Comprehensive Technical Review of Mivan Construction Technology and Conventional Building Systems: Comparative Assessment of Structural Performance, Construction Efficiency, Sustainability, and Economic Feasibility

Chaitanya Sambhaji Gaikwad[1], Dhiraj Sambhaji Patil[2], Ruturaj Dattatray Repe[3], Vikrant Vinayak Nazare[4], Samarth Satish Khot[5], Ashish Banderav Powar[6]
[1,2,3,4,5,6] *Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology Warananagar, India*

Abstract—**The rapid growth of urbanization, population density, and housing demand has accelerated the adoption of advanced construction technologies aimed at improving productivity, structural reliability, and project delivery efficiency. Among these innovations, Mivan Construction Technology has emerged as a prominent industrialized construction system, particularly for high-rise residential and mass housing developments. Unlike conventional reinforced concrete construction, which relies on beam column framing and masonry infill walls, Mivan technology utilizes reusable aluminium formwork to facilitate monolithic wall slab construction, thereby enhancing construction speed and dimensional precision. Despite its increasing implementation in largescale projects, a comprehensive technical evaluation of its performance relative to conventional building systems remains limited. This paper presents a critical review and comparative assessment of Mivan Construction Technology and Conventional Building Systems based on key performance indicators including construction efficiency, structural performance, economic feasibility, sustainability, quality of construction, labour productivity, and Mechanical, Electrical, and Plumbing (MEP) coordination. The study synthesizes findings from published literature, industry practices, and representative case studies involving a 22storey residential building constructed using Mivan technology and a conventional reinforced concrete residential building. A systematic evaluation framework is employed to examine the advantages, limitations, and application suitability of both construction methodologies. The analysis indicates that Mivan technology significantly reduces construction cycle time, material wastage, labour dependency, and finishing requirements while improving structural rigidity, seismic resistance, dimensional accuracy, and service integration. However, higher initial investment costs, limited flexibility for postconstruction modifications, and dependence on repetitive floor layouts restrict its applicability in smaller projects. Conversely, conventional construction remains advantageous for low-rise developments requiring architectural flexibility and lower capital investment. The findings of this review provide valuable insights for engineers, developers, researchers, and policymakers in selecting appropriate construction technologies and contribute to the ongoing transition toward sustainable and industrialized construction practices.**

I. INTRODUCTION

The construction industry is experiencing a paradigm shift toward industrialized and technology driven building systems to address increasing demands for rapid urbanization, affordable housing, improved quality, and sustainable infrastructure development [1], [2]. Conventional reinforced concrete (RCC) construction, characterized by beam column framing and masonry infill walls, has been extensively adopted worldwide due to its flexibility and familiarity among construction practitioners [3], [4]. However, the conventional approach is often associated with longer construction durations, higher labour dependency, material wastage, and quality variations resulting from site execution practices [5], [6]. In response to these challenges, advanced construction technologies have emerged to improve project efficiency and productivity. Among these, Mivan Construction Technology has gained significant attention in high-rise residential and mass housing projects because of its ability to facilitate rapid construction through reusable aluminium formwork systems [7], [8]. Unlike conventional construction methods, Mivan technology employs monolithic casting of reinforced concrete walls and slabs, thereby eliminating the need for extensive masonry work and reducing the number of construction joints [9]. This integrated structural approach enhances dimensional accuracy, improves surface finish quality, and accelerates project delivery schedules [10], [11].

The increasing adoption of Mivan technology in countries such as India, Malaysia, Singapore, and the United Arab Emirates reflects the growing preference for industrialized building systems capable of achieving faster construction cycles and consistent quality standards [12], [13]. Additionally, the high reusability of aluminium formwork contributes to reduced material consumption and lower construction waste generation, supporting sustainable construction objectives and resource efficient development practices [14]. The technology also enables better coordination of Mechanical, Electrical, and Plumbing (MEP) services by incorporating conduits and service provisions before concrete casting, thereby minimizing rework during later stages of construction [15].

From a structural engineering perspective, monolithic wall slab systems exhibit improved rigidity, enhanced load transfer mechanisms, and superior seismic performance compared to conventional beam column frame structures [16]. These characteristics make Mivan technology particularly suitable for high-rise developments located in regions where structural stability and construction speed are critical requirements. Nevertheless, the technology also presents certain limitations, including high initial investment costs, dependence on repetitive floor layouts, and limited flexibility for postconstruction modifications [17].

Although numerous studies have investigated individual aspects of Mivan construction such as cost efficiency, productivity improvement, structural behavior, and formwork performance, a comprehensive comparative review encompassing construction efficiency, structural performance, sustainability, economic feasibility, labour productivity, and MEP integration remains limited in the existing literature [18]. Furthermore, the growing emphasis on industrialized construction and sustainable building practices necessitates a holistic evaluation of modern construction technologies relative to conventional systems.

Therefore, this study presents a comprehensive technical review of Mivan Construction Technology and Conventional Building Systems. The review critically evaluates both construction approaches based on construction speed, quality, structural performance, cost implications, sustainability, labour requirements, and service coordination. The findings aim to provide valuable insights for researchers, engineers, developers, and policymakers in selecting appropriate construction technologies for future building developments.

II. FUNDAMENTALS OF BUILDING CONSTRUCTION SYSTEMS

Building construction systems have evolved significantly in response to increasing demands for rapid urbanization, improved structural performance, cost optimization, and sustainable development. Conventional reinforced concrete construction and Mivan construction technology represent two widely adopted construction approaches that differ considerably in terms of structural configuration, execution methodology, construction speed, and resource utilization. Understanding the fundamental characteristics of these systems is essential for evaluating their suitability for modern construction projects.

A. Conventional Building System

The conventional building system is one of the most extensively used construction methods worldwide. It primarily consists of a reinforced concrete beam column framework combined with masonry infill walls. Due to its adaptability and ease of execution, this system continues to be preferred for residential, commercial, and institutional buildings, particularly in low-rise and medium rise developments.

1) Structural Configuration:

In conventional construction, the primary load resisting framework consists of reinforced concrete columns, beams, and slabs. Structural loads are transferred from slabs to beams, subsequently to columns, and finally to the foundation. Brick masonry walls are generally used as partition or infill elements and do not significantly contribute to the structural load carrying mechanism. The separation between structural and nonstructural components provides flexibility in architectural planning and future modifications.

