Need for Adoption of Versatile Formwork - MIVAN Technology

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Abstract -Construction is one of the significant components and Integral part for the contribution of Indian economy. A sustainable construction and its practice is one of the major supporting sector for development of any country.The various advancements and evolution of new trends on adoption of newer techniques help to increase efficiency and pave way for better Infrastructural growth. One such emerging trends are modification in conventional formwork to aluminium formwork. The paper intends to give a detailed discussion on Mivan shuttering - an aluminium formwork technique that is developed by Malaysian firm, which has been widely adopted around the world.

Key Words:Sustainable construction, Aluminium formwork, Mivan technique.

1. INTRODUCTION

As there is a high revolution in construction Industry, there are new techniques that rise to the trend. One such trend is adoption of right type of formwork. The conventional formwork materials such as timber, plywood and steel made the formwork heavy. Then the aim was to reduce the weight of materials used for formwork and now extended to materials such as Aluminium, Plastic , Glass, Fiber and etc. Aluform system provides formwork for Reinforced concrete load bearing or RCC framed multistored buildings and enables walls and slabs to be poured in same operation. This types of construction provides speed, high strength and quality of structure. Aluminium formwork also called as Mivan technology. This type of construction is a successful construction practices in East-Asia and Europe countries. Aluform construction is a load bearing structure and its components such as wall and slab are reinforced concrete structure, which enables it to show high earthquake resistant properties.

Aluform is a type of system for scheduling and controlling other construction activities such as steel reinforcement, concrete placement and mechanical and electrical conduits by cast in place concrete construction system. . This enables to restructure the entire conventional type of formwork and enables interaction among the design phase and construction planning in order to improve and speed up the construction. Hence the speed of construction by adoption of this system will surpass speed of most other construction methods. This paper aims to showcase the need and adoption of versatile Mivan formwork, comparing the aspects of project cost, project duration and quality of work obtained.

2. TRENDS IN CONSTRUCTION

Conventional method of construction that comprises of load bearing walls with an appropriate roofing would be totally inadequate for mass housing projects. Adding on to it such constructions are prone to poor quality control even in case of contractors with substantial resources and experiences.

For mass housing works its necessary that Innovative techniques are adopted which are capable of fast rate construction with good quality and durable in cost effective manner. Various systems are in vogue and trying to evolve. The are based on mode of construction such as precast or In-situ construction.

2.1. 3-S SYSTEM OF PRECAST CONSTRUCTION

The 3-S System was developed by B.G. Shirks Construction Tech Ltd. for achieving speed, strength and Safety with economy in construction practices. It involves series of activities such as:

- Cast in-situ sub-structure including foundations, stem columns, plinth beams, plinth masonry.
- Erection of partial pre-cast components, jointing of these components using cast in-situ concrete with appropriate reinforcement.
- Lying of reinforced cast in-situ screed over slab panels, construction of panels, construction of walling, flooring, plastering, water proofing etc.

This 3-S system of construction is very much effective in Mivan construction technology.

2.2. CAST IN-SITU CONSTRUCTION

It is quick mode and Fast track construction technique where wall panels and slabs are cast-in placed. Two types of materials such as Aluminium (MIVAN), Steel (Tunnel form) are used for formwork. The material should be selected such that it should be economical. Indian markets are now exposed to certain patent systems such as MASCON system (Canada) , MIVAN system (Malaysia). Here traditional walls and columns are eliminated instead walls and slabs are casted in one operation. Rapid construction of multiple units of repetitive type structure with few semi skilled labors is achieved through adoption of the Mivan technology.

3. LOADS ON FORMWORK

Design of formwork includes following into consideration:

- Self- weight of Formwork
- Weight of wet concrete
- Live load due to labour
- Impact on it due to pouring concrete and workmen on it
- Vibrations due to vibrators
- Hydrostatic pressure of concrete.

Table -1:Permissible loads and Deflection

Activity	Permissible Load	Permissible Deflection
Liveload including Impact	370 kg/m²	0.25 cm
Self weight of Joist	200kg/m²	0.25 cm

4. MIVAN - VERSATILE FORMWORK

The Aluminium forms are key player in industry for the construction of mass housing projects. This is one of the systems identified to be very much suitable for Indian conditions for mass housing construction where quality and speed can be achieved at high level.

