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Comparative Study of Various Types of Aluminium Formworks

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Abstract: The construction industry is rapidly changing. With-changing times, new processes and the materials are being used. A lot of research and development is carried out in the construction industry throughout the globe. Time, economy and utility of space have become the important aspects of the construction industry. Formwork systems are among the key factors determine the success of a construction project in terms of Speed, Quality, Cost, and Safety of work.

The significant uses of advanced formwork are not only usable for complex construction processes but also results in the cost effectiveness of this economy of construction industry. Therefore Aluminium Formwork identified to be suitable for Indian conditions for mass construction where quality and speed can be maintained at a reasonably high level. This paper deals with the comparison of various types of Aluminium formwork systems with conventional formwork.

key words — Aluminium Formwork(AF), Cost Effectiveness, Time Effectiveness

Objective of study:

To compare the aluminium formworks on the basis of

1) Cost Parameter,

2) Time parameter,

Relevance of Study:

Concrete is a basic building material of our everyday world. It's used in almost every type of structure that we build today. Formwork is a structure, usually temporary, used to contain poured concrete and to mold it to the required dimensions and support until it is able to support itself.

Today the construction and maintenance becoming complicated, new techniques have evolved in order to keep speed with changing demands. Today the contractor is facing tight construction schedules and increasing labour costs. The major element in construction cycle is time, so now it's essential to adopt the new technologies for better and quicker construction results. Timber is used as conventional material for formwork, but it suffers disadvantages of warping, deterioration with exposure to heat and moisture, due to these problems there is need of advancement in technology with new materials like Aluminium.

I. INTRODUCTION

"Formwork is the term given to either temporary or permanent moulds into which concrete or similar materials are poured".

In the present construction the cost of formwork may differ 20% to 65%, in case of fears competition contractor is always trying to complete the project in time with better & acceptable quality without line & level. If at all you want to make tool to effective shuttering the line, level or quality of concrete is increased the costs for touchup will n times high, again that may becomes the problem for sustainability & durability of structure. Hence in incent time lots of advancement has taken place in case of formwork

technology. The world is moving basically from Timber to Steel & now from Steel to Aluminium. For AF the advantage is lightweight & more the number of usages.

In the world of competition the contractor is trying to reduce the cost of the formwork to reduce the cost of the product. But the reduction in cost of the product may leads to the problem of unevenness, honeycombing, and lack of levels & lines. To avoid this new development is taken place in the form of AF.

A lot of research and development is carried out in the construction industry throughout the globe. Time, economy and utility of space have become the important aspects of the construction industry so the formwork companies are making all efforts to innovate new systems for better and quicker results. Taking cue from the developed world, Indian construction industry has started using some of the world class technologies. Several formwork systems are in use at different places in the world, eventually the systems which are reasonably economical and easy for operation with skilled labour are more useful in India. Leading players in this industry are Doka, Mascon System, MFE Formwork Technology (Mivan), Meva, Waco, Forming Access and Support, Inc (FASI), Peri, BSL Scaffolding, Uday Structural's & Engineers, Paschal and Pranav Construction Systems.

In India many housing projects are coming up to meet the requirement of shortage of housing. There is need to have enhance the quality and timely completion of the project, there always reduce the cycle time of formwork for timely completion, for which new technology i.e. AF will help.

The traditional system i.e. Timber formworks are using. The more number of labours are required to assembling, disassembling, cleaning and storing of wooden formwork. Formwork, this traditional method of construction for large housing is comparatively a slow process and has limited quality control. Another demand for future formwork systems is the need of labour saving because of scarcity of skilled labours and increasing in labour costs. It is therefore obligatory to work out a method or scheme for systematic approach, for which AF will really help.

1.1 Aluminium Formwork System:

Aluminium Formwork System is one of the systems identified to be very much suitable for Indian conditions for mass construction, where quality and speed can be achieved at high level. Aluminium Formwork is successfully used in Japan, Singapore, Malaysia and the Middle East for the construction of apartments and buildings, both low and high rises. The speed of construction by this system will surpass speed of most of the other construction methods and technologies. The labour handles this method effectively to speed up the construction, to assure quality control and durability. Adoption of this system reduces overall cost of the structure.

