

COMPARATIVE STUDIES OF CONSTRUCTION TECHNIQUES (CONVENTIONAL TECHNIQUE VS ALUMINIUM FORMWORK TECHNIQUES)

¹NINJAL M PAREKH, ²BHUPENDRA M MARVADI, ³UMANG PATEL

¹Student, M.E. Infrastructure Engineering, Dept. of Civil Engineering,
L.D.R.P. Institute of Technology and Research, Gandhinagar-382015, Gujarat.

^{2,3}Assistant Professor, Dept. of Civil Engineering,
L.D.R.P. Institute of Technology and Research, Gandhinagar-382015, Gujarat.

ninjal.parekh@gmail.com

ABSTRACT: Recent trends in construction become indispensable within the coming years to emphasize on sustainable development. The paper discusses the importance and scope of recent trends in construction techniques. The paper emphasizes on exploitation differing kinds of materials in modern trends and for effectiveness in infrastructure building for fast economic process and development of a nation exploitation recent advancements within the field of construction technology. Nowadays, the prefabrication and aluminium Formwork technique in trade construction industry is developed countries has improved the standard of the construction industry.

Aluminium Formwork System is a construction system for forming cast in situ concrete structure of a building. Classified information's given for Aluminium Formwork technique and Conventional techniques. Two case studies are taken for the analysis of the construction techniques. The concept of formed (also called "prefabricated") construction includes those buildings wherever the bulk of structural parts are standardized and created in plants during a location far from the building, so transported to the location for assembly

Keywords: Conventional Technique, Aluminium Formwork Technique, Cost, Time, Quality.

1. Introduction:

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 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.

As described by the manufacturers a low-cost system for housing using aluminium formwork. Aluminium formwork system is construction system for forming cast in place concrete structure of building. It is also a system for scheduling and controlling the work of other construction trends such as steel reinforcement, concrete placement and mechanical and electrical conduits.

This type of construction requires a restructuring of the entire conventional construction process to enable interaction between the design phase and production planning in order to improve and speed up the construction.

2. Objectives:

- To reduce construction time of project
- To minimize construction total cost (Direct cost and indirect cost) of project.
- To measure and improve the quality of construction projects

3. Aluminium Formwork:

- The speed of construction by aluminium formwork system will surpass speed of most of the other construction technologies.
- The work manages aluminium lightweight formwork approach effectively in order to accelerate the particular development, to reassure quality manage along with strength. Adoption of this system reduces overall cost of the structure.
- 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.

Technology

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.

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.

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.

Importance of the Aluminium Form work System^[8]

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. Case Study and Data collection:

Case Study 1: Paavan city Modasa is totally based on aluminium formwork construction. Total numbers of units in Paavan city 575 units and 17 blocks in which 12 blocks are 2BHK and 5 blocks are 3BHK. G + 8 storey buildings are constructed on site. In Paavan city, MAINI formwork construction company provides the formwork and the overall cost of formwork is 5200/ sq ft. The maintenance of formwork is also done by the MAINI formwork construction. Total area for one floor in 2BHK building is 4065 sq feet. Four units are constructed on each floor. Formwork design is for only one floor. After completion of one floor then cycle is going to repeat for next floor.

Table 1. Summary of Paavan city

	Quantity	Units
Total Area On Each Floor	4065	Sq ft
Quantity For Steel	11044.91	Kg
Quantity For Concrete	164.95	Cu m
Labour For Centring	60	Nos.
Plant Operation	12	Nos.

