Punjab Energy Development Agency (PEDA)

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Punjab Energy Conservation Building Code (Punjab ECBC)

“Energy Efficiency in Buildings”
ECBC and Punjab ECBC
ECBC Introduction

- ECBC, Energy Conservation Building Code is a document that specifies the energy performance requirements for all commercial buildings that are going to be constructed in India and is mandated by EC Act, 2001.

- The Energy Conservation Act 2001 empowered the central government to prescribe an Energy Conservation Building Code (ECBC). ECBC was launched in May 2007 developed by an Expert Committee, set up by India’s Bureau of Energy Efficiency (BEE).
Why Energy Efficiency?

- Energy Efficiency will reduce the increasing demand of energy consumption.
- Contribute to serious environmental and economical problems because of excessive consumption of energy and other natural resources.
- Help to control global emissions of greenhouse gases.
- Energy efficiency reduces costs, energy imports and pollution.
- Energy Conservation and Renewable Energy are said to be the “twin pillars” of a sustainable energy which leads to Energy Efficiency.
Punjab ECBC Notification

- Punjab ECBC – Punjab Energy Conservation Building Code

- Govt. of Punjab issued the Notification on 24th June 2016 for mandatory use of Punjab ECBC for the Energy Efficiency and its Conservation in the buildings or building complexes in the state of Punjab.

- Punjab ECBC has been notified and is now mandatory in the state of Punjab for upcoming buildings or building complexes.
Objective & Scope

- The Objective of Punjab ECBC is to provide **Minimum Requirements for Energy Efficient Design and Construction of Buildings** and their systems.

- The Punjab ECBC is applicable to buildings or building complexes that have-
  - Connected Load in excess of 100kW OR
  - Contract Demand in excess of 120 kVA
  - Recommended for all buildings with conditioned area >500m²
Building Covered in Punjab ECBC

Commercial Buildings
Office Buildings
Group Housing Complexes
Malls
Educational Buildings
IT Parks
Hospitals
Hotels
Govt. Buildings
Applicable Building Systems

The provision of the Punjab ECBC applies to:

- Envelope of building
- Heating, Ventilation and Air Conditioning (HVAC)
- Service Hot Water and Pumping
- Lighting
- Electrical power
Why ECBC?

- Estimates based on simulation models indicate ECBC compliant buildings can use 40 – 60% less energy than conventional buildings.

- At the lowest estimate, this implies an annual saving of nearly Rs. 6 billion; with new rates for commercial establishments, this amount would be far higher.

- It has been estimated that the implementation of ECBC for commercial buildings with connected load above 100kW, will lead to energy savings to the tune 65 Million units which can supply electricity to 40,000 rural families for a year without additional installation of power plants, at current rate of commercial growth in cities.
ECBC Compliance

- Make **Mandatory use of ECBC in Govt./Private Buildings and Building Complexes in state**

- Provision of ECBC shall be integrated for **Effective Implementation in Building Bye-Laws, Specifications, Manuals, by Concerned Authorities and Local Bodies.**

- After 6 months of Notification (Jan 2017), Building plans sanctioned by Govt. departments/Municipal Corporations/Councils/Panchayats or other authorities, **Without ECBC Implementation shall not be Allowed**

- All the line departments like PUDA, Local Govt, PWD B&R, WSS, Architecture and other Authorities should make a **circular in their departments to ensure the Implementation of ECBC**

- The concerned departments will **designate Nodal Officer to monitor and report the progress of enforcement of State Government Decisions** to Department of New & Renewable Energy, Govt. on quarterly basis.
Steps to meet ECBC Compliance

Building Applying For ECBC Compliance

Compliance Approaches

Meet Mandatory Provisions of Sections 4-8

Prescriptive Method

Trade-off option (for ENVELOPE only)

Whole Building Performance Method

ECBC Compliance

Applicable Building Systems

4.2 ENVELOPE
5.2 HVAC
6.2 SERVICE HOT WATER & PUMPING
7.2 LIGHTING
8.2 ELECTRICAL POWER
Mandatory Requirements

Building Envelope
- Fenestration
- Opaque
- Building Envelope Sealing

HVAC
- Natural Ventilation
- Minimum Equipment Efficiencies
- Controls
- Piping and Ductwork
- System balancing
- Condenser

