

Comparative Analysis of Conventional Formwork with Specialized Emerging Formwork Regarding Project Engineering Factors for High-rise Building

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Abstract

Today, because of globalization, there have been a number of improvements in the construction of modern technology worldwide, as a result of the quick and reliable distribution of new and emerging technologies through societies worldwide and the cross-border information sharing. Shaping which helps to mount the concrete in the desired shape It is a critical component of the construction to support the loads placed on it, as well as supporting moist cement until it sets. Formwork is a significant building function that accounts for 20–25 percent of overall construction costs. As a result of using the more recent formwork techniques, it is possible to cast larger components quicker than normal, reducing the need for time and labour when opposed to traditional methods. This paper conducts a comparative analysis between current formwork technologies and recently evolving formwork systems such as aluminum formwork and jump formwork systems, which are not widely used in India, and thus suggests which approach is best for the project under consideration. To gain a better understanding of this topic, various construction projects using newly emerging formwork techniques are analyzed, and the data obtained from these projects is used to compare newly emerging formwork with traditional formwork systems.

Keywords: Aluminum formwork, jump formwork, traditional formwork, construction cost, comparative study

INTRODUCTION

Identifying factors that will reduce the number of work hours needed to lift, change, and strip concrete formwork can increase the cost-effectiveness of construction activities. Formwork expenses account for about 35% of the total cost of work. To keep work costs to a minimum, the board and streamline requirements on the job site by focusing on the elements that will maximize work quality. Redundant structure calculations, legal system selection, skilled booking, and prudent movement coordination will all result in large benefit investment funds [1]. Nonetheless, poor content usability, adjustment, inefficient sequencing, and disruptions are among the issues.

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If supporting structural members and weights, the formwork should also have a seamless and high-quality finish. The construction industry has a clear point of view. The formwork is an integral part of the construction process. With the advancement of recent technologies, traditional

formwork is being replaced by suitable materials in terms of expense, time, construction efficiency, waste production, and worker safety during the work process. Utilization Ease With the frantic pace of construction, a standard design approach for individual buildings with load bearing walls and an assembly roof over them or reinforced cement (RC) built base construction is completely inappropriate for the mass housing industry. However, whether the builder has extensive resources and expertise, these structures are often prone to low quality assurance [1].

A variety of schemes are introduced in various countries around the world; finally, comparatively inexpensive, and easily operated services are useful in India. Some technologies are common, and a growing number of people are attempting to implement new technologies. The architectural style, whether precast or in situ architecture, serves as the basis for both.

The formwork is the most fundamental feature of the structure. Formwork is a mould or matrix pattern into which fresh concrete is poured and which protects the hardened concrete. There are two kinds of support in particular: horizontal support and vertical support. Formwork supports a wide range of loads, including dead loads, live loads, and so on. Formwork is a temporary system that provides the necessary shape and dimensions of the structure. Vertical support is referred to as shuttering, and horizontal support is referred to as shuttering. Staging in the shape of bellies, props, and jacks would be used to center such vertical and horizontal supports.

FORMWORK

It is constructed of plastic in the same way as concrete is. Temporary support and appropriate castings are expected until it is strong enough to support its own weight. A shuttering or shuttering is a partial shielding. The term moulds are often used to describe the construction of very small units such as lintels, cornices, and so on.

Conventional Formwork

Conventional Timber Formwork

It is the most traditional formwork method in use in the building industry. This style of formwork is made of wood and plywood. This style of formwork is easy to make, but it takes longer to build and has a shorter life cycle. This style is more suited to small houses of two or three floors, because they are less expensive. These constructions are also in use. However, this is not enough for large schemes or high-rise buildings [2]. The key drawback of this formwork is that it does not maintain its shape as heavy loads are applied, and it absorbs concrete water, resulting in a decrease in concrete strength.

