THE STUDY ON PRODUCTION AND STRENGTH OF ARCH PAN AS PERMANENT FORMWORK FOR FLOOR SLABS

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ABSTRACT

The increasing cost of materials in the construction industry, new types of construction methods need to be introduced. The application of permanent formwork can reduce the wastage produced hence reduce the construction costs. This is because the formwork will remain permanent on the structure and there is no need to dismantle the formwork. This project aims to introduce arch pan as permanent formwork for the slabs by experimental investigation. The scope of this research is focused particularly on the method of producing arch pan as permanent formwork for the floor slabs. This research also includes laboratory testing for the samples in order to get the strength characteristics of the structure. The experiment shows that this arch pan can be used as permanent formwork for the floor slabs structures.

Keywords: arch pan, concrete, plastic netting, plastic mesh, formwork

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

Nowadays, the world becomes more advanced but construction industry is still having waste in construction. Most of the contractors are still using the methods of construction that produce waste such as using temporary formwork for example wood. As we know, the wood is a bit expensive and because of that, the project's profit cannot be optimized. Level of waste during the construction process must be reduced for environmental and economic reason, (www.tandonline.com, 2010). Because of this problem, the permanent formwork needs to be innovated to help contractor reduce the waste in construction. Conventional construction methods have slow pace and higher cost and because of this, it has not been able to meet the demand (Badir et al, 2002)

To meet with future demand, the arch pan as permanent formwork for the slabs can be innovated to help solve this problem. The idea of using arch pan as permanent formwork can be used worldwide because floor slabs are built all over the place around the

world. Maybe it is hard to innovate it for the first time but once it is done, it will be a very useful thing in construction industry. As reinforced concrete (RC) slabs are widely being perceived as costly, time consuming and labour extensive, attempts and researches were made over the years to discover, improve and engineered an alternative system in suspended floor slab construction. To overcome these known deficiencies, a large number of precast systems have been developed (Pessiki et al, 1995).

In this research, the arch pan will be fabricated using different reinforcement materials and the reinforcement material that produce highest flexural strength will be choose to produce the arch pan. The best arch pan with the highest flexural strength can be used as the permanent formwork for the floor slabs in the construction industry.

1.2 PROBLEM STATEMENT

Construction industry is developing rapidly due to the development and modernization of the developing country and also due to the increasing of growth rate of population. It gives a high demand to the material construction especially the usage of woods which is as we know that wood is high in price. **In traditional construction for the slabs, the temporary formwork goes to waste.** Then, there are a lot of wastes in industry, so the researcher needs to find the solution in reducing the cost in construction and to get the optimum profit. It is include reducing waste in construction.

In this research, **production of the arch pan to be introduced to overcome this problem is still not determined.** The researcher needs to find the best method in fabricating arch pan. Then they need to find the best method or the best reinforcement material that produce the arch pan with highest strength.

As the best arch pan is produced, the next problem is how to change the use of woods as temporary formwork to arch pan as permanent formwork for floor slabs. **Setting**

up the temporary formwork using scaffolding and plywood is a waste of time. Thus, study about the construction of floor slabs need to be done by the researcher to help the contractor in reducing the cost and time delay in construction.

Based on the previous research, the arch pan produced does not meet the desired specification. For an example the end of the arch pan is supposed to be a flat end. But instead of flat end, it became pointy end. The pointy end is not good because during the test, it cannot transfer the force equally. Because of this problem, the handwork must be improved or produce a better design for mold.

In addition, the compressive strength and the flexural strength of the cube and arch pan did not meet the desired strength. To improve this problem, we can design better mixture proportion for the concrete.

1.3 OBJECTIVE

The main objective for this research is to determine the best reinforcement material to be used to produce arch pan as permanent formwork for floor slabs.

Other sub objectives that may follow this research is:

i. To identify the method of production for construction components.

ii. To fabricate arch pan using different reinforcement materials.

iii. To determine the compressive strength of cube and flexural strength of arch pan.

1.4 SCOPE OF STUDY

To explore and understand the methods of production of construction components from literature reviews.

1. To identify the methods of production of construction components from internet.
2. To fabricate arch pan using different reinforcement materials.
3. To carry out experimental tests on the compressive strength of cube and flexural strength of arch pan.
4. To analyses and determine the reinforcement materials that gives the optimum strength to the arch pan.

