A SYSTEM OF SUSTAINABLE BUILDING CONSTRUCTION MATERIALS INCORPORATING THE RAISED FLOOR INNOVATION – THE TASIK CHINI RESEARCH CENTRE EXPERIENCE

[1] Tahir M.M., [1] I.M.S. Usman, [1] Mohd-Nor M.F.I., [2] Goh Abdullah N.A., [3] Abdul Halim Ismail

[1] Jabatan Seni Bina dan Alam Bina (SErAMBI),
Fakulti Kejuruteraan dan Alam Bina,
[3] Pusat Citra Universiti,
Universiti Kebangsaan Malaysia,
43600 Bangi, Selangor, Malaysia.

[2] Jabatan Senibina
Fakulti Alam Bina
Universiti Malaysia Sarawak
94300 Kota Samarahan, Sarawak

ABSTRACT

The Malaysian construction industry sector covers the aspects of the planning, design, conservation, demolition and repairing of various types of buildings and all types of mechanical and civil engineering works as well as other field work involved. It has attracted many researchers and most studies that have been done on the construction industry revolved around the study of technology as a design analysis. However, in reality it is still largely dependant on a conventional system established decades ago. This paper intends to propose a system of sustainable construction materials by redefining the traditional Malay architecture element of the raised floor and its innovation with the Industrialised Building System (IBS). The paper will present experience from Tasik Chini Research Centre of UKM as an alternative solution in providing a more significant and comprehensive construction process, offering fast and efficient system using components or materials that are sustainable. The development in itself incorporated the philosophy of or treading the earth gently, a development aimed at reducing the impact on the environment by lifting buildings from the ground. It complied with UNESCO development guidelines and the Strategic Implementation Action Plan for Tasik Chini's Biosphere Reserves. The development used traditional architectural principles as references and applied the many significant constructs and variables that may influence development in a tropical setting. A raised floor architectural concept was integrated with a structural system, thus providing a diverse range of functions. An IBS systems was implemented with the use of structures, floor panels and modular walls using low thermal mass (low thermal mass) materials, as well as green roofs with green concrete use to prevent heat from sunlight. It proposes a new paradigm in architecture that includes sustainability concern, technological simplicity as well as social aspiration and architectural identity. The system is designed to incorporate many passive design principles and climatic controls that combine with the use of IBS thus making it an efficient and easy-to-install system.

Keywords*: sustainable construction materials, traditional Malay architecture, raised floor, Industialised Building System (IBS), architecture identity*

INTRODUCTION

This paper focused on a system of sustainable construction materials by redefining the traditional Malay architecture element of the raised floor and its innovation with the Industrialised Building System (IBS). Its production is observed from scientific studies as well as case studies conducted on the design of modern terraced housing as well as observations on traditional architecture. Its design implements IBS with modular floor and wall panels as well as green roof features. Particularly important, it emphasizes on issues related to the construction of raised floor or pilotis as it opens up the possibility for the construction of various floor systems and modular coordination. This design also takes a unique floor design approach as seen in traditional Malay houses with perforated floor concepts to allow natural ventilation and cross ventilation through space. A new set of foundation system also addresses problem of torrential flood and surface water runoff prevalent in the tropics with a basic building system that will also use groundwater storage space.

The building also provides social spaces on the ground floor which act as gathering space, children play area, parking, storage and even space for vegetations and planting. The inclusion of an internal courtyard and water feature as part of a rain water harvesting system further adds to the sustainability of this design. Added with the integration of photovoltaic panels to generate solar energy, the building will be the first prototype of an architecture which addresses the issues of sustainability, renewability and livability at its extreme.

The use of IBS and modular coordinated panels allows the building elements such as floor and wall panels to be designed of various low thermal mass materials and design configuration. With ever increasing attention on environmental protection and energy prices, the once exclusive low energy dwellings are now getting more cost competitive and contribute significantly to the sustainable development of the nation.

RESEARCH PROBLEM

The central purpose of architectural design and construction is to create an environment that supports its user’s needs. We currently have little understanding of the degree that culture and traditions are reflected in the design and use of private and social spaces within our built environment that we fail meet or comfortably provide the needs of our society. Research into the construction industry has revolved around the study of technology as a design analysis. However, in reality a conventional system still prevails. It resulted in various effects such as construction delays, substandard quality of work and even buildings that are designed to the discomfort of users. Influence of the three key principles of design and planning, construction technology as well as building materials could further understand of the specific needs of our society within the built environment from a design perspective. In light of the gaps in knowledge about the ways in which we practice our traditions and beliefs within the construction industry, as discussed above, research is needed in order to provide this kind of information. The construction industry is growing rapidly every year and the needs with respect to the built environments have implications for architecture and the construction industry players across Malaysia.

OVERALL RESEARCH OBJECTIVE

The main objective of this exploratory research is to investigate and examine the ways in which a system of sustainable construction materials, based on the traditional building idea with the raised floor design can provide solution to our current construction industry sector within our Malaysian-designed built environment and to understand the influence of traditional construction principles and sustainable design philosophy on the creation of our nation.

The key research question to be addressed in this study is:

To what degree can the traditional architectural principles and philosophy meet the needs of the Malaysian construction industry in terms of enabling them to perform a more significant and comprehensive construction process, offering fast and efficient system using components or materials that are sustainable.

In answering this question, specific attention has been given to traditional principles of design and construction as well as sustainable philosophy and how they achieve these objectives within a Malaysian context.

RESEARCH APPROACH

This exploratory research adopted case study method to investigate the domains of Malaysian construction industry by looking at terrace housing design in Malaysia which is an elementary work in the built environment providing comfort living to Malaysian home-owners. For the purpose of this study, ‘home-owners’ was defined as those who are living in a terrace housing scheme and either have children or one or more members of their extended families living in their home.

