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BUILDING ENERGY EFFICIENCY IN NEPAL

BUILDING ENERGY EFFICIENCY (EE)

COMPLIANCE TOOLKIT

universität innsbruck
Unit of Energy Efficient Buildings

MinErgy

Greentech Knowledge Solutions Pvt. Ltd.

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BUILDING ENERGY-EFFICIENT COMPLIANCE TOOLKIT

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This Building Energy Efficiency (EE) Compliance Toolkit has been developed to guide architects, designers, and engineers in preparing submissions for building permits in compliance with energy-efficient (EE) and renewable energy (RE) policy provisions. It is also intended for use by municipal officials in municipalities that have adopted these policies.

This document gives the details of all the essential steps to be followed as well as the calculation to be made using the tools (developed under BEEN project), before submitting the documents and supporting calculations to the municipality for the issuance of building permits in compliance with energy-efficient (EE) and Renewable Energy (EE) provisions. Designers must ensure that all relevant provisions are integrated and demonstrated as in this document. This does not replace the need to refer to the guidelines for designing the building.

This document has four parts, and it is aligned with all the design requirements as per the "ऊर्जा प्रभावकारिता सम्बन्धी विवरण". These parts include:.

- Part I: Key steps to prepare all the submittals for the design requirements
- Part II: User manual for the U-value calculation tool (For Design Requirement, EE Measure, Building Envelope: Wall and Roof, S.N. 1.1 and 2.1)
- Part III: User manual for the BPS tool (For Design Requirement, EE Measure, Building Envelope: Fenestration, S.N. 4.1, 4.2, 4.3 and 4.4)
- Part IV: Calculation method with example for Daylighting (For Design Requirement, EE Measure, Building Fenestration, S.N. 4.5)
- Part V: Compliance submission (Information required with a Sample Report). This gives a list of documents required and a sample report to prepare the compliance submission report.

PART

I

TOOLKIT FOR COMPLYING WITH (EE) AND (RE) PROVISIONS

TOOLKIT FOR COMPLYING WITH (EE) AND (RE) PROVISIONS

This toolkit outlines the essential steps to be followed before submitting the documents to the municipality for the issuance of building permits in compliance with energy-efficient (EE) and Renewable Energy (EE) provisions. Designers must ensure that all relevant provisions are integrated and demonstrated as in this toolkit. This does not replace the need to refer to the guidelines for designing the building.

A. ENERGY EFFICIENT (EE) MEASURES

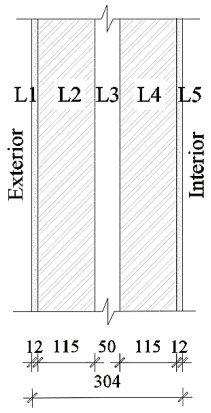
1. Building Envelope: External Wall

a. Submit a typical wall section drawing (1:10 or 1:20 scale) of the external walls, showing all material layers (e.g., insulation, finishes, structural components) along with U-value in the tabular format for different construction typology (Construction typology 1, Construction typology 2, etc.)

b. The material names and thicknesses for each layer should be mentioned.

c. The excel sheet should be submitted to confirm the compliance. (User manual for U-value calculation is added in Part-II)

EXAMPLE 1: INPUT INFORMATION FOR WALL CONSTRUCTION (BRICK WALL WITH INSULATION)



Envelope Component			Wall
Climatic Zone			Warm Temperate and Temperate
Layer: Outermost to Innermost			
U-value (W/m^2.K)			0.51
R_{total} (m^2.K/W)			1.94
R_{si} (m^2.K/W)			0.13
R_{se} (m^2.K/W)			0.04
Material	Thickness (mm)	k (W/m.K)	R (m^2.K/W)
Cement plaster, Density-1762 kg/m3	12	0.721	0.02
Solid burnt clay brick, Density-1600 kg/m3	115	0.74	0.16
EPS Insulation, Density-24 kg/m3	50	0.035	1.43
Solid burnt clay brick, Density-1600 kg/m3	115	0.74	0.16
Cement plaster, Density-1762 kg/m3	12	0.721	0.02

U-Value: The U-value of the external walls should be less than or equal to 1.8 W/m^{2}k.

Note: The designer should include the section details as per their proposed construction and with proper hatch. The provided typical wall section is a representative case scenario.

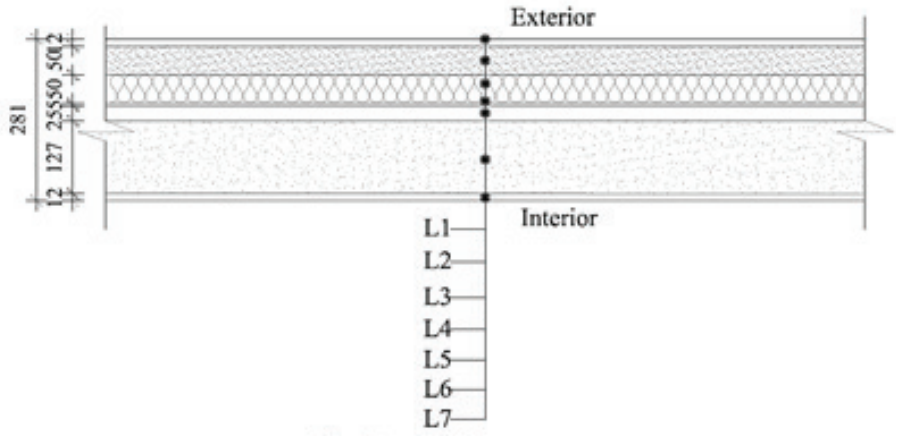
2. Building Envelope: Roof

a. Submit a typical wall section drawing (1:10 or 1:20 scale) of the external walls, showing all material layers (e.g., insulation, finishes, structural components) along with U-value in the tabular format for different construction typology (Construction typology 1, Construction typology 2, etc.)

b. The material names and thicknesses for each layer should be mentioned.

c. The excel sheet should be submitted to confirm the compliance. (User manual for U-value calculation is added in Part-II)

EXAMPLE 2: INPUT INFORMATION FOR ROOF CONS TRUCTION (RCC ROOF WITH INSULATION)



Envelope Component			Roof
Climatic Zone			Warm Temperate and Temperate
Layer: Outermost to Innermost			
U-value (W/m^2.K)			0.55
R_{total} (m^2.K/W)			1.80
R_{si} (m^2.K/W)			0.17
R_{se} (m^2.K/W)			0.04
Material	Thickness (mm)	k (W/m.K)	R (m^2.K/W)
Brick tile, Density-1892 kg/m3	12	0.80	0.02
Cement screed , Density-2100 kg/m3	25	1.40	0.02
XPS Insulation, Density-35 kg/m3	50	0.04	1.43
Cement screed , Density-2100 kg/m3	50	1.40	0.04
Reinforced concrete cement (RCC), Density-2288 kg/m3	125	1.58	0.08
Cement plaster, Density-1762 kg/m3	12	0.72	0.02

U-Value: The U-value for the roof should be less than or equal to 1.2 W/m^2.K, while for a traditional/vernacular building (as mentioned in the EE/RE guidelines) the U-value for the roof should be less than or equal to 1.5 W/m^2.K.

3. Building Envelope: Floor

The information on the floor consisting of insulation should be provided, if any. It is recommended to provide insulation in all the regularly occupied spaces adjacent to the ground, particularly in the cold climate.

4. Building Envelope: Fenestration

a. Submit the opening schedule with windows typology, size, quantity, and shadings.

b. Submit detailed window elevation drawings (e.g., single glazed, double glazed, openable %, glazing area etc.). This information should be entered into the BPS tool, in order to check the compliance.

c. Submit the detail calculation sheets for compliance check. (User manual for the BPT tool is added in Part-III)

Compliance Check

This requires checking of five design parameters and submitting the required calculations and documentation.

Submit the detail calculation sheets for compliance check. (User manual for the BPT tool is added in Part-III)

4.1 Minimum Openable Area to Floor Area Ratio (WFRop), %

The minimum openable area to floor area ratio (WFRop) ensures there is sufficient provision for natural ventilation in the building. The openable area of all the doors and windows in the habitable spaces, which is directly connected to the ambient, is to be considered for the calculation.

Minimum openable area to floor area ratio (WFR_{op}) (%)

$$= \frac{\textit{Openable area (doors, windows) in the habitable spaces (m}^2\textit{)}}{\textit{(Area of habitable spaces (m}^2\textit{)}} \times 100$$

The minimum requirement for WFR_{op} is defined as per the climatic zone, for which the calculations must be made using BPS tool.

Climatic Zone	Minimum WFRop (%)
Warm Temperate*	16.66
Temperate	12.50
Cool Temperate	8.33
Cold climate#	6.25

**Source: Ktm valley Bye-laws 2064*
#Source: NBC:206, 2024

4.2 Minimum Glazed Area to Floor Area Ratio (GFR), %

The minimum glazed area to floor area ratio (GFR) ensures there is sufficient provision for daylight in the building. The glazed area of all the doors and windows in the habitable spaces, which is directly connected to the ambient, is to be considered for the calculation.

$$\textit{Minimum glazed area to floor area ratio (GFR) (\%)} = \frac{\textit{Total glass area (doors, windows) } (m^2)}{\textit{Area of habitable spaces } (m^2)} \times 100$$

The minimum requirement for GFR is defined as per the table below, for which the calculations must be made using BPS tool.

Climatic Zone	Minimum WFRop (%)
All climate zones*	12.5

**Source: NBC: 206, 2024*

4.3 & 4.4 Window-to-Wall Ratio (WWR) for Each Façade and Corresponding Properties of the Glass

Window allow both heat and light and it should be optimized to balance both. Also, the heat and daylight from the windows changes significantly as per the orientation. To address this, the provision for glass specifications is decided based on its area and the calculation needs to be done for each orientation.

Calculate the window-to-wall ratio for each façade (North, South, East and West). For compliance the WWR of each façade needs to be less than or equal to 40% . However, if the WWR exceeds more than 40%, the glass properties and specification as mentioned in the table must be complied.

For the non-opaque area, consider all the glazing area on the façade, directly exposed to ambient. For the area of building envelope, calculate the gross wall area which is directly exposed to the ambient. The area below plinth and area of the parapet should be excluded while calculating the area of envelope.

Window to wall ratio (WWR) (%)

$$= \frac{\textit{Non - Opaque area}}{\textit{Area of envelope (Respective facade)}}$$

The minimum requirement for Window-to-Wall Ratio (WWR) for each façade and corresponding properties of the glass is defined as per the table below. Calculations must be made using BPS tool to show these design requirements.

Glass properties	WWR ≤ 40%	WWR > 40%
U-value (W/m^2.K)	≤ 5.8	≤ 2.8
Shading Coefficient (SC)	-	≥ 0.31 for Cold, Cool Temperate and Temperate climate ≤ 0.70 for Warm Temperate climate
Visible Light Transmittance (VLT)	-	≥ 0.30

4.5 Daylighting: Cumulative Daylighting of Habitable Rooms in the Building, %

This provision requires that the daylight area should be at least 40% of the total habitable area.

Daylit area (%)

$$= \frac{\textit{Total daylit area in habitable spaces (m}^2\textit{)}}{\textit{Area of habitable spaces (m}^2\textit{)}} \times 100$$

To show this compliance, the key steps and submittals are:

a. Daylit area should be calculated for each floor as per the methodology as described in “Part IV: Calculation method with example for Daylighting” of this document.

b. Provide a 1:100 scale floor plan drawing (a separate architectural plan) showing the daylit area on each floor.

c. Prepare a summary table with the details of daylight area and habitable area, with an overall daylit area percentage.

5. Weather Shade

This provision is mainly to protect the building from the heat as well to provide basic protection from the rain.

- A minimum 450 mm of horizontal shade is mandatory on East, South and West façade.
- For warm temperate climate, it is recommended that vertical fins are provided on East and West façade.
- For warm temperate climate, it is recommended that the external movable shading system are provided on East, South and West façade.
- Submit the drawing showing the details of all the fixed shading and other shading devices used in the building.

B. RENEWABLE ENERGY (RE) MEASURES

This provision is mainly to recognize and promote (currently, not mandatory) the use of renewable energy in buildings.

- Solar water heating, if used in the buildings, should be submitted with the key details of the system. This includes, type of collector, area (in m^2), capacity (in liters per day), etc.
- Solar based heating and cooling, if used in the buildings, should be submitted with the key details of the system. This includes, type of solar collector, collector area (in m2), application (heating/cooling/both), conditioned area through solar (in m^2), etc.

PART

II

User manual for the U-value calculation tool

USER MANUAL FOR THE U-VALUE CALCULATION TOOL

- This manual provides a step-by step process for effectively using the “U-value Calculator_v5 .xlsx” Excel file to determine the U-Value (overall heat transfer coefficient) of walls and roofs of building envelope components. Understanding and accurately calculating U-values is fundamental for assessing the thermal performance of building envelopes.
- Through this tool, the U-Value calculation can only be done for the wall/roof assembly.
- All the input value should be in a metric system.
- This will be required for the design requirement, EE Measure, Building Envelope: Wall and Roof, S.N. 1.1 and 2.1.

