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SCHOOL OF ARCHITECTURE, BUILDING & DESIGN (SABD)
ASIAN ARCHITECTURE
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Analysis On How Contextual Aspects Influence The Passive Design Of Warehouse 1, Sekeping Serendah To Achieve Thermal Comfort

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i. ABSTRACT

In a country with hot and humid climate, heat gain and energy consumption are always the worries for an architect to design a building and achieve its thermal comfort of its users. One of the best solutions for achieving thermal comfort in a building is by using passive design strategies. This refers to design strategies to minimize the usage of mechanical system to keep the indoor temperature and also lighting the house using natural elements, such as; sunlight to heat, cool and light the building to achieve thermal comfort. Passive design could reduce or eliminate 40% of the energy usage in a building and maybe more in some climates. In supporting the validation of "passive design" research, literature reviews based on various sources, such as, books and websites are conducted to assist the process. Warehouse 1, Sekeping Serendah Retreats, designed by Ar. Ng Sek San, is a shed that is intentionally kept basic and free from lavishness due to opportunities of passive design strategies that were influenced by the surrounding context sitting on the tropical site of Serendah, Selangor.
Warehouse 1 is built without any walls except for the toilets. The architect took advantage of the foliage surrounding the building to act as walls of the building, which gives an impression of the users being outdoors to embrace the nature. Furthermore, the absence of walls allows prevailing wind to have constant cross ventilation in result of using lesser mechanical systems. Additionally, The floor slabs of the building are raised to follow the existing contour, which maximizes the preservation of the topography. With the presence of daylight, the architect uses transparent roof panels to allow natural light to penetrate through and preventing the usage of artificial lighting during daytime. Lastly, the materials

used are reclaimed timber, clay bricks, concrete and steel which most of them are abundant, long lasting and environmental friendly.

1.0 INTRODUCTION

Malaysia has adopted the western construction techniques, which uses building materials such as bricks, cements, sands, gravel, reinforced concretes, and masonry which has given negative impacts to the surrounding environments due to site clearing and landfill operations at the construction sites.

Chosen the site in Warehouse 1, Sekeping Serendah Retreats, its context being surrounded by tropical rainforests, it in a way respects its surroundings and was thought of sustainability in long terms. According to World Weather Online 2016, the highest average temperature of Rawang Selangor is around 33ºC, which is not comfortable for its users. The architect has chosen to use passive design as an approach to achieve thermal comfort while retaining sustainability. Furthermore, the architect took the advantage of the context from it being the foliage, topography, etc. to reduce the amount of energy needed to achieve thermal comfort for it inhabitants. Other than that, the materials used are sustainable and preserve the natural environment. For example, the architect uses reclaimed timber as the roof structures, this prevents from further deforestations.

Research Question(s):

Question 1: What is contextual architecture?

Question 2: What is the context at Warehouse 1, Sekeping Serendah?

Question 3: What is passive design and how does it achieve thermal comfort?

Question 4: What are the passive designs used in Warehouse 1 that are influenced by the context?

