PERPUSTAKAAN UMP

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PRODUCTION AND STRENGTH OF FIBER REINFORCED ARCH PAN AS PERMANENT FORMWORK FOR FLOOR SLABS

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ABSTRACT

Nowadays, the methods and cost of construction rapidly change parallel to the current technology development. The application of the permanent formwork will reduce the time consumption and the number of workers for a certain construction project. This is due to the reduction of working load on site. The advantage of the permanent formwork is where the formwork will become a part of the structure. Other than that, the replacement of the temporary formwork will reduce the construction waste during construction. The purpose of this research is to identify the materials, to fabricate and also to determine the strength of fibre reinforced arch pan as a permanent formwork. The scopes of this research are focused on the materials and cost of producing the arch pan as permanent formwork for the slabs and also included laboratory testing for the sample to get the strength characteristic of the structure. This research is to determine the optimal strength of arch pan under uniformly distributed load from the slab and to achieve the required load of 100kg or 1000N of concrete arch pan without cracking. Kenaf fibers were laid inside the length of the concrete arch pan which acts as a flexural reinforcement. Based on the arch pan design calculation, the maximum height of arch pan is 75mm and the required load for the concrete arch pan has successfully passed without cracking. The strength of concrete arch pan increases with the use of kenaf fiber as a reinforcement.

ABSTRAK

Pada masa kini, kaedah dan kos pembinaan membangun pesat selari dengan arus perkembangan teknologi. Penggunaan acuan kekal boleh mengurangkan tempoh masa dan bilangan pekerja di sesuatu projek pembinaan. Kelebihan utama acuan kekal adalah di mana acuan itu akan menjadi sebahagian daripada struktur itu untuk selama lamanya. Selain daripada itu, penggunaan acuan kekal akan mengurangkan sisa pembinaan di tapak projek. Tujuan kajian ini adalah untuk mengenal pasti bahan campur dalam konkrit dan juga untuk menentukan kekuatan bertetulang konkrit 'arch pan' sebagai acuan kekal. Skop kajian ini tertumpu kepada mengenalpasti bahan campur dalam konkrit dan juga melakukan ujian makmal ke atas sampel untuk mendapatkan kekuatan optimum bagi struktur. Tujuan kajian ini adalah untuk mengenal pasti ketinggian optimum 'arch pan' dan untuk mencapai bebanan yang diperlukan iaitu 100kg atau 1000N yang mana konkrit 'arch pan' tersebut tidak akan retak. Gentian kenaf telah digunakan di dalam konkrit yang mana ia bertindak sebagai tetulang lenturan. Berdasarkan pengiraan reka bentuk 'arch pan': ketinggian maksimum 'arch pan' adalah 75 mm dan bebanan yang diperlukan untuk konkrit 'arch pan' telah berjaya dicapai tanpa retak. Dengan menggunakan gentian kenaf, kekuatan konkrit 'arch pan' didapati makin meningkat.

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INTRODUCTION

1.1 BACKGROUND OF STUDY

In Malaysia, there are a lot of contractors involved in the construction industry. Most of them are small contractors. These small contractors will face problem to construct more than one-story building. This is because workers are using lots of scaffolds to construct the first floor slab. While they are using the conventional method of construction, the workers have to erect all of the scaffolds below the first floor slab in order to support the structure of the temporary formwork while the concrete were casting. Then, they also have to wait for ten days of duration time before all of the scaffolds can be removed. (Abrahamsson, 2003).

The arch pan as permanent formwork for the slabs can be invented to help solve this problem. The consideration using arch pan as permanent formwork can be used worldwide because floor slabs is built all over the place around the world. It will be a very useful thing in construction industry as reinforced concrete slabs are widely being perceived as costly, time consuming and labor extensive, attempts and researches were made over the years to discover, improve and engineer an alternative system in suspended floor slab construction. To overcome these known deficiencies, a large number of precast systems have been developed.

