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# EFFECT OF DIFFERENT FILLER ON THE STRENGTH OF INTERLOCKING BLOCK BEAM

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# ABSTRACT

Interlocking block beam can replace normal beam in conventional construction method as a lintel in real construction. The interlocking block system may not solved all of the construction problems but this system does resolve a lot of problem associated with conventional method construction. The main feature of the interlocking block is the replacement of mortar layers commonly used in bonded masonry with interlocking keys (S. F. Omar, 2009). The objective of this study is to determine the ultimate flexural strength of interlocking block beams with two type of fillers, mortar and mortar with superplasticizer and the best arrangement of the interlocking blocks in the production of the beam samples by comparing with the normal concrete beam. A four point bending test is conducted to all five beam samples to determine the properties of the beams including strength, deflection and strain. From the collected data, the interlocking block beam samples have higher flexural strength reading than the control beam sample except one of them. The best filler for the interlocking block beam is mortar with superplasticizer based on the results gathered. All experimental and theoretical results were discussed in this study.

# ABSTRAK

Rasuk blok saling mengunci boleh menggantikan rasuk biasa dalam kaedah pembinaan konvensional sebagai ambang pintu dalam pembinaan sebenar. Sistem blok saling mengunci mungkin tidak selesaikan semua masalah pembinaan tetapi sistem ini telah menyelesaikan banyak masalah yang berkaitan dengan pembinaan kaedah konvensional. Ciri utama blok saling mengunci adalah penggantian lapisan mortar yang biasa digunakan dalam batu terikat dengan saling kunci (SF Omar, 2009). Objektif kajian ini adalah untuk menentukan kekuatan lenturan muktamad rasuk blok saling mengunci dengan dua jenis pengisi, mortar dan mortar dengan superplasticizer dan susunan yang terbaik daripada blok saling mengunci dalam pembuatan sampel rasuk saling mengunci dengan membandingkan dengan rasuk konkrit biasa. Ujian lenturan empat titik dijalankan untuk semua lima sampel rasuk untuk menentukan sifat-sifat rasuk termasuk kekuatan, pesongan dan ketegangan. Daripada keputusan ujian, sampel rasuk blok saling mengunci mempunyai kekuatan lenturan yang lebih tinggi membaca daripada sampel kawalan rasuk kecuali salah satu daripada mereka. Pengisi terbaik untuk blok rasuk saling adalah mortar dengan superplasticizer berdasarkan keputusan yang didapati. Semua keputusan eksperimen dan teori telah dibincangkan dalam kajian ini.

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# CHAPTER 1

# INTRODUCTION

## 1.1 INTRODUCTION

Industrialised Building System (IBS) is a technique of construction whereby the components are manufactured in a controlled environment. This system has a lot of advantages such as the number of unskilled workers can be reduced which means the cost can be reduced a little bit, the wastage of building materials can be lessen, provide better quality of environment and construction site cleanliness.

Interlocking blocks system is an alternative way to replace the conventional building material that can be used as a structural member like column and wall and no formworks are needed. Production of compressed stabilised earth blocks is environmentally friendly because the construction material is primarily made from soil, small amount of cement and water and no firewood are needed in the production of the blocks. Laterite soil has the potential to be used as a compressed stabilised soil load bearing (Nasly & Yassin 2009).

The interlocking block system has been declared as an IBS system due to its concept of production and the ability to make construction faster and also low man power are needed. Rahman and Omar (2006) defined IBS as a construction system that used pre-fabricated components to build. The compressive strength of the compressed blocks is different based on the dimensions and sizes (Aris, 2010).

This study will determine the flexural strength of interlocking block beam by comparing to the normal beam (conventional method) as the control lintel beam and the effect of different filler used in the interlocking block beam on the flexural strength of the beam itself.

## 1.2 PROBLEM STATEMENT

Lintel beam which is a word that came from Middle English, "lyntel" is a horizontal structure member that used in the construction in order to support loads from above of an opening of a building like window or door. It is also considered as the finishing of an opening and it is being supported by two vertical supports. A lintel can be a long thick wood, a concrete beam or can be made of steel.

