ESTIMATING PROJECT COST OF ENERGY COMPLIANCE BUILDING

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ABSTRACT: *India is experiencing an unprecedented construction boom. The country doubled its floor space between 2001 and 2005 and is expected to add 35 billion m2 of new buildings by 2050 (Shnapp and Laustsen, 2013).*

Buildings account for 35% of total final energy consumption in India today, and building energy use is growing at 8% annually. Studies have shown that carbon policies will have little effect on reducing building energy demand.

Chaturvedi et al. (2014) predicted that, if there are no specific sectoral policies to curb building energy use, the final energy demand of the Indian building sector will grow over five times by the end of this century, driven by rapid income and population growth.

The growing energy demand in buildings is accompanied by a transition from traditional biomass to commercial fuels, particularly an increase in electricity use. This also leads to a rapid increase in carbon emissions and aggravates power shortages in India.

Growth in building energy use poses a challenge for the Indian government. To curb energy consumption in buildings, the Indian government issued the Energy Conservation Building Code (ECBC) in 2007, which applies to commercial buildings with a connected load of 100 kW or 120kVA.

Previous studies estimated that the implementation of ECBC could help save 25-40% of energy, compared to reference buildings without such energy-efficiency measures. However, the impact of ECBC depends on the effectiveness of its enforcement and compliance.

Currently, the majority of buildings in India are not ECBC-compliant. The United Nations Development Programme projected that code compliance in India would reach 35% by 2015 and 64% by 2017. Whether the projected targets can be achieved depends on how the code enforcement system is designed and implemented.

Although the development of ECBC lies in the hands of the national government – the Bureau of Energy Efficiency under the Ministry of Power, the adoption and implementation of ECBC largely relies on state and local governments. Six years after ECBC's enactment, only two states and one territory out of 35 Indian states and union territories formally adopted ECBC and six additional states are in the legislative process of approving ECBC (BEE, 2013).

Several barriers slow down the process. First, stakeholders, such as architects, developers, and state and local governments, lack awareness of building energy efficiency and do not have enough capacity and resources to implement ECBC. Second, most jurisdictions have not yet established effective legal mechanisms for implementing ECBC; specifically, ECBC is not included in local building by-laws in most jurisdictions or incorporated into the building permitting process. Third, there is not a systematic approach to measuring and verifying compliance and energy savings, and thus the market does not have enough confidence in ECBC.

1. INTRODUCTION

Building construction is a combination of a designer's skill and the owner's imagination. All building projects include some elements in common such as design, finance, estimation, and legal consideration. Consumption of energy can be reduced by changing the building envelope mechanism and proper selection of the comfort system.

Energy compliance building is the practice of constructing and modifying structures to be environmentally responsible, sustainable, and resource-efficient throughout their life cycle. Building and construction activities worldwide consume 3 billion tons of raw materials each year and represent 40 percent of total global use. It is broadly estimated that buildings worldwide consume about 40 percent of the planet's materials resources and 30 percent of its energy and generates between 10 and 40 percent of the solid waste streams in most countries.

The strong impact that buildings have on the quality of the environment, resource use, human health, and global economy is one of the main drivers that helped the concept of sustainable construction become more and more popular during the last decade.

A building envelope is what separates the indoor and outdoor environments of a building. It is the key factor that determines the quality and controls the indoor conditions irrespective of transient outdoor conditions. Various components such as walls, fenestration, roof, foundation, thermal insulation, thermal mass, external shading devices, etc. make up this important part of any building.

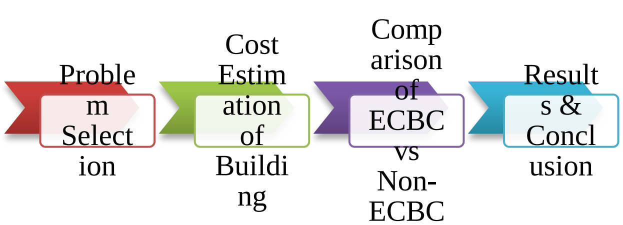
A structure configuration dependent on energy spring criteria diminishes monetary expenses all through the valuable existence of the building because of its lower energy utilization, and this more than adjusts for the more prominent starting venture.

