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COLLEGE OF ARCHITECTURE AND PLANNING
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COMPARATIVE COST ANALYSIS OF PRECAST AND IN SITU CONCRETE FLOOR SLABS IN GHANA

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DECLARATION

I hereby declare that this submission is my own work towards the Masters Degree and that, to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree of the University ,or elsewhere except for references which have been duly cited and acknowledged.

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ABSTRACT

There is a huge housing deficit in Ghana. As a result, majority of people in both rural and urban communities put up their own houses. The principal factor clients consider before initiating projects is cost. Precast and in situ reinforced concrete are widely used in the construction industry for the construction of suspended floor slabs. An informal survey conducted by the researcher showed that the use of cast in situ reinforced concrete slab surpasses the use of precast concrete slabs. In Ghana, it costs one a lifetime to put up a decent accommodation. Others have found the need to put up commercial and other buildings for renting using sub-standard materials or compromising on standards, all in the name of cutting down cost. In doing this some have compromised on quality to the detriment of society. There is the need to explore other alternatives and avenues that meet quality standards at a reduced cost. The purpose of this study was to analyse and compare the initial cost of precast and in situ reinforced concrete slabs. The study made use of descriptive research design and quantitative approach. Estimates of precast/prestressed beams and hollow blocks as well as Bills of Quantities were prepared from the structural drawings of slabs and beams of the suspended floors for the study. Results from the study confirmed that the initial cost of constructing a precast floor slab is cheaper than the cast in situ, and the cost savings made depends on the function of the building as its design parameters are not the same.

The recommendation made were: the use of precast floors must be encouraged, prestressed beam and block precast slab could be adopted as oversight concrete slab in water logged area to avoid hardcore filling which aids rising damp and awareness of the cost reduction in the use of precast floors must be created. Further research works that arose from the study were: a study into the feasibility of using

other precast elements like beams and column in Ghana, a survey must be conducted to see society’s readiness to use the precast floor system and a study to find out if pretensioned cables could be used to reduce the amount of reinforcement in slabs and a study to find the whole life cycle cost of precast and in situ floor slabs.

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I am also indebted to friends and loved ones and all those who helped, supported me and offered encouragement in cause of my studies. Finally I wish to say a big thank you to my mum Mrs Grace Ogyiri Opare and my siblings for their joint effort and emotional support.

DEDICATION

I dedicate this research to my wonderful Mum, Grace Ogyiri Opare, my brothers, Ogyiri and Gyan and to my lovely sisters, Nyarkoa and Denne for their immense and selfless support, encouragement and commitment throughout my education.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete must meet the required standard of strength and durability. In Ghana, the use of concrete and reinforced concrete for construction purposes is very common. The most commonly used coarse aggregate is granite aggregate obtained from commercial sources (machined quarries). In rural and semi urban communities where commercial granite is not readily available, hand quarried weathered coarse aggregates are used. The cost of the hand quarried aggregate is low as compared to those obtained from commercial sources. It is said that time is money and so everybody want value for money when it comes to investing in buildings. The more time is spent on a building the more costly it becomes; therefore if one can reduce the time for making such investment, cost could be reduced.

Precast concrete offers an almost endless variety of products and design options. Precast is one of the most versatile and sustainable building materials available for today's fast-paced, environmentally conscious construction (The Association, 1996).

In situ concrete can be formed into complicated shapes and aspects of quality control on site are sometimes less than ideal. Loads cannot be applied immediately. Precast concrete gives benefits of speedy production and quality control (Ashworth, 2010). This study seeks to compare the cost of using precast concrete products in constructing floor slabs with the conventional reinforced concrete slab to see its effect on project cost.

1.2 STATEMENT OF THE PROBLEM

There is a huge housing deficit in Ghana (GSS Housing census 2010). As a result, majority of people in both rural and urban communities put up their own structures. The principal factor clients consider before initiating projects is cost. Precast and in situ reinforced concrete are widely used in the construction industry for the construction of suspended floor slabs. An informal survey conducted by the researcher showed that the use of cast in situ reinforced concrete slab surpasses the use of precast concrete slabs. In Ghana it costs one a lifetime to put up a decent accommodation, others have found the need to put up commercial and other buildings for renting using sub-standard materials or compromising on standards, all in the name of cutting down cost. In doing this some have compromised on quality to the detriment of society. There is the need to explore other alternatives and avenues that meet quality standards at a reduced cost.

1.3 AIM

The purpose of this study is to analyse and compare the initial cost of precast and in situ reinforced concrete slabs.

1.4 OBJECTIVES

- To analyse the cost element of precast and in situ reinforced concrete slabs.
- To compare the cost element of precast and in situ concrete slab.
- To find out by what percentage reduction in cost is one advantageous over the other.

1.5 SIGNIFICANCE OF STUDY

Concrete is an expensive but durable material for construction and so users of concrete would want to have value for money (i.e. fine aggregates, coarse aggregates, cement and water). Most semi urban and urban dwellers use granite coarse aggregates in the production of concrete. This research work would help in:

- Comparing the cost of producing and placing concrete slab on site and the cost of using precast component to do the same area floor of slab
- Comparing the quality of workmanship in both cases as well as the advantages and disadvantages in each case.
- Enhance cost planning during the design stage of project.
- Enable the building team to give clients exactly what they want at exact cost.

1.6 SCOPE

The study looked mainly at selected proposed public buildings, residential and school buildings, health facility and a commercial building, analyses the cost of constructing the suspended floor slab and compared the cost of the same area of floor slab using precast components in Kumasi. There different designs of slabs. These are one way and two way slabs; for the purpose of this research both slabs would be considered since the facilities used in the research has both.

1.7 LIMITATION

There are several structural element in a building e.g. beams, column, walls ,roof, slabs etc. that could be looked at, but this study would be limited to only suspended floor slabs. It would also be concerned with the cost analysis and comparison between cast in situ floor slab and beam and block precast floor slab.

1.8 METHODOLOGY

In order to achieve the set objectives, the study would include a comprehensive review of existing literature on cost analysis of buildings. The primary sources of information would be obtained by taking off from proposed drawings. Copies of the same drawings would be sent to precast companies in Ghana for estimates. The secondary sources of information would be from journals, conference papers, books and the internet. The research would be comparative since it would be comparing two cost elements. The study would solicit the views of society to know their choices should they have other alternatives.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The most widely used construction material on earth is concrete. Concrete infrastructure comprises about sixty per cent of the built environment in many developed countries. In fact, concrete has shaped civilization from as far back as the ancient Egypt and the Roman Empires. Today it is indispensable in the development of infrastructure, industry and housing. Without concrete the built environment would fail to accommodate our modern and demanding lifestyle. (www.ccanz.org.nz 2011).

2.1.1 Concrete

Concrete is a product of coarse and fine aggregates, cement and water. Depending on the compressive strength needed the constituents are mixed to achieve the required strength. Through ages, concrete has been used as the major construction material. Lopez-Mesa *et al*. (2009) observes that 40% of the world's material and energy is used by buildings in current practice in architecture and construction. Williams (1983) also note that concrete is the most basic of building materials and yet, in the hands of the expert, is capable of providing strength, durability and even elegance far in excess of many of its manufactured competitors. The technology is by now well established but the production of concrete of a consistently good quality is by no means simple. The selection of the type of concrete is governed by the strength required which in turn depends on the intensity of the loading and the form and size of the structural members (Table 2.1).

Table 2.1: Concrete grade and their uses

Grade	Lowest grade for use as specified
C 7.5	Plain concrete
C 10	
C15	Reinforced Concrete with lightweight aggregate
C20	
C25	Reinforced Concrete with dense aggregate
C30	
C35	Concrete with Post -tensioned tendons
C40	Concrete with Pre -tensioned tendons
C50	
C60	

Source :Mosley, et al(1999)

Figure: 2.1 Vibrating concrete in place

Source: Field Survey, 2013

Figure 2.2 Tampering concrete in place

Source: Field Survey, 2013

2.1.2 Reinforcing steel

Reinforcement bars or rebar combined with concrete works very well, as concrete is very strong in compression, easy to produce at site, and steel is very strong in tension. Reinforcing bars are produced in two grades; hot rolled mild steel bars with yield strength of 250N/mm² and hot rolled or cold work high yield strength of 460N/mm². Steel fabric is made from cold draw steel wire welded to form a mesh (Macginley and Choo, 1995).

Figure 2.3: Reinforced steel ready to receive concrete

Source: Field Survey, 2013

The reliance on concrete is based on the fact that its constituent materials are readily available locally. The properties of concrete; whether precast, in situ or masonry cannot match any other building materials in terms of durability, fire resistance and maintenance cost. However placing concrete come with other cost which cannot be overlooked, i.e. formwork

2.1.3 Formwork (shuttering)

Formwork is a temporary mould for green concrete. The surface of formwork must be adsorbent to the water content in the concrete. There are different types of formwork but the most commonly used are timber and steel formwork. For formwork to perform its function very well it must have characteristics such as being rigid to contain the weight of wet concrete, well braced and tight enough to prevent the escape of cement grout. A good formwork system should be easier to strike and reuse, depending on the complexity of a design the formwork could cost up to twenty percent of the cost of the project.

Figure 2.4: Formwork for beams and slab deck

Source: Field Survey, 2013

2.2 USES OF CONCRETE

Concrete has a wider range of uses. It could be used for the construction of:

- commercial buildings
- roads
- harbours
- dams
- bridges
- electric poles
- residential buildings

- retaining walls
- reservoirs
- septic tanks
- canals and a whole lot more.

The durability of concrete is of vital importance regarding the life cycle cost of the structure. The life cycle cost includes not only the initial cost of the material and labour, but also the cost of maintenance and repair. The durability of concrete is therefore defined as its ability to resist weathering action, chemical attack, abrasion and other forms of deterioration. The most common problems that affect concrete durability are:

a. Sulphate and chemical attach
b. Carbonation
c. Corrosion of steel
d. Cracking of concrete in hot places

Concrete has much higher level of fire resistance than other building materials. It has four times longer in fire resistance. It is not combustible and would not produce smoke or fuel the fire (www.irishconcrete.com.).

