U-Block Precast Concrete

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Abstract

This study aimed to create a new, economical system of constructing columns and beams using an innovative design of pre-cast concrete. Further, this study aimed to find out added advantages, uses, and relevance of pre-cast concrete in low-rise building construction.

The result of this study showed that using the U-Block pre-cast concrete sections minimizes expenses for the construction of a structure and eliminates extra manpower activities in the formwork stage compared to the conventional system of concrete construction. It also discovered the versatility of concrete.

The findings and conclusions were based from the data gathered after actual use of materials for concrete and mixture for a U-block section designed for application in beams and columns. The U-blocks were found out to be applicable in the construction of low-rise structures with faster construction time. The use of U-blocks entirely eliminates the use of plywood forms and reduces the use of scaffoldings.

From the conclusions, the researcher presents the following recommendations:

A follow-up study must be conducted to know the actual compressive strength of the U-block pre-cast section produced; design a reinforced concrete section which will be based from the acquired data on the actual compressive strength and the application of the designed section, and know the required spacing or span of the support of the designed section.

Introduction

Background of the Study

Concrete is an artificial engineering material made from a mixture of portland cement, water, fine and coarse aggregates, and a small amount of air. It is the most widely-used construction material in the world. Portland cement is not a brand but a type of hydraulic cement. The name was given in 1824 by Sir Joseph Aspdin, a brick layer of Leeds, England, to a hydraulic lime that he patented because it resembled a natural limestone quarried on the isle of Portland in England. (Max B. Fajardo Jr,, 1993)

The durability of concrete is evidenced by the fact that concrete columns built by the Egyptians who introduced a bonding material using lime more than 3600 years ago are still standing. The Romans used pozzolan cement in their structures many of which still exist. In contemporary times, Le Corbusier, an architect, developed and applied in his project modem materials like sheet glass, synthetics, and ferroconcrete. His work did much to bring about general acceptance of the now-common international style of low-lying, unadorned buildings that depend for aesthetic effect on simplicity of forms and relation to function. Concrete is the only major building material that can be delivered and transported in a plastic state. This unique quality makes concrete desirable as a building material because it can be molded to virtually any form or shape. (Encarta Encyclopedia, 200I)

Related to the conventional construction of concrete structures is the need for formworks. Trees which serve **a** broad need in the construction industry especially as sources of commonly-used conventional form of lumber and plywood are now scarce, such that the DENR and local government units are mandated to institute measures to conserve this natural resource.

The U-block pre-cast concrete was conceptualized out of concern for a need to **preserve** our trees, for economy in construction, to introduce a new construction method of pre-casting in the locality, and to enskill workers for a new method of pre-cast construction. The research was conducted with one-storey structures as actual laboratories.

This study was conducted to design and produce a U-block pre-cast concrete section that is economical, practical, functional, and applicable according to structural standards for the construction of columns and beams.

Review of Related Literature

This study was anchored on the basic characteristics of concrete which, as a building material, has many desirable qualities like strength, economy, and durability. Concrete is versatile. It can be formed to obtain any design or shape and it can be mixed anywhere. (Grolier Incorporated, 1995)

Depending on the mixture of materials used, concrete will support, in compression, 700 or more kg/sq cm (I0,000 or more lb/sq in). The tensile strength of concrete is much lower, but by using properly designed steel reinforcing, structural members that are as strong in tension as they are in compression can be made. (Encarta Encyclopedia, 2001)

Composition

The two major components of concrete are cement paste and inert materials. The cement paste consists of portland cement, water, and some air either in the form of naturally entrapped air voids or minute, intentionally entrained air bubbles. The inert materials are usually composed of fine aggregates or coarse aggregates.

The aggregate represents 60 to 80% of the volume of the concrete and the gradation (range of particle *sizes)* affects the amount of cement and water required in the mix, the physical properties during placing and finishing, and the compressive strength. Aggregates should be clean, hard, strong and free of surface materials.

When portland cement is mixed with water, the compounds of the cement react to fonn a cementing medium. In properly-mixed concrete, each particle of sand and coarse aggregate is completely surrounded and coated by this paste, and all spaces between the particles are filled with it. As the cement paste sets and hardens, it binds the aggregates into a solid mass.

Concrete Mixtures

Concrete mixtures are usually specified in terms of the dry-volume ratios of cement, sand, and coarse aggregates used. A 1:2:3 mixture, for instance, consists of one part by volume of cement, two parts of sand, and three parts ,of coarse aggregate. Depending on the applications, the proportions of the ingredients in the concrete can be altered to produce specific changes in its properties, particularly strength and durability. The ratios can vary from 1:2:3 to 1:2:4 and 1:3:5. The amount of water added to these mixtures is about 1 to 1.5 times the volume of the cement.