4.1. SALIENT FEATURES OF MIVAN

- Aluminium Formwork system is highly suited to load bearing wall construction whereas conventional formwork with plywood and timber is not suitable to the high pressures of fresh concrete on the wall.
- Cost: Use of this formwork in load bearing design gives an average of 15% cost saving in the structure of the building and inccreased usable floor space of 8% over RCC design.
- Time: If it is assumed to be "X" days for the completion of a project through conventional formwork method, the same work is completed at the rate of 1/6th of x time.
- Labour: Due to simple procedure of assembling, only unskilled labour are required with minimal supervisions.
- Repetitions: The Aluminium formwork system is removable and can be reused approximately upto 200 - 250times with little maintenance.
- Erection: As the aluminium formwork is lightweight, no tower cranes are required unlike other formworks.
- Environmental Friendly: This type of formwork is environment friendly as there is no use of timber.
- Earthquake Resistance: The formwork gives cellular design resulting in the walls to provide support to the super structure on two directions. As a result. The structure are more resistant to earthquakes than conventional RCC framed structures.
- Scrap Value: Aluminium has higher scarp value, once after multiple use they can be given for scrap and yield high scrap value.

4.2. CONSTRUCTION SEQUENCE IN MIVAN

The construction activities are carried out in three stages:

- Pre - Concrete activities
- On- Concrete activities
- Post- Concrete activities

4.2.1. PRE - CONCRETE ACTIVITIES

1. Level Survey and Setting out.
2. Erect Formwork
3. Erect Deck Formwork
4. Setting Kickers

4.2.2. ON - CONCRETE ACTIVITIES

Other operatives should be on standby during concreting for checking pins, wedges and wall ties as the pour is in progress. Pins, wedges or wall ties missing could lead to a movement of the formwork and possibility of the formwork being damaged. This affected area will then required remedial work after striking of the formwork. Things to look for during concreting:

- Dislodging of pins / wedges due to vibration.
- Beam / deck props adjacent to drop areas slipping due to vibration.
- Ensure all bracing at special areas slipping due to vibration.
- Overspill of concrete at window opening etc.

4.2.3. POST - CONCRETE ACTIVITIES

1. Strike wall and deck form.
2. Clean, and stack formwork.
3. Strike kicker and wall Formwork.
4. Working platform and erect wall.

4.3. 4- DAY WORK CYCLE IN MIVAN

Table -2: Work cycle in Mivan Construction

DAY	ACTIVITY
DAY-1	Erection of Vertical reinforcement bars and one side of vertical formwork for part of one floor or the entire floor.
DAY-2	Erection of 2nd side of vertical formwork and set formwork for floors
DAY-3	Fixing reinforcement bars for floor slabs and together casting of walls and slabs.
DAY-4	Removal of Vertical formwork panels after 24hours and leaving props in place for another 7 days and floor slab formwork for 2.5 days.

Approximate time schedule for 1000-1080 sq.m. with formwork with 70-80cum. of concrete and reinforcement is

Table -3: Activity duration in Hours

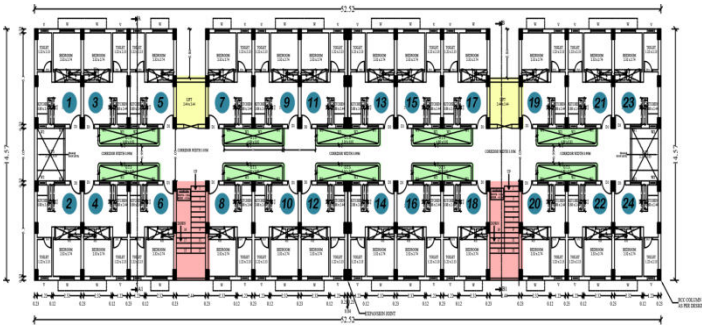
HOURS	ACTIVITY
12-15	De-shuttering of panels from existing structure
10-15	Positioning of brackets and platforms
7-10	Lifting and Erection of panels on floor
6-8	Wall shutters
10-12	Placement of Reinforcement bars
10	Fixing of electrical conduits
10-12	Rest time before shuttering

4.4. STRUCTURAL DESIGN OF MIVAN FORMWORK STRUCUTRE

The following plan of high rise residential building with G+7 floors with 192 units is built over plinth area 28.87sq.m is taken into consideration for structural design

After analysis and design of the structure using STAAD PRO the following results are listed below.

