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Integration of Aluminium Formwork in Sustainable and Affordable Housings

Reena Sharma[1], Dr. Bipasha Kumar[2], Dr. Deepashree Choudhury[3]

[1]M.Arch 1st Year, AIT-SAP, Greater Noida, India
[2,3]Professor At AIT-SAP, Greater Noida, India

Abstract:
India is characterized by the presence of a vibrant construction industry that has contributed to economic growth in the country, particularly in fast-growing urban areas.
The high demand for housing in India,which has the second highest urban population globally, calls for an affordable form of building that caters for the need of everyone and does not harm environment.This calls for new strategies to ensure that there are sustainable and affordable methods of building houses.The paper aims at explicating how aluminum formwork can be employed to deal with these difficulties/challenges.
Aluminum Form-Work provides several advantages over traditional systems such as faster construction time;stronger structures and less environmental impact.This study assesses the effectiveness of aluminum form-work systems on sustainable & affordable housing in India through case studies and comparison
The research looks into factors such as cost-effectiveness, energy efficiency and durability all of which will help us understand when and where aluminium form-work may be preferable. This paper evaluates thoroughly the analyses,casestudies,concluding how integration can be implemented in line with aluminum formwork in relation to sustainable & affordable house development.

Keywords: Aluminium Formwork, Sustainable Construction, Affordable Housing, Low Cost Housing Solution, Rapid Construction Technique, Modular Construction, Lifecycle Assessment.

Introduction

The construction industry in India plays a pivotal role in the country's economic advancement,particularly in its bustling urban areas, the housing landscape of which is a mosaic of contrasts.
Amidst towering skyscrapers,one can still find sprawling informal settlements,a stark reminder of the challenges in providing affordable and sustainable housing for all.A drive through Mumbai,forinstance,reveals a juxtaposition of luxury high-rises and densely packed slums,demonstrating the housing disparity that persists (Kundoo, 2014).This dynamic underscores the urgent need for innovative construction methods that can address the country's diverse housing demands.
With urbanization on the rise,India faces the challenge of providing affordable and sustainable housing to its growing population.This challenge is compounded by traditional construction methods that may not adequately meet the needs of modern,eco-conscious development(Mandala &Nayaka, 2023).

The quest for affordable and sustainable housing in India is not just a matter of economic growth but also one of social justice and environmental responsibility.Traditional construction methods,while familiar and reliable,often fail to meet the demands of the modern world, especially in terms of the speed,cost&sustainability(Cherian et al.,2020).This presents an opportunity for new technologies,such as aluminum formwork, to bridge the gap between the past and the future,offering a pathway to a more equitable and resilient housing landscape.

Aluminum formwork emerges as a promising solution to address these challenges by offering an array of benefits,such as expedited construction timelines,enhanced structural integrity,and minimized environmental impact(Azharuddin Ansari,2018;Magdum et al., 2017).This innovative technique also promotes the efficient use of resources,aligning with sustainable construction practices (Liebringshausen et al., 2023).

This paper delves into the potential of aluminum formwork in the context of India's housing crisis.By exploring its integration into sustainable and affordable housing projects,the research aims to assess the impact of aluminum formwork on cost-effectiveness,energyefficiency&longevity

Aims and Objectives

This paper aims to explore how well Integration of aluminum formwork works in India when building affordable and sustainable housing.This study looks at a number of factors, including durability, energy efficiency, cost-effectiveness, productivity. The goal is to determine how aluminum formwork might assist satisfy the nation's expanding housing demand while reducing its negative environmental effects.

Methodology

In approaching the research on the Integration of aluminum formwork in sustainable and affordable housing,a multi-method strategy was employed to provide a comprehensive understanding of the topic.

- **Literature Review**:to identify the trends & gaps in the existing knowledge on aluminum formwork in housing projects.
- **Research Questions**:
  What is Aluminium Formwork(MIVAN) Technology? How It works?
  What are the environmental benefits of using aluminum formwork compared to traditional methods?
  How does the cost of aluminum formwork compare to other construction methods over the life cycle of a building?
- **Research Design**: involves case studies of existing projects, interviews with stakeholders (architects, engineers, builders), & comparative analysis of different construction methods.
- **Data Collection**: includes integration process right from drawings to construction.
- **Site visits** to observe ongoing projects using aluminum formwork.
- **Data Analysis**: Analyze the data collected to draw meaningful conclusions. Use both qualitative (thematic analysis of interviews, for example) and quantitative (cost-benefit analysis) methods as appropriate.
- **Findings**: Summarizing findings based on the analysis. Highlighting the advantages and challenges of using aluminum formwork in affordable and sustainable housing.
- **Conclusion**: Summing up the key points ofresearch, emphasizing the significance of using aluminum formwork in achieving affordable and sustainable housing goals.

Background Study

The landscape of housing in India is a complex and multifaceted one,driven by rapid urbanization and an ever-increasing demand for affordable homes.With a burgeoning urban population,the country faces significant challenges in meeting housing needs,especially in terms of sustainability & affordability (Kundoo, 2014).

Given that the country's urbanization rate is predicted to reach 55–60 percent in the next 10–15 years, 75 million new dwellings must be constructed in India.

What location will these houses be?

The majority will be found in the 100 smart cities that the Indian government has suggested, as well as in large cities like Mumbai, Delhi, Bangalore, Hyderabad, Chennai, and Ahmedabad.

India will have 900 million urban residents by 2050. However, purchasing a property in the cities will get harder due to growing land costs and an average household income of $1,876 (INR 1,31,320) in 2020. (Source:Amplify Infra)

The pressing need for affordable homes stems from the widening gap between housing supply and demand,exacerbated by factors such as rising land prices and construction costs. Many urban areas face a severe shortage of housing,particularly for low-income and middle-income groups.This shortage contributes to the proliferation of informal settlements and overcrowded living conditions, which pose health and safety risks to residents(Windapo et al., 2021)

Sustainability is another crucial aspect of the housing challenge. Traditional construction methods often result in substantial waste,excessive energy consumption,high carbon emissions.As global awareness of climate change and environmental degradation increases, there is a growing call for construction practices that minimize ecological impact and promote resource efficiency(Cherian et al., 2020).