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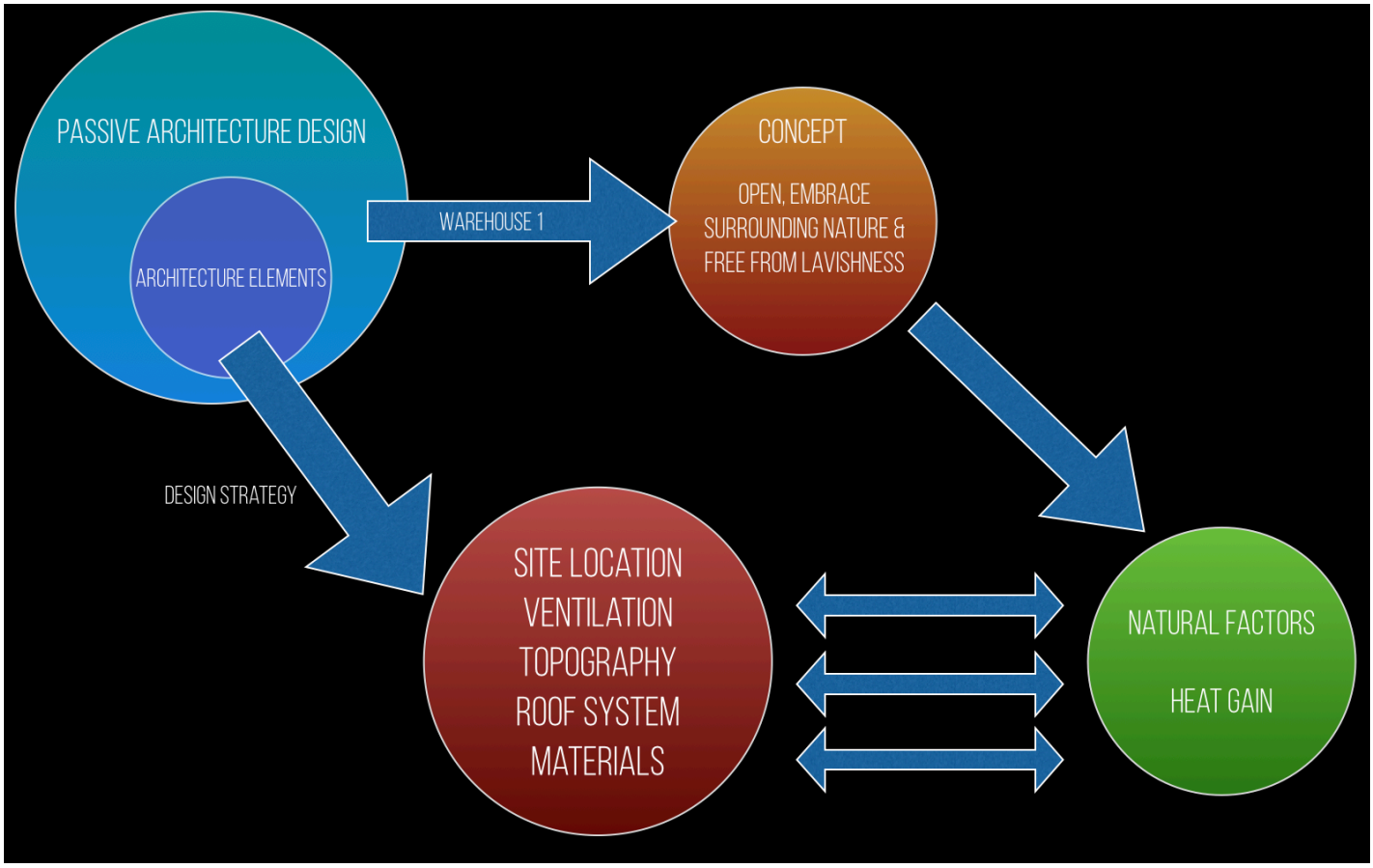

Figure 1.0: Concept mapping for research paper; Analysis on How Contextual Aspects Influence the Passive Design of Warehouse 1, Sekeping Serendah to Achieve Thermal Comfort.

2.0 CONTEXTUAL ARCHITECTURE

"Before any design, is the context. After the design, this design itself becomes a context for future thinking and design. Any existing entity in the universe – living or non living is part of the contextual reality of another." (Krishan, 2004)
Contextual architecture is architecture that responds to its surroundings by respecting what is already there such as the topography, natural environments, existing structures etc. Most of the time, contextual architecture creates an impression that the building gives out a sense of belonging where the building sits perfectly on site like it belongs there due to the respect of the building's surrounding. Furthermore, not only it doesn't disturb the surroundings, it also blends with them mostly through design.

Architecture is the process and the product of planning, designing and constructing buildings and other physical structures. However, before designing a building, architects often observe the surroundings in which their building will ultimately exist, before making their initial drawings. The same goals for every architect before designing a building are to recognize the context and designing their buildings that somehow responds to it. Some might argue that these goals are need not to be achieved every time – which certain designs excel their surroundings and eventually create their own context.

