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Tunnel Formwork Technology

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***Abstract*: Winds of change are blowing across every industry in India but the construction Industry is still reluctant to utilize the advanced techniques that can enhance the Productivity and efficiency of the construction industry. In recent years construction Industry is witnessing increased demand in multistory construction and repetitive Modular structures are becoming an integral part of it. Real estate construction industry has a reputation of not begin very technologically sophisticated, generally lagging in innovation, construction techniques & management. But now a day's lot of research is carried out in this sector. These structures require detailed planning in order to save cost and time. As formwork accounts for about 25-40% of the total project cost and almost 60% of the time in concrete construction, we need to pay attention to the development in formwork techniques and replace Conventional formwork with new formwork techniques like tunnel formwork. This Paper aims at focusing on the benefits and limitations of tunnel formwork in contrast to conventional formwork thus changing the mind set of local construction industries that are still dependent on conventional formwork techniques.**

***Keywords*: Tunnel formwork.**

1. Introduction

The increase in population and the limitation of space has leaded the way to multistorey or high-rise buildings. In order to make these structures sound, we need to focus on factors that impart strength to concrete and this is where formwork plays an integral role. Formwork is a temporary structure like a die or mould, used to contain poured concrete, to give concrete the desired shape and support it until it attains sufficient strength to carry its own weight. Formwork should be capable of carrying all imposed dead and live loads apart from its own weight. Pantheon, a former Roman temple and now a church in Rome, is the earliest example of use of mould for concreting. Formwork should be properly designed, fabricated, and erected to achieve high quality concrete finish. If this is not done properly the desired shape and strength of concrete is not achieved. Advanced Tunnel formwork is one of the new formwork techniques to hit Indian construction industry. It is found to be suitable for mass construction in Indian conditions. It delivers quality and speed at a rate which is higher than the speed achieved by most of the formwork systems. The labour in coordination with heavy machineries like tower crane speeds up the construction, assures quality control and durability. This reduces overall time and cost of the structure. This paper mainly focuses on advanced tunnel formwork systems, its components, working cycle, cost involved, its benefits and its limitations based on speed and economy.

2. Objectives

1. To introduce advanced tunnel formwork systems to Indian construction industry and lay emphasis on the high quality, speedy construction and if used effectively the economically which tunnel formwork yields.
2. To present comparative study of tunnel formwork and conventional formwork system on the basis on,
   - Slab cycle time
   - Cost parameters.
   - Quality parameter
3. To eliminate the reasons which act as barrier for the local construction industries while opting for new formwork techniques like tunnel formwork.

3. Detailed Study

Tunnel form is a box sized steel fabricated form that allows the wall and the slab to be casted in a single operation. Once reinforcement is placed, concrete for walls and slabs can be poured in a continuous pour. An arrangement of hot air blowers accelerates the setting of the concrete and one slab is achieved in one day i.e. 24 hours slab cycle. 300- 400 m2 of floor area can be poured on a daily basis. A crew of 10 people can achieve a daily cycle of casting 1-2 apartments per day depending on the type of structure. A 10 storied building can be completed in 20-30 days maximum. For low-rise buildings e.g. 5 storeys, total weight of the building can be designed 1.10 – 1.20 tons/m2 lighter than compared to 1.30 in conventional method. Precast element is one of the critical activity at the time of using tunnel formwork, it results in increased productivity at very short period of time which results in time and cost saving. It is particularly effective in projects suited to repetitive cellular construction involving huge symmetrical work such as residential blocks, hotels, student accommodation, barracks and prisons. Tunnel form is also used in several housing projects especially for earthquake resistant projects as the construction time is reduced. Tunnel form systems are used to construct repetitive cellular structures (such as hotels and apartment blocks) and enable the construction of horizontal and vertical

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elements (floors and walls) together. Each unit is in the form of an inverted L, the vertical leg being the formwork for one face of a wall and the horizontal leg being soffit formwork. Several units are erected together to create the formwork for a number of 'tunnels' consisting of walls and ceiling slab. The normal dimensions of tunnel form units are 8 to 11m long and 2.4 to 6.8m wide, but individual units can be joined to give tunnels of greater length.

4. Machine Requirement

- Require 10 ton capacity Tower Crane.
- A 60 to 80 m3 batching plant.
- Mesh Welding Machine.
- Gas heaters (for cold climate).
- Hydra
- Concrete Distributor
- Other Routine Machineries

Fig. 1.

Fig. 2.