Plan -1 Floor plan



4.4.1. DESIGN OF RC WALLS

M25 grade of concrete and Fe 415 grade of steel is taken into consideration for the design.

- Determination of thickness of wall (t) = 200 mm.
- Reinforcement details

Provide 12mm diameter bar at 230mm centre to centre each at vertical direction.

Provide 12mm diameter bar at 1130.4mm centre to centre in horizontal direction.

4.4.2. DESIGN OF RC SLABS

- Load Calculations

  Dead Load = 4.5 KN/m²; Live Load = 4 KN/m²

  Floor Finish = 1.5 KN/m²

  Total Load = 10KN/m²

  Mux = 25.38 KNm.

- Calculation of steel (Ast) = 477 mm² with

  spacing 165mm and not exceeding 300mm.

- Load Calculations

  Dead Load = 2.75 KN/m² Live Load = 4 KN/m²

  Floor Finish = 1.5 KN/m²

  Total Load = 8.25KN/m²

  Mux = 15.40 KNm.

- Calculation of steel (Ast) = 612 mm².

5. COMPARITIVE ANALYSIS OF MIVAN WITH CONVENTIONAL FORMWORK

The comparative analysis focuses on factors of consideration such as:

- ✓ Cost
- ✓ Duration
- ✓ Quality

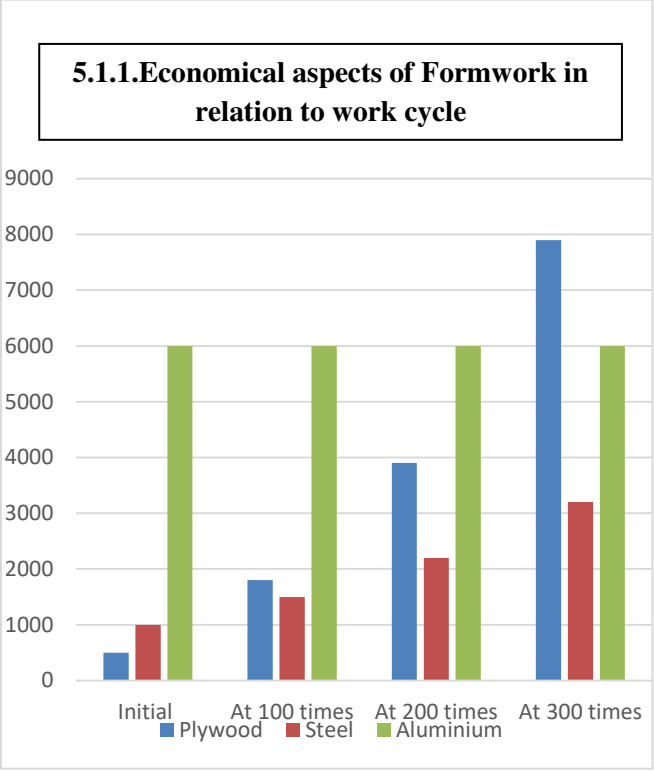
5.1. COST COMPARISION OF MIVAN

The cost of construction unit using aluminium shuttering depends on the repetition and duration of the project. Usually formwork can be reused over 250 times, hence this reduces the initial cost per unit area of formwork when compared to conventional methods. The various reasons for reduction of cost are as follows:

- ➢ There is cost reduction due to the elimination of brick/block work plastering and time that is involved in such activities.
- ➢ Due to adoption of shear wall concept there is reduced masonry and plastering work along with larger need for shuttering.