Traditional construction methods often fall short in addressing these demands due to lengthy construction times,highlabor costs, and significant environmental impacts.These are often resource-intensive and can contribute to ecological degradation(Bayliss et al., 2016).As the world becomes more conscious of the need for sustainable development,there is a growing imperative to adopt construction methods that are both environmentally responsible and economically viable.Therefore, we need housing that is more affordable, built faster, and of better quality, all while adhering to environmental standards.

The skyline of modern Indian cities is punctuated by cranes and scaffolding,a testament to the country's rapid urbanization and economic growth (Sharma & Agarwal,2023).As demand for housing rises,the construction industry finds itself at the intersection of tradition and innovation.

The challenge lies in balancing speed and cost-effectiveness with long-term durability and energy efficiency.With this approach,the industry can keep pace with the growing demands of urban development while contributing positively to the environment and the lives of those who call these houses their homes.

This context has opened the door for modern construction techniques like aluminum formwork, which offers a pathway to achieve sustainable and affordable housing.Aluminum formwork systems streamline the construction process by enabling the rapid casting of entire building sections, reducing both labor and time costs (Magdum et al., 2017). Additionally,the material's reusability and minimal waste production align with contemporary sustainability goals (Cherian et al., 2020).Aluminum formwork can revolutionize India's housing sector by delivering affordable, sustainable homes efficiently. This innovative technique streamlines construction, reduces resource waste, and aligns with sustainability

goals, addressing the environmental and economic challenges of traditional methods. It offers significant advantages, making construction more sustainable, efficient, and cost-effective.

Literature Study

Table 1

Title	Author/ Date	Theoretical/ Conceptual Framework	Research Question(s)/ Hypotheses	Methodology	Analysis & Results	Conclusions	Implications for Future research	Implications For practice
A Review Paper on Aluminium Formwork and It's Utilization in Affordable Housing	Azharuddin Ansari, A. A. (2018)	Not explicitly mentioned	The paper reviews the utilization of aluminum formwork in affordable housing	Literature review of existing research and case studies	Provides an overview of aluminum formwork technology, highlighting its benefits such as efficiency and reduced labor costs	Aluminum formwork is a promising technology for affordable housing, though some challenges exist	Further research is needed on long-term durability and large-scale implementation	Offers insights into how aluminum formwork can streamline construction processes and save costs for developers
Construction technologies for sustainable affordable housing within fragile contexts	Atta, N., Dalla Valle, A., Campioli, A., Chiaroni, D., &Talamo, C. (2021)	The paper discusses a decision support tool for selecting construction technologies for sustainable affordable housing	The paper evaluates different construction technologies for sustainable	Case studies and a decision support tool to analyze construction technologies	The analysis highlights the need for careful consideration of local contexts and community needs when choosing constructio	The authors emphasize the importance of selecting technologies that balance cost-	Further research is needed to refine decision-making tools and assess the long-term	The decision support tool can aid practitioners in choosing appropriate

: Proposal of a decision support tool			affordable housing		n technologies	effectiveness with sustainability and community preferences	impact of selected technologies on communities	construction technologies, balancing affordability and sustainability
"A state of art review on time, cost and sustainable benefits of modern construction techniques for affordable housing "	Mandala, R. S. K., &Nayaka, R. R. (2023)	The paper reviews various modern construction techniques for affordable housing, including aluminumformwork, through a sustainability lens	The paper aims to evaluate time, cost, and sustainable benefits of different construction techniques used for affordable housing projects	Literature review and analysis of case studies from recent construction projects	The paper compares different modern construction techniques and their impact on cost, time, and sustainability	Aluminum formwork stands out as a sustainable construction technique with potential for cost and time savings	Future research could focus on refining these modern techniques and implementing them on a larger scale	This paper can guide practitioners toward adopting aluminum formwork and other modern techniques to improve affordability and sustainability in housing projects
A	Azharuddin	Reviews	Evalua	Literature	Provides an	Alumin	Future	Offers

Review Paper on Aluminium Formwork and It's Utilization in Affordable Housing	Ansari, A. A. (2018)	the utilization of aluminum formwork for affordable housing	tes the advantages and challenges of using aluminum formwork in affordable housing	review of existing research and case studies	overview of aluminum formwork technology, highlighting its benefits such as efficiency and reduced labor costs	um formwork is a promising technology for affordable housing, though some challenges exist	research could focus on large-scale implementation and long-term durability	insights into how aluminum formwork can streamline construction processes and save costs for developers
Construction technologies for sustainable affordable housing within fragile contexts: Proposal of a decision support tool	Atta, N., Dalla Valle, A., Campioli, A., Chiaroni, D., &Talamo, C. (2021)	Discusses a decision support tool for selecting construction technologies for sustainable affordable housing	Evaluates different construction technologies for sustainable affordable housing	Case studies and a decision support tool to analyzeconstruction technologies	Analysis highlights the need for careful consideration of local contexts and community needs when choosing construction technologies	Emphasizes the importance of selecting technologies that balance cost-effectiveness with sustainability and community preferences	Future research should refine decision-making tools and assess the long-term impact of selected technologies on communities	The decision support tool can aid practitioners in choosing appropriate construction technologies, balancing affordability and sustainability
Structur	Sanket S.	Focuses on	Explor	Analytical	Analysis	Alumin	Suggest	Offers

al Design of Aluminium Formwork Used in High-rise Building	Desai, Dr. V. R. Rathi (March 2022)	structural design aspects of aluminum formwork used in high-rise buildings	es the application and performance of aluminum formwork in high-rise building construction	and case study approach examining the structural design aspects of aluminum formwork	includes structural performance, efficiency, and adaptability of aluminum formwork in high-rise buildings	um formwork provides high efficiency, improved structural integrity, and reduced construction times for high-rise buildings	s further research into advanced design features and optimization of aluminum formwork for complex structures	guidance for engineers and developers on adopting aluminum formwork for efficient and durable high-rise building construction
Aluminium Formwork Technology	HimanshuRivankar, AkshayChordiya (April 2017)	Discusses aluminumformwork technology and its application in construction	Investigates the advantages and challenges of using aluminum formwork in construction projects	Literature review and case studies focusing on aluminum formwork technology	Analysis includes cost-effectiveness, time efficiency, and structural integrity of aluminum formwork in construction	Aluminum formwork is beneficial for its speed, cost-effectiveness, and strength, but requires initial investment	Suggests exploring advancements in aluminum formwork technology and its application in various building types	Offers guidance for construction practitioners on the efficient use of aluminum formwork for different projects
Analysis of	SujitShelke, Kanupriya	Explores the	Investigates	Case studies	Analysis shows that	Aluminum	Suggests further	Provides