1.2 PROBLEM STATEMENT

Generally, the application of the permanent formwork will reduce the time consumption and the number of workers needed for a certain construction project. This is due to the reduction of working load on site. There is no need to dismantle all the formwork. Other than that, the replacement of the temporary formwork will reduce the construction waste generation during construction. Then, this kind of application will directly improve safety by reducing hazards during construction and no need to burn all of the formwork that cannot being used anymore. (Metin Arslan, May 2005)

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1.3 RESEARCH OBJECTIVES

The main objectives of this research are as follow:

1.3.1 To identify the materials for production of fiber reinforced arch pan.

1.3.2 To fabricate arch pan using three different materials mixture.

1.3.3 To determine the flexural strength of fiber reinforced arch pan.

1.4 RESEARCH QUESTIONS

1.4.1 What are the materials can be use in this research to produce fiber reinforced arch pan with highest strength?

1.4.2 Which is the best materials mixture to produce fiber reinforced arch pan?

1.4.3 What is the maximum load that can be applied?

1.5 SCOPE OF STUDY

This research is conduct:

1.5.1 To identify the fiber materials to be used as reinforcement of arch pan.

1.5.2 To test the tensile strength of the fiber.

1.5.3 To fabricate arch pan using plain concrete.

1.5.4 To fabricate arch pan using kenaf fiber and different per cent composition.

1.5.5 To find the treatments for the kenaf fiber before mix with the mortar.

1.5.6 To carry out experimental tests on the flexural strength of arch pan.

1.5.7 To analyses and determine the fibers that give the optimum strength of the arch pan.

1.6 SIGNIFICANCE OF RESEARCH

1.6.1 The best method to produce arch pan is determined.

1.6.2 The construction materials such as plywood are not going to waste anymore.

1.6.3 Faster construction time and can low the risks of delay in construction.

1.7 EXPECTED RESULT

1.7.1 Identify the methods of production of construction components such as culvert, slabs etc.

1.7.2 Determine the best way to produce arch pan to be used as permanent formwork for floors slabs.

1.7.3 Determine the flexural strength of arch pan and then know which method produce arch pan with highest flexural strength.

1.8 CONCLUSION

The study has been focused on the design process of concrete arch pan formwork. The main materials used for arch pan formwork is plywood. The required force for the concrete arch pan is 1000N. The optimum height of the concrete arch pan is 75mm, while the thickness of concrete arch pan is 15mm. The kenaf fiber is used as the reinforcement in order to increase the flexural strength of the concrete arch pan.

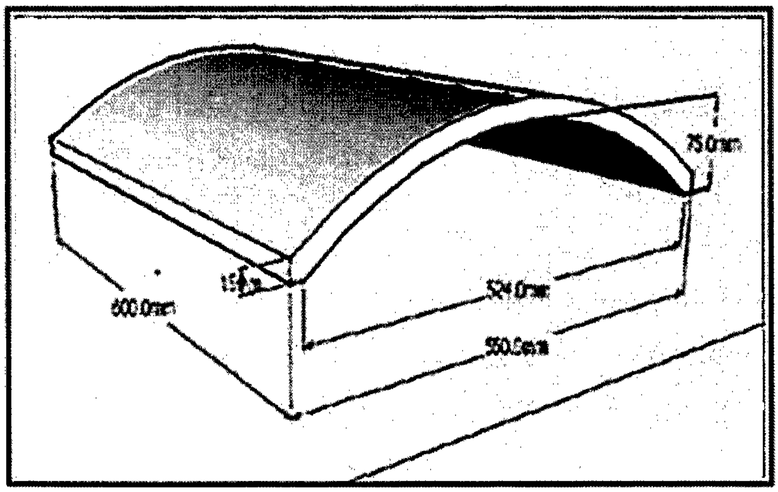

Figure 1: Arch pan dimension

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

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 slabs are widely being perceived as costly, time consuming and labour 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 have been developed. (Pessiki et al.1995).

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 including 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.

2.2 KENAF FIBER

The development of high-performance engineering products made from natural resources is increasing worldwide, due to renewable and environmental issues. Among the many different types of natural resources, kenaf plants have been extensively exploited over the past few years. Therefore, this paper presents an overview of the developments made in the area of kenaf fibre reinforced composites, in terms of their market, manufacturing methods, and overall properties. Several critical issues and suggestions for future work are discussed, which underscore the roles of material scientists and manufacturing engineers, for the bright future of this new "green" material through value addition to enhance its use. (H.M. Akil, September 2011).

