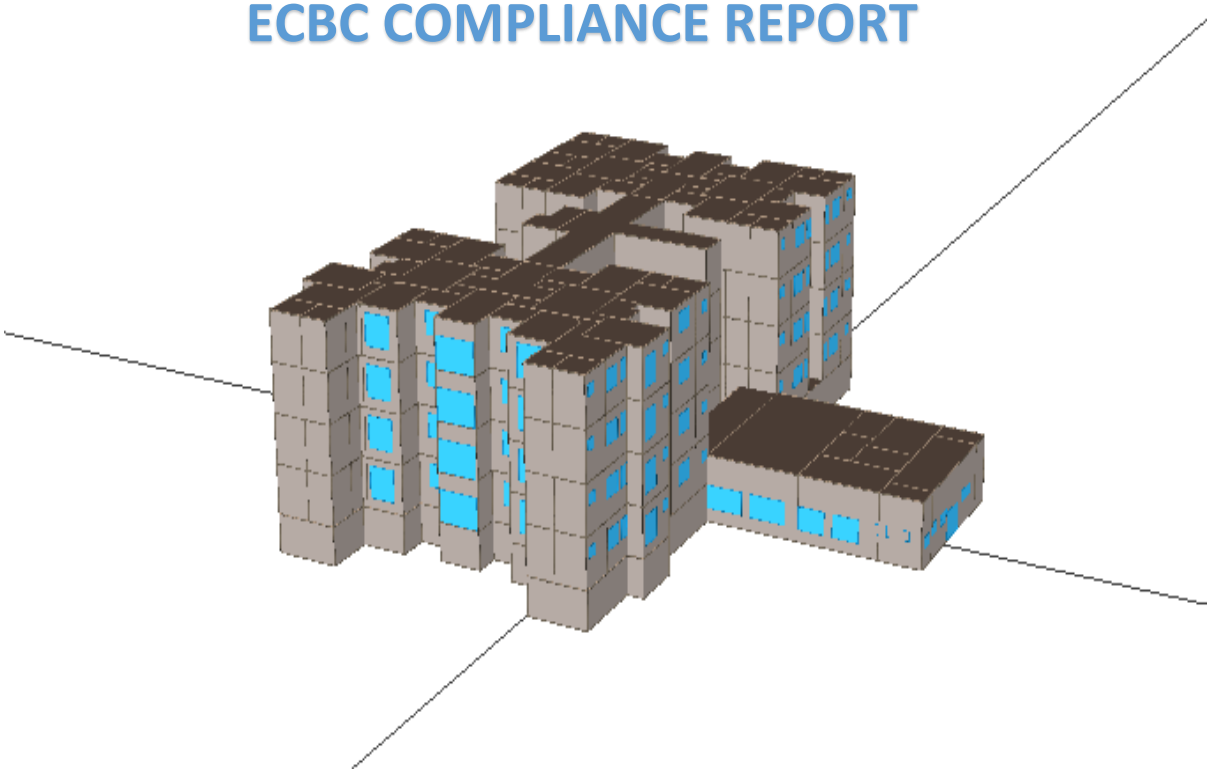
ENERGY EFFICIENT IMPROVEMENTS IN COMMERCIAL BUILDINGS

ECBC COMPLIANCE REPORT



Transit Flats, Assandh
Karnal (Haryana)

(Building Type – Multi Family Residential)

(Climate - Composite)

Project Team

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Plot No. 1, Sector 17,
Panchkula

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Disclaimer
This report has been compiled based on the recommendations and implementation of interventions adopted in the demonstration building to achieve ECBC compliance. The views expressed in this publication, however, do not necessarily reflect those of the United Nations Development Programme and the Bureau of Energy Efficiency, Ministry of Power, Government of India.

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1. EXECUTIVE SUMMARY

BUILDING NAME	Transit Flats
BUILDING TYPE	Multifamily Residential
LOCATION	Assandh, Karnal
CLIMATIC ZONE	Composite
AREA, m^2	7,535 m^2
CONDITIONED AREA, m^2	5000 m^2
OCCUPANCY TYPE	24 Hours
Total Connected Load/ Contract Demand	-
ECBC compliance achieved	ECBC 2007 through prescriptive method
EPI (Baseline Case), KWh/m^2/year	-
EPI (Proposed Case), KWh/m^2/year	-
ENERGY CONSUMPTION BUSINESS AS USUAL, kWh/YEAR	-
ENERGY CONSUMPTION WITH ENERGY EFFICIENCY INTERVENTIONS, kWh/ YEAR	-
ENERGY SAVING ACHIEVED, kWh/ YEAR	-
Expected reduction in annual energy bills, INR % over BAU	-
Estimated GHG reduction, tCO_2 per year	-
Cost of project, total, incremental cost of interventions, INR	Rs. 1,00,01,112
PAYBACK PERIOD (in years)	-
DETAILS OF CONTACT PERSON	B. B. Mehta, Senior Architect Deptt. Of Architecture, Haryana M. - 9814145461