2.3 STRUCTURAL ELEMENT AND FRAMES OF BUILDINGS

Building structures and frame can be broken down into the following elements:

Beams	-	horizontal members carrying lateral loads
Slabs	-	horizontal plate element carrying lateral loads
Columns	-	vertical members primarily carrying axial load and moment
Wall	-	vertical plate element resisting vertical, lateral or in-plane loads

Bases and foundations - pad or strips supported directly on the ground that spread the load from columns or walls so that the bearing capacity of the soil could safely take it. These structural elements can be made using precast forms or casting in-situ. There are different types of floors slabs. Giussani and Mola (2006) defined slab as a two dimensional structural system variously restrained and able to serve as a plate, subjected to flexural and shear stresses. Chudley and Greeno (2005) said the function of any floor is to provide a level surface which is capable of supporting all the live and dead loads imposed. Slab would be defined as any solid or hollow cored suspended or non-suspended cast in situ or precast plate able to withstand any sort of applied load. Slabs come in different forms, cast in situ and precast. For the purpose of this research both slabs would be considered since the facilities used in the research have both.

Examples of cast in situ reinforced concrete suspended slabs are: ribbed floors, waffle floors, flat slabs, and solid slabs. Examples of precast concrete slabs are: prestressed precast concrete (PCC) beams and block composite floor, PCC planks and pot composite floor, PCC cored unit.

For the purpose of this research, the cost of solid reinforced slab and the cost of PCC beam and block composite slab would be considered.

2.4 PRECAST CONCRETE

Structural engineering and geospatial consultants (www.paradiamgn.in) defines precast as a concept that uses standardized structural components produced away from the construction site. The components are transported to the site for assembly. The concept of precast (also known as “prefabricated”) construction includes those buildings where majority of structural components are standardized and produced in plants at a location away from the building, and then transported to the site for assembly.

These components are manufactured by industrial methods based on mass production in order to build a large number of buildings in a short time at low cost. The main features of these construction processes are as follows:

- The division and specialization of the human workforce
- The use of tools, machinery, and other equipment, usually automated, in the

production of standard, interchangeable parts and products (WHE REPORT 55)

Cudney (1998) defined precast as structural systems consisting of plant fabricated elements e.g. column, shear walls beams and double tees, prestressed beams, (Figs 2.5 & 2.10). The double tees that make up the floor systems can be pre-topped or field topped. A three to five inch cast- in -place concrete topping is cast over the precast tee in the case of the field topped slab.

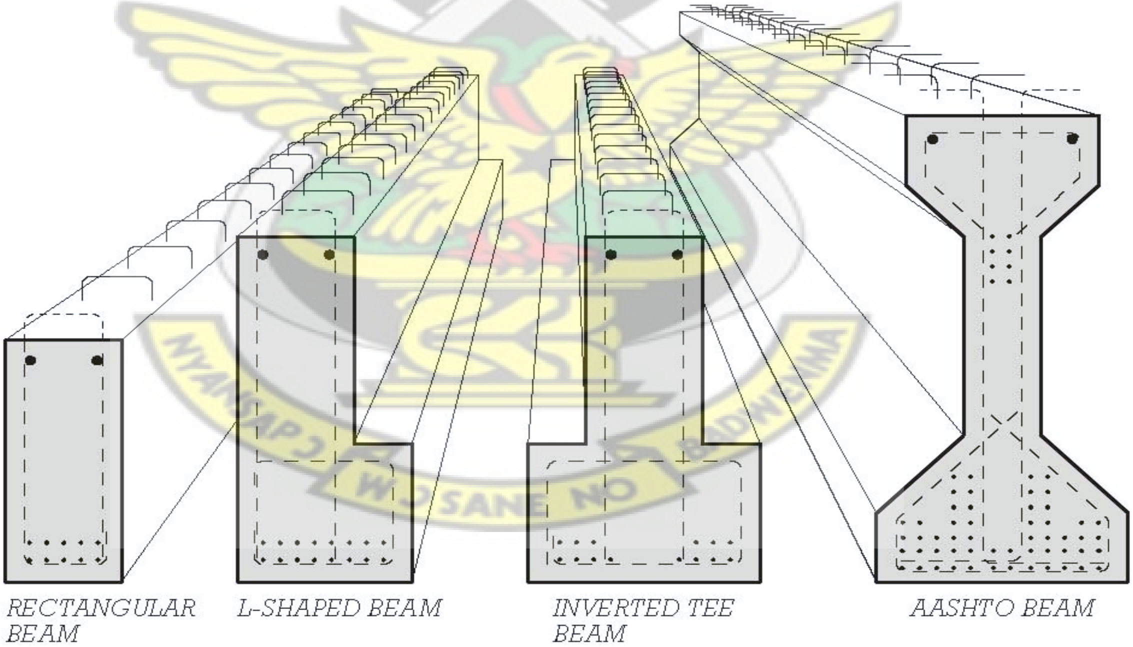

Figure 2.5: Types of precast beams

Source: www.paradiagm.in, 2003

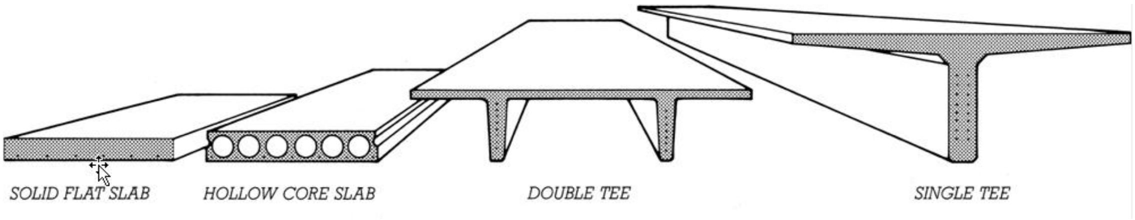

Figure 2.6: Types of precast slabs

Source: www.paradiagm.in, 2003

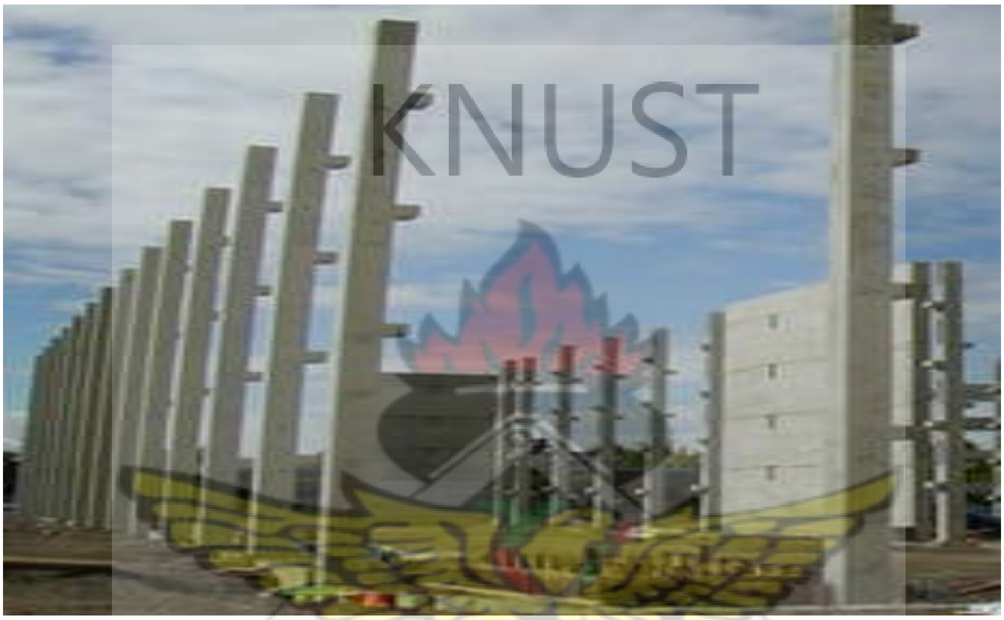

Figure 2.7: Precast column

Source: www.paradiagm.in, 2003

Figure 2.8: Inverted Tee supported on precast column

Source: www.paradiagm.in, 2003

Figure 2.9: Beam and block precast floor under construction

Source: Concrete Manufacturers Association, 1986

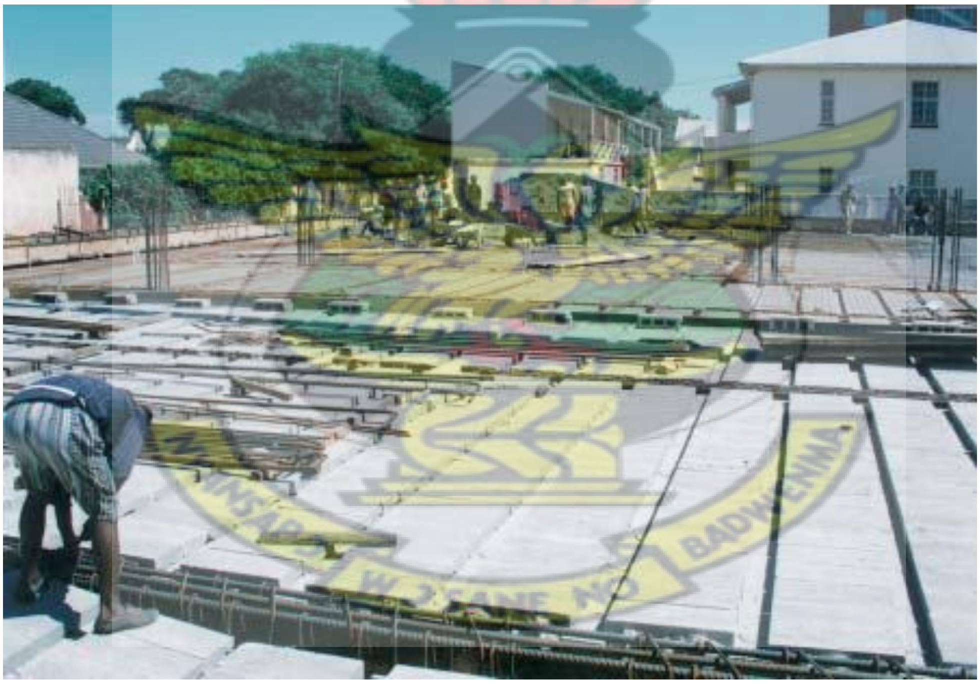

Figure 2.10: Beam and block slab system ready to receive hogging bars and concrete topping

Source: Concrete Manufacturers Association, 1986

Figure 2.11: Beam and block system with mesh and topping

Source: field survey, 2013

Cudney (1998) goes on to compare the advantages and disadvantages of precast structural element.