Table 1. **Effect of water content on compressive strength of** concrete **(Non-Air Entrained)**

Water Cement Ratio	Probable compressive strength (gt28 day)
9	2000 psi
8	2500 psi
7	3200 psi
6	4000 psi
5	5000 psi
4	6000psi

• Water-cement ratio= Gals. of water per bag of cement. From ACI 613:
ACI Recommendcd practice for selecting proportions of concrete (C. Douglas Aurand, 1991)

Curing of Concrete

When cement, aggregates and water are mixed, a chemical reaction is started that is independent of drying. Concrete does not need air to cure. It can set under water. Water starts the reaction. Concrete sets or becomes firm within hours after it has been mixed, but curing, the process of attaining strength, takes considerably longer.

Proper curing of concrete is essential if the design strength of the concrete mix is to be obtained. Hydration is a chemical reaction between the water and the cement when concrete is on curing. The longer the water is present in the concrete, the longer the reaction takes place, hence, the stronger it becomes.

After exposed surfaces of concrete have hardened sufficiently to resist marring, they should be cured by sprinkling (covering) with water or by using moisture-retaining materials such as waterproof paper, plastic sheets, wet burlap, or sand, or left in forms for a longer period. In hot weather, it should be kept moist for at least three days. (Encarta Encyclopedia, 2001)

Strength of Concrete

Under normal conditions, concrete grows stronger as it grows older. The chemical reactions between cement and water that cause the paste to harden and bind the aggregates together require time. The reactions take place very rapidly at first and then more slowly over a long period of time. In the presence of moisture, concrete continues to gain strength for years. For instance, the strength of just-poured concrete may be about 70,307 g/sq cm (1000 lb/sq in) after drying for a day, 316,382 g/sq cm (4500 lb/sq in) in 7 days, 421,842 g/sq cm (6000 lb/sq in) in 28 days, and 597,610 q/sq cm (8500 lb/sq in) after 5 years.

Concrete Duration of Compressive Strength

50%	3 days
70%	7 days
100% -	28 days

Remaining 30% - 21 days @ slower rate
(Max B. Fajardo Jr., 1993)

Note: The compressive strength of concrete may continue to increase beyond the designed strength, depending on its curing.

Composition of Hydration of Cement

The main compounds in portland cement and their typical percentage content are tricalcium delicate (55%), dicalcium silicate (25%), and tricalcium aluminate (10%), •

The chemical reaction of the two silicates with water produces calcium silicate hydrates and calcium hydroxide. These hydrates make the largest contribution to the strength of the hydrated cement paste. (Grolier Incorporated, 1995)

Construction Techniques

Concrete is poured into place in a number of ways. For the footings of small buildings, the wet concrete is poured directly into trenches dug into the earth. Concrete for foundations and certain types of walls is placed between supporting wood or metal fonns, which are removed after the concrete has hardened. In lift-slab construction, floors and roof slabs are cast at ground level and then raised by hydraulic jacks and fastened to columns at the desired elevation. Slip fonns are used to produce vertical shafts for silos and the cores of buildings. They are moved upward at a rate of IS to 38 cm (6 to 15 in) per hour while concrete and reinforcements are put in place. The tilt-up method of construction is frequently used for one- and two-story buildings. Walls are cast in place on the ground or on the previously laid concrete floor and tilted into position by cranes. The walls are joined at the comers or between panels with cast-in-place concrete columns.

For certain applications, such as the construction of swimming pools, canal linings, and curved surfaces, concrete may be applied by the shotcrete method. In shotcreting, concrete is sprayed under pneumatic pressure rather than placed between fonns. Often, the use of shotcrete eliminates the need for fonnwork and permits placement of concrete in confined areas where conventional forms would be difficult or impossible to construct. (Encarta Encyclopedia, 2001)

Concrete Masonry

Concrete masonry is block building units molded of concrete and used in all types of masonry construction. Concrete masonry is used for load-bearing and non-load-bearing walls; piers; partitions; fire walls; backup for walls of brick, stone, and stucco facing materials; fireproofing over steel structural members; firesafe walls around stairwells, elevators, and other enclosures; retaining walls and garden walls; chimneys and fireplaces; concrete floors; and many other purposes.

In the Philippines, the size of the concrete hollow block is 4 x 8"x 16 for interior walls, and 5" x 8"x 16and 6 x 8"x 16" for exterior walls. CHB units are

laid every 3 layers with horizontal steel reinforcement and every 2 blocks vertical reinforcement.

