COST COMPARISON FOR CONSTRUCTION OF HOUSE USING CONVENTIONAL AND INTERLOCKING BLOCK METHOD

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ABSTRACT

The population growth in Malaysia has contributed to the increasing number of construction industry for building and residential area. However, the rising price for building materials has influence the rising price of housing. This issue has affected the small construction industries in Malaysia especially in housing construction. Thus, many developers and parties are trying to find ways to construct affordable houses with shortest time. However, most of them are not aware about new method of construction which is interlocking block method. By using this method, many problems can be overcome especially the duration of construction and offers good solution in construction of affordable housing. The aim of this project is to make a feasibility study on interlocking block building system as an alternative to conventional building system for affordable housing. A sample of single storay house was chosen to calculate the cost of project which is applies conventional and interlocking block method. The difference in cost is compared using bill of quantity calculation and questionnaire method. Briefly, the results show that from survey, interlocking block system help to reduce cost and can be save up to 11.36% and 2.6% from bill of quantity calculation method. From these findings, interlocking block building system can overcome the wastage of formwork problem and reduce the number of skilled labor. Indirectly the cost of construction can be reduced.

ABSTRAK

Pertumbuhan populasi di Malaysia telah menyumbang kepada peningkatan industri pembinaan untuk bangunan dan kawasan perumahan. Walau bagaimanapun, peningkatan harga untuk bahan-bahan bangunan telah menyebabkan peringkatan harga rumah. Masalah ini telah mempengaruhi industri pembinaan kecil terutamanya pembinaan rumah. Maka pemaju-pemaju dan parti-parti mula mencari jalan untuk membina rumah dengan kos yang berpatutan dengan masa yang pantas. Walau bagaimanapun,kebanyakan daripada mereka tidak sedar akan sistem baru pembinaan iaitu sistem blok saling mengunci. Dengan menggunakan sistem ini, banyak masalah dapat diselesaikan terutamanya tempoh pembinaan dan menawarkan penyelesaian yang bagus untuk pembinaan rumah yang berpatutan. Fokus projek ini adalah untuk kajian kemungkinan ke atas sistem bangunan blok saling mengunci sebagai alternatif kepada sistem bangunan konvensional. Satu contoh rumah setingkat telah dipilih untuk mengira kos projek yang mengaplikasikan sistem konvensional dan blok saling mengunci. Perbezaan kos telah dibanding menggunakan pengiraan tafsiran harga dan kaedah soalan kajian. Secara terperinci, keputusan menunjukkan daripada kajian, sistem blok saling mengunci dapat mengurangkan kos dan jimat sehingga 11.36% dan 2.6% daripada sistem pengiraan tafsiran harga. Melalui keputusan ini,sistem blok saling mengunci dapat mengatasi masalah pembaziran bekas acuan dan mengurangkan bilangan pekerja mahir. Secara tidak langsung, kos pembinaan juga dapat dikurangkan.

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c/c	Center to center
D	Diameter
ft	Feet
ft	Feet square
kg	Kilogram
L	Length
m	Meter
m^2	Meter square
m^3	Meter cube
mm	Millimeter
PVC	Polyvinyl Chloride
RM	Ringgit Malaysia
Y10	High teel reinforcement with diameter 10mm
γ	density

LIST OF ABBREVIATIONS

BQ	Bill of Quantity
CIDB	Construction Industry Development Board
FKASA	Fakulti Kejuruteraan Awam & Sumber Alam
FYP	Final Year Project
GDP	Gross Domestic Product
JKR	Jabatan Kerja Raya
MBAM	Master Builder Association Malaysia
RHA	Rice Husk Ash
RMK9	Rancangan Malaysia Kesembilan
SPNB	Syarikat Perumahan Nasional Berhad

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

From the report on The 14th Asia Construct Conference prepared by CIDB,2007, the population growth in Malaysia has increase and contributing the increasing number of construction industry for buildings and residential area. Meanwhile, Master Builders Association Malaysia (MBAM) stated that, the price of raw materials for domestic construction sector is expected to increase due to the positive outlook of the nation's construction industry this year. Sources from Central Bank of Malaysia Yearly Report 2007 in table 3 below shows the growth populations in Malaysia.

Table 1.1 : Labour Market Indicator

	2003	2004	2005	2006	2007
Population (people)	25.3 million	26.0 million	26.1 million	26.6 million	27.2 million
Population Growth Rate	3.3%	2.8%	0.4%	1.9%	2.3%

This study is conducted to compare the cost of house construction for different method used in Malaysia. The result obtained from this study hopefully can help class F contractor to choose the feasible method that can be apply in their construction project. Besides that, a single-storey house can be construct with the most economical budget by focusing on the construction material used which is using interlocking block compared to the conventional construction.