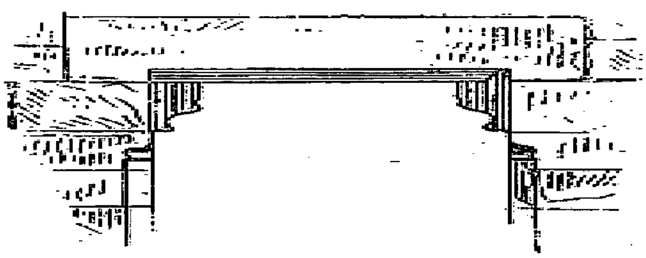

**Figure 1.1: The position of a lintel beam (concrete lintel)**

The production of a lintel beam by using conventional method will need a formwork to hold the concrete before it is started to hardened. Meanwhile, the usage of interlocking block system, no formwork is needed because the blocks will be stacked together just like IBS system. The interlocking block system also can decrease the wastages from construction works like woods from the formwork and concrete.

The construction waste is a serious issue for the environment and also a serious public concern in the whole world that led to many efforts to minimize the waste from it is become unstoppable including by applying the environmental friendly type of construction.

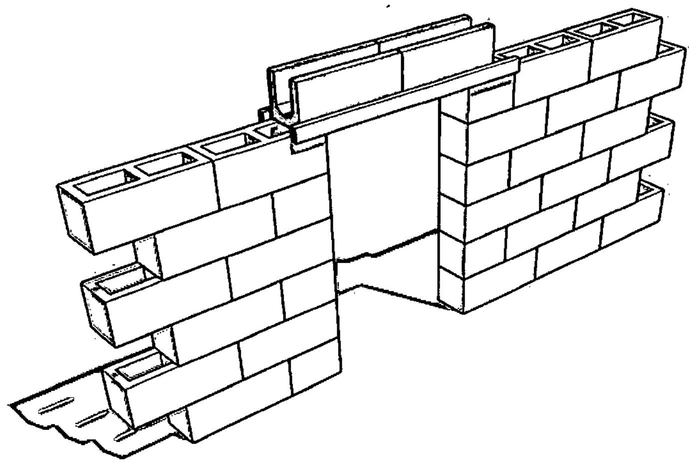

**Figure 1.2: Lintel beam by using interlocking blocks**

Making lintel beam by using this interlocking block system yet cannot be that easy due to the right placement of the reinforcement bars and must be very careful when handling the interlocking blocks when casting the lintel beam since they are mainly made of soil (laterite soil).

## 1.3 OBJECTIVE OF STUDY

The objectives of this research are:

i. To identify the effect of of different filler (either mortar or mortar with superplasticizer) used on the interlocking block beam flexural strength.

ii. To determine the best blocks arrangement in the lintel making either the AU arrangement (both layers of blocks are turned upside down) or the UU arrangement (bottom layer is turned upside down and the upper layer is placed the opposite of the bottom layer).

iii. To identify suitable the placement of reinforcement bars arrangement in the production of the interlocking block beam samples.

## 1.4 SCOPE OF STUDY

This scope of this study is focus on:

i. Particle size analysis is going to be conducted to determine the silt content in laterite soil and river sand.

ii. Production of the interlocking blocks (compressed stabilized earth block), U-channel, full block and half block of the U-channel block by using the same type of laterite soil.

iii. Construct 4 lintel beam samples by using the interlocking blocks made with two different block arrangements (AU and UU) with two different fillers for each type of block arrangements.

iv. Construct a lintel beam by using normal concrete with the same dimension of the interlocking block beam as the control beam for the test that is going to be conducted.

v. Carry out a 4 point bending test on the interlocking block beam samples and also the control beam to get the ultimate flexural strength reading for all of the beam samples.

vi. Analyse all of the data collected through the laboratory testing.