SHW&P
- Solar Water Heating
- Equipment Efficiency
- Supplementary Water Heating System
- Piping Insulation
- Heat Traps
- Swimming Pools
- Compliance Documentation
Mandatory Requirements

**LIGHTING**
- Lighting control
- Exit signs
- Exterior Building
- Ground Lighting

**ELECTRICAL POWER**
- Transformers
- Energy Efficient motors
- Power Factor correction
- Check metering & monitoring
- Power Distribution Systems
ECBC Amended States

ECBC Amendment (20): –

Odisha, Punjab,
Karnataka, Rajasthan,
Andhra Pradesh, Telangana, Uttarakhand,
UT of Puducherry,
Uttar Pradesh, Kerala,
Gujarat, Tamil Nadu,
Haryana, Chhattisgarh, Maharashtra,
West Bengal, Himachal Pradesh, Bihar, Madhya Pradesh,
Assam, Goa
ECBC Notified States

States completed ECBC notification (10):

- Odisha
- Punjab
- Karnataka
- Rajasthan
- Andhra Pradesh
- Telangana
- Uttarakhand
- UT of Puducherry
- Haryana
- West Bengal
Impact of ECBC Compliance

- Lesser addition of power generation capacity
- Lower HVAC load
- High Energy-Efficiency HVAC System
- Improved Building Performance
- Natural Ventilation/Free Cooling System
- Building Insulation
- High Efficient windows
Challenges for ECBC Implementation

- Less knowledge on technical aspects of ECBC.
- ‘Whole Building Performance’ and Building Simulation Approach of ECBC, training is required.
- Higher Initial cost is a barrier, which is not practically in implementation.
- Enforcement and Monitoring are major challenges, and can add significantly to costs.
- Need to address the large stock of Existing Buildings and to improve their energy performance.
Steps to Improve ECBC Implementation

- Awareness Sessions, Capacity Building, Accreditation, Credibility
- Feedback Mechanisms and Decision processes to enable constant monitoring and adjustments are essential.
- Monitoring - at different stages of implementation (Through CEA)
- ECBC with Adequate and Credible information, people and organizations can make investments with paybacks of 2-5 years.
- Technological involvement from different expertise.
Punjab ECBC Cell
ECBC Cell and their Functionaries

- ECBC Cell has been established and made functional from October 2016 in PEDA Office, Chandigarh.
- The main objective of the Cell is to make the awareness among the people of Punjab.
- Regular Interaction with Govt. departments for proper Implementation of Punjab ECBC.
- Discussion and Co-ordination with stakeholder departments to carrying out the activities for the mandatory use of ECBC code.
- To support the Local Authorities involved in the building sanction in amending their bye-laws.
- To arrange and support the Capacity Building programmes among the Architects, Engineers, Consultants, Contractors and other Stakeholder Departments.
Available Support for ECBC Facilitation

**Step-1:** Provide Information to ECBC Cell, SDA about Upcoming Non-Residential Building Projects above 100kW connected load.

**Step-2:** Provide List of Project Co-ordination Team to ECBC Cell OR Intimate Project Team to Coordinate with ECBC Cell.

**Step-3:** The team members of ECBC cell will guide the Project Team for Implementation of ECBC to make their building Energy Efficient.

**Step-4:** ECBC cell will provide Compliance Checklist Forms and List of Empanelled ECBC Consultants to project team, and stakeholders etc.

**Step-5:** ECBC Cell will assist in verifying ECBC compliance forms received from the Certified Energy Auditor/ECBC Empanelled Consultant for further building sanctioning approval.
Support by ECBC Cell in Interactive Session & Capacity Building Programmes
## Summary Overview

- Total No. of Interactive Sessions conducted - 22

- Total No. of Officials/Participants attended - 190

**Punjab ECBC Interactive Sessions**

- Total No. of Capacity Building Programmes conducted - 9

- Total No. Participants attended Capacity Building Programmes - 650
Participation in Interactive Session

Major Departments Involved-
- Department of Architecture (Punjab), Chandigarh
- Department of Town & Country Planning, S.A.S. Nagar, Mohali
- Department of Local Government, Chandigarh
- Department of PWD (B&R) (Elect.), Chandigarh
- Punjab PWD (B&R) (Bldg.), Chandigarh
- Department of Water Supply & Sanitation, Chandigarh
- Punjab State Power Corporation Limited (PSPCL), Patiala
- Punjab Urban Development Authority (PUDA), S.A.S Nagar, Mohali
- Private Architects- Chandigarh, Panchkula, Mohali
- Municipal Corporation, Mohali
- Municipal Council, Zirakpur
### Brief Summary of Interactive Session

