IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

FINANCIAL ASSESSMENT OF DIFFERENT TYPES OF WALLING SOLUTIONS IN MULTISTORIED RESIDENTIAL BUILDINGS

[1]Kevin Lu, [2]Abhijit Rastogi, [3]Dr. Virendra Kumar Paul
[1]Student, [2]Assistant Professor, [3]Professor
[1]Department of Building Engineering & Management ,
[1]School of Planning and Architecture , New Delhi, India

Abstract: Housing is one of the major needs across the globe as well as in India. The housing shortage in India around 18 million houses, majority of the needs in urban housing for economically weaker sections mostly. The housing provided in urban areas is in the form of multistoried residential apartment due to space constraints and high land cost. The cost of construction plays a major part in cost paid up by the end user .This construction cost takes up around 50-60% of the overall cost of the project .Looking closely at this cost of construction through appraisal of the Plinth area rates by CPWD one can observe the R.C.C. captures the major sector of the cost and the main constituents of this cost component comprises of concrete and steel. The design of structure commands the quantity of steel and concrete which can be reduced by reducing the dead load the structure has to support .Walls contribute a large share in the overall dead load , therefore by substitution of walling solution with a lighter counterpart dead load can be reduced which in turn will reap financial benefits by saving the quantity of steel and concrete in the RCC structure. Structural analysis is carried out STAAD Pro for four multistoried buildings taking earthquake and wind loads in consideration. The five walling solutions considered were as follows: clay brick, autoclaved aerated concrete, fly-ash blocks, cellular light weight concrete and drywall partitions. for the Cost analysis shows that drywall which is the lowest dead load has major savings with cost reduction being 9.45% in comparison to other walling solutions.
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***Index Terms* – Walling solutions, cost analysis , cost of construction, value engineering .**

I. INTRODUCTION

1.1 Construction Industry in India

The construction industry has a gross value added of 7.3% in India's GDP. As of 2017 the construction industry employed 49.8 million people (Industry, 2017).The rapid growth in the population in the urban areas as a product of urbanization has led to shortage of land , housing shortfall and scarce basic amenities such as open space, water supply and power in the towns and cities. In India, private developers have the premium luxury, high end and upper mid segment housing as the prime target customers group. This has led to a continuous supply of units and have even unsold inventory for this segment. On the other side, the housing for the poor and EWS is primarily provided by the government for the purpose of welfare. Therefore, there is a huge gap in the demand and supply of the housing this particular income group in India (Mayank, 2012) One of the major issues for providing affordable housing is the rising cost of construction. Any residential project is guided majorly by the land cost and the construction cost .This is regardless with the fact that there is an exponential price drop in the price of land from the heart of the city to the peripheral location ,while the cost of construction falls gradually from the premium luxury, mid-income and the low income group. While the cost of land s fixed in nature the aspect of improvisation falls on the cost of construction. (Gulam Zia, 2019)

1.2 Residential Housing scenario in India

According to the 2011 census in the report by the technical group constituted by the Ministry of Housing and Urban Poverty Alleviation [MHUPA] with the housing shortage at 18.78 Mn within which the economically weaker section has 10.55 Mn (56.18 %), LIG has 7.41 Mn (39.44%) and MIG and above have (0.82 Mn) i.e. 4.38% (MHUPA, 2012-17). Urban India has a severe shortage of housing, yet Indian cities have many vacant houses. According to the census of India 2011, out of 90 million residential census units, 11 million units are vacant; that is about 12% of the total urban housing stock consists of vacant houses. To put these numbers in perspective, consider these houses constructed by the central government under its three largest programs related to urban housing. Jawahar Lal Nehru National urban renewal mission (2005- Extended till march 2017), Rajiv Awas Yojana (2011-2015) Pradhan Mantri Awas Yojana (urban) altogether only provided 1.1 million units. The total vacant housing stock may not exactly match- in terms of quality and type -the requirements of the households crowded out of the housing market. But this paradox of vacant houses and a shortage of housing is a symptom of the distortions in the functioning of land and housing markets (India, 2018). However, majority of the housing supply that has been built across urban

India is beyond the affordability of the EWS and LIG segment. Real estate developers, private players in particular, have primarily targeted luxury, high-end and upper-mid housing segment owing to the higher returns that can be gained from such projects. Further, high land costs, archaic building bye laws, stringent licensing norms, delay in project approval and unfavorable banking policies made low cost housing projects uneconomical for private developer (KPMG, 2012)

