Aluminium Formwork Simplified:

Basics and Beyond

CREDAI

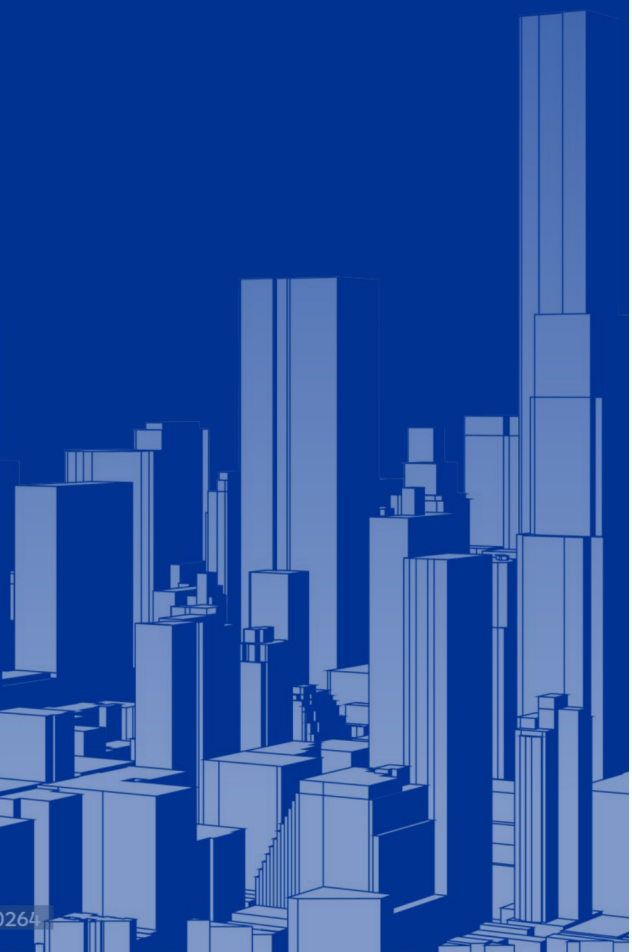
Foreword

Youth Wing has been unwavering in its dedication to equip members with technical knowledge and empowering them to deliver projects on time with best quality. Despite a prevailing misconception that aluminium formwork is exclusively reserved for high rise projects, some of our developers have successfully employed Aluform in smaller projects, as low as 80 units and 5 floors.

The key factor lies in the power of repetitions, where the ease of replicating identical units streamlines construction, offering efficiency even in small projects. This paper aims to remove myths, showcasing Aluform's adaptability and potential to revolutionize conventional construction methods.

As labor shortages are affecting our industry and inflating costs, the Aluform methodology emerges as a transformative solution. By minimising dependency on extensive labor forces, it not only addresses a persistent challenge but also optimizes project economics. This paper stands as a guiding light of transformation, encouraging developers to explore the versatility of Aluform. Our goal is to inspire a change in mindset, drive efficiency, cost savings and higher project outcomes. We hope this resource serves as a guide for those who are ready to embrace innovation and advance industry standards, guiding us towards a future that is not merely an objective but a reality created through knowledge and change.

Nithish Reddy
National Convener
CREDAI Youth Wing



Foreword

We at the Construction and Project Management Committee are looking at the practical implementation and execution of various subject matters that are of great importance towards cost effective completion of the projects within the time frame.

The paper on Aluform is to remove doubts and myths which are attached to the use of this technology which has delivered millions of construction area within record time, improved quality and at the same time being cost effective.

It is the background planning and preparation that is of paramount importance for the success of any technology and Aluform is no different. We have covered most of those areas and focussed on the cost comparison with conventional shuttering in detail which is fulcrum of our decision making in favour of Aluform.

We aim to bring many more whitepapers, podcasts etc. which will help the community in managing the construction and project management of all in future.

Saurav Bafna
Head – Construction and Project Management Committee, CREDAI Youth Wing

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1. Introduction

1.1. India & Real Estate

India is growing, as it should, as it must. In 2047, when India completes its 100-year anniversary it is projected to become an economy of more than USD 33 Trillion. Out of this real estate, the backbone of the Indian economy will account for USD 5.8 Trillion, 15% of the country's economic output. While doing so India will have to support the housing demands of a population that is already 1.4 Billion in 2023. One of the most crucial statistics to consider is India's urban population which was already over 500 Million in 2022.

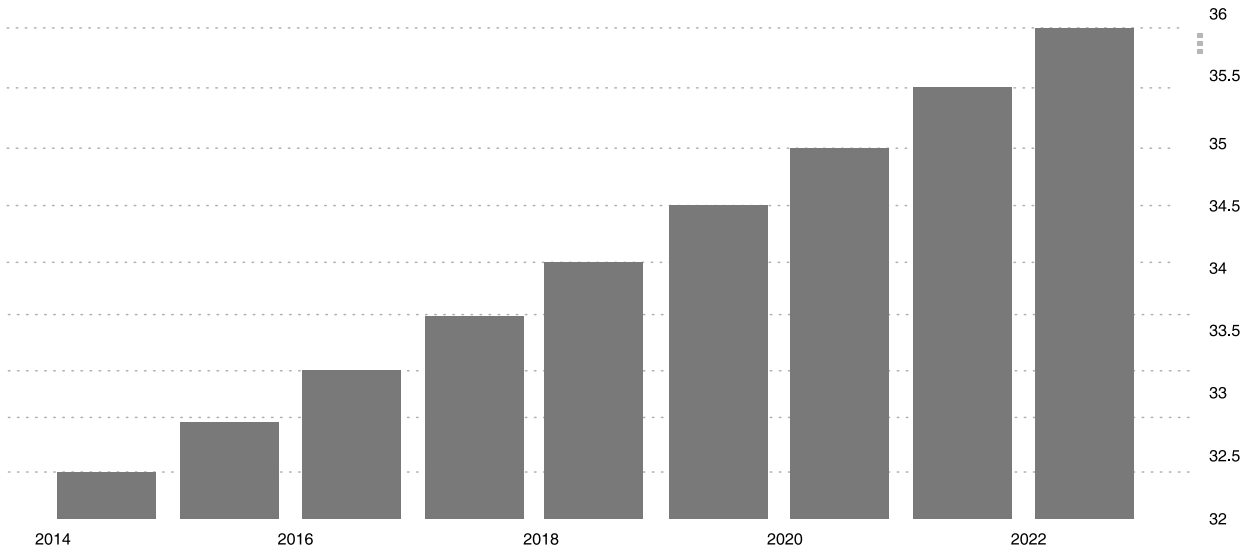


Fig 1. India - Urban Populations (% of Total) | Source: Worldbank via Tradingeconomics.com

An urban population that is aspirational and bullish on housing. Be it the evolution of customer sentiment, robust fiscal policies or competitive offerings, Indian real estate is robust. Across the 7 key urban clusters, the numbers have already reached/surpassed pre-Covid levels, and show no signs of stopping.

1.1. India & Real Estate

Q2 2023: At a glance

New Launches:
76,143 units ▲ 24%y-o-y

In Q2 2023, new launches jumped by 24% y-o-y, expected to further go up in the second half of the year.

Sales:
64,547 units ▲ 22% y-o-y

Sales recorded an increase of 22% y-o-y in Q2 2023, highest quarterly sales since 2008.

Year-to-sales (YTS):
2.5 years

The expected time to liquidate stock has declined from 2.7 years in Q1 2023 to 2.5 years in Q2 2023, indicating robust sales growth.

Residential prices increased across all top 7 cities

Residential prices in major cities have risen in the range of 6-9% y-o-y except in Bengaluru and Kolkata. Bangaluru witnessed the highest increase of around 11-12% y-o-y.

Fig 2. India's Residential Market Update Q2 2023 | Source: JLL Research

The positive trends, however, give way to a moment of reckoning. The rapidly growing urban population across traditional & new clusters is only going to increase the demand for housing & urban infrastructure.

1.1. India & Real Estate

Fig 3. India's Residential Market Update Q2 2023 | Source: JLL Research

1.2. Need For Modern Construction Technologies

The status quo number suggests a potential housing deficit situation in the country. This situation can be attributed to several factors such as scarcity of urban land, procedural-administrative delays, rising input costs, inadequate access to finance schemes, etc.

