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JUMP FORMWORK TECHNOLOGY A TIME SAVING BOON FOR HIGH-RISE STRUCTURES

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ABSTRACT
The Indian populace has crossing 125 Cr. In todays date. Hence in today's date fulfilling thebasic needs in way of living is getting difficult. To achieve the equilibrium between nature and human basic needs, finding new way is necessary. As there is an improvisation in people's lifestyle hence, they are demanding the high standard facilities like infrastructure, modern housing. As the land percentage of non-agricultural area is less in our nation so rather than spreading horizontally, enhancing verticality construction is the best option.The vertical development consists of high-rise buildings, sky-scrapers, super-tall towers etc. For such constructions use of in-expensive formwork which is using conventionally formwork is good but not enough as it doesn't fulfil other needs such as quality, time and speed. Hence automation in advanced formwork i.e. Jump Formwork technique is the better option shown in this research paper. Also, in research work the scheduling and sequencing of activities is made in Microsoft project and compared their duration with conventional formwork. The other factors which influences project are also discussed.

KEYWORDS: High-rise building, Jump-Formwork technology, Microsoft project, Rapidclimb formwork**,** Vertical development.

INTRODUCTION
In India, the present land area is 3.28 million square km. It is classified into 3 points plains, mountains and plateaus.43% India's plain land area is utilized for agriculture and industry. The plain land area comprises of nine divisions.According to that only 7.92% land of non-agricultural purposes is utilized for building various structures such as of Real Estate Projects and infrastructure projects.
As the Indian populace is almost at hike, hence land requirement is more to provide basic needs to the citizens.If proportion of increased population is compared in city/town areas and rural areas then it founds more in urban city area due to facilities provided, modernization, education and employment opportunities. Hence requirement of great amount of plot area is there for fast growing population for which cultivable lands are getting converted into plots for construction. Due to this the quantum of agricultural and forest lands is getting much lower which is affecting the environmental balance. Hence rather than spreading horizontally, developing the lands vertically is the much better option to satisfy the demands of current population by constructing the Multi-story structures such as high-rise edifices, sky scrapers, towers etc.

FORMWORK TECHNOLOGIES FOR MULTI-STORY STRUCTURE
Constructing a high-rise tower is not an easy thing as the complexity of workincreases as height of it increases. The traditional formwork patterns of the India are not enough to construct such structures as they don't have that much properties which required for such towers. Hence to construct such tall structures favourableand well mechanized site is required.
Now-a-days for constructing such tall structures various new technologies are introduced and trending such as Slip form technology, Jump formwork technology etc. Slip form type of formwork arises to next floor leveluninterruptedly, supporting itself on the core which is generally preferred for constructing cooling towers in thermal and nuclear power plants in India.Jump formwork technology is the system consists of formwork and platforms which used by labours for cleaning/fixing of the formwork, steel reinforcement and concreting which is generally preferred for:

- Shear walls
- Core walls
- Lift shafts

- Stair shafts
- Bridge pylons

Basically 2 main companies are involved in manufacturing of Jump formwork technology which are RMD KWIKFORM, DOKA etc.

METHODOLOGY

The following methodology is adopted:

- Choose typical core wall layout.
- Application of Jump formwork technology on structure
- Data collection related to Jump Formwork Technology
- Analysis of one complete cycle of structure and time required using Minima Panel Formwork and Jump Formwork Technology by means of Microsoft Project.

DATA COLLECTION

The Jump Formwork system is also known as climbing formwork system. The climbing formwork/Jump formwork is a shuttering technique for high-rise projects in which concrete is placed into anuninterruptedly moving formwork. The formwork is confine with a three-storey-staging platform on which labours like carpenters, fitters can stand, place reinforcement steel thenpouring of concreteis done and assures a smoothly poured concrete and great finishing of the final rigid concrete surface.The concrete formwork and its platform made for working is arised concurrently, with the help of crane/hydraulic jackswhich are fixed over rail on theouter side surface.

❖ Types of Jump Form/Climbing formwork system

Jump Formwork technology/Climbing Formwork technology is mainly classified into 3 types which are:

- Normal jump/climbing form-units are independently lifted off the structure and realigned at the next structural level using a crane. Availability of crane is important.
- Guided-climbing jump form- it renders anchored/guided by the structure still crane is required.
- Self-climbing jump form-no need of a crane as it climbs on rails up the building with the help of hydraulic jacks.

