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Sustainable Design Strategies of Eco Housing Estate in Seremban 2, Malaysia

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***Abstract*—The Eco Housing Estate in Seremban 2, Negeri Sembilan, Malaysia features a new terrace house concept with the dual or veiled facade and open planning scheme. The eco housing scheme is ecologically and environmentally friendly utilising sun shading elements, thermal buffer envelope and addressing strategic site orientation to minimise solar penetration. The proposal is inspired from the environmental issues of the typical terrace houses in Malaysia. The sustainable design strategies implemented are drawn from previous researches on passive design strategies of residential buildings.**

***Keywords*— Eco housing, passive strategies, sustainable design**

I. INTRODUCTION

The Eco Housing Estate is a new terrace house scheme in Kota Warisan Putri, Seremban 2, Negeri Sembilan developed for Tabung Haji Properties. The design project was comissioned in 2016 and consists of 55 units. Seremban 2 is an ideal location for experimenting with new architectural design being a rapidly developing area with a mixture of commercial and residential buildings. The client, Tabung Haji Properties requested for a terrace housing concept that is new and competitive in the market. The architect, Syed Faisal Syed Abdullah, an associate of Domaine Architect Sdn Bhd produces design of terrace houses enveloped by aluminium louvers which act as sun screens for thermal buffer and glare protection. The terrace houses adopt passive design strategies in order to reduce energy consumptions. According to Mirrahimi, S. et al [1] residential buildings in Malaysia contribute to approximately 19% of the country's energy consumption. Therefore, passive strategies especially in relation to the envelope design of the houses in the hot and humid climate of Malaysia are highly recommended. The terrace house also applies open-planning concept on the ground floor for better air circulation while adhering to the local trend, building by-law and practicality as much as possible. The terrace housing scheme is envisioned to be ecologically and environmentally friendly. The total cost for the eco housing estate development is estimated to be approximately RM25 million.

II. ECOLOGICAL DESIGN STRATEGIES

The Eco Housing Estate in Kota Warisan Putri, Seremban 2, Negeri Sembilan utilises several passive strategies including facade treatment, orientation, shading, roof insulation, open interior layout and thermal resistent construction material. Saveral of these sustainable passive strategies such as building orientation, facade treatment, roof projections, shading devices and have been highlighted by other researchers such as A.K.J. Wanti, S. Sakri and V. Swamy [2] although in other climatic region and in relation to vernacular architecture.

A. Façade Treatment and Orientation

The eco terrace house facades are covered by horizontal and diagonal aluminium louvres which protects the elevations from direct sunlight. Typical terrace house facades are usually not covered or shaded, therefore very exposed to sunlight and become heat transfer elements. The eco terrace house front facades are aligned approximately in north or south orientations on the site in Kota Warisan Putri, Seremban 2 to minimise sunlight panetration into the interior spaces. This site orientation has been recommended by numerous researchers and architects such as K.Yeang [3] for climatic reason. Front facades facing north or south orientations would receive sunlight from higher altitude angle. The horizontal louvers which envelope the terrace house font facade would therefore serve as as an ideal sun shading device to block high altitude sunlight from penetrating the interior.

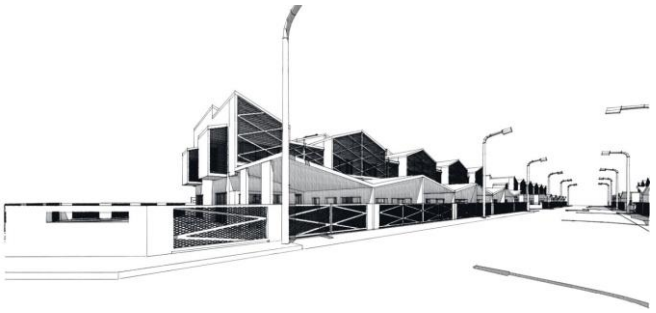

Fig. 1. Perspective view of the eco terrace houses (source: Syed Faisal Syed Abdullah)

