

Investigation for Finding out Difficulties in Construction of High Rise Building & Suggest Remedial Measures to Expedite the Execution Process of Activities

Dharmakar Dhammanand Chandrakant, Arjun. R. Vasatkar

Abstract: High-rise buildings are designed with all modern & luxuries amenities for giving comfort & happy life style to buyers. The service lines & setup of infrastructure required for providing amenities are normally provided in basements. Such like, parking, CCTV Control room, Drivers room, Society office, Rooms for servants, Toilets for Drivers, Servants & maintenance staffs. Electrical Transformers, UG Tank, Fire fighting tanks, STP etc. Therefore basement of high rise building is very important part of building. Developer, Architects & Engineers are very much conscious about construction activity involved in basement as it is underground structure. In basements activities especial care to be taken because activities involved such like waterproofing, raft, footings & retaining wall includes. Membrane coatings for waterproofing of RCC elements are presently getting used in most of high-rise buildings. To stop entry of water in basements, waterproofing is needed to get done to horizontal & vertical plane that is, to retaining wall in vertical plane & below raft in horizontal plane. Due to rounded section of shore piles in vertical plane level surface to fix waterproofing membrane is not possible to get. So to make level surface plume concrete wall (PCW) is required to construct. It is observed during case study that, construction of plume concrete wall (PCW) required for fixing waterproofing membrane is time consuming activity. The object of this study is to expedite construction activity of plume concrete walls by finding out another option to plume concrete wall. Also to suggest new material of constructing PCW & reduce PCW construction duration & cost. On bases of case study at project site, Second option of "Skin wall" Construction instead of "Plume concrete wall" is suggested.

Keyword: -Plum concrete wall (PCW), Skin wall (SWC), Waterproofing Membrane, Shore Piles, Basement, Retaining wall.

I. INTRODUCTION

Construction of high rise building is today's demand of metro cities all over the world. High-rise building is designed with basements to provide maximum services of building in basement.

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Activities of basement such as raft, retaining wall & waterproofing are important activities. At presently, waterproofing membrane is normally used in construction industry for waterproofing of basements. To fix waterproofing membrane, level surface is needed therefore, in vertical plane plume concrete wall (PCW) is constructed & in horizontal plane PCC is used for this purpose.

Deliver the project to buyers on committed time is biggest challenge in front of Engineers, Architects, consultants & Developers. Government of Maharashtra has implemented RERA Act 2016 (Regulation & Development) in real estate. One of the benefits of this Act is that now there is lawful binding to developers for delivering the projects on given timeline. Therefore it is necessary for engineers & developers to see that any activity which is delaying the progress of building should be identified & makes necessary changes in its construction methodology & material to reduce construction duration also to reduce cost of construction. The case study of on-going projects project, & data collected on site identified that plume concrete wall (PCW), which required for fixing waterproofing membrane is time consuming & costly activity. Also at site there is lot of difficult locations noticed where smooth construction of plume concrete wall is not possible due to topography of site. On this project here waterproofing membrane HDPE (High-Density Poly-Ethylene) of 1.2mm thick fully bonded sheet for raft & retaining wall is getting used. The full bonded HDPE waterproofing membrane sheet shall consists of a multi-layer composite film which consists of highly resilient HDPE film, self-adhesive polymer layer and a trafficable particulate layer. To reduce duration & cost of plume concrete wall (PCW) the concept of skin wall construction (SWC) is suggested. This is wooden material wall called "Skin wall", it is suggested instead of plume concrete wall to make construction, faster & economical. Now a day in construction industry availability of labour is also one of the big challenges. In construction of skin wall less labours required, it doesn't needs very highly skilled labour. Material required for constructing skin wall is easily available in market. It required pine wood of section 3'' X 2'' & 8' long , 12mm thickness commercial plywood , M.S.flats , Concrete & wooden Nails. Reference taken from Paper Publication International Journal of Engineering Research ISSN: 2319-6890(online), 2347-5013(print), Volume No.5, Issue Special, pp.: 32-36, 8 & 9 Jan 2016.

II. OBJECTIVES

- (a) To study the various activities involved in construction of high rise buildings & execution process implemented by construction companies for constructing any high-rise building project.
- (b) Identify those activities which are delaying construction progress.
- (c) Suggesting new working methods of those activities, which are delay further activity & affecting construction progress.
- (d) Recommending use of new material to reduce construction cost of plume concrete wall (PCW).
- (e) Suggesting to implementing new methods & new material recommended during the case study at upcoming projects in construction industry.

III. METHODOLOGY

A. Plume Concrete wall (PCW)

Two rounded shore piles constructed adjacent to each other in straight line does not form line & level surface because of rounded shape. To make it in line & level surface by providing shuttering at edge of shore piles, Space between two adjacent piles is needs to fill with lean concrete. This activity is known as “Plume concrete wall”. Plume concrete wall is not a structural member. It is constructed just to provide line & level surface for fixing waterproofing membrane on it, So that water could not entered from soil through retaining wall & later in basement area.



