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COMPARISION OF PRESTRESSED HOLLOW CORE SLAB AND PRECAST CONCRETE BEAM-HCB SLAB SYSTEM

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ABSTRACT

Precast prestressed concrete member with continuous voids provided to reduce weight and, therefore, cost and, as a side benefit, to use for concealed electrical or mechanical runs. Primarily used as floor or roof deck systems, hollow core slabs also have applications as wall panels, spandrel members and bridge deck units. This system of construction does not require form work and Propping during installation. Precast, prestressed concrete floors offer significant advantages in many types of building construction. Precast and prestressed structures offer cost advantages over other flooring materials and systems and are suitable for concrete, masonry and steel structures. Use of precast prestressed concrete elements is not widely used for construction of most buildings. The conventional cast in-situ construction required more resources and time when compared to precast prestressed structures. Hence hollow core slab elements are introduced in vast amount in the construction of buildings, an economical construction could be achieved. The hollow core slab system is requiring a short construction time and less expensive compared to precast beam slab system. Each slab on a given casting line will have the same number of pre-stressing strands. Therefore, the greatest production efficiency is obtained by mixing slabs with the same reinforcing requirements from several projects on a single production line. This implies that best efficiency for a single project is obtained if slab requirements are repetitive. Advantages of prestressed hollow core slab elements, for construction of the floor slabs of four story building, is shown by making cost comparison between the precast beam-slab system and pre-stressed hollow core slab system by selecting the same span length is chosen for the two slab systems. Cost comparison is made between the two systems of slab construction. The cost comparison showed that the prestressed hollow core slab system of construction is more economical and faster than the precast beam-slab system.

Keyword: *Prestressed concrete, HCB Slab, Compression.*

I. INTRODUCTION

Precast and prestressed concrete flooring offers an economic and versatile solution to ground and suspended floors [12]. It gives both the design and cost advantages over the most common methods of construction such as cast in-situ concrete, steel-concrete composite and timber floors [12, 20]. Approximately, half of the floors used in commercial and domestic buildings around the developed world are constructed using precast concrete floors [12].

Precast prestressed hollow core concrete slab is one of the existing methods of flooring construction which has got a self weight of about one-half of a solid section of the same depth [12, 19]. It is now the most widely used type of precast flooring system in the developed and developing countries. This success is largely due to the highly efficient design and production methods, flexibility in use, surface finish and structural efficiency [1, 11, and 12].

II. MODEL BUILDING FOR THIS STUDY

For cost comparison G+4 building (Fig.1) is considered. Slabs for the building are designed as prestressed and precast method.

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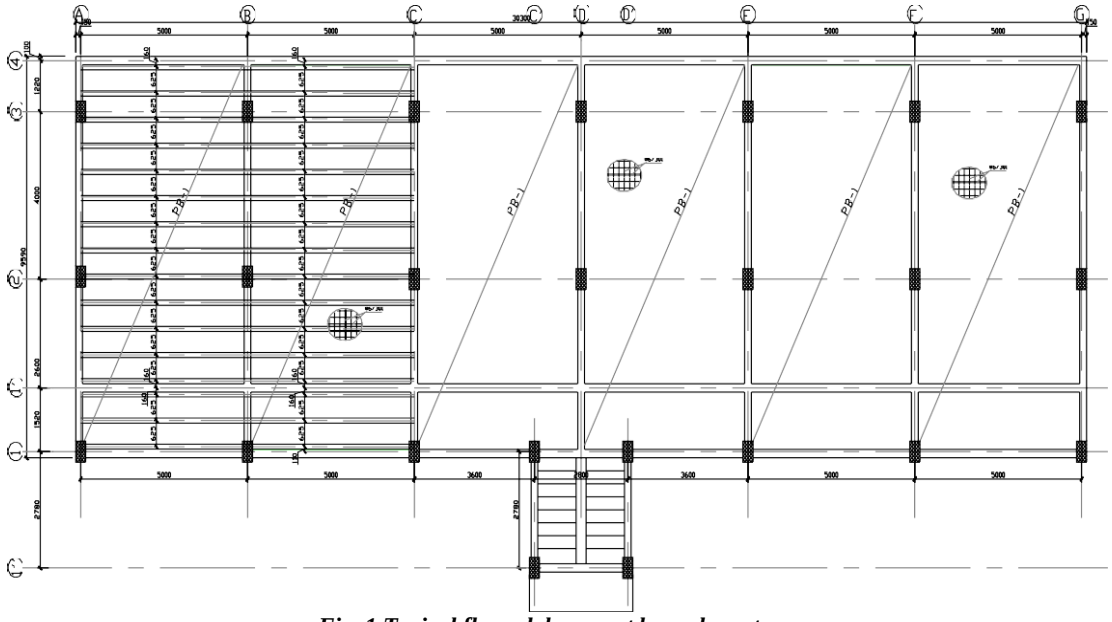

Fig. 1 Typical floor slab precast beam layout

Slab area of the building of length 30m and wide 9.50m and having thickness of 9.5 cm thick.