1.5 LIMITATION OF STUDY

The main focus of this study is to find the best reinforcement material to be used to reinforce the arch pan as permanent formwork for floor slabs. The place is limited at the FKASA concrete lab and also FIST lab. After that, identify the methods from the internet such as Google, YouTube for the methods of production of construction components. Then, there will be three reinforcement materials to reinforce the arch pan. In this research, I will find the most suitable reinforcement material for the arch pan.

1.6 EXPECTED OUTCOMES

1. Identify the methods of production of construction components such as culvert, slabs etc.
2. Determine the best way to produce arch pan to be used as permanent formwork for floors slabs.
3. Determine the flexural strength of arch pan and then know which method produce arch pan with highest flexural strength.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discuss about what I had found during my reading on journal and articles. The content will include on type of permanent formwork. I will also include the advantages of permanent formwork. In general, the permanent formwork is function to support the concrete poured with acceptable deflections and it will becomes part of the complete structure.

2.2 BACKGROUND STUDY

With the emergence of technology and demands for the development in the world today has influenced the need to improve the construction process, as conventional method is becoming expensive and time consuming due to inefficient approach.

As reinforced concrete (RC) slabs are widely being perceived as costly, time consuming and labor extensive, the researchers has made over attempts and researches to discover, improve and engineer an alternative system in suspended floor slabs construction. To overcome these known deficiencies, a large number of precast systems has been developed (Pessiki et al. 1995).

The use of profiled steel sheeting as an integral part of RC deck slabs has gained wide acceptance in many countries, especially those where the cost of profiled steel sheeting is low (Kim and Youn, 2009 ; Redzuan and Samuel, 2009).

The trend of inflation in the economy of developing countries and depletion of their foreign monetary reserves have led to increases in the prices of conventional building materials. Many research efforts in recent times in the developing nations have been directed to find the solution in reducing the cost in construction and to get the optimum profit. It is include to reducing waste in construction.

Research has been directed towards in finding the methods to solve it. The solution will help contractor in optimizing the profit of the project and also will cut the cost of something temporary. Woods that has been used in the temporary formwork is more expensive than concrete, so higher profit can be gain by using this permanent formwork. Faster speed of construction can also be gain by using this arch pan as permanent formwork.

2.3 TYPES OF PERMANENT FORMWORK

There are various types of permanent formwork. In this subtopic, I will discuss about some types of permanent formwork that already exist in our world of construction industry. There are various type materials that are being used in generating the permanent

formwork such as timber, concrete, plastic, polystyrene and so on. Each materials will be used depend on the durability, strength and appearance of each case.

2.3.1 Concrete Permanent Formwork

Reinforced concrete plank is one of the most common materials used in permanent formwork. The concrete planks are usually precast and it will be held in the position along the in-situ concrete that is placed around them. There will be some spaces between the precast units. Mortar will be used to fill the empty spaces. To complete the construction process, the in-situ casting will be casted until the finish level.

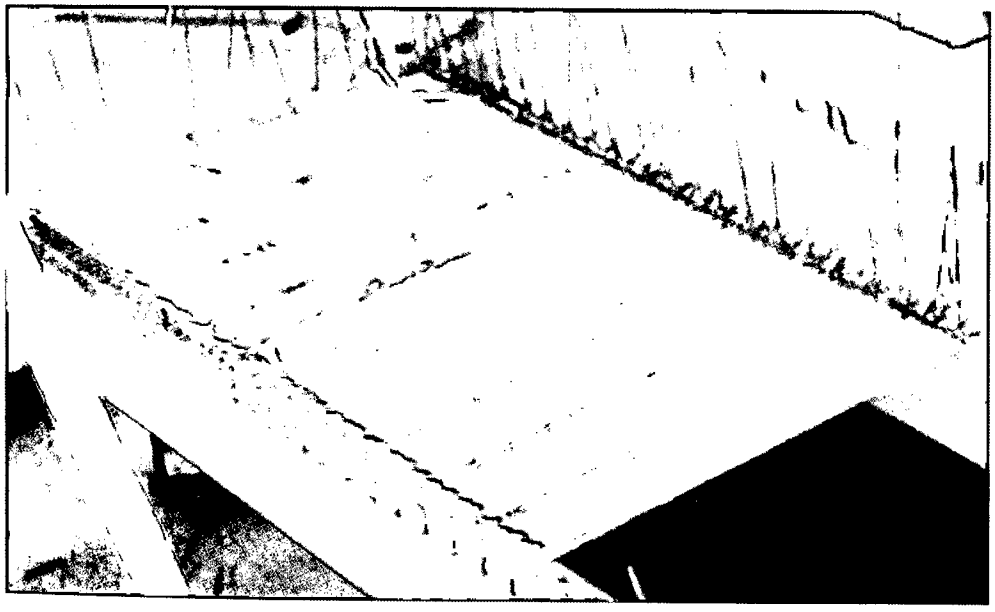


Figure 2.1: Concrete permanent formwork

(Source: http://www.oberbeton.com.ua/en/permanent_formwork)