Figure1. Plume concrete wall constructed for fixing waterproofing membrane at Project site

B. Materials & Machineries for PCW

- One sided Plume concrete walls formwork.
- M-5 concrete
- Concrete pump
- Concrete breaker
- Concrete Dill machines
- Plywood cutting Machine
- Plywood drilling Machine
- Concrete vibrator set.

C. Methodology of PCW Construction

- Survey of shore pile location is done & layout is finalised, so that minimum thickness of plum concrete wall should come to entire periphery of plot.
- One side formwork panels are fixed for plume concrete wall with adequate Wellers & supporting props.

- Formwork is checked before casting for it stability against concrete pressure & allowed to pour.
- M5 pure concrete is poured wherever average thickness in between 150mm to 200mm having .If thickness is more than 200mm wide then, Along with M5 concrete boulders less than of size 230mm in the ratio of 70:30 is used (that is, 70% quantity is of concrete & 30% quantity is of boulders).
- After 12 Hours deshuttering is done & plume concrete wall is cured for minimum 3days.
- After curing period completes waterproofing membrane sheet is get started fixing on plume concrete wall.
- Once waterproofing membrane sheet gets fixed, reinforcement for retaining wall & raft is started.
- After completion of reinforcement activity, Electrical conduit & module boxes for electrical points are fixed in reinforcement of retaining wall also grouting pipe is provided. In case, if leakages found in retaining wall, grouting to be done in later stage to stop leakages.
- Engineer Incharge approve the reinforcement & MEP work before fixing negative shuttering for retaining wall.
- Shuttering panels are fixed as per formwork scheme at site.
- Shuttering work’s line, level & supporting system is getting checked from Engineer Incharge & approval taken for concreting of retaining wall.
- After 12 hours deshuttering is get done of retaining wall.

D. Advantages of PCW

- No voids remain in between shore pile area.
- It is additional protective layer of concrete to retaining wall to avoid any damages by ground water to attack of RW reinforcement & concrete.
- No voids are present in-between ground soil & plume concrete wall because in plume concrete wall fills all voids by M5 concrete.

E. Disadvantages of PCW

- It consists of more activities therefore time consuming to complete this activity is more.
- It required skilled carpenter in more strength.
- Material like Formwork, concrete, concrete pump, pipeline, vibrator & pipe labours is needed.
- Construction Cost per sq. meter is more.

Table.1 Cost analysis for construction of plume concrete wall (PWC)

Sr.No	Description	Qty	Unit	Rate	Amount (Rs)	Remark
(A) Material Cost						
a. 1	M5 Concrete Cost	54	Cum	3627/-	195905/-	
a. 2	12mm film coated plywood	99	Nos	2216/-	219384/-	

	Cost of one repetition				21938/-	Considering 10 repetition
a. 3	Pinewood in Horizontal Direction	116.01	Cft	415/-	48144/-	
	Cost of one repetition				4814/-	Considering 10 repetition
a. 4	Waller Rent	150	Nos	12/-	1600/-	Rent of Waller's for 04 day
a. 5	CT Prop Rent	80	Nos	8/-	2560/-	Rent of Waller's for 04 day
Total Material Cost					232695/-	
a. 6	Hardware consider 2% of material cost				4654/-	
Material Cost= A					237349/-	
(B) Labour Cost						
b. 1	Carpentry work labour charges	240	Sq.mtr	310	74400/-	
b. 2	Concreting pouring labour charges	56.08	Cum	240	13459/-	
b. 3	Riggers for making platform for concreting	360	Cum	32/-	11520/-	
Labour Cost = B					99379/-	
Cost { A+B}					336728	
(C)	Concrete Pump Charges (Rs.150 per Cum)				8412/-	
(D)	Total Cost(A+B+C)				345140/-	
Contractors Profit @ 15% on total "D"					51771/-	
Total Construction Cost of Plume concrete wall 240 Sq.mtr					399611/-	
So, Rate of Plume concrete wall Per Square meter					1653.80/-	
Say (Round off) Rs.					1654/-	Per Sq.mtr

F. Skin wall Construction (SWC)

Skin wall concept is an innovative idea to replace plume concrete wall. Skin wall having same purpose of plume concrete wall, Duration & cost required to construction skin wall is less than plume concrete wall. Material & labour required for skin wall is easily available in market.