1.2 PROBLEM STATEMENT

An article entitle "Rising Price of Building Materials will Hamper Construction Industry" stated that, the growth of the construction sector recovered after experiencing three consecutive years of decline, recording a growth of 4.6% (2006 : -0.5%). The civil engineering sub-sector was the major contributor as a result of the RMK9 projects executed expediently in 2007. Federal Government development expenditure increased to RM 40.6 billion (2006: RM 35.8 billion) due to the funding of building and improvements of infrastructure such as, schools, hospitals, and government living quarters. Activities in the residential sub-sector continued to remain positive, supported by residential property transactions with foreign citizens which increased by 30% during the first half of 2007. This was due to the Government's efforts in liberalizing property purchases, Property Gains Tax exemptions and relaxation of residential property borrowings allowing foreigners to also obtain loans for the purpose.

Future offers for the housing sector in 2007 increased to 1.5%. However, the national house prices measured by the Malaysian House Prices Index increased 3.8% during the first half of 2007 (2006: 1.9%). This increase was partly due to the constantly increasing building materials prices. The whole ceiling price has been reviewed thrice with a total increase of 45% while the ceiling price for cement was revised at the end of 2006 with a total increase of up to 10%". Master Builders Association Malaysia (MBAM) issued by a local news agency earlier this year said that, the price of raw materials for domestic construction sector is expected to increase due to the positive outlook of the nation's construction industry this year.

Thus this issue has affected the small construction industries in Malaysia especially in housing construction. With current volatility in price, contractor no longer able to absorb price fluctuations on their own without facing serious flow cash problems. Nowadays among class F contractor, they are striving to get the best construction materials with high quality within a tight budget. Problems also occur among client of construction which is the owner of the house to be constructing where they only have a small budget for constructing the house. Moreover, the problem on the wastage from construction such as formwork, cement, sand and many others had causes harmful to the environment such as visual pollution and soil pollution.

Hence, a proper research result by comparing cost is needed in analyses the best option for contractor to choose the effective method by using interlocking block in construction single-storey house within a tight budget and indirectly can help Malaysian with low capital to have their own house.

1.3 OBJECTIVE

The objective of this study is as follows:

1.3.1 To compare the cost of construction between interlocking block and conventional method using bill of quantity calculation and survey.

1.3.2 To determine the problems occur during construction and the awareness among contractor about the beneficial of applying interlocking block method

1.4 SCOPE OF STUDY

In general, this study is much related to the concept and implementation of Industrialised Building Systems in Malaysia. Besides, the main purpose is to have some ideas on how effective and economic these systems are. Regarding to that purpose, here are the scope of study that being highlighted

1. Literary study on Conventional Systems and Interlocking Block Building Systems
2. Focused on single storay house construction
3. Do the survey by distributing BQ form and questionnaire to class F contractors
4. Calculate the cost of each types of building systems
5. Make the comparison between the data gathered from survey and calculation method

1.5 SIGNIFICANCE OF STUDY

By applying the conventional method, developer will only create situations which lead our construction industry into the low productivity and efficiency. For example, an excessive wastage of construction material is always happened in most of the construction projects and clearly can be seen in the construction sites. The example of this situation is the wastage of concrete mix and the formworks in construction sites. Due to lack of coordination, the ordered materials are not as the specification given by the contractor and sometimes it is not sufficient. This is another contribution to the wastage of time, cost and etc.

The condition of construction site which is improperly managed can created lots of problems. The safety of construction workers in construction site is neglected as most of the contractor only thinks about the profit without considering about the safety of their workers. Problem that comes across to this conventional system is the delays due to extension of completion date. Not only the small projects facing this problem. In fact, it has also affected the mega projects like construction of schools and as a result, the school cannot be used as it is planned to be. The end users, for example the students have to suffer using this low quality product. After all, people will accept the fact that most of the products from construction activities are low in quality as well as having so many defects. In simple, people will conclude that construction industry is such an inferiority industry.

The issues about the price for construction materials also increasing and incapability of having own houses among rural resident always occur although Malaysian is achieving a development country

In order to overcome all those problems and help these people, the result gained from this study is valuable in analyzing the best option for contractor to choose the feasible method to be applied in their construction

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The demand of houses for low to medium income population of Malaysia has exceeded more than 37,000 units nationwide. The government has assigned the Syarikat Perumahan Nasional Berhad (SPNB) to develop these houses (The Economic Planning Unit, 2006). With the increase of construction materials costs such as cement, steel and timber, contractors are not enthusiastic to build these houses on a tight budget.