2.1 CONTEXT OF SEKEPING SERENDAH RETREAT

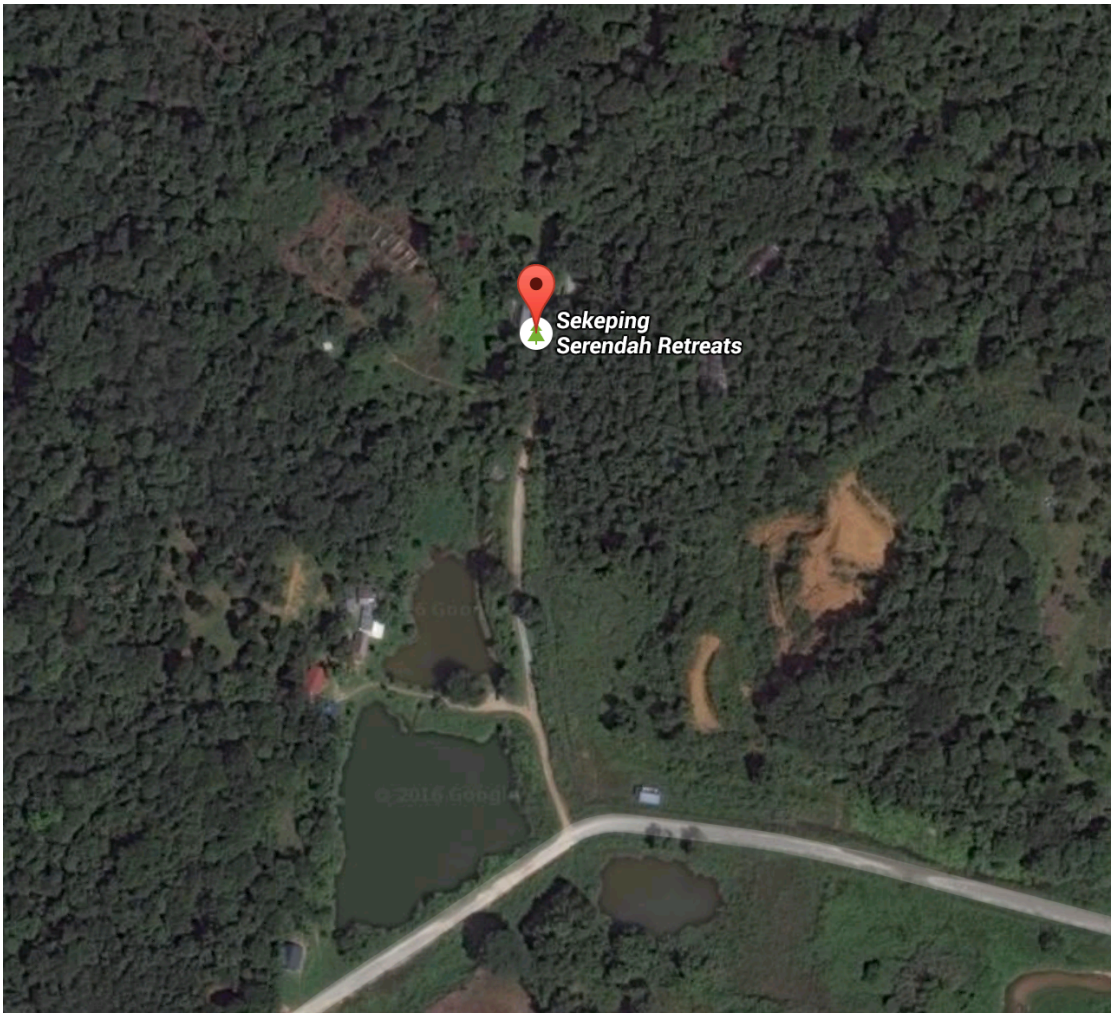

Figure 2.1: Location of Sekeping Serendah Retreats, Selangor. (source: Google Maps)

Warehouse 1, Sekeping Serendah Retreats is located in the dense tropical forest of North-East of Selangor **(Figure 2.1)** where the climate is hot and humid due to the context of Malaysia where it is located near the equator. The density of the forest surrounding it allows the architect to design the building with passive design as a strategy to encounter the heat gain factors of the climate here in Malaysia.

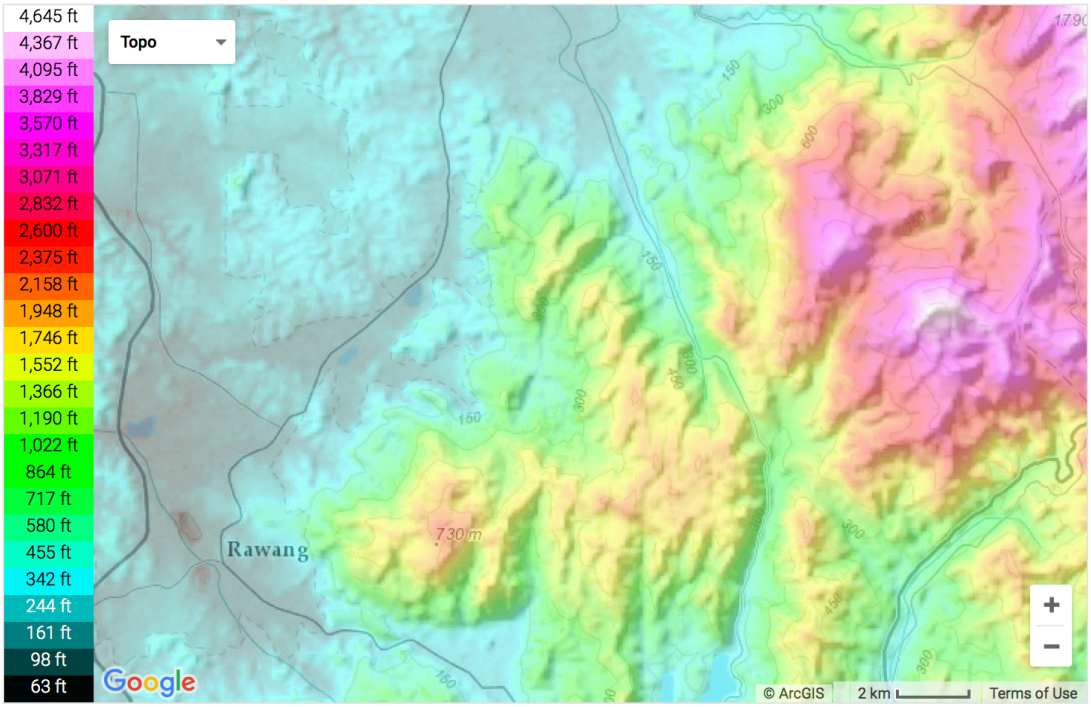

Figure 2.2: Topography map of North-East Selangor (source: Google Maps)