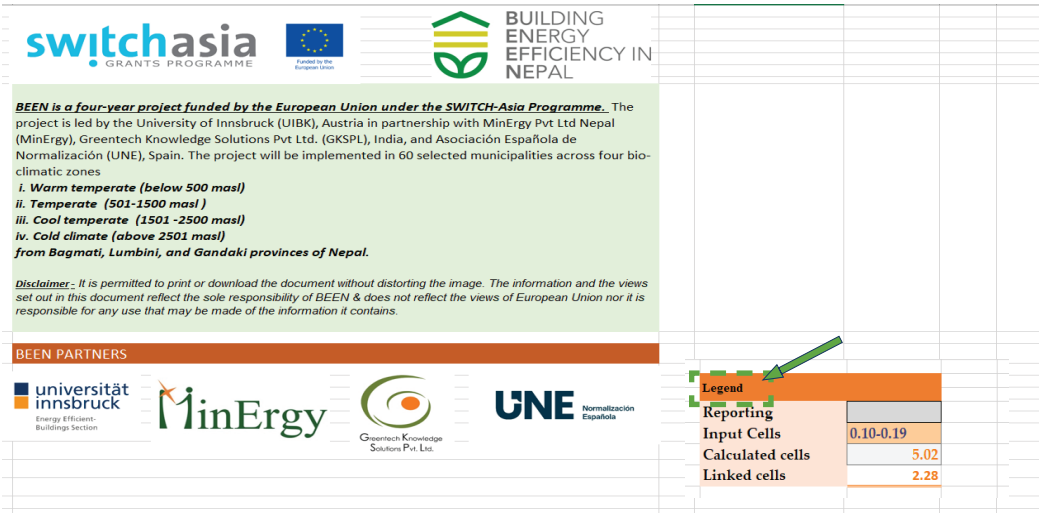
Step 1: Understand the Project Context and Tool Conventions (Info.Sheet)

Before beginning the calculation of U-values, it's essential to get familiarized with the tool's background and how to interpret its data.

- **Project Overview:**
  - Open the Info. sheet. This sheet contains important contextual information about the "BEEN" project, including its funding from the European Union under the SWITCH-Asia Programme, and its key partners (University of Innsbruck (UIBK), MinErgy Pvt. Ltd. Nepal (MinErgy), Greentech Knowledge Solutions Pvt. Ltd. (GKSPL), and Asociación Española de Normalización (UNE)).
  - It specifies that the project is implemented in 60 selected municipalities across four distinct bio-climatic zones in Nepal:
    - Warm temperate (below 500 masl)
    - Temperate (501-1500 masl)
    - Cool temperate (1501 -2500 masl)
    - Cold climate (above 2501 masl)
  - Understanding which climatic zone, the proposed project falls into is crucial as it directly impacts the thermal resistances (R-values) used in calculations, particularly for surface resistances.

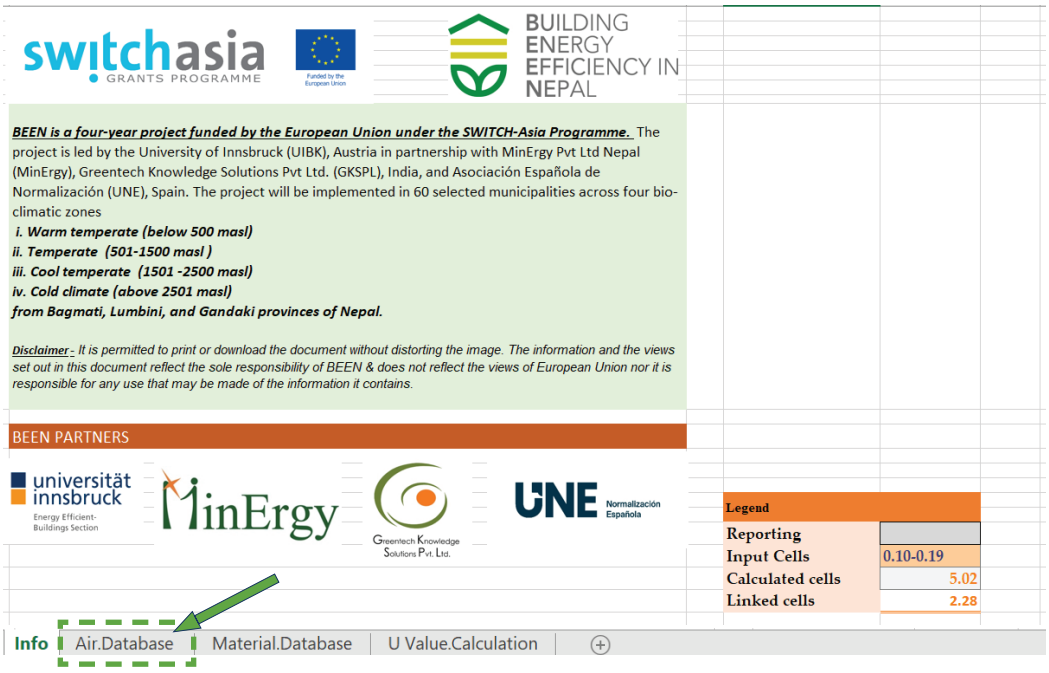
Legend for Cell Types:

- Locate the "Legend" section on this sheet. This legend explains the color-coding system used throughout the Excel workbook, which is vital for proper interaction:



- **Reporting Cells:** These cells are intended solely for data collection purposes. Users should enter the required information in these cells if it is known. If the information is not available, the cells can be left blank. Please note that the inputs in these cells are not used for any calculations.
- **Input Cells:** These are the cells where users are expected to manually enter or select data. These cells are shaded/highlighted with orange color with black text.
- **Calculated Cells:** These cells contain formulas and automatically display results derived from user inputs. Do not attempt to manually edit these cells, as it could disrupt the formulas and lead to incorrect calculations.
- **Linked Cells:** These cells automatically pull data from other sheets or sections within the workbook, ensuring consistency. Similar to calculated cells, user should not manually edit linked cells.

Step 2: Understand Air Layer Properties (Air.Database Sheet)



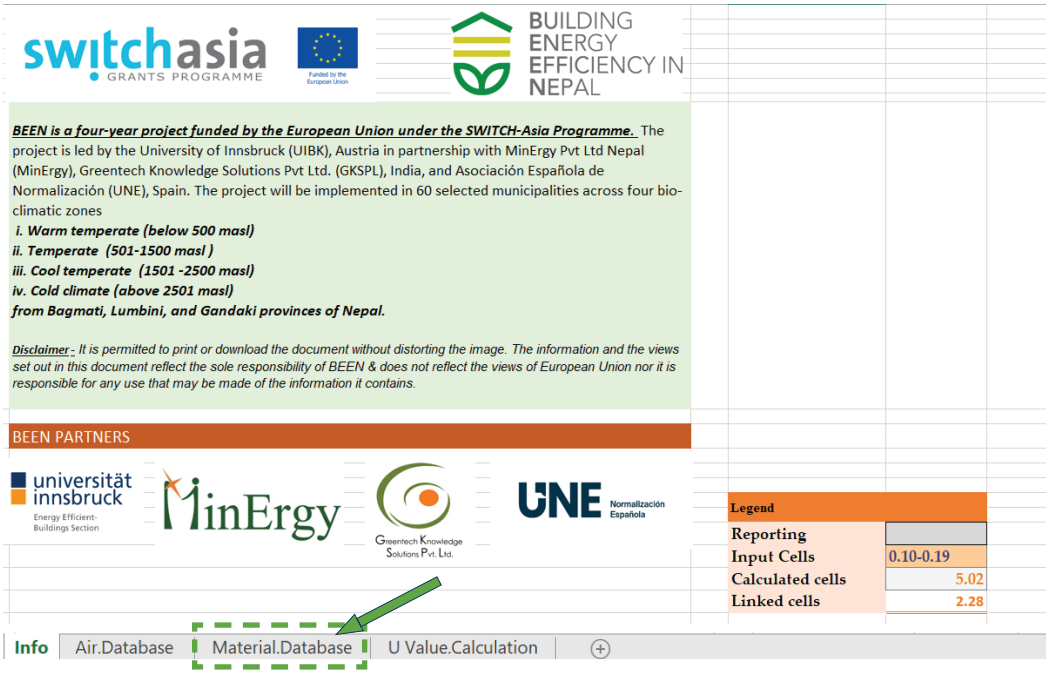
Air layers (e.g., air gaps within walls or roofs) and surface resistances play a significant role in the overall U-value calculation.

- **Surface Resistances (R_{si}, R_{se}):**
  - Go to the Air.Database sheet.
  - The top section of this sheet provides Rsi (internal surface resistance) and Rse (external surface resistance) values for different Envelope Component types (e.g., Wall, Roof) and Climatic Zone combinations (e.g., "Wall, Warm Temperate and Temperate," "Roof, Cool Temperate and Cold").
  - These values account for the thermal resistance of the air films at the interior and exterior surfaces of the building component. The tool will automatically select the appropriate Rsi and Rse values based on the user inputs of component type and climatic zone.
- **Air Layer Resistances:**
  - Further down the sheet, user will find a list of specific Air Layer types with various thicknesses (t in mm) and their corresponding R (thermal resistance in m^2.K/W) values (e.g., "Air Layer-5 mm Wall Warm Temperate and Temperate").
  - These values represent the thermal resistance of enclosed air gaps. User will select these from a dropdown when adding air layers to building component in the U Value.Calculation sheet.

***Refer to Annex 1 for Air Data Base**

Step 3: Familiarize with the Material Database (Material.Database Sheet)

This sheet serves as a repository for the thermal properties of various common building materials.



- **Material Properties:**

  a. Navigate to the Material.Database sheet.

  b. User will find a comprehensive list of materials. Each material entry typically includes the following properties:

  c. **Index:** A unique identifier or name for the material (e.g., "Aerated autoclaved concrete (AAC) block, Density-642 kg/m^3", "Cement mortar, Density-1648 kg/m^3").

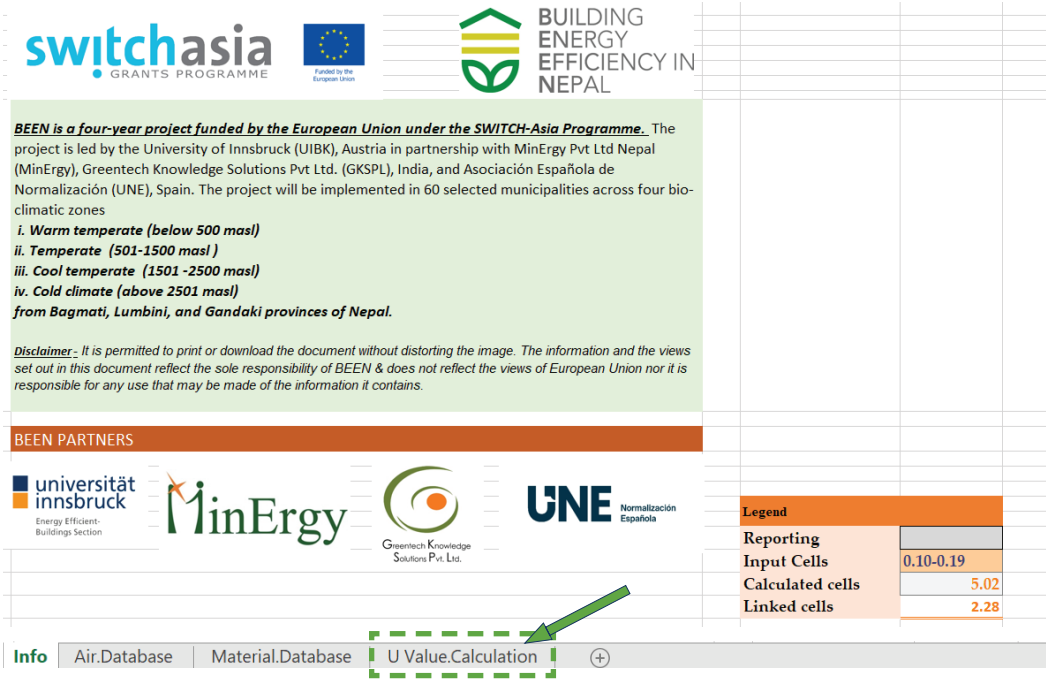
  d. **Density (kg/m^3):** The material's density, indicating its mass per unit volume.

  e. **Thermal Conductivity (W/m.K):** This is a crucial property, representing how well the material conducts heat. A lower value indicates better insulation.

***Refer to Annex 2 for Material Data Base**

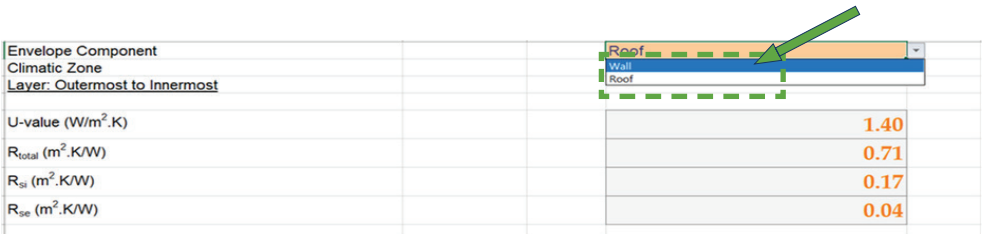
Step 4: Perform U-value Calculation (U Value.Calculation Sheet)

This is the main sheet where user will define user building component's layers and calculate its U-value.