A qualitative and quantitative approach was taken in order to capture qualitative data from the "lived experience" of individuals from their perspectives. Participants were selected and interviewed from various housing schemes throughout Malaysia.

Substantial findings from the research were used in a real construction project development to test the validity of the research.

RESEACH RESULTS

There are several findings obtained throughout the research that led to the suggestion of applying a system of sustainable construction materials incorporating the traditional raised floor or stilts as a local architectural model. That is;

i. There is no scientific research on the raised floor or stilt element of the traditional Malay houses.

ii. Application of raised floor element not only increases the need for space but also provides privacy and security controls to the occupants as well as thermal comfort.

iii. The raised floor element is the basis for prefabricated and modular building technology and feasible to be a modeled development of the Industrialized Building System (IBS).

iv. The raised floor element can be used as a notion of a national identity.

CREATIVITY IN SOLUTION

The results from the findings were then used to formulate a design and construction system which considered;

a. A raised floor architecture integrated with a structural system, thus providing a diverse range of functions.

b. IBS systems with the use of structures, floor panels and modular walls using low thermal mass (low thermal mass) materials, as well as perforated walls and floors.

c. Rainwater harvesting system which also acts as a building cooling system.

d. Green roofs with green concrete use to prevent heat from sunlight and indirectly provide additional space on the roof.

e. An internal courtyard with a vertical garden application to achieve internal heat cooling through a stack effect.

POTENTIAL PRODUCTS

Several potential from the findings also indicated that there are potential in the development of;

a. Modular floor and wall panels for both indoor and outdoor applications (The whole building can be manufactured at the factory and installed on the site).

b. Application of different materials for walls and floors using sustainable components.

c. A structural framework system using prefabricated components.

Benefits to Community

The development of contemporary residential building tipilogens especially housing with ground floor space can be used as a multipurpose space as well as with an effective natural ventilation. Spaces can be used for social, cultural and community activities such as khenduri, space for children to play and control of floods. Elevated floor heights enabling privacy control to the public. The design concepts produced can be applied not only to the tipilogical of residential buildings but also to the typology of other buildings.

Commercialization Level

A new research laboratory complete with administrative building, cafeteria, surau and research house was built at Lake Chini under the East Coast Economic Region Development Region (ECERDC). The entire research complex combines this concept and complies with UNESCO's Biosphere Reserve Development Requirements. Contract No. ECERDC-P010 / 0034.

Disclosure

The simplicity in design is inspired from the reinterpretation of traditional Malay houses. Its construction focuses on building quality and materials as well as construction or installation efficiency. The implementation of raised floor components is the creativity of a heritage architecture that presents life holistically. It proposes a new paradigm in architecture that includes sustainability concern, social aspiration, safety and security of the occupants as well as thermal comfort. The use of sustainable materials in the modular panel makes the building components easy to replace. Coupled with the use of solar panels and rain water harvesting, the house-dwelling tipilogy is able to represent the architecture of life that symbolizes the essence of Malaysia's tropical architecture.

The system is designed to incorporate many passive design principles. The most important aspect of this system is the adoption of the raised floor element, which is one of the basic elements of the traditional Malay house that meets the concept of space requirements, privacy controls and climatic controls that combine with the use of IBS thus making it an efficient and easy-to-install system.

The contemporary terrace house in Figure 1 shows a mass living scenario with space on the open ground to the environment but gets shaded from the sun and rain. It provides space for social interactions with neighbors, areas for children to play and avoid accidents and unwanted events from being hit by cars and providing good cross-ventilation and air movement. The concept of raised flooring allows the floor system from different materials compared to conventional concrete floor slabs. In this case it can use wooden floor with air gap (as seen in traditional house) for the breathing floor system as shown in Figure 2.

The concept of this terrace house implements the Industrial Building System (IBS) with Modular Coordination MC. This allows the home components especially the walls and floors to be modularally designed or in panel components. It combines a variety of innovative systems and sustainable materials. The use of the Industrial Building System (IBS) and the Modular Coordination (MC) allows the entire architecture to be easy and ready to be installed as well as parts or components replaced by wear and tear, destruction of components or the choice of occupants to be changed. MC components such as walls and floors can be developed to be the main architectural components and tailor-made, recyclable, made of low thermal mass materials available in local contexts such as wood, composite panels or concrete panels as shown in Figure 3.

Other aspects of passive low energy arch are low gate feature energy is the use of shading devices, full windows can be opened, internal courtyard, green roof using photovoltaic cell panel and rainwater harvesting system as shown in Figure 4. and green concrete technology as shown in Figure 5. Underground storage for rainwater harvesting is located on the ground floor to be easily accessible for maintenance.

The overall concept of this prototype has been accepted beyond the habitat of habitual architecture and was built as an investigation complex in Lake Chini such as Contract ECERDC-P010 / 0034.

Figure 1 Contemporary terrace houses with pilotis element provide spaces for multi-purpose and control of flood disaster.

Figure 2 Application of raised floor system with air gaps as evident traditional Malay houses to enable efficient air movement into buildings from under the floor.

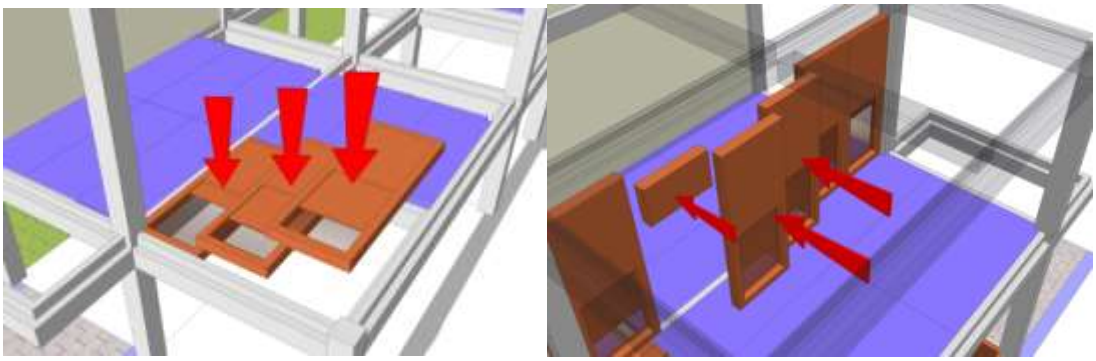


Figure 3 Modular wall panel application for indoor and outdoor walls and modular floor panels that can use different materials such as wood, composite panels or concrete panels.