Reinforced Concrete

Concrete used in most construction work is reinforced with steel. When concrete structural members must resist extreme tensile stresses, steel supplies the necessary strength. Steel is embedded in the concrete in the form of a mesh or deformed bars. A bond forms between the steel and the concrete, and stresses can be transferred between both components. (Encarta Encyclopedia, 2001)

Reinforcing Steel

Reinforcing steel, manufactured as round rods with raised deformations for adhesion and resistance to slip in the concrete, is available in several grades (yield strengths). Commonly used reinforcing rods have yield strengths of 40,000 and 60,000psi available in sizes from #3 (10mm diameter) to any bigger size.

Proportion of Structural Elements

BEAM
Depth (d) = 1 inch is to 1 ft span/length of beam
Span (s) = length of a beam
Base (b) = two-thirds on the depth of beam

COLUMN
Area of Steel (As) = is the cross sectional area of steel
=3t0 6% of cross-sectional area of column is the common range
= 8% of cross-sectional area of column is the maximum

Building Code

The building code application on curing of concrete so provides that concrete shall be maintained at about 10°C temperature and in a moist condition for at least the first 7-days after placing, except that high early strength concrete shall **be** so maintained for at least the first 3-days... Curing by high pressure steam at atmospheric pressure, heat and moisture or other accepted process, maybe employed to accelerate strength gain and reduce the time of curing. (Max B. Fajardo Jr., 1993)

Definition of Terms

ACI, American Concrete Institute

Admixture, A material other than water, aggregate, or hydraulic cement, used as an ingredient of concrete and added to concrete before or during its mixing to modify its properties.

Aggregate. An inert granular material such as natural or manufactured sand, gravel, crushed stone, vermiculite, perlite, and air-cooled blast-furnace slag, which when bound together into a conglomerate mass by a matrix forms concrete or mortar.

Air-entrained Concrete. A concrete in which minute air bubbles are intentionally trapped by the addition of an admixture to the cement, either during its manufacture or during the batching and mixing of the concrete.

ASTM. American Society for Testing and Materials

Bar. A length of metal or other solid material used as part of a structure.

Cast-in Place Concrete. (same as *in-situ* concrete)

CHB. Concrete Hollow Block madder from a mixture of cement, fine aggregates, and water formed from a steel mold.

Concrete. A mixture of cement, sand, aggregate, and water in specific proportions that hardens to a strong stony consistency over varying length of time.

Construction. A structure or thing that has been built.

Conventional concrete construction. **A** system of construction using plywood, board, and wood used as forms and scaffoldings of the concrete poured at job site.

In-situ concrete. A term given to any concrete that is poured in place at a job site.

Ferroconcrete. Also known as Reinforced Concrete, it is a concrete made with metal wire or rods embedded in it to increase its strength.

Fine Aggregate. Any aggregate that passes a No. 4 sieve (which has wires spaced / in. on centers in each direction).

Fly ash. This refers to finely divided residue resulting from the combustion of ground or powdered coal, used as an admixture for concrete fortifier.

Hydraulic Cement. This is a bonding agent that *reacts* with water to form *hard* stone-like substance that is resistant to disintegration in water, with specific combination of silicate and aluminates of lime

Malleable, This *is* used to describe a metal or other substance that can shaped in any form

Metal *is* **a** chemical element such as iron that *is* usually *solid* in fonn, malleable, and ductile

Pre-cast is to pour concrete into a cast of the required shape and alJowed to harden before being taken out and put into position

Reinforce. To make something stronger, adding a tensile strength of the concrete

Slip Form. In concrete construction, **it is a** form designed *to* move upward slowly by means of hydraulic jacks

Steel *is* a strong alloy of iron containing up *to 1.5%* carbon along with small amount of other elements such as manganese, chromium, and nickel

Structure is a building, framework, or another object that has been *put* together from many different parts

U-block is **a** large solid piece of a hard substance, usually *flat* sides and in "U" shape used to enclosed steel reinforcement *to* become a reinforced concrete structure.

Delimitation of the Study

This study *is* delimited to finding out the application and economy of use of U-block pre-cast concrete in the construction of *columns* and beams of one-storey structures.

Methodology

The system of fabricating pre-cast concrete was applied in the study to create a U-form block so *that* steel reinforcements can be inserted in the blocks. The idea of creating the block was based on the CHB *as* a building block using fine aggregates, cement and water and the mixture poured on a molder. The U-form was adopted to create a continuous rectangular shape which is the usual form of columns and beams.

