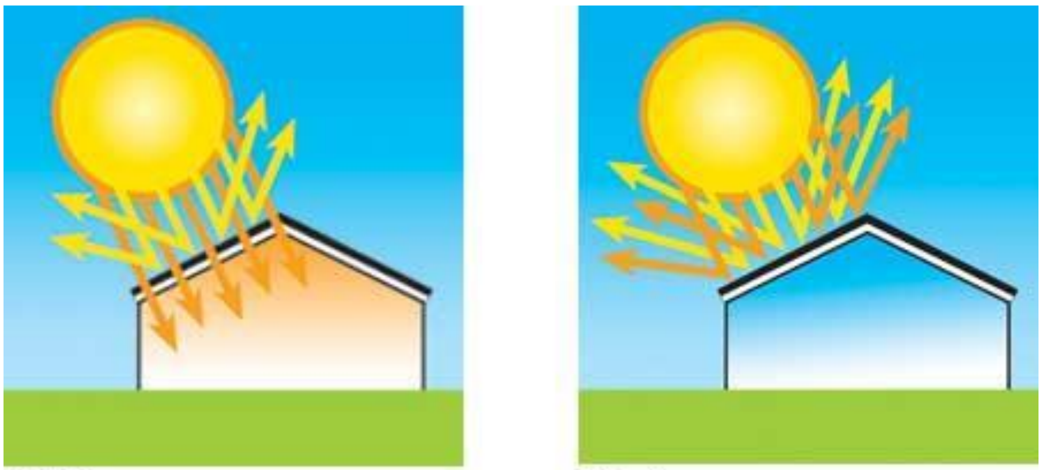


FIG. A
ROOF WITH CONVENTIONAL PAINT

FIG. B
ROOF WITH WHITE PAINT

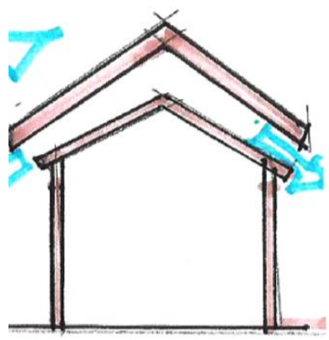
VISIBLE LIGHT WAVES
ULTRA VIOLET WAVES

C. Mix and Match:

Mix and Match is the method we use to help us determine the appropriate green techniques and materials to be applied on the school building accordingly. Mix will allow the experimentation of different kinds of green techniques and materials possible for the green school while match will help distinguish the best and most suitable green technique/material match for the green school building's structural system.

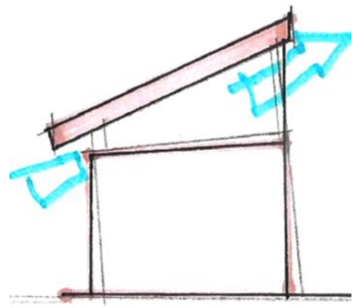
C1) ROOF SYSTEM

a) Double Roof - A double roof system uses a ventilated air gap between an upper exposed roof and a lower protected roof to minimize heat gain. Much of the solar gain from the upper leaf is carried away by the air before it can pass to the lower leaf.



- **Construction System:** layered roof structural frame
- **Complexity of Construction:** simple construction system
- **Workforce level of skills:** skilled, semi-skilled
- **Material availability:** readily available
- **Advantages:**
- Main roof covers the secondary roof for efficient ventilation, minimizing heat transfer to the interior spaces
- Cross ventilation
- Two-sides gutter for better rainwater collector
- **Disadvantages:**
- Double cost in material and labor

b) Shed Roof - A shed roof system requires basic roofing materials and can be constructed easily. The long slope of the roof makes it a good choice for use with skylights or solar panels for alternative energy systems. It can also help protect the interior from excessive sunlight at certain times of the day.



- **Construction system:** Single sloped inclined roof structural frame- simple frame
- **Complexity of Construction:** simple construction system
- **Workforce level of skills:** skilled, semi-skilled
- **Material availability:** readily available
- **Advantages:**

- Less expensive than the double roof, simple framed roof
- Simple /easy to construct
- Appropriate framing system for alternative energy and natural lighting systems (skylight) to be incorporated

- **Disadvantages:**

- Less efficient in terms roof heat transfer performance to the interior spaces.
- One side gutter location for rain water collection
- There is a need to install roofing insulation to cut on heat gain stored between the roof and the ceiling.
  (Roofing material: Galvanized iron roofing sheets (G.I. sheets), indigenous roofing material e.g. bamboo, nipa, grass, wood shingles

C2.) Alternative Energy and Natural Lighting Systems

a) Skylight – maximizes natural light and can help reduce the use of artificial lighting.

Material: Plastic and fiberglass roof sheets: cheap, bigger in dimensions, easy to construct and attached. Life span of the material is shorter than of the G.I. roofing sheets.

b) Solatube - a high-performance day lighting system that uses advanced optics to significantly improve the way daylight is harnessed.

Material: a plastic bubble with tube accessory that capture sunlight and funnel the light to the inner spaces. It has a luminaire that multiply sunlight rays for efficient natural lighting to the classrooms. It is a very efficient natural lighting accessory but cost per unit ranges from 30 - 50 thousand Philippine peso. It is Expensive and with limited availability. (not readily available)

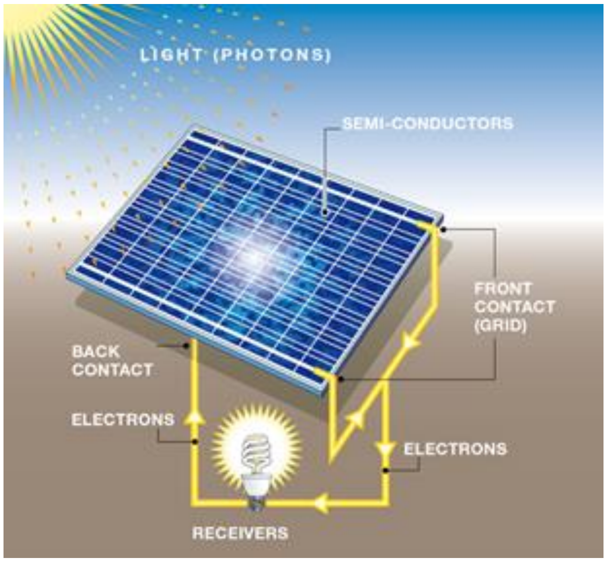
c) Glass- metal-framed roof skylight - This type is of glass on metal framing attached to the roof providing natural ventilation. Expensive and not readily available

d) Detachable roof mechanism - A system where partial section of the roof can be move to open for natural lighting and air to filter to the inner spaces. It is an expensive and complicated construction system.

- **Advantages:**
- brings-in natural lighting to the interior spaces
- lower operational cost (saves electrical energy)
- natural lighting and open to sky concept enhances an effective and efficient learning environment than artificial lighting
- environmentally friendly solution

- **Disadvantages:**
- None at all except for additional cost in construction

e.) Photovoltaic - A photovoltaic system can be used to generate electricity from sunlight, converting solar energy to electrical energy.



- **Advantages:**
- environmentally friendly solution
- economically efficient in terms of energy consumption

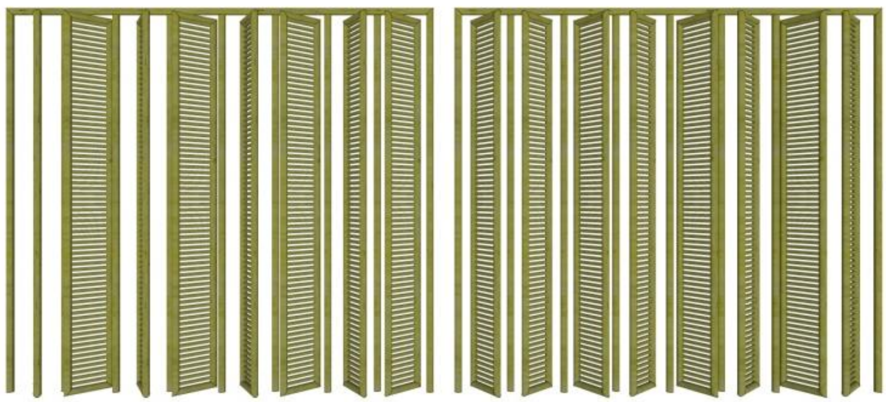
C3.) WALL SYSTEM

a) Rotating Wall Panel System- Rotating wall panels allows natural air to freely flow in the interiors to provide high indoor air quality. The material component used can either be made out of:

LOUVER

GLASS ON WOOD

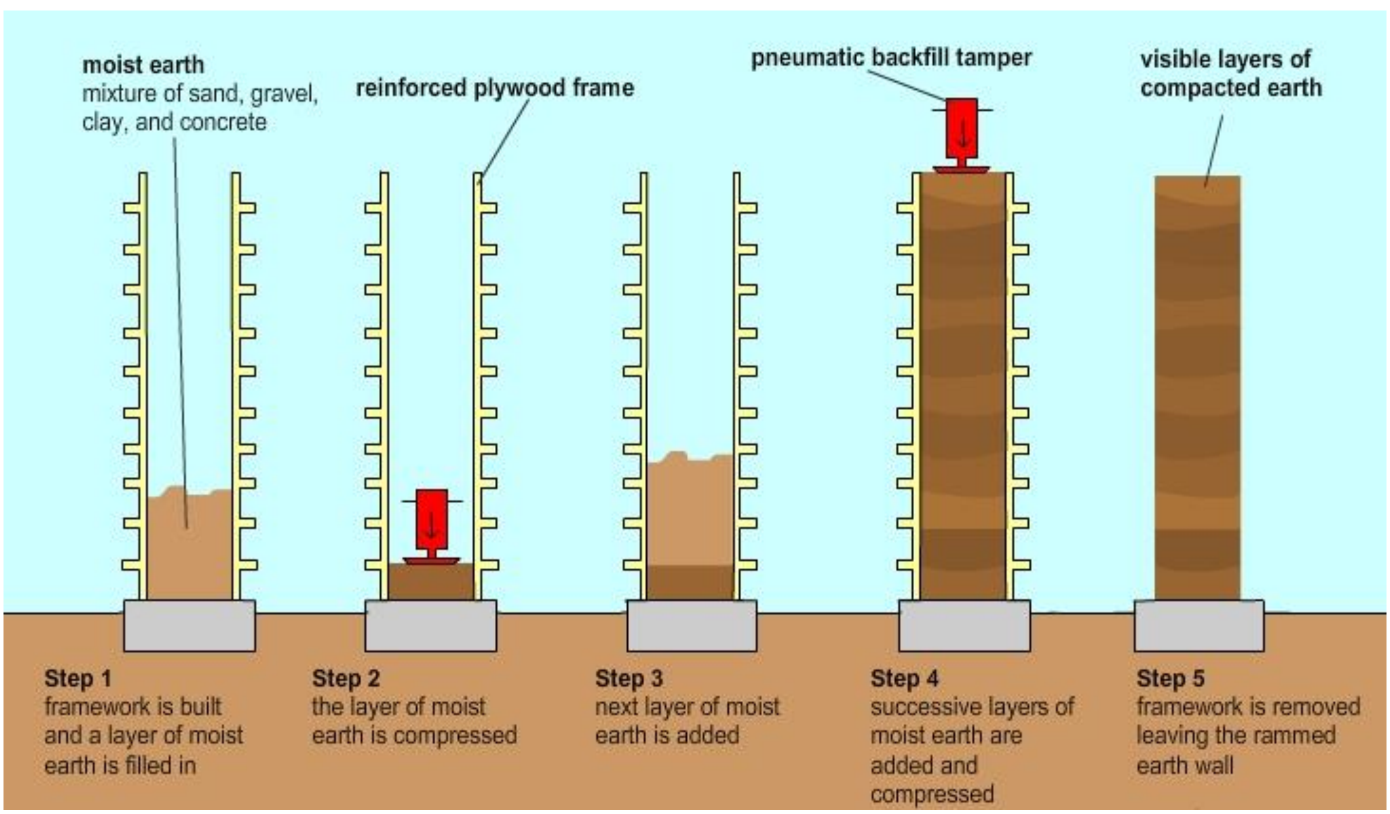
BAMBOO



- **Advantages:**
- Allows maximum air ventilation and draws light into the interior spaces.
- Simple /easy to construct except for the aluminum/ glass, wood glass
- The cost depends on the kind of material used. This type of wall paneling allows flexibility on in terms of cost variable and usage.
- Easy operation

- **Disadvantages:**
- Added cost on pivotal hinge, guide and or folding mechanism

b) Rammed Earth - Rammed earth is a technique for building walls using raw and sustainable materials of earth, chalk, lime and gravel.



moist earth
mixture of sand, gravel, clay, and concrete
reinforced plywood frame
pneumatic backfill tamper
visible layers of compacted earth
Step 1
framework is built and a layer of moist earth is filled in
Step 2
the layer of moist earth is compressed
Step 3
next layer of moist earth is added
Step 4
successive layers of moist earth are added and compressed
Step 5
framework is removed leaving the rammed earth wall

- **Advantages:**
  - Earth has good insulating properties.
  - Simple /easy to construct
  - Using locally available building materials which can bring down the cost of construction
  - Non skilled and low skilled workers can build and erect the structure because of its simple method which results to low labor cost
  - Re-usable vertical panels formworks

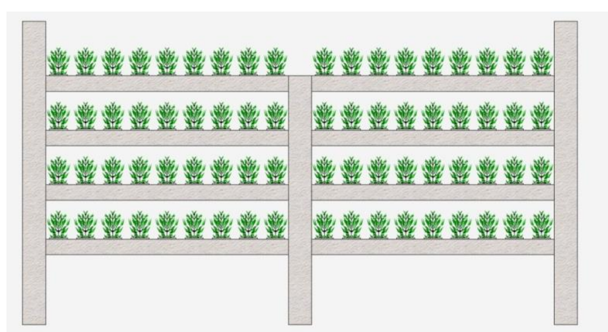
- **Disadvantages:**
  - Not all earth (on a given location) are applicable for this system
  - Limited seismic properties

c) Green Walls - A wall, either free-standing or part of a building that is partially or completely covered with vegetation and, in some cases, soil or an inorganic growing medium.

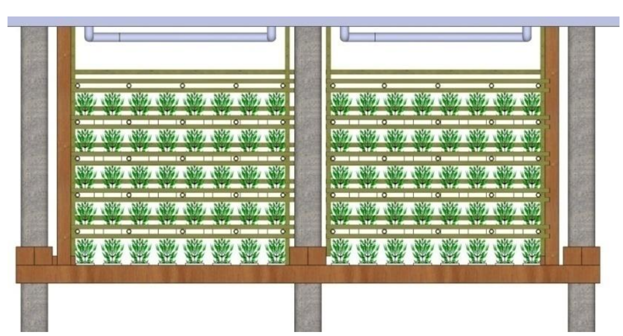
<u>Planter Green Wall System</u>

Green walls using conventional plant boxes or planters made out of the following materials:

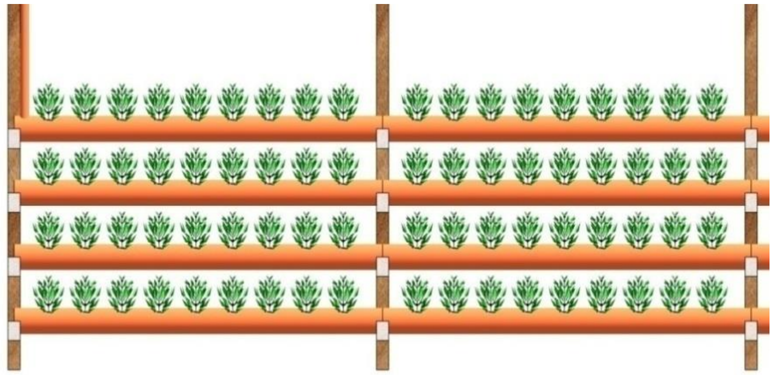
CONCRETE



BAMBOO

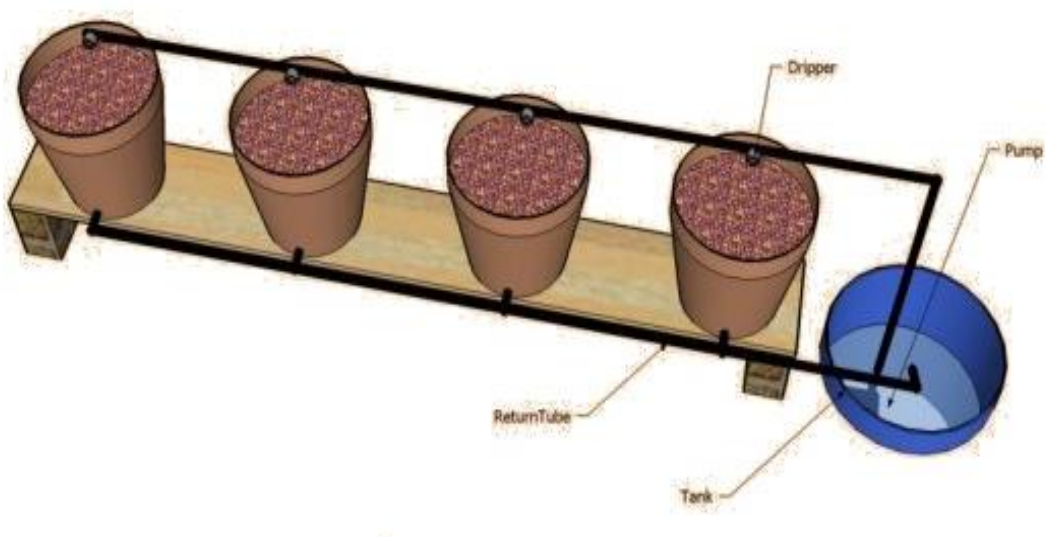


RECYCLED PIPE



Hydroponic Green Wall System

These are plant boxes which have the option to use a hydroponic drip system in its green wall. It is a subset of hydroculture and is a method of growing plants using mineral nutrient solutions, in water, without soil.



- **Advantages:**

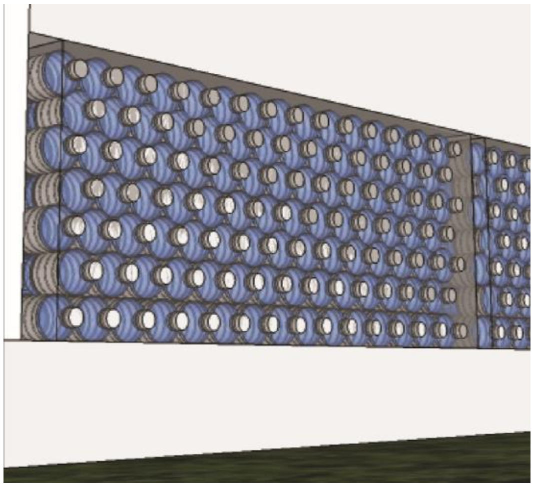
- Earth has a good insulating properties.
- Simple /easy to construct
- Using locally available building materials which can bring down the cost of construction
- Non skilled and low skilled workers can build and erect the structure because of its simple method which results to low labor cost
- Re-usable vertical panels formworks
- Sustainable element- Environmentally friendly

- Acoustical and air natural insulation (green buffer)
- Wind breaker
- Sun shading element- cut solar heat
- Uses rainwater and recyclable material

- **Disadvantages:**
- Additional cost to the projected building cost
- Acceptability to the society and people will have to be educated with this proposed system

d) Walls using recyclable materials plastic bottle block

Composed of used plastic bottles each filled with sand, gravel and earth wrapped altogether by a wire mesh to form into blocks, reinforced and plastered with concrete.



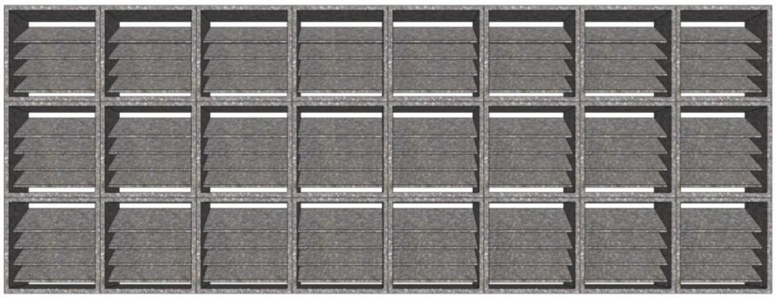
- **Advantages:**
- Recyclable Plastic bottle / and or glass bottle filled with earth has a good insulating properties.
- Simple /easy to construct
- Using locally recyclable available building materials which can bring down the cost of construction
- Non skilled and low skilled workers can build and erect the structure because of its simple method which results to low labor cost
- Sustainable element- Environmentally friendly
- Good acoustical and thermal
- Help improve the environment by re-use, recycle waste as building

- **Disadvantages:**

- Additional cost on concrete – concrete mortar as mounting mortar
- Acceptability to the society and people will have to be educated with this proposed system

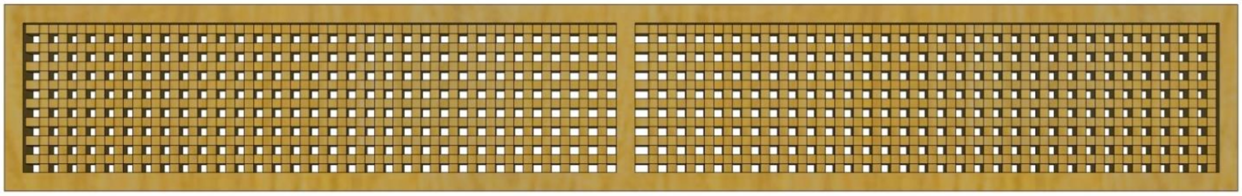
C4.) WINDOW SYSTEM

a) Concrete Louver Decorative Blocks - Concrete Decorative blocks are good to use not just for ventilation and decoration. It can resist fire and natural disasters such as tornadoes and earthquakes; Concrete blocks are also highly resistant to cracking and crumbling in extreme temperatures. It also helps virtually soundproof rooms and insulate against cold and heat to maintain comfortable temperatures.



- **Advantages:**
- Concrete decorative- louver blocks solar heat but allows air to ventilate and filter through and cooling the inner space.
- Easy to maintain – no movable parts
- Sturdy and structurally stable
- Non skilled and low skilled workers can build and erect the structure because of its simple method which results to low labor cost
- Sustainable element- Environmentally friendly
- Efficient indoor ventilation
- Partial natural light penetration to the inner spaces

b.) Wood Lattice - Lattice windows made out of wood in grids that are embedded between two panes. The panes are well insulated and sturdy enough to hold the grids. Wood lattice are good to use for natural ventilation and are suitable for any room.



- **Advantages:**

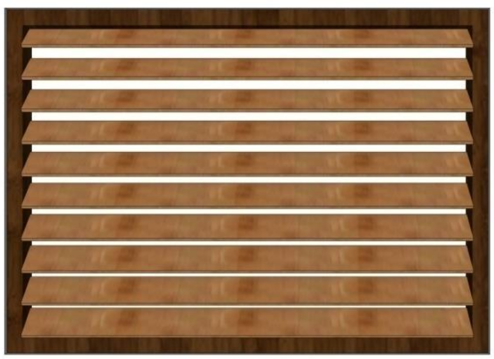
- breaks solar heat but allows air to ventilate and filter through, cooling the inner space- full ventilation
- Easy to maintain – no movable parts
- Needs skilled workers to fabricate. It could either be fabricated or manually assemble
- Sustainable element- Environmentally friendly
- Efficient indoor ventilation
- Wood is a sustainable building material
- Material could be easily substituted with other sustainable materials like bamboo, etc.
- User can access the view of the outside physical environment
- Partial natural light filtering into the inner spaces

- **Disadvantages:**

- Costly in terms of production if done manually
- Does not have an efficient acoustical character

c.) Louver - Louver windows open twice as wide as regular windows to maximize ventilation. They can also be left open in gentle rain and the amount of airflow through the window can be precisely controlled. Louvre windows positioned up high will let the hot air escape, and those positioned down low will let the cool air in. Its louvered design also ensures an unobstructed view.

<u>WOOD LOUVER</u>

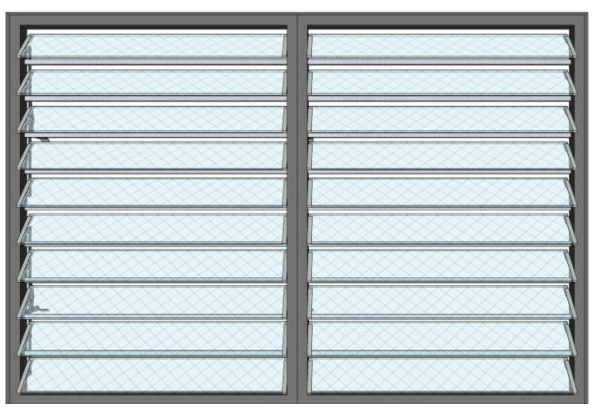


- **Advantages:**

- Breaks solar heat but allows air to ventilate and filter through, cooling the inner space- full ventilation
- Easy to maintain – no movable parts
- Needs skilled workers to fabricate. It could either be fabricated or manually assemble
- Sustainable element- Environmentally friendly
- Efficient indoor ventilation
- Wood is a sustainable building material
- Material could be easily substituted with other sustainable materials like bamboo, etc.
- User can access the view of the outside physical environment
- Partial light filtering into the inner spaces

- **Disadvantages:**
- Costly in terms of production if done manually
- Does not have an efficient acoustical character

GLASS JALOUSIE - Jalousie windows offer tremendous ventilation to any room. Due to their slatted design, practically the entire window can be opened up from top to bottom. By using the entire window area, jalousie windows allow for much greater airflow and improved air circulation and quality. They can even be kept open during a summer rain, as the outward slant of the slats keeps most of the rain out while letting the fresh, cool air in. Jalousie windows design ensures an unobstructed view. The louvered nature of the windows gives you a much larger viewing area.



- **Advantages:**
- Controlled air-flow to ventilate and filter through, cooling the inner space- full ventilation
- Easy to maintain

- Needs skilled workers to fabricate. It could either be fabricated or manually assemble
- Efficient indoor ventilation
- Material could be easily substituted with other sustainable materials like wood jalousies window.
- User can access the view of the outside physical environment
- Full natural light ventilation

- **Disadvantages:**
- Cost more
- Needs a security iron grill as protection from break-ins
- Additional cost for screens as protection from insects mosquitoes

d) Sliding Wood Slatted Window

- **Advantages:**
- Controlled air-flow to ventilate and filter through, cooling the inner space- full ventilation
- Easy to maintain
- Needs skilled workers to fabricate. It could either be fabricated or manually assemble
- Efficient indoor ventilation
- User can partially access the view of the outside physical environment
- Natural light filters in to the inner spaces

- **Disadvantages:**
- High cost of labor for skilled labor
- Additional cost for screens as protection from insects mosquitoes

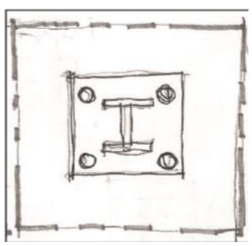
e.) Sliding Glass Aluminium Window

- **Advantages:**
- Offers half air penetration to the inner spaces.
- Needs skilled workers to fabricate. It could either be fabricated or manually assemble
- User can partially access the view of the outside physical environment
- Full natural light penetration to the inner spaces

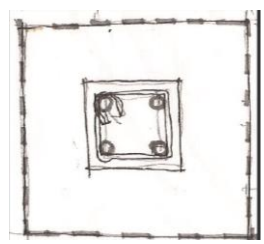
- **Disadvantages:**
- Aluminum and glass an expensive building material
- Additional cost for screens as protection from insects mosquitos

C5.) COLUMN SYSTEM

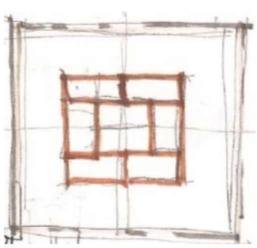
a) STEEL COLUMN



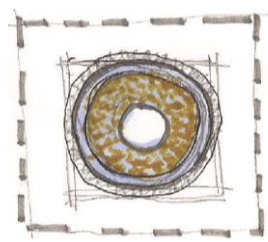
b) CONCRETE COLUMN



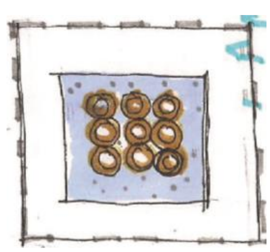
c) BRICK COLUMN



d) WOOD TIMBER COLUMN



e) BAMBOO COLUMN



a.) STEEL on concrete footing pedestal

- **Advantages:**
  - Structurally sound and withstand disastrous climate change effects
  - Long lasting
  - Short construction time frame (fast construction system)
  - Seismic resistant

- **Disadvantages:**
  - Expensive building material
  - Need highly skilled workers with specific welding skills
  - Not readily available for some dimensions
  - High building cost

b.) CONCRETE – Reinforced Concrete

- **Advantages:**
  - Structurally sound and withstand disastrous climate change effects
  - Long lasting
  - Seismic resistant
  - Traditional technology
  - Uses readily available building materials
  - Less costly than the steel system of construction

- **Disadvantages:**
  - Curing time of concrete extends the construction time frame
  - Manufacturing process of cement is bad for the environment because it uses so much heat.
  - Form works is an added cost in the construction.

c.) BRICK

- **Advantages:**
  - Best suited in a locality where soil is ideal for manufacture of brick
  - Long lasting
  - Not much degree of seismic rating
  - Less costly than the steel and concrete system of construction
  - Environment friendly and sustainable building material

- **Disadvantages:**
  - Availability of structural bricks

- Will have train masons on brick laying skills
- Not a traditional technology

d.) WOOD TIMBER

- **Advantages:**
- Long lasting
- Re-use and recycle used timber (e.g. timber electrical post that is being
- replaced with concrete pipe electrical post
- High degree of seismic rating
- Less costly than the steel and concrete system of construction
- Simple construction
- Environment friendly and sustainable building material
- Traditional system of construction
- Mostly applicable in the rural, lowland and mountainous areas
- Structurally sound and withstand disastrous climate change effects
  (e.g. timber framed "Gabaldon" school buildings)

- **Disadvantages:**
- Availability of approved timber specie (Some species are banned)
- Termite infestation is a problem

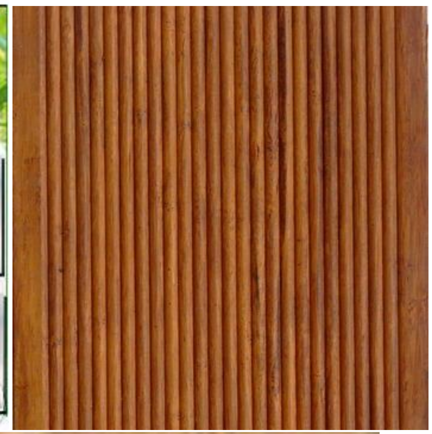
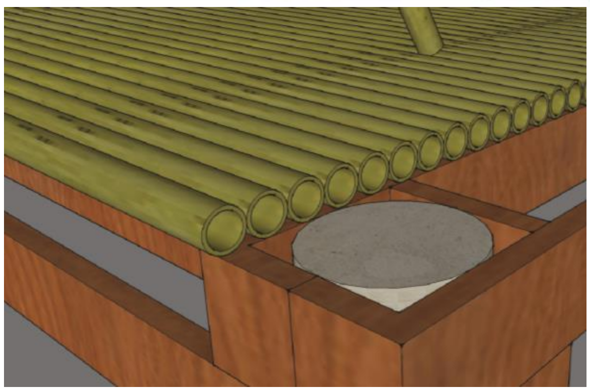
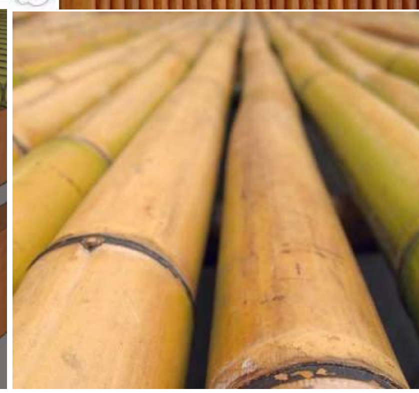
e.) BAMBOO COLUMN

- **Advantages:**
- Structurally sound because of its pliant property
- High degree of seismic rating
- Simple construction
- Environment friendly and sustainable building material
- Traditional system of construction
- Mostly applicable in the rural, lowland and mountainous areas
- Cost less than other method of construction

- **Disadvantages:**
- Availability of approved bamboo specie
- Termite infestation is a problem

C6) FLOOR SYSTEM

a) BAMBOO FLOOR - Bamboo is an eco-friendly, highly renewable source of material. Compared to wood it grows much faster because bamboo is a grass not a wood. It is also locally available which makes it an ideal option as a flooring component for the green school. Moso bamboo is the species most commonly used for flooring.

- **Advantages:**
    - Abundant supply
    - Simple construction
    - Environment friendly and sustainable building material
    - Traditional system of construction
    - Mostly applicable in the rural, lowland and mountainous areas
    - Cost less than other method of construction

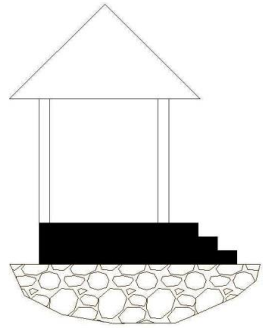
- **Disadvantages:**

- Process of fabricating veneered bamboo is very expensive
- Availability of approved bamboo specie

b) **CONCRETE FLOOR -** Concrete flooring can have a long service life. As concrete has a high thermal mass and very low permeability, it can do for energy efficient housing.

C7) FLOOR FOUNDATION SYSTEM

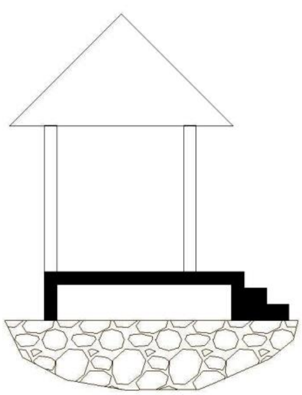
a) On Ground / Slab on Fill - A conventionally reinforced slab-on-ground foundation which is simply a ground-supported concrete slab foundation that is reinforced with what are called deformed steel bars. The earth in direct contact with the floor helps maintain a cooler floor surface.



- **Advantages:**
  - traditional technology and widely used here in the Philippines/ easy to construct
  - Earth fill is readily available
  - High degree of seismic rating
  - Labor component- semi skilled and non skilled
  - Use readily available building materials
  - Bamboo as alternative material to steel bars as reinforcing bar

- **Disadvantages:**
  - The production process of cementand steel bar are harmful to the environment
  - Curing stage –longer construction time frame

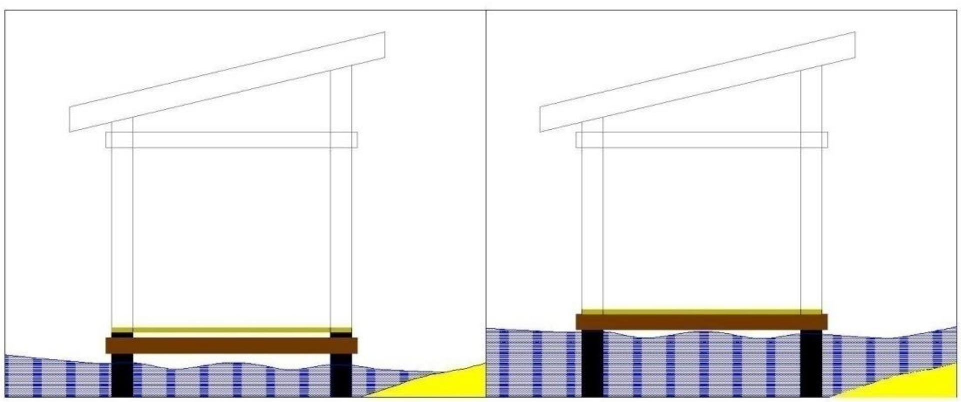
b) Raised Flooring - Type of foundation system wherein the floor is raised above the natural grade line or supported on stilts to raise the structure over the surface of the soil or a body of water. It is built primarily as a protection against flooding, but also serves to keep out vermin. The shady space under the structure can also be used for work or storage. It also enables fresh, cool air to traverse under the floor, maintaining a cooler floor surface and to the rooms above.



- **Advantages:**
- traditional technology and widely used here in the Philippines/ easy to construct
- sand and gravel a component of concrete are readily available here in the Philippines
- High degree of seismic rating
- Labor component- semi skilled and non-skilled
- Structurally stable
- Air gaps between the floor and earth allows cross ventilation

- **Disadvantages:**
- The production process of cement and steel bar are harmful to the environment
- Costly because of its formworks, reinforcing steel bars, scaffoldings, shoring and cement additives
- Curing stage / takes a longer construction time frame

c) Emerging - An emerging type of support is a designed mechanism which allows the structure's floor line to rise as the water level rises due to flooding or sea level rise. It is best for structures in coastal areas or where major flooding may take place.



- **Advantages:**
- The applicability of material component can be of reinforced concrete with concrete structural framing and or wood-timber framing and floors
- Adaptable to climate change effects
- Labor component- skilled workers
- Adaptable to climate change effects

- **Disadvantages:**
- Costly (in terms of building system Cost)
- The need to train workers in this system of construction

- Timber treatment
- Availability of good quality treated lumber

C8) WASTE WATER MANAGEMENT

a) 4 Chamber Septic Tank + Reed Bed + Pond/Seepage Pit

b) 4 Chamber Septic Tank + Filtration Boxes + Pond/Seepage Pit

■ 4 CHAMBER SEPTIC TANK

A 4 chamber septic system is designed as an onsite wastewater treatment system that processes and purifies the building's waste (effluent). The effluent consists of blackwater (toilet wastes) and greywater (kitchen sink and laundry wastes).

■ CONSTRUCTED REED BED

A constructed reed bed can be added as a method of removing pollutants from grey water. It is a 'green' water treatment technology, incorporating fit with the landscape, ecological added value, by providing habitats for wildlife, and sustainability, in addition to significantly reduced operational costs compared to a conventional biological effluent treatment system.

BENEFITS:

- Low operational costs compared to conventional biological treatment systems
- No need for mechanical or electrical requirements
- Does not produce sludge
- Low tech in nature
- Doesn't require highly trained operators
- As the degradation of the organic content of the effluent occurs within a solid matrix, it should be free from odor

■ FILTRATION BOXES

These boxes are made of hollow blocks with stones and filtration pebbles inside to strain the sediments that are with the effluents coming from the septic tank before it will be returned to the environment through pond or seepage pit.

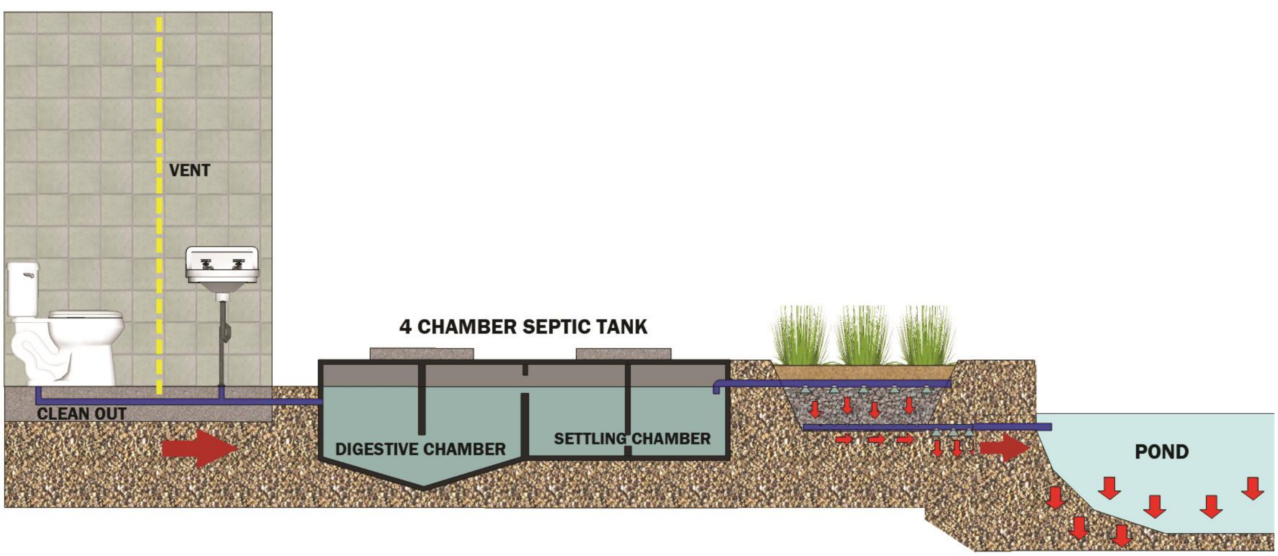
■ **PONDS**

Treated waste water from the filtration process of either by reed bed system or by filtration boxes will be channelled to the pond. The pond will become the last percolation zone and a holding area for the treated water to be reused. The treated water can also seep through the ground beneath the pond and go back to the environment.

