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Techno-Economic Comparison of Mivan Formwork and Conventional RCC Construction for a G+12 Building

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1. INTRODUCTION

The construction industry in India is experiencing unprecedented growth driven by rapid urbanization and an acute shortage of affordable housing. High-rise residential buildings — particularly those in the G+10 to G+15 range — represent the primary response to this challenge. In this context, the efficiency of the formwork system employed is among the most critical determinants of project cost, quality, and schedule.

Conventional formwork systems, which employ timber frames and plywood sheets, have served the industry for decades. Their primary advantage lies in adaptability to irregular geometries and low initial procurement cost. However, conventional timber formwork is limited to approximately 8–9 reuse cycles, demands high labor input for assembly and striking, and produces variable surface quality that often necessitates extensive plastering.

Mivan formwork — an advanced aluminum panel system developed by Mivan Company Ltd., Malaysia, in the early 1990s — presents a compelling alternative for large-scale repetitive construction. The system enables the monolithic, simultaneous casting of walls, slabs, beams, columns, and staircases in a single continuous concrete pour. This integrated approach produces a highly uniform, dimensionally accurate structure with superior resistance to seismic and environmental loads. Aluminum panels are engineered for 200–250 repetition cycles, dramatically reducing the per-floor formwork cost on large projects.

Despite its well-documented advantages, Mivan technology's adoption in India remains limited due to significant initial capital investment, the need for a trained workforce, and limited industry awareness. This study addresses these gaps by providing a rigorous, data-driven techno-economic comparison for a G+12 residential building, quantifying differences in structural material consumption, formwork economics, and labor productivity.

2. LITERATURE REVIEW

A substantial body of research has established the relative merits and limitations of Mivan and conventional formwork systems. Jangid et al. (2023) demonstrated that Mivan formwork achieves construction cycles of 4–7 days per floor and promotes environmental sustainability, since aluminum panels are 100% recyclable with high scrap value. Patel et al. (2022) observed that while conventional timber formwork degrades after only 8–9 cycles, Mivan panels sustain functionality for 250–300 cycles, virtually eliminating recurring formwork expenditure on large housing projects.

Kasegaonkar and Dhote (2024) undertook a three-way comparison of Mivan, conventional, and precast construction, concluding that Mivan delivers the best balance of time savings, structural quality, and long-term cost efficiency for mass housing. Hinduja et al. (2025) analyzed G+12 buildings in high seismic zones and confirmed that Mivan structures exhibit measurably lower storey displacement, reduced inter-storey drift, lower base shear, and higher lateral stiffness — all attributable to the monolithic wall-slab configuration.

Patekar and Shaikh (2023) quantified the productivity differential: Mivan reduced project duration from 364 days to 156 days while simultaneously lowering labor requirements and improving safety standards. Srivastava and Khan (2021)

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reported that aluminum formwork reduces overall construction time by 35–40% and can reduce structural costs by 20–25% on sufficiently large projects. Sharma and Mehta (2020) found cycle time reductions of 40–50%, achieving a seven-day slab cycle compared to the 21–28 day cycle typical of conventional construction.

Singh and Raj (2023) noted that Mivan's economic benefits diminish for non-repetitive or small-scale projects, and Joshi and Kulkarni (2024) highlighted barriers to adoption including shortage of skilled labor and limited industry awareness. These gaps motivate the present study's focus on quantifying the techno-economic trade-offs for a specific G+12 building project under Indian construction conditions.

3. METHODOLOGY

3.1 Building Configuration

The study building is a G+12 residential structure comprising eight symmetrically arranged apartment units per floor, centered on a common lift lobby and staircase core. Each floor has a typical built-up area of 300 sq.m. The floor plan geometry was held identical for both the conventional RCC and Mivan formwork models to ensure a directly comparable analysis.