Conventional Steel Formwork

Often used in large construction projects or where the same shuttering may be re-used in large quantities. It is used for buildings such as drainage tunnels and wall retention and is suitable for circular or angled structures such as tanks, columns, chimneys, and so on [3]. This is powerful, long-lasting, and robust. Steel installation and removal with greater ease and pace will result in lower labour costs. By absorbing concrete water and reducing honeycombing, there is no danger of formwork.

Specialized Emerging Formwork

The use of advanced formwork techniques for framework building has developed over time. In today's dynamic market, pace and efficiency are critical; hence, by using newly emerging formwork technologies, the duration of the project is reduced by using the latest methods that are reliable, robust, and accelerate the construction speed. Any of the newer formwork methods that are being used today are as follows:

Aluminum Formwork System

Aluminum Formwork System, a relatively recent technology in India, saves time, money, and improves construction performance. Aluminum Formwork is commonly used in Japan, Singapore,

Malaysia, and the Middle East for the design of low- and high-rise apartments and houses. Aluminum Formwork is a low-cost choice for repeating building plans and above-the-plinth work. It is one of the systems that has been identified as being very suitable for Indian mass construction conditions, where high levels of quality and speed can be achieved [4, 5]. The construction speed of this device will outperform that of most other building methods/technologies (Figure 1).



Figure 1. Aluminum formwork system.

The aluminum Formwork panels may be constructed for any building condition or part, such as bay windows, stairs, balconies, and specific architectural features. This style is unique in that all of the building materials are concrete, including the slabs, floors, walls, columns, beams, staircases, balconies, and window hoods, and no block or brick work is needed. It provides a shape finish, eliminates the need for external and internal plastering, and allows the walls to be painted directly with minimum skim coat, all of which lead to cost savings.

Jump Formwork System

Jump Formwork System is used where there is no floor on which to support the wall formwork, even when the wall and column extend instead of the floor, a formwork framework is used. Jump-forms are made up of a fixed plate with two or three sturdy backrests attached. They can be one floor high, backed by lift inserts underneath. It is also possible to use two sets, one floor high, that hop over each other alternately [6]. The typical jump-form method includes three simple operations: stripping, shifting, and resetting.

Jump style structures usually provide formwork and working platforms for cleaning and repairing formwork, steel fastening, and concreting. The formwork is supported by the concrete that was previously cast, so it does not require assistance or access from other building pieces or permanent works. Jump formwork systems are suitable for designing multi-story vertical concrete elements in high-rise buildings such as shear walls, core walls, elevator shafts, stair shafts, and bridge pylons [6]. This is a highly versatile system intended to increase speed and productivity while decreasing the amount of time spent on work and cranes. Systems are typically modular and can be combined to create long lengths to suit different building geometries.

Slip Formwork System

It is a vertically type of reinforced concrete extrusion that is ideal for Core wall construction in high-rise buildings-lifting Shafts, stair shafts, partitions, and so on. This is a self-contained Formwork device that requires very little crane time, Construction. The formwork grows gradually at a rate of 300 mm per hour, supporting itself in the middle. This formwork is divided into three stages. The top

floor fills the possible e region of circulation, the center stage conducts the main stage of work, and the bottom level is the highest level of solid dimension poured out. The lower stage has excellent wrap-up power [7]. Rapid building for large floor spaces, there is less of a requirement for long-term on-site jobs. Individual formwork components may be precisely adjusted.

Table Formwork System

A table type or flying form is a massive pre-assembled formwork and falsework unit that often forms an entire bay of suspended floor slab. For regular usage in the new construction, the equipment needs enough room to travel the table device above the building line. At bearing locations, the supporting slab must be able to withstand heavy loads. It offers flexibility and ease of implementation in construction projects with traditional design configurations or lengthy repetitive designs, making it ideal for flat slab and beam and slab layouts [8]. It is commonly used for residential flats, hotels, hostels, offices, and commercial buildings (Figures 2–4).

