

Enhancing the Construction Efficiency of Mid Rise Construction Projects with Partial Precast Construction Technique

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Abstract:- The primary success parameter of every construction project is to achieve the better quality products, in the most reasonable time and at an economic cost.

Along with the materials the method of construction used in mid rise construction projects contributes mainly for the cost of the project, time duration to complete the project & structural behavior such as stability, durability, quality etc. of these structures.

This paper is about understanding the need for creating an awareness about the construction method to be adopted & enhancing the construction efficiency of mid rise construction projects with partial precast concrete construction technique. The study also speaks about the cost, time and quality effectiveness as compared to cast in-situ concrete construction techniques for the mid rise construction projects.

The research findings shows that partial precast construction for mid rise construction projects is time and quality effective. Thus, we can achieve the cost effectiveness in partial precast concrete construction if the recommendations made are implemented.

Keywords:- Mid Rise Construction Projects, Partial Precast Concrete Construction Technique.

I. INTRODUCTION

In India the technology of concrete construction is practically looked at in two ways, in-situ or precast. Along with the many advantages in-situ construction has a very long construction process as compared to precast construction process which is shortened by the fact that production of elements is done in factories and just assembled on site which just require one third (1/3) of the time as compared to cast in situ.

The construction industry heavily relies on conventional cast in situ construction, which has many issues like extensive use of timber formworks, production of large quantities of waste, labor intensive, polluting, delayed

production and time. The need to control all these issues are also of great concern. All such issues can be resolved if we change the method of construction.

The one of the alternative choice as the method of construction is the adoption of a combination of partial precast and cast in situ construction techniques which has the capacity to offer advance quality and value for money in construction projects.

By replacing the repetitive components with the use of precast components can improve the construction in terms of time, quality, cost, performance, safety, environmental performance and sustainability, socio-economic aspects (labor) and client satisfaction, which also contribute to the industrialization of the construction industry.

The aim of this research is to investigate and compare the factors like time, cost & quality for cast in situ type building construction & Partial precast type building construction techniques in midrise construction projects. Also to study the components which can be replaced with precast components in the conventional construction.

II. METHODOLOGY

The methodology adopted is the qualitative method in which the literature review, Google survey & the structured interviews of the experts in the field are conducted along with the case studies of ongoing midrise residential projects constructed with cast in situ & partial precast concrete construction techniques.

The comparative data analysis of the results is done for studying the benefits, challenges & extent of limitations for adopting the partial precast construction technique in the midrise construction projects with respect to cost, time and quality.

➤ Interviews :

The aim of the interviews with Project developers , Project designers (Architects, Structural engineer) Contractors, and the occupants was to find out the construction technology they were most familiar with, the

benefits and challenges they experienced if they had used partial precast concrete construction before.

➤ *Google Questionnaires :*

Questionnaire were administered to various groups of people who are generally associated with the project decisions which included Project designers, Project developers, Architects / Structural Engineers, Contractors, Occupants in already completed buildings etc. to get their perceptions on the cost, time and quality of construction.

➤ *Case Studies:*

Case studies are conducted for comparative analysis through the standards of construction. For case study purpose the buildings of similar scale constructed with the conventional technique & partial precast construction techniques are selected from the same locality. The sub-structure cost is relatively equivalent in the two strategies.

On the basis of partial precast construction technique adopted as a construction method, two ongoing construction

projects were identified for the case study. The first Project is midrise housing development project located at Shriwardhan, Dist. Ratnagiri. The second Project is Bungalows scheme (30 Bungalows) located at Buri, Tal.- Mandangad, Dist. Ratnagiri. Both the two projects are constructed with partial Precast & partial cast in situ type techniques with certain experiments by architect & owner. Despite the lack of a genuine factory made precast concrete components on construction project, they replaced some of the concrete components with on site casted precast components.

These case studies concentrated on examining the three traditional maxims of management (cost, time and quality) which contribute to the effectiveness of these maxims. Most importantly the site observations were meant to determine quality which is not quantified. Hence quality in this case was to be determined by the differences in workmanship between similar products or works.

➤ *Project 1: Apartment Project: Stilt+5 Floor BUILDINGS Total No. of Buildings: 4 , FSI Permissible :1.1*

Table 1 Building Details

Building	Type of Unit	Units Per Floor	Total Units in Bldg
TOWER 1	1RMK 2no.&1BHK1no.	3unit x5fl	15Units
BLDG 2	1BHK 4no.	4unit x5fl	20units
BLDG 3	1BHK4no.	4unit x5fl	20units
BLDG 4	1RMK 2no.	4unit x5fl	20units
Total units in four buildings		75units	

Special features of the project: Partial precast and partial in-situ concrete technology. The in situ concrete is used for foundations, columns, beams & slabs.

