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A Study on Construction of Multi-Storeyed Residential Building using Monolithic Concrete Construction (Mivan - Shear Wall) Technology

Yuvaraj K[1], **Santhosh L**[2]

[1] Assistant Professor, Department of Civil Engineering,K.S.Rangasamy College of Technology, Tiruchengode, Tamilnadu, India
[2]Bachelor of Engineering, Department of Civil Engineering, K.S.Rangasamy College of Technology, Tiruchengode, Tamilnadu, India

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Abstract - RC shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Shear walls are more effective when located along exterior perimeter of the building such a layout increases resistance of the building to twisting. Shear walls are generally casted monolithically, in this type of construction the beams and columns are placed inside the walls so that you can never find beams inside any floor in this type of construction. So, it is commonly known as "Monolithic Concrete Construction Technique".MivanFormwork Shuttering is a fast-paced construction technology which offers strength and durability to a building by use of Aluminum Framework System. With a growing focus on affordable homes and housing for all, there is increasingly emphasizing on the use of new and innovative construction techniques. One such technology is MivanFormwork Shuttering which is being promoted for its ability aid mass construction activity.

Keywords:Mivan formwork, Shear wall, wall panel, RCC, Seismic resistant, Monolithic construction

I. INTRODUCTION

Shear wall (Mivan) Technology reduces the construction time by almost the half in comparison to conventional practices. It minimizes the need of skilled labour and completely eliminates the labour intensive activities such as masonry and rendering. On the structural front, the technology makes the buildings more seismic-resistant and durable, since there are lesser number of joints, the building faces reduced leakages, hence requiring negligible maintenance. There is uniformity in the Mivan construction and the walls and slabs, have a smooth finish. Moreover, the Technology gives the scope to take out more 'carpet areas' in comparison to conventional technologies.Conventional type of foundation such as wall strip foundation or Raft or Isolated footing based on soil conditions and safe bearing capacity of soil will be used. RCC is the primary material used in this type of monolithic construction. Walls are designed as shear walls using limit state method as per the standard design equations given in IS 13920 and IS 456. Slabs are being designed as per IS 456. Element thickness (walls, slabs and beams) are chosen based on fire rating and structural requirements. Limit state of strength is used for the structural design of various elements of the housing units. Limit state of serviceability (stability, cracking and defection) will be used for ascertain durability criteria.RCC is intended to be used in the proposed project guidelines confirming to the IS456, IS1390, IS 875, IS 1893 are followed to design the structure.

II. MIVAN FORMWORK

Mivan formwork is the advanced formwork system made of strong and sturdy aluminum components that has great strength, durability, simple to install, adaptable and is used in the construction of residential units and mass housing projects.Mivan technology is mostly suitable for constructing large number of houses in a short span of time using room size forms to construct walls and slabs in one continuous pour on concrete. Aluminum formwork is very cost effective for repetitive Building layouts and for above the plinth work. This system is very unique as all the components in a buildings, including slabs, beams, walls, columns, staircases, balconies and special window hood are of concrete and there is no need for block works or brick works.

a) Components of Mivan Formwork

It consists of four components Beam components, Deck components and wall components these all are made of high strength aluminium alloy. The modular nature of the Mivanaluminium formwork system allows easy assembling and removal of formwork. The construction can proceed speedily with very little deviation in dimensional tolerances. This System is quite flexible and can be easily adapted for any variations in the layout.

1. Wall Components :

- Wall Panel :The basic and major component of Mivan formworks is the wall panels. It forms the face of the wall made out of an aluminum sheet properly cut to fit the exact size of the wall.
- Rocker :Rocker is an L-shaped panel having allotment holes for stub pin to support the wall panels.
- Kickers :It acts as a ledge to support the wall panels by forming a wall face at the top of the panel.
- Stub Pin :It is the joining component of all other wall components.

2. Beam Components

- Beam Side Panel :It is a rectangular structure cut into the required size of the beam which forms the sides of the beams.
- Prop Head and Panel for Soffit Beam :In the beams, where there is no support from the bottom, prop heads are used to support the beam. It has a V-shaped head for easy dislodging of the formwork. Soffit beam panel is a rectangular aluminum structure placed in the prop head to support the soffit beams.

3. Deck Components

- Deck Panels :A horizontal flat surface upon which the slab is cast.
- Deck Prop and Prop Length :Deck prop is the same as that of beam deck prop, here it is used to support the slab and bears the load coming on the deck panel. Prop lengths are the vertical support to the deck prop which are adjustable as per the slab height.
- Soffit Length :Soffit length provides support to the edge of the deck panels at their perimeter of the room.

4. Other Components

The other components used excluding wall, beam and deck components are internal and external soffit corners, exterior and interior corners for wall panels.

Figure 1 : Mivan Components

III. PROCESS OF MONOLITHIC CONCRETE CONSTRUCTION

1) Shear Wall Reinforcement

In Mivan formwork, the stress distributed on shear wall rather than conventional framed structure of columns and beams. The wall reinforcing steel is used to give a structure to the building and support the concrete until they gain half of the required strength. The aluminium formworks are cast around the steel mesh, which is factory made and directly erected on the construction site. The Main horizontal reinforcement bars are provided at the lintel level which acts like a beam and it is also provided at the sill levels to resist the external loads. The main vertical reinforcement bars are provided at the end sheathing corners of wall panel.