Transit Flats, Assandh, Karnal is an upcoming multi-family residential apartment building. The building is being built by Haryana Government. The architectural plans of the building have been designed by Department of Architecture, Haryana. The execution work of construction will be done by PWD (B&R), Haryana. It is a 6 storied building i.e. G+5 type.

The project is under design stage and the project is targeting for ECBC during design stage. The project is using AAC Block walls with insulation, PUF insulation in roof, LED lights,

occupancy sensors, and energy efficient chillers. The architectural plans are placed at Annexure – 1.

2. SUMMARY OF ECBC COMPLIANCE

2.1 ENVELOPE

2.1.1 MANDATORY PROVISIONS UNDER ECBC

2.1.1.1 U-Factors and Solar Heat Gain Coefficient

U-factors are determined for the overall fenestration product (including the sash and frame) in accordance with ISO-15099, by an accredited independent laboratory, and labeled and certified by the manufacturer or other responsible party.

2.1.1.2 Air Leakage

Air blower test will be adopted for determining the air leakage for swinging entrance doors and revolving doors and it will be sealed, caulked, gasket, or weather-stripped in order to minimize air infiltration and leakage and shall not exceed 5.0 l/s-m^2. Air leakage for other fenestration and doors shall not exceed 2.0 l/s-m^2.

2.1.1.3 Building Envelope Sealing

The project team will seal, caulk, gasket, or weather-strip the following areas of the enclosed building envelope to minimize air leakage:

a) Joints around fenestration and door frames;
b) Openings between walls and foundations and between walls and roof and wall panels;
c) Openings at penetrations of utility services through, roofs, walls, and floors;
d) Site-built fenestration and doors;
e) Building assemblies used as ducts or plenums; and
f) All other openings in the building envelope

2.1.1.4. Building Orientation and Massing

The longer axis of the building is in East-West direction. The building site plan showing the orientation of the building is shown below.

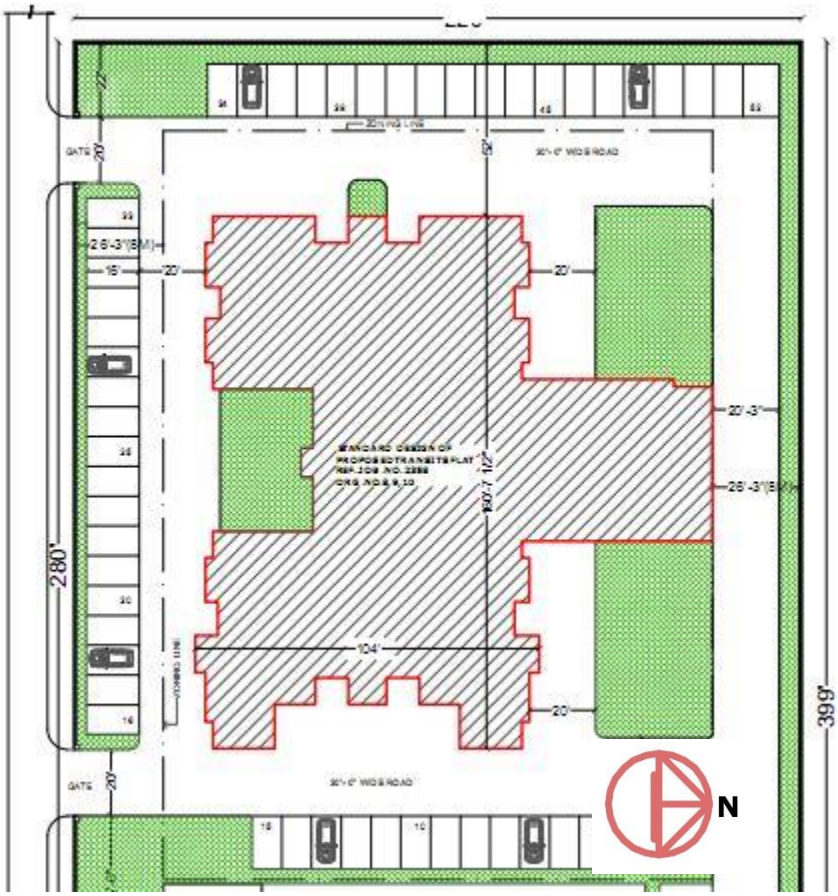

Figure 1: Building Site Plan

2.1.2 Building Opaque Envelope

The project will go for double AAC block wall with 5 mm air cavity. The U-Factor of the wall assembly will be maintained at 0.4 W/m2 K. The wall section is provided in Annexure-2.