#### Summary of Punjab ECBC Interactive Sessions

<table>
<thead>
<tr>
<th>Date</th>
<th>Department</th>
<th>No. of Attendees</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.01.2017</td>
<td>Department of Architecture</td>
<td>4</td>
<td>PEDA Office</td>
</tr>
<tr>
<td>17.01.2017</td>
<td>Deptt of Local Govt.</td>
<td>12</td>
<td>Local Govt. Office</td>
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<td>18.01.2017</td>
<td>PWD B&amp;R Bldgs.</td>
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<td>#221 (ECBC CELL), Sector 11A, Chandigarh</td>
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<td>19.01.2017</td>
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<td>8</td>
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<td>24.01.2017</td>
<td>Deptt of Town and Country Planning</td>
<td>28</td>
<td>PUDA Bhawan</td>
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<tr>
<td>30.1.2017</td>
<td>PMIDC</td>
<td>4</td>
<td>PMIDC Office</td>
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<tr>
<td>7.2.2017</td>
<td>Privates Architects</td>
<td>4</td>
<td>#221 (ECBC CELL), Sector 11A, Chandigarh</td>
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<tr>
<td></td>
<td>(Planner Groups, Creative Consortium, Chandigarh)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.2.2017</td>
<td>PGI</td>
<td>7</td>
<td>PGIMER, Chandigarh</td>
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<tr>
<td>17.2.2017</td>
<td>Privates Architects &amp; Chitakara College (By Design, Chandigarh)</td>
<td>4</td>
<td>#221 (ECBC CELL), Sector 11a, Chandigarh</td>
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</table>
Glimpses of Interactive Session
Capacity Building Programmes

- Planned 37 Programmes
- Completed 9 Programme in Phase-I
- Phase-II is being planned

Summary of Punjab ECBC Capacity Building Programmes

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Programme</th>
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</thead>
<tbody>
<tr>
<td>20.01.2017</td>
<td>NITTTR Chd</td>
<td>Capacity Building Program</td>
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<tr>
<td>23.01.2017</td>
<td>PIT Mohali</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>13.02.2017</td>
<td>Giani Zail Singh College, Bathinda</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>20.02.2017</td>
<td>Indo Global College, Ropar</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>27.02.2017</td>
<td>Ambuja Knowledge Centre, Bathinda</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>06.03.2017</td>
<td>Ambuja Knowledge Centre, Jalandhar</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>18.03.2017</td>
<td>LPU Jalandhar</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>27.03.2017</td>
<td>CT University Jalandhar</td>
<td>Capacity Building Program</td>
</tr>
<tr>
<td>08.04.2017</td>
<td>ITPI, Chandigarh</td>
<td>Capacity Building Program</td>
</tr>
</tbody>
</table>
Glimpses of Capacity Building Programmes
Steps Undertaken by Govt. of Punjab for ECBC Implementation
A Punjab ECBC Advisory Committee meeting have been formulated with the Nodal Officer from every Stakeholder departments for Implementation of Punjab ECBC in the state.

The Objective of Punjab ECBC Advisory Committee is to conduct regular meetings, coordination, feedback, inputs for proper implementation of Punjab ECBC.

2 meetings have been conducted till the date.
Department of Local Government, Punjab released a Notification on 29th December 2016 under ‘The Punjab Municipal Green Buildings Incentives Policy – 2016’ where Incentives for Punjab ECBC Compliance are being provided.

Punjab is the first state in India where incentives are being provided for ECBC Compliant Buildings

Incentives – 15% Rebate in Property Tax for Punjab ECBC Compliance

Incentives for Green Building – 5% Extra FAR for GRIHA, IGBC & LEED
Department of Housing and Urban Development, Punjab released a Notification on 29th October 2013 under Section 180(2)(i) where provisions for use of Punjab ECBC included.

“The use of Punjab Energy Conservation Building Code as notified under Energy Conservation Act, 2001 shall be applicable while approving the building plans for construction of buildings.”
Govt. of Punjab, PWD B&R constituted a committee to study the various clauses of ECBC and put forward the ways and means for smooth and steady implementation of Punjab ECBC completely and collectively.

