

## TO UNDERSTAND DIFFICULTIES IN ADOPTING TUNNEL FORM WORK METHOD COMPARED TO CONVENTIONAL METHOD

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### ABSTRACT

As India is a developing country and many more innovations are yet to happen in each sector. Whereas, with an increase in globalization and population, it is necessary that some changes should be carried out in the construction industry, to move from labor-oriented to machine-oriented which also increases the accuracy of construction and saves time. The technique for construction can affect the cost and accuracy, hence the technique should be developed from all perspectives. And as we all know the complications and wastage in the conventional method of construction unable to fulfill the requirements of people. Hence to overcome this, the updated techniques like the TUNNEL FORM (shear wall) construction technique can be used for the construction of high-rise buildings. So basically, this paper aims at focusing on assets and liabilities of TUNNEL FORMWORK in the construction industry and compare it with Conventional Method on the basis of construction components like Steel, Plaster, Scrap value of Shuttering, Brickwork and Concrete combined, and Time Duration; using a Floor plan of one floor.

**Keywords:** Tunnel Form Casting Method, Conventional Method, Time Saving, Economical, Advance Form Of Mivan Method, Etc.

### I. INTRODUCTION

Not only technique but also the formwork used for construction plays an important role in time and cost factor. The selection of proper formwork can greatly affect the project in terms of cost, speed, quality, and safety of workers. In the conventional technique of construction industry, wood is used, has less life span and weak strength. It states that the use of the Conventional Method is not beneficial and economical. To overcome this drawback, the use of some advanced techniques like the Tunnel Formwork is necessary to provide an opportunity for early recovery of invested cost and complete the project at desired duration. This system acts as a single unit and can be casted at one time which acts as an RCC load-bearing structure. It is also earthquake resistant. The form is then heated using hot air blowers for accelerated curing of concrete for a particular area. And also, the repetitive nature of this technique leads to minimizing the labor cost and effectiveness in workmanship.

### II. OBJECTIVE

The objectives of this paper are to

1. Introduce tunnel formwork system to the Indian construction industry.
2. Compare Tunnel formwork system with Conventional method of construction on the basis of
  - a. Steel Quantity,
  - b. Plastering,
  - c. Shuttering
  - d. Brickwork.
3. Discover, what are difficulties faced in the adaptation of this technic in the Indian Construction Industry.

### III. INTRODUCTION TO TUNNEL FORMWORK SYSTEM

Tunnel form is nothing but it is a box-sized steel fabricated form that allows the structure to be cast monolithic i.e. to cast RCC walls and slab in a single continuous pour. The formwork system is then heated with the hot air blowers which accelerates the setting time of the concrete, which in return makes us achieve one slab in one day i.e., 24 hours slab cycle. This system is more cost effective for even construction of large projects and has more symmetric work.

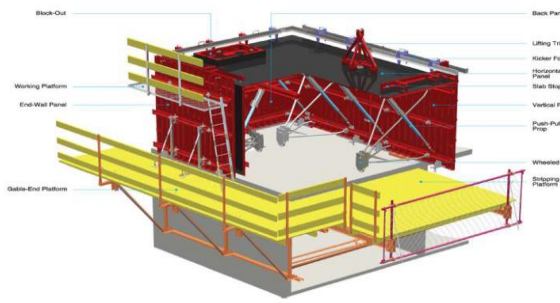


Figure 1:- Tunnel Form and its components

Figure 2:- Tunnel Form and its components

#### IV. COMPARISON OF THE COMPONENTS

We have compared the components like,

1. Steel Quantity
2. Plastering,
3. Shuttering,
4. Brickwork,

For a plan of one floor (shown below- fig 3) which will help us to get to know in more detail about the Tunnel Form Casting Method and Conventional Method.