2) Construction Sequence:

The conventional construction process follows a sequential execution methodology. Initially, foundation work is completed, followed by reinforcement fixing, shuttering installation, and concreting of columns. Subsequently, beams and slabs are cast, after which brick masonry, plastering, flooring, and finishing activities are executed. Mechanical, Electrical, and Plumbing (MEP) services are generally installed after masonry construction, resulting in multiple construction stages and longer project durations.

3) Advantages:

The conventional building system offers several advantages, including lower initial investment, design flexibility, ease of architectural modifications, and widespread availability of skilled labour. The system is particularly suitable for projects involving irregular floor plans, low-rise structures, and customized residential developments. Maintenance and repair activities are also comparatively easier because masonry walls can be altered without significantly affecting the primary structural framework.

4) Limitations:

Despite its widespread use, conventional construction is associated with several limitations. The requirement for separate execution stages increases project duration and labour dependency. Surface finish quality often depends on workmanship, resulting in variations in dimensional accuracy and construction quality. Furthermore, material wastage, rework, and maintenance requirements may be comparatively higher than those associated with industrialized construction technologies.

B. Mivan Construction Technology

Mivan Construction Technology is an advanced aluminium formwork-based construction system developed to improve construction efficiency, quality control, and structural performance. The technology enables monolithic casting of reinforced concrete walls and slabs, making it particularly suitable for high-rise residential and mass housing developments.

1) Historical Development:

Mivan technology was originally developed by Mivan Company Ltd., Malaysia, as an innovative formwork solution for largescale housing projects. Over the past two decades, the technology has gained widespread acceptance in countries experiencing rapid urban growth due to its ability to reduce construction cycles and improve productivity. In India, Mivan technology has been increasingly adopted in metropolitan cities for high-rise residential developments and government housing projects.

2) Components of Mivan Formwork:

The Mivan formwork system consists of lightweight, precision engineered aluminium panels designed for repetitive use. The major components include wall panels, deck panels, beam side panels, beam bottom panels, soffit panels, prop heads, pins, and wedges. These components are manufactured with high dimensional accuracy and assembled onsite to create moulds for monolithic concrete casting. The reusable nature of the aluminium panels significantly reduces material wastage and enhances construction efficiency.

3) Construction Process:

The construction process begins with the assembly of aluminium wall and slab formwork panels according to the architectural and structural layout. Reinforcement, electrical conduits, plumbing sleeves, and service provisions are installed within the formwork before concreting. Subsequently, walls and slabs are cast simultaneously in a single concrete pouring operation. After achieving the required concrete strength, the formwork is dismantled and reused for subsequent floors, enabling rapid and repetitive construction cycles.

4) Monolithic RCC Concept:

A defining feature of Mivan technology is the monolithic reinforced concrete wall slab system. Unlike conventional construction, where structural members are cast separately, Mivan technology integrates walls and slabs into a single structural unit. This monolithic arrangement improves load transfer efficiency, reduces structural discontinuities, enhances stiffness, and provides superior resistance to lateral and seismic forces. The reduction of construction joints further contributes to improved durability and structural integrity.

5) Global Adoption Trends:

The adoption of Mivan technology has increased substantially in countries such as Malaysia, Singapore, China, the United Arab Emirates, and India. Growing demand for affordable housing, labour shortages, and the need for accelerated project delivery have encouraged the implementation of industrialized construction technologies. In India, the technology is extensively utilized in high-rise residential projects and largescale housing schemes where repetitive floor layouts and rapid construction cycles provide significant economic benefits.

6) Advantages:

Mivan technology offers several advantages, including faster construction cycles, superior dimensional accuracy, improved surface finish quality, reduced labour dependency, lower material wastage, enhanced seismic performance, and efficient MEP integration. The reusable aluminium formwork system also contributes to sustainable construction practices and long-term cost savings in repetitive projects.

7) Limitations:

The major limitation of Mivan technology is its high initial investment associated with aluminium formwork procurement and specialized construction management. The system is most economical for projects with repetitive floor layouts and may not be suitable for small-scale developments. In addition, postconstruction modifications are difficult because structural walls form an integral part of the loadbearing system, reducing architectural flexibility during later stages of occupancy.

C. Review Methodology

This study adopts a systematic review and comparative assessment approach to evaluate the technical performance of Mivan Construction Technology and Conventional Building Systems. The methodology integrates published research findings, technical reports, industrial practices, and realworld construction case studies to establish a comprehensive evaluation framework. In addition to literature synthesis, practical construction data collected from selected residential projects were incorporated to validate the observations obtained from the literature.

The overall methodology consists of four stages: literature review, case study selection, data collection and analysis, and comparative performance evaluation. The adopted methodology is illustrated in Fig. 1.

Topic Identification → Literature Review → Case Study Selection → Data Collection → Comparative Analysis → Results and Discussion

Fig. 1: Research methodology adopted for the study.

1) Literature Sources:

Relevant literature was collected from internationally recognized databases to ensure the reliability and quality of the review. The search focused on studies related to Mivan construction technology, aluminium formwork systems, conventional RCC construction, structural performance, sustainability, productivity, and construction management.

Table I: Literature Sources Used in the Review

Database	Purpose
Scopus	Peer reviewed journal articles
Web of Science	High impact publications
ScienceDirect	Engineering and construction studies
ASCE Library	Construction engineering research
Google Scholar	Conference papers and reports

2) Inclusion Criteria:

The following criteria were used for selecting the literature:

- Studies related to Mivan and conventional construction systems.
- Peer reviewed journal articles and conference papers.
- Research addressing construction quality, cost, time, sustainability, structural performance, and MEP coordination.
- Publications written in English.
- Studies containing technical or comparative evaluations.

3) Exclusion Criteria:

The following documents were excluded:

- Duplicate publications.
- Nontechnical articles and promotional materials.
- Studies lacking sufficient methodological details.
- Research unrelated to building construction systems.
- Incomplete publications without verifiable results.