❖ CASE STUDY

- CLIENT: KRC Infrastructure & Projects Pvt. Ltd.
- RCC Consultant: STUP Consultant
- Contractor: Millennium Engineers and Contractors Pvt. Ltd.
- Architectural Consultant: P.G. Patki Associates
- History –

  Due to comfortability in the building of a structure like core wall, Millennium Engineers and Contractors Pvt. Ltd started using the Jump Formwork System. The first project using Jump Formwork System was ‘Trump Tower’ in Kalyani Nagar Pune in 2013. After that one more project was done using same technique which was EON phase -2 Kharadi. Now 2 more ongoing projects are there in Kharadi by using same technique for core wall construction.

  In the current project i.e., KRC IT Tower G2 building total 12 no of lift shafts are there with total Built-up area 74.823 sq.

The typical core wall structure layout is shown below:

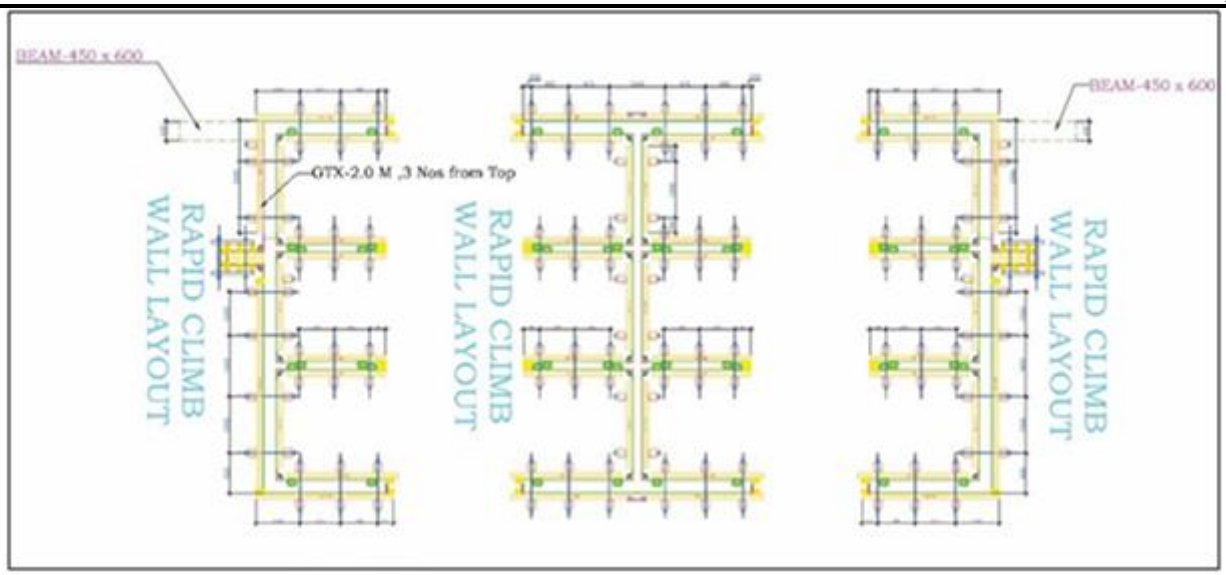


Figure 1: Typical Core wall structure layout

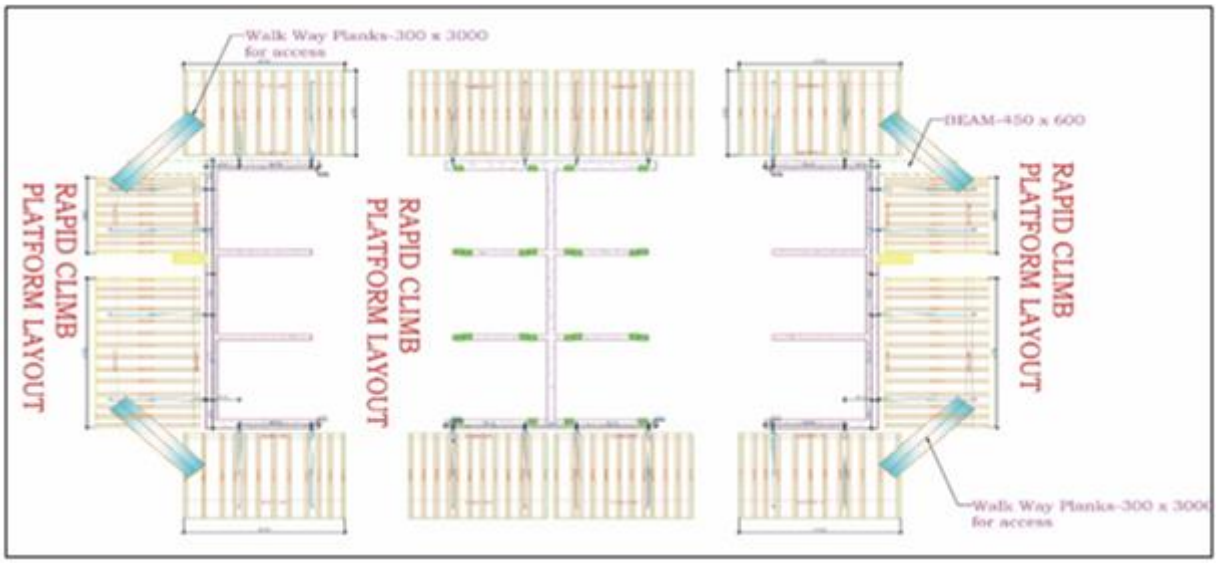


Figure 2: External platform

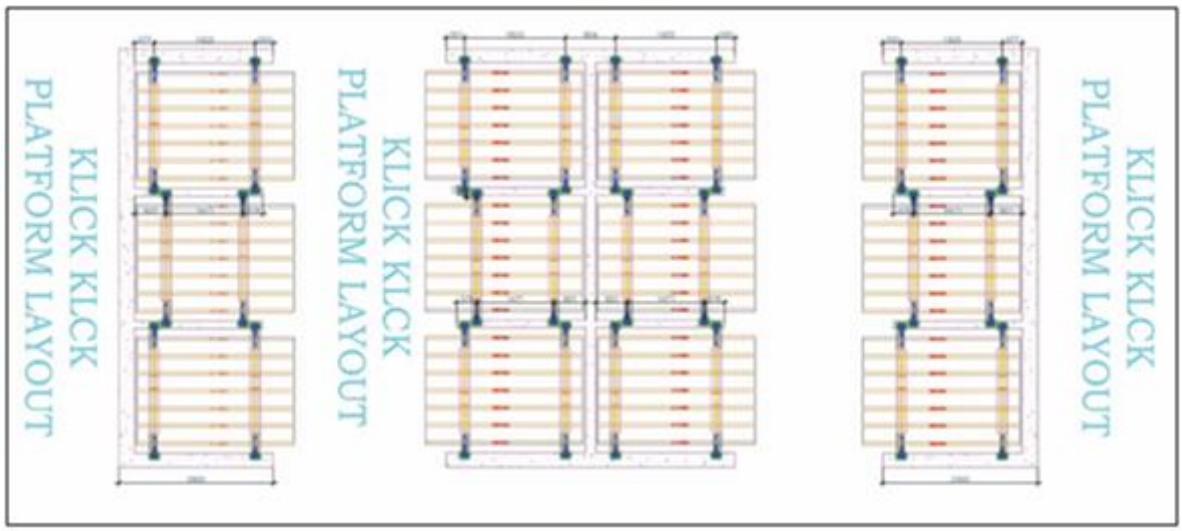


Figure 3: Internal platform

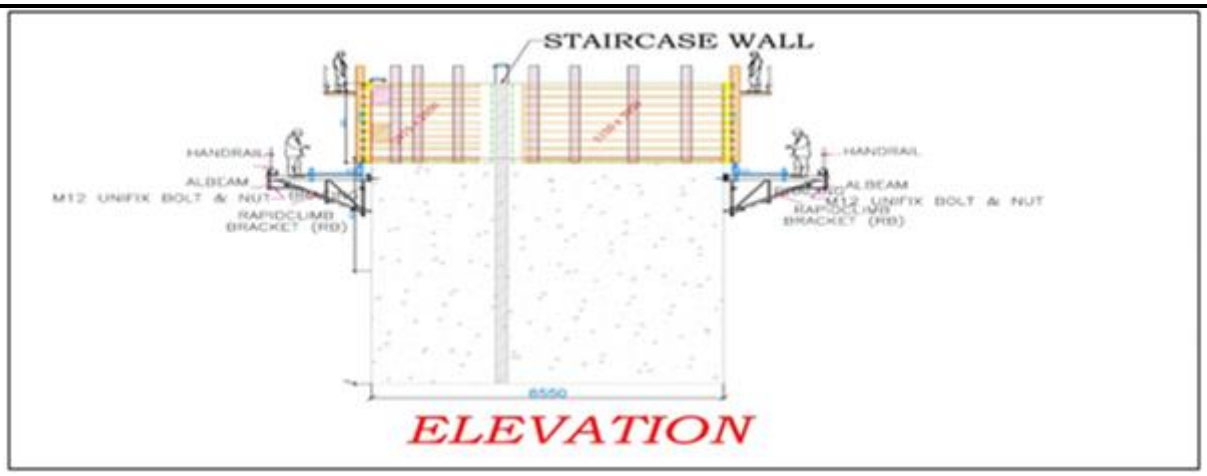


Figure 4: Elevation

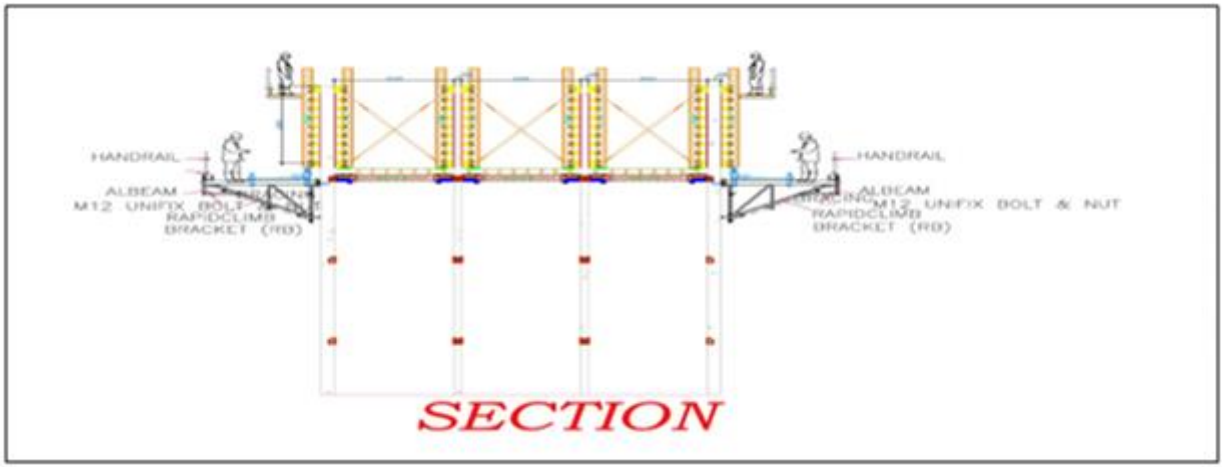


Figure 5: Section

- **The basic accessories used in Jump Formwork system are shown below:**

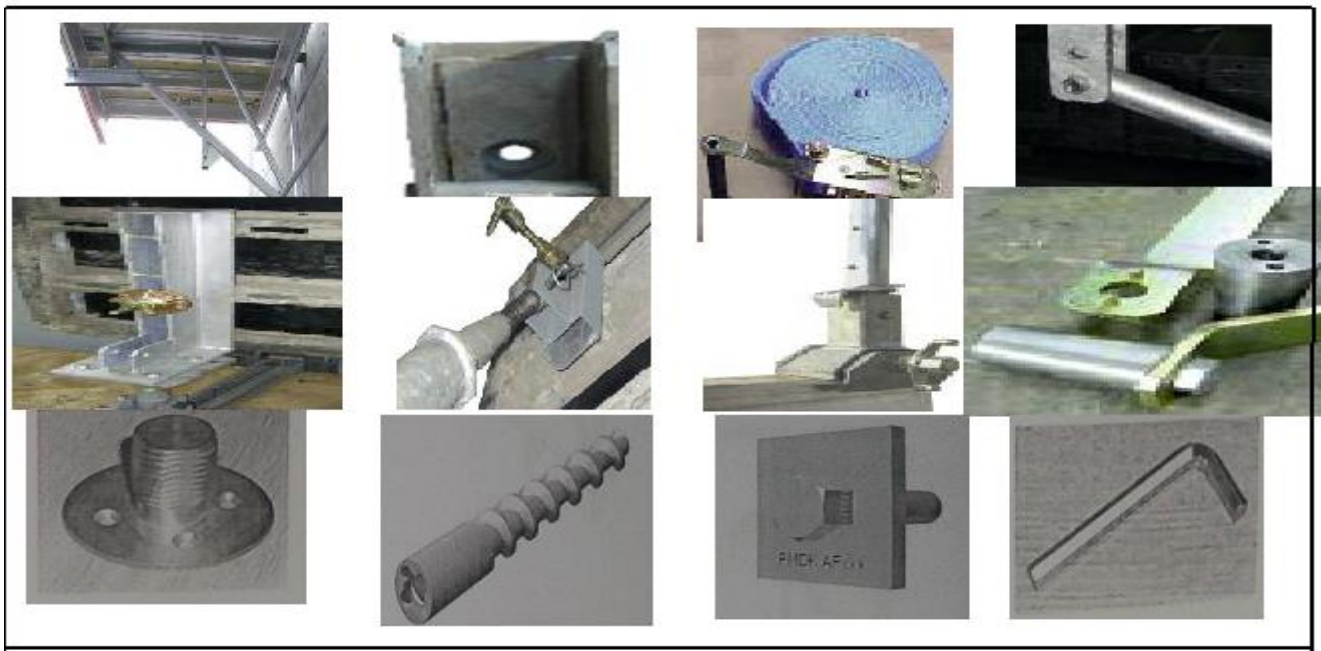


Fig (i) **Fig (j)** **Fig (k)** **Fig (l)**

Table 1: Accessories utilised Jump Formwork Technology

Sr. No	Accessories	Purpose
Fig (a)	Rapidclimb Frame	Main structural component of the system which supports the forms & access platforms.
Fig (b)	Rapidclimb Bracket	Used to connect the bracket to the structure. Fixed with an M24 X 60 grade 10.9 Countersunk Bolt to the previously cast in anchor.
