

APPROPRIATE CONSTRUCTION TECHNOLOGY FOR RESIDENCE IN CHAO PHRAYA RIVER ESTUARY : A case study of Sakla Village

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ABSTRACT

Construction technology from the West plays an important role in building construction in Thailand, especially in the last 50 years. Major cities can absorb this latest technology faster and greater than any other city due to personnel, organization and capital. Thus the construction of small or large buildings using brand new technology have been constructed extravagantly and carelessly. Moreover, this trend also extends to other regions of the country which lead to the neglect of folk wisdom. The wisdom of local construction has been substituted by new technology without concern for the geography of the area. In 1996, however, the economic crisis caused construction business to come to a halt. The cost of oversea technology had greatly increased due to the baht flotation policy. At that time, many manufacturers and contractors went bankrupt including small building owners in rural areas. Even though construction problems from the past seemed to be relieved some signs of financial crisis can still be found these days. In order to prevent the problems occurring again appropriate construction technology must be studied to create resiliency for society.

The Chao Phraya River estuary is a significant geographic area because it is the most important river in Thailand flows into the gulf of Thailand. This area is highly affected by high tide. The rising tide has an impact on architecture and construction in the area. This thesis employs Sakla village, Nague district, Amphoe Phra Samut Chedi, Samut Prakan Province as a study case. The research aims to study the construction technology of houses and buildings in Sakla village and to understand factors affecting construction technology in the village as well as to analytically summarize appropriate technology for dwelling construction these days. The study also proposes designing guidelines for the village.

This paper is divided into 4 parts. The first part is the study of technological philosophy in terms of the appropriate technology as well as establishing a guidelines for area selecting, basic data studying and the initial survey of the study area. The second part is field work data

collecting with 62 samples from dwelling construction survey and dwelling owner interviews, and 14 interviewing samples from building contractors in order to analyze construction technology in the village. The third part is the description part of construction technology in Sakla village by dividing level of construction techniques and grade of construction materials. And this part also analyzes the pattern of construction technology in the village. The last part synthesizes the appropriate dwelling construction technology for the village and create appropriate technological criteria and design guidelines as well as providing conclusion and suggestions. This paper will focus on the summary of the study and only provide some components of concept, general ideas and dwelling construction in the village.

Keywords : Appropriate Technology / Construction Technology / Chao Phraya River

1. CONCEPT

Appropriate construction technology is based on appropriate technology, as proposed by E. F Schumacher, an English economist in 1970. He elaborated that appropriate technology in developing countries is an 'Intermediate Technology'. Since then, an Intermediate Technology Development Group has been established in England and whenever we are talking about an appropriate technology in developing countries, it will automatically include intermediate technology. In addition, in order to have a better view of an appropriate technology, the review of related literature and texts both in Thai and English has been made. The review found that technology can be divided by the level of tools usage and knowledge transmission. When the criteria for technological selection has been made, the concept of appropriate technology will be revealed. And then after careful consideration of location and geographical characteristics, there will be the answer for an appropriate technology for certain areas according to the relationship of technology, an appropriate technology and an appropriate construction technology, as shown in figure 1.

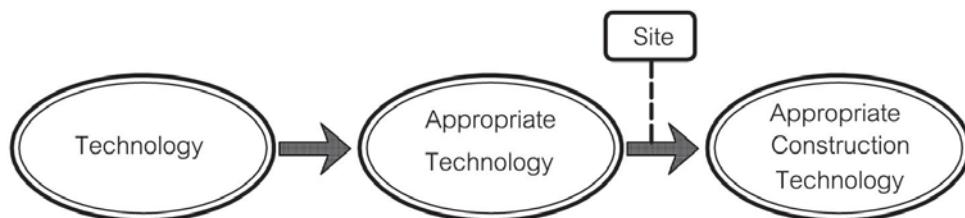


Figure 1: The relationship of technology, appropriate technology and appropriate construction technology.
[Source: Researcher]

1.1 Appropriate construction technology

Summary of appropriate construction technology from a literature review can be described as follows:

1) Technology is the implementation of science for human benefit both physically and mentally. It has two major components :

- Concrete components are hardware and peopleware.
- Abstract components are software and managementware.

2) Level of technology regarding tools and learning :

- Low or Traditional Technology
- Intermediate Technology
- High Technology
- Future Technology.