RC shear walls reduces lateral sway which prevents the structure from the seismic forces. In the case of RC moment-resisting framed structures, the horizontal forces due to windor earthquake are resisted by the frames resulting in the bending moments in columns toresist bending moment and vertical loads would be more than that required to resistvertical loads without bending moment. Similarly, additional reinforcement will berequired in beams at supports. In the case of RC load-bearing walls, monolithic casting of slab along with RCwalls results in a box type structure, which is very strong in resisting horizontal forcesdue to wind or earthquake. In view of large depth of shear walls, the resulting stressesdue to bending moment and vertical loads are smaller and in many cases, concrete aloneis capable of resisting these forces.

Figure 2 : Shear Reinforcement

2) Placement of Mivan Formwork

Mivan aims in using modern construction techniques and equipment in all its projects. On leaving the Mivanfactory all panels are clearly labeled to ensure that they are easilyidentifiable on site and can be smoothly fitted together using the formwork modulationdrawings. All formwork begins at a corner and proceeds from there. Mivan formwork is majorly used in the places where the whole structures made of concrete. All formwork is cleaned and coated with an approved realize agents.The wall reinforcing steel is placed with the floor slab.Along with the wall reinforcing steel, prefabricated room-sized walls panels and floor slabs panels are erected.Plumb, level, and dimensions are checked.The aluminum alloy slabs are accurately made as per the required sizes.Spaces for windows, ducts, doors and other features such as staircases, façade panels, and chajjas are also integrated into these structures.The forms are then joined together using the pin and wedge system, which can be dismantled quickly after the concrete structure is made.

Figure 3 : Erection of Formwork shuttering

3) Pouring of Concrete

After casting the forms, high-quality Self Compacting concrete of grade M30 is poured. This concrete takes the form and shape of the cast. At least two operatives should be on standby during concreting for checking pins, wedges and wall ties as the pour is in progress. Special attention to be given while pouring concrete for dislodging of pins/wedges, slipping of props or overspill of concrete at openings. The design criteria for the structural elements are described as shown below,

a) All Structural Concrete of Cube Crushing Strength at 28 days for Columns, RC Core Walls & Shear wall are
   - Ground Floor to Terrace Floor Level = M30 (30 N/sq.mm)
   - Foundation to Ground Floor = M40 (40 N/sq.mm)

b) Plain Cement Concrete should have Cube Strength of 20 N/sq.mm at 28 days.

Table 1 : Design proportions of RMC

COMPONENTS	M30 KG	M40 KG
CA I	526	494
CA II	564	529
M SAND	710	636
CEMENT	326	433
GGBS	94	126
WATER	180	180
ADMIXTURE	8-1.2%	8-1.2%
W/C RATIO	0.42	0.32

Figure 4 : Concrete Pouring work

4) Striking of Formwork

Normally all formwork can be struck after 12 hours of concreting. First, the wall formwork is strike down, followed by deck formwork. The removed formwork is cleaned with scrapers and wire brushes as soon as they are struck. Once cleaned, it is transported and stacked properly for the next use.Duration Period for De-shuttering/striking of formwork as shown below

a. Slab = 36 hours (10 N/mm^2)
b. RC Wall = 12 hours (2 N/mm^2)

Each floor can be completed within the period of 7 days.

Figure 5 : Striking of Mivan Formwork

IV. RESULTS AND DISCUSSION

As a result, the Mivan formwork technology have various features when compared to the conventional system. In this system, the walls and floor are casted together in one continuous operation in matter of few hours and in built accelerated curing overnight enable removable and reuse of forms on daily cycle basis. Some of the eternal features of the mivan formwork are,

- **Load Carrying Capacity** :The load-carrying capacity of Mivan formwork is 7-8 Tonnes per square meter. Mivan formwork is lightweight and weighs around 18-20 kg per meter square.
- **Striking Time** :The striking time of vertical (wall) formwork is 12 hours after concreting or when concrete strength has reached 2N/mm2 and horizontal (deck) formwork is 36 hours after concreting or when concrete strength has reached 10N/mm2.
- **Durability**: As the panels of Mivan formwork are made of structural grade aluminum alloy, they are very durable and sturdy. A single component can be repeated around 200 times.
- **Cycle Time** :High speed of construction can be achieved by this system that means faster completion of the project. Approximately, the times required to cast floor is 7 days with the use of Mivan formwork.

V. CONCLUSION

Traditionally, construction firms all over the world have been slow to adopt the innovation and changes. Contractors are a conservative lot. It is the need of time to analyze the depth of the problem and find effective solutions. Mivan serves as a

cost effective and efficient tool to solve the problems of the mega housing project all over the world. Mivan aims to maximize the use of modern construction techniques and equipments on its entire project. This technology has great potential for application in India to provide affordable housing to its rising population. Thus it can be concluded that quality and speed must be given due consideration with regards to economy. Good quality construction will never deter to projects speed nor will it be uneconomical. In fact time consuming repairs and modification due to poor quality work generally delay the job and cause additional financial impact on the project. Eventhough, this method has enormous features but it has some backlogs such as modifications after casting is difficult due to monolithic structure, it should be pre-planned and this method is highly preferable for mass structures like high rise buildings.

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