Precast components are used for staircase, Lofts, Chajjas, U.G. tank .OH tank,Septic tank, standard lintels and Arches, Precast Electric &Compound wall poles

Treated laterite blocks of 14’’x9’’x8’’ are used for masonry with external pointing finishing 1:3 mortar with fine sand & Internal 1:6 plastering for better finish.

- At the time of study almost 80% of the works was complete.
- The mechanical concrete mixer is used.M25 & M-20 grade of concrete is used.



Fig 1 Precast Chajja Resting& Fixed Along with the Chira Stone



Fig 2 Images Showing Loft, Chajja, Slab casting

Total 75 No. of flats .

Estimated construction cost 52.724 Sqft x Rs 1650

Total Built up Area of project: 44,765 sqft+7959 sqft

= **Rs.86,994,600/-** Eight Crore Sixty Nine Lakh Ninetyfive Thousand Only.

= 52,724 sqft



Fig 3 Typical Floor Plan for Bldg. 2,3,4 & 1 (Coloured Part Showing the use of Precast Slab)

Precast elements per Flat :

Loft slab on toilet 90.00sqft*1No.,Tank:16.00sqft=16sqft

Chajja 17.05sqft *3No.=51.15 sqft

Total Precast elements in 1 flat :51.15+15.75+90+16:172 sqft

Chajja 15.75sqft*1No.=15.75 sqft

Table 2 Comparative Analysis for Chajja with In Situ & Pre cast Method: Total Area of Bldg. No.1: **7958.39+stilt**

	Cast in situ	Precast
Time Required	16 Days (casting + curing)	1day+8 Factory Day
Rate Per Sqft	580/Sqft (Due To Labor)	420/Sqft
Cost factor	580*172=99760	172*420=72240
Saving cost factor = Rs.27,520		
Precast Staircase flight used:4'x6'8''=28 sqftx2=56 sqft/floor		