- Aluform provides integrated scaffolding system that reduces the cost of scaffolding equipment.
- Mivan formwork is economical when floors are typical and due to utilization of unskilled labour cost of Mivan is slightly less when compared to conventional.
- Aluform shuttering are more durable as they could be used with maximum repetition of 300 times where as there is only maximum repetition of 10 times in conventional formwork hence making Aluform more economical.

Chart - 1: Economical aspects of formwork in relation to work cycle.



The chart shows the aluminium formwork is economical when the use of cycle.The steel formwork is economical than the other formwork.

5.1.1. COST ANALYSIS BY LABOUR AND MATERIAL PER UNIT

Table -4: Cost variation for Labour and Material

CONTENT	MIVAN	CONVENTIONAL
Shuttering and Initial Cost	Rs. 85/ sq.m	Rs. 200/sq.m
Concreting	Rs. 1500/sq.m	Rs. 1400 /sq.m
Reinforcement	Rs.2000/sq.m	Rs 1500/sq.m
Brickwork	Rs.0	Rs 480.00/Sq.m
Plastering	Rs.0	Rs 700/Sq.m
Skilled Labour cost	Rs.470/day	Rs.650/day
Unskilled Labour cost	Rs.350/day	Rs.400/day

5.1.2. COST COMPARISION OF FORMWORK

Table -5:Initial cost of formwork

S.NO	FORMWORK	RATES
1	WOODEN	Rs.3000/sq.m.
2	STEEL	Rs.4500/sq.m.
3	ALUMINIUM	Rs.7500/sq.m.

5.1.3. SCRAP VALUE OF FORMWORK

Table -6: Scrap value of formwork

S.NO	FORMWORK	SCRAP VALUE IN %
1	CONVENTIONAL	10
2	STEEL	30
3	ALUMINIUM	50

5.2. COMPARISION OF PROJECT DURATION

With the help of case study of site with plinth area of 270sq.ft constructed under Pradhan Mantri Awas Yojana (Gramin)scheme from thingalore, we infer the following results on project duration of both conventional and Mivan formwork of construction.

Table -7: Duration of project by Conventional Method

ACTIVITY	No. of Days
Masonry(excavation, filling, flooring)	7
Brick masonry till lintel level	3
Lintel work(shuttering, concreting, curing)	6

Brick masonary till roof level	1
Curing process	7
Roofing concreting(shuttering,reinforcement)	5
Concrete curing	21
Deshuttering and parapet wall	2
Plastering	4
TOTAL	56

Table -8: Duration of project by Mivan Method

ACTIVITY	No. of Days
Masonry(excavation, filling, flooring)	7
Plinthbeam(shuttering, reinf.,concreting)	2
Shear wall reinforcement erection	2
Wall shuttering and roof shuttering	2
Roofing reinforcement and electrical	2
Concreting	1
Deshuttering and wall panels and roof slab	2
TOTAL	18

5.3. QUALITY OF WORK OBTAINED FROM MIVAN FORMWORK

- The Quality of work obtained through Mivan formwork is superior. In-situ casting of whole structure and transverse walls done in a continuous operation, using controlled concrete mixers obtained from central batching, mixing plants and mechanically placed through concrete buckets using crane and compacted in leak proof moulds using high frequency vibrators.
- The Room-sized wall panels and the ceiling elements cast against steel plates have smooth finishing and the interiors have neat and clean lines without unsightly projections in various corners. The walls and ceiling also have smooth even surfaces, which only need colour/ white wash.
- Textured/pattern coloured concrete facia can be provided. This will need no frequent repairing.
- The walls and ceiling being smooth and high quality concrete repairs for plastering and leakage's are not frequently required. It can be concluded that maintenance cost is negligible.

5.4. COMPARISION TABLE

From the results obtained on Investigation we can give a conclusion comparison of Mivan and Conventional formwork as:

Table -9: Comparison of Mivan over Conventional

PARAMETER	CONVENTIONAL	MIVAN
Initial Investment	Low	High
Repetition	5-8 times	150-200 times
Durability	Less	High
QualityOf Surface Finish	Plastering is required for best out finish	Plastering is not required. Excellent finishing is obtained
Labour	Skilled labour required	Semi-Skilled labour
Cycle Time	3-4 weeks cycle is adopted.	4-8 days cycle adopted
EconomyIn Construction	Economical on small scale construction.	Economical on Mass housing projects and Repetitive housing projects.
Wastage Of Formwork Material	High wastage	Very low wastage
Scrap value	5-10% of Initial cost	30-50% of Initial cost.