Since the formwork is made of aluminium, it has sections that are large enough to be effective, yet light enough in the weight to be handled by a single worker. Individual workers can handle all the elements necessary for forming the system with no requirement for heavy lifting equipment or skilled labour. By ensuring repetition of work tasks on daily basis it is possible for the system to bring assembly line techniques to construction site and to ensure quality work, by unskilled or semi-skilled workers.

Trial erection of the formwork is carried out in factory conditions which ensure that all components are correctly manufactured and no components are missed out. Also, they are numbered and packed in such a manner so as to enable easy site erection and dismantling.

1.2 Different Types of Aluminium Formwork:

Basically aluminium formwork is differentiated on the basis of manufactures or company or brand name. MIVAN is first manufacturer who introduced aluminium formwork. Mivan is basically an aluminium formwork system developed by one of the construction company from Europe. In 1990, the Mivan Company Ltd from Malaysia started the manufacturing of such formwork systems. Now days more than 30,000 sq m of formwork used in the world are under their operation. Kumkang kind is another type which started in Korea in 1992. Kumkang is an upcoming technology which has empowered and motivated the mass construction projects throughout the world.

In India there are number of buildings constructed with the help of the above systems which has been proved to be very economical and satisfactory for Indian Construction Environment.

1.3 Components of Mivan and Kumkang Kind of Aluminium Formwork:

Aluminium as usual is not a very strong material, so the basic element of the formwork system is the panel which is a formwork of extruded Aluminium sections welded to an Aluminium sheet. It consists of high strength special Aluminium components. This produces a light weight panel with an excellent stiffness to weight ratio, yielding minimal deflections when subjected to the load of weight concrete. The pan sizes with non-standard elements produced to the required size and size to suit the project requirements. In Aluminium formwork stress gives on shear wall rather than conventional framed structure of column and beams.

The panels of aluminium formwork are made from high strength aluminium alloy, with 4mm thick skin plate and 6mm thick ribbing behind to stiffen the panel. The panels are held in position by a simple pin and wedge arrangement system that walls are together with high strength wall ties, while the decks are supported by beam and props.

The technology has been used extensively in other countries such as Europe, Gulf Countries, Asia and all other parts of the world. Aluminium Formwork technology is suitable for constructing large number of houses within short time using room size forms to construct walls and slabs in one continuous pour on concrete. Early removal of forms can be achieved by hot air curing / curing compounds. This facilitates fast construction, say two flats per day. All the activities are planned in assembly line manner and hence result into more accurate, well – controlled and high quality production at optimum cost and in shortest possible time.

In this system of formwork construction, cast – in – situ concrete wall and floor slabs cast monolithic provides the structural system in one continuous pour. Large room sized forms for walls and floors slabs are erected at site. These forms are made strong and sturdy, fabricated with accuracy and easy to handle. They afford large number of repetitions (around 250). The concrete is produced in RMC batching plants under strict quality control and convey it to site with transit mixers.

The frames for windows and door as well as ducts for services are placed in the form before concreting. Staircase flights, façade panels, chajjas and jalis etc. and other pre-fabricated items are also integrated into the structure. This proves to be a major advantage as compared to other modern construction techniques.

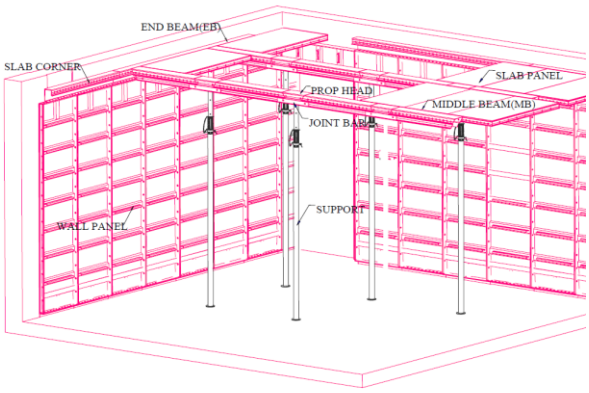

Fig 1 Assembling of components of AF

1.4 Construction Activities with Aluminium Formwork:

The construction activities are divided as pre – Concrete activities, during concreting and post – concrete activities. They are as follows:

1.4.1 Pre – Concrete Activities:

1 Receipt of Equipment on Site – The equipment is received in the site as ordered.
2. Level Surveys – Level checking are made to maintain horizontal level check.
3. Setting Out – The setting out of the formwork is done.
4. Control / Correction of Deviation – Deviation or any correction are carried out.
5. Erect Formwork – The formwork is erected on site.
6. Erect Deck Formwork – Deck is erected for labours to work.
7. Setting Kickers – kickers are provided over the beam.

