COMPARISON OF THE USE OF ALUMINIUM AND
ONVENTIONAL FORMWORK SYSTEMS

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Abstract: Formwork systems are among the key factors determining the success of a construction project in terms of speed, quality, cost and safety of works. Nowadays, most projects are required by the client to complete in the shortest time possible as a means to minimise costs. For high-rise buildings, the most effective way to speed up works is to achieve a very short floor cycle — to have the structure of a typical floor completed in the shortest time.

This paper aims to compare the aluminum formwork system and conventional formwork system on the basis of cost and time parameter.

Keywords: Cost effectiveness, Reduce time, Improve quality.

1. INTRODUCTION

The Aluminium Formwork System was developed by W. J. Malone, a Canadian Engineer in the late 1970s as a system for constructing low–cost housing unit in developing countries. The units were to be of cast-in-place concrete, with load bearing walls using a formwork of aluminium panels. To be erected by the hundreds, of a repetitive design, the system ensured a fast and economical method of construction. The in-situ construction of all walls and partitions reduces the requirement for followon wet trades. The concrete surface finish produced with the aluminium forms allows achievement of a high quality wall finish without the need for extensive plastering.

This 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. The speed of construction by this system will surpass speed of most of the other construction methods/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.

2. CONVENTIONAL FORMWORK

This usually consists of standard framed panels tied together over their backs with horizontal members called waling. The waling is provided with the basic function of resisting the horizontal force of wet concrete. One side of the wall formwork is first
assembled ensuring that it is correctly aligned, plumbed and strutted. The steel reinforcement cage is then placed and positioned before the other side of the formwork is erected and fixed. Plywood sheet in combination with timber is the most common material used for wall formwork. The usual method is to make up wall forms as framed panels with the plywood facing sheet screwed on to studs on a timber frame. This allows for the plywood to be easily removed and reversed and used on both sides so as to increase the number of reuses. The wall forms are susceptible to edge and corner damage and must be carefully handled. Special attention must be given to corners and attached piers since the increased pressures applied by wet concrete could cause the abutments to open up, giving rise to unacceptable grout escape and a poor finish to the cast wall.

3. NEED FOR MODERN FORMWORK SYSTEMS
The earliest formwork systems made use of wooden scantlings and timber runners as it enabled easy forming and making at site. But these wooden scantlings and timber runners tend to lose their structural and dimensional properties over a period time and after repeated usage thus posing safety problems. Many of the accidents take place in Reinforced Cement Concrete (RCC) construction because of inferior formwork and scaffolding. Now focus has to be shifted to other key factor “Formwork”, to face the challenges for the completion of fast track projects. By going in for system formwork, substantial savings are possible by faster return on investments.

4. ALUMINIUM FORMWORK
Aluminium formwork also known as MIVAN technology. MIVAN system is 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. Formwork systems for buildings are classified as either horizontal or vertical formwork. Horizontal formwork systems are those used to form the horizontal concrete work (slabs or roofs), while vertical formwork systems are those used to form the vertical supporting elements of the structure, e.g., columns, core walls, and shear walls. Aluminium Formwork System is highly suited to load bearing wall construction whereas traditional formwork consisting of plywood and timber is not suitable to the high pressures of fresh concrete on the wall. The system of Aluminium forms has been used widely in the construction of residential units and mass housing projects. It is fast, simple, adaptable and cost – effective. It produces total quality work which requires minimum maintenance and when durability is the prime consideration. This system is most suitable for Indian condition as a tailor–made aluminium formwork for cast–in–situ fully concrete structure.
4.1 TECHNOLOGY

➢ COST: Use of this formwork in load bearing design gives an average of 15 per cent cost saving in the structure of the building and increased usable floor space of 8 per cent over RCC design.

➢ TIME: For 100 per cent work, construction through slab beam wall construction takes X time and through Aluminium Formwork technology the time required is 1/6th of the X time.