3) Criteria for appropriate technology selection :

- Technology must conform to geography and climate of the particular area.
- Technology that can be manipulated by human focusing mainly on local workers to create job opportunities for local people.
- Must be simple technology that can be studied easily and can be trained in the area.
- Must be low investment technology, low investment risk and can be possessed by a majority in the community.
- Must be a technology that uses local materials and low energy production.
- Must be environmental and user friendly technology.
- Must be durable, long lasting and occasionally be recyclable.

4) Appropriate Technology is the accurate use of technology according to situations and the environment such as location, local resources, users' skill, tools, transportation, social state, culture and economic for desired purpose.

5) Appropriate construction technology comes from 2 components which are construction material production's technology and construction technology using the materials. Influential factors depend on location, local resources users' skill, tools, transportation, social environment, culture and economy.

According to the summary, the concept of the relationship between technology and appropriate technology and appropriate construction technology can be created as shown in figure 2.

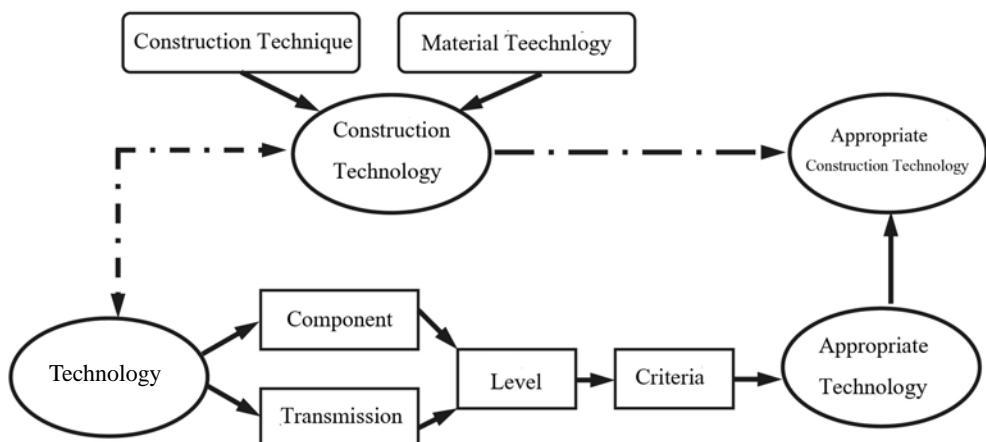


Figure 2: concept of the relationship between technology and appropriate technology and appropriate construction technology [Source: Researcher]

1.2 Concept of level of construction technology

Construction technology in Thailand can be classified into 2 types construction material manufacturing technology and construction technology from those materials called construction technique (Apichart Anukul-Ampai, 1981). Both technological combinations will form a building.

1.2.1 Level of construction material manufacturing technology can be classified into 4 levels regarding current manufacturing technology as follows (Thamrong Prempri, 2003) :

1) **Traditional or Low Material Technology** supplies and manufactured construction material using raw material from local or nearby resources with local workers to adapt and process them. Tools and techniques must be simple and be easy to copy or to operate. For example, soaking and sun dried local bamboo from the forest then cut them in half and arrange them outer surface up and down alternately, use as a roof.

2) **Intermediate Technology Material** brings natural raw material into a useful long life by using simple chemical methods and skilled tools or using machine and labor together, such as wood processing from logs and pottery manufacturer etc.

3) **High Technology Material** uses natural raw material to modify and synthesize by using a scientific process with material properties experiment and test. For example, gypsum board manufacturers must study the proportion of water, rock powder and other chemical substances for special properties such as figure stabilization or durability. Manufacturing must use precise and effective machine controlled by human regarding the target.

4) **Future Technology Material** uses natural raw material in particle synthesis processing to gain higher quality. Also this level uses a variety of research and other new technology. For instance, the development of building painting color regarding the temperature of the day using Nano technology in electron transformation exchange with light particles during the day into an atom layer of that substance.

1.2.2 Level of construction technology can also be generally classified into 4 levels concerning knowledge and laboring skill in using hardware.

1) **Traditional or Low Construction Technique** uses simple equipments such as knife, chisel and hammer or other substitute equipment without training, and labor could be substituted. For example, the construction of a wooden house using bamboo and ropes tie the structure together and take the bamboo to preserve their wood in natural method.

2) **Intermediate Construction Technique** also uses simple equipments such as knife, chisel and hammer but the equipment usage is more complex and needs more skill in the construction. Or there will be the use of labor-saving equipments in this level. Substitute labors must be technically trained. For example, the construction of wooden house using a chisel to pierce holes and chip off bamboo together must depend on calculation and use a chemical method to preserve wood.