A basic consideration in the design of the U-block as a building block unit is that it must be comparable to the regular compressive strength of CHB which ranges from 330psi to 450psi but which capacity can be increased by around 20%.

The U-block was also designed to eliminate the entire use of conventional wood and plywood as concrete formworks. The U-block acts as concrete covering itself of the steel reinforcement to become a composite reinforced concrete beam or column.

Technical Description of the Process

The research was conducted in one-storey structures as actual projects with the following procedures:

1. **Observation.** Actual site visits were undertaken to observe the construction of a one-storey residential structure using the conventional system, i.e. use of wooden formworks, fabrication of steel reinforcements and the erection of reinforced concrete columns and beams.

2. Quantity Survey. The quantity and cost of labor and materials actually used 'Bild the duration of activities for the structure being built in the conventional construction method were estimated.

For comparison, a U-block pre-cast concrete was used to construct a similar structure with the aim of reducing material and labor costs and minimize the work activities.

An estimate was done which compared the cost of conventional method of constructing a column with the method using the U-block pre-cast concrete.

From Table 2-A below, one set of column using the conventional system of concrete construction was provided with forms in a day before concrete pouring took place. For this particular example, one skilled worker was assisted with one laborer who provided and installed the fonnworks for one column.

Table Z-A. Average estimated cost of formworks for one () column using the conventional method of construction

Description	Q'y	Unit	Unit Price	Total
2 Thick Marine Plywood	1	pc.	350	350.00
2x2x8' Tanguille Phil Wood	11	pcs.	102	1122.00
2x3x10' Coco Lumber	20	pcs.	100	2000.00
CWN (Asstd)	0.50	kg.	50	25.00
			Cost of Material	3,497.00
			Cost of Labor (Form fabrication+ Installation)	500.00
			Cost of Labor and Materials per I-Column alone	3997.00
			Stripping Cost after Erection of Column	63.00
			Total Expenses for One 1 Column Formworks	P 4,060.00

Table **2-B.** Estimated cost of materials in the installation of one (1) column using the u-block method and using only a wooden guide

Description	Q'y	Unit	Unit Price	Total
2x2x12' Tanguille Phil Wood	2	pcs.	152	304.00
2x3x8' Coo Lumber	4	pcs	80	320.00
CWN (Asstd)	0.12	kg	50	6.00
			Cost of Material	630.00
			Cost of Labor	30.00
			Removal of Guide/Braces	4.00
			Total Expenses for One (1) Column Guide	P 664.00

From Table 2-B, the installation of a column using U-block method does not need formworks and scaffoldings unlike the conventional method. Only the wooden guide to plumb the vertical and horizontal module lines is needed in this method. For this example, one skilled worker and one laborer will position the guide before the installation of the said block.

All columns were set to position before concrete pouring took place. For the conventional system, two skilled workers and six laborers were needed in the pouring of the five columns. Concrete pouring were done to two columns simultaneously, and the remaining farthest column was poured by all the eight manpower.

For the U-block system, five columns had one skilled worker each, and three laborers that suppled the skilled workers with concrete. The first laying of U-block for the column started just after the pouring of footing to have a monolithic pouring for footing and column (See Figure 2). Block-laying stopped just above the surface of the natural grade line to harden first the laid blocks and to work for the wall footing and CHB wall installation while waiting for the columns to stabilize. After approximately two hours, backfill fr the excavated column and wall footings were undertaken, From this time, the U-blocks for column was in ready for laying until its maximum height (Sec Figure 3). The laying of U-blocks for amn $-t (2.40m) column height cquivlent to 6-blocks was done st an avsge of 25 minutes,

Tablcs 3— and 3-B below show the differences of the cast be»an he conventional column construction and the U-block installation.

Table 3-A, Estimatd cost of materials and labor for concrete ued for five (5) columns at 2.40m length using the conventional method

Description	Qy	Unit	Unit Cost	Toal
Portland Cement	6.00	bags	**160.00**	960.00
Sand	0.329	**M3**	**350.00**	**115.00**
3/4" Aggregate	0.660	**M3**	**450.00**	**297.00**
Labor Cost	1.00	hr	225	225.00
	Total Cost of Materials & Labor			**P 1597.00**

Table 3-B. Estimated cost of materials and labor for concrete used for five (5) columns at 2.40m length using the —block method

Description	Qy	Unit	Unit Cost	Total
Portland Cement	3.20	bags	160.00	512.00
Sand	0.225	M3	350.00	78.75
3/4 " Aggregate	0.180	M3	450.00	81.00
U-Block Precast	60	pcs	13.00	780.00
Labor Cost	0.457	hr	262.50	120.00
	Total Cost of Materials & Labor			P 1.571.75

Similarly, the formworks of one beam were installed using the conventional method of concrete construction and a wooden guide for another beam that was to be constructed using the U-block system. Tables 4-A and 4-B show the comparison of costs.