Figure.2 Wooden framing for skin wall construction



Figure.3 Commercial plywood fixed on wooden frame constructed for skin wall

G. Material & Machineries for SWC

- Pinewood of section size 3" x 4" & 2" x 3" & 8' long.
- Commercial plywood 12 mm thicknesses
- MS Flat, 25mm wide of 5mm thickness
- Concrete & Wooden threaded nails
- Concrete breaker
- Concrete Dill machines
- Plywood cutting Machine
- Plywood drilling Machine

H. Construction Method of SWC Construction

- Setting out of layout
- Fixing vertical wooden runner (Section -4" x 3") with shore pile with MS flat by screwing.
- Fixing Horizontal wooden runner (Section -3" x 2") with vertical wooden runners by screwing.
- After wooden framing completion 12mm commercial plywood is fixed on it for line & level surface.
- Once commercial plywood gets fixed, it is ready for fixing waterproofing on it.

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I. Advantages of SWC

- Skin wall material is easily available in market.
- Do not require more labours & skilled lbrs because its construction of skin wall simple.
- Construction of skin wall is faster than plume concrete wall because it consists less activities.
- It can be fixed & completed in less time at dangerous location.
- No need of concrete & boulders to be arranged or poured.
- It is much more economical then construction of plume concrete wall.

J. Disadvantages of SWC

- Material used for skin wall like wooden frame & commercial plywood's has to left in ground as it is & it is scarified material, cannot be reused.
- Wooden material having variations in size & voids present behind skin wall.

Table.2 Cost analysis for construction of Skin wall (SWC)

S r. No	Description	Qty	Unit	Rate	Amount (Rs)	Remark
(A)	Material Cost					
a. 1	Pinewood in Horizontal Direction (Size:- 8' x2" x 3")	136.708	Cft	415/-	56734/-	
a. 2	Pinewood in vertical Direction (Size:- 8' x2" x 3")	56.222	Cft	415/-	23332/-	
a. 3	Commercial Plywood 12mm thk (Size:- 8' x 4')	266.667	Sft	50.63/-	135000/-	
a. 4	Fixture & Fasteners (Full threaded MS Screw vertical Direction)	3280	Nos	3.0/-	9840/-	
a. 5	Fixture & Fasteners (Full threaded concrete MS Screw in Vertical Direction)	578	Nos	2.50/-	1435/-	
a. 6	MS Flat 25mm x 5mm thk	57.40	kg	35/-	2009/-	
A= Material Cost for Skin Wall (For -240 Sq.mtr)					228350/-	
B= Labour Cost for constructing Skin wall @ Rs.280/- Sq.mtr (For -240 Sq.mtr)					75600/-	
C= (A+B) Cost of Skin Wall (Material + Labour)					303950/-	
D= Per Sq.mtr Cost of Skin Wall (Material + Labour)					1266.46/-	
Say (Round off) Rs.					1266/-	Per Sq.mtr

Table.3. Cost Comparison of PCW & SWC

(A) Cost Difference between Plume concrete wall & Skin wall (Material + Labour)	Rate	Unit	Percentage
(a.1) Cost of Plume concrete wall construction (Avg thickness of 200mm)	1654/-	Rs/Sq.mtr	100%
(a.2) Cost of Skin wall Construction	1266/-	Rs/Sq.mtr	74.55%

Difference of Rate Between PCW & SWC	313/-	Rs/Sq.mtr	25.45%
(B) Labour Rate Difference between Plume concrete wall & Skin wall			
(b.1)Labour Rate for constructing plume concrete wall construction	414/-	Rs/Sq.mtr	100%
(b.2)Labour Rate for constructing Skin	280/-	Rs/Sq.mtr	67.63%
Difference of labour Rate Between PCW & SWC	134/-	Rs/Sq.mtr	32.37%

IV. TESTS & RESULTS



Figure.4 Cube testing of plume concrete wall (M5) for compressive test

Table.4:- Test results of plume concrete wall (PCW)

Compressive Test (N/mm2)				Weight (Kgs)				
Days	Load-1 (KN)	Load-2 (KN)	Load-3 (KN)	Avg Load (KN)	W1	W2	W3	Avg Weight
7Days	130	150	160	146.67	8.51	8.54	8.61	8.56
8Days	200	210	220	210	8.54	8.62	8.72	8.63

Compressive Test Results:-

Sample Cube Area: - 150mm X 150mm = 22500mm²

- Avg 7 Days Strength :-146.67 KN = 146670 N
Compressive Strength: -Load/ Area of Cube
146670/22500
6.51N/mm²
- Avg 28 Days Strength:-210 KN = 210000 N
Compressive Strength: - Load/ Area of Cube
210000/22500
9.33N/mm²

Target Strength :- (fck +t+SD)

(Assumed Std Dev- 3.5 as per IS456-2000 Table 8)

$$: - 5+1.65+3.5$$

$$= 10.775N/mm^2$$



Figure.5 Compressive test carried out on Skin wall Sample.