3) **High Construction Technique** uses more complex equipment or machine to reduce labor cost and increase product quality. It must depend on equipments and machine usage skills of workers. Substitute labors must be well trained. For instance, the construction of wooden house using laser cutter which would puncture and chip off according to a fixing or calculating pattern and then set up a mirror into the bamboo using rubber and special chemical substances to seal the joint .

4) Future Construction Technique uses a machine to replace labor cost and to increase product quality. The process of manufacturing and planning must be designed and installed.

2. GENERAL BACKGROUND OF SAKHLA VILLAGE

Sakhla village is located in Sakhla Naklue district administration, 15 kilometers from Samut Prakarn province's city center. The total area is approximately 20,000 rai. There are 8 villages according to the administration boundary. Most dwellings are on the Sapasamit canal and originally most people are farmers. However, recently seawater rose so the tide rose, replaced fresh water and infiltrated into soil layers, rice cannot grow in the area. Later, people do salt pan for a living but floods occurred. Now they mainly do shrimp farming for living.

2.1 Geography : Sakhla village is situated on the basin on the mouth of the Chao Phraya River surrounded with canals, with only 4.5 kilometers from the Gulf of Thailand. According to these factors, the tide level has greatly influenced the environment of the area. Together with the digging of a bar at the mouth of a river in 1942, the tide has been raised through Sapasamit canal to Sakhla canal which also benefits local people for water transportation purposes. Local people used this advantage to shift water to do salt pan, making the village well-known for large salt pan sources. Later mangrove trees have been found along the canalside. Since water in the canal is salty, people use them in shrimp farms transforming the area into shrimp ponds. Soil characteristics change from organic substances to muddy soil and cannot be used to plant. Moreover, in the last 15 years, due to over pumping of groundwater and deposit accumulation from the tide, the land subsides more and more every year and has become a main problem of the village.



Figure 3: Aerial photo of Sakla village in 1952, 1967, 1996 Source: Royal Thai Survey Department

2.2 Transportation : In the past, the villagers mainly used water transportation and the most common routes were Chao Praya River-Sapasmith canal-Sakhla canal. They used these routes to transport then used other small canals to the inner village. Boats were used as a vehicle to transport goods to the village and then used workers to transfer goods to houses. After the estuarial evacuation, water quantity and way had been extensively changed between 1983 and 1994 and large engine boat could enter the village which benefits the way of transportation of the area at that time. In 1994, the villagers started to use land transportation instead changing their way of living. The village can be accessed conveniently by car. However, the obstacle was the road ended at Sakhla temple where the rest of the village had to depend on water transportation or pushcart as a mean of transport. Due to the topographical change by flood, people used planks for their walkways and later constructed raised walkway for their transport in the unreachable area by road.

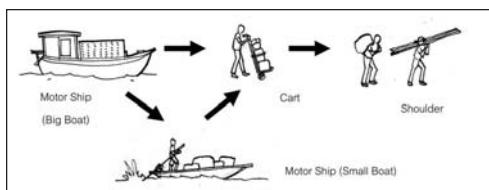


Figure 4: Delivery sequence to Sakla village during 1972 – 1982 [Source: Researcher]

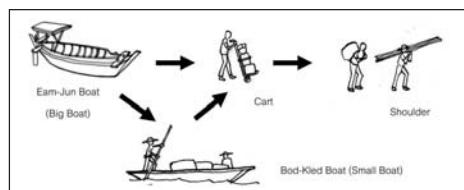


Figure 5: Delivery sequence to Sakla village during 1982 – 1994 [Source: Researcher]

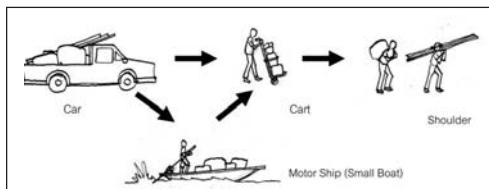


Figure 6: Delivery sequence to Sakla village from 1994 – present [Source: Researcher]

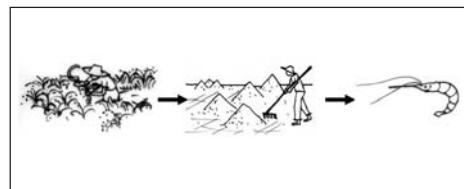


Figure 7: The development of major economics in Sakla village [Source: Researcher]

2.3 Economic Aspect : The village relies on local environment and resources for their living such as salt pan, shrimp farm and crab farm according to the geography. For this reason, the Sakhlas are well-adjusted people. Their occupations change regarding their surroundings without leaving their home resulting in economic stability of the village. Proportion of villages' income is classified as wide-based pyramid type which means there are more low-income people than high-income people. Most villagers collect gold as their assets or build better houses to show their social status. Whenever, the economy grows, residential construction or improvement will increase.