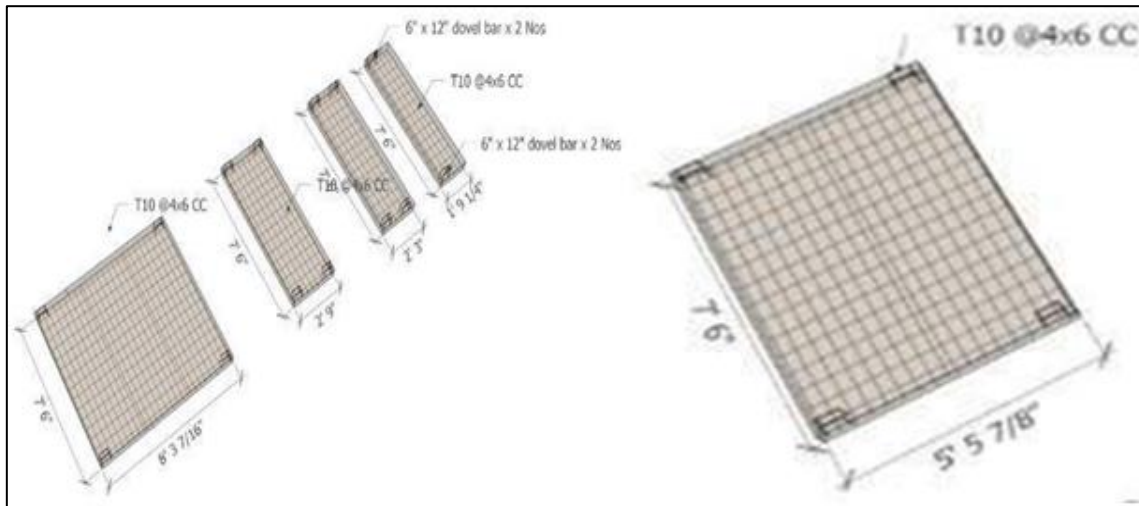


Fig 4 Showing Precast Elements Casting Framework

Table 3 Data Result and Analysis

	Bldg1	Bldg.2	Bldg3	Bldg4
Stilt +5 Residential Bldg.	1RK(10) + 1BHK(5)=15 .flats	1BHK=20 No. flats	1BHK Total20 flats	1BHK Total20 flats
Project status	100%	80% complete	80% complete	80% complete
Project duration month	8 months	Stoped due to financial problem for 14months		
Area of bldg (sqft)	7958.39/sqft	14921.54x3bldgs=44764.65 sqft		
Estimated cost	1650/sqft	1650/sqft		
Actual cost	1350/sqft	1350/sqft		
Insitu elements	RCC Foundation, Columns,Slab,walls with 14''x9''x8'' laterite block ie Chira stone			
Precast elements	RCC Staircase,RCC chajja,RCC lintel,RCC loft slab,OHT,UG tank,Septic tank			
life span	50 yrs	50 yrs	50 yrs	50 yrs

➤ *Precast Lintel Ready on Site*



Fig 5 Showing Precast Elements on site Onsite

➤ *Project 2: Bungalow Construction*

Total No. of Bungalows : 30 (ranging from BUA710 sqft to 1500 sqft, village Buri,Tal.- Mandangad, dist. Ratnagiri) constructed with partial precast technique

Cast in situ concrete is used for the foundations,columns,beams and slabs.

Precast components are used for staircase ,loft, chajjas, U. G. Tank,OH Tank ,Septic Tank.

For masonry walls treated Laterite Blocks of 14’’x9’’x8’’ are used with external pointing finish in 1:3 mortar with fine sand and cement & internal 1:6 plastering for better finish.

The developer has completed one bungalow with lock and key possession within 50 days due to the use of precast components & proper project management . Generally the construction period for one bungalow is 105 days (3&½ month) with in-situ concrete technique.

III. DATA RESULT AND ANALYSIS

Table 4 Bungalow Data Sheet

Area in sqft	BUA710 Carpet487	Bua896 Carpet633	BUA:356 Carpet257	BUA1419 Carpet974
Precast component/ unit in sqft	172.9 x 10	206 x 5	126 x 5	346 x 10
Precast component	Chajja , Loft slab, Lintel, arch Lintel ,U. G. Tank,Septic tank etc			
Project duration months	50days	50days	60days	60days
project status	complete	Finishing stage		
Estimated cost	1650/sqft	1650/sqft		
Actual cost	1475/sqft	1210/-sqft		
future lifespan	50 yrs			

30Bungalow:10(1bhk)+5(2bhk)+5(1rk)+10(1bhk twin)

➤ *Construction Costs Comparison Analysis for Partial Precast Concrete Construction with Cast in Situ Concrete Construction:*

As per the location ,time of study it is observed that

- For the RCC+Bandhkam+complete Plaster cast in- situ construction Cost is up to Rs.1650/- per sqft .
- For the RCC+Bandhkam+complete Plaster Partial precast construction Cost range is between 1210/per sqft up to Rs.1350/- per sqft .

Observation concludes that by replacing 30% of in situ concrete part with precast components 3-7%cost saving can be achieved This changes as per the percentage of replacing cast in situ concrete with precast components & the methods of construction.

The effectivity in terms of time ,quality and cost factor in case of Partial Precast Construction techniques changes as per the scale of project. For better results minimum scale of the project should be approximately 30 flats or 15 to 20 stand alone Bungalows or minimum 10,000 sqft or more built up area .Cost difference can be observed only after 2/3rd completion of project.

Since there are many quality parameters ,it is not appropriate to make any conclusion regarding the quality but the observation shows that due to use of precast components the better quality can be achieved during construction.

In case of delay in the construction period for the partial precast project the total construction cost of the whole project was not affected as compared to cast in situ projects since the most of the precast components was ready

& only.assembling of precast components was done later on which demands less labor & material resulting in time and cost saving.

On the matter of quality of the building product, it was evident that partial precast concrete construction technique or modular construction offered better quality during construction. This is because there was very less remedial work required as compared to cast in-situ concrete technique,

➤ *Interviews*

A few Architect,structural engineer,Project Developers & occupants who has a experience of handling the midrise development projects was interviewed.

The questions asked concerned the methods of construction they were most familiar with, which method they thought was most economical, gives shorter construction time and which one offered better quality.

➤ *The Responses are as Below:*

- *Regarding Cost of Construction:*

On the question of total construction costs developers who developed the midrise Apartment projects indicated that in situ was cheaper than precast modular construction. The same person also said that Precast is usefull only in mass housing projects.

Other developer said vice versa because from their comparative studies of the two methods partial precast concrete construction was 3%-5% cheaper than in-situ construction.