Fig (c)	Rapidclimb Ratchet	Used to tie the Rapidclimb frame to the core wall which prevent overturning.
Fig (d)	Rapidclimb System Suspended Tube	System suspended tubes permitsextraction of wall brackets and essential concreting finish.
Fig (e)	Rapidclimb Maxima Shoe	It is a shoe like a structure which connects the railing system.
Fig (f)	Rapidclimb Turnbuckle	A turnbuckle, which adjusts the tension in tie rods, and other systems under tensioning.
Fig (g)	Rapidclimb Guard Rail	It is utilised for connecting railing system and to provide guard for that.
Fig (h)	Rapidclimb Anchor Accessories	Using anchor accessories climbing brackets are connected to wall which can resist 30kN vertical load.
Fig (i)	Ascent Anchor Plate	A consumable M24 gr8. 8 anchors used with the M24x100 mm Anchor cone (AGX10021) & Rapidclimb Anchor Cone (RCX10009)
Fig (j)	M24Anchor Screws	A fully recoverable alternative to the cone for fixing on the core wall.
Fig (k)	Rapidclimb 45kNCone Retainer	Used to attach the 45kN Anchor Cone or 30kN anchor screw to the shutter prior to pouring. This is nailed to the shuttering face and the anchor is hand tightened onto it.
Fig (l)	14 mm Allen Key	A 14A/F key used to extract the Cone Retainer from the Anchor cone after the pouring process.

DATA ANALYSIS

Basically, the main use of Jump Formwork System/Climbing Formwork System is construction of core wall is always one floor above the normal floor slab level. Hence the core wall construction is much speedy than remaining.

The construction sequence followed in Jump Formwork technique is as follows:

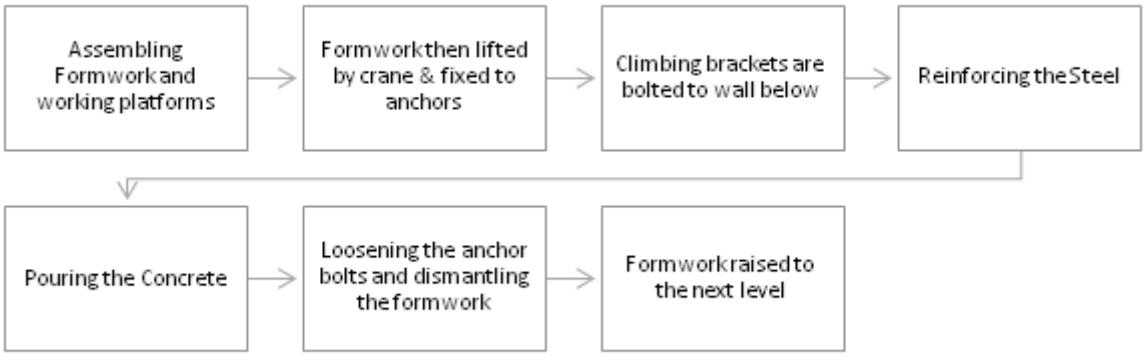
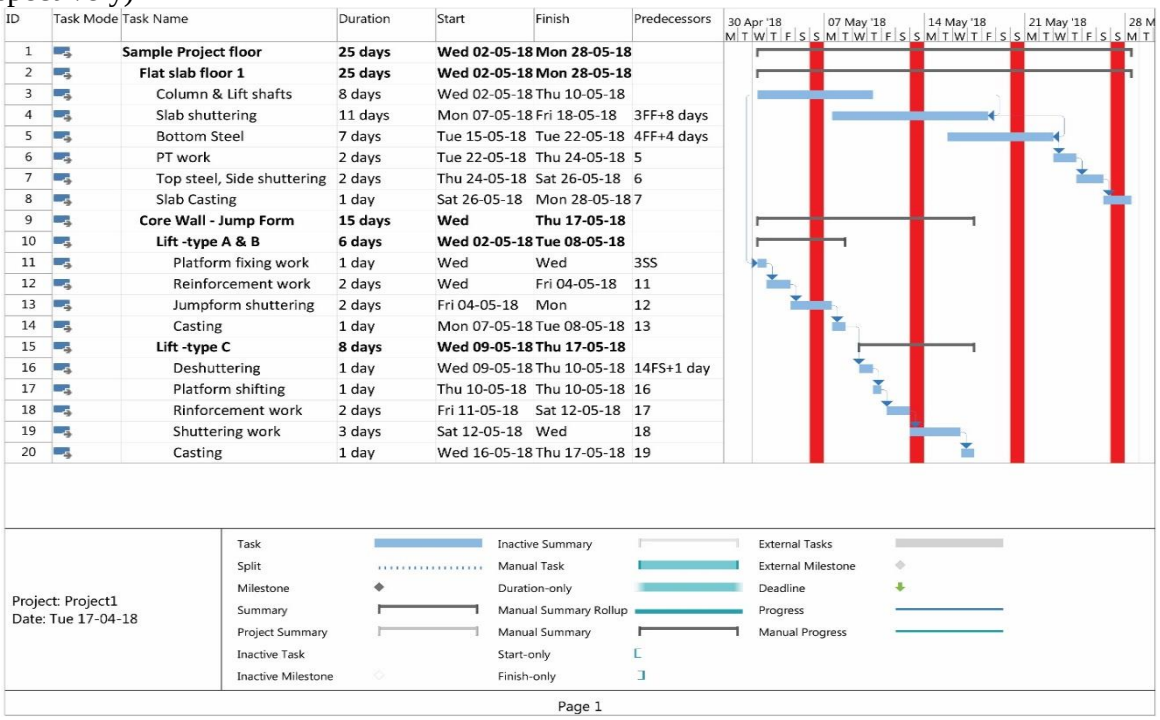


Figure 6: Construction Sequence in Jump Formwork Technology

The main aim of this research is the analysis of required schedule for construction of core wall using Jump Formwork System and Minima Panel Formwork System using Microsoft Project.

In Microsoft Project one flat floor slab and core wall structure construction scheduling is prepared and compared where flat floor slab formwork material is table formwork in both schedules only core wall formwork material is differed.

