IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SELECTION OF FORMWORK FOR BUILDING CONSTRUCTION

[1]Hepil Patel, [2]Prof. Ankitkumar Patel, [3] Prof. Jayraj V. Solanki

[1]Post Graduate Student, [2]Assistant Professor and PG head, [3]Assistant Professor

[1]Civil Engineering Department,

[1] U. V. Patel College of Engineering, Ganpat University, Kherva, Gujarat, India

Abstract: The duration of a construction project is significantly influenced by the formwork system, which is a crucial component. It utilizes a range of materials, including timber, steel, aluminum, plastic, and more. This structure needs to possess adequate strength to support both the weight of the materials used during the casting process, as well as any additional loads until the concrete sets and achieves a certain percentage of its intended strength. The selection/design of a formwork system for a project is influenced by the building design, site conditions, available resources, the contractor's experience with different systems, and their availability. The selection of a formwork system is made by a senior member of the contractor's organization. In the construction of traditional Reinforced Cement Concrete (RCC) buildings, the expenses associated with formwork play a significant role. Based on a rough estimate, formwork costs can range from 40 to 60 percent of the total cost of the concrete frame, making it approximately equal to 10 percent of the overall cost of the entire building structure. The aim of this research is to examine the factors that impact the choice of formwork system. By conducting a questionnaire survey, both Conventional (traditional) and modular formwork systems are analyzed in order to evaluate the factors involved in their selection. When evaluating various formwork systems like traditional formwork, Peri, Mivan and Doka. Several essential aspects were taken into account including cost, quality, cycle time, number of repetitions, and safety. This research study aims to assist construction project contractors in making informed decisions when choosing a formwork system that is both safe and cost-effective for concrete construction purposes.

Index Terms **– Formwork Selection, Conventional Formwork System, Modular Formwork System, Peri, Mivan.**

I. INTRODUCTION

It is temporary structure used to support concrete during poring process and then removed to be reused later. Its purpose is to give the concrete material shape, achieve desired shape, and provide support until concrete is hardened enough. It shapes concrete to desire forms of formworks used in construction, which vary with building requirements, the term 'formwork' is employed in this paper as a generic term that includes false work. This eliminates the need for repetition in the text. Formwork plays a crucial role in cast-in-place concrete buildings, accounting for a significant portion of the construction cost. Various materials such as wood, steel, aluminum, and prefabricated forms are commonly used to create formwork structures for pouring concrete. This includes not only the larger structural elements like columns, beams, slabs, and shear walls but also smaller features such as steps. The global Formwork Panels market looks promising in the next 5 years. As of 2022, the global Formwork Panels market was estimated at USD 1003.45 million, and it's anticipated to reach USD 1120.12 million in 2028.

Any nation's building industry's advancements could be viewed as an indicator of that nation's development. The Indian economy depends heavily on the construction industry, which has contributed to the growth of the nation. India currently has the second-largest urban population in the world. Most people live in houses or other structures. The introduction of international corporations for construction activities in India has aided in expediting project construction. It is essential to have the most recent technologies for mass home construction projects in order to create high-quality, long-lasting structures quickly and affordably.(Yadav & A, n.d.)

Construction engineering and management (CEM) research is particularly difficult because of the dynamic and ephemeral character of construction projects. As an illustration, experimental studies on innovation, risk management, safety, and technology forecasting is frequently unreal due to the delicate and intricate nature of the subjects. Researchers frequently use survey and group brainstorming procedures to gather subjective data when studying such topics. These studies' inherent design may contain significant bias, which researchers must identify and reduce. Therefore, a structured research methodology that enables researchers to manage bias and guarantee respondent qualification is preferred.(Hallowell & Gambatese, n.d.)