Further comparisons proved that by replacing few components of building with precast components we can curtail the construction cost per square foot without affecting quality & performance.

• *Regarding Construction Time*

The question on which method was time efficient the developers said precast modular construction gives shorter construction time than in-situ construction. This response corresponds with what the project designers said.

• *Regarding Quality*

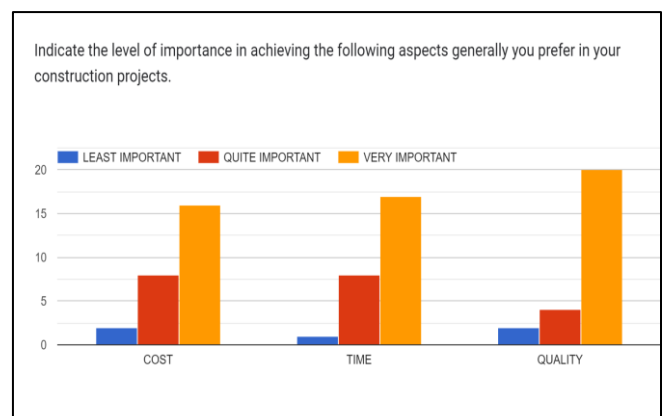
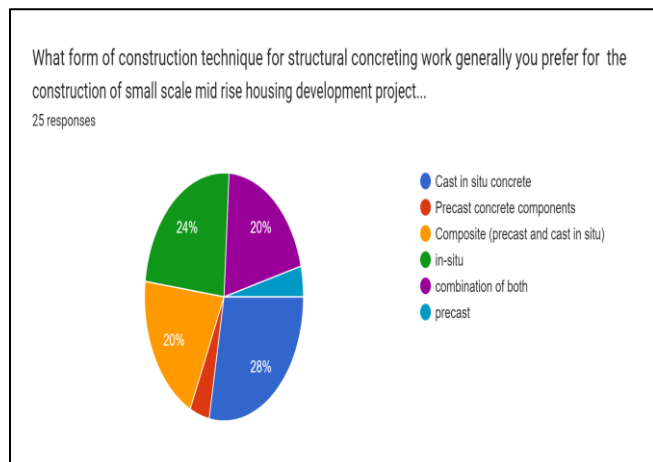
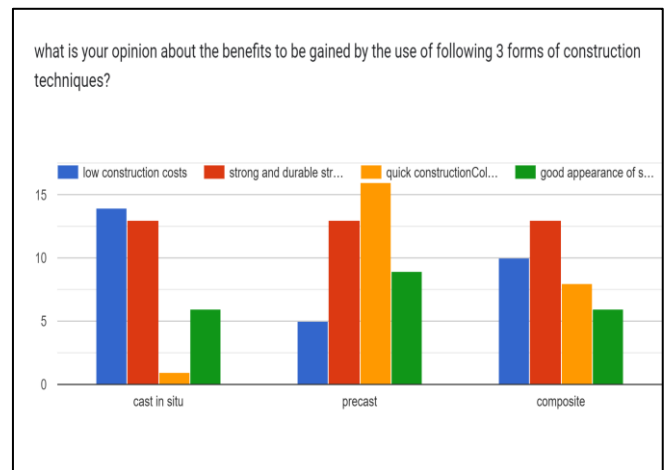
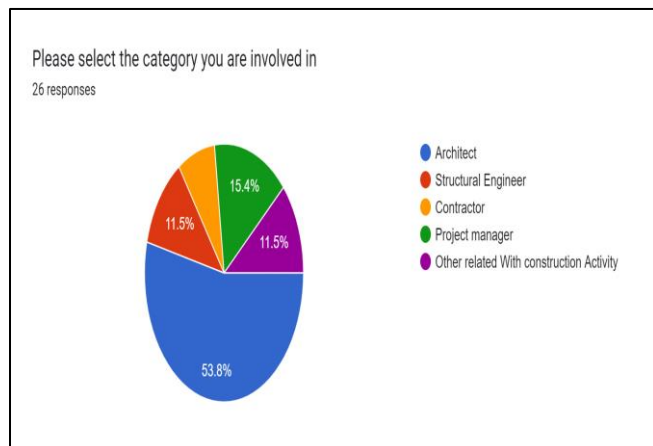
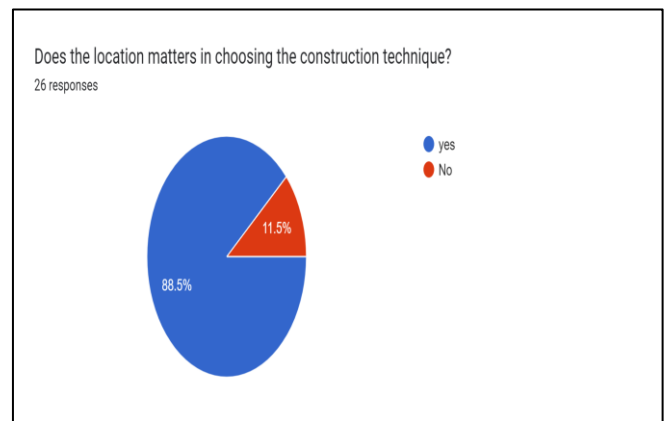
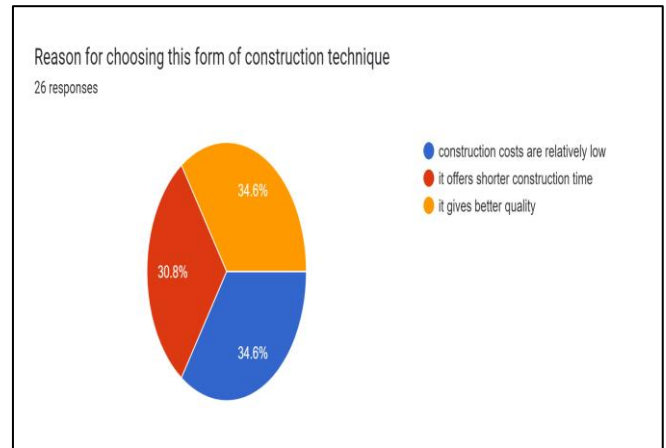
Asked which method offered better quality on housing development projects developers indicated that precast modular construction gives better quality than in-situ construction both during construction and in the long run.

