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COST-EFFECTIVE STUDY OF G+3 CONVENTIONAL AND MIVAN STRUCTURES

Ashok Y. Kankuntla[1], Padma Govindraj Mahendra[2], Abhangrao Parth Sunildatta[2], Padma Rushikesh Mahendra[2], Chavan Suraj Valu[2]

[1] Assistant Professor, Department of Civil Engineering; N. K. Orchid College of engineering and Technology, Solapur 413002, Maharashtra, India

[2] B.Tech Civil Engineering Students; N. K. Orchid College of engineering and Technology, Solapur413002, Maharashtra, India

Abstract

The economic viability of construction systems for low-rise multi-storey housing depends on structural material quantities, construction sequencing, finishing costs and the number of repeated floor plates. This paper revisits an undergraduate G+3 residential-building report containing a 16-flat architectural plan, STAAD.Pro models, gravity/seismic/wind loading illustrations, quantity take-offs and Microsoft Project schedules. The documented conventional alternative is an M20 reinforced-concrete frame with 300 × 600 mm columns, 230 × 450 mm beams and a stated 150 mm model slab. The report's second analysed alternative is a prefabricated structural-steel/deck system, not a Mivan wall–slab system; the two are therefore separated rather than conflated. The source reports conventional/prefabricated concrete volumes of 373/225.4 m³, steel quantities of 22.70/66.53 tons and programme durations of 255/179 days. Its project-level scheduled costs are ₹103.56/₹75.01 lakh. The report also presents per-flat figures that do not reconcile with those project totals, requiring an explicit cost-base audit before empirical publication. Using this report as a defined geometric and loading baseline, the paper specifies the additional modelling, bills of quantities, tender rates and formwork-allocation data necessary to evaluate a genuine Mivan monolithic RCC alternative. A break-even expression for reusable aluminium formwork shows why costs cannot be transferred from the documented prefabricated option to Mivan. The contribution is a transparent, reproducible comparison framework together with an evidence audit of the available G+3 case.

Keywords: G+3 housing; conventional RCC; Mivan; aluminium formwork; STAAD.Pro; construction cost; schedule; prefabrication; formwork reuse.

1. Introduction

Four-storey housing projects commonly repeat the same floor plan, but repetition alone does not establish the economy of a proprietary formwork system. Conventional reinforced-concrete frames carry floor actions through slabs, beams, columns and foundations; masonry partitions are generally accounted for separately. In a typical Mivan-type monolithic alternative, engineered aluminium panels form concrete walls and floor slabs in coordinated pours. Consequently, its structural load path, concrete distribution, foundation reactions, openings and work programme require independent design rather than a change of formwork rate within the original RCC estimate.

The supplied undergraduate report evaluates conventional RCC and a prefabricated steel-frame/deck option for a 16-flat G+3 arrangement. Although it introduces aluminium formwork, it does not provide the STAAD.Pro model, reinforcement take-off, formwork procurement price or execution

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schedule for a separately designed Mivan building [1]. Its conventional model nevertheless supplies useful plan and loading evidence for defining such a study. Here, “source result” denotes a value transcribed from [1], “derived result” denotes arithmetic on those values, and “proposed Mivan analysis” denotes work for which numerical project evidence has not yet been furnished.

2. Review of related work

Jaillon and Poon [2] documented the evolution of precast residential systems, providing context for repeatable housing geometries. Jaillon, Poon and Chiang [3] reported waste reduction associated with prefabrication in sampled Hong Kong projects; that finding concerns off-site precasting and is not automatically a measured result for aluminium formwork on this G+3 site. Ansari and Kudale [4] compared Mivan and conventional formwork in a G+21 case with different saleable floor areas, highlighting the importance of normalising the functional unit before drawing cost conclusions. A 2025 comparison of aluminium and tunnel formwork [5] likewise treats repetitions, initial investment and programme as central economic variables. Those studies motivate a floor-cycle and whole-building cost analysis, while their building heights, locations and procurement conditions must not be treated as project measurements for this G+3 case.