According to **Figure 2.2,** the lowest topography of North-East Selangor is approximately around 150 meters where the highest point is 730 meters. Sekeping Serendah Retreat is sitting around 200 meters above sea level. This is an opportunity for catching high velocity of winds for the ventilation of Warehouse 1 where the architect took advantage of to have a passive design for the building resulting in a sustainable design.

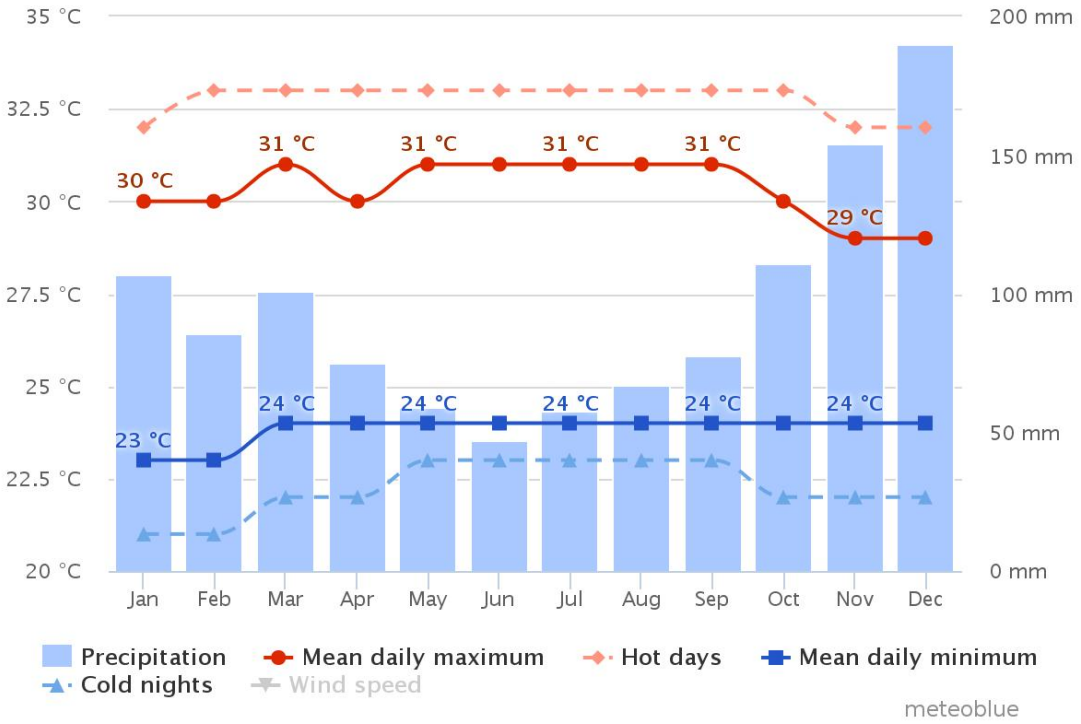

Figure 2.3: Weather report of Selangor, 2014. (source: www.meteoblue.com)