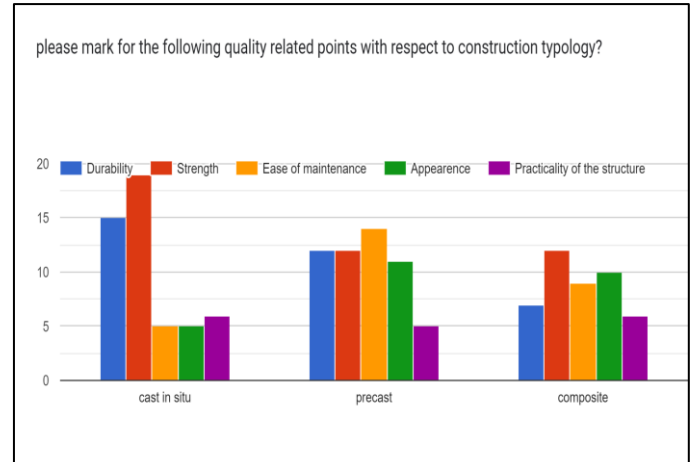
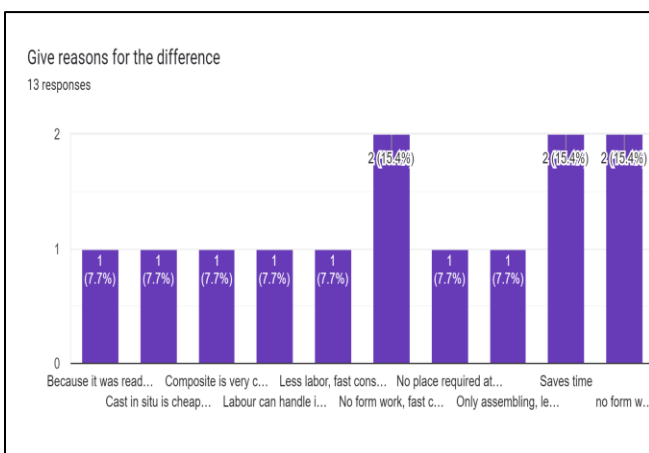
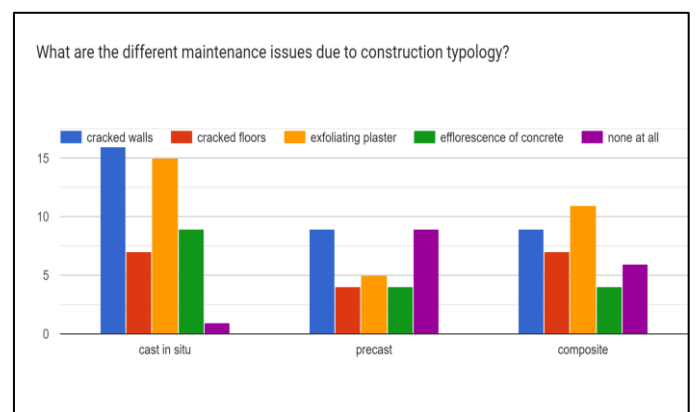
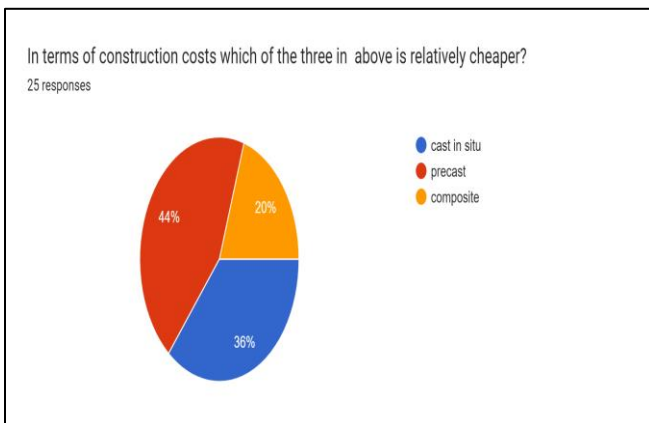
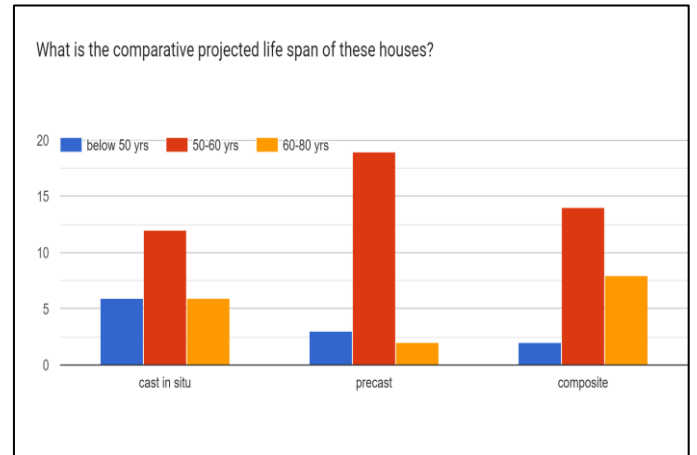
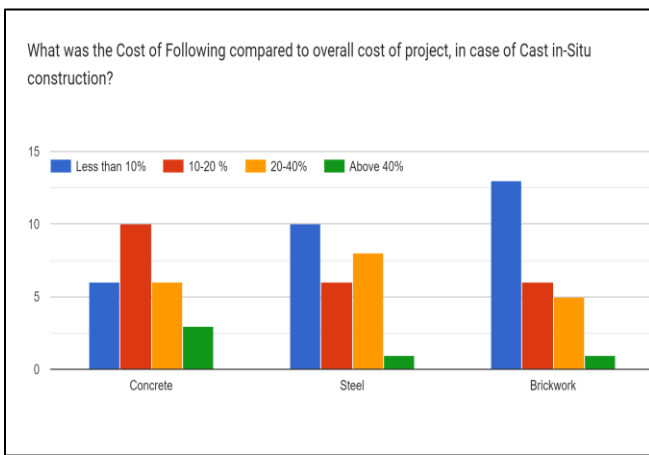