3. Case-study description and source evidence

3.1 Architectural plan and functional unit

The source plan provides 16 flats over four levels (ground plus three upper storeys), corresponding to four planned flats per level. The proposed Mivan comparison must retain the same plot, footprint, total built-up area, usable area, circulation and housing specification, or document every change. The report does not supply a reliably reconciled built-up-area denominator in its reported price-per-square-foot results.

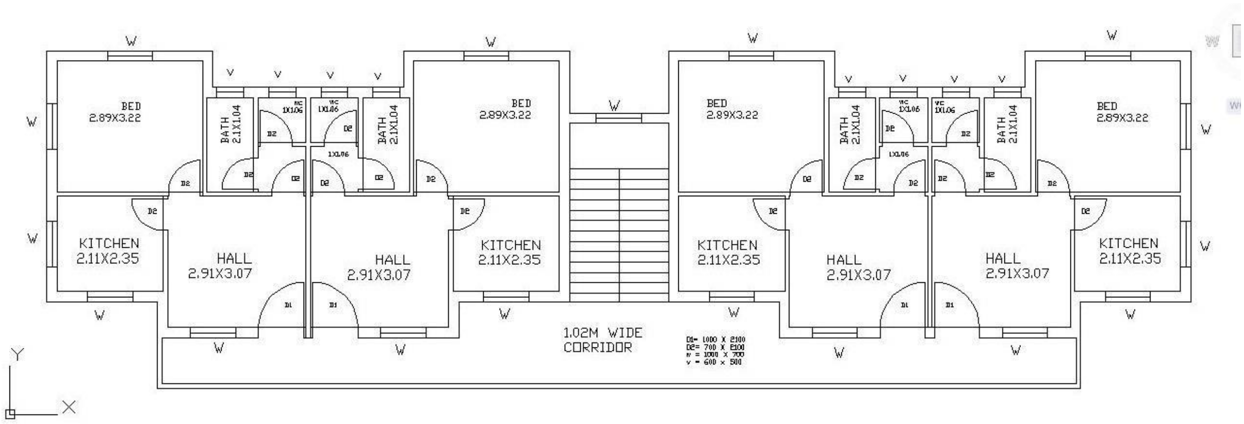
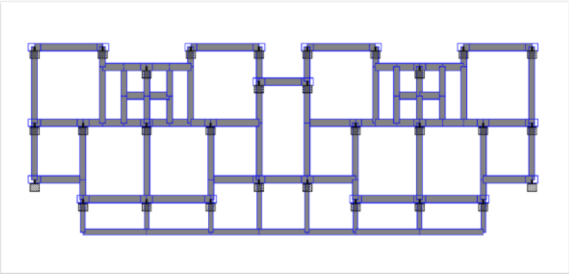


Figure 1. Typical G+3 residential plan used for the conventional and prefabricated Structure

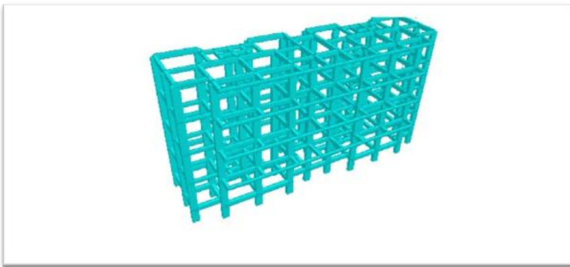
3.2 Structural Systems

System	Structural details
Conventional RCC	300 × 600 mm RCC columns; 230 × 450 mm beams; stated 150 mm model slab; M20 concrete; Fe415 reinforcement; RMC.

System	Structural details
Prefab steel/deck	230 × 230 × 8 mm square tubular columns; ISMB 225/175 beams; 100 × 100 × 5 mm bracing; stated 125 mm slab; M20/Fe415 in concrete work.
Proposed Mivan	Cast-in-place monolithic RCC wall–slab system using reusable aluminium panels; openings, thicknesses and reinforcements to be designed.