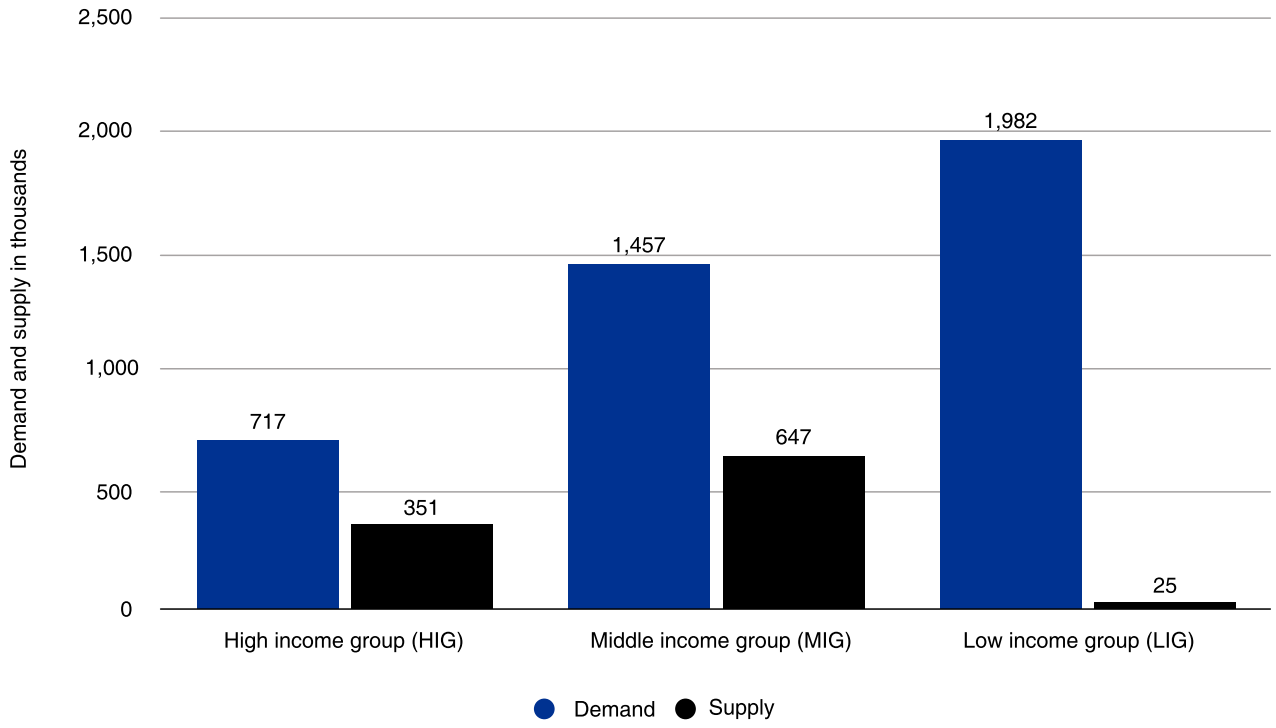


Fig 4. Cumulative numbers of demand and supply for housing in India (2016 to 2020) | Source: Statista.com

1.2. Need For Modern Construction Technologies

City	Change in Demand	Change in Supply	Average change in Rental
Ahmedabad	5.9%	-3.6%	-0.8% ↓
Bengaluru	12.2%	-5.8%	3.9% ↑
Chennai	14.3%	-9.3%	1.3% ↑
Delhi	-1.8%	-4.7%	0.7% ↑
Greater Noida	-10.3%	-0.7%	2.7% ↑
Gurugram	8.9%	-12.0%	8.2% ↑
Hyderabad	10.8%	-0.6%	4.9% ↑
Kolkata	-0.9%	-0.1%	2.0% ↑
Mumbai	5.1%	-2.9%	4.2% ↑
Navi Mumbai	5.5%	-18.8%	1.4% ↑
Noida	-0.7%	4.2%	5.1% ↑
Pune	7.8%	-7.7%	2.9% ↑
Thane	5.2%	-13.1%	-0.5% ↑
Average	7.3%	-5.7%	4.1%

Fig 5. QoQ Change in Jan-March 2023 | MagicBricks Research

There is also a big gap in the affordable housing segment. Take Mumbai for example, according to reports, 67% of the housing is for houses under Rs. 25 Lakh but only 22 % of the supply falls in that budget range.

Total Housing Need in EWS & LIG Segment (2019 - 2030)

Total Housing Gap in India (2019 to 2030)			
	EWS	LIG	Total
Urban	3,01,62,725	62,60,878	**3,64,23,603**
Rural	4,63,96,398	1,45,25,676	**6,09,22,074**

Fig 6. Source: Knight Frank

Developers & real estate companies have to adopt the best technologies to deliver quality residential projects in faster delivery timelines due to the new emergent reality. Against this backdrop, Formwork Technology can be the long-awaited solution.

2. Formwork Technology

2.1. About Formwork Technology

The history of formwork dates back to ancient Rome during the 60s AD. People understood that it was easier to create shapes of desired dimensions by pouring concrete into moulds. The Romans used materials like reed & fibre for the moulds and were able to construct landmarks as grand as The Colosseum and The Pantheon.

Fig 7. The Colosseum; built using ancient Formwork Technology in 80 AD

2.1. About Formwork Technology

Fundamentally, there are three components to the technology:

1. The Mould: Created out of flexible but shape-holding material that can be altered to the preferred shape & size.

2. The Poured Material: Mixture with fluid consistency that settles, solidifies and has bonding properties.

3. The Assembly: They are modular and can be precast or cast-in-place/cast-in-situ.

It was only in the last 50 years that we have seen large-scale developments in formwork technology. Concrete, made out of cement, aggregates & water, has been the go-to choice for poured material due to its availability, affordability and distinct chemical & mechanical properties. With concrete as the constant construction methodologies, the mould & assembly have evolved over time. Let's deep dive.

Fig 8. Concrete pouring on-site

2.2. Type of Formworks

While concrete has evolved as the main-stay of formwork technology, the material of the mould/construction has emerged as a point of difference. They now come along with specialised accessories and hardware. The different types of formwork systems are Timber Formwork, Plywood Formwork, Steel/Tunnel Formwork, Plastic Formwork, Fabric Formwork and Aluminium Formwork.

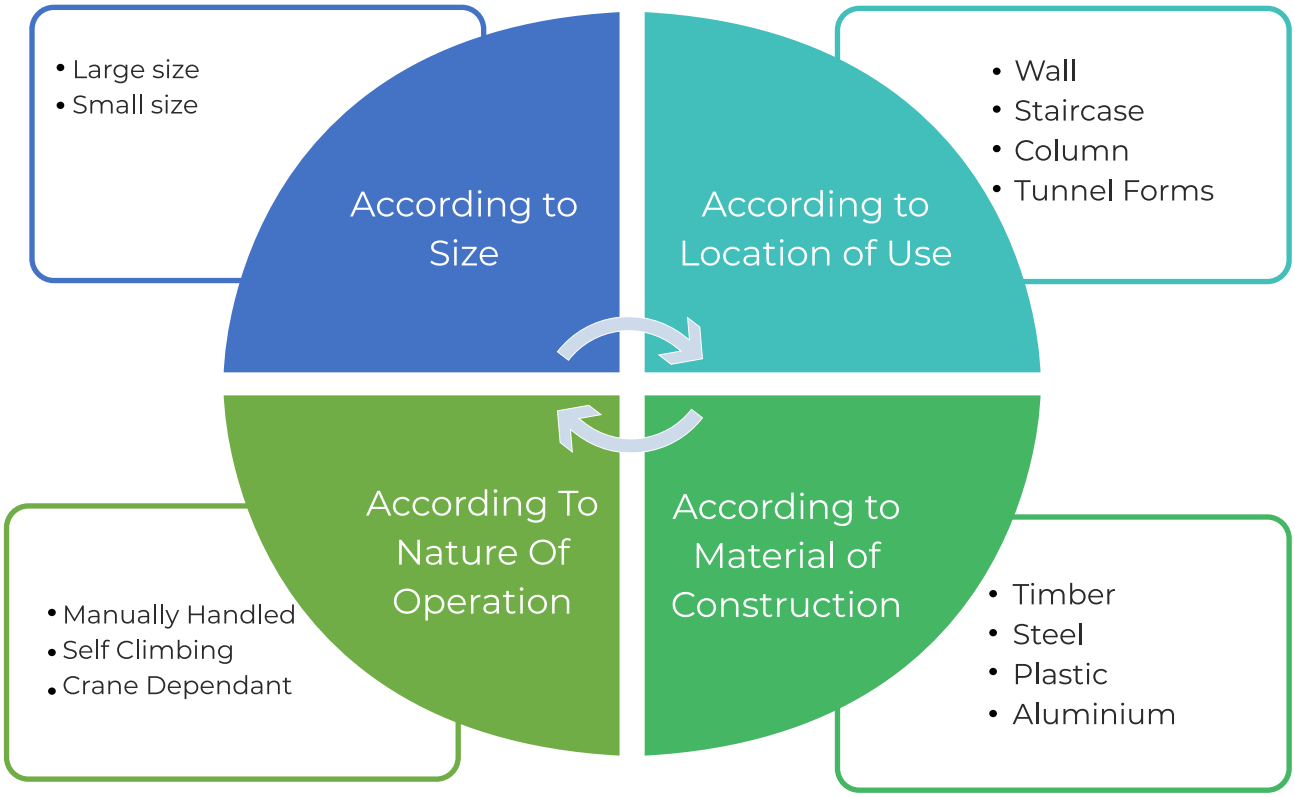


Fig 9. Classification of Formwork | Source: Conference Paper
(International Conference: Engineering: Issues, Opportunities and Challenges for Development)

2.2. Type of Formworks

Timber Formwork

The Timber formwork is one of the most used in the construction industry. It's lightweight and easy to fix & remove. Its on-site fabrication provides flexibility but is extremely time-consuming for larger structures. It has limited reusability, only up to 10 repetitions, and is environmentally unsustainable.