After the above activities have been completed it is necessary to check the following.

i. All formwork should be cleaned and coated with approved realize agent.
ii. Ensure wall formwork is erected to the setting out lines.
iii. Check all openings are of correct dimensions, not twist.
iv. Check all horizontal formwork (deck soffit, and beam soffit etc.) in level.
v. Ensure deck and beam props are vertical and there is vertical movement in the prop lengths.
vi. Check wall ties, pins and wedges are all in position and secure.
vii. Any surplus material or items to be cleared from the area to be cast.
viii. Ensure working platform brackets are securely fastened to the concrete.

1.4.2 On Concrete Activities:

At least two 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 require remedial work after striking of the formwork.

Things to look for during concreting:

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

1.4.3 Post – Concrete Activities:

1. Strike Wall Form- It is required to strike down the wall form.
2. Strike Deck Form- The deck form is then removed.
3. Clean, Transport and stack formwork.
4. Strike Kicker Formwork – The kicker are removed.
5. Strike wall – Mounted on a Working Platform the wall are fitted on next floor.
6. Erect Wall – Mount Working Platform and the wall is erected

1.5 Speed Of Construction:

Aluminium Formwork is a system for scheduling & controlling the work of other connected construction trades such as steel reinforcement, concrete placements & electrical inserts. The work at site hence follows a particular sequence. The work cycle begins with the deshuttering of the panels. It takes about 12-15hrs. It is followed by positioning of the brackets and platforms on the level. It takes about 10-15hrs simultaneously.

The deshuttered panels are lifted & fixed on the floor. The activity requires 7-10 hrs. Kicker & External shutters are fixed in 7 hrs. The wall shutters are erected in 6-8 hrs One of the major activity reinforcement requires 10-12 hrs. The fixing of the electrical conduits takes about 10 hrs and finally pouring of concrete takes place in these.

This is a well synchronized work cycle for a period of 7 days. A period of 10-12 hrs is left after concreting for the concrete to gain strength before the beginning of the next cycle. This work schedule has been planned for 1010-1080 sq.m. of formwork with 72-25cu m of concreting & approximate reinforcement.

The formwork assembling at the site is a quick and easy process. On leaving the MIVAN factory all panels are clearly labeled to ensure that they are easily identifiable on site and can be smoothly fitted together using formwork modulation drawings. All formwork begins from corners and proceeds from there.

The system usually follows a four day cycle:

Day 1: The first activity consists of erection of vertical reinforcement bars and one side of the vertical formwork for the entire floor or a part of one floor.

Day 2: The second activity involves erection of the second side of the vertical formwork and formwork for the floor.

Day 3: Fixing reinforcement bars for floor slabs and casting of walls and slabs.

Day 4: Removal of vertical form work panels after 24hours, leaving the props in place for 7 days and floor slab formwork in place for 2.5 days.

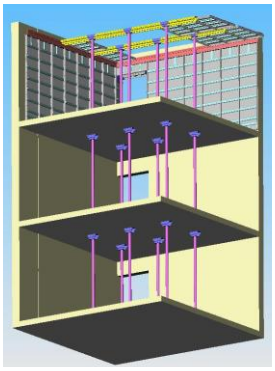

Fig. 2 Two Levels of prop

II Case Study:

2.1 Mivan Formwork:

1. Project Name - Blue Ridge
2. Address - Paranjape Schemes Venture, S.No.173, Rajiv Gandhi Infotech Park, Phase-1, Hinjewadi, pune.
3. Owner - Paranjape Schemes
4. Architect - ECADI, China.
5. Consultant - JW Consultant
6. Formwork System - MIVAN Technology
7. Built-Up Area - 36800 Sq.m.
8. Towers - 5 Towers with Thirty Floor each.
9. Construction Cost – 8331 per Sq.m.