4) PRISMA-Based Literature Screening Process:

A PRISMA inspired screening approach was adopted to ensure systematic identification and selection of relevant studies. Publications were identified using keywords such as “Mivan Construction Technology”, “Aluminium Formwork”, “Monolithic RCC

Construction", and "Conventional Building Systems". After removal of duplicate records, title and abstract screening was performed. Fulltext articles satisfying the inclusion criteria were subsequently reviewed and synthesized for comparative analysis.

D. Case Study Selection

To validate the findings obtained from the literature review, two residential construction projects representing different construction systems were selected for comparative assessment. Detailed site observations, structural drawings, and Mechanical, Electrical and Plumbing (MEP) drawings were analyzed for both projects.

E. Data Collection

Data collection was carried out through both primary and secondary sources.

- Site visits and field observations.
- Structural drawing analysis.
- MEP drawing analysis.
- Observation of construction sequencing.
- Evaluation of quality and finishing standards.
- Cost and project duration assessment.
- Literature review and technical reports.

The collected information was used to compare the selected projects with respect to construction quality, execution time, structural performance, labour productivity, and service coordination.

F. Comparative Evaluation Framework

The comparative evaluation framework was developed using the key performance indicators identified from the literature review and field observations. The final comparative assessment was performed by synthesizing literature findings with observations obtained from the selected case studies. The results were then analyzed to identify the strengths, limitations, and suitability of Mivan Construction Technology and Conventional Building Systems for different construction scenarios.

III. COMPARATIVE TECHNICAL ASSESSMENT

This section presents a comprehensive technical comparison between Mivan Construction Technology and Conventional Building Systems based on literature findings, field observations, and case study analysis. The assessment focuses on critical performance indicators influencing project delivery, structural reliability, economic feasibility, sustainability, and service integration.

A. Construction Speed Analysis

Construction speed is a key performance indicator affecting project economics, resource utilization, and return on investment. The repetitive nature of aluminium formwork systems enables Mivan technology to achieve significantly shorter construction cycles compared with conventional construction methods.

1) Floor Cycle Duration:

In Mivan construction, walls and slabs are cast simultaneously using aluminium formwork, resulting in repetitive floor construction cycles typically ranging between 7 to 10 days. In contrast, conventional construction requires separate execution of columns, beams, slabs, masonry, and plastering works, leading to longer floor cycle durations.

2) Project Completion Time:

The selected Mivan case study, Mariton Heights WingB, consisting of 22 floors, was planned for completion within approximately 15 months. Conventional construction projects generally require longer completion periods because of sequential construction activities and higher labour dependency.

3) Productivity Analysis:

Mivan technology improves labour productivity by minimizing repetitive manual activities and reducing dependence on masonry and plastering operations. Consequently, labour output per construction cycle is considerably higher than that achieved using conventional building systems.

B. Quality Performance Assessment

Construction quality directly influences structural durability, maintenance requirements, and user satisfaction. The use of precision engineered aluminium formwork significantly enhances construction quality in Mivan technology.

Table II: Selected Case Study Projects

Parameter	Mivan Project	Conventional Project
Project Name	Mariton Heights WingB	Sky Line
Location	Ravet, Pune	Gadhinglaj, Kolhapur
Developer	SVTN Real Estate Pvt. Ltd.	Symbiotic Developers LLP
Construction Technology	Mivan Technology	Conventional Method
Structural System	Monolithic RCC Wall slab	RCC Beam column Frame
Number of Floors	22	7
BuiltUp Area	10,000 m2	–
Estimated Cost	INR 23.7 Crore	INR 23.1 Crore
Drawings Available	Structural + MEP	Structural + MEP

Table III: Comparative Evaluation Parameters

Parameter	Assessment Metric	Purpose
Construction Quality, Construction Time Cost Efficiency Structural Performance, Sustainability, MEP Coordination Labour Productivity Safety, Life Cycle Cost Adaptability	Surface finish, dimensional accuracy, Floor cycle and project duration Initial and overall project cost Strength, rigidity and seismic resistance, Material wastage and resource utilization, Service integration efficiency Labour requirement and output Construction practices Maintenance and durability Future modifications and flexibility	Evaluation of construction quality, Assessment of execution efficiency Economic feasibility analysis Structural evaluation, Environmental assessment, Coordination evaluation Productivity assessment Site safety evaluation, Long-term economic assessment Functional assessment

Table IV: Construction Speed Comparison

Parameter	Mivan	Conventional
Floor Cycle Duration	7 to 10 Days	15 to 20 Days
Project Completion	Faster	Slower
Labour Productivity	High	Moderate
Construction Sequence	Repetitive	Sequential

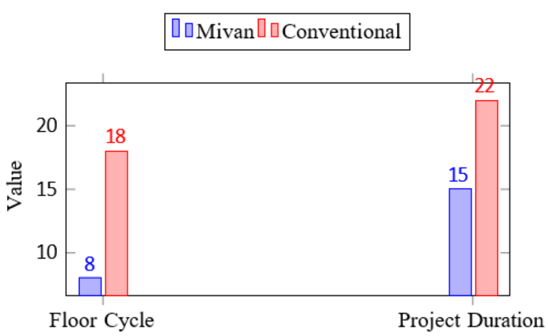

Fig. 2: Construction speed comparison between Mivan and conventional construction systems.

1) Surface Finish Quality:
The aluminium formwork system provides smooth and uniform concrete surfaces with minimal imperfections. Consequently, plastering requirements are substantially reduced. In conventional construction, surface quality largely depends on masonry workmanship and plastering accuracy.

2) Dimensional Accuracy:
Factory manufactured aluminium panels ensure consistent dimensions throughout the structure. The repetitive use of standardized panels minimizes dimensional deviations and improves alignment.

3) Crack Resistance:
Monolithic casting of walls and slabs reduces the number of structural joints and discontinuities, thereby lowering the probability of crack formation.

4) Leakage Resistance:
The monolithic RCC wall slab system offers improved waterproofing performance due to the reduction of joints and interfaces.

5) Rework Requirement:
Since Mivan technology integrates structural and service planning before concreting, rework requirements are significantly reduced.

Table V: Quality Performance Comparison

Parameter	Mivan	Conventional
Surface Finish	Excellent	Moderate
Dimensional Accuracy	High	Moderate
Crack Formation	Low	Moderate
Leakage Resistance	Better	Standard
Rework Requirement	Low	High

C. Structural Performance Assessment

Structural performance determines the safety, durability, and long-term functionality of buildings.