Kenaf fibre is unique and potentially reliable. Kenaf fibre is extracted from bast fibre of kenaf plants. Properties of kenaf fibre composite are comparable to conventional fibre composites. This fibre composite can be produced using conventional fibre composite manufacturing. It composite has a bright future due to its renewability and eco-friendly.

Figure 2: Kenaf plant

2.2.1 Usage of kenaf fibre

Natural plant fibers are being increasingly used in manufacturing industrial products because of their renewable and biodegradable natures. Natural fiber-based products have been seen in industries like automotive, paper, construction, environmental cleaning, transformations, food, biofuel, paper pulp, automotile interior panels, composite with PP in polymer industry, fiberglass substitute, textile composite, animal bedding, particle board, industrial absorbent materials, soil-less potting mixes, animal forage, packing material, and organic filler for plastics.

Usage	**Description**
Kenaf Fiber/Plastic Compounds	Replace glass reinforced plastics.
The Automotive Industry	In 1996 Ford Mondeo interior automobile panels.
Construction and Housing Industry	Moulded into lightweight panels and can replace wood and wood based products.
Food Packaging Industry	Bulk chemical and pharmaceutical packaging, parts packaging in the electrical and electronics industries.
Oil & Chemical Absorbents	Clean up operations in refineries, utility companies, land and sea spills and oil rigs.

Table 1: The use of kenaf fiber

2.2.2 Kenaf Fiber Pre-treatment

The kenaf fibres that were used were received from the supplier retted, dried and cut to lengths of approximately 25 to 38 mm. Due to the presence of lignin, the fibres were not easily separated but were rather held together in small fibre bundles. Upon receiving the fibres several pre-treatments steps were conducted to ensure that the fibres were in a suitable condition to be incorporated into a concrete mixture. This included mechanical separation or 'opening' and chemical pre-treatments of the fibres. The fibre opening was achieved by passing the fibre bundles through a series of metallic combs and blowing with air. This is similar to the process used to open textile fibres. (Elsaid, 2011)

Chemical pre-treatments are essential to ensure the successful performance of natural FRC's. Chemical pre-treatments are applied to enhance the bond between the organic fibres and the inorganic concrete matrix. Anti-microbial treatments are applied to prevent degradation of the fibres and to enhance the overall durability of the FRC. In the current study the kenaf fibres were treated with propriety, urethane based surface treatment which was designed to enhance the bond between the kenaf fibres and the cement matrix. The coating was prepared in a dilute aqueous solution. The fibres were thoroughly coated by immersion in the solution and subsequently left to air dry to allow cross-linking of the polymer on the fibre surface. (Elsaid, 2011)

Figure 3: Kenaf fiber after process

2.2.3 KFRC Mixture Proportions and Mixing Procedure

Several trial mixtures were prepared to determine suitable mixture proportions and to develop an appropriate mixing procedure for the KFRC. Based on these trials two mixtures were selected for further study. The two mixtures had fiber volume contents of 1.2% and 2.4%. The fiber volume content was determined based on the measured weight of the fibers and a bulk fiber density of 1 g/cm^3 which was recommended by the fiber supplier. The mixture proportions for the two selected mixtures are given in table 2.

Fiber content (%)	Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)	Water (kg/m^3)	*w/c*ratio	Kenaf fibers (kg/m^3)	Additional water^a (kg/m^3)	HRWR^b(ml/m^3)
1.2	810	648	648	284	0.35	12.2	27.9	2650
2.4	806	645	645	282	0.35	24.3	55.6	2650

