

# Comparison of Conventional, Aluminium and Tunnel Formwork

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**Abstract-** Construction industry is having biggest role in economy of India. In recent times, if we look at the global economy and growth of population in India, land acquisition has become more difficult. To fulfill the need of shelter of this growing population and increasing industrialization, speedy construction is the necessity of time. Same time, due to inadequacy of land Vertical growth is preferable than Horizontal one. Formwork plays an important role in construction of the buildings. It constitutes 20% cost and 60% time of the total construction. This project does the comparison of the Conventional Formwork, Tunnel Formwork and Aluminum Formwork systems.

**Index Terms-** Conventional Formwork, Tunnel Formwork, Aluminium Formwork, Construction Cost, time

## I. INTRODUCTION

Formwork is a temporary structure which supports fresh concrete till it becomes strong enough to sustain its own weight. After setting of concrete, the formwork is removed and a solid structure of required shape and size is produced. This is the very important element in the construction of building. For many years, in the field of construction, use of conventional i.e. wooden formwork was a regular practice. Now the scenario of construction field is much different, but the study is needed in order to choose the suitable Formwork with different perspectives. Cost, time are the basic parameters but along with that we should also focus on quality, safety and construction waste generation during the process.

Now days, low waste formwork systems for construction are being used. The large sized columns in buildings are now being replaced by small thickness shear/RCC Walls. So it gives a large carpet area and removal of offsets in the building. Also the quality of construction is getting upgraded. At the present time, many formwork solutions are available in the market, but the study has to be done in order to choose the best formwork for any particular type of building.

## II. DATA COLLECTION

### 2.1 Basic types of formwork

#### 1. Conventional Formwork

#### 2. System Formwork

As the name system itself gives the idea that it must be well organized and time saving also.

The quality of conventional formwork degrades as the repetition increases and also it needs proper maintenance in order to get more repetitions. So to avoid this, the comparison between different types of Formwork is needed in order to maintain the quality of construction. Also the current formwork field in India is labour intensive and also skilled labours are also lacking. So to avoid or minimize the manual errors, System formwork is being adopted by the contractors for speedy and economic construction.

Frequency of accidents in Reinforced Cement Concrete (RCC) construction because of

inferior formwork and scaffolding is also accountable. So system Formwork has the challenge of safety during the construction along with faster completion of the projects.

### 2.2 Conventional Formwork

The most common material used for formwork of wall is the Plywood sheet in which it is used in combination with timber. Normally, wall forms are framed panels with the plywood facing sheet connected to a timber frame. If the special attention is not given to the corners and joints of the panels, grout may come out in the form of slurry which will lead to poor quality construction.

The cycle time for one floor with the use of conventional formwork is minimum 3-4 weeks. Also the block or Brick work and plastering is needed in order to get the finished surface. This takes more time and skilled labours too. This ultimately increases the time required for the completion of the project.

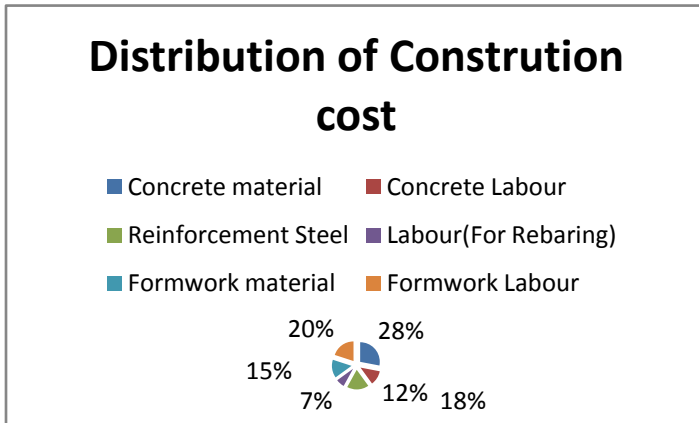
### 2.3 System Formwork

The name System Formwork itself clears that the approach is systematic. Speed in construction activities will lead to faster completion of project. This will save the time and ultimately money involved in it.