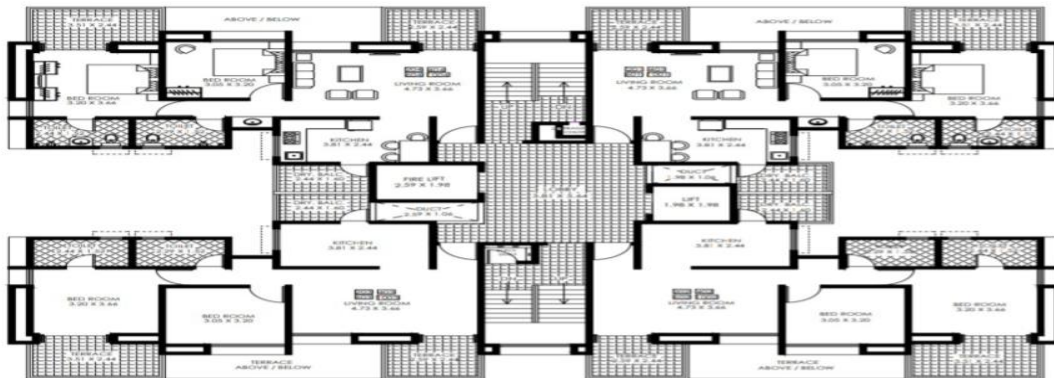


Figure 3:- Plan for which we have compared the given components for one floor.

##### 1. Steel Quantity:

Comparing the reinforcement required for Slab & Beam in both the Method is the same. The main difference in the reinforcement quantity comes in the wall and column. As in the Tunnel Form Casting Method, the wall and column are of the same size and are being cast with concrete at the same time i.e., the Shear wall is used.

##### 2. Plastering:

In Tunnel Form Casting Method, the double coat of plastering is not required as the surface/wall after the casting is quite smooth. We do not need to go for 1st coat we just need to go directly for the paint. No gypsum is provided. And in return, it reduces the cost of Construction. We also can use the concrete exposure as the aesthetic view for the building.

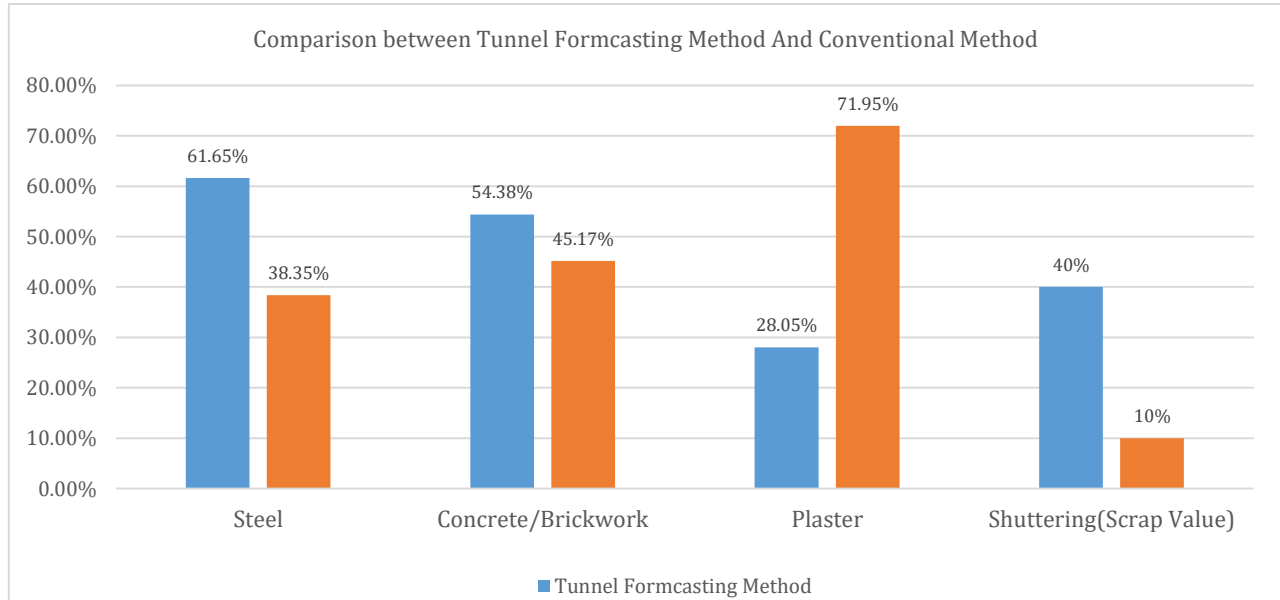
##### 3. Shuttering:

Shuttering required for both methods is approximately the same. The main difference occurs only in the material of which it is made that will be used on the construction site. For the conventional method, we mostly go for the wooden shuttering which has negligible or no Scrap value; whereas for the Tunnel Form Casting Method the tunnel shuttering is made up of steel which gets us 40% Scrap value.