Table 2: Mixture proportion for KFRC

To ensure even distribution of the fibres in the concrete mixture, the kenaf fibres were pre-opened by hand prior to mixing. The concrete was mixed in a gas powered, 0.2 m^3 capacity rotary drum mixer. The coarse and fine aggregates were thoroughly mixed together. A maximum aggregate size of 9.5 mm was used for the coarse aggregate to increase the workability of the KFRC. The mixing was continued while all of the cement and approximately half of the water were gradually added. The high range water reducer was mixed with the remaining water and added to the mixture. Mixing was continued for several minutes until the concrete exhibited a uniform consistency. At this stage several 100 mm diameter × 200 mm long plain concrete control cylinders were cast to serve as the baseline for comparison between the various mixtures. The amount of kenaf fibres that were to be added to the mix was adjusted to account for the mass of the plain concrete which was removed. The fibres were gradually added to the mixture to ensure even distribution of the fibres in the concrete. The trial mixes revealed that the addition of kenaf fibres resulted in a significant reduction of the workability of the fresh concrete. This was partly due to absorption of some of the mix water by the fibres. Thus some additional water (noted in Table 1) was gradually added to the mixture during addition of the fibres to achieve a sufficiently workable mixture. The amount of this additional water was calculated as the difference between the measured moisture absorption capacity of the fibres and their measured moisture content under ambient conditions. All of the specimens were cast and moist-cured according to ASTM Standard C 192.

2.3 BASIC MATERIAL

2.3.1 Ordinary Portland cement (OPC)

There are many types of Portland cement .high alumina cement; super sulphate and special cement as masonry. Under ASTM standard the type (I, II, III) is preferred to use because its fineness and chemical composition.

However, Ordinary Portland cement (to BS 12:1996 or BS EN 197: Part 1: 2000) is usually used as tile main binder for foamed concrete. However rapid-hardening Portland cement to BS 915:1983 has also been used, and there does not seem to be any evidence why sulphate resisting cement could not be used.

Portland cement is essentially calcium silicate cement, which is produced by firing to partial fusion, at high temperature approximately 1500 C°. It has different rheological and strength characteristics, especially use in combination with chemical admixtures and supplementary cementing materials. Therefore, it is necessary to look at its fitness and chemistry content when choosing.

2.3.2 Fine aggregate

Generally the fine aggregate shall consist of natural sand, manufactured sand or combination of them. The fine aggregate for concrete that subjected wetting, extended exposure to humid atmosphere, or contact with moist ground shall not contain any material that deleteriously reactive in cement to cause excessive expansion of mortar concrete.

Recommend that only fine sands suitable for concrete (to BS 882:1992) or mortar (to BS 1200: 1976) having particle sizes up to about 4 mm and with an even distribution of sizes should be used for foamed concrete. This is mainly because coarser aggregate might settle in a lightweight mix and lead to collapse of the foam during mixing.

2.3.3 Water

Water use in this study is obtained from clean water supply system for mixing, curing, and others. The proportion of water cement ratio must be perfect to produce the stronger concrete and more durable concrete. Water cement ratio that use in this research was 0.50.

2.3.4 Mix proportion

The mix proportion for the concrete mixture is design based on concrete 20. The precaution that must take into consideration is to control the water-cement ratio, where the excess of water content will reduce the concrete strength while low water will reduce the workability of the concrete. The mix proportion design for this project is referring to the British Research Establishment: where the materials for the mix proportion are weight in kilogram (kg).

2.3.5 Concrete Compression Test

Concrete compression test is widely used to measure the compressive strength of the cube concrete specimen. Compressive strength is measured on a Universal Testing Machine. The compression strength is calculated from the failure load divided by the cross-sectional area resisting the load. The dimension of cube used is 100x100x100 mm.

2.4 PERMANENT FORMWORK

In this research, permanent formwork has been used as development in flooring system. A permanent formwork is not temporary where it is stay with the slab as a permanent supporting for the structure and become element structure of the building.

There are types in preparing formwork which is has a pan with different rise of dimensions. An improved concrete slab and steel construction wherein a pan is extended between adjacent joists, said pan having a bend line axially along its length, a portion of said pan resting a joist, a second portion being transversely notched such that said pan straddles adjacent joists at said notches, said pan serving to support poured in place concrete such that said concrete haunches down to supporting beams, thereby forming a composite concrete slab and steel structure (McManus, 1979).