Fig 10. Timber Formwork I Source: IRJAES

Plywood Formwork

Plywood Formwork uses remoulded, bonded ply sheets attached to timber-based panels. It's strong, flexible & easy to handle. Although it's more reusable than Timber Formwork, it has a short lifespan, creates large-scale waste and is also not environmentally sustainable. Similar to Timber Formwork it has limited reusability with maximum repetitions of 14 i.e. 7 per side.

Fig 11. Plywood Formwork I Source: IRJAES

2.2. Type of Formworks

Steel Formwork

Steel formwork uses steel as the base material with great mechanical properties such as long life span and reusability. It gives a smoother concrete finish than any of the previous two and can be used for different shapes, however, can be difficult to work with connecting brackets & unique designs. It's good for larger projects, but the most expensive vis-a-vis investment among all formworks. Due to its inert mechanical properties, steel formwork is durable enough to provide up to 100 repetitions.

Fig 12. Steel Formwork I Source: IRJAES

Plastic Formwork

Plastic Formwork is made from robust plastic and uses an interlocking system to hold everything in place. It's lightweight, has manifold usability and does not require releasing agents. However, due to the inherent properties of plastic, they have limitations and are extremely unhealthy for the environment. With proper care & maintenance, Plastic Formwork can provide 100 repetitions.

Fig 13. Plastic Formwork I Source: IRJAES

2.3. About Aluminium Formwork Technology

Aluminium Formwork is a temporary work mould used for forming cast in-situ structures. Unlike timber, aluminium formwork is best suited to load-bearing wall construction as it can easily withstand high pressures from freshly poured concrete.

Historically a Canadian Engineer W.J. Malone has been credited with developing the Aluminium Formwork System in the late 1970s. The system was to be used for constructing low-cost housing units in developing countries. The units were to be made of cast-in-place concrete with load-bearing walls formed with aluminium panels.

The panels & system were to be erected by the hundreds, using a repetitive design, to ensure a fast and economical method of construction. Egypt, Iraq, Malaysia and eventually entire Asia & the world have adopted this technology as the primary mode of construction.

Fig 14. Aluminium Formwork Panels

2.3. About Aluminium Formwork Technology

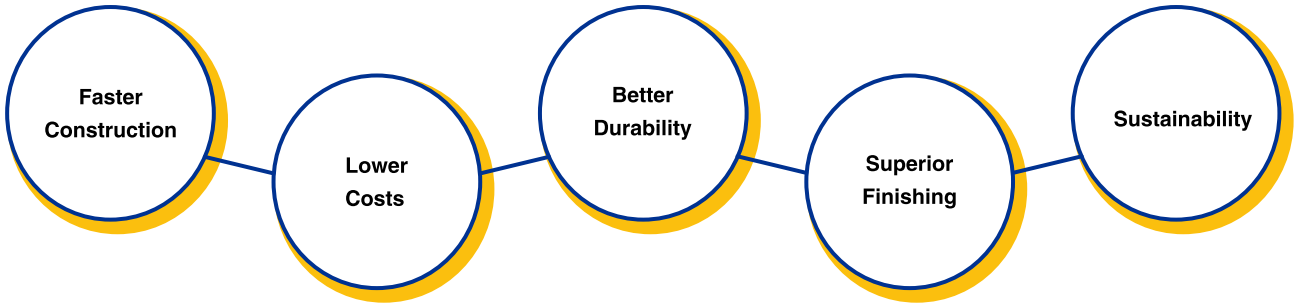
Flexible, lightweight and easy to install, this formwork system offers a cost-effective solution that produces high-quality work every single time. It is fast, simple, cost-effective and agile, as it creates all parts of the building at the same time, leading to superb dimensional accuracy and perfect fitting spaces in the construction site.

It has empowered the construction of all types of Reinforced Concrete Cement (RCC) structures including high-rise buildings, complex architecture and unique facades. It is also a system for scheduling and controlling the work of other construction trades such as steel reinforcement, concrete placement and mechanical and electrical conduits.

Fig 15. Aluminium Formwork Panels

Benefits of Aluminium Formwork Technology

Against the backdrop of efficiency, sustainability, affordable housing & other 21st-century developments, Aluminium Formwork is poised to be the mainstay construction technology. It's no surprise considering the wide array of benefits that it delivers.



3.1. Faster Construction

In the fast-paced world of real estate, where timing can make or break a deal, Aluminium Formwork can significantly reduce construction time and ensure faster project delivery. Aluminium Formwork Systems can reduce construction time by up to 2/3rd of the status quo. This is possible because:

Easy Assembly: The modular & intuitive fitting of different components of the Aluminium Formwork system inevitably makes the set-up & even the dismantling quick.

Simultaneous Casting: The simultaneous casting of walls/slabs in Aluminium Formwork Systems can reduce the slab cycles from the standard of 21 Days with conventional methods to just 7-10 Days.

Hasslefree Transition: The systems are designed in a way that makes floor-to-floor shifting of the different components an easy & hassle-free process.

Repeatability: Buildings/towers with identical floor & unit plans can use the same Aluminium Formwork for different floors. This integrated reusability especially helps in the construction of high-rise buildings & skyscrapers. Take for example the Burj Khalifa where Aluminium Formwork has been used in part for the construction of the approx. 830m tall architectural landmark.

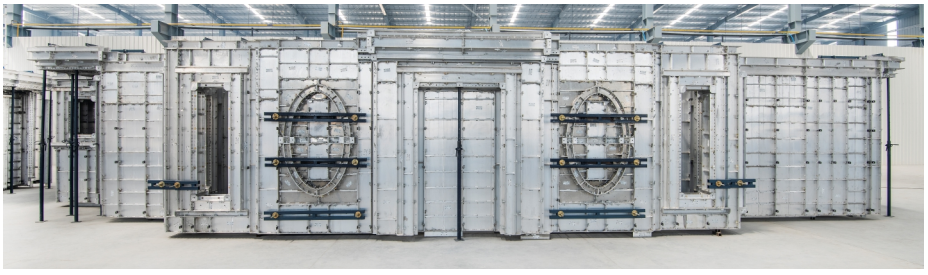


Fig 16. Aluminium Formwork System

Fig 17. High Rise Buildings

3.2. Lower Costs

Although the initial investment in Aluminium Formwork can seem high, it is only a small part of the overall project cost and offers long-term financial benefits vis-a-vis Capital Expenditure (CAPEX) and Operational Expenditure (OPEX). This is possible because:

Easy Assembly: As mentioned previously the system is modular & its set-up is intuitive. This reduces dependency on skilled workers and manual tasks can be performed by semi-skilled & even unskilled workers.

Lightweight Panels: The weight of the standard panel is less than 24kg and can be handled manually by labour on-site. This eliminates the need for large cranes for carrying & lifting.

Scrappage: Made out of aluminium, a material with significant circular recyclability, the formwork systems can fetch up to 60% in scrap value even after manifold use. This, however, can vary depending on the aluminium grade, use, & condition.

Reusability: The same formwork system can give up to 250 repetitions and can be reused across projects with necessary modifications & customizations. This makes Aluminium Formwork a long-term net positive investment when used correctly.

All the aforementioned results in a lower per square metre construction for Aluminium Formwork technology as compared to traditional methods.

Fig 18. Lightweight Aluminium Formwork Panel

3.3. Better Durability

The residential buildings made from Aluminium Formwork are stronger, safer & resilient to external environmental pressures such as earthquakes. This is possible because of:

Gold Standard Material: The use of structural grade aluminium such as 6xxx Series of Aluminium Alloy with great tensile strength, weather resistance & flexibility is recommended practice in Aluminium Formwork technology. This aids the long-term durability of the project structure.

Monolithic Construction: Due to its continuous nature, Reinforced Concrete Cement (RCC) structures made from Aluminium Formwork are free of bricks & joints. This minimises leakages & weaknesses.

Fig 19. Under-construction highrise building

3.4. Superior Finishing

Walls/Floors constructed using Aluminium Formwork are seamless, and smooth as compared to the relatively coarse surfaces of structures made using conventional formwork technologies. Further, the elimination of additional levelling & plastering with Aluminium Formwork not only saves time but also costs. This is possible because:

Industrially Produced Panels: The panels in Aluminium Formwork are industrially produced using assembly line infrastructure, robots and even specialised lacquering & buffing techniques. So, the final concrete surface is ready to be painted or tiled right after.