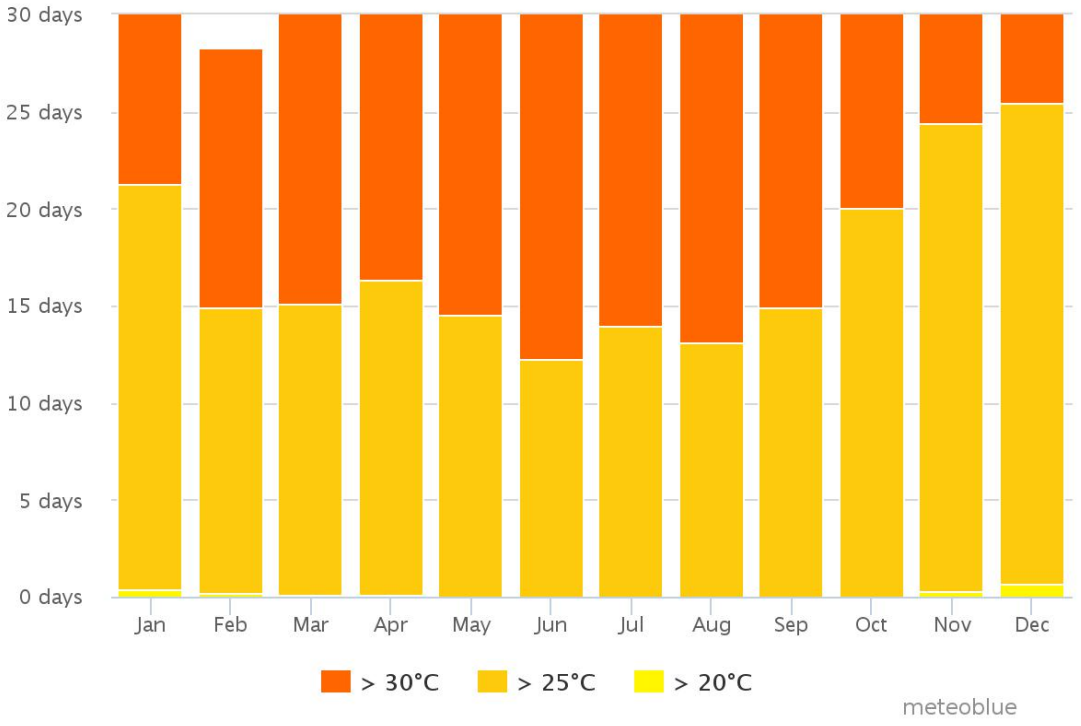

Figure 2.4: Average maximum temperature (˚C) in Selangor, Malaysia, 2014. (source: www.meteoblue.com)

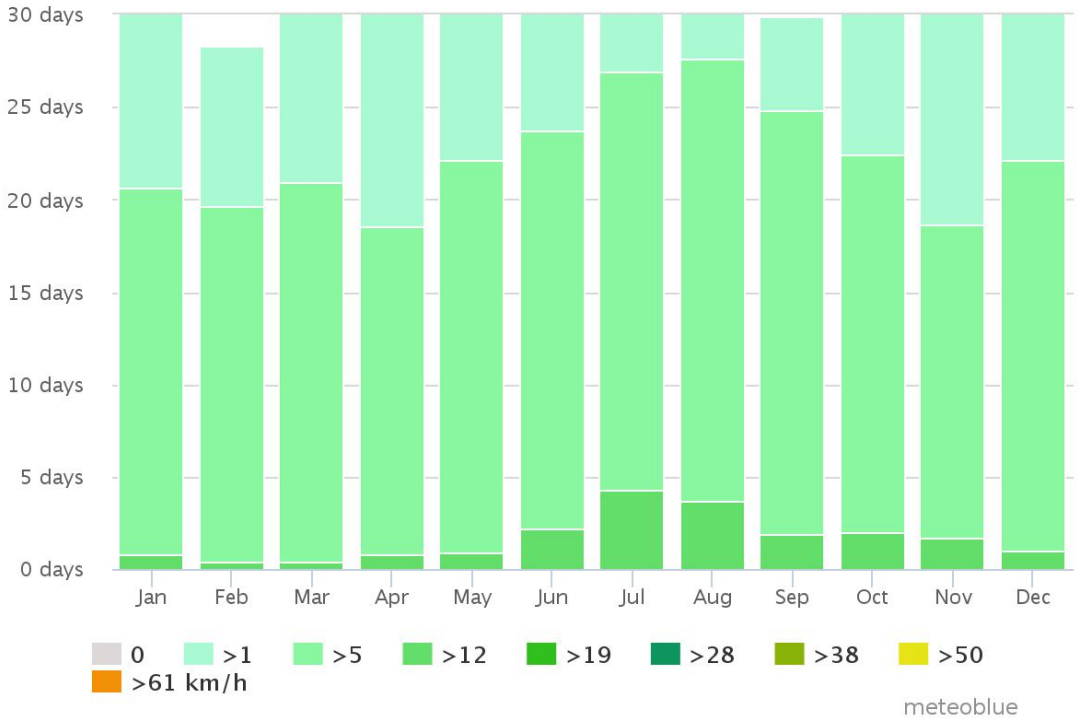

Figure 2.5: Average wind speed of Selangor, Malaysia, 2014. (source: www.meteoblue.com)