##### 4. Brick work:

Brick used in Tunnel Form Casting Method is only for the Internal Wall / Partition wall only; whereas in Conventional Method brickwork is used to differentiate between the rooms.

The required quantity of bricks used in the Tunnel Form Casting Method is approximately 30% of bricks used in the Conventional Method. Whenever there is brickwork Cement mortar (1:6) comes along with it, which also, in turn, affects the construction cost.



**Graph:** showing the comparison of the components(in Rs)

## V. WHAT ARE DIFFICULTIES FACED IN ADAPTATION IN THE INDIAN CONSTRUCTION INDUSTRY?

1. Investment cost of formwork system increases formwork cost per m2 for the small size project.
2. A regular and speedy cash flow system that is required for speed of construction is much needed. Due to high construction speed, proper planning and functioning is necessary. Multi-tasking of several work unit cause delays in time as mentioned in the given schedule.
3. A skilled labour unit is required compared to other systems of construction.
4. Machinery costs is high due to the cranes.
5. The bottom slab is not possible as it does not allows the removal of formwork, a suspended ceiling is necessary.
6. Basement stories cannot be constructed by using a tunnel formwork system; removal of formwork is not possible
7. Tower cranes are required for the erection, removal, and carriage of formworks, scaffolds, and pre-cast components.
8. Requires proper management of cranes since co-ordination of multiple crane at the same time is quite difficult.

## VI. LITERATURE REVIEW

In the current situation, all over the world due to the increase in population, the requirement for housing is rising, and provide housing is become the biggest priority. And the conventional method of construction take-up is an expensive and time taking technique. But in recent times, to overcome this issue, lots of construction techniques are introduced in our construction industry which can provide better housing at cheaper prices and it also creates the opportunity for builders to recover the invested cost in less interval of time.

Some of the techniques used for construction are as follows:

1. Conventional formwork system,
2. Tunnel formwork system
3. Mivan formwork system
4. Slip formwork system

Above mentioned formwork systems are mostly used techniques all over the globe in our construction industry from which conventional formwork technique is traditional technique.

## VII. METHODS FOR CASTING

There are many methods for casting. It can be the Conventional Method used from the old times or can be the Tunnel Form Casting Method.

Some types of Casting Methods are as follows:

1. Conventional Method,
2. Mivan Formwork,
3. Aluform Formwork,
4. Tunnel Form Casting Methods

### 7.1 CONVENTIONAL FORMWORK SYSTEM

- Conventional technique is the oldest technique of construction which commonly involves the utility of traditional materials like timber and bamboo. The conventional storages depend upon convenient and simple measurement plans and floor plans.

- Conventional buildings are defined as buildings that are pre-fabricated on-site by wooden shuttering formwork, steel reinforcement, and casting of the elements by concrete.

- But by use of such technique, the construction becomes much more costly, which includes labor, raw material, transportation with low speed of construction time. Hence this technique is suitable for small houses with two to three-storied.

### 7.2 TUNNEL FORMWORK SYSTEM

- Tunnel Formwork system of construction was first used and invented in Turkey 50 years ago. The use of tunnel-form produces high-quality monolithic structures (i.e., slab and walls are cast simultaneously).

- It is a highly systematic, earthquake-proven technique. It provides the best possible way to solve the problem faced due to sound transmission.

- This system is used in the construction of structures with high numbers of repetition such as Jail, Student Hostels, Personal Housings, Hotels, Commercial Developments.

- The steel formwork is reused more than 500 times and it can be used according to variety of module shape and sizes. This makes it very flexible and extremely affordable for the construction. affordable for the construction.