(a) Conventional analytical plan



(b) Conventional 3D STAAD.Pro frame

Figure 2. Structural idealisation of the documented G+3 conventional RCC case

4. Loading and Structural analysis

4.1 Documented actions and input parameters

The source states residential live loading of 3 kN/m² and floor-finish loading of 1 kN/m² in its representative slab calculation; it shows a two-way slab panel of 2.83 × 3.22 m. The authors describe gravity, earthquake and wind actions in two horizontal directions, with load combinations said to follow Indian Standards [1]. Numeric seismic zone, importance and response parameters, site-specific wind speed, soil type, combination tables and full STAAD.Pro output are not included in the material supplied here. Accordingly the loading images evidence the modelled action categories, not independent confirmation of design adequacy.

Item	Value reproduced from [1]	Interpretation
Configuration	G+3; 16 flats	Fixed case-study functional unit
Columns / beams	300 × 600 / 230 × 450 mm	Conventional model sections
Concrete / reinforcement	M20 / Fe415	Report-stated grades; verify current design requirements
Model slab / manual slab calculation	150 mm / 110 mm	INCONSISTENCY: recalculate loads, actions and take-off
Representative slab	2.83 × 3.22 m	Reported two-way slab panel

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Item	Value reproduced from [1]	Interpretation
Live / finish load	3 / 1 kN/m²	Reported slab inputs; occupation/roof areas need separate checks
Lateral actions	Earthquake and wind in X and Z	Source figures; values/combinations not recoverable

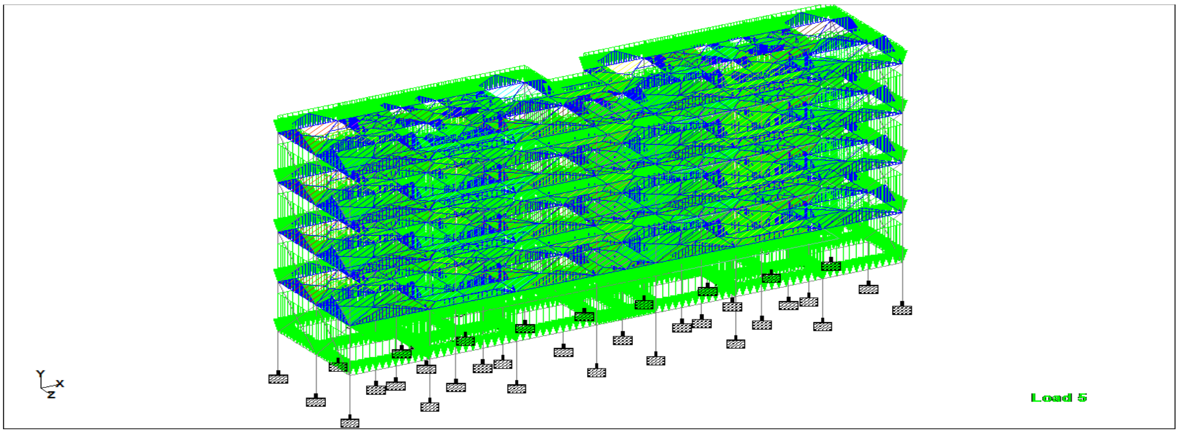
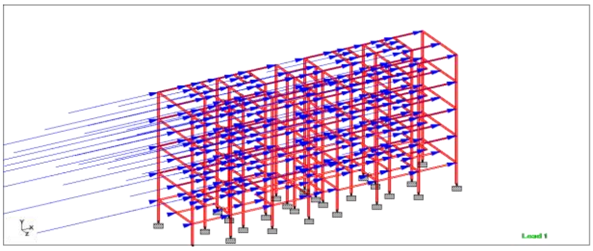
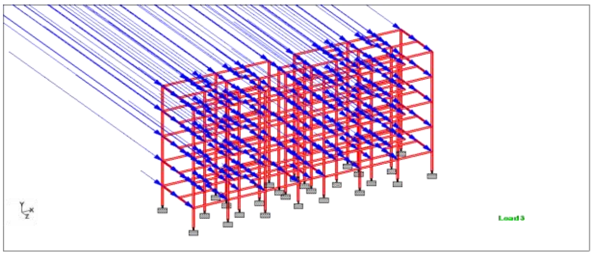


Figure 3. Gravity-loading view from the conventional STAAD.Pro mode.

