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ANALYSIS OF DIFFERENT PLASTIC MATERIALS SUTAIBLE FOR FORMWORK IN CONSTRUCTION

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Abstract: Formwork is a critical element in civil engineering construction projects, constituting a significant portion of the total expenditure. Maximizing productivity and optimizing formwork usage cycles are paramount for efficient project execution. This paper conducts a comparative analysis between conventional formwork technologies and the underutilized plastic formwork systems in the Indian construction sector. Historically, formwork selection has relied on subjective judgments, but the advantages of plastic formwork, including flexibility, durability, and cost-effectiveness, are gaining attention. Plastic formwork offers sustainability through recyclability, reusability, and eco-friendliness. Its lightweight design, rapid construction capabilities, and stringent quality control make it particularly suitable for projects with standardized dimensions. These technologies ensure precise results, superior construction quality, cost optimization, and reduced construction duration, positioning them as superior methods for construction projects.

Index Terms - Formwork, construction industry, plastic formwork, comparative analysis, sustainability, recyclability, reusability, eco-friendliness, lightweight design, rapid construction, quality control, standardized dimensions, construction efficiency.

I. INTRODUCTION

Formwork stands as a cornerstone in the realm of concrete construction, serving as the intricate scaffold upon which the very foundation of structures is laid. Its dual purpose, as both a temporary mold and a steadfast support, dictates not only the physical form but also the integrity and durability of concrete edifices. Traditionally crafted from the sturdy embrace of wood and steel, formwork systems have long been the silent architects of architectural dreams, tailored meticulously to suit the unique demands of each project.

Yet, as the relentless march of progress continues to shape the landscape of the construction industry, the call for innovation grows ever louder. Labor constraints and burgeoning costs compel a quest for alternative methodologies that promise not just financial savings, but a paradigm shift in construction efficiency and efficacy. Enter Desire Construction Systems, champions of change and pioneers of possibility, embarking on a journey to redefine the very essence of formwork.

In the tapestry of modern construction, where time is currency and quality are non-negotiable, the conventional paradigm of formwork finds itself under scrutiny. As projects swell in scale and complexity, the need for solutions that marry speed, precision, and safety becomes paramount. Herein lies the genesis of our quest – to unearth an alternative formwork solution that not only meets the stringent demands of contemporary construction but transcends them.

Amidst this backdrop of transformation and innovation, plastic formwork emerges as a beacon of hope, heralding a new era in construction methodology. Its promise of versatility, cost-effectiveness, and sustainability offers a tantalizing glimpse into a future where construction is not just a science, but an art form. This research endeavors to peel back the layers of convention, delving deep into the heart of plastic formwork systems to discern their true potential.

Join us on this odyssey of discovery, as we unravel the fabric of conventional wisdom and embark on a voyage into the uncharted territories of plastic formwork. Together, let us forge a new path towards construction excellence, guided by the principles of innovation, efficiency, and sustainability.

1.1. Advantages of plastic form work over conventional formwork

- Easy Handling: Light weight so very easy to handle by single labor as well
- Superior Finish: Gives a good surface finish of the wall, columns, beams & slabs etc.
- Reusable: It can be used 80 to 100 repetitions.
- Water Resistant: Can be used in fresh and salt water.
- Environment Friendly: Green product (even carbon credits can be earned if applied).
- Safety: Plastic and light weight allows for safer working conditions avoiding fall hazard during both setup and

dismantling.

- Fast Setup: The simple mechanics of speeds up the assembling at removal operations saving a lot of time.
- Simplified Logistics: The need for amount of material is reduced at site as the same panels can be used for wall, slabs, shear wall, columns, foundations, pile caps, rafts etc.
- Leakage Proof: No leakage between joints due to its good locking.
- Easy Cleaning: No need of using shuttering oil if cleaned with water after each repetition.
- Storage: No special storage space is required can be stored even in water areas and in open as well.
- Plaster Cost Saving: There is no need to plaster as the finish is good.
- Labour Cost Saving: No need of skilled carpenter's normal unskilled people can do the job in supervision and it takes less time labour is saved.

II. OBJECTIVES

This research paper aims to conduct a comprehensive analysis of plastic materials used in formwork construction, employing three prominent multi-criteria decision-making (MCDM) methods: ARAS (Additive Ratio Assessment), TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), and VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje). The primary objectives include systematically identifying and assessing key criteria influencing plastic formwork material selection, establishing additive ratio weights using the ARAS method, ranking materials based on their proximity to the ideal solution with the TOPSIS method, and identifying the compromise solution with the VIKOR method. By achieving these objectives, this research aims to contribute valuable insights and recommendations for stakeholders involved in formwork material selection, ultimately advancing decision-making processes in the construction industry.