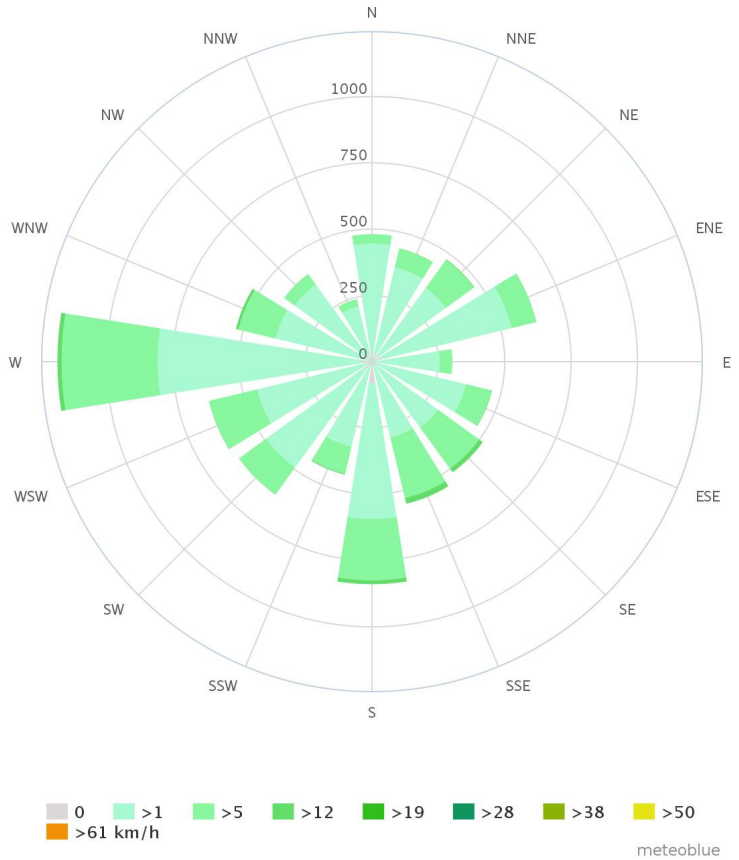

Figure 2.6: Wind rose of Selangor, Malaysia, 2014. (source: meteoblue.com)

In accordance to the data from **Figure 2.3-Firgure 2.4** above, the average highest temperature throughout the year is 32˚C whereas the lowest temperature throughout the year is 29˚C. Furthermore, the average maximum temperature is mostly above 30˚C, where the coolest days are during the month of November to January due to the monsoon season.

Fortunately, Serendah Sekeping Retreat is located 200 meters above sea level where winds are frequent and the average speed throughout the year is 12 kilometers per hour (km/h) to 19km/h according to **Figure 2.5** and **Figure 2.6.**

In conclusion, the climate of Malaysia is the main factor of heat gain in buildings. The architect has used passive design strategies as a solution for these factors to minimize the energy consumption of the building to maximize sustainability.

3.0 THERMAL COMFORT

Mankind has always striven to achieve a thermally comfortable environment. This is proven from buildings around the world – from ancient history to today. Achieving thermal comfort is one of the important parameters for architects to consider when designing buildings. Thermal comfort is defined in the ISO 7730 standard as being "That condition of mind which expresses satisfaction with the thermal environment". Thermal comfort depends on a few factors, that are – air temperature, humidity, air movement and velocity, thermal radiation, metabolic rate and level of clothing. The aim of designing a building should be to create conditions for optimal thermal comfort to satisfy the highest possible percent of the users. Probably at best only 80% of the occupants would be comfortable at any one time under the best possible conditions. The individual differences in preferred temperatures would arise in part from the differences in clothing, activity and acclimatization to the local climate. Hence, thermal comfort varies accordance to the location of the building.

4.0 PASSIVE DESIGN

Passive design refers to the particular way to design a building using the natural movement of heat and air, passive solar gain and cooling in order to maintain a good internal comfort for the occupants. Through the use of passive solutions, it is possible to eliminate or reduce the use of mechanical systems that increases the energy consumption whereas passive design strategy reduces the energy demand by 80% as well as the carbon dioxide emissions resulting in a sustainable building.

A few things to put in mind before designing a passive building are the sun paths, orientation, vegetation, etc. Also having to understand and recognize the contextual analysis of micro to macro is essential to passive designing.

Figure 4.0: Absence of walls due to the density of trees surrounding the building. (source: www.sekeping.com/serendah)

Warehouse 1 is a basic shed that is designed free from lavishness that could occupy 8-10 person designed by Ar. Ng Sek San. The building is recognized because of the contemporary architecture that uses passive design strategy. The building uses openness concept so that it embraces the natural environments surrounding it. It involves with a lot of critical thinking for the design approach, as it contains no walls surrounding the building except for the toilets.

The main passive design strategies of Warehouse 1 are:

1. Absence of walls,
2. Ventilation,
3. Natural Sun Shading,
4. Topography,
5. Natural Lighting and,
6. Thermal Mass of Materials.

4.1 ABSENCE OF WALLS

From **Figure 4.0**, we could observe that Warehouse 1 was designed without any walls except for the toilets. Derived from the contextual architecture of Malaysia, Warehouse 1 was built in the tropical rainforest of Selangor and it respects the surroundings by not clearing away any trees around it in fact it used the foliage as the walls of the building. The architect took advantage of the foliage surrounding the building as the barrier between the inside of the building and the outside. One of the reasons for this is that he wants the users to feel like they one with nature and away from the urban context. Furthermore, with the thick density and height of the trees that are exceeding the height of the building allows wind to channel through the building for cross-ventilation and it also gives out shade from the solar exposure during the day.