Aluminium Formwork Structure Based on Duration and Cost	Waghmare, Nikhil Thorat, RohanWadekar, Prof. Nikhil Maske (June 2021)	analysis of aluminum formwork structures focusing on duration and cost	the efficiency of aluminum formwork in terms of time and cost savings	and analytical approach assessing the use of aluminum formwork	aluminum formwork offers significant time and cost savings in construction projects	formwork is effective for reducing construction time and costs while improving quality	research to optimize formwork design for even greater efficiency	practical insights for construction professionals on leveraging aluminum formwork for faster, more cost-effective projects
Pre-Fabricated Architecture For Urban Adaptability: Factory Built Constructions– Sustainable & Flexible Urban Solutions	Shroff, D. N., & Joshi, A. T. (2022)	Examines pre-fabricated architecture and its potential for sustainable and flexible urban construction solutions	Investigates how factory-built constructions can provide sustainable and adaptable urban solutions	Case studies and an analysis of pre-fabricated architecture projects	Analysis shows pre-fabricated architecture can offer sustainable and flexible solutions for urban construction	Prefabrication is effective for its adaptability and sustainability in urban environments	Suggests further exploration of prefabricated systems and materials for wider urban application	Offers insights for urban planners and construction professionals on integrating prefabricated architecture for flexible urban develo

								pment
Comparative study of embodied energy of affordable houses made using GFRG and conventional building technologies in India	Cherian, P., Palaniappan, S., Menon, D., &Anumolu, M. P. (2020)	Focuses on comparing the embodied energy of affordable houses using GFRG (Glass Fiber Reinforced Gypsum) and conventional building technologies	Investigates the differences in embodied energy between affordable houses constructed using GFRG and traditional methods	Comparative analysis of case studies involving houses constructed with GFRG and conventional technologies	The study finds that GFRG-based houses exhibit lower embodied energy compared to conventional construction	The use of GFRG can lead to significant energy savings and reduced environmental impact in affordable housing projects	Suggests further research on the long-term durability and performance of GFRG-based houses	Offers practical guidance for architects and builders on adopting GFRG for more energy-efficient and sustainable construction
Comparative Study of Various Types of Aluminium Formworks	Magdum, M. J. S., Kumthekar, M. B., &Jadhav, G. D. (2017)	Explores the comparative analysis of different types of aluminum formwork systems	Investigates the performance, efficiency, and applicability of various aluminum formwork systems	Case studies and comparative analysis of different aluminum formwork types	The study examines several types of aluminum formwork systems, evaluating their efficiency, cost, and applicability	The paper identifies the best-performing aluminum formwork systems in terms of cost-effectiveness and construction	Suggests further research to optimize the design and use of aluminum formwork in various construction scenarios	Offers insights for construction practitioners on choosing the most suitable aluminum formwork system for specifi

						efficiency		c project needs
Adopting the Low-Cost Housing Technology in Residential Buildings in Chennai	Krishnan, K. M., Manikandaprabhu, S., &Nigitha, D. (2023)	The paper examines the adoption of low-cost housing technologies in residential buildings in Chennai	Investigates the potential of low-cost housing technologies for residential buildings and their impact on cost, time, and sustainability	Case studies and surveys of residential projects in Chennai using low-cost housing technologies	Analysis of case studies and surveys shows positive outcomes in terms of cost savings, faster construction times, and improved sustainability	Low-cost housing technologies are effective in achieving affordable, sustainable housing in residential projects in Chennai	Suggests further research to explore and compare different low-cost housing technologies for broader application	Provides practical insights for developers and policy makers on adopting low-cost housing technologies to achieve cost-effective and sustainable residential projects
Comparative Study of Various Types of Aluminium	Magdum, M. J. S., Kumthekar, M. B., &Jadhav, G. D. (2017)	Not explicitly mentioned	The paper compares different types of alumin	Comparative analysis of various aluminum formwork systems based on literature review and	Findings highlight the efficiency and advantages of different aluminumformwork	Aluminum formwork systems offer a range of benefits	Further research is suggested to explore more types of aluminu	Insights into how different aluminum formwork

Formworks			um formwork systems and evaluates their performance	case studies	systems	in terms of cost-effectiveness, construction speed, and durability	m formwork systems and their suitability for different projects	systems can be applied in various construction projects for improved performance
Affordable Housing	AnupamaKundoo (2014)	Examines affordable housing through the lens of inclusive urbanization and climate change	Investigates strategies and practices for sustainable and affordable housing in urban settings	Review of existing literature and analysis of case studies on affordable housing	Focuses on the interplay between affordability, sustainability, and inclusive urbanization	Highlights the need for innovative, low-cost housing solutions that align with sustainability goals	Suggests further research into integrating traditional and modern building techniques for affordable housing	Offers insights into policies and practices that can facilitate sustainable, inclusive urban development

Inferences from Literature Study

Aluminum formwork has been shown to significantly improve construction speed and efficiency compared to traditional construction methods due to the reusable and easy-to-assemble nature of aluminum formwork,which allows for rapid progression of construction projects(Magdum et al., 2017).