2.4.1 Advantages of Precast

- Duration of construction is slightly shorter.
- Initial cost of construction is slightly lower.
- Concrete quality is better and in good finish.
- Benefit of precast flooring having long span ability thus reducing the use of formwork since it is self-supporting.
- More adaptable in harsh condition.
- Reduces waste

2.4.2 Disadvantages of Precast

- Relatively higher maintenance cost since the gap between two components needs to be sealed.

- The gap provide avenue for leakages and needs to be repaired at regular period of time.
- The depth of the beams affects the head room and lighting.

In as much as concrete is versatile in its use, reducing the time in constructing the various elements saves cost, as the saying goes “time is money”. It is in this light that professionals, concrete manufacturers, concrete companies have considered the use of precast concrete. In general, precast building systems are more economical when compared to conventional multifamily residential construction in many countries and during the second half of the 20th century, many countries used precast components to provide low income housing for the growing urban population (Guevara-Perez n.d).

Dabhade *et al* (2009) worked on time and cost evaluation of construction of steel framed composite floor with precast floor structure, and confirmed that time saving in precast construction can compensate significant portion of the overall construction cost. Yardin *et al* (2013) showed that Autoclave Aerated Concrete (ACC) composite precast panel provide reasonable weight reduction without sacrificing the structural capacity of the slab.

Chan (2011) noted that many developed countries have been reported to be concerned about improving the quality of construction products and to increase productivity through the use of prefabricating technology and skill upgrade of workers. Chan (2011) went on to say that in the early 1970’s construction companies in Europe and the US had to use precast concrete building systems to cope with the increasing demand for housing.

National Precast Concrete Association Australia (2009) as cited in Chan (2011) reported that Precast concrete construction took off in 1990’s in Australia and owners of buildings and their designers noticed that there was a cost and time reduction in the construction of the precast walls and floors as compared to conventional in situ.

Precast concrete can be made in a large variety of shapes and sizes. The use of prestressed beams provides for relatively longer spans than can be achieved when conventional in situ method of construction are used (Cudney, 1998). Yee (2001) commented that architects and engineers have longed hailed precast/prestresses concrete for its high quality architectural and structural products.

Many people had feared the performance of precast in seismic areas. However, Yee (2001) allay this fear by commenting that research and intensive testing of precast joinery with mechanical coupler and composite deck framing system indicate that multi-storey precast frames can be designed and constructed to resist most severe seismic force.

2.5 IN SITU CONCRETE

MacGinley and Choo (1995) defined reinforced concrete as a composite material of steel bars embedded in a hardened concrete matrix; concrete, assisted by steel, carries the compressive forces, while steel resist tensile forces.

2.5.1 Advantages of Cast in Place

- Monolithic construction so fewer joints
- Easier to achieve positive drainage
- Flexible framing layout to fit the site with typical column spacing of 20-24 feet
- Lower maintenance cost
- Construction can be done by local subcontractors using local labour and materials
- Better lighting distribution and visibility due to fewer beam soffit

2.5.2 Disadvantage of cast in place

- Slightly longer on site construction period
- Less adoptable in harsh weather condition
- Construction quality more difficult to achieve.

(Source:Cudney,1998)

Adlakha and Puri (2003) as cited in Dosumu and Adenuga (2013) agreed that structural floors accounted for substantial cost of building in normal situation. Therefore, any savings achieved on floor/slab considerably reduce cost of building. Conventional cast in situ floor systems make use of non-permanent shuttering which increase construction time and cost.

Dosumu and Adenuga (2013) linked the variance in the hollow and solid floor slab to the methods of construction and installation.The study highlighted the delivery time as one of the advantages of precast slab over in situ concrete slab and hence the variation in the duration cannot be under estimated. He linked the variance to the method of construction and determined the variation in cost of production of the two floor systems in Lagos.

Dosumu and Adenuga (2013) attested to the fact that holes or voids, which are created in the precast floors replaces the ineffective concrete in the neutral zone of the slab ,thereby decreasing the dead load and increasing efficiency of the slab. This gives a significant advantage over conventional solid slab in terms of reducing material usage (reinforcement and concrete), reduce cost, enhance structural efficiency, decrease construction time and it is an alternative technology in the construction industry. Lam *et al* (2009) investigated the improved structural response that results from utilizing the composite action that takes place between precast prestressed concrete hollow core floor slab and Universal beams.

There has been various works on comparing concrete and steel construction but not much has been done on comparing the cost of in situ concrete slab and precast floors

Some works have been done on cost comparison of building. Haron *et al* (2005) talked about using a more systematic approach in doing this whilst Chan (2011) examine the cost structure of precast and conventional methods reviewing the extent to which low wage migrants workers affect the choice of technology used for construction. The cost comparison offers a best case scenario for cast in place since problems associated with concrete cast on site may include lack of proper coordination of tradesmen (Dosumu and Adenuga 2013). The various tradesmen; carpenters who would form and strike, steel benders to crank and place reinforcement, masons and labourers to pour and vibrate into place, can cause additional cost, confusion and unnecessary risks of downtime. The use of precast as an alternative would eliminate problems like poor quality control associated with placing and vibrating of concrete and delay in aggregate deliveries.

Precast concrete comes in various forms. These are columns, shear walls, claddings, beams, solid slab, hollow slabs etc.

This study would look at the direct cost in constructing in situ floor slab of different functions and the cost saving that could be made using precast alternatives in Kumasi, Ashanti Region of Ghana

2.6 COST ANALYSIS

Cost analysis is the systematic breakdown of cost of a building according to the sources from which they arise (Seeley, 1991).

Purposes of cost analysis:

- To provide data on completed projects
- To provide basis for detailed cost comparisons between different design options
- To facilitate the preparation of cost plans for proposed project. There are different ways of producing a cost analysis. These are trade selection, labour and material content, single rate estimating systems and element of a building (Flanagan & Tate, 1997).

The three essential constituents of cost analysis are:

1. ***Element***- major component common to most buildings which usually fulfils the same function, irrespective of its design, specification or construction.
2. ***Cost***-cost to the client in the tender.
3. ***Yardstick*** – allows the comparison of cost between buildings of different uses and sizes. To help achieve this the cost of an element is divided by the gross floor area(i.e.the area measured inside the external wall without any deduction for partitions column stairs and lift well) this is the most useful way of expressing cost in cost per square meter (Flanagan & Tate, 1997).

2.6.1 Elemental Cost analysis

4. Elemental cost analysis is the analysis of the costs to client which are given to tenders to determine the probable cost of each element of a building. The

purpose of elemental cost is to show the distribution of the cost of a building among its elements in a meaningful term to both clients and design team, and by so doing, allow the cost of two or more buildings to be compared. However there are other factors that affect elemental cost and these are quantity, quality and price levels. (Flanagan & Tate, 1997).

2.7 COST ELEMENTS

The construction resources are:

- Material
- Labour
- Plant

2.7.1 Materials

The world is composed of different material .Construction material is the most widely used material on earth. The largest tonnage usage in the world of construction is material (Haris & McCaffer, 2006). Materials used for construction can be straw, wood, bamboo, stone, bitumen, laterite, steel, concrete, and in recent years polymers.

Concrete is the most widely used construction material, second to it is steel then timber. In the advanced countries the use of steel and timber is a common place, for example most residences are built with wood and steel. Steel has been used for construction and as reinforcement for concrete and prestressed concrete. In selecting material for any construction project, the physical, mechanical and chemical properties are considered since the quality of materials used in a construction project contributes greatly to the stability and longevity.

Haris & McCaffer (2006) commented that on the average materials for building forms 60-70 % of the cost of the project. It is therefore important that contractor's view on material purchase does not exceed the total sum allowed when pricing the bills of quantities in order to avoid losses. Materials form the basis of every development.

2.7.2 Labour

The skilfulness of tradesmen or the labour force in the construction industry can speed up the work and minimize accident in the industry. This contributes a great deal to safety and security of workmen almost all of the times.

The type and the number of labour needed on the construction site for the construction of floor slab is determine by the amount of work or work load. The work involves in putting up an in situ or cast in place floor slab includes

- Mounting or erection of formwork for beams and slabs
- Fixing of reinforcement for beams and slabs
- Mixing and placing of concrete beams and slabs
- Striking formwork from soffit of beam and slab and sides of beams.
- Curing concrete

Considering this work load, the type of labour needed are:

i. Carpenters
ii. Steel benders/fixers
iii. Masons
iv. Labourers

This labour force comes with cost which cannot be overlooked.

The work load in precast floor construction involves the assembly and erection of prestressed beams and hollow blocks floor panel either solid or hollow, a few skeleton props are needed when span exceeds 4.5 meters (ITAL prestress company). In precast flooring the labour would be

a. Carpenter
b. Steel fixers
c. Masons
d. Labourers

These tradesmen would be fewer than in the case of in situ flooring.

2.7.3 Plant

Mechanizing some activities to achieve the aim of client and builder, the contractor cannot overlook the use of machines (plant). Plant has played a major role in various ways in the construction industry in facilitating the execution of major and minor construction project. 'The plant supply industry provides a wide range of equipment. Some of these plants are offered on hire or outright purchase, and in some cases lease and contract rental schemes'. Brook (2004) enumerated some steps to follow when building rates for plant and advice that plant that serve several trades should be included in the project overheads. Estimators should price for the erection and dismantling of plant at completion.