1.3 Impact of walling solutions on the cost of construction in Housing

During the past decade , construction costs have significantly increased by nearly 80-100 % due to the appreciation in the prices of construction materials such as steel , cement and sand .Shortage of labor has also resulted in a rapid increase in wages (Limaye, 2012). Affordable housing and conventional residential are two very different business models and simply reapplying mid-income/luxury housing business models into affordable housing cannot solve the problem. Traditional developers often lack the expertise and wherewithal to successfully execute an affordable housing project. (Gulam Zia, 2019). Alim Shaikh (2017) found out that the usage of AAC block reduces the cost of construction up to 25% as reduction of dead load of wall on beam makes it comparatively lighter members. The use of AAC block also reduces the requirement of materials such as cement and sand up to 55%.The load analysis assumptions are taken for a 3 storey G+2 framed concrete structure with a residential layout .The building is designed for static loading or say for gravity loading i.e. Dead load & Live load . (Rathi, 2015)found out that the Usage of AAC Block reduces the cost of construction up to 20% as reduction of dead load of wall on beam makes it a comparatively lighter member. The use of AAC block also reduces the requirement of materials such as cement and sand up to 50%. It is 3-4 times lighter than traditional bricks and therefore, easier and cheaper to transport. (Hontus, 2014)concludes that the cost of the house without painting and other features and furnishings is given by the construction materials -70 % and labor used -30%.The advantage of AAC is that it is a light building material with 500-700 Kg/m^3 apparent density , which means lower loads on the structure system ,which in its turn translates to lower reinforcement consumption for reinforcing the smaller concrete segments of the structural elements. (Khan, 2018)found there is a need to find more cost saving alternatives so as to maintain the cost of constructing houses at prices affordable to people. Two such material i.e., Fly Ash brick and AAC blocks can be used as an alternative material for construction. This project presents brief analysis and Design of building for G+2, G+10 & G+18 by using Conventional brick, Fly Ash brick and AAC block with considering earthquake forces for zone III. Cost analysis is made by using Conventional brick, Fly Ash brick and AAC block and overall modeling and analysis is done by using STAAD-Pro software. Mistry et al (2011) found that as compare to conventional brick masonry prism compressive strength it is between 13.75 kg/cm2 to 121.80 kg/cm2 at 28 days strength. While FaL-G brick prism strength is 88.83kg/cm2 for cement mortar (1:6) and 85.05 kg/cm2 for fly ash mortar (1:6) just in 14 days. It can be increased up to 135 kg/cm2 to 145 kg/cm2 at 28 days. According to case study the fly ash bricks with conventional masonry work have 28% saving in cost with common red brick and conventional masonry work. (Kumar S, 2017)found out by considering the high strength fly ash brick infill property for building, analysis is carried out to evaluate strength and also to provide effective performance against the lateral loading. Analysis also done by taking sample of multi-storey building by using E-TABS and compare the results obtained with conventional clay brick. When compare to clay bricks, fly-ash bricks is 10.60% lighter. Hamad (2014) this paper is attention to classified of aerated lightweight concrete into foamed concrete and autoclaved concrete. The literature review of aerated lightweight concrete on material, production, properties and its applications. The aerated lightweight properties are focusses on the porosity, permeability, compressive strength and splitting strength. It possesses many beneficial such as low density with higher strength compared with conventional concrete, enhanced in thermal and sound insulation, reduced dead load in the could result several advantages in decrease structural elements and reduce the transferred load to the foundations and bearing capacity. Aerated concrete is considered economy in materials and consumptions of by-product and wastes materials such as fly ash. (Verma, 2019)Cellular Lightweight Concrete has been successfully used and it has gained popularity due to its lower density and comparative strength than conventional brick. It is created by uniform distribution of air bubbles throughout the mass of concrete. The foam contains isolated air bubbles, which creates millions of unconnected tiny voids/cells in the mix resulting in lighter weight of concrete. CLC can be produced in wide range of controlled densities from 400 kg/m3 to 1,800 kg/m3. As we known that in this building masonry wall contributes around 45% load of the building so if the weight of the block decreases then total load of the building can be decreases. Blocks are 1/3 weight of bricks and 1/5 weight of concrete and are in easily handed sizes. It reduces dead load of the structure, consequently consumption and investment in steel saving up to 15% and concrete. (Kulbhushan, 2018)found lightweight blocks are 10 times the size of clay bricks, with their demand increasing rapidly due to their overall low cost, light weight, almost 70% less than clay bricks and sound and thermal insulation properties. The primary goal of this examination is to study about the effect of Lightweight concrete blocks on building structure with specific stress on spearing in general cost and weight of the structure. Lightweight blocks were created reasonable as indicated by IS specification. Lightweight concrete blocks of 80% substitution 14.8% lessening in the overall building, weight has been watching when the contribution of block masonry load in overall building was 45% it was seen in the wake of performing examinations on various kinds of structure that light weight blocks indicate responsible outcome in elevated structure overwhelm in the block masonry. (Sabau, 2018)found the building with lightweight partitions made from drywall presented the lower vertical deformations and story drifts from all three partition systems analyzed in this study. Lower values as much as 12% for deformations and 19% for drifts have been obtained. _ The cost of the building with drywall partitions was 88% of the cost of the building with clay brick masonry partitions and 89% of the cost of the building with concrete block masonry partitions. _ Savings as much as 12% can be made regarding reinforcing steel when using lightweight partitions in buildings.