- Purchasing aluminum formwork systems requires an initial investment, but over time, the labor and time savings during construction can result in cost benefits all around(Shelke et al., 2021).
- The quick turnaround time also allows developers to start new projects sooner,increasing their return on investment.
- Aluminum formwork enables the construction of monolithic structures,which results in better structural integrity and reduced risk of leakage or cracking.
- Higher-quality, durable buildings that require less maintenance over time (Rivankar&Chordiya,2017).

- The reusable nature of aluminum formwork systems contributes to a circular economy by reducing construction waste and resource consumption,minimizing the environmental impact of construction projects.This is a crucial consideration given the increasing emphasis on green building practices and the need to address climate change.
- Despite its benefits, there are challenges to widespread adoption of aluminum formwork,including high initial costs and the need for skilled labour familiar with the system (Ansari, 2018).

Nevertheless, in order to encourage and adapt a wider use of aluminum formwork, these issues point to areas that require additional research about when and how the integration of aluminum formwork is justified for affordable housing (despite the high initial cost).

Sustainability is another major theme.It's reusability and waste reduction align with eco-friendly practices and global sustainable development goals.

It significantly cuts construction costs and time,promoting resource efficiency through its reusable and recyclable nature.It enhances energy efficiency by ensuring tighter seals and better insulation,while its durability improves resistance to natural disasters.Overall, aluminum formwork supports safe,comfortable, & sustainable housing,empowering community development.

What Is Aluminium Formwork (Mivan) Technology

An Overview

Formwork, which consists of a die or mold and any supporting structures, is used to shape and support concrete until it reaches a strength that allows it to support itself.Aside from its own weight, it should be able to support any imposed dead and live loads.The surface in contact with the concrete and any required supporting structure are included in the formwork.Using this construction technique, aluminum forms are used in place of conventional lumber forms. By enabling single-pour construction, it not only expedites the building process but also increases the structure's overall strength. The MIVAN formwork technology produces buildings with flawless finishes, so that further plastering is not necessary to obtain smooth surfaces.

History:

Aluminium formwork gained prominence in the construction industry in the latter half of the 20th century. Its origins can be traced back to Europe and Asia,where it was developed as an alternative to traditional formwork materials like timber and steel.

a. Mivan is a quality aluminum structure developed by a European construction company known as Mivan Company Ltd. In 1990, the company from Malaysia began manufacturing these formwork systems. (*YogeshRadheshyamJangid et al.) Therefore is is commonly known as MIVAN Technology.*

b. The Aluminium Formwork System was developed by W. J. Malone, a Canadian Engineer in the late 1970s as a system for constructing low–cost housing unit in developing countries.*(Prasanth S-Grand Edifice Developers ,Azharuddin Ansari)*

c. Several nations, including Egypt, Hong Kong, India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand, have effectively employed the aluminum formwork system (Vrushalkokane)

Features:

1. The MIVAN Formwork is lightweight, weighing approximately 18–20 kg per square meter. In spite of this, it can handle an impressive 7-8 tonnes of weight per square meter.
2. After 36 hours of concreting or when the concrete reaches a strength of 10N/mm2, horizontal panels

made with MIVAN can be removed. Even faster disassembly times are possible for vertical walls: 12 hours after concreting or when the concrete reaches a strength of 2N/mm2.

3. Since aluminum is used to create the formworks, they can be reused over 250 times and are exceptionally durable.
4. With the MIVAN formwork system, a floor can be cast within just 7-8 days, significantly reducing the construction timeline.

Advantages:

1. Consistent Dimensions: The high-quality aluminum formwork ensures consistent dimensions in construction, as it is resistant to damage.
2. Smooth Finish: After removing the formwork, the concrete construction boasts a smooth finish, eliminating the need for rectification.
3. Customizable: The formwork can be tailored to suit the specific requirements of each project.
4. Easy Assembly: Skilled labor is not required for assembling the formwork, simplifying the construction process.
5. Faster Construction: MIVAN technology enables much quicker construction timelines.

Disadvantages:

1. Costly Modifications: Modifying the formwork can be challenging and expensive, as each piece is cast with a mould.
2. Seepage Issues: During monsoons, seepage and leakage problems may arise.
3. Shrinkage Cracks: The box-type construction method can make buildings susceptible to shrinkage cracks.
4. Cost-Effectiveness for Large Projects: MIVAN forms may not be cost-effective for large projects such as townships or extensive residential and commercial complexes if not used repeatedly at a large volume.
5. Skillful Joint Setting: Setting joints for construction requires skillful execution.

Techincal Specifications:

Table 2: Technical Specifications(Source : Multiple Vendors/Manufacturers)

Formwork Material:	6061-T6/6082-T6 Aluminium alloy
Thickness of material:	4mm
Type:	Flat,corner,beam,etc.
Weight:	18-22kg
Thickness of Formwork:	65mm
Safe Working Load:	60kN/m2
Cycle Times:	≥300
Shape:	Rectangular,customized
Size:	0.5m-11.85m, non-standard:custom-made as/requirement
Process:	Drilling,bending,welding,precise cutting,punching
Standard:	EN755-9, GB/T6892-2015, GB5237.1-2008, JGJ386-2016
Package:	Standard pallet with waterproof film or acc. to requirement.