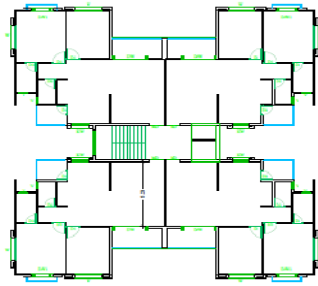


Figure 1. Working plan of Paavan city

Case Study 2: Tulsi city Badlapur is totally based on aluminium formwork construction. Tulsi city is developing in 5 phase, in which first phase is comes to an end which name of TULSI AARAMBH. In this TULSI AARAMBH exclusive G + 4 and 7 story of 22 towers .TULSI AARAMBH have luxurious 1 and 2BHK flats. Batching plant of Tulsi city is about 0.25 cu m capacity. Pumping unit for the batching plant is not combined but the pumping unit is assembled in it. Total area for one floor in 1 and 2 BHK building is 2147 sq feet. Four units are constructed on each floor. Formwork design is for only one floor. After completion of one floor and then after cycle is going to repeat.

Table 2. Summary of Tulsi city

	Quantity	Units
Total Area On Each Floor	2147	Sq ft
Quantity For Steel	7052.72	Kg
Quantity For Concrete	96.29	Cu m
Labour For Centering	52	Nos.
Plant Operation	9	Nos.

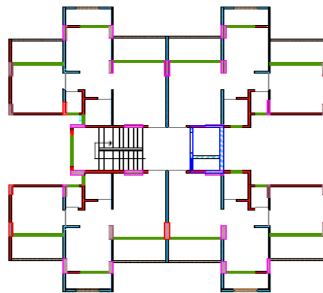


Figure 2. Working Plan of Tulsi city

Flow Chart for Aluminium formwork at Site

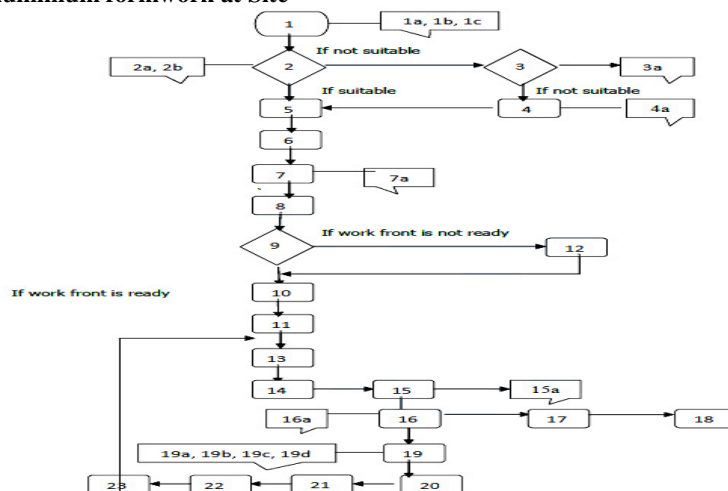


Figure 3. Flow Chart of Aluminium Formwork Process

5. Data Analysis:

Comparison of Construction Techniques:

Case study 1: Paavan city

Construction with Aluminium Formwork

Table 3. Construction with Aluminium Formwork

Item	Quantity	Unit	Rate	Amount
Concreting MIX M25	164.98	Cu m	3900	6,43,422
Labour	106	No.	-	24,906
Steel	11044.91	Kg	45	4,97,020
Formwork	4065	Sq ft	5200	2,11,38,000
Total				2,23,03,348
Aluminium formwork can be cost effective Applied after 100 time				

Construction with Aluminium Formwork

Table 4. Construction with Conventional Techniques

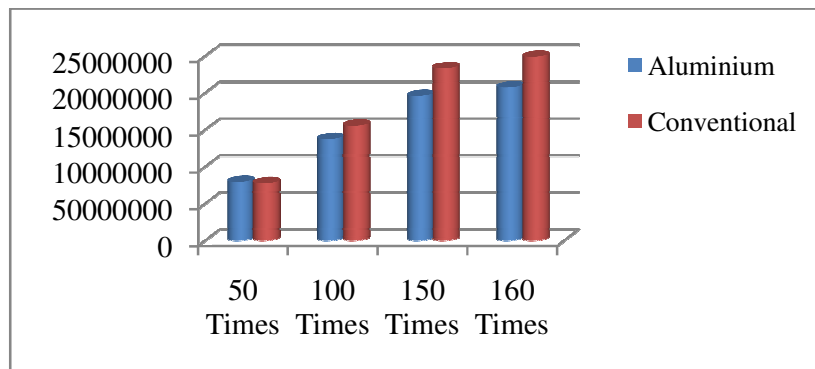
Item	Quantity	Unit	Rate	Amount
Concrete M25	102.86	Cu m	5100	5,24,586
Steel	11044.91	Kg	45	4,97,021
Formwork	4065	Sq ft	25	1,01,623
Wall	62.09	Cu m	3450	2,14,210
Plaster	221.48	Sq m	989.93	2,19,250
Total				1,55,6690