## 1.5 SIGNIFICANCE OF STUDY

This study is mainly about to identify the ultimate flexural strength of the interlocking block beam by using two different fillers and two type of block arrangement in the production of interlocking block beam samples. The data collected after laboratory test on the interlocking block beam samples will be compared to the normal concrete beam sample in order to determine either the interlocking block beam sample can be used and replace the normal lintel in the real construction. IBS give a lot benefits to the construction such as cost savings and more environmental friendly.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 INTRODUCTION

Interlocking block system or the IBS is a system that is being widely used around the world including Malaysia for low rise construction. IBS is used to construct small buildings for the benefits offered by the system itself which are time saving and effective cost term. This system is used to develop low-cost houses which proven to be better than conventional method due to the factors and benefits. The interlocking blocks can be produced by using the laterite soil and recycled laterite soil as the main production material which will reduce the cost of building materials. It also can be used to build many type of building, the main design principle is that the plan should be rectangular and all wall dimension openings must be more width. All the other principle of design and construction are the same as other standard building conventional.

## 2.2 LINTEL BEAM

A lintel beam is a horizontal member that its function is to support any loads (dead load and live load) from above of an opening of a single building. It is used to withstand loads without any deformation or breaking it. It is also known as lintel and post which the beam (the horizontal member) will be supported by two vertical loads such as posts and columns. Some countries used it for timber construction and this technique later adopted for stones structure for load bearing structural member. One of the advantages of this technique is it has a good respond to earthquakes.

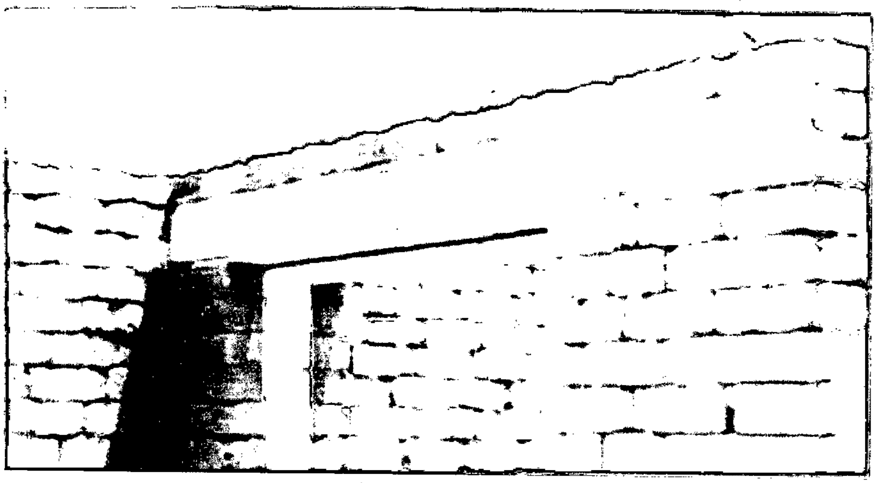

**Figure 2.1: A lintel beam in construction.**

**(http://rebk-tineo.wikispaces.com/Post+and+Lintel)**

## 2.2 CONSTRUCTION OF INTERLOCKING BLOCK

Interlocking blocks are like pieces of legos or jigsaw puzzles only in bigger dimension and brick shapes. The blocks have 2 vertical holes in them which to reduce the material used in casting without compromising the strength and steel rods can be installed in it or mortar can be poured into the holes to increase the strength of a building.

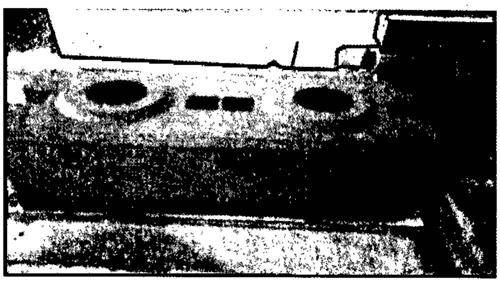

**Figure 2.2: An interlocking block sample**

There are varieties of dimension of the interlocking blocks which provided different functions in the construction. In this study, there are three types of blocks were produced, full blocks, channel blocks and half blocks by using the constructed channel blocks and cut in half by using masonry block saw.