The cost of construction resources coupled with other indirect costs make up the total cost of constructing the various slabs.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The main method used for this research is literature review and a market research of current prices of materials and unit rate build up pricing the various cost items of constructing reinforced concrete floor slab and precast concrete floor slab. The sample size for this study was five different functional buildings. Two were educational buildings (out of the two one is a tertiary institution while the other is a second cycle institution), one health facility, one commercial facility and one residential building. The review aimed at summarizing past research by drawing conclusion from different studies that addressed related topics on cost comparisons.

3.2 DATA COLLECTION

The primary source of data for this study was obtained from engineering drawings of suspended slabs with beams. With the help of a quantity surveyor a Bill of Quantities was prepared. Prices of materials were collected from the open market which was used for the unit rate build up. Copies of the same drawings were sent to ITAL Prestressed Company to get estimates for the various slabs of different functional buildings. The results were then analysed.

3.3 SAMPLING

The research made use of the descriptive research design and quantitative approach to the study. Estimates of precast/prestressed beams and hollow blocks as well as Bills of Quantities were prepared from the structural drawings of slabs and beams of the suspended floors for the study.

The sample population was chosen from some selected public and domestic buildings. The sample size was chosen using purposive sampling. Considering the public buildings, two educational facilities were considered (tertiary and secondary), one commercial, one health facility and one domestic building. Hospitality was not considered since it functions as domestic building.

3.4 DESCRIPTION OF FACILITIES

3.4.1Secondary School Block

This building is a rectangular four storey reinforced concrete framed block with a courtyard . It has veranda facing the voids with 150mm thick sandcrete block walls. The slab is 150mm thick on 600x250mm beams supported on 250x250 columns

3.4.2 Tertiary Institution

This building is a seven shaped four storey reinforced concrete framed block with 150mm thick floor slabs on 700 x325 mm beams supported by 325 x325 mm column. The frame has deep beams since there are no columns in the classroom and lecture halls

3.4.3 Health Facility

This facility is an L-shaped one storey reinforced concrete framed structure with 150mm slab on varied beams ranging from 300-550 x225 mm supported on 250 x250mm column, with the L having an obtuse angle between the legs. It is double banked with central corridor. The ground floor has one of the legs suspended with a basement.

3.4.4. Commercial Facility

This facility is a two storey rectangular reinforced concrete frame with projections and recesses and a notch on the side facing the main road. The building has 150mm thick slab on 600 x225mm beams supported by 325x250 mm column.

3.4.5 Residential Facility

This is a single storey rectangular reinforced concrete frame with a notch at one corner having a void and a circular frontage projection, with 150mm slab on a 300 x225mm beams supported on 225 x 225mm columns.

In all the facilities the first floor slab was considered. The cost of the slabs, both in situ and precast, was calculated. The gross floor areas used were the same as the areas of slab (Fig 4.7).

3.5 METHOD OF ANALYSIS

The analysis was carried out quantitatively and comparatively following the aim and objectives of this study. The estimates from ITAL prestressed company did not consider the 50mm concrete topping. Calculations of the concrete topping as well as the cost of transporting and placing the prestressed beam and blocks were made and then added to the estimates to get the true cost of the precast floor.

The data was analysed using Microsoft Excel spread sheets to compare the estimates and charts drawn to show the savings made. The various costs to different elements of the functional spaces are shown in Appendix A1 to A5.

The various tables (i.e. Appendix A1 to A5) shows the cost of constructing the various suspended floors of cast in situ and prestressed beam and block precast floor slab as of August 2014 and Appendix A6 shows the total cost and the savings made.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

The analysis for the study was carried out quantitatively and comparatively. The main tool used for the analysing the result was Microsoft Office Excel (Excel 2010)

The analyses were carried out in relevance to the study's aim and objectives

4.2 COMPARISON OF IN SITU AND PRECAST

Figure 4.1 to 4.5 shows that in the comparison of the cost of elements in the construction of floor slab; cost of formwork in beams reinforcement in beams and concrete in beams are same in both slabs. This is because in Fig 4.8and 4.9 reinforced concrete beams are common to both slabs. However, the major variation occurs in the cost of formwork, reinforcement and concrete in slab. This is because of the process involved in constructing in situ floor slab; decking for the slab has to be put up (Fig 2.4), lay reinforcement in slabs (Fig 2.3), pour and vibrate concrete and tamper concrete in place (Fig 2.1 and 2.2). The cost of the formwork, reinforcement in slab and concrete in precast floors is reduced as compared to the in situ floor (Table A1-A6). This is because precast prestressed beams are self-supported (Fig 2.9 and 2.10) and does not need much formwork as in the case of in situ except for some skeletal props to support the floor when spreading the concrete topping. The reinforcement in precast floor is small as compared to in situ (Fig 2.11); hence, the cost that element is also small as compared to in situ floor slab. This is because the beam and block arrangement serve as the horizontal plate. The concrete in the in-situ floor slab is 150mm thick while that in the precast is 50mm used as topping for the beam and blocks system to even out the surface. The volume of concrete used is one third of that used in in-situ.

The chart below (Figs 4.1 to 4.5) shows the comparison between the various cost items of precast floor and the in situ floor.

