Office Building Refurbishment

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Original building
New design

New design
Measures taken

- Shading device
- Improved daylight distribution
  1. Light well
  2. Changed planview – open planview
  3. Higher reflection
  4. Changed windows towards West
- Added insulation & changed windows/doors
- Heat exchanger with higher efficiency
- Green roof
- PV-panels
Shading
Parametric study – Integrated horizontal shading

Irradiation on one window on the third floor

<table>
<thead>
<tr>
<th>Shading Type</th>
<th>Cooling Period</th>
<th>Heating Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>No shading</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td>0.9m</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td>1m tilted</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>1m tilted</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>1.1m tilted</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
Shading
Parametric study

Integrated horizontal shading was tested in Ecotect.

The irradiation was measured on the southern windows during heating and cooling season.
Daylight Light well
Daylight

**Increased reflectance (%)**

- outside Wall
- inside
- outside Roof
- inside Ceiling
- inside Ground
- Partition wall
Daylight

Daylight factor: The ratio of internal light level to external light level

Average Daylight factor for the entire building 72%
Without the basement it is instead: 79%
Breeam: 80%

Existing
New proposal

Daylight

Daylight Factor
Daylight

Usefull Daylight Index > 2000 lux

Basement

Second floor

Ground floor

Third floor

First floor

Rooftop

Details

Wall

U-value: Existing = 0.85 W/m2K
New = 0.16 W/m2K

- Brick cladding, 10 mm
- Metal sheet, 3 mm
- Ventilated slunggy 45 mm + steel columns 40 x 95 mm
- Rock wool 70 mm (λ = 0.030 W/m-K)
- Gypsumboard, exterior 13 mm
- Mineral wool 120 mm (λ = 0.038 W/m-K)
- Concrete 175 mm
- Gypsumboard, interior 13 mm
Details

Roof/wall

New: 0.11 W/m²K
Existing: 0.39 W/m²K

- Brick cladding 10 mm
- Metal sheet 3 mm
- Bitumen 1,0 mm
- Stone wool 70 mm (λ = 0.033 W/mK)
- Gypsumboard, exterior 13 mm
- Brick wood 120 mm (λ = 0.25 W/mK)
- Concrete 270 mm
- Gypsumboard, interior 13 mm

Basement, wall & foundation

New: 0.11 W/m²K
Existing: 1.30 W/m²K

- Soil
- Drainage
- Extruded polystyrene, 300 mm
- Waterproofing membrane
- Concrete, 345 mm
- Rendering

New: 0.31 W/m²K
Existing: 1.54 W/m²K

- Flooring
- Polystyrene, 100mm
- Concrete, 200 mm
- Drainage
### Energy consumption

#### Steady state

<table>
<thead>
<tr>
<th>Input</th>
<th>Existing building</th>
<th>Refurbishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation heat exchange</td>
<td>75%</td>
<td>88%</td>
</tr>
<tr>
<td>Thermal bridges</td>
<td>1.4 x transmission losses</td>
<td>1.1 x transmission losses</td>
</tr>
<tr>
<td>Air leakage</td>
<td>0.2 1/h</td>
<td>0.1 1/h</td>
</tr>
</tbody>
</table>

#### FEBY12 criteria (Swedish passive house criteria)

- Annual energy consumption
- Peak load

#### Parametric study in Design Builder

- **No1**: 20°C heating + 26°C cooling.
- **No2**: 21°C heating + 26°C cooling.
- **No3**: 21°C heating + 25°C cooling + shading device.
- **No4**: 21°C heating + 25°C cooling + shading device + photovoltaic panels, 377m².
Energy consumption
Design Builder

- **FEBY12** = 63 kWh/m² year for district heating/cooling and building electricity.
- **Refurbished Office (No3)** = 50 kWh/m² year for district heating/cooling and building electricity. 60 kWh/m² year in total energy consumption.
- **Base Case** = 141 kWh/m² year for district heating/cooling and building electricity.

Thermal comfort
Design Builder

The Operative temperature is more than 26°C for 4 working days over the whole year. The criteria from FEBY12 is maximum 10 working days, which is clearly met!

To prevent overheating at any time of the year, an openable window as high as possible will be integrated in the refurbished office building.
THE END  Thank you for listening