Roof assembly consists of over deck 85 mm PUFF insulation to meet the ECBC 2007 requirement of 0.26 W/m2 K for 24-hour use buildings. The U-Factor of the roof assembly will be maintained at 0.25 W/m2 K using the PUFF insulation. The roof section is provided in Annexure 2.

Table 1: Opaque envelope specification

OPAQUE ASSEMBLY	Construction Layers	Specification
Ext. WALL assembly	Assembly layers: Innermost – 12 mm Plaster + 115 mm AAC Blocks + 5mm Air Cavity + 230 mm AAC Blocks + 12 mm Plaster	U-value, W/m²K: 0.4 W/m²K Assembly thickness, mm: 369
Wall insulation	Type: No Insulation	R-value, K m²/W: N/A Thickness, mm: N/A

Roof Assembly	Assembly layers: Cement Screed Topmost - 10mm tiles + 50 mm Portland Cement Concrete +85 mm PUFF insulation + 150mm RCC + 12 mm Cement Plaster	U-value, W/m²K: 0.39 Assembly thickness, mm: 257 mm
Roof insulation	Type: PUFF Insulation	R-value, K m²/W: 1.33 Thickness, mm: 85 mm

2.1.3. Window Wall Ratio

The project has designed a glass laden building. Overall Window Wall Ratio is coming out to be 23.5%. The building has also used overhangs over windows in some directions in some sections of the building. Following is the brief summary of WWR calculations in 4 Directions-

Table 2: Window wall ratio

FACADE	AREA, m²	Opaque wall area , m²	Glazed area, m²	WWR
North	1049.4	847.4	148.76	**14.17%**
West	693.34	488.84	199.43	**28.76%**
South	1049.4	851.84	249.78	**23.8%**
East	693.34	479.5	224.26	**32.34%**
Total	**3485.48**	**2667.58**	**822.23**	**23.5%**

2.1.5 Shading Recommendation

The longer axis of the building is in East-West direction, the project was recommended to provide overhangs over all the windows in South and West directions. The project team has provided overhangs in all the directions for uniformity and aesthetics. A 3 feet projection is given over the windows in all the directions.

2.1.6 Solar Shading Analysis

The project has used overhangs in all the directions, the M-Factor calculation is shown in following table.

Table 3: SHGC calculation

Façade Orientation	Window Type	ECBC Recommended SHGC	Projection Factor (PF)	M-Factor	Equivalent SHGC
North	W1	0.25	0.33	0.88	0.28
West	W1	0.25	0.33	0.79	0.316
South	W1	0.25	0.33	0.79	0.316
East	W1	0.25	0.33	0.79	0.316

2.1.7 Glazing Recommendation

Since the project has WWR less than 40%, the Project was recommended to use Double Glazed windows in all directions with SHGC less than 0.25. Since the project also has overhangs over windows, the project was assisted in calculation the adjusted SHGC for those windows. Glass of SHGC of 0.28 in North direction and glass of SHGC of 0.31 is used in windows with overhangs in non-north directions.

Table 4: Glazing recommendation

GLAZING ASSEMBLY	Specification	Incremental cost (compared to BAU)
Glazing type 1	Assembly layers: a. 6mm toughened glass b. 12 mm air gap c. 6mm toughened glass U-value, W/m²K: 1.5 SHGC: 0.28 VLT: 46%	Rs. 7,43,470 (As compared to conventional clear glass)
Glazing type 2	Assembly layers: d. 6mm toughened glass e. 12 mm air gap f. 6mm toughened glass U-value, W/m²K: 1.8 SHGC: 0.31 VLT: 36%	Rs. 3,18,630 (As compared to conventional clear glass)

2.1.8 Summary of recommendations for envelope

ECBC Cell had recommended several options in wall and roof sections and glazing also.

i) WWR – Window-Wall ratio is 23.5%
ii) Roof - RCC with over deck PUFF insulation.
iii) Wall - Double AAC Block wall with air cavity to meet ECBC through prescriptive approach.
iv) Glass – Double Glazed glass with effective SHGC shall be less than 0.25 after considering the overhangs and calculating the equivalent SHGC through and VLT shall be more than 27%.