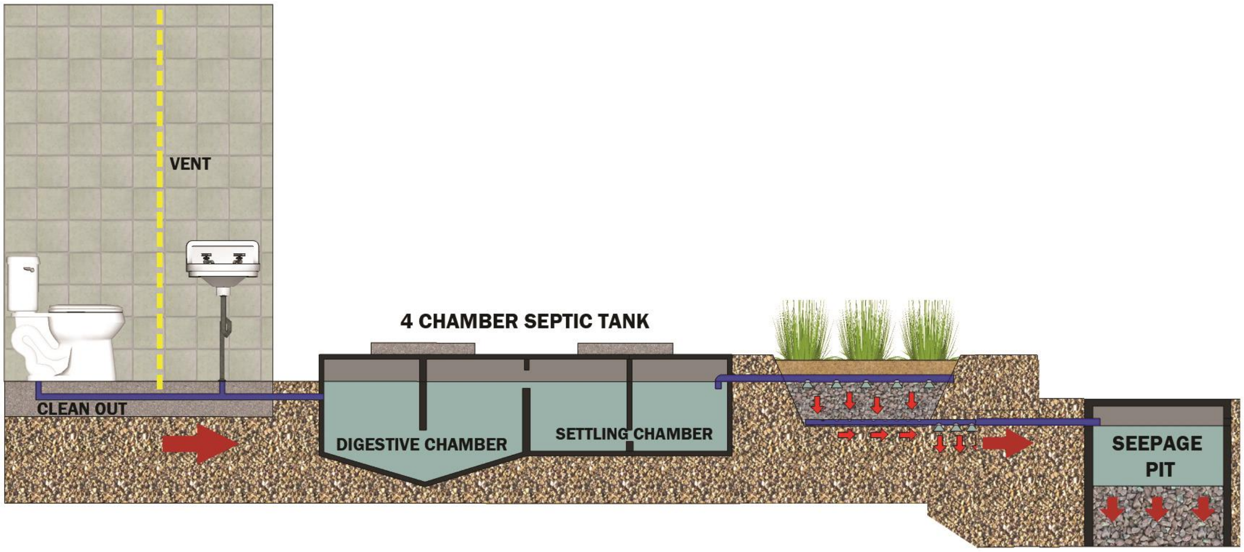
■ **SEEPAGE PIT**

It is a large pit lined with concrete rings, or porous masonry block to support the walls of the pit, and a surrounding bed of gravel. Only effluent that has come from filtration boxes enters a seepage pit. The effluent has already been through the stages of processing in the tanks. Once it enters the seepage pit it is temporarily stored there until it gradually seeps through the walls and ground and into the surrounding soil.

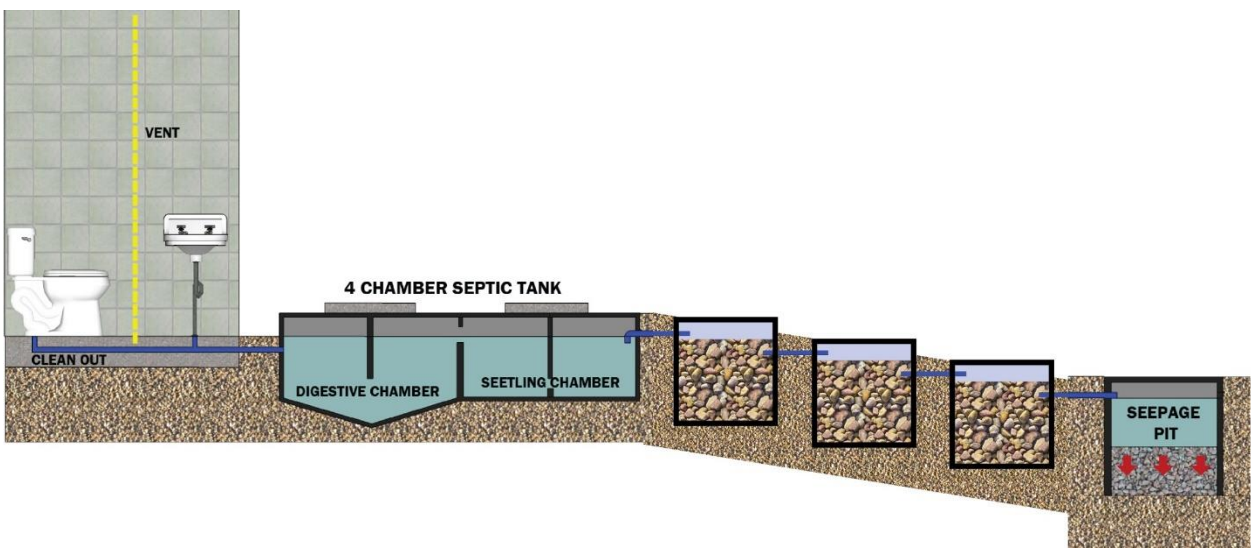
a.) 4 CHAMBER SEPTIC TANK + REED BED + POND



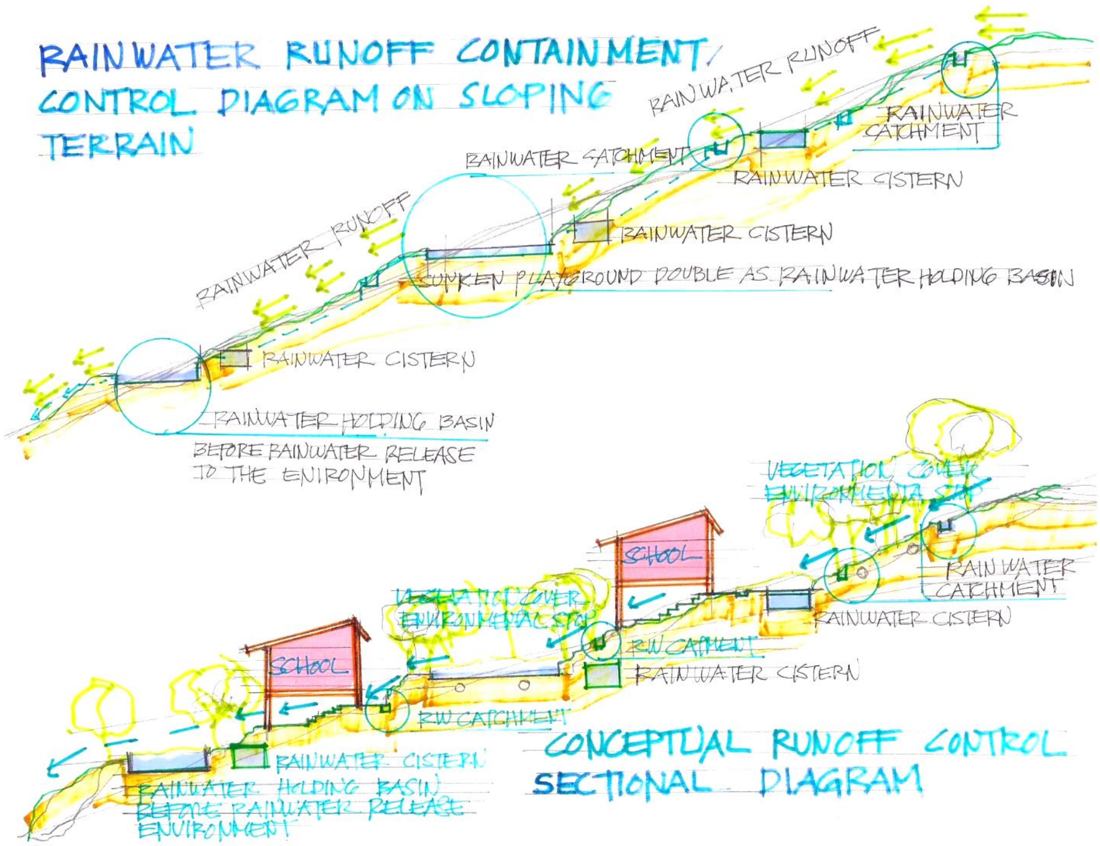
a.) 4 CHAMBER SEPTIC TANK + REED BED + SEEPAGE PIT



b.) 4 CHAMBER SEPTIC TANK + FILTRATION BOXES + SEEPAGE PIT



C9) STORM WATER MANAGEMENT



VI. Green and Sustainable Applications on Prototype Models

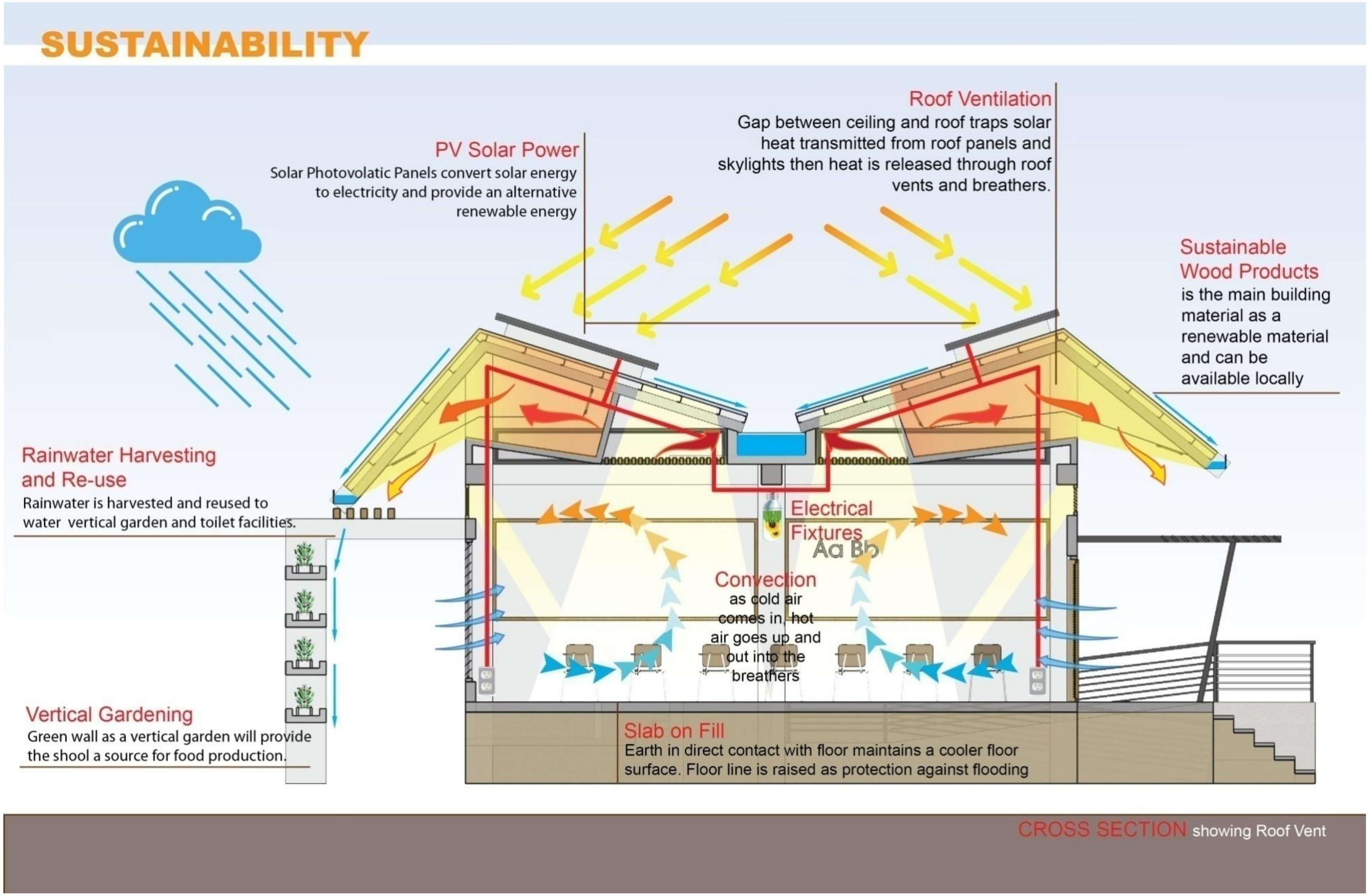
We came up with 3 sets of conceptualized architectural designs for green school buildings.

A. Urban School

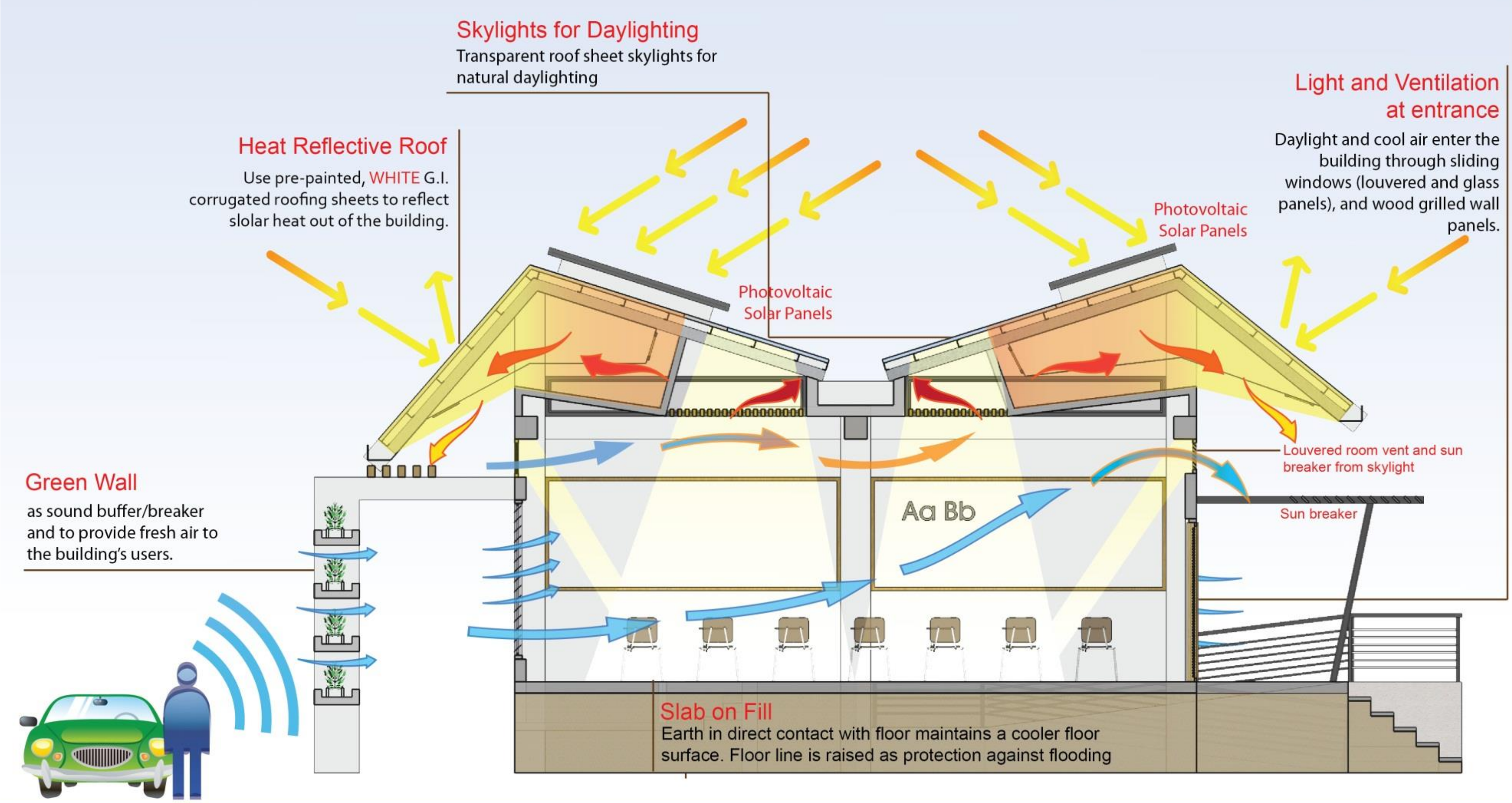
The Building structure is designed to be sustainable; applying different green strategies and technologies to withstand the impacts of climate change in the urban areas and at the same time to teach the students about environmental conservation and motivate communities to live sustainably.

Characteristics:

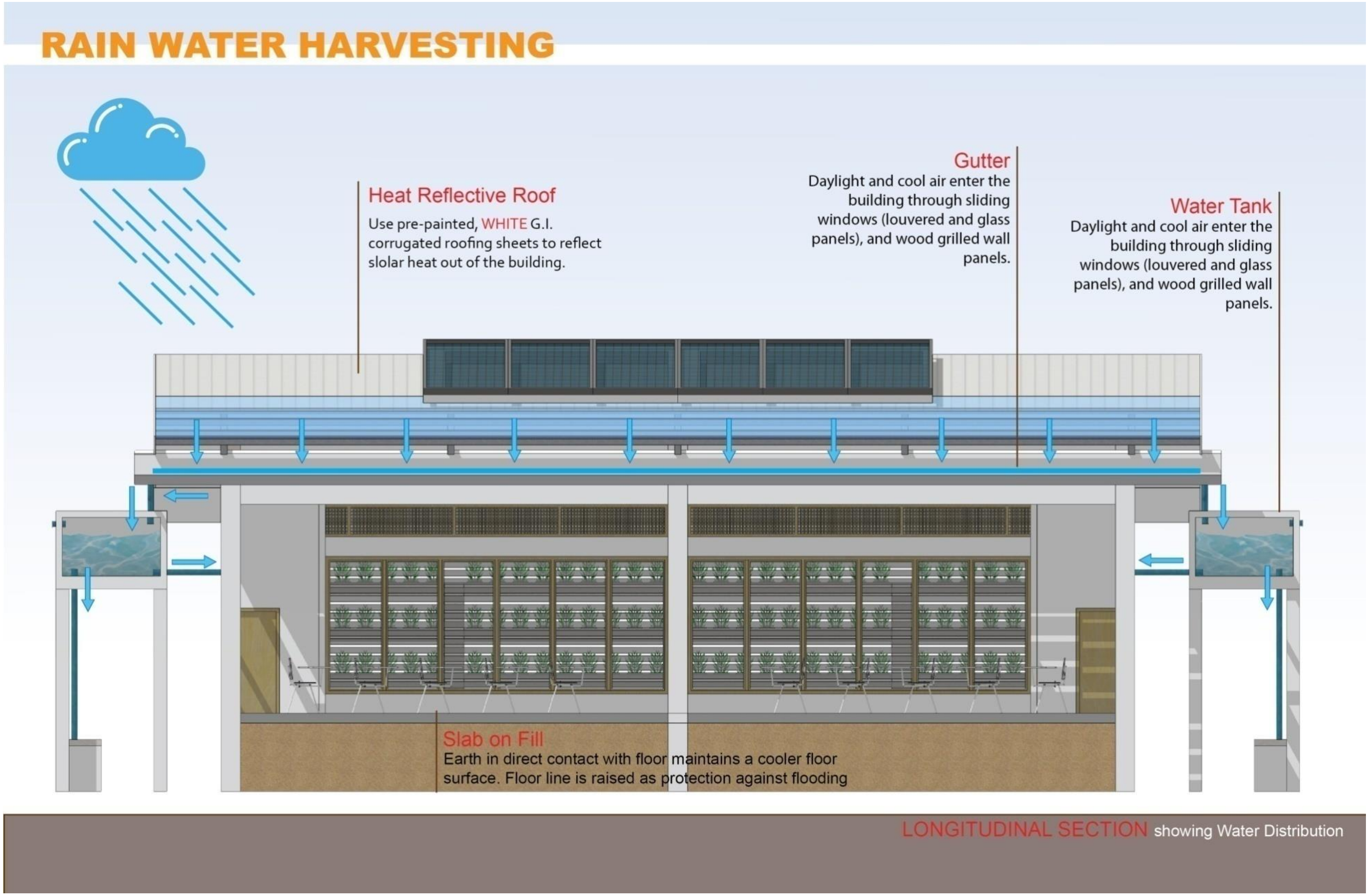
- G.I. roofing with white colored paint to reflect heat outside the structure
- Concrete plant boxes which serve as sound and sun buffer to help cool down the building.
- Louvered windows and rotating glass panels for lighting and ventilation
- Walls made up of plastic bottle blocks (composed of bottles filled with sand, gravel and earth wrapped by metal mesh into blocks) Reinforced and plastered with concrete.
- Turbine wind ventilator
- Double layer fiber glass skylight to illuminate the interior
- Ceiling louvers to filter heat
- Solar photovoltaic panels on its roof to convert solar heat to energy
- Integrated rainwater harvesting and distribution system
- Wood sun breakers
- Double roof for double insulation

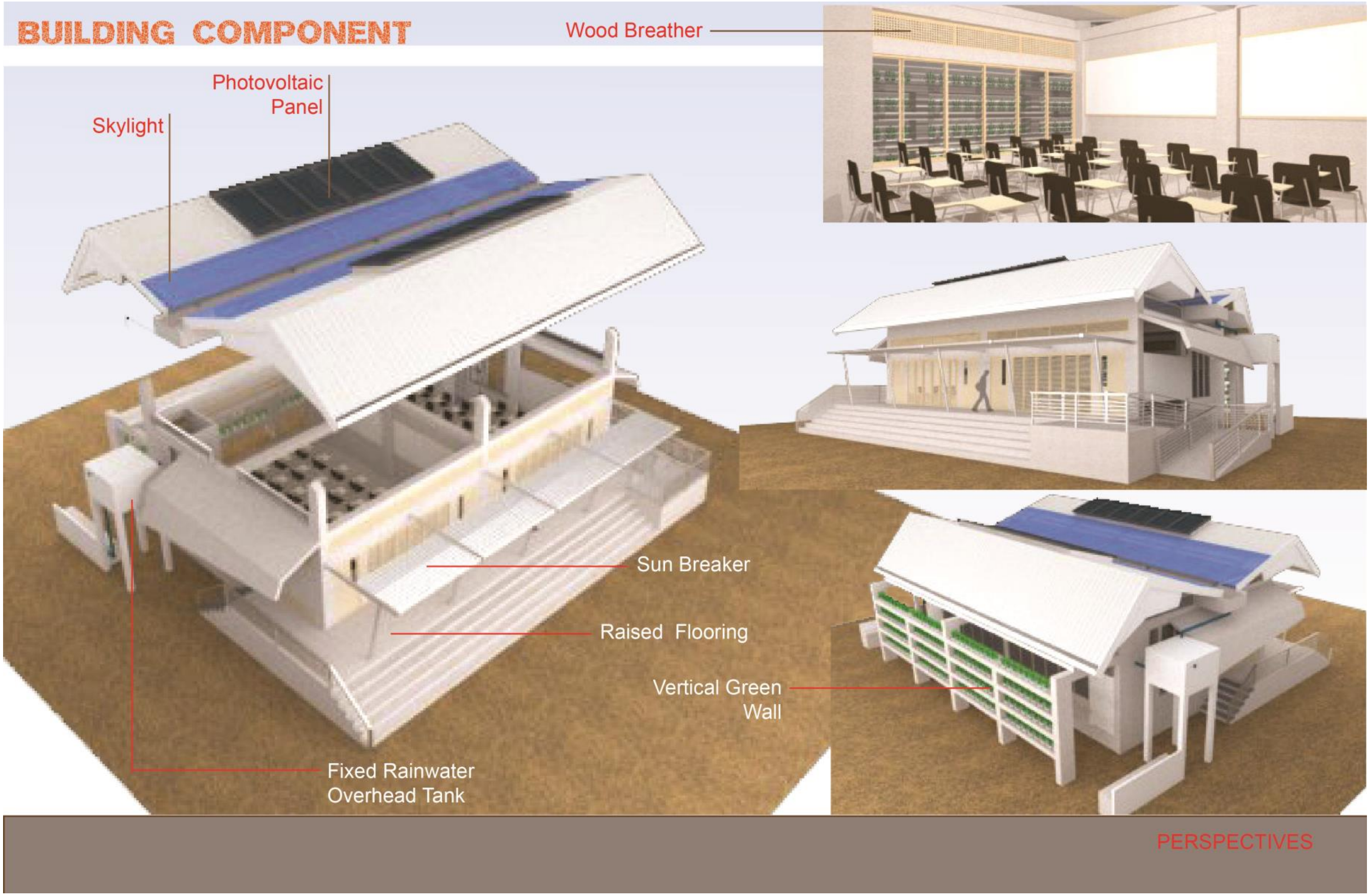

SUSTAINABILITY
PV Solar Power
Solar Photovolatic Panels convert solar energy to electricity and provide an alternative renewable energy
Roof Ventilation
Gap between ceiling and roof traps solar heat transmitted from roof panels and skylights then heat is released through roof vents and breathers.
Sustainable Wood Products
is the main building material as a renewable material and can be available locally
Rainwater Harvesting and Re-use
Rainwater is harvested and reused to water vertical garden and toilet facilities.
Electrical Fixtures
Aa Bb
Convection
as cold air comes in, hot air goes up and out into the breathers
Vertical Gardening
Green wall as a vertical garden will provide the shool a source for food production.
Slab on Fill
Earth in direct contact with floor maintains a cooler floor surface. Floor line is raised as protection against flooding
CROSS SECTION showing Roof Vent

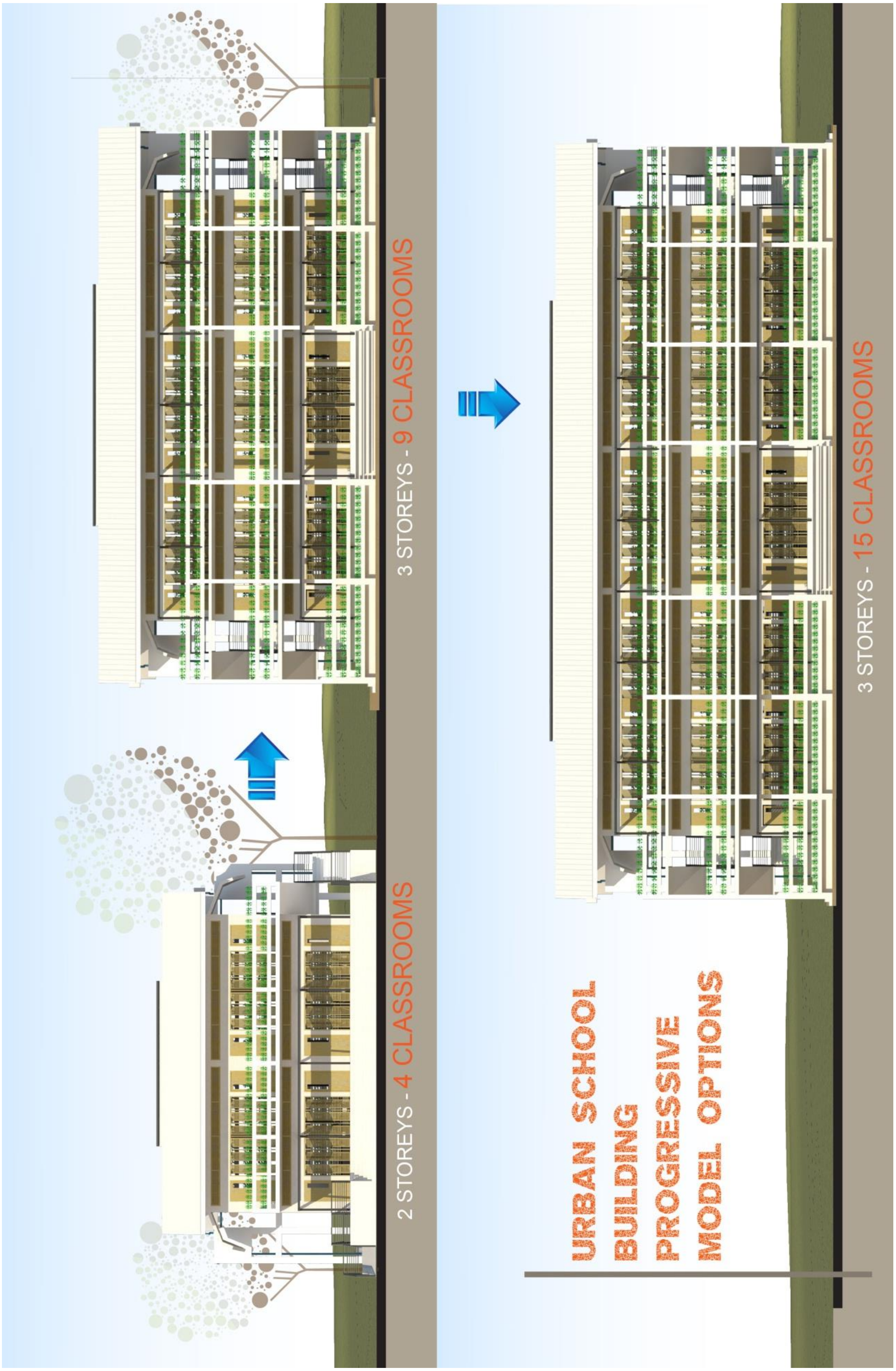
SUSTAINABILITY

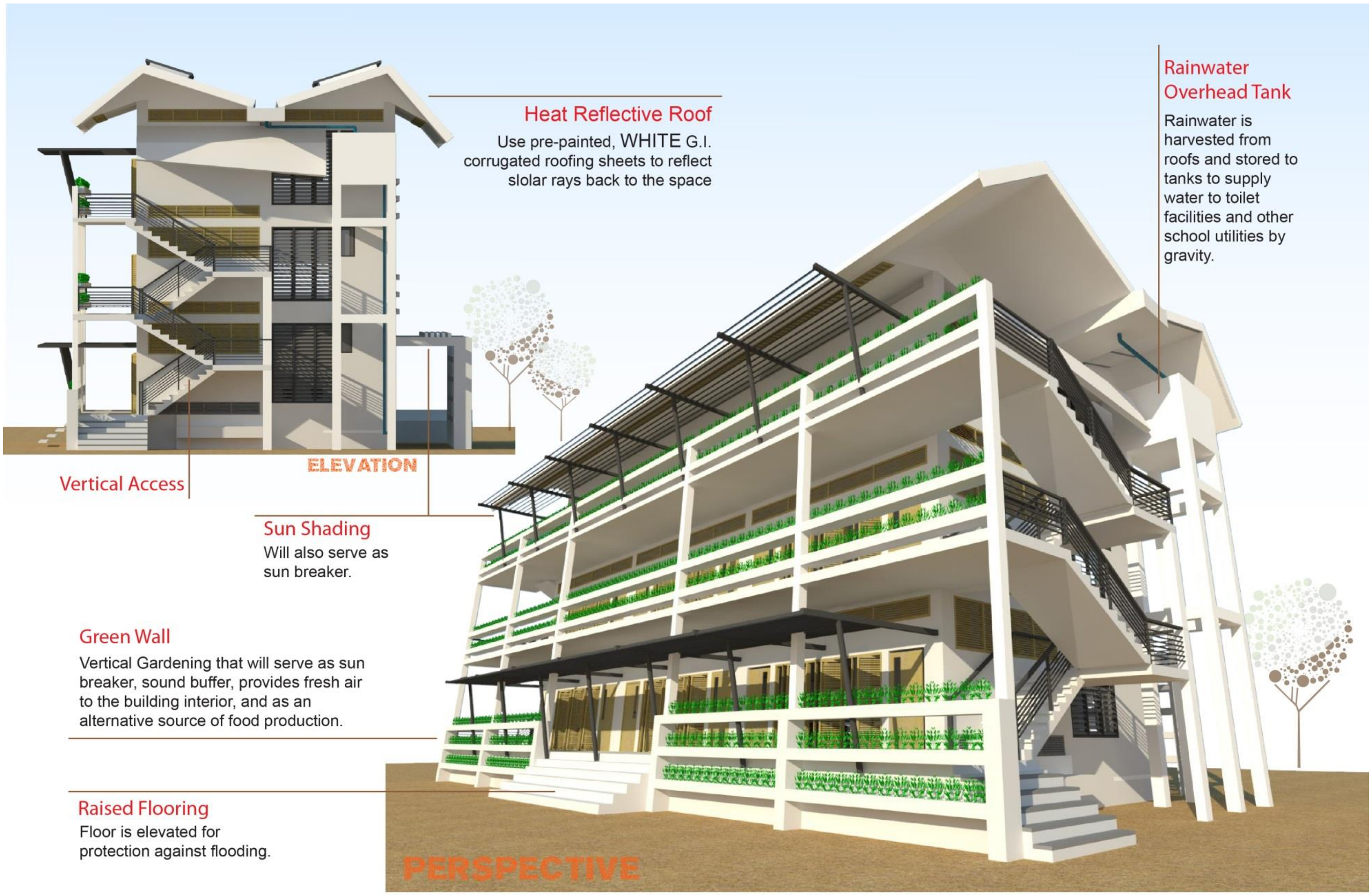


CROSS SECTION showing Roof Vent


RAIN WATER HARVESTING
Heat Reflective Roof
Use pre-painted, WHITE G.I. corrugated roofing sheets to reflect slolar heat out of the building.
Gutter
Daylight and cool air enter the building through sliding windows (louvered and glass panels), and wood grilled wall panels.
Water Tank
Daylight and cool air enter the building through sliding windows (louvered and glass panels), and wood grilled wall panels.
Slab on Fill
Earth in direct contact with floor maintains a cooler floor surface. Floor line is raised as protection against flooding
LONGITUDINAL SECTION showing Water Distribution


BUILDING COMPONENT
Wood Breather
Photovoltaic Panel
Skylight
Sun Breaker
Raised Flooring
Vertical Green Wall
Fixed Rainwater Overhead Tank
PERSPECTIVES


3 STOREYS - 9 CLASSROOMS
2 STOREYS - 4 CLASSROOMS
3 STOREYS - 15 CLASSROOMS
URBAN SCHOOL
BUILDING
PROGRESSIVE
MODEL OPTIONS

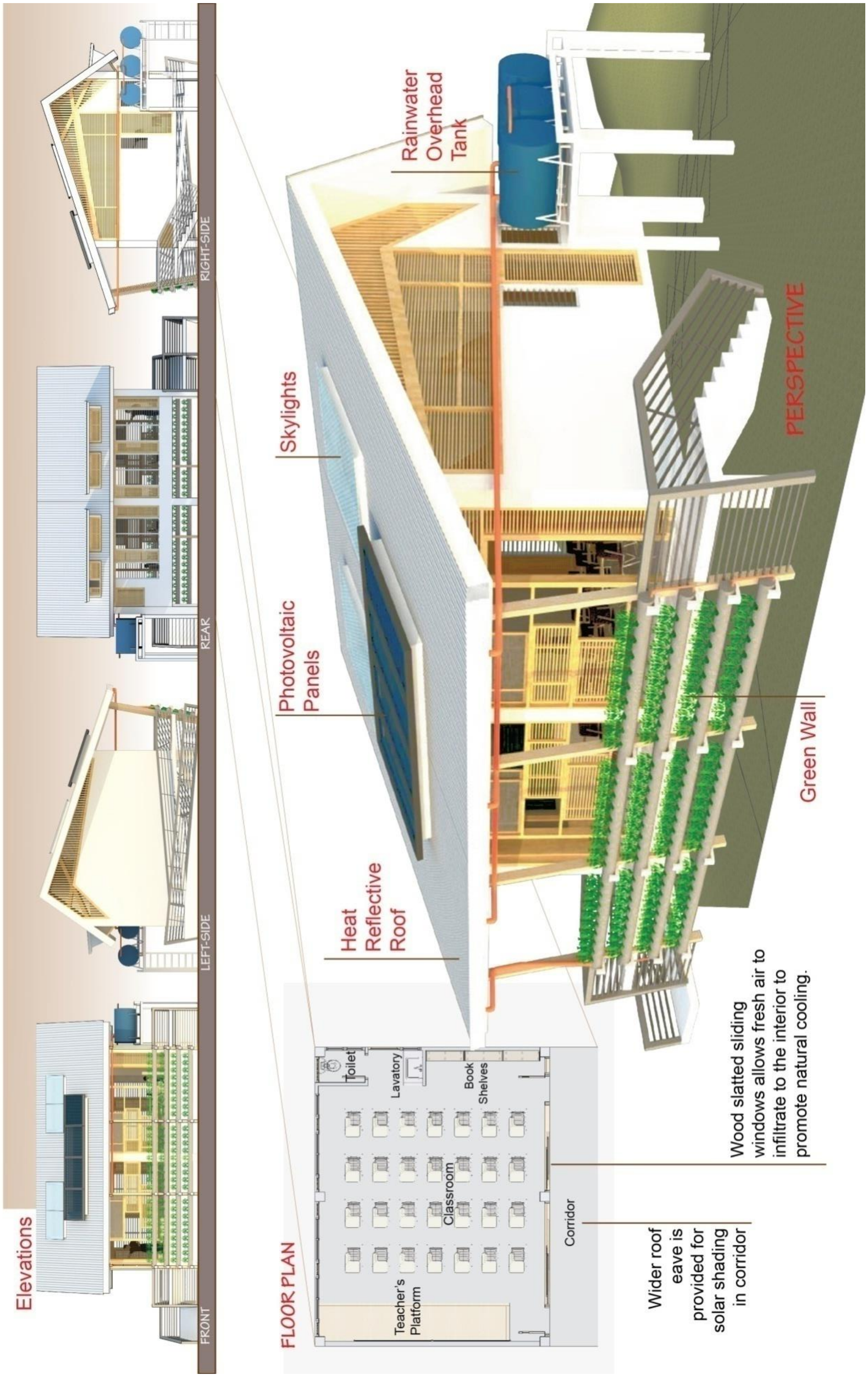

Heat Reflective Roof
Use pre-painted, WHITE G.I. corrugated roofing sheets to reflect slolar rays back to the space
Rainwater Overhead Tank
Rainwater is harvested from roofs and stored to tanks to supply water to toilet facilities and other school utilities by gravity.
ELEVATION
Vertical Access
Sun Shading
Will also serve as sun breaker.
Green Wall
Vertical Gardening that will serve as sun breaker, sound buffer, provides fresh air to the building interior, and as an alternative source of food production.
Raised Flooring
Floor is elevated for protection against flooding.
PERSPECTIVE

B. Rural School

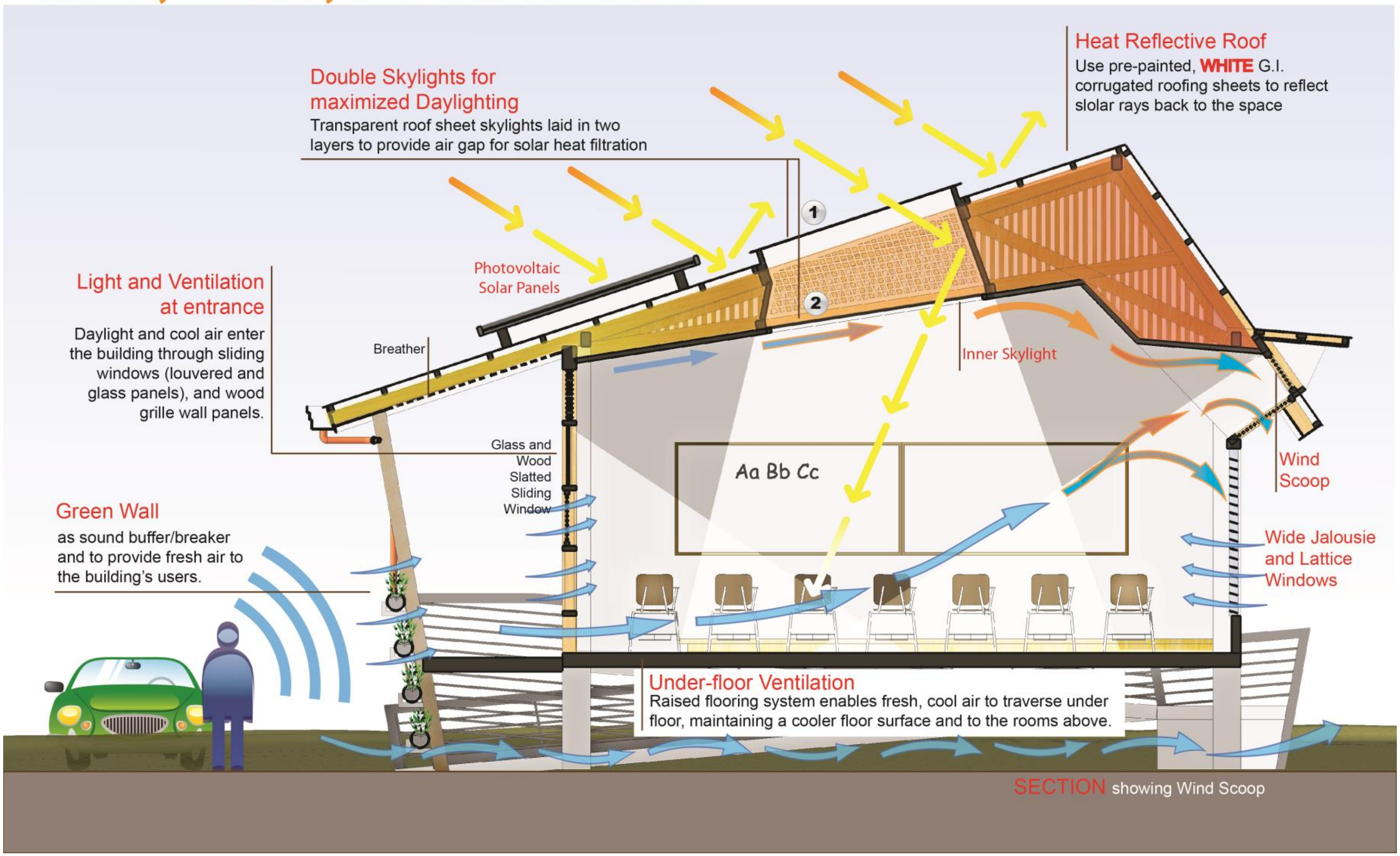
The Building structure is designed to be sustainable; applying different green strategies and technologies to withstand the impacts of climate change in the rural areas and at the same time to teach the students about environmental conservation and motivate communities to live sustainably.