The committee will review-
1. Implementation of ECBC at Admin/Field Level.
2. Modifications and development of provisions of CSR with reference to procurement of materials needed for construction of buildings in order to implement ECBC Code.
3. Holding a seminar for imparting training to workforce of Architect, Civil, Electrical & Public Health wing.
Punjab ECBC Implementation Process
Steps for ECBC Compliance Process

Design Stage
(Building Plans Sanctioning Approval)

On Submission of Occupancy Certificate

Punjab ECBC Compliant Building
ECBC In Building Approval Process

Building Permission Process in ULBs

Application for building construction by project promoter to ULB

- Appointment & Acceptance of Structural Engineer
- Appointment & Acceptance of Architect
- Appointment & Acceptance of ECBC Assessor
- Appendix B E – Supervision form ECBC Assessor
- Annexure – I U/S 44 of MRTP Act

Plans With Proforma – I Mentioning Area Computation, Tenament And Parking Details

- Certificate of area by Architect
- Certificate of commercial area by Architect

Scrubtn by TP Department

- IOD & CC by TP Department

Completion and Occupation by TP Department

Typical Process

Additional Requirement
Various Responsibilities & Available Support

How the process will take place for ECBC Compliance?
- Architect will submit the plans to Competent Authority.
- The approval should only be provided when the ECBC Compliance forms would be submitted along with supporting documents.
- Supporting Documents – Compliance Forms, Calculation Sheets, Certificate of ECBC Empanelled Consultant

Non-Compliance of Punjab ECBC-
- Occupancy Certificate will not be Issued for non-compliance of Punjab ECBC in the upcoming buildings in the state of Punjab.

Available Support-
- ECBC Empanelled Experts, ECBC Master Trainers, ECBC Professionals, ECBC Cell, Architects

63 – ECBC Empanelled Experts/Consultants
122 – ECBC Master Trainers
ECBC Compliance Forms
ECBC Resources

- ECBC Tips Sheets
- ECBC User Guide
- ECBC Notifications
- ECBC Incentives
- ECBC App
Building taken-up for Punjab ECBC Compliance
Ongoing Building – PSPCL, Patiala

Multistoried Integrated Corporate Office Complex

- Punjab State Power Corporation Limited (PSPCL)
- Patiala
- Architect: Planners Group, Chandigarh

Punjab Energy Conservation Building Code Compliance
Building Information

- Built-up Area/Covered Area = 22881.2 square feet
- Conditioned Area – 20838.9 sqm
- Contract Demand - 2550 kVA (Revision Required)
- Basement + Ground + Six Floors
- Plot Area – 24745 sqm
- Office Building with Training Block
- Solar PV Capacity - 80 kVA (Roof PV) + 150 kVA (Parking Roof PV) (Revision Required)
- Address: PSPCL, Shakti Vihar, Patiala 147001
### Area Details

<table>
<thead>
<tr>
<th>Floor</th>
<th>Area (sqm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basement</td>
<td>546.6</td>
</tr>
<tr>
<td>Ground Floor</td>
<td>3744.7</td>
</tr>
<tr>
<td>First Floor</td>
<td>3604.9</td>
</tr>
<tr>
<td>Second Floor</td>
<td>3871.4</td>
</tr>
<tr>
<td>Third Floor</td>
<td>3707.8</td>
</tr>
<tr>
<td>Fourth Floor</td>
<td>3183.9</td>
</tr>
<tr>
<td>Fifth Floor</td>
<td>3180.9</td>
</tr>
<tr>
<td>Sixth Floor</td>
<td>1587.5</td>
</tr>
<tr>
<td>Roof Area</td>
<td>4047.5</td>
</tr>
<tr>
<td>Ground Coverage Area</td>
<td>3744.7</td>
</tr>
<tr>
<td>Parking Area</td>
<td>11136.0</td>
</tr>
</tbody>
</table>
## Project Team Details