Figure 4 A void space that can be used for water storage from rainwater harvesting systems.

DESIGN CONCEPTS

The design concepts and approaches are based on the creation of an architectural framework that emphasizes low passive energy and sustainable architecture, the quality aspect and the built-in IBS-based architecture and the architectural architectural philosophy. (Refer to Figure 5 and Table 1) Design features, characteristics and planning.

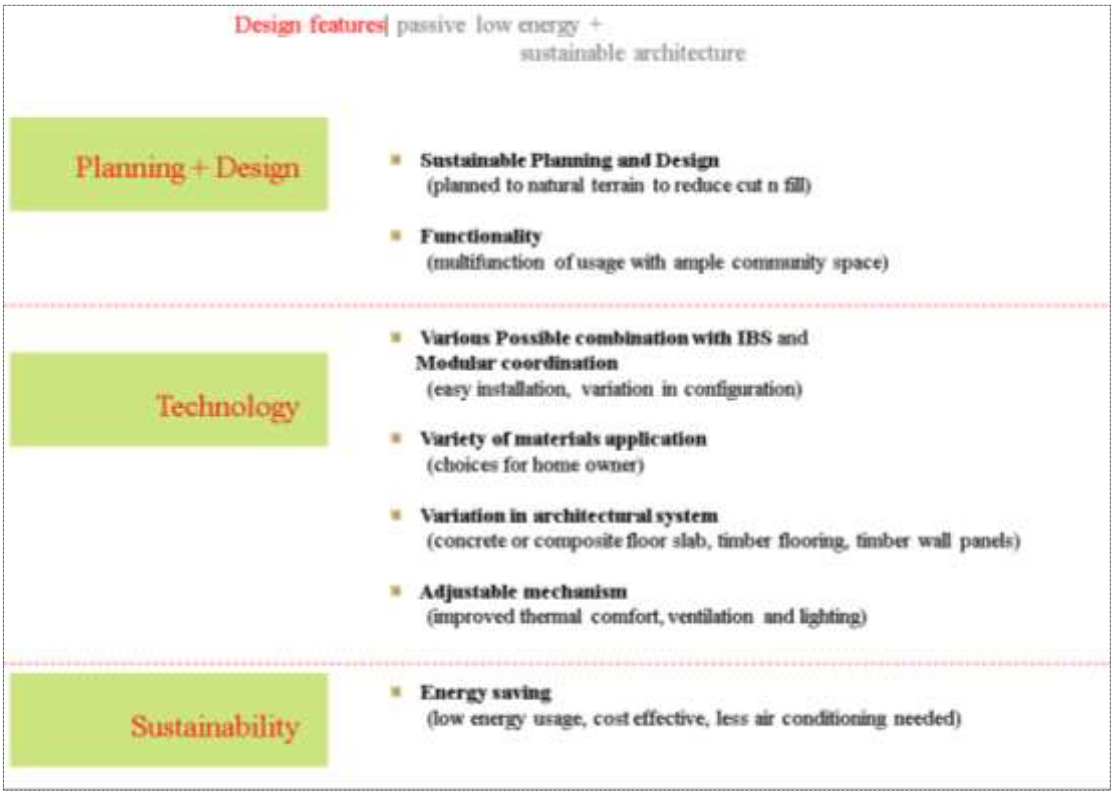


Figure 5 Design Features

Design Features: Low passive energy and sustainable architecture

The house is designed to combine various passive design principles. The most important aspect of the home is the introduction of the raised floor, a climatic feature characterized by the traditional Malay house that has long been ignored or abandoned in modern architecture in Malaysia. A raised floor concept is an extremely important aspect of ecologically sustainable architecture that needs to be explored and is capable of being able to transform the face of architecture in Malaysia into something special and global in general.

Implementation of IBS (Industrial Development System) with Modular Coordination enables home components, especially the walls and floors to be modularly designed. It can also be combined with innovative systems and sustainable materials.

In addition, aspects such as low passive energy on design features are for the use of shading devices, full height windows can be opened, inner courtyard, green roofing introduction using green concrete technology, the establishment of photovoltaic panels and rainwater harvesting systems. The underground storage tank for rainwater harvesting is located at the bottom of the ladder downstairs and is easily accessible for any maintenance.

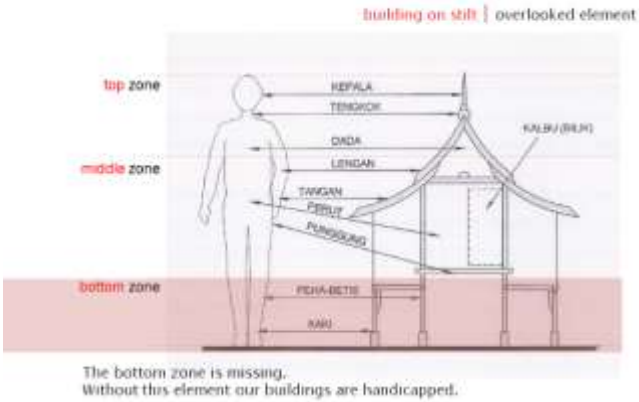
Related Issues

Relevant environmental and sustainable degradation related to the construction and development of residential terrace schemes in Malaysia. The current construction industry is still implementing conventional methods that do not consider wastage of materials, causing severe environmental problems such as floods due to excessive land purification and no longer adding to the discomfort of homeowners through the design itself. Investigations look at these issues and identify areas that can improve this situation such as material recycling and innovation design.