1) Load Transfer Mechanism: Mivan construction follows a monolithic RCC wall slab structural system in which loads are transferred directly through reinforced concrete walls. Conventional buildings utilize a beam column framework where

loads are transferred through slabs, beams, and columns before reaching the foundation.

2) Structural Rigidity: The integrated wall slab arrangement significantly increases lateral stiffness and structural rigidity.

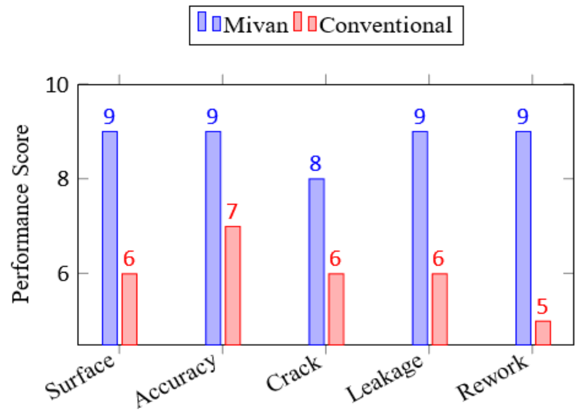

Fig. 3: Quality performance assessment of Mivan and conventional construction.

3) Seismic Behaviour: Monolithic RCC construction demonstrates superior seismic performance due to enhanced load distribution and reduced structural discontinuities.

4) Durability Assessment: The reduction in joints, improved concrete quality, and lower crack formation contribute to enhanced durability.

5) Service Life Expectancy: Due to improved structural integrity and durability characteristics, Mivan buildings are expected to achieve longer service life with lower maintenance interventions.

Table VI: Structural Performance Comparison

Parameter	Mivan	Conventional
Structural Rigidity	High	Moderate
Joint Strength	High	Moderate
Seismic Resistance	Better	Standard
Durability	High	Moderate
Service Life	Longer	Standard

D. Economic Analysis

Economic viability remains a major consideration in selecting construction technologies.

1) Initial Investment Cost: Mivan technology requires substantial initial investment due to aluminium formwork procurement. Conventional construction requires comparatively lower initial capital investment.

2) Labour Cost: The systematic nature of Mivan construction reduces labour dependency and labour costs.

3) Material Consumption: The elimination of extensive masonry work and reduced finishing requirements decrease material consumption in Mivan projects.

4) Maintenance Cost: Improved construction quality and durability reduce long-term maintenance expenditures in Mivan structures.

5) Life Cycle Cost Analysis: Although the initial investment is higher, Mivan technology demonstrates favourable lifecycle economics due to faster completion, lower labour requirements, reduced maintenance, and higher productivity.

Table VII: Economic Comparison

Parameter	Mivan	Conventional
Initial Cost	High	Moderate
Labour Cost	Low	High
Material Wastage	Low	High
Maintenance Cost	Low	Moderate
Life Cycle Cost	Lower	Higher

E. Sustainability Assessment

1) Material Wastage: The high reusability of aluminium formwork significantly reduces construction waste generation compared with conventional timber and plywood-based systems.

2) Carbon Footprint: Reduced material wastage, shorter construction duration, and lower resource consumption contribute to a lower overall environmental impact.

3) Resource Utilization: The repetitive use of aluminium panels improves resource efficiency and minimizes unnecessary material consumption.

4) Circular Economy Perspective: The reuse of formwork panels over multiple construction cycles supports circular economy principles by extending material life and reducing waste generation.

5) Green Building Compatibility: Mivan technology aligns with sustainable construction objectives through improved material efficiency and reduced site waste generation.

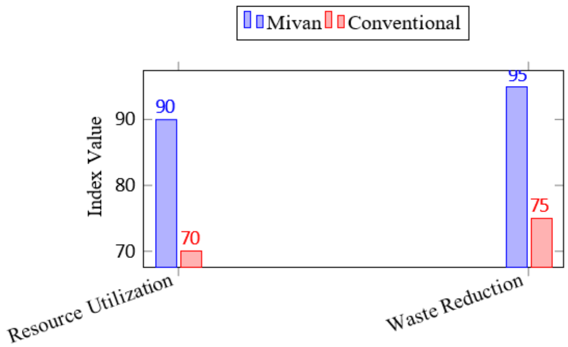

Fig. 4: Sustainability performance comparison.

F. MEP Coordination Efficiency

1) Conventional Construction: In conventional construction, electrical conduits, plumbing lines, and service provisions are generally installed after masonry work. This often results in wall chasing, rework, service clashes, and additional execution time.
2) Mivan Construction: Mivan technology requires service planning before concrete casting. Electrical conduits, sleeves, plumbing openings, and service provisions are integrated during the formwork stage itself, reducing rework and improving execution quality.
3) BIM-Based Service Coordination: The integration of Building Information Modelling (BIM) with Mivan technology can further enhance service coordination through clash detection, visualization, and digital planning. BIM-assisted coordination enables accurate placement of electrical, plumbing, and mechanical services before construction, thereby minimizing project risks and improving construction efficiency.

IV. CASE STUDY ANALYSIS

To bridge the gap between theoretical findings reported in the literature and practical implementation in the construction industry, two residential building projects employing distinct construction methodologies were selected for detailed investigation. The selected projects represent contemporary applications of Mivan Construction Technology and Conventional Reinforced Concrete (RCC) Construction within the Indian construction sector. The objective of the case study analysis is to evaluate the practical implications of each construction system with respect to project execution efficiency, structural performance, quality management, and service integration.

The comparative assessment was performed using project documentation, structural drawings, MEP layouts, site observations, and construction records. The analysis further facilitates validation of the performance indicators identified during the literature review and provides practical evidence supporting the comparative framework developed in this study.

A. Case Study I: Mariton Heights WingB, Pune

Mariton Heights WingB, located at Ravet, Pune, was selected as a representative project utilizing Mivan Construction Technology. The project comprises a 22storey residential structure constructed using a monolithic RCC wall slab system formed through reusable aluminium formwork. The adoption of Mivan technology was primarily motivated by the requirement for accelerated project delivery, improved construction quality, and enhanced productivity.