Formwork comes in a wide range of varieties, typically varying depending on the needs and difficulties of the particular building project. Concrete is poured into molds made of wood, steel, aluminum, or prefabricated forms, which are utilized as formwork. After this has had time to harden and set, it is either stripped or, in the case of stay-in-place formwork, left in place as part of the building. Formwork enables builders to quickly cast and construct both larger architectural components, like staircases, and smaller components, like floors and walls, which need to have a strong structural foundation. The most crucial aspect of high-rise building construction in terms of price, quality, and timeliness is the type of the

Formwork used in the project.(Dinesh & Soundararajan, 2017)

The two main restrictions on these projects are time and money. Reducing the floor-to-floor cycle time is the most efficient technique to quicken the construction process for high-rise residential building projects. When compared to the cycle time obtained from a conventional timber formwork system, it is possible to cut the usual floor cycle time by more than 70% by using complex formwork systems. However, the expense associated with implementing such complex formwork systems could not always be justified, particularly for small-scale, low-budget (affordable) projects. According to Shin (2011), formwork accounts for 10% of the overall construction costs and between 40% and 60% of the cost of the concrete skeleton.

(Basu & Jha, 2016)

When selecting formwork, cost, time, and quality are the key factors considered. In traditional formwork, timber planks were supported by timber columns. However, as technology has advanced, plywood sheets and steel props with jacks have replaced hardwood planks, providing improved support and convenience. To enhance efficiency, formwork units have been designed to connect and repeat throughout the building. Initially, steel was widely used for formwork systems, but its weight presented challenges. To address this, the industry has shifted towards lighter materials like aluminum, plastic, and other lightweight options, aiming to minimize the weight of the formwork system.

The construction industry is one of the most significant sectors globally, requiring substantial investments and contributing to the growth of various other economic sectors. Given the direct impact of formwork on quality and productivity, studying formwork becomes essential for achieving successful construction projects.

1.1 Objectives

1) To find out the types of formworks used in construction industries now days.
2) Identification of the potential factors, affecting the selection of formwork system for residential buildings with literatures.
3) To identify the weights for the factors affecting the formwork system using Relative important index method.

II. LITERATURE REVIEW

Das et al., (2016) The importance of formwork in building and how it affects project cost, timeline, and quality are covered by the authors. Based on factors including cost, construction speed, reusability, durability, adaptability, and environmental impact, they assess various formwork methods. Case studies and examples of formwork systems, such as conventional timber formwork, metal formwork, and modular formwork, are included in the article. The writers evaluate the benefits and drawbacks of each method, taking into account elements like the accessibility of materials, the simplicity of construction, the stability of the structure, and the cost-effectiveness. The writers also go over recent developments in formwork technology, namely precast formwork systems and lightweight materials. They draw attention to the advantages and drawbacks of these advancements, such as increased sustainability and building efficiency.

Hallowell & Gambatese, n.d. The Delphi method is presented by the authors as an effective tool for qualitative research, particularly in the CEM field where there are few qualitative approaches. They describe the Delphi approach, highlighting the significance of selecting an expert panel, precise research objectives, and numerous iterations to reach consensus. The article contains a case study on the use of the Delphi method to identify key success factors (CSFs) for implementing sustainable construction practices. To obtain a consensus among sector experts, the study required several rounds of questionnaires and comments. The results highlighted important elements including leadership dedication and stakeholder involvement.

(Dinesh & Soundararajan, 2017) The authors stress the importance of selecting the appropriate formwork system for successful project completion and effective construction operations. The report analyses a number of variables that should be taken into account when choosing a formwork system. Cost, construction speed, adaptability, durability, safety, and environmental effect are some of these considerations. Each element is covered in depth by the authors, who also offer information on how it affects the decision-making process. It emphasizes the necessity of a methodical assessment of various formwork systems based on the noted parameters. The need of taking into account project-specific requirements, such as the type of structure, building process, budget, and timeline, is highlighted by them. The writers also go into the benefits and drawbacks of various formwork systems, such as conventional timber formwork, metal formwork, and modular formwork. They offer case studies and real-world examples to demonstrate how these technologies are used in building projects and how well they work.