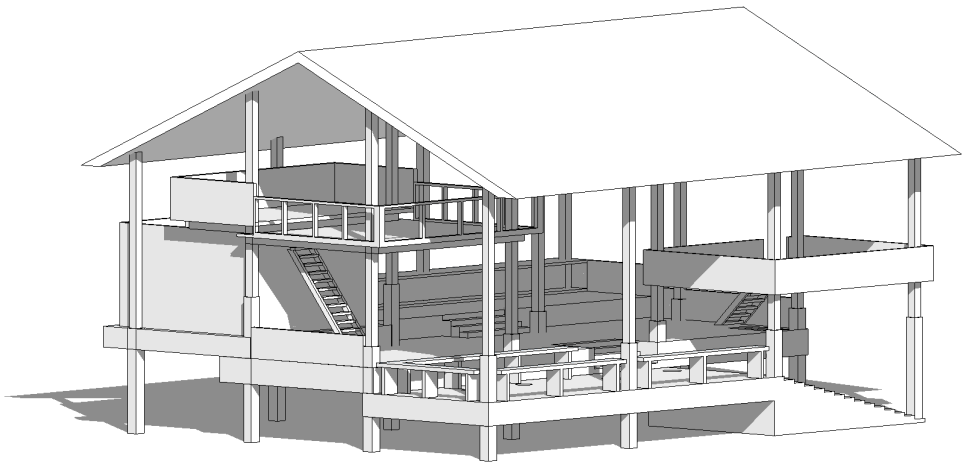

Figure 4.1: 3D Model of Warehouse 1, Sekeping Serendah Retreat.

4.2 VENTILATION

Ventilation is the intentional introduction of outside air into a space. The main purpose of this is to control indoor quality by diluting or displacing indoor pollutants. It can also be used for thermal comfort purposes where it cycles out the hot air and replaces it with cool air by the natural wind occurrences. Due to the absence of the wall in Warehouse 1, it does not use mechanical systems such as air-condition to cool down the indoor space instead it depends on the winds for cross ventilation.

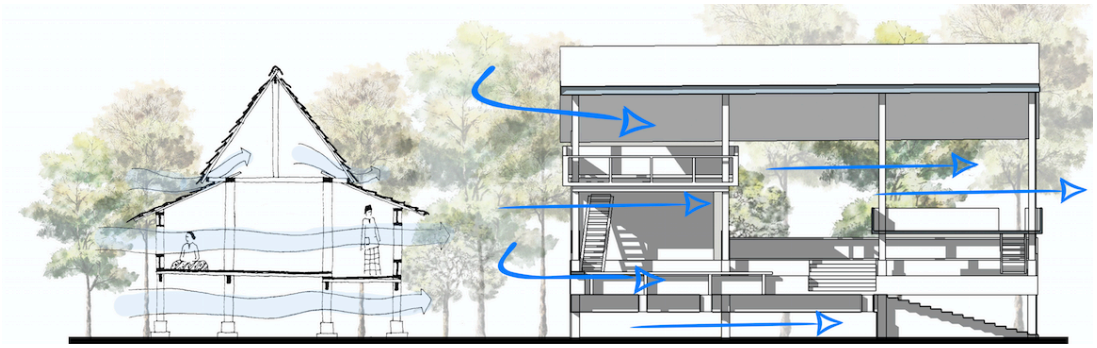

Figure 4.2: Comparison of cross-ventilation between a Malay house and Warehouse 1.

From **Figure 4.2**, Warehouse 1 uses the same concept as a Malay house for cross ventilation where the building it allows wind to achieve cross-ventilation by having big windows to channel air whereas Warehouse 1 eliminated the four walls of the building. Additionally, Warehouse 1 adapts double-volume so that the roof of the building will be higher than normal buildings. This creates a bigger gap so that more volume of air would perform cross-ventilation to all over the building and catching higher velocity for maximum ventilation.

4.3 NATURAL SUN SHADING

With the use of shading, it reduces the use of energy consumption of the building because they are very efficient in blocking or reducing thermal radiation from the outside air into the building. Most buildings use window awnings, roof overhangs, shutters, eaves, and louvers for sun shading whereas Warehouse 1 took the opportunity of the thick density of trees surrounding the area.