1.4 Need of the study

In many construction projects managers and the contractors find difficulties like poor planning of the project, labor shortage, cost escalation and delay in deliveries which eventually lead to cost and time overrun and has conflicts in the project. One of the goals which are constant goal for the construction industry is the reduction in the cost of construction. So, there is a need to study the costs which are included in the project and to identify the cost reduction techniques for carrying out projects in the construction industry (Mahadik, 2015). Besides these reasons there are other reasons for which the need of the study is present such as the use of resources efficiently which form the major constituents in the construction of R.C.C. framed building structure. In order to have a better overall overview of the cost estimation starting in the inception stage and which goes on the execution stage.

Accuracy in the calculation of the structural members in terms of the quantity and the cost. terms. The various ways to keep account of the factors such as the construction methodology, materials and techniques used, structural systems simultaneously following the factors which are responsible for the increment in cost .This study would be very helpful for the project manager, architect , engineer , owner and the contractor in the initial stages of the project with aspect of decision making (Guite, 2014). Since India is a developing country and therefore the resources have been scarce and need to utilized effectively to the full potential and in a manner which is sustainable. The development of any country is dependent on the progress of the infrastructure. Though the infrastructure development is progressing in a very rapid manner but it is specified in particular areas only .In order to take this development in every corner of the country and satisfying the sustainability condition is possible only if the resources especially monetary resources are efficiently utilized while developing the infrastructure of the country with particular emphasis in the case of buildings (Saxena, 2011)

1.5 Aim

To identify the elements of costs through recognized technique, select the elements with maximum cost contributions and recognize the component which has impact on the cost of these elements. Devise strategies to provide the necessary function at the lowest overall cost.

1.6 Objectives

The Objective of this research is

1. To identify the elements of cost, establish their weightage by utilization of plinth area rate, group the elements which have maximum contribution in the cost of contribution.
2. To identify the component of the building whose substitution has major impact on the element of cost with major share in the overall cost.
3. To prepare an optimized quantity and cost model by analysis of the element with major cost contribution by substituting the component which has impact on the function of the element. Along with recommendations of effective utilization for the component with fixed cost.
4. To validate the cost and quantity model by performing analysis in a case study and find the most optimized solution with lowest overall cost.

1.7 Scope of work

The research is focused on the cost of construction and strategies by which cost reduction can be achieved, the major cost elements taken into consideration are the construction cost and the land cost. While strategies are formulated to reduce the construction cost, recommendations for the effective land utilization are identified for the land component. since the price is fixed for the land and the only resort is to ensure effective utilization. The building is analyzed in terms of the cost including design analysis of the structural system for the high-rise residential buildings in Danapur, Bihar. Various quantitative tools to ascertain the maximum impact on the cost of construction to be utilized, the metrics include the limit state method for dead load calculation, quantity of steel and concrete being utilized and the cost of work for the particular element with substitution

1.8 Hypothesis

On the basis of the of Literature review

1. As the dead load of the structure reduces the cost of construction decreases
2. More savings can be achieved with buildings with more height .

2 Study Area

Residential complex known as Aqua city , located in Danapur, Bihar .The residential complex has a variety of residential buildings for various income groups ranging from 10 storey to 20 storey high buildings. For the purpose of the study the buildings selected are as follows:

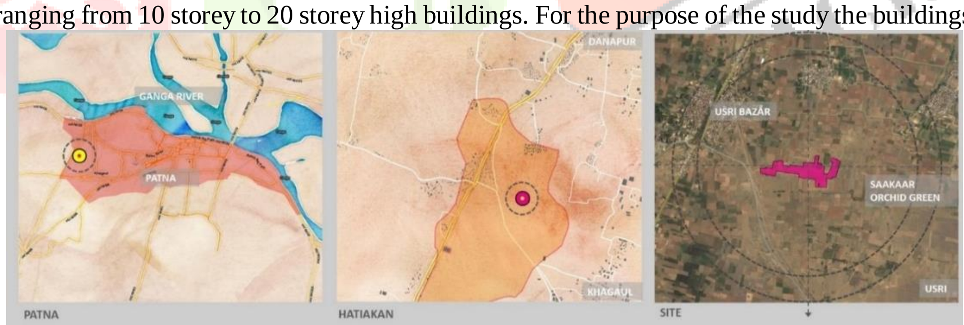


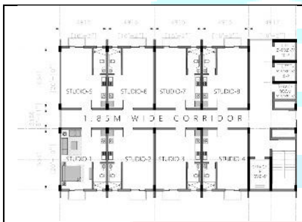
Figure 1 – Site Location

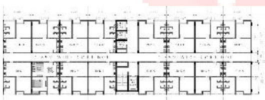
plot area – 44070 m2 located in – **patna, bihar** ,3 side road access100ft wide road abutting site important buildings – saakaar orchid green, usri, dav khagaul ,12 km from patna airport – approx. 30mins drive 3 km from danapur railway station – approx 8 min drive 6 km from ganga river – approx 15min drive.