B. Sun Shading

Zain-Ahmed et al [4] recommend three important strategies for bioclimatic building design in the Klang Valley, Malaysia which has a hot and humid tropical climate – ventilation, shading and dehumidification. The Eco Terrace House in Seremban 2, approximately 45km away from the Klang Valley is provided with a distinctive shading element consisting of horizontal and diagonal aluminium louvres which protects the elevations from direct sunlight. Typical terrace house facades are usually not covered or shaded,

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therefore very exposed to sunlight and become heat transfer elements. A study by G. Evola, F. Gullo and L. Marletta [5] indicates that appropriate shading device such as external blind can enormously improve thermal and visual comfort inside glazed buildings. The eco terrace house front facades are aligned approximately in north or south orientations on the site in Kota Warisan Putri, Seremban 2 to minimise sunlight panetration into the interior spaces. This site orientation based on sun path direction in the tropic has been recommended by numerous researchers including J.Rilatupa [6] who proposes coordinated adjustment with other site factors and oportunities. Therefore the eco houses front facades do not face exactly north or south orientations due to site configurations. The horizontal external louvers which envelope the terrace house front facade serve as a sun shading device to block high altitude sunlight coming from the north or south directions.

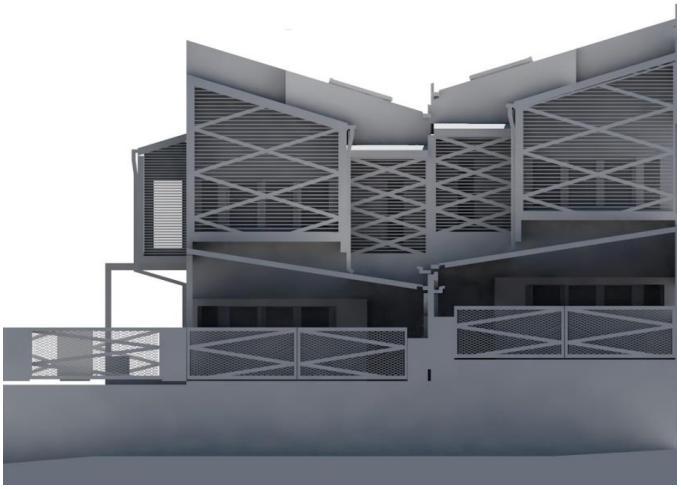

Fig. 2. North/South facing front facade (source: Syed Faisal Syed Abdullah)

The external envelope of aluminium louvers act as sun shading and glare control device against the sun. The space between the louver screen and the concrete and glass façade act as thermal buffer zone and is also appropriated as an air conditioner ledge outside the master bedroom on the first floor. The louver screen provides the owners with extra privacy while inside the master bedroom and at the same time hides the air conditioning unit from the view outside.

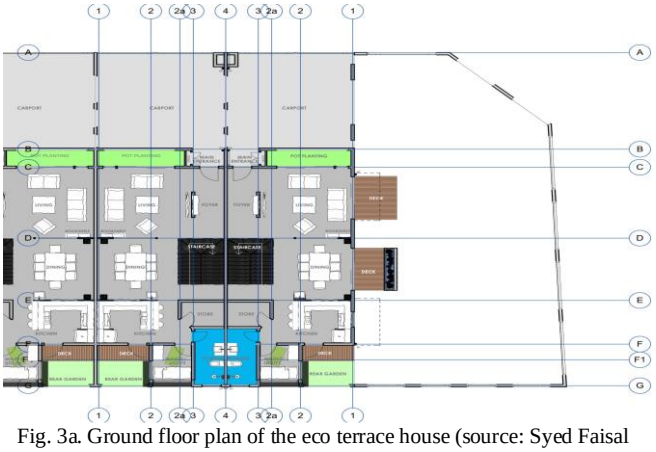

Fig. 3a. Ground floor plan of the eco terrace house (source: Syed Faisal Syed Abdullah)