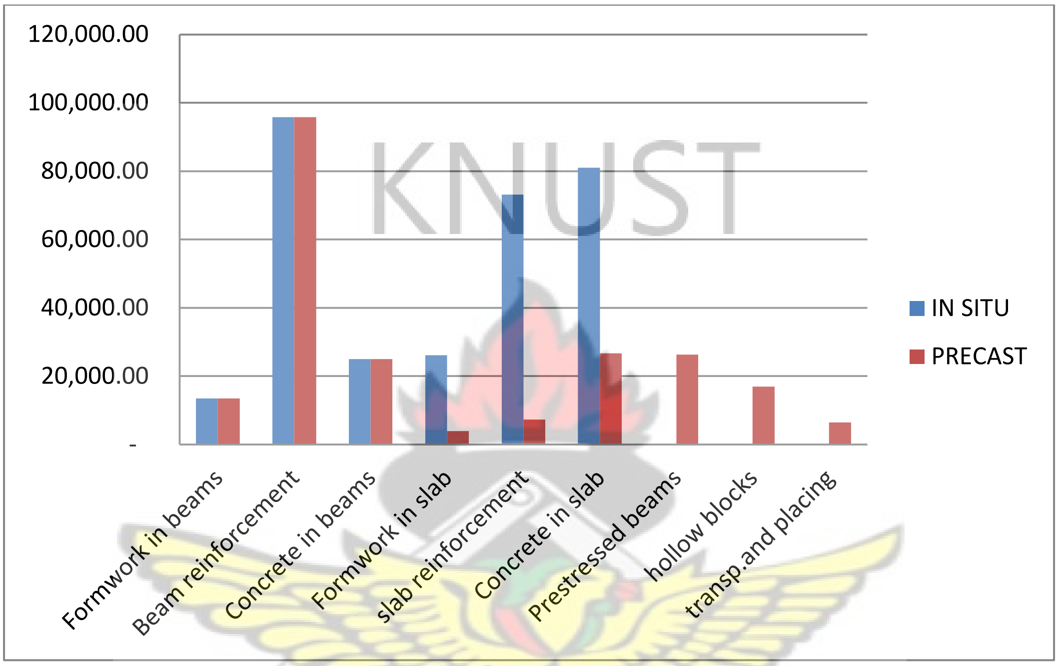

Figure 4.1 Health Facility Floor Slab

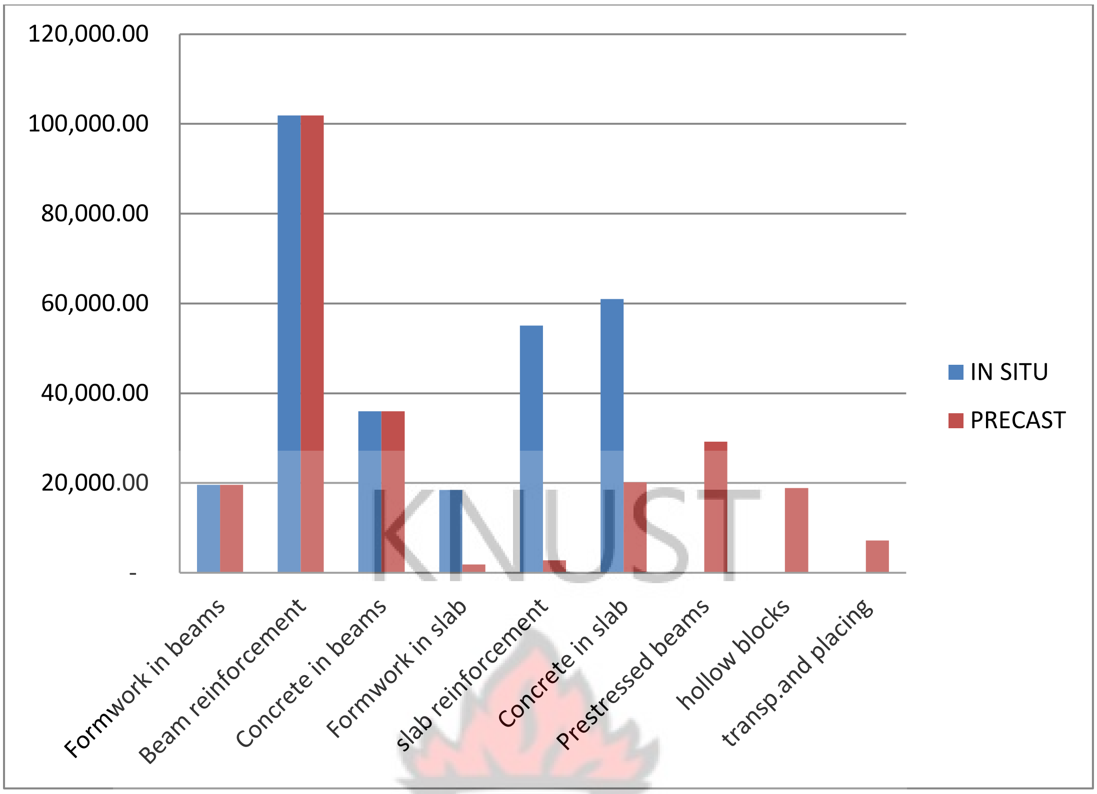

Figure 4.2 Secondary Sch. Floor slab

Source: Field Survey, 2014

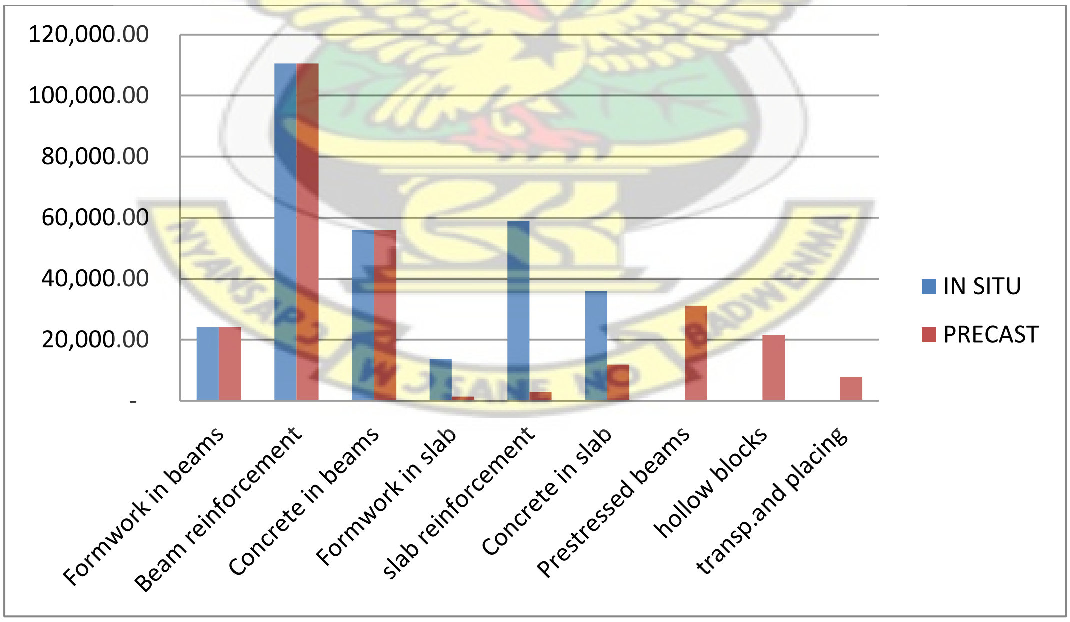

Figure 4.3 Tertiary Institution Floor Slab

Source: Field Survey, 2014

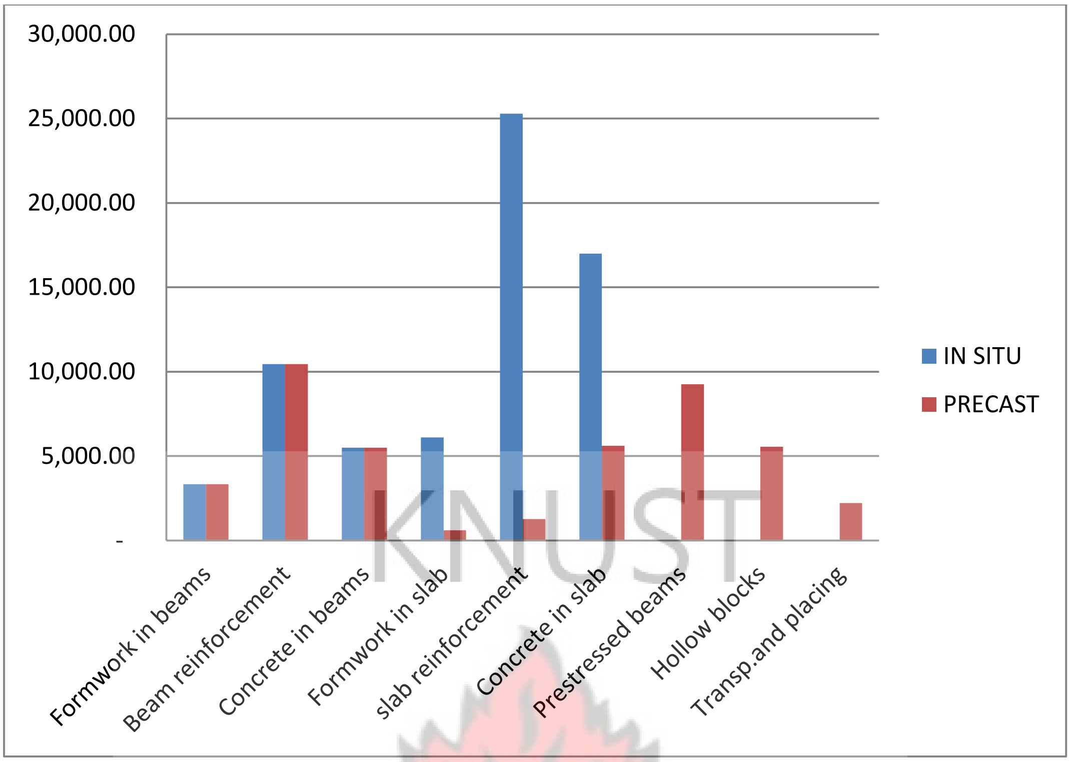

Figure 4.4 Residential Floor Slab

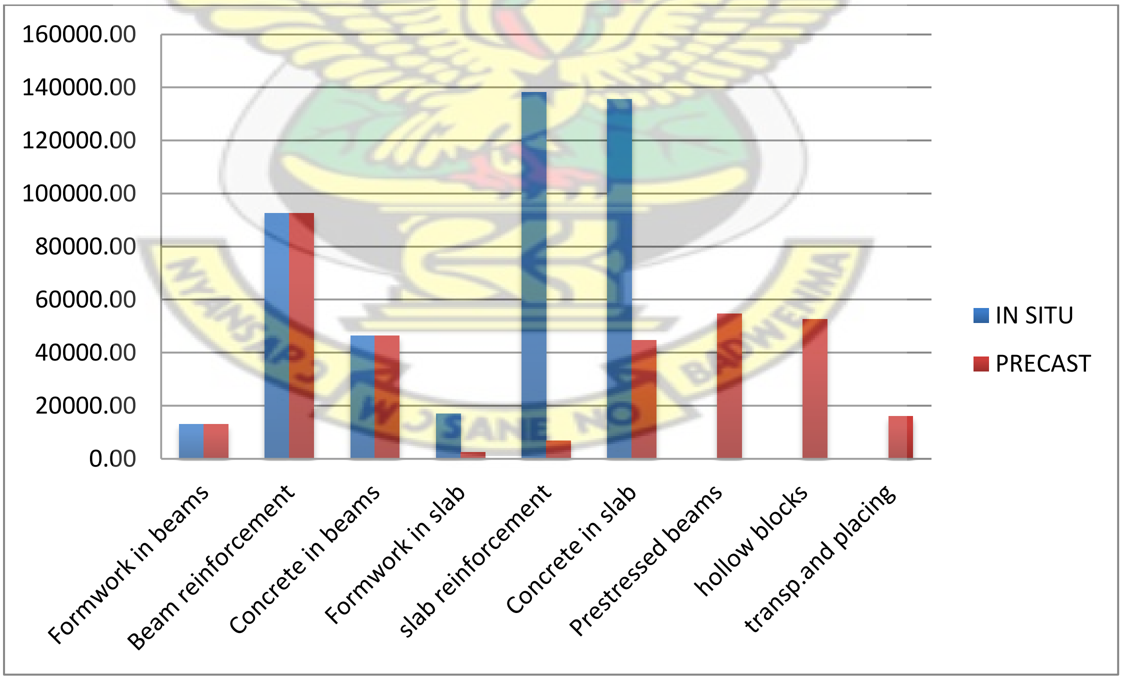

Figure 4.5: Commercial Facility Floor Slab

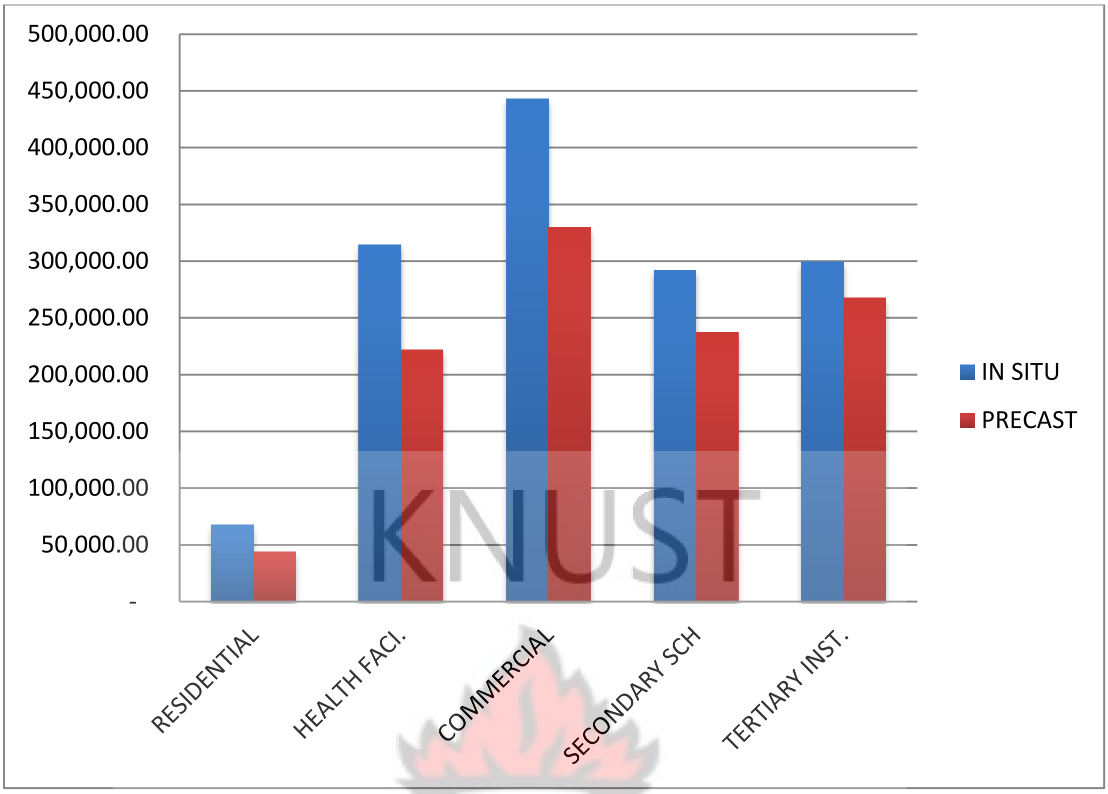

Figure 4.6: Total Cost for Various Floor Slab

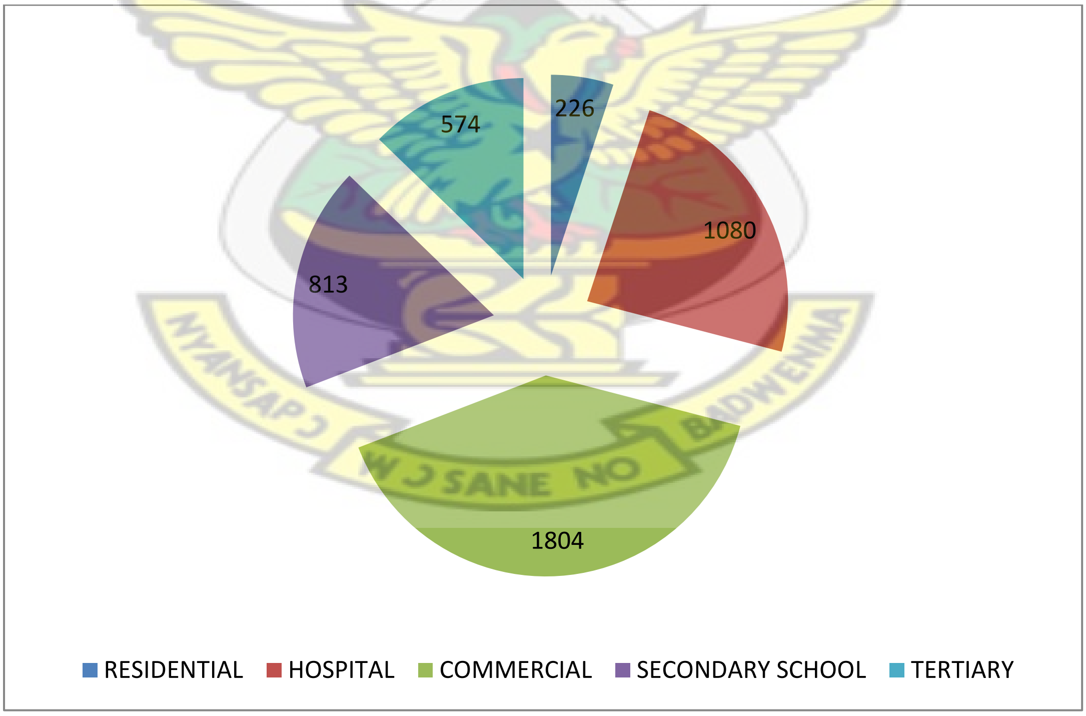

Figure 4.7 areas (m²) of slabs considered

Table 4.1 Elemenatal cost of floor areas

FACILITY	AREA	INSITU	PRECAST	INSITU COST/M²	PRECAST COST/M²	SAVING	%SAV.
RESIDENTIAL	226	67684.5	43813.783	299.49	193.87	105.62	35%
HOSPITAL	1080	314597.5	221982.79	291.29	205.54	85.75	29%
COMMERCIAL	1804	443004.5	329999.09	245.57	182.93	62.64	26%
SECONDARY SCH.	813	292003	237478.11	359.17	292.10	67.07	19%
TERTIARY	574	299400.5	267551.92	521.60	466.12	55.49	11%

In a typical cost analysis, the proposed data is extracted from previous completed cost data; however this study made use of proposed cost. The reason is that in Ghana prices change by the day and so comparing previous works to proposed works make the dynamics of the comparison complex. There was no data for presstress buildings so the comparison was done at the same time frame so that the cost would not be far from the actual. The approach cancels out these complex dynamics

From Fig 4.1 to 4.5 the costs of formwork in beams, reinforcement in beams and concrete in beams for both in situ and precast are the same in all the facilities. This is because from the sketch below, formwork, reinforcement and concrete in beams are common to both floors (i.e. precast and in situ floors). However, the costs of formwork, reinforcement and concrete in slab for the in situ are high as compared to the precast prestressed beam and block slab. This account for the high cost of conventional in situ slab. Table 4.1 showed that in all the facilities the precast slabs were cheaper with 35% saving on slab of residential facility, 29% saving made on slab of health facility, 26% saving on the slab of the commercial facility, 19% savings on slab of secondary school block and 11%savings on tertiary institution.

4.3 CONFIRMATION OF FACT

Guevara-Perez (n.d.) commented that precast building systems are more economical when compared to cast in situ. Adlakha and Puri (2003) as cited in Dosumu and Adenuga (2013) said structural floors accounted for substantial cost of a building, so savings made in the floor would reduce the cost of the building . Therefore the savings made on the slab would reduce the cost of the entire building

Results from the findings (Appendix A) confirm that precast is more economical in terms of actual cost as well.