Picture 1:Formwork for beams(Source-Goldapple)

Picture 2: Formwork for Walls (Source-Walcoom)

Benefits of Using Aluminium Formwork compared to Traditional Methods

Table 3:Comparitive Analysis of Aluminium Formwok Technologe & Other Shuttering Technology

Characteristics	Aluminium Formwork	Steel Shuttering	Timber Shuttering	Plywood Shuttering	Plastic Shuttering
Material	Aluminium	Steel	Wood	Engineered wood panels with veneers	Toughened plastic (often with fiberglass)
Weight	Lightest	Heavy	Light to Medium	Light	Lightest
Assembly	Easy and fast with modular panels	Requires skilled labor for fabrication and assembly	Requires skilled labor for cutting and assembly	Requires cutting and framing with timber supports	Easy to assemble with interlocking panels
Deshuttering	Quick	Time-consuming	Time-consuming	Requires careful handling to	Easy

				avoid damage	
Reusability	Highly reusable	Highly reusable	Limited reusability (prone to warping, damage)	Limited reusability (delamination, warping)	Moderate reusability (depending on quality)
Labor Costs	Lower due to faster assembly/disassembly	Higher due to skilled labor needs	Lower for simple designs, higher for complex	Lower for simple designs, higher for complex	Moderate
Concrete Finish	Generally smooth finish	Smooth finish	Finish can vary depending on wood quality	Finish can vary depending on plywood quality	Finish can be smooth, but may require additional treatment
Durability	Durable with proper care (corrosion resistant)	Very durable	Susceptible to rot, warping, and fire	Susceptible to delamination, warping, and moisture damage	Moderate durability (depending on quality)
Environmental Impact	More environmentally friendly due to high reusability	High carbon footprint due to steel production	Renewable resource, but requires tree harvesting	Wood with potential for formaldehyde in adhesives	Varies depending on material source and recycling options
Cost (Initial Investment)	Highest	High	Low	Low to moderate	Moderate
Cost (Life Cycle)	Lower overall cost due to reusability	Moderate overall cost (depending on maintenance needs)	Low overall cost for simple projects	Low to moderate overall cost (depending on reuse)	Moderate overall cost (depending on reuse)
Suitability	Ideal for repetitive pours, complex designs, high-quality finishes	Suitable for high-load projects, repetitive pours	Suitable for simple, low-rise projects, or when budget is a major concern	Suitable for walls, beams, columns (often with timber support)	Suitable for simple curves, architectural finishes, limited reuse projects

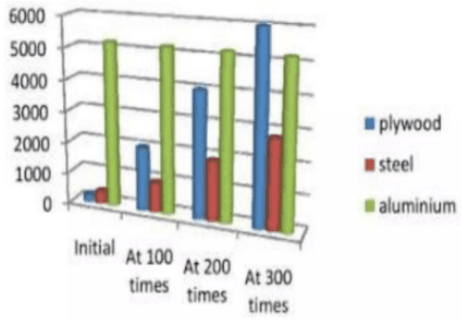
Effectiveness Analysis of Aluminium Formwork v/s Traditional Formwork

Table 4: Effectiveness Comparison of Aluminium Formwork Shuttering & Traditional Shuttering

Aspect	Aluminum Formwork	Conventional Shuttering
Installation	5-7 days	7-10 days
Reinforcement Placement	3-4 days	3-4 days
Concreting	1 day	3-4 days
Curing	7-10 days (can overlap with dismantling)	7-10 days
De-shuttering	2-3 days	5-7 days
Total Time per floor	7-8 days	14-21 days
Cost	Higher initial cost, cost-effective in long-term	Lower initial cost, higher long-term cost
Quality	Higher quality finish, No plastering needed	Require additional finishing work
Labor	Requires skilled labor	Can use semi-skilled labor
Reusability	Up to 200-300 uses	Up to 20-25 uses

Cost Comparitive Analysis:

Chart 1: Cost Analysis Graph (for Repetitions)Source:Civilenggseminar.blog(prem mohan)



Impact on Indian Real Estate:

The MIVAN Formwork System is widely recognized and utilized in Gulf, European, and select Asian countries,

A recent application of the Aluminium Formwork System in India has been in the implementation of the PradhanMantriAwasYojana (PMAY).

The PMAY initiative, also known as Housing For All, aims to provide affordable housing opportunities to lower-income groups in India.This ambitious scheme requires rapid construction of residential units while ensuring high-quality and durable structures.

The MIVAN construction technology facilitates both speed and quality, unlike conventional methods, making it an essential component of the PMAY scheme.As MIVAN technology becomes more

prevalent, it is anticipated that construction costs may decrease, mitigating one of the major drawbacks of the MIVAN Formwork System.

This potential cost reduction could incentivize more developers in India to embrace MIVAN technology, paving the way for its broader adoption in the country's real estate sector.

Case Study:

11.1 Affordable Housing In Gurugram-

General Information :

Built Up Area – 50,000 Sq.M.

Towers-7 No.s(G+14);3No.s(G+21) ; Total Floors – 171 No.s

Picture 3(Source:DFI Renders)

Picture 4(Source:DFI Renders)

Speed- 7 days/floor

COST ANALYSIS :

Flats/Floor- 8No.s

Aluminium Shuttering :

1800 sq.m(Approx) – 4 Sets of ½ Floors @Rs.11,000/sq.m. + 2 sets of Refabricated shuttering from other site(reusable)

Cost of Shuttering: ≈Rs.11,000/sq.m

Total Cost of Shuttering: ≈2 CR.(for 171 floors)

Shuttering Cost/Floor: ≈1.15 lacs

Labour Cost:≈Rs.1000/sq.m

Finishing Cost:≈ 0

Salvage Value:80%

Reusable:More that 250Times

COMPARITIVE COST ANALYIS :

(to check the cost of same project for Traditional Formwork on Hypothesis that It will be Costlier)

For Affordable Housing in Gurugram:

Aluminum Formwork:

Qty ordered:1800 sq.m.(one floor) @Rs.11,000/sq.m.

Total Cost- 2 Cr(approx)

Reusability: 171 floors (7 Towers:G+14 & 3 Towers:G+21) (200-300 times)

Cost per floor:1.16 lac (Rs. 210/sq.m) or (Rs.21/sq.ft)

No finishing required,
Maintenance Cost: Low,
Slab Cycle: 7-8 days

Let's Assume the same project for Ply Shuttering:
Traditional(Ply) Shuttering:
Shuttering Cost :@Rs.650/sq.m.
Total Cost-
Reusability: 8-10 floors
Cost per floor:3.25 lac. (considering a slab of ≈500 sq.m)
Labour Cost increases with increased height,
Finishing required, Maintenance/Repair Cost: High
Slab Cycle: 14-21 days.