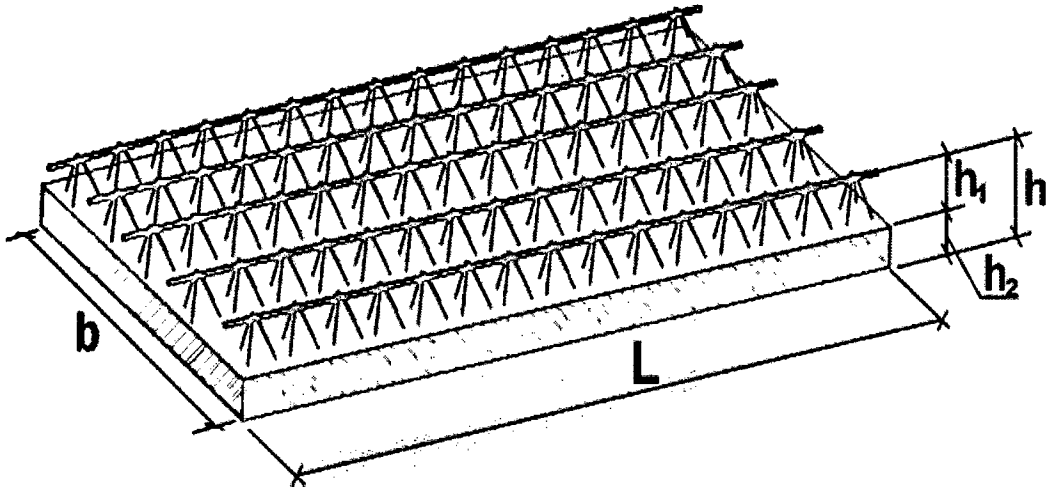


Figure 2.2: Dimension of concrete permanent formwork

(Source: http://www.oberbeton.com.ua/en/permanent_formwork)

This kind of construction method will save the time for the construction process. It will reduce the on-site formwork task that will be such a waste for the woods use and the times consuming.

2.3.2 Plastic Permanent Formwork

Plastic permanent formwork is made of plastic modular elements. It combines engineering with simplicity to produce a cost effective floor. This technology is specifically designed to suit site condition and available in the range of size of 50 mm to 700 mm in height with 260 mm in diameter domes. This formwork in coherence with its purpose, which is quick and easy work in the construction site, is permit intuitive and quick assembly with multiple advantages which is less time used for shuttering, saving time in cleaning and planking which will be smooth and clean, saving time and expenses related to storing, depositing and transporting formwork.