Cost estimation of any project is done to build a framework that could incorporate cost control forms. It's a project's probable cost which is prepared at the concept stage, refined throughout the project-preparation process, and updating during implementation. It's imperative to approach it at an early stage for achieving energy-efficient buildings.

By designing an envelope according to the climate, making suitable material choices, fenestration, and shading device sizes, the load on the mechanical heating and cooling can be reduced. This study reviews the various components of the building envelope, its effect on heating and cooling loads of the office buildings, and the relevant cost parameters.

2. Problem Statement

This study chooses a hypothetical problem of a commercial building and makes necessary changes to make the building energy compliance building. The following diagram shows the scheme of work adopted for the project:



3. Scheme of work adopted for the project

Problem Selection:

The problem selection for this project consists of a 6690 sqm office space.

Estimation of Conventional Building:

By making the changes in the building envelope such as replacing the conventional walls, roof and fenestration (Doors and Windows) with lightweight concrete walls & roof, double tinted glass for windows, applying insulation material to walls and roof. By implementing these changes to the conventional building, we will calculate the cost of the building.

Comparison of ECBC vs Non-ECBC:

We will make the cost comparison between the ECBC (Energy Conservation Building Code) vs Non-ECBC, by making different strategies (Combinations) with the alternatives available for building envelope changes. We will choose the optimum strategy (Combination).

Results & Conclusion:

With the optimum strategy, we will calculate the electrical equipment sizes required for the building. We will add the equipment cost to the ECBC design and we will find the total project cost of the energy compliant building.

Introduction to ECBC:

The purpose of the Energy Conservation Building Code is to provide minimum requirements for the energy-efficient design and construction of buildings. The Code also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements. The Code applies to buildings or building complexes that have a connected load of 100 kW or greater or a contract demand of 120 kVA or greater and are intended to be used for commercial purposes.

The ECBC provides design norms for:

a) The building envelope, including thermal performance requirements for walls, roofs, and windows;
b) Lighting system, including day lighting, and lamps and luminaire performance requirements;
c) HVAC system, including energy performance of chillers and air distribution systems;
d) Electrical system; and
e) Water heating and pumping systems, including requirements for solar hot water systems.

The code provides three options for compliance:

a) Compliance with the performance requirements for each subsystem and system;
b) Compliance with the performance requirements of each system, but with trade-offs between subsystems;
c) Building-level performance compliance.

The Buildings where ECBC is applicable are:

1. Large Commercial Buildings
2. Office Buildings
3. Large Amenity Buildings
4. IT Parks

5. Government Buildings
6. Hospitals
7. Retail Malls
8. Hotels
9. Major Residential Buildings

During the development of ECBC, an analysis conducted through energy simulation indicated that ECBC-compliant buildings may use 40 to 60% less energy than similar buildings being designed and constructed at that time.

The provisions of this code do not apply to plug loads, and equipment, and parts of buildings that use energy for manufacturing processes unless otherwise specified in the Code.

U-factors shall be determined for the overall fenestration product (including the sash and frame) following ISO-15099 by an accredited independent laboratory and labeled or certified by the manufacturer. SHGC shall be determined for the overall single or multi glazed fenestration product (including the sash and frame) following ISO-15099 by an accredited independent laboratory and labeled or certified by the manufacturer. Visual light transmittance (VLT) shall be determined for the fenestration product following ISO-15099 by an accredited independent laboratory and labeled or certified by the manufacturer. U-factors shall be calculated for the opaque construction following ISO-6946. Testing shall be done following an approved ISO Standard for respective insulation type by an accredited independent laboratory and labeled or certified by the manufacturer.