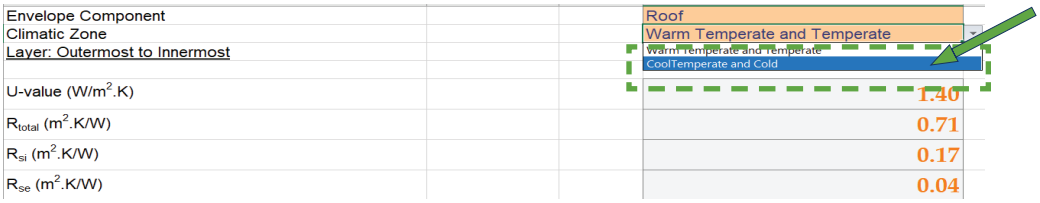


Define Component and Climatic Zone:

- Open the U Value.Calculation sheet.
- At the top, locate the input cells for:
  - **Envelope Component:** Use a dropdown menu to select the type of building component user are analyzing (e.g., "Wall," "Roof"). This selection will automatically fetch the relevant Rsi and Rse values from the Air.Database sheet.



- **Climate Zone:** Use a dropdown menu to select the specific climatic zone applicable to user project (e.g., "Warm Temperate and Temperate," "CoolTemperate and Cold"). This selection also influences the surface resistances.



Wall/Roof Assembly Layers (Outermost to Innermost):

- Below the component and climatic zone selection, user will find a section to define the layers of user building component, typically listed from the Outermost to Innermost.
- For each layer:
  - **Layer:** Use a dropdown menu to select the material or air layer. Once selected, it will populate the thermal conductivity or R value from the Material.Database sheet.
  - **Thickness (mm):** If user selects a solid material, manually input its thickness in millimeters. If users select an air layer with a predefined thickness (e.g., "Air Layer-5 mm"), the thickness will not be required for calculation. However, users can enter the thickness manually.
  - **Thermal Conductivity (W/m.K):** This value will be automatically populated for solid materials based on user Layer selection from the Material.Database. For air layers, the resistance values are given directly in the database, so this column is not applicable/required.
  - **Resistance (m².K/W):** This column will calculate the thermal resistance (R-value) for each individual layer. For solid materials, it's typically Thickness/Thermal Conductivity. For air layers, it's directly obtained from the Air.Database.

Envelope Component			Roof
Climatic Zone			Warm Temperate and Temperate
Layer: Outermost to Innermost			
U-value ($W/m^2.K$)			1.40
R_{total} ($m^2.K/W$)			0.71
R_{si} ($m^2.K/W$)			0.17
R_{se} ($m^2.K/W$)			0.04

Material	Thickness (mm)	k (W/m.K)	R ($m^2.K/W$)
Alluvial clay, Density-1960 kg/m3	230	1.21	0.19
Brick tile, Density-1892 kg/m3	50	0.85	0.06
Bitumen, felt/sheet, Density-1100 kg/m3	25	1.21	0.02
Cast Concrete, Density-2000 kg/m3	50	0.36	0.14
Cellular concrete, Density-704 kg/m3	3	0.23	0.01
Cement mortar, Density-1648 kg/m3	127	1.58	0.08
Cement screed , Density-2100 kg/m3			
Cement plaster, Density-1762 kg/m3			
Reinforced concrete cement (RCC), Density-2288 kg/m3			

Review Calculated U-value:

- Once user have defined all the layers of user component, the tool will automatically calculate and display the results in the following cells:
  - **U-value ($W/m^2.K$):** This is the overall heat transfer coefficient of user defined wall/roof assembly. A lower U-value indicates better insulating properties.
  - **R_{total} ($m^2.K/W$):** This is the total thermal resistance of the entire building component, including all layers and surface resistances. It is the reciprocal of the U-value.
  - **R_{si} ($m^2.K/W$):** The internal surface resistance, pulled from the Air.Database based on user component and climatic zone selection.
  - **R_{se} ($m^2.K/W$):** The external surface resistance, also pulled from the Air.Database.

Envelope Component			Roof
Climatic Zone			Warm Temperate and Temperate
Layer: Outermost to Innermost			
U-value ($W/m^2.K$)			1.40
R_{total} ($m^2.K/W$)			0.71
R_{si} ($m^2.K/W$)			0.17
R_{se} ($m^2.K/W$)			0.04
Material	Thickness (mm)	k (W/m.K)	R ($m^2.K/W$)
Alluvial clay, Density-1960 kg/m3	230	1.21	0.19
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Cement mortar, Density-1648 kg/m3	127	1.58	0.08
Cement screed , Density-2100 kg/m3			
Cement plaster, Density-1762 kg/m3			

By following these detailed steps, users can accurately calculate the U-Value of various building components using the provided Excel tool, aiding in the design of more energy efficient buildings.

- **Iterate and Optimize:** Users can experiment with different materials, thicknesses, and air layers to see how they impact the overall U-value. This allows users to optimize building component's thermal performance to meet specific criteria set for the U-Value of roof and wall in the building permit system for the respective municipalities.

ANNEX 1: Air Database

Index			R_{si}	R_{se}	
Wall, Warm Temperate and Temperate	Wall	Warm Temperate and Temperate	0.13	0.04	
Wall, CoolTemperate and Cold	Wall	CoolTemperate and Cold	0.13	0.04	
Roof, Warm Temperate and Temperate	Roof	Warm Temperate and Temperate	0.17	0.04	
Roof, CoolTemperate and Cold	Roof	CoolTemperate and Cold	0.1	0.04	
			t	R	
Air Layer- 5 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	5	0.11	Air Layer- 5 mm
Air Layer- 7 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	7	0.13	Air Layer- 7 mm
Air Layer- 10 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	10	0.15	Air Layer- 10 mm
Air Layer- 15 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	15	0.17	Air Layer- 15 mm
Air Layer- 25 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	25	0.18	Air Layer- 25 mm
Air Layer- 50 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	50	0.18	Air Layer- 50 mm
Air Layer- 100 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	100	0.18	Air Layer- 100 mm
Air Layer- 300 mmWallWarm Temperate and Temperate	Wall	Warm Temperate and Temperate	300	0.18	Air Layer- 300 mm
Air Layer- 5 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	5	0.11	Air Layer- 5 mm
Air Layer- 7 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	7	0.13	Air Layer- 7 mm
Air Layer- 10 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	10	0.15	Air Layer- 10 mm
Air Layer- 15 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	15	0.17	Air Layer- 15 mm
Air Layer- 25 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	25	0.18	Air Layer- 25 mm
Air Layer- 50 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	50	0.18	Air Layer- 50 mm
Air Layer- 100 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	100	0.18	Air Layer- 100 mm
Air Layer- 300 mmWallCoolTemperate and Cold	Wall	CoolTemperate and Cold	300	0.18	Air Layer- 300 mm
Air Layer- 5 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	5	0.11	Air Layer- 5 mm
Air Layer- 7 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	7	0.13	Air Layer- 7 mm
Air Layer- 10 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	10	0.15	Air Layer- 10 mm
Air Layer- 15 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	15	0.17	Air Layer- 15 mm
Air Layer- 25 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	25	0.19	Air Layer- 25 mm
Air Layer- 50 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	50	0.21	Air Layer- 50 mm
Air Layer- 100 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	100	0.22	Air Layer- 100 mm
Air Layer- 300 mmRoofWarm Temperate and Temperate	Roof	Warm Temperate and Temperate	300	0.23	Air Layer- 300 mm
Air Layer- 5 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	5	0.11	Air Layer- 5 mm
Air Layer- 7 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	7	0.13	Air Layer- 7 mm
Air Layer- 10 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	10	0.15	Air Layer- 10 mm
Air Layer- 15 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	15	0.16	Air Layer- 15 mm
Air Layer- 25 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	25	0.16	Air Layer- 25 mm
Air Layer- 50 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	50	0.16	Air Layer- 50 mm
Air Layer- 100 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	100	0.16	Air Layer- 100 mm
Air Layer- 300 mmRoofCoolTemperate and Cold	Roof	CoolTemperate and Cold	300	0.16	Air Layer- 300 mm

ANNEX 2: Material Database

Index	Index		(kg/m3)	Conductivity (W/m.K)	Specific Heat (kJ/kg.K)	(m2.K/W)
AC sheet, Density-1520 kg/m3	AC sheet, Density-1520 kg/m3	AC sheet	1520	0.245	0.84	
Aerated autoclaved concrete (AAC) block, Density	Aerated autoclaved concrete (AAC) block, Density-642 kg/m3	Aerated autoclaved concrete (AAC) block	642	0.184	1.24	
Asbestos mill board, Density-1397 kg/m3	Asbestos mill board, Density-1397 kg/m3	Asbestos mill board	1397	0.249	0.84	
Alluvial clay, Density-1960 kg/m3	Alluvial clay, Density-1960 kg/m3	Alluvial clay	1960	1.210	0.84	
Brick tile, Density-1892 kg/m3	Brick tile, Density-1892 kg/m3	Brick tile	1892	0.798	0.88	
Bitumen, felt/sheet, Density-1100 kg/m3	Bitumen, felt/sheet, Density-1100 kg/m3	Bitumen, felt/sheet	1100	0.230	1	
Cast Concrete, Density-2000 kg/m3	Cast Concrete, Density-2000 kg/m3	Cast Concrete	2000	1.130	1	
Cellular concrete, Density-704 kg/m3	Cellular concrete, Density-704 kg/m3	Cellular concrete	704	0.188	1.05	
Cement mortar, Density-1648 kg/m3	Cement mortar, Density-1648 kg/m3	Cement mortar	1648	0.719	0.92	
Cement screed , Density-2100 kg/m3	Cement screed , Density-2100 kg/m3	Cement screed	2100	1.400	0.65	
Cement plaster, Density-1762 kg/m3	Cement plaster, Density-1762 kg/m3	Cement plaster	1762	0.721	0.84	
Cement stabilized soil block (CSEB), Density-1700	Cement stabilized soil block (CSEB), Density-1700 kg/m3	Cement stabilized soil block (CSEB)	1700	1.026	1.03	
Cement stabilized soil block (CSEB), Density-1800	Cement stabilized soil block (CSEB), Density-1800 kg/m3	Cement stabilized soil block (CSEB)	1800	1.201	1.07	
Cement stabilized soil block (CSEB), Density-1900	Cement stabilized soil block (CSEB), Density-1900 kg/m3	Cement stabilized soil block (CSEB)	1900	1.303	1.07	
Chip board (perforated), Density-352 kg/m3	Chip board (perforated), Density-352 kg/m3	Chip board (perforated)	352	0.066	1.26	
Chip board, Density-432 kg/m3	Chip board, Density-432 kg/m3	Chip board	432	0.067	1.26	
Clay Tiles, Density-2000 kg/m3	Clay Tiles, Density-2000 kg/m3	Clay Tiles	2000	1.000	0.8	
Ceramic Tiles, Density-1900 kg/m3	Ceramic Tiles, Density-1900 kg/m3	Ceramic Tiles	1900	0.850	0.84	
Closed cell flexible elastomeric foam- NBR, Densit	Closed cell flexible elastomeric foam- NBR, Density-40-55 kg/m3	Closed cell flexible elastomeric foam- NBR	40-55	0.043	1.2	
Coconut pith insulation board, Density-520 kg/m3	Coconut pith insulation board, Density-520 kg/m3	Coconut pith insulation board	520	0.060	1.09	
Coir board, Density-97 kg/m3	Coir board, Density-97 kg/m3	Coir board	97	0.038	1	
Cork slab, Density-164 kg/m3	Cork slab, Density-164 kg/m3	Cork slab	164	0.043	0.96	
Cork slab, Density-192 kg/m3	Cork slab, Density-192 kg/m3	Cork slab	192	0.044	0.96	
Cork slab, Density-304 kg/m3	Cork slab, Density-304 kg/m3	Cork slab	304	0.055	0.96	
Dense concrete, Density-2410 kg/m3	Dense concrete, Density-2410 kg/m3	Dense concrete	2410	1.740	0.88	
Exfoliated vermiculite (loose), Density-264 kg/m3	Exfoliated vermiculite (loose), Density-264 kg/m3	Exfoliated vermiculite (loose)	264	0.069	0.88	
Expanded polystyrene, Density-16 kg/m3	Expanded polystyrene, Density-16 kg/m3	Expanded polystyrene	16	0.038	134	
Expanded polystyrene, Density-24 kg/m3	Expanded polystyrene, Density-24 kg/m3	Expanded polystyrene	24	0.035	134	
Expanded polystyrene, Density-34 kg/m3	Expanded polystyrene, Density-34 kg/m3	Expanded polystyrene	34	0.035	134	
Fly ash brick, Density-1650 kg/m3	Fly ash brick, Density-1650 kg/m3	Fly ash brick	1650	0.856	0.93	
Foam concrete, Density-320 kg/m3	Foam concrete, Density-320 kg/m3	Foam concrete	320	0.070	0.92	
Foam concrete, Density-400 kg/m3	Foam concrete, Density-400 kg/m3	Foam concrete	400	0.084	0.92	
Foam concrete, Density-704 kg/m3	Foam concrete, Density-704 kg/m3	Foam concrete	704	0.149	0.92	
Foam glass, Density-1270 kg/m3	Foam glass, Density-1270 kg/m3	Foam glass	1270	0.056	0.75	
Foam glass, Density-160 kg/m3	Foam glass, Density-160 kg/m3	Foam glass	160	0.055	0.75	
GI sheet, Density-7520 kg/m3	GI sheet, Density-7520 kg/m3	GI sheet	7520	61.060	0.5	