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The study aimed at analysing and comparing the cost of constructing a precast and in situ suspended floor slab for different functional buildings in Kumasi and the savings one could make .To achieve this, structural details of slabs (Appendix D) of different functional building were sent to ITAL Prestress Company for estimates for the prestressed beams and blocks that would be used for the precast floor (Appendix C). The costs of volume of concrete topping, reinforcements to check hogging moments, transportation and installation were calculated and the cost added to the cost of prestressed beam. Taking offs and Priced Bills of Quantities (Appendix B) were prepared from copies of the same drawings. Conclusions were drawn from the finding of the cost derived from the study and supported with available literature. Recommendations were made from the conclusions drawn and further research proposed from the study.

5.2 CONCLUSIONS

Conclusions drawn from the study were as follows:

- The initial cost of constructing a precast floor slab is relatively cheaper than the cast in situ.
- The cost savings made depends on the function of the building as its design parameters are not the same.

5.3 RECOMMENDATIONS

From the conclusions drawn the following recommendation are made

- Since reduction in the cost of slab can reduce the total cost of building, the use of precast floors must be encouraged.
- Prestressed beams and block precast slab can be adopted as oversight concrete slab in water logged area to avoid hardcore filling which aids rising damp.
- Awareness of the cost reduction in the use of precast floors must be created.

5.4 FURTHER RESEARCH

Further research works that could be taken up from this study are:

- The feasibility of using other precast elements like beams and column in Ghana
- A survey must be conducted to see society's readiness to use the precast floor system because of the costs savings client can make.
- A study to find out the feasibility of using pretension cables as reinforcement in slabs as in the case of prestressed beams.
- A study to find the whole life cycle cost of precast and in situ floor slabs.

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APPENDICES

APPENDIX A COST BREAKDOWN

Table A1: Cost Breakdown of Elements in the Residential Floor Slab

ITEM	DESCRIPTION	IN SITU(GH₵)	PRECAST(GH₵)
A	Formwork in beams	3,348.00	3,348.00
B	Beam reinforcement	10,444.50	10,444.50
C	Concrete in beams	5,500.00	5,500.00
D	Formwork in slab	6,102.00	610.20
E	Slab reinforcement	25,290.00	1,264.50
F	Concrete in slab	17,000.00	5,610.00
G	Prestressed beams		9,252.42
H	Hollow blocks		5,562.00
J	Transportation and Placing		2,222.16
	TOTAL	**67,684.50**	**43,813.78**

Table A2: Cost Breakdown of Elements in the Health Facility Floor Slab

ITEM	DESCRIPTION	IN SITU(GH₵)	PRECAST(GH₵)
A	Formwork in beams	13,500.00	13,500.00
B	Beam reinforcement	95,800.50	95,800.50
C	Concrete in beams	25,000.00	25,000.00
D	Formwork in slab	26,136.00	3,920.40
E	Slab reinforcement	73,161.00	7,316.10
F	Concrete in slab	81,000.00	26,730.00
G	Prestressed beams		26,284.12
H	Hollow blocks		16,947.00
J	Transportation and Placing		6484.67
	TOTAL	**314,597.50**	**221,982.79**

Table A3: Cost Breakdown of Elements in the Commercial facility floor slab

ITEM	DESCRIPTION	IN SITU (GH₵)	PRECAST(GH₵)
A	Formwork in beams	13,122.00	13,122.00
B	Beam reinforcement	92,704.50	92,704.50
C	Concrete in beams	46,500.00	46,500.00
D	Formwork in slab	17,037.00	2,555.55
E	Slab reinforcement	138,141.00	6,907.05
F	Concrete in slab	135,500.00	44,715.00
G	Prestressed beams		54,788.95
H	Hollow blocks		52,598.00
J	Transportation and Placing		16,108.04
	TOTAL	**443,004.50**	**329,999.09**