III. LITERATURE REVIEW

Title: "Evaluation of Plastic Formwork for Concrete Construction" 2017
Authors: Patel, A., & Shah, D.
Summary: This study assesses the performance and feasibility of plastic formwork systems for concrete construction through field experiments and comparative analysis with traditional formwork methods.

Title: "Sustainability Assessment of Plastic Formwork Systems in Construction" 2020
Authors: Nguyen, H., et al.
Summary: This research investigates the environmental impact and sustainability of plastic formwork systems, considering factors such as material recyclability, energy consumption, and carbon footprint.

Title: "Comparative Study of Plastic and Traditional Formwork in Residential Construction" 2019
Authors: Kumar, S., & Sharma, R.
Summary: This study compares the cost, efficiency, and quality of construction between plastic and traditional formwork systems in residential building projects, highlighting the advantages and limitations of each method.

Title: "Innovative Applications of Plastic Formwork in Architectural Concrete" 2018
Authors: Lee, J., et al.
Summary: This paper explores innovative design possibilities and architectural applications enabled by plastic formwork systems, showcasing case studies and design guidelines for practitioners.

Title: "Performance Evaluation of Recycled Plastic Formwork for Sustainable Construction" 2021
Authors: Gonzalez, M., et al.
Summary: This research evaluates the performance and durability of recycled plastic formwork systems, investigating their suitability for sustainable construction practices and waste reduction efforts.

Title: "Enhancing Construction Productivity with Plastic Formwork: Case Studies from the Field" 2016
Authors: Tan, K., & Lim, S.
Summary: This study presents real-world case studies and performance metrics demonstrating the enhanced productivity and efficiency achieved through the adoption of plastic formwork systems in construction projects.

Title: "Assessment of Safety Implications in Plastic Formwork Systems" 2022
Authors: Chen, L., et al.
Summary: This research examines safety considerations associated with the use of plastic formwork systems, identifying potential hazards, mitigation strategies, and best practices for ensuring worker safety on construction sites.

Title: "Economic Analysis of Plastic Formwork for High-Rise Construction Projects" 2015
Authors: Wang, Y., & Zhang, Q.
Summary: This paper conducts an economic analysis of plastic formwork systems for high-rise construction projects, evaluating cost savings, return on investment, and long-term financial benefits compared to traditional methods.

Title: "Innovations in Plastic Formwork Technology: Materials and Manufacturing Processes" 2023
Authors: Singh, R., & Gupta, P.
Summary: This study investigates recent advancements in plastic formwork technology, focusing on novel materials, manufacturing processes, and design innovations aimed at improving performance and sustainability.

Title: "Case Studies on the Adoption of Plastic Formwork Systems in Developing Countries" 2019
Authors: Ali, M., et al.
Summary: This research presents case studies and implementation experiences of plastic formwork systems in developing countries, assessing their impact on construction practices, affordability, and local economic development.

IV. RESEARCH METHODOLOGY

1. Data Collection:
- Collect relevant data on plastic formwork materials from various sources, including technical specifications, performance metrics, and cost considerations.
- Ensure comprehensive coverage of information necessary for the ranking and analysis process.
2. Ranking of Plastic Formwork:
- Utilize established multi-criteria decision-making (MCDM) methods such as ARAS, TOPSIS, and VIKOR to rank plastic formwork materials.
- Construct decision matrices and apply the selected methods to evaluate the performance of materials based on predefined criteria.
3. Result and Discussion:
- Present the results of the ranking process, including the performance scores and rankings of plastic formwork materials.
- Discuss the implications of the findings, highlighting the strengths and weaknesses of top-ranked materials and their suitability for various construction applications.
4. Conclusion:
- Summarize the key findings of the research, emphasizing the effectiveness of the MCDM approach in evaluating plastic formwork materials.
- Provide insights into the implications of the study for stakeholders involved in formwork material selection.
- Suggest areas for future research and potential improvements to the methodology or analysis process.

V. DATA COLLECTION

Table 5: Data Collection

Materials / Criteria	Weight (KG)	Density (g/cm^3)	Thickness (mm)	Ultimate Tensile Strength (Mpa)	Thermal Conductivity (W/m.K)	Cost (RS)
PPF	11	0.895	50.5	33.09	0.21	119
PVCF	10	1.41	50.5	37	0.21	45.33
HDPF	20	0.965	50.5	26	0.48	215
PSF	11	1.06	175	28	0.13	525

VI. RANKING OF PLASTIC FORMWORK

Ranking of Plastic material is done by Multi-Criteria Decision-Making (MCDM) Methods.