Index	Index		(kg/m3)	Conductivity (W/m.K)	Specific Heat (kJ/kg.K)	(m2.K/W)
Glass wool (unbonded), Density-189 kg/m3	Glass wool (unbonded), Density-189 kg/m3	Glass wool (unbonded)	189	0.040	0.92	
Glass wool (unbonded), Density-69 kg/m3	Glass wool (unbonded), Density-69 kg/m3	Glass wool (unbonded)	69	0.043	0.92	
Glass wool , Density-69 kg/m3	Glass wool , Density-69 kg/m3	Glass wool	69	0.043	0.92	
Glass wool, Density-189 kg/m3	Glass wool, Density-189 kg/m3	Glass wool	189	0.040	0.92	
Glass, Density-2350 kg/m3	Glass, Density-2350 kg/m3	Glass	2350	0.814	0.88	
Gravel -Loose fill, Density-1840 kg/m3	Gravel -Loose fill, Density-1840 kg/m3	Gravel -Loose fill	1840	0.360	0.84	
Gypsum plaster, Density-1120 kg/m3	Gypsum plaster, Density-1120 kg/m3	Gypsum plaster	1120	0.512	0.96	
Hard board, Density-979 kg/m3	Hard board, Density-979 kg/m3	Hard board	979	0.279	142	
Hollow Concrete Block (lightweight), Density-880 k	Hollow Concrete Block (lightweight), Density-880 kg/m3	Hollow Concrete Block (lightweight)	880	0.480	0.84	
Hollow Concrete Block (mediumweight), Density-1	Hollow Concrete Block (mediumweight), Density-1040 kg/m3	Hollow Concrete Block (mediumweight)	1040	0.620	0.84	
Jute felt, Density-291 kg/m3	Jute felt, Density-291 kg/m3	Jute felt	291	0.042	0.88	
Jute fibre, Density-329 kg/m3	Jute fibre, Density-329 kg/m3	Jute fibre	329	0.067	1.09	
Lime concrete, Density-1646 kg/m3	Lime concrete, Density-1646 kg/m3	Lime concrete	1646	0.730	0.88	
Lime Plaster, Density-1750 kg/m3	Lime Plaster, Density-1750 kg/m3	Lime Plaster	1750	0.800	0.84	
Mineral wool (unbonded), Density-73.5 kg/m3	Mineral wool (unbonded), Density-73.5 kg/m3	Mineral wool (unbonded)	73.5	0.030	0.92	
Mineralwool, Density-73.5 kg/m3	Mineralwool, Density-73.5 kg/m3	Mineralwool	73.5	0.030	0.92	
Mud Phuska, Density-1622 kg/m3	Mud Phuska, Density-1622 kg/m3	Mud Phuska	1622	0.519	0.88	
Mud Plaster, Density-1600 kg/m3	Mud Plaster, Density-1600 kg/m3	Mud Plaster	1600	0.700	1	
Particle board, Density-750 kg/m3	Particle board, Density-750 kg/m3	Particle board	750	0.098	1.3	
PE Foam (Black Foam), Density-27.5 kg/m3	PE Foam (Black Foam), Density-27.5 kg/m3	PE Foam (Black Foam)	27.5	0.040	1.6	
Plywood, Density-640 kg/m3	Plywood, Density-640 kg/m3	Plywood	640	0.174	1.76	
PU Foam Insulation, Density-45 kg/m3	PU Foam Insulation, Density-45 kg/m3	PU Foam Insulation	45	0.025	1.4	
PVC Cladding , Density-1400 kg/m3	PVC Cladding , Density-1400 kg/m3	PVC Cladding	1400	0.190	0.9	
Reinforced concrete cement (RCC), Density-2288 k	Reinforced concrete cement (RCC), Density-2288 kg/m3	Reinforced concrete cement (RCC)	2288	1.580	0.88	
Resin bonded mineral wool, Density-16 kg/m3	Resin bonded mineral wool, Density-16 kg/m3	Resin bonded mineral wool	16	0.040	1	
Resin bonded mineral wool, Density-24 kg/m3	Resin bonded mineral wool, Density-24 kg/m3	Resin bonded mineral wool	24	0.036	1	
Resin bonded mineral wool, Density-48 kg/m3	Resin bonded mineral wool, Density-48 kg/m3	Resin bonded mineral wool	48	0.042	1	
Resin bonded mineral wool, Density-64 kg/m3	Resin bonded mineral wool, Density-64 kg/m3	Resin bonded mineral wool	64	0.038	1	
Resin bonded mineral wool, Density-99 kg/m3	Resin bonded mineral wool, Density-99 kg/m3	Resin bonded mineral wool	99	0.036	1	
Resource efficient (hollow) brick, Density-1520 kg	Resource efficient (hollow) brick, Density-1520 kg/m3	Resource efficient (hollow) brick	1520	0.631	0.65	
Rice husk, Density-120 kg/m3	Rice husk, Density-120 kg/m3	Rice husk	120	0.051	1	
Rock wool (unbonded), Density-150 kg/m3	Rock wool (unbonded), Density-150 kg/m3	Rock wool (unbonded)	150	0.043	0.84	
Rock wool (unbonded), Density-92 kg/m3	Rock wool (unbonded), Density-92 kg/m3	Rock wool (unbonded)	92	0.047	0.84	
Rockwool , Density-92 kg/m3	Rockwool , Density-92 kg/m3	Rockwool	92	0.047	0.84	
Rockwool, Density-150 kg/m3	Rockwool, Density-150 kg/m3	Rockwool	150	0.043	0.84	
Saw dust, Density-188 kg/m3	Saw dust, Density-188 kg/m3	Saw dust	188	0.051	1	

Index	Index		(kg/m3)	Conductivity (W/m.K)	Specific Heat (kJ/kg.K)	(m2.K/W)
Soft board, Density-249 kg/m3	Soft board, Density-249 kg/m3	Soft board	249	0.047	1.3	
Soft board, Density-320 kg/m3	Soft board, Density-320 kg/m3	Soft board	320	0.066	1.3	
Solid burnt clay brick, Density-1440 kg/m3	Solid burnt clay brick, Density-1440 kg/m3	Solid burnt clay brick	1440	0.620	NA	
Solid burnt clay brick, Density-1600 kg/m3	Solid burnt clay brick, Density-1600 kg/m3	Solid burnt clay brick	1600	0.740	NA	
Solid burnt clay brick, Density-1760 kg/m3	Solid burnt clay brick, Density-1760 kg/m3	Solid burnt clay brick	1760	0.850	NA	
Solid burnt clay brick, Density-1920 kg/m3	Solid burnt clay brick, Density-1920 kg/m3	Solid burnt clay brick	1920	0.980	0.8	
Solid concrete block 25/50, Density-2427 kg/m3	Solid concrete block 25/50, Density-2427 kg/m3	Solid concrete block 25/50	2427	1.396	0.2	
Solid concrete block 30/60, Density-2349 kg/m3	Solid concrete block 30/60, Density-2349 kg/m3	Solid concrete block 30/60	2349	1.411	0.3	
Stone Cladding, Density-2500 kg/m3	Stone Cladding, Density-2500 kg/m3	Stone Cladding	2500	1.800	0.84	
Stone Masonry, Density-2400 kg/m3	Stone Masonry, Density-2400 kg/m3	Stone Masonry	2400	2.000	0.84	
Straw board, Density-310 kg/m3	Straw board, Density-310 kg/m3	Straw board	310	0.057	1.3	
Strawthatch Insulation, Density-125 kg/m3	Strawthatch Insulation, Density-125 kg/m3	Strawthatch Insulation	125	0.050	1.5	
Tar felt (23 kg/m2), Density- kg/m3	Tar felt (23 kg/m2), Density- kg/m3	Tar felt (23 kg/m2)		0.479	0.88	
Tile Cladding, Density-1900 kg/m3	Tile Cladding, Density-1900 kg/m3	Tile Cladding	1900	1.200	0.84	
Timber, Density-480 kg/m3	Timber, Density-480 kg/m3	Timber	480	0.072	1.68	
Timber, Density-720 kg/m3	Timber, Density-720 kg/m3	Timber	720	0.144	1.68	
Wall board, Density-262 kg/m3	Wall board, Density-262 kg/m3	Wall board	262	0.047	1.26	
Wood wool board (bonded with cement), Density	Wood wool board (bonded with cement), Density-398 kg/m3	Wood wool board (bonded with cement)	398	0.081	1.13	
Wood wool board (bonded with cement), Density	Wood wool board (bonded with cement), Density-674 kg/m3	Wood wool board (bonded with cement)	674	0.108	1.13	
XPS Insulation, Density-35 kg/m3	XPS Insulation, Density-35 kg/m3	XPS Insulation	35	0.035	1.3	

PART

III

USER MANUAL FOR THE BUILDING PERMIT SYSTEM (BPS) TOOL

USER MANUAL FOR THE BUILDING PERMIT SYSTEM (BPS) TOOL

- This guide will walk the user through the process of using the "BPS_Tool_Training_v6.xlsx" Excel file to validate users' building design against the Building Permit System (BPS) checklist from project data to reviewing compliance.
- All the input values should be in the metric system.
- This will be required for the design Requirement, EE Measure, Building Envelope: Fenestration, S.N. 4.1, 4.2, 4.3 and 4.4.
- The BPS tool offers the flexibility to select from eight cardinal orientations. Based on the design submission requirements, four primary orientations[1] (North, South, East, and West) must be considered. Data for other building orientations may be entered as applicable.

Step 1: Understand the Project Context and Tool Legend (Info.Sheet)

Before user begin inputting data, it's crucial to understand the foundational information and the tool's conventions.

- **Project Overview:**
  - Navigate to the Info. sheet.This sheet provides essential background about the "BEEN" project.

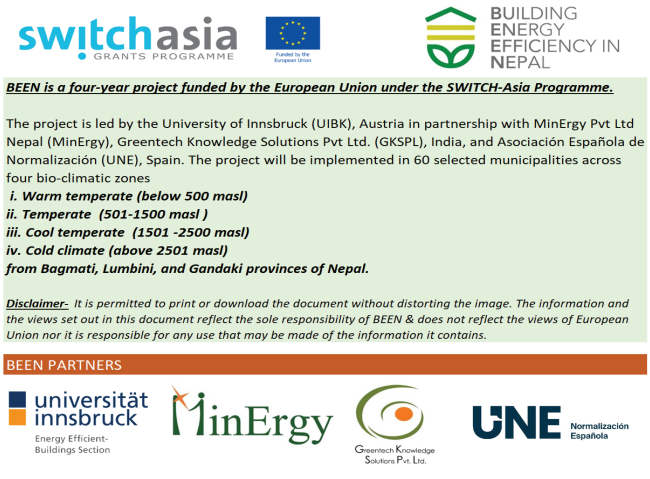
[1] The four orientations must be considered with a range of 90 degree (± 45 degree).
E.g. Any orientation facing (North -45) to (North + 45) degree would be considered as North.

- It specifies the project's implementation scope, highlighting the four bio-climatic zones in Nepal where it is applicable: Warm temperate, Temperate, Cool temperate, and Cold climate. Understanding which zone the project falls into is important as it may influence specific BPS criteria.

Legend for Cell Types:

Pay close attention to the "Legend" section on this sheet. This legend explains the color-coding used throughout the Excel workbook, which is vital for distinguishing between different cell types:

- **Reporting Cells:** These cells are intended solely for data collection purposes. Users should enter the required information in these cells if it is known. If the information is not available, the cells can be left blank. Please note that the inputs in these cells are not used for any calculations.
- **Input Cells:** These are the cells where user is expected to manually enter or select data. These cells are shaded/highlighted with orange color with black text.
- **Calculated Cells:** These cells contain formulas and automatically display results derived from user inputs. Do not attempt to manually edit these cells, as it could disrupt the formulas and lead to incorrect calculations.
- **Linked Cells:** These cells automatically pull data from other sheets or sections within the workbook, ensuring consistency. Similar to calculated cells, user should not manually edit linked cells.