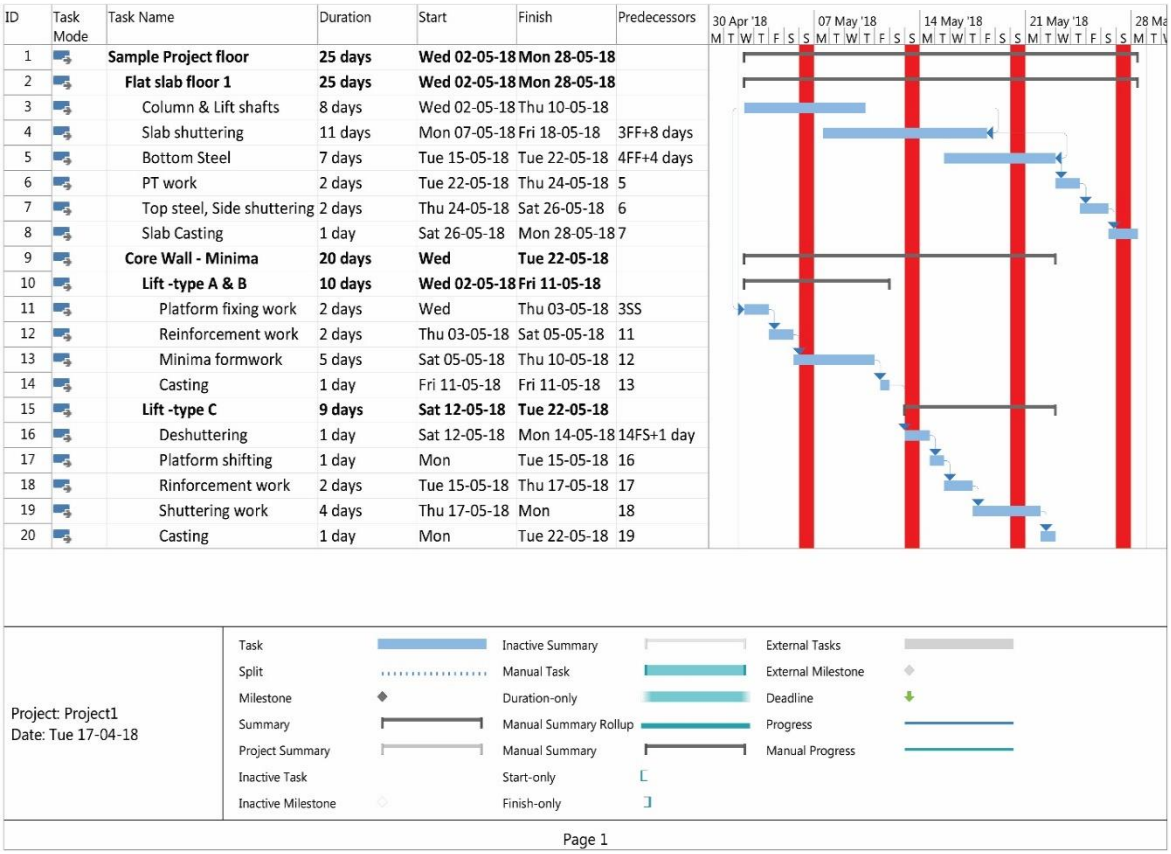
1. Schedule of Flat floor slab and Core wall (Formwork – Table Formwork and Jump Formwork respectively)



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Sample Project floor**	**25 days**	**Wed 02-05-18**	**Mon 28-05-18**	
2		**Flat slab floor 1**	**25 days**	**Wed 02-05-18**	**Mon 28-05-18**	
3		Column & Lift shafts	8 days	Wed 02-05-18	Thu 10-05-18	
4		Slab shuttering	11 days	Mon 07-05-18	Fri 18-05-18	3FF+8 days
5		Bottom Steel	7 days	Tue 15-05-18	Tue 22-05-18	4FF+4 days
6		PT work	2 days	Tue 22-05-18	Thu 24-05-18	5
7		Top steel, Side shuttering	2 days	Thu 24-05-18	Sat 26-05-18	6
8		Slab Casting	1 day	Sat 26-05-18	Mon 28-05-18	7
9		**Core Wall - Jump Form**	**15 days**	**Wed**	**Thu 17-05-18**	
10		**Lift -type A & B**	**6 days**	**Wed 02-05-18**	**Tue 08-05-18**	
11		Platform fixing work	1 day	Wed	Wed	3SS
12		Reinforcement work	2 days	Wed	Fri 04-05-18	11
13		Jumpform shuttering	2 days	Fri 04-05-18	Mon	12
14		Casting	1 day	Mon 07-05-18	Tue 08-05-18	13
15		**Lift -type C**	**8 days**	**Wed 09-05-18**	**Thu 17-05-18**	
16		Deshuttering	1 day	Wed 09-05-18	Thu 10-05-18	14FS+1 day
17		Platform shifting	1 day	Thu 10-05-18	Thu 10-05-18	16
18		Rinforcement work	2 days	Fri 11-05-18	Sat 12-05-18	17
19		Shuttering work	3 days	Sat 12-05-18	Wed	18
20		Casting	1 day	Wed 16-05-18	Thu 17-05-18	19