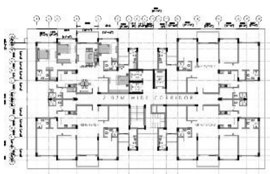
Figure 2- Site plan

The project consists of a site area of 11.53 Acres (46652.15 sq.m.) with a total of 21 towers and 1264 dwelling units proposed. For the purpose of the study 4 towers were taken into consideration :Tower 12(G+7), tower 11(G+9), tower 17(G+14) and Tower 1(G+20) for the study.

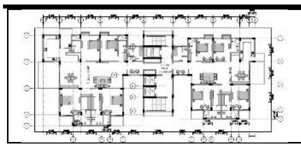
Table 1- Area description

	Unit -tower 11	Unit area (SQ.M.)	Unit built up area	Total number of DU	Units/floor	Floors	Total BUA (SQ.M.)
	Studio	32.61	34.18	80	8	10	2734
	Core ground	95				1	95
	Core typical	95				6	570
				80			3394

	Unit Tower 11	Unit area (SQ.M.)	Unit built up area	Total number of DU	Units/floor	Floors	Total BUA (SQ.M.)
	1 BHK	40.3	44.06	160	16	10	7049
	Core ground	225.5				1	225.5
	Core typical	225.5				9	2029
				160			9304.6

	Unit Tower 17	Unit area (SQ.M.)	Unit built up area	Total number of DU	Units/floor	Floors	Total BUA (SQ.M.)
	4 BHK	169.3	177.4	52	4	13	9224
	Core ground	125.56				1	125.6
	Core typical	125.56				9	125.6
				52			10857.08

	Unit tower 21	Unit area (SQ.M.)	Unit built up area	Total number of DU	Units/floor	Floors	Total BUA (SQ.M.)
	4 bhk type2	206	229	21	1	21	4818.03

	4 bhk type 3	261	291	21	1	21	6113.94
	Core ground	90.4				1	90.04
	Core typical	90.4				20	1800
				42			12822

3 Research Methodology

3.1 Cost study

In the fourth edition of building economics by Ivory H. Seeley highlights (Seeeley, 1996) cost study by breaking down the total cost of the building,

Cost study. Breaking down the total cost of buildings with the following objectives:

(1) to reveal the distribution of costs between the various parts of the building;
(2) to relate the cost of any single part or element to its importance as a necessary part of the whole building;
(3) to compare the costs of the same part or element in different buildings;
(4) to consider whether costs could have been apportioned to secure a better building;
(5) to obtain and use cost data in planning future buildings; and
(6) to ensure a proper balance of quantity and quality within the appropriate cost limit.

3.2 Major cost structures

Tangible construction cost compromise only about 50% of the price paid by a consumer. The affordable housing projects a significant opportunity to take advantage of economies of scale. Right priced affordable housing projects have been demonstrated to attract significant demand (Gulam Zia, 2019)

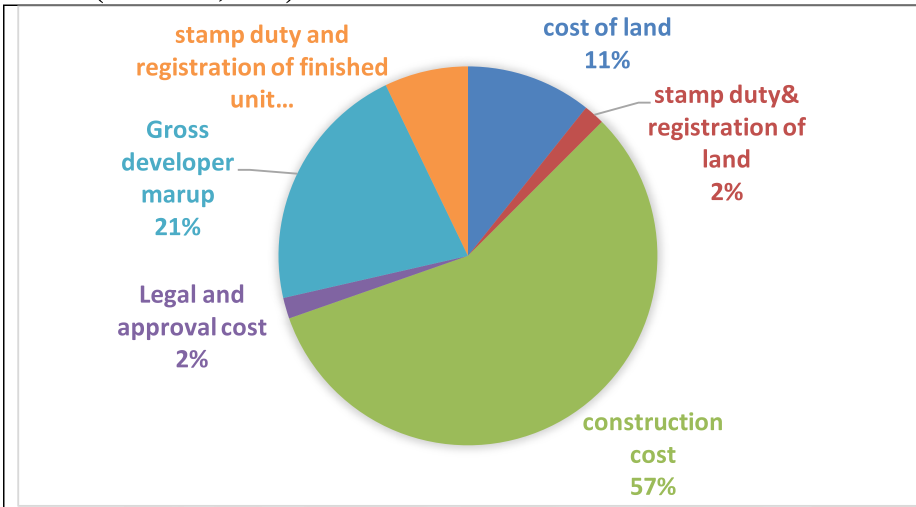


Figure 3-Major cost structures

The price premium of residential projects is guided by majorly guided by the land cost and the construction cost. The cost of construction has a compelling contribution in the price premium of affordable housing. This is due to the fact that while land prices fall exponentially from the city center to the locations which are in peripheral boundary of the city, construction costs generally follow a gradual trend from premium luxury, mid-income to low-income housing. (Mayank, 2012)