Legend	
Reporting	
Input Cells	0.125
Calculated cells	4.00
Linked cells	2.28

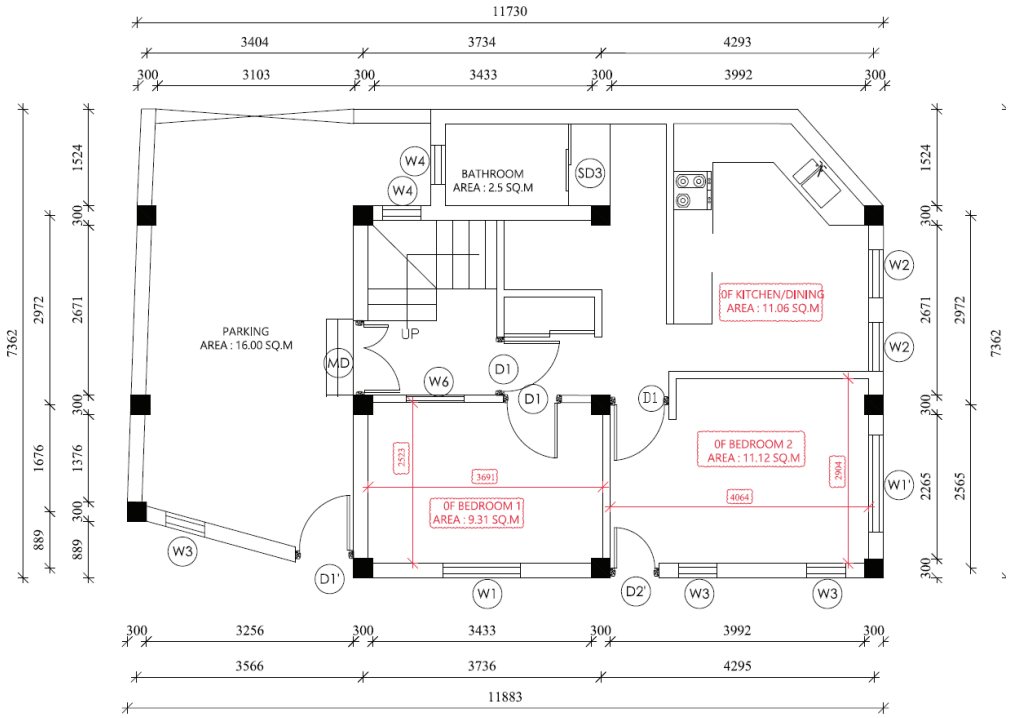
Step 2: Input Space-Wise Area Details (SpaceWise.Area Sheet)

This sheet is where users define the different functional spaces within the building and their respective areas.

- **Data Entry:**
  - Open the SpaceWise.Area sheet.
  - **City:** Enter the name of the city where the building project is located.
  - **Elevation:** Provide the elevation(in meters) of the project site.
  - **Latitude:** Provide the latitude of the project site.
  - **Climatic Zone:** Based on the altitude where your building is located, refer to the Info sheet and select the corresponding climatic zone. (e.g., "Warm Temperate," "Temperate," "Cool Temperate," "Cold Climate"). This selection determines the compliance check for energy efficiency criteria for building permits.

After the basic information is filled in, proceed to fill in the building level data.For each unique space or area type in the building, complete the following columns:

- **Space Nomenclature/Type:** Clearly label each habitable space in the building, such as "Living Room," "Bedroom 1," "Kitchen/Dining," "Study room", etc. Use a consistent naming format — for example, “0F_Bedroom01,” where: “0F” refers to the ground floor, and “Bedroom01” refers to a specific bedroom on that floor.
- **Carpet Area (m²) Type:** Enter the precise usable floor area (excluding walls and structural elements) for each habitable space.



GROUND FLOOR PLAN

For example, the carpet area of Kitchen/Dining on the ground floor (0F Kitchen/Dining) is 11.06 sq.m. For irregular spaces, the total carpet area may be specified; otherwise, the dimensions of the space must be provided as shown in the figure below.

- **Number of Spaces Nomenclature/ Type:** Specify the total number of such spaces in the proposed building.
  - For example, the number of Bedroom1 of the ground floor i.e 0F_Bedroom01, needs to be entered.
  - For typical repetitive spaces on the upper floors, the number of such spaces can be entered accordingly.

- **Total Carpet Area (m²):** This field is typically calculated automatically (Carpet Area × Number of Spaces). **Do not edit this column manually.**

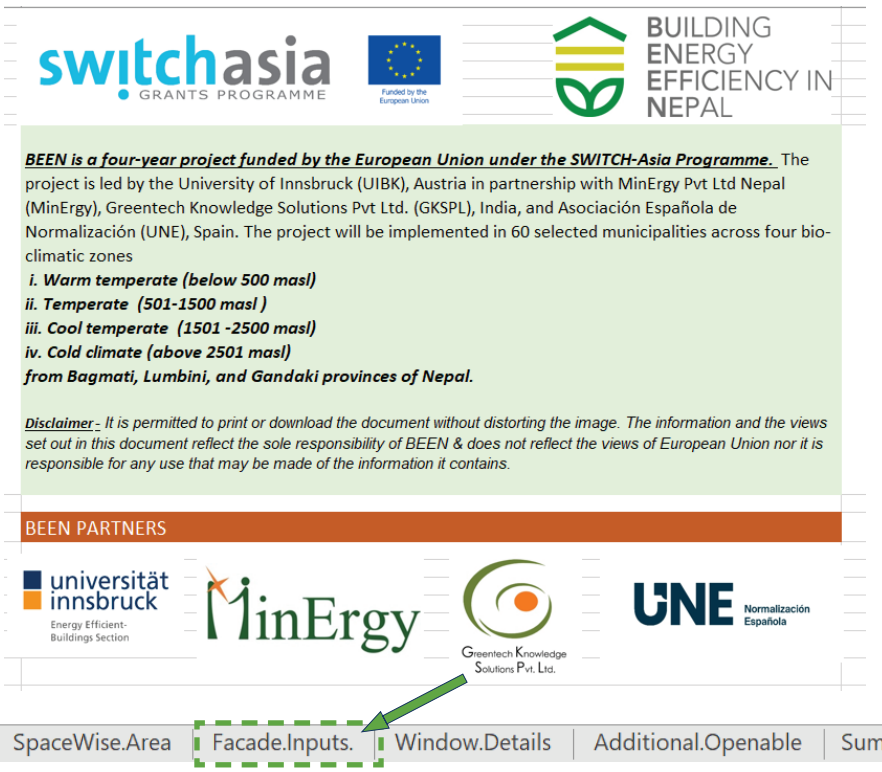
The input parameters in SpaceWise.Area sheet for the habitable spaces of the ground floor plan along with the upper floor spaces of the proposed building is filled below.

	Space Nomenclature/ Type	Carpet Area (m²)	No.	Total Carpet Area (m²)		City	Elevation(m)	Latitude	Climatic.Zone
1	0F Bedroom 1	9.31	1	99.29		Kathmandu	1421	28.6	Temperate
2	0F Bedroom 2	11.12	1						
3	0F Kitchen /Dining	11.06	1						
4	1F Bedroom 1	9.85	1						
5	1F Bedroom 2	9.48	1						
6	1F Bedroom 3	15.98	1						
7	1F Meditation Room	9.85	1						
8	2F Living Room	9.05	1						
9	2F Kitchen/Dining	13.59	1						
10									
11									

Info. | SpaceWise.Area | Facade.Inputs. | Window.Details | Additional.Openable | Summary

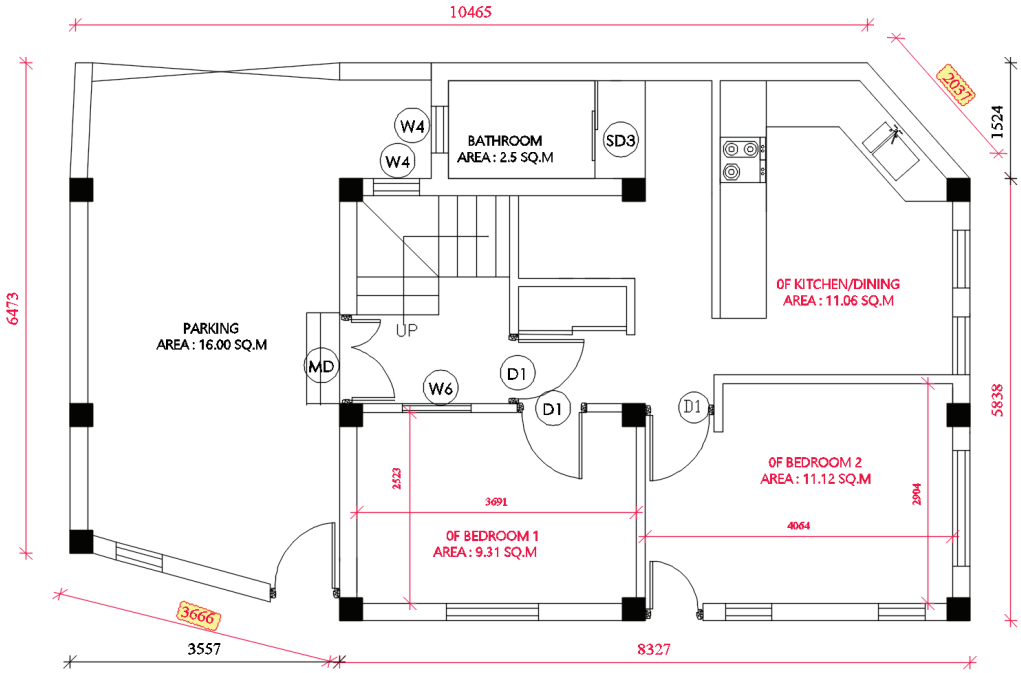
Step 3: Provide Facade Input Details (Facade.Inputs. Sheet)

This sheet captures the geometric information of the building's exterior walls, which is essential for the calculation of the total envelope area.

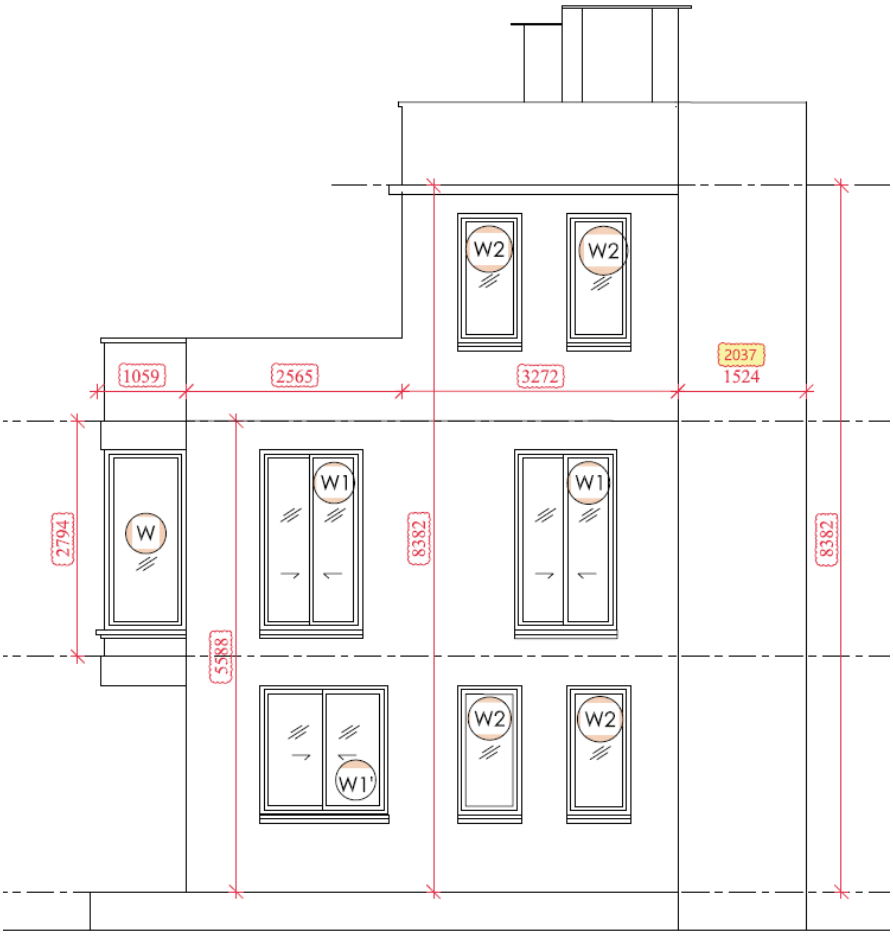


Data Entry:

- Access the Facade.Inputs. sheet.For each primary orientation of building's façade.
- **Orientation:** Specify the direction for each facade which it faces. Four cardinal directions and four non-cardinal directions can be selected from the drop-down menu.
- **Total facade length (m):** Enter the total horizontal length of the facade for that specific orientation. The true length of the wall needs to be taken when the wall is inclined. As shown in the figure below, for the East elevation, the inclined wall length of 2.037 m must be taken, rather than the projected length of 1.524 m.
- **Total facade height (m):** Input the total vertical height of the facade for that specific orientation. The plinth height and the parapet height should not be included. The height difference in the elevation due to the storey difference, needs to be taken separately.
- **Area (m²):** This column will calculate the area of each facade (length x height).
- **Total Envelope Area (m²):** This column will sum up all the facade areas to give the total building envelope area. Do not manually edit these calculated fields.



SOUTH ELEVATION



EAST ELEVATION

The input input parameters in the Facade Inputs for the East and South elevation is filled below. Other façade data needs to be filled with the similar approach.

	Orientation	Total facade length (m)	Total facade height (m)	Area (m2)	Total Envelope Area (m^2)
1	South	3.666	8.382	30.73	162.32
2	South	8.327	8.382	69.80	
3	East	2.037	8.382	17.07	
4	East	3.272	8.382	27.43	
5	East	2.565	5.588	14.33	
6	East	1.059	2.794	2.96	
7	North			0.00	
8	West			0.00	
9				0.00	
10				0.00	
11				0.00	
12				0.00	
13				0.00	
14				0.00	

Step 4: Detail Window and Opening Specifications (Window.Details and Additional.Openable Sheets)

These sheets are critical for providing comprehensive data on all fenestration elements (windows, doors, ventilators), to calculate the WFRop and GFR which significantly impact energy performance.

