EN ISO 13790 Standard (2008) Tests for the calculation of energy use for space heating and cooling


1.0 Purpose
This standard is checked in accordance with European Standard EN 15265.

2.0 Input Data (All input data shall be listed and justified)

2.1 Geometry

A base geometry was created for use in all the tests. This used three extruded blocks with a height of 2.8m placed on top of each other. The middle block was a building block with wall thickness 0.01m. All blocks had external dimensions of 5.52m (north and south walls) by 3.62m (west and east walls). This produced a block of internal dimensions 5.5m x 3.6m x 2.8m. The lower and upper blocks were adiabatic component blocks. Adiabatic component blocks were placed on each of north, south and east walls, these had a nominal thickness of 0.01m. A window was placed in the west wall with sill height 0.4m, width 3.5m and height 2.0m. This geometry was used for Tests 5 to 8. For Tests 9 to 12 the upper adiabatic block was removed.
2.2 Constructions

The following constructions were defined at Building Level:

- **External Walls:** Type 1
- **Internal partitions:** Type 2
- **Internal floor:** Type 4f
- **Flat roof:** Type 5

In some of the tests the internal floor was replaced with Type 3f (listed below in Table ?). New materials were created as component layers for these constructions, these are listed below.
## DesignBuilder EN ISO 13790 Test Results

<table>
<thead>
<tr>
<th>Material Name</th>
<th>Conductivity</th>
<th>Specific Heat</th>
<th>Density</th>
<th>Thermal absorptance (emissivity)</th>
<th>Solar/Visible absorptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 15265 acoustic board</td>
<td>0.06</td>
<td>840</td>
<td>400</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 cement floor</td>
<td>1.40</td>
<td>850</td>
<td>2000</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 concrete</td>
<td>2.10</td>
<td>850</td>
<td>2400</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 gypsum plaster</td>
<td>0.21</td>
<td>850</td>
<td>900</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 insulating layer</td>
<td>0.04</td>
<td>850</td>
<td>30</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 internal plastering</td>
<td>0.70</td>
<td>850</td>
<td>1400</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 masonry</td>
<td>0.79</td>
<td>850</td>
<td>1600</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 mineral wool-insulating</td>
<td>0.04</td>
<td>850</td>
<td>50</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 mineral wool (low density)</td>
<td>0.04</td>
<td>850</td>
<td>30</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 outer layer</td>
<td>0.99</td>
<td>850</td>
<td>1800</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 plastic covering</td>
<td>0.23</td>
<td>1500</td>
<td>1500</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>EN 15265 rain protection</td>
<td>0.23</td>
<td>1300</td>
<td>1500</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

The constructions were defined as follows:
DesignBuilder EN ISO 13790 Test Results

Note that infiltration was deselected.

**Openings**
Two Glazing Types were defined for the tests: EN 15265 DP and EN 15265 Shaded DP. The latter being used in the base test 5. Two glass specifications were created for the layers (one for pane and one for shade) and two gas types were defined to achieve the correct gas space resistances:

<table>
<thead>
<tr>
<th>Glass Name</th>
<th>Thickness</th>
<th>Conductivity</th>
<th>Solar Transmittance</th>
<th>Inside/Outside Reflectance</th>
<th>IR Transmittance</th>
<th>Inside/Outside Emissivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 15265 Shade</td>
<td>0.1</td>
<td>0.9</td>
<td>0.20</td>
<td>0.50</td>
<td>0.00</td>
<td>0.90</td>
</tr>
<tr>
<td>EN 15265 Pane</td>
<td>6.0</td>
<td>1.0</td>
<td>0.84</td>
<td>0.08</td>
<td>0.00</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Note that U value was determined by DesignBuilder according to its inbuilt glazing EN 673³ U value.