Government has advising construction industry to use the industrialized building systems (IBS) as an alternative in their project. Projects using the IBS will be completed faster hence reducing construction completion time and cut the cost of manpower to more than half. Incentives for IBS usage is also given by the Malaysian government. "IBS has been introduced in Malaysia since early 1960s when Ministry of Housing and Local Government of Malaysia visited several European countries and evaluate their housing development program (Thanoon et al, 2003). After their successful visit in 1964, the government had started first project on IBS, just a year later aims to speed up the delivery time and built affordable and quality houses. About 22.7 acres of land along Jalan Pekeliling, Kuala Lumpur was dedicated to the project comprising 7 blocks of 17 stories flat there are 3000 units of low-cost flat and 40 shops lots"(Hamid, 2011).Sources from IBS centre stated that Industrialised Building Systems (IBS) is defined as the complete assembly construction: a construction system where components are

manufactured at factories on or off site, transported and then assembled into a structure with minimum work. IBS utilizes techniques, products, components, or building systems which involve prefabricated components and on-site installation. Interlocking block system used in house construction also an IBS structure.

From CIDB Industialised Building System Road Map (2003-2010),based on structural aspects, IBS can be divided into five major types:

- Type 1: Pre-cast Concrete Framing, Panel and Box Systems
- Type 2: Steel Formwork Systems
- Type 3: Steel Framing Systems
- Type 4: Prefabricated Timber Framing Systems
- Type 5: Block work Systems

The first four types of the IBS are for high class contractors where the initial cost of entry is very high while type 5 would be suitable for all contractors including the class F group.

2.2 INTERLOCKING BLOCK METHOD

"The block's sizes are modular and rectangular (100 mm high, 125mm to150 mm wide and 300 mm long) in shape. Its dimensions permit multi-dimensional walls making configuration such as buttresses, lintels or columns possible. Corner or junction block is required to maintain right angled corner or a proper T junction.

The interlocking blocks are different from conventional bricks since they do not require mortar to be laid during bricklaying work. Because of this characteristic, the process of building walls is faster and requires less skilled labour as the blocks are laid dry and lock into place. Concrete blocks may be produced with hollow centres to reduce weight, avoid seepages or improve insulation. The holes inside the concrete block allow rebar and concreting (creating reinforced concrete) to run vertically through the block to compensate for the lack of tensile strength.

Rebar used can be of mild steel instead of the usual higher grade steel. Once a section of wall is built, grout holes are filled with a lean cement mixture to seal the wall and making a permanent solid wall. The amount of grout used was calculated to be less than 7.5% of the mortar used in conventional masonry"(Nasly,2009).

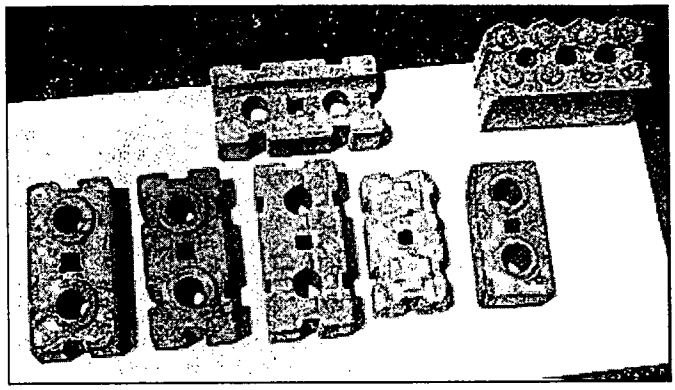


Figure 2.1: Various types of interlocking blocks

Source: Weinhuber 1995

The concept of interlocking blocks is based on the following principles:

- The blocks are shaped with projecting parts, which fit exactly into depressions in the blocks placed above, such that they are automatically aligned horizontally and vertically - thus bricklaying is possible without special masonry skills.
- Since the bricks can be laid dry, no mortar is required and a considerable amount of cement is saved.
- Each block has vertical holes, which serve two purposes: 1. to reduce the weight of the block, and 2. to insert steel rods or bamboo for reinforcement, and/or to pour liquid mortar (grout) into the holes, which run through the full height of the wall, thus increasing its stability.
- The length of each block is exactly double its width, in order to achieve accurate alignment of bricks placed at right angles.