Table VIII: Details of Mivan Construction Project

Project Name	Mariton Heights WingB
Location	Ravet, Pune
Technology	Mivan Construction
Floors	22
Structural System	Monolithic RCC Wall slab
Project Cost	Rs. 23.7 Crore
Duration	15 Months

The project demonstrates the practical advantages of industrialized construction systems in largescale residential developments. The monolithic casting methodology enabled simultaneous construction of structural walls and slabs, resulting in reduced floor cycle durations and enhanced construction continuity. Furthermore, the integration of electrical conduits, plumbing sleeves, and service openings before concrete placement minimized postconstruction modifications and significantly reduced rework requirements.

Field observations indicated that the aluminium formwork system produced highly uniform structural elements with superior dimensional accuracy and surface finish quality. Consequently, plastering requirements were substantially reduced, resulting in lower finishing costs and improved project efficiency. From a structural perspective, the continuous wall slab arrangement enhanced load distribution and structural stiffness, thereby improving the overall performance of the building under lateral loading conditions.

B. Case Study-II: Sky Line, Gadhinglaj

The Sky Line residential project located at Gadhinglaj, Kolhapur, was selected as a representative example of conventional RCC construction. The project utilizes a beam column framing system with masonry infill walls and follows the traditional sequential construction methodology commonly adopted in residential developments.

Table IX: Details of Conventional Construction Project

Project Name	Sky Line
Location	Gadhinglaj, Kolhapur
Technology	Conventional RCC
Floors	7
Structural System	RCC Beam column Frame
Project Cost	Rs. 23.1 Crore

The conventional construction methodology provided greater flexibility in architectural modifications and design customization. However, the execution process involved multiple independent construction stages, including column construction, beam and slab casting, masonry work, plastering, and service installation. The sequential nature of these activities increased project duration and labour dependency compared with the Mivan project.

Field investigations further revealed that construction quality was highly dependent on workmanship and site management practices. Variations in masonry alignment, plastering quality, and service installation were observed, necessitating corrective measures during later construction stages. Although the structural performance of the beam column system satisfied design requirements, the discontinuous nature of structural and nonstructural components resulted in lower overall rigidity compared with the monolithic wall slab configuration observed in the Mivan project.

C. Comparative Findings

The comparative analysis demonstrates that the observed differences between the two construction systems extend beyond construction speed and encompass multiple technical, economic, and operational dimensions.

1) Quality Index:

The quality assessment indicates that Mivan technology achieved superior performance in terms of dimensional accuracy, surface finish quality, structural continuity, and construction consistency. The standardized aluminium formwork system minimized workmanship related variability and reduced dependence on finishing operations. Conversely, the quality of conventional construction was found to be highly dependent on labour skill levels and site supervision practices.

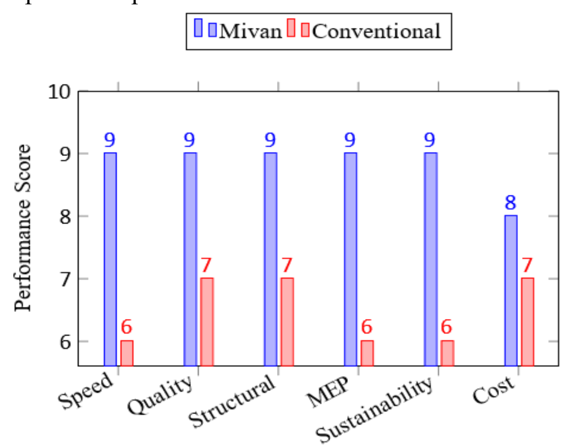

Fig. 5: Overall comparative performance of Mivan and conventional construction systems.

2) Time Index:

A significant reduction in construction cycle duration was observed in the Mivan project due to the simultaneous casting of walls and slabs and the repetitive nature of formwork operations. The elimination of extensive masonry and plastering activities further accelerated project execution. In contrast, the conventional project exhibited longer construction durations because of sequential work packages and increased coordination requirements.

3) Cost Index:

Although Mivan technology requires higher initial capital investment for aluminium formwork procurement, the reduction in labour requirements, material wastage, construction duration, and finishing activities contributed to improved overall project economics. The economic advantage becomes increasingly significant in projects involving repetitive floor layouts and large construction volumes.

4) Structural Performance Index:

The monolithic RCC wall slab system demonstrated superior structural performance owing to enhanced continuity, efficient load transfer mechanisms, and improved lateral stiffness. These characteristics contribute to improved seismic resistance and structural reliability. In comparison, the conventional beam column system exhibited lower stiffness due to the presence of multiple structural interfaces and discontinuities.

5) MEP Coordination Index:

MEP coordination emerged as one of the most significant advantages of Mivan technology. The incorporation of conduits, sleeves, and service provisions during formwork assembly substantially reduced clashes and rework. In contrast, the conventional project required extensive coordination between masonry and service installation activities, increasing the likelihood of modifications during execution.

6) Overall Performance Rating:

The overall evaluation indicates that Mivan Construction Technology outperforms conventional RCC construction in construction efficiency, quality control, structural performance, sustainability, and service integration. However, conventional construction continues to offer advantages in architectural flexibility, adaptability to design modifications, and lower initial capital requirements. Consequently, the suitability of each system is strongly influenced by project scale, repetition level, construction timeline, and economic objectives.

Table X. Comparative Performance Assessment

Performance Parameter	Mivan	Conventional
Construction Speed	Excellent	Moderate
Quality Control	Excellent	Good
Structural Performance	Excellent	Good
MEP Coordination	Excellent	Moderate
Sustainability	Excellent	Moderate
Labour Productivity	Excellent	Moderate
LifeCycle Economy	Excellent	Good
Design Flexibility	Moderate	Excellent
Overall Performance	Excellent	Good

V. DISCUSSION

The comparative assessment conducted in this study demonstrates that the choice of construction technology significantly influences project performance across multiple dimensions, including construction speed, quality, structural behavior, economic viability, sustainability, and service coordination. The findings obtained from the literature review and case study analysis indicate that Mivan Construction Technology offers substantial advantages for largescale residential developments, particularly where rapid project delivery and standardized construction practices are required. However, the suitability of any construction system is highly dependent on project specific requirements, economic constraints, and regional construction practices.