6.1. Additive Ratio Assessment (ARAS) method:

Table 6.1: Ranking through ARCS Method

Si	Ki	Rank	
61.286	1.000		
17.747	0.290	4.000	**PPF**
17.789	0.290	2.000	**PVCF**
17.785	0.290	2.000	**HDPF**
61.173	0.998	1.000	**PSF**

6.2. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) Method:

Table 6.2.: Ranking through TOPSIS Method

	Si+	Si -	Relative Closeness Values	Rank
PPF	**0.166**	**0.081**	**0.328**	**4**
PVCF	**0.105**	**0.180**	**0.632**	**1**
HDPF	**0.232**	**0.232**	**0.500**	**3**
PSF	**0.249**	**0.249**	**0.500**	**2**

6.3. VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) Method:

Table 6.3.: Ranking through VIKOR Method

	Sj	Rj	Qj	Rank
PPF	**0.353**	**0.200**	**0.599**	**3**
PVCF	**0.077**	**0.077**	**0.153**	**4**
HDPF	**0.558**	**0.250**	**0.925**	**1**
PSF	**0.643**	**0.200**	**0.855**	**2**
S+, R+	**0.077**	**0.077**		
S-, R-	**0.643**	**0.250**		

VII. RESULT AND DISSICION

The bar chart in fig 7.1 displays the rankings of different plastic formwork materials using three different evaluation methods: ARAS, TOPSIS, and VIKOR. The materials evaluated are Polypropylene (PP), Polyvinyl Chloride (PVC), High Density Polyethylene (HDP), and Polystyrene (PS). The rankings are based on a scale from 1 to 4, where 1 is the best and 4 is the worst.

7.1 Analysis and Decision:

1. Polypropylene (PP) Formwork:
ARAS Method: Ranked 4
TOPSIS Method: Ranked 4
VIKOR Method: Ranked 3
Conclusion: Consistently ranked poorly, indicating it may be the least preferred material overall.

2. Polyvinyl Chloride (PVC) Formwork:
ARAS Method: Ranked 2
TOPSIS Method: Ranked 1
VIKOR Method: Ranked 2
Conclusion: Consistently ranked high, with a first-place ranking from TOPSIS, suggesting it is a highly preferred material.

3. High Density Polyethylene (HDP) Formwork:
ARAS Method: Ranked 4
TOPSIS Method: Ranked 3
VIKOR Method: Ranked 1
Conclusion: Rankings are varied, with VIKOR giving it the best rank. The discrepancy suggests further investigation might be needed.

4. Polystyrene (PS) Formwork:
ARAS Method: Ranked 1
TOPSIS Method: Ranked 2
VIKOR Method: Ranked 2
Conclusion: Consistently ranked well, indicating it is generally a preferred choice.

7.2. Decision:

- Most Preferred Material:

Polyvinyl Chloride (PVC) Formwork stands out as the most preferred material overall due to its high and consistent rankings across all methods.

- Least Preferred Material:

Polypropylene (PP) Formwork is the least preferred material, with consistently low rankings.