➢ ENVIRONMENT FRIENDLY: The technology is environment friendly as there is no use of timber. The formwork gives the box or cellular design resulting in the walls giving support to the super structure in two directions. As a result, the structures are more resistant to earthquakes than the traditional RCC column and beam designs.

➢ LIFTING: As the Aluminium Formwork is lightweight, no tower cranes are required for the same unlike in tunnel framework.

➢ LABOURS: Due to simplicity of the assembly, only unskilled labours are required with minimal supervision.

➢ REPETITIONS: The Aluminium Formwork System is removable and can be reused hundreds of times with little maintenance.

➢ SCRAP VALUE: Moreover, the requirement of steel is also reduced in this technology as aluminium has a higher scrap value.

4.2 ASSEMBLY

The simplicity of Aluminium Formwork and the repetitive nature of the assembly process make it possible to accurately programme construction sequences and thus cycle times well in advance. In addition, this enables the unskilled labour to work with the formwork, therefore reducing the burden on skilled labour when this is in short supply. On leaving the factory, all panels are clearly labelled to ensure that they are easily identifiable on site and can be smoothly fitted together using the formwork modulation drawings.

SIMPLE ASSEMBLY SYSTEMS

☐ PIN AND WEDGE SYSTEM

➢ The panels are held in position by a simple pin and wedge system that passes through holes in the outside rib of each panel.

☐ QUICK STRIP PROP HEAD

➢ One of the principal technical features which enables this speed to be attained using a single set of formwork panels is the unique V shaped prop head which allows the 'quick strip' to take place whilst leaving the propping undisturbed. The deck panels can therefore be reused immediately.

☐ SPEED

➢ The in-situ construction of all walls and partitions reduces the requirement for follow-on wet trades.

➢ The concrete surface finish produced with the aluminium forms allows achievement of a high quality wall finish without the need for extensive plastering. Doors and windows are formed in position, with this high degree of precision items such as door and window frames can be directly installed on site with minimal re-sizing required.
QUALITY

- High quality Aluminium Formwork panels ensure consistency of dimensions.
- On the removal of the Formwork mould, a high quality concrete finish is produced to accurate tolerances and verticality.
- The high tolerance of the finish means that no further plastering is required.
- Typically a 3mm to 4mm skim coat is applied internally prior to finishing and a 6 mm build up coat prior to laying tiles.

4.3 Necessity of the Aluminium Formwork System

- Rapid urbanization has resulted in a geometric increase in the housing demand, which cannot be fulfilled using conventional materials and methods of construction.
- The traditional or conventional method of construction for mass housing & high rise buildings is comparatively, a slow process and has limited quality control, particularly when a large size project is involved.
- It is therefore obligatory to work out a method or a scheme where the speed and quality of construction are controlled automatically by a systematic approach.
- Therefore Aluminium Formwork System (AFS) identified to be suitable for Indian conditions for mass housing construction where quality and speed can be maintained at a reasonably high level.

4.4 Aluminium Formwork System

- Aluminium Formwork System is a construction system for forming cast in place concrete structure of a building. It is also a system for scheduling and controlling the work of other construction trades such as steel reinforcement, concrete placement and mechanical and electrical conduits.
- The System is fast, simple, adaptable and very cost effective. It is unique because it forms all of the concrete in a building including walls, floor slabs, columns, beams, stairs, window hoods, balconies and various decorative features in exact accordance with the architects' design. The dimensional accuracy of the concreted work also results in consistent fittings of doors and windows. The smooth--off form finish of the concrete eliminates the need for costly plastering.
- Aluminium Formwork System provides Aluminium Formwork for RCC load bearing or RCC framed multi-storied buildings and enables the walls and slabs to be poured in the same operation. These increases efficiency and also produces an extraordinarily strong structure with excellent concrete finish. Due to the fine tolerance achieved in the machined metal formwork components, consistent concrete shapes and finishes are obtained floor after floor. This allows plumbing and electrical fittings to be prefabricated with the certain knowledge that there will be an exact fit when assembled.
- Unlike other construction systems, Formwork Systems of aluminium forms can be erected by unskilled labour and without the need for hoisting cranes. The largest panel weighs not more than 25 kgs which means it can be handled by a single worker.
4.5 Aluminium formwork System Benefits and disadvantage