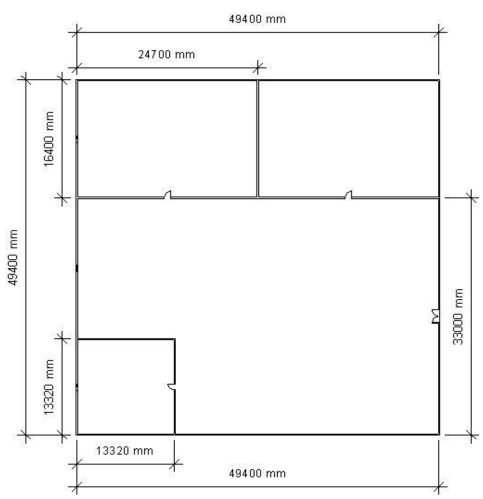


Figure 1: Layout of the Office Space

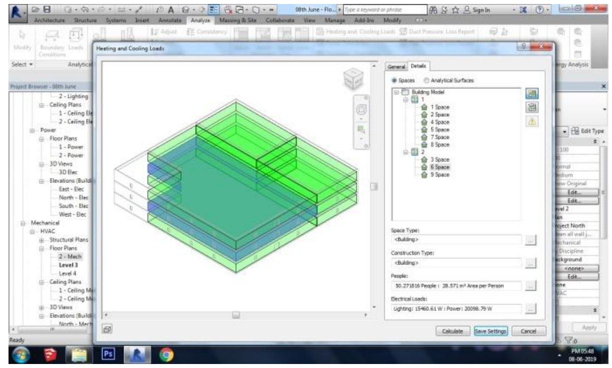


Figure 2: 3d Model of Office Space

Assumptions considered in the estimation of Civil BOQ:

- The estimation of steel is 150 kg / m^3.
- The Rolling Margin of Steel is 5%.
- Grouting Holes are considered as 4 No's per sqm.
- The size of the Grouting Hole is 15 cm X 20 cm X 15 mm.
- Main Door is 2 Hr Fire Rated.
- All Windows are Aluminium Windows.
- The cost of Grouting is Rs. 15/- per sqm.
- Cost of Shuttering per Sqm is Rs. 120/-
- Rate Considered for Mivan Shuttering from Ihita quotation is Rs. 8142 /- per sqm.

SHUTTERING & CONCRETE ESTIMATION

Sl.No	Description	No	Length (Mtr)	Height (Mtr)	Thickness (Mtr)	Shuttering		Concrete	
1	South Side Wall	1	49.4	3	0.25	296.4	Sqm	37.1	Cum
2	North Side Wall	1	49.4	3	0.25	296.4	Sqm	37.1	Cum
3	West Side Wall	1	48.9	3	0.25	293.4	Sqm	36.7	Cum
	Deductions								
	Windows (3 No's)	3	0.8	1.25	0.25	3.0	Sqm	0.8	Cum
	Additions								
	Windows (3 No's)	3	0.8	1.25	0.25	3.1	Sqm	0	Cum
						293.5	**Sqm**	**35.9**	**Cum**
4	East Side Wall	1	48.9	3	0.25	293.4	Sqm	36.7	Cum
	Deductions								
	Door (1No)	1	2	2.75	0.25	5.5	Sqm	1.4	Cum
	Additions								
	Door (1No)	1	2	2.75	0.25	2.4	Sqm	0	Cum
						290.3	**Sqm**	**35.3**	**Cum**
5	Partition Walls	1	91.3	3	0.15	547.8	Sqm	41.1	Cum
	Deductions								
	Door (3No's)	3	1	2.5	0.15	7.5	Sqm	1.1	Cum
	Additions								
	Door (3No's)	3	1	2.5	0.15	3.2	Sqm	0	Cum
						543.5	**Sqm**	**40.0**	**Cum**
6	Slab	1	48.9	48.9	0.15	**2391.2**	**Sqm**	**41.1**	**Cum**
	Total Quantity					**4,111.2**	**Sqm**	**226.4**	**Cum**

Figure 3: Estimation of Shuttering & Concrete of Office Building (One Floor)