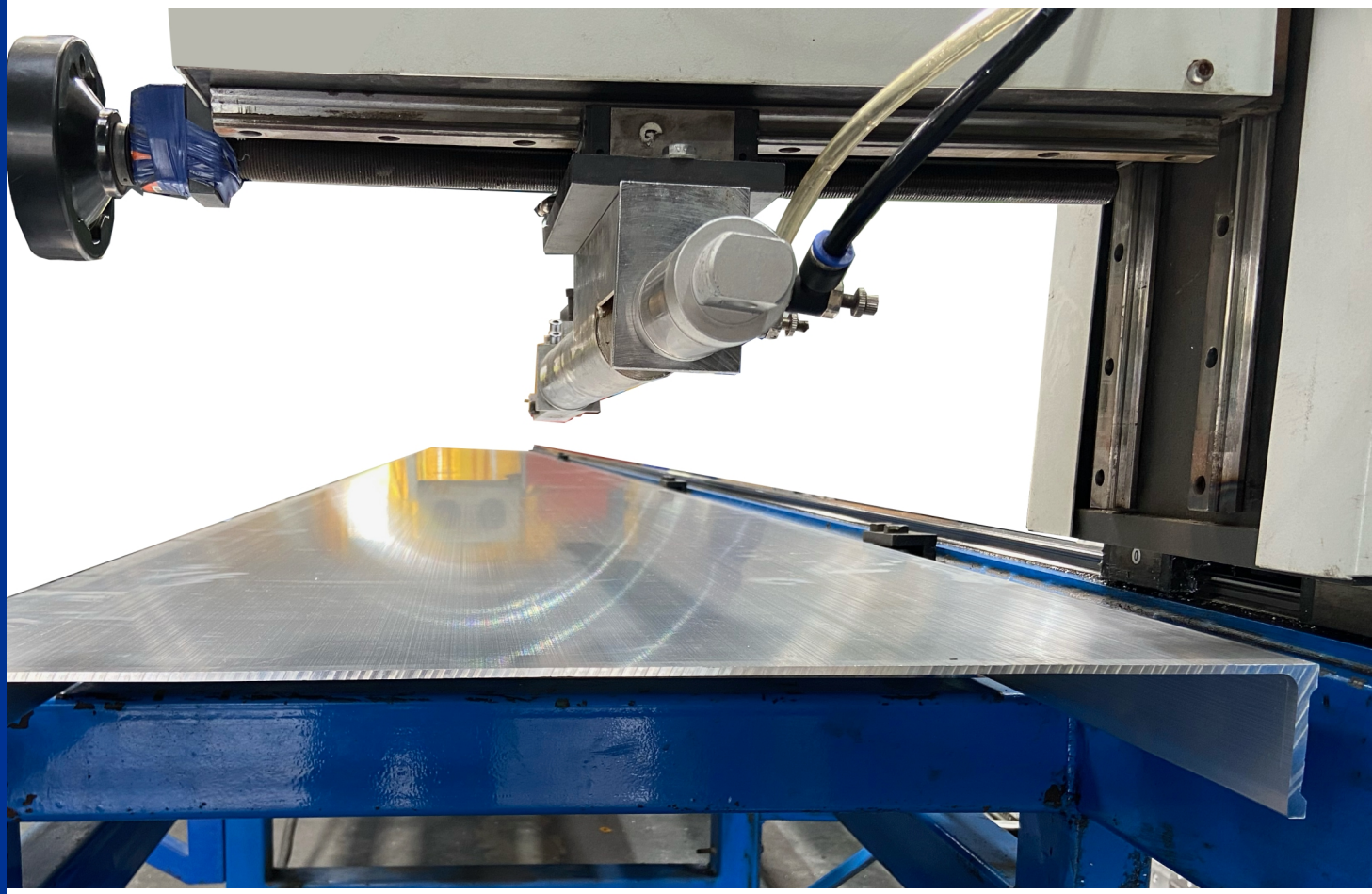


Fig 20. Aluminium Formwork Panel

3.5. Sustainability

Developers can adopt & promote sustainability in real estate development through the use of Aluminium Formwork solutions. Aluminium Formwork is a system of reusable panels and components that are used to create walls, floors, and other structural elements of a building. Compared to traditional construction methods, which often rely on timber formwork, Aluminium Formwork offers several benefits in terms of sustainability.

Less Timber: Aluminium Formwork reduces the demand for timber, which is a significant cause of deforestation worldwide. In India, timber is often sourced unsustainably, leading to the destruction of forests and loss of biodiversity. The use of Aluminium Formwork reduces the demand for timber, thereby preserving forests and their ecosystems.

3.5. Sustainability

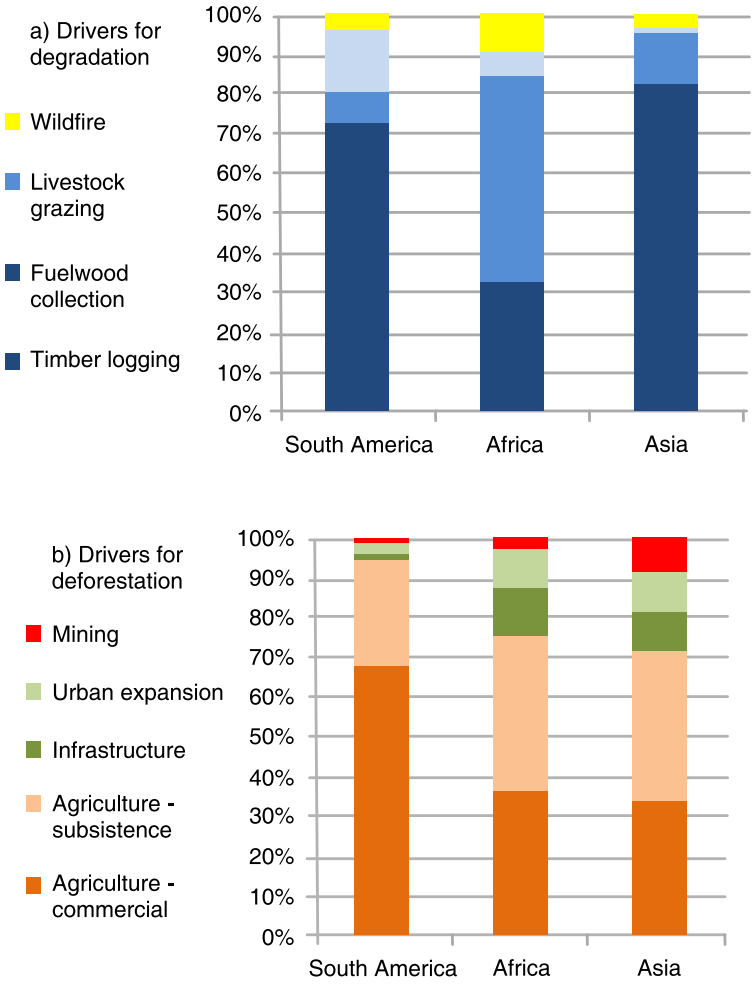


Fig. 21. Drivers for a) forest degradation and b) deforestation in developing regions | Source: Science Direct

Forest degradation refers to damage to forest 'quality' (vis tree density, biodiversity), but the damage is not associated with a change in land use and the forest is expected to naturally regrow. In contrast, deforestation refers to the reduction in forest area due to the conversion of forests (by complete removal of trees) into other land uses, and consequently, the forest is not expected to naturally regrow.

Data for 2000–2010. Adapted from Hosonuma et al. and Kissinger et al.

Less Waste: Aluminium Formwork results in less waste generation during construction, which is essential in India, where waste management is a significant challenge. Aluminium Formwork is reusable and durable, resulting in less waste generation during construction. This not only reduces landfill use but also saves resources by eliminating the need for new materials for each construction project.

Less Materials: Along the same lines, the superior ready-to-paint finish of Aluminium Formwork allows efficient use of river sand & other finishing materials. The Indian construction industry is one of the largest consumers of river sand, and its extraction has resulted in the depletion of groundwater and erosion of riverbanks. According to a study published in the International Journal of Engineering and Advanced Technology, using Aluminium Formwork systems can reduce the consumption of river sand significantly.

3.6. Comparison

While there is a lot of merit in every type of Formwork Technology, Aluminium Formwork emerges as the most reliable, cost-effective and sustainable solution. Here's an overview of the same:

Sr. No	Characteristics	Aluminium Formwork System	Conventional Formwork System
1.	Speed of Construction	7-10 Days Cycle Per Floor	Min Cycle Time is Of 15 Days
2.	Quality of Surface Finish	Plaster not required	Plaster is Required
3.	Pre-Planning of Formwork System	Required	Not Required
4.	Type of Construction	Cast-In Situ Cellular Construction	Simple RCC Framed Construction
5.	Wastage of Formwork Material	Very Less	In Great Amount
6.	Accuracy in Construction	Accuracy in Construction	Accuracy is Less than Modern Systems
7.	Coordination Between Different Agencies	Essential	Not Neccessarily Required
8.	Resistance to Earthquake	Good Resistance	Less Than Modern Systems
9.	Removing of Floor Slab Forms without Removing Props	Possible	Not Possible
10.	Need of Any Timber or Plywood	Not Required	These are The Main Components
11.	Re Usage Value of Formwork	Up to 250	Maximum 30
12.	Suitability for High Rise Construction	Very Much Suitable	Not Suitable
13.	Initial Investment In the System	High	Less
14.	Economy In Construction	Economical For Mass Housing	Economical on Small Scale
15.	Design Flexibility	Very Low Scope	High Scope
16.	Tower Crane	Not Required	Required For Tall Building
17.	Staff Required	Moderate	High
18.	Type of Labour	Moderate Skill	Skilled
19.	MEP + Kitchen Slabs	Simultaneously	After

Fig. 22 Comparison between Conventional & Aluminium Formwork System

To understand the most important parameter i.e. Effective Cost After Scrap & Recycling, we have used two examples:

Fig 22.1 Effective Cost Per Sq. Ft. After Scrap & Recycling (Stilt + 5 Floor)

	With Conventional Method	With Aluminium Formwork	Scan to see the detailed breakdown
Aluminium Structure Amount	10,41,03,682.30	9,75,19,800.00	
Saleable Area (In Sq. Ft.)	94430	94430	
Cost Per Sq. Ft.	1,102.44	1,032.72	
Scrap & Recycled Material Amount	0/Neglible	- 61,06,500.00	
Effective Cost Per Sq. Ft.	(Aluminium Structure Amount - Scrap & Recycled Material Amount / Saleable Area)		
Effective Cost Per Sq. Ft.	1,102.44	968.05	

Fig 22.2 Effective Cost Per Sq. Ft. After Scrap & Recycling (Stilt + 13 Floor)

	With Conventional Method	With Aluminium Formwork	Scan to see the detailed breakdown
Aluminium Structure Amount	13,02,76,154.98	12,87,49,678.69	
Saleable Area (In Sq. Ft.)	117000	117000	
Cost Per Sq. Ft.	1113.47	1100.42	
Scrap & Recycled Material Amount	0/Neglible	-1,91,08,094.00	
Effective Cost Per Sq. Ft.	(Aluminium Structure Amount - Scrap & Recycled Material Amount / Saleable Area)		
Effective Cost Per Sq. Ft.	1113.47	937.10	

4. More on Aluminium Formwork

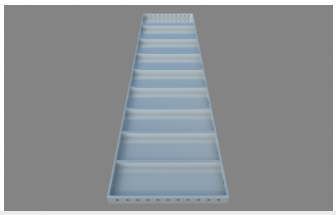
4.1. Components

There are thousands of components, small to big, in a complete Aluminium Formwork System. Each of these components commands special utility and importance in the system. We can divide them broadly into Aluminium Formwork Panels, Platform Brackets and Mild-Steel (MS) Accessories.

For your understanding, we have listed components & accessories from a standard Monolithic Aluminium Formwork System.

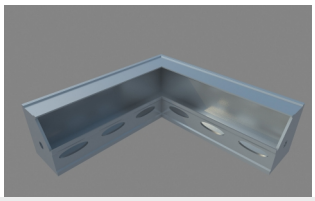
Aluform Components

Wall Panel



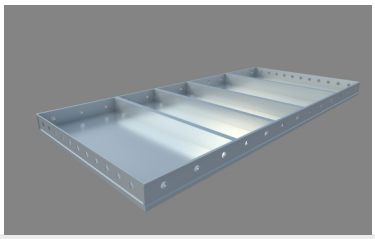
Details
Used for the walls of the formwork system
Specifications
100 to 600 x 2400 (Length x Breadth)

Soffit Corner (SC)



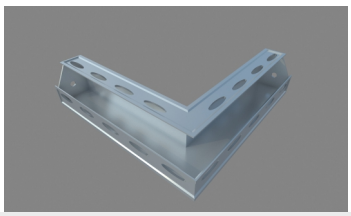
Details
Used to connect the wall panel and slab panel at the in-corner position

Slab Panel / Deck Panel



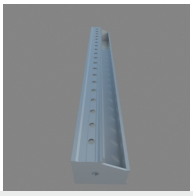
Details
Used for the walls of the formwork system
Specifications:
100 to 600 x 2400 (Length x Breadth)

Soffit Corner (SCE)



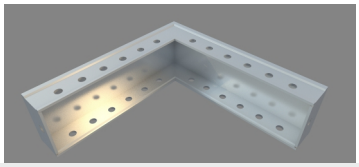
Details
Used to connect the wall panel and slab panel at the in-corner position

Soffit Length (SL)



Details
Used to connect wall & slab panels vertically

Kicker Corner (KC & KCE)

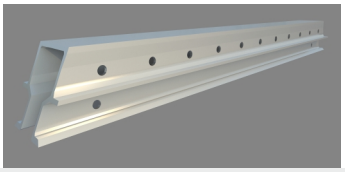


Details
Used to support the external wall panels for the next floor

4.1. Components

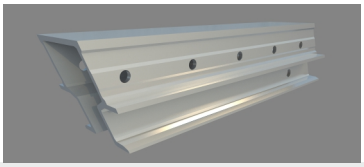
Aluform Components

Mid Beam



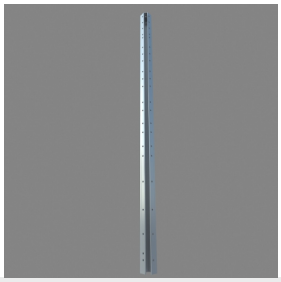
Details
Used to connect prop head and end beams

End Beam



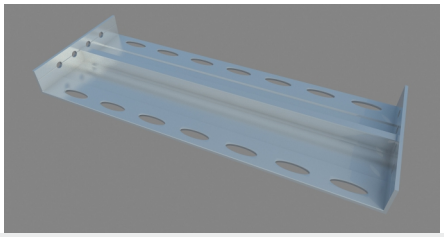
Details
Used to connect the wall panel and slab panel at the in-corner position

Incorner (IC)



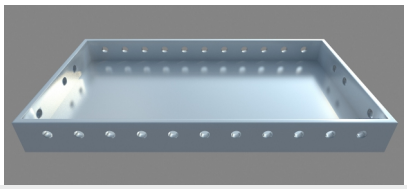
Details
Used for corners where two wall panels join

Plate Cover End (PCE)



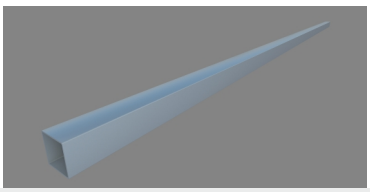
Details
Used to cover plate at beam bottom panel

T Panel



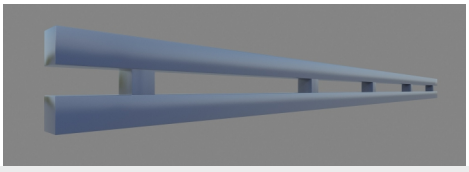
Details
Used between wall panels & slab panels

Alignment Waller



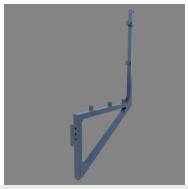
Details
Used for horizontal alignment of wall panels

Support Waller



Details
Used for additional support to the vertical formwork system

Aluform Bracket Type A (Wall)

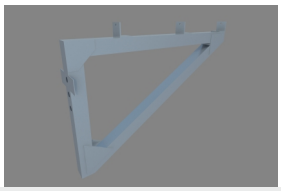


Details
Used as a substitute for scaffolding system to fix the working platform

4.1. Components

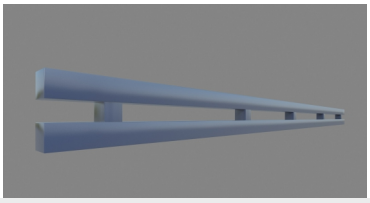
Aluform Components

Aluform Bracket Type B (Elevator)



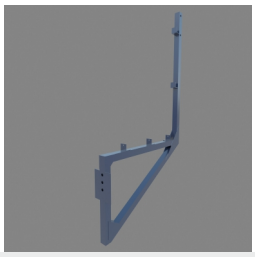
Details
Used as a substitute for scaffolding system to fix the elevator platform

Alignment Waller



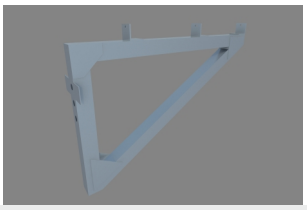
Details
Used for additional support to the vertical formwork system

Aluform Bracket Type A (Wall)



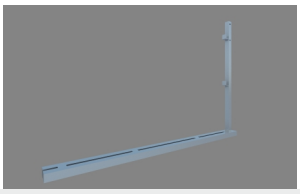
Details
Used as a substitute for scaffolding system to fix the working platform

Aluform Bracket Type B (Elevator)



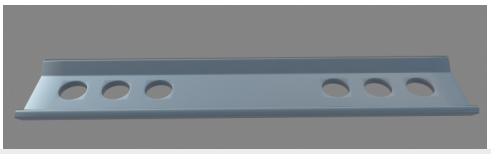
Details
Used as a substitute for scaffolding system to fix the elevator platform

Aluform Bracket Type C (Slab)



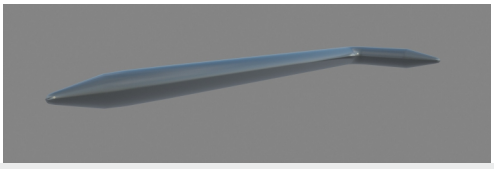
Details
Used as a substitute for scaffolding system to fix the slab platform

BKS Patti



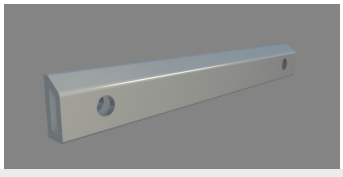
Details
Used for additional support to soldiers & stability to formwork system