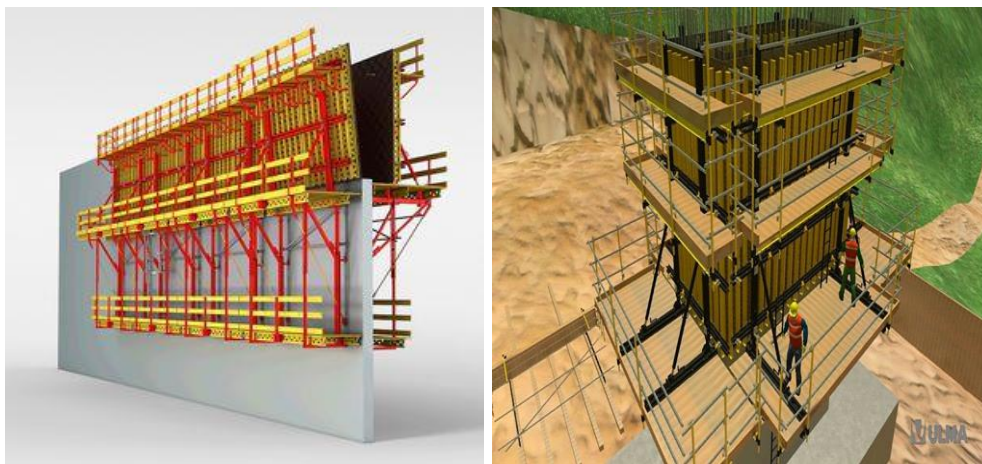


Figure 2. Jump formwork system.



Figure 3. Slip formwork system.



Figure 4. Table formwork system.

METHODOLOGY

Since expense, time, and efficiency are the three most critical factors in a project's performance, contractors tend to concentrate on the formwork cost. To highlight the importance of formwork selection, an attempt has been made in this paper to decide the best suitable technique for a specific project by comparing those techniques and then to establish a connection between these techniques in terms of time and cost parameters. For the comparative analysis, various formwork systems such as traditional timber, conventional steel, aluminum formwork system, and jump style of formwork system are used. This is accomplished in the following stages (Figure 5) [9–11].

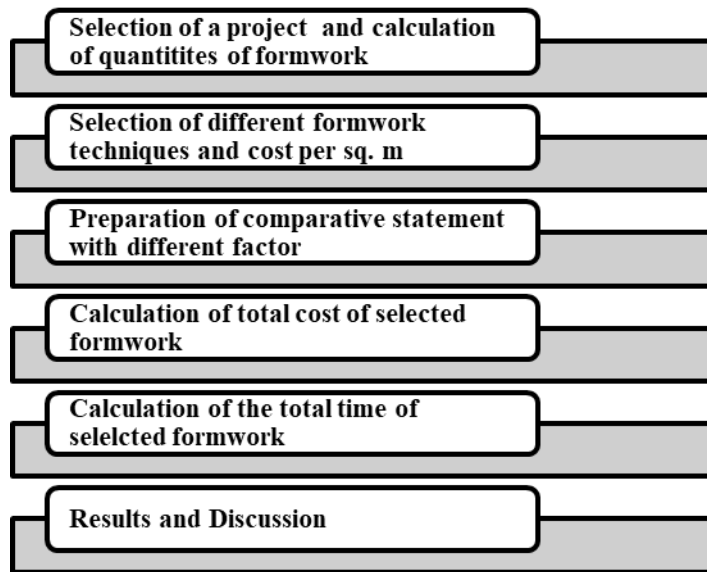


Figure 5. Flow process of work.

DATA COLLECTION

The collection of data from existing projects was carried out on 3 types of formwork building in Ahmedabad city as targeted to scope of project and selected with same number of floors (G+21) and all the details were filled through questionnaire and interview with the stakeholders on the particular site (Table 1). The four sites were selected are listed below

1. Sundaram Heights, by Sundaram Construction, Ahmedabad.
2. Nilamber Bellesimo II, by Nilamber Group, Ahmedabad
3. The North, by Trine Projects Pvt. Ltd., Ahmedabad

Table. 1 Comparison of different formwork.