<table>
<thead>
<tr>
<th>Consultant</th>
<th>Name</th>
<th>Firm</th>
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<tbody>
<tr>
<td>Architect</td>
<td>Mr. Vikram Malik</td>
<td>Planners Group</td>
</tr>
<tr>
<td>HVAC Consultant</td>
<td>Mr. Anuj Agarwal</td>
<td>Ambience Consultants</td>
</tr>
<tr>
<td>Electrical Consultant</td>
<td>Rattan Lal</td>
<td>Sunrise Power Consultants</td>
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<tr>
<td>Plumbing Consultant</td>
<td>Selection in Process</td>
<td>Selection in Process</td>
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<tr>
<td>Civil Contractor</td>
<td>Rajesh Kumar Singla, Praveen Kumar</td>
<td>Praveen Kumar Consultants</td>
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<tr>
<td>Green Building Consultant</td>
<td>Selection in Process</td>
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<tr>
<td>Structural Consultant</td>
<td>Pankaj Chopra</td>
<td>Chopra Consultancy Engineers</td>
</tr>
<tr>
<td>Landscape Consultant</td>
<td>Mr. Vikram Malik</td>
<td>Planners Group</td>
</tr>
<tr>
<td>Fire Fighting</td>
<td>Mr. Anuj Agarwal</td>
<td>Ambience Consultants</td>
</tr>
</tbody>
</table>
Drawings & Calculations Received

Received and Guided

- Floor Plans
- Site Plan
- Elevations
- Sections
- Overall Wall Assembly Section
- Overall Roof Assembly Section
- WWR Calculation
- U Value Calculation
- M-Factor Calculation - Awaited
Ground Floor Plan
Roof Plan
Elevation & Section Plan

Elevation Plan

Section Plan
## ECBC Cell Advise for Punjab ECBC Compliance

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Initial Proposed</th>
<th>After ECBC Cell Advise</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Wall:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 25 mm PUFF Panel</td>
<td>Already Meets Prescriptive Requirement</td>
</tr>
<tr>
<td></td>
<td>- Double Brick Wall – AAC Blocks</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Roof:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 50 mm Glass wool</td>
<td>Roof:</td>
</tr>
<tr>
<td></td>
<td>- 150 mm RCC Slab</td>
<td>- 50 mm PUFF Spray</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 150 mm RCC Slab</td>
</tr>
<tr>
<td>3</td>
<td>Roof Surface without High SRI Tiles</td>
<td>Roof with High SRI Tile</td>
</tr>
<tr>
<td>4</td>
<td>Glass not decided</td>
<td>Two type of Glass with SHGC of 0.2 and 0.23</td>
</tr>
<tr>
<td>5</td>
<td>Projection Factor Not Considered for Compliance</td>
<td>Projection Factor Considered for the Glass having SHGC of 0.23. Calculation is Awaited.</td>
</tr>
<tr>
<td>6</td>
<td>WWR 48%</td>
<td>Already Meets Prescriptive Requirement</td>
</tr>
<tr>
<td>7</td>
<td>Lighting with LED fixtures</td>
<td>Recommended to maintain uniform Lighting with proper LPD Design</td>
</tr>
<tr>
<td>8</td>
<td>Chiller</td>
<td>Chiller below 300 tons with 5.4 COP at least</td>
</tr>
<tr>
<td>9</td>
<td>Option (Geothermal/Cooling tower)</td>
<td>Any options would be suitable. The pumps used for circulation should be VFD integrated.</td>
</tr>
</tbody>
</table>
Recommended Building Materials for Punjab ECBC Compliance
Opaque Construction (Wall)

**Opaque Wall**
- The wall thickness, materials and finishes can be chosen based on the heating and cooling needs of the building.

**ECBC Requirements for Opaque Walls**
Opaque walls shall comply with either the maximum assembly U-factor or the minimum insulation R-value.

**Table 4.2: Opaque Wall Assembly U-factor and Insulation R-value Requirements**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Hospitals, Hotels, Call Centres (24 Hour)</th>
<th>Other Building Types (Daytime)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum U-factor of the overall assembly (W/ U-0.440)</td>
<td>Minimum R-value of insulation alone (m²·°C/W)</td>
</tr>
<tr>
<td>Composite</td>
<td>U-0.440</td>
<td>R-2.10</td>
</tr>
</tbody>
</table>

**Note:** Punjab is covered by Composite climate zone only. For information on other climate zones, please refer relevant tables of ECBC.
Opaque Construction (Wall)