- **Window Details Data Entry:**

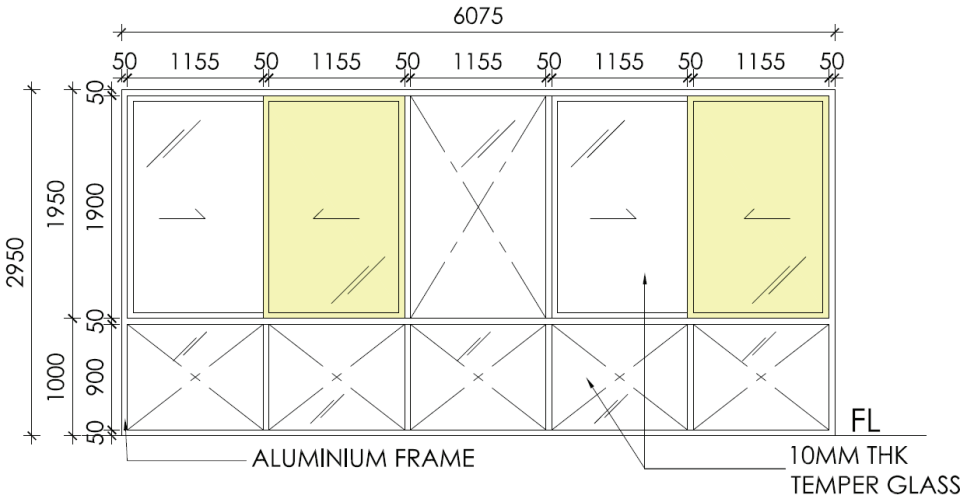
Go to the Window Details sheet to enter details of all the openings, which are directly connected to the ambient.

For every unique window, door, or ventilator type in user design, the following information must be entered in the input cells for further calculations.

1. **Orientation:** Specify the direction the openings.
2. **Opening (Window/ Door/Ventilator) Nomenclature:** Assign a clear identifier (e.g., "W1" for Window Type 1, "D" for Door, "V" for Ventilator).
3. **No of Openings:** Enter the quantity of this specific opening type.
4. **Opening Width (m):** Input the width of the opening.
5. **Opening Height (m):** Input the height of the opening.
6. **Openable Area (%):** Enter the percentage of the total door/ window/ventilator area, which can be opened for ventilation. The openable area of a window in percentage is the ratio of the area that can actually be opened for ventilation to the total area of the window, expressed as a percentage.
    a. For example: In two pane sliding window, the openable percentage is approximately 50%.
    b. In casement window, the openable percentage is approximately 90%.
    c. In fixed window, the openable percentage is 0%.

For any other design of the windows the openable area percentage in the window can be calcualted as:

EXAMPLE 1: TYPICAL WINDOW DETAIL



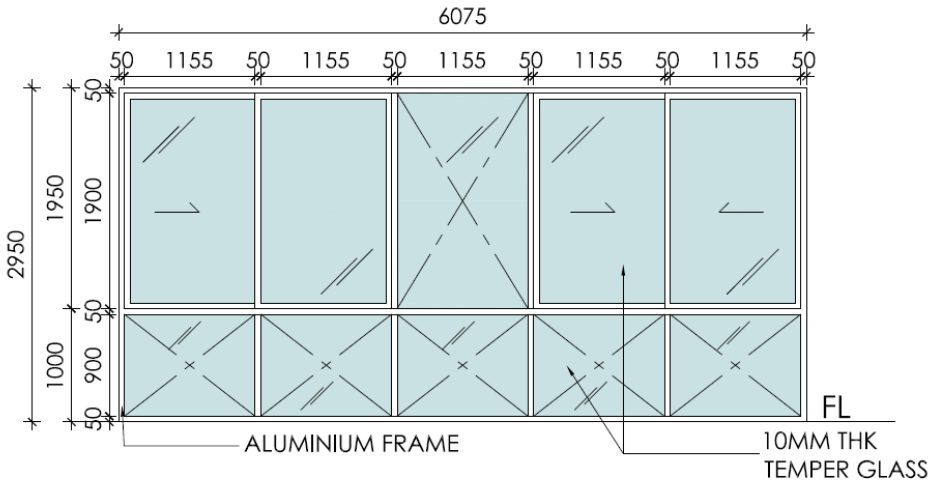
Openable Area (%)

= (Openable Area of Window/Total Area of Window)*100

Openable Area (%) = 2*(1900*1155)/(6075*2950)

= 24.49% ~ 25%

7. **Glass Area in opening (m^2):** The user must input the glass/non opaque area of a single opening.



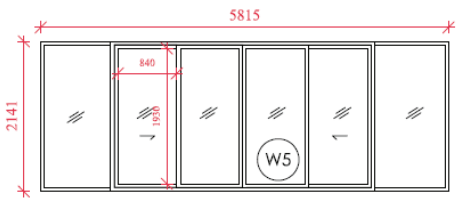
All the glass area in the window should be taken, irrespective of its openability. For the above example, the total glass area is 15.09 m^2.

8. **Define glass properties:** The properties of glass are just for reporting purposes and will not be used in the calculation. The user should input this value for all the windows/door/ventilators where glass is used. The properties that needs be reported are:

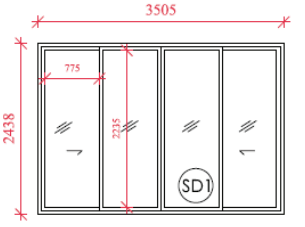
   - **Glass type:** Specify the type of glass used (e.g., "Single Clear Glass," "Double Glazed Low-E"). These are just for reporting purposes and will not be used in the calculation. The user should input this value for all the windows/door/ventilators where glass is used.
   - **Glass U-value ($W/m^2.K$):** Enter the U-value of the glass, which indicates its thermal transmittance (lower is better).
   - **Visible Light Transmittance (VLT):** Input the VLT, representing how much visible light passes through the glass (a value between 0 and 1, higher is better for daylight).
   - **Shading Coefficient (SC):** Enter the SC, which measures the solar heat gain relative to a clear 6mm single pane glass (lower is better for reducing solar gain in warm/hot climate).

Based on these informations the following will be calculated.

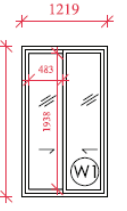
1. **Opening Area (m^2):** Calculated for each opening (width x height).
2. **Total Opening area (m^2):** Calculated as opening area (m^2) multiplied by no. of openings.
4. **Total openable area (m^2):** Calculated based on the opening area (m^2) and openable area (%).
5. **Openable Window to Floor Area ratio (WFR_{op}) will be calculated** in percentage.
6. **Total Glass Area (m^2):** Calculated field for the total glass area of all openings of each type.
7. **Glazing to Floor Area will be calculated** in percentage.
8. **Total opaque area (m^2):** The total opaque area in a door or window refers to the portion of the assembly that is not transparent, usually the solid or non-glazed part.



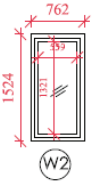
Window 5
26% Openable
Sliding and Fixed
10.51m^2 Glass Area



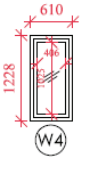
Sliding Door SD1
50% Openable
Sliding and Fixed
6.93 m^2 Glass Area



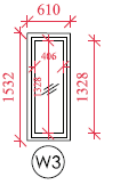
Window 1
50% Openable
Sliding window
1.87 m^2 Glass Area



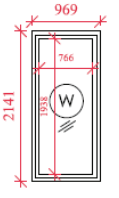
Window 2
90% Openable
Casement window
0.74 m^2 Glass Area



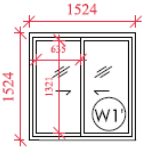
Window 4
90% Openable
Casement window
0.41 m^2 Glass Area



Window 3
90% Openable
Casement window
0.54 m^2 Glass Area

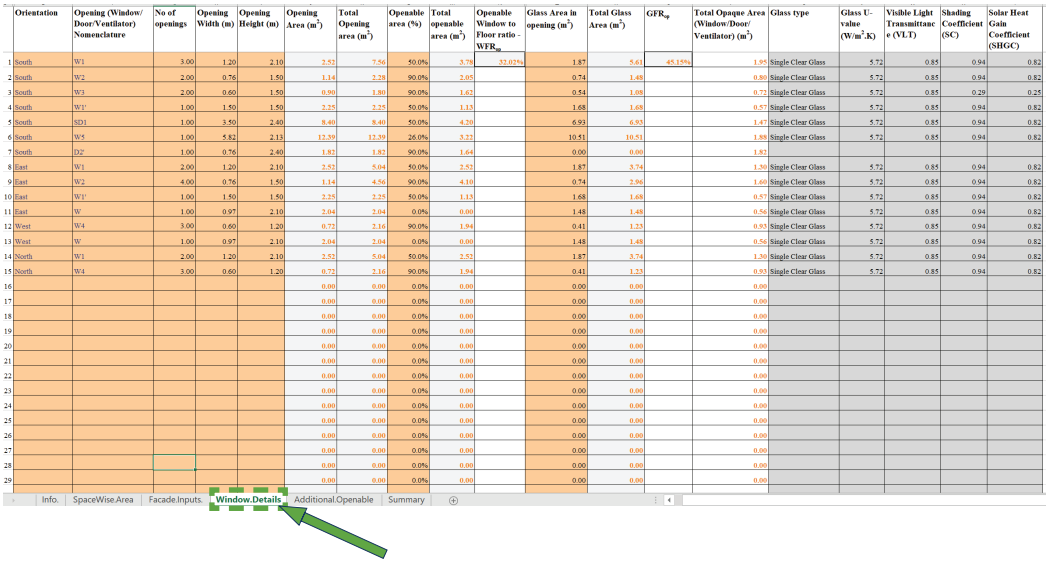


Window
0% Openable
Fixed window
1.48 m^2 Glass Area



Window 1'
50% Openable
Sliding window
1.68 m^2 Glass Area

The input parameters for the Windows.Details sheet for the above opening detail is shown below.



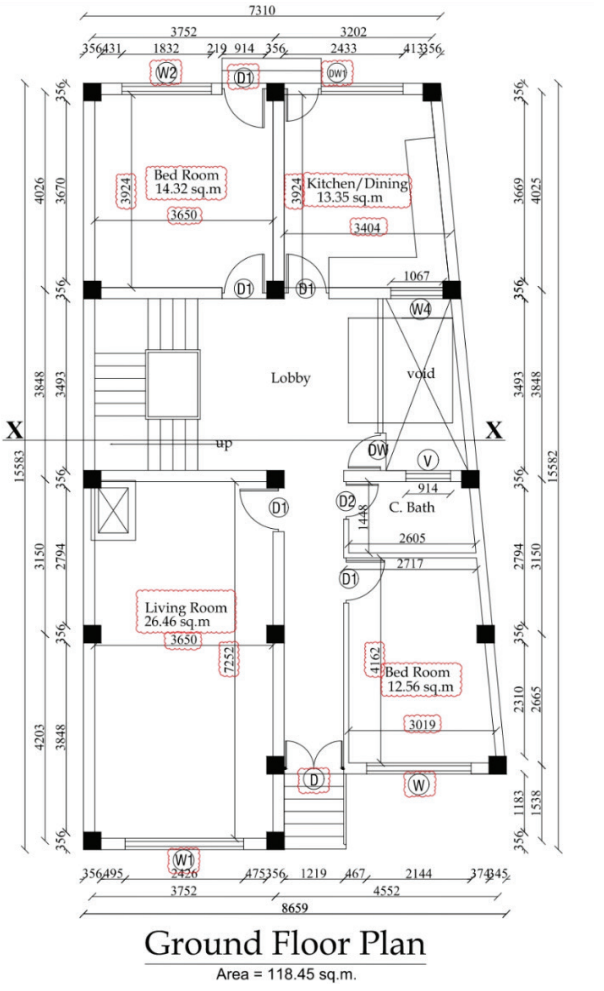
	Orientation	Opening (Window/ Door/Ventilator) Nomenclature	No of openings	Opening Width (m)	Opening Height (m)	Opening Area (m^2)	Total Opening area (m^2)	Openable area (%)	Total openable area (m^2)	Openable Window to Floor ratio - WFR_{op}	Glass Area in opening (m^2)	Total Glass Area (m^2)	GFR_w	Total Opaque Area (Window/Door/ Ventilator) (m^2)	Glass type	Glass U-value ($W/m^2.K$)	Visible Light Transmittance (VLT)	Shading Coefficient (SC)	Solar Heat Gain Coefficient (SHGC)
1	South	W1	3.00	1.20	2.10	2.52	7.56	50.0%	3.78	32.02%	1.87	5.61	45.15%	1.95	Single Clear Glass	5.72	0.85	0.94	0.82
2	South	W2	2.00	0.76	1.50	1.14	2.28	90.0%	2.05		0.74	1.48		0.80	Single Clear Glass	5.72	0.85	0.94	0.82
3	South	W3	2.00	0.60	1.50	0.90	1.80	90.0%	1.62		0.54	1.08		0.72	Single Clear Glass	5.72	0.85	0.29	0.25
4	South	W1'	1.00	1.50	1.50	2.25	2.25	50.0%	1.13		1.68	1.68		0.57	Single Clear Glass	5.72	0.85	0.94	0.82
5	South	SD1	1.00	3.50	2.40	8.40	8.40	50.0%	4.20		6.93	6.93		1.47	Single Clear Glass	5.72	0.85	0.94	0.82
6	South	W5	1.00	5.82	2.13	12.39	12.39	26.0%	3.22		10.51	10.51		1.88	Single Clear Glass	5.72	0.85	0.94	0.82
7	South	D2'	1.00	0.76	2.40	1.82	1.82	90.0%	1.64		0.00	0.00		1.82					
8	East	W1	2.00	1.20	2.10	2.52	5.04	50.0%	2.52		1.87	3.74		1.30	Single Clear Glass	5.72	0.85	0.94	0.82
9	East	W2	4.00	0.76	1.50	1.14	4.56	90.0%	4.10		0.74	2.96		1.60	Single Clear Glass	5.72	0.85	0.94	0.82
10	East	W1'	1.00	1.50	1.50	2.25	2.25	50.0%	1.13		1.68	1.68		0.57	Single Clear Glass	5.72	0.85	0.94	0.82
11	East	W	1.00	0.97	2.10	2.04	2.04	0.0%	0.00		1.48	1.48		0.56	Single Clear Glass	5.72	0.85	0.94	0.82
12	West	W4	3.00	0.60	1.20	0.72	2.16	90.0%	1.94		0.41	1.23		0.93	Single Clear Glass	5.72	0.85	0.94	0.82
13	West	W	1.00	0.97	2.10	2.04	2.04	0.0%	0.00		1.48	1.48		0.56	Single Clear Glass	5.72	0.85	0.94	0.82
14	North	W1	2.00	1.20	2.10	2.52	5.04	50.0%	2.52		1.87	3.74		1.30	Single Clear Glass	5.72	0.85	0.94	0.82
15	North	W4	3.00	0.60	1.20	0.72	2.16	90.0%	1.94		0.41	1.23		0.93	Single Clear Glass	5.72	0.85	0.94	0.82
16						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
17						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
18						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
19						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
20						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
21						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
22						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
23						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
24						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
25						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
26						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
27						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
28						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					
29						0.00	0.00	0.0%	0.00		0.00	0.00		0.00					