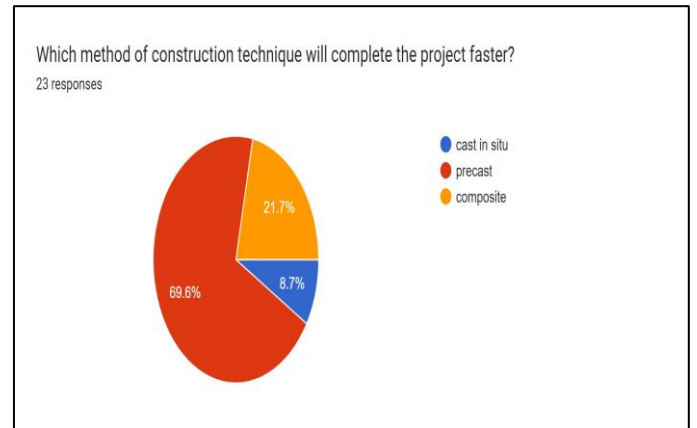
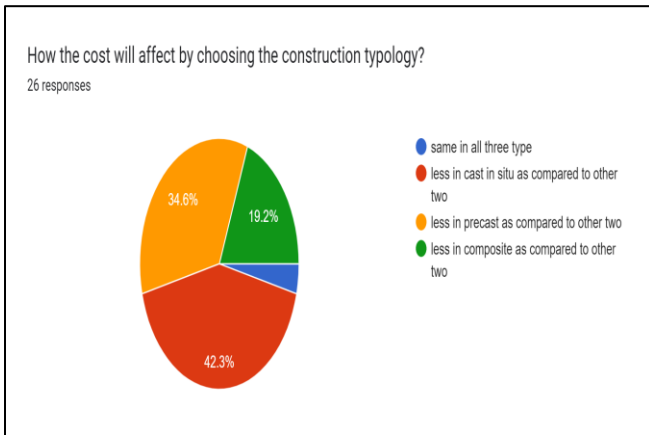
This response is in contrast to that by project designers who both that the methods they had used on their respective projects offers better quality than the other method.