(Poon & Yip, 2005) The writers want to shed light on the benefits and drawbacks of each method. The notion of formwork systems and their importance in the building industry are introduced in the first paragraphs of the article. It draws attention to how formwork supports concrete during construction. This paper discusses conventional formwork technologies, such as timber formwork, and its advantages, including accessibility, use, and affordability. They also address the drawbacks of conventional systems, such as their poor capacity for reuse, protracted construction times, and less resistance against inclement weather. The following section of the essay examines contemporary formwork systems, such as engineered, metal, and modular formwork. The writers go over the benefits of these systems, including their increased strength, productivity, quality, and reusability.

(Hanna et al., 1992) The authors' goal is to present a methodical method for choosing the best formwork system for construction projects. The importance of formwork selection in building projects and the demand for an efficient decision-making process are highlighted in the paper's opening paragraphs. The authors stress that choosing the appropriate formwork system can increase project efficiency and cost effectiveness. This paper presents a knowledge-based formwork selection method that takes into account the expertise and experience of experts. They talk about how to develop the necessary knowledge, including how to conduct surveys, interviews, and case studies to learn from subject-matter experts. The knowledge base, inference engine, and user interface for the formwork selection system are all described in detail in the paper. The authors describe how the system makes use of the learned information to evaluate project needs and suggest the best formwork system in light of elements including project type, complexity, budget, and schedule. The authors also go into the formwork selection system's validation and evaluation through case studies and comparisons to manual selection techniques..

(Mathematics, 2016) The paper discusses the management of construction materials, which is a large topic. It can be assumed that the magazine covers a variety of themes relating to the materials used in building projects and the management techniques utilized in the sector, even though detailed information about the paper's content is not supplied. The study probably examines a number of construction-related topics, including material selection, performance, sustainability, and applications. The management facets of construction projects, such as project planning, scheduling, cost estimating, quality control, risk management, and procurement, may also be covered in depth. The editorial staff, which is made up of seasoned experts and researchers in the industry, seeks to offer insightful information, research findings, and best practices on building materials and management. The study is likely to expand our understanding of the construction industry and operate as a valuable tool for academics, researchers, and industry personnel looking to learn more about and apply what they have learned to their work.

(Elazouni et al., 2005) In order to assess the practicality and potential success of novel formwork systems, the authors work to create a prediction model. The importance of formwork systems in building projects and the requirement for effective evaluation techniques are covered in the opening section of the article. The authors suggest using neural networks to increase the accuracy and efficiency of the evaluation process because conventional methods of evaluating formwork systems may be time-consuming and subjective. The paper's conclusion emphasizes the potential of neural networks as a tool for determining if new formwork systems are acceptably designed. The research makes a contribution to the field by offering a data-driven and

objective way to evaluating the viability and effectiveness of cutting-edge formwork systems. This technique helps construction professionals make wise judgements about how to deploy these systems.

(Yadav & A, n.d.) The review examines and contrasts the usage of Mivan formwork versus conventional formwork in building. The term "conventional formwork" describes the age-old practise of building forms out of plywood and wood. The writers emphasise its adaptability, affordability, and accessibility. On the other side, Mivan formwork is a contemporary method that makes use of aluminium panels and a network of connected parts. The writers go over its benefits, which include quicker construction, lower labour costs, higher quality, and enhanced safety. These two formwork techniques are thoroughly compared in the review paper, taking into account things like cost, time, labour, quality, and safety. It seeks to help building professionals make educated decisions on the use of formwork techniques based on project needs.

(Basu & Jha, 2016) The Analytic Hierarchy Process (AHP) is used in the study as a decision-making method to assess and rank various formwork systems. AHP uses a structured process to take into account many factors and their respective weight when making judgements. The framework that the authors suggest combines AHP with the unique demands and limitations of the Indian residential construction sector. The model evaluates the feasibility of various formwork systems by taking into account a number of variables, including cost, time, quality, safety, and sustainability. It also considers the special qualities and difficulties faced by the Indian building industry. The model's findings might help building industry professionals choose the best horizontal formwork solution for residential buildings in India.

III. DATA COLLECTION

In this research collection of primary data structured survey is used to collect people's responses to this problem. Structured questionnaire created through Google form concerning problem statement. Some supporting questions to create the proper basis for the main problem statement. For collecting data, put this questions in questioner form. And add the factors that affect the selection of formwork. And you have to give the ranking according to your importance. Conditions are to be listed on a rating system of 1 to 5, with 1 being the lowest and 5 being the most impact.