Info. | SpaceWise.Area | Facade.Inputs | Window.Details | Additional.Openable | Summary

■ Additional Openable (Supplementary Openings) Sheet Data Entry:

In any floor plan, openings located within void spaces and not visible in external elevations should be entered in this sheet. This includes openings facing shafts or internal corridors that are not seen in the elevation as shown in the figure below.

For each additional opening, the data should be entered in the same format as the window details sheet.



Ground Floor Plan

Area = 118.45 sq.m.

	Opening (Window/Ventilator) Nomenclature	*Opening Width (m)*	*Opening Height (m)*	*Openable area (%)*	*No. of openings*	*Additional Openable Area (m^2)*
1	W4	1.067	1.372	50%	2	1.74
2	V1	0.915	0.61	50%	1	
3						
4						
5						

SpaceWise.Area | Facade.Inputs. | Window.Details | **Additional.Openable** | Summary

For example,the details of window (W4) and the ventilation (V4) of the above samples floor plan is added here.

Step 5: Review the Summary and Compliance (Summary Sheet)

This is the final and most crucial step, where you assess user building's compliance with the BPS checklist criteria.

Compliance Review:

- Navigate to the Summary sheet. This sheet consolidates all user inputs and presents the results of the BPS checklist validation.
- Examine the columns, which typically include:
  - **Criteria:** Lists the specific BPS checklist items criteria or thresholds (e.g., "Openable window-to-floor area ratio (WFRop)", "Glazing-to-floor area ratio (GFR)" and “Window-to-Wall Ratio (WWR) for each façade and corresponding properties of the glass”.
  - **Value:** Displays the calculated value for each criterion based on user inputs.
  - **Compliance:** This critical column will show "YES" if user design meets the BPS requirement for that criterion and "NO" if it does not.

- **Detailed Window Information:** The summary sheet also provides a detailed breakdown of window properties:
  - Uglass (W/m². K), SC, and VLT (%) for different Window Details (e.g., "Single Glazed," "Double Glazed"). This allows for a quick overview of the performance of various glazing types used.

		Criteria	Value	Compliance
Openable window-to-floor area ratio	WFR_{op}	12.50%	30.5%	YES
Glazing-to-floor area ratio	GFR	12.50%	38.3%	YES
$WWR_{oreintation\ wise}$ (If WWR > 40% for any orientation, enter window details for it as per the bye-law, Section 4.3)	North	≤ 40%	6.4%	YES
	North East	≤ 40%	#N/A	#N/A
	East	≤ 40%	23.6%	YES
	South East	≤ 40%	#N/A	#N/A
	South	≤ 40%	18.2%	YES
	South west	≤ 40%	#N/A	#N/A
	West	≤ 40%	5.5%	YES
	North West	≤ 40%	#N/A	#N/A
Window to Wall Ratio	$WWR_{building}$	13.2%		

Window Details

Window type	U_{glass}(W/m².K)	SC	VLT (%)

- **Adjustments:** If any Compliance item shows "NO," you will need to revisit the input sheets (SpaceWise.Area, Facade.Inputs., Window.Details, Additional.Openable) to adjust user design parameters (e.g., reduce window sizes, change glass types, modify facade dimensions) until all critical criteria show "YES."

  For example, if the Window-to-Wall Ratio (WWR) for any elevation exceeds 40%, the compliance status will display “NO”. In such cases, a pop-up alert will appear, prompting the user to choose one of the following two options:
  - **Reduce the WWR** by adjusting the window dimensions in the Window.Details sheet to bring it to 40% or below.
  - **Provide additional glass specifications** - including U-Value, Shading Coefficient (SC), and Visible Light Transmittance (VLT) — as requested in the pop-up.

		Criteria	Value	Compliance
Openable window-to-floor area ratio	WFR_{op}	12.50%	30.5%	YES
Glazing-to-floor area ratio	GFR	12.50%	38.3%	YES
$WWR_{oreintation\ wise}$ (If WWR > 40% for any orientation, enter window details for it as per the bye-law, Section 4.3)	North	≤ 40%	6.4%	YES
	North East	≤ 40%	#N/A	#N/A
	East	≤ 40%	53.0%	NO
	South East	≤ 40%	#N/A	#N/A
	South	≤ 40%	18.2%	YES
	South west	≤ 40%	#N/A	#N/A
	West	≤ 40%	5.5%	YES
	North West	≤ 40%	#N/A	#N/A
Window to Wall Ratio	$WWR_{building}$	13.2%		

Window Details

Window type	U_{glass}(W/m².K)	SC	VLT (%)
	2.8	0.7	

Double Glazed Window (DGU)
Triple Glazed Window (TGU)

By diligently following these steps and ensuring accurate data entry, you can effectively use this Excel tool to validate user building's design against the Building Permit System (BPS) checklist.

PART

IV

CALCULATION METHOD WITH EXAMPLE FOR DAYLIGHTING

CALCULATION METHOD WITH EXAMPLE FOR DAYLIGHTING

This will be required for the design Requirement, EE Measure, Building Envelope: Fenestration, S.N. 4.5. It defines the requirement as “The daylight area of the habitable rooms in the building should be at least 40%.”

To calculate the daylight area, the first step is to understand the Daylight Extension Factors (DEF).

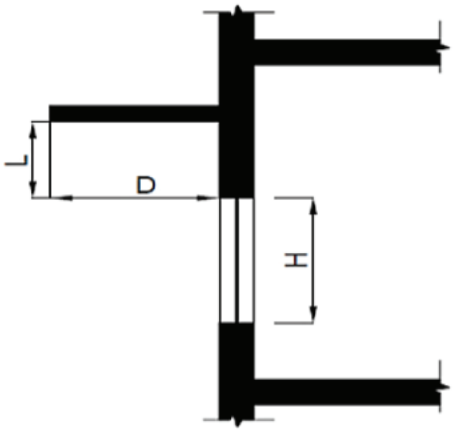
Daylight Extension Factor (DEF): It is a factor to manually calculate the daylight area on floor plates. It is to be multiplied by the head height of the windows. It is dependent on orientation and glazing VLT, shading devices adjacent to it, and building location.

TABLE 1: DAYLIGHT EXTENT FACTORS (DEF) FOR MANUALLY CALCULATING DAYLIGHT AREA. SOURCE/CREDITS: ENERGY CONSERVATION BUILDING CODE 2017, BUREAU OF ENERGY EFFICIENCY (BEE).

Shading	VLT <0.3				VLT ≥ 0.3			
	North	South	East	West	North	South	East	West
No shading or PF < 0.4	2.5	2.0	0.7	0.5	2.8	2.2	1.1	0.7
Shading with, PF ≥ 0.4	2.8	2.3	1.5	1.1	3.0	2.5	1.8	1.5

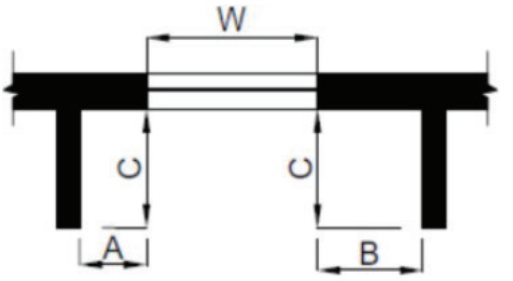
The project factor (PF) can be calculated as:

Projection factor, overhang: It is the ratio of the horizontal depth of the external shading projection to the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection, in consistent units.



Projection factor overhang ($PF_{overhang}$) = D/(H+L)

Projection factor, side fin: It is the ratio of the horizontal depth of the external shading projection to the distance from the window jamb to the farthest point of the external shading projection, in consistent units.



Projection factor Left Fin (PF_{left}) = C/(A+W)

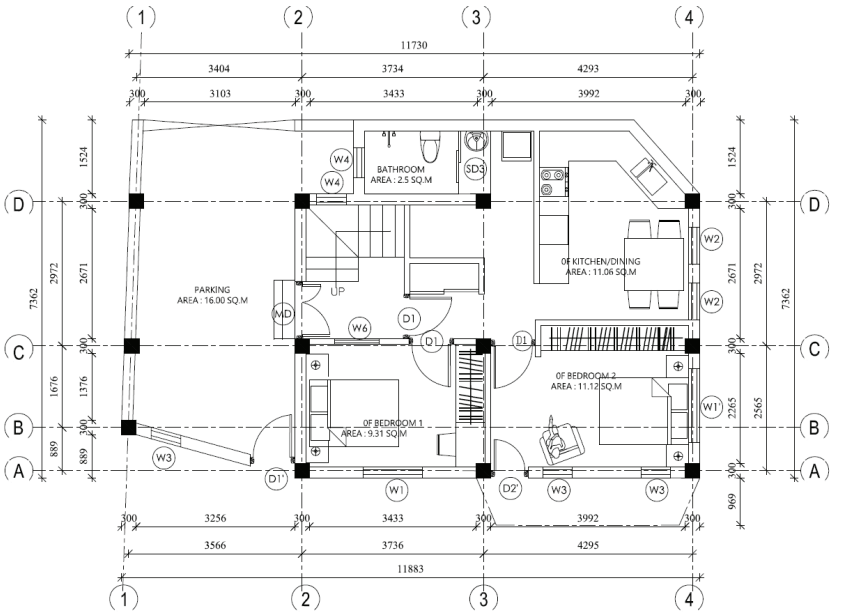
Projection factor Right Fin (PF_{right}) = C/(B+W)

Projection factor, overhang and side fin: Average ratio of projection factor for overhang only and projection factor of side fin only.

Example of Manual Calculation Method

Step 01: Determine the Daylight Extent Factor from table 1 for each orientation.

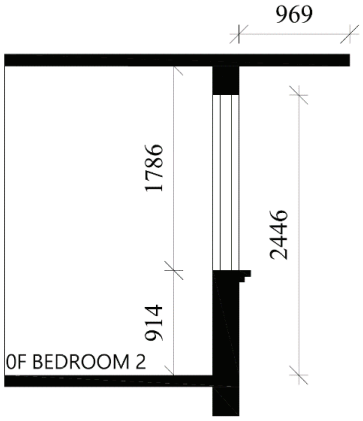
For example: The building is located in Kathmandu, Nepal. The designer has proposed single clear glass having VLT > 0.3. Shading is not provided in the all the windows; thus the projection factor will differ. Based on the projection factor the DEF values will then be selected.



GROUND FLOOR PLAN

For 0F Bedroom 1 and 0F Kitchen/Dining, single clear glass is proposed with no shading, therefore the corresponding DEF values will be:

Shading	VLT ≥ 0.3			
	North	South	East	West
No shading or PF < 0.4	2.8	2.2	1.1	0.7



For 0F Bedroom 2, single clear glass is proposed with a shading of 0.97m of width. Therefore, the projection factor needs to be calculated at first.