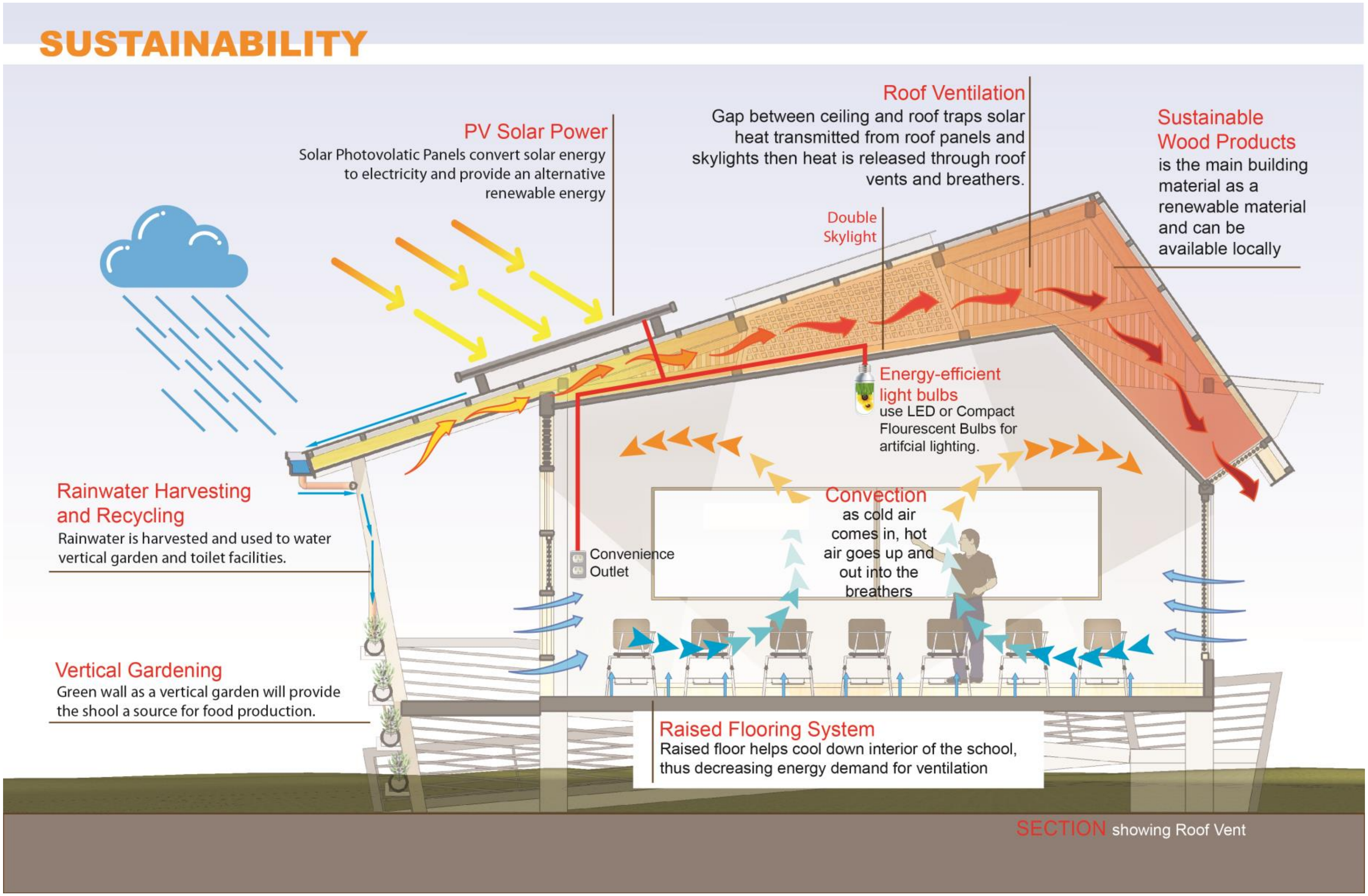
Characteristics:

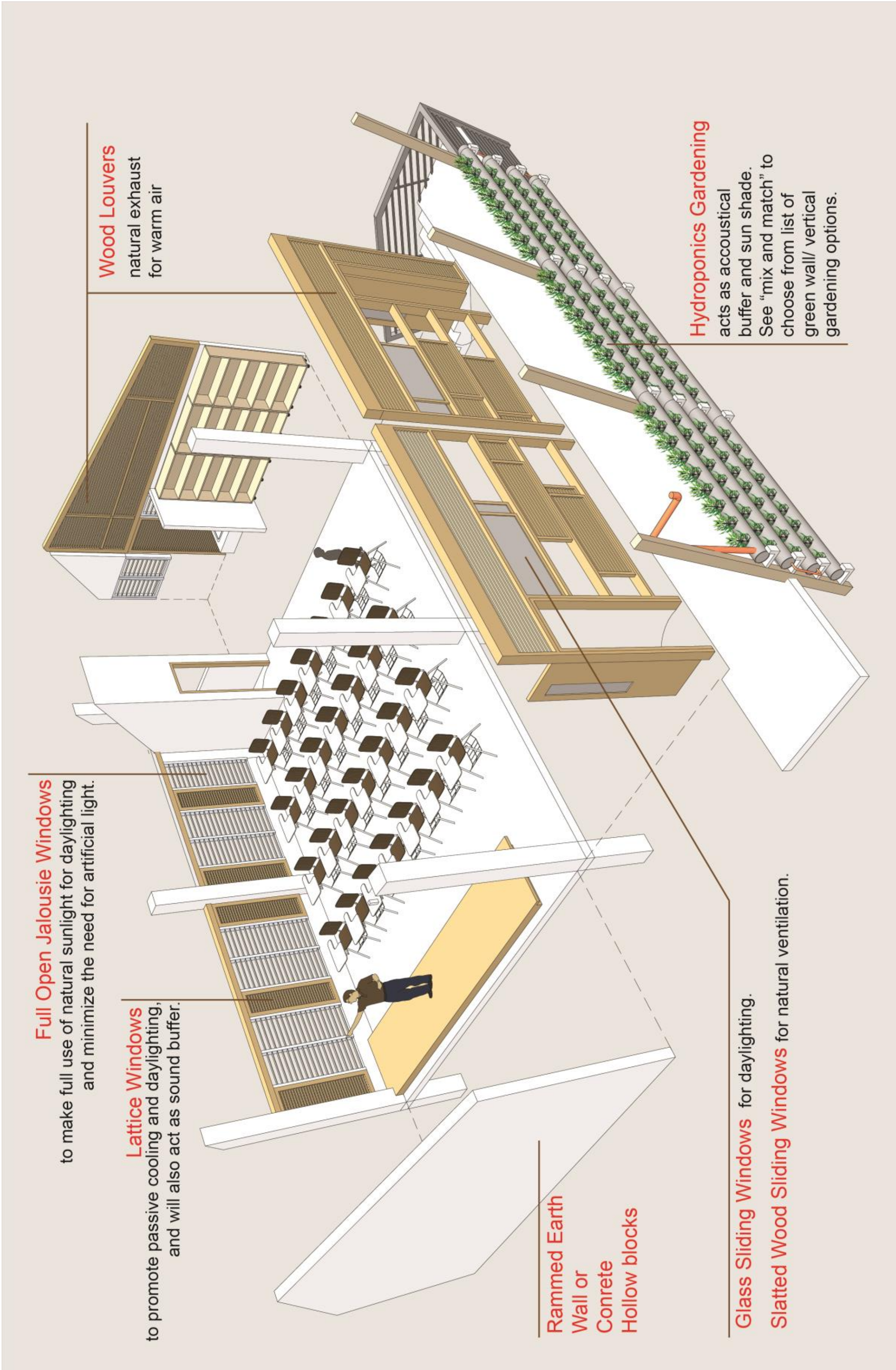
- Double layer fiber glass skylight to illuminate the interior
- G.I. roofing with white colored paint to reflect heat outside the structure
- Solar photovoltaic panels on its roof to convert solar heat to energy
- Applied hydroponics w/ recycled pipes as planters which serves as sun and sound buffer
- Ventilated ceiling
- Foldable partitions
- Louvered windows and rotating glass panels for lighting and ventilation
- Integrated rainwater harvesting and distribution system
- Raised flooring
- Reed beds for waste water treatment

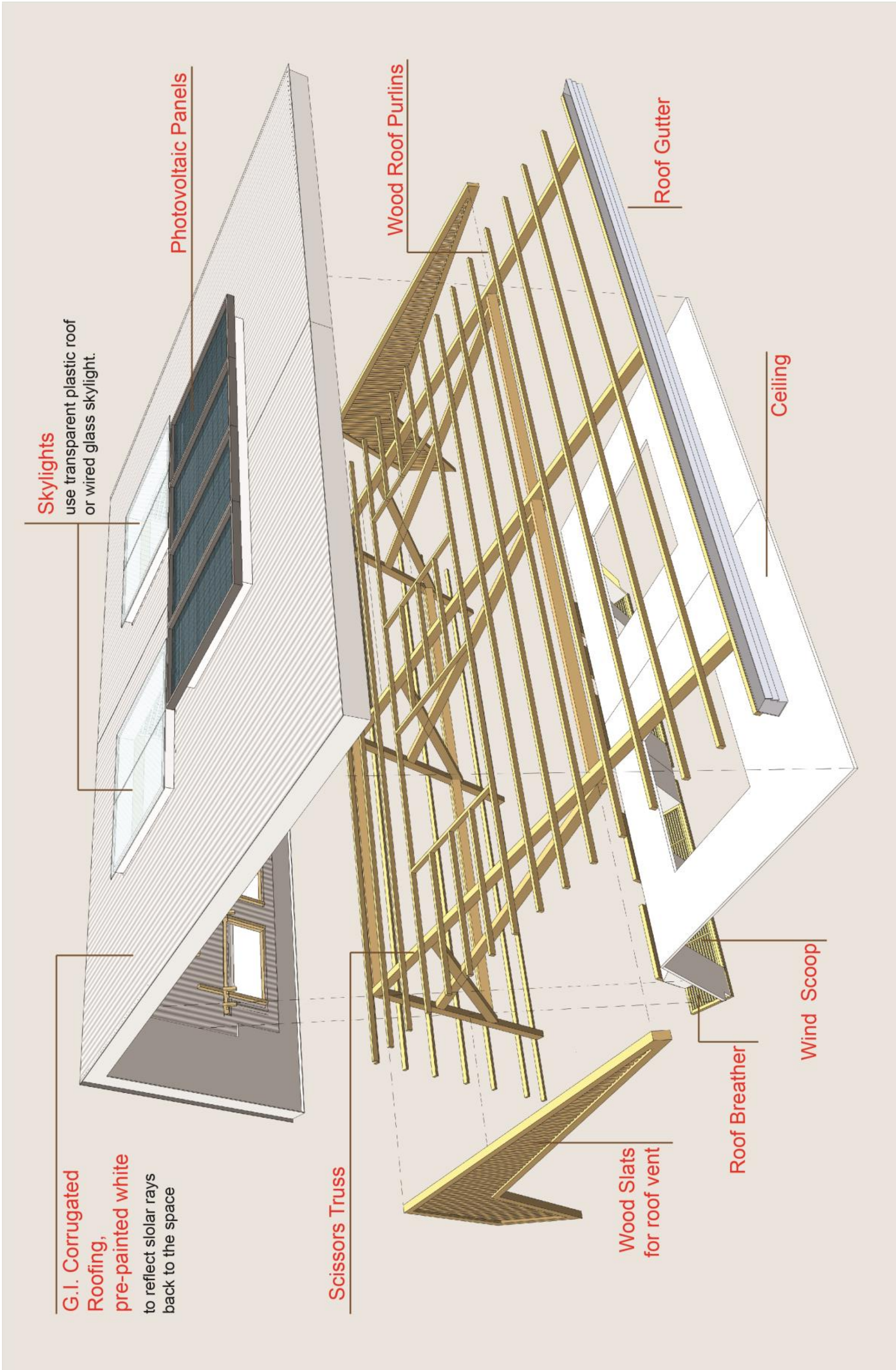

Elevations
FRONT
LEFT-SIDE
REAR
RIGHT-SIDE
FLOOR PLAN
Teacher's Platform
Classroom
Corridor
Toilet
Lavatory
Book Shelves
Wider roof eave is provided for solar shading in corridor
Wood slatted sliding windows allows fresh air to infiltrate to the interior to promote natural cooling.
Heat Reflective Roof
Photovoltaic Panels
Skylights
Rainwater Overhead Tank
PERSPECTIVE
Green Wall

LIGHT, SOUND, and VENTILATION

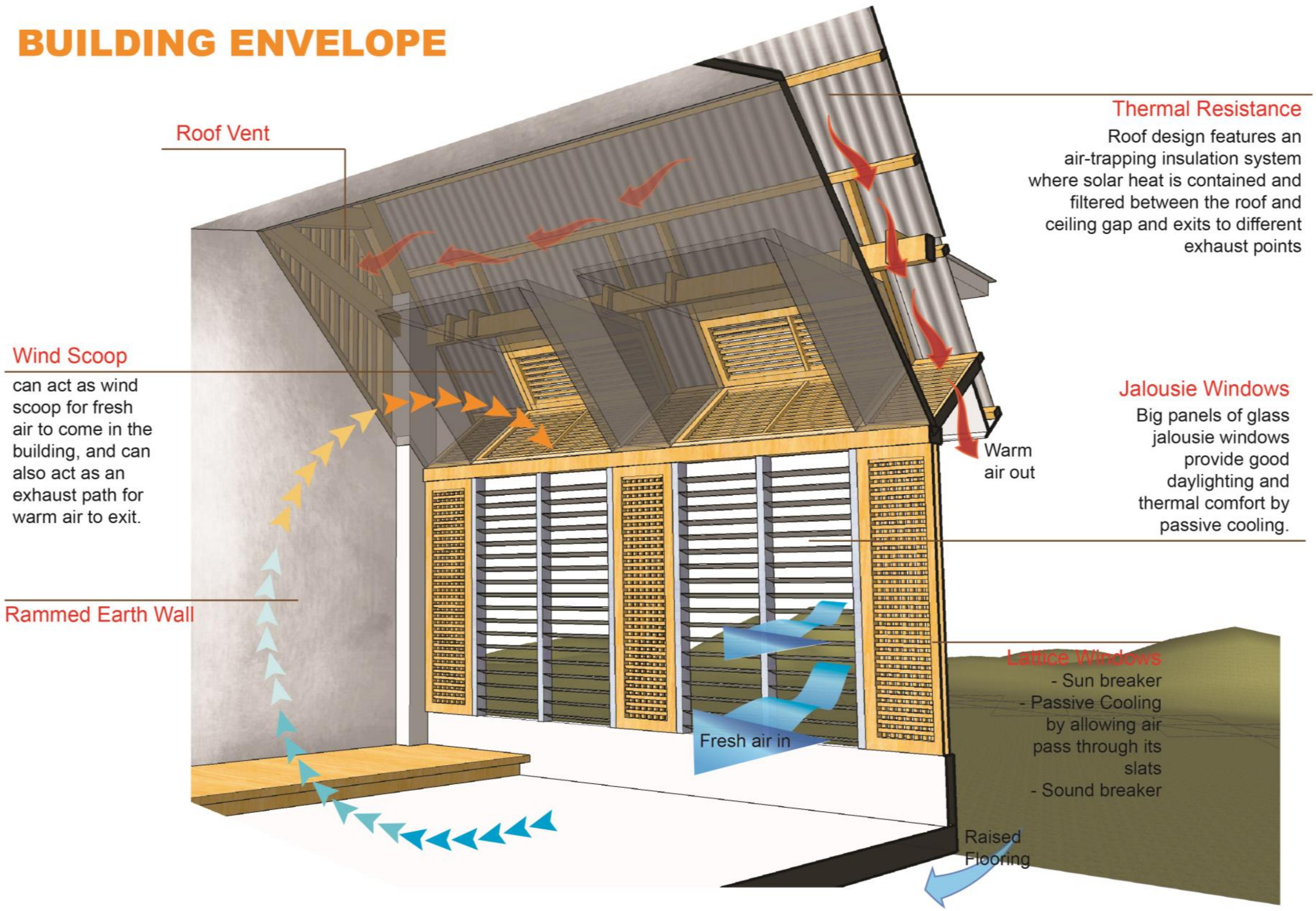



SUSTAINABILITY
PV Solar Power
Solar Photovolatic Panels convert solar energy to electricity and provide an alternative renewable energy
Roof Ventilation
Gap between ceiling and roof traps solar heat transmitted from roof panels and skylights then heat is released through roof vents and breathers.
Sustainable Wood Products
is the main building material as a renewable material and can be available locally
Double Skylight
Energy-efficient light bulbs
use LED or Compact Flourescent Bulbs for artifcial lighting.
Rainwater Harvesting and Recycling
Rainwater is harvested and used to water vertical garden and toilet facilities.
Convenience Outlet
Convection
as cold air comes in, hot air goes up and out into the breathers
Vertical Gardening
Green wall as a vertical garden will provide the shool a source for food production.
Raised Flooring System
Raised floor helps cool down interior of the school, thus decreasing energy demand for ventilation
SECTION showing Roof Vent

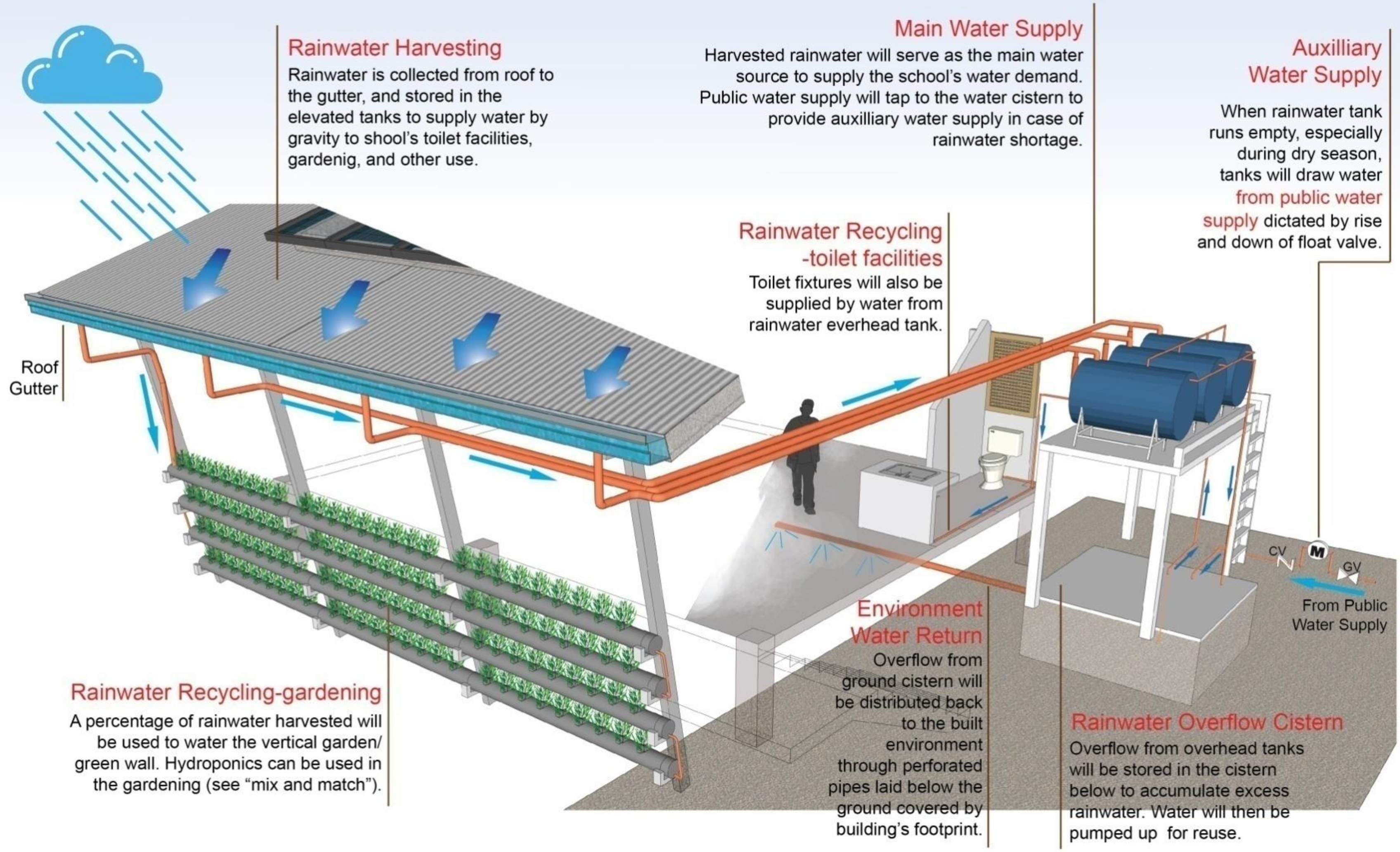

Wood Louvers
natural exhaust
for warm air
Hydroponics Gardening
acts as accoustical
buffer and sun shade.
See “mix and match” to
choose from list of
green wall/ vertical
gardening options.
Full Open Jalousie Windows
to make full use of natural sunlight for daylighting
and minimize the need for artificial light.
Lattice Windows
to promote passive cooling and daylighting,
and will also act as sound buffer.
Rammed Earth
Wall or
Conrete
Hollow blocks
Glass Sliding Windows for daylighting.
Slatted Wood Sliding Windows for natural ventilation.


Photovoltaic Panels
Wood Roof Purlins
Roof Gutter
Skylights
use transparent plastic roof
or wired glass skylight.
Ceiling
G.I. Corrugated
Roofing,
pre-painted white
to reflect slolar rays
back to the space
Scissors Truss
Wood Slats
for roof vent
Roof Breather
Wind Scoop

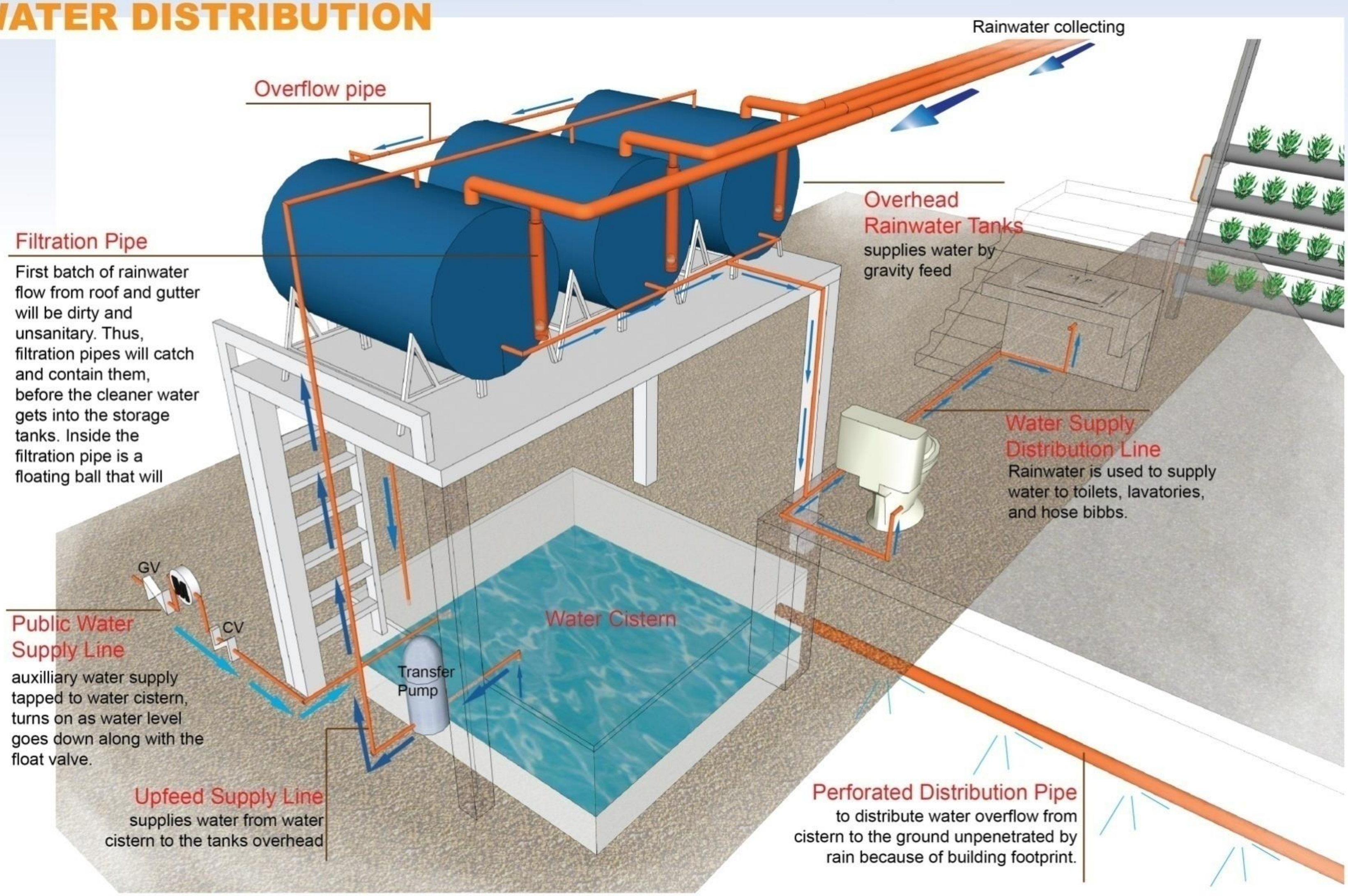
BUILDING ENVELOPE



WATER DISTRIBUTION



WATER DISTRIBUTION



C. Emerging/Floating Structure for lowland and coastal areas

The building structure is designed to be adaptable in lowland areas where in case of calamities such as flooding, the structure itself will rise along with the rise of water level. The structure should use lightweight building materials to facilitate the structure's EMERGING capability.

Characteristics:

-G.I. roofing with white colored paint to reflect heat outside the structure

-Awning wall that serves as an opening for cross ventilation

-Timber columns

-Raised bamboo flooring and ceiling

-Fiber glass skylight to illuminate the interior

-Rotating louvered windows of lightweight material

-Bamboo planters which will serve as sound and sun buffer

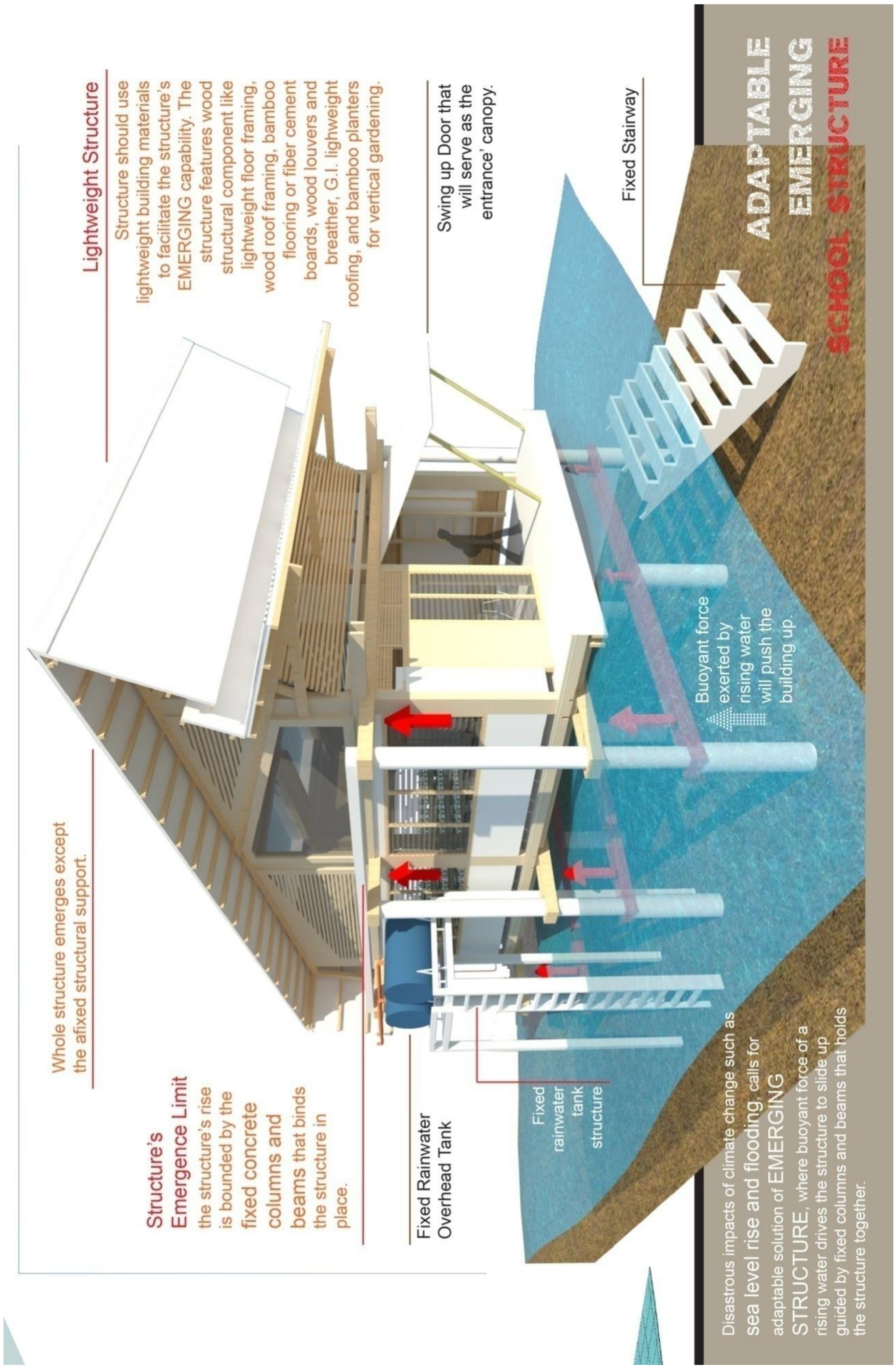
-Lightweight floor framing

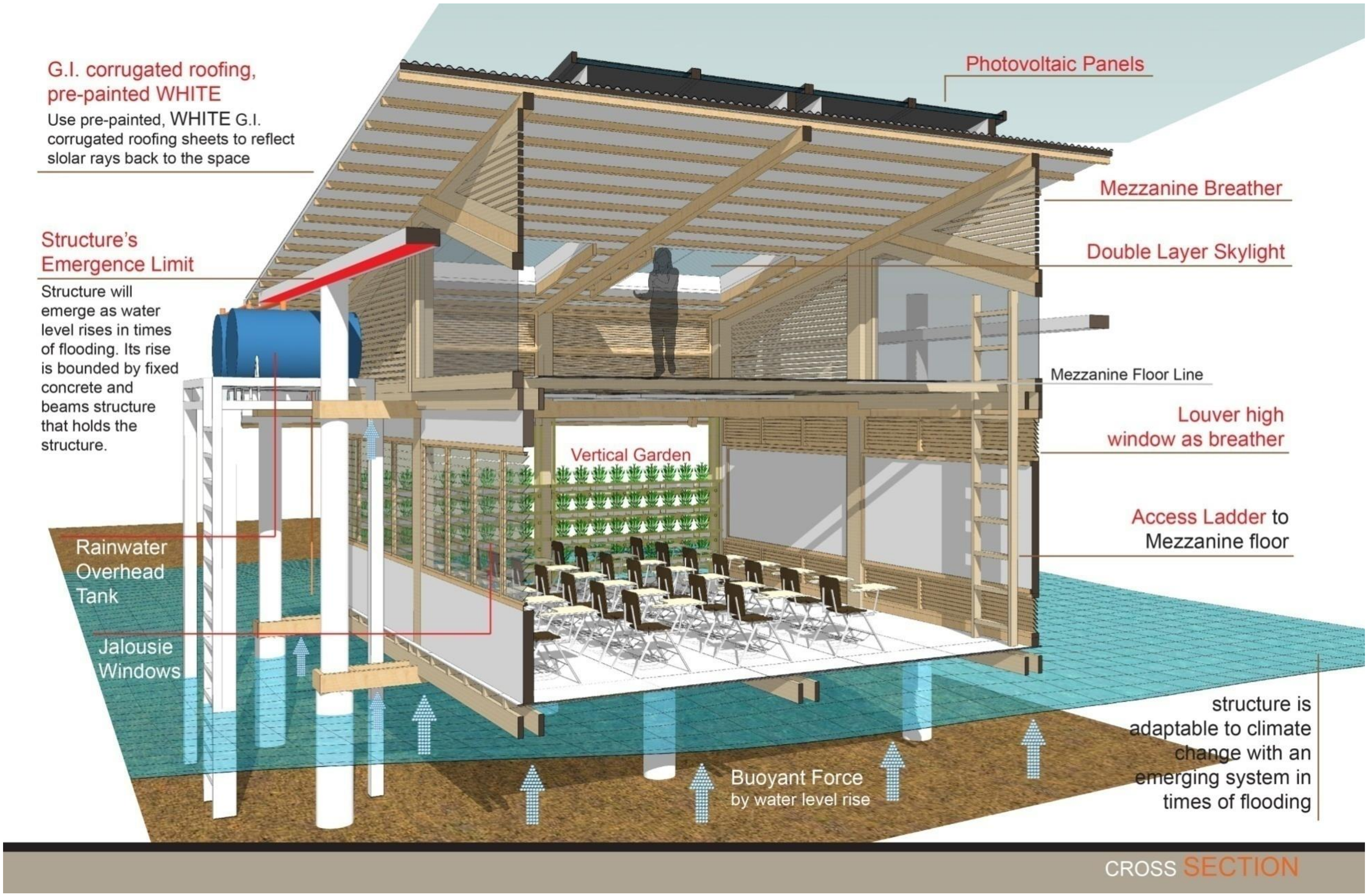
-On-stilts foundation system

-Floating structure support that rises along sea level rise

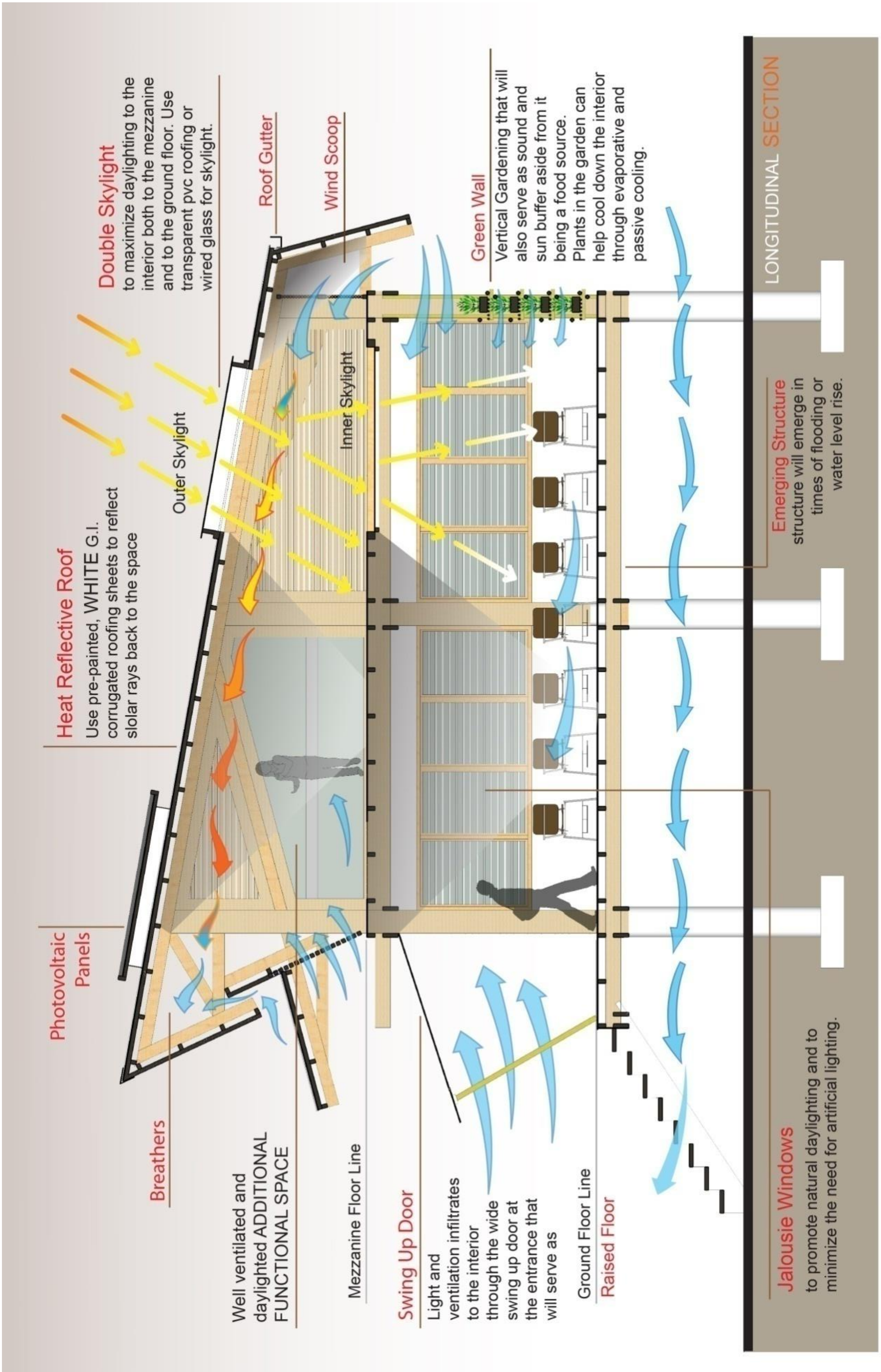
-Multi-function raft which could serve as an entry porch or emergency raft

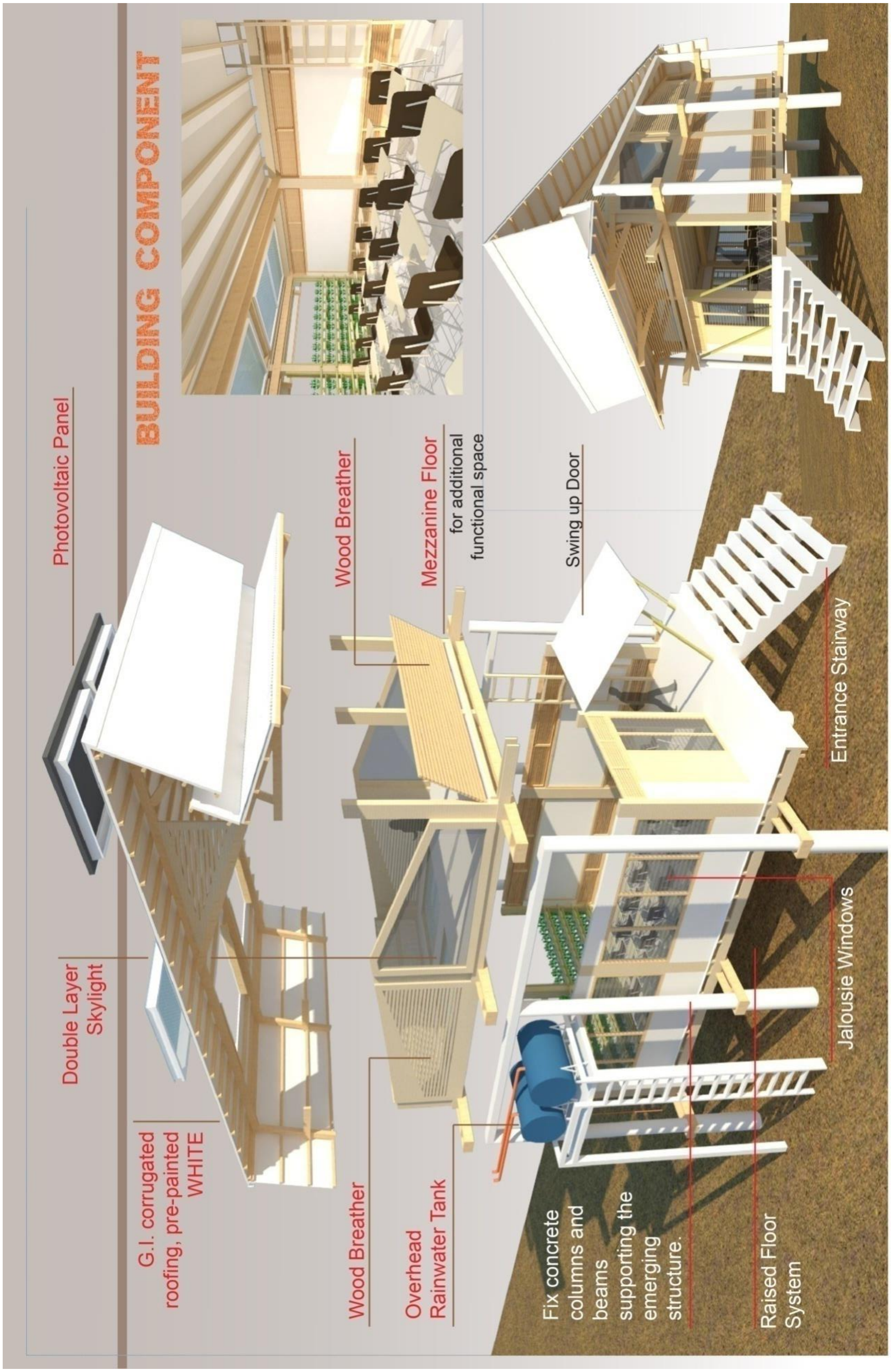
-Solar photovoltaic panels on its roof to convert solar heat to energy


Lightweight Structure
Structure should use lightweight building materials to facilitate the structure's EMERGING capability. The structure features wood structural component like lightweight floor framing, wood roof framing, bamboo flooring or fiber cement boards, wood louvers and breather, G.I. lighweight roofing, and bamboo planters for vertical gardening.
Swing up Door that will serve as the entrance' canopy.
Fixed Stairway
ADAPTABLE
EMERGING
SCHOOL STRUCTURE
Whole structure emerges except the afixed structural support.
Structure's Emergence Limit
the structure's rise is bounded by the fixed concrete columns and beams that binds the structure in place.
Fixed Rainwater Overhead Tank
Fixed rainwater tank structure
Buoyant force exerted by rising water will push the building up.
Disastrous impacts of climate change such as sea level rise and flooding, calls for adaptable solution of EMERGING STRUCTURE, where buoyant force of a rising water drives the structure to slide up guided by fixed columns and beams that holds the structure together.



G.I. corrugated roofing, pre-painted WHITE
Use pre-painted, WHITE G.I. corrugated roofing sheets to reflect slolar rays back to the space
Structure's Emergence Limit
Structure will emerge as water level rises in times of flooding. Its rise is bounded by fixed concrete and beams structure that holds the structure.
Rainwater Overhead Tank
Jalousie Windows
Photovoltaic Panels
Mezzanine Breather
Double Layer Skylight
Mezzanine Floor Line
Louver high window as breather
Vertical Garden
Access Ladder to Mezzanine floor
structure is adaptable to climate change with an emerging system in times of flooding
Buoyant Force by water level rise
CROSS SECTION


Double Skylight
to maximize daylighting to the interior both to the mezzanine and to the ground floor. Use transparent pvc roofing or wired glass for skylight.
Roof Gutter
Wind Scoop
Green Wall
Vertical Gardening that will also serve as sound and sun buffer aside from it being a food source. Plants in the garden can help cool down the interior through evaporative and passive cooling.
LONGITUDINAL SECTION
Heat Reflective Roof
Use pre-painted, WHITE G.I. corrugated roofing sheets to reflect slolar rays back to the space
Outer Skylight
Inner Skylight
Emerging Structure
structure will emerge in times of flooding or water level rise.
Photovoltaic Panels
Breathers
Well ventilated and daylighted ADDITIONAL FUNCTIONAL SPACE
Mezzanine Floor Line
Swing Up Door
Light and ventilation infiltrates to the interior through the wide swing up door at the entrance that will serve as
Ground Floor Line
Raised Floor
Jalousie Windows
to promote natural daylighting and to minimize the need for artificial lighting.