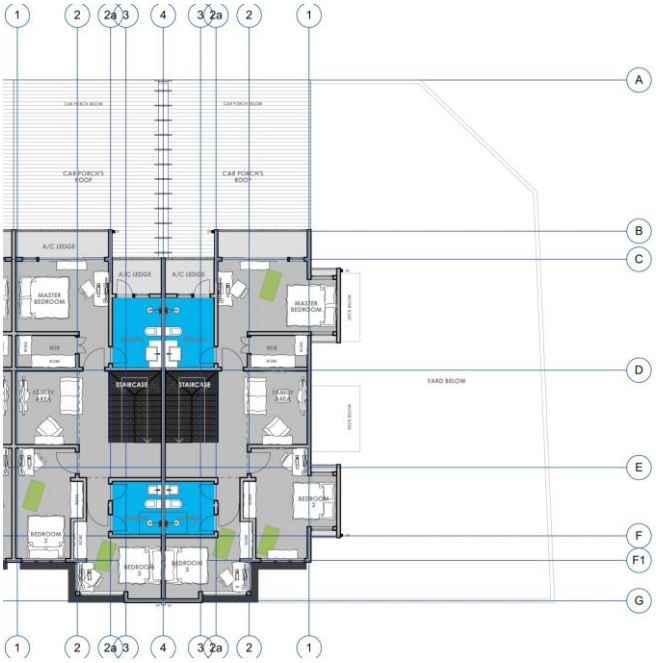

Fig. 3b. First floor plan of the eco terrace house (source: Ar. Syed Faisal Syed Abdullah)

C. Roof Insulation

Terrace house roof is usually the part which receives the most impact from direct solar radiation therefore providing insulation under the roof is essential to prevent heat gain inside the house. This heat gain issue is addressed by proposing insulated roofs for the eco terrace houses which should be able to minimize heat gain from above. The roofs above the family areas and staircases of the eco terrace houses are also provided with skylights to allow daylight into the interior spaces.

The roof or the eco terrace houses will be constructed using metal decking with fibreglass insulation underneath. L. Aditya et al [7] have indicate this type of insulation as recommendable for roof insulation as well as reflective roof surface. The eco terrace houses with metal decking roofs will also have highly reflective surface to reduce heat transfer into interior space underneath.

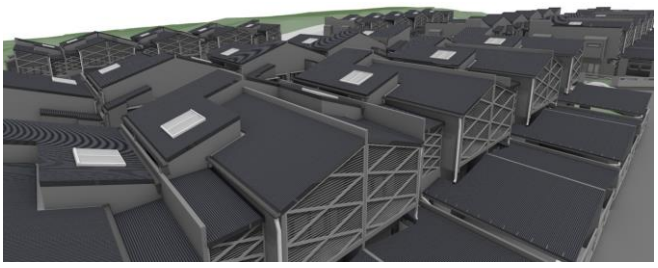

Fig. 4. Bird's eye view of the eco terrace houses showing roof configurations and skylights (source: Syed Faisal Syed Abdullah)

D. Interior Space

Inside the eco terrace house, the living, dinning and kitchen areas are arranged as one continuous space

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separated only by means of permeable partition walls. Originally, the architect proposed the different areas on the ground floor to be totally opened without any dividing partitions, but the idea was rejected by the developer, Tabung Haji Properties on the basis of privacy inside the house. However, the transparencies between the three adjacent spaces are maintained by means of strategically located openings on the partition walls. The wall openings are provided at eye level to allow visibility between the adjacent spaces while maintaining a certain degree of privacy. The openness and continuity between the spaces are meant to reflect contemporary easy and casual life style as well as allowing better ventilation and air movement across the spaces. Ventilation and air movement is important in the design of terrace houses in Malaysia as the lack of it usually contributes to poor indoor air quality thus affecting the occupants' health and perception. A study by Y.H. Lim [8] indicates that this is a crucial aspect in Malaysian terrace house which could influence occupants' perceived comfort and health.