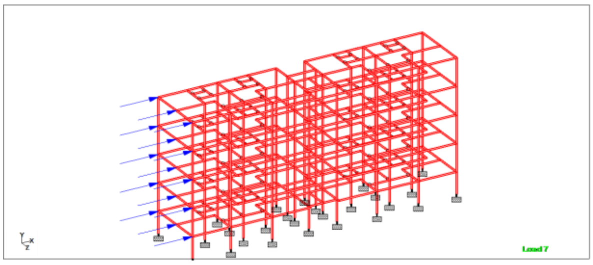


(a) Earthquake action, X direction.

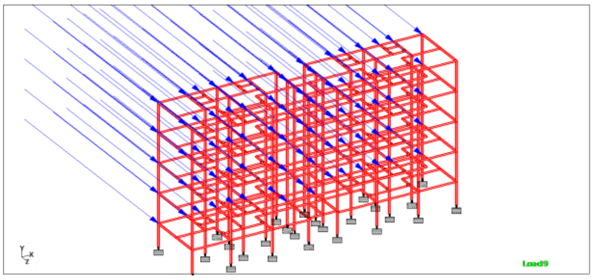


(b) Earthquake action, Z direction.

Figure 4. Source seismic-loading views for the conventional case



(a) Wind action, X direction.



(b) Wind action, Z direction.

Figure 5. Source wind-loading views for the conventional case.

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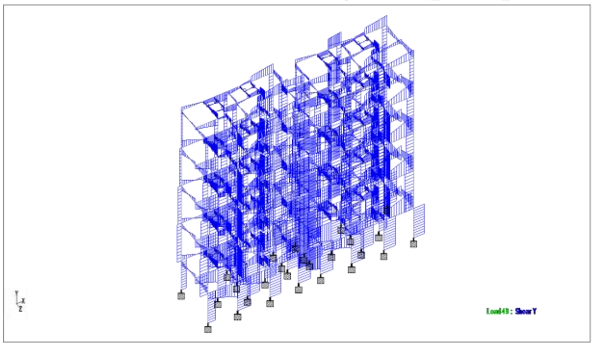
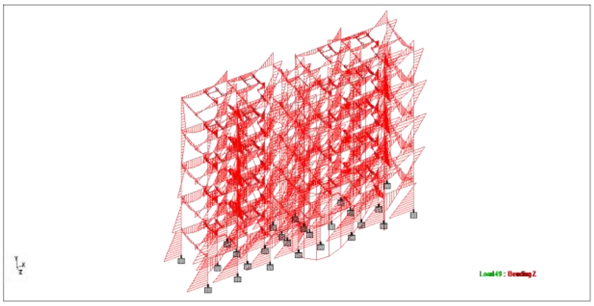
4.2 Structural Interpretation and Required Mivan Analysis

The uploaded report also includes shear-force and bending-moment screenshots for the RCC model (Figure 6), but does not provide an auditable member-force schedule or comparable Mivan shear-wall results. Its manual conventional footing example reports a 1258 kN maximum shear/force entry, 140 kN·m moment and a selected 2.0 × 2.4 m footing. These values should be treated as source-design entries requiring re-check: the footing arithmetic and units contain inconsistencies, and copying the same footing into an alternative structural system is not a verified foundation design.



(a) Conventional source shear-force view.



(b) Conventional source bending-moment view.

Figure 6. Analytical Output

For a defensible Mivan model: retain the architectural grid and locations of openings; select structurally designed RCC wall and slab thicknesses; account for stair/lift-core walls and diaphragm assumptions; apply the same current-code site hazards and area loads; model wall–slab connectivity and foundation interaction; and tabulate storey shear, drift, displacement, member/wall actions, reinforcement and reactions. The engineer must verify the applicable BIS editions at submission and design approval, including IS 456, IS 875 Parts 1–3 and the applicable IS 1893 provisions [6].