The adjustment level occupancy for the terrace housing category from various aspects of environmental comfort, sustainability and thermal comfort. Household designs for current housing such as not having much difference to the innovation innovation for the last 30 years. As always, the development of each housing continues to be constructed using high thermal mass materials such as bricks and does not care about the aspects of energy-efficient features. This assessment will help to determine the key areas that most have affected every homeowner. Household designs for current housing such as not having much difference to the innovation innovation for the last 30 years. As always, the development of each housing continues to be constructed using high thermal mass materials such as bricks and does not care about the aspects of energy-efficient features. This assessment will help to determine the key areas that most have affected every homeowner.

A new concept of sustainable housing through the introduction of various design components and raised floor innovation. Concentration is often given to the current housing scenario in providing a healthier home and a more orderly lifestyle especially for those with higher income. However, the chances of the average earner living at home are mostly patios and medium cost apartments, which are a concern to survive with all the problems faced due to the construction industry's preference for conventional systems and current guidelines.

Table 1 Characteristics and Design Planning

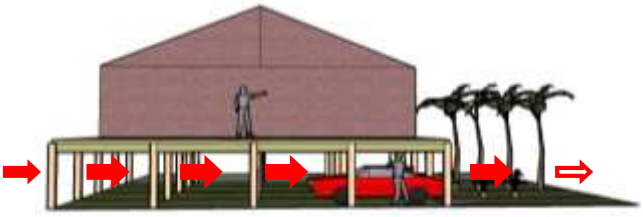
Characteristics	Rational
1. Architecture on Stilts: Climate Adaptation The house is designed to catch higher wind velocities and provide protection against disasters such as floods. This is an important component design that has been overlooked for many years in which this design may have some significant impact on the existing housing system.	 The architectural raised floor element has never been adapted to the design of modern terraced houses anywhere in the world and can lead to paradigm shift in architectural and design thinking.
2. Architecture on Stilts: The Forgotten Element The modern day terrace houses while designed may also be overlooked one of the most important elements of a raised tropical house. The identification of the charged components can create a more integrated and responsive social culture that has been lost and denied. The study aims to explore the sustainable aspects of our traditional architecture in creating a new unique design for home-based dwellings.	

Traditional design of the floor is raised in handling various issues such as ventilation, lighting, thermal comfort, security and safety and social aspects

3. Architecture on Stilts: Natural Ventulation

With the development of technology, especially with the introduction of air conditioning and ceiling fans, the need for natural ventilation elements is no longer regarded as a major concern.

This has resulted in various traditional ways of providing thermal comfort in the internal environment has been neglected, causing the internal environment to be uncomfortable and unhealthy and thereby requiring consideration for active means such as air conditioning for internal environmental control.

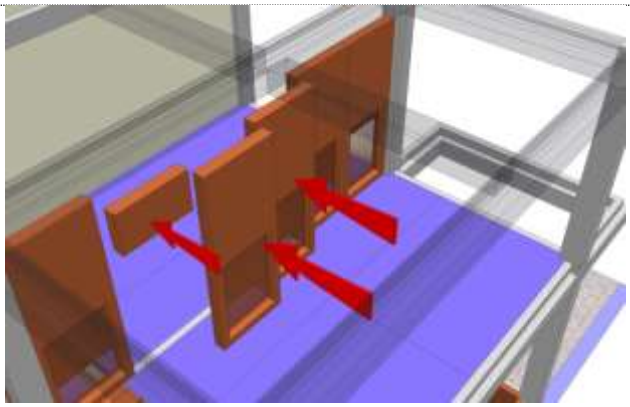


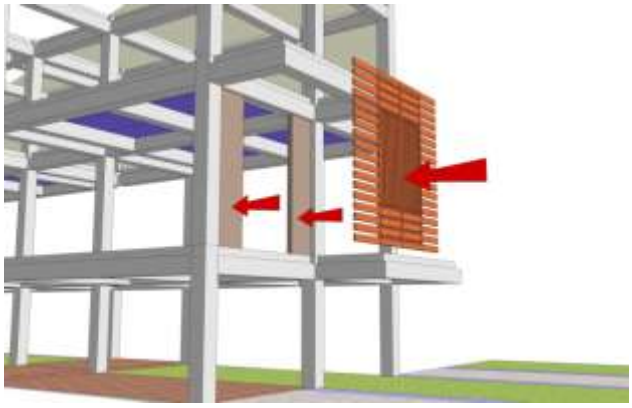
A study was conducted on Malaysian residential buildings in relation to natural ventilation and resident satisfaction (Kubota and Ahmad, 2005; Kubota, 2006; Kubota et al, 2009; Mohit et al, 2010; Talib, 2011; Teck-Hong, 2012; Zainal et al, 2012). However, the question of whether or not provided adequate natural ventilation provisions are still not answered.

To achieve adequate ACH for aeration and pollution control, Hassan and Ramli (2010) state that the maximum aperture on the walls of the building should be considered as this will make high air intake into the house, thereby causing an increase in internal aeration rate. This can be achieved when the opening area provided on the walls of the building is not less than 40% of the total floor area (Tantasavasdi et al, 2001

4. Application of technology: IBS and Modular Coordination

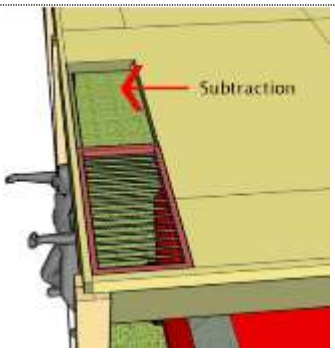
The use of IBS to accelerate and facilitate construction. Implementing a variety of sustainable materials technology to modular panels such as panel walls and floor systems.