Single (Brick) Wall
- 9" thick cement plaster
- U value: ~1.78

Single (Brick) Wall + ACP
- U value: ~1.40

Double Wall (Brick) with air gap
- U value: ~0.93

Single (Brick) Wall + 50mm Insulation
- U value: ~0.39

Brick Wall + ACP + 50mm Insulation
- U value: ~0.40

Double Wall + air gap + 50mm insulation
- U value: ~0.37

Source: Owens Corning
Recommended Techniques for Wall

- Thermal performance of walls can be improved by following ways:
  - Increasing Wall Thickness
  - Providing Air Cavity between Walls and Hollow Masonry Blocks
  - Applying Insulation on the External Surface.
  - Use Fly Ash Bricks, AAC Blocks, etc.
  - Applying Light Colored distemper on the Exposed side of the Wall.
  - Applying Solar PV on Exterior Façade of the Wall.
  - Provide Hanging Garden on the East-West side of a building is beneficial in a Composite Climate.

Sample U-Value Calculation for Wall for Punjab ECBC Compliance

<table>
<thead>
<tr>
<th>Option 4</th>
<th>LAYER</th>
<th>BRAND</th>
<th>THICKNESS (L) (mm)</th>
<th>L/1000</th>
<th>THERMAL CONDUCTIVITY (K)-W/MK</th>
<th>REFERENCE</th>
<th>RESISTANCE (L/K)</th>
<th>U VALUE (1/R)</th>
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<tr>
<td></td>
<td>Surface Film</td>
<td>On Site</td>
<td>12</td>
<td>0.012</td>
<td>0.750</td>
<td>ECBC User Guide</td>
<td>0.1</td>
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<tr>
<td></td>
<td>Resistance (Rse)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Cement Plaster</td>
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<td>0.012</td>
<td>0.750</td>
<td>ECBC User Guide</td>
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<tr>
<td></td>
<td>Insulation PUFF Spray</td>
<td>Lloyd</td>
<td>25</td>
<td>0.025</td>
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<td>Lloyd Data Sheet</td>
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<td>AAC Blocks</td>
<td>Bitech</td>
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<td>0.160</td>
<td>ECBC User Guide</td>
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<td>Resistance (Rse)</td>
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</tr>
<tr>
<td></td>
<td>Total Thickness</td>
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<td>2.665</td>
<td>0.375</td>
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Opaque Construction (Roof)

Roof

- It also denotes the framing or structure which supports that covering.

ECBC Requirements for Opaque Roof

Roofs shall comply with either the maximum assembly U-factor or the minimum insulation R-value.

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>24-Hour use buildings Hospitals, Hotels, Call Centers, etc.</th>
<th>Daytime use buildings Other Building Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum U-factor of the overall assembly (W/ m².°C)</td>
<td>Minimum R-value of insulation alone (m².°C/W)</td>
</tr>
<tr>
<td>Composite</td>
<td>U-0.261</td>
<td>R-3.5</td>
</tr>
</tbody>
</table>
Opaque Construction (Roof)

- Brick Bat Coba
- Expanded Polystyrene Slabs
- Polyurethane/Polysocyanurate Slabs
- Roof under deck insulation
- Foam Concrete
- Extruded Polystyrene Slabs
- Coated Roof
- Roof over deck insulation
- Green Roof
Recommended Techniques for Roof

- Thermal performance of roof can be improved by following ways:
  - Apply Insulation on Roof (Underdeck/Overdeck)
  - Use light colored Roofs having high SRI (Solar Reflectance Index) value
  - Covered with Highly Reflective tiles.
  - Covered with Solar PV.
  - Covered with Green Roof.