5. Quantity, cost and programme extraction

5.1 Consistent comparison basis

For each system, construction cost should include foundations, superstructure, partitions or concrete walls, finishing, shutters, procurement, handling, plant, labour, services, wastage, preliminaries and taxes on an identical specification and price date. Land, financing, occupancy acceleration and salvage should be either consistently included or separately reported. The original source provides both MSP project cost totals and a different set of flat/unit prices; they are retained as separate reported measures rather than silently reconciled.

Cproject = Σ (measured quantityi × installed ratei) + temporary works + preliminaries

Cost per flat = Cproject ÷ 16; Cost per m² = Cproject ÷ same verified total built-up area

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5.2 Original project-level quantities and time

Source quantity	Conventional RCC	Prefab steel/deck	Derived change (prefab vs conventional)
Concrete	373.0 m³	225.4 m³	−147.6 m³ (−39.6%)
Steel	22.70 t	66.53 t	+43.83 t (+193.1%)
Project duration	255 days	179 days	−76 days (−29.8%)
MSP project total	₹103.56 lakh	₹75.01 lakh	−₹28.55 lakh (−27.6%)

Percent changes are calculated on the conventional value. The increase in steel reflects the reported structural-steel/deck alternative and cannot be assigned to Mivan RCC walls.

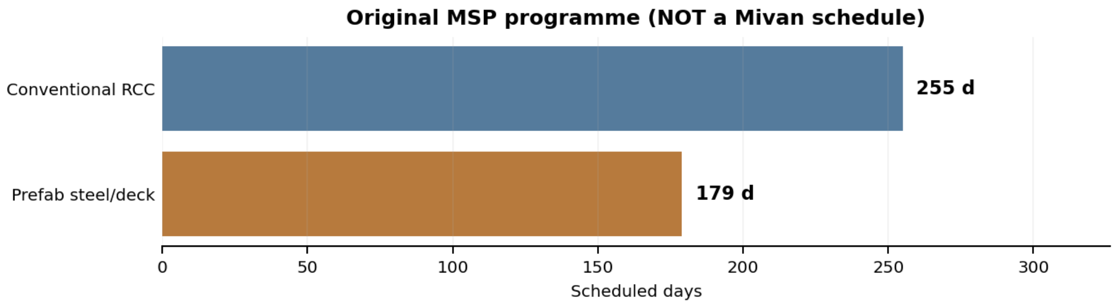

Figure 7. Original report project programmes; calculated difference = 76 days (prefab versus conventional only).

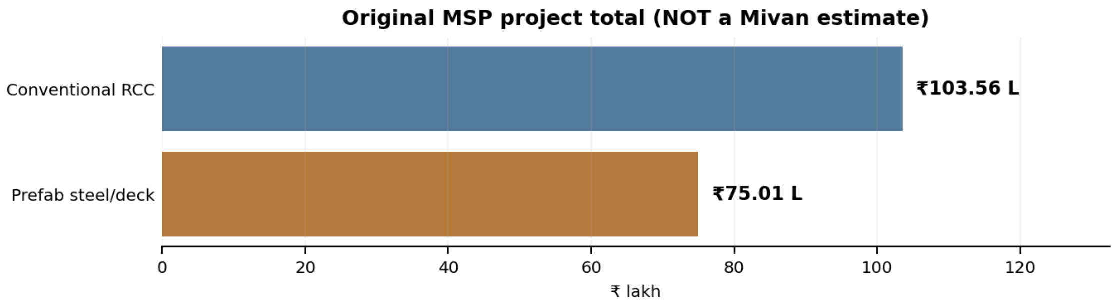

Figure 8. Original MSP project totals, plotted without inflation updating (prefab versus conventional only).

5.3 Reported Unit Prices and Reconciliation Audit

Cost measure [1]	Conventional RCC	Prefab steel/deck
cost/flat	₹5,06,485.20	₹4,26,688.30
cost/ft²	₹1,400	₹1,200
MSP total ÷ 16	₹6,47,235.64	₹4,68,793.24

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Cost measure [1]	Conventional RCC	Prefab steel/deck
Discrepancy per flat	₹1,40,750.44	₹42,104.94

The MSP projects list ₹1,03,55,770.24 for the 255-day conventional programme and ₹75,00,691.84 for the 179-day prefabricated programme. Dividing each by the stated 16 flats yields the values above.