• *Google Survey Questionnaires*

Four types of questionnaires were administered to various groups of people who included Project designers, Project Developers, Architects/ Engineers, & Occupants to get their perceptions on the cost, time and quality of construction.

• *Following are the 100% Response each*





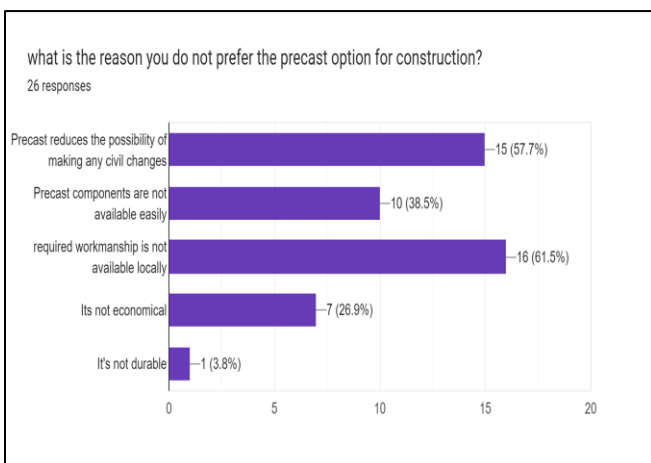
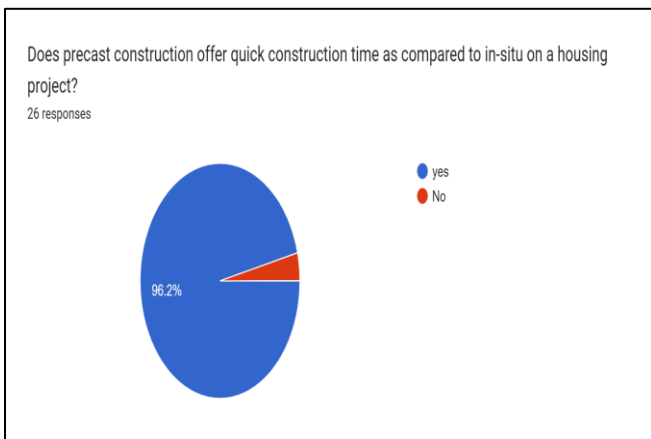
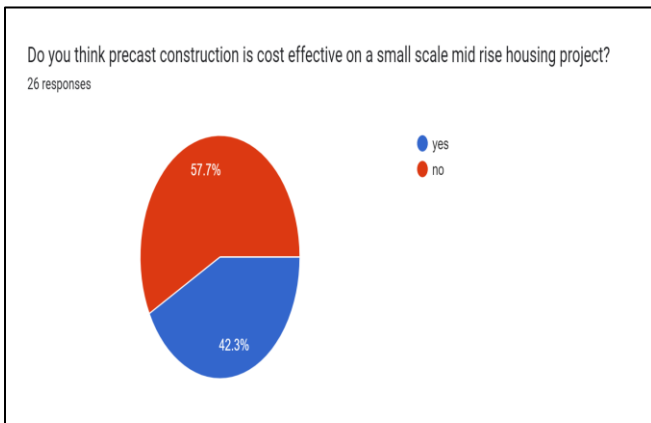
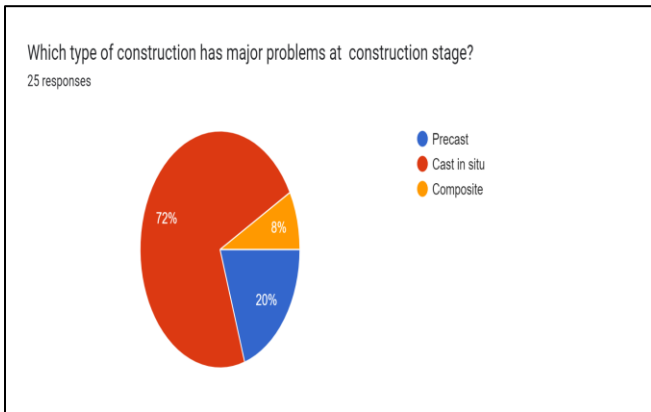