2.4 Social and cultural characteristics : Primitively, Sakhla village was a close agricultural society helping each other. In the last 30 years, however, there have been various significantly changes and the most significant change was land transportation, road, which replaced water transportation which had been used for 200 years. The second factor was the changing of occupation from salt farming to shrimp farming causing major emigration both in and out of the village. From these factors, the closed culture of the village has been merged with alien culture and with majority culture from radio and television media.

3. RESIDENTIAL CONSTRUCTION IN THE SAKHLA VILLAGE

According to the field surveys, the methods of residential construction in the village could be classified in 5 categories.

3.1 Building construction on vacant land comes from family extension to a bigger land or new married couples move from family's houses to live on their own. They usually move to live on vacant land on the edge of the village.

3.2 Demolishing and construction occurs from family extension or needs more space which the old building cannot support the family or the old construction is not stable. In some case, the old building subsided.

3.3 Building modification (building lifting) comes from building subsidence problems about 0.05 – 0.10 meters per year. The problems occurred from floods and a higher road level. Moreover, the old construction and the layout are still acceptable. The cost of building lifting per post for 1-2 floors building was 3,000 baht and for 2-3 floors was 3,500 baht.

3.4 Building modification (Building lifting) and annexing some buildings have subsiding problems so building lifting and annexing are needed.

4. RESULT SUMMARY

4.1 Significant found

4.1.1 Residential construction technology consists of construction technique and construction material technology.

The result of residential or building construction technology in Sakhla village from 60 samples of building field survey and owner interview, as well as 14 samples from contractor interview revealed that:

1) Residential and building construction techniques can be summarized regarding equipment usage and technological instruction into 3 levels :

- Low construction technique
- Intermediate construction technique
- High construction technique.

According to the study, intermediate technique can be mostly found in the area. Contractors in the area are especially specialized in their knowhow. Factors causing the uniqueness of the village construction technique are personal skill, family, education and economic status.

2) Construction material technology used in Sakhla village regarding production tools can be classified into 3 levels :

- Low construction material technology
- Intermediate construction material technology
- High construction material technology.

Regarding, construction material technology in the three levels, only the first level can be produced in the village. Other material technologies must be imported from other areas. The study found that Intermediate construction material technology is widely used in the village. The building owners mostly choose material themselves by using information and suggestions from local contractors. Factors causing the selection of construction materials in the village are geography, transportation, society, culture and economy.

4.1.2 Crossing level between level of construction techniques and level of construction materials lead to appropriate construction technology.

The study result of dwelling construction technology pattern from 60 building samples analyzing separately by bases, surface structures, walls and roofs found 10 types of construction technology. And most importantly found that there were technique combinations between level of construction techniques and level of construction material technology both between the same levels and different levels leading to an appropriate construction technology for the area. The crossing levels came from:

- 1) Residential contractors can apply their own techniques with another level of technique to match construction design and to be accepted by the building owners and other contractors.
- 2) One contractor may have a variety of construction techniques. Lower techniques can be used regarding the situation and can develop construction techniques to the upper technique.
- 3) High technological construction materials are easily acquired and can be used with lower construction techniques. Thus contractors use lower construction techniques using higher construction material technology.

4.1.3 Major factors impacted the change of construction techniques in Sakhla village

The study result of Sakhla village development in three studied periods found that geography, transportation, socioeconomic and culture are the major impact to the change of dwelling construction technology respectively.

1) Geography: Sakhla village is situated in the heart of the mouth of the river and is geographically impacted by high tide and alluvial deposits. These factors determine structure, building and durability of the building as well as determining other factors which impacted construction technology.

2) Transportation: Sakhla village located more than 7 kilometers from the other villages and surrounded by canals. The way of transportation shapes the method of delivering, sizes of construction materials and equipment. And it also shapes economy, society and culture which are factors impacted construction techniques.

3) Economic: The economy of Sakhla village consists of fishery, trading and general employment which determine cost of construction, building requirements and sizes.

4) **Society and culture:** Sakhla village is a relative society in conservative in their customs and way of life which shape area, material and construction technique.