Currently in India other types of Formworks are also available. Different range of systems of formwork gives wide solutions to

construction of concrete which suits the requirements of a particular building. The choice of such Formwork system changes and depends upon required slab cycle, required quality of construction and budget or funds available for the project . Out of them ,Tunnel Formwork and Aluminium formwork are the two leading systems.

The distribution of the construction cost is as shown below in pie chart 2.3



2.3 Distribution of Construction cost

### 2.3.1 Aluminium Formwork

This is the formwork which can be a good option for timely completion of construction with maximum efficiency. In this system an Aluminium alloy Al-6061-T6 is normally used. This can withstand the load of about 65 KN/m<sup>2</sup>. In this system of Formwork ,Aluminium panels are placed vertically , attached to each other with the help of stub pins and wedge pins. In this basically three types of panels are there:

1. Wall-Wall(with and without Rocker ,Wall Top panel, Wall End Panel
2. Beam-Beam panels, Beam Bottom panels, Beam props
3. Slab- Slab panels, Slab prop

Also in addition to this, many types of accessories are also needed in order to maintain the verticality and alignment of wall. Those are wailers, wire rope, ACT props(Adjustable Collapsible Telescopic)

### 2.3.2 Tunnel Formwork

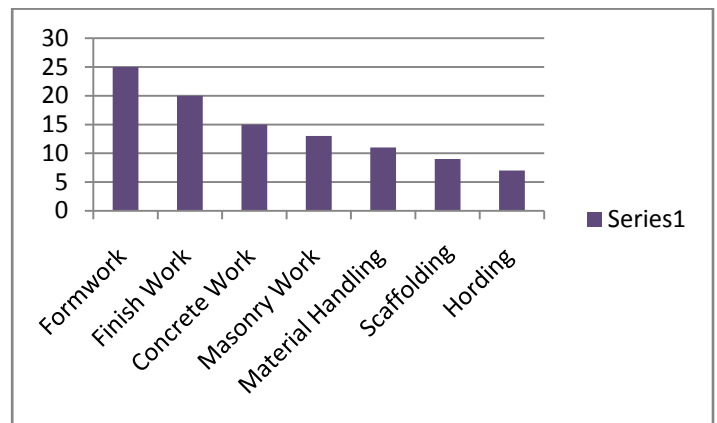
Tunnel formwork system is used for a multi storied building construction in order to reduce cycle time .As this is the type of system formwork slab & the wall are cast monolithically. So Tunnel Formwork is a fast-track construction method .It is best suited for repetitive type cellular projects. Different components of this system are made up of steel.

Normally used for the rooms with span between 2.5m to 6.5 m. If the span exceeds 11m then the new component called Mid-Span Table is introduced .There are no loose fittings in this system of formwork.

Basic and the main component of the Tunnel formwork is Half tunnel. When these two tunnels are joined together , it forms Tunnel. It is available in two lengths i.e. 1.2 & 2.5m.

### 2.3.3 Construction waste generation

Construction waste generated during the complete process of formation of a building is also a matter of concern which make us to turn towards Low Waste housings. The System Formwork van give better results than Conventional Formwork for this aspect of comparison. The Following chart 2.3.3 gives an idea about the percentage contribution of each item in the generation of construction waste .



2.3.3 Construction waste generation

2.3.4: Table for Cost analysis for Conventional villa N F 30X40

Sl. No	Scope of work	Units	Quantity	Rate/Unit (in Rs.)	Amount (In Rs.)
1	Laying Plain cement concrete	m <sup>3</sup>	14.51	4,400	63,844
2	Laying Reinforced cement concrete	m <sup>3</sup>	18.28	8,500	1,55,380
3	Laying Reinforced cement concrete (for column)	m <sup>3</sup>	8.91	8,500	75,735
4	Laying Reinforced	m <sup>3</sup>	3.25	8,500	27,625