DOORS & WINDOWS ESTIMATION							
Sl.No	Description	No	Length	Height	Thickness	Quantity	
1	Main Door						
	Shutter (1.9 X 2.6 Mtr)	1	1.9	2.6	0.25	4.9	Sqm
	Frame (2 X 2.75 Mtr)	1	24.9	11.0	3.0	5.7	Cft
2	Internal Door						
	Shutter (0.9 X 2.35 Mtr)	3	0.9	2.35	0.15	6.3	Sqm
	Frame (1 X 2.5 Mtr)	3	19.7	4.0	3.0	4.9	Cft
3	Aluminium Windows						
		3	0.8	1.25	0.25	3.0	Sqm

Figure 4: Estimation of Aluminium Windows & Doors (One Floor)

Rate analysis for RCC M30

Reference : CPWD 4.19, 4.19.1, 4.19.1.1

Sl.No.	Code	Description	Unit	Quantity per unit	Remarks
		Details of cost for 1 cum			
A		**MATERIAL as per the design mix**			
1		Portland Cement tonne	Tonne	0.330	
2		Flyash	Tonne	0.090	
3		Sand	MT	0.792	
4		Aggregate - 20mm	MT	0.573	**As per Design Mix Report**
5		Aggregate - 12.5mm	MT	0.569	
6		Admixture	Kg	1.890	
7		Water	Kg	73.50	
B		**Labour for pouring, consolidating & curing (Including P.F 25.61%)**			
1	155	Mason (average)	Day	0.170	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
2	114	Beldar	Day	2.000	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
3	101	Bhisti	Day	0.900	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
C		**Machinery Charges**			
1	2206	Carriage of Stone aggregate 20 mm nominal size and above	MT	0.573	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
2	2202	Carriage of Stone aggregate below 20 mm nominal size	MT	0.569	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
3	2203	Carriage of Coarse sand	MT	0.792	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
4	2262	Carriage of Flyash	MT	0.090	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
5	2209	Carriage of Cement	MT	0.330	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
6	4	Production cost of concrete by batch mix plant	Cum	1.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
7	12	Vibrator(Needle type 40mm)	Day	0.07	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
8	9	Pumping charges of concrete including Hire charges of pump, piping work & accessories etc.	Cum	1.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
9	29	Carriage of concrete by transit mixer.	km/cum	10.000	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached

Figure 5: Quantity considered for RCC M30

Rate analysis for RCC M30

Reference : CPWD 4.19, 4.19.1, 4.19.1.1

Sl.No.	Code	Description	Unit	Rate per unit	Remarks
		Details of cost for 1 cum			
A		**MATERIAL as per the design mix**			
1		Portland Cement tonne	Tonne	3,984.00	**CPWD Notification-DG/10CA/43 attached**
2		Flyash	Tonne	875.00	**Scan copy of Invoice attached**
3		Sand	MT	650.00	**Scan copy of Invoice attached**
4		Aggregate - 20mm	MT	650.00	**Scan copy of Invoice attached**
5		Aggregate - 12.5mm	MT	650.00	**Scan copy of Invoice attached**
6		Admixture	Kg	23.73	**Scan copy of Invoice attached**
7		Water	Kg	0.08	
B		**Labour for pouring, consolidating & curing (Including P.F 25.61%)**			
1	155	Mason (average)	Day	387.73	Rate arrived as per Sheet Enclosed as per Minimum Wages Act 1948
2	114	Beldar	Day	361.87	Rate arrived as per Sheet Enclosed as per Minimum Wages Act 1948
3	101	Bhisti	Day	334.03	Rate arrived as per Sheet Enclosed as per Minimum Wages Act 1948
C		**Machinery Charges**			
1	2206	Carriage of Stone aggregate 20 mm nominal size and above	MT	68.36	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
2	2202	Carriage of Stone aggregate below 20 mm nominal size	MT	68.36	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
3	2203	Carriage of Coarse sand	MT	68.36	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
4	2262	Carriage of Flyash	MT	122.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
5	2209	Carriage of Cement	MT	61.09	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
6	4	Production cost of concrete by batch mix plant	Cum	400.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
7	12	Vibrator(Needle type 40mm)	Day	350.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
8	9	Pumping charges of concrete including Hire charges of pump, piping work & accessories etc.	Cum	200.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
9	29	Carriage of concrete by transit mixer.	km/cum	23.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached

Figure 6: Rates considered for RCC M30

Rate analysis for RCC M30

Reference : CPWD 4.19, 4.19.1, 4.19.1.1

Sl.No.	Code	Description	Unit	Quantity	Rate	Amount	Remarks
		Details of cost for 1 cum					
A		**MATERIAL as per the design mix**					
1		Portland Cement tonne	Tonne	0.330	3,984.00	1,314.72	
2		Flyash	Tonne	0.090	875.00	78.75	
3		Sand	MT	0.792	650.00	514.80	
4		Aggregate - 20mm	MT	0.573	650.00	372.45	**Ref: Attached sheets**
5		Aggregate - 12.5mm	MT	0.569	650.00	369.85	
6		Admixture	Kg	1.890	23.73	44.85	
7		Water	Ltr	73.500	0.08	5.51	
B		**Labour for pouring, consolidating & curing**				-	
1	155	Mason (average)	Day	0.17	387.73	65.91	
2	114	Beldar	Day	2.00	361.87	723.73	
3	101	Bhisti	Day	0.90	334.03	300.63	
C		**Machinery Charges**		-			
1	2206	Carriage of Stone aggregate 20 mm nominal size and above	MT	0.573	68.36	39.17	
2	2202	Carriage of Stone aggregate below 20 mm nominal size	MT	0.569	68.36	38.90	
3	2203	Carriage of Coarse sand	MT	0.792	68.36	54.14	**Ref: Attached Sheets**
4	2262	Carriage of Flyash	MT	0.090	122.00	10.98	
5	2209	Carriage of Cement	MT	0.330	61.09	20.16	
6	4	Production cost of concrete by batch mix plant	Cum	1.000	400.00	400.00	
7	12	Vibrator(Needle type 40mm)	Day	0.070	350.00	24.50	
8	9	Pumping charges of concrete including Hire charges of pump, piping work & accessories etc.	Cum	1.00	200.00	200.00	
9	29	Carriage of concrete by transit mixer.	km/cum	10.00	23.00	230.00	
D		**TOTAL (A+B+C)**				**4,809.05**	
E		Add 1% Water Charges on "D"				48.09	
F		Sum after adding Water Charges @ 1% on "D"				4,857.14	
G		Add 12% GST applicable on work contract by reversible method (multypling factor 0.1405) on "D" - As per CPWD memorandum				682.43	
H		Sum after adding GST (F+G)				5,539.57	**Ref: Attached sheets**
I		Add 15 % CP & OH on "H"				830.94	
J		Sum after adding 15% (H+I)				6,370.51	
K		Add labour cess 1% on "J"				63.71	
L		**Gross Total (J+K)**				**6,434.21**	

Figure 7: Rate per cum of RCC M30

Rate analysis for RCC M40

Reference : CPWD 4.19, 4.19.1, 4.19.1.1

Sl.No.	Code	Description	Unit	Quantity per unit	Remarks
		Details of cost for 1 cum			
A		**MATERIAL as per the design mix**			
1		Portland Cement tonne	Tonne	0.360	
2		Flyash	Tonne	0.090	
3		Sand	MT	0.766	
4		Aggregate - 20mm	MT	0.551	**As per Design Mix Report**
5		Aggregate - 12.5mm	MT	0.549	
6		Admixture	Kg	2.250	
7		Water	Kg	119.81	
B		**Labour for pouring, consolidating & curing (Including P.F 25.61%)**			
1	155	Mason (average)	Day	0.170	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
2	114	Beldar	Day	2.000	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
3	101	Bhisti	Day	0.900	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
C		**Machinery Charges**			
1	2206	Carriage of Stone aggregate 20 mm nominal size and above	MT	0.551	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
2	2202	Carriage of Stone aggregate below 20 mm nominal size	MT	0.549	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
3	2203	Carriage of Coarse sand	MT	0.766	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
4	2262	Carriage of Flyash	MT	0.090	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
5	2209	Carriage of Cement	MT	0.360	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
6	4	Production cost of concrete by batch mix plant	Cum	1.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
7	12	Vibrator(Needle type 40mm)	Day	0.07	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
8	9	Pumping charges of concrete including Hire charges of pump, piping work & accessories etc.	Cum	1.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
9	29	Carriage of concrete by transit mixer.	km/cum	10.000	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached

Figure 9: Quantity considered for RCC M40

Rate analysis for RCC M40

Reference : CPWD 4.19, 4.19.1, 4.19.1.1

Sl.No.	Code	Description	Unit	Rate per unit	Remarks
		Details of cost for 1 cum			
A		**MATERIAL as per the design mix**			
1		Portland Cement tonne	Tonne	3,984.00	**CPWD Notification-DG/10CA/43 attached**
2		Flyash	Tonne	875.00	**Scan copy of Invoice attached**
3		Sand	MT	650.00	**Scan copy of Invoice attached**
4		Aggregate - 20mm	MT	650.00	**Scan copy of Invoice attached**
5		Aggregate - 12.5mm	MT	650.00	**Scan copy of Invoice attached**
6		Admixture	Kg	23.73	**Scan copy of Invoice attached**
7		Water	Kg	0.08	
B		**Labour for pouring, consolidating & curing (Including P.F 25.61%)**			
1	155	Mason (average)	Day	387.73	Rate arrived as per Sheet Enclosed as per Minimum Wages Act 1948
2	114	Beldar	Day	361.87	Rate arrived as per Sheet Enclosed as per Minimum Wages Act 1948
3	101	Bhisti	Day	334.03	Rate arrived as per Sheet Enclosed as per Minimum Wages Act 1948
C		**Machinery Charges**			
1	2206	Carriage of Stone aggregate 20 mm nominal size and above	MT	68.36	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
2	2202	Carriage of Stone aggregate below 20 mm nominal size	MT	68.36	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
3	2203	Carriage of Coarse sand	MT	68.36	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
4	2262	Carriage of Flyash	MT	122.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
5	2209	Carriage of Cement	MT	61.09	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
6	4	Production cost of concrete by batch mix plant	Cum	400.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
7	12	Vibrator(Needle type 40mm)	Day	350.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
8	9	Pumping charges of concrete including Hire charges of pump, piping work & accessories etc.	Cum	200.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached
9	29	Carriage of concrete by transit mixer.	km/cum	23.00	As per DAR 4.19, 4.19.1, 4.19.1.1-Sheet attached

Figure 10: Rates considered for RCC M40

For the electrical BOQ, first, we have finalized the SLD (Single Line Diagram) for the office building then we have calculated the required major equipment for the comparison of the ECBC Vs Non-ECBC building case.

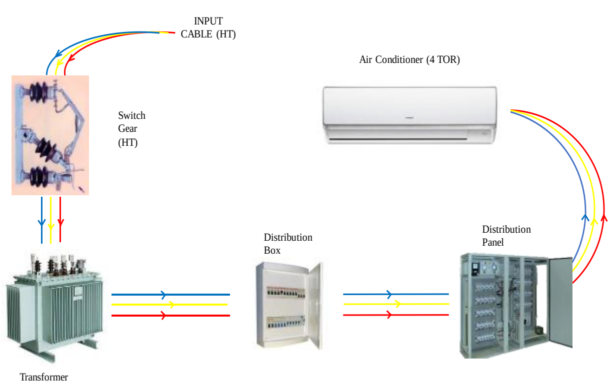


Figure 11: Single Line Diagram (SLD)

By following the Single Line Diagram (SLD), we have estimated the electrical BOQ by considering the Mumbai M&E SOR 2018.