III. METHODOLOGY OF THE STUDY

Precast Beam and Slab Block

This modern\product allows the construction market to eliminate the need for conventional cumbersome\bulky\ in situ decking system. In addition the precast concrete and blocks reduce the amount of in-situ concrete required [7].The relative speedy erection and completion ensures easy access to other trades and earlier occupation of completed building. Skilled laborers on site like bar benders and carpenters are reduced considerably due to the simplicity of the system and ease of handling making it ideal for the builder. The precast beam and block slab system, eliminating the requirement for crane erection, has proven ideally suitable for commercial and industrial developments, schools, town houses, cluster homes and domestic homes

Cost of construction of slab systems is compared for both precast and prestressed system.

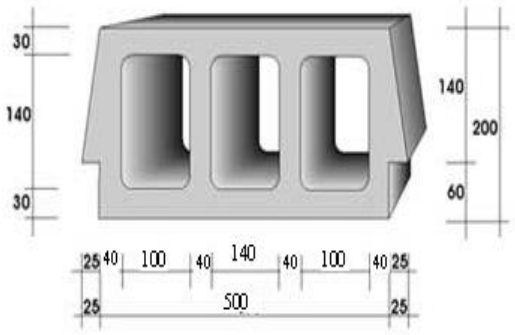

Fig. 2 Typical hollow block for slab construction

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The cost of construction (Material, Labor and equipment including profit and overhead costs), using the two slab systems of four-story building (Fig.1) is calculated. Disposition of cost calculation

Prestressed Hollow Core Concrete Floor Slab

Hollow core units, which were developed around 1950s, can be used without any structural topping [12]. This is because the slab is designed to have effective shear key joints between adjacent units such that when grouted the individual slabs become a system that behaves similar to a monolithic slab standard edge profiles have evolved to ensure an adequate transfer of horizontal and vertical shear between adjacent units [7, 12]. Mostly, these kinds of floor units are one-way spans which are simply supported and are also prestressed.

(a) **(b)**

Fig. 3 Typical Prestressed hollow core concrete floor units

Cores are typically either circular or elliptical (Fig.3). Slabs may be reinforced or pre- stressed. The hollow cores afford a reduction in self weight of 30% or more compared with a solid slab of the same depth. Depending on the loading do not necessarily need structural topping, although a leveling screed is required.

IV. COST COMPARISON

The cost comparison is divided in to two components, the first is construction cost component, and the second one is construction time component

This study is to investigate the advantages of the use of prestressed hollow core slab elements (Fig.3) with the precast beam-block slab constructions (Fig.2), this section deals with cost comparison of the two systems.

The cost comparison is depending on direct cost, indirect cost and other overheads.
Bid sum = Direct cost + Indirect costs + other overhead costs

i) Direct costs
- a) Material costs
- b) Labor costs
- c) Equipment costs

ii) Indirect costs
- a) Site overhead costs
- b) General overhead costs
- c) Risk and profit

iii) Other costs
- Loading, unloading and transportation costs
- Wastages
- Standard wages

- Extra pay
- Ownership of plant
- Hire of plant

In this study the overheads, risk and profit are considered as 25% of the direct costs.

V. CONSTRUCTION COST COMPONENTS

Quantities of Materials:
Quantities of materials are taken from the drawing and following points are considered for estimation of cost.

- Quantity of material required to produce a unit amount
- Basic price at the source of material
- Transport, loading and unloading to the site
- Waste/loss

The quantities of materials required for the construction of the floors, in both systems, are calculated referring the layout plans on Figs. 1.