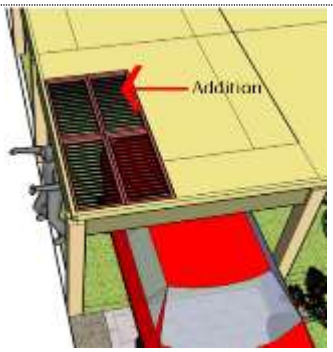




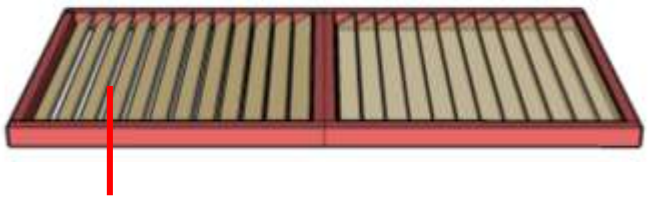
5. Innovative Idea: Materials Application

Various combinations of installation and use of materials.





Environmentally friendly materials / recycled materials



Modular panels which can be added.

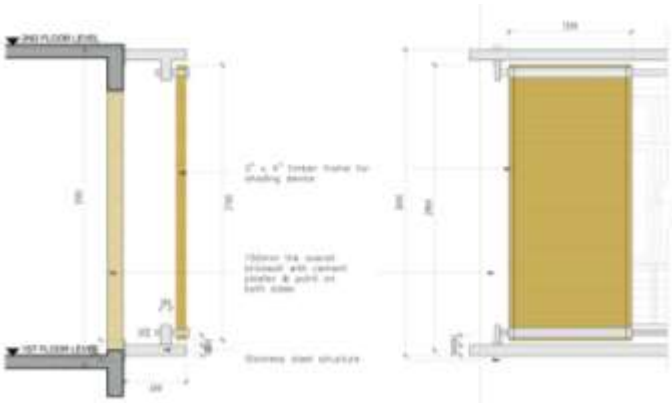
6. Spatial Arrangement: Community integration

Space under the house as a multifunctional space.

7. Sustainable Design : Breathing elements

The goal is on creativity and innovation rather than imitating.

Commitment is to introduce certain unique traditional solution for climate.

8. Sustainable Design : ***'Shading devices'***	
9. Sustainable Design : Rain Water Harvesting Storage of the water sources from rainwater harvesting, is purified and sterilized by rainwater processing units. The rainwater is then used to cool down the roof, watering the garden and toilet flushing. The pool also helps with cooling. Storage for rainwater harvesting systems is located in the ground space for maintenance and overflow from the storage system to the pool which will also be used as a refrigerating cooling system.	

Installation Framework

The whole process takes the approach or adaptation of the traditional architecture where the traditional architecture emphasizes the integrity of the construction and is based on the value and quality of the design. Scientific studies have already explained how the heritage architecture encompasses all aspects of the life of the local community from its socio-cultural values to environmental values and this includes design concepts. Hence the construction process itself must include aspects of building system, construction quality and materials, skill and accuracy of installation, quality and job planning. It will then re-design and fabricate. This approach introduces the possibilities for complex and various elements that will be inserted into blocks or chunks before shipment on the site. This is synonymous with traditional design approaches and the whole process can be observed in Table 2 below.

Schedule 2: Implementation Process for System Installation

ASSEMBLY PROCESS

Elements or Elements This concept uses an elemental or building element approach rather than a small and trivial	**Site** Piling and Utility
Installation This concept applies to the installation process of construction. Installation is fast while construction takes much longer.	***Structure*** Skeletal or *Scaffold*
Installation This concept applies to the installation process of construction. Installation is fast while construction takes much longer.	**Floor Catridge** Wood paneled floor panels, ceilings and roof panels with structural, mechanical and electrical integrated systems
Accuracy This concept requires research on dimensioning quality rather than estimates such as regular construction	**Block** The bathroom comes with mechanical rooms and integrated fixtures, appliances, pipes, wiring, and airways
Installation This concept applies to the installation process of construction. Installation is fast while construction takes much longer.	**Wall Catridge** Wood sheathed wall panels with integrated windows, insulation, cement boards and furniture lekapan dan peralatan
Planning This concept requires a scheduler to install so that the allocated time is completed quickly	**Furnishing, Fixtures and Equipments** Furniture, cabinets, stairs, doors and so on

COMMERCIALIZATION

Design of the Tasik Chini Research Centre (PPTC) Universiti Kebangsaan Malaysia, Lake Chini, Pahang with the Application of Stilt Element

The Lake Chini Research Center (PPTC) is a research complex development project for Universiti Kebangsaan Malaysia conceptualizing sustainable development with the application of elemental strengths as the most important foundation. This development brings treading the earth lightly '(Figure 1) or gently treads the ground a development aimed at reducing the impact on the environment by lifting high-rise buildings from the ground. It complies with UNESCO development guidelines and a study of the Strategic Implementation Action Plan for Lake Chini's biosphere reserves. The research complex is also the first development in Lake Chini which was declared by UNESCO in March 2009 as Malaysia's first Biosphere Reserve.

Picture 1 Tasik Chini Research Centre - Geological and Climatology Laboratory

The complex consists of four lab buildings, a guardhouse, an information kiosk, an administrative building comprising of seminar halls, conference halls and lecture rooms as well as a museum gallery. The complex also provides 4 blocks of residential quarters for researchers. (Refer to Figure 6)

The complexity of the research is mainly in the field of relevant freshwater environmental studies: water quality, environmental impact, air, geography, climate, flora and fauna, zoology, herbs and plants, related to freshwater microbiological studies, tourism, and more related research. (Refer to Figure 7). It offers green technology engineering and development for not only Lake Chini but also other freshwater and ecosystem resources

in Pahang as well as the country. It will also provide services to neighboring countries such as Thailand, the Philippines and Indonesia.