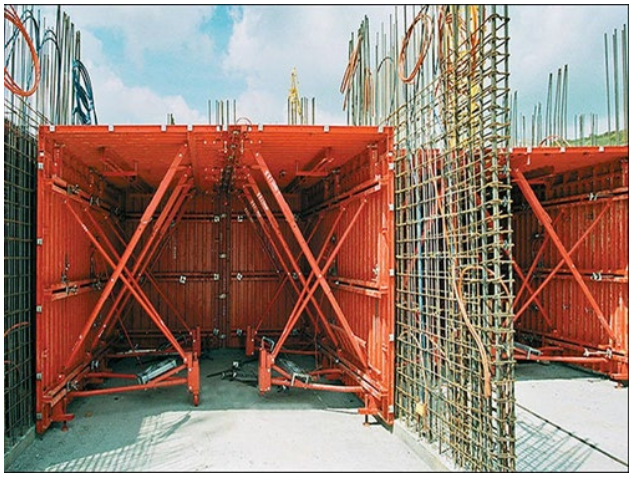

Fig. 3.

Fig. 4.

5. Role of Management

Coordination plays an important role in process of concreting with tunnel formwork. Cost and time constraints are always impacting design and quality considerations. In order to achieve conformity with design and maximum quality with reduction in cost and time, management comes into picture.

1. Responsibility of training the labours to ensure smooth execution.
2. Building should be so planned that maximum tunnel from can be done with the help of one location of tower crane. Positioning of the crane, precast workshop, material storage, etc. are to be planned to reduce transportation time and idle time.
3. Detailed planning is required. All the activities are to be planned before the commencing of the project. This will reduce the lag time. The activities dependent on one another can be foreseen and executed in sequence this helps in providing space for ducts and facilities.
4. Alternatives should be decided beforehand incase barriers are faced in tunnel form especially in very short and very large spans of slab. This will help in speedy construction.
5. Tunnel form system comes with highest jobsite safety due to full perimeter platform system but risk management should not be ignored. Involvement of all the sectors is needed. The designing team, execution team and architectural team need to be in sync so that tunnel.

Table 1

Characteristics	Conventional Formwork Technology	Mivan Formwork Technology	Tunnel Formwork Technology
Capital Cost	Less	High	Very High
Accuracy & Quality of construction	Less	Good accuracy	Superior
Plastering	Required	Not Required	Not Required
Cycle time for RCC work	21 to 28 days	10 to 12 Days	1 day repeat cycle possible
No. of repetitions of shuttering material	12-15 times	100-150 times	500+ times
Advantages	Low cost, Easy to operate	Low manpower, Moderate to fast construction	Long lifespan, Low manpower, Speedy Constuction
Limitations	Short lifespan, Slow speed, Poor quality	Moderate lifepan and manpower required	High investment, Only work with tower crane
Cost of shuttering material	Around Rs,400 to 500/sqft	Around Rs.5000 to 6000/sqft	Around Rs,9000 to 10000 /sqft
Labour Cost	Around Rs,85 to 100 /sqft	Around Rs.175 to 250/sqft	Around Rs,250 to 300 /sqft

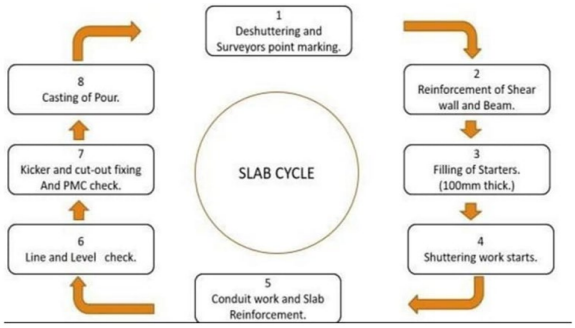

Fig. 5.

6. Conclusion

1. We can achieve 1-3 days slab cycle by 'Tunnel Formwork System'.
2. Considering Indian conditions tunnel formwork if used 100% quantum of slab, as it involves heavy investment in procurement, heavy machineries, specialized expert labour it becomes uneconomical. In case project involves more than 20 storied building over large area, total economics may change considerably.
3. Also, after studying and comparing both the systems it can be concluded that, though initial investment and per day operational cost in Tunnel Formwork is more than Conventional and Mivan formwork System, due to more reuses and reduced slab cycle time Tunnel Formwork works out ultimately economical.
4. Also returns from initial investment regained due rapid completion of project Hence in long term consideration Tunnel Formwork System is beneficial than that of Conventional and Mivan formwork System.

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