Figure 7: Schedule of Core wall using Jump Formwork System

2. Schedule of Flat floor slab and Core wall (Formwork – Table Formwork and Minima Panel Formwork



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**Sample Project floor**	**25 days**	**Wed 02-05-18**	**Mon 28-05-18**	
2		**Flat slab floor 1**	**25 days**	**Wed 02-05-18**	**Mon 28-05-18**	
3		Column & Lift shafts	8 days	Wed 02-05-18	Thu 10-05-18	
4		Slab shuttering	11 days	Mon 07-05-18	Fri 18-05-18	3FF+8 days
5		Bottom Steel	7 days	Tue 15-05-18	Tue 22-05-18	4FF+4 days
6		PT work	2 days	Tue 22-05-18	Thu 24-05-18	5
7		Top steel, Side shuttering	2 days	Thu 24-05-18	Sat 26-05-18	6
8		Slab Casting	1 day	Sat 26-05-18	Mon 28-05-18	7
9		**Core Wall - Minima**	**20 days**	**Wed**	**Tue 22-05-18**	
10		**Lift -type A & B**	**10 days**	**Wed 02-05-18**	**Fri 11-05-18**	
11		Platform fixing work	2 days	Wed	Thu 03-05-18	3SS
12		Reinforcement work	2 days	Thu 03-05-18	Sat 05-05-18	11
13		Minima formwork	5 days	Sat 05-05-18	Thu 10-05-18	12
14		Casting	1 day	Fri 11-05-18	Fri 11-05-18	13
15		**Lift -type C**	**9 days**	**Sat 12-05-18**	**Tue 22-05-18**	
16		Deshuttering	1 day	Sat 12-05-18	Mon 14-05-18	14FS+1 day
17		Platform shifting	1 day	Mon	Tue 15-05-18	16
18		Rinforcement work	2 days	Tue 15-05-18	Thu 17-05-18	17
19		Shuttering work	4 days	Thu 17-05-18	Mon	18
20		Casting	1 day	Mon	Tue 22-05-18	19

Figure 8: Schedule of Core wall using Minima Formwork System

OBSERVATION

According to above schedules it shows that Jump formwork for core wall takes minimum time for construction and it is ahead of one slab and in the case minima panel formwork time for construction is more than jump formwork and little behind of flat slab.

Figure 9: Elevation of Jump Formwork system on site

Figure 10: Fixing of Superslim Soldier in Jump Formwork system on site

Other than time aspect these are the following points under which Jump Formwork System and Minima Formwork System are Compared:

Table 2: Differentiation between Traditional and Jump Formwork System

Sr.No.	Points	Traditional Formwork Systems	Jump Formwork Systems
1.	Height	Maximal 100m	Minimal 75 m no maximal limit
2.	Area	Maximal of 600m^2/floor	Not an issue
3.	No. of stories	5-10 floors	5 floors and above (more than 20 floors)
4.	Type of high-rise structure	Rigid Frame system	Framed wall system
5.	Workspace	For preparing panels	Not an issue
6.	Type of projects	Not an issue	Medium
7.	Construction sequence	Construction of flat floor slab and core wall goes hand-in-hand	Construction of core wall is always one floor ahead of flat floorslab
8.	No. of reuse	15-20	80-90
9.	Rework	Lot of reworks	No problem misalignment
10.	Concrete Finish	Rough finish needs plaster	Extreme Quality Finish
11.	Material cost	Low	High
12.	Fabrication cost	High	Prefabricated assembly
13.	Storage cost	High	Less Ready-made setup
14.	Transport cost	Less	High
15.	Labour	More Labours	Less labours (7-10 labours)
16.	Rate of concrete pour	35 kN/m^2	85 kN/m^2
17.	Temperature	Mostly for normal temperature	Utilised in any kind of temperature by means of specific provision
18.	Form type	Gang Formwork	Rail Formwork
19.	Platform	Need Scaffolding	Platform with formwork itself
20.	Safety	Low	High
21.	Accessibility	Required higher offers lesser	Performed even in small space but it offers more space than required 1.5 m

CONCLUSION

Referring to the above discussion, Jump Formwork System is the better solution in the case of Multi-storystructures rather than conventional formwork. The initial investment of Jump Formwork is much larger still it is one-time investment as its number of repetitions are more than conventional formwork so it seems to be highly cost-effective in the case of Multi-story structures. Due to Jump-formwork the construction of core wall is always one floor ahead which helps to reduce time require for construction and resources can be shifted to other works. According to the future expansion, material can be import in large amount. So, the schedule of structure can be more reduced.

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