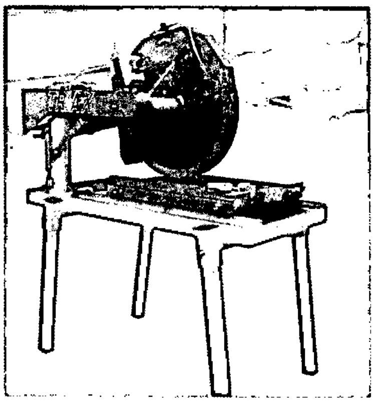

**Figure 2.3: Masonry block saw**

## 2.3. LATERITE SOIL

Laterite soil is type of soil that is rich in iron and aluminium is usually derived from rock weathering under strongly oxidizing and leaching conditions. Almost all of laterite soil existed in rusty red colour due to iron oxide inside of the soil. It forms in tropical and sub-tropical regions where the climate is humid (Mahalinga Iyer & Williams, 1997). The interlocking block can be produced by using laterite soil due to its strength. Laterite soil can be used to as a compressed stabilised soil load bearing block (Nasly MA et al 2009).

Historically, laterite soil has been used in construction long time ago like the construction of Angkor Watt and other Southeast Asian temples. The laterite soil cut into a brick like shapes and were used in the construction of the building.

The laterite are formed from the changes of weathering (laterization) effect in the tropical and sub-tropical region, which resulting in varieties of thickness, grade and chemical composition of the soil. Laterite soil from different locations has different grade and different strength (Akeem AR 2012). Normally, different colours of laterite soil indicate the different chemical compound in the soil which will affect the strength of the laterite soil. A colour change indicates the degree of maturity and is due to the various degree of iron, titanium and manganese hydration (Posnjak and Mervin, 1919).

The construction by using the laterite soil is an ancient construction method. Laterite can be easily cut into brick shape when it is wet and when it is exposed to the air the laterite will gradually hardened due to evaporation process. However, laterite soil is low in strength and it needs stabilizers to be added on to increase the compressive strength. The stabilizers that usually used for soil in improvement of soil strength are cement and lime (Raheem et al., 2012).

## 2.4 MORTAR

Mortar is a paste that made of cement, sand and water that always be used in binding together construction materials such as bricks, masonry and stones and also to fill the voids or gaps between those construction materials. Mortar also has the important role to increase the ability of the load bearing capacity of construction materials. It becomes hard when it cured but the strength is not the same as the construction materials. Mortar is a plastic material with low water/cement ration and high in cement content. Any excess water from the mortar is absorbed into the masonry unit and this will help to create bond between mortar and masonry units (Maizatul Asnie MA, 2010).

**Figure 2.4: Mortar mixed**

## 2.5 FLEXURAL STRENGTH OF BEAM

Flexural strength is also known as modulus of rupture is a parameter that used for brittle material such as concrete. It is also defined the ability of a material to withstand deformation under load and it is symbolised as "$\sigma$". Flexural strength indicates the highest stress experienced in a material as its moment of rupture (Maizatul Asnie MA, 2010).

Flexural strength is measured in term of stress which its SI unit is N/mm$^2$. The value of flexural strength will be known by going through laboratory testing for each material (beam sample). According to ASTM C78-09 Standard Test Method for Flexural Strength of Concrete, flexural strength can be determine by doing the transverse bending test which is most frequently employed, in which a rod specimen having either a circular or rectangular across section is bent until fracture using a three point or four point flexural test technique. The formula used to calculate the flexural strength is:

- For a rectangular sample in a three-point bending setup:

$$\sigma = \frac{3FL}{2bd^2}$$

Where;

$F$ = load at the fracture point (N)

$L$ = length of the support span (mm)

$b$ = width (mm)

$d$ = thickness (mm)

- For a rectangular sample under a load in a four-point bending setup where the loading span is one-third of the support span:

$$\sigma = \frac{FL}{bd^2}$$

Where;