Table A4: Cost Breakdown of Elements in the Secondary School floor slab

ITEM	DESCRIPTION	IN SITU(GH₵)	PRECAST(GH₵)
A	Formwork in beams	19,602.00	19,602.00
B	Beam reinforcement	101,839.50	101,839.50
C	Concrete in beams	36,000.00	36,000.00
D	Formwork in slab	18,468.00	1,846.80
E	slab reinforcement	55,093.50	2,754.68
F	Concrete in slab	61,000.00	20,130.00
G	Prestressed beams		29,242.42
H	Hollow blocks		18,849.00
J	Transportation and Placing		7,213.71
	TOTAL	**292,003.00**	**237,478.11**

Table A5: Cost Breakdown of Elements in the Tertiary Institution Floor Slab

ITEM	DESCRIPTION	IN SITU (GH₵)	PRECAST(GH₵)
A	Formwork in beams	24,138.00	24,138.00
B	Beam reinforcement	110,547.00	110,547.00
C	Concrete in beams	56,000.00	56,000.00
D	Formwork in slab	13,743.00	1,374.30
E	Slab reinforcement	58,972.50	2,948.63
F	Concrete in slab	36,000.00	11,880.00
G	Prestressed beams		31,121.30
H	Hollow blocks		21,630.00
J	Transportation and Placing		7,912.70
	TOTAL	**299,400.50**	**267,551.92**

Table A6: Total cost of slab for various facilities and their savings

FACILITY	IN SITU(GHȻ)	PRECAST(GHȻ)	SAVING
RESIDENTIAL	67,684.50	43,813.78	23,870.72
HEALTH FACI.	314,597.50	221,982.79	92,614.71
COMMERCIAL	443,004.50	329,999.09	113,005.41
SECONDARY SCH	292,003.00	237,478.11	54,524.89
TERTIARY INST.	299,400.50	267,551.92	31,848.58

APPENDIX B: BILLS OF QUANTITIES

Item	Description	Quantity	Unit	Rate	Amount
	BILL No 2:-MAIN BUILDINGS SUPERSTRUCTURE				
	CONCRETE WORK				
	Reinforced in-situ Concrete				
	Reinforced vibrated concrete grade C25/30				
A	Horizontal beam	93	m^3	500.00	46,500.00
B	150mm Suspended floor or roof slab	271	m^3	500.00	135,500.00
	Reinforcement (all provisional)				
	High Tensile Steel Bar Reinforcement				
D	20mm Diameter do	10,131	kg	4.50	45,589.50
E	10mm Diameter do	8,411	kg	4.50	37,849.50
F	12mm Diameter bar in slab or landing	30,698	kg	4.50	138,141.00
	Formwork				
	Sawn formwok to:				
H	Floors and roof slab	631	m^2	27.00	17,037.00
	CONCRETE WORK Carried to Summary				**443,004.50**

SECONDARY SCHOOL

Item	Description	Quantity	Unit	Rate	Amount
	BILL No 2:-MAIN BUILDINGS SUPERSTRUCTURE				
	CONCRETE WORK **Reinforced in-situ Concrete**				
	Reinforced vibrated concrete grade C25/30				
A	Horizontal beam	72	m^3	500.00	36,000.00
B	150mm Suspended floor or roof slab	122	m^3	500.00	61,000.00
	Reinforcement (all provisional)				
	High Tensile Steel Bar Reinforcement				
C	25mm Diameter bar in beam	18,898	kg	4.50	85,041.00
D	16mm Diameter do	906	kg	4.50	4,077.00
E	10mm Diameter do	2,827	kg	4.50	12,721.50
F	12mm Diameter bar in suspended floor and landing	12,243	kg	4.50	55,093.50
	Formwork Sawn formwork to:				
G	Sides and soffits of beam	726	m^2	27.00	19,602.00
H	Floors and roof slab	684	m^2	27.00	18,468.00
	CONCRETE WORK Carried to Summary				**292,003.00**

HEALTH FACILITY

Item	Description	Quantity	Unit	Rate	Amount
	BILL No 2:-MAIN BUILDINGS SUPERSTRUCTURE				
	CONCRETE WORK **Reinforced in-situ Concrete** Reinforced vibrated concrete grade C25/30				
A	Horizontal beam	50	m^3	500.00	25,000.00
B	150mm Suspended floor or roof slab	162	m^3	500.00	81,000.00
	Reinforcement (all provisional)				
	High Tensile Steel Bar Reinforcement				
C	25mm Diameter bar in beam	13,039	kg	4.50	58,675.50
D	20mm Diameter do	3,840	kg	4.50	17,280.00
D	16mm Diameter do	3,650	kg	4.50	16,425.00
E	10mm Diameter do	760	kg	4.50	3,420.00
F	12mm Diameter bar in slab or landing	16,258	kg	4.50	73,161.00
	Formwork Sawn formwork to:				
G	Sides and soffits of beam	500	m^2	27.00	13,500.00
H	Floors and roof slab	968	m^2	27.00	26,136.00
	CONCRETE WORK Carried to Summary				**314,597.50**

RESIDENTIAL ESTIMATE

Item	Description	Quantity	Unit	Rate	Amount
	BILL No 2:-MAIN BUILDINGS SUPERSTRUCTURE				
	CONCRETE WORK				
	Reinforced in-situ Concrete				
	Reinforced vibrated concrete grade C25				
A	Horizontal beam	11	m^3	500.00	5,500.00
B	150mm Suspended floor or roof slab	34	m^2	500.00	17,000.00
	Reinforcement (all provisional)				
	High Tensile Steel Bar Reinforcement				
C	20mm Diameter do	144	kg	4.50	648.00
D	16mm Diameter do	1664	kg	4.50	7,488.00
E	10mm Diameter do	513	kg	4.50	2,308.50
F	12mm Diameter bar in slab or landing	5,620	kg	4.50	25,290.00
	Formwork				
	Sawn formwork to:				
G	Sides and soffits of beam	124	m^2	27.00	3,348.00
H	Floor	226	m^2	27.00	6,102.00
	CONCRETE WORK Carried to Summary				**67,684.50**

COMMERCIAL FACILITY ESTIMATE

Item	Description	Quantity	Unit	Rate	Amount
	BILL No 2:-MAIN BUILDINGS SUPERSTRUCTURE				
	CONCRETE WORK				
	Reinforced in-situ Concrete				
	Reinforced vibrated concrete grade C25/30				
A	Horizontal beam	93	m^3	500.00	46,500.00
B	150mm Suspended floor or roof slab	271	m^3	500.00	135,500.00
	Reinforcement (all provisional)				
	High Tensile Steel Bar Reinforcement				
C	25mm Diameter bar in beam	2,059	kg	4.50	9,265.50
D	20mm Diameter do	10,131	kg	4.50	45,589.50
E	10mm Diameter do	8,411	kg	4.50	37,849.50
F	12mm Diameter bar in slab or landing	30,698	kg	4.50	138,141.00
	Formwork				
	Sawn formwork to:				
G	Sides and soffits of beam	486	m^2	27.00	13,122.00
H	Floors and roof slab	631	m^2	27.00	17,037.00
	CONCRETE WORK				
	Carried to Summary				**443,004.50**

TERTIARY INSTITUTION

Item	Description	Quantity	Unit	Rate	Amount
	BILL No 2:-MAIN BUILDINGS SUPERSTRUCTURE				
	CONCRETE WORK				
	Reinforced in-situ Concrete				
	Reinforced vibrated concrete grade C25/30				
A	Horizontal beam	112	m^3	500.00	56,000.00
B	150mm Suspended floor or roof slab	72	m^3	500.00	36,000.00
	Reinforcement (all provisional)				
	High Tensile Steel Bar Reinforcement				
C	25mm Diameter bar in beam	13,039	kg	4.50	58,675.50
D	20mm Diameter do	5,336	kg	4.50	24,012.00
E	10mm Diameter do	6,191	kg	4.50	27,859.50
F	12mm Diameter bar in slab or landing	13,105	kg	4.50	58,972.50
	Formwork				
	Sawn formwork to:				
G	Sides and soffits of beam	894	m^2	27.00	24,138.00
H	Floors and roof slab	509	m^2	27.00	13,743.00
	CONCRETE WORK				
	Carried to Summary				**299,400.50**

APPENDIX C: ESTIMATES FROM ITAL COMPANY

Customer #	
Name	Victoria Oparebea Ogyiri
Address	KNUST
City	KUMASI
Phone	0208-345853

ANY OTHER INFO

Kumasi Office **03220-39570**

HEALTH FACILITY

Proforma Invoice No.	**KSI/14/OGF/**
Site Location	
Contact	
Tel:	
Fax	
Date	14-Jul-14
Order #	10000

Qty	Description	Actual length	Std. Length	Total Length (m)	Unit Price Ex VAT GH¢	Total Ex VAT. GH¢
52	Pre-Stressed Beams	4	4.00	208.00	16.81	3,496.48
104	Pre-Stressed Beams	3.8	3.80	395.20	16.81	6,643.31
216	Pre-Stressed Beams	3	3.00	648.00	16.81	10,892.88
142	Pre-Stressed Beams	2.2	2.20	312.40	16.81	5,251.44
514				1,563.60		26,284.12
	H20 Beam Blocks					
6,300.00	H16 Beam Blocks				2.69	16,947.00
	H12 Beam Blocks					
	8" Hollow Blocks					
	6" Hollow Blocks					
	4" hollow Block					
	6" Solid					
	8" Solid					
	Roofing Tiles					
	Ridge Caps					
	Galvanized Trusses					
	Galvanized Purlins					
	Galvanized Screws					

NO REFUNDS

	SUB TOTAL	43,231.12
VAT	15.00%	6484.67
N.H.I.L	2.50%	1080.78
DISCOUNT %		
	TOTAL GH¢	**50,796.56**

Rate

NOTES:

Part Payments made to order for the Prestress beams and blocks is valid for only a period of 90 days. After that, if full payment has not been made and there is a price increment, it will affect the client.

: **NOTE : TRANSPORT & INSTALLATION EXCLUDI**

IPCP PRODUCTS SHOULD BE INSTALLED AND SUPERVISED BY A QUALIFIED STRUCTURAL ENGINEER.