Fig 6 The 100% Response



Fig 7 Construction with Partial Precast Elements

IV. CONCLUSIONS

➤ *The Following General Conclusions can be Drawn from this whole Research:*

Precast concrete construction gives the least cost per unit than in-situ concrete construction.

If we replace certain repetitive components in a construction with precast components, construction process becomes easy, speedy & quality wise better since there is no formwork to be erected and stripped. The cost of formwork and that of labour contributes a considerable amount to the total cost of construction.

Partial precast construction project requires shorter total construction time than in-situ concrete construction. It is faster than in-situ concrete construction because elements are assembled on site without any waiting period for concrete to cure.

Quality of construction is measured by determining the durability, reliability, precision, stability and appearance of the building structure. However, at a practical level quality is concerned with workmanship. The research results have shown that precast concrete gives better quality than in-situ concrete. Professional architects and contractors perceive precast concrete to give better quality than in-situ concrete construction. The case studies of existing precast buildings and in-situ concrete buildings support the fact that precast concrete gives better quality in terms of durability, stability and reliability among others.

Professional architects review is that generally they do not specify partial precast concrete construction unless and until the precast concrete elements are readily available even though they perceive it to be more cost, time and quality effective than in-situ construction.

There should be more precast concrete factories thus making precast concrete elements readily available. Transportation costs is also the another factor which is generally considered while suggesting precast elements on site & there should be literate contractor on site to understand & to carry out precast concrete construction.

The majority of contractors interviewed indicated that they are ready to specialize in precast concrete construction provided the architects specified it on any project.

Those who have used and are using precast concrete construction said it becomes a problem when loads and connections are wrongly calculated.

RECOMMENDATIONS

Generally it appears that partial precast concrete construction could be a better alternative to the research problem.

However, there are various problems that impede its application on construction projects.

These include professional architects do not specify the use of precast concrete construction on construction projects.

Other reasons are that developers lack knowledge of precast concrete construction, and they also think that this construction technique demands more machineries & equipments like Crane for lifting precast components which for them is very difficult and expensive to hire or purchase.

Therefore having considered the problems above the following recommendations were made in the hope of trying to change the trend as far as the application of precast concrete construction is concerned.

There should be more precast concrete factories thus making precast concrete elements readily available. This will increase the entrepreneurship opportunities among the young engineers. This will also help to solve the problem of availability & transportation distances.

Easy availability of equipments like Setting up crane hire schemes would also give a solution to the problems encountered in hiring such machinery. Individuals and companies should be encouraged to undertake such ventures.

In a situation where crane hiring schemes are not possible, contractors can combine resources in joint ventures. A joint venture is a contracting system in which two or more contractors combine resources to achieve a common goal.

Thus in this case those who have the necessary equipment can combine forces and carry out precast concrete projects.

Professional architects should educate developers & owners, occupants on the benefits of using precast concrete construction on construction projects.

If they do, contractors concerned will ensure they get the required equipment. When developers and would-be developers know the benefits of using precast concrete they request that designers specified it on their projects. This will create a demand for precast concrete elements, and manufacturers will be forced to develop and expand their markets.

Concrete precasters should assure the users about the standards & should certify about the specification & standards

There should be awareness about precast concrete construction in journals or any other publications to educate the public about the same. They can also do this by holding seminars and workshops for contractors and designers. This can be done in conjunction with academic institutes, professional bodies such as Institute of Architects etc

Academic Institutes should introduce and teach in detail the techniques and methods involved in precast concrete construction in the same as way brick or block laying. Such training would enable specialization in precast concrete construction.

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APPENDIX -A:

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