<table>
<thead>
<tr>
<th>Type 1</th>
<th>outside surface convective heat transfer</th>
<th>coefficient (Wm⁻²K⁻¹)</th>
<th>23.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN 15265 outer layer thickness (m)</td>
<td>0.115</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 insulating layer thickness (m)</td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 masonry thickness (m)</td>
<td>0.175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 internal plastering thickness (m)</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inside surface convective heat transfer</td>
<td>coefficient (Wm⁻²K⁻¹)</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 2</th>
<th>outside surface convective heat transfer</th>
<th>coefficient (Wm⁻²K⁻¹)</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN 15265 gypsum plaster thickness (m)</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 mineral wool (low density) thickness (m)</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 gypsum plaster thickness (m)</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inside surface convective heat transfer</td>
<td>coefficient (Wm⁻²K⁻¹)</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 3f</th>
<th>outside surface convective heat transfer</th>
<th>coefficient (Wm⁻²K⁻¹)</th>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN 15265 concrete thickness (m)</td>
<td>0.180</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 mineral wool-insulating thickness (m)</td>
<td>0.040</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 cement floor thickness (m)</td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 plastic covering thickness (m)</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inside surface convective heat transfer</td>
<td>coefficient (Wm⁻²K⁻¹)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 4f</th>
<th>outside surface convective heat transfer</th>
<th>coefficient (Wm⁻²K⁻¹)</th>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN 15265 acoustic board thickness (m)</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 mineral wool-insulating thickness (m)</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 concrete thickness (m)</td>
<td>0.180</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 mineral wool-insulating thickness (m)</td>
<td>0.040</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 cement floor thickness (m)</td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 plastic covering thickness (m)</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inside surface convective heat transfer</td>
<td>coefficient (Wm⁻²K⁻¹)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 5</th>
<th>outside surface convective heat transfer</th>
<th>coefficient (Wm⁻²K⁻¹)</th>
<th>23.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EN 15265 rain protection thickness (m)</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 mineral wool-insulating thickness (m)</td>
<td>0.080</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 concrete thickness (m)</td>
<td>0.200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inside surface convective heat transfer</td>
<td>coefficient (Wm⁻²K⁻¹)</td>
<td>5.0</td>
</tr>
</tbody>
</table>
DesignBuilder EN ISO 13790 Test Results

calculation. Neither window type was defined as having a reveal or frame.

<table>
<thead>
<tr>
<th>Glazing Name</th>
<th>Layers</th>
<th>U value (EN 673)</th>
<th>g value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 15265 DP</td>
<td>EN 15265 Pane</td>
<td>2.930</td>
<td>0.764</td>
</tr>
<tr>
<td></td>
<td>Air 13.6mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 Pane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN 15265 Shaded DP</td>
<td>EN 15265 Shade</td>
<td>2.372</td>
<td>0.206</td>
</tr>
<tr>
<td></td>
<td>Air 3mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 Pane</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air 13.6mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EN 15265 Pane</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Activity**

Occupancy was set to zero by both setting the occupancy density to zero and schedule to Off. Heating Setpoint was set to 20.0 (with setback of 0.0) and Cooling Setpoint set to 26.0 (with setback of 40.0). The only internal gains were defined as Office Equipment, These were 20.0W/m2 using the general schedule '8:00 – 18:00 Mon – Fri'.

**HVAC**

The zone was defined as heated by a 100% convective system and cooled. The building was mechanically ventilated at a rate of 1ac/hr. Air distribution was set as mixed. Both HVAC systems operated according to the same schedule (08:00 – 18:00 Mon – Fri) as was used for the internal gains.

**Site**

Weather data was extracted from EN 15265 and converted to EnergyPlus weather format. The following data was assigned as specified in that document:

- Dry Bulb Temperature, Direct Normal radiation, Diffuse Horizontal radiation.
- Global Solar Radiation was calculated according to an EnergyPlus internal formula and annual Global West Solar Radiation was checked from output and matched specification to a tolerance of 2.5%.

The following assumptions were made:

- 50% external Relative Humidity
- Air Pressure 99.323kPa
- wind speed 2.5m/s
- wind direction: random
- Latitude 48.80N
- Longitude 2
- Surface Solar Reflection 0.2

**Test Cases**

The Base Test Case (5) has already been defined. Test Cases 6 – 9 are defined below according to the changes made to Case 5. Test Cases 10 – 12 are defined according to changes made to Case 9.

<table>
<thead>
<tr>
<th>Test</th>
<th>Change from Test 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Internal Floor 3f</td>
</tr>
<tr>
<td>7</td>
<td>Internal Gain schedule set to off</td>
</tr>
<tr>
<td>8</td>
<td>Glazing: DP</td>
</tr>
<tr>
<td>9</td>
<td>Top Adiabatic block removed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Change from Test 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Internal Floor 3f</td>
</tr>
<tr>
<td>11</td>
<td>Internal Gain schedule set to off</td>
</tr>
<tr>
<td>12</td>
<td>Glazing: DP</td>
</tr>
</tbody>
</table>

**Simulation**

A full annual simulation was conducted. The simulation options are shown in the following figure. Note that
the Inside Convection Algorithm chosen was Simple i.e. directly used the input heat transfer coefficients. The Outside Convection Algorithm: SimpleCombined was used as the declared heat transfer coefficients represented the combination of convective and radiative coefficients.