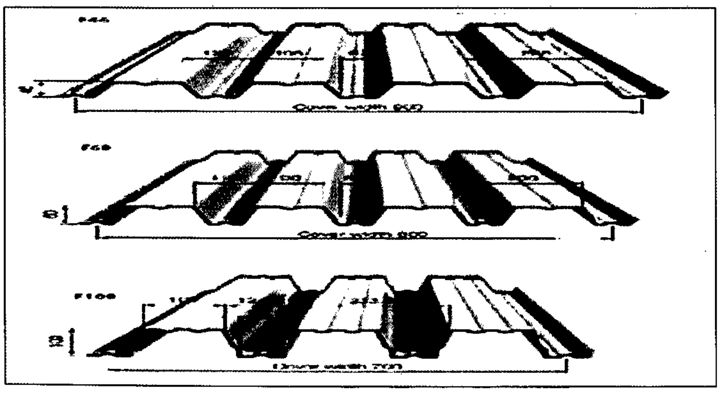

Figure 4: Tegral permanent formwork

2.4.1 Examples of Permanent Formwork

2.4.1.1 Rib and block suspended slab

A structural concrete topping of desire strength and thickness is applied over the ribs and blocks to form a slab. In this system, non-structural hollow concrete rebated filler blocks are placed between these ribs, which strengthen the floor and become the formwork. The block sizes determine the spacing for the beam and provide a flush soffit. Welded mesh is placed in this topping to control possible shrinkage cracks and tensile stress.

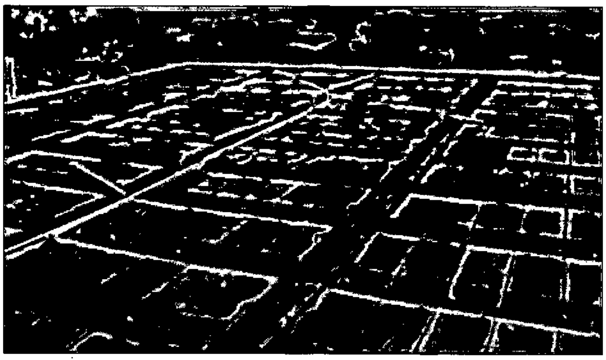

Figure 5: Example of ribs and block suspended slab construction

2.4.1.2 Composite slab construction

Composite slab use steel decking as both temporary support for the concrete placed on it and as a composite element to withstand the load. The slab span is between support beam, masonry walls or concrete. This steel support the fresh concrete while it sets and hardens. The slab decking looks like corrugated iron roof sheeting where it comes from different profile, which is the shape that the sheeting is mould in.

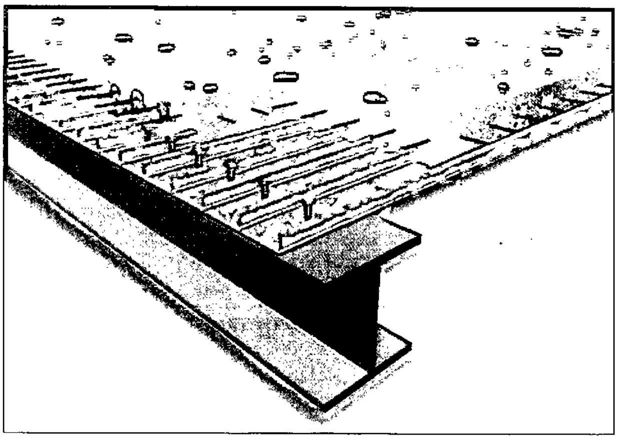

Figure 6: Example of composite slab construction

2.4.2 Advantages of Permanent Formwork

They are several benefits for the application of permanent formwork during construction process including:

i. Site labour saving on site construction.
ii. Accelerating speed in construction.
iii. Reduction or elimination of false work.
iv. Allowing off-site modular fabrication followed by schedule and appropriate deliveries.

The use of permanent formwork helps to reduce the construction and maintenance cost while the off-site modular fabrication helps to prevent potential error that can occur during construction process. All the advantages of the permanent formwork improve site safety tidiness by reducing hazards and waste generation during construction.