BUILDING COMPONENT
Photovoltaic Panel
Double Layer Skylight
G.I. corrugated roofing, pre-painted WHITE
Wood Breather
Mezzanine Floor
for additional functional space
Wood Breather
Overhead Rainwater Tank
Swing up Door
Entrance Stairway
Jalousie Windows
Fix concrete columns and beams supporting the emerging structure.
Raised Floor System

CHAPTER 9

DESIGN DEVELOPMENT PHASE OF HOLISTIC RESILIENT AND ECO-EFFICIENT SCHOOL

The design development phase is a design process that considers conceptual factors as a guide to develop holistic resilient eco-efficient school. The process involves identifying principles needed to develop innovative and creative designs. The principle of Biomimicry, Aerodynamics, Hydrodynamics (fluid Dynamics) are the principles needed to develop a resilient school that is typhoon and earthquake resistant school. The process of incorporating resiliency with eco-efficient green school design will lead to the design conceptualization of a Holistic Resilient Eco-efficient School.

I. Conceptual Basis

The consolidation of architectural philosophies namely; Biomimicry, the principle of Aerodynamic and the principle of Hydro Dynamics (fluid dynamics) acts as the conceptual basis to be able to come up with a basic form for holistic eco-efficient resilient school. It addresses the fundamental structural system needed to address the issues of earthquake and typhoon resistance.

A. Biomimicry

(Structural frame)- The analogy of a human structure that carries the bulk of the load which the upper body considering other factors such as movement and other stresses. All these features can be used and translated into the building's structural system. The result will be a resilient structural system with extra strength gaps to handle the effects of earthquakes and typhoons inclusive of wind, seismic and flooding.

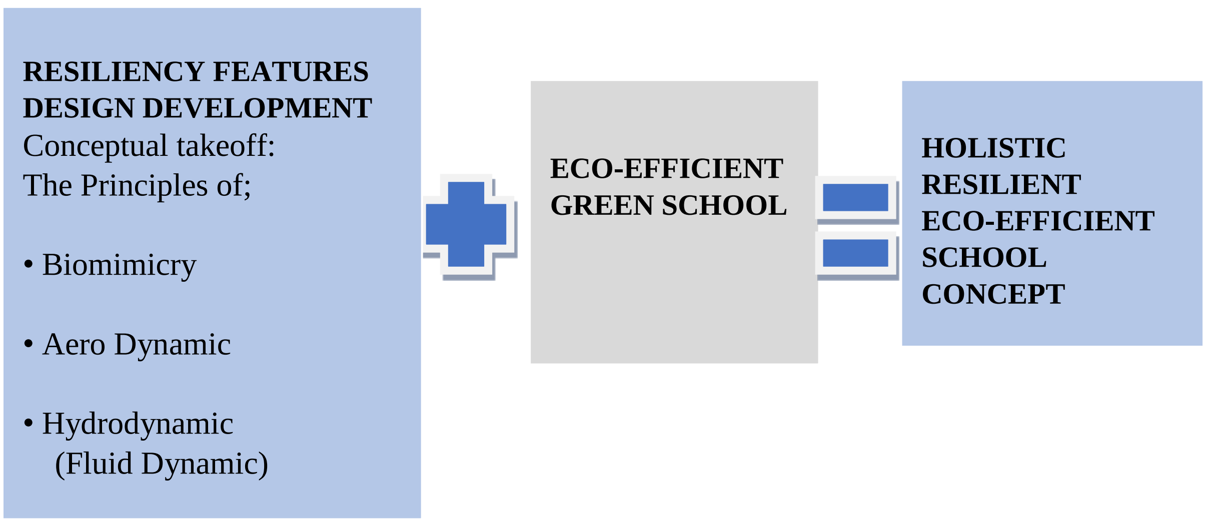
B. Aerodynamics

Aerodynamics guides the formulation of the design of the form, the roof and plan configuration. It is a tool to conceptualize form and shape where there is less drag, allow wind and air to flow to be able to come up with a resilient design.

C. Hydrodynamics

water flow behavioral character guides the designer in formulating flood resistant and tsunami resistant design element and that includes form and layout of horizontal planes like raised flooring to allow water to flow, thereby protecting the users as well as the structure.

II. Design Development Conceptual Flow



Resiliency Concepts Developed by Koradesigngroup

III. Typhoon Resistant Forms

A. Aerodynamics

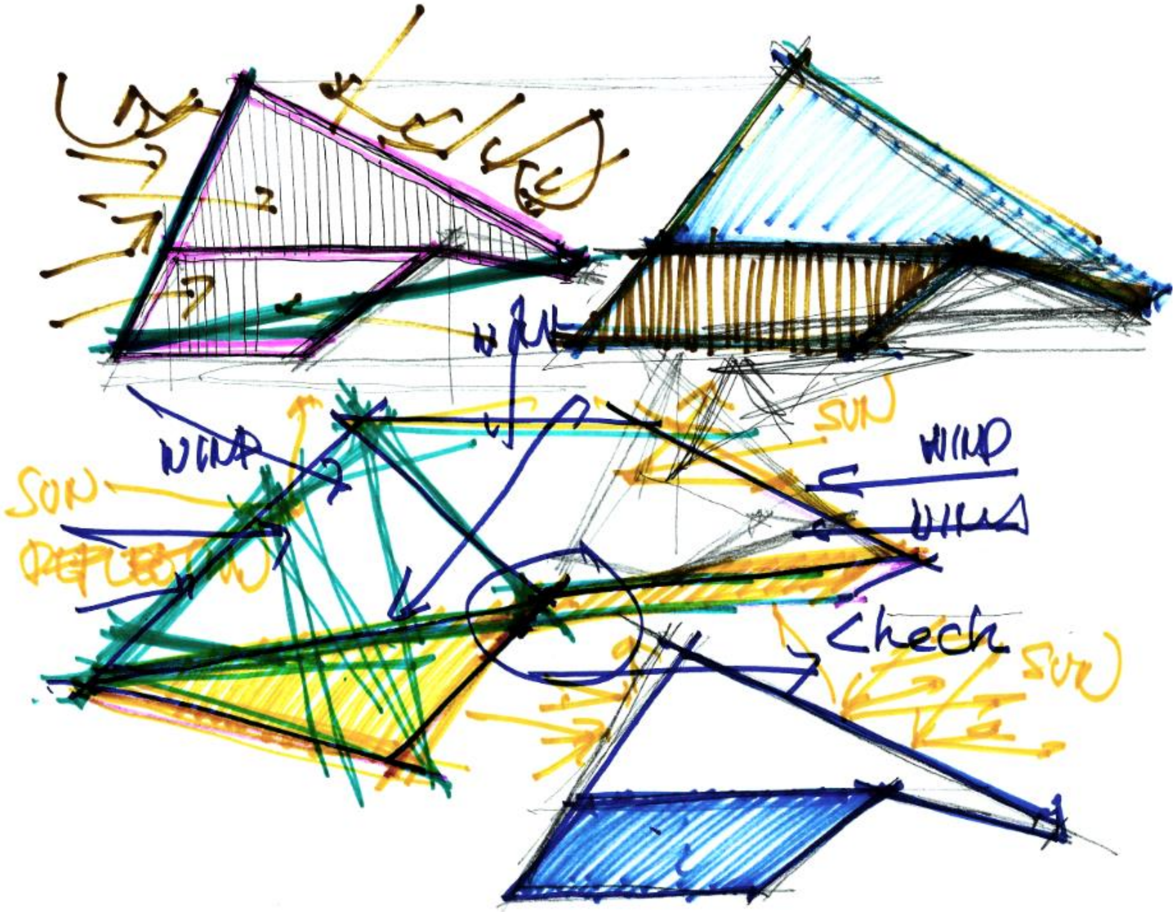


Illustration 1: koradesigngroup

The sketch above shows the different wind load direction that hit the on the roof profile we designed. Considered external force is the wind uplift force.

B. Wind Load Factor

Aerodynamic form allows wind/ air to negotiate with less resistance enabling the structure to withstand strong wind loads. Aero dynamic roof allows wind to glide on the surface and pass through with less resistance all these because of the roof's slope and aerodynamic form of the roof. (illustration1)

The other factor is the uplift force of the wind which will affect the eaves and the gutter system. Overall wind factor affects the slope, form and design of the roof. The goal is to be able to come up with a design that is that is least resistant to wind least drag and wake.

C. Sun Impact factor

As the sun impact on the aerodynamic designed roof, reflective sun angle is oblique in nature allowing reflective solar heat to reflect indirectly. Meaning if the solar heat reflects back with a sharp angle the sun's heat tends to push back directly to the roof while on an oblique angle the sun's heat reflection bounce away from direct sun angle. This results more heat reflected than heat being absorb by the roof. (Illustration 2)

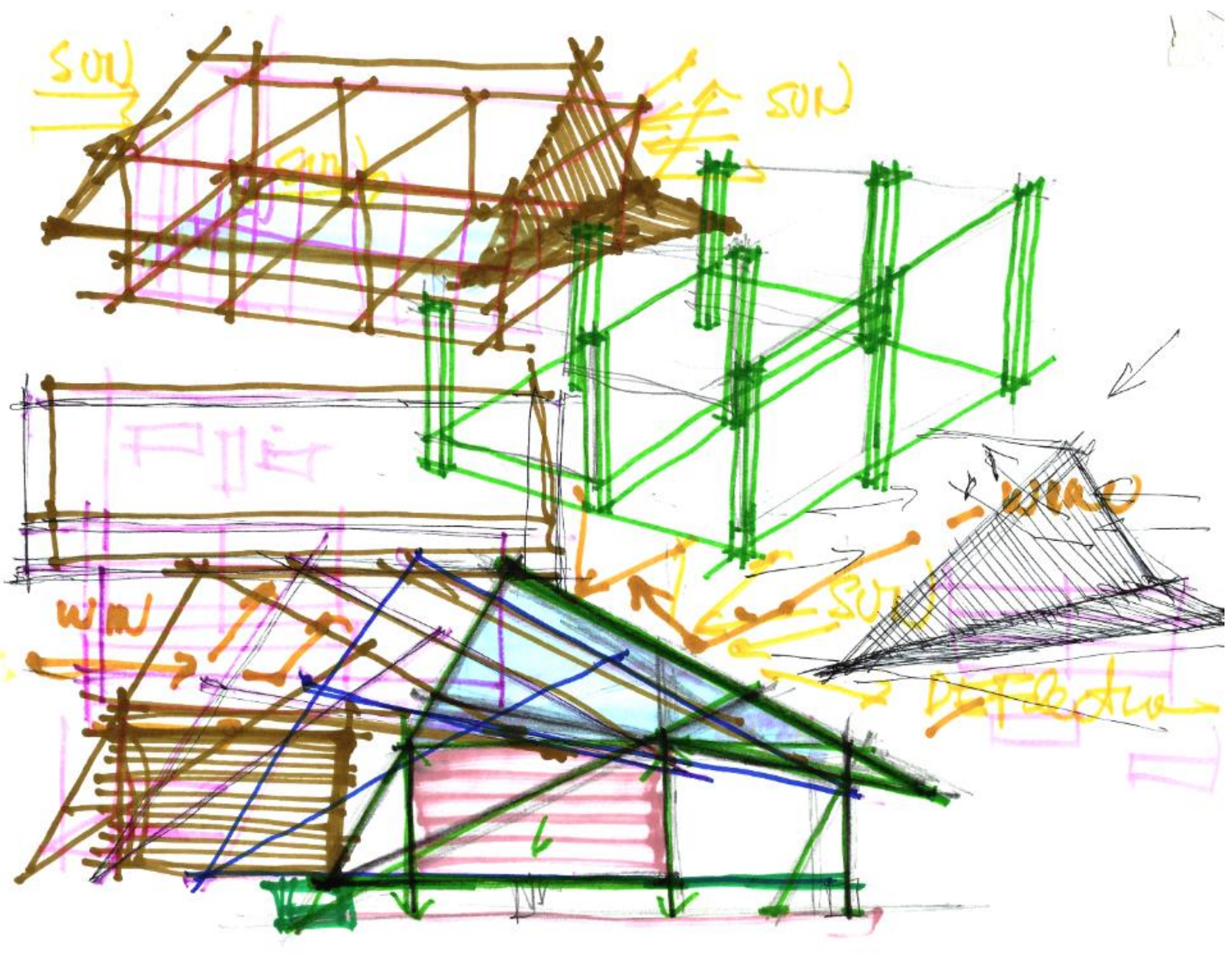


Illustration 2: by koradesigngroup

As seen above (Illustration 2) aerodynamic dictates the roof angle profile, shape of the roof and structural roof frame. Structurally the triangle configuration is one of the most stable structural frame profiles. This profile is different roof profile than traditional roof angles.

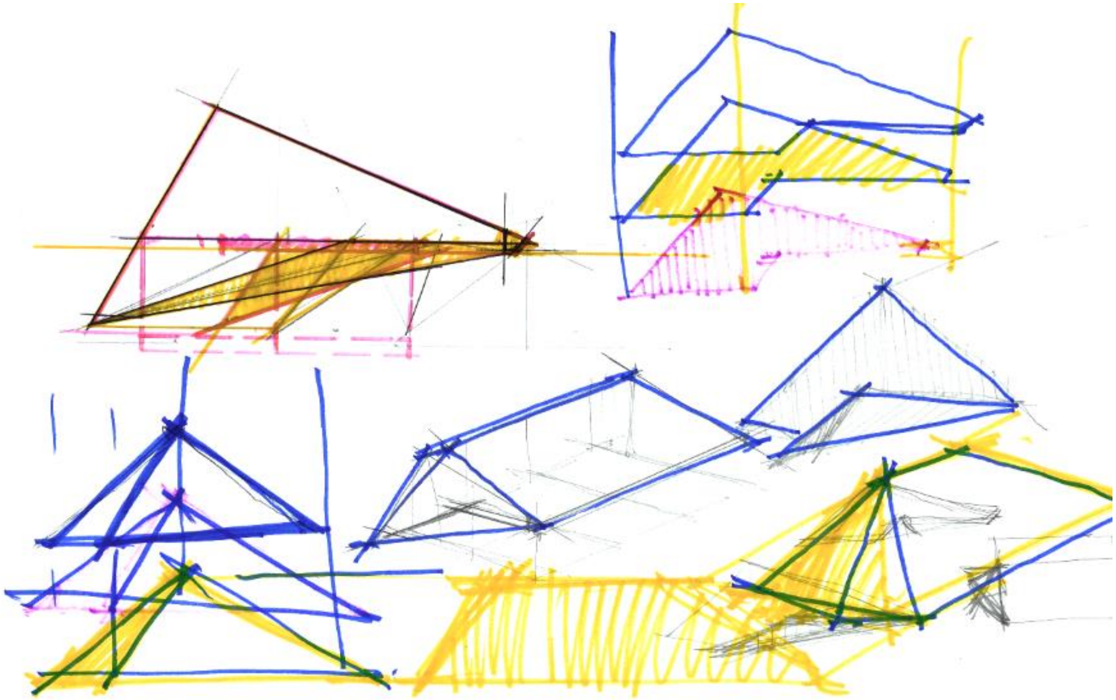


Illustration 3: koradesigngroup

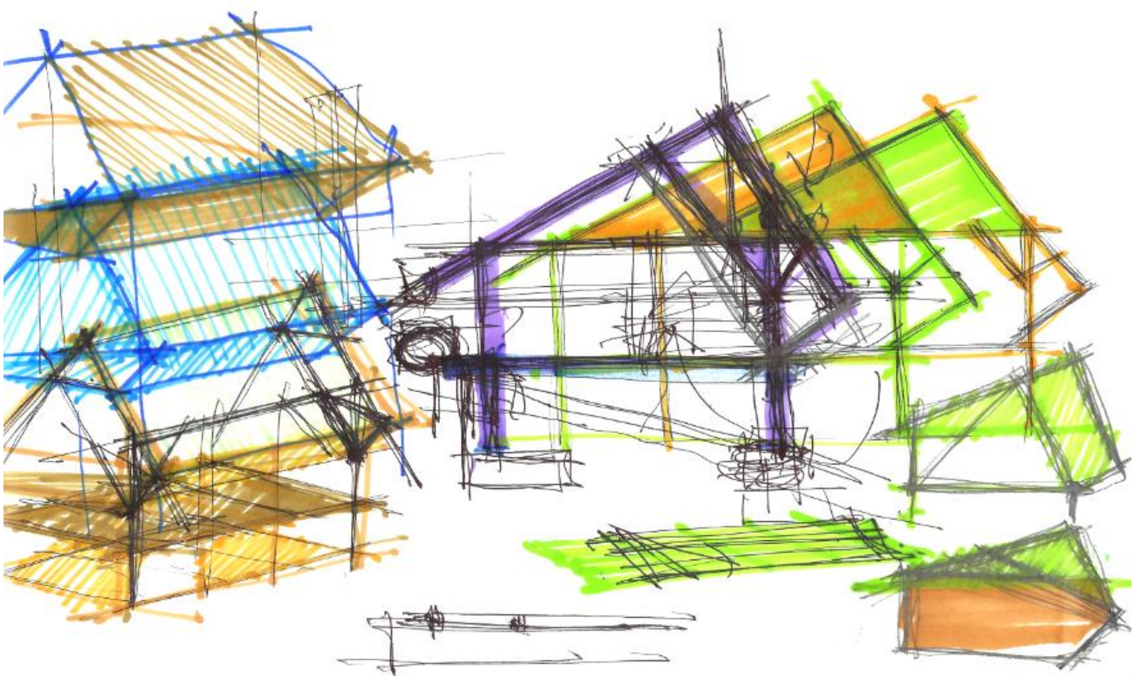


Illustration 4: koradesigngroup

Shapes, forms and structures are within the confines of the parameter set by aerodynamic principle.

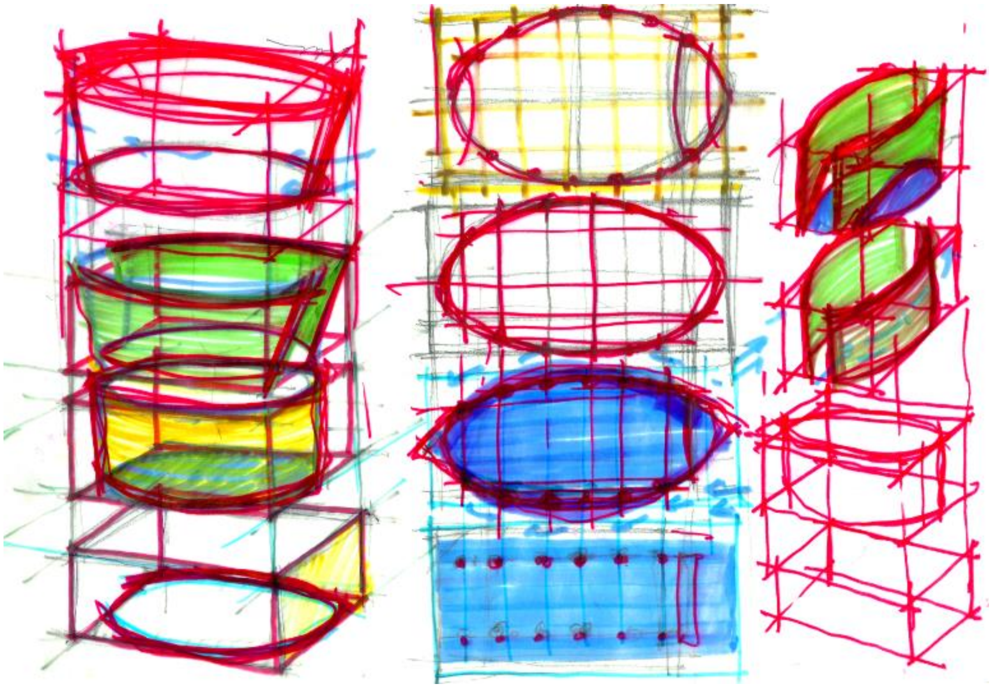


Illustration 5: by koradesigngroup

D. Aerodynamic: Wind

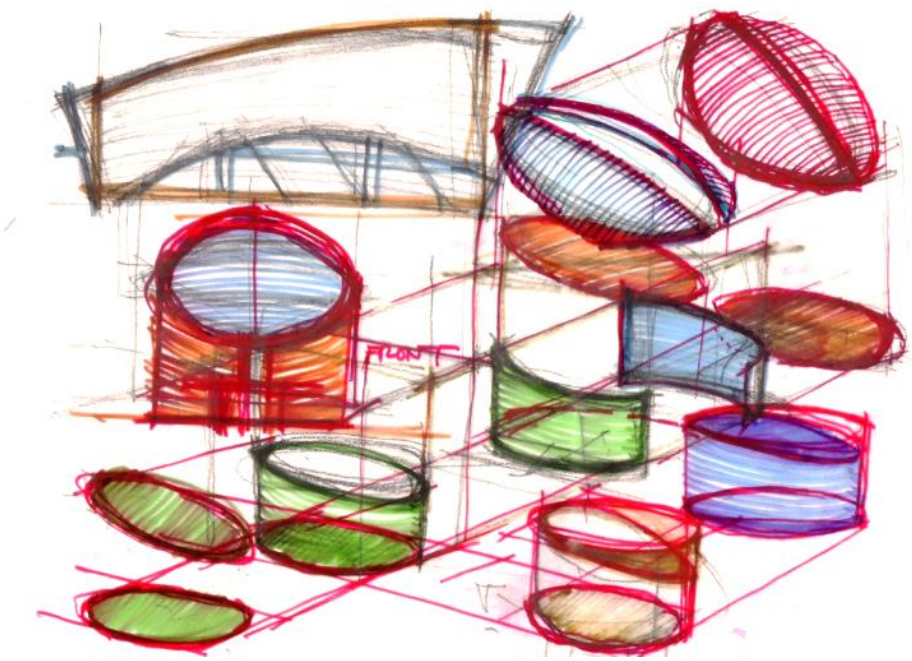


Illustration 5a: by koradesigngroup

The illustration above shows curve surface exhibit least resistance to wind flow. Rounded front and rear (oval) configuration surface is functional aerodynamic form less wake effect and drag.

E. Hydrodynamic: Flooding and Surges

Curve surfaces works well with water flow pressure. It will allow to flow with least resistance and with less wake and drag. This curve shape configuration can be translated into the structural system of the building like the shape of the columns and walls. Columns can be shape into a rounded column or oval shaped columns.

Durable solution will be a raised building. Raised building or structure is a design where the floor is raised by columns. Columns can act as stilts and allow flood water to flow underneath the floor.

F. Aerodynamic Roofing Profile Design by koradesigngroup

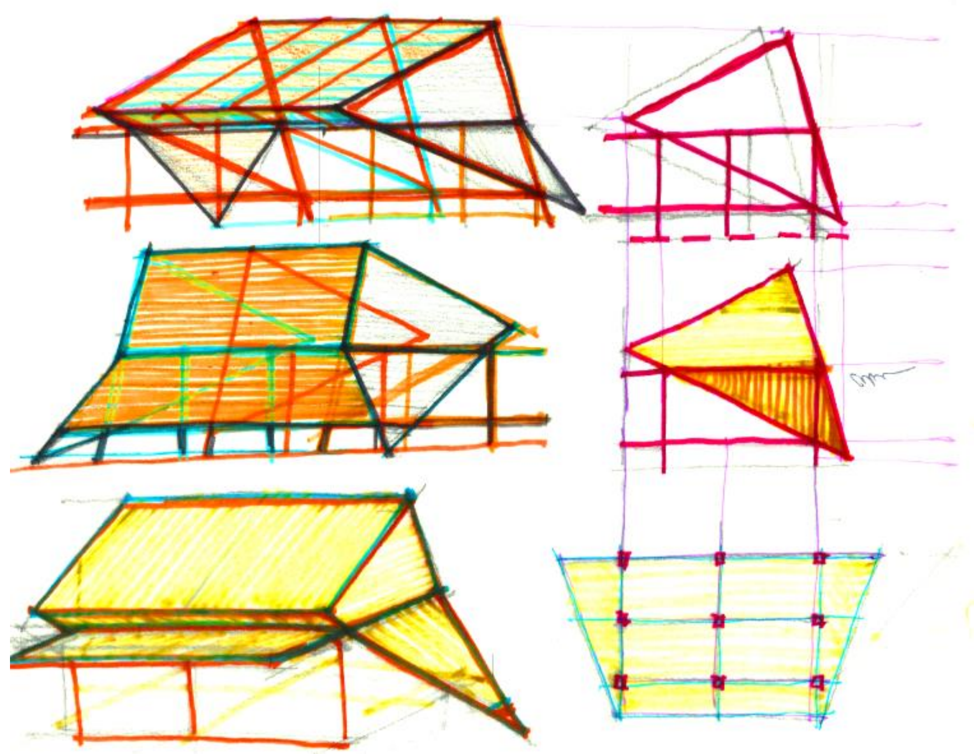


Illustration 6: koradesiggroup

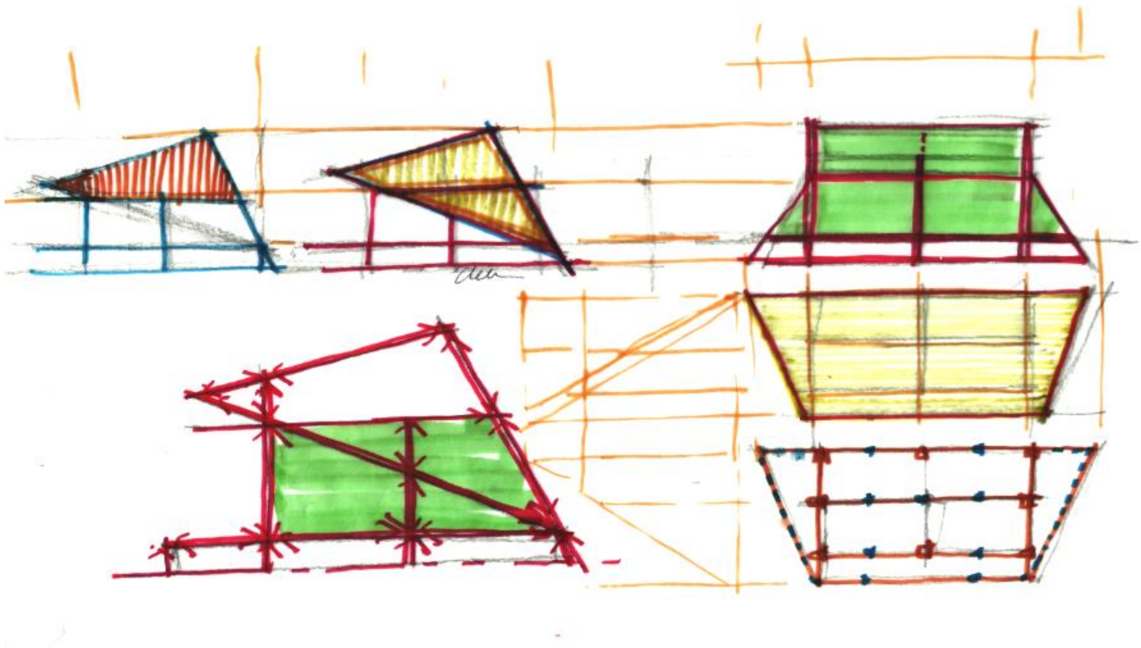


Illustration 7: by koradesigngroup

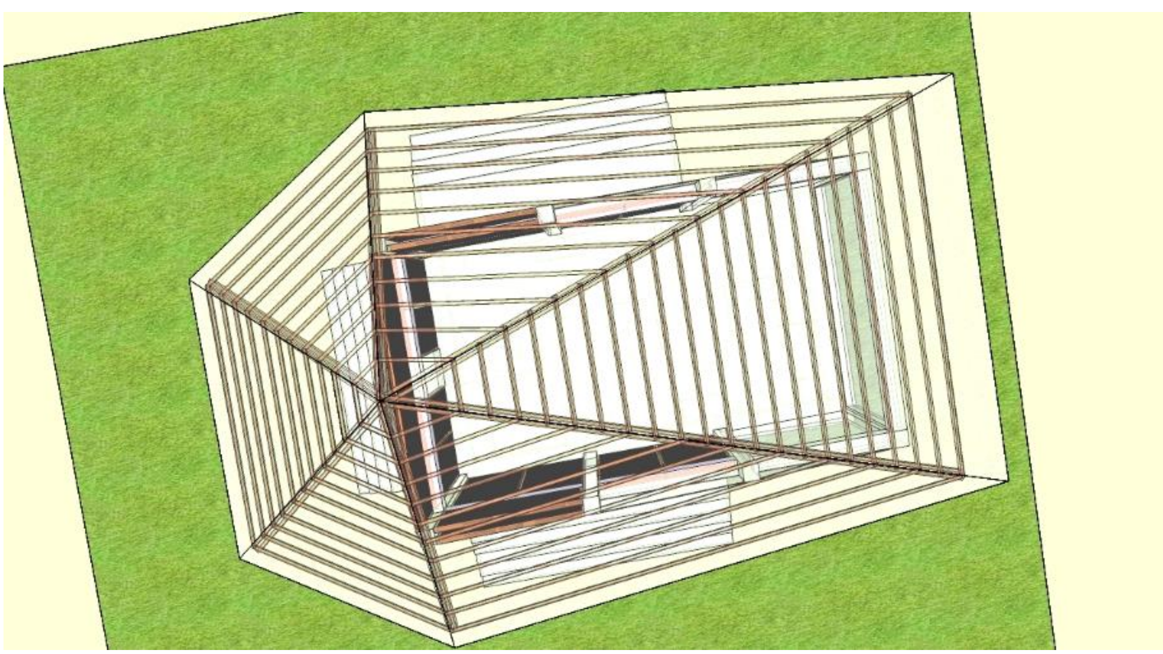


Illustration 8: by koradesigngroup

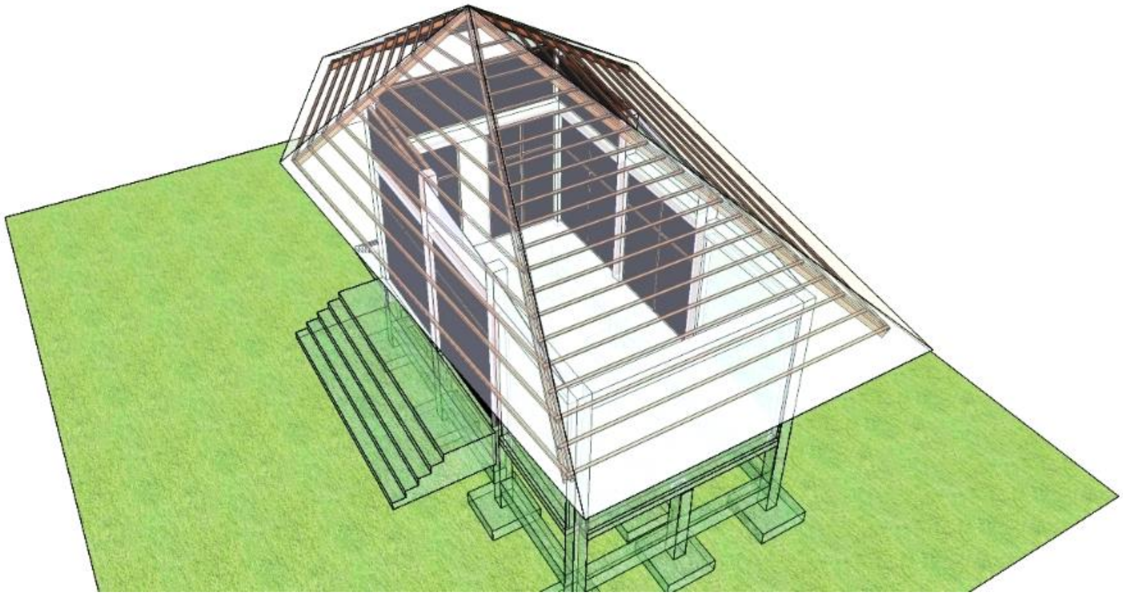


Illustration 9: by koradesigngroup

The illustrations above shows a roof plan developed and designed by koradesigngroup. It is a sic sided roof with aerodynamic feature. It is designed to have a simple roof framing for cost efficiency and maximum wind pressure resistance.

The above roof profile was taken as inspiration from a Dutch invented umbrella that is wind resistant because properties

The above pictures are the profile of a Dutch invented umbrella developed and design by TU Delft, Delft, The Netherlands.

Aerodynamically designed profiles of Dutch umbrellas performed well in times of strong extreme weather bearing strong winds.

IV. Earthquake Resistant Concepts

Referring to performance based process of design where it involves involve evaluation of performance during hazards events, disasters both natural and manmade, calamities and other conditions and the adverse effects of climate change we came into conclusion that we have to include with importance the performance of structures and buildings that survived previous disasters. This refers to the performance in reference to functionality, capacity and stability in addressing appropriate responses and tolerable level when it comes to building system performance regardless of the type of hazards.

- Referring to the different socio-cultural, historical layers of the Philippines, architecturally those structure that survived earthquakes and typhoons are those structures built during the Spanish, American, Japanese eras. Mostly as noticed are structures that rest on column pedestal aside from the main supporting columns. These are series of above grade and below floor short columns aside from the main columns. Shown by “Gabaldon Schools” structural framing and design. Gabaldon Schools are in a series of column pedestal aside from the main support columns. It has a raised flooring system sitting on pedestal columns.” Gabaldon Schools” withstood the test of time with excellent resiliency characteristics that are of typhoon and earthquake resistant.
- We conceptualized a combined system of conventional and traditional structural system that should be earthquake resistant.

A. "Gabaldon" Schools

1. Location of "Gabaldon" Schools

“Gabaldon Schools’ are most located and widely spread in the urban centers, sub-urban areas, in the Provinces, rural and a few in the mountain areas.

2. Character of "Gabaldon" Structure

“Gabaldon schools” exhibits green elements and resiliency character in the design and structure. It is in some aspects exhibits adaptable character.

3. Positive Aspect of "Gabaldon" Schools

a. Gabaldon Schools are on raised flooring resting on short column pedestal as secondary support for the main structural frame aside from the main building support frame. Taking into consideration of the different historical hazard events for so many decades, Gabaldon schools survived specifically earthquake and typhoons. Evidently these structures are still functional and operational considering that these structures are declared heritage buildings.

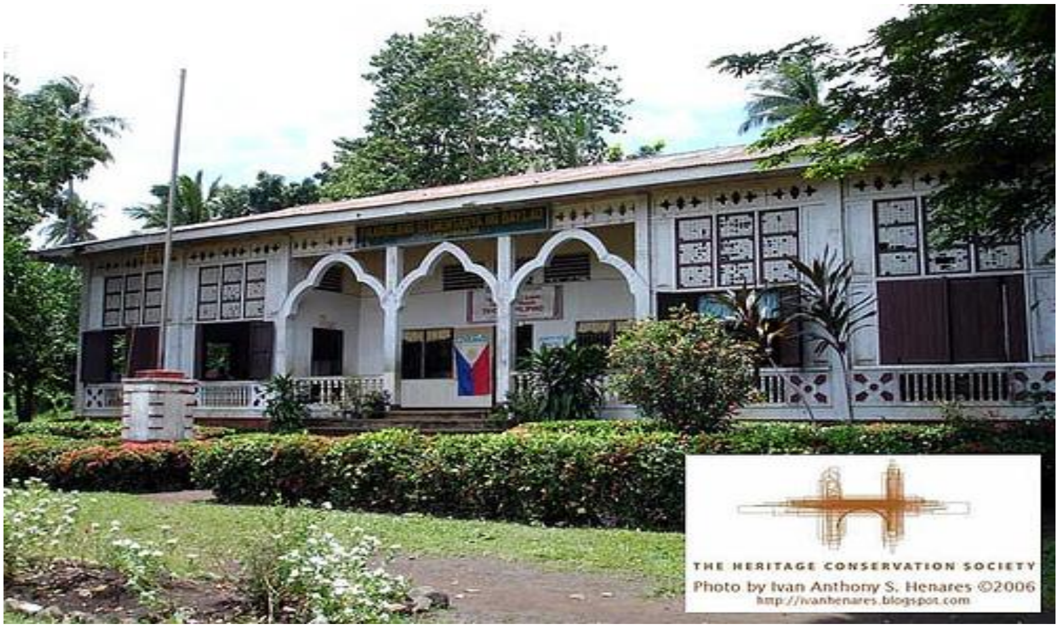
b. “Gabaldon Schools” as I have observed is of four or more different design and construction system. The parameter set in determining the type of design and construction depends on the site and dimensions. Urban areas use cement and wood with a composite accessorial material such steel. Rural and Mountainous areas use wood construction and design.

c. Raised flooring and or on stilts footing pedestal construction which is a protection against the elements and animals. It allows air to cross ventilate.
d. High floor to ceiling Height: allows more air circulation
e. Wide window openings in some design floor to ceiling window system may it be awning type, full slide, wood louver, glass jalousies. There windows characterized by half two-thirds opening and the rest are fix panels.
f. Other schools have concrete walls design with wood louvers or decorative perforated wood panels. Some panels are constructed in full decorative perforated wood panels, a means air to penetrate to the classrooms spaces.
g. As observed these schools building are sturdy and solid to withstand the test of time.
h. "Gabaldon" schools mostly in the provinces and in the rural areas have wood (timber) as floor while others are on earth on fill with concrete floor construction.
i. Roof: mostly on a high pitched roof applicable to a tropical country like the Philippines.
j. Materiality: the school uses readily available building materials that the school's design incorporates minimal passive cooling
k. Positive aspect in principle.

3. *The Other Aspects of High Pitched Roof Lacks*

a. The use of "Capiz" shells as window component. This type of shell is endangered and banned. Capiz windows are semi transparent in nature that allows light to transfer to the inner spaces.
b. Timber species used in the construction especially hardwood are banned now, a mitigating action as prevention to forest degradation.

c. Mostly are up for restoration and repair. Affected are the corroding galvanized iron roof sheets and wood members affected by termites.
d. The high pitched roof lacks ridge ventilation for hot trapped air to circulated and ventilate.
e. The high pitched roof lacks light openings for natural ventilation to penetrate the inner spaces.
f. The roof need roof insulations and needs to be painted white.
g. Not all "Gabaldon" schools have a gutter and down spout system
h. The absence of a gutter and downspouts



"GABALDON SCHOOLS" Study Drawings by Koradesigngroup

V. Structural Concepts Proposed by koradesigngroup

The proposed structural component will be derived from the structural system of "Gabaldon Schools". Gabaldon School's structural system composes of a series of short column pedestals aside from the main structural support which are the columns.