A. Why Mivan Outperforms Conventional Systems

The superior performance of Mivan Construction Technology can be attributed to its industrialized construction approach and monolithic structural configuration. Unlike conventional RCC construction, where structural and nonstructural components are executed through multiple independent stages, Mivan technology integrates wall and slab construction into a single operation. This integration reduces construction cycle duration, improves structural continuity, and minimizes coordination complexities.

One of the most significant advantages of Mivan technology is the reduction in project execution time. The reusable aluminium formwork system enables repetitive floor construction cycles, thereby improving productivity and accelerating project delivery. In high-rise residential projects, where repetitive floor layouts are common, this advantage becomes particularly significant from both economic and managerial perspectives. From a quality management standpoint, Factory manufactured aluminium formwork ensures superior dimensional accuracy and consistency. The resulting concrete surfaces exhibit improved finish quality, reducing dependence on plastering and corrective work. Consequently, quality variations associated with workmanship are minimized.

Structurally, the monolithic RCC wall slab system provides enhanced load transfer efficiency and lateral stiffness. The reduction of construction joints improves structural continuity and contributes to better seismic performance. These characteristics are particularly beneficial in multistorey residential buildings subjected to dynamic loading conditions.

Furthermore, Mivan technology facilitates early integration of Mechanical, Electrical, and Plumbing (MEP) services. The incorporation of conduits, sleeves, and service provisions before concrete placement minimizes rework and improves overall project coordination. The combined impact of improved productivity, quality control, structural reliability, and service integration explains the superior overall performance of Mivan technology observed in the present study.

B. Situations Where Conventional Construction Remains Preferable

Despite the advantages offered by Mivan technology, conventional RCC construction continues to remain relevant in several construction scenarios. The flexibility associated with beam column framing systems allows architects and engineers to accommodate complex building geometries, irregular floor layouts, and customized design requirements. This flexibility is often difficult to achieve using standardized aluminium formwork systems.

Conventional construction is also economically advantageous for small-scale and low-rise developments where the high initial investment associated with aluminium formwork cannot be justified. Projects involving limited repetition or unique architectural configurations may not achieve sufficient formwork reuse to offset the initial capital expenditure. In addition, postconstruction modifications and future alterations are comparatively easier in conventional buildings. Since masonry walls generally do not form part of the primary load resisting system, modifications can be performed with relatively limited structural implications. Consequently, conventional construction remains preferable in projects where adaptability and future expansion are major design considerations.

The widespread availability of skilled labour and familiarity with conventional construction techniques further contribute to its continued adoption, particularly in semiurban and rural regions where industrialized construction technologies have not yet achieved significant penetration.

C. Challenges in Adoption of Mivan Technology

Although Mivan technology offers numerous advantages, several technical, economic, and organizational challenges continue to limit its widespread adoption across the Indian construction industry.

1) Indian Construction Industry Perspective:

At the national level, the primary challenge associated with Mivan technology is the substantial initial investment required for aluminium formwork procurement and maintenance. The economic feasibility of the system is highly dependent on large project volumes and repetitive floor layouts, limiting its applicability in many construction projects. Another challenge involves the requirement for precise planning and execution. Since service provisions are incorporated before concrete placement, any design modifications introduced during construction can significantly affect project schedules and costs. Consequently, successful implementation requires effective coordination among structural, architectural, and MEP teams during the early design stages. The Indian construction sector also continues to exhibit varying levels of technological adoption and workforce skill development. In many regions, contractors remain more familiar with conventional construction practices, creating resistance to the implementation of advanced construction technologies.

2) Maharashtra Perspective:

Maharashtra represents one of India's most rapidly urbanizing states and has witnessed increasing adoption of industrialized construction technologies, particularly in metropolitan regions such as Mumbai, Pune, and Nagpur. The growing demand for affordable housing and high-rise residential developments has created favorable conditions for the implementation of Mivan technology.

However, challenges remain with respect to workforce training, formwork logistics, project planning, and capital investment. While large developers can effectively utilize Mivan systems across multiple projects, smaller construction firms often face difficulties in recovering the initial investment required for formwork acquisition.

Furthermore, increasing land costs and stringent project timelines have encouraged the adoption of faster construction techniques, but broader implementation requires improved awareness, technical training, and institutional support.

3) Kolhapur Region Perspective:

The construction industry in the Kolhapur region remains predominantly dependent on conventional RCC construction practices. Most residential and commercial developments consist of low-rise or medium rise structures where conventional methods continue to offer economic advantages.

Limited project scale, reduced repetition of floor layouts, and comparatively lower labour costs reduce the economic attractiveness of Mivan technology in the region. Additionally, local contractors and construction workers possess greater familiarity with conventional construction methods, contributing to slower adoption of industrialized systems.

Nevertheless, increasing urbanization, infrastructure development, and demand for multistorey residential projects may create future opportunities for the implementation of Mivan technology in selected developments within the region.

D. Future of Industrialized Construction in India

The future of the Indian construction industry is expected to be increasingly influenced by industrialized and technology driven construction methodologies. Growing urbanization, housing demand, labour shortages, and sustainability requirements are likely to accelerate the adoption of advanced construction systems.

Mivan technology is expected to play a significant role in largescale housing developments due to its ability to deliver projects rapidly while maintaining high quality standards. Furthermore, integration with digital technologies such as Building Information Modelling (BIM), Digital Twins, Artificial Intelligence (AI), and Construction Automation can significantly enhance planning accuracy and execution efficiency. In addition to Mivan technology, other industrialized construction approaches including precast concrete systems, modular construction, tunnel form construction, and 3D concrete printing are expected to gain prominence in the coming decades. These technologies offer opportunities to improve productivity, reduce environmental impacts, and address the increasing complexity of modern construction projects.

The transition toward industrialized construction will require collaborative efforts involving government agencies, academic institutions, industry stakeholders, and technology providers. Investments in workforce development, research and innovation, standardization, and digital infrastructure will be essential for achieving widespread adoption and realizing the full benefits of modern construction technologies.

Overall, the findings of this study suggest that industrialized construction systems, particularly Mivan technology, will play a critical role in shaping the future of sustainable and efficient building construction in India.