### Sample U-Value Calculation for Roof for Punjab ECBC Compliance

<table>
<thead>
<tr>
<th>Option 1</th>
<th>LAYER</th>
<th>BRAND</th>
<th>THICKNESS (L) (mm)</th>
<th>L/1000</th>
<th>THERMAL CONDUCTIVITY (K)-W/MK</th>
<th>REFERENCE</th>
<th>RESISTANCE (1/k)</th>
<th>U VALUE (1/R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Film Resistance (Rsi)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ECBC User Guide</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>White Tile</td>
<td>Thermatek</td>
<td>8</td>
<td>0.008</td>
<td>0.236</td>
<td>Thermatek</td>
<td>0.034</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement Screed</td>
<td>Onsite</td>
<td>50</td>
<td>0.050</td>
<td>1.208</td>
<td>ECBC User Guide</td>
<td>0.041</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation PUFF Spray</td>
<td>Lloyd</td>
<td>60</td>
<td>0.060</td>
<td>0.023</td>
<td>Lloyd Data Sheet</td>
<td>2.609</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother slab (RCC)</td>
<td>On Site</td>
<td>100</td>
<td>0.100</td>
<td>1.411</td>
<td>ECBC User Guide</td>
<td>0.071</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement Plaster</td>
<td>On Site</td>
<td>12</td>
<td>0.012</td>
<td>0.750</td>
<td>ECBC User Guide</td>
<td>0.016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Film Resistance (Rse)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ECBC User Guide</td>
<td>0.040</td>
<td></td>
</tr>
<tr>
<td><strong>Total Thickness</strong></td>
<td></td>
<td></td>
<td>230</td>
<td></td>
<td></td>
<td></td>
<td><strong>2.941</strong></td>
<td><strong>0.340</strong></td>
</tr>
</tbody>
</table>
Glass

Glazing Area
80-90% of the total area and therefore the most important part to address for achieving energy efficiency.

Frame
Important to optimize the overall energy efficiency of the window.

- Proper location, sizing, Glazing, Frames and shading form
- Proper location, sizing, Glazing, Frames and shading form

Window

ECBC Requirements for Vertical Fenestration
Vertical fenestration shall comply with the maximum area weighted U-factor and maximum area weighted SHGC requirements.

Table 4.3: Vertical Fenestration U-factor and SHGC requirements (U-factor in W/ m²·C)

<table>
<thead>
<tr>
<th>Climate</th>
<th>Maximum U-factor</th>
<th>WWR≤40%</th>
<th>40%&lt;WWR≤60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite</td>
<td>3.30</td>
<td>0.25</td>
<td>0.20</td>
</tr>
</tbody>
</table>

See Appendix C clause 11.2.1 for Default values of Unrated Fenestration
Recommended Techniques for Glass

GLAZING
- Single Glazing with High Performance Coating
- Double Clear Glazing
- Double High Performance Glazing

FRAME
- UPVC Frame
- Aluminum Frame With Thermal Break

UPVC Window
- Single Glazing
- Double Glazing
- High Performance Single Glazing
- High Performance Double Glazing

Solar Control Interior Shading
Movable Louvers/Barriers
Fixed Overhangs/Louvers
Recommended Techniques for Lighting

- Provide Automatic Lighting Controls
- Internal and External Lighting Controls
  - Occupancy Sensors
  - Daylight & Motion Sensors
  - Astronomical Time Switch & Photo sensors
- Maintain Minimum LPD (Lighting Power Density)
- Separate Controls for Separate Lighting
- Recommended to use LED fixtures
- Energy Efficient Lighting Applications
Latest Energy Efficient HVAC Technologies

1. VRV/VRF (Variable Refrigerant Volume/Variable Refrigerant Flow)
2. Chiller and Other Centralized Air-Conditioning Systems
3. District Cooling Systems
4. Radiant Cooling Systems
5. Geothermal Cooling
6. Thermal Energy Storage
7. Boilers
8. Unitary Heat Pumps
9. Earth Air Tunnel
10. Chilled Beams
and so on........
Ongoing & Upcoming Buildings
# Ongoing Buildings for ECBC Compliance

<table>
<thead>
<tr>
<th>Client Name</th>
<th>Project Name</th>
<th>Location</th>
<th>Built-Up Area (SQ.FT.)</th>
<th>Type of Building</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab State Power Corporation Limited (PSPCL)</td>
<td>Multistoried Integrated Corporate Office Complex</td>
<td>Patiala</td>
<td>2,46,190</td>
<td>Office</td>
<td>5 meetings have already been conducted with Architects &amp; concerned Departments.</td>
</tr>
<tr>
<td>IK Gujral-Punjab Technical University (IKG-PTU)</td>
<td>Residential Quarters &amp; Group Complex</td>
<td>Kapurthala</td>
<td>12,35,412</td>
<td>Building Complex</td>
<td>Compliance forms are being prepared.</td>
</tr>
<tr>
<td>PGIMER</td>
<td>Satellite Center</td>
<td>Sangrur</td>
<td>5,00,340</td>
<td>Hospital</td>
<td>Site meeting have been conducted with Contractor, Consultants &amp; Architects</td>
</tr>
<tr>
<td>IIT, Ropar</td>
<td>Administrative Blocks &amp; Hostels</td>
<td>Ropar</td>
<td></td>
<td>Institute &amp; Building Complex</td>
<td>Building information details with Compliance forms are being prepared.</td>
</tr>
<tr>
<td>CMC Ludhiana</td>
<td>Christian Medical College and Hospital</td>
<td>Ludhiana</td>
<td>7,76,134</td>
<td>Hospital</td>
<td>Punjab ECBC Compliance forms submitted. Supporting documents are being prepared.</td>
</tr>
</tbody>
</table>
## Upcoming Buildings for ECBC Compliance