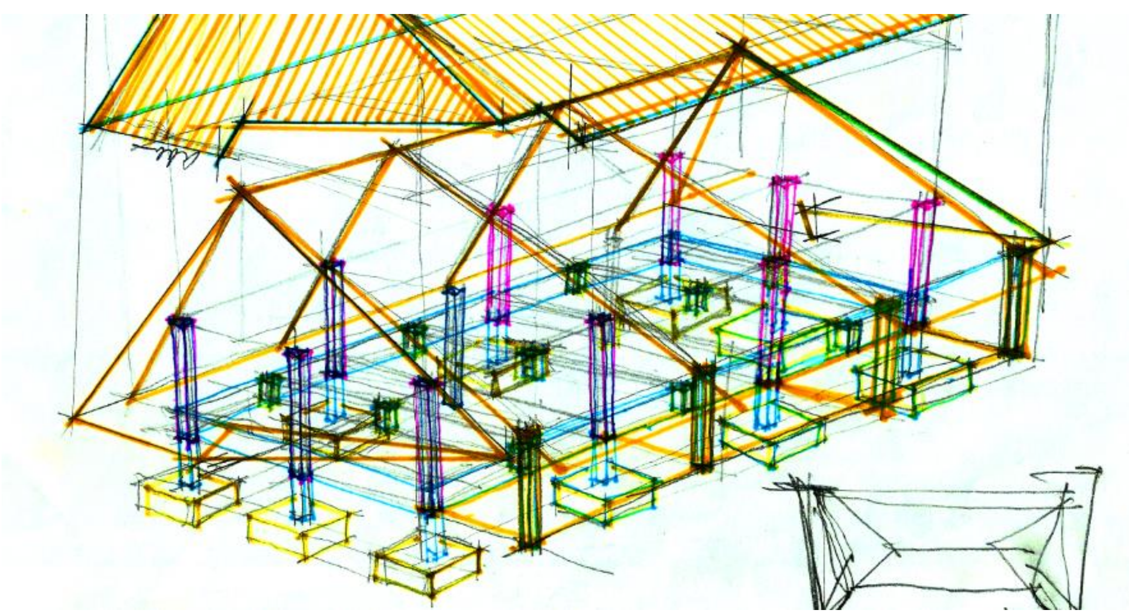


Illustration 11: Concept Drawing by Koradesigngroup

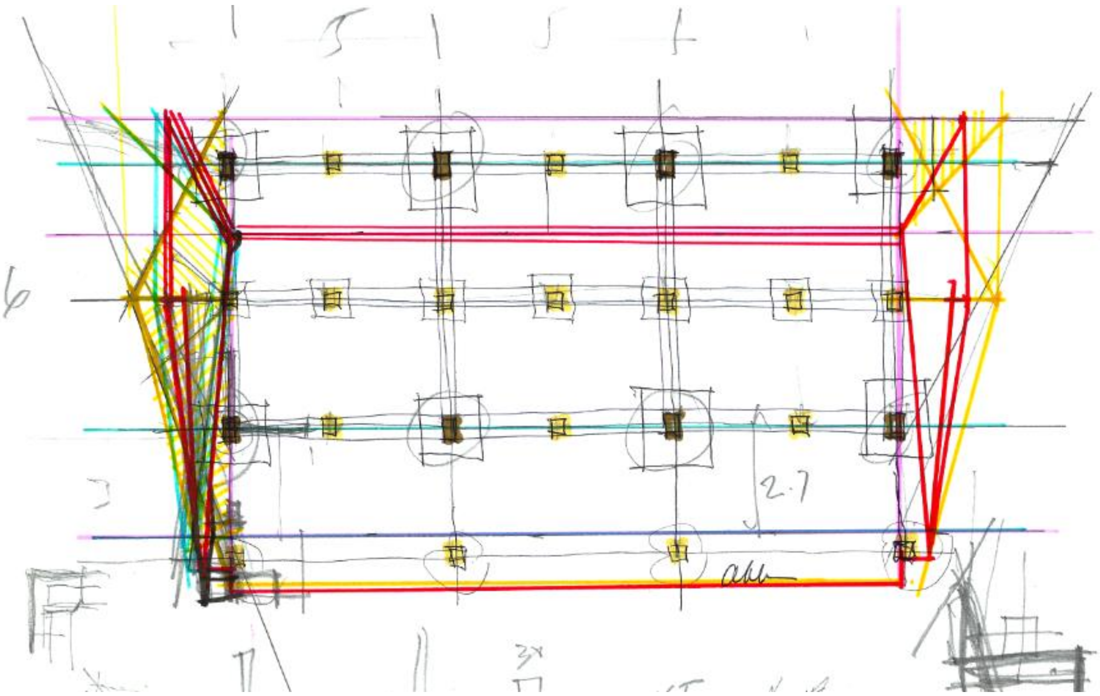


Illustration 12: Concept Drawing by Koradesigngroup

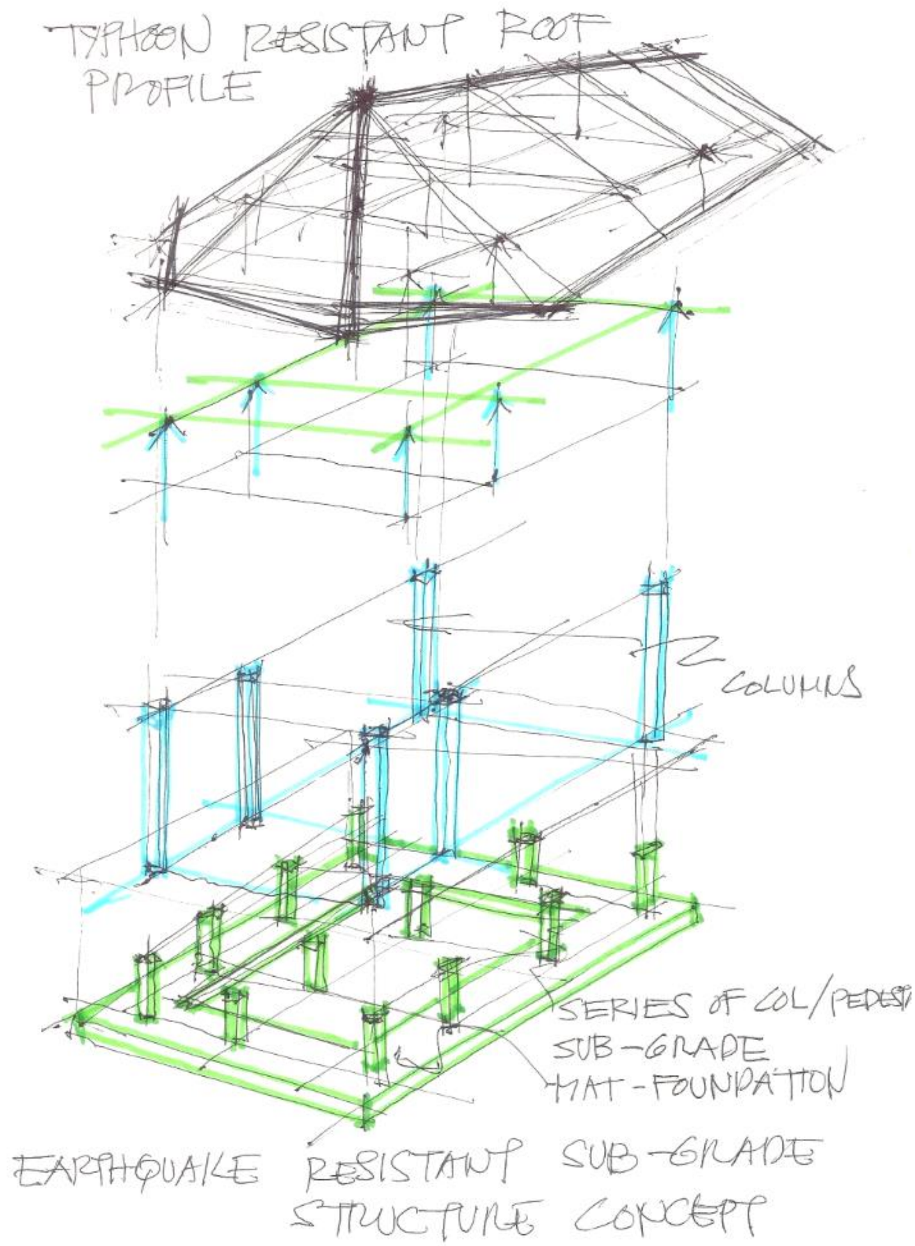


Illustration 13: by Koradesigngroup

Illustration 13 shows main column support with short column pedestals as secondary structural support tied and connected with tie beam or ground horizontal lateral beam-mat tie foundation.

This concept allows a unified movement in times of seismic movement. Mat tie beam restrict independent movement of the sub-grade structural footing and column pedestal by holding each structural members together for one single action in times of earthquake and erosion from flooding.

VI. Eco-Efficient Green School Concept

There are three goals of sustainable design −Eco-efficient green school:

1. Minimize the negative impact of the environment on the built environment
2. Connect people to the natural environment
3. Adapt (Adaptive Design) to adverse effects of climate change

A. The Benefits of Eco-Efficient Green

1. *Environmental **Benefits***

Helps Sustain the Environment and Mitigate Climate Change Effects

Such as Storm water management, temperature moderation, emission reduction and water conservation.

2. *Social and Health **Benefits***

Eco- efficient green school design brings about a Healthy and Productive Society, thereby improving the user's health, comfort, productivity and increase indoor environment.

3. *Economic **Benefits***

Multiplier Effect of Cost Reduction- This includes energy and water savings, lower operation management cost and other cost related to energy and water savings.

B. Criteria for Green Building Design and Function

1. *Sustainable / Green Design + Universal Design*

Green design addresses the need of energy and resource conservation as well social values and environmental consequences.

Universal design is a set of design system and standards created to be friendly and functional to all ages, disabilities, physical wellbeing, and race.

2. Flexible and Adaptable in Spatial Function

Flexible and Adaptable in function and usage at any given circumstance and situations whether in times of disaster, humanitarian usage and or civic functions

C. Key Features of Eco-Efficient Green School

- Multiplicity of Function: Shelter/Refuge Center, Emergency Shelter Community Promotions, Trade Fairs
- Universality
- Sustainability: rainwater harvesting for building use like toilet facilities, organic farming/ gardening, inland fish farm, recycling, composting.
- Adaptability: Climate Change Effects, Different Geological Conditions
- Green: Reduced energy demand and energy use, reduced ecological footprint reduce green house gas emissions, proper waste management appropriate use of locally available building materials
- Educational: School that teaches school with environment as an interactive tool for teaching

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

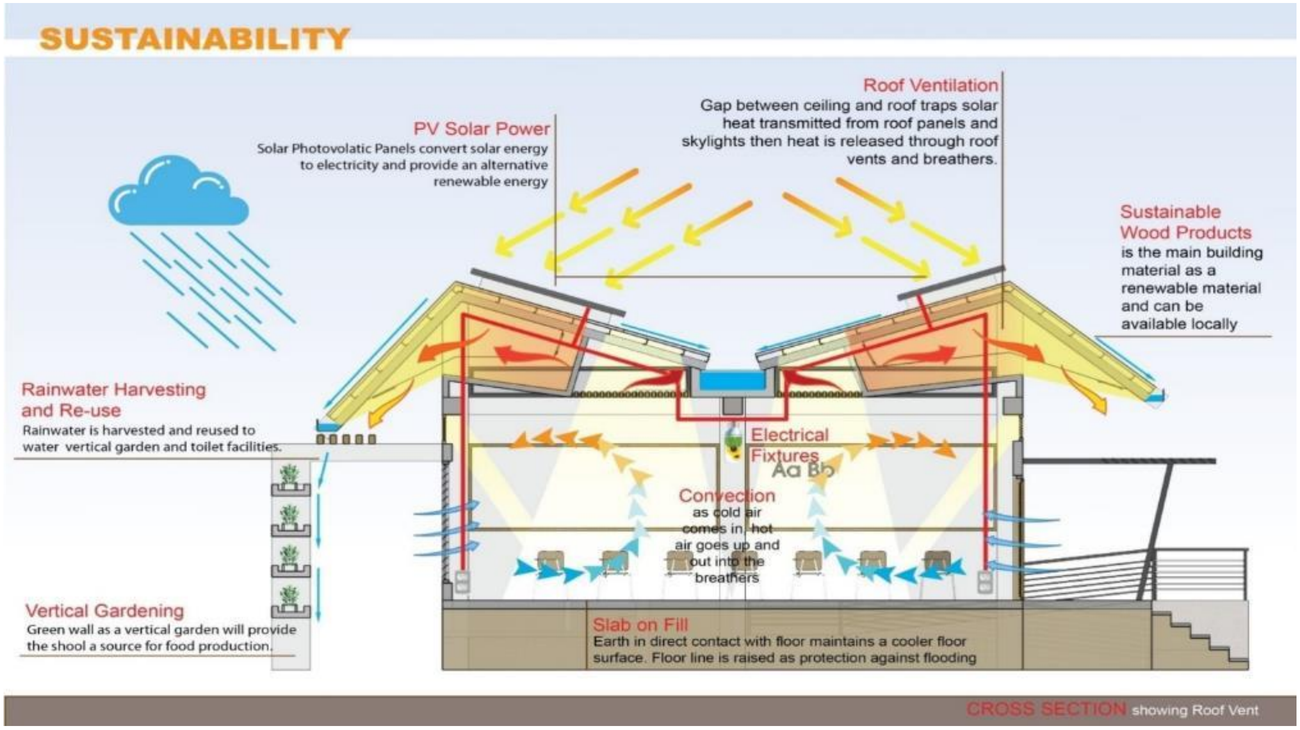


Illustration 14: Urban Dimension Green School Design and graphics by UN ESCAP, Department of Science and Technology –Region 7 and koradesigngroup

The eco-efficient and green features of greens school shall be incorporated with resilient design features to be able to come up with holistic eco-efficient school design. The sectional illustration shows eco-efficient green school profile the following features;

1. *Flooring elevation*

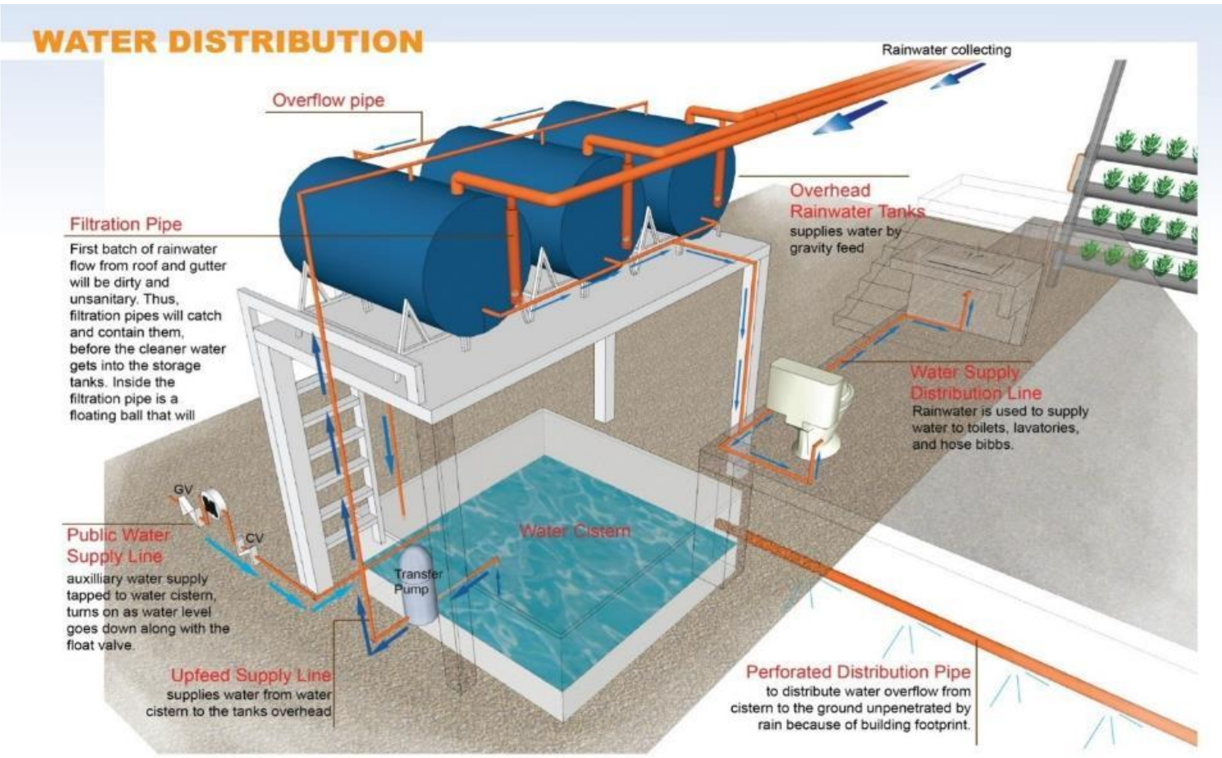
   The profile shows raised flooring as protection against flooding and against the elements.

2. *The roof profile*

   The roof is of a butterfly roofing form with center gutter as rainwater harvesting element and roof skylight openings. Skylights are roof openings for natural light to penetrate the interior spaces. Study shows that natural light penetration to the classrooms is more conducive to learning than artificial lighting (light fixtures). Proposed photo voltaic panels mounted on the roof energize the artificial lighting fixture and convenience outlets.

3. *Rain water harvesting and distribution system*

Rain water colleting and distribution system shown have three sections of the rain water collection, the two side gutters and central gutter. Rainwater collected goes to a main storage tank and the extra rainwater when the primary storage is full it goes to the secondary water tank for storage. The distribution source can be two ways; first rain water collected from the raised rain water tank and the ground mounted tank. Pumping can be done by solar pump or manual pump for distribution. This kind of system prevents rainwater runoff and delays flooding.



Concepts by koradesigngroup

a. Wall system

Wall system designed to allow free air to flow and cross ventilate the classrooms. The wall system allows light to penetrate the classroom as natural light source. The objective is allows the building to breathe.

b. Green Wall

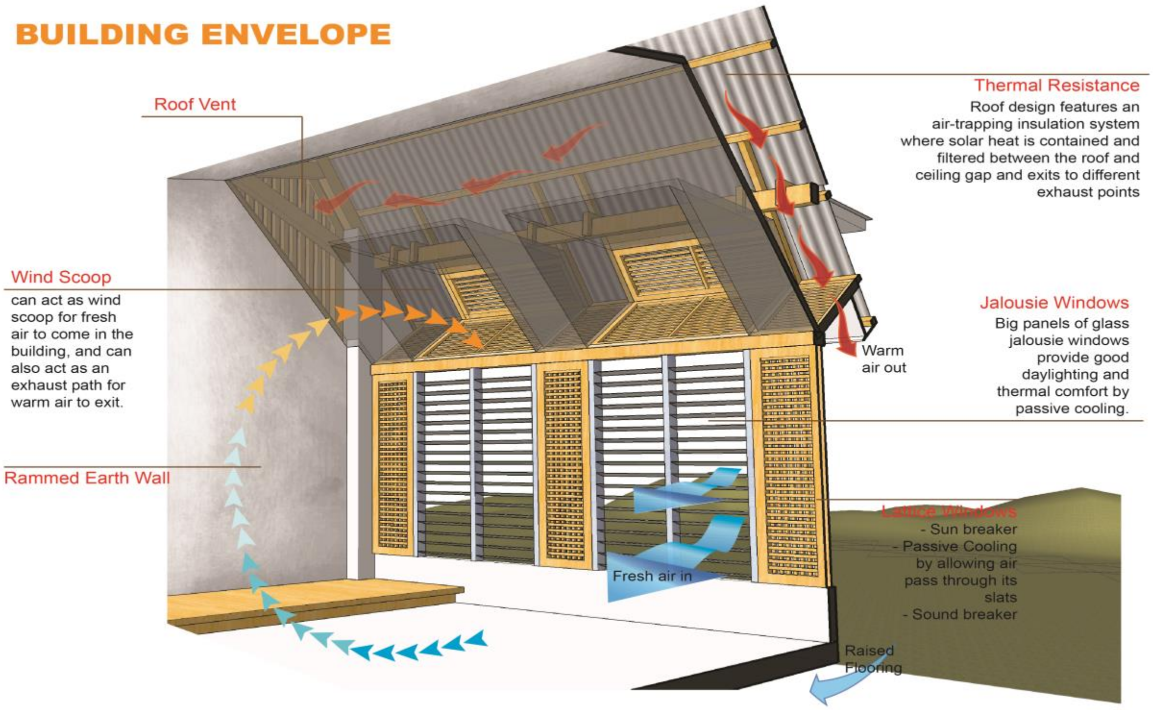
Green walls function as wind and sound buffers. Green wall teach students about growing food, teaching food sufficiency. Study shows the sight of green plant induces a place conducive for learning. Rain water distribution system is designed to water the green wall. Green wall can serve as sun shading or sun buffer.

c. Sun Shading Element

Sun shading element cut the heat transfer and limit glare. It helps cool the inner spaces of the school.

d. Breathers: Under roof and upper ceiling ventilation

Ventilation opening allows hot air trap between the roof and the ceiling to ventilate by allowing cool air to penetrate and push the trapped hot air to the breather. This system allows the building to breathe.



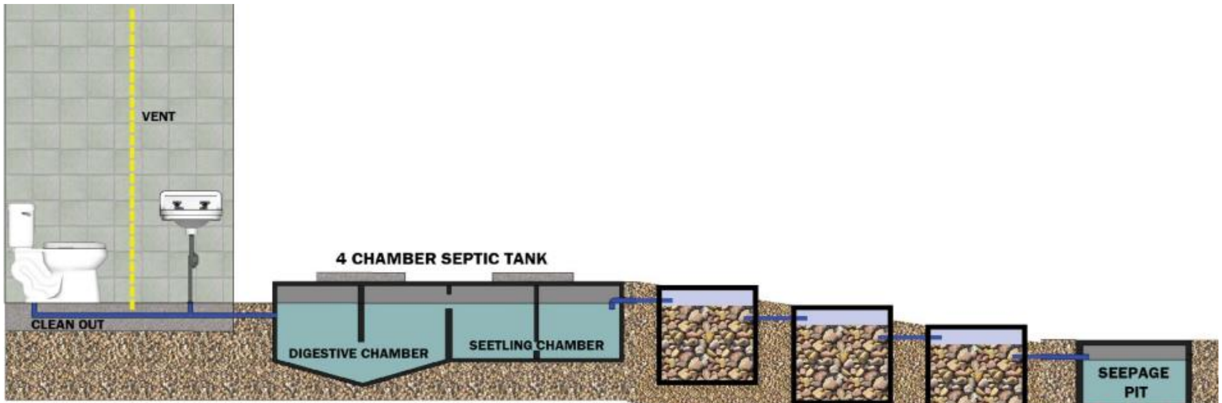
Concepts by koradesigngroup'

4. *Universal Design Element*

   Design elements of green schools are of universal design. Universal design elements are design standards applicable to address and serve issues like gender, disability and the vulnerable.

5. *Waste Management System*

   It is proposed that the green school shall be installed with a waste management system that was conceptualized by koradesigngroup to ensure proper waste disposal management and protect the environment. The components of the WMS (waste management system) are Four chamber septic tank, a series of filtration boxes, seepage pit and a holding pond before it is being release to the environment.



4 CHAMBER SEPTIC TANK + FILTRATION BOXES + SEEPAGE PIT

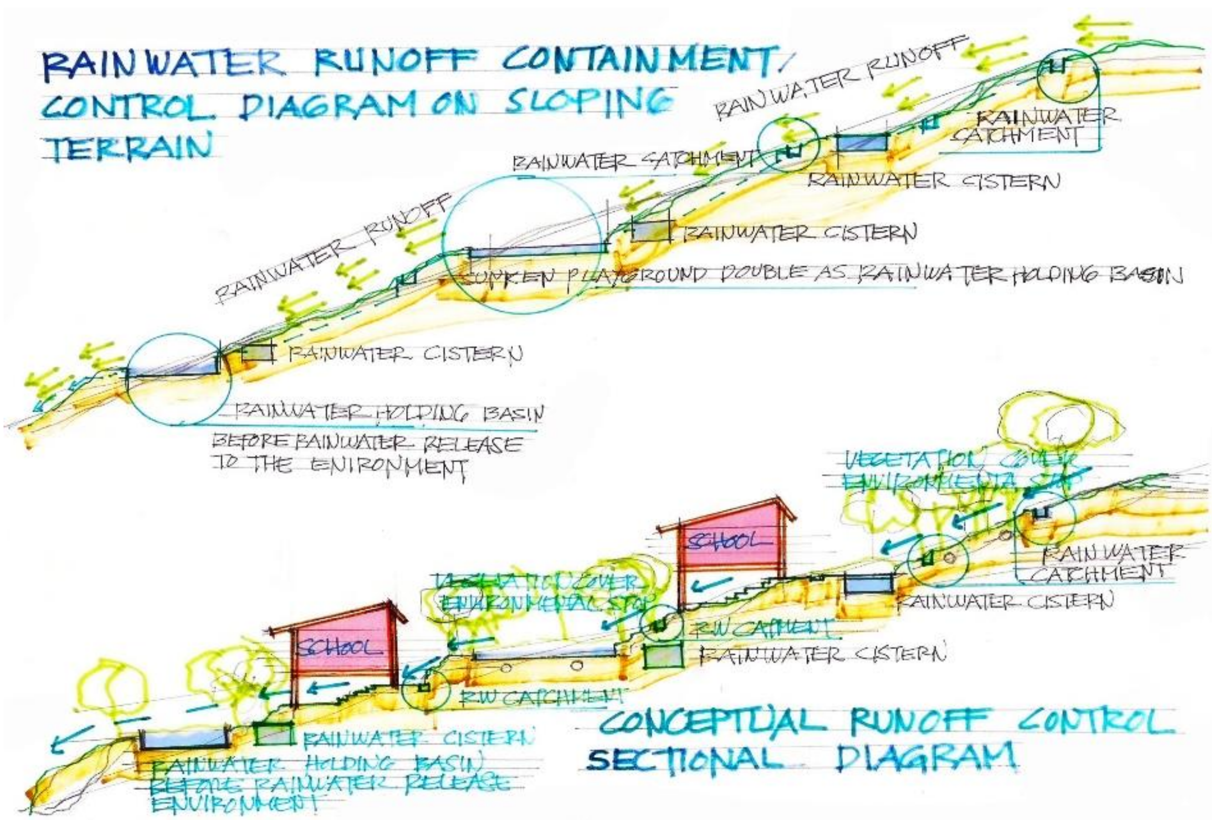


Illustration by koradesigngroup

Rainwater containment system or holding area prevents rainwater runoff and delays flooding. It is a series of rain water catchment and holding basins with a holding pond as the last catchment.

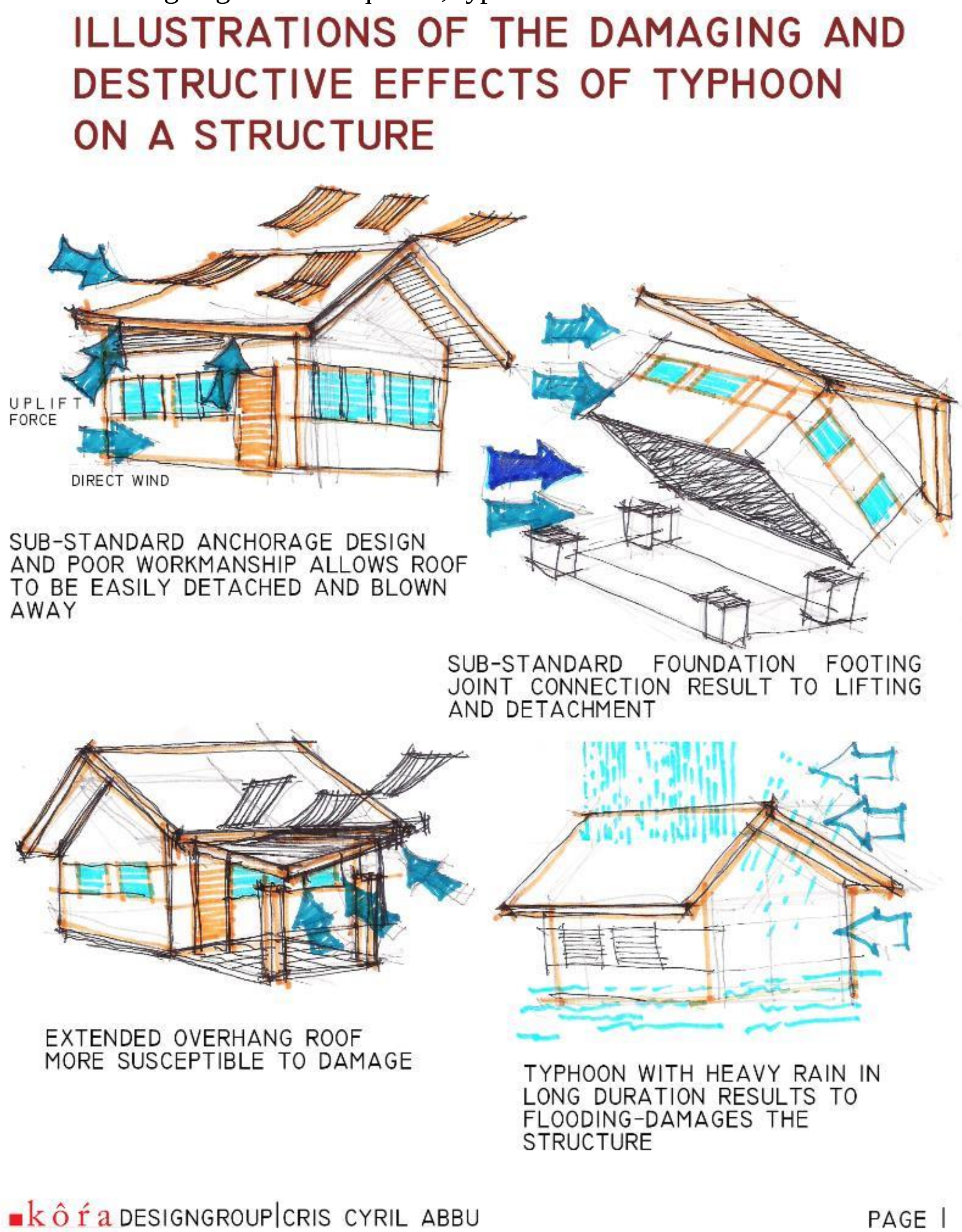
CHAPTER 10

ARCHITECTURAL AND STRUCTURAL PLANNING GUIDE - A CONCEPT BY KORADESIGNGROUP

I. Planning and Design Guide

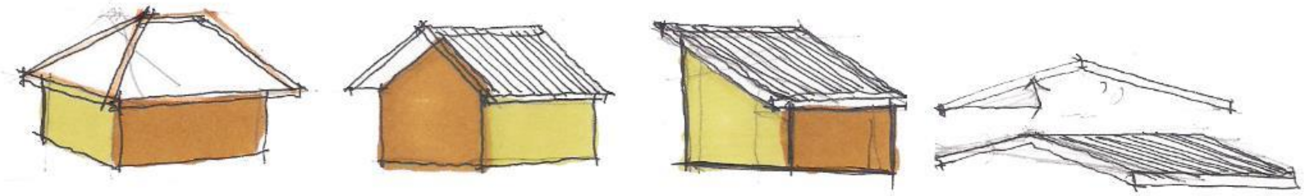
Resilient Construction- Build Better and Safer Design Guide

Illustrated guide suggested by koradesigngroup for a resilient disaster responsive structure design against earthquakes, typhoons and other hazards.



ROOFS

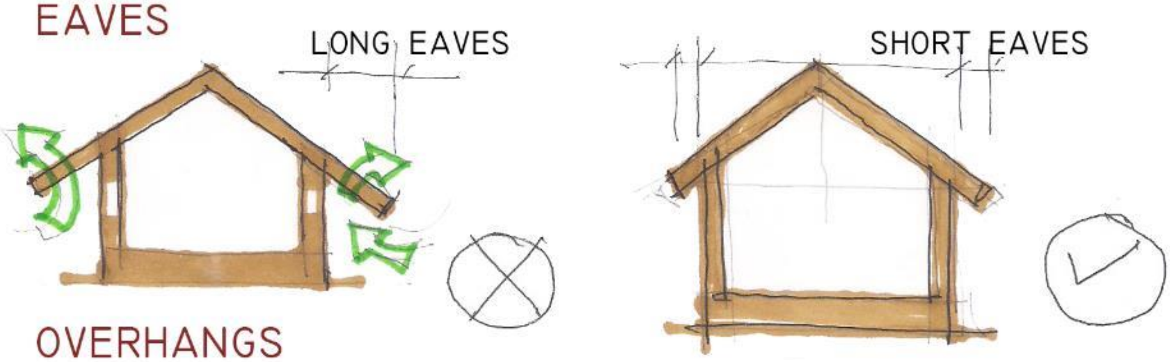
-ROOFS SHOULD HAVE A MINIMUM OF 25° SLOPE TO ALLOWABLE 45° SLOPE
-AVOID LOW PITCHED ROOF
-AVOID LONG EAVES
-AVOID LONG EXTENDED OVERHANGS



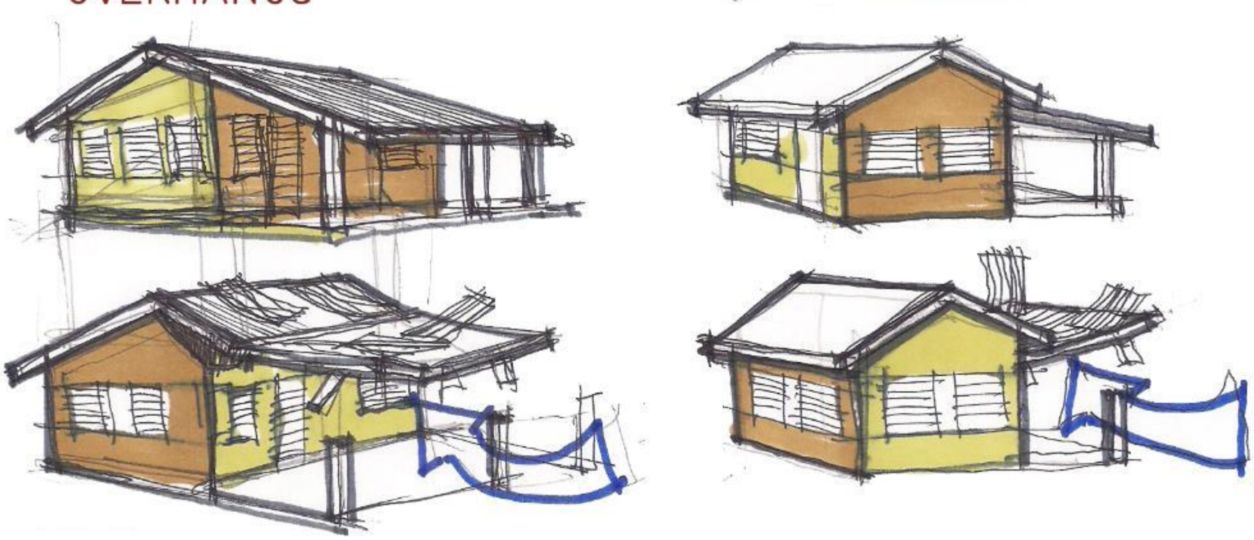
HIP ROOF HIGH GABLE LEAN-TO ALMOST FLAT

HIP ROOFS ARE FOUND TO BE MORE TYPHOON-RESISTANT THAN THE GABLE, LEAN-TO AND ALMOST FLAT ROOFS. THE HIGH ANGLE SLOPE ALLOWS WIND TO CIRCULATE WITH LEAST RESISTANCE. ANOTHER POSITIVE ATTRIBUTE OF HIP ROOFS IS ITS FOUR-SIDED HIGH SLOPE WHICH IS AERODYNAMIC IN FORM.

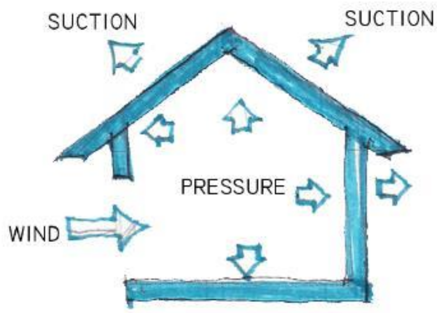
EAVES



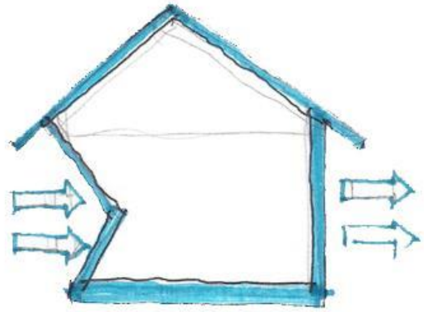
OVERHANGS



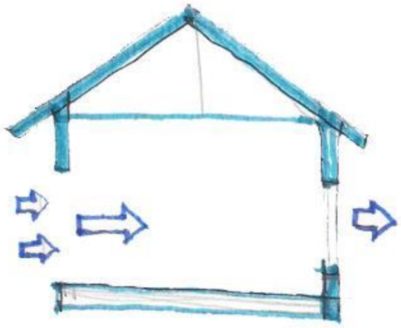
WIND SPEED AND PRESSURE



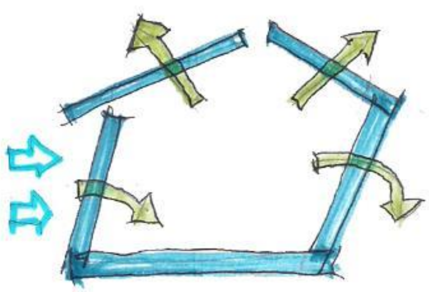
TYPHOON-GENERATED WIND INCREASES THE PRESSURE OF THE INTERNAL SURFACES WHILE GENERATING A SUCTION EFFECT ON THE EXTERNAL SURFACE.



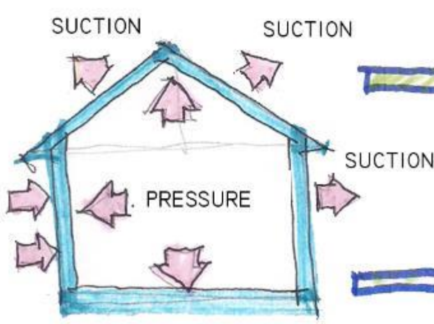
WINDWARD SIDE OF THE HOUSE OR STRUCTURE WILL COLLAPSE UNDER STRONG WIND PRESSURE.



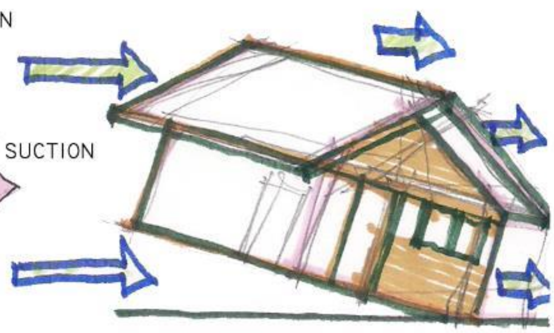
WIND PRESURE MAYBE RELIEVED BY PROVIDING AN OPENING ALONG THE LEEWARD SIDE



SUB-STANDARD ANCHORAGE RESULT TO THE DETACHMENT OF ALL THE JOINT COMPONENTS OF THE STRUCTURE LEADING TO A COLLAPSE

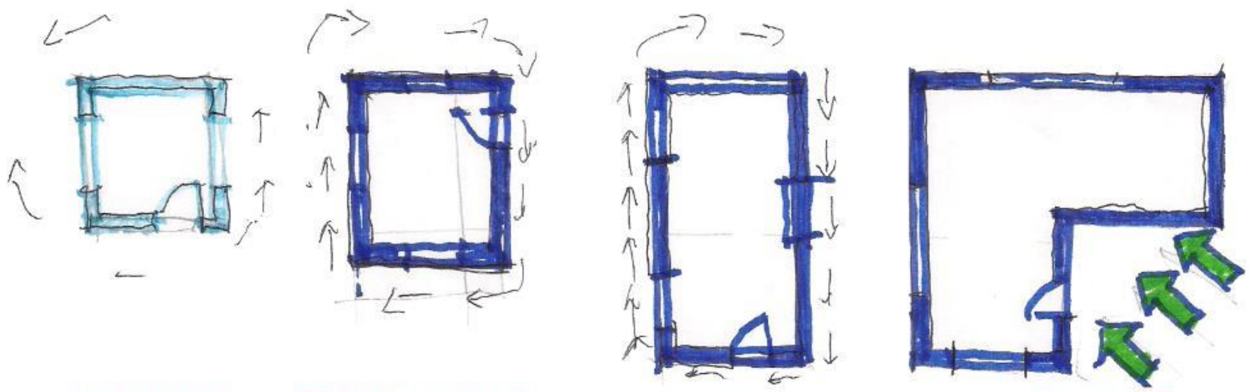


ABOVE IS AN ILLUSTRATION OF WIND PRESSURE PUSHING ON DIFFERENT DIRECTIONS COMBINED WITH THE SUCTION EFFECT.



ABOVE IS AN ILLUSTRATION OF AN UPROOTED OR OVERTURNED STRUCTURE-THIS IS THE PROBLEM OF LIGHT STRUCTURES WHOSE WEIGHT IS INSUFFICIENT TO RESIST THE PRESSURE

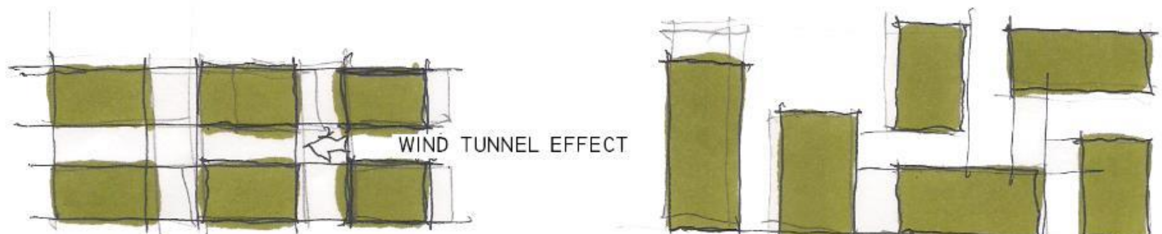
BASIC PLANNING CONFIGURATIONS



SQUARE (BEST) RECTANGLE LONGITUDINAL L-SHAPE

SHAPE OF ONE OF THE MOST IMPORTANT FACTOR IN DETERMINING THE PERFORMANCE OF THE STRUCTURE (SHAPE=DETERMINANT) AGAINST TYPHOONS AND STORMS.

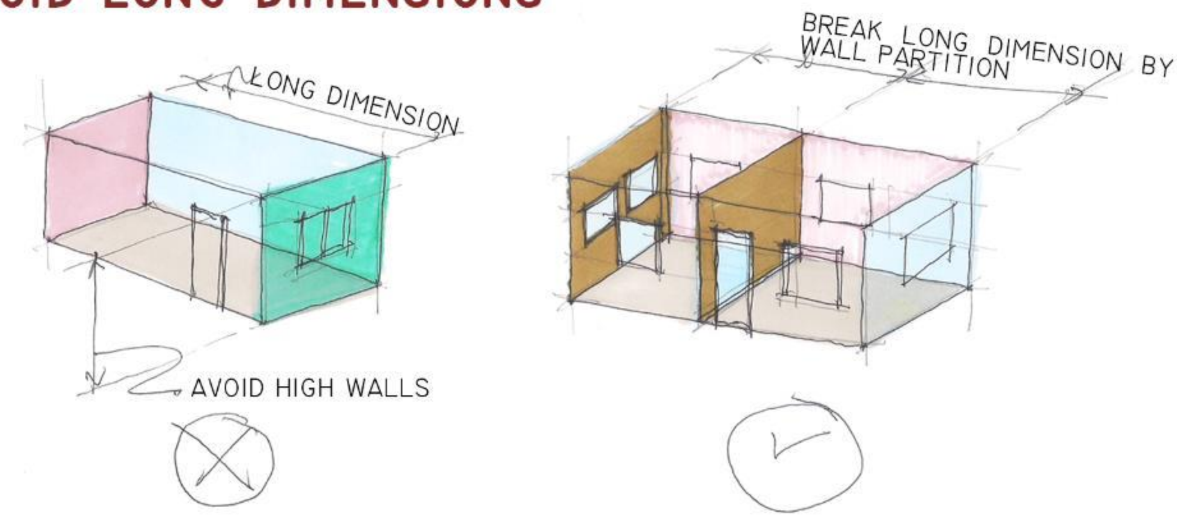
SQUARE PLAN ALLOWS HIGH WIND TO MOVE FORWARD ON ITS SIDE. IT IS SIMPLE AND SYMMETRICAL, STABLE AND BEST TO RESIST HIGH WINDS.