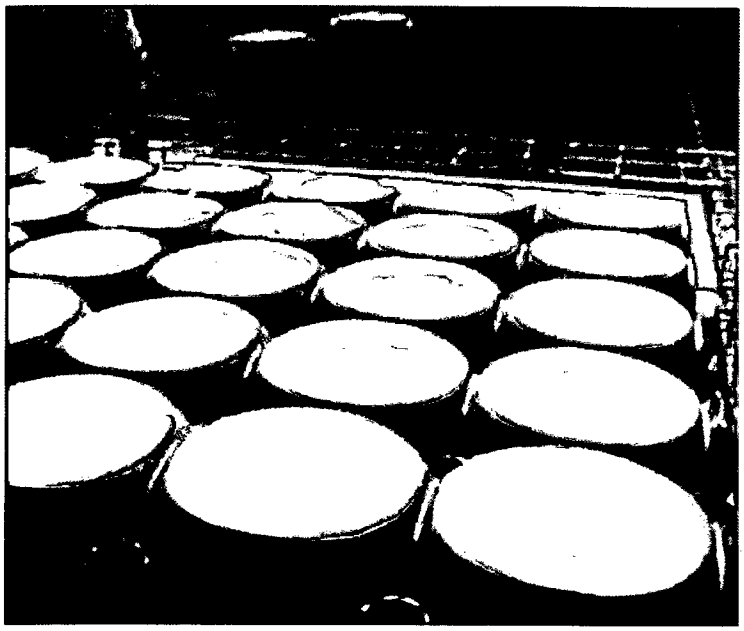


Figure 2.3: Plastic Permanent Formwork

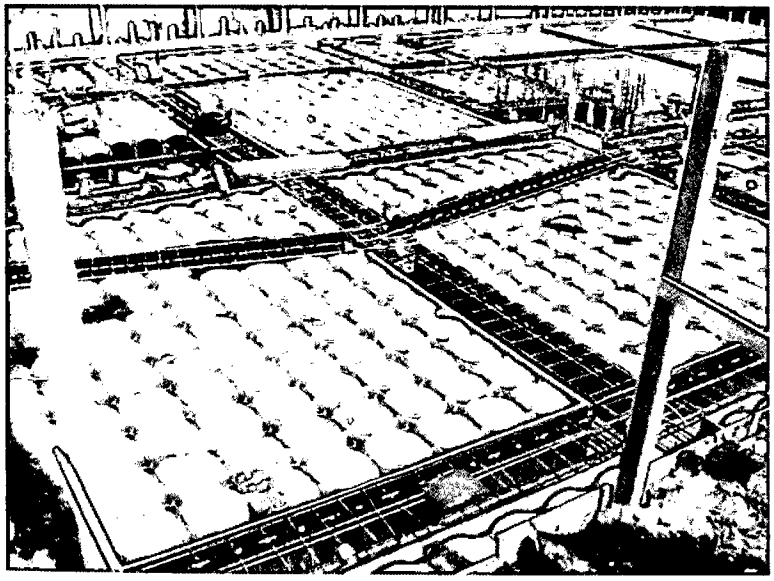


Figure 2.4: Plastic Permanent Formwork

(Source: http://www.archiexpo.com/prod/daliform-group-srl/plastic-permanent-formwork-raft-foundations-52772-1307111.html#product-item_919512)

2.3.3 Fibre-Cement Formboard Permanent Formwork

The fibre-cement formboard is mainly design as one of the crucial part of the whole structure of slab. This fibre-cement formboard is placed between the two beams that are launch in grid accordingly to the geometry of the building. Then a light reinforcing mesh is placed over the surface and will be fully covered by the in-situ concrete. The primary aim in the development of this system floor is to reduce the cost and wasteful formwork from the process of constructing the reinforced concrete suspended floor.

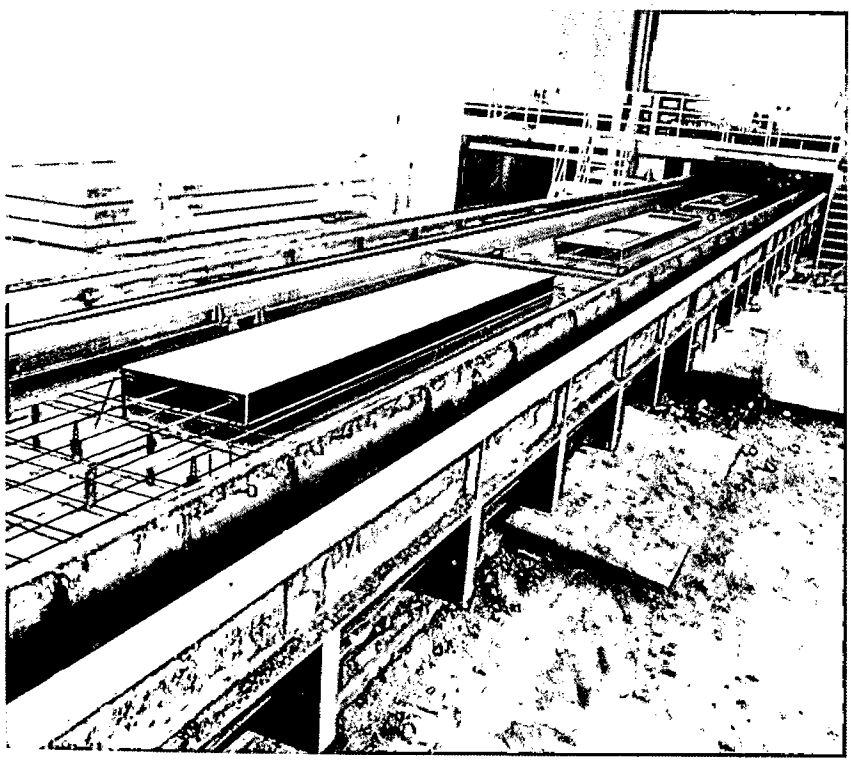


Figure 2.5: Fibre-cement formboard permanent formwork

2.4 ADVANTAGES OF PERMANENT FORMWORK

Permanent formwork is an alternative method in the construction of floor slabs. The contractor should study the construction process and evaluate the benefits and cost of the permanent formwork. These benefits include:

1. Site labour savings on site construction because it will reduce the on-site formwork task
2. Reduction or elimination of false work
3. Saving times in the construction process
4. Reduce the wasteful material on the construction process

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

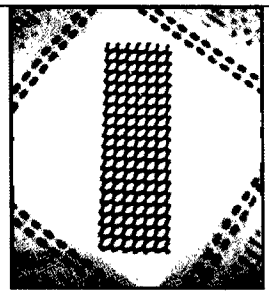
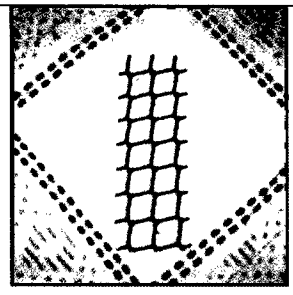
The research of the arch pan as a permanent formwork for the concrete slab was started by having some kind of reading and discussion. The reading is done by having some kind of reading materials through the journals and articles. All of the related finding has been gathered in the literature review. After that, the project will be conducted by doing some design works for the mold of the arch pan. Material testing which called cube test and flexural test also involve in this project. The experiment need to be conducted in a proper precaution steps. After that, an accurate data can be obtained by handling in cautions and following the method procedure systematically. Finally, all of the data recorded will be analyzed to verify the objectives of the project.

3.2 REINFORCEMENT MATERIAL CHARACTERIZATION

The main objective of this research was to determine the best method to produce arch pan as permanent formwork for floor slabs. This chapter will explain more regarding the research been conducted and clearly shows how the objective of this research has been achieved. When doing this research, various tests that has been conducted on the specimens were discussed.

In this research, there are two materials that were used as reinforcement in the concrete arch pan which is plastic netting and plastic mesh. These materials are used to supposedly increase the strength of the concrete arch pan. There are two sizes of plastic mesh which is plastic mesh 5mm and 10mm.

Table 3.1: The Types of Plastic Mesh and Plastic Netting

Plastic Netting	Plastic Mesh – 5mm	Plastic Mesh – 10mm
		

3.3 SPECIMEN PREPARATION

3.3.1 Design of Concrete Arch Pan Formwork

In this research, the equation that are used for the symmetrical parabolic arch are as follow ;

$$y = [4hx(L-x)] \div L^2$$

Where;

h = height of arch

L = length of span

x = vertical distance

y = horizontal distance

The dimension of the arch pan is 570mm x 600mm . The moment at one end of the arch pan needs to take into consideration in order to obtain the shear reaction. The shear equation reaction are as below;

$$V = \int My\, dx / \int y^2\, dx$$

Based on the moment equation, we can obtain the moment values at any points along the arch pan. These values will be used to design the arch pan. The thickness of concrete arch pan can be determined by using maximum shear stress and maximum normal stress equation. The equations are as below;

Maximum Shear stress;

$$tmax = VQ/It$$

Maximum Shear Stress;

$$\sigma max = VQ/It$$

Where;

V = the internal resultant shear force

M = the resultant internal moment

I = the moment of inertia of the entire cross-section area computed about the neutral axis

T = the width of the member's cross sectional area, measured at the point where t is to be determined

C = the perpendicular distance from the neutral axis to a point furthest away from the neutral axis

Q = y A , where A is the top (or bottom) portion of the member's cross sectional area, that was defined from the section where t is measured and y is the distance to the centroid of A, that measured from the neutral axis.

From the equation above, we can obtain the thickness of the concrete arch pan. The maximum moment and the maximum resultant shear forces that exerting along the arch pan are the data needed. The maximum normal stress and maximum shear stress values are needed specifically for concrete Grade 20. Thus, the thickness of the concrete arch pan can be calculated through the moment of the inertia value that being considered in these two formula. The concrete arch pan thickness was chose based on the maximum value.

The arch pan permanent formworks are manufactured manually. It is made of cement, water, sand, carbon fibers, sponge, plastics, and reinforcement bars etc. Removable formwork was constructed made up from plywood. It is complicated process to shape the