### Information of ongoing Projects in the Jurisdiction of STP office, Patiala

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Sub/Junction of CLU</th>
<th>Purpose</th>
<th>Area in Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Government Girls School (Punjab)</td>
<td>Educational</td>
<td>0.50</td>
</tr>
<tr>
<td>2</td>
<td>Anand Public School (Punjab)</td>
<td>Educational</td>
<td>1.50</td>
</tr>
<tr>
<td>3</td>
<td>Sidhwan Bagh Village</td>
<td>Residential</td>
<td>2.00</td>
</tr>
<tr>
<td>4</td>
<td>Shree Pathak Village</td>
<td>Residential</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>Mata Anand Kaur Colony</td>
<td>Educational</td>
<td>0.50</td>
</tr>
<tr>
<td>6</td>
<td>Mata Anand Kaur Village</td>
<td>Educational</td>
<td>1.00</td>
</tr>
<tr>
<td>7</td>
<td>Mata Anand Kaur Village</td>
<td>Educational</td>
<td>0.50</td>
</tr>
<tr>
<td>8</td>
<td>Mata Anand Kaur Village</td>
<td>Educational</td>
<td>1.00</td>
</tr>
<tr>
<td>9</td>
<td>Mata Anand Kaur Village</td>
<td>Educational</td>
<td>0.50</td>
</tr>
<tr>
<td>10</td>
<td>Mata Anand Kaur Village</td>
<td>Educational</td>
<td>1.00</td>
</tr>
<tr>
<td>11</td>
<td>Mata Anand Kaur Village</td>
<td>Educational</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Information of ongoing Projects in the Jurisdiction of STP office, Patiala.
Proforma for Buildings Information

- This proforma have been circulated to all concerned departments for providing upcoming building information.

- If any support will be required to make the buildings Punjab ECBC Compliance, proforma with the complete building information will be required.

- Punjab ECBC Cell will facilitate the project team to make their buildings ECBC Compliant with filing of compliance forms.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Project Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Name of Building</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Location with Address</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Building Type (Hotel/Mall/Hospital/Building Complex/Retail/IT/Office)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Project Type (New Building/Addition/Alteration/Change of Use)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Building Area</td>
<td>Plot Area (sq. ft.) - Built-up Area (sq. ft.) -</td>
</tr>
<tr>
<td>6</td>
<td>No. of Floors in Building</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Owner's Details</td>
<td>Name of Owner - Owner's Address - Owner's Contact Number - Owner's Email Id -</td>
</tr>
<tr>
<td>8</td>
<td>Architect Details</td>
<td>Name of Architect - Architect Address - Architect Contact Number - Architect Email Id -</td>
</tr>
<tr>
<td>9</td>
<td>Project Comes Under (Corporation/Council/Committee/Authority/Nagar Panchayat) with Address</td>
<td>Name - Address -</td>
</tr>
<tr>
<td>10</td>
<td>Any other Information related to the building</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Name &amp; Contact Number of the Nodal Officer In-charge</td>
<td></td>
</tr>
</tbody>
</table>
A Way Forward

- Implementation of Punjab ECBC in design and construction of upcoming buildings in the state of Punjab.

- Every Stakeholders (Architects/Builder/Consultants/Contractors/Engineers) should provide extending support to make ECBC Compliant Buildings.

- To maintain regular mechanism for ECBC Implementation in the state.

*******Energy Efficiency!!************
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P.G. In Environment & Sustainable Development
Mechanical Engineer

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YEA – ASHRAE India Chapter
Member – IAEMP, IAQA, IBPSA-India
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