Cost comparison of Paavan city

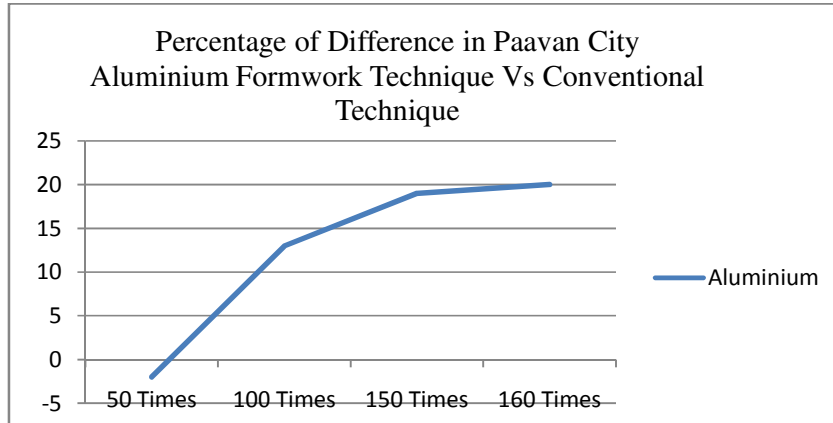
From the above tables of comparison we can conclude that the aluminium formwork method is convenient for mass construction projects. Aluminium formwork method is very important to reduce the time of construction it will directly affect on the economic conditions of project. When the cycle of construction is reduced it will directly affect on the overall cost of construction and it will also create financial stability.

Table 5. Cost comparison of Paavan city

Cost Comparison of Paavan City				
Techniques	50 time	100 time	150 time	160 times
Aluminium	79405400	137672800	195940200	207593680
Conventional	77834500	155669000	233503500	249070400
Percentage	-2%	13%	19%	20%



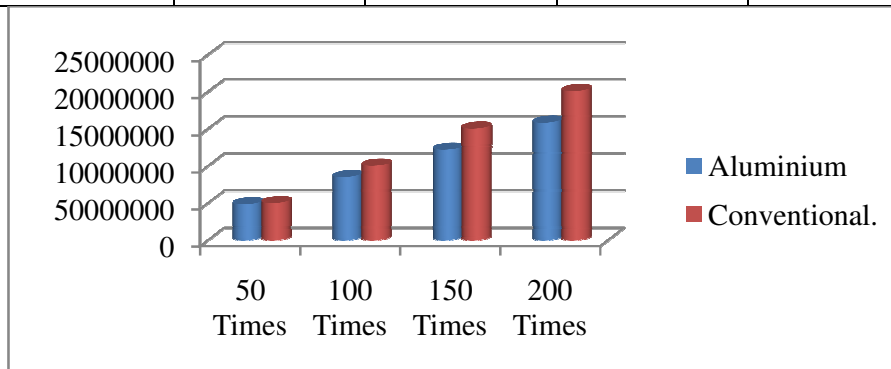
This is the graphical representation of the cost comparison of aluminium form work technique to the conventional technique. It clearly shows that the aluminium form work method is effective. And I have also included the line diagram for the percentage of difference in Paavan city Modasa. These calculations are based on data collection which is taken from the Paavan city. Further case study is the Tulsi city Badlapur.



