A Holistic Design Approach for Ultimate Building and Construction Performance

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Abstract

Building a house is a big decision for family. Home construction in Thailand costs around 12,000 to 16,000 baht per square meter. Construction today has many techniques to be applied to building construction. A single house in Thailand mostly constructs with masonry which has a huge amount of dead load in its structure. Many special skilled labors are needed to complete the house such as carpenter, brick builder, aluminum, ceramic tile installer, etc. Therefore, the administration cost is as high as 17 to 20 percents of construction budget. Mostly, contractors take about 8 months for completion of one conventional single house. Compared to the new construction and ecological design techniques, building would take about 3-6 month for the whole construction. The eco-house as a sample for this paper shows that labor cost is only 12-42 person-hours per square meter while conventional house has 124-175 person-hours per square meter. The air condition required in Eco-houseis 63-100 square meters per ton compared to 8-11 square meters per ton for conventional house. The construction budget of eco-house ranges from 10,000 – 16,800 baht per square meter which similar to the cost of conventional one. Finally, the results show that using new construction and ecological design techniques can have a better building performance with the similar construction cost.

Keywords: Eco-house, Low income house, Energy conservation, Construction, Thermal comfort**.**

1. Introduction

Thailand home construction has been developed for decades. The conventional materials and structure techniques are masonry and reinforce concrete. In general, to finish one single house, it takes roughly about 8-10 months. Some takes more than a year. The construction cost is also quite high as 12,000 – 18,000 baht per square meter or even as high as 25,000 baht per square meter. The contractor needs to manage different labor skill teams such as carpenter, masonry, steel, and so on. Moreover, to organize the materials and stocks would be very complicated. Besides the construction errors, a huge amount of materials is wasted and discarded to the landfill.

Conventional houses in Thailand normally have poor comfort conditions that cause a lot of energy consumption from air condition system. The more energy use means a lot of green house gas emission. Consumers always seek for a good house at reasonable price. Thai government has been proposing many housing projects such as low income house and government low income house (Figure 1-2) but they are still not good enough for the people to live in. Two factors of major concern are: 1) the good quality house and 2) the affordable construction cost. This paper would review and propose the solution for designers and contractors to build an appropriate house in Thailand.

2. Method

The construction costs of low income houses were evaluated to find the ways to reduce material cost, labor cost, skilled labor as well as construction time. Human comfort conditions inside

each house were evaluated. The energy consumptions were compared to find the investment assumption.

An eco-house was introduced as an example to illustrate the ecological design technique approach for affordable construction. Person-hour of human labour was estimated throughout the construction processes. The energy load was designed as low as 100 square meters per ton of air-conditioning system.

3. Results

Conventional home construction cost ranges from 12,000 to 16,000 baht per square meter. Construction today has many techniques to be applied to building construction. A single house in Thailand is mostly constructed with masonry which has a huge amount of dead load in its structure. Many special skilled labors are needed to complete the house such as carpenter, brick builder, aluminum, ceramic tile installer, etc. Therefore, the administration cost is quite high upto 17 to 20 percents of construction budget. Mostly, contractors take about 8 months for completion of one conventional single house. Compared to the new construction and ecological design techniques, building would take about 3-6 month for the whole construction. The Eco-house as a sample shows that labor cost is only 12-42 person-hr per square meter while conventional house has 124-175 person-hr per square meter. The air condition required in eco-house is 63-100 square meters per ton compared to 8-11 square meters per ton of conventional one. The construction budget of eco-house ranges from 10,000 – 16,800 baht per square meter which similar to that of the conventional one.

Building material is a big portion of construction budget and it accounts for about 65 percent. Labor cost ranges from 15-18 percent. Administration cost would be roughly 20 percent. Energy consumption in building is a key factor to be considered. Figure 4 shows that the energy used in 10 years would be about 70 percent of construction cost for low income house while 20 percent for eco house. As 30 years of energy consumption in a house, low income house consumes energy about 2.5 times of construction budget while eco-house still have only 65 percent of construction budget at the first cost. The main factor to make it success is the good design and we can see the increasing design fee from 2 percent to 8 percent of the construction cost.

The key factor to make the eco-house success is the design integration of structural wall with all utility ducts integrated. Taking advantage of hot humid climate is another key point to reduce energy consumption. The foam cement block is introduced as a building envelope with hollow core as structure column if needed and for wiring ducts including air condition duct.

By integrating all architectural elements with structural system and utilities, the person-hours of special skilled workers is reduced thereby reducing the labor cost. Finally, the results show that using new construction and ecological design techniques can have a better building performance with the similar construction cost of conventional one.

Fig 1. Low income house.

Fig 2. Government low income house.

Fig 3. Sphere house (Note: This figure is not refered in the text)

Fig 4. Eco-house as affordable house for low income housing.