6. ISSUES FACED IN MIVAN CONSTRUCTION

Due to complexity of reinforcement and less thickness of wall there are various deficiencies faced when adopting the technique. These problems need to be tackled in effective way to ensure quality and safety of structure. The problems can be reduced by improving concrete characteristics.

Problem Statement

1. Honey combing and segregation occurs due to less thickness of wall and due to high density of reinforcement at corners.

2. Shrinkage cracks are likely to occur

In Mivan Technology of construction the concrete is placed from height of 3 meter in shear wall and compacted using vibrator, now as height of placing concrete is more there are chances of segregation in concrete resulting in honeycombing and cracks in wall. In mivan construction it is generally happened that after removing formwork there is honeycombing in shear wall. This deficiency can be arrested by the use of MasterGlenium ACE 30JP as admixture to concrete so as to increase the work ability of concrete to reduce honeycombing and increase the strength of concrete.

Specification of MasterGlenium ACE 30JP

Appearance: Brownish Liquid

Specific gravity -1.02 g/cm3

pH Value: 6-9

7. CONCLUSIONS

From the results obtained we conclude that Mivan construction technique is one such systems that are identified to be very much suitable for India conditions for mass construction where quality and speed can be achieved at high level. From the results obtained, it results that speed of construction by this system surpass speed of most of the other construction methods. The labour handles in this method is found to be effective to speed up the construction to assure quality control and durability. From the results we can assure derive that adoption of this system reduces overall cost of structure. The below listed are few salient aspects that are observed as a result of the project that make Mivan superior formwork system:

1. Achieving quality objective of planning department.

2. Minimize project duration, schedule and labour requirement.

3. Easy handling of Mivan shuttering.

4. Higher durability of Mivan shutters.

5. Cost effective than conventional method.

6. Scrap value for Aluminium shutters is obtained.

Thus we have tried to cover each and every aspects related to Mivan types of construction and thus we infer that Mivan form of construction is able to provide high quality construction at higher speed under reasonable cost.

Thus we conclude that quality and speed must be given due consideration with regards to economy. Good quality construction will never deter to speed of the project speed nor be uneconomical. Poor quality construction result in time consuming repair and modification along with financial impacts on project. Therefore it is suggested to adopt housing alternatives with low maintenance required to be preferred even if there is higher initial cost.

REFERENCES

1. Mayank Patel, Prof. Jayeshkumar Pitroda, Prof. J.J Bhavasar.: Recent Scenario in formwork : Aluminium formwork. International conference on “Engineering: Issues, opportunities and challenges for Development.
2. M.Sandeep, S.Suriya Prakash, M.Vetrivel, R.Ranjani: Comparison of conventional building and Mivan formwork building based on scheduling. International Journal Intellectual advancements and Research in Engineering Computations.
3. V.Adithya, Dr. S.Anandakumar: Scope of aluminium formwork technology in affordable housing scheme based on cost and duration. International Journal of Advanced science and Engineering Research.
4. Naveen V.Chikkaveerayanavar, Naresh Patil: Planning and Scheduling of shuttering system for Multi-stored building. International Research Journal of Engineering and Technology.
5. Shankar Bimal Banerjee, Pawan Dilip Barhate, Vipul Pradip Jaiswal: Mivan Technology, International Journal of Innavations in Engineering Research and Technology.
6. Danish Sadruddin Ansari, Pratik Sudhakar Kudale: Comparative analysis of Mivan formwork building and Conventional formwork building based on cost and duration: International Journal of Engineering and Research.
7. N.Kalithasan, K.Shanthi, B.Jose Ravindraraj, R.Vijayasarathy: Structural design of Aluminium formwork structure over framed structure: International Journal of Advanced Research in Biology engineering science and technology.