Cheque #

CHEQUES MADE PAYABLE TO IPCP LIMITED

ITAL PRESTRESS & CONST. PRODUCTS LTD.

Signed OGF
0244592955(Sales Engineer)

Date

Checked by:

Production Date:

Customer #			**Proforma Invoice No.** KSI/14/OGF/
Name	Victoria Oparebea Ogyiri	**Kumasi Office** 03220-39570	**Site Location**
Address	KNUST		**Contact**
City	KUMASI		**Tel:**
Phone	0208-345853	**SECONDARY SCHOOL**	**Fax**
			Date 14-Jul-14
			Order # 10000
	ANY OTHER INFO		

Qty	Description	Actual length	Std. Length	Total Length (m)	Unit Price Ex VAT GH¢	Total Ex VAT. GH¢
11	Pre-Stressed Beams	5.2	5.20	57.20	16.81	961.53
5	Pre-Stressed Beams	4.4	4.40	22.00	16.81	369.82
244	Pre-Stressed Beams	4	4.00	976.00	16.81	16,406.56
15	Pre-Stressed Beams	3.8	3.80	57.00	16.81	958.17
48	Pre-Stressed Beams	3.6	3.60	172.80	16.81	2,904.77
10	Pre-Stressed Beams	3.4	3.40	34.00	16.81	571.54
37	Pre-Stressed Beams	3.2	3.20	118.40	16.81	1,990.30
29	Pre-Stressed Beams	2.6	2.60	75.40	16.81	1,267.47
399				1,512.80		25,430.17
	H20 Beam Blocks					
6,100.00	H16 Beam Blocks				2.69	16,409.00
	H12 Beam Blocks					
	8" Hollow Blocks					
	6" Hollow Blocks					
	4" hollow Block					
	6" Solid					
	8" Solid					
	Roofing Tiles					
	Ridge Caps					
	Galvanized Trusses					
	Galvanized Purlins					
	Galvanized Screws					

		SUB TOTAL	41,839.17
NO REFUNDS	VAT	15.00%	6275.88
	N.H.I.L	2.50%	1045.98
	DISCOUNT %		
		TOTAL GH¢	**49,161.02**

Rate

NOTES:

Part Payments made to order for the Prestress beams and blocks is valid for only a period of 90 days. After that, if full payment has not been made and there is a price increment, it will affect the client.

: **NOTE : TRANSPORT & INSTALLATION EXCLUDED.**

IPCP PRODUCTS SHOULD BE INSTALLED AND SUPERVISED BY A QUALIFIED STRUCTURAL ENGINEER.

Cheque #

CHEQUES MADE PAYABLE TO IPCP LIMITED

ITAL PRESTRESS & CONST. PRODUCTS LTD.

Signed OGF
0244592955(Sales Engineer)

Checked by:

Date

Production Date:

KUMASI

Customer #			**Proforma Invoice No.**	**KSI/14/OGF/**
Name	Victoria Oparebea Ogyiri	**Kumasi Office:** **03220-39570**	**Site Location**	
Address	KNUST		**Contact**	
City	KUMASI		**Tel:**	
Phone	0208-345853	**RESIDENTIAL**	**Fax**	
			Date	14-Jul-14
	ANY OTHER INFO		Order #	10000

Qty	Description	Actual length	Std. Length	Total Length (m)	Unit Price Ex VAT GH¢	Total Ex VAT. GH¢
2	Pre-Stressed Beams	5.8	5.80	11.60	16.81	195.00
2	Pre-Stressed Beams	5.4	5.40	10.80	16.81	181.55
12	Pre-Stressed Beams	4.8	4.80	57.60	16.81	968.26
41	Pre-Stressed Beams	4.2	4.20	172.20	16.81	2,894.68
14	Pre-Stressed Beams	3.8	3.80	53.20	16.81	894.29
18	Pre-Stressed Beams	3.4	3.40	61.20	16.81	1,028.77
11	Pre-Stressed Beams	3.2	3.20	35.20	16.81	591.71
9	Pre-Stressed Beams	2.6	2.60	23.40	16.81	393.35
24	Pre-Stressed Beams	1.8	1.80	43.20	16.81	726.19
11	Pre-Stressed Beams	1	1.00	11.00	16.81	184.91
144				479.40		8,058.71
	H20 Beam Blocks					
1,800.00	H16 Beam Blocks				2.69	4,842.00
	H12 Beam Blocks					
	8" Hollow Blocks					
	6" Hollow Blocks					
	4" hollow Block					
	6" Solid					
	8" Solid					
	Roofing Tiles					
	Ridge Caps					
	Galvanized Trusses					
	Galvanized Purlins					
	Galvanized Screws					
					SUB TOTAL	12,900.71
	NO REFUNDS			VAT	15.00%	1935.11
				N.H.I.L	2.50%	322.52
				DISCOUNT %		
					TOTAL GH¢	**15,158.34**

Rate

NOTES:

Part Payments made to order for the Prestress beams and blocks is valid for only a period of 90 days. After that, if full payment has not been made and there is a price increment, it will affect the client.

: NOTE : TRANSPORT & INSTALLATION EXCLUDI

IPCP PRODUCTS SHOULD BE INSTALLED AND SUPERVISED BY A QUALIFIED STRUCTURAL ENGINEER.

Cheque #

CHEQUES MADE PAYABLE TO IPCP LIMITED

ITAL PRESTRESS & CONST. PRODUCTS LTD.

Signed OGF

0244592955(Sales Engineer)

Checked by:

Date

Production Date:

KUMASI

Customer #		**Proforma Invoice No.**	**KSI/14/OGF/**
Name	Victoria Oparebea Ogyiri	**Site Location**	
Address	KNUST	**Contact**	
City	KUMASI	**Tel:**	
Phone		**Fax**	
		Date	12-Aug-14
		Order #	10000

ANY OTHER INFO

COMMERCIAL FACILITY

Qty	Description	Actual length	Std. Length	Total Length (m)	Unit Price Ex VAT GH¢	Total Ex VAT. GH¢
56	Pre-Stressed Beams	5.8	5.80	324.80	19.33	6,278.38
52	Pre-Stressed Beams	4.8	4.80	249.60	19.33	4,824.77
110	Pre-Stressed Beams	4.2	4.20	462.00	19.33	8,930.46
145	Pre-Stressed Beams	4	4.00	580.00	19.33	11,211.40
28	Pre-Stressed Beams	3.6	3.60	100.80	19.33	1,948.46
28	Pre-Stressed Beams	3.2	3.20	89.60	19.33	1,731.97
210	Pre-Stressed Beams	3	3.00	630.00	19.33	12,177.90
12	Pre-Stressed Beams	2.8	2.80	33.60	19.33	649.49
46	Pre-Stressed Beams	2.6	2.60	119.60	19.33	2,311.87
72	Pre-Stressed Beams	2.2	2.20	158.40	19.33	3,061.87
18	Pre-Stressed Beams	1.8	1.80	32.40	19.33	626.29
28	Pre-Stressed Beams	1.6	1.60	44.80	19.33	865.98
4	Pre-Stressed Beams	1.2	1.20	4.80	19.33	92.78
4	Pre-Stressed Beams	1	1.00	4.00	19.33	77.32
813				2,834.40		54,788.95
11,900.00	H20 Beam Blocks				4.42	52,598.00
	H16 Beam Blocks					
	H12 Beam Blocks					
	8" Hollow Blocks					
	6" Hollow Blocks					
	4" hollow Block					
	6" Solid					
	8" Solid					
	Roofing Tiles					
	Ridge Caps					
	Galvanized Trusses					
	Galvanized Purlins					
	Galvanized Screws					
					SUB TOTAL	107,386.95
NO REFUNDS				VAT	15.00%	16108.04
				N.H.I.L	2.50%	2684.67
				DISCOUNT %		
					TOTAL GH¢	**126,179.67**

Rate

NOTES:

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: **NOTE : TRANSPORT & INSTALLATION EXCLUD**

IPCP PRODUCTS SHOULD BE INSTALLED AND SUPERVISED BY A QUALIFIED STRUCTURAL ENGINEER.

Cheque #

CHEQUES MADE PAYABLE TO IPCP LIMITED

ITAL PRESTRESS & CONST. PRODUCTS LTD.

Signed OGF
0244592955(Sales Engineer)

Checked by:

Date

Production Date:

KUMASI

Customer #		Proforma Invoice No.	KSI/14/OGF/
Name	Victoria Oparebea Ogyiri	Site Location	
Address	KNUST	Contact	
City	KUMASI	Tel:	
Phone		Fax	
		Date	12-Aug-14
		Order #	10000

TERTIARY INSTITUTION

ANY OTHER INFO

Qty	Description	Actual length	Std. Length	Total Length (m)	Unit Price Ex VAT GH¢	Total Ex VAT. GH¢
480	Pre-Stressed Beams	3.0	3.00	1,440.00	19.33	27,835.20
40	Pre-Stressed Beams	2.0	2.00	80.00	19.33	1,546.40
50	Pre-Stressed Beams	1.8	1.80	90.00	19.33	1,739.70
570				1,610.00		31,121.30
	H20 Beam Blocks					
7,000.00	H16 Beam Blocks				3.09	21,630.00
	H12 Beam Blocks					
	8" Hollow Blocks					
	6" Hollow Blocks					
	4" hollow Block					
	6" Solid					
	8" Solid					
	Roofing Tiles					
	Ridge Caps					
	Galvanized Trusses					
	Galvanized Purlins					
	Galvanized Screws					
					SUB TOTAL	52,751.30
	NO REFUNDS			VAT	15.00%	7912.70
				N.H.I.L	2.50%	1318.78
				DISCOUNT %		
					TOTAL GH¢	**61,982.78**

Rate

NOTES:

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Cheque #

CHEQUES MADE PAYABLE TO IPCP LIMITED

ITAL PRESTRESS & CONST. PRODUCTS LTD.

Signed	OGF	Checked by:	
	0244592955(Sales Engineer)		
Date		Production Date:	