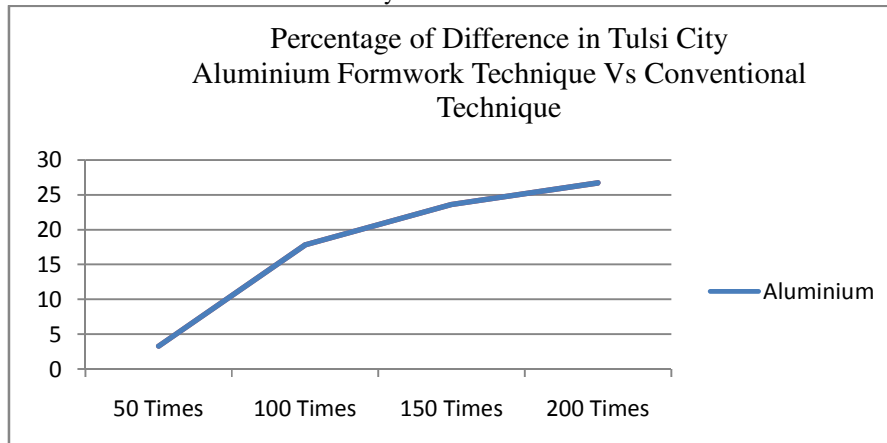
Case study 2: Tulsi city

Table 6. Cost comparison of Tulsi city

Cost Comparison of Tulsi City				
Techniques	50 time	100 time	150 time	200 times
Aluminium	4,86,84,600	8,53,69,200	12,20,53,800	15,87,38,400
Conventional	5,02,82,856	10,05,65,700	15,08,48,450	20,11,31,400
	3.28	17.80	23.59	26.70



This is the graphical representation of the cost comparison of aluminium form work technique to the conventional technique. It clearly shows that the aluminium form work method is effective. And I have also included the line diagram for the percentage of difference in Tulsi City, Badlapur. These calculations are based on data collection which is taken from the Tulsi city.



Time of Construction

Time of construction of any construction technique is depending on the labour force. If we are increasing the maximum amount of labour force than the construction can be reduced. The second most important factor of construction technique is material use and wastage.

In aluminium formwork construction technique in which the foundation and ground floor construction is done with conventional technique. The aluminium formwork technique is very costly for that the foundation formwork cost can be increase the total project cost. For that the construction till first floor is done with the conventional techniques.

Table 7. Time of Construction of One Block of Paavan city

	Days	Week	Month
Aluminium	64	9.2	2.2
Conventional	242	34.5	8.1

Table 8. Time of Construction of One Block Tulsi city

	Days	Week	Month
Aluminium	56	7	2
Conventional	189	27	6.9

Quality of Work

- 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.

Safety

Safety in formwork is another major concern today especially in high-rise construction and large infrastructure projects like metros, flyovers, airports etc. It is a known fact that in India, There is a lot of pressure on the Indian construction companies today to improve the same by the Govt. of India, Foreign Investors and also the increased number of PMC's (which are basically reputed MNC's). Safety cannot be treated as a separate entity, rather it should be an integral part of the formwork system.

Formwork & scaffolding being the major contributors to the safety in construction sites as they are also used for the rebar and concreting works, it is time we pay proper heed to how these have to be integrated with safety so as to ensure the overall safety at sites

Comparison of Formwork:

The main objectives of formwork are three fold like Quality, Safety and Economy. Formwork should be made with quality material and should be constructed properly. The formwork should be constructed in such a way that the where used is cut to the minimum and it can be struck off with ease and reused with least damage.