Table 5.1 Calculation of total production cost of one precast beam elements

S.No.	Materials	Unit	Quantity	Cost per unit Rs./unit	Cost per one pcs
1	**Concrete**	m3	0.036	3400	122.4
2	**Reinforcement**				
	a)diameter 6	kg	4.57	48	219.36
	b)Diameter 14	kg	6.04	45	271.8
	c)Diameter 16	kg	15.77	45	709.65
3	**Steel formwork**	Pcs.	1	167	167
4	**Welding**	Joints	34	5	170
5	**Direct cost**				1660.21
6	25% (profit and overhead)				415.0525
7	**Total cost Rs./Pcs**				**2075.2625**

Table 5.2 Calculation of total production cost of one hollow core floor slab

S.No.	Materials	Unit	Quantity	Cost per unit Rs./unit	Cost per one pcs
1	Concrete including formwork	m3	0.804	3400	2733.6
2	Diameter 6 Prestressing wire	kg	48	35.26	1692.48
3	Direct cost				4426.08
4	25% (profit and overhead cost)				1106.52
5	Total cost (Rs/pcs)				**5532.6**

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Table 5.3 Construction cost of topping in the first floor

S.No.	Materials	Unit	Quantity	Cost per unit Rs/unit	Cost per one pcs
1	Concrete	m3	9.98	2700	26946
2	Diameter 6 mm dia	kg	426.1	48	20452.8
3	Direct cost				47398.8
4	25% (profit and overhead cost)				11849.7
5	Total cost Rs/Pcs				**59248.5**

Table 5.4 Construction cost of hollow core slab in the first floor

S.No.	Materials	Unit	Quantity	Cost per unit Rs/unit	Cost per one pcs
1	Production and Construction	**m3**	48	4739.175	227480.40
2	Topping	**LS**	4	9935	39740
3	Direct cost				**267220.4**
4	25% (profit and overhead cost)				66805.10
5	Total cost Rs/Pcs				**334025.50**

Table 5.5 Construction cost calculation using precast beam-block slab system in the first floor

S.No.	Cost per unit Materials	Unit	Qty	Rate	Total Cos (Rs.P)
1	Production and construction cost	pcs	96	1664.9715	159837.26
2	Slab HCB	pcs	2016	23.001	46370.02
3	Diameter 6 reinforcement	kg	426.13	48	20454.24
4	Concrete work cost	m3	24.66	2109.768	52026.88
5	Support Work	pcs	96	49.2915	4731.98
6	2mm thick ceiling plastering	m2	243	107.61	26149.23
7	Direct cost				**309569.61**
8	25% profit and overhead cost				77392.40
9	Total cost (birr/unit)				**386962.02**

Cost per unit of installation of precast beam, slab HCB, reinforcement, concrete, support and 2mm thick ceiling plastering works are considered.

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VI. COST COMPARISONS

Table 5.6 Summery of cost comparison for both precast beam-block slab and prestressed hollow core floor slab

Floor	Precast beam-block Slab cost in Rs. P.			Prestressed hollow core slab cost in Rs. P.			Cost Difference Rs. P.
	Direct cost (a)	Indirect cost (b)	Total c= a + b	Direct Cost (d)	Indirect Cost (e)	Total f= d+ e	g = c - f
1st	309569.61	77392.40	386962.02	267220.40	66805.10	334025.50	52936.52
2nd	312665.31	78166.33	390831.64	269892.60	67473.15	337365.76	53465.88
3rd	315791.96	78947.99	394739.95	272591.53	68147.88	340739.41	54000.54
4th	318949.88	79737.47	398687.35	275317.45	68829.36	344146.81	54540.55
Total	**1256977**	**314244**	**1571221**	**1085022**	**271255**	**1356277**	**214943**

VII. CONCLUSION AND RECOMMENDATION

A cost comparison between the two systems of construction the hollow core slab system and the precast beam slab system was made by designing the floor slabs of a typical four-story building, using both systems.
Based on the cost comparison, the theoretical investigation the following conclusions and recommendations may be drawn.

1. The cost comparison shown that the hollow core slab system of construction is faster and less expensive than the precast beam-block slab system. The total saving obtained from the use of system is about 6.31% of the total construction cost of a building using the precast beam-block slab systems.
2. As it can be seen from the cost comparison the saving from construction cost component is 44% of the total saving. Higher value of construction cost saving and hence total saving could have been obtained if the precast pre-stressed hollow core slab elements are designed and produced more economically
3. For the production of the precast prestressed hollow core slab elements. it is recommended to use a minimum concrete class C-25 and the upper surface of the slab elements should be sufficiently roughened to create a good bond with the floor finish cement screed or structural topping and the lower surface slab surface should be smooth enough for final painting.
4. During handling, transporting and erecting the hollow core slab elements great care should be taken not to impair some structural properties
5. For a country like India, where timber and eucalyptus poles resource are limited the application of this system of construction not only has economical benefits but also preserves the national resource by avoiding excessive use of formwork and scaffolding.
6. It is suggested that further research to be carried out in this area for proper utilization of the system. It is hoped that the present study serve as an aid for further developments and other related studies.

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