Table.5:- Test results of compressive strength of Skin wall sample

Compressive Test (N/mm ²)				Weight (Kgs)				
	Load-1 (KN)	Load-2(KN)	Load-3(KN)	Avg Load (KN)	W 1	W 2	W 3	Avg Weight
Sample	180	190	185	185	6.6	6.8	6.76	6.72

Compressive Test Results:-

Sample of Skin Wall : - 150mm X 150mm = 22500mm²

- **Avg Strength** :-185 KN = 185000 N
Compressive Strength: - Load/ Area of Cube
 $185000/22500$
8.22N/mm²



Figure.6 Compressive test carried out on Skin wall Sample

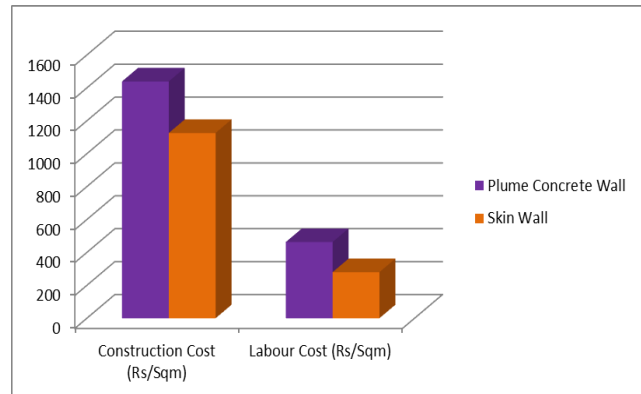


Figure.7 Graphic comparison between PCW & SW with respect construction cost, Labour Cost, Compressive test & Duration.

V. DISCUSSION

During the case study it is observed & brings to the notice of site execution team that, construction of plume concrete walls is giving less productivity & delaying further dependable activities of waterproofing membrane fixing, Raft & Retaining wall casting at difficult locations. Considering the purpose of plume concrete wall, at difficult locations. Therefore wooden material skin wall is suggested for giving smooth & level surface to fix waterproofing membrane instead of plume concrete wall to complete the work fast. Out of all discussions, experiment, results & mock-up of skin wall construction, We come to conclusion that Skin wall is most suitable than plume concrete wall with respect to its construction duration, construction cost & labour strength required to construct it.

VI. CONCLUSIONS

- Activity involved & their sequence of construction in high-rise buildings is studied & recorded. Process implemented by constructing company to execution process is observed at live project.
- Identified activities having difficulties at construction stage & becoming reason of delaying project progress are Plume concrete wall, Reinforcement tying, Laitance removal, Honey combing in Columns, Leakages in basements & tower crane utilisation, Pumping by concrete pump & chowkup issues all this activities are recorded for further studies.
- In basement retaining walls waterproofing & construction of plume concrete wall is required to fix waterproofing membrane. It is identified that plume concrete wall is difficult & time consuming activity.
- The observation, study & analysis of plume concrete wall construction had given new thought of constructing "skin wall" instead of plume concrete wall for fixing waterproofing membrane of retaining wall, It is new thought & innovated option to plume concrete wall, which reduce duration of this activity & construction cost. Tentatively 25% to 26% construction cost of this activity can be reduce, this change in construction method & material to current method of plume concrete wall will benefit to developer, buyers & ends to the society.

VII. APPLICATION

As per the suggestions to construction company for constructing skin wall instead of plume concrete wall to fix waterproofing membrane at dangerous location to achieve more productivity & reduce construction cost of this activity. Looking to case the study & data collected shows that skin wall is next option to plum concrete wall. From construction points of view, Skin wall gives better results than plume concrete wall without affecting its main purpose & gives more progress in less duration, also it is more economical than plume concrete wall. Therefore project team had approved construction of skin wall instead of plume concrete wall for rest of balance areas of project. They are now recommending skin wall construction to other upcoming projects of theirs for reducing construction duration & cost. Base on the case study, data collected from on-going project & conclusion of cost comparisons was very much useful to make decision of suggesting application of skin wall in upcoming projects to team "ShivKumar Enterprise & CIPL".

FUTURE SCOPE

Shape of Shore pile is rounded normally, Instead of rounded shape of shore piles. If rounded shore piles modified to rectangular shore piles of same design without increase in its construction cost for giving line & level surface to fix waterproofing membrane directly on shore piles surface. Then there is no need of plume concrete wall or skin wall construction for fixing waterproofing membrane or design a waterproofing membrane sheet of getting fixed directly on Shore piling surface.

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In depth information of on-going basement activities was explained & allowed to collect data for project study by Project Incharge. He shared all required data for project study time to time. Planning Engineer has made to understand the procedures followed by Construction Company to execute high rise building projects. The all staff members & Project Guide Prof. A.R. Vasatkar of "Civil engineering Department "BSCOER, Nahre.Pune"

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