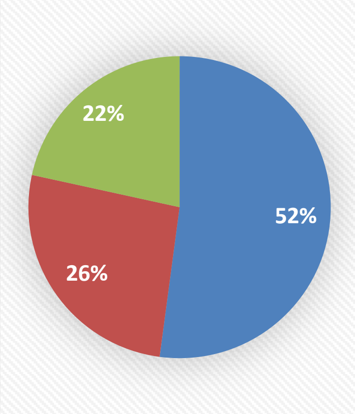
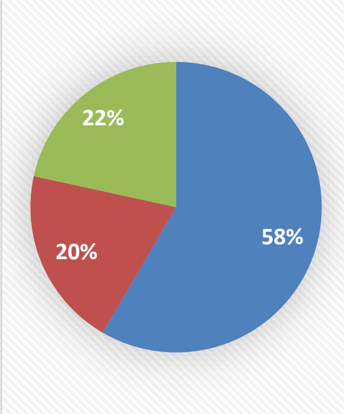
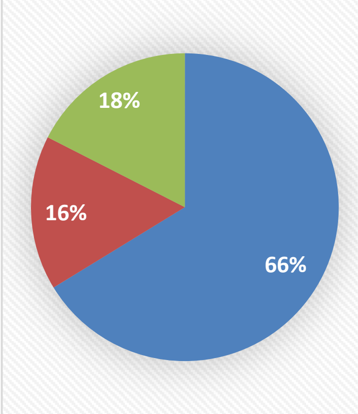
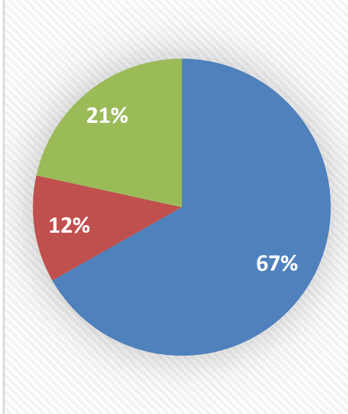
4.Appraisal of Plinth Area Rate, CPWD 2019.

Appraisal of the Plinth Area rates by the CPWD, shows that in the cost of construction the major cost contributor is through the R.C.C. construction.

Table 2-Plinth Area Rate for Residential, CPWD

Building type	Foundation Type	R.C.C.	Fire alarm	SERVICES	TOTAL COST
Residential	Stronger foundation to take one additional floor	19500	9850	8071.25	37421.25
	R.C.C. Raft foundations (Ground floor only)	28730	9850	10609.5	49189.5
	Pile foundation (On ground floor area only)	40180	9850	13758.25	63788.25
	Basement floor	56480	9850	18240.75	84570.75

Table 3-Major cost contribution of RCC in the plinth area rate of Residential

			
Stronger foundation to take one additional floor	R.C.C. Raft foundations (Ground floor only)	Pile foundation (On ground floor area only)	Basement floor

R.C.C. fire alarm SERVICES

5.Dead Load Calculation

Table 4-Dead load calculation for walling solutions

Wall Type	Length (m)	Breadth(m)	height (m)	Volume (cum.)	Density (Kg/cum.)	Density (Kn)	Weight of wall type(Kn)	Weight of cement plaster(Kn)	total wall load /m(Kn)
Clay brick	1	0.23	3	0.69	2000	19.61	13.53	1.94	15.47
1/2 Clay brick	1	0.115	3	0.345	2000	19.61	6.77	1.94	8.71
AAC block	1	0.2	3	0.6	1000	9.8	5.88	1.94	7.82
1/2 AAC block	1	0.1	3	0.3	1000	9.8	2.94	1.94	4.88
Fly-ash block	1	0.2	3	0.6	1700	16.67	10.00	1.94	11.94
1/2 Fly-ash block	1	0.1	3	0.3	1700	16.67	5.00	1.94	6.94
CLC	1	0.2	3	0.6	1100	10.79	6.47	1.94	8.41
1/2 CLC	1	0.1	3	0.3	1100	10.79	3.24	1.94	5.18
Drywall	1	0.05	3	0.15	530	5.2	0.78		0.78