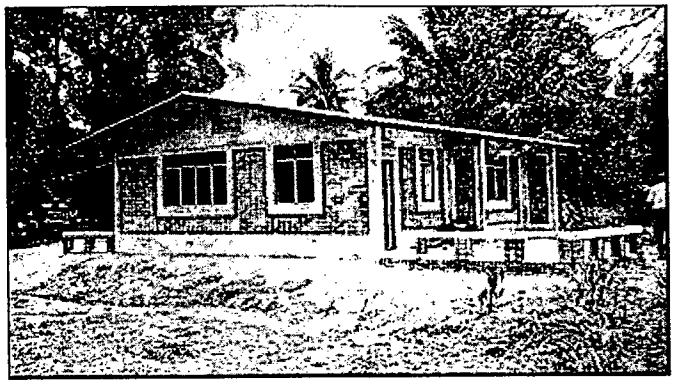


Figure 2.2 : House built with concrete interlocking blocks

Source: Weinhuber 1995

2.2.1 Types of Interlocking Blocks

A variety of interlocking blocks have been developed during the past years, differing in material composition, shape and size, depending on the required strengths and uses:

Different materials

- Soil-cement blocks

-Depending on the soil and cement qualities, the cement-to-soil ratio usually lies between 1: 6 and 1: 10, by volume. (Laboratory tests are essential).

- Rice husk ash (RHA) cement blocks

-The cement-to-RHA ratio is generally 1: 4, by volume. Two types of blocks can be produced: white blocks, with a compressive strength of 4 N/mm, using ash (amorphous silica) from field kilns, burnt below 900C; black blocks, with a compressive strength of 1.4 N/mm, using boiler ash (crystalline silica), burnt up to 1200C;

- concrete blocks

-A typical mix proportion of cement-to-sand-to-gravel is 1: 5: 3.

2.2.2 Different shapes and sizes

Differing in shape and size is depending on the required strengths and uses. The system developed has the following shapes and forms:

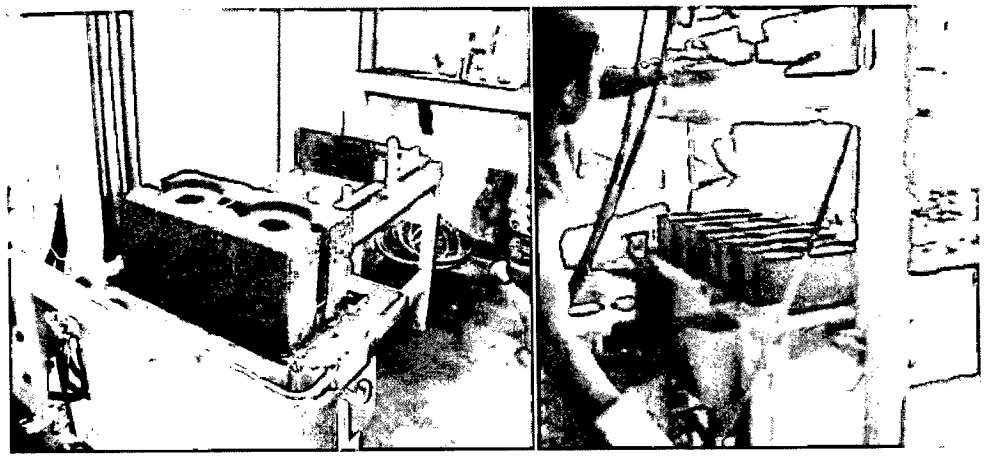
- Full blocks (300x 150x 100 mm) for all standard walls (single or double brick thick)
- Half blocks (150 x 150 x 100 mm), which can be moulded to size, or made by cutting freshly moulded full blocks in half.
- Channel blocks, same sizes as full and half blocks, but with a channel along the long axis, into which reinforcing steel and concrete can be placed to form lintels or ring beams.
- The vertical sides of the blocks can be flat or have recesses, and the vertical grout holes can be square or round.

2.2.3 Production of Interlocking Blocks

From journal entitle "Sustainable Housing Using an Innovative Interlocking Block Building System" written by Nasly,2009, the detail information about interlocking block is explained from the jurnal, she stated that interlocking blocks are produced in special moulds, in which compaction can be done by hand or mechanically, depending on the type of block, material used, required quality and available resources. The blocks can be made directly at the building site, or on a larger scale in a production yard.

Soil-cement blocks are commonly manufactured in manually operated blockpresses (modified CINVA Rams). Two workers prepare the soil mix, shovel it into the mould box and close the lid. Compaction is done by a third worker, who pulls down a long steel handle (lever arm), which pushes up the base plate. After opening the lid and ejecting the block, it is removed by a fourth worker and stacked in a shaded place for curing and hardening.