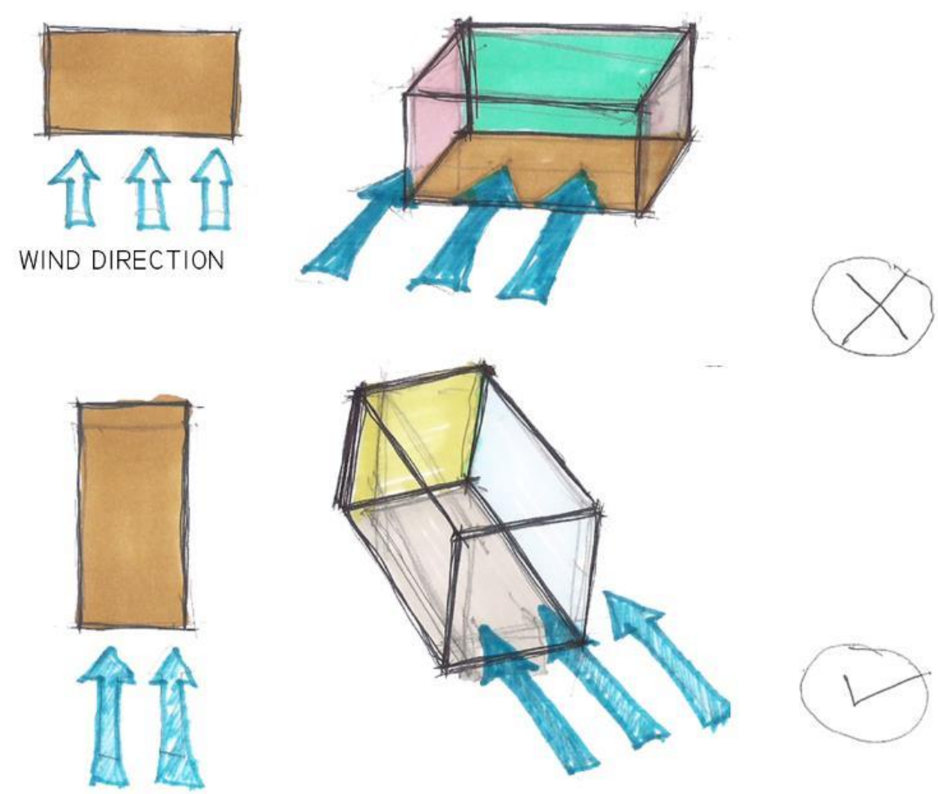
ROW PLANNING CREATES WIND TUNNEL EFFECT

ZIG-ZAG PLAN AVOIDS AND SHIELDS FROM WIND

AVOID LONG DIMENSIONS



WINDWARD SHOULD FACE SHORTER SIDE

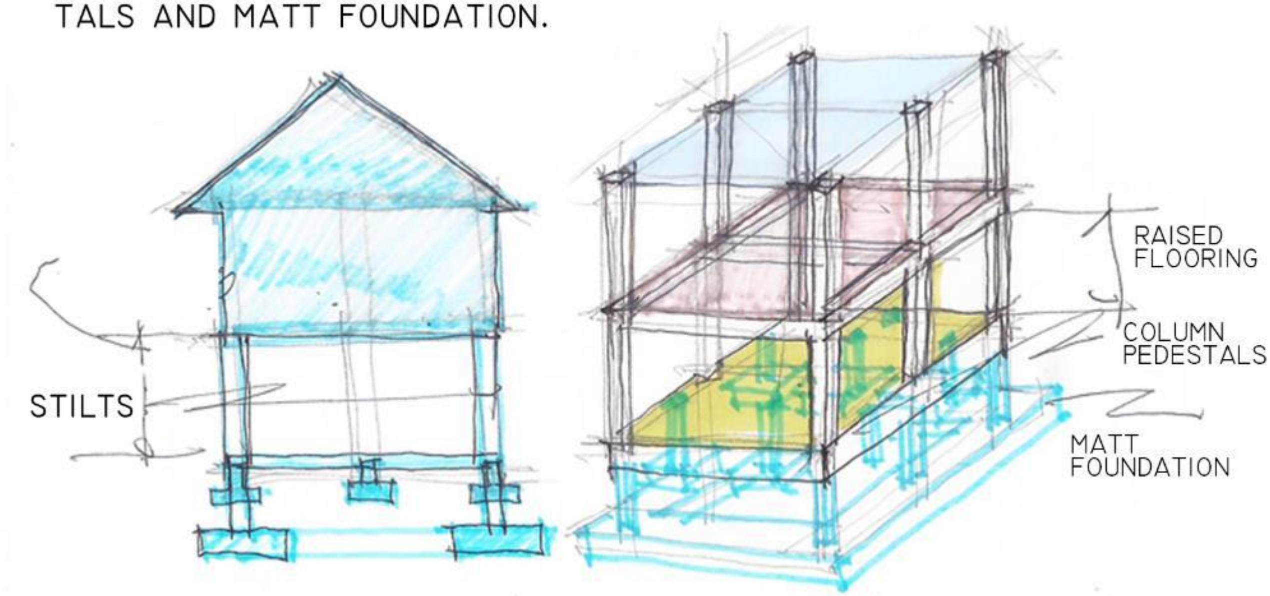


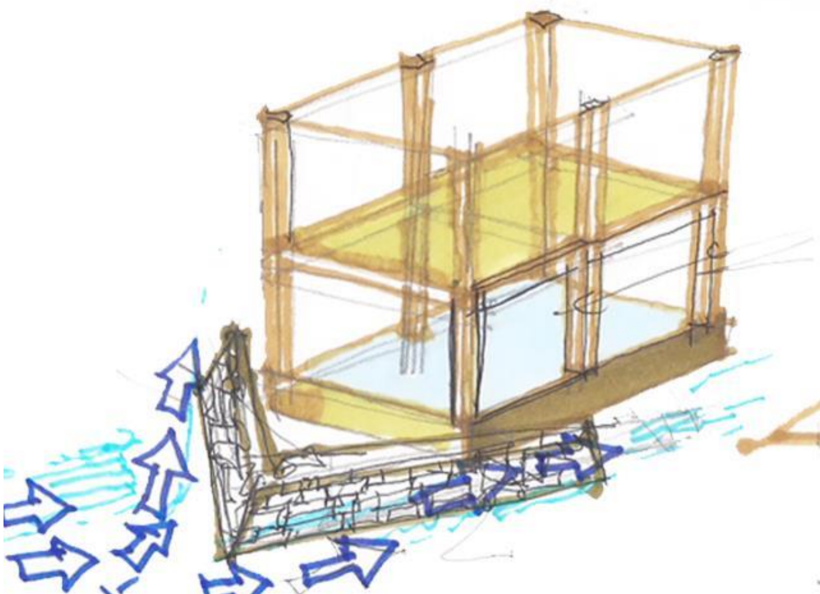
AVOID LONGER WALLS FACING THE DIRECTION OF THE WIND

LET THE SHORTER SIDE FACE THE WIND DIRECTION FOR LESS RESISTANCE

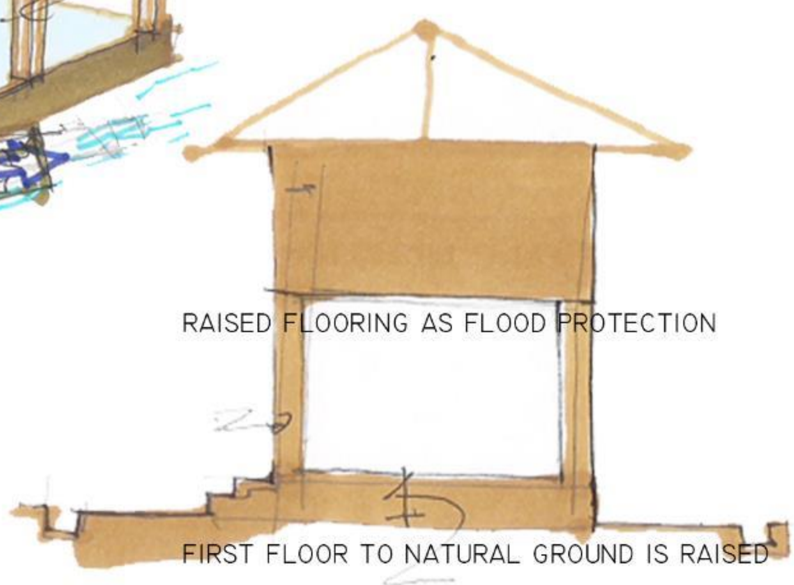
EARTHQUAKE/TYPHOON RESISTANT

INTEGRATING DESIGN ELEMENTS IN THE LIKES OF STILTS AND RAISED FLOORING FOR PROTECTION AGAINT FLOODING AND EROSION. STRUCTURAL ELEMENTS ENCOURAGED WOULD BE THE ADDITION OF COLUMN PEDESTALS AND MATT FOUNDATION.

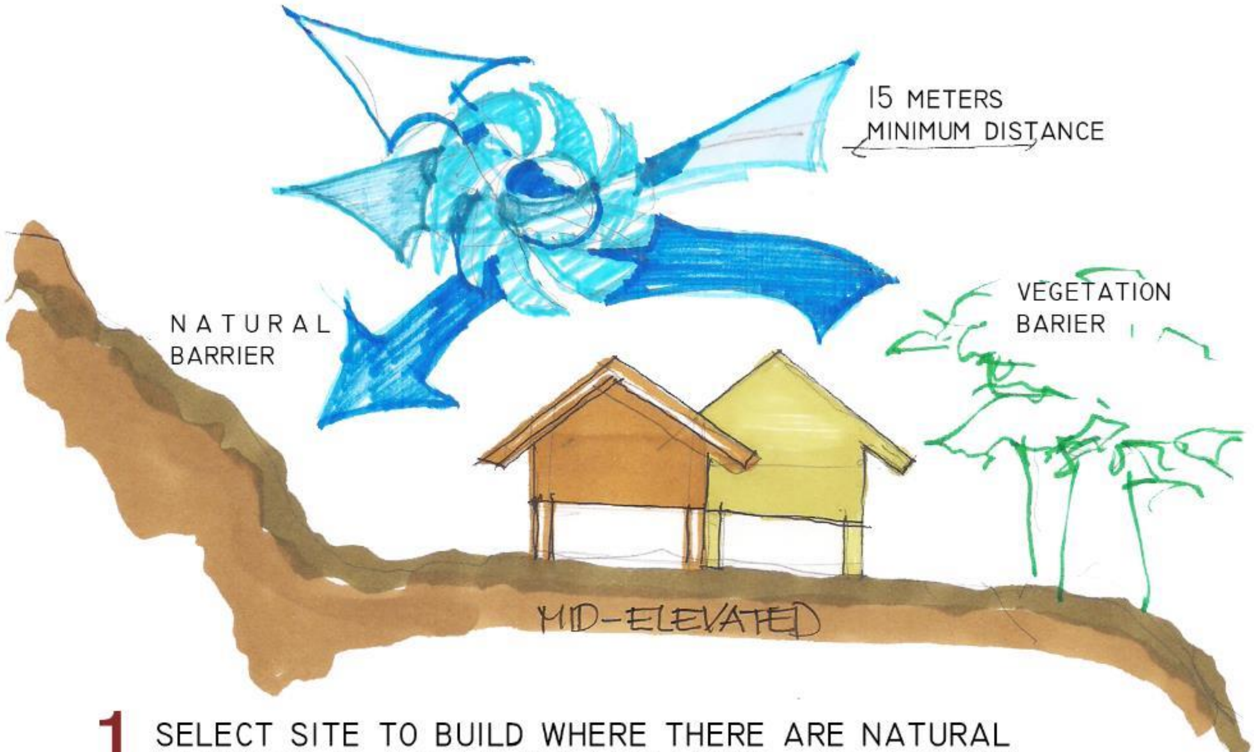




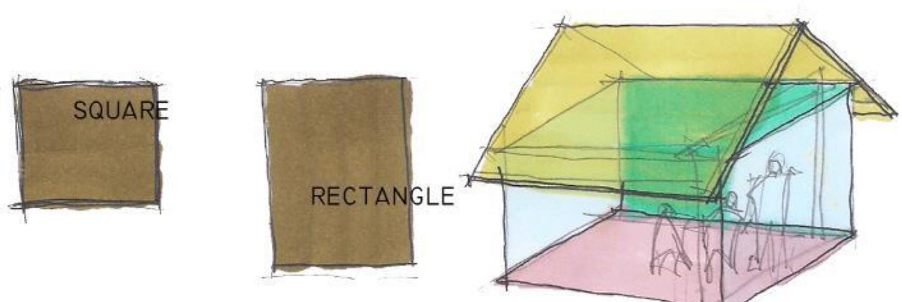
FLOOD BARRIER



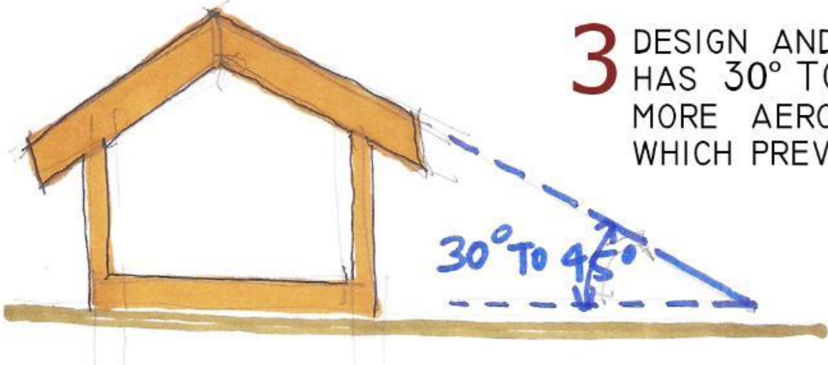
PRINCIPLES OF TYPHOON-RESISTANT STRUCTURES



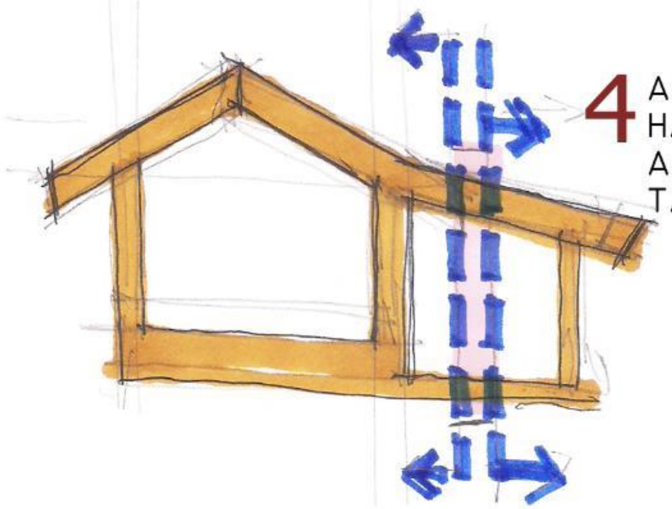
1 SELECT SITE TO BUILD WHERE THERE ARE NATURAL BARRIERS AS PROTECTION FROM WIND AND FLOODING



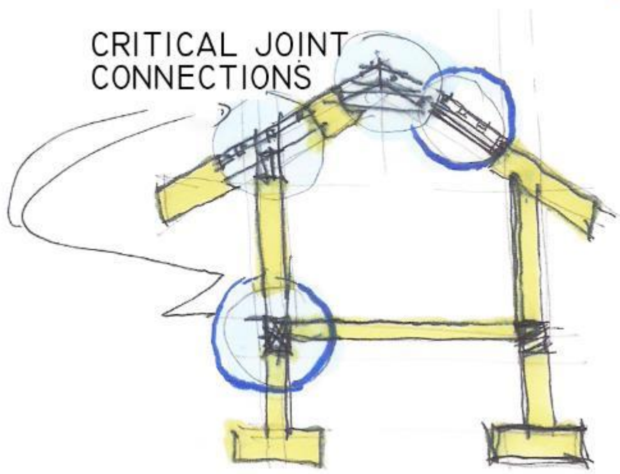
2 USE SIMPLE PLAN LAYOUT-EFFECTIVE FOR AVOIDING THE CONCENTRTATION OF PRESSURE



3 DESIGN AND PLAN A ROOF THAT HAS 30° TO 45° ANGLES FOR A MORE AERODYNAMIC CHARACTER WHICH PREVENTS THE LIFT ACTION

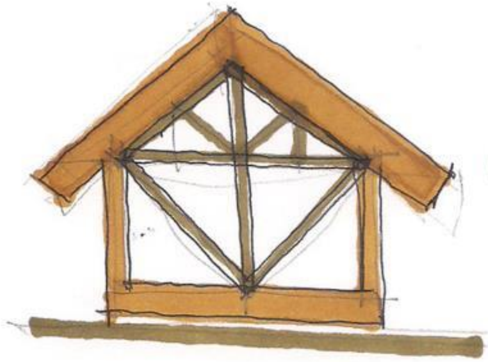


4 AVOID WIDE EXTENDED OVER-HANGS. IT IS ADVISABLE TO USE A SEPARATE OVERHANG AT-TACHEMENT FROM THE MAIN ROOF

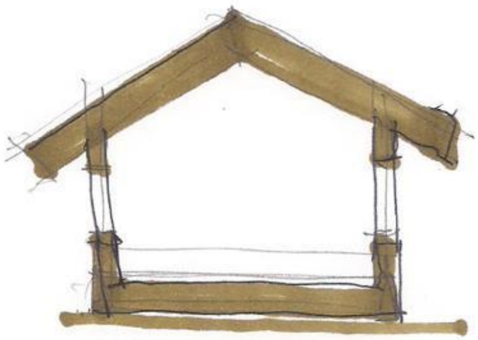


5 MAKE SURE THAT THE CRITICAL JOINT CONNECTIONS ARE SAFELY ANCHORED-FIRMLY FIXED AND FASTENED

MAKE SURE THAT THE ROOF IS PROPERLY ATTACHED USING ABOVE STANDARD MATERIALS, TO PREVENT LIFTING



6 REINFORCE MAIN STRUCTURAL FRAME BY INSTALLING BRACING AND CROSS-BRACING ON WALLS, ROOF FRAME TO STRENGTHEN AND IINCREASE RESISTANCE TO SEISMIC AND WIND MOVEMENT



7 INCASE OF AN EMERGENCY, WHERE DOOR AND WINDOW OPENINGS ARE FORCED OPEN-MAKE SURE THAT THERE ARE OPPOSING OPENINGS TO REDUCE PRESSURE BUILD-UP

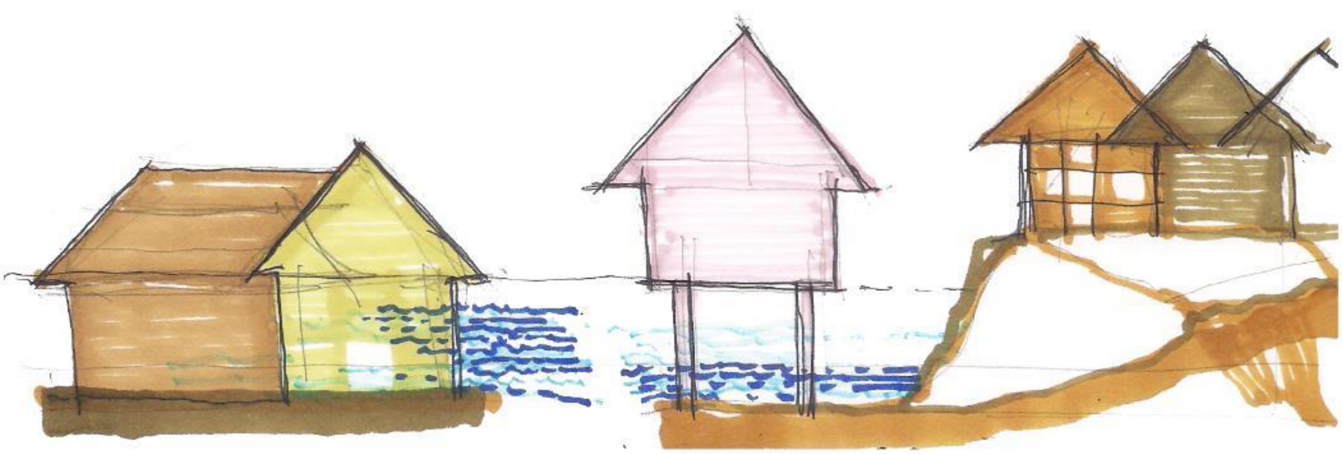
8 PLANT TREES IN THE PERIMETER OF THE STRUCTURE TO ACT AS WIND SHIELD AND DELAY FLOOD WATER

SITE SELECTION: NATURAL WIND BARRIERS AND PROTECTION

NATURAL BARRIER FROM HIGH WINDS IS A NATURAL GEO-PHYSICAL SHIELD BUFFER AS PROTECTION

ABSENCE OF BARRIERS -NO PROTECTION

VEGETATION AS NATURAL WIND BARRIERS



GROUND LEVEL:RISK OF INUNDATION

CONSTRUCTION ON STILTS OR ON AN ELEVATED ENVIRONMENT

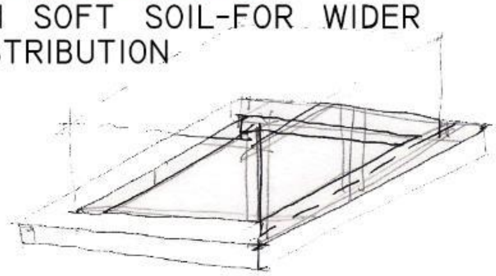
STRUCTURAL ELEMENTS: FRAMES AND FOUNDATIONS

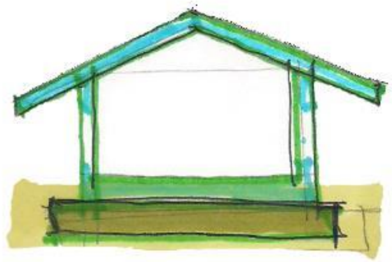
FLOODING/STORM SURGE

RAISED FLOORING ON STILTS ON LOWLANDS AND FLOOD-PRONE AREAS

RAFT FOUNDATION

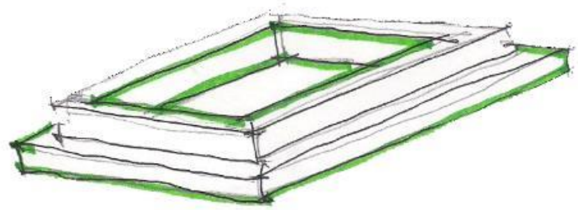
USED ON SOFT SOIL-FOR WIDER LOAD DISTRIBUTION





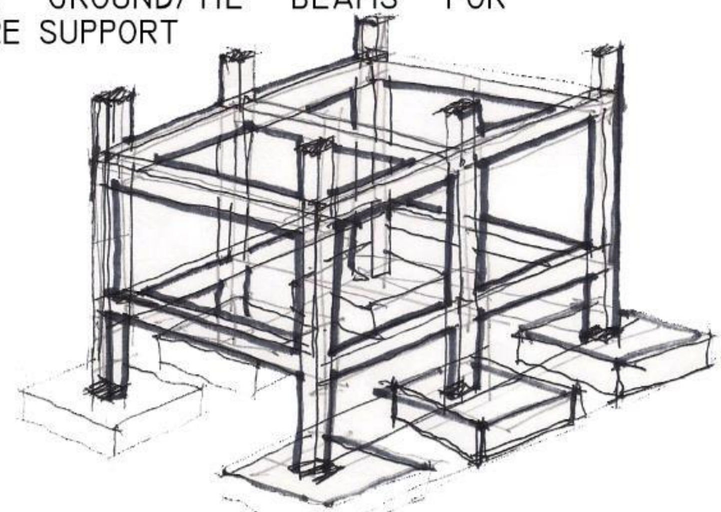
STRIP FOUNDATION

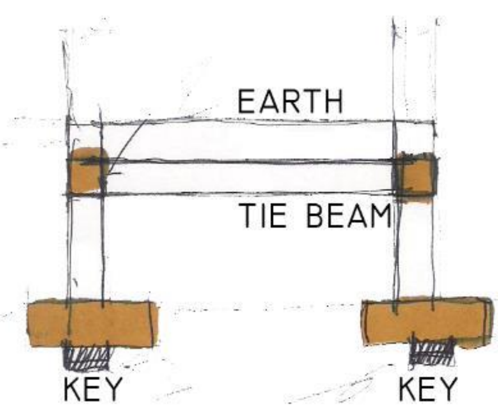
BEST IN FLOOD-PRONE AREA, RESISTS EROSION



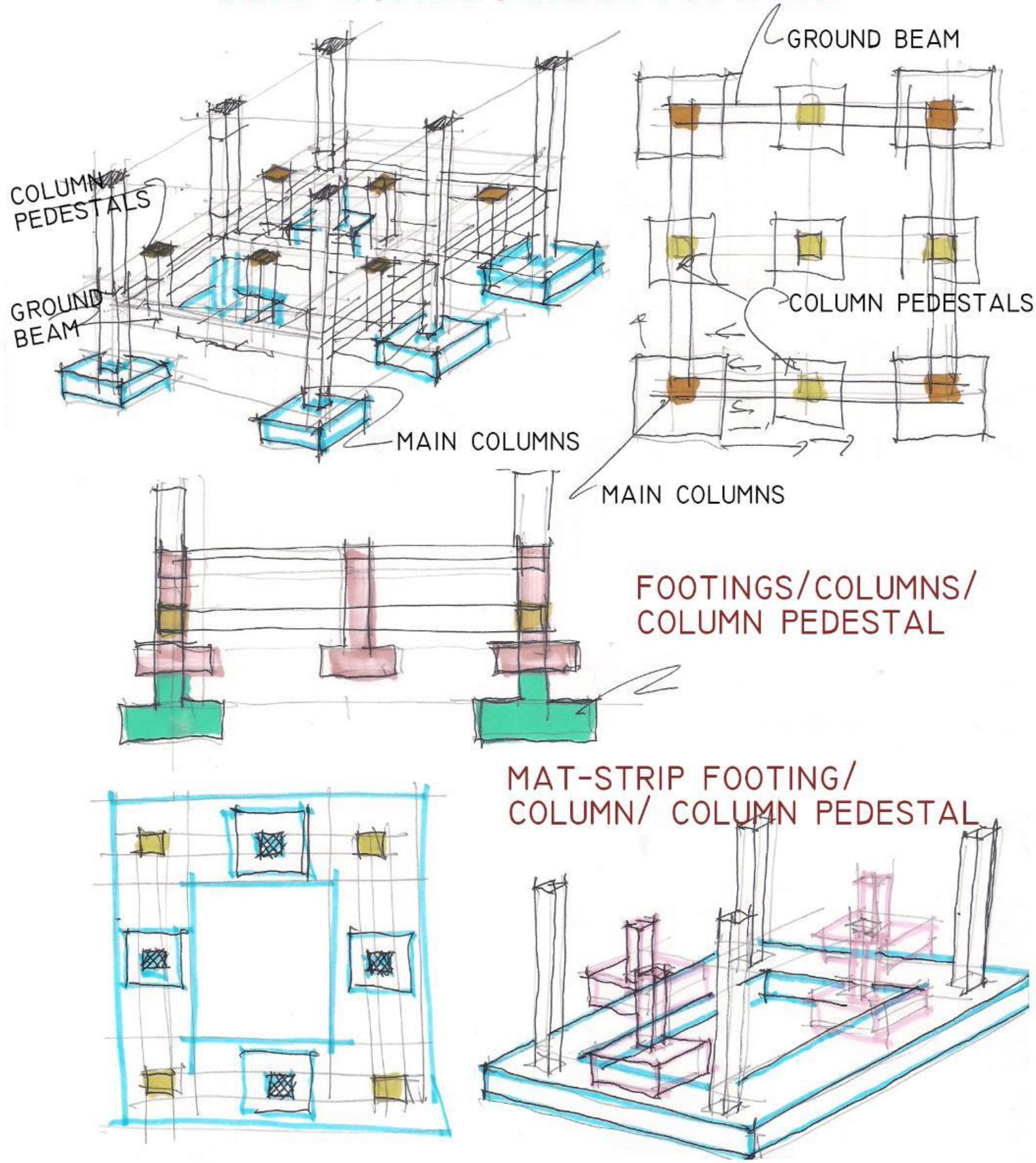
COLUMN FOUNDATION

ADD GROUND/TIE BEAMS FOR MORE SUPPORT





EARTHQUAKE-RESISTANT FOUNDATIONS AND STRUCTURAL FRAMES

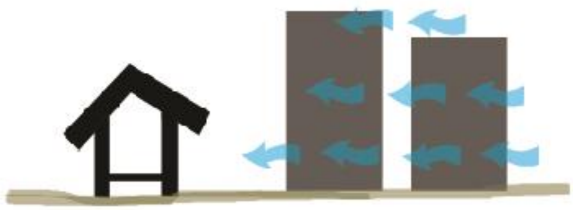


Architectural Guidelines:

ARCHITECTURAL GUIDELINES FOR AN ADAPTABLE HOUSE

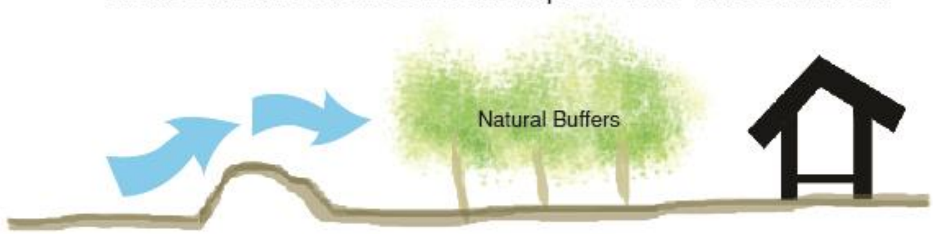
TOPOGRAPHY AND VEGETATION

Make use of the physical environment as protection against strong winds.



Use tall structures as buffer.

Use trees and vegetation as wind buffers and breakers as protection of the structure and reduce the impact of the wind and flood.



Use Artificial and Natural elements as wind buffer.

Ideal site orientation. Use natural and artificial (fence) buffers to reduce impact of wind and flood.

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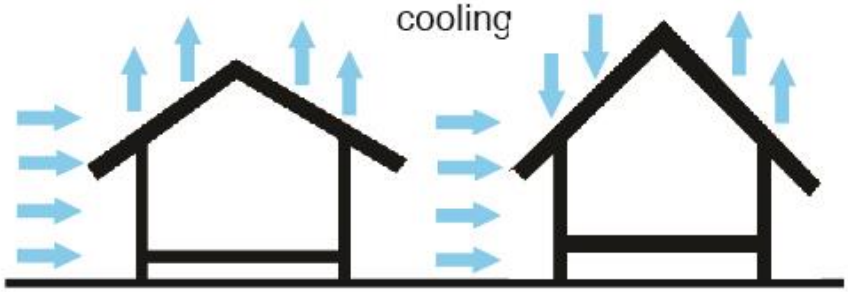
koradesigngroup@gmail.com

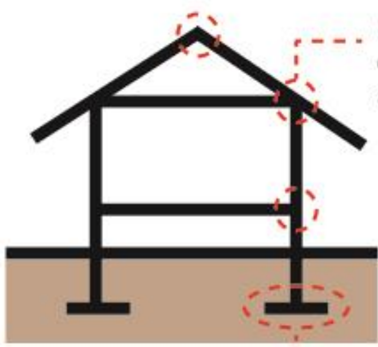
ARCHITECTURAL GUIDELINES FOR AN ADAPTABLE HOUSE

ARCHITECTURE

Raised flooring, windows opened for interior passive cooling

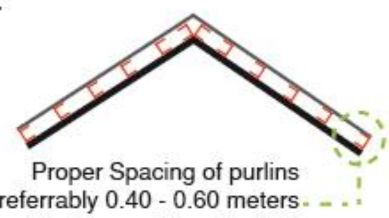


Build the roof to 7:12 slope to prevent being lifted off by strong winds.

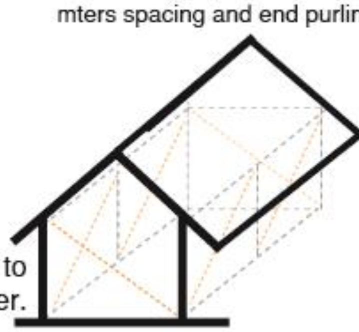


Strong roof- truss design and attachment.

Stable foundation.



Proper Spacing of purlins preferrably 0.40 - 0.60 meters with ridge purlins with 0.60 mters spacing and end purlins.



Use diagonal bracing to hold the structure together.

Keep the structure low; the proportion of the structure matters.

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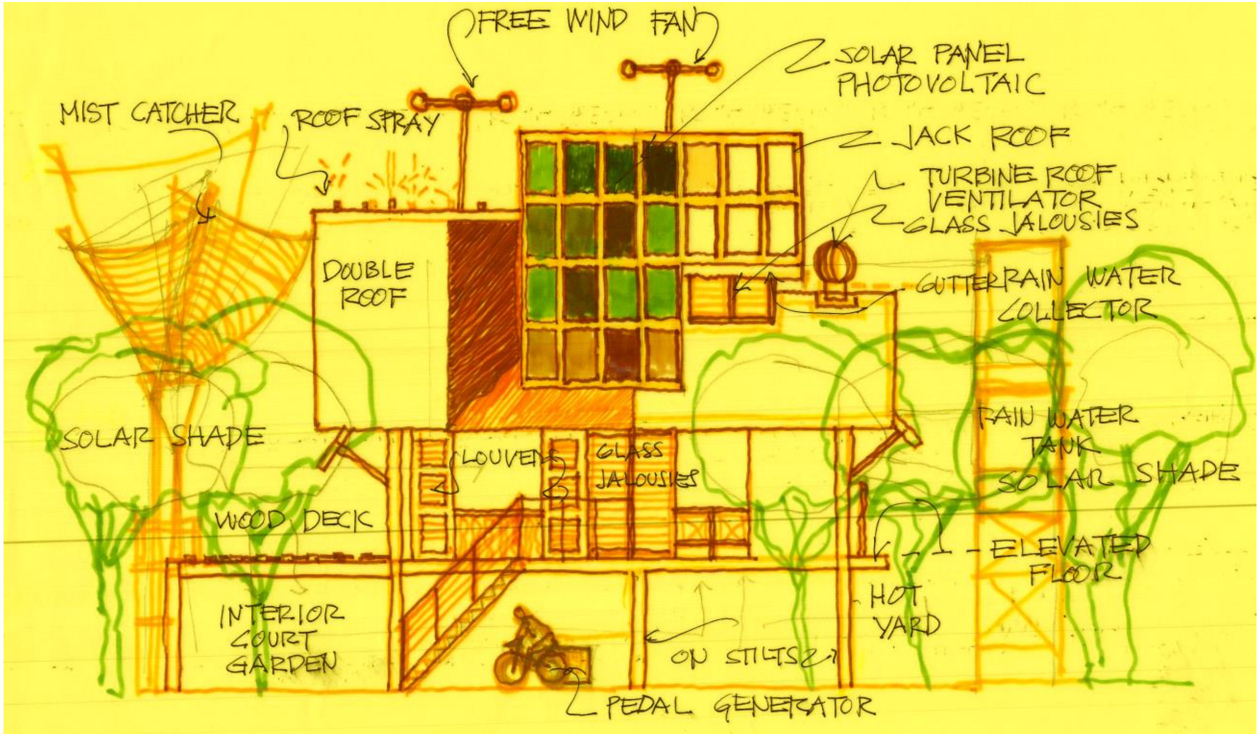
"BAHAY KUBO"- adapting vernacular building technology and system and good practices

"Bahay Kubo" a sustainable flood resistant structure with earthquake resistant and sustainable construction materials. "Bahay kubo" has raise flooring as protection against the elements.

The use of passive design elements is a distinct character of a highly ventilated structure. With high pitch roof of Aero-dynamic angle makes the roof of least wind resistance. The use of indigenous building material makes the hut resistant to heat transfer to the interior. In some extent the "Bahay Kubo" exhibits some features of resiliency and sustainability.



Conceptual Design Proposal

IIllustration by Koradesigngroup

The above illustration is our version of a conceptual design of resilient, eco-efficient, green structure. It will have resilient and sustainable in features in the design, the raised flooring is a protection against storm surges and flooding as well as protection against the elements and animals. Raised floor allows air to cross ventilate and cool the interior of the structure. Beneath the raised floor is a space intended as work space. The open deck will serve as emergency platform in case of emergency- flooding.

Timber will be used on raised columns for timber is the most efficient material in times of earthquakes. Structural foundation will be column pedestal stilt on mat ground beams structural stability during earthquake.

It uses big openings- full openings for cross ventilation and natural lighting to penetrate the interior spaces using passive cooling principle and natural lighting inlets and breathers.

The Roof:
The roof shall be double roof to cut on heat transfer to the interior spaces.
It has a high pitch roof and a rain water harvesting system for rain water use. The Roof shall be shall roof natural lighting openings and photovoltaic panels mounted for energy sufficiency. High pitch roof is an important element in allowing the wind to flow and pass with less resistance.

Rainwater is harvested and stored in raised rain water tanks and distributed through a pedal push energy generating system and pumping water for distribution.
Roof may have accessories like roof ventilator to suction hot air inside the interior. It may also have a water spray system to cool the roof.

Green wall shall be an accessory for food sufficiency and green acoustical buffer.

Solar and heat Shading- Acoustical Barrier- Wind Protection – Rain water absorption as flood mitigating measure, Flood Delay Protection: using natural barriers such as trees, plants and other green elements

Waste and waste water management as environmental management stop by using simple methods of a combination of septic tank, filtration boxes, seepage pit and holding pond.

II. The Geometry of Resilience: Three Dimensions of Holistic Resilient Schools

A. Holistic Resilient Eco- efficient Rural Dimension:

In order to achieve a holistic building, we also have to consider its resiliency to natural disasters. Eco-efficiency and green concepts have already been integrated into the schools, the next step is to design it to be adaptable to the ever-changing phenomena of calamities that has been increasing in strength. These natural catastrophes have been observed to not increase in number but instead, its capacity to be felt and to disturb the living environment.

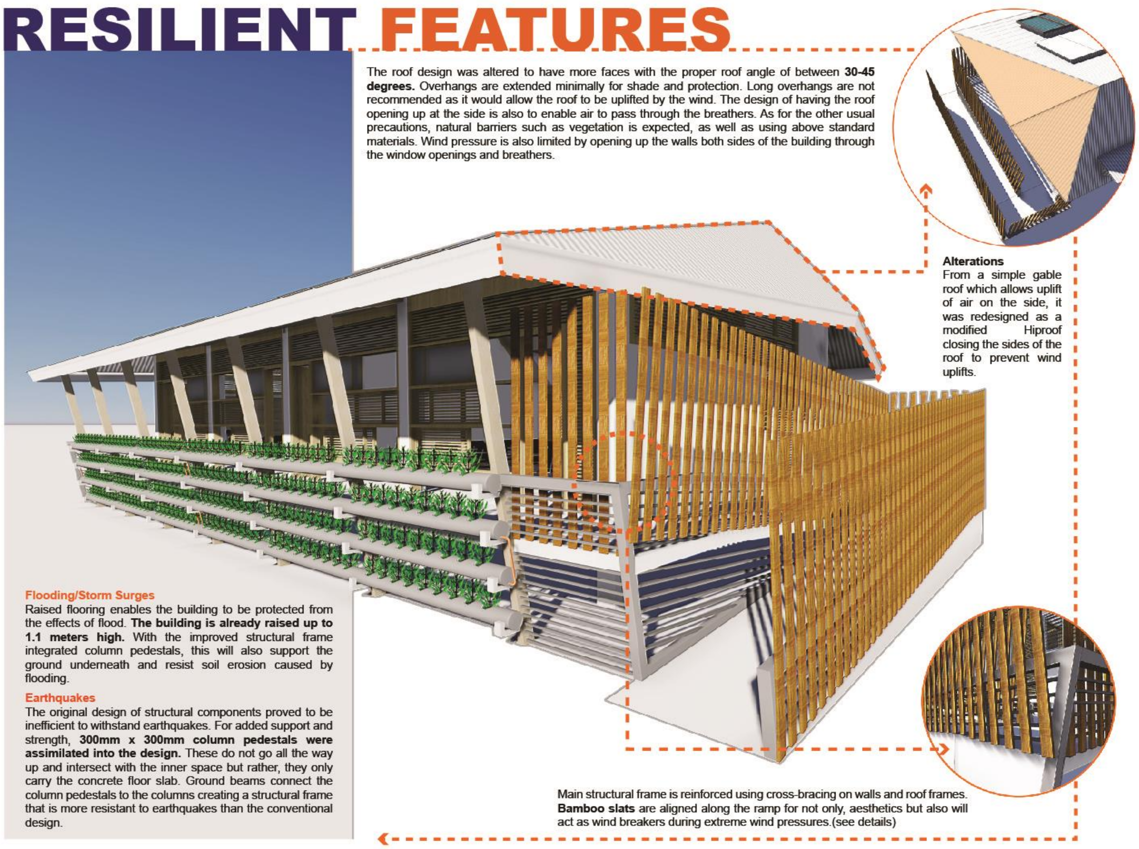
1. Rural

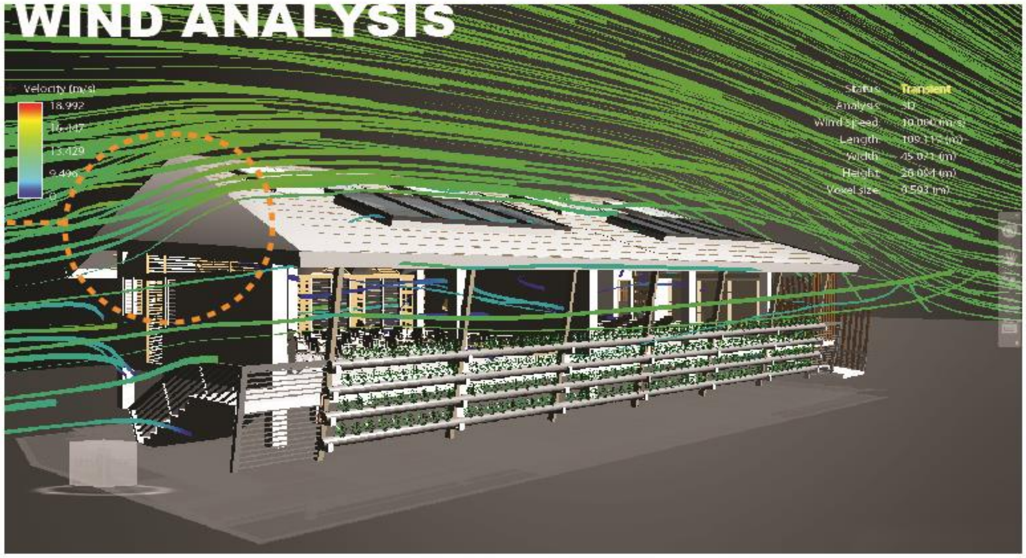
- **Earthquakes**
  The original design of structural components proved to be inefficient to withstand earthquakes. For added support and strength, 300mm x 300mm column pedestals were assimilated into the design. These do not go all the way up and intersect with the inner space but rather, they only carry the concrete floor slab. Ground beams connect the column pedestals to the columns creating a structural frame that is more resistant to earthquakes than the conventional design.