Table 4-A. Estimated cost of formworks for one (d) beam at 3.0 meter **length using the conventional method of construction**

Description	Q'ty	Unit	Unit Price	Total
⁄2 Thick Marine Plywood	0.80	pc.	350	280.00
2?2" Tanguille Phil Wood	20	Bd.ft.	38	760.00
2"x3" Coco Lumber	144	Bd.f.	20	2,880.00
CWN (Asstd)	1.80	kgs.	50	90.00
			Cost of Material	4,010.00
			Cost of Labor (Form fabrication + Installation)	880.00
			Stripping Cost after Erection of Beam	70.00
			Total Expenses for One 1 Beam Formorks	**P 4.960.00**

Table 4-B. Estimated cost of formworks for one (l) beam at 3.0 meter length using the U-block method

Description	Q'y	Unit	Unit Price	Total
2"x2" *Tanguille* Phil Wood	10	Bd.ft.	*38*	380.00
2x3x8' Coco Lumber	*116*	Bd.ft.	20	2,320.00
CWN (Asstd)	J.30	kg	*50*	65.00
			Cost of Material	2,765.00
			Cost of Labor	580.00
			Removal of Guide/Braces	45.00
			Total Expenses for One (1 Column Guide	**P 3,390.00**

A summary of the costs in the construction of five (S) beams using the conventional method and another set of five *(5)* beams that were installed using the U-block system is presented below.

Table 5-A. Estimated cost of materials and labor in concrete used for five (5) beams at 3.00 meters length using the conventional method

Description	Q'ty	Unit	Unit Cost	Total
Portland Cement	3.50	bags	160.00	560.00
Sand	0.20	M3	350.00	70.00
3/4 " Aggregate	0.40	M3	450.00	180.00
Labor Cost	*1.05*	hr	225	236.25
			Total Cost of Materials & Labor	P1946.25

Table **5-B.** Example of estimated cost of materials and labor in concrete used for five (5) beams at 3.00 meters length using the U-block method

Description	Q'y	Unit	Unit Cost	Total
Portland Cement	1.70	bags	160	272.00
Sand	0.094	M3	350	33.00
3/4 " Aggregate	0.187	M3	450	**84.00**
U-Block Precast	37.50	pcs	13	487.50
Labor Cost	0.644	hr	225	145.00
		Total Cost of **Materials** & Labor		P1O21.50

3. Design. The researcher considered a design for the U-block to be **a** compact molded concrete. The block has a width of 150mm, height of 190mm and a 400mm length, the same size as the Concrete Hollow Block (CHB) in order to tit and align with the CHB walls (See Figure I). A provision of holes in the block was made to stabilize the position of the block during concrete pouring (See Figure 6). Sizes and measurements were designed to resist the loading to be transmitted in the structure. The location of reinforcing bars is based on the 3.00m average height of columns and span of beams for one-storey structures.
(See Figure 3 & 4).

4. Fabrication. The U-block pre-cast concrete molder was fabricated from steel into the size as designed above. (See Figure 5).

5. Production. The production of the U-block pre-cast concrete is similar to that of CHB, but has a lesser volume of aggregates. Approximately *S* cu.ft. to 6 cu.ft. fine aggregates were mixed with 1 bag portland cement and 2.5 to 3.5 gallons of water. After thorough mixing, the fresh concrete was poured inside the steel molder and tamped hard for compaction. (See Figure 7)

The computed cost ofU-block fabrication is shown in Table-6 below.

Table 6. Estimated cost of production of the u-block pre-cast concrete for one (1) mixing, using 1-bag of cement with 5.50 cu ft. fine aggregates.

Description	Q'ty_	Unit	Unit Cost	Total
Portland Cement	1.00	bag	160	160.00
3/4 " Aggregate	0.156	M3	320	49.92
Labor Cost	1.00	bag	60	60.00
		Total Cost of Materials & Labor		P269.92
(Plus)		10% Contingencies		26.99
(Plus)		5% Delivery(Labor)		13.50
(Plus)		I0% Overhead & Profit		26.99
		Tota! Cost of 1-Mixing		P 337.40

One (I) Mixing could produce an average of 26-pcs U-Blocks.
Therefore, the cost of I-**pc** U-Block Pre-cast Concrete is Php 13.00.