Hole Bari



Details
Used to adjust & securely grip panels

Joint Bar

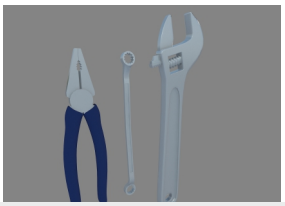


Details
Used to connect a prop head between middle and end beams

4.1. Components

Mild Steel Components - Accessories

Nose Piller & Spanner

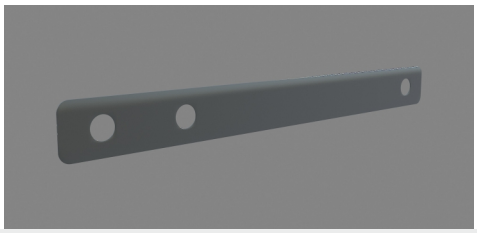


Details
Used for tightening nut bolts

Panel Puller

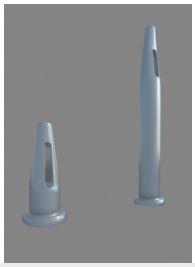
Details
Used to remove & adjust panels

Wall Tie



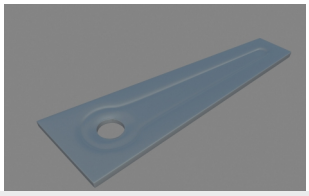
Details
Used to hold together opposite faces of wall panels

Pin & Long Pin



Details
Used to join different components together

Wedges

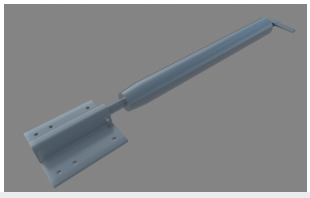


Details
Used with Pins to secure & tighten wall tie

Adjustable Prop

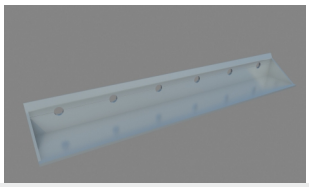
Details
Used to support horizontal & vertical formwork panels

Push Pull Prop



Details
Used to support & stabilise vertical formwork panels

Rocker

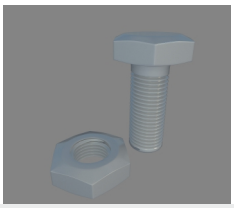


Details
Used for alignment & easy removal of wall panels

4.1. Components

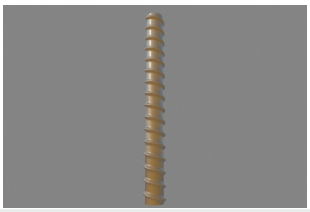
Mild Steel Components - Accessories

Rocker Nut & Bolt



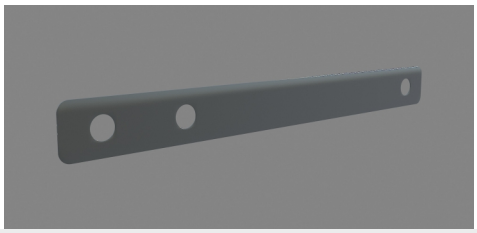
Details
Used to provide adjustable connections between panels

Tie Rod



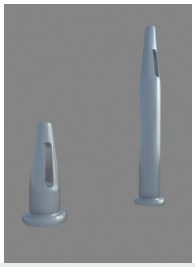
Details
Used to remove & adjust panels

Wall Tie



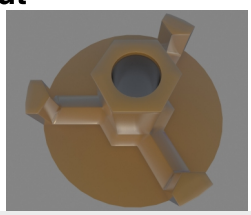
Details
Used to hold together opposite faces of wall panels

Pin & Long Pin



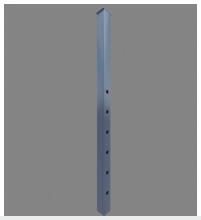
Details
Used to fix brackets on concrete surface

Wing Nut



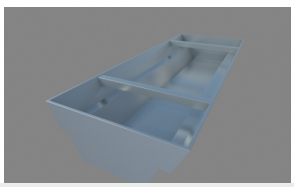
Details
Used with Tie Rods to tighten the brackets

VS Tube



Details
Used to support formwork components during construction

Transfer Box



Details
Used to transfer internal panels from one floor to another

Wall Tie Puller

Details
Used to remove wall ties from the concrete walls

4.2. Planning

4.2.1. How is aluminium formwork cheaper?

We have previously talked about the lower costs associated with building with Aluminium Formwork. Let's understand with an example how the per square metre cost of construction is significantly lesser for Aluminium Formwork than traditional methods.

Construction with Conventional Formwork

Formwork Cost	3000	Per Sq. m.		Design Factor	10.764
Formwork Cost	279	Per Sq. ft.			
Interest Cost	12%	P			
Buy Back Quantity	0	Per Sq. ft.		Buy Back Value	0
Total Slab Area	1100	Sq. m			
Total Slab Area	11840	Sq. ft.			
Total Formwork Area	41441	Sq. m.		Area Factor	3.5
Slab Cycle Time	15	Days			
Life	12	Nos.			

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Repetitions	12	24	36	48	60	72	84	96
Time in months	6	12	18	16	30	36	42	48
Formwork cost	11,550,000	23,100,000	34,650,000	42,350,000	57,750,000	69,300,000	80,850,000	92,400,000
Interest cost	693,000	2,772,000	6,237,000	6,776,000	17,325,000	24,948,000	33,957,000	44,352,000
Buy back value	-	-	-	-	-	-	-	-
Effective cost after buy back	12,243,000	25,872,000	40,887,000	36,421,000	75,075,000	94,248,000	114,807,000	136,752,000
Shuttering cost/repetition	1,020,250	1,078,000	1,135,750	758,771	1,251,250	1,309,000	1,366,750	1,424,500
Shuttering cost/sq.ft.	25	26	27	18	30	32	33	34

Fig. 23 Cost of Conventional Formwork with Long-term Use

4.2. Planning

4.2.1. How is aluminium formwork cheaper?

Construction with Aluminium Formwork

Formwork Cost	11000	Per Sq. m.		Design Factor	10.764
Formwork Cost	1022	Per Sq. ft.			
Interest Cost	12%	P			
Buy Back Quantity	307	Per Sq. ft.		Buy Back Value	30%
Total Slab Area	1100	Sq. m			
Total Slab Area	11840	Sq. ft.			
Total Formwork Area	41441	Sq. m.		Area Factor	3.5
Slab Cycle Time	10	Days			
Life	250	Nos.			

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Repetitions	12	24	36	48	60	72	84	96
Time in months	4	8	12	16	20	24	28	32
Formwork cost	42,350,000	42,350,000	42,350,000	42,350,000	42,350,000	42,350,000	42,350,000	42,350,000
Interest cost	1,694,000	3,388,000	5,082,000	6,776,000	8,470,000	10,164,000	11,858,000	13,552,000
Buy back value	12,705,000	12,705,000	12,705,000	12,705,000	12,705,000	12,705,000	12,705,000	12,705,000
Effective cost after buy back	31,339,000	33,033,000	34,727,000	36,421,000	38,115,000	39,809,000	41,503,000	43,197,000
Shuttering cost/repetition	2,611,583	1,376,375	964,639	758,771	635,250	552,903	494,083	449,969
Shuttering cost/sq.ft.	63	33	23	18	15	13	12	11

Fig.24 Cost of Aluminium Formwork with Long-term Use

Key Observation: In the tables above, approximate costs have been taken based on market reality. As you can see, for the construction of the same slab area and with the same formwork requirements, the effective cost per square ft with aluminium formwork is much less than conventional formwork.

Possible Additional Savings
Outside & Inside Plaster
Chiselling for Plumbing & Electrical
Debris Management
Kitchen Slab Support
Leakage & Repairs

Possible Additional Spending
Finishing & Plastering
Blockwork & Cracks in Blockwork
Chiselling for Plumbing & Electrical
Debris Management
Leakage & Repairs

Fig. No. 25 Outcome Comparison of Aluminium Formwork & Conventional Formwork

4.2. Planning

4.2.2 How to determine quantity?

The initial investment in aluminium formwork is sizable, this necessitates the right planning, and it starts with determining the right quantity.

The right quantity is determined by calculating the Concrete Contact Surface Area. Let's look at a sample process of calculating the total formwork required.

1) Lock project layout & plan.

2) Now from the plan we find out the number of wings/blocks in the project.

3) The wings/blocks are colour-coded to ascertain similarities and differences in design.

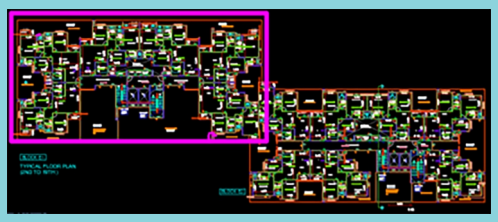
4) After deciding the types of systems needed, the 3D Design & subsequent extrusion of all relevant layouts are made.

5) Then from this the Total Area is calculated using special arithmetic formulas.