Table 5:Cost Benefit Analysis

Cost Component	**Aluminum Formwork**	**Conventional Shuttering**
Shuttering Costs	Rs.11000/sq.m.	Rs.2000/sq.m.
Labor Costs	(Rs.1000/sq.m) Lower, due to faster installation and deshuttering	(Rs.1300/sq.m) Higher, due to longer installation and dismantling time
Time-Related Costs	Lower, due to reduced construction time (savings on overheads)	Higher, due to longer construction time (increased overheads)
Quality and Finishing Costs	Lower,as No plaster required	Higher, due to additional plastering and finishing
Reusability Benefits	Reused up to 170 times (amortized cost over multiple projects)	Reusable up to 20-25 times
Overall Construction Time	7-8 days per floor	14-21 days per floor
Total Estimated Cost	Potentially lower overall, despite higher initial investment	Potentially higher overall, due to increased labor, time, and finishing costs

Hence, The overall Quality,Time & Speed increases with Aluminium Formwork(with more repetitions) with Overall Decrease in Cost.

Site Pictures:

Picture 5(Source:Author) Picture 6(Source:Author)


Picture 7(Source:Author) Picture 8(Source:Author)


Unique Features :IGBC Platinum Certified Project.
Advantages:More Seismic Resistance, Increased Durability Of Structure, Monolithic Casting,
Higher Carpet Area- Due to Thin Shear Walls.
Negligible Maintenance.
Faster Completion.
Better Sound Proof due to Natural Density of Concrete
Limitations:
Concealed services are challenging due to thin components, requiring uniform planning and elevations for cost-effectiveness. Modifications are impossible with RCC casting, and large volumes of work (≈200 repetitions) are needed. Shrinkage cracks and high hydration heat are issues, Despite higher initial costs, the quality and speed of construction benefit low-income housing projects.

11.2 Luxury Housing In Lucknow (Rishita Mulberry) -Rishita Developers Pvt.Ltd.
General Information :
Towers – 16 No.s(G+14)

Picture 9(Source:DFI Renders) Picture 10(Source:DFI Renders)

Speed:7 days/Floor

Construction Information

Internal walls–Blockwork/Brickwork & Exterior walls–160 mm. (Conc.)

Picture 11Source:Author)

Picture 12(Source:Author)

Picture 13(Source:Author)

Picture 14(Author in Picture)

Picture 15(Source:Aluminium Formwork- An Innovation in Construction Technology (COA))

In India there are number of buildings constructed with the help of the above system which has been proved to be very economical and satisfactory for Indian Construction Environment

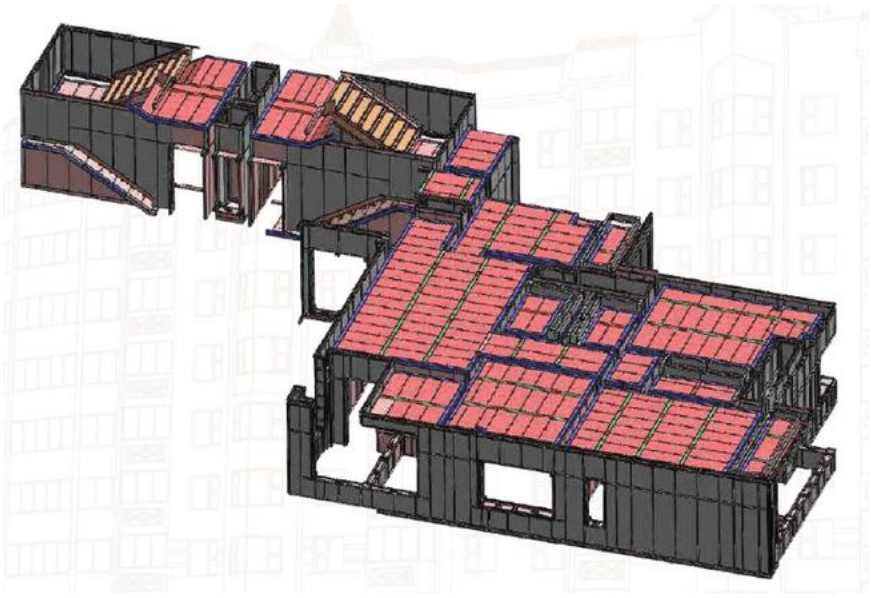
Data Collected

The data collected,primarily focuses on observing the construction process alongwith application of the formwork in practice.

Construction Process:involves assembling a shell based on architectural designs,placing reinforcement(sariya) & pouring concrete to create seamless structures that integrate slabs and walls.

a. Preparation of Shell Plans:

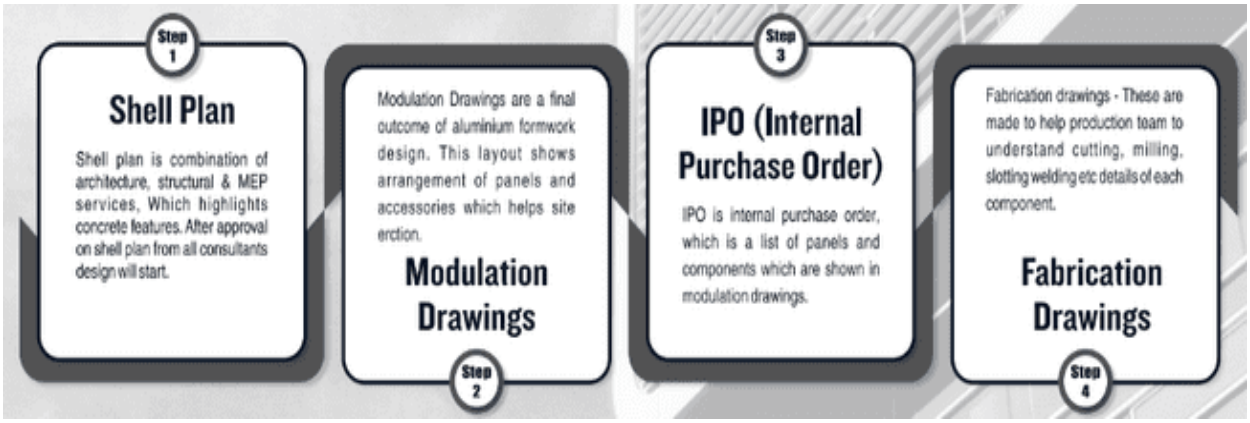
Picture 16 (Source : MFS Scaffolding & Formwork)