Results

<table>
<thead>
<tr>
<th>Test</th>
<th>$Q_{H,ref}$</th>
<th>$Q_{c,ref}$</th>
<th>$Q_{tot,ref}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>463.1</td>
<td>201.7</td>
<td>664.8</td>
</tr>
<tr>
<td>6</td>
<td>509.8</td>
<td>185.1</td>
<td>694.9</td>
</tr>
<tr>
<td>7</td>
<td>1067.4</td>
<td>19.5</td>
<td>1086.9</td>
</tr>
<tr>
<td>8</td>
<td>313.2</td>
<td>1133.2</td>
<td>1446.4</td>
</tr>
<tr>
<td>9</td>
<td>747.1</td>
<td>158.3</td>
<td>905.4</td>
</tr>
<tr>
<td>10</td>
<td>574.2</td>
<td>192.4</td>
<td>766.6</td>
</tr>
<tr>
<td>11</td>
<td>1395.1</td>
<td>14.1</td>
<td>1409.2</td>
</tr>
<tr>
<td>12</td>
<td>533.5</td>
<td>928.3</td>
<td>1461.8</td>
</tr>
</tbody>
</table>
The following Table shows the reference results as they appear in EN 15265. These are the values against which the DesignBuilder results were compared using the accuracy criteria (A, B, C) which are described in this document. The second table shows the actual Annual Heating and Cooling delivered in each test.

<table>
<thead>
<tr>
<th>Test</th>
<th>$Q_{H,act}$</th>
<th>$Q_{c,act}$</th>
<th>$Q_{tot,act}$</th>
<th>$r_{QH}$</th>
<th>$r_{QC}$</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>516.1</td>
<td>182.5</td>
<td>698.6</td>
<td>0.080</td>
<td>0.029</td>
<td>B</td>
</tr>
<tr>
<td>6</td>
<td>533.1</td>
<td>173.6</td>
<td>706.7</td>
<td>0.034</td>
<td>0.017</td>
<td>A</td>
</tr>
<tr>
<td>7</td>
<td>1117.5</td>
<td>14.5</td>
<td>1131.9</td>
<td>0.046</td>
<td>0.005</td>
<td>A</td>
</tr>
<tr>
<td>8</td>
<td>385.4</td>
<td>922.1</td>
<td>1307.5</td>
<td>0.050</td>
<td>0.146</td>
<td>C</td>
</tr>
<tr>
<td>9</td>
<td>885.1</td>
<td>159.7</td>
<td>1044.8</td>
<td>0.152</td>
<td>0.002</td>
<td>fail</td>
</tr>
<tr>
<td>10</td>
<td>881.4</td>
<td>166.0</td>
<td>1047.5</td>
<td>0.401</td>
<td>0.034</td>
<td>fail</td>
</tr>
<tr>
<td>11</td>
<td>1513.2</td>
<td>14.7</td>
<td>1527.9</td>
<td>0.084</td>
<td>0.000</td>
<td>B</td>
</tr>
<tr>
<td>12</td>
<td>680.8</td>
<td>815.4</td>
<td>1496.1</td>
<td>0.101</td>
<td>0.077</td>
<td>C</td>
</tr>
</tbody>
</table>

**Discussion**

All tests bar Test 9 and 10 are within the acceptable range of results. All cooling results are within tolerance. The heating delivered in Test Case 9 is only very marginally out of range. The heating delivered in Test Case 10 is quite considerably out of range. However, the reference results for Tests 9 and 10 should be very similar as there is very little difference in their specification. Tests 9 and 10 differ in their specification by the definition of the internal floor (In these cases, the ceiling/roof is the same), however the first 4 layers of each are the same and include both high mass and insulation so it is very surprising that the results are expected to be so different. Note that in Tests 5 and 6 the internal floor is also used for the ceiling and in this the exposed thermal mass of the Test 6 ceiling is shown to have a (marginal) effect.

**References**

2. EN 15265-2007 Thermal performance of buildings — Calculation of energy use for space heating and cooling – General criteria and validation procedures, European Committee for Standardisation, 2007
3. EN 673