3.2 Structural Analysis — STAAD.Pro

The conventional RCC framed structure was modeled as a three-dimensional moment-resisting frame using STAAD.Pro 2025, incorporating beams, columns, and slab elements with fixed supports at foundation nodes. Load combinations incorporating Dead Load (DL), Live Load (LL), Wind Load (WL), and Earthquake Load (EQ) were applied per IS code requirements. RCDC software was used to generate detailed Bar Bending Schedules (BBS) and Bill of Quantities (BOQ). The following Indian Standard codes governed the design:

- IS 456:2000 — Plain and Reinforced Cement Concrete
- IS 875 (Parts 1, 2, 3):2015 — Dead, Live, and Wind Loads
- IS 1893 (Part 1):2016 — Seismic Loads
- IS 13920:2016 — Ductile Detailing of RC Structures

3.3 Architectural Drafting — AutoCAD

AutoCAD 2025 was used to prepare the architectural and structural layouts for both construction systems. For the Mivan model, additional drawings were prepared including wall panel layouts, deck arrangements, sunken slab configurations, and staircase details, capturing the formwork system's unique panel nomenclature and assembly sequence.

3.4 Material Specifications

Both models used M30 grade concrete and Fe550 grade steel reinforcement. Column sections were 450 x 600 mm and beam sections were 300 x 450 mm for the conventional model. The Mivan model used continuous shear walls of 100 mm, 120 mm, and 160 mm thickness in lieu of discrete columns and masonry infills, with slab thicknesses ranging from 125 mm to 180 mm depending on span and loading conditions.

Table 1: Quantity Estimate and Direct Material Cost — Conventional vs. Mivan

Particulars	Qty (Conv.)	Cost Conv. (Rs.)	Qty (Mivan)	Cost Mivan (Rs.)
Concrete	1,782 cu.m	1,32,75,900	2,298 cu.m	1,71,20,100
Steel	191.25 MT	1,14,75,000	268.5 MT	1,61,10,000
TOTAL DIRECT COST	**—**	**2,47,50,900**	**—**	**3,32,30,100**

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Table 2: Key Design Parameters — Conventional RCC vs. Mivan Formwork

Sr.	Parameter	Conventional RCC	Mivan Formwork
1	Concrete Grade	M30	M30
2	Wall Thickness	230 mm	100 / 120 / 160 mm
3	Steel Grade	Fe550	Fe550
4	Slab Thickness	150 mm	125 / 150 / 180 mm
5	No. of Floors	G+12	G+12
6	Typical Floor Area	300 sq.m	300 sq.m

4. RESULTS AND DISCUSSION

4.1 Increased Material Costs — Reinforcement and Concrete

The Mivan system's monolithic shear wall methodology replaces the conventional column-beam frame and masonry infill walls with continuous, fully reinforced concrete walls cast in a single operation. While this eliminates brick and block masonry entirely, it substantially increases the total volume of concrete and the density of steel reinforcement throughout the structure. The quantitative impact is significant:

- Steel consumption increased from 191.25 MT (conventional) to 268.5 MT (Mivan) — a 40.39% increase — raising reinforcement costs from Rs. 1,14,75,000 to Rs. 1,61,10,000.
- Concrete consumption rose from 1,782 cu.m to 2,298 cu.m — a 28.96% increase — raising concreting costs from Rs. 1,32,75,900 to Rs. 1,71,20,100.

These increases are a direct and expected consequence of the Mivan system's structural logic. The shear walls perform the load-bearing function of both the conventional columns and the brick infill panels; accordingly, higher material consumption reflects a structural necessity, not an operational inefficiency.

4.2 Dramatic Reduction in Formwork (Shuttering) Costs

The most striking economic benefit of Mivan formwork lies in the sharply reduced cost of shuttering when evaluated over the full project life cycle. Conventional timber formwork, limited to approximately 8 reuse cycles, incurred amortized shuttering costs of Rs. 44,44,890. Mivan aluminum panels, engineered for up to 200 repetitions, reduce this to Rs. 50,175 — a reduction of approximately 91%. This comparison fairly reflects how the two systems should be economically evaluated: the high initial procurement cost of the aluminum formwork set is amortized across a large number of floor pours, whereas conventional timber must be substantially replaced after every 8 uses. For any project with a sufficiently large number of repetitive floors, the per-floor formwork cost of the Mivan system is dramatically lower.