4.1.4 An appropriate construction technology for residence in The Chao Phraya River: A case study of Sakhla village

The study result of appropriate construction technology in Songkhla village due to the analysis of the level of construction techniques and the level of residential construction technology in each component of the building as well as the study of residential construction technology patterns found that appropriate construction technology for residential area in The Chao Phraya River estuary: A case study of Sakhla village. The appropriate construction technology can be classified below:

1) **Construction technique** uses intermediate construction technique in material preparation, composition and installation. And the technique also includes construction planning and controlling. On the other hand, low construction technique was used in material transportation and construction cleaning.

2) **Construction material technology** uses material technology in all levels that are appropriate to geography, transportation, economic, society and culture of the village.

- **Geography:** Using durable and salt-tolerant materials, as well as humidity-tolerant materials which are flood resistant.

- **Transportation:** Using materials that can be transported by car, boat and pushcart to the construction sites. Material size should not be more than 3-5 meters in length in order to pass narrow walkway with only 1.2-1.5 in width. And the weight of materials should be able to be carried by man (one man can carry up to 80-100 kilogram).

- **Economic:** Using modified and recycling materials or material that can be used for other purposes and the construction time should not exceed 1 week to save labor costs for the construction. And material should be available in the area.

- **Society and Culture:** Sakhla villagers are used to easily modified material or no construction planning. They imitate construction techniques in the village and the material must be able to adapt with their local techniques.

4.1.5 Appropriate residential construction technology in dynamic change

The study result of construction technology pattern and construction period in Sakhla village found that the relationship between the 10 construction technology patterns and construction period can be shown in a dome or parabola graph. Low and high construction technology pattern range in both ends of the graph. Median and maximum points depend on most popular technology pattern. The study found that the trend of construction technological pattern is higher and the low technology used in the past will be overlooked. The factors that appropriate residential construction technology has dynamically changed are:

1) Factors impacted residential construction technological change such as geography, transportation; economic, society and culture vary in a certain period of time. Thus, an appropriate construction technology is modified.

2) Levels of residential construction technology in certain periods of time vary. Thus, an appropriate construction technology is changed.

3) Levels of residential construction material technology in certain period of time vary. Thus, an appropriate construction technology is changed.

4.1.6 Problems and obstacles in using appropriate construction technology

The result of residential construction technology's study for The Chao Phraya River estuary: A case study of Sakhla village, found that problems and obstacles in using appropriate technology are :

1) Dramatic differences between levels of construction technique in Sakhla village and import technology from external areas

■ Contractors' construction technique in Sakhla village is mostly ranged between low construction techniques and intermediate ones. Also lacking of education and experience create a gap for them to use high construction material technology causing loss of resources and danger for lives and asset when using them.

■ Regarding high construction material technology manufactured outside the village, the materials are durable, strong and of standard size. Moreover, their price is affordable and their marketing is effective. Thus, high construction material technology replaces low or intermediate construction material technology produced or used resources in the village. Local people cannot rely on themselves and the lack of technological passing on and will be finally lost. On top of that, at present high construction material technology grows significantly fast similarly to other technology creating more gaps between high construction material technology and local construction material technology.

2) Lack of systematic knowledge management in appropriate construction technology

■ Appropriate technological knowledge in Thailand was neglected for 25 years; since academics at that time paid their attention to foreign technology and ignored local wisdom. Therefore, documents, personnel, and organization related to local appropriate construction technology were abolished or lost. These days only senior academics with love and conscious in appropriate construction technology in local Thailand pay attention to it.

■ Architectural and engineering education in all levels is still parallel with local wisdom lacking of knowledge integration. Thus, the gap between construction technology from academics (including architects and engineers) and local people is wider.

4.2 Suggestions

According to the study of appropriate construction technology for wetland in The Chao Phraya estuary, the suggestions will be described as follows:

1) There should be appropriate residential construction technology used in the other areas to compare factors influenced the construction technology and technological usage patterns to create a knowledge base for appropriate construction technology for dwellings in Thailand.

- 2) There should be an implementation of appropriate construction technology concept in dwelling design and construction in order to carry out sustainability and sufficiency regarding the sufficiency economic concept of His Majesty the King Bhumipol of Thailand.
- 3) There should be other fields related to construction technology such as Engineering and Economics working together in appropriate construction technology and publicize the outcome concept to building owners and contractors in the region to strengthen the knowledge in appropriate construction technology in the future.
- 4) All levels of institutions should combine knowledge and local wisdom to train personnel who fully aware of modern technology and appropriate technology for local area in Thailand.
- 5) The government should pay attention and create criteria in obtaining and transferring construction technology from foreign countries to Thailand to create immunity for the Thai construction industry.

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