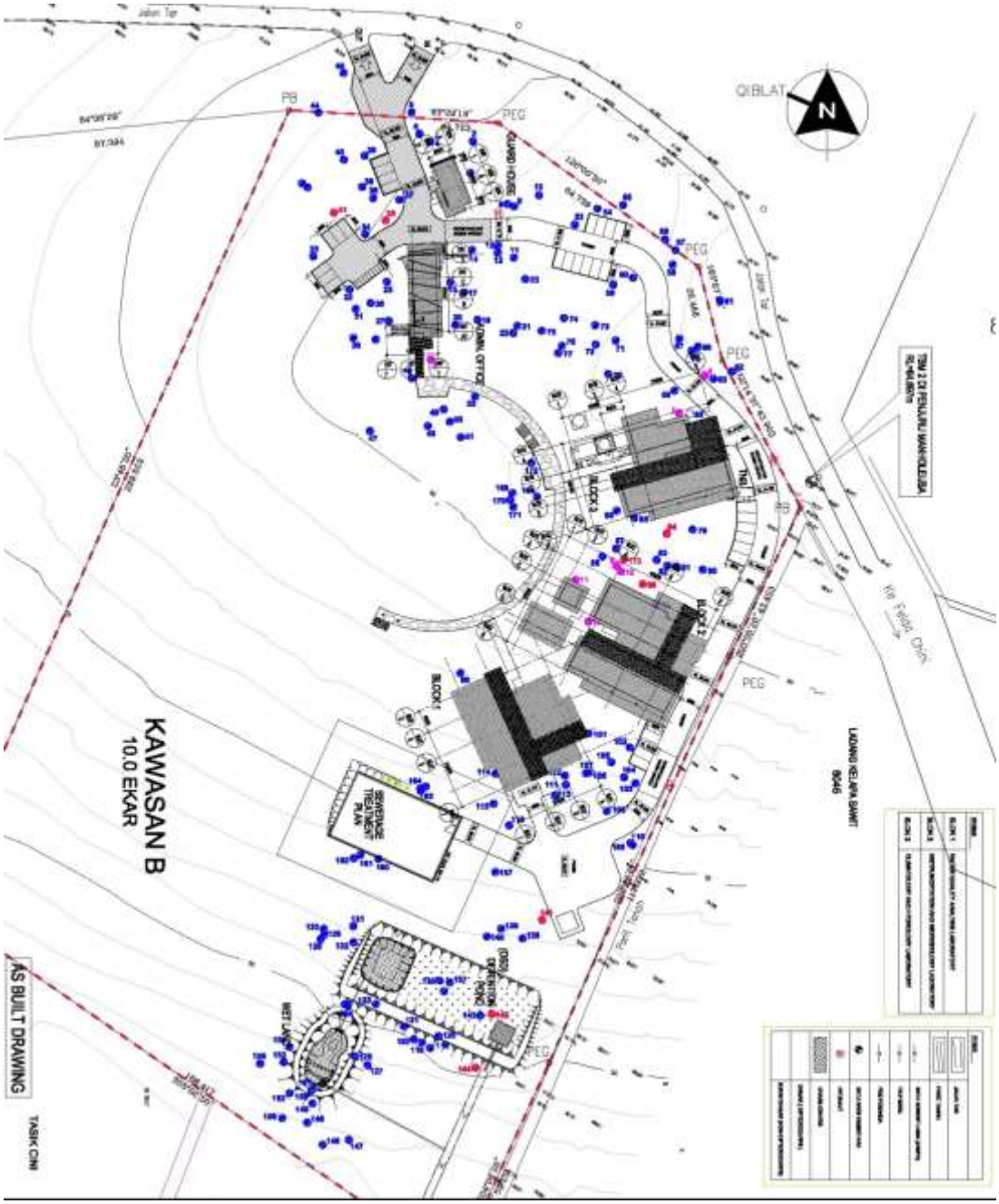


Figure 6 Development Plan of Tasik Chini Research Centre

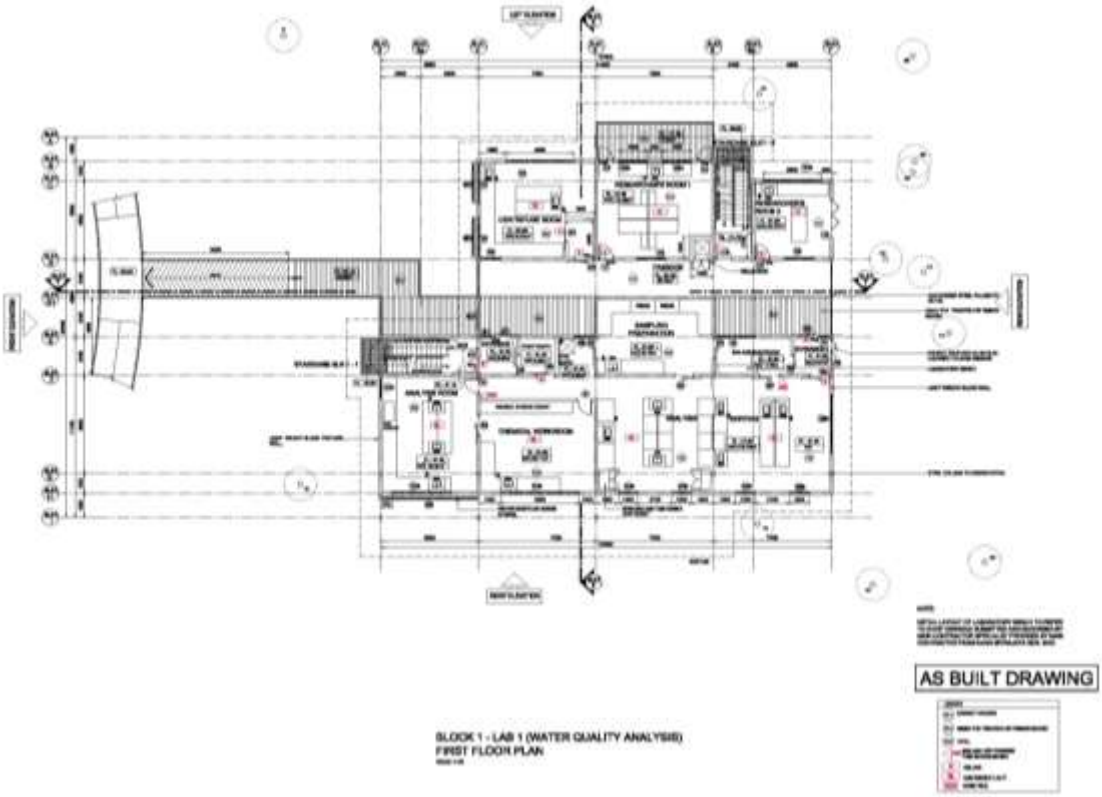


Figure 7 Floor Plan of the Tasik Chini Research Centre

Tasik Chini Research Centre sits on a sloping land and tries to Tasik Chini. It is flanked to the left and right of the palm oil plantation so the soft soil makes the development with appropriate architecture bears. The site of this development site has also experienced flooding and its construction takes into account the highest level of floodwater to ensure that the bottom floor will not be recurring.

Design Characteristics of Tasik Chini Research Centre

The design of PPTC is inspired from the design of traditional Malay and Orang Asli houses with characterized flooring. The entire research complex has a height of different floors based on topography or gradient of the soil. The Orang Asli architecture, which has similarities with traditional Malay architecture, is also taking on an approachable stance in order to create harmonious architecture with nature and share land with surrounding life. All research complexes are connected with boardwalks that are also vulnerable.

This complex character features a characteristic and traditional design that also features various side effects. The complex is built with the concept of Industrialized Building System (IBS) using iron as the main framework for reducing wet work on the site and accelerating the construction process. While the walls use concrete blocks with partially wrapped walls with wooden screens.

This concept implies a traditional building that adopts local design approaches and designs. Design skills are described through the structural and building materials while design planning leads to the harmony and adaptability of an architecture with its climate and environment. This complex design also takes into account the ventilation aspect with full window openings, roof openings, and local sustainable architectural elements. Selection of sites is also based on the topographical situation of the area and indigenous geomancy rituals.