Shading	VLT ≥ 0.3			
	North	South	East	West
Shading with, PF ≥ 0.4	3.0	2.5	1.8	1.5

Projection factor overhang ($PF_{overhang}$) = 0.97/1.786

= 0.54

There for the corresponding DEF values will be

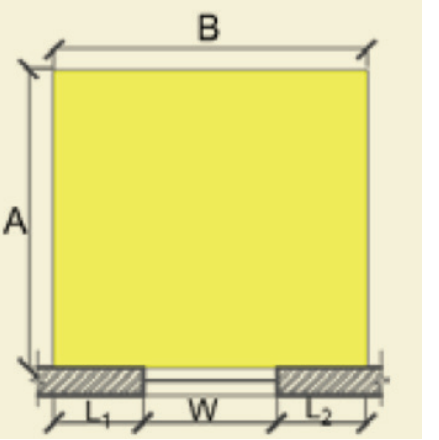
Shading	VLT ≥ 0.3			
	North	South	East	West
Shading with, PF ≥ 0.4	3.0	2.5	1.8	1.5

Step 02: For fenestration clear of any opaque obstructions calculate daylit floor area (A x B).

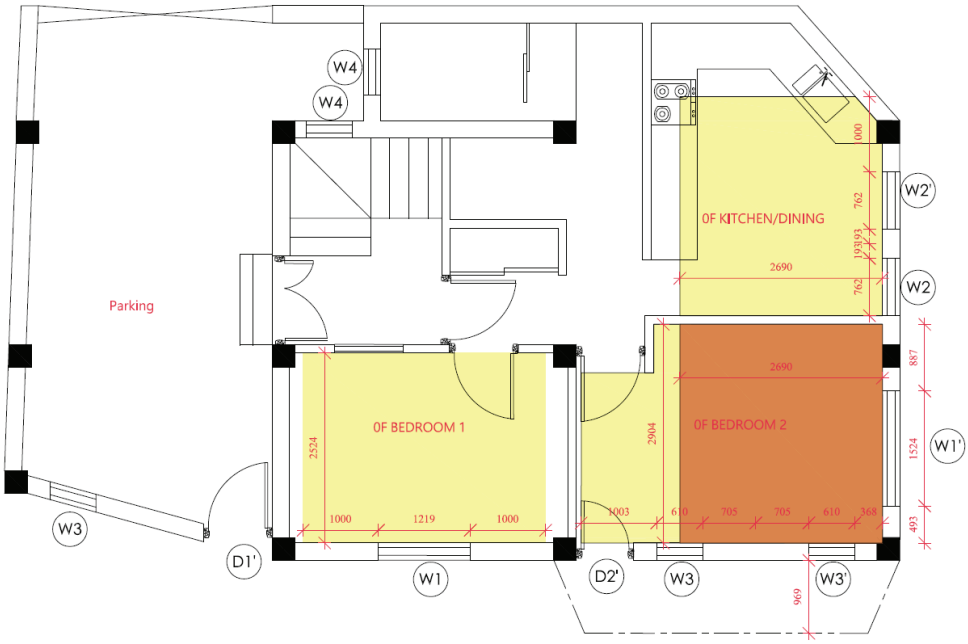
A. In the direction perpendicular to the fenestration, daylit area extends to lintel height of the fenestration multiplied by the daylight extent factor (DEF) or distance till an opaque partition higher than lintel height of the fenestration, whichever is less.

B. In the direction parallel to the fenestration daylit area extends a horizontal dimension equal to the width of the fenestration plus either one meter on each side of the aperture or the distance to an opaque partition of 2m high, or one-half the distance to an adjacent fenestration, whichever is least.

FIGURE 1: CALCULATION OF DAYLIT FLOOR AREA FOR WINDOW WITH NO OPAQUE OBSTRUCTION. SOURCE/ CREDITS: ENERGY CONSERVATION BUILDING CODE 2017, BUREAU OF ENERGY EFFICIENCY (BEE).



Habitable Spaces	Window	Oreintation	VLT	DEF	A =DEF*Lintel Height	B = L1+ W+L2, where L1=L2 = 1m	Daylit Area
0F Bedroom 1	W1	South	≥ 0.3	2.2	= 2.2* 2.446 = 5.38 m Opaque wall at 2.524m, therefore A=2.524m	= 1+1.219+1 = 3.219 m	8.12m^2
0F Bedroom 2	W3	South	≥ 0.3	2.5	= 2.5* 2.446 = 6.11 m Opaque wall at 2.904m, therefore A=2.904m	= 1+0.61+0.705	10.98m^2
	W3'	South		2.5	= 2.5* 2.446 = 6.11 m Opaque wall at 2.904m, therefore A=2.904m	= 0.705+0.61 +0.37 = 1.682 m	
0F Bedroom 2	W1'	East		1.1	= 1.1* 2.446 = 2.69 m	= 0.493+1.524 +0.887 = 2.904 m	7.81m^2
0F Kitchen/ Dining	W2	East		1.1	= 1.1* 2.446 = 2.69 m	= 0.762+0.193 = 0.955 m	7.73m^2
	W2'	East		1.1	= 1.1* 2.446 = 2.69 m	=0.193+0.762+1 =1.955 m	



GROUND FLOOR PLAN

Step 03: For overlapping daylit areas such as in 0F Bedroom 2, the overlapping daylit area from the sum of daylit area (marked in orange) must be substracted.

Step 04: Prepare a summary sheet to sum up all the daylight areas of all the spaces and also sum up the area of all the habitable spaces (Refer to Figure 2). Calculate the overall daylight area for the building, as,

$$\textit{Daylitght area (\%)} = \frac{\textit{Total daylit area in habitable spaces (m}^2\textit{)}}{\textit{Area of habitable spaces (m}^2\textit{)}} \times 100$$

$$= \frac{8.12+10.98+7.73\ (m^2)}{31.49\ (m^2)} \times 100$$

$$= 85\%$$

Documentation Requirement:

a. A separate architectural plan shall be prepared with all daylit areas marked on the floor plans.

b. Summary calculation sheet showing the daylight area percentage.

Sum of Daylit Area of habitable spaces	= (8.12+10.98+7.81+7.72) = 34.63 m^2
Sum of overlapping daylit area	= 7.81 m^2
Total Daylit area in habitable spaces	26.82 m^2

PART

V

COMPLIANCE SUBMISSION (INFORMATION REQUIRED WITH A SAMPLE REPORT)

COMPLIANCE SUBMISSION (INFORMATION REQUIRED WITH A SAMPLE REPORT)

Below is the list of information required for the compliance submittal.

SN	Description	Details to check	Remarks
	Architectural Design Set	All the drawings must be submitted in metric system i.e mm.	
1.	Floor Plan	Include areas for habitable spaces (as per NBC:206,2024), and mark names for external openings (door, window).	As per the current provision of drawing submission
	Elevations	Façade length and height, mark names for external openings (door, window).	
2.	Wall and Roof Section	Along with the building section, sectional details of wall, floor and roof should be provided, with construction assembly and its U-value.	Additional sectional drawings, U-value calculations to be submitted along with architectural set
3.	Windows/ Fenestration/ Opening Schedules	Openings (door, window, ventilation) elevation details mentioning its type, % of openable area, dimension of glazed area along with the tabular format should be provided for the habitable spaces.	Detailed drawings to be submitted along with architectural set and excel calculation.
4.	Reports	Summary report of the EE measures along with daylight compliance, shading details and applied RE-measures.	

Drawing scale for additional EE measures

Section details: 1:20/1:40

Note: If above scale does not comply, submit drawing using reasonable scale as required but the details should be clear.

A sample report is attached below for preparing the submission report for compliance.

... ... Municipality

Detailed Report on Energy Efficient Design of Proposed ... ... Building at ... ... *(Site location)*

Submitted by:

Consultant

... ... Pvt. Ltd.

F/Y ... ... /...

(Place)

Title of the Project:

Construction of … … … … … … (Building type) Building of … … … … … … (Owner/Proponent)

1. Project Introduction:
(Briefly introduce the institution/owner/proponent, if an organization or individual. Mention full address of site location, building parameters, it's importance, project relevance, scope of work and limitations, if any including Designer's TOR under the assignment)
2. Designer:
(Include designer's introduction, corporate and professional registration, VAT/PAN #, authorized representative/ personnel and full contact details)
3. Design Inputs/Parameters:
Climatic Region/Zone: Elevation AMSL: … … … m, Climatic Zone: Cold/Cool Temperate/Temperate/Warm Temperate
4. Building Envelope:
a. External Wall: The information should include details of all types of external walls, specifying the material for each layer and its thickness, along with the calculation of U-value. The preferred method is to show these details using the U-value tool. E.g.

Envelope Component			Wall
Climatic Zone			Warm Temperate and Temperate
Layer: Outermost to Innermost			
U-value ($W/m^2.K$)			0.51
R_{total} ($m^2.K/W$)			1.94
R_{si} ($m^2.K/W$)			0.13
R_{se} ($m^2.K/W$)			0.04
Material	Thickness (mm)	k (W/m.K)	R ($m^2.K/W$)
Cement plaster, Density-1762 kg/m3	12	0.721	0.02
Solid burnt clay brick, Density-1600 kg/m3	115	0.74	0.16
EPS Insulation, Density-24 kg/m3	50	0.035	1.43
Solid burnt clay brick, Density-1600 kg/m3	115	0.74	0.16
Cement plaster, Density-1762 kg/m3	12	0.721	0.02

Alternatively, the calculations should be made manually giving all the details as shown above.

Any insulation material used for external wall – Yes/No?

b. Roof: The information should include details of all types of roof, specifying the material for each layer and its thickness, along with the calculation of U-value.

The preferred method is to show these details using the U-value tool. E.g.

Envelope Component			Roof
Climatic Zone			Warm Temperate and Temperate
Layer: Outermost to Innermost			
U-value ($W/m^2.K$)			0.41
R_{total} ($m^2.K/W$)			2.43
R_{si} ($m^2.K/W$)			0.17
R_{se} ($m^2.K/W$)			0.04
Material	Thickness (mm)	k (W/m.K)	R ($m^2.K/W$)
Brick tile, Density-1892 kg/m3	12	0.798	0.02
Cement mortar, Density-1648 kg/m3	50	0.719	0.07
PU Foam Insulation, Density-45 kg/m3	50	0.025	2.00
Cement mortar, Density-1648 kg/m3	25	0.719	0.03
Reinforced concrete cement (RCC), Density-2288 k	127	1.58	0.08
Gypsum plaster, Density-1120 kg/m3	12	0.512	0.02

Alternatively, the calculations should be made manually giving all the details as shown above.

Any insulation material used for external wall – Yes/No?

c. Ground Floor:

Any insulation material used for external wall – Yes / No?

If yes, specify the material and its thickness.

5. Detail Calculations related to habitable rooms: excel calculations sheet to be provided, (TO be included in below section with windows/ fenestrations)

(These details must be entered into the BPS tool and submitted along with the report.)

a. Typology of Fenestration (All Windows and Doors):

(These details must be entered into the BPS tool and submitted along with the report.)

b. Specification of Glazing Materials:

a. U-Value: … … … … ($W/m^2.K$)

b. Shading Coefficient, … … … SC

c. Visible light transmission, … … … %

(These details must be entered into the BPS tool and submitted along with the report.)

d. Minimum openable area to floor area ratio (WFRop): …%

(Results from BPS tool should be entered here.)

e. Minimum glazed area to floor area ratio (GFR): …%

(Results from BPS tool should be entered here.)

f. Window to wall ratio for each façade:

North:

East:

South:

West:

(Results from BPS tool should be entered here.)

If the WWR is more than 40% for any orientation, specify the glazing specifications:

Orientation:

Uglass ($W/m^2.K$):

SC:

VLT (%):

6. Daylighting: Cumulative daylighting of habitable rooms in the building, %

(The calculations must be done as per Part IV of this toolkit. Attach the drawings with daylight area and compiled excel sheet.)

7. Weather Shade

(The detail of shading is to be defined for each window, orientation-wise.)

a. Horizontal shading:

East:

Window 1: ... mm

Window 2: ... mm

South:

Window 1: ... mm

Window 2: ... mm

West:

Window 1: ... mm

Window 2: ... mm

b. Vertical shading or side fins (For Warm Temperate only), if installed

East:

Window 1: ... mm

Window 2: ... mm

West:

Window 1: ... mm

Window 2: ... mm

c. External Movable Shading System (For Warm Temperate only), if installed

East:

Window 1: Is it installed? Yes / No

Window 2: Is it installed? Yes / No

West:

Window 1: Is it installed? Yes / No

Window 2: Is it installed? Yes / No

South:

Window 1: Is it installed? Yes / No

Window 2: Is it installed? Yes / No

8. Renewable Energy (RE) Systems, if installed (Provide details)

a. Solar water heating

Type of collector: .... (Flat plate/Evacuated Tube/ other)

Collector area: ..... m^2

Capacity: .... liters per day

Primary use: .....

b. Solar based heating and cooling

Type of collector: .... (Flat plate/ Evacuated Tube/Concentrator/ other)

Collector area: .... m^2

Application: heating/cooling/both

Conditioned area through solar: .... m^2

9. Codes/Specifications/Manuals and By-laws followed in the design

The report should also include BPS tool (excel sheet) and below details:

3-D models (at least two different views to cover all four facades)
Diagrams showing daylight coverage in all different floor plans:

BUILDING
ENERGY
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