5. Curing. All produced U-blocks were piled in sheds to avoid rapid evaporation of the moisture content of the concrete (See Figure 8). All fresh concrete blocks were protected from being wet. Curing started only after 24 hours. Sprinkling with water 4-6x a day for one week *was* done to attain the required strength before installation. •

6. Application. The U-blocks were applied in selected constructions as follows:

1. As fence column

   The U-block was first applied in the construction of the fence of the Cockpit Arena of Caoayan, Ilocos Sur (See Figure 9).

2. As building column

   The U-block was used as columns of the one-storey Caoayan Commercial Center(See Figure 10 & 11).

3. As tie beams/wall footing

   The U-block was used as wall footing of the fence of the Caoayan Cockpit Arena. (See Figure 9).

4. As roof beam

   The U-block was used as roof beams of the Caoayan Commercial Center(See Figure 12).

Results and Discussion

The actual production output for the mixture of 1-bag of cement and 5.5 cubic feet of fine aggregates is 26-pcs of U-block pre-cast concrete. The size and measurement of the produced U-block is shown in Figure-1.

From the actual application, the estimated materials and labor in constructing reinforced concrete using the U-block system is found out to be cheaper than the conventional system by 76% for column, and 30% for beam.

Table 7. Summary of cost comparison between the conventional and the u-block system of constructing five (5) sets of reinforced concrete columns

DESCRIPTION	COST OF WORK Conventional System	COST OF WORK U-Block System	Cost of savings/ column	Percentage (%) savings
A) Formworks and Guides	P 20,300.00	P 3,320.00	P 16,980.00	83.65%
B) Concrete Works	P1,597.00	P 1,571.75	P 25.25	1.58%
Total	P 21,897.00	P4,891.75	P 17,005.25	76.42%

Table 8. Summary of Cost Comparison between the Conventional and the U-block System of Constructing Five (5) Sets of Reinforced Concrete Beams

DESCRIPTION	COST OF WORK Conventional System	COST OF WORK U-Block System	Cost of savings/ column	Pere. (%) savings
C) Formworks and Guides	P 24,800.00	P 16,950.00	P 7,850.00	31.65%
D) Concrete Works	P 1,046.25	P 1,021.50	P 24.75	2.37%
Total	**P 25,846.25**	**P17971.50**	**P 7,874.75**	30.47%

Conclusions and Recommendations

The U-blocks reduce expenses for labor and materials, and is recommended for the construction of columns, tie beams and roof beams of one-storey low-rise structures.

The U-blocks make possible for faster construction time. This system for column construction eliminates formwork activities except for the wooden block guides which are only needed to ensure the plumb and alignment of the installation. Hence, there is no need to install side forms of the reinforced concrete columns and beams, and completely eliminates stripping time for forms and scaffoldings. The steel reinforcing bars and the concrete itself attain a composite function both of tension and compression for the entire structure.

The designed size of the U- block has a limited strength and application for a structure. There is a need for a Structural Engineer to compute and investigate the safety of the application. The U-block columns need to be analyzed based on the span of the structure to project a safer size and correct number of reinforcing bars in the design.

Based on the conclusions, the researcher presents the following recommendations:

I. There is a need to get the actual compressive strength of the pre-cast concrete to compare the composite structure (U-block system) with the monolithic (conventional) structure.

2. Since the section is small and it has only a limited use in a structure, the pre-cast must be designed for a more flexible and complex use such as for the construction of floor and roof beams of two-storey structures.

3. The mixture ratio of the U-block pre-cast must be studied to increase its strength, bonding capability to the cast-in place concrete, and to increase the quantity of production.

4. Other shapes aside from U must be designed also for flexibility of use and application in structures.

5. The required maximum span of the pre-cast beam must be studied, and to identify the safe load to be carried by the U-block pre-cast column.

6. A follow-up study should be conducted for increased idea on the pre-casting methods of construction.

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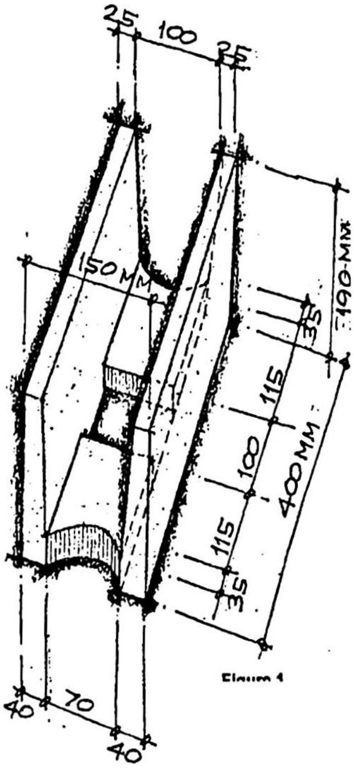