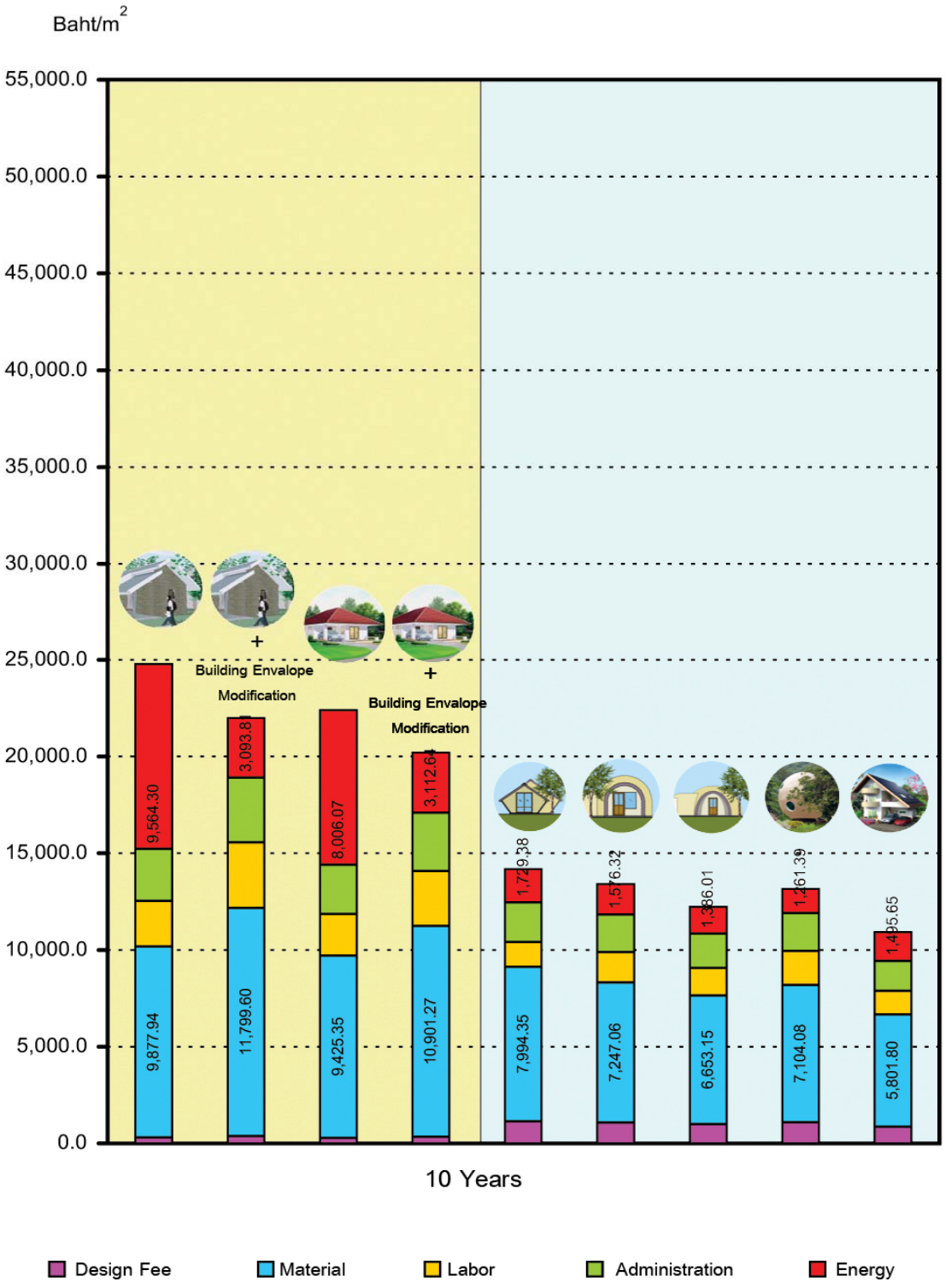

Fig 5. The 10 years construction Budget and energy load comparisons of conventional and ecological design techniques house(Does the chart compare two designs?). (Note: This figure is not refered in the text)