In cost analysis, we got the results as total project cost for Mivan formwork as 43,48,67,287/- and total project cost for Conventional Formwork (Wooden) as 62,35,21,264 /-.So cost saving by Mivan formwork is 18,86,53,977/- and total Time saving by using Mivan formwork are 2.6 years than using conventional wooden formwork.

2.2 Kumkang Kind Formwork:

1.Project Name - Nanded City
2. Address - Nanded City, beside Lokmat press,S hihgad Road, Nanded, Pune.
3. Owner - Mr. Satish Magar
4. Architect - ECADI, China.
5. Consultant - JW Consultant
6. Formwork System - KUMKAND KIND Technology.
7. Built-Up Area - 21578 Sq.m.
8. Towers - 7 Towers with Twenty Two Floor each
9. Construction Cost - 12912 per Sq.m.

In cost analysis, we got the results as total project cost for Kumkang Kind formwork as 62,14,02,123.72/- and total project cost for Conventional Formwork (Wooden) as 74,77,3,341.58 /-. So cost saving by Kumkang Kind formwork is 12,63,21,217.86/- and total Time saving by using Kumkang Kind formwork are 2.7 years than using conventional wooden formwork.

2.3 The Advantages of Kumkang and Mivan over Conventional Formwork:-

1. More seismic resistance: - The box type construction provides more seismic resistance to the structure.
2. The durability of a complete concrete structure is more than conventional brick bat masonry.
3. Lesser number of joints thereby reducing the leakages and enhancing the durability.
4. Due to shear walls, the walls are thin thus getting increasing area.
5. Integral and smooth finishing of wall and slab

6. Uniform quality of construction – Uniform grade of concrete is used.
7. Strong built up of concrete needs no maintenance.
8. Unsurpassed construction speed can be achieved due to light weight of forms.
9. Less labour is required for carrying formworks.

Quality and speed must be given along with economy. Good quality construction will never deter to projects speed nor should it be uneconomical. In fact, time consuming repairs and modifications due to poor quality work generally delay the job and cause additional financial impact on the project. Some experts feel that housing alternatives with low maintenance requirements may be preferred even if the initial cost is high.

2.4 Limitations:

Even though there are so many advantages of AF the limitations cannot be ignored. However the limitations do not pose any serious problems. They are as follows: -

1. Because of small sizes finishing lines are seen on the concrete surfaces.
2. Concealed services become difficult due to small thickness of components.
3. It requires uniform planning as well as uniform elevations to be cost effective.
4. Modifications are not possible as all members are caste in RCC.
5. Large volume of work is necessary to be cost effective i.e. at least more than 100 repetitions of the forms should be possible at work.
6. Architectural changes not possible on the structure.
7. Reinforcement will be congested in the lower floors up to 4th floor thus max. Slump (200mm) is required, so cement content will be increased.
8. Due to tremendous speed of construction, working capital finance needs to be planned in advance.
9. Number of holes will be more in the vertical wall, outer wall which is in direct contact with the rain, hole should be grouted by Non Shrink compound.
10. The formwork requires number of spacer, wall ties etc. which are placed @ 2 feet c/c; these create problems such as seepage, leakages during monsoon.
11. Due to box-type construction shrinkage cracks are likely to appear.
12. Heat of Hydration is high due to shear walls.

III Conclusion :

The task of housing due to the rising population of the country is becoming increasing.

The modern methods of construction such as 'Aluminium formwork system' are the key to meeting the demand for efficient, sustainable housing.

Aluminium formwork construction system is able to provide high quality construction at unbelievable speed and at reasonable cost. This technology has great potential for application in India to provide affordable housing to its rising population.

In the Aluminium Formwork System, the overhead charges reduce subsequently because of its fast construction. The conventional system required a large number of skilled labours to construct timber formwork for the construction of one particular level. This may cause to an extension of construction period for the project.

Traditional formwork can be repeated only 7-8 times, but Aluminium Formwork can be repeated 250 times.

Aluminium Formwork system overcomes the problem of time consuming repairs and modification due to poor quality work, it generally delay the job and cause additional financial impact on the project.

Thus, the Aluminium Formwork system that being selected for the construction can be said the most appropriate system for a high-rise building.

Aluminium Formwork system is only economical when number of repetitions are more. When numbers of repetitions are less the conventional formwork system is economical.

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