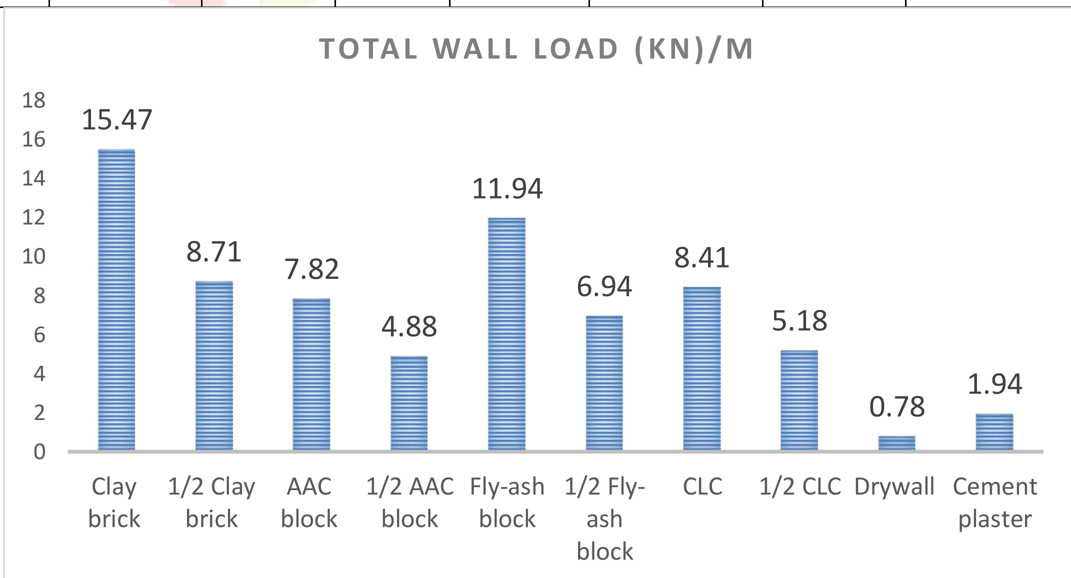


Figure 4-Comparison of dead load for various walling solutions

6.Design Considerations

6.1 Wind Loading

The structure is to be designed by IS-875 (Part 3) using the parameters shown as mentioned below.

BASIC TERMS:

Vb = Basic Wind Speed. = 47 m/sec.

K1 = Probability factor. = 1 [Table-1, Page-11]

K2 = Terrain, Height and structure size factor. = As/Height [Table-2, Page-12]

(This depends upon shape and size of building.) Category -3, Class - B (Ref. as per clause 5.3.2.1 of IS-875(3)

K3 = Topography factor. = 1, [cl-5.3.3.1, Page-12]

Design Wind Speed (Vz) = Vb x K1 x K2 x K3

6.2 Earthquake loading

The structure is to be designed for the minimum static seismic base shear set out by IS 1893 - 2014 using the parameters shown in the table below. These forces are treated as ultimate forces.

Table 5-Earthquake Loadings

Design Earthquake	10% chance of being exceeded within a 50 year return period
Seismic Zone	Zone IV
Seismic Zone Factor, Zone II	Z = 0.24
Soil Profile Type	II
Occupancy Category	Residential Tower
Seismic Importance Factor, I	I = 1.2
Response Reduction Factor, R	R = 5.0 (Refer to Table 7, IS 1893-2016)
Fundamental Natural Period of Vibration, T	$\frac{0.09H}{\sqrt{d}}$
Seismic Weight of Building	To include all components of Self Weight, Superimposed Dead Load, permanent equipment Load and %age of Imposed Load

7.0 Analysis of Results

7.1 Steel and concrete take off from STAAD analysis

Table 6 Steel and concrete take off from STAAD Pro software

Case study 1- Tower 11 (Studio)		
Type of walling solution	Steel (TON)	Concrete (CUM.)
Brickwork	537.5	541
AAC	521.1	541
Fly-ash	530	543
CLC	522	541
Drywall	535	541.5
Case study 2- Tower 12 (1 BHK)		
Type of walling solution	Steel (TON)	Concrete (CUM.)
Brickwork	1010	1011
AAC	974	1011
Fly-ash	994	1011
CLC	974	1011.9
Drywall	958	1003
Case study 3- Tower 17 (4BHK)		
Type of walling solution	Steel (TON)	Concrete (CUM.)
Brickwork	1448.5	1494
AAC	1396	1498
Fly-ash	1413	1497
CLC	1403	1498
Drywall	1389	1493
Case study 4- Tower 21(4BHK)		
Type of walling solution	Steel (TON)	Concrete (CUM.)
Brickwork	1493	2346
AAC	1468	2346
Fly-ash	1489	2374
CLC	1470	2380

Drywall	1450	2346

7.2 Combined cost of concrete and steel

The combined cost of concrete and steel is calculated using the data from the total quantity of steel and total quantity of concrete for the following non-load bearing partitions: brickwork, fly-ash, AAC, CLC and drywall

The figure 14 shows the comparison of the total overall cost of the various non-load bearing partitions being used in the structure. This comparison shows that by using the alternative partition system the overall savings considering steel, concrete and cost of particular work, **fly-ash (3.7%), AAC (6.2%), CLC (5.4%), Drywall (11.9%).** There is maximum saving in the drywall when considering the overall cost of the non-load bearing material which includes the cost of concrete, cost of steel and the cost of the work.