3.1 Factors Affecting Selection of Formwork

Factors affecting selection of "Conventional formwork system"	Factors affecting selection of "Modular formwork system"
➢ Cost of repair ➢ Transportation ➢ Local condition ➢ Productivity ➢ Degree of repetition ➢ Capital cost ➢ Labour cost of formwork ➢ Surface finish ➢ Life span ➢ Availability of labour (Conventional) ➢ Storage of formwork	➢ Surface finish ➢ Life span ➢ Availability of labor (Modular) ➢ Cost of labour (Modular) ➢ Cost of repair ➢ Transportation ➢ Building design ➢ Local condition ➢ Productivity ➢ Degree of repetition ➢ Capital cost ➢ Storage of formwork

Table 1 shows factors affecting selection of formwork

IV. DATA ANALYSIS

4.1 Primary Data analysis

This analysis begin with frequency analysis method. In this data analysis general information regarding respondent are given. Basic
Question and answer are mentioned in this questionnaire form.
This chart shows type of respondent. In this questionnaire form respondents is Contractor (Class D & Class E1 Grade), Client,
Consultant, Site engineer, Project manager.

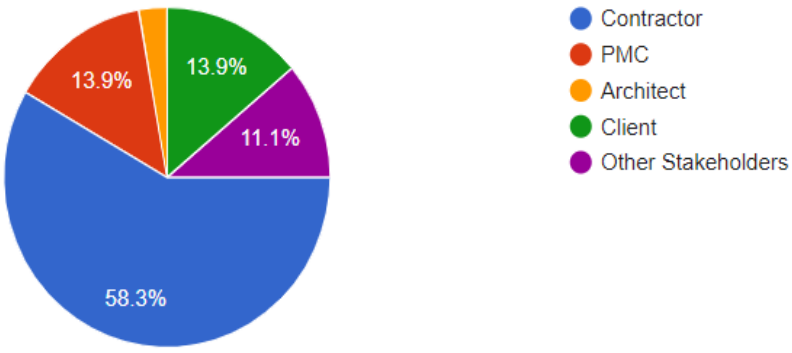

Figure 1 1 shows Respondent Type of Profession

4.2 Data Analysis by RII (Relative Importance Index)

The Relative Importance Index analysis was used in this study to arrange the parameters based on Relative Importance. The
Following formula is used to determine the Relative Importance Index.

$$RII = \Sigma w / A \times N$$

W= Weighting assigned by respondent

Also, the formula can be explored as:

$$RII = \frac{5\,n5+4\,n4+3\,n3+2\,n2+1\,n1}{AxN}$$

4.2.1 Top 5 factors according to RII

SR NO.	Factors (Convocation)	RII
1.	Capital cost	0.691
2.	Productivity	0.670
3.	Storage of formwork	0.667
4.	Cost of repair	0.641
5.	Transportation	0.629
	Factors (Modular)	
1.	Productivity	0.705
2.	Life span	0.694
3.	Cost of labour (Modular)	0.682
4.	Capital cost	0.676
5.	Availability of labour (Modular)	0.670

Table 2 shows Top five factors according to RII Result

4.3 Data Analysis by Correlation Matrix

A correlation matrix, in basic words, is a table that illustrates the correlation, a method of statistical analysis that demonstrates how
Strong the association between two variables or the amount of linkage between the two. Findings the relationship between two
Quantitative variables without being able to inter-causal relationship.

	Client factor	Contractor factor	Consultant factor	Other factors
Client factor	1			
Contractor factor	.758**	1		
Consultant factor	.350**	.550**	1	
Other factors	.373**	.577**	.764**	1

Table 3 shows Correlation Matrix

The correlation coefficient (r) value between Client & Contractor is 0.758 which shows a high positive correlation between
Both the variables.