## VIII. COMPARISON

ACTIVITY	FOR CONVENTIONAL	FOR TUNNEL FORMWORK
<b>Capital Cost</b>	Minimum.	Initial cost due to formwork and other equipments is very high
<b>Casting System</b>	All the elements such as column, beam, and slabs are casted individually.	Entire structure is casted together only the Internal portion of the wall is built afterwards.
<b>Accuracy and Quality of construction</b>	Less	Good accuracy
<b>Internal/external Plastering required</b>	Required	Not required, but for the later build walls it is required.
<b>Design Changes</b>	Flexible	Difficult
<b>Changes</b>	Possible	Difficult
<b>Speed of work</b>	Average	Fast

<b>Cycle time for RCC work</b>	28 days	1-3 days repeat slab cycle.
<b>Special Machinery</b>	Not required	Require 10 Ton capacity Crane, Welding Machine, 60m <sup>3</sup> to 80m <sup>3</sup> Batching plant, Mesh, etc.
<b>Staff on Site</b>	Require More	Less than other system
<b>Safety</b>	Less Safe	Crane operation is critical
<b>Scrap Value of shuttering</b>	10%	40% - 50%
<b>No. of repetition of shuttering material</b>	Up to 15 times	450 +
<b>Time saved</b>	Depends upon the workmanship	More than 50% time saved based on the studies

### IX. CASE STUDY

A case study was conducted at **ROHAN Abhilasha**, Wagholi, Pune(Tunnel form casting method) and **Shaurya Residency of 3S Properties** to understand the difficulties and the compare the two system with one another.

Sr no.	Details	Case Study (Conventional Method)	Case Study (TFCM)
1.	<b>Name of the Firm</b>	<b>3 S Properties</b>	<b>ROHAN Builders Pvt Ltd</b>
2.	<b>Name of the Project</b>	Shaurya Residency	ROHAN Abhilasha
3.	<b>Location of Project</b>	Lohegaon, Pune	Wagholi, Pune
4.	<b>Type of Project</b>	Residential	Residential
5.	<b>Type of System Used</b>	Basement + G + 11, Conventional Formwork (13 Floor)	Up to 2 <sup>nd</sup> Parking level: - Conventional Formwork, 3 <sup>rd</sup> to 14 <sup>th</sup> Floor: - Tunnel Formwork
6.	<b>Area of Construction (Plot Area)</b>	14164 Sq.m	1,20,800 sq.m
7.	<b>Architectural Consultant</b>	Spectrum Consultant	Mindspace Architects, Bangalore
8.	<b>RCC Consultant</b>	Spectrum Consultant	JW Consultants, Pune

### X. RESULT

After studying both the method, even after the time duration is much less in Tunnel Form Casting Method just because of the initial investment is more Construction Industry prefers for the Conventional method. Except the initial cost there is no such disadvantage in the Tunnel form casting method. In construction times plays very vital role as the time duration is directly proportional to the cash flow. Tunnel form casting method gives us the best of best results, then other system of construction. We can conclude that, due to the reusability and the reduced slab cycle time required for construction makes it more economical.

### XI. CONCLUSION

The growth in construction industry has increased from its early use after adopting the tunnel formwork system but then also many local companies hesitate in adopting different formwork techniques. We are focusing on enhancing the quality and to reduce the cost and time duration of project. The cost of entire project is reduced by 45% and the time duration for construction is also reduced by 60% compared to the Conventional Method. Though it has drawbacks like design building, the requirement of skilled labor, crane availability, etc. but these

drawbacks don't matter when compared to long-run benefits. Though it is not cost effective for small projects but is very useful in high-rise building projects. After complete study and analyses with the conventional method we can conclude that, though initial investment cost is high, the reusability and the reduced slab cycle time make it more economical. Rapid completion of the project helps in refund the initial investment. Thus, considering this factors for future industrial growth, Tunnel form Method Casting is much beneficial than Conventional Methods.

### ACKNOWLEDGEMENT

We are grateful to **Mr. Milind Lunkad M.D** of **ROHAN Builder and Developers Pvt. Ltd** for giving us the required support for learning and understanding the tunnel form formwork. I am also thankful to the Project Manager and the Site staff for providing the necessary infrastructure required for completing this paper.

We are also grateful to **Mr. Sujay Shah** of **3 S Properties** for giving us the required support for learning and understanding the tunnel form formwork. I am also thankful to the Project Manager and the Site staff for providing the necessary infrastructure required for completing this paper.

We are also grateful to **Mrs. Gauri Patil Ma'am** for guiding us and providing us the necessary information required for the completion of the paper.

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