Table 7-Combined cost of concrete and steel

	Clay brick	Fly-ash	AAC	CLC	Drywall
steel (Ton)	1493	1489	1468	1470	1450
CONCRETE	2346	2346	2346	2380	2346
Cost of steel	86594000	86362000	85144000	85260000	84100000
Cost of Concrete	11730000	11730000	11730000	11900000	11730000
cost (concrete+steel)	98324000	98092000	96874000	97160000	95830000
Quantity /floor	111.7143	111.7143	111.7143	113.3333	111.7143
floors	21	21	21	21	21
Cost of work/unit	4970	3300	2750	3200	692
Total cost of work	11659620	7741800	6451500	7616000	1623432
total cost	**1.1E+08**	**1.06E+08**	**1.03E+08**	**1.05E+08**	**97453432**
total cost Cr.	11.00	10.58	10.33	10.48	9.75
	Clay brick	Fly-ash	AAC	CLC	Drywall
Total cost	1.1E+08	1.06E+08	1.03E+08	1.05E+08	97453432
difference	0	4149820	6658120	5207620	12530188
% saving		3.77	6.291	5.04	11.959

7.3 Cost of sub structure

Taking reference from the cost model of foundations of reinforced concrete buildings, the quantities of steel and concrete are calculated. (V. Thiruvengadam, n.d.)

Table 8-Cost of sub-structure

Foundations with Raft Foundation: Structural quantities per sq.m of floor area		
floors	Concrete cum.	Steel kg
8	0.11	6.7
10	0.12	7.1
14 <	0.12	12.54

foundation						
case study	area	quantity of concrete(cum)	quantity of steel ton	cost of concrete@INR 5000/cum	cost of steel @ INR 58000/Ton	cost of foundation (INR)
11 studio	4130	454.3	29.32	2271500	1700734	3972234
12 1bhk	9304	1116.48	66.06	5582400	3831387	9413787
tower 17	10857	1302.84	136.15	6514200	7896513	14410713
tower 21	12822	1538.64	160.79	7693200	9325697.04	17018897.04

Shear wall cost						
cost of sub-structure	area	area of shear wall @ 5%	quantity of concrete(cum)	quantity of steel ton	cost of concrete@INR 5000/cum	cost of steel @ INR 58000/Ton
11 studio	4130	206.5	22.715	1.38	113575	80246
12 1bhk	9304	465.2	55.824	3.30	279120	191569
tower 17	10857	542.85	65.142	6.81	325710	394826
tower 21	12822	641.1	76.932	8.04	384660	466285

Total substructure cost				
cost of sub-structure	cost of foundation	cost of shear wall	total sub-structure cost	cost in cr .
11 studio	3972234	80246	4052480	0.41
12 1bhk	9413787	191569	9605357	0.96
tower 17	14410713	394826	14805539	1.48
tower 21	17018897	466285	17485182	1.75

7.4 Total cost of sub structure and super structure

Table 9-Combined cost of sub-structure and super structure

total cost(cr.)	Clay brick	Fly-ash	AAC	CLC	Drywall
case 1	₹ 4.07	₹ 3.93	₹ 3.85	₹ 3.88	₹ 3.82
saving		₹ 0.14	₹ 0.22	₹ 0.19	₹ 0.25
% saving		3.44%	5.41%	4.67%	6.14%
case 2	₹ 7.83	₹ 7.56	₹ 7.39	₹ 7.44	₹ 7.09
saving		₹ 0.27	₹ 0.44	₹ 0.39	₹ 0.74
% saving		3.45%	5.62%	4.98%	9.45%
case 3	₹ 11.37	₹ 10.92	₹ 10.74	₹ 10.85	₹ 10.39
saving		₹ 0.45	₹ 0.63	₹ 0.52	₹ 0.98
% saving		3.96%	5.54%	4.57%	8.62%
case 4	₹ 12.75	₹ 12.33	₹ 12.08	₹ 12.23	₹ 11.50
saving		₹ 0.42	₹ 0.67	₹ 0.52	₹ 1.25
% saving		3.29%	5.25%	4.08%	9.80%