4.3.1 Top 5 factors according to mean through SPSS Software

Sr. No	Factors (Conventional)	Mean	Std. Deviation
1.	Productivity	3.97	1.114
2.	Capital cost	3.82	1.141
3.	Life span	3.68	1.173
4.	Storage of formwork	3.62	1.206
5.	Surface finish	3.62	1.101
	Factors (Modular)		
1.	Capital cost	3.79	1.388
2.	Productivity	3.79	1.149
3.	Life span	3.71	1.244
4.	Cost of repair	3.56	1.050
5.	Building design	3.56	1.160

Table 4 shows Top Ten factors according to Mean value

Table 6 shows that which factors are most affecting for delay payment of contractors. In this table Delay in progress of work
and activities was ranked first with the mean value of 3.39 and Design changes during construction was ranked tenth with the mean value of 3.20.

V. RESULTS

In this study it was observed from the different studies that there is a need for fast construction techniques. Furthermore, the initial expense of formwork plays a crucial role in the selection process. When dealing with big scale projects that involve numerous repetitions and modular construction, opting for the latest formwork systems consistently offers advantages compared to conventional methods. It is observed that in all the type of formwork systems Conventional, Peri, Mivan and Doka three factors which are listed below have been given more significance by the respondents.

1. Initial Cost of the formwork system.
2. Productivity in less time
3. Life span of formwork (Repetition)

It is observed that in all formwork systems, respondents have given more importance to capital cost, time and productivity. In this survey it was observed that in big scale project use of modular formwork system is necessary because repetition of modular formwork in between 250 to 300 but the initial cost of modular formwork is very high. If the project scale is small, so use of conventional formwork system is fruitful because of initial cost is low as compare to modular formwork system.

VI. ACKNOLEDGMENT

I would like to thank my Guide Prof. Ankit S.Patel, Assistant Professor of Civil Department & PG Co-Ordinator, M.Tech (CEM), UVPCE, for his support, constant encouragement, suggestion and guidance throughout this project. With gratitude, I would like to thank Prof. Jayraj V. Solanki, PG head & Assistant Professor, M.Tech (CEM), UVPCE. Contractor and Clients have provided me with the necessary knowledge and guidance for the completion of this research work successfully.

REFERENCES

1. Dinesh P, Soundararajan M. Analysis of Effective Selection of Formwork System Based on Various Factors for Construction Projects. *Int J Adv Res Trends Eng Technol* . 2017;4(11):85-89.
2. Yadav PD, A APKB. Review Paper on Conventional and Mivan Formwork used for Construction. :101-107.
3. Hanna AS, Willenbrock JH, Sanvido VE. Knowledge Acquisition and Development for Formwork Selection System. *J Constr Eng Manag*. 1992;118(1):179-198. doi:10.1061/(asce)0733-9364(1992)118:1(179)
4. Poon CS, Yip RCP. Comparison of the Use of Traditional and. *2005 World Sustain Build Conf*. 2005;2005(September):27-29.
5. Elazouni AM, Ali AE, Abdel-Razek RH. Estimating the Acceptability of New Formwork Systems Using Neural Networks. *J Constr Eng Manag*. 2005;131(1):33-41. doi:10.1061/(asce)0733-9364(2005)131:1(33)
6. Mathematics A. *Construction Materials AndManagement*.; 2016.
7. Terzioglu T, Turkoglu H, Polat G. Formwork systems selection criteria for building construction projects: a critical review of the literature. *Can J Civ Eng*. 2022;49(4):617-626. doi:10.1139/cjce-2021-0190
8. Das R, Bhattacharya I, Saha R. Comparative Study between Different Types of Formwork. *Int Res J Adv Eng Sci*. 2016;1(4):173-175.
9. Hallowell MR, Gambatese JA. Qualitative Research: Application of the Delphi Method to CEM Research. doi:10.1061/ASCECO.1943-7862.0000137
10. Basu R, Jha KN. An AHP Based Model for the Selection of Horizontal Formwork Systems in Indian Residential Construction. *Int J Struct Civ Eng Res*. 2016;(January). doi:10.18178/ijscer.5.2.80-86