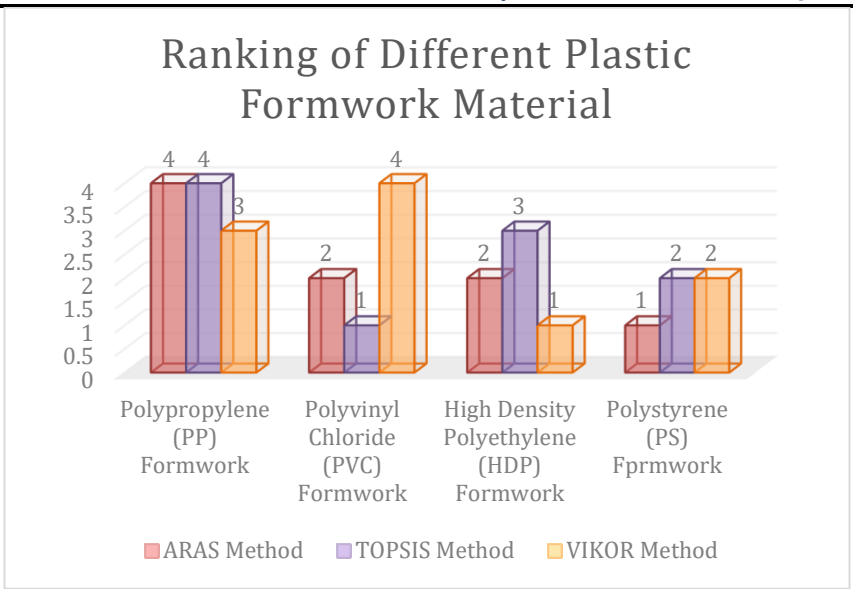

Fig 7.1. Ranking of Plastic Material

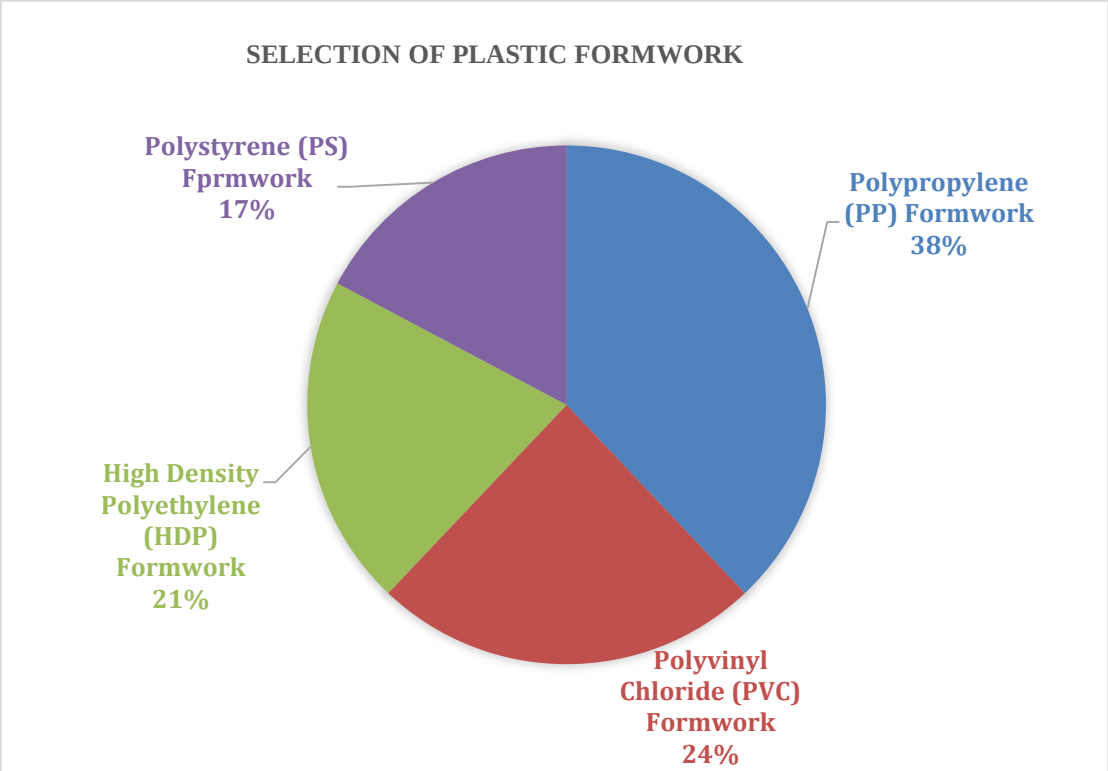

Fig 7.2. Selection of Plastic Formwork

VIII. CONCLUSION

Polypropylene (PP) Formwork (38%):
Observation: This material holds the largest share of the selection, indicating it is the most preferred choice among the options.
Implication: Despite the poor ranking in the previous bar chart analysis, this high percentage suggests that PP formwork might be favored due to factors not considered in the ranking methods, such as cost-effectiveness, availability, or specific industry practices.
Polyvinyl Chloride (PVC) Formwork (24%):
Observation: This material is the second most selected, which aligns with its high ranking in the previous evaluation methods.
Implication: PVC formwork is a popular choice, likely due to its favorable properties such as durability and versatility.
High Density Polyethylene (HDP) Formwork (21%):
Observation: HDP formwork is the third most selected material.
Implication: The selection of HDP formwork reflects its balanced performance and attributes, despite the varied rankings it received in the prior analysis.
Polystyrene (PS) Formwork (17%):
Observation: This material has the smallest share in the selection.
Implication: PS formwork is the least preferred option among the four materials, consistent with its lower rankings in the previous bar chart analysis.

Overall Conclusion:

Preference Trends: The pie chart indicates that Polypropylene (PP) formwork is the most widely chosen material, which could be influenced by factors such as cost and specific application needs. On the other hand, the previous rankings suggest that PVC formwork is generally seen as high-performing.

Discrepancies: The discrepancy between the ranking methods and actual selection percentages suggests that while performance metrics are crucial, practical considerations (e.g., cost, availability) also significantly impact material selection decisions.

Balanced Decision-Making: For comprehensive decision-making, both performance rankings and practical selection percentages should be considered to understand the full scope of preferences and usage trends in plastic formwork materials.

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