Cost Comparison of Formwork

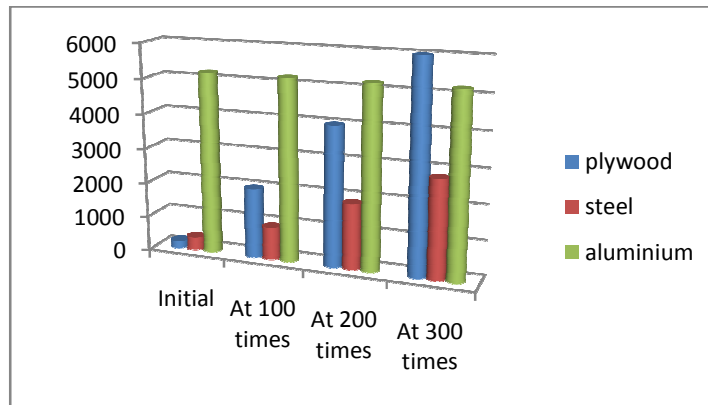
The following study of the formwork in which the latest rates of formwork is taken to analyzed for the study to minimized the project overall cost. Plywood formwork, steel formwork and aluminium formwork are taken in the analysis like the market rates of the material of the formwork and the best rate at which formwork can be buy.

Cost of Formwork:

Table 9. Cost of Formwork

Cost of Formwork		
Type of formwork	Unit	Rates
Plywood	Sq ft.	6000
Steel	Sq ft.	2812
Aluminum	Sq ft.	5200

Following the graphical representation of the above study of rates at the different rates of formwork. The chart shows the aluminium formwork is economical when the use of cycle. The steel formwork is economical than the other formwork.



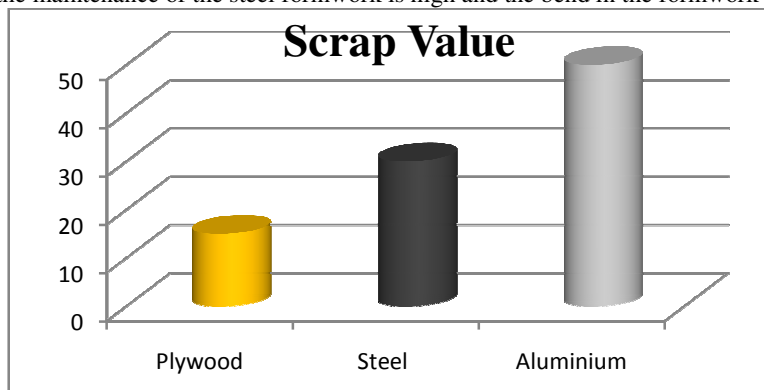
Most Important Scrap Value of Formwork:

The scrap value is also going to in consideration for the maximum return. The companies of aluminium formwork are dealing in such a way that maximum return at the relative interval. The deals are done on the basis of use. The aluminium formwork is economical because of rate of return is high.

Table 10. Scrap Value of Formwork

Sr no	Formwork	% scrap
1	Plywood	15 %
2	Steel	30 %
3	Aluminium	50 %
Scrap value of Aluminium formwork is minimum 50 %		

The graphical representation shows that the aluminium formwork is the giving maximum back at the scrap and the minimum scrap value is plywood formwork. The aluminium formwork is economical on the repeat ion of 100 cycle because the scrap value shows the 50 % back at the reuse. The steel formwork is also economical but the maintenance of the steel formwork is high and the bend in the formwork is frequently seen.



Time of formwork:

It is very important to keep the formwork in position till the cement concrete develops sufficient strength and achieves bonding strength. If the formwork is kept too long it will result in extra cost and therefore a balance has to be arrived at between economy and strength of concrete.

The Indian Standard Code IS-456 gives stripping time of formwork for different RCC members. In general, it states that forms shall not be removed until the concrete has reached strength at least twice the stress to which it may be subjected at the removal of formwork.

Table 10. Traditional Formwork

Sr No	Structural Element	Time Period (Days)
1	Wall, column and vertical sides of beam	1-2
2	Slabs (probs left)	3
3	Beam soffits (probs left)	7
4	Removal of probs to slab	
	(1) Upto 4.5 m	7
	(2) over 4.5 m	14
5	Removal of probs beam	

(1)	span upto 6m	14
(2)	span over 6m	21

Time of aluminium formwork

Formwork is made from aluminium are in many respects similar to those made of steel. However, because of their lower density, aluminium formworks are lighter than steel forms, and this is their most important advantage when compared to steel.