VI. RESEARCH GAPS AND FUTURE DIRECTIONS

Despite the increasing adoption of Mivan Construction Technology in high-rise residential and mass housing developments, the existing body of literature remains fragmented and primarily focused on isolated aspects such as construction speed, cost comparison, and formwork efficiency. A comprehensive examination of published studies reveals several research gaps that limit the understanding of the long-term technical, economic, and environmental implications of Mivan-based construction systems. Addressing these gaps is essential for supporting informed decision-making and promoting wider implementation of industrialized construction technologies.

A. Identified Research Gaps

A critical review of the available literature highlights the following key research gaps:

Limited LifeCycle Assessment (LCA) Studies: Most existing studies evaluate Mivan technology based on initial construction cost and project duration. However, limited attention has been devoted to comprehensive lifecycle assessment, including embodied energy, operational performance, maintenance requirements, repair costs, and end of life considerations. Consequently, the long-term sustainability performance of Mivan buildings remains insufficiently quantified.

Limited Carbon Footprint Assessment: Although Mivan technology is often considered environmentally advantageous due to reduced material wastage and formwork reusability, detailed carbon footprint studies remain scarce. Quantitative evaluation of greenhouse gas emissions associated with aluminium formwork manufacturing, transportation, repeated usage cycles, and building operation is required to establish its true environmental impact.

Insufficient Research on BIMMivan Integration: Building Information Modelling (BIM) has transformed construction planning, coordination, and project management. However, relatively few studies have investigated the integration of BIM workflows with Mivan construction processes. Research concerning BIM-enabled formwork planning, automated quantity estimation, clash detection, and schedule optimization remains limited.

Limited AI-Based Construction Planning Studies: Artificial Intelligence (AI) and Machine Learning (ML) technologies have demonstrated significant potential in construction management applications. Nevertheless, research focusing on AI-driven planning and optimization of Mivan construction activities remains underdeveloped. Predictive scheduling, labour allocation optimization, productivity forecasting, and automated decision support systems require further investigation.

Lack of Comprehensive Structural Performance Studies: Most available studies focus on basic structural comparisons between monolithic wall slab systems and conventional beam column systems. Advanced investigations involving nonlinear analysis, progressive collapse resistance, seismic resilience, and long-term structural performance are relatively limited.

Limited Regional Adaptability Assessments: The majority of published research focuses on metropolitan projects and largescale housing developments. Studies evaluating the economic feasibility and implementation challenges of Mivan technology in semiurban and rural regions are scarce, particularly within emerging construction markets.

Insufficient Integration of Sustainability Metrics: Current research often evaluates construction performance using isolated technical or economic indicators. Comprehensive frameworks integrating environmental, social, and economic sustainability dimensions remain largely unexplored.

B. Future Research Opportunities

The identified research gaps provide several promising directions for future investigation. Emerging digital technologies and sustainable construction practices present significant opportunities to enhance the effectiveness and applicability of Mivan Construction Technology.

Digital Twins for Construction: Digital Twin technology enables the creation of dynamic virtual replicas of physical construction assets. Future research can explore the integration of Digital Twins with Mivan construction projects for real-time monitoring, predictive maintenance, productivity analysis, and lifecycle management. Such systems could significantly improve decision-making throughout the project lifecycle.

BIM Integrated Mivan Planning: The integration of BIM with Mivan technology offers opportunities for enhanced project visualization, formwork planning, quantity estimation, construction sequencing, and MEP coordination. Future studies should investigate automated BIM-based workflows specifically tailored for monolithic construction systems.

AI-Based Formwork Optimization: Artificial Intelligence techniques can be employed to optimize formwork allocation, construction sequencing, labour scheduling, and material logistics. Machine learning models capable of predicting productivity, cost performance, and project risks could substantially improve project efficiency.

Smart Construction Monitoring Systems: The adoption of Internet of Things (IoT) sensors, wireless monitoring systems, and cloud-based analytics can facilitate real-time tracking of construction activities. Future research should focus on integrating smart monitoring technologies with Mivan projects to improve quality control, safety management, and productivity assessment.

LifeCycle Sustainability Assessment Frameworks: Future investigations should develop comprehensive frameworks combining environmental, economic, and social sustainability indicators. Such frameworks would provide a holistic basis for evaluating construction technologies beyond traditional cost and time considerations.

Advanced Structural and Seismic Performance Evaluation: Further research involving finite element modelling, nonlinear dynamic analysis, and performance based seismic design is required to better understand the long-term structural behaviour of monolithic RCC wall slab systems under extreme loading conditions.

Automation and Robotics in Mivan Construction: The increasing adoption of construction automation presents opportunities for integrating robotic assembly, automated concrete placement, and intelligent inspection systems within Mivan construction workflows. These developments could significantly enhance productivity and safety.

Integration with Industry 4.0 Technologies: Future research should explore the convergence of Mivan

technology with Industry 4.0 concepts, including cyberphysical systems, cloud computing, artificial intelligence, and advanced data analytics to create intelligent and highly efficient construction ecosystems.
Overall, future advancements in digital construction technologies, sustainability assessment methodologies, and intelligent project management systems are expected to significantly enhance the effectiveness and competitiveness of Mivan Construction Technology. Addressing the identified research gaps will contribute to the development of more sustainable, resilient, and technologically advanced construction practices capable of meeting the evolving demands of the global construction industry.

VII. CONCLUSIONS

This study presented a comprehensive technical review and comparative assessment of Mivan Construction Technology and Conventional Building Systems with respect to construction efficiency, structural performance, economic feasibility, sustainability, and service integration. The findings were synthesized through an extensive literature review and validated using representative case studies comprising a 22storey residential building constructed using Mivan technology and a conventional RCC residential building. Based on the analyses performed, the following conclusions can be drawn.

A. Technical Conclusions

The comparative evaluation demonstrates that Mivan Construction Technology provides significant advantages in construction productivity, quality control, and project execution efficiency. The use of reusable aluminium formwork and monolithic RCC wall slab construction enables repetitive and standardized construction cycles, resulting in reduced project duration and improved construction consistency. Superior dimensional accuracy, enhanced surface finish quality, reduced rework requirements, and improved coordination among project stakeholders further contribute to the technical superiority of the system. Conversely, conventional construction continues to offer greater flexibility in accommodating architectural modifications and irregular structural configurations.