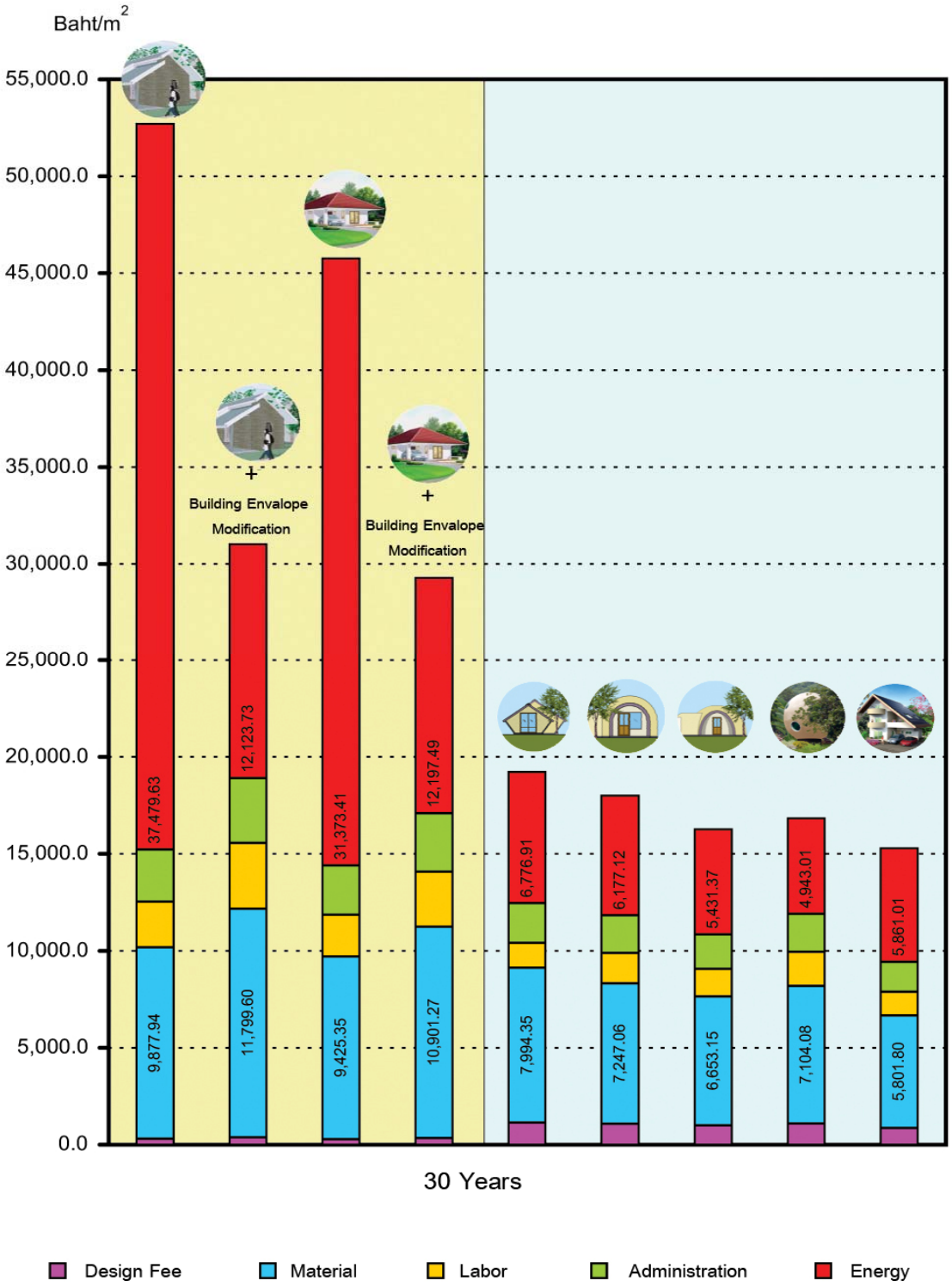

Fig 6. The 30 years construction Budget and energy load comparisons of conventional and ecological design techniques house(Does the chart compare two designs?). (Note: This figure is not refered in the text)