	cement concrete				
5	Laying Reinforced cement concrete	m <sup>3</sup>	22.98	8,500	1,95,330
	(for slab)				0
6	Laying Reinforced cement concrete (for chejja ,Lintels )	m <sup>3</sup>	3	8,500	25,500
7	Providing and removing centring, shuttering (for flat surfaces)	m <sup>2</sup>	166	240	39,840
8	Providing and removing centring, shuttering (for stairs)	m <sup>2</sup>	33.93	374	1,94,779
9	Providing and removing centring, shuttering (for columns)	m <sup>2</sup>	149.45	282	42,144.9
10	Providing and removing centring, shuttering (for beams)	m <sup>2</sup>	186.05	206	38,326.3
11	Reinforcement for RCC works	MT	7.35	63875	4,69,481.25
12	Precast concrete Solid blocks	m <sup>2</sup>	186.29	725	1,35,060.25

	Size- (40x15x20)				
13	Precast concrete Solid blocks Size- (40x10x20)	m <sup>2</sup>	62.76	710	44,559.60
14	Providing 12mm thick cement plaster (for internal walls)	m <sup>2</sup>	393.56	362	1,42,468.72
15	Providing rough cement plastering 15mm thick (for dadoing)	m <sup>2</sup>	69.92	318	22,234.56
16	Providing 12mm thick cement plaster (for ceiling)	m <sup>2</sup>	158.74	362	57,463.88
17	Providing 20mm thick cement plaster external	m <sup>2</sup>	359.35	385	1,38,349.75
<b>Total in Rs/-</b>					<b>19,29,582.91</b>

2.3.5: Table for Cost analysis for Aluminium formwork villa NF 30X40

Sl. No	Scope of work	Units	Qty.	Rate / Unit (in Rs.)	Amount (In Rs.)
1	Providing and laying cement concrete (For	m <sup>3</sup>	44.2	5,186	2,29,221.20

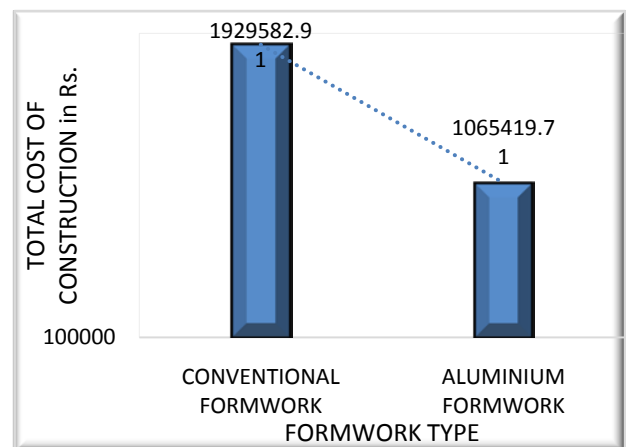
	Monolithic shear walls)				
2	Providing and laying cement concrete (For Beam)	m <sup>3</sup>	1.58	5,186	8,193.88
3	Providing and laying cement concrete (For slabs)	m <sup>3</sup>	18.54	5,186	96,148.44
4	Providing and laying cement concrete (For chejjas)	m <sup>3</sup>	0.89	5,186	4,615.54
5	Providing and laying cement concrete (For staircase)	m <sup>3</sup>	2.86	5,186	14,831.96
6	Providing and removing centring, shuttering (For Slabs)	m <sup>2</sup>	131.53	300	39,459
7	Providing and removing centring, shuttering (For Monolithic shear walls)	m <sup>2</sup>	748.99	300	2,24,697
8	Providing and removing centring, shuttering (For stairs)	m <sup>2</sup>	21.28	300	6,384
9	Providing and removing centring, shuttering (For Lintel	m <sup>2</sup>	5.9	300	1,770

	Beam)				
11	Steel reinforcement for RCC works	MT	6.89	63875	4,40,098.75
<b>Total in Rs/-</b>					<b>10,65,419.77</b>

2.3.6: Table for Estimated cost of Conventional formwork and Aluminium formwork Construction