Tasik Chini Research Centre is a development project with a thorough focus on the requirements of UNESCO's Biosphere Reserve Forest with the following objectives:

i. Compliance to the preservation and restoration of Flora and Fauna found on Lake Chini.

ii. Maintain, understand the culture, motives, symbols, stories and values of the local community.

iii. Appreciate the heritage architecture by introducing the architectural elements of an insightful architectural concept.

Height Characteristic and Applied Ground Floor Usage at Lake Chini Research Center to Achieve Thermal Comfort, Lighting and Ventilation

The height of this complex floor level is determined taking into account the flood situation in Lake Chini according to recorded flood data. Hence, when taken into account, the complex is constructed with a difference of floor height between 2.4 meters to 3.6 meters from ground level. The principle of building a legacy home floor is also taken into account where in certain spaces, complex floors are built using hollow metal (perforated metal grating) to promote ventilation and drying. Part of the toilet, for example, the use of hollow floors makes the room easy to dry and not leave the scent.

Open space under the complex is the most comfortable space in terms of terms. This space keeps comfort even during daytime without the help of a mechanical fan. This stratified design also provides multipurpose space and provides double-sided space over the amount of built-in space. It also managed to isolate service zones and mechanical utilities by placing all the services or maintenance in the space below to facilitate maintenance. In addition, the complex safety of animals and theft is guaranteed. According to local Orang Asli beliefs, the height of the main pillars of their homes is also dependent on their nature that holds the foundation of life and share with nature. Their architecture is simple, elevated to avoid flooding and wild beasts as well as lower grounds as a place to store hunting tools or fishing tools according to their search sources.