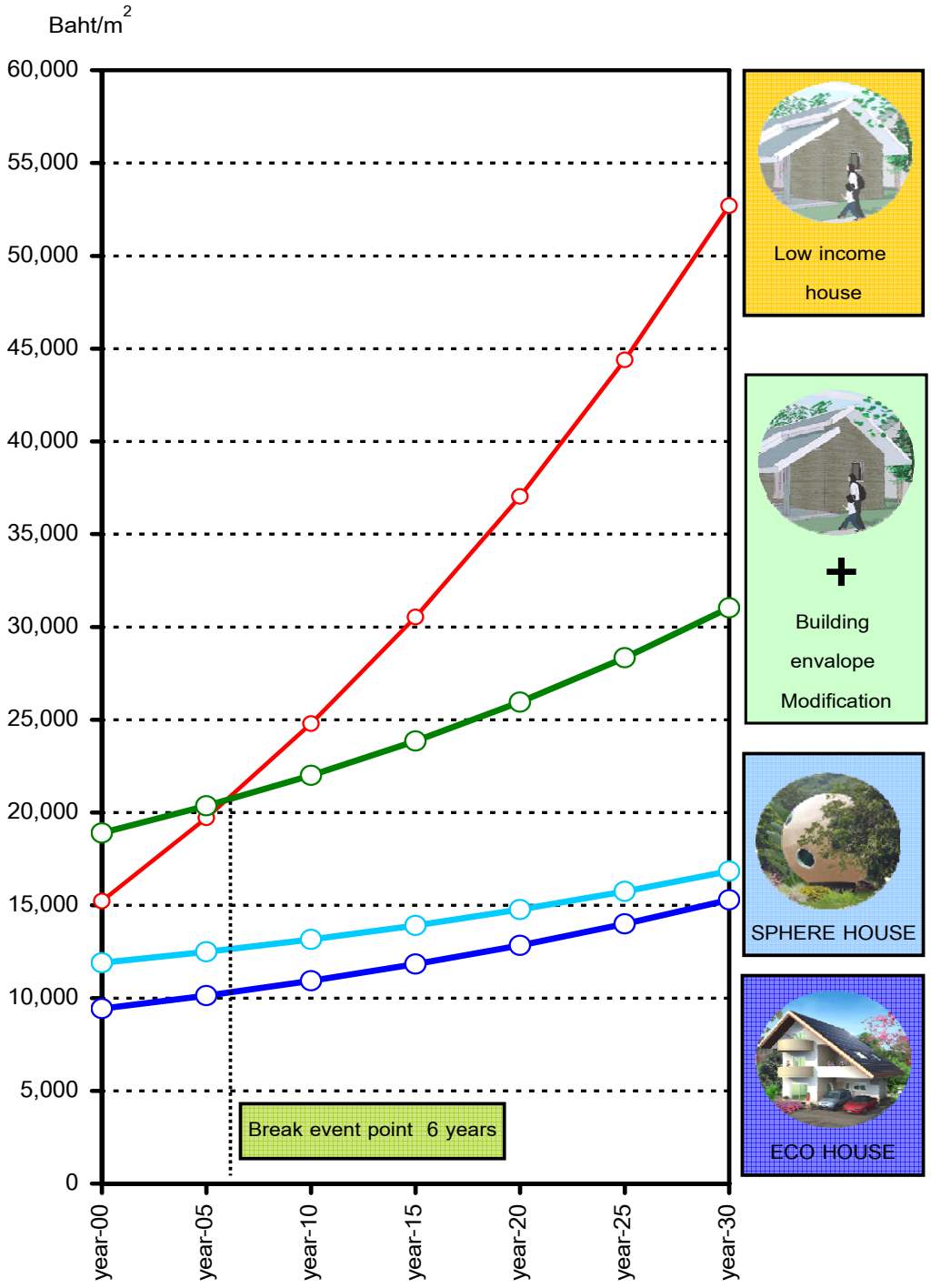

Fig 7. Cost comparative of low income housings. (Note: This figure is not refered in the text)

4. Conclusion

The design integration of structure, architectural elements, finishing, and utilities will reduce skilled labor cost, building material cost, construction time, and provide a better quality of life inside the building. A single house would be built completely within 2 months compared to 8-10 months of brick wall house.(I could not see any supportive information in the paper) A high performance building can be done by using a good insulation envelope as well as door and window. The eco-house uses foam cement block (0.60*0.40*0.20 meter) and uPVC fenestrations with laminated glass. Therefore, human comfort condition inside the house would be close to comfort zone, especially with low mean radiant temperature (MRT). Most low income house would not have acceptable comfort conditions inside the rooms since the use of brick wall and high conduction materials of building envelope. Then, the air condition system is used to cool down the space to reach the comfort zone. Since a good insulation envelope was used, the air condition size would be less at least 6 times compared to the conventional house.

References (Not referred in the text!)

[1] America Society of Heating, Refrigerating and Air Conditioning Engineerings. (2001) ASHRAE Fundamentals Handbook. I-P Edition. Atlanta Geogia: (n.p.).

[2] Boonyatikarn, S. (1999) Design technique: for energy conservation home. Bangkok: Chulalongkorn University Press. [In Thai]

[3] Boonyatikarn, S. (2002) Integrated design approve: Shinawatra University. Bangkok: G M Max Media. [In Thai]

[4] Fanger, P.O. (1970) Thermal comfort analysis and application in environmental engineering. New York: McGraw Hill, 1970.

[5] Olgyay, V. (1992) Design with climate: Bioclimatic approach to architectural regionalism. 2nd ed. New York: Van Nostrand reinhold,.

[6] Stein, Benjamin and Reynolds, John S. (1992) Mechanical and electrical equipment for buildings. 7th ed. New York: John Wiley & Sons.

[7] Boonyatikarn, S. (2004) Bio-Solar home: It is power by the Sun. Bangkok: Chulalongkorn University Press.