Rice husk ash and concrete blocks need tamping, or better still vibration, for proper compaction. Therefore, the manual block press is not suitable. Manual tamping is done by jabbing the mix with a piece of wood or dropping the filled mould several times on a hard surface. Higher compaction and greater strengths are achieved by placing the mould on a vibrating table, or holding a portable vibrator against the sides. After demoulding, the blocks are carried away on pallets for curing.



(a) soil-cement blocks and (b)concrete blocks

- **Figure 2.3:** Hydraulic powered block press for making interlocking

Source: Nasly 2009

2.2.4 Building design

Almost any type of building can be constructed with interlocking blocks, the main design constraints being that the plan should be rectangular and all wall dimensions and opening must be multiples of the width of the block type used. All other principles of design and construction, such as dimensioning of foundations, protection against rain and ground moisture, construction of ceilings and roofs, and the like, are the same as for other standard building types.

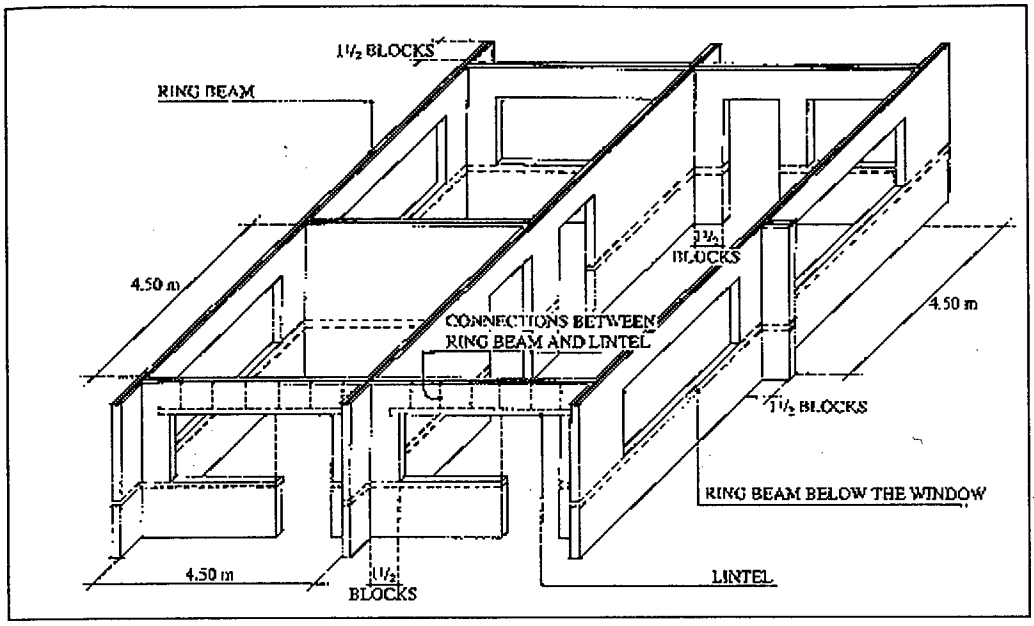


Figure 2.4 : Principles of interlocking block construction

Sources: Nasly 2009

2.3 CONVENTIONAL METHOD

"The conventional building system is divided into two major components. The first component is the structural system, which includes cast in-situ column-beam-slab frames. These frames are constructed through four operations, namely, erection of timber formwork and scaffolding, erection of steel bar, pouring of fresh concrete into form and dismantling of formwork and scaffolding. These operations are labour intensive, tedious and require a lot of on-site coordination. The second component consists of brick and plaster as the non-structural infill material"(Kadir,2006).

Figure 2.5: conventional method- produce wastage by using many formworks.

2.4 ADVANTAGES OF INTERLOCKING BLOCK IN HOUSE CONSTRUCTION

K. Weinhuber,1995 had listed some advantages of using interlocking Block in house construction. The advantages are:

1. The materials required for block production and building construction are usually locally available in most regions; therefore, in areas in which timber is scarce and expensive, construction with interlocking blocks has environmental advantages (no deforestation, low energy requirement for block production and transportation).
2. Unlike the case of timber constructions, termites cannot cause damage to the blocks.
3. Compared with conventional masonry, the dry assembly of interlocking blocks saves construction time and a large amount of mortar, which would otherwise be required for the horizontal and vertical joints.
4. Without the need for high-waged skilled masons (except for the base course), by saving cement (less mortar) and with the speed of construction, the building costs are lower than for standard masonry construction. Additional costs are saved by building loadbearing walls, instead of infill walls between a structural framework.
5. The structural stability and durability of interlocking block constructions can be far greater than for comparable timber constructions. Grout holes and channel blocks