• The authorized shell plan is followed while extruding the three-dimensional structural model. (Pic14)
• The structural model is fully configured with components from the previously developed library, as depicted in the figure. At this point, the software automatically detects any overlaps or clashes, which are fixed before the program generates and releases the shop drawing. This guarantees error-free manufacture drawings,final BOQs,site operational drawings,which serve as the foundation for manufacturing of the full aluminum formwork system. The aforementioned procedure guarantees a soft mock-up of the whole project.

b. Design Process:

Picture 17

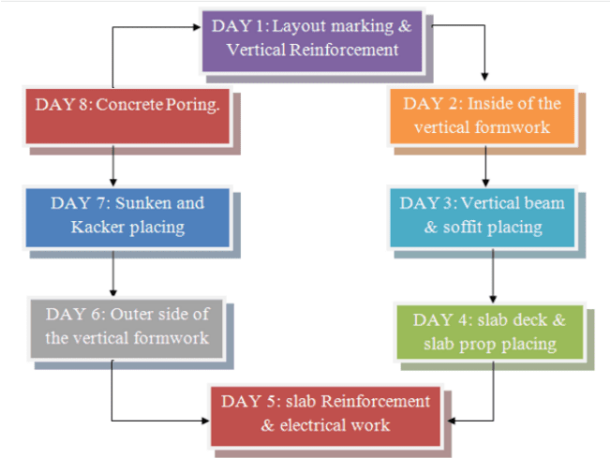


c. Production Process:

Picture 18

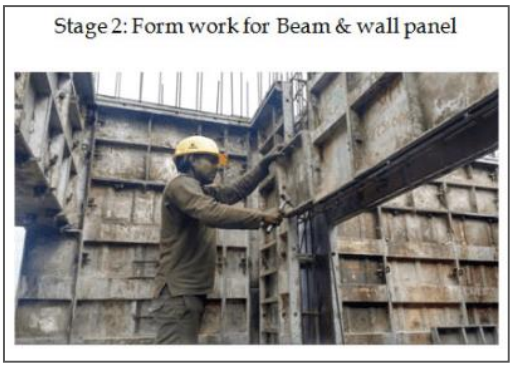
d. Construction Process:

Chart 2: Slab Cycle



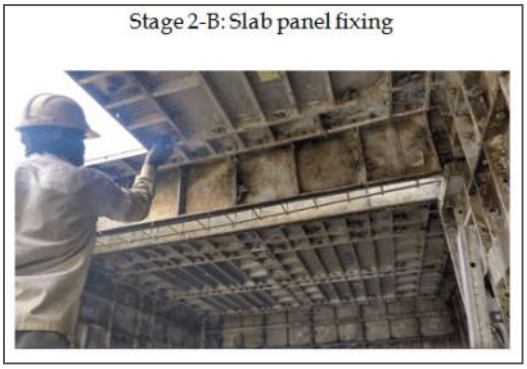
Picture 19 Picture 20

Picture 21



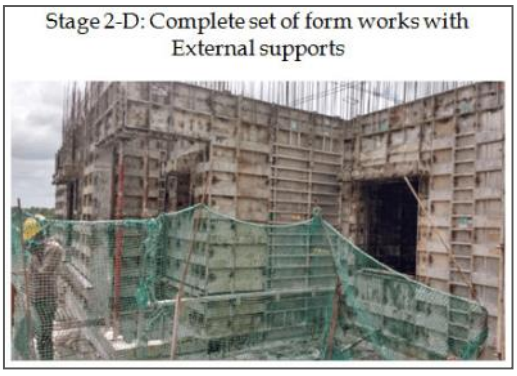
Picture 22

Picture 23



Picture 24

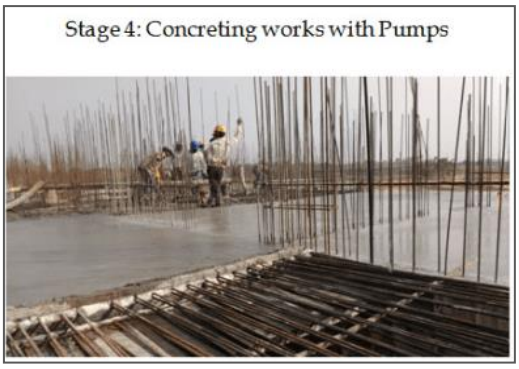
Picture 25



Picture 26

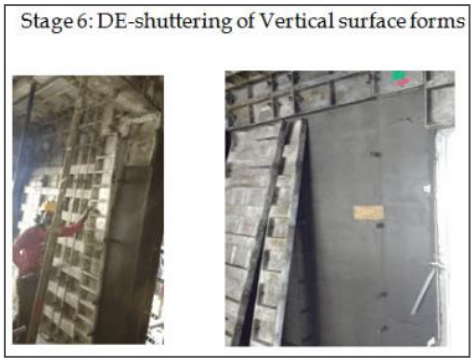
Picture 27

Picture 28



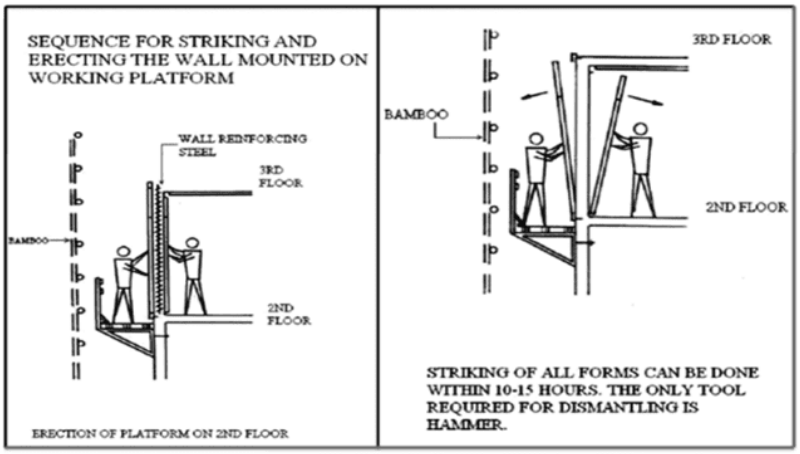
Picture 29

Picture 30



e. Erecting Formwork For Construction:

Picture 31



This system allows the walls and slabs to be poured in the same operation and provides formwork for multi-story buildings with RCC framing.This boosts productivity and results in a very sturdy building with good concrete finishing.Because of this,plumbing & electrical fixtures can be prefabricated with the assurance that they will fit perfectly when put together. The weight distribution is 23–24 kg/m^2.It may be put together entirely by hand without the need of any machinery 20-30 sq.m. can be installed each day by a skilled installer.(1 storey in every four days)

Aluminum formwork is available in a variety of standard sizes and can be assembled to suit the needs of any given project.When the formwork is reused for a new project, just 10–15% of the non-standard board needs to be changed,which lowers the cost.Aluminum Alloy Plate is used to assemble every component of the aluminum alloy formwork.After the system is put together,a complete structure with excellent stability and a bearing capacity of up to 60k per square meter will be constructed.(2020

ConstroFacilitator)
As the largest panel weighs no more than 25 kg,single worker can handle it.

Site Images

-Vertical Formwork:

Picture 32

Picture 33

-Surface Finish:

Picture 34

Picture 35

-MEP Services

Picture 36

Picture 37

-Storage of Raw Material:

Picture 38

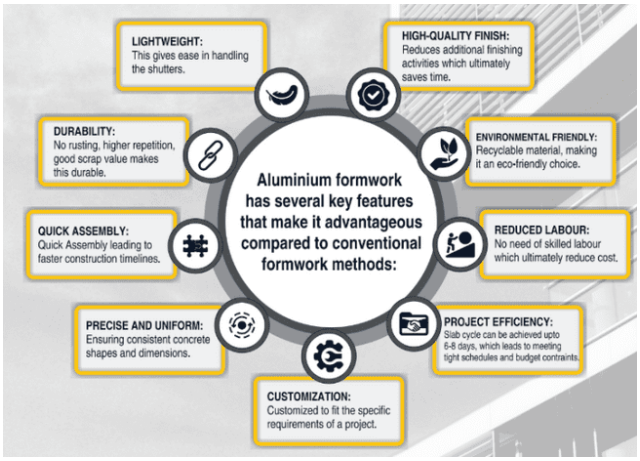
Picture 39

indings

The research findings on the integration of aluminum formwork in sustainable and affordable housing projects reveal several significant advantages and insights.

- **Benefits:**

Picture 40



- **Time Savings**:This efficiency is crucial for affordable housing projects where time constraints are often strict,faster completion can result in quicker occupancy and return on investment.
- **Cost-Effectiveness**:While there is an initial investment in aluminum formwork systems,this technology's ability to expedite the building process without compromising quality can lead to overall cost savings and improved project budgets.
- **High-Quality Structures**:Creation of monolithic structures, resulting in high-quality buildings with fewer defects and greater durability contributes to longer-lasting, low-maintenance structures that can better withstand the test of time.
- **Sustainability**: The technology's reusable nature contributes to sustainability by minimizing construction waste and resource consumption.
  This technology minimizes the consumption of resources and promotes a circular economy

Conclusion:

Research on aluminum formwork for sustainable and affordable housing highlights its transformative potential.

Key benefits include time and cost savings, high-quality, durable structures, and alignment with sustainability goals, positioning it as a revolutionary technology for India's housing sector.

This paper concludes that how can Aluminium Formwork (MIVAN) technology revolutionize the construction of faster, higher quality, sustainable, and cost-effective homes"

Faster: Recent years have seen a considerable evolution in construction technologies,most notably with the introduction of prefab construction methods and Mivan shuttering.

These innovations have drastically reduced construction times,enabling the completion of large residential complexes in less than half the time compared to traditional methods.Prefabricated components have streamlined commercial building construction, cutting both time and labor efforts. Additionally,advancements like 3-D printing of villas promise even faster construction timelines in the near future.Project management has also seen significant improvements with the adoption of such technology, facilitating seamless coordination between teams and better decision-making.

Better: Affordable housing no longer means compromising on quality. Technologies like Mivan Shuttering ensure uniformity and high quality in home construction, enhancing structural stability and finish. Precast walls with integrated plumbing and electrical systems further improve efficiency and quality, while mobile applications enable real-time quality checks and approvals. Artificial intelligence and machine learning will further enhance quality control by analyzing defects and suggesting corrective measures.

Sustainable: The future of building must prioritize resource efficiency and environmental impact reduction. Incorporating features like solar rooftops, rainwater harvesting, and waste recycling can minimize energy and water usage, moving towards net-zero buildings. Sustainable construction techniques like pre-fabrication, Mivan Shuttering reduce waste and pollution, contributing to a cleaner environment.

Budget-Friendly: Addressing the demand for budget-friendly homes requires a multi-faceted approach. Effective construction technologies and streamlined execution can help control costs, although challenges like fluctuating material prices persist. To truly meet the demand for affordable housing, land availability and affordability are crucial. Government institutions must make affordable land parcels accessible to developers to ensure the realization of housing for all amidst rapid urbanization.Aluminum formwork's advantages are numerous:it reduces wood use due to its reusability (200-250 times),allows faster construction with its lightweight nature,reduces production waste,and is recyclable at the end of its lifecycle.Despite higher initial costs compared to wood, frequent use and faster construction times can compensate for this expense,making it cost-effective for common designs and large projects.

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