Assumptions considered in the estimation of Electrical BOQ:

Table 1: Assumptions made for preparing the electrical BOQ

Sl. No	Particular	Non-ECBC	ECBC
1	Lighting Load	12 Watt / Sqm	9 Watt / Sqm
2	AC Load	1 kW / 1 TR	1 kW / 1 TR
3	PC Load	65 Watt / Unit	65 Watt / Unit

ELECTRICAL BOQ OF NON-ECBC Vs ECBC BUILDING

		MUMBAI SOR_2018	Cost of Non-ECBC (Load 530 KW)		Cost of ECBC (Load 170 KW)	
DESCRIPTION	UOM	Clause No	Quantity	Amount	Quantity	Amount
LOAD CALCULATION						
			Assumption	Total		
Lighting Load	kW		12 Watt/Sqm		9 Watt/Sqm	
Ac Load	kW		1 kW/TR		1 kW/TR	
PC Load	kW		65 Watt /Unit		65 Watt /Unit	
TOTAL LOAD				529kW		169kW
Transformer (200KVA)	No		3	15,00,000.00	1	5,00,000.00
HT Breakers (11KV, 15/16 Amp)	No	R2-ME-1-1-a	3	1,929.00	1	643.00
Load Break Switches HT (11KV, 15/16 Amp)	No		3	-	1	-
HT Cables (3C x 120 sqmm)	Mtr	R2-ME-2-23-d	150	3,08,100.00	50	1,02,700.00
HT Cable Jointing Kits (120 sqmm kits)	No		9	-	3	-
Air Conditioning (4 TR)	No		112	1,80,09,600.00	27	43,41,600.00
Load Break Switch/ Switch Fuse Units (415 V, 300 Amp)	No	R2-ME-1-1-o	3	80,943.00	1	26,981.00
Distribution Panel (415V Main Distribution Panel 1 short circuit reating 50kA)	No	R2-ME-1-28-a	3	13,18,614.00	1	4,39,538.00
LT Cables (1.1 KV, 4C X 10 sqmm)	Mtr	R2-ME-2-1-r	3000	5,22,000.00	1000	1,74,000.00
TOTAL AMOUNT				2,17,41,186.00		55,85,462.00

Figure 12: Electrical BOQ

RESULTS

We have calculated the electrical equipment sizes required for the building. We have added the equipment cost to the ECBC design and found the total project cost of the energy compliant building.

Cost Estimation of Energy Compliance Building

COST COMPARISON OF Non-ECBC & ECBC Building

Sl.No	Description	Unit	Non - ECBC	ECBC	% Variation
i)	Civil	Cr	4.23	5.32	25.95
ii)	Mechanical	Cr	1.80	0.43	-75.89
iii)	Electrical	Cr	0.37	0.12	-66.67
	TOTAL		6.40	5.88	-8.10

Figure 13: Cost Comparison of Non-ECBC & ECBC Building

- The cost of the Civil scope increased by 26% from the base model (Non-ECBC).
- The cost of Mechanical & Electrical has reduced by 76% and 66% respectively from the base model (Non-ECBC).

The overall cost of the building is reduced by 8% from the base case (Non-ECBC).

CONCLUSIONS

We have proposed a case ECBC (Energy Conservation Building Code) for the office space. We have selected 3 floors which are having a built-up area of 6690 sq.m and found out how the cost of the project is impacting. This study will help the stakeholders to implement the ECBC practices to the commercial as well as residential projects. The study also identifies the ways to reduce the operational cost in the long run, to reduce the requirement of the electrical and mechanical equipment which ultimately leads to a reduction in the cost of the project.

Implementing the ECBC practices not only reduces the cost of the building will also reduce the impact on the environment because of the heat and carbon emissions from the construction of buildings. By implementing more practices like this we can apply for green building certificates for a particular project like IGBC (Indian Green Building Council), LEED (Leadership in Energy and Environmental Design), etc., by obtaining these certificates the reputation of the project increases as well as the sales of the project increases due to eco-friendly concept.

We have considered this project as a simulator model for an office space building, further we can implement these practices in high-rise construction buildings which would result in higher savings of cost and reduces the mechanical and electrical equipment requirement.

There is a vast potential for energy saving through the efficient design of building envelope design for office buildings. This study highlights the fact that different components of building envelopes have different energy-saving potential.

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