4.2.2 How to determine quantity?

Area Calculation For Flat - 1

Total Concrete Skin Area = 699.53 Sqm
Deduction for Top Surface = 112.41 Sqm
Deduction for Bottom Surface = 12.65 Sqm
Deduction for Common Surface = 23.3*2/3= 15.35 Sqm
Addition of Sunken = 4 Sqm
Shuttering Area = Total Concrete Skin Area - Deduction for Top Surface - Deduction for Bottom Surface - Deduction for Common Face + Addition Of Sunken
Shuttering Area = 699.53 – 112.41 – 12.65- 15.35 + 4
Shuttering Area = 563.12 Sqm = **563 Sqm**

(2-18TH) TYPICAL FLOOR - AREA STATEMENT (FULL SET)					
SR. NO	**DESCRIPTION**	**AREA**	**QTY**	**TOTAL**	**NOTES**
1	FLAT 1	563.00	3	**1689**	
2	FLAT 2	514.00	2	**1028**	
3	FLAT 3	548.00	1	**548**	
4	STAIRCASE 01	88.000	1	**88**	
5	STAIRCASE 02	143.00	1	**143**	
6	PASSAGE	303.00	1	**303**	
	TOTAL AREA			**3799.00**	
	5% EXTRA (Double set panels, grooves etc.)			**189.95**	**HEIGHT - 3.00 MTRS**
	REQUIRED APPROXIMATELY FORMWORK AREA			**3988.95**	**SQM**

Example-

Plan Area = Two Blocks (Block E1 & Block E2)
Flat 1 (Red) = 3 No.s
Flat 2 (Yellow) = 2 No.s
Flat 3 (Magenta) = 1 No.s
3D Extrusion of Flats, Staircase & Passage

Fig. No. 26

As a rule of thumb, you can determine the quantity of Aluminium Formwork required by multiplying the area of the project or plan area into 5.5. This will give you a rough idea of the area required. Note, that this is only valid if all walls, columns and windows are constructed using Aluminium Formwork.

Plan Area x 5.5 = Required Aluminium Formwork Area

4.2. Planning

4.2.3. How to maximise utility for a building?

The reusability of Aluminium Formwork systems is one of its most important feature benefits. From aid in faster construction to ROI to environmental sustainability, it is important for all.

Here's an example for you to understand how you can maximise its utility.

	PROJECT 1	PROJECT 2	
Area of Typical Floor	4100	3700	sqm
Floors	12	7	nos
Floor Changes	2	3	nos
Floor Height	2,900	2900	mm
Additional Area floor changes (3%)	246	333	sqm
TOTAL APPROX. AREA	4,346	4,033	sqm
Re-Usage (70%)		3,042	sqm
Additional Area after Reuse		991	sqm

Fig. No. 27

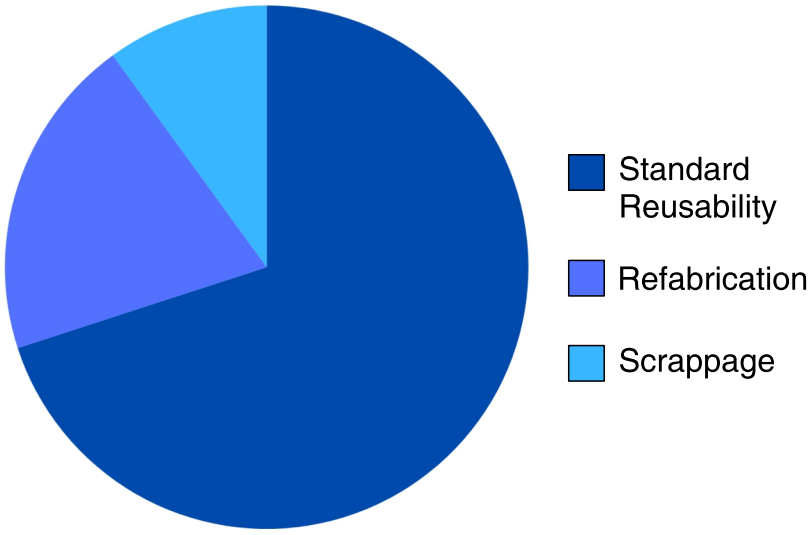


Fig. No. 27.1

As you can see, with 70% standard reusability, 20% refabrication and 10% scrappage the additional investment is minimal after accounting for variations in doors & windows of the second project.

4.3. Execution

4.3.1. Installation Tutorial

After all the thinking & all the planning, we reach the most crucial stage of all - the execution.

The on-site execution of Aluminium Formwork involves three stages:

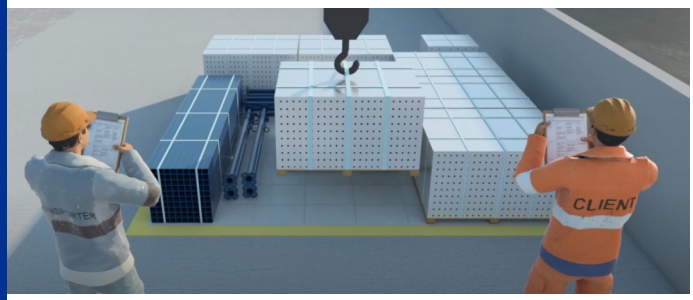
I) Pre Pouring

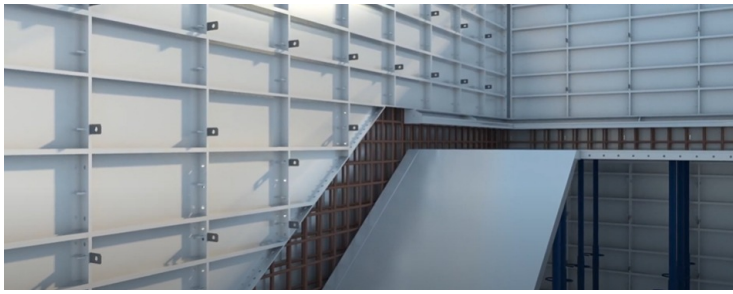
ii) During Pouring

iii) Post Pouring

The following video will give you a detailed & exhaustive walkthrough of the entire execution process.

Product Installation Film





4.3. Execution

4.3.2. How to assemble the first pour?

1. Generally 6 days slab cycle. For a 4-day cycle, all the supports (Props, Prop Heads) and safety system (External Brackets) have to be procured in 3 sets.
2. Adequate space for material stacking and sorting with security.
3. Formwork Release Oil/Form Oil or any other suitable releasing lubricant to be used.
4. Paint marking is to be applied as soon as the first mockup is done.
5. Grade slab (base slab) should be even for proper alignment & flatness.
6. Bins for collection of small accessories and to avoid losses/wastages.
7. Only SCC is to be used and no vibrators.

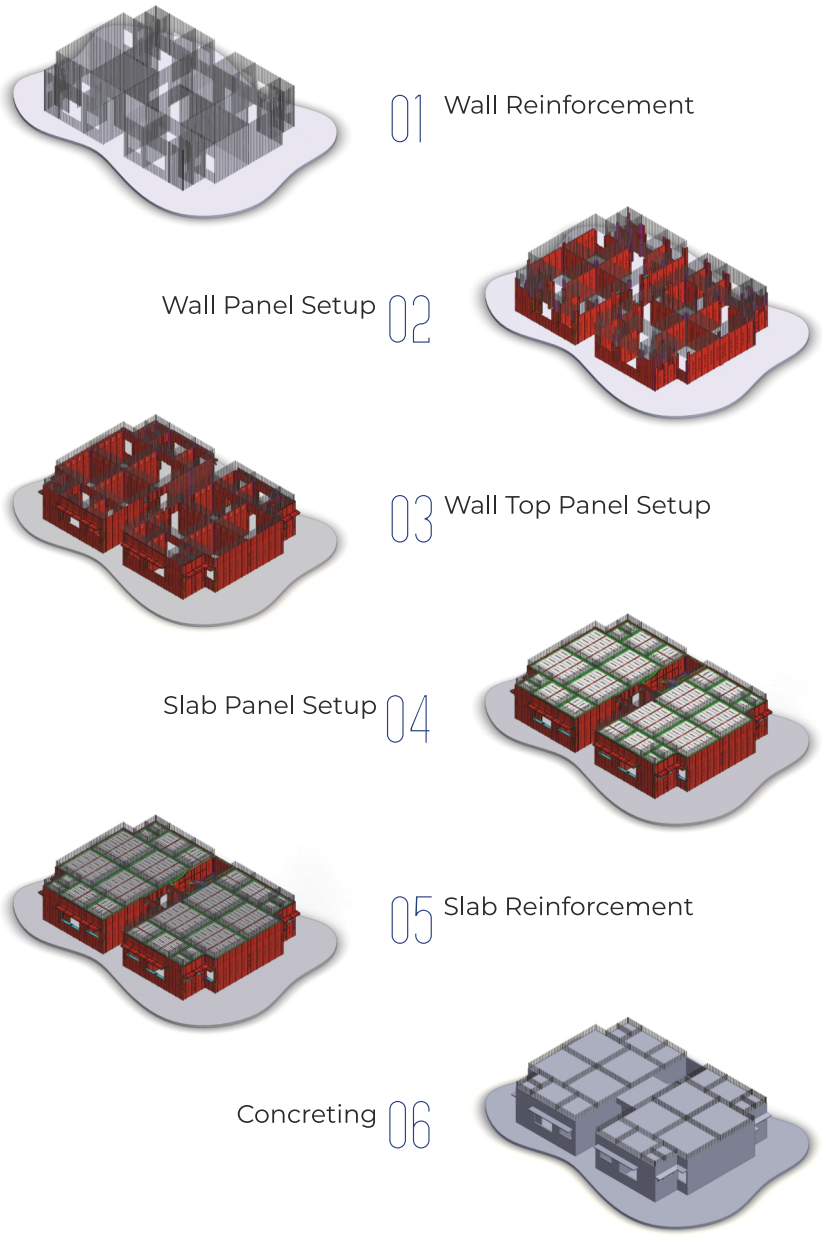


Fig 28. Overview of the assembly process

4.3. Execution

4.3.3. Precautions

Construction with aluminium formwork systems is fairly simple & intuitive. It can be executed with minimum training & supervision, however, certain precautions need to be followed to ensure the requisite final product.