4.3 Significant Savings in Labor Costs

Mivan formwork's modular panel system, with standardized connection hardware, allows trained crews to erect and strip a complete floor formwork assembly far faster than conventional timber methods. This efficiency translated directly into reduced labor consumption:

- Total man-days fell from 15,613 (conventional) to 9,257 (Mivan) — a reduction of 40.7%.
- Skilled labor requirements dropped from 7,505 to 4,580 man-days; unskilled labor from 8,108 to 4,677 man-days.
- Total labor cost was reduced from Rs. 1,08,38,650 to Rs. 64,65,350, achieving a saving of Rs. 43,73,300.

This labor reduction has implications beyond direct cost savings. Faster formwork cycles translate to accelerated project schedules, reducing overhead costs, financing charges, and the period of capital lock-up.

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Table 3: Shuttering and Labour Cost Comparison

Cost Head	Conventional (Rs.)	Mivan (Rs.)
Shuttering – Total (amortised over repetitions)	44,44,890 (8 repetitions)	50,175 (200 repetitions)
Labour – Skilled	63,79,250 (7,505 man-days)	38,93,000 (4,580 man-days)
Labour – Unskilled	44,59,400 (8,108 man-days)	25,72,350 (4,677 man-days)
Total Labour Cost	**1,08,38,650**	**64,65,350**

4.4 Overall Economic Position

Table 4 consolidates all cost heads and presents the net economic position. When shuttering and labor savings are factored in alongside the higher direct material costs, the Mivan system demonstrates a net cost advantage of approximately Rs. 36,00,464 over the conventional method for this G+12 project.

Table 4: Comprehensive Cost Comparison — All Cost Heads

Material / Cost Head	Conventional (Rs.)	Mivan (Rs.)	Difference (Rs.)
Reinforcement	1,14,75,000	1,61,10,000	−46,35,000
Concreting	1,32,75,900	1,71,20,100	−38,44,200
Foundation	15,12,573	15,12,573	Equal
Shuttering	44,44,890	50,175	+5,05,436 (saving)
Labour	1,08,38,650	64,65,350	+43,73,300 (saving)
NET DIFFERENCE	**—**	**—**	**−36,00,464 (Mivan advantage)**

The overall direct structural cost of Mivan is approximately 9.5% higher than conventional construction when only material and execution costs are considered. However, this premium is more than offset when the full cost picture — including amortized formwork and reduced labor — is taken into account. Furthermore, this analysis excludes the additional financial benefit of faster project completion, which typically reduces overhead, interest on working capital, and site management costs substantially.

5. CONCLUSION

This study has conducted a rigorous techno-economic comparison between Mivan aluminum formwork and conventional RCC construction for a G+12 residential building. The following principal conclusions are drawn:

- The G+12 conventional RCC framed structure was successfully modeled, analyzed, and designed using STAAD.Pro under dead, live, wind, and seismic loads per IS 456:2000, IS 875, IS 1893:2016, and IS 13920:2016.
- Mivan technology produces a monolithic structure offering superior dimensional accuracy, better surface finish, and enhanced structural integrity compared to conventional brick-and-beam construction.
- Mivan requires 40.39% more capital for steel and 28.96% more for concrete — structured costs reflecting the shear wall system's load-bearing logic.
- Aluminum formwork's 200-cycle reusability reduces amortized shuttering costs by nearly 91% compared to conventional timber shuttering limited to 8 cycles.
- Labor efficiency gains reduce total man-days by 40.7%, cutting labor costs by over Rs. 43 lakhs.
- The net economic position favors Mivan by approximately Rs. 36 lakhs when all cost heads are considered for this project scale.
- Mivan formwork is the preferred choice for large-scale, repetitive, high-rise residential construction. Conventional formwork remains the more practical option for smaller or architecturally irregular structures.

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5.1 Future Scope

- Life-cycle cost and sustainability assessment — carbon footprint, recyclability, and long-term maintenance comparison.
- BIM integration — combining Mivan layout planning with Building Information Modeling for enhanced coordination and clash detection.
- Adaptability for smaller projects — investigation of hybrid formwork systems combining Mivan panels with conventional elements.
- Seismic performance — comparative nonlinear pushover analysis under IS 1893 Zone IV and Zone V demands.
- Skill development — structured training programs to address the specialized labor requirement limiting Mivan adoption in India.

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