2.2. Heating, Ventilation and Air Conditioning (HVAC)

2.2.1. Mandatory ECBC requirements

2.2.1.1. Natural Ventilation

The project team has designed the building following all the necessary provisions of NBC 2005 including the design guidelines for Natural Ventilation. Since the building is a residential apartment building, the natural ventilation is provided such that the building is comfortable without Air -Conditioning.

2.2.1.2 Minimum Equipment Efficiencies

The project will meet all the minimum equipment efficiency norms under ECBC 2007 for Chillers, unitary AC systems, ceiling fans etc. The project is under design stage; the project will take the necessary measures to meet with ECBC 2007 while designing HVAC Systems. The builders are not providing Air Conditioning System. It is up to the discretion of the occupants of the flat to install the Air Conditioning. In offices and other common spaces, operated by builders, BEE 5 star rated ACs will be installed.

2.2.1.3 Controls

The project will give all the necessary controls required for heating and cooling equipment. The dead band between the heating and cooling temperature shall be maintained at 3^0 C.

2.2.1.4 Building HVAC design and systems

The project is installing split AC and will take the necessary measures to meet with ECBC while designing HVAC Systems. The builders are not providing Air Conditioning System. It is up to the discretion of the occupants of the flat to install the Air Conditioning. In offices and other common spaces, operated by builders, BEE 5 star rated ACs will be installed.

Table 6: Equipment Efficiency

Equipment type	ECBC recommended efficiency	System efficiency
Equipment 1 (Split AC)	BEE 3 star rated	BEE 5 star rated

2.2.1.5 Piping and Ductwork

The piping for cold fluid less than 15^0 C temperature, the insulation will have R value of 0.35 Sq. m. K/W or higher.

Table 7: Piping and ductwork insulation

System Description (with operating temperature, °C)	Pipe size (mm)	ECBC recommended R value (m^2.K/W)	R value of insulation used (m^2.K/W)	Thickness of insulation used (mm)
Nitrile Rubber	20 mm	1.4	0.38	13mm

2.2.2. Summary of recommendations for HVAC

- The project team was recommended to install minimum BEE 3 Star rated split ACs which is as per ECBC and Haryana mandatory provision.
- The ACs shall also have thermostat with temperature indicator and controller.
- The outdoor units of the Split ACs shall be free from any obstruction

2.3. LIGHTING

2.3.1. Mandatory Requirement

2.3.1.1 Automatic Controls

The project will install Occupancy sensors in areas like society offices and conference rooms and Astronomical time switch will be provided for exterior lighting. The occupancy/motion sensors will be installed in the building which specify the accessibility of the occupant in the specific areas mentioned.

2.3.2. Lighting Power Density

The project has gone for space function method to meet ECBC requirement of ECBC. The project will be using LED lights in all building.

Table 5: Interior Lighting Power Density

S.No	Building Type	Area, m^2	LPD (W/sqm) Baseline	LPD (W/sqm) Proposed	Wattage Baseline	Wattage Proposed
1	Bedroom and Drawing Room	1794.3	11.8	9	21172.74	16148.70
2	Lobby	587	11.8	9	6926.60	5283.00
3	Toilets	381	9.7	7	3695.70	2667.00
4	Kitchen	484.44	12.9	10	6249.28	4844.40
5	Common Areas	346.96	5.4	4	1873.58	1387.84

2.3.3. Lighting Control

The project will install Occupancy sensors in areas like society offices and conference rooms and Astronomical time switch will be provided for exterior lighting. The occupancy/motion sensors will be installed in the building which specify the accessibility of the occupant in the specific areas mentioned.

2.3.4. Exterior Lighting Detail

LED lights will be used in the exterior of the building. All the fixtures used in the exterior part of the building are having minimum efficacy of 80 lumens/watt.

2.3.5. Exterior Lighting control

Astronomical time switch will be provided for automatic control of exterior lighting. The astronomical time switch will provide maximum energy efficiency which will operate according to the time already defined.

2.3.6. Summary of recommendations for lighting

For interior lighting control, day light sensors and occupancy sensors have been recommended for areas like corridors, toilets, offices and conference rooms.

For exterior lighting control, astronomical time switch has been recommended for automatic control.