- **Typhoons**
  With typhoons and hurricanes able to reach as high as 300 kph, it is time to rethink on the conventional designs of roofs. Along the study of aerodynamics, one can understand how a solid object behaves under the force of air. The roof design was altered to have more faces with the proper roof angle of between 30-45 degrees. Overhangs are extended minimally for shade and protection. Long overhangs are not recommended as it would allow the roof to be uplifted by the wind. The design of having the roof opening up at the side is also to enable air to pass through the breathers. As for the other usual precautions, natural barriers such as vegetation are expected, as well as using above standard materials. Wind pressure is also limited by opening up the walls both sides of the building through the window openings and breathers. Main structural frame is reinforced using cross-bracing on walls and roof frames. Bamboo slats are aligned along the ramp for not only, aesthetics but also will act as wind breakers.

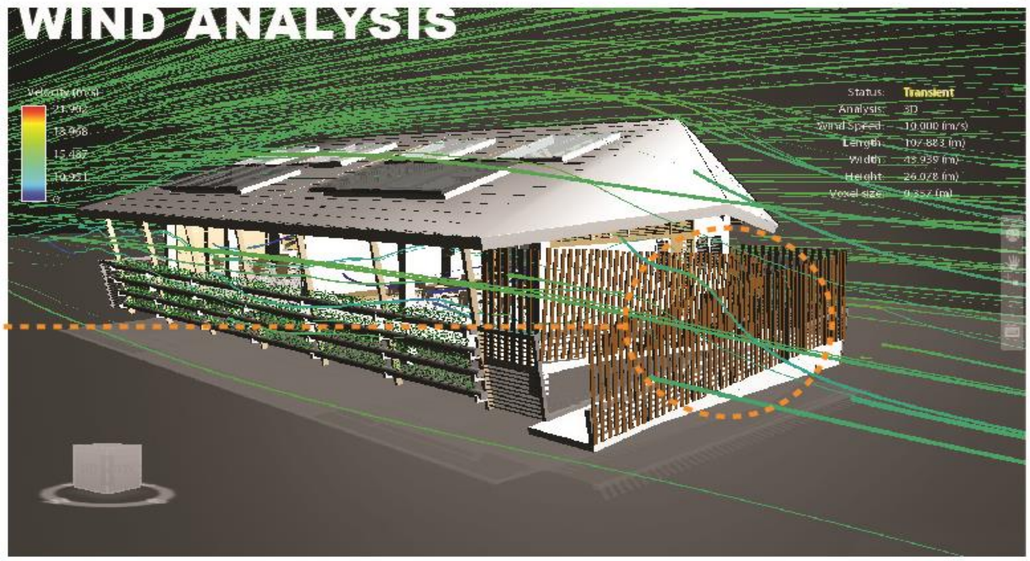
- **Flooding/Storm Surges**

  Raised flooring enables the building to be protected from the effects of flood. The building is already raised up to 1.1 meters high. With the improved structural frame integrated column pedestals, this will also support the ground underneath and resist soil erosion caused by flooding.



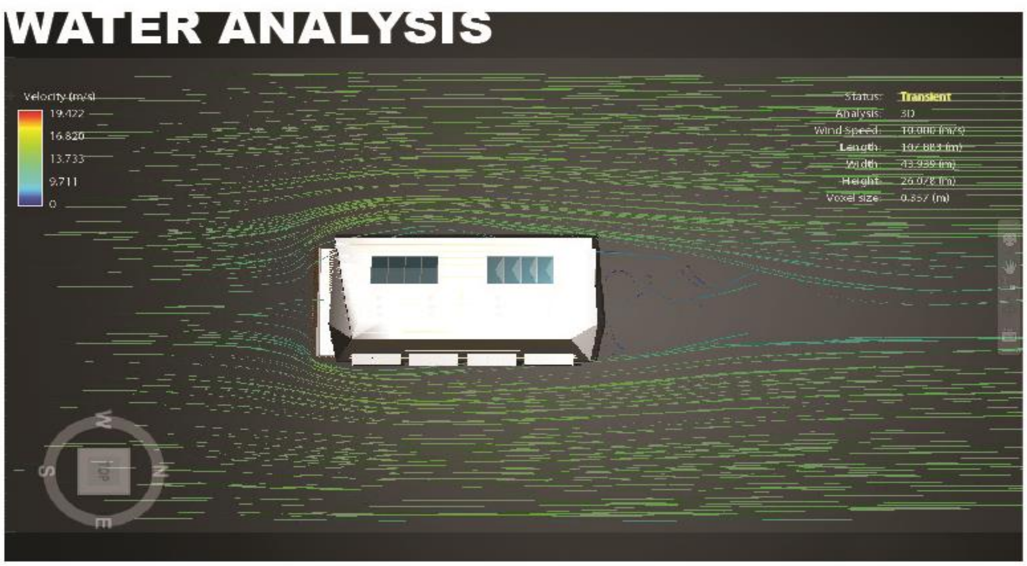


From a gable roof, it is modified and changedinto a specialized hiproof (see plan view) to allow wind to move swiftly into the roof making a smooth flow into the roof's profile. This way the wind is not being resisted, but allowing it to flow and pass through into the structure.

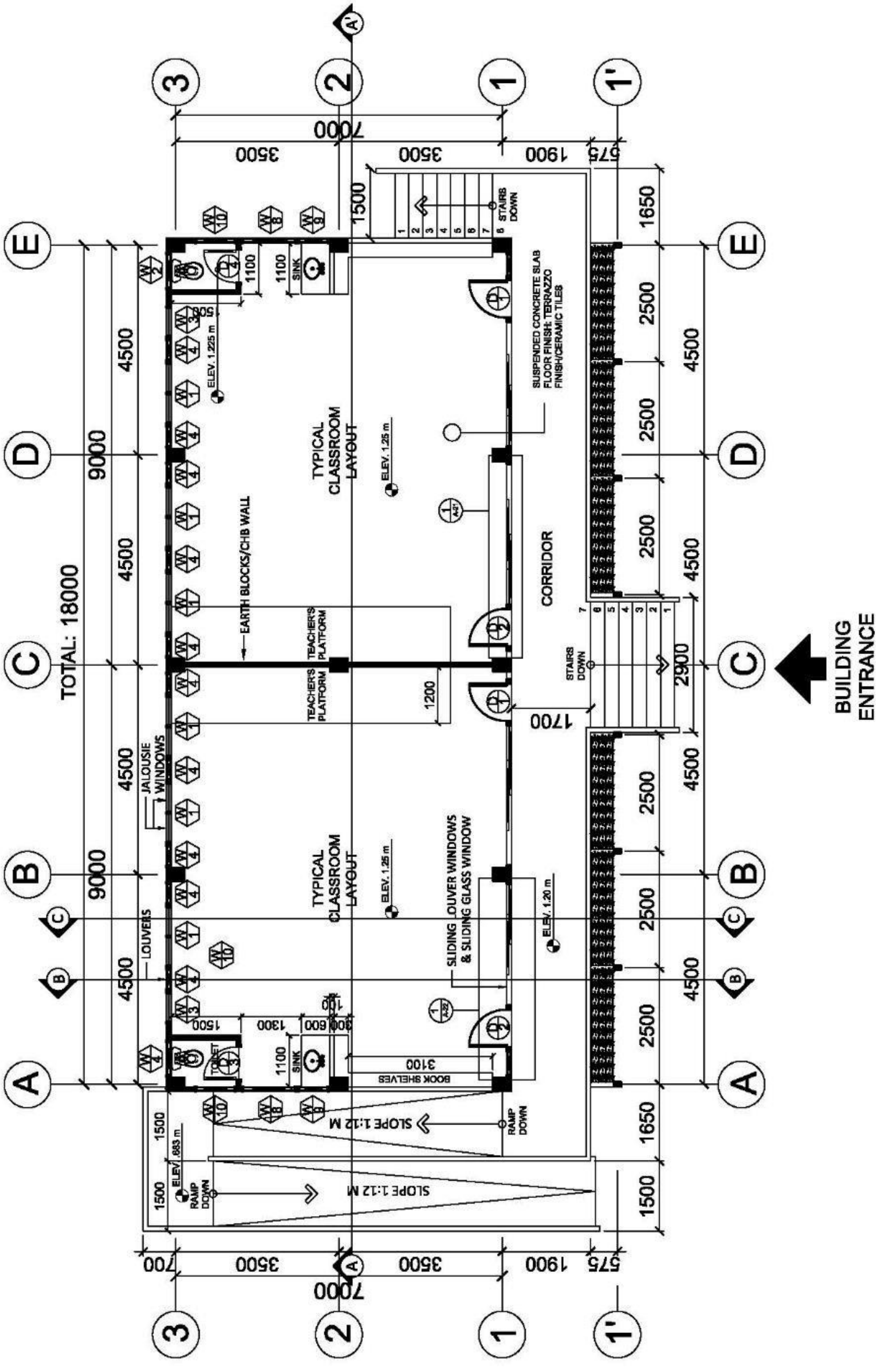


Colors
The colors of the lines representing the wind determine the wind velocity (in meters per seconds) that passes through the building. from cool color (blue)-slower velocity to warm color (red)-stronger velocity.

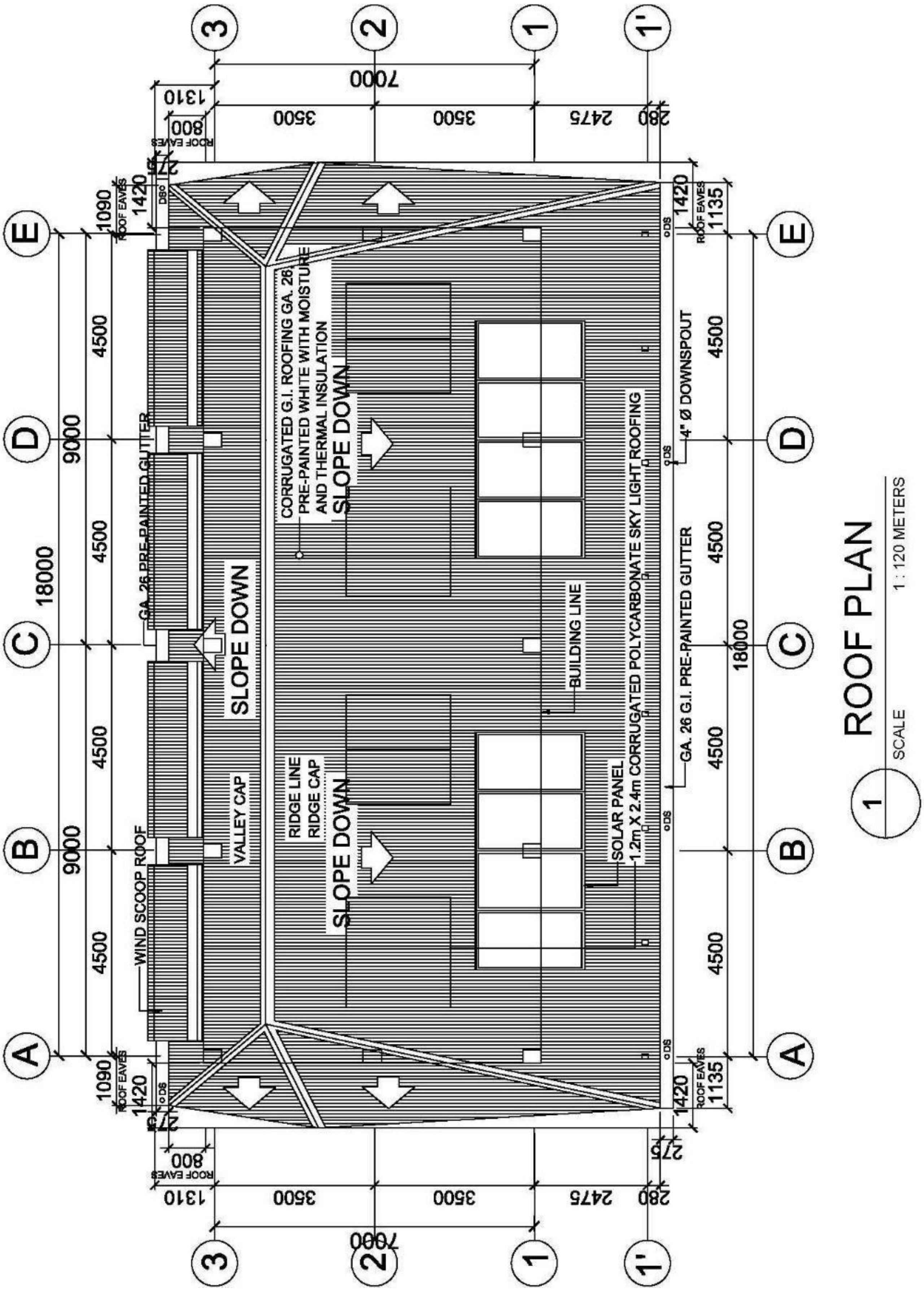
Bamboo slats are aligned along the ramp for not only, aesthetics but also will act as wind breakers during extreme wind pressures.(see details)

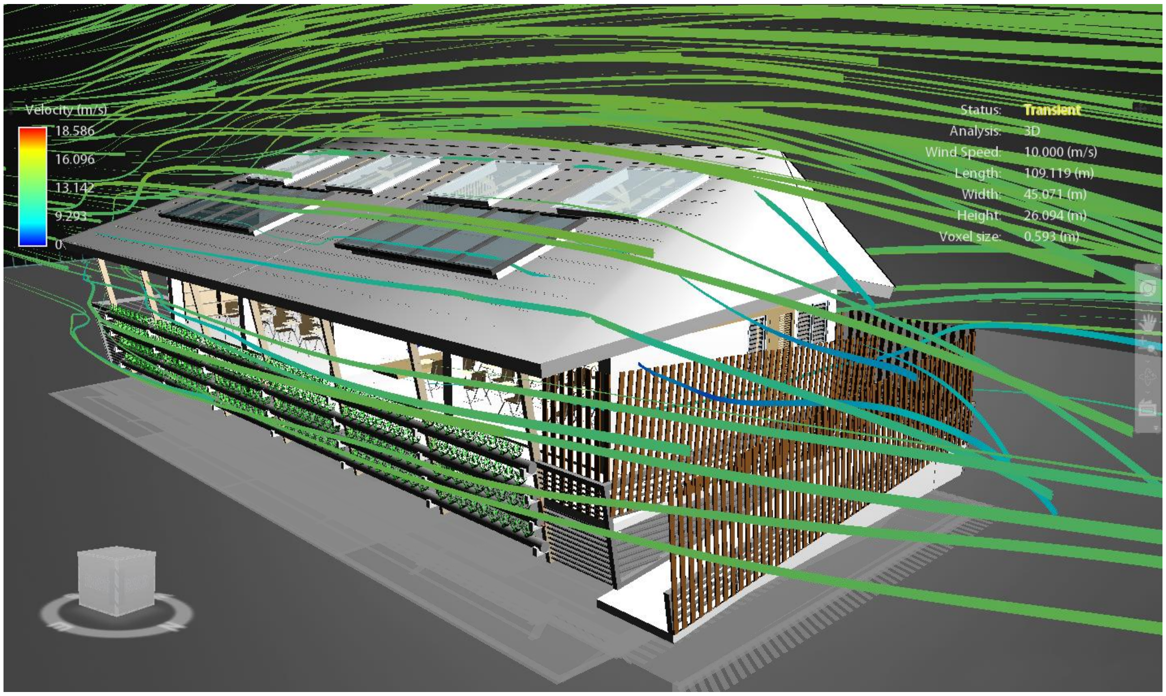


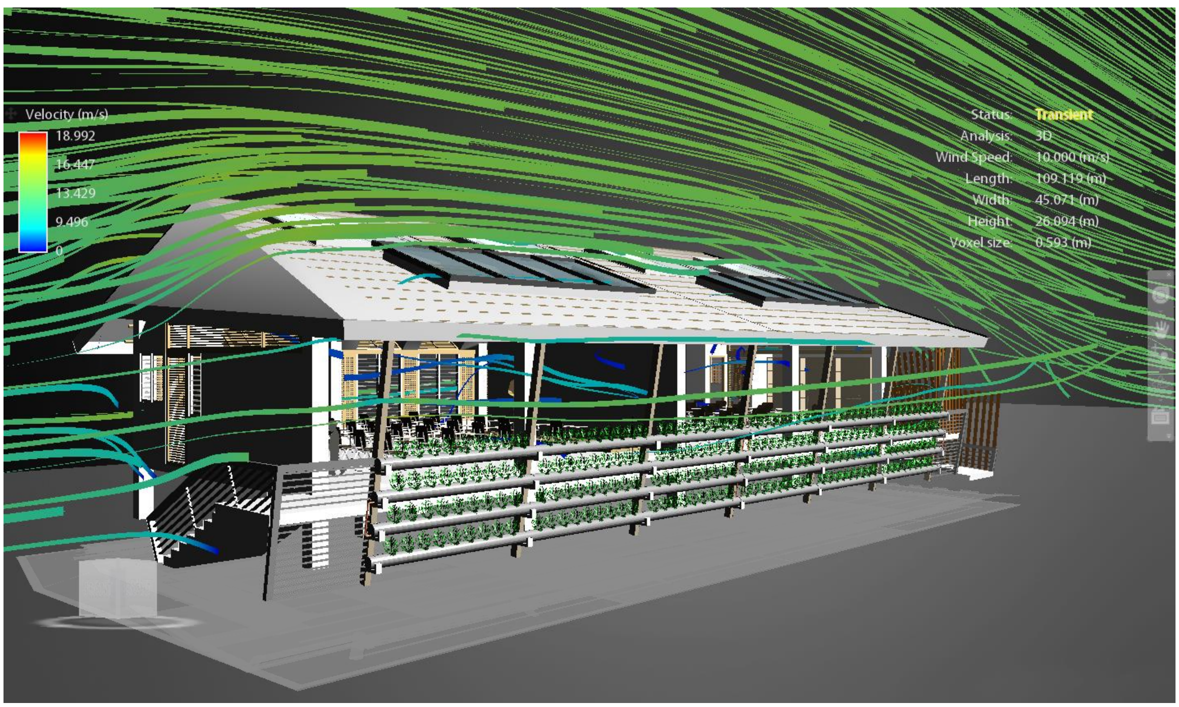
Hydrodynamics
Since the building is raised on stilts, the water during flooding will just pass through the stilts without intervention. In addition to that, the structures will be arranged in a slanting and alternate fashion (not in grid) so as not to create stronger water movements/flow.

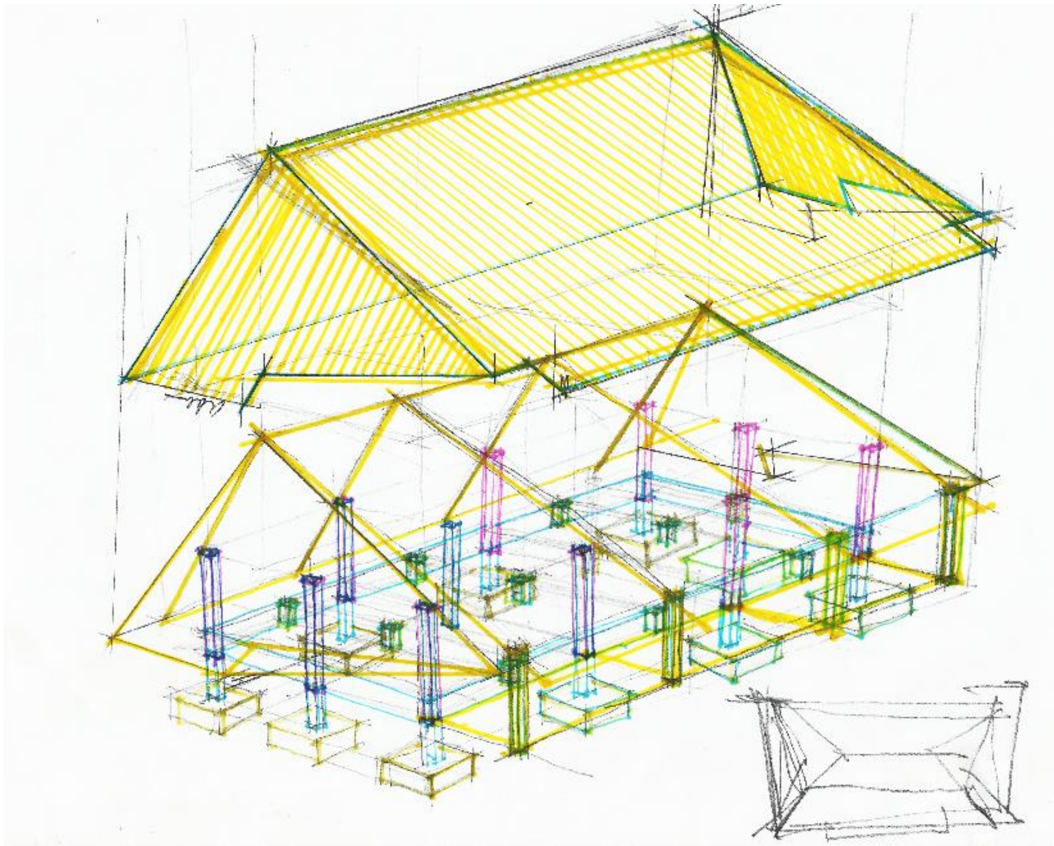


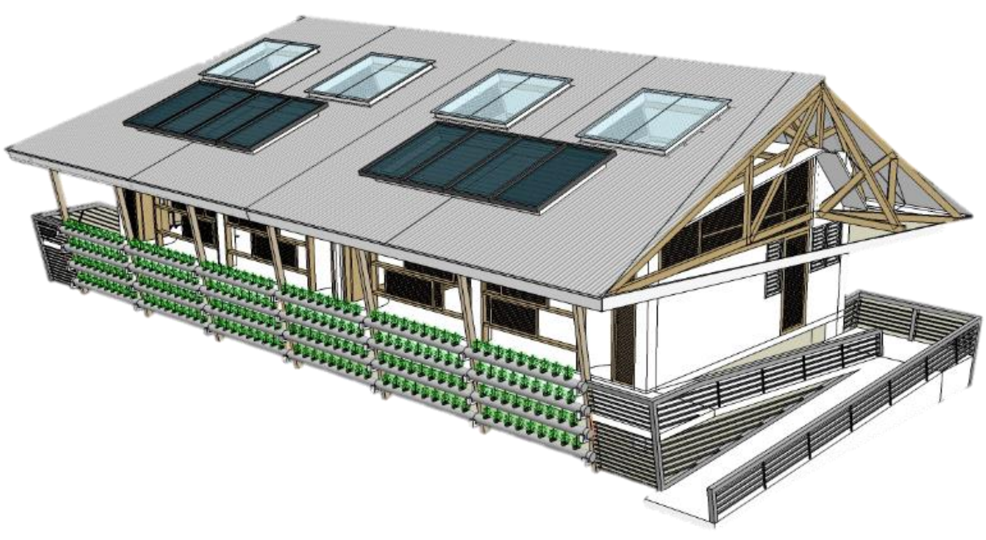
1 GROUND FLOOR PLAN
SCALE 1 : 120 METERS


ROOF PLAN
SCALE 1 : 120 METERS
1
SLOPE DOWN
SLOPE DOWN
SLOPE DOWN
CORRUGATED G.I. ROOFING GA. 26 PRE-PAINTED WHITE WITH MOISTURE AND THERMAL INSULATION
GA. 26 PRE-PAINTED GUTTER
WIND SCOOP ROOF
VALLEY CAP
RIDGE LINE
RIDGE CAP
SOLAR PANEL
1.2m X 2.4m CORRUGATED POLYCARBONATE SKY LIGHT ROOFING
BUILDING LINE
GA. 26 G.I. PRE-PAINTED GUTTER
4" Ø DOWNSPOUT
ROOF EAVES
DS
18000
9000
4500
7000
3500
2475
280
1310
800
1090
1420
1135
A
B
C
D
E
1
1'
2
3


Velocity (m/s)
18.586
16.096
13.142
9.293
0
Status: Transient
Analysis: 3D
Wind Speed: 10.000 (m/s)
Length: 109.119 (m)
Width: 45.071 (m)
Height: 26.094 (m)
Voxel size: 0.593 (m)


Velocity (m/s)
18.992
16.447
13.429
9.496
0
Status: Transient
Analysis: 3D
Wind Speed: 10.000 (m/s)
Length: 109.119 (m)
Width: 45.071 (m)
Height: 26.094 (m)
Voxel size: 0.593 (m)





The three conceptual principles and its application to Holistic Resilient Eco-efficient Rural School Dimension are;

Aero Dynamics: the design mimics and influenced by aero dynamic design for a typhoon resistant capacity. The roof's design allows wind to pass with least resistance. The roof's inclination shall have a slope of 25 to 45%. Aero dynamic somehow dictate the form of the roof. As noted in the design guide secondary roof (canopies, sun cover, sun breakers) shall not be a part of the main roof. Secondary roof attached to the main diminishes aero dynamic properties and vulnerable to strong wings in times of typhoon.

Hydrodynamics: Flooding and storm surges resiliency features are manifested be the raised flooring and rounded column and flood water barriers designs. Other flood barriers are water breaker like plant boxes. Hydro dynamic might influence the form of the walls and plans and importantly the main floor elevation as raised flooring. Plant boxes are of double purpose, firstly, it is meant to be as flood water protection and secondly, it acts as green buffer- acoustical and wind breaker. Other function is teaching student to grow and plant edible vegetable for food sustainability.

Bio-mimicry: like a human body the whole structure 60% of our body structure is carried by the lower body. Mat footing and footings acts like the feet and the columns the legs. To allow more flexibility in times of earthquake appropriate structural stress allowances be taken into consideration and the joints shall be safely designed to allow flexibility. The tie footing design and /or mat footing allow the under grade support to move together and not separately.

Green School: all design feature of the green school shall be applied and taken into account. Included are the waste and waste water system. All other items such as rain water harvesting and rainwater use and re-use included.

B. Holistic Resilient Eco- Efficient Urban School Dimension

- Earthquakes
  For added support and strength, 300mm x 300mm column pedestals were also assimilated into the design. These do not go all the way up and intersect with the inner space but rather, they only carry the concrete floor slab. Ground beams connect the column pedestals to the columns creating a structural frame that is more resistant to earthquakes than the conventional design.

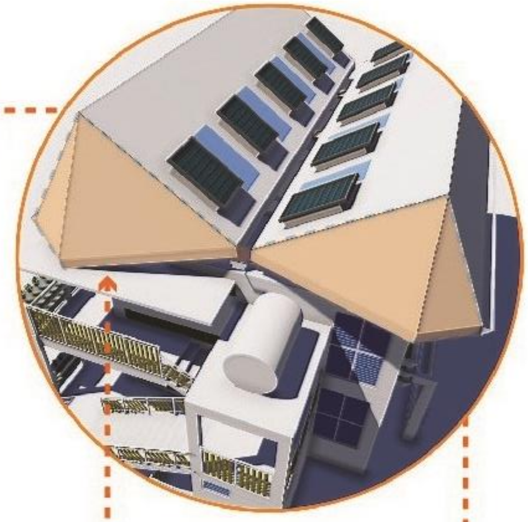
- Typhoons
  The roof design was altered from being a gable butterfly roof into a hip roof butterfly. With this, the wind would be able to move swiftly along the roof, without causing wind force uplift that tears off the roof from the building. Roof angles are between 30 to 45 degrees for a more aerodynamic character. Overhangs are extended minimally for shade and protection. As for the other usual precautions, natural barriers such as vegetation are expected, as well as using above standard materials. Wind pressure is also limited by opening up the walls both sides of the building through the window openings and breathers. Main structural frame is reinforced using cross-bracing on walls and roof frames. Bamboo slats are aligned along the stairs for not only, aesthetics but also will act as wind breakers.

- Flooding/Storm Surges
  Raised flooring enables the building to be protected from the effects of flood. The building is already raised up to 1.1 meters high. With the improved structural frame integrated column pedestals, this will also support the ground underneath and resist soil erosion caused by flooding.

RESILIENT FEATURES

Flooding/Storm Surges
Raised flooring enables the building to be protected from the effects of flood. The building is already raised up to 1.1 meters high. With the improved structural frame integrated column pedestals, this will also support the ground underneath and resist soil erosion caused by flooding.

Roof angles are between 30 to 45 degrees for a more aerodynamic character. Overhangs are extended minimally for shade and protection. As for the other usual precautions, natural barriers such as vegetation is expected, as well as using above standard materials.



Alterations
The roof design was altered from being a gable butterfly roof into a hip roof butterfly. With this, the wind would be able to move swiftly along the roof, without causing wind force uplift that tears off the roof from the building.

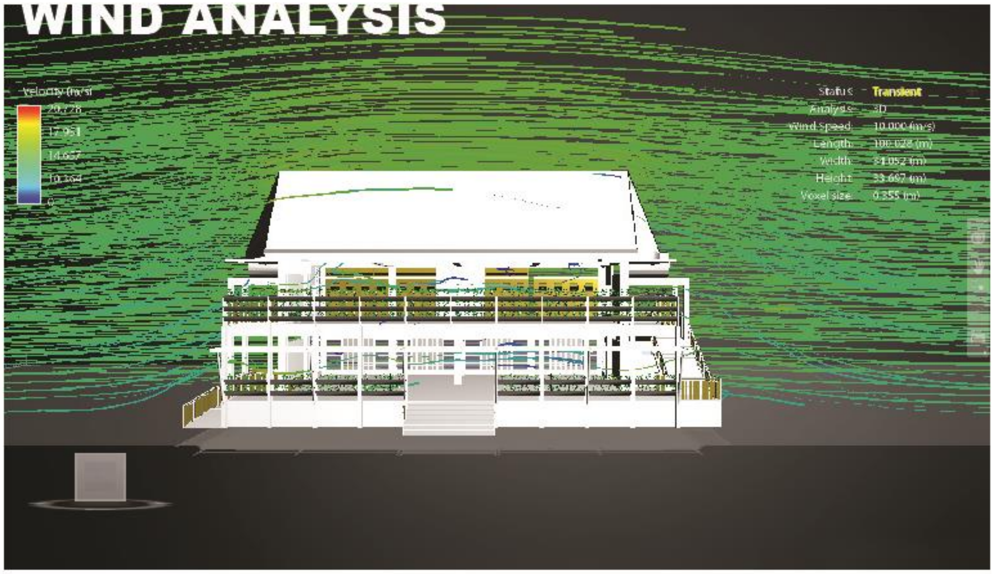
Wind pressure is also limited by opening up the walls both sides of the building through the window openings and breathers. Main structural frame is reinforced using cross-bracing on walls and roof frames.

Earthquakes Design
For added support and strength, 300mm x 300mm column pedestals were also assimilated into the design. These do not go all the way up and intersect with the inner space but rather, they only carry the concrete floor slab. Ground beams connect the column pedestals to the columns creating a structural frame that is more resistant to earthquakes than the conventional design.

Economic and Social Commission for Asia and the Pacific

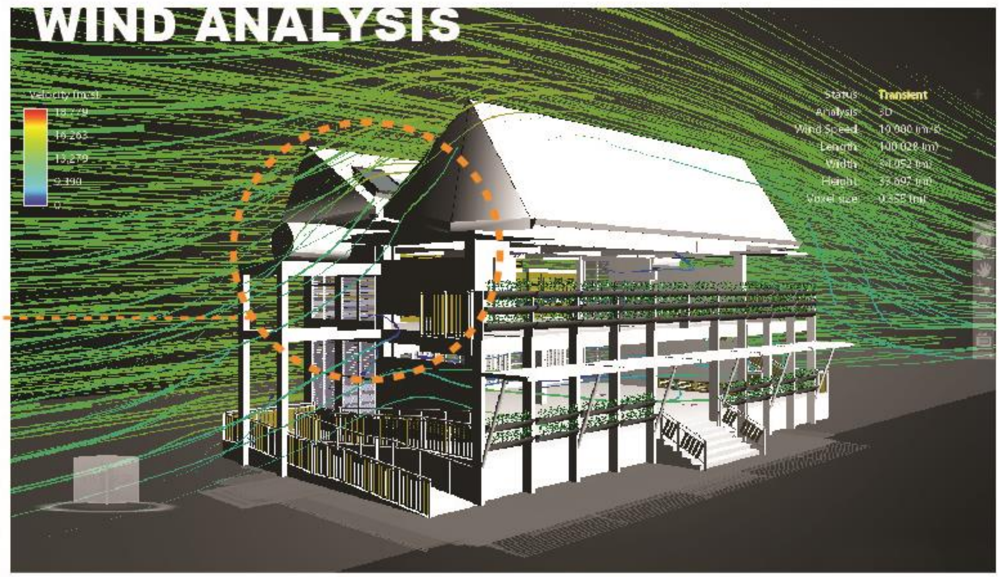
The structure is designed to allow wind to pass through within its interior rather than resisting it.

This photo shows how are flows into the interior and into the roofs profile.

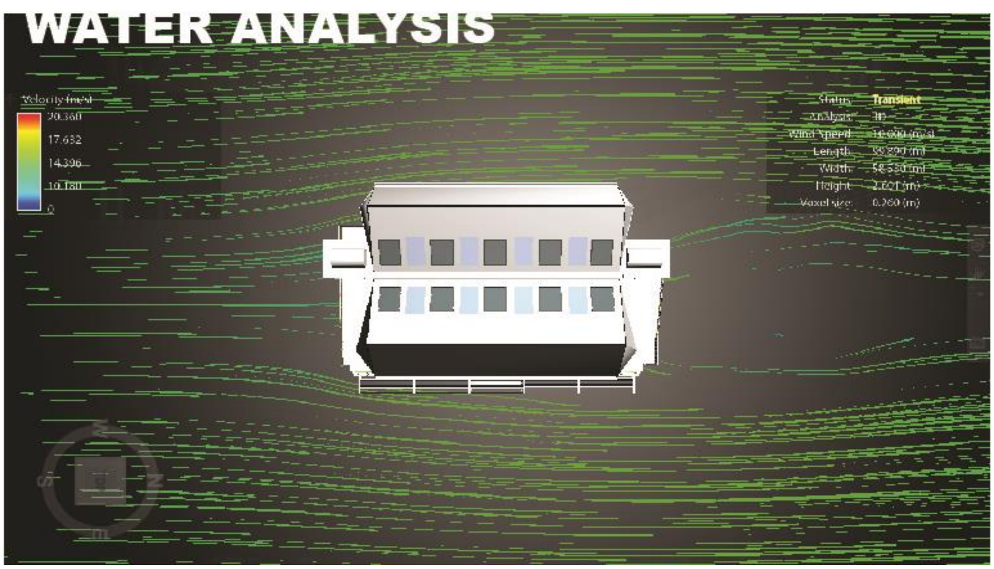


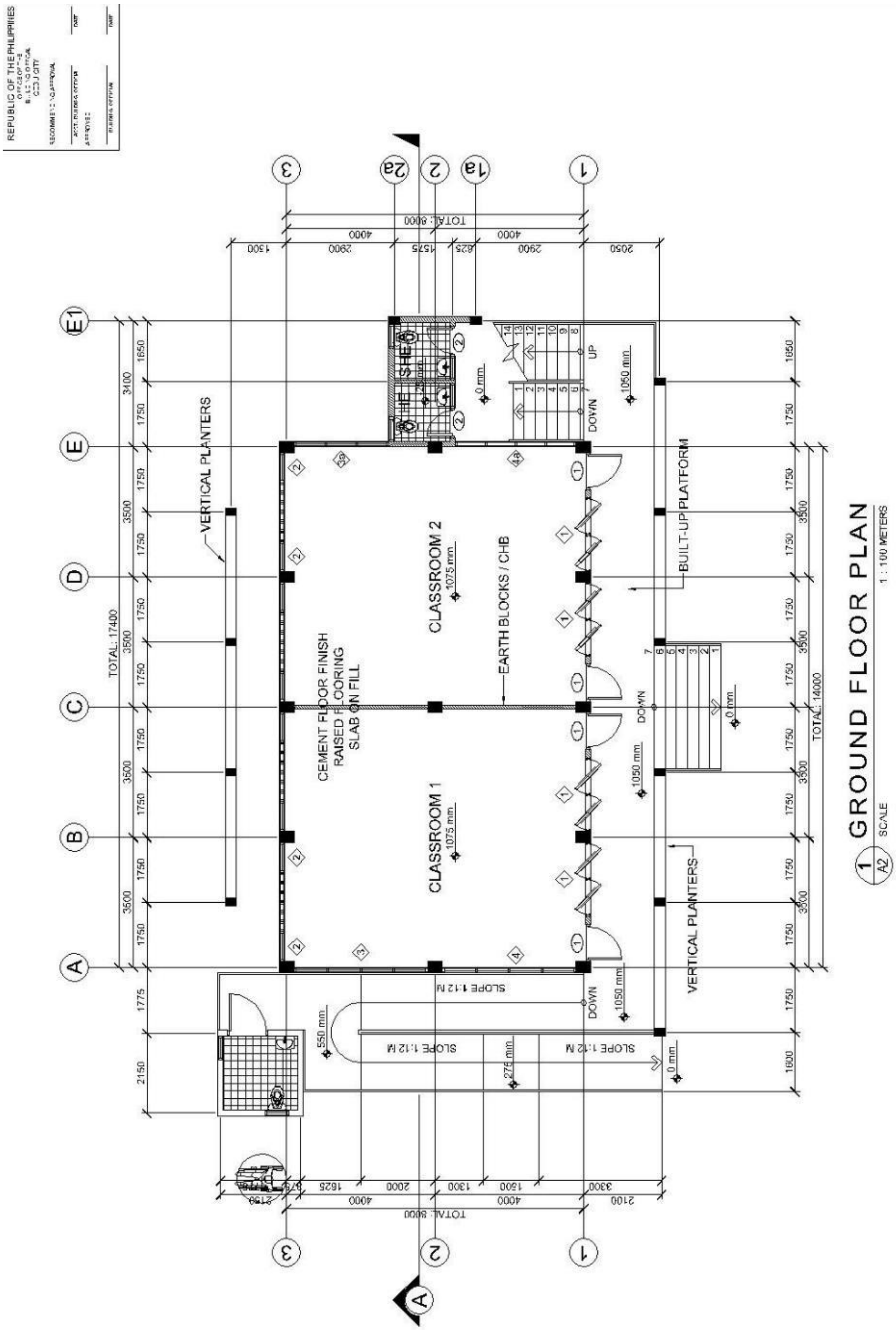
Color legend
The colors of the lines representing the wind determine the wind velocity (in meters per seconds) that passes through the building. from cool color (blue)-slower velocity to warm color (red)-stronger velocity.

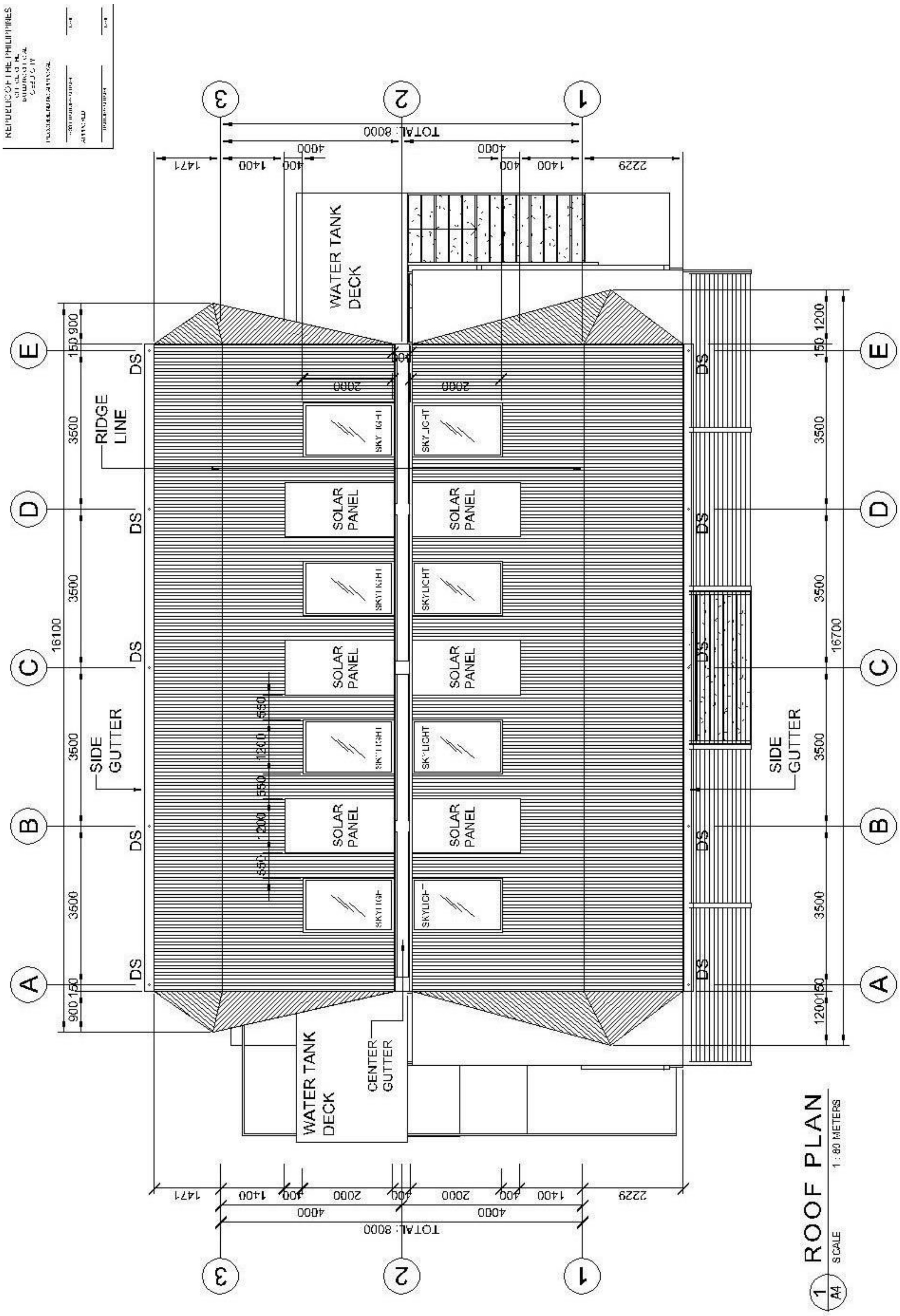
As far as the roof is concerned, by making it like a hip roof, we were able to close the sides of the roof specific angles so as to let a smooth flow of wind passing through its profile without creating uplift to the roof structure.