B. Economic Conclusions

The economic assessment indicates that Mivan technology requires a relatively higher initial investment due to the procurement, fabrication, and maintenance of aluminium formwork systems. However, the reduction in labour dependency, material wastage, construction duration, and finishing activities significantly improves overall project economics. The economic benefits become increasingly pronounced in largescale residential developments characterized by repetitive floor layouts and high construction volumes. In contrast, conventional construction remains economically attractive for low-rise and small-scale projects where the cost of specialized formwork systems cannot be effectively recovered through repeated utilization.

C. Structural Conclusions

From a structural engineering perspective, the monolithic RCC wall slab system employed in Mivan construction exhibits superior performance compared with conventional beam column framing systems. The integrated structural configuration enhances load transfer efficiency, increases lateral stiffness, and improves overall structural continuity. The reduction of structural discontinuities and construction joints contributes to improved seismic resistance, durability, and long-term structural reliability. While conventional RCC systems continue to satisfy standard design requirements, their structural performance is comparatively lower with respect to rigidity and resistance to lateral loading conditions.

D. Sustainability Conclusions

The sustainability assessment revealed that Mivan technology aligns well with contemporary sustainable construction objectives. The high reusability of aluminium formwork significantly reduces construction waste generation and improves resource utilization efficiency. Reduced material wastage, lower rework requirements, shorter construction durations, and enhanced durability collectively contribute to improved environmental performance. Furthermore, the technology supports the principles of industrialized construction and circular economy by maximizing material reuse and minimizing construction related inefficiencies. Nevertheless, further research is required to quantify the complete lifecycle environmental impacts and carbon footprint associated with aluminium formwork production and transportation.

E. Practical Implications

The findings of this study provide valuable insights for engineers, contractors, developers, policymakers, and researchers involved in construction planning and technology selection. The results suggest that Mivan Construction Technology is particularly suitable for high-rise residential developments, mass housing projects, and largescale urban infrastructure programs where rapid project delivery, quality consistency, and long-term operational efficiency are critical requirements. Conversely, conventional RCC construction remains a practical solution for projects requiring design flexibility, lower initial investment, and limited construction repetition.

As the construction industry continues to transition toward industrialized and technology driven methodologies, the integration of Mivan technology with emerging digital tools such as Building Information Modelling (BIM), Artificial Intelligence (AI), Digital Twins, and Smart Construction Monitoring Systems is expected to further enhance project performance and sustainability. Therefore, wider adoption of industrialized construction systems, supported by appropriate training, technological innovation, and policy frameworks, will play a crucial role in addressing the future housing and infrastructure demands of rapidly urbanizing regions.

Overall, the study concludes that Mivan Construction Technology represents a highly effective alternative to conventional building systems for largescale and repetitive construction projects, offering substantial benefits in terms of construction speed, quality, structural performance, and sustainability while contributing to the modernization and digital transformation of the construction industry.

REFERENCES

[1] United Nations, World Urbanization Prospects 2018: Highlights. New York, NY, USA: Department of Economic and Social Affairs, 2019.

[2] World Bank, Housing for All by 2030: Challenges and Opportunities. Washington, DC, USA, 2020.

[3] Gibb M. and Isack F., “Reengineering through preassembly: Client expectations and drivers,” Building Research & Information, vol. 31, no. 2, pp. 146–160, 2003.

[4] Lawson R. M., Ogden M., and Goodier C., Design in Modular Construction. Boca Raton, FL, USA: CRC Press, 2014.

[5] Love P. E. D., Edwards D. J., and Irani Z., “Moving beyond optimism bias and strategic misrepresentation: An explanation for social infrastructure project cost overruns,” IEEE Transactions on Engineering Management, vol. 59, no. 4, pp. 560–571, 2012.

[6] Ofori G., “Nature of the construction industry, its needs and its development: A review of four decades of research,” Journal of Construction in Developing Countries, vol. 20, no. 2, pp. 115–135, 2015.

[7] Kulkarni A. and Patil P., “Comparative study of Mivan technology and conventional construction method,” International Research Journal of Engineering and Technology (IRJET), vol. 8, no. 5, pp. 3245–3250, 2021.

[8] Sharma S. and Verma R., “Performance evaluation of Mivan formwork system in high-rise construction,” International Journal of Civil Engineering and Technology, vol. 11, no. 7, pp. 45–54, 2020.

[9] Kumar P. and Singh V., “Comparative analysis of Mivan technology over conventional construction techniques,” International Journal for Research in Applied Science & Engineering Technology, vol. 10, no. 6, pp. 1120–1128, 2022.

[10] Mivan Company Ltd., Mivan Aluminium Formwork System Technical Manual. Kuala Lumpur, Malaysia, 2021.

[11] Reddy K. and Rao P., “Productivity assessment of Mivan construction technology in residential projects,” International Journal of Engineering Research and Technology, vol. 9, no. 8, pp. 210–217, 2020.

[12] Construction Industry Development Board (CIDB), Industrialised Building System Roadmap 2016–2025. Kuala Lumpur, Malaysia, 2016.

[13] Ministry of Housing and Urban Affairs (MoHUA), Technology Sub-Mission under Pradhan Mantri Awas Yojana. New Delhi, India: Government of India, 2022.

[14] Gupta S. and Verma R., “Sustainability

assessment of aluminium formwork systems in modern construction," International Journal of Sustainable Construction Engineering and Technology, vol. 13, no. 1, pp. 78–89, 2022.

[15] Jadhav A., Patil S., and More R., "MEP coordination in high-rise buildings using integrated construction technologies," Journal of Building Engineering and Management, vol. 7, no. 2, pp. 55–64, 2023.

[16] Singh V., Sharma R., and Kumar P., "Structural performance evaluation of monolithic RCC wall systems under seismic loading," Materials Today: Proceedings, vol. 46, pp. 5478–5484, 2021.

[17] Deshmukh M. and Patil S., "Quality assessment of Mivan and conventional construction systems: A comparative study," International Journal of Advanced Structural Engineering, vol. 14, no. 3, pp. 301–312, 2022.

[18] Bureau of Indian Standards, IS 456:2000 – Plain and Reinforced Concrete: Code of Practice. New Delhi, India: BIS, 2000.