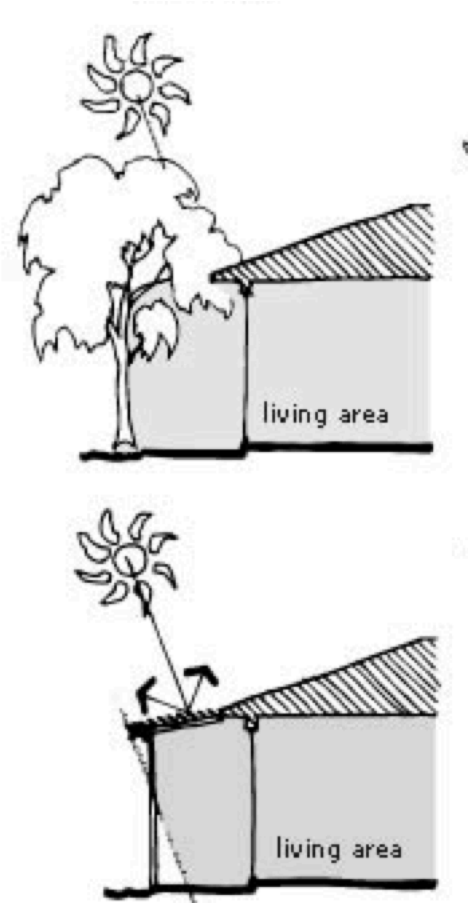

Figure 4.3: Comparison of natural shading vs. man made.

The foliage surrounding Warehouse 1 plays an important role for the building. Not only it acts as the walls of the building, it also allows shades due to the height that are mostly higher than the building itself.

4.4 TOPOGRAPHY

The contour of Sekeping Serendah Retreat varies from 150m – 120m above sea level, which means the land is not totally flat. To obtain the 'respect' of the site and achieve sustainability, the architect planned the layout of the building to follow the topography of the site in order to prevent site clearing and excavation, which is a waste of energy.

Figure 4.4: Site topography of Warehouse 1.

Figure 4.4 above shows the raised floor slabs, which are supported by several small columns. This allows the minimization of contact to the ground resulting of maximizing the preservation of the natural topography and attributes of the site for a more sustainable architecture.

4.5 NATURAL LIGHTING

Electricity is the main influence of energy consumption. The easiest way to achieve thermal comfort is by using mechanical systems but it is not sustainable in long-term. One of the solutions of reducing the usage of artificial lighting in the Warehouse 1 is by using solar exposure. As there are no walls surrounding the four corners of the building, the amount of sunlight is exposed more compared to a building with normal sized windows. With that, the occupants are encouraged to use artificial lighting during nighttime resulting in a low energy consumption of the building.

Figure 4.5: Transparent roof panels to allow sunlight into the building.

Furthermore, with the massive surface area of the roof, the architect decided to replace a few roof panels with corrugated polycarbonate roof panels, which are transparent (**Figure 4.5** – highlighted in red) – allowing sunlight to enter the building through the roof.

4.6 THERMAL MASS

Thermal mass is the ability of a material to absorb and store heat energy. A lot of heat energy is required to change the temperature of high-density materials like concrete, bricks and tiles. They are therefore said to have high thermal mass. Lightweight materials such as timber have low thermal mass. The types of materials used in a building are also essential to achieving thermal comfort because different materials have different thermal mass. A higher thermal mass means having to generate more energy to cool down the building resulting in a non-sustainable building.

Figure 4.6: Reclaimed timber and concrete are the main materials used in Warehouse 1.

From **Figure 4.6** above, the materials used are mostly reclaimed timber and concrete. This is because they have a high thermal mass that absorbs heat during the day and releases it during the night resulting in cooling down the building passively and efficiently.

4.6.1 TIMBER

We live in a world of diminishing natural resources, over-deforestation and environmental concerns. Timber is one of the most used materials in buildings such as homes, commercial buildings and so on. This is due to the cooling impression that it gives out. To achieve sustainability, the architect uses reclaimed timber to prevent more of deforestation.

The reclaimed timbers are used for roof structures. This is because they are not only sustainable, but also considered flexible, strong and have strengths to support heavy loads for a long duration of time. The porosity or small gaps in between of the members, promotes ventilation for air circulation and bring down energy consumption inside the house.

5.0 CONCLUSION

In my opinion, one of the best solutions of having a sustainable building is by implementing the passive design strategies. This is achieved by thoroughly understanding and recognizing the context of the site – from micro to macro analysis. Warehouse 1 should be one of the examples for architecture students to study for them to understand because it defines contextual architecture. Lastly, we must also remember our roots and study our local vernacular architecture because it was the first steps that developed our buildings today.

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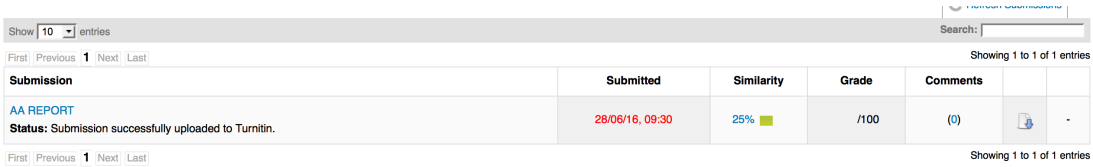

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