$F$ = load (force) at the fracture point

$L$ = length of the support (outer) span

$b$ = width

$d$ = thickness

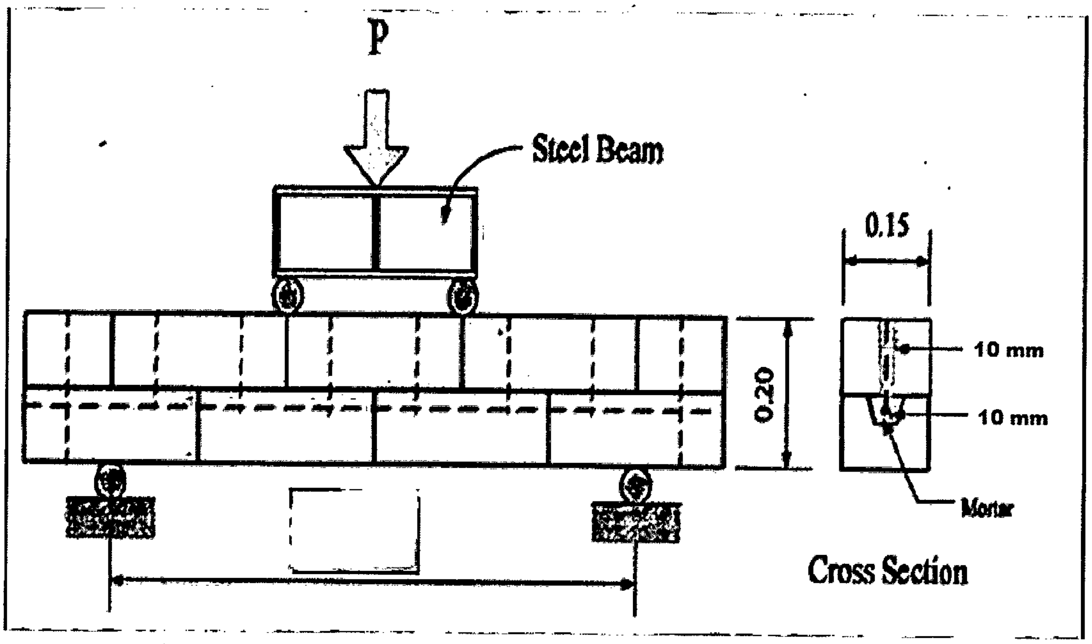


**Figure 2.5: Configuration of the tested interlocking block beam by C. Pongburanakit and T. Aramraks, 2006**

## 2.7 DISCUSSION

From the analysis that has been done in the previous studies related to this topic of study, the filler used in the interlocking block beam did not fully spread the void area in the lintel beam samples due to lack of workability of the mortar. This study will use two types of different filler, mortar and mortar with superplasticizer to determine the comparison. Superplasticizer will lower the water content used in the mortar mix without lowering the strength of the filler and improving the workability of the filler itself. Lastly, when pouring the filler into the channel blocks, make sure the filler does cover all the voids by using vibrator or manually tamp with a steel rod.

# CHAPTER 3

# METHODOLOGY

## 3.1 GENERAL

This chapter will commence the methods used and procedures in details to achieve the objective of this study. It will discuss on how to produce samples of interlocking block (full blocks and channel blocks), fillers that used to fill in the void when the interlocking block beam samples were made and the procedure to produce the interlocking beam samples, curing method until the samples were tested to identify the flexural strength will be discussed in this chapter.

## 3.2 MATERIALS PREPARATION AND TESTING

This section will mainly focus on the preparation of raw materials needed to produce the interlocking block. These raw materials include Ordinary Portland Cement (OPC), Fresh Laterite Soil, Recycled Fine Aggregate and River Sand.

### 3.2.1 Ordinary Portland Cement

There are varieties of Portland cement available in the market. In this study, Ordinary Portland Cement is chosen to be used in producing the interlocking block. This selected type of cement is widely been used and applied in most construction environment.

### 3.2.2 Laterite Soil

The laterite soils were obtained at Kolej Matrikulasi Pahang, Gambang, Pahang, KMPh.

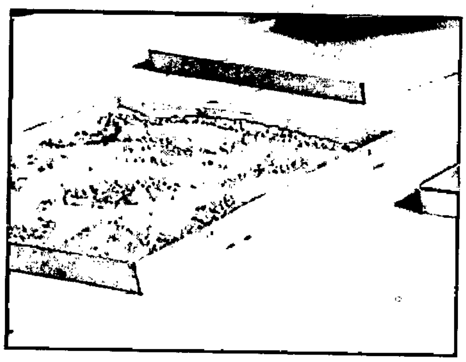

**Figure 3.1: Laterite soils**

### 3.2.3 Sand

River sand has been chosen to be used in this study for the natural fine aggregate.

**Figure 3.2: River sand**

### 3.2.4 Water

The water is also needed in the mixing process. Specified water content used in the mix proportion is 10% from the weight of sand for a single batch of casting.