Figure 1

The Designed U-Block
Pre-Cast Concrete

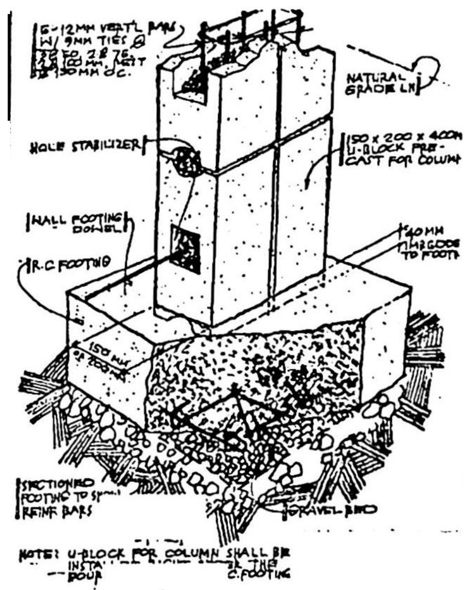

Figure 2

U-Block Pre-cast
Concrete Installed on
Fresh Concrete of
Footing

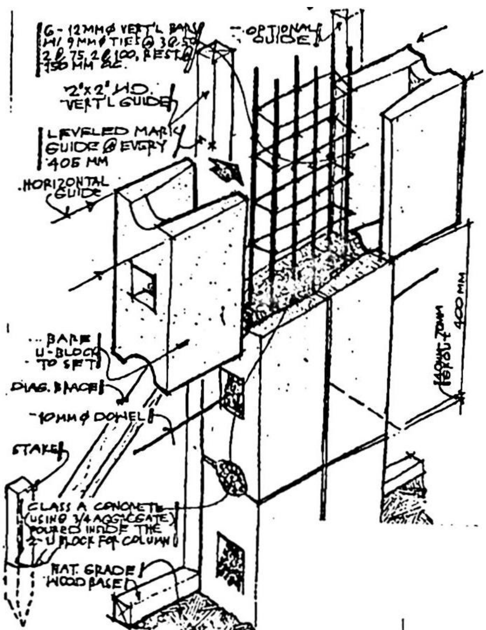

Figure3

U-Block Pre-cast Concrete Installed for R.C. Column

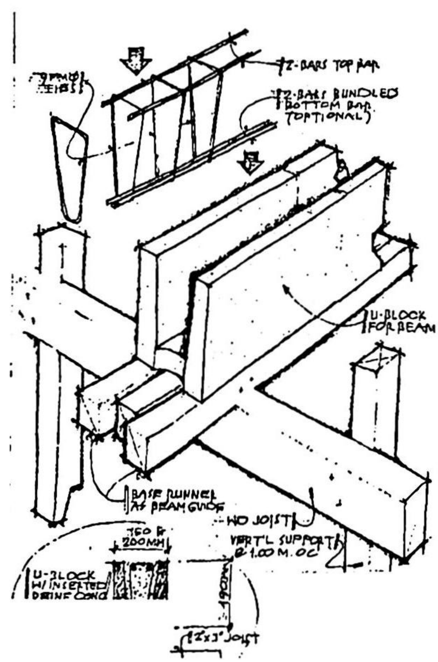

Figure 4

U-block Pre-cast Concrete Used as Lintel Beam

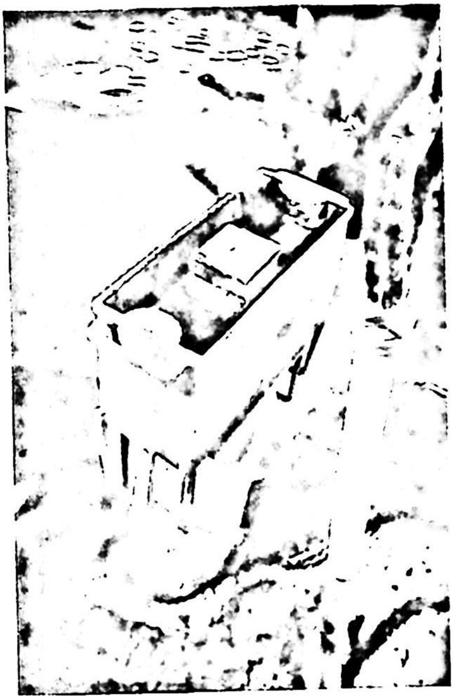

Figure 5

Steel Molder of the U-block Pre-cast Concrete

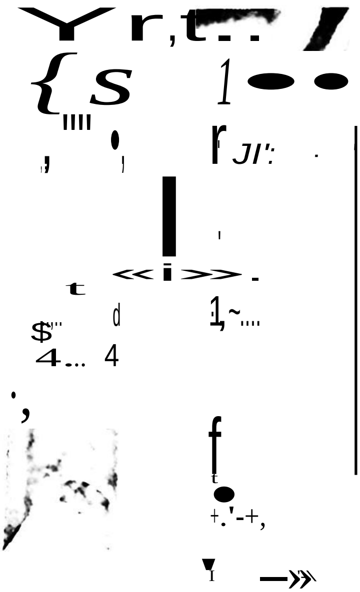

Figure 6

The Design of the U-Block has holes to stabilize the position of the block during concrete pouring.

Figure 7