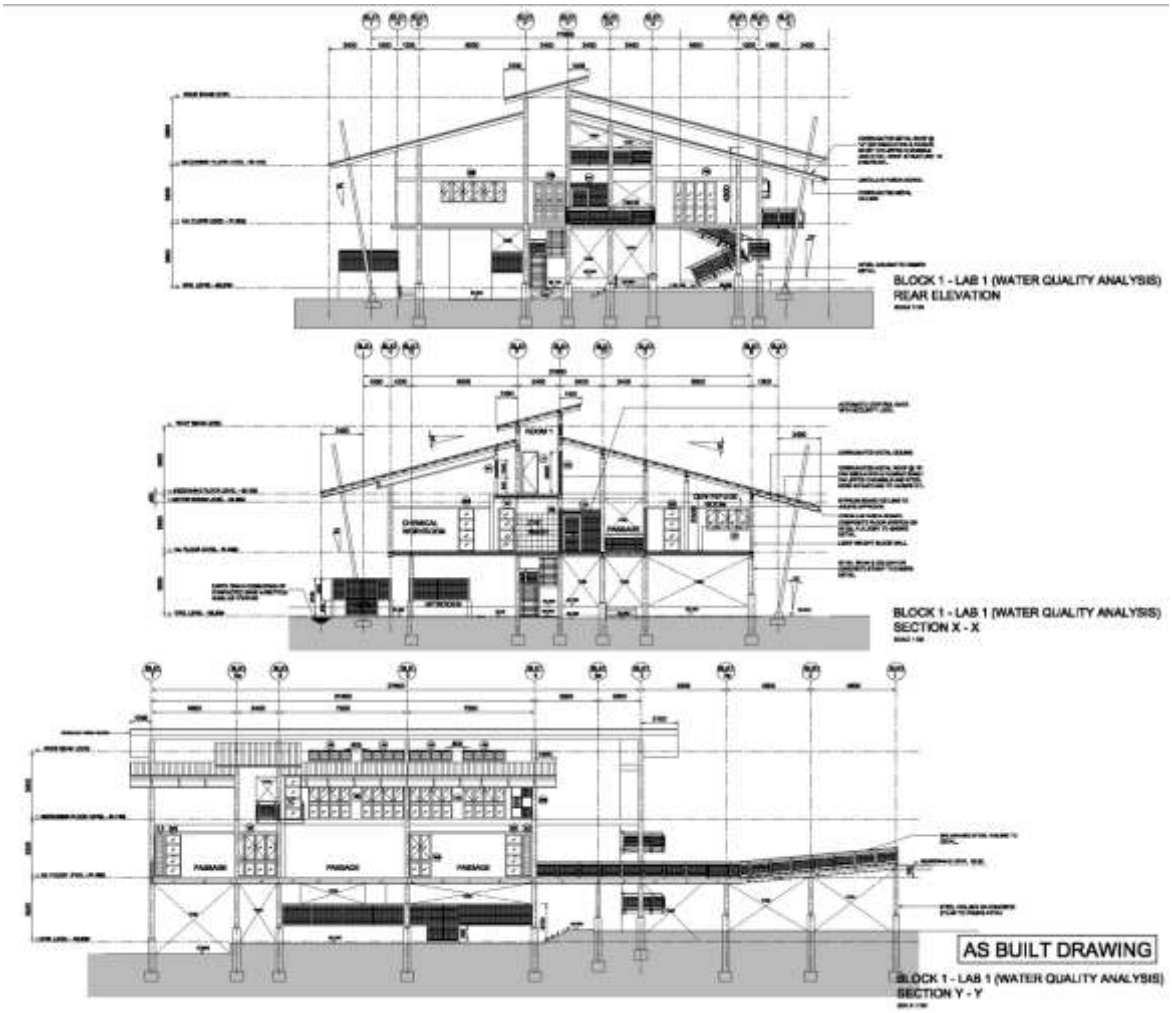


Figure 8 The concept of the development of the Lake Chini Research Center with the raised floor concept

SUMMARY OF TASIK CHINI RESEARCH CENTRE CONSTRUCTION

What is important for the development of this complex is that the elemental approaches are the main concept which transforms architectural perceptions in a more holistic tropical area that is concerned with local conditions. Elemented element transforms construction system by reducing site impact (footprint) building with foundation base

accommodating load from pole support. Hence the building is constructed with a reduction to the cut and fill system that often affects the local nature. The surface water run-off (run-off run) has been reduced because the water is absorbed directly into the soil to provide nutrients for the trees. The lower section of the open building has resulted in double the extra space from the original without high cost increases and has successfully provided a more efficient mechanical maintenance, piping and sewerage system. This approach also provides better thermal ventilation and thermal comforts as a result of more uniform wind movement.

SUMMARY OF PATENT

The patents are aimed at highlighting a more rigorous design and construction process by observing the culture and environment of a society. As a result of the observation, a comprehensive building system process with the use of Industrialized Building System (IBS) offers efficient, fast, and efficient building materials using components or materials that are sustainable. It also offers a concept of sustainability or sustainability with a system of rebuilding rainwater and green roofs. This design concept also takes the approach of observing local traditions and highlighting the element of being played as an alternative solution to local architecture.

REFERENCE

[1] Abdul Halim Nasir & Wan Hashim Wan Teh, (1996). The Traditional Malay House. Shah Alam: Penerbit Fajar Bakti.

[2] Abdul Halim Nasir & Wan Hashim Wan Teh, (1997). Warisan Senibina Melayu, Bangi: Penerbit Universiti Kebangsaan Malaysia.

[3] Abdul Halim Nasir, (1985). Pengenalan Rumah Tradisional Melayu Semenanjung Malaysia. Cetakan Pertama. Kuala Lumpur: Darulfikir.

[4] Abel, C. (1985). “Built Sources of Malaysian Identity” dalam Majalah Arkitek 3, hlm. 32-40.

[5] Abel, C. (1997). Architecture and Identity: Towards a Global Eco-Culture.

[6] Chris Abel (1982). Living in A Hybrid World: The Evolution of Cultural Identities in the Developing Nations, Design 3, Volume 3.

[7] Hyde, R. (2000). Climate Responsive Design. E & FN Spon. London and New York.

Ismail Hussein (1988). Antara Dunia Melayu dan Dunia Indonesia. Bangi: IBKKM-UKM.

[8] Maryam Qays Oleiwi (2015), Industrialized Building System: The Malaysian Approach. Filspay Academy

[9] Maryam Qays Oleiwi, Kamal Nasharuddin Mustapha & H. M. A. Al-Mattarneh (2010), Industrialized building system in Malaysia; Challenges and the Way Forward. Conference: The International Conference on Construction and Building Technology (ICCBT) Malaysia

[10] Killman, W., Sickinger, T., & Hong, L.T. (1994). Restoring & Reconstructing the Malay Timber House. Kuala Lumpur: Forest Research Institute Malaysia.

[11] Lim Jee Yuan, (1987). The Malay House: Rediscovering Malaysia's Indigenous Shelter System, Pulau Pinang: Institut Masyarakat, Malaysia.

[12] Mohamad Tajuddin Mohamad Rasdi, (2004). Sahutan Regionalisme dalam Identiti Senibina di Malaysia: Adaptasi Awal Tradisi Modenisme 1950-1980. Penerbit Universiti Teknologi Malaysia.

[13] Powell, R. (2001). The New Malaysian House. Periplus Edition (HK) Ltd.

[14] Rapoport, A. (1969). House, Form & Culture. Englewood Cliffs, N.J: Prentice Hall.