S. N.	Parameters	Conventional		Specialized	
		Timber	Steel	Aluminium	Jump
1	Initial Investments	Low	High	High	High
2	Average Cost (Rs) (sq. m)	700	1200	1500	1300
3	Prop & Accessories Cost (Rs)	6/sq.m	6/sq.m	Included in formwork cost	Included in formwork cost
4	Labour Cost	30	30	35	40
5	Repetition Cycle	7	30	150	220
6	Repetition Cost/sq.m	65	45	15	8
7	Cycle time for casting at least 100 sq.m	4	4	3	1
8	Strength (Permissible Fresh Concrete Pressure) in kN/sq.m	32	-	80	60
9	Durability	Low	Low	High	High
10	Surface Finishing	Rough	Average	Smooth	Fair Face Surface
11	Wastage of Material	High	Average	Nil	Nil
12	Planning System	Not Required	Not Required	Required	Required

CALCULATION

Formwork required for column = 19755 m²
 Formwork required for beams and slabs = 59468 m²
 Formwork required for stair case = 158 m²
 Formwork required for retaining wall = 485 m²
 Total quantity of Formwork required = 79886 m²

Cost

Overall cost of Conventional timber = 79886*65 + 79886*6 + 79886*30
 Total Cost = Rs.8068486

Overall cost of Conventional steel = 79886*45 + 79886*6 + 79886*30
 Total Cost = Rs.6470766

Overall cost of Aluminium System = 79886*15 + 79886*35
 Total Cost = Rs.3994300

Overall cost of Jump System = 79886*8 + 79886*40
 Total Cost = Rs.3834528

Duration

Overall Duration of Conventional timber = (79886*4/100)/365
 Total Duration = 8.5 years

Overall Duration of Conventional steel = (79886*4/100)/365
 Total Duration = 8.5 years

Overall Duration of Aluminium System = (79886*3/100)/365
 Total Duration = 6.2 years

Overall Duration of Jump System = (79886*1/100)/365
 Total Duration = 2.4 years

RESULTS AND DECLARATION

Figures 6 and 7 show a comparison of the cost and duration of various types of formwork systems, such as traditional timber, conventional steel, aluminum, and jump systems. Using aluminum formwork or jump system may be recommended depending on suitability and other factors such as construction speed and availability of skilled labour. Conventional approaches need 20% more time than aluminum formwork systems and 65% more time than leap formwork systems. Aluminum formwork and hop formwork systems are 25% less expensive than traditional formwork systems. As a result, the use of this newly emerging style of formwork method reduces the expense and time of the project.



Figure 6. Cost comparison.

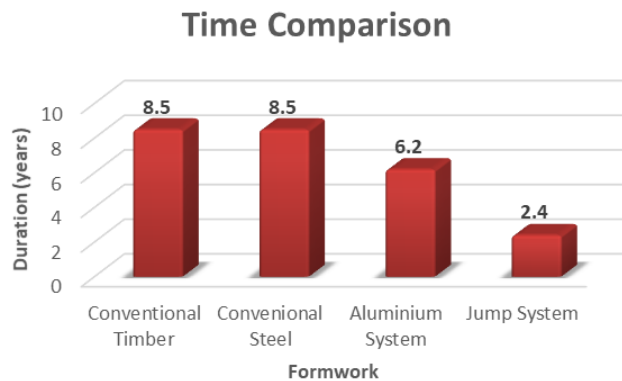


Figure 7. Time comparison.

CONCLUSION

Based on the findings, it is proposed that the jump formwork method is a better option for the research project. Though aluminum tends to take less time, the average cost after the jump mechanism is very high. Projects can be executed successfully, quickly, and at a low cost while maintaining the required intensity by using these newly evolving technologies. Since building takes less time, it will save money on construction costs indirectly. The above findings suggested that the implementation of the hop type of formwork would reduce the duration and cost of the project by introducing this newly evolving formwork on the construction site. Despite the expense and time, people choose traditional methods because they believe that the cost of advanced methods is higher, and they prefer conventional methods for large-scale construction projects. Therefore, specialized advanced methods are used in India for large-scale construction projects.

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