Before Pouring Concrete

1. Check for straightness and verticality of the wall.
2. Check that the Wedge-pin and Wall-ties have been installed correctly.
3. Check for props spacing as per the formwork layout.
4. Check for external working platforms as per the formwork layout.
5. Check if shuttering oil has been applied on the slab panels.
6. Check for interlocking with all components.
7. The moulds should be dry and clean.
8. Any residues of rust and concrete must be removed.
9. Apply Form Oil on the concrete-facing side of the panel, covering the entire surface.
10. Use a spray gun with an operating pressure of 3-6 bar and a flat spraying nozzle to apply the oil.

It is recommended to use Self Compacting Concrete(SCC) on-site for best results.

While Pouring Concrete

1. The vertical rate of rise of concrete should not exceed 1.8 m/hr.
2. The height of liquid concrete in any wall should not exceed 1.8 metres at any given point in time. So if the wall is of 3-metre height – 1.5 metres are to be poured first – then after it hardens, the remaining 1.5 metres are to be poured.
3. Don’t dump or heap concrete in one area.
4. Use jet spray to keep panels clean while concreting.
5. Give gentle blows with a wooden mallet to avoid honeycombing on the concrete surface.

4.3. Execution

4.3.3. Precautions

After Pouring Concrete

1. Slab cycle can be from 7 days. De-shuttering can be done in 24 hours for walls and in 72 hours for slab.
2. After removing concrete scraps, apply Form Oil on the panels using a spray/roller, and gently remove the smaller concrete blocks.
3. Fill the Tie-Rod cavity with GP2 filling material.
4. Follow the same precautions from ‘Before Pouring Concrete’ when taking the panels/system to the next level.

4.3.4 Aluminium Formwork On-site


KUMAR PROPERTIES, PUNE


MY HOME, HYDERABAD


SIGNATURE GLOBAL, GURUGRAM


LODHA, PALAVA CITY


GODREJ, MUMBAI


GODREJ NIRVAAN, THANE


SHAPOORJI PALLONJI, VIJAYAWADA


PPG, PUNE


ACC UTALIKA, KOLKATA


MEGAPOLIS SERENITY, PUNE

5. Conclusion

5.1. Checklist: How to choose the best Aluminium Formwork?

The selection of the right aluminium formwork can make or break your project. Therefore, it becomes necessary to do an in-depth analysis of all available options and select the optimal option.

We have prepared a comprehensive checklist covering a range of parameters to help you pick the best provider. Get your pens out & start answering! Hope it helps.

Item	Recommendation	Rationale	Answer
Type Of Formwork	Aluminium Formwork	Ensures best-in-class Construction by providing efficiency from costs to quality	
Type Of Welding (1)	Friction Stir Welded (FSW)	Ensures minimal loss of tensile strength and gives a seamless finish	
Type of Welding (2)	Machine/Robotic Welding for Stiffeners	Ensures error-free precise welding of specific parts	
Material Quality	6xxx T6 Grade Aluminium	Ensures superior strength, long-term durability & unmatched flexibility	
Weight Per Sq. Mt	-/= 21 Kg (No single panel should be more than 25 Kg)	Ensures easy handling & less labour of panels while maintaining the same benefits	
Weight Handling Capacity Per Panel	+/= 3000 Kgs	Ensures ideal resistance to the pressure of poured concrete without hampering the structural integrity	
Reusability	150+ Repetitions	Ensures more utility out of each system & a positive Return-on-Investment (ROI)	
Turn-Around-Time (TAT)	-/= 75 Days	Ensures faster project delivery and quick in-quick out of projects	
Production Capacity	+/= 1,00,000 Sq. Mt. / Month	Ensures multiple clients & projects are catered to at any given point in time	
Size of Design Team	+/= 100 Designers	Ensures easy collaboration & hassle-free customizations at the planning stage	
Client Portfolio	100+ Clients	Ensures credibility, reliability & possibility of peer review	
Service	Dedicated Service Team	Ensures focused assistance throughout the project life cycle	
Execution	Expert Execution Team	Ensures guidance to the on-site team for easy adoption & usage	
Delivery Record	+/= 95%	Ensures trust & signifies a proven track record	

5.2. Conclusion

Real estate development is not just construction, it is an enabler of life. Just like lives are anchored on a home, real estate development is anchored on the plethora of methods & methodologies used in construction. Aluminium Formwork Technology is the method that empowers developers to be more efficient, scalable & sustainable. From speed of construction to durability of structure, from capital utilisation to labour productivity, from on-site efficiency to Return-on-Investment (ROI) and many more - by leveraging the benefits of Aluminium Formwork you can scale your enterprise.

Developers bring tangible impact to lives across the globe. Aluminium Formwork is the tech-forward, business-friendly and growth-focussed solution to help you continue bringing that impact.

5.3. FAQs

What is the cost of buying Aluminium Formwork?

The cost of buying Aluminium Formwork is dependent on several factors including project design, project location, architectural features, and so on. The cost is variable, however, it is important to focus on the Return-on-Investment (ROI) and not just the cost.

Do I need skilled labour to use Aluminium Formwork?

No. Unlike Plywood/Timber Formwork, Aluminium Formwork Systems don't need on-site creation & modification of panels. Aluminium Formwork panels are also handy & easy-to-handle. Therefore, they can be executed by unskilled & semi-skilled labour just by following the plan & with minimal supervision.

When to start MEP Work?

Mechanical, Electrical & Plumbing are indispensable to any construction. While using Aluminium Formwork Systems the MEP Process can start right after the Vertical Reinforcement Work with rebar.

What if I lose or break a part/component?

There are hundreds of components in an Aluminium Formwork System, each with its own utility. In case you lose/break a component, please reach out to your Aluminium Formwork provider for replacement. In emergencies, plywood can be used to compensate for the missing component. However, it should be done only after consulting with the RCC Consultant.

How do I transfer material from one floor to another?

Internal

The heaviest and longest i.e. full height wall panels can be carried up the nearest stairway. Passed up through void areas/openings on the slab.

External

Panels can be transferred via working platforms. Self-climbing systems can be used for this process.

Where do I store the material after my project site is completed?

The deshuttered material with accessories can be stored in a designated area within the active site, or any other area that you wish to. It is recommended to keep it undercover.

However, before storing the material, verify & segregate the material. Then stack using wooden packaging such as pallets in which they are delivered to you.

5.4. References

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5.5. Testimonial

"As an architect, I can confidently say that transitioning to aluminium formwork has been a game-changer in the way we approach construction projects. The precision and flexibility it offers have transformed our designs into reality with unparalleled efficiency and accuracy. The lightweight nature of aluminium formwork has not only streamlined the construction process but has also allowed for greater architectural creativity and innovation. Its versatility enables us to achieve intricate designs and complex geometries with ease, while its durability ensures the longevity of our structures. Overall, aluminium formwork has become an indispensable tool in our toolbox, enabling us to push the boundaries of architectural possibility and deliver exceptional results to the buildings."

I appreciate the remarkable effort in making this Whitepaper on Aluminium Formwork.

Ar. Vijay Kumar Jain

Proprietor V.K. JAIN
Associates Architectes & Interior Designer

"As a structural engineer, I've had the opportunity to work with various construction methodologies, and I must say, aluminium formwork stands out for its remarkable efficiency and versatility. Its lightweight yet durable nature facilitates swift assembly and disassembly, streamlining the construction process.

Aluminium formwork not only enhances the speed of construction but also ensures impeccable precision in structural elements. The system's rigid framework allows for consistent alignment, resulting in smooth finishes and minimal rework.

Additionally, its ability to withstand diverse environmental conditions and repetitive use makes it a sustainable choice for long-term projects.

From a structural perspective, aluminium formwork provides exceptional strength-to-weight ratio, ensuring robustness without compromising on agility. This feature is particularly advantageous in seismic-prone regions, where structures require both resilience and flexibility.

Overall, aluminium formwork has revolutionized the way we approach construction projects, offering a blend of efficiency, durability, and sustainability that aligns perfectly with modern engineering standards."

Dr. (Er.) Gaurav Rastogi

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