5.4 Material-quantity comparison

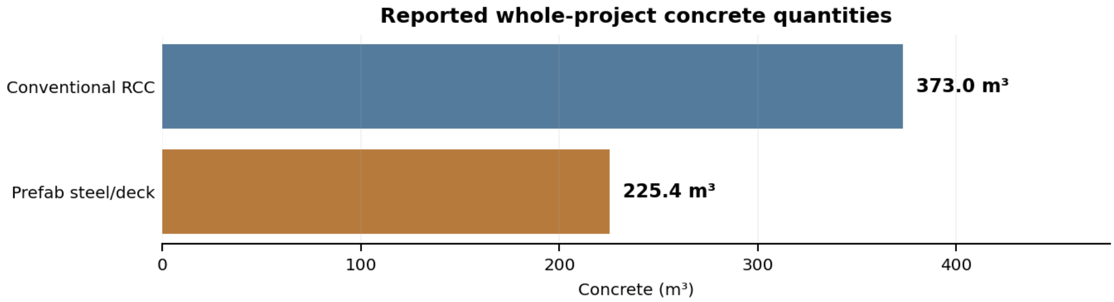


Figure 9. Project-level concrete quantities

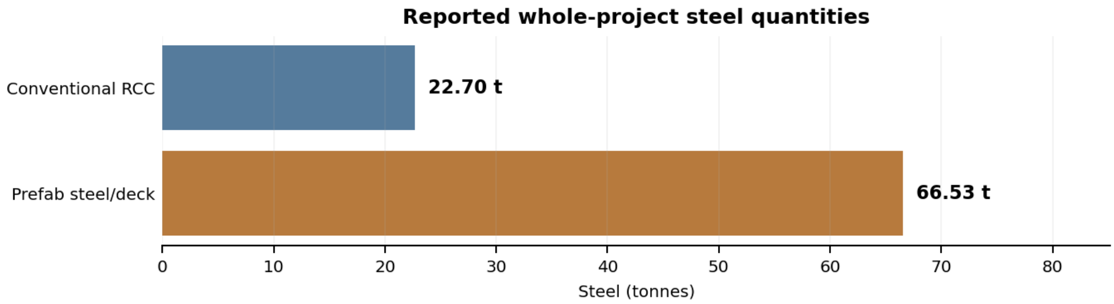


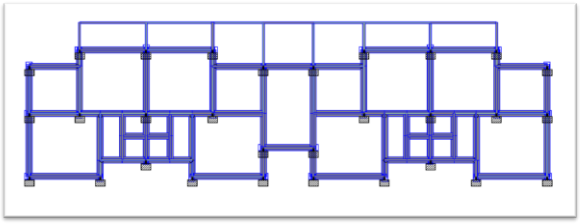
Figure 10. Project-level steel quantities; categories of rebar and structural steel should be itemised.

Concrete use is lower and steel tonnage higher in the documented prefabricated model; however, the physical substitution of steel frames and decking for an RCC frame is not a proxy for aluminium shuttering. An actual Mivan comparison needs separate RCC wall/slab concrete, rebar, embedding, formwork, and partition-replacement quantities.

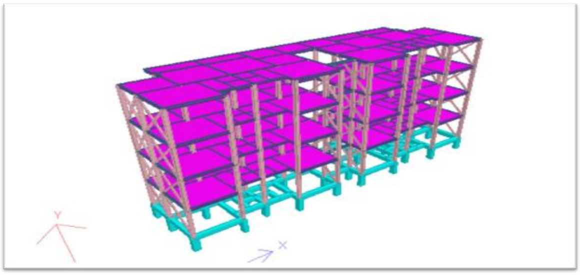
6. Developing the Mivan alternative on the same G+3 plan

6.1 Structural and geometric equivalence

On Figure 1, prepare a wall-layout drawing identifying structural walls, openings, stairwell walls and any removable internal partitions. Rebuild the same four-storey building with the architecturally equivalent Mivan-compatible geometry, record any carpet-area changes, and design the walls, coupling beams, slabs, foundations and integrity reinforcement. Do not use the prefabricated steel-frame screenshots (Figure 11) as Mivan analytical output; they are provided only to make the report's actual alternative transparent.