Benefits

- NO Plastering required.
- Savings on overhead expenses due to speedy construction (4 days per floor).
- Monolithic crack free structures.
- Doesn't require timber or plywood for construction activities.
- Casting of walls and slabs possible simultaneously.
- Doesn't require skilled labour.
- Floor slab forms removed without moving props.
- Earthquake resistance of resulting structures increases manifold.
- The Formwork is specifically designed to allow rapid construction on all types of architectural layouts.
- Total system forms the complete concrete structure.
- Custom-designed to suit project requirements.
- Unsurpassed construction speed.
- High quality finish.
- Eliminates plastering, saves almost 50 percent construction time.
The system becomes cost effective where there is considerable repetition of floor layouts on a project such as in the case of low cost mass housing.

Panels can be reused up to 280 times.

Erected using unskilled labour.

Requires no cranes or heavy lifting equipment.

Suitable for low as well as high rise buildings.

**Disadvantages**

- Initial high investment.
- Compares very poorly on modifications, against brick work constructions.
- Fear of theft of valuable Aluminium Extrusions & sheets & hence kit not being complete at critical stages of construction.
- Mass Housing projects are not as high for investing in large number of Aluminium Formwork.

**5- COMPARISON BETWEEN ALUMINIUM FORMWORK SYSTEM AND CONVENTIONAL FORMWORK SYSTEM**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Characteristics</th>
<th>Aluminium Formwork System</th>
<th>Conventional Formwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Speed of construction</td>
<td>Four days cycle per floor.</td>
<td>Min. cycle time is of 21 days.</td>
</tr>
<tr>
<td>2</td>
<td>Quality of surface finish</td>
<td>Excellent. Plastering is not required</td>
<td>Bad. Plastering is required</td>
</tr>
<tr>
<td>3</td>
<td>Pre-planning of formwork system</td>
<td>Required</td>
<td>Not required</td>
</tr>
<tr>
<td>4</td>
<td>Type of construction</td>
<td>Cast-in-situ Cellular construction</td>
<td>Simple RCC framed construction</td>
</tr>
<tr>
<td>5</td>
<td>Wastage of formwork material</td>
<td>Very less</td>
<td>In great amount.</td>
</tr>
<tr>
<td>6</td>
<td>Accuracy in construction</td>
<td>Accurate construction</td>
<td>Accuracy is Less than Modern Systems</td>
</tr>
<tr>
<td>7</td>
<td>Coordination between different agencies</td>
<td>Essential</td>
<td>Not necessarily required</td>
</tr>
<tr>
<td>8</td>
<td>Resistance to earthquake</td>
<td>Good resistance</td>
<td>Less than Modern Systems</td>
</tr>
<tr>
<td>9</td>
<td>Removing of floor slab forms without removing props</td>
<td>Possible</td>
<td>Not possible</td>
</tr>
<tr>
<td>10</td>
<td>Need of any timber or plywood</td>
<td>Not required</td>
<td>These are the main components</td>
</tr>
<tr>
<td>11</td>
<td>Re-usage value of formwork</td>
<td>250 – 300</td>
<td>Maximum 50</td>
</tr>
<tr>
<td>12</td>
<td>Suitability for high rise construction</td>
<td>Very much suitable</td>
<td>Not suitable</td>
</tr>
<tr>
<td>13</td>
<td>Initial investment in the system</td>
<td>High</td>
<td>Less</td>
</tr>
<tr>
<td>14</td>
<td>Economy in construction</td>
<td>Economical for mass</td>
<td>Economical on small scale</td>
</tr>
</tbody>
</table>
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. This paper aim is saves cost for construction work and time of construction work. Our aim is to maximize the use of modern construction techniques and equipments on its entire project. This paper shows the benefits of aluminium formwork over on conventional formwork system. We thus infer that aluminium form construction is able to provide high quality of construction at higher speed and at reasonable cost. 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.

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