The eco terrace house provide ample operable windows which allow occupants to adjust indoor ventilation and air movement levels to suit their preferences. Ibeyeye Ai, Z. Shari and M.F.Z. Jaafar [9] conducted a survey on 298 households of terrace houses in Putrajaya, Malaysia and concluded that the majority of them opened their house windows from time to time. This behavioral pattern indicates that most occupants desire to have operable windows in their terrace houses thus allowing more control of the indoor air quality.

Fig. 5. Interiors of the eco terrace house unit (source: Syed Faisal Syed Abdullah)

E. External Wall Construction

The eco terrace houses will be erected using typical reinforced concrete structure with the external walls constructed using AAC (Autoclaved Aerated Concrete) blocks for thermal performance. The AAC blocks are three times lighter than normal bricks, durable, fire resistant, high-insulating and could minimize heat transfer inside the house through the external walls. K. Sethy, M.S. Nayak and S.R Nanda [10] describe aerated concrete as a revolutionary construction material which provide heat insulation, sound insulation, fire and mould resistance, reduced dead weight and many other benefits.

III. CONCLUSION

The Eco Housing Estate in Kota Warisan Putri, Seremban 2, Negeri Sembilan capitalises on several passive design strategies to reduce energy consumption and also to increase indoor environmental confort. The passive strategies of the eco terrace houses include facade treatment, building orientations, shading device, roof insulation, open interior space, and thermal resistent external walls. It is hoped that with the sustainable design interventions, the proposed housing scheme would reduce possibilities of post construction alterations by occupants which frequently occur in Malaysia as reported by N.Saji [11].

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REFERENCES

[1] S. Mirrahimi, M.F.Mohamad, L.C. Haw, N.L. Nik Ibrahim, W.F.M.Yusoff, and A. Aflaki, "The Effect of Building Envelope on the Thermal Comfort and Energy Saving for High-Rise Building in Hot-Humid Climate," in Renewable and Sustainable Energy Reviews, 53, pp.1508-1519.

[2] A.K.J. Wanti, S. Sakri and V. Swamy, "Vernacular Passive Cooling techniques - A case study of a Vernacular House in Allur Village, Kalaburagi, India," in International Journal of Engineering Research & Technology (IJERT), Vol. 9 Issue 08, August-2020, pp.334-341

[3] K. Yeang, The Skyscraper Biocimatically Considered. Chicester: Wiley-Academic, 1996.

[4] A. Zain-Ahmed, A.A.M. Sayigh, P.N. Surendran & M.Y. Othman, "The Bioclimatic Design Approach to Low Energy Buildings in the Klang Valley, Malaysia," in Renewable Energy, 15, Pergamon, 1998, pp. 437–440.

[5] G. Evola, F. Gullo and L. Marletta, "The Role of Shading Devices to Improve Thermal and Visual Comfort in Existing Glazed Buildings." In Energy Procedia, 134, 2017, pp.346-355.

[6] J.Rilatupa, "Factor of building orientation direction as determinant the thermal comfort quality," in IOP Conference Series: Materials Science and Engineering, 620, 2019.

[7] L. Aditya, Mahlia, Rismanchi, Hasan, Metselaar, Muraza and Aditiya, "A review on insulation materials for energy conservation in buildings," in Renewable and Sustainable Energy Reviews, 73, June 2017, pp.1352-1365.

[8] Y.H. Lim, "Indoor Environmental Comfort in Malaysian Indoor Housing," in American Journal of Environmental Science, 9 (5): 431-438, 2013

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

[9] Ibeyeye Ai, Z. Shari and M.F.Z. Jaafar, "Occupants' Utilization of Natural Ventilation: A Study of Selected Terrace House Designs in Hot-humid Climate," in International Journal of Built Environment and Sustainability, IJBES 2(2)/2015, 62-74.

[10] K. Sethy, M.S. Nayak and S.R Nanda, "Aerated Concrete: A Revolutionary Construction Material," in International Journal of Engineering Technology Science and Research, Volume 5, Issue 4, April 2018, pp.989=993.

[11] N. Saji, "A Review of Malaysian Terraced House Design and the Tendency of Changing," in Journal of Sustainable Development, Vol. 5, No. 5; May 2012, pp.140-149.