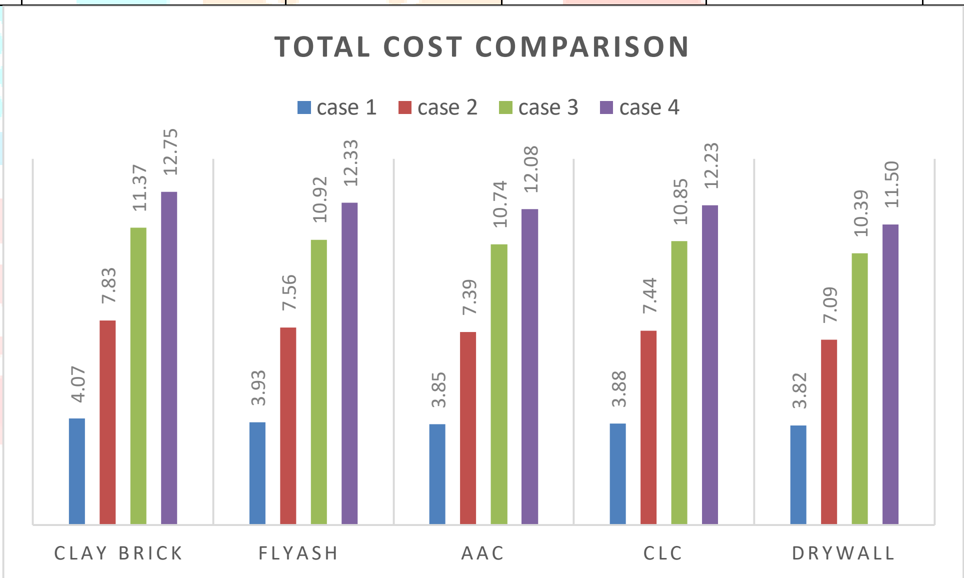


Figure 5-Total cost comparison

7.5 Cost savings as a part of land cost with the effective land utilization and the space saving achieved with respective walling solution

The wall area covered by the various walling solutions are high for the respectable case study is highlighted in table 10 which is given below .It is evident that the drywall partition has the lowest wall area coverage among clay brick work, fly-ash blocks , autoclaved aerated concrete blocks and cellular light weight concrete blocks. The configuration of the tower 12 shows reduction in the wall area from 4.7% in the clay brickwork to 1.3% of the area. Thus more usable space is generated.

Table 10-Contribution of wall area

Projects	BuA(in Sq.m.)	Selling price (Rs/Sq.m.)	Wall Area (in Sq.m.)					Wall Area (%)				
			CB	FAB	AAC	CLC	DW	CB	FAB	AAC	CLC	DW
tower 21	10932	5881	441	383	383	341	170	4.0%	3.5%	3.5%	3.1%	1.6%
tower 17	9607	5881	397	345	345	290	145	4.1%	3.6%	3.6%	3.0%	1.5%
tower 11	9304	5881	624	542	542	357	178	6.7%	5.8%	5.8%	3.8%	1.9%
tower 12	3394	5881	160	144	139	86.6	43.3	4.7%	4.2%	4.1%	2.6%	1.3%

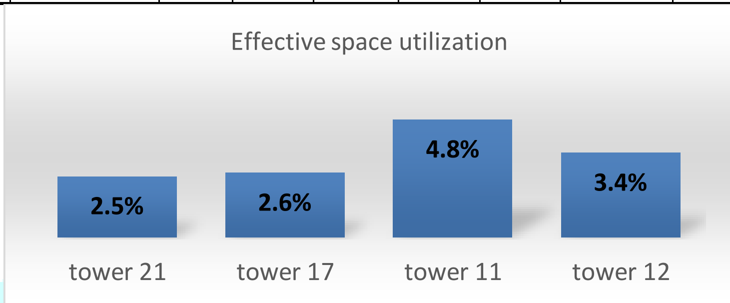


Figure 6-Effective space utilization

8.Conclusions

The following conclusions can be drawn out from this study:

1) Major share of the project cost is dependent on the cost of construction which is in the range of 50-60% of the overall cost which is derived from the literature.
2) RCC takes up the major share in the cost of construction which can be derived by appraisal of the plinth area rate by CPWD.
3) The design of the structure is dependent on dead load in which the walling solutions have maximum contribution and by substitution of wall partitions with lighter alternatives the same area program can be achieved with lesser cost.
4) The total cost of the construction is depicted in the following figure 34. In this figure drywall shows the lowest cost of the construction among all the 4 cases .In case 1 the savings for drywall are 6.14%(INR 25 lakh), in case 2 the savings are 9.45%(INR74 lakh), in case 3 the savings are 8.35%(INR 98 lakh) and in case 4 the savings are 9.8%(INR 1.25 cr.)
5) As the height of the structure changes the savings which can be achieved also changes.

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