Sl. No	Wing type	Type of formwork used	Estimated cost (in Rs.)
1	NF	Conventional formwork	19,29,582.91
2	NF	Aluminium formwork	10,65,419.77
<b>Saving in cost</b>			<b>8,64,163.14</b>
<b>% Saving in cost</b>			<b>44.78</b>

2.3.7: Figure for Cost of conventional formwork and aluminium formwork construction



2.3.8 Saving in the cost of formwork material

Sl. No	Description	Aluminium Formwork	Conventional Formwork
1	Formwork area for NF 30X40	907.7m <sup>2</sup>	907.7 m <sup>2</sup>
2	No. of repetitions available	150	13
3	Total area of shuttering work that can be carried out by a single set of formwork	136155 m <sup>2</sup>	11800.1 m <sup>2</sup>
4	Number of sets required for shuttering for villa	1	12
5	Procurement cost/m <sup>2</sup>	Rs. 11250	Rs. 600
6	Procurement cost to finish a shuttering work of villa for 136155 m <sup>2</sup>	(No. of sets x Area of single set of formwork x cost/m <sup>2</sup> ) = 1,02,11,625	(No. of sets x Area of single set of formwork x cost/m <sup>2</sup> ) = 65,35,440
7	Scrap value @ Rs.128/kg (1m <sup>2</sup> =30 kg)	Rs. 3485568	Rs. 0
8	Total investment	Rs. 6726057	Rs. 6535440

9	Formwork cost/m <sup>2</sup>	Rs. 49.4	Rs. 553.84
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### 2.3.9 Time analysis

#### Planning for 100 Villa (aluminium formwork)

- Total number of villas= 100
- Number of aluminium formwork sets available at site= 1 full set
- 1 full set requires 25 days to complete concreting of one villa
- Number of days required to complete ground floor of 100 the villa = (100/1)\*10 = 1000 days.
- Total number of days required complete 100 villas with one set of aluminium form work =1000+15=1015 days
- Note – To complete 100 the villa we need extra 15 days after ground floor.
- Construction period in above example:
- Ground floor slab –10 days
- First floor slab – 10 days
- Terrace floor Slab – 5 days
- Total = 1015days = 39.03 months considering 26 working days per month.
- Total days required to complete the finishing works of villa =2 months
- Total construction period will be about 41.03 months for 100 villas, if only one set of aluminium formwork is used for construction.
- Planning for 100 villas (Conventional formwork).
- Ground floor slab –41days.
- First floor slab – 31 days.
- Terrace floor Slab – 10 days.
- Total days required for one villa =82days.
- Total number of villas= 100.

Number of day conventional formwork sets available at site= 8 full set /13 repetitions

1 full set requires 82 days to complete concreting of one villas  
required to complete 100th villa =  $(13 \times 82) = 1066$  days.

- Time necessary to complete the Block work and plastering works = 40 days.
- Time essential to complete the finishing works of villa = 120 days.
- Total number of days required to complete 100 villas =  $1066 + 40 + 120 = 1226$  days.

Total construction period will be about 47.15 months for 100 villas, if we use 8 sets of formwork with 13 repetitions of Conventional formwork is used for construction.

### III. CONCLUSION

The time plays the main role in the cost of any project and is greatly affected by the type of system adopted. The case study will be helpful for the choice of formwork to be used in coming future. Also this will be helpful to minimize the construction waste due to the formwork.

- From the results obtained we came to a finale that when the aluminium formwork is utilized in the Villa project, the sum project cost can be reduced by nearly 40 % and the duration of the project can be reduced by 50% compared to conventional formwork.
- Although the Aluminium system formwork is the most costly formwork type in terms of high initial cost, it proves to be economical if the number of repetitions is between 200 and 250 in construction of villa project.
  - Mean while the highest total expenditure is obtained when contemporary conventional kind of formwork is utilized in the building project which is the slightest costly formwork sort.
  - A floor cycle of 3-10 days can be obtained using aluminium formwork and hence the whole project time will be condensed.

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