The major disadvantage of aluminium forms is that no changes can be made once the formwork is fabricated and the time of construction is done in the cycle of days of construction. The cycle shows the 8 days of construction with aluminium formwork technique.

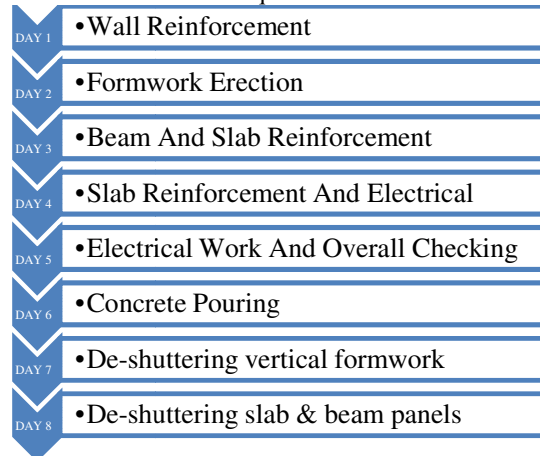


Figure 4. Time Duration of Aluminium Formwork

Quality of formwork

Formwork is the most important task for any construction element in which the strength of element can be achieved easily. Formwork must be capable of safely withstanding without distortion or danger the dead weight of the fluid concrete is placed on it, labour weight, equipment weight and any environmental loadings. Quality of formwork is in which the respective factors are affecting on it.

Weight of formwork

Material of formwork

Work done of formwork

Table 11. Summary of Formwork

Item	Plywood Formwork	Steel Formwork	Aluminium Formwork
Overall Cost	High	<ul style="list-style-type: none"> • Unit cost is Low • Overall cost is Low 	<ul style="list-style-type: none"> • Unit cost is High • Real-time investment is High
Quality and Processing	<ul style="list-style-type: none"> • Lightest • Difficult to Clean • Easy to Transport, Store, Move. 	<ul style="list-style-type: none"> • Heavy • Easy to Clean • Difficult to Transport, Store, Disassemble 	<ul style="list-style-type: none"> • Light • Easy to Transport, Store, Clean and Disassemble
Strength	30 (KN/m ²)	65 (KN/m ²)	60 (KN/m ²)
Recycle	Can be recycled in about 10 Times	Can be recycled in about 40 Times	Can be recycled over 300 Times
Difficulty	Easy	Difficult	Easy
Carrying capacity	<ul style="list-style-type: none"> • Easy to bend • carrying capacity is low. 	<ul style="list-style-type: none"> • Strongest • carrying capacity is high 	<ul style="list-style-type: none"> • Strong • carrying capacity is high
Application	Wall Column Beam Slab Bridge	Wall Column Beam Slab Bridge	Wall Column Beam Slab
Construction Time and Usage	<ul style="list-style-type: none"> • Construction time is long. • Complex 	<ul style="list-style-type: none"> • Use heavy machinery during assembly • Construction time is 	<ul style="list-style-type: none"> • Easy to use • Simple assembly procedures

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	assembly procedures.	longer than that of the aluminium formworks	• Construction time is the Shortest
Recovery Value	Rough	Smooth like dry Wall	Smooth Finishing
Shape Elasticity	Shape elasticity is High	<ul style="list-style-type: none"> • Shape elasticity is low • Can be combine with other Types of Formwork 	<ul style="list-style-type: none"> • Shape elasticity is low • Can be combine with other Types of Formwork

6. Conclusion:

Finally concluded, Selection of Aluminium formwork construction is depending on the project type and project requirements.

- Aluminium formwork construction technique is cost effective for the mass construction and repetitive projects.
- Aluminium formwork construction is rapid construction technique in which construction at high speed.
- Aluminium formwork construction is offering high quality of construction and low maintenance at the minimum cost.

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