Hydrodynamics
This picture shows the flow of water passing the structure. Since the building is raised on stilts, the water during flooding will just pass through the stilts without intervention.




REPUBLIC OF THE PHILIPPINES
VERTICAL PLANTERS
CLASSROOM 1
CLASSROOM 2
EARTH BLOCKS / CHB
CEMENT FLOOR FINISH
RAISED FLOORING
SLAB ON FILL
BUILT-UP PLATFORM
TOTAL: 17400
TOTAL: 14000
TOTAL: 8000
SLOPE 1:12 M
DOWN
UP
GROUND FLOOR PLAN
SCALE 1 : 100 METERS


REPUBLIC OF THE PHILIPPINES
ROOF PLAN
1
A4
SCALE 1 : 80 METERS
TOTAL 8000
4000
4000
1471
1400
400
2000
2229
WATER TANK DECK
WATER TANK DECK
RIDGE LINE
SIDE GUTTER
SIDE GUTTER
CENTER GUTTER
SOLAR PANEL
SKYLIGHT
DS
16100
16700
3500
900
150
1200
550
1200
A
B
C
D
E
1
2
3

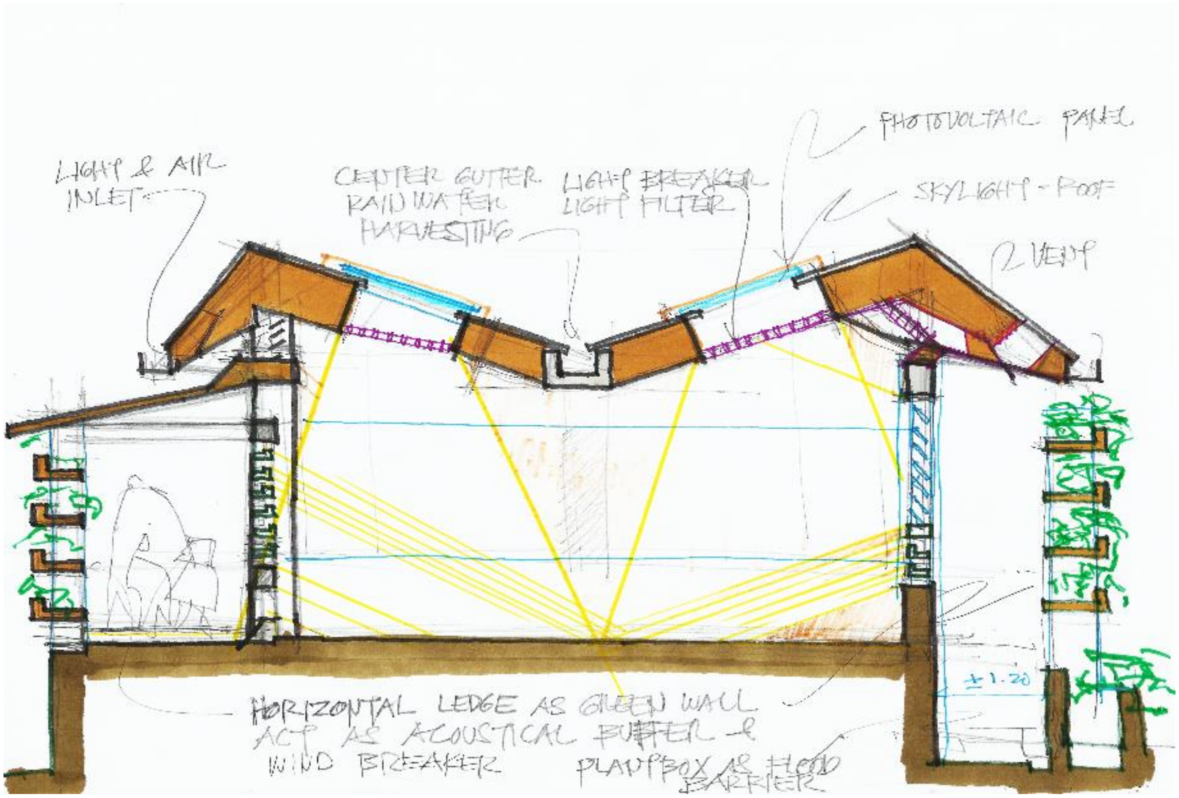
The three conceptual principles and its application to Holistic Resilient Eco-efficient Rural School Dimension are;

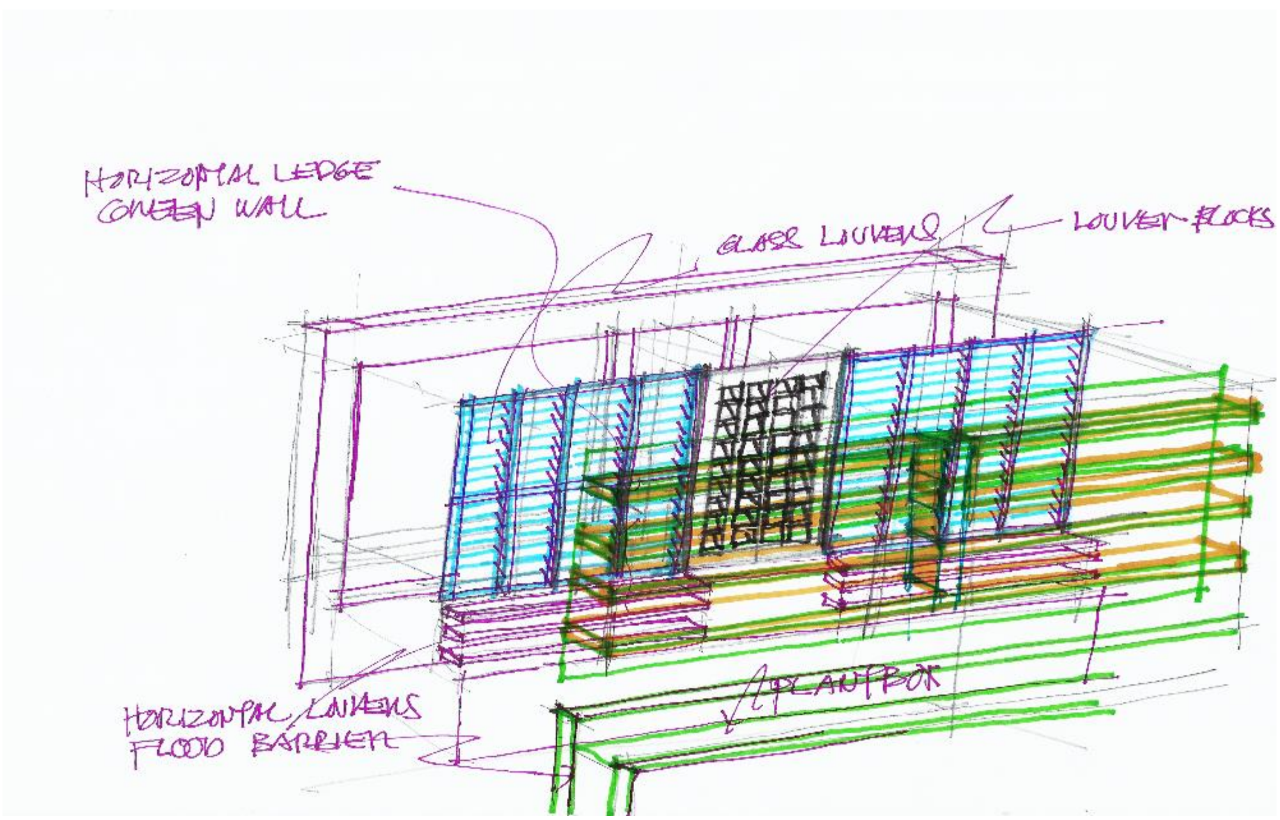
Aero Dynamics: In the urban school dimension the roof is of butterfly roof profile. This will have to be adjusted to be able to conform to an aero-dynamic design roof. The urban school roof design is of central rain water collection system. The design mimics and influenced by aero dynamic design for a typhoon resistant capacity. The roof's design allows wind to pass with least resistance. The roof's inclination shall have a slope of 25 to 45%. Aero dynamic somehow dictate the form of the roof. As noted in the design guide secondary roof (canopies, sun cover, sun breakers) shall not be a part of the main roof.

Hydrodynamics: Unlike the rural school dimension, the urban school can be on a raised platform as protection from flooding and storm surges. Platform can be formed slightly inclined to ease up water pressure when flooding. It allows the water to circulate with less wakes and drags thus enhancing its flood resistant features. Proper drainage-highly recommended in order to divert water flow. Flooding and storm surges resiliency features are manifested be the raised flooring and rounded column and flood water barriers designs. Other flood barriers are water breakers like plant boxes. Hydro dynamic might influence the form of the walls and plans and importantly the main floor elevation as raised flooring. Plant boxes are of double purpose, firstly, it is meant to be as flood water protection and secondly, it acts as green buffer- acoustical and wind breaker. Other function is teaching student to grow and plant edible vegetable for food sustainability.

Bio-mimicry: like a human body the whole structure 60% of our body structure is carried by the lower body. Mat footing and footings acts like the feet and the columns as legs. To allow more flexibility in times of earthquake appropriate structural stress allowances be taken into consideration and the joints shall be safely designed to allow flexibility. The tie footing design and /or mat footing allow the under grade support to move together and not separately.

Green School: all design feature of the green school shall be applied and taken into account. Included are the waste and waste water system. All other items such as rain water harvesting and rainwater use and re-use included.


PHOTOVOLTAIC PANEL
LIGHT & AIR INLET
CENTER GUTTER RAIN WATER HARVESTING
LIGHT BREAKER LIGHT FILTER
SKYLIGHT - ROOF
VENT
±1.20
HORIZONTAL LEDGE AS GREEN WALL ACT AS ACOUSTICAL BUFFER & WIND BREAKER
PLANTBOX AS FLOOD BARRIER


HORIZONTAL LEDGE GREEN WALL
GLASS LOUVERS
LOUVER BLOCKS
PLANTBOX
HORIZONTAL LOUVERS FLOOD BARRIER

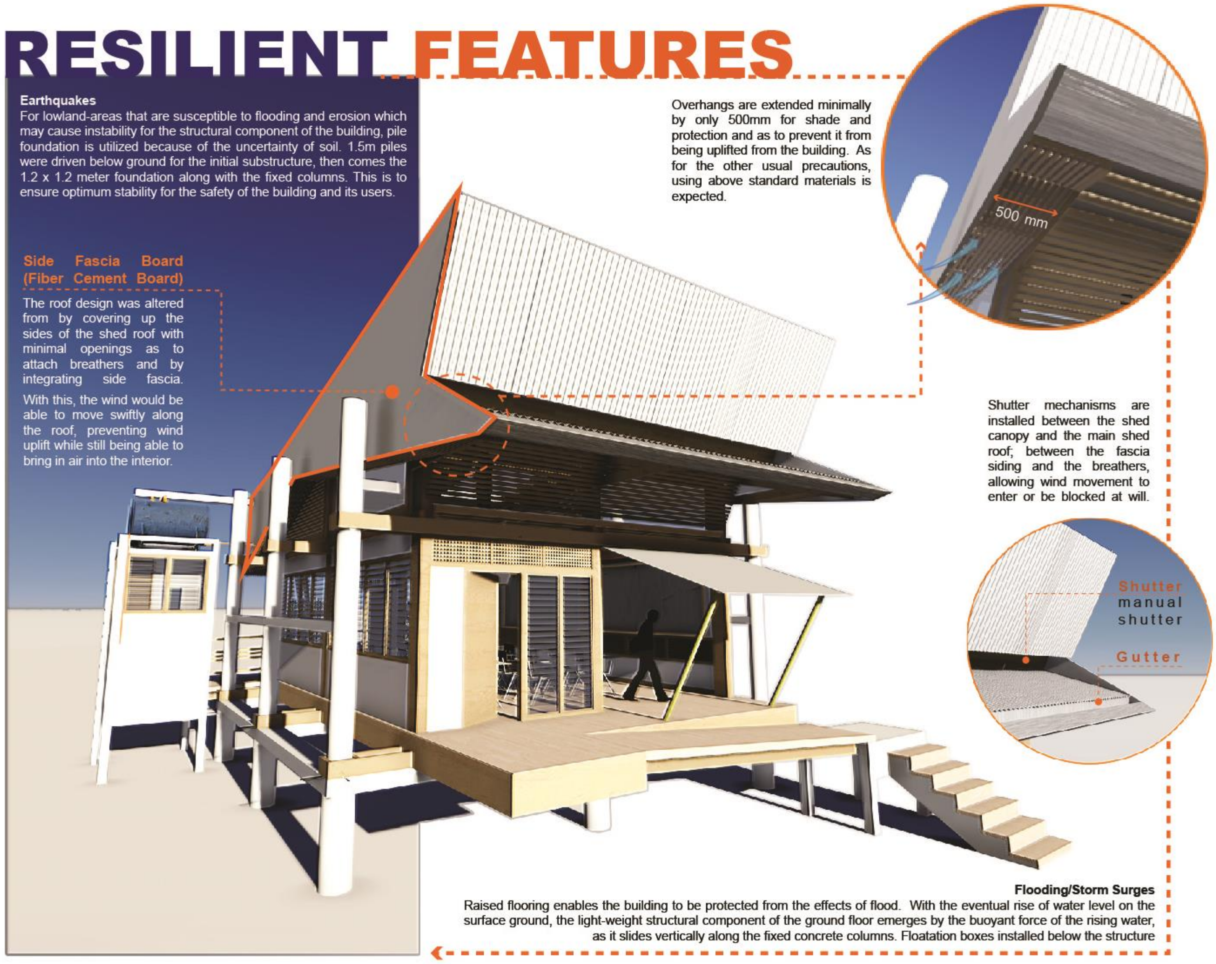
C. Holistic Resilient eco-efficient Lowland dimension;

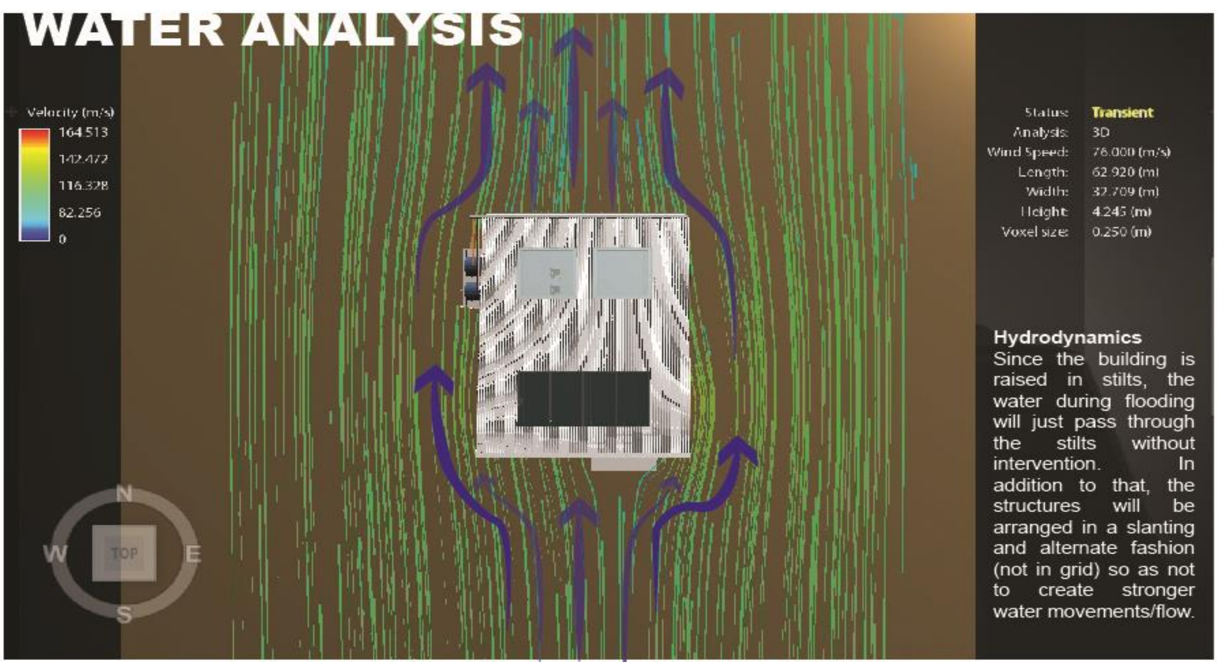
- Earthquakes
  For lowland-areas that are susceptible to flooding and erosion which may cause instability for the structural component of the building, pile foundation is utilized because of the uncertainty of soil. 1.5m piles were driven below ground for the initial substructure, then comes the 1.2 x 1.2 meter foundation along with the fixed columns. This is to ensure optimum stability for the safety of the building and its users.

- Typhoons
  The roof design was altered from by covering up the sides of the shed roof with minimal openings as to attach breathers and by integrating fascia sides. With this, the wind would be able to move swiftly along the roof, preventing wind uplift while still being able to bring in air into the interior. Overhangs are extended minimally by only 500mm for shade and protection and as to prevent it from being uplifted from the building. As for the other usual precautions, using above standard materials is expected. Main structural frame is reinforced using cross-bracing on walls and roof frames. Shutter mechanisms are installed between the shed canopy and the main shed roof; between the fascia siding and the breathers, allowing wind movement to enter or be blocked at will.

- Flooding/Storm Surges
  Raised flooring enables the building to be protected from the effects of flood. With the eventual rise of water level on the surface ground, the light-weight structural component of the ground floor emerges by the buoyant force of the rising water, as it slides vertically along the fixed concrete columns. Floatation boxes installed below the structure facilitates this action. If flooding persists, the light-weight mezzanine floor can be detached from the main structure and will act as an Emergency Raft to evacuate the area.

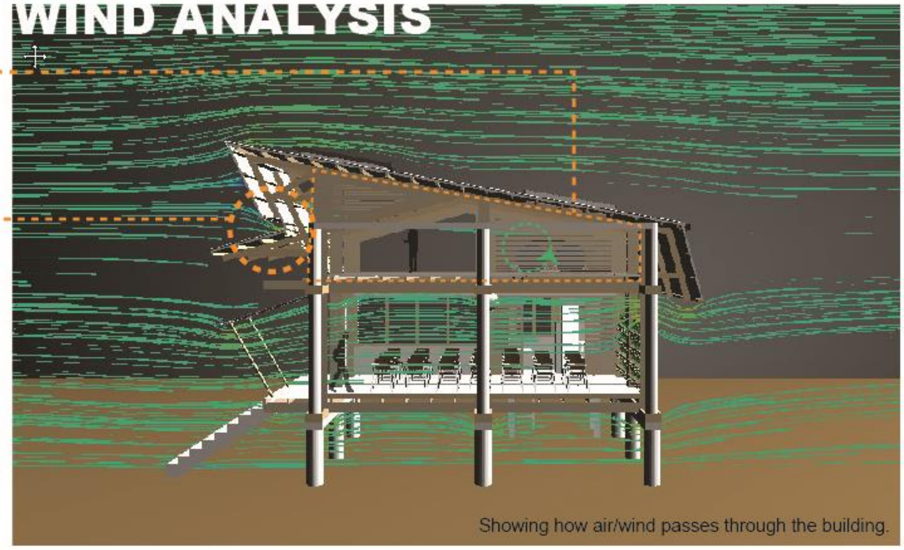
UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific





Wind entering into the Mezzanine level is controlled because of the additon of shutters at the roof's frontage.

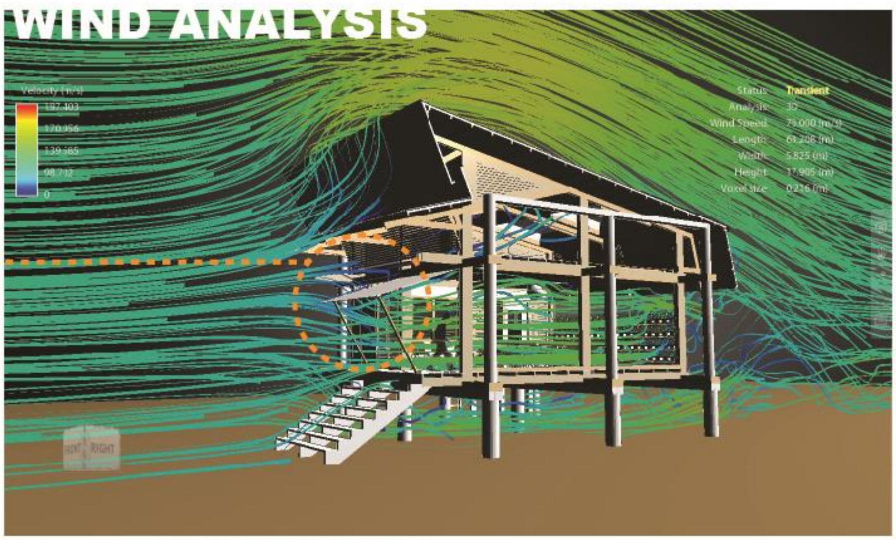
Wind Shutter
with the addition on wind wind shutter, the wind entering into the mezzanine floor is controlled making it the safest place to be; and at the same time allowing the wind to slide into the roofs profile rather than receiving it into the mezzanine floor.



Showing how air/wind passes through the building.

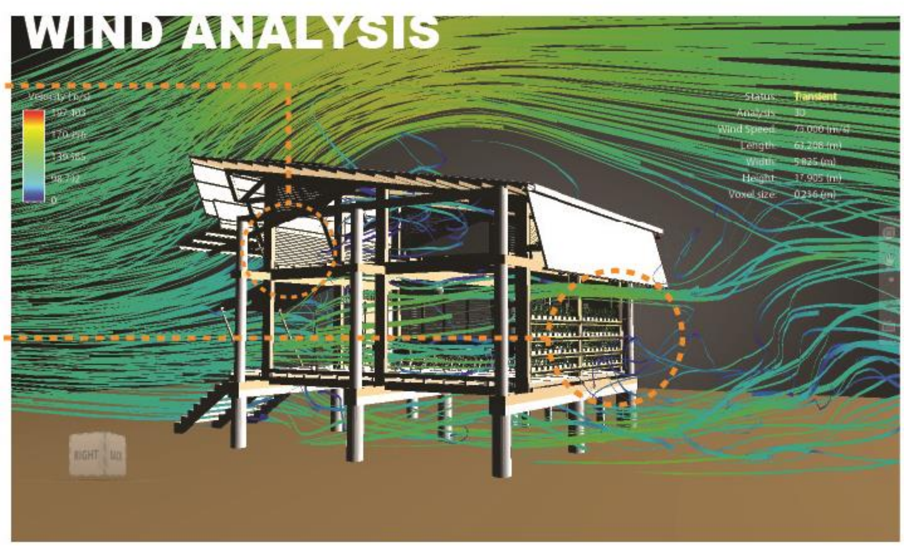
The colors of the lines representing the wind determine the wind velocity (in meters per seconds) that passes through the building. from cool color (blue)-slower velocity to warm color (red)-strong velocity.

The structure's open design is not just for natural ventilation purposes but also an advantage during extreme typhoons since the structure does not resist the wind hitting it, but only let it flow within its interiors to avoid wind uplifts.

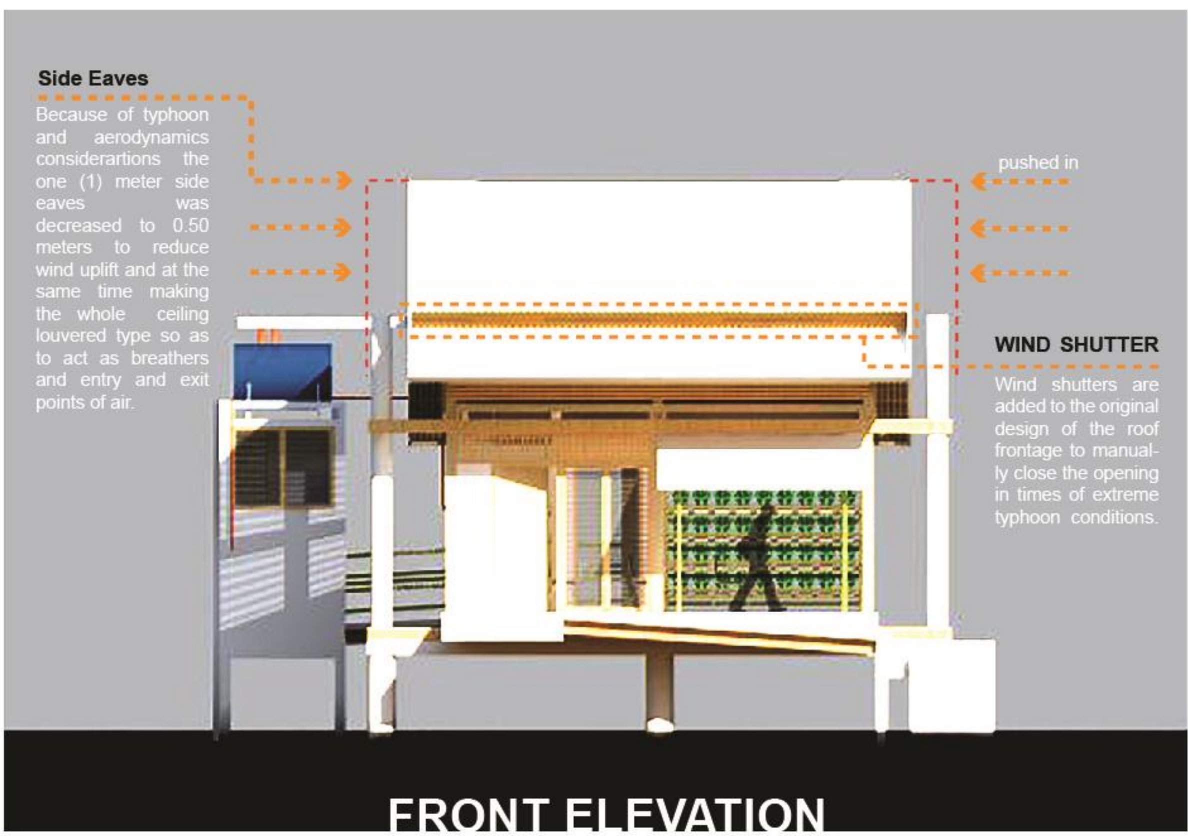


Filtered amount of wind passes through the louvers at the mezzanine level.

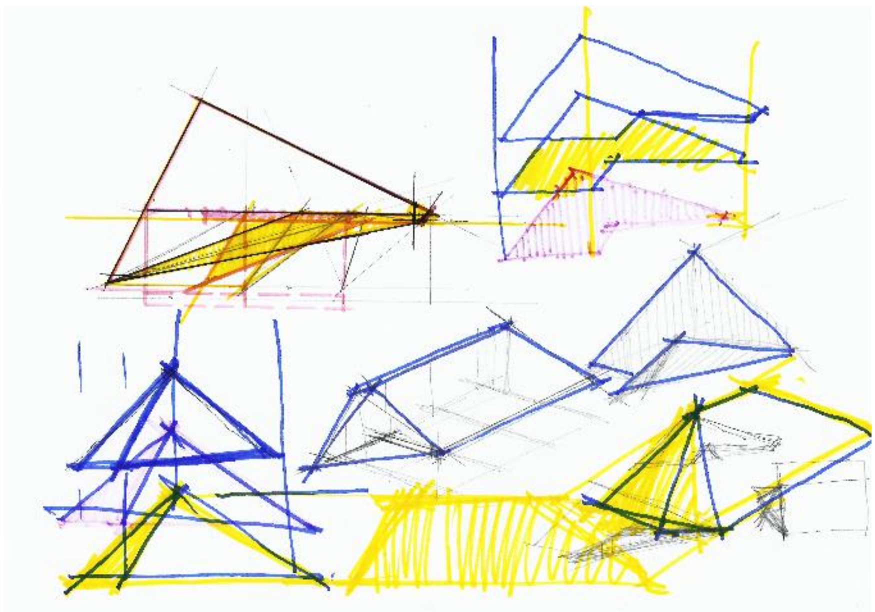
Outlet
Since we allow the wind to pass through the building, a corresponding design was also incorporated to act as the outlet of the wind.

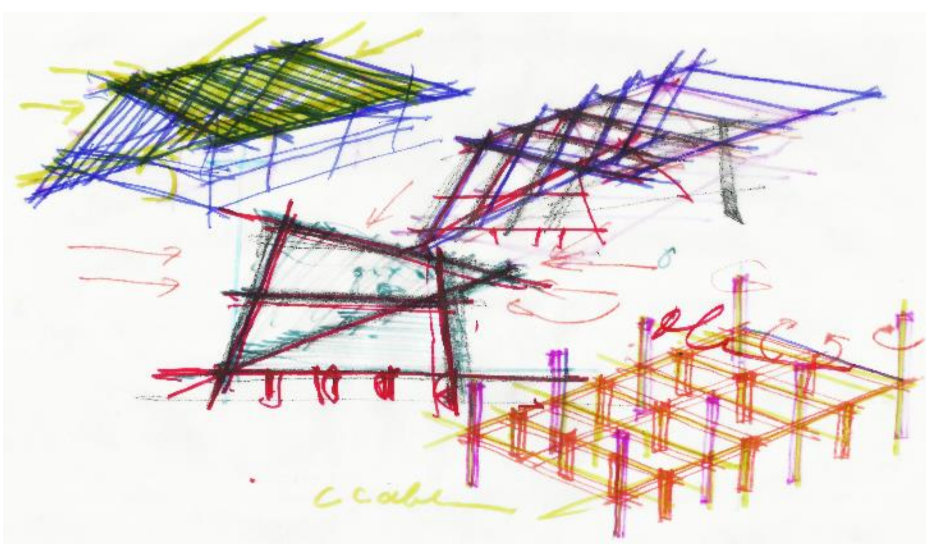



SIDE FASCIA PROFILE
Shutter mechanisms are installed between the shed canopy and the main shed roof; between the fascia siding and the breathers, allowing wind movement to enter or be blocked at will.
RIGHT SIDE ELEVATION


Side Eaves
Because of typhoon and aerodynamics considerartions the one (1) meter side eaves was decreased to 0.50 meters to reduce wind uplift and at the same time making the whole ceiling louvered type so as to act as breathers and entry and exit points of air.
pushed in
WIND SHUTTER
Wind shutters are added to the original design of the roof frontage to manual-ly close the opening in times of extreme typhoon conditions.
FRONT ELEVATION

Basically it has the same property as in the urban and rural dimensions when it comes to aerodynamics, bio-mimicry, and the incorporation of the green school. The difference is in the structural component for seismic- earthquake resistant properties where the footings are resting on a pile. Another design is the footing shall have a key (please refer to drawings). Most importantly these footing shall be tied together by a tie beam. The purpose of which is the prevention of these footing –columns not to move separately. Structural system must move as one and together.





CHAPTER 11

POLICY GUIDE

"Climate change is something legislatures around the world need to understand. The cost of inaction is higher than the cost of action," World Bank (WB) vice president and special envoy for climate change Rachel Kyte said.

I. Guiding Principles

Holistic eco-efficient green school shall be guided by the following principles:

A. The School or Structure should stand the test of time

The school building should stand the test of use and disasters addressing the adverse effect of climate change and the protection and preservation of the environment. The school shall be resilient and adaptive in order to stand the different test and stresses of disasters and the destructive effect of climate change.

B. Resilient Design

A building shall be designed with resiliency features and shall consider different scenarios as part of design process. The different scenarios of past performances of buildings during earthquakes, typhoons, flooding, storm surges, tsunami and other form of disasters. This design process examines normal situation stresses, its effects on the environment and during disasters that could challenge the integrity of the building and users.

Resilient design must integrate eco- efficient design criteria and risk reduction design element to be able to protect social, cultural, economic and environmental assets. Protection is one but the other aspect is capacity building enhancing capacities for local and national officials, decision makers and policy make

C. Emergency Resiliency & Disaster Preparedness

The design firstly is to consider the stresses brought about by different disaster scenarios. With emergency resiliency we have to build better and safe. Meaning building should be structurally sound to handle the different stresses and damaging destructive effects of the different kind of hazards. Emergency features such as emergency access shall be provided. Incorporate disaster preparedness features in the design, meaning it should be disaster prepared structure in concept but teaches disaster preparedness also.

D. Involve the community in the decision making process

Collective ideas and inputs are largely desirable in order to address resiliency, adaptability and sustainability. Community participation is a process that will deal with the socio-cultural- religious- historical layers of the society. This process addresses the issues of acceptability, resiliency and capacity building.

E. Flexible and adaptable in Spatial Function

The school shall have a character of multiple flexible functions. Functional use may be social, religious, community functions and for emergencies during disasters. It is very important that the school shall have eco-green efficient features such as effective waste management, rainwater use and food generating features like green walls and pond.

F. Universal Design

Universal design is a set of design system and standards created to be friendly and functional to all ages, disability, gender, race and physical well being. The level of applicability will have to be universal and includes disaster preparedness design elements.

G. Sustainable /Green Design

Build holistic resilient schools whose design addresses the needs of energy and resource conservation as well as social values and environmental consequences. This process makes us understand what the proposed structures might be. Our ultimate goal is for our proposed development to be economically, socially- environmentally sustainable.

H. Disaster Hazards, Typhoon and Earthquake Resistant Design

This item refers to the structural integrity in reference to seismic and typhoon related elements. This also refers to the design's ability to withstand, resist, mitigate and adapt to forms of disasters. Resistant design shall have a principle frame the safety of the users, structural stability and adaptability.

I. Innovative Design

The design shall be innovative and creative to resist disasters with taking into consideration economic cost, environmental and social costs. Careful consideration shall be taken on socio-cultural layers of the society. This is in reference to the question of acceptability. Use appropriate traditional technology using readily available local materials and the other is the use of modern/ sophisticated / eco-efficient technology.

II. Policy Guide

A. Build low carbon eco-efficient schools
B. Build resilient schools (typhoon and earthquake resistant)
C. Use low carbon manufactured building materials that are readily available in the locality
D. Involve the community in the decision making process
E. Discourage the use fossil fuel-coal generated energy and promote, encourage the use of renewable energy sources like solar, wind, water, and geothermal.
F. Build green schools that are adaptable to climate change effects and sustainable
G. Encourage school administrators to invest more on renewable energy
H. Build schools that encourage rain water harvesting and reuse
I. Encourage proper waste disposal that is environmentally friendly, using low technology of waste management of filtration boxes, seepage pit and holding pond.
J. Promotes Disaster Preparedness

K. Motivates citizens regarding emergency preparedness

L. Sustainably prepared in times of disaster in reference to water and power

M. Rainwater harvesting is an important attribute regarding the need of water during emergencies and disasters.

N. Reduce ecological footprints

O. Promote ecological sustainability by pursuing green building and maintenance practices.

P. Adaptable school to climate change effects

Q. Provide sustainable nutritional food supplements

R. Sustainable means of income for sustainable maintenance and operation

S. Multiplicity of purpose and function- an added dimension will be stable and structurally sound emergency shelter in times extreme disaster. (firstly, the purpose and function: school, alternative function: a space for public gathering and community meetings (social centers), Election voting centers, and emergency shelter in times of climate change effects like typhoons, flood and disaster manmade or natural

T. The school as an instrument of learning, associates the environment closely as an interactive tool including objects, color, texture, size, breeze, sustainable features, and arrangement within as an additional experience to augment the learning process.

U. The use of tree buffers not only as solar shades but also wind buffer especially during storms and typhoons. This also includes the use of the physical environment as natural barrier and protection.

V. Environmentally Friendly Waste Disposal Management

W. Environmentally Sustainable Operation and Management

X. Positive contributory factors to society, education and environment

II. Suggested Points Policy Guidelines of Government and Policy Makers

1. That Government and the private sector work together in the upgrading of a resilient building construction methods and system that will be appropriate solutions in terms

of disaster resistant capability.

2. That Government and the private sector review- revise and upgrade existing building codes and laws. Suggested resiliency and resistant ratings are;

A. Specifics

- Earthquakes: there is a need to upgrade the earthquake resistance capacity to a magnitude 9 and possible a much higher gap of magnitude 9.5 earthquakes. The system of a seismic tolerable gap ensures an earthquake resistant safe structure. Seismic tolerable gap is an allowance seismic structural building resistant capacity by raising the acceptable safe seismic rating found in the existing codes.

- Wind loads: Revise the design of Wind Zone II structures to withstand wind velocity from 200 kph to 390 kph to 400 kph. The last recorded peak gust wind typhoon "Yolanda" was 380 kilometers per hour recorded in Samar-Leyte Area.

- Universal Accessibility Design- Universal Design: to consider including the universal accessibility design to replace current provisions cited in BP 344 to enable PWD (Persons with Disability), elderly, children, and pregnant women access to the public and private facilities. Universal design are set of design system and standards created to be friendly and functional to all ages, disability, gender, race and physical well being. This will allow easy access in time of emergency to all gender. The level of applicability will have to be universal and includes disaster preparedness design elements.

- Information drive: improve and upgrade information and education system of the existing National Building Codes, the upgraded NBC and the proposed revised and upgraded resilient adaptive building codes and land use. The construction industry professionals are not thoroughly familiar with the present Building Code. There should be refresher course on National Building Code on a periodic basis to ensure sufficient knowledge and prevent errors.

- Zoning and Land Use Maps: upgrade zoning and land use maps and hazard maps.

Zoning and land use maps shall be in consonance with updated hazard maps. Clearances must procure for any land development.

- Office of the Building Official: strengthened power of the office of the building official to implementation standards and monitor workmanship of professionals. Most damaged schools in the last typhoon “Yolanda” were found to be poor in workmanship specifically along the structural joints and the quality of materials used which are sub-standards.

- Upgrading of building construction system and methods: upgrade and revise existing building construction that will result will ensure increased resistant capacity resilient to the disaster and the adverse effects of climate change.

- Illegal construction: Strengthen illegal construction law and its implementation system. Disseminate and implement anti-squatting ordinances and laws to prevent illegal construction activities. Most illegal construction are of sub-standard construction using sub-standard materials.

- Quality Standards (width, weight, thickness, etc.) on construction materials (e.g. bars, GI sheet, nails, wires, etc.) under Philippine National Standards, as specified by building professionals should be matched by those delivered by suppliers.

  There is a wide spread distribution of sub-standard building construction material in the market in the Philippines. They have the premium which is the standard, the sub-standard and below standards. This is a very big problem in the procurement of standard quality of materials. THERE IS A NEED TO STRICTLY IMPLEMENT THE LAW AGAINST SELLING SUB-STANDARD BUILDING MATERIALS AND PRODUCTS. There should be strict monitoring from the government agency in charge and private sector.

  Information drive and similar activities shall be conducted on quality control of products with concerned stakeholders and with the help of the media. Open communication between the proprietors is a vital information link to update on the latest issuances, ratings and upgraded standards. Stiff penalties shall be meted against those who sell sub-standard building materials and suspension and revocation of permit to sell.

Conduct of information dissemination and education to consumers on trade
And industry laws particularly on products under the mandatory list of DTI (department of Trade and Industry) for monitoring and enforcement, which includes construction materials

- Specification and application of building materials: Local and National entities shall determine the bases of specifications and application of building materials for typhoon and other disaster – resilient structures

B. Expand accountability of professionals

Professionals like Architects, Civil Engineers, Contractors, must monitor to ensure compliance of material specification, the general specification and instructions:

1. That Holistic Resilient Eco-efficient school building ensures sustainability and act as a driver for the Search-Research and Use Renewable Energies, Promote Sustainable Initiatives and Practices in Protecting the Environment.

2. That government must demonstrate commitment to green building program, comply with eco-sustainable building programs and policies, promote and encourage the adoption of green building practices and encourage active participation by the private sector.

3. Search-Research and Use Renewable Energies, Promote Sustainable Initiatives and Practices in Protecting the Environment.

4. That the Holistic Resilient Eco-efficient green building should include mitigation and adaptation strategies for a responsive and resilient future.

5. That Holistic Resilient Eco-efficient building be Flexible and Adaptable in function and usage at any given circumstance and situations whether in times of disaster, humanitarian usage and or civic functions.

6. That the policy makers and government promotes and support sustainable Application of rain water to protect our water sources and resources, stressing the Benefit such as for emergency use, reduces run-off and erosion.

7. That policy maker support sustainable application waste water and waste water management to protect our water sources and aquifers. That the government shall institute measure regulations and implement programs and projects that prevents the depletion of water resources. Support sustainable application rain water run-of management to protect the environment and prevent flooding.

8. Another dimension that should be look into is ECO-SUSTAINABLE DESIGN ELEMENTS RETROFITTED TO EXISTING BUILDINGS IN THE PHILIPPINES. The government promotes comprehensive retrofitting program to convert government complex into green buildings for energy efficiency and promote utilization of alternative energy resources.

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