(a) Documented prefab frame/deck plan.



(b) Documented prefab STAAD.Pro model.

Figure 11. Original report's second engineering model (prefabricated steel frame)

6.2 Mivan cost-allocation equations

Let F be the contracted net aluminium formwork cost attributable to the compatible repeated plan, including fabrication, mobilisation, repair, recovery and salvage credit; n the actual number of effective repetitions charged to the study; Dm the installed direct construction cost per level excluding F/n; Dc the corresponding conventional cost per level; and $\Delta = Dc - Dm$ the direct per-level saving before formwork allocation. Then:

C_Mivan(n) = n × Dm + F + nonrepeating Mivan costs

C_conventional(n) = n × Dc + nonrepeating conventional costs

If nonrepeating costs are equal: break-even condition $F \leq n \times \Delta$, for $\Delta > 0$

For this one-block G+3 case, n = 4 nominal level pours. Panels reused on other compatible blocks can increase effective reuse, but only with evidence of transferability, storage, refurbishment, transport and contractual attribution. If a supplier instead rents panels per square metre and cycle, apply its rental/handling rate directly and do not add a second full panel-purchase charge.

Net F / project (illustrative only)	Δ = ₹1 lakh/level	Δ = ₹2 lakh/level	Δ = ₹3 lakh/level
₹8 lakh	8 levels	4 levels	3 levels
₹12 lakh	12 levels	6 levels	4 levels
₹16 lakh	16 levels	8 levels	6 levels

Table above is a mathematical sensitivity illustration using hypothetical F and Δ, not quotations or results from [1]. "Levels" = minimum whole comparable repetitions required for $F \leq n\Delta$, excluding unequal nonrepeating costs, finance and programme acceleration. In particular, this table does not establish which G+3 construction system is cheaper.

6.3 Construction-cycle and time-value comparison

Establish measured conventional and aluminium-formwork task networks from foundation to handover. For Mivan, capture design freeze; panel fabrication and trials; wall reinforcement and embedded services; panel erection; slab reinforcement; checks; concreting; curing/striking; and panel transfer. Finish and commissioning duration, rather than slab-pour time alone, govern handover. If earlier occupancy or reduced project overhead is claimed, calculate it from a dated financing/overhead schedule; the original source explicitly says project duration was not included in its cost comparison [1].

7. Discussion

The report is valuable because it joins a reproducible housing plan, explicit lateral-loading views, approximate structural sizes and schedulable work packages. Its quantitative benchmark indicates that a prefabricated steel/deck option was scheduled faster than its conventional RCC baseline.

Mivan economics on a four-level standalone building should therefore be expressed conditionally. With the same verified floor area and structural safety, the required savings in masonry, plastering, labour, rework and time must be measured alongside the extra monolithic wall concrete, reinforcement, service coordination, panel cost, changes to foundations and potential modifications to the plan

8. Conclusions

1. A 16-flat G+3 conventional RCC model and an independent prefabricated structural-steel/deck model. It introduces aluminum formwork descriptively but does not quantify a Mivan alternative.

2. In the conventional-to-prefab comparison, source quantities change from 373.0 to 225.4 m^3 of concrete and 22.70 to 66.53 t of steel. The source programmes change from 255 to 179 days.

3. An economic G+3 Mivan assessment needs a separately analysed wall–slab structure and a contract-specific reusable-panel costing model. With four repetitions in a standalone block, panel utilisation is a necessary sensitivity variable rather than an assumed cost advantage.

References

[1] Undergraduate project report, “UG Report” (user-supplied, undated), chapters 1–4, architectural and STAAD.Pro illustrations, quantity sheets, Microsoft Project estimates and results tables. Internal primary case-study source; authors/institution to be inserted from original cover.

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[6] Bureau of Indian Standards (BIS). IS 456; IS 875 Parts 1–3; and relevant, currently applicable IS 1893 documents. Verify edition and jurisdictional adoption at project-design/submission date. BIS standards catalogue: https://www.services.bis.gov.in/