The fabrication of a pre-cast concrete is similar to CHB.

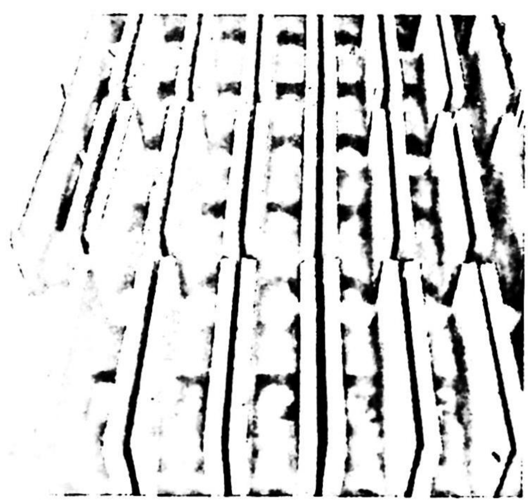

Figure8

The piling of the fresh pre-cast concrete

Figure 9

The application of the U-block intended for columns and tie beam wall fence of the Cockpit **Arena,** Don Alejandro Quirolgico, Caoayan, Ilocos Sur

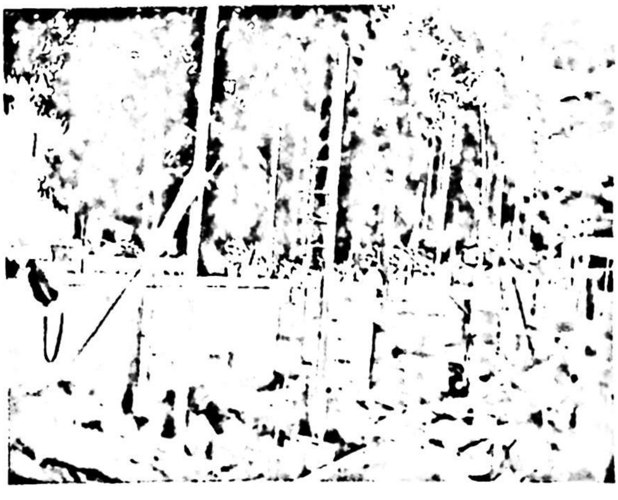

Figure 10

The U-block used as a column for the Caoayan Commercial, Caoayan, Ilocos Sur

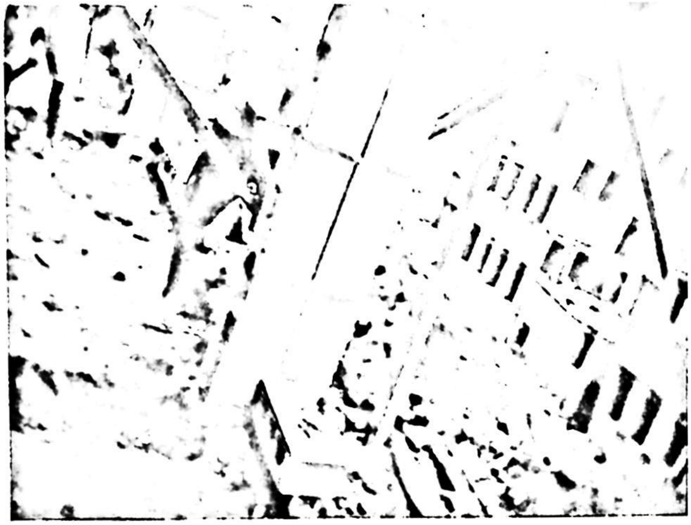

Figure 11
A full view of U-block used as a column @ Caoayan Commercial Structure

Figure 12

The U-block intended for short span roof beam with minimal loading at the Caoayan Commercial