2.4. SERVICE WATER HEATING

2.4.1. Hot water requirement in the building

The building contains 32 2-BHK Flats and 32 1-BHK Flats. Assuming 5 people per flat in 2-BHK Flats, and 4 people per flat in 1-BHK Flats there will be total occupancy of 288. Assuming a person will require 20 Liter of hot water per day, 5760 Liters of hot water will be required per day.

Table 6 : Hot Water Requirement Calculation

Block Type	Type of Flats	No. of Flats	No. of peoples in Flat Type	Total Occupancy	Water Requirement per Person Per Day (as per NBC)	Total Water Requirement
A	2BHK	32	5	160	20	3200
B	1BHK	32	4	128	20	2560
Total						5760

The building will install evacuated type solar water heaters with capacity of 1500 Liters per day to meet the minimum ECBC requirement of 20% hot water through solar water heaters. The brand and model have not been selected yet. The model will be selected such that it has minimum efficiency level mentioned in IS 13129 Part (1&2).

2.5. ELECTRICAL

2.5.1 Transformer

The building is in design phase and the oiled filled transformer shall be selected with ECBC norms and the Energy Efficiency Level of the Transformer shall be selected based on IS-1180 with following Losses: -

Transformer Losses shall be as per IS-1180, Energy Efficiency Level-II (maximum losses according to table 8.1 and 8.2 of ECBC 2007 at 50%/100% loading respectively).

2.5.2 Motors (type, efficiency)

The motors better than IS 12615 rated motors will be installed for plumbing purposes. IS Certified recommended motors improves better energy efficiency and consuming less energy as compared to conventional case.

2.5.3 Check Metering and Monitoring

The project shall install separate electric meters in all the flats that can display kVA, kWh, PF, current, voltage, THD.

2.5.4 Power Factor Correction

Automatic Power Factor Controller Relay with programmable microprocessor will be installed to maintain the Power Factor between 0.95 and 1.

2.5.5 Power Distribution System

ALL LT Power Cables will be 1.1KV Grade, XLPE insulated, PVC sheathed, Armored cables (A2XFY). The size of the cables selected shall be decided as per the Load requirement duly consideration that the cable losses (heat losses) shall not exceed 1%.

3. SUMMARY OF DIFFERENT ENERGY EFFICIENCY INTERVENTIONS

The project team has done several iterations for the building in order to find most appropriate solution for energy efficiency. Earlier the project was going for 9-inch-thick red brick wall. The project was recommended to go for insulation in cavity in order to meet ECBC 2007 requirement. Thought after analysis, the project team decided to meet the ECBC 2007 requirement through 369 mm thick AAC wall assembly with 5 mm air cavity.

The project team was recommended to either use over deck PUFF or XPS insulation or under deck Rock Wool insulation. Also thermal resistance of PUFF and XPS is superior to glass wool and rock wool insulation. The project decided to go for over deck PUFF insulation.

Other than this, major energy efficient interventions used in the building were Double Glazed Glasses, Automatic Controls for lighting, Energy Efficient Electrical Systems, etc.

4. COST ANALYSIS AND FEASIBILITY REPORT

For the increased energy performance of the building, energy efficient materials were used in the building which are not conventionally used. Cost comparison analysis was done for the building systems coming under the scope of ECBC for both the conventional and proposed ECBC complied building. The total investment in the conventional building is Rs. 1,44,54,176.1 for the building systems coming under the scope of ECBC. As for the proposed building it is Rs. 2,43,56,267.08. The incremental cost of investment in energy efficient systems is Rs. 1,00,01,112.

Since the building is in designing stage, cost reference is taken from the most accepted market price that was taken from market research.

The number of fixtures required in the building were estimated based on LPD. Conventional building has 40 W CFL fixtures and proposed case has 20 W LED fixtures. The detailed calculation of number of calculation is placed at annexure-4 along with cost analysis.

Table 7 : Cost Analysis Report

	Conventional Case	**Proposed Case**	**Cost Difference**
Total Cost	14454176.1	24356267.08	9902090.95

Capital Investment	**99,02,091**
Maintenance cost (@1%)	**99,021**
Total	**1,00,01,112**

*Note – The above cost details has been referred from market research assessment with various vendor's (manufacturers/suppliers) as per availability & selection of material/product in the state of Haryana.

Detailed Calculations of cost analysis are placed at Annexure -4.

5. ECBC COMPLIANCE FORMS

The Compliance Forms are placed at Annexure – 3.

6. APPENDIX

Annex 1- Architectural Plans
Annex 2- U-Factor Calculations (Wall and Roof)
Annex 3- Compliance Forms
Annex 4- Cost Analysis