

Review of Optimization of Constructional Strength and Profitability Using Pre-Fabrication Technology

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Abstract – The technology involving the fabrication and pre-assembly of constructional elements and components before they are installed into their final location. The precedent of prefab industry is the significant for the development of new technology in construction business of any nation. The present age demands a great need for affordable and fast housing facilities so the projects need to be completed at competitive fast rates. Conventional construction methods fail to deliver the desired speed of construction. So we opt for some other methods of construction. Total time of construction can be lowered through application of precast construction. Despite of the advantageous features of fast and speedy erection, low cost precast construction. Components and structures made using prefabrication are increasingly directed to improving technology to achieve low cost and fast construction in the construction industry. Application trend of prefabricated components can aid a much faster output for the ever increasing construction demand in urban areas. Through mechanization promotion and application of prefabrication technology to create new employment opportunities and new ideas in construction. The study highlights the influence of prefabrication technology on the construction profitability and its effect in the work cycle time in construction detail review and study of literature and research work indicated that prefabrication is an emerging, innovative technology; generally existing in developed nations, in which various materials are joined to fabricate a final component before installation. The main benefit of prefabrication is saves construction time, reduces construction throw away, together with improved quality. It is prominently observed that the building cost of structures using prefab technology is significantly less and duration of construction is also much diminishing as compared to traditional constructional method. Lowering the undesirable influence or impact of the construction methods on environment can be considerably lowered using the eco-friendly prefabrication technology. Sustainability and stringent quality control are attainable through prefabrication technology. Study is conclusive that the prefab technology is economical. Social and economic progress can be attained towards sustainability by application of the prefabrication technology.

Although construction cost is a dominating constraint in affordable shelters, their durability and strength are equally important. Project aims at evaluating various pre-fabrication technology on their role with perspective of strength -durability and cost. Optimization of the various parameters using Minitab software the optimal technology will be proposed. Grey relation analysis will be carried out to predict the profitability of structures maintaining desired strength and durability.

Keywords — Prefabrication, Sustainability, Profitability, Optimization

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1. INTRODUCTION

Rapid growth in construction industry is observed with the increasing demand housing facilities from the consumers. In order to Fulfill the demands in competitive time frame the construction industry needs innovative method of construction without compromising the strength of the structure and safety

prefabrication Technology is an emerging solution to this problem in India the prefabrication technology is although in its infancy stage in Maharashtra state the Maharashtra Housing and Area Development authority (MHADA) is effectively using this technology to build cost effective housing solutions in optimal time frame prefabrication Technology uses the method of construction structural members on

yards or offsite which involves reduction in manpower requirement and also contributes to reduction in labour force at the worksheet moreover the prefabrication technology developed compounds develops components that are unaffected by the bad weathering conditions.

Majority of the components structure members under construction are cast offsite or on yards using fully automated or semi-automated manufacturing by using materials and still Steel moulds which required skilled labour but also brings down the amount of unskilled labour required at the conventional construction sites with the help of only few skilled technician the operation of prefabricated structure units can be smooth leader. Elements which are free cast are often low in weight and simple in loading so can be easily transported to erection site which saves a considerable amount of destruction time. although the components are light in weight but are designed to meet the constructional strength required stop it is also so you also observe that the components that fabricated using the prefabrication technology are often at par instant in strength as compared to the cast in situ compounds does the strength safety and speed that is the prefabrication technology offers greater benefits in construction off fast and cost-effective housing.

In Maharashtra especially in Mumbai due to the limitation of construction land and limited space it is becoming increasingly difficult to carry out on site concreting in construction. In this case the prefabrication technology offers an overwhelming solution to carry out minimal construction work at site. The best example of prefabrication technology used in India is the construction of the bridges, flyovers roads, metro tunnels, metro bridges etc. Although this technology is still not used widely in India in the housing construction business exception being the MHADA and SRA in Maharashtra state. using this technology for schemes involving low cost housing makes it less expensive than the conventional construction methods.

1.2 PREFABRICATION TECHNOLOGY IN ACCELERATED BRIDGE CONSTRUCTION:

The application of prefabrication Technology in accelerated bridge construction using elements of the fabricated Bridge elements and Systems is effectively use in India for the past few years construction of Brijesh flyovers Metro tennis and Metro bridges stop the use of the abc in most of most parts of India has been driven by the acute traffic control issues especially in the Metropolis cities of India accelerated bridge construction or relatively new to India although some elements of the PBS have been applied many times in the past in modern pit construction The commonly used structures in the PBS systems for accelerated bridge construction are as follows .

1.3 OPPORTUNITIES IN BUILDING MANUFACTURING USING PREFABRICATION TECHNOLOGY

1.3.1 Need for affordable housing in India

the need for affordable housing in India primary the need of the time which also provides an opportunity to built manufactured buildings using the prefabrication technology as we have the potential to deliver the housing project as a product to the market at comparatively low cost than the traditional options available there is significant opportunity in India given the large population and the densely populated Metropolis of India that offer the maximum job opportunity and attract the population to this city insert of labour. thereby in order to deliver more sustainable and affordable houses housing projects need to be developed in the coming decades

1.3.2 Job creation using prefabrication Technology as a tool

with minimal training offered to the workforce in order to acquire the knowledge of Information Technology and the new to manufacture building industry skilled labour can be developed and employable opportunities can be provided to the local communities which will also solve the problem of labour migration and dysfunctional manufacturing sector in the construction industry provide revive

Although the prefabrication technology technicians need to have unique set of skills and an equally important part been supply chain, Research and design of manufactured building components and equally effective joining Technology for construction of the final product as an affordable housing solution

1.3.3 Local and international competitiveness

With the support and policy changes in the manufactured building markets and on the government part the prefabrication technology could expand to provide investment at the local and international level with the assurance of family completing projects and and family Returns from the project it is possible to attract foreign direct investment also.

1.3.4 Contribution to sustainability

The goals of sustainability can we e easily achieve through development of affordable and environment friendly mass manufactured housing projects which will demonstrate the effective use of resources saving strategies and also increase others in the consumers about this housing solutions.

The simultaneous pursuit of constructional quality ensuring safety durability environment friendliness can lead to economic prosperity and social equity.

many aspects of the the manufactured building systems using the prefabrication technology redefine the bottom line benefits that range from reduce waste in construction material as control operations are involved which will lead to shorter on-site construction activities and programs and reduce the financial cost .

B. Affordable housing schemes in India

With the view to encourage affordable housing schemes and focus on consumers belonging to different social strata in Indian society the Government of India along with Central Government housing schemes has an ambitious plan to offer no cost housing facilities under under the the housing of all initiative by the year 2022 the housing schemes are listed below.

1. **Pradhan Mantri Awas Yojana (PMAY)**
2. **Pradhanmantri Gramin Aawas Yojana**
3. **Rajiv Awas Yojana**
4. **DDA housing scheme**
5. **Tamil Nadu Housing Board scheme**
6. **Mhada lottery scheme**
7. **NTR housing scheme**

OBJECTIVES

- ▶ To improve the work process in terms of production time and to identify the parameters to increase productivity using prefab technology
- ▶ To measure the material content and work content during job of side panels and compare them in weight , strength and costs.
- ▶ To find correlation various human activities related to erection of side wall panels using prefab structures and comparing them to conventional methods in cost and time

PROBLEM STATEMENT

To improve the profitability and optimize constructional strength in construction of side wall panels for low cost housing .

2. LITERATURE REVIEW

2.1 Chinmay Ramesh Khadtare “Methodology of 3S Construction Method “Prefabrication Technology, Volume: 06 Issue: 12 | Dec 2019 International Research Journal of Engineering and Technology

The technology involving the fabrication and pre-assembly of constructional elements and components before they are installed into their final location. The precedent of prefab industry is the significant for the development of new technology in construction business of any nation. The present age demands a great need for affordable and fast housing facilities so the projects need to be completed at competitive fast rates. Conventional construction methods fail to deliver the desired speed of construction. So we opt for some other methods of construction. Total time of construction can be lowered through application of precast construction. Despite of the advantageous features of fast and speedy erection, low cost precast construction. Components and structures made using prefabrication are increasingly directed to improving technology to achieve low cost and fast construction in the construction industry. Application trend of prefabricated components can aid a much faster output for the ever increasing construction demand in urban areas. Through mechanization promotion and application of prefabrication technology to create new employment opportunities and new ideas in construction.

2.2 Joseph L. Hartmann “Engineering Design and Erection of Prefabricated bridges and Systems” June 2013 , U S Department of transportation Federal Highway Administration

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2.3 Prof. Peter Newman "Strengths, Weaknesses, Opportunities and Threats of Manufactured Buildings" A Sustainable Built Environment National Research Centre (SBEnrc) Research Report 2014

The authors in the report shed light various types of manufactured housing structures their strengths and weaknesses and also bring forward the challenges and obstacles in the construction industry of Australia. Authors investigate the present day innovation in manufactured building construction in process as well as product . A structured and balanced review of SWOT factors with the view of increasing the deployment of prefabrication technology of manufactured buildings as an

increasing potential housing as an sustainability option to conventional methods of construction in Australia.

2.4 Tharaka Gunawardena “Behaviour of Prefabricated Modular Buildings Subjected to Lateral Loads” Department of Infrastructure Engineering University of Melbourne 2016.

Author conducts the research on Prefabricated Modular Buildings and sheds light on the technology of speedy construction to achieve cost effective buildings to cater to urban construction demand. The thesis describes the design of lateral load resisting systems which is vital for these structures in order to perform effectively. According to author an absence of detailed scientific research and case studies investigating the structural performance of prefabricated modular buildings resulting in the knowledge gap has and thereby the low confidence in structural Engineers to produce optimal designs of modular buildings. The thesis underlines the fact that over-designed structures to ensure structural stability and safety result in higher building costs.

The authors formulate a scientific methodology for analysis and design of structures to take lateral loads according to globally standards. The outcome knowledge obtained about the performance against lateral loads and structural behaviour and of new modular buildings can be used to propose an effective key design that the structural design engineers. Economical design of structures keeping the strength intact is thereby proposed in the study

2.5 Suraj Kumar “A comparative study on Precast/ prefabricated structures an cast-istu structures "International journal of Science and Research 2018

Author shows the merits and demerits of precast structures and helps identify the importance of prefabrication in comparison to the cast-instu structures. The suthor concludes that safety , cost effectiveness and speed in construction can be achieved through application of the precast structures.

2.6 Prajjwal Paudel Study on prefabricated modular and steel structures, Glasgow Caledonian University, International journal of Civil engineering May 2016

The author reffers to the devastating effect of the earth quake in 2015 in Nepal on the houses and structures in the country. The author brings to light that comparatively in developed countries like China and Japan similar earthquakes affected the structures although the harm to human life and property was considerably subdued which according to the author is accounted to the use of light weight prefabrication building in these countries that use aluminium and steel instead of heavy concrete. The application of light steel frames and sandwich panel held together using bolt connection comes as new concept in

reducing the construction time as curing time is not required. The author also suggest the use of hollow concrete blocks in reducing the weights of the structures. The study helps bring forth the key knowledge about modular housing, to provide stable, safe and cost effective shelters.

2.7 Zhenmin Yuan et. al. “Research on the Barrier Analysis and Strength Measurement of a Prefabricated Building Design” MDPI Sustainability April 2020

The authors describe in their article the design barriers faced by the pre-fabricated buildings in comparison to the non-prefabricated buildings in regards to sustainable and cleaner design features. The authors identify these barriers and show they influence the success rate of these modular structures. Various techniques like grounded theory (GT), Linear weighted sum method (LWSM) , analysis network process (ANP) are used by the authors to carry out the analysis . The authors classify the eight barriers into three clusters namely the technical bnarriers, management barriers and the economic barriers.

2.8 Alireza Baghchereisa “Using Prefabrication in building Construction” International Journal of Applied Engineering Research, November 2015

The authors include the overview and literature study of the prefabricated structures in the erection of modular buildings. They categorize the systems to materials, methods, structural configuration etc. in prefabrication. Despite the numerous advantages stated in the development and assembling buildings by use of prefabrication construction the major constraints might are seen to exist. Tailored to residents is often the goal of prefabrication systems at least roughly needs. The author shows the utility of prefabrication in terms of construction on time and cost reduction.

Author state that disadvantages of prefabrication if solved then further improvement of prefabrication systems can enhance the application real time in building construction

2.9 Dr. Jalindar Patil et. al. “Prefabrication Technology- A Promising Alternative in Construction Industry”, International Journal of Science and Research (IJSR), Vol.8 Issue 8th August 2019

The authors conducted a study on overall effects of prefabrication technology and elements on work cycle and environment. Authors found that prefabrication technology more efficient in case of repetitive construction. According to the authors the prefabrication is seen to save time and material consumption also bring down the wastage thereby

leading to a more efficient and sustainable construction process.

2.10 Li, Z.; Shen, G.Q.; Xue, X. Critical review of the research on the management of prefabricated construction. Habitat Int. 2014, 43, 240–249

The authors in their show traditional construction method to be slow and inefficient, and burdens the environment in terms of waste pollution and visual intrusion, and affects the social welfare in terms of noise and public health. For sustainable a new approach in the form of prefabricated buildings is need of the time.

3. LITERATURE GAP

It is found in the literature review that majority of the research work limited to the static cost analysis and subsequent cost control. However, considering that the cost of prefabricated building differs from that of traditional manufacturing industry and construction industry. It can also be seen that the cost influence factors are not only diverse in nature but and the cost relationship is more complex. It can also be seen that cost increase may be as a result of different reasons, or in some cases a single reason may induce several cost increases. In short, the cost rise is a function of the dynamic relation between the diverse cost drivers, and it is necessary to study the effect of a factor on the whole from a scientific perspective.

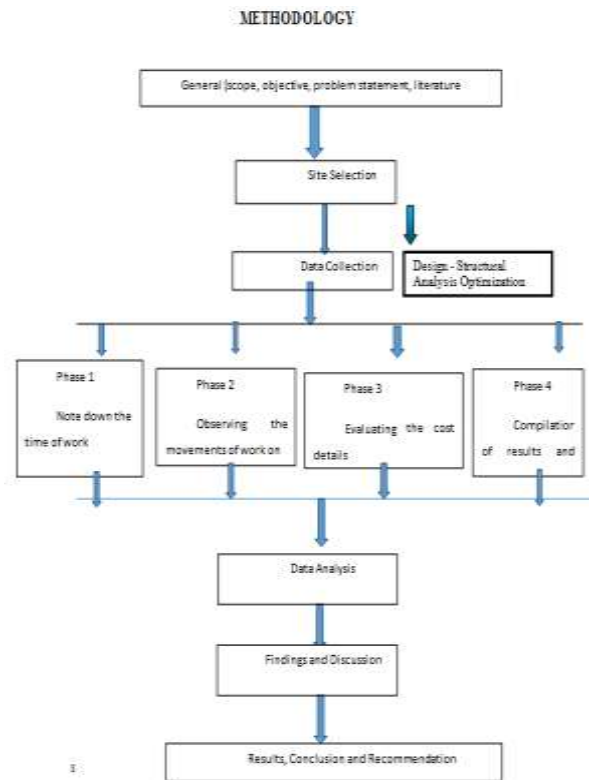
Although construction cost is a dominating constraint in affordable shelters, their durability and strength are equally important. Project aims at evaluating various pr-fabrication technologies on their role with perspective of strength -durability and cost. Optimization of the various parameters using Minitab software the optimal technology will be proposed. Grey relation analysis will be carried out to predict the profitability of structures maintaining desired strength and durability.

Advantages of prefabrication:

- Self-supporting ready-made components are used, so the need for formwork, shuttering and scaffolding is greatly reduced.
- Construction time is reduced and buildings are completed sooner, allowing an earlier return of the capital invested.
- On-site construction and congestion of site is minimized.
- Better quality control can be achieved in a factory assembly line setting than at the construction site.
- Prefabrication site can be located where skilled labour is more readily available and the

costs of labour, power, materials, space and overheads are reduced.

- Time spent due to bad weather or hazardous environments at the construction site is minimized.
- Less wastage of construction material.
- Advanced materials such as sandwich-structured composite etc. can be easily used, improving thermal and sound insulation and air tightness



Disadvantages of prefabrication:

- Leaks can form at joints in prefabricated components.
- Transportation costs may be higher for voluminous prefabricated sections.
- Large prefabricated sections require heavy-duty cranes and precision measurement from handling to place in position.
- Larger groups of buildings from the same type of prefabricated elements tend to look drab and monotonous.
- Local jobs may be lost, if the work done to fabricate the components being located in a place far away from the place of construction. This means that there are less locals working on any construction project at any time, because fabrication is outsourced.

Prefab Vs Conventional Structures

- Prefab structures are designed lighter section in comparison to conventional structure.
- Prefab structures are fabricated in workshop which reduces the required construction time. However, in case of conventional structure there is no precise control over construction time.
- In prefab structure there is more accuracy in construction as the fabrication of the structure is done in workshop by the skilled worker as per approved quality assurance plan (QAP). However in case of conventional building, there is not much control over accuracy as the same is done by skilled/ semi-skilled workers at site.
- In case of prefab structures, cost is analyzed at the stage of design itself and therefore chances of fluctuation of cost are very less. However the construction cost of conventional structure depends upon time and market fluctuations.
- In the PEBs, ready-made components are used, so the need for formwork, shuttering and scaffolding is greatly reduced. However in conventional construction, building components constructed at site requiring formwork, shuttering and scaffolding. There is minimal effect of climatic or weather conditions in case of PEBs while in conventional construction, time spent due to bad weather or hazardous environments at the construction site increases the construction cost and project completion time.
- In the PEBs, fabrication unit can be located where skilled labour is readily available and costs of labour, power, materials, space and overheads are lower. However in conventional construction, construction cost depends upon location, zone, climatic condition & availability of material & man power.

4. FUTURE SCOPE:

Design & Analysis of Precast Bearing wall Panel

Several advantages of precast concrete are observed over conventional in-situ cast concrete. Increased quality control is possible as the precast is cast and cured under controlled environment which allows stringent tolerances. Parallel production is permitted by precast a design which improves considerably the speed of production and efficiency.

As the precast elements are manufactured offsite the construction process of construction less labor intensive and faster. But the precast elements require assembly on-site which needs still some work in form of different concrete joints or in form of joints made up of mortar cast in place. Behaviour of the structure prepared from precast elements depends upon these joints, and also the design of these precast wall elements is rarely done using finite element analysis (FEA).

- Design of Experiment (DoE) by using Taguchi Technique in Minitab 18 for maximum stress & minimum weight

5. CONCLUSION

- ▶ It is found in the literature review that majority of the research work limited to the static cost analysis and subsequent cost control
- ▶ The cost rise is a function of the dynamic relation between the diverse cost drivers, and it is necessary to study the effect of a factor on the whole from a scientific perspective.
- ▶ As the precast elements are manufactured offsite the construction process of construction less labor intensive and faster.
- ▶ Design & Analysis of Precast Bearing wall Panel, behaviour of the structure prepared from precast elements depends upon these joints, and also the design of these precast wall elements is rarely done using finite element analysis (FEA).
- ▶ Several advantages of precast concrete are observed over conventional in-situ cast concrete